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South Thomson Barge Landing Development, Wadjemup / Rottnest Island

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Contents

EXECUTIVE SUMMARY **1**
Introduction 1
Purpose and scope of this document 1
Overview of the South Thomson Barge Landing development 2
Summary of environmental factors and proposed mitigation and management outcomes 6

1 INTRODUCTION **18**
1.1 Purpose and scope of this document 18
1.2 Proponent information 19

2 PROPOSAL **20**
2.1 Justification 20
2.1.1 Key benefits 20
2.1.2 Rottnest Island Management Plan 2023–2028 20
2.1.3 Rottnest Island Land Use Plan 23
2.2 Proposal description 23
2.2.1 Proposal content 30
2.3 Proposal alternatives 34
2.3.1 Not implementing the proposal 34
2.3.2 Alternative locations 35
2.3.3 Options analysis 35
2.4 Local and regional context 36
2.4.1 Site history 36
2.4.2 Historical photography 37

3 LEGISLATIVE CONTEXT **40**
3.1 South Thomson Bay Barge environmental assessment process 40
3.2 Environmental impact assessment process – state legislation 40
3.2.1 Environmental Protection Act 1986 40
3.3 Other state approvals and regulations 41
3.4 Environmental impact assessment process – federal legislation 42
3.4.1 Environment Protection and Biodiversity Conservation Act 1999 42
3.4.2 EPBC Act assessment context 43

4 STAKEHOLDER ENGAGEMENT **44**
4.1 Key stakeholders 44
4.2 Stakeholder engagement process 44
4.3 Stakeholder consultation outcomes 44

5 OBJECT AND PRINCIPLES OF THE EP ACT **47**

6 ENVIRONMENTAL FACTORS AND OBJECTIVES **49**

7 BENTHIC COMMUNITIES AND HABITATS **52**
7.1 EPA objective 52
7.2 Policy and guidance 52
7.3 Environmental investigations 52
7.4 Receiving environment 53
7.4.1 Benthic habitats 53
7.4.2 Local Assessment Unit 55
7.5 Potential environmental impacts 56
7.5.1 Assessment of impacts 58
7.6 Mitigation 61
7.7 Assessment and significance of residual impact 62
7.8 Environmental outcomes 63

8 COASTAL PROCESSES 65
8.1 EPA objective 65
8.2 Policy and guidance 65
8.3 Environmental investigations 65
8.3.1 Coastal processes assessment 65
8.4 Receiving environment 66
8.4.1 Regional setting 66
8.4.2 Wave climate 66
8.4.3 Water levels and tides 66
8.4.4 Wind conditions 66
8.4.5 Bathymetry and reefs 67
8.4.6 Sediment cells 69
8.4.7 Shoreline characteristics and coastal structures 70
8.4.8 Wrack accumulation 71
8.5 Potential environmental impacts 71
8.5.1 Assessment of impacts 72
8.6 Mitigation 77
8.7 Assessment and significance of residual impact 79
8.8 Environmental outcomes 79

9 MARINE ENVIRONMENTAL QUALITY 81
9.1 EPA objective 81
9.2 Policy and guidance 81
9.3 Environmental investigations 82
9.3.1 Water quality monitoring 82
9.3.2 Sediment sampling 83
9.4 Receiving environment 84
9.4.1 Historical land uses 84
9.4.2 Sediment quality 85
9.4.3 Water quality 86
9.5 Potential environmental impacts 87
9.5.1 Assessment of impacts 88
9.6 Mitigation 95
9.7 Assessment and significance of residual impact 97
9.8 Environmental outcomes 98

10 MARINE FAUNA 100
10.1 EPA objective 100
10.2 Policy and guidance 100
10.3 Environmental investigations 100
10.3.1 Marine fauna 100
10.3.2 Marine fauna habitat 101
10.3.3 Underwater noise assessment 101
10.4 Receiving environment 102
10.4.1 Benthic communities and habitats 102
10.4.2 Biologically important areas 102
10.4.3 Conservation significant marine fauna species 102
10.5 Potential environmental impacts 115
10.5.1 Assessment of impacts 116
10.6 Mitigation 127
10.7 Assessment and significance of residual impact 131
10.8 Environmental outcomes 132

11 FLORA AND VEGETATION 134
11.1 EPA objective 134

11.2 Policy and guidance 134
11.3 Environmental investigations 134
11.4 Receiving environment....136
11.4.1 Regional vegetation 136
11.4.2 Vegetation units 137
11.4.3 Vegetation condition 138
11.4.4 Flora species....139
11.4.5 Ecological communities 140
11.5 Potential environmental impacts 140
11.5.1 Assessment of impacts....141
11.6 Mitigation....144
11.7 Assessment and significance of residual impact 146
11.8 Environmental outcomes....147

12 TERRESTRIAL FAUNA....148
12.1 EPA objective....148
12.2 Policy and guidance 148
12.3 Environmental investigations 148
12.4 Receiving environment....149
12.4.1 Fauna habitat....149
12.4.2 Fauna species....150
12.5 Potential environmental impacts 152
12.5.1 Assessment of impacts....152
12.6 Mitigation....153
12.7 Assessment and significance of residual impact 155
12.8 Environmental outcomes....156

13 SOCIAL SURROUNDINGS 157
13.1 EPA objective....157
13.2 Policy and guidance 157
13.3 Environmental investigations 158
13.3.1 Ethnographic Aboriginal Heritage Survey....158
13.3.2 UXO survey....158
13.3.3 Stakeholder engagement....159
13.3.4 Airborne noise assessment 160
13.4 Receiving environment....160
13.4.1 Tourism, recreation and fishing 160
13.4.2 Aboriginal heritage....161
13.4.3 Natural and historic heritage....162
13.4.4 Shipwrecks....163
13.4.5 Unexploded ordnance....163
13.5 Potential environmental impacts 166
13.5.1 Assessment of impacts....166
13.6 Mitigation....169
13.7 Assessment and significance of residual impact 172
13.8 Environmental outcomes....173

14 OTHER ENVIRONMENTAL FACTORS OR MATTERS....174
14.1 EPA environmental factors....174
14.2 Matters of national environmental significance 176
14.2.1 Listed threatened species....176
14.2.2 Migratory species....182
14.3 Other Commonwealth obligations under the EPBC Act 185
14.3.1 Critical habitat 185
14.3.2 Recovery and threat abatement plans....185

14.3.3 Wildlife Conservation Plans 185
14.3.4 Offshore dredge disposal 186

15 OFFSETS 187

16 HOLISTIC IMPACT ASSESSMENT 188
16.1 Residual impacts from the proposal as a whole 189

17 CUMULATIVE ENVIRONMENTAL IMPACT ASSESSMENT 191

18 CONCLUSION 194
18.1 Section 38 referral 194
18.2 EPBC referral 194

19 REFERENCES 195

Tables

Table 1: Environmental assessment process summary 2
Table 2: Predicted zones of impact (Baird, 2024b) 3
Table 3: Summary of the proposal 3
Table 4: Description and identification of proposal elements 4
Table 5: Summary of the potential impacts, proposed mitigation and outcomes – benthic communities and habitats 7
Table 6: Summary of the potential impacts, proposed mitigation and outcomes – coastal processes 8
Table 7: Summary of the potential impacts, proposed mitigation and outcomes – marine environmental quality 9
Table 8: Summary of the potential impacts, proposed mitigation and outcomes – marine fauna 11
Table 9: Summary of the potential impacts, proposed mitigation and outcomes – flora and vegetation 13
Table 10: Summary of the potential impacts, proposed mitigation and outcomes – terrestrial fauna 15
Table 11: Summary of the potential impacts, proposed mitigation and outcomes – social surroundings 16
Table 12: Key benefits from implementation of the proposal 20
Table 13: Rottnest Island Management Plan 2023–2028 Strategic Focus Areas 21
Table 14: Description of construction stages 26
Table 15: Predicted zones of impact (Baird, 2024b) 30
Table 16: Summary of the proposal 31
Table 17: Description and identification of proposal elements 32
Table 18: Options assessment 35
Table 19: Historic photography summary 38
Table 20: Environmental assessment process summary 40
Table 21: Applicable EPA guidance and technical reports 41
Table 22: Other approval requirements 41
Table 23: Matters of national environmental significance 42
Table 24: Stakeholder engagement process 44
Table 25: Summary of consultation with state government agencies and regulators, local government and the local community 45
Table 26: Object and principles of the EP Act 47
Table 27: EPA key environmental factors and their relevance to the proposal 50
Table 28: Relevant policy and guidance; benthic communities and habitats 52
Table 29: Benthic communities and habitats present within the survey area and development envelope 54
Table 30: Potential impacts on benthic communities and habitats 57

Table 31: Predicted zones of impact (Baird, 2024b) 58
Table 32: Predicted direct and indirect impacts to benthic communities and habitats 59
Table 33: Application of mitigation hierarchy to benthic communities and habitats 61
Table 34: Consideration of the significance of the residual impacts on benthic communities and habitats 62
Table 35: Relevant policy and guidance; coastal processes 65
Table 36: Potential impacts on coastal processes 72
Table 37: Wave scenarios showing the change in the wave impacts with and without the proposed wharf 75
Table 38: Application of mitigation hierarchy to coastal processes 78
Table 39: Consideration of the significance of the residual impacts on coastal processes 79
Table 40: Relevant policy and guidance; marine environmental quality 81
Table 41: Water quality within South Thomson Bay; metals 86
Table 42: Water quality within South Thomson Bay; other parameters 87
Table 43: Potential impacts on marine environmental quality 88
Table 44: Application of mitigation hierarchy to marine environmental quality 95
Table 45: Consideration of the significance of the residual impacts on marine environmental quality 97
Table 46: Relevant legislation, policy and guidance 100
Table 47: Conservation significant marine fauna species (RPS, 2024a) 103
Table 48: Potential impacts on marine fauna 115
Table 49: Key marine fauna receptors and associated ecological windows 116
Table 50: Summary of pressures on selected protected species in the South-west Marine Region (DSEWPC, 2013) 117
Table 51: Thresholds for non-impulsive and impulsive noise – marine mammals 121
Table 52: Thresholds for non-impulsive and impulsive noise – fish and sea turtles 122
Table 53: Injury and Behavioural Onset Criteria Threshold Distances (meters) for Vibratory Hammer Pile Installation (proposed method) and Impact Pile-Driving (contingency method) 124
Table 54: Application of mitigation hierarchy to marine fauna 128
Table 55: Consideration of the significance of the residual impacts on marine fauna 131
Table 56: Relevant legislation, policy and guidance 134
Table 57: Extent of vegetation complexes within the terrestrial survey area 136
Table 58: Vegetation units 137
Table 59: Areas of vegetation units within the development envelope 138
Table 60 Endemic taxa in the survey area 139
Table 61: Introduced taxa in the survey area 140
Table 62: Potential impacts on terrestrial flora and vegetation 140
Table 63: Assessment against the clearing principles for native vegetation under Schedule 5 of the EP Act 142
Table 64: Application of mitigation hierarchy to terrestrial flora and vegetation 144
Table 65: Consideration of the significance of the residual impacts on terrestrial flora and vegetation 146
Table 66: Relevant legislation, policy and guidance 148
Table 67: Fauna habitat 150
Table 68: Conservation significant fauna species with the potential to occur within the development envelope 151
Table 69: Potential impacts on terrestrial fauna 152
Table 70: Application of mitigation hierarchy to terrestrial fauna 154
Table 71: Consideration of the significance of the residual impacts on terrestrial fauna 155
Table 72: Relevant legislation, policy and guidance 157
Table 73: Potential impacts on social surroundings 166
Table 74: Application of mitigation hierarchy to social surroundings 170
Table 75: Consideration of the significance of the residual impacts on social surroundings 172
Table 76: Overview of other environmental factors 174
Table 77: Significant impact criteria – Listed threatened species (terrestrial fauna) 177

Table 78: Listed threatened marine fauna species (RPS, 2024a) 179
Table 79: Significant impact criteria – Listed threatened species (marine fauna) 180
Table 80: Migratory species 182
Table 81: Significant impact criteria - Migratory species 183
Table 82: Compliance with recovery and threat abatement plans 185
Table 83: Wildlife Conservation Plans 186
Table 84: Connections and interactions between key environmental factors relevant to the proposal 189
Table 85: Assessment of cumulative impacts 191

Plates

Plate 1: *Zephyr* ported at the 'excursionist jetty', 1924 (RIA 2012.239) 36
Plate 2: 'Excursionist jetty', 1930 (RIA 2012.96) 36
Plate 3: Original timber jetty with gantry on the right, facing west (RIA 2012.265) 37
Plate 4: Original timber jetty facing west to shore (National Archives Australia (NAA)) 37
Plate 5: Reconstruction works, 1971 (NAA) 37
Plate 6: Reconstruction works, rockfill and barge hardstand (NAA) 37
Plate 7: Edge of Posidonia spp. seagrass meadow (first) and Posidonia spp. meadow (second) 54
Plate 8: Sea anemones on bare sandy sediment (first) and *Posidonia* and *Amphibolis* spp. epiphytic brown algae (second) 54
Plate 9: Public boat ramp at the Army Groyne 71
Plate 10: Army Groyne structure with a view of Thomson Bay to the west and view of the groyne from the eastern seaward side 71
Plate 11: Existing wrack accumulation on the eastern side of the Army Groyne looking seaward (top, mid) and looking landward (bottom) (Baird, 2024a) 74
Plate 12: Historical mooring area or enclosed swimming area to the east of the proposal 164

Figures

Figure 1: Regional overview 1
Figure 2: Development envelope 2
Figure 3: Development envelope and predicted zones of impact 3
Figure 4: Regional overview 18
Figure 5: Rottnest Island Land Use Plan (RIA, 2024) 23
Figure 6: Barge Landing design concept 25
Figure 7: Proposal development plan (Stage 1) 28
Figure 8: Proposal development plan (Stage 2) 29
Figure 9: Development envelope 30
Figure 10: Development envelope and predicted zones of impact 31
Figure 11: Indicative process for reclamation showing the Army Groyne (A), bund wall (B), placement of dredge spoil in the south-west corner of the area (C) and direction dredge spoil will be placed and spread (D) (PAEMAC, 2024) 33
Figure 12: Conceptual cross-section of the reclamation fill, bunding and adjacent dredge zone 33
Figure 13: Rock armour classes proposed for construction of the wharf (AECOM, 2020) 34
Figure 14: Benthic habitat survey area and plume extension survey area 53
Figure 15: Benthic habitats within the development envelope and modelled dredge plume 55
Figure 16: Benthic habitat map of Wadjemup / Rottnest Island (Harvey, 2009) 56
Figure 17: Predicted indirect (within the ZoMI and ZoI) and direct impacts (within the development envelope and ZoHI) to benthic communities and habitats 59
Figure 18: Bathymetry 68
Figure 19: Bathymetry proximate to the development envelope 69

Figure 20: Secondary and Tertiary sediment cells around Wadjemup / Rottnest Island (Stul et al. 2015) 70
Figure 21: Potential impact of proposed facility on sediment dynamics in South Thomson Bay 73
Figure 22: Potential wrack dynamic associated with the proposal 73
Figure 23: Baseline marine water quality monitoring locations 83
Figure 24: Baseline marine sediment sampling locations 84
Figure 25: Zones of influence from dredging activities 89
Figure 26: Spatial plots of the dredge plume model (Baird, 2024b) 90
Figure 27: Locations where timeseries SSC data is presented (Baird, 2024b) 91
Figure 28: Location of underground fuel storage 94
Figure 29: Underwater noise modelling – piling locations 101
Figure 30: Pygmy blue whale distribution (DoE, 2015) 107
Figure 31: Southern right whale Biologically Important Areas and habitat critical to the survival (reproduction BIA) in Western Australia (DCCEEW, 2024) 108
Figure 32: Green turtle habitat in Australia (DoEE, 2017) 112
Figure 33: Loggerhead turtle habitat in Australia (DoEE, 2017) 113
Figure 34: Leatherback turtle habitat in Australia (DoEE, 2017) 114
Figure 35: Underwater Received Sound Levels (SPL): Unmitigated impact pile driving 24-inch pile installation (contingency piling method) 125
Figure 36: Underwater Received Sound Levels (SPL): Unmitigated vibratory 24-inch pile installation (proposed piling method) 125
Figure 37: Terrestrial flora and vegetation survey area 135
Figure 38: Terrestrial flora and vegetation surveys undertaken within vicinity of the proposal (Focused Vision Consulting survey area) 135
Figure 39: Vegetation complexes 136
Figure 40: Vegetation units 138
Figure 41: Vegetation condition 139
Figure 42: Terrestrial fauna survey area and survey effort 149
Figure 43: Ethnographic Aboriginal heritage survey area 158
Figure 44: UXO survey area (red boundary) 159
Figure 45: Rottnest Island marine and boating guide reserve map (Rottnest Island Authority 2023) 160
Figure 46: Restricted speed area within Thomson Bay (Rottnest Island Authority, 2013) 161
Figure 47: Historic heritage 162
Figure 48: Social surroundings 163
Figure 49: UXO risk mapping 164
Figure 50: Magnetic field survey for UXO 165
Figure 51: Location of impacted moorings 167
Figure 52: Relationship between key environmental factors 188
Figure 53: Projects and approvals within 5 km of the proposal 193

Graphs

Graph 1: Total ferry-based visitation to Wadjemup / Rottnest Island, visitors by financial year, and lower and upper scenario (ACIL Allen, 2024) 22
Graph 2: Rose of wind direction versus wind speed in km/h (29 Nov 1987 to 10 Aug 2023); 9.00 am conditions (Commonwealth of Australia, 2023) 67
Graph 3: Rose of wind direction versus wind speed in km/h (29 Nov 1987 to 10 Aug 2023); 3.00 pm conditions (Commonwealth of Australia, 2023) 67
Graph 4: Average post-July 2017 TSM values with (orange line) and without (blue line) a data correction for the blank at Wadjemup / Rottnest Island between September 2017 and July 2018 (Baird, 2024b) 90

Graph 5: Calculation of total SSC and daily mean values of modelled SSC analysed against nominal seagrass impact thresholds at the Army Groyne location (Baird, 2024b) 92
Graph 6: Calculation of total SSC and daily mean values of modelled SSC analysed against nominal seagrass impact thresholds at the South Thomson Bay 1 location. Analysis shown for the background SSC of 3 mg/L (Baird, 2024b) 92
Graph 7: Calculation of total SSC and daily mean values of modelled SSC analysed against nominal seagrass impact thresholds at the South Thomson Bay 2 location. Analysis shown for the background SSC of 3 mg/L (Baird, 2024b) 93
Graph 8: Calculation of total SSC and daily mean values of modelled SSC analysed against nominal seagrass impact thresholds at the Aquadopp location. Analysis shown for the background SSC of 3 mg/L (Baird, 2024b) 93

Appendices

Appendix A: Construction methodology
Appendix B: Marine fauna and benthic habitat assessment, South Thomson Barge Landing Development (RPS 2024)
Appendix C: Benthic habitat assessment: Plume extension survey area, South Thomson Barge Landing Development (RPS 2024b)
Appendix D: South Thomson Bay Barge Development, Coastal Processes Assessment (Baird 2024)
Appendix E: PER349327 – RIA peer review of dredge plume modelling and coastal processes reports (RPS 2024c)
Appendix F: South Thomson Bay Barge Development, Dredge Plume Modelling Assessment (Baird 2024b)
Appendix G: Baseline water quality laboratory results
Appendix H: SAP implementation report, Rottnest Island Army Jetty dredging (RPS 2020)
Appendix I: Flora and vegetation survey; South Thompson and Kingstown, Rottnest Island (Wadjemup) (FVC 2023)
Appendix J: South Thomson Barge redevelopment flora and vegetation survey (RPS 2024d)
Appendix K: Rottnest Island Basic Fauna Survey (Eco Logical 2024)
Appendix L: Greenhouse Gas Emission Assessment, South Thomson Barge Development Landing (Kewan Bond 2024)
Appendix M: Aboriginal cultural heritage documents
Appendix N: Assessment of benthic habitats, South Thomson Bay barge and cargo facility
Appendix O: Dredging Environmental Monitoring and Management Plan (02 Environment 2024)
Appendix P: Construction Environmental Management Plan (CEMP) Rottnest Island Authority – South Thomson Barge Landing Development (Emerge Associates 2024)
Appendix Q: Operational Environmental Management Plan (OEMP) Emerge Associates 2024
Appendix R: Database searches
Appendix S: Underwater Acoustic Assessment, South Thomson Barge Landing Development (Tetra Tech 2024)
Appendix T: Marine Magnetic survey at proposed barge landing site, South Thomson (Surrich 2019)
Appendix U: Rottnest Barge Facility, Rottnest Island, Acoustic Assessment (Herring Storer Acoustics 2024)

We acknowledge the Whadjuk Noongar People and recognise their continuing connection to land, waters, and community. We pay our respect to them and their cultures and to Elders past and present

ACKNOWLEDGEMENT OF COUNTRY

EXECUTIVE SUMMARY

Introduction

Ferry berthing and barge operations currently occur at the Main Jetty on Wadjemup / Rottnest Island. Rottnest Island Authority (RIA) is proposing to relocate the existing barge operations from the Main Jetty at central Thomson Bay to the Army Groyne in South Thomson Bay. This will separate barge operations from public passenger transfer activities and ease congestion at the ferry terminal at the Main Jetty.

Figure 1 provides a regional overview of the location of the proposed South Thomson Barge Landing development and the existing barge operations at the ferry terminal at central Thomson Bay.

Figure 1: Regional overview

Purpose and scope of this document

The purpose of this Environmental Supporting Document is to describe and assess the significance of the environmental impacts to the environmental values associated with the implementation of the proposal. This report provides information on the proposal, local and regional setting, key stakeholders, potential environmental impacts, cumulative impacts and proposed mitigation measures associated with the construction and operation of the proposal.

This document has been prepared to provide a detailed description of the proposal to inform an environmental impact assessment and support both the state and federal environmental approvals as outlined in Table 1.

Table 1: Environmental assessment process summary

Jurisdiction	Environmental approval	Relevant legislation	Key sections of this report
State	Referral of the proposal to the Environmental Protection Authority (EPA) under Section 38 of the *Environmental Protection Act 1986* (EP Act) to describe and assess the potential impacts to the EPA's environmental factors.	Refer to Section 3.2 of this document.	The environmental impact assessment process under state legislation is outlined in Sections 7 to 13 of this document.
Federal	Referral of the proposal to the Department of Climate Change, Energy, the Environment and Water (DCCEEW) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) to address potential impacts to matters of national environmental significance (MNES).	Refer to Section 3.4.2 of this document.	The assessment of potential impacts to MNES is outlined in Section 14.2 of this document.

Overview of the South Thomson Barge Landing development

The proposal comprises an onshore component and offshore component (an area of reclamation and an extension of the existing Army Groyne to form the proposed wharf) as summarised below:

- **Indicative disturbance footprint (Figure 2):** The indicative disturbance footprint encompasses the onshore and offshore physical infrastructure associated with proposal and dredge areas:
  - The onshore component comprises approximately 1 hectare (ha).
  - The offshore component comprises a wharf area (extension of the existing Army Groyne) (1.13 ha) and a dredge area (1.02 ha), resulting in a combined indicative disturbance footprint of up to 3.15 ha.
- **Development envelope (Figure 2)**: Comprises 4.6 ha and encompasses the indicative disturbance footprint and a buffer area (the majority of which comprises the dredge Zone of High Impact).

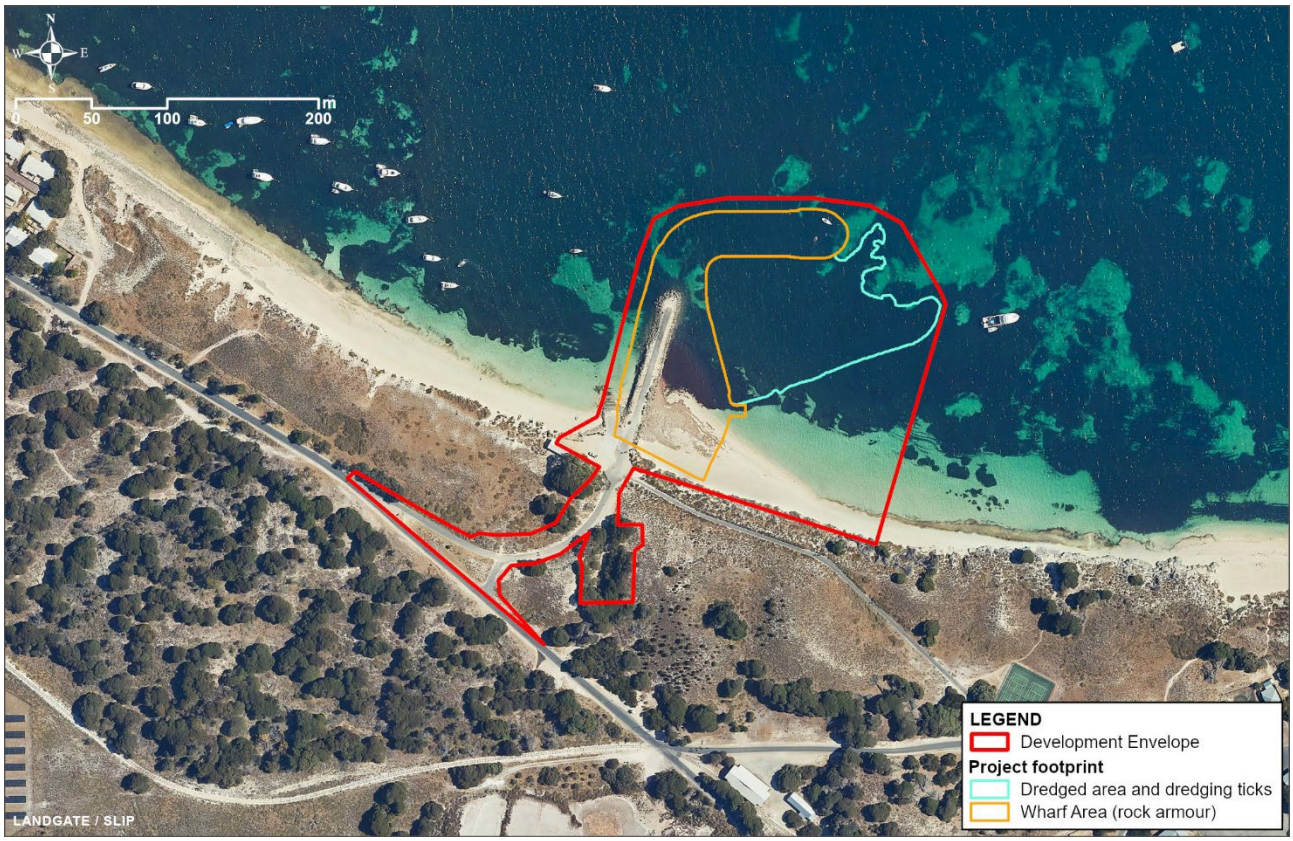


Figure 2: Development envelope

In addition to the development envelope, the environmental impact assessment presented in this report has included the predicted zone of impact from the proposed dredging activities. A Dredge Plume Modelling Assessment was undertaken by Baird (2024b) and modelled the zones of impact, these are summarised in Table 2 and shown in Figure 3.

Table 2: Predicted zones of impact (Baird, 2024b)

Zone of impact	Definition
Zone of High Impact (ZoHI)	The area where impacts on benthic communities or habitats are predicted to be irreversible. The term irreversible means 'lacking a capacity to return or recover to a state resembling that prior to being impacted within a timeframe of five years or less'.
Zone of Moderate Impact (ZoMI)	The area within which predicted impacts on benthic communities or habitats are recoverable within a period of five years following completion of the dredging activities. This zone abuts, and lies immediately outside of, the ZoHI.
Zone of Influence (ZoI)	The area within which changes in environmental quality associated with dredge plumes are predicted and anticipated during the dredging operations, but where these changes would not result in a detectible impact on benthic biota. At any point in time, the dredge plumes are likely to be restricted to a relatively small portion of the ZoI.

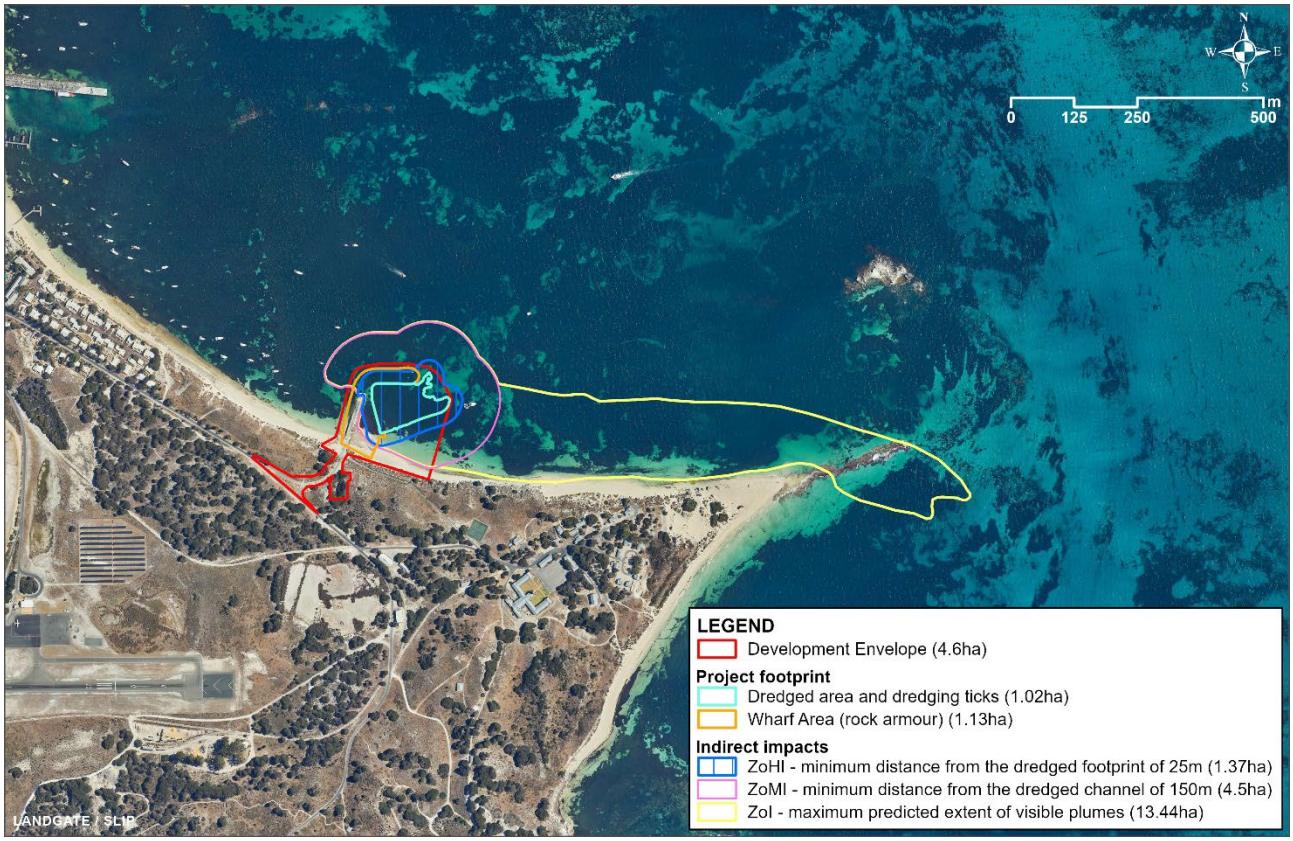


Figure 3: Development envelope and predicted zones of impact

A summary of the proposal is provided in Table 3 and a description and identification of the elements for the proposal is provided in Table 4..

Table 3: Summary of the proposal

Proposal title	South Thomson Development Barge Landing Development
Proponent name	Rottnest Island Authority
Short description	Rottnest Island Authority is proposing to relocate the island's existing barging operations away from the Main Jetty to the existing Army Groyne in South Thomson Bay. This will help reduce congestion and improve the arrival experience to the island. To support the relocation of the barge operations, Rottnest Island Authority is proposing to extend and redevelop the existing Army Groyne.

Table 4: Description and identification of proposal elements

Proposal element	Location / description	Maximum extent, capacity or range
Physical elements		
Development envelope	Figure 10 Encompasses the indicative disturbance footprint and a buffer area, the majority of which comprises the dredge Zone of High Impact (ZoHI)).	4.6 ha
Indicative disturbance footprint	Figure 10 The indicative disturbance footprint encompasses the onshore and offshore physical infrastructure associated with proposal and dredge areas.	Total area: 3.15 ha Terrestrial disturbance footprint: 1 ha Wharf and laydown area (marine footprint): 1.13 ha Dredge area (marine footprint): 1.02 ha
Construction elements		
Dredging	Construction methodologies are provided as Appendix A. Dredging and piling are likely to be undertaken in the winter months of 2026. Dredge plume modelling by Baird (2024b) estimates that dredging may take up to 7.5 weeks to complete. The dredging methodology is summarised below: • Dredging will be undertaken with the use of a Backhoe Dredge (BHD). • The BHD is positioned with a support tug and then using its spud piles and excavator arm it manoeuvres into the required dredging location. • The loosening or cutting process breaks the in-situ materials' cohesion, allowing these materials to be removed. The process will be carried out mechanically using the cutting edge of a bucket on a BHD. Once loosened or dislodged, these materials will be raised to the water's surface mechanically via raising the bucket or grab of a BHD. • Excavated material is placed onto a flat-top barge moored alongside the BHD. When the barge is filled to its safe working capacity, it will drive to the RORO facility to be unloaded. • A silt curtain around BHD will be installed to mitigate the potential environmental impact from the dredge plume. • The dredged material will be reused as fill material in the laydown/hardstand and reclamation area.	The proposed dredge area is shown in Figure 10 and comprises 1.02 ha. Dredging will be undertaken to a declared depth of – 3.0 m Chart Datum, which will include a turning basin with a nominal diameter of 80 m. An estimated 14,000 m^3 of sand and 2,017 m^3 of rock will be dredged.
Reclamation	Construction methodologies are provided as Appendix A. The reclamation methodology depicted in Figure 11 is summarised below: • Existing armour from the eastern side of the Army Groyne will be removed and used for construction of bunding. Bunding will be constructed along the eastern and northern sides of the reclamation zone to allow dredge spoil to settle and remain in place. This bunding will prevent dredge spoil from being washed away into the marine environment. Figure 11 provides an indication of the bund wall location. • The bunding will be constructed using core materials, followed by a geotextile filter layer and an armour layer. Figure 12 provides a conceptual cross-section of the bunding, reclamation fill and then adjacent dredge zone. • As reclamation progresses, the bunding on the marine side of the reclamation zone will need to be progressively moved to the north to ensure that each successive round of dredge spoil placed will remain in place. • Using the dredged spoil, the contractor will establish a tip head to place the dredged material into the water in the south-west corner of the reclamation area. Dredge spoil will be placed and spread in a north and east direction. • Material will be tipped from the Articulated Dump Truck and pushed out over the tip head using a wheel loader or similar. • Material will be compacted using a static pad foot roller. • Reclamation will continue until all dredge spoil has been placed. AECOM (2020) and PAEMAC (2024) estimated that the dredge spoil will be sufficient to complete the laydown area. There is not expected to be a requirement to import fill to complete the laydown area.	The proposed reclamation area is shown in Figure 10
Construction of the wharf	Construction methodologies are provided as Appendix A. On completion of the reclamation works summarised above, the wharf will be constructed through extending the existing Army Groyne with rock armour as outlined below: • Remove excess rock and materials and reshape the existing Army Groyne. • Import all rock and core materials from the mainland using a conventional barge converted for handling rock. • Place core materials along exposed batter. • Place filter layer (geotextile). • Place class 2 rock armour along exposed batter and class 1 rock armour along the northern breakwater. The proposed rock armour classes are shown in Figure 13. • Place a layer of crushed rock basecourse and asphalt along the Army Groyne extension to match that placed in the reclamation area.	The proposed wharf area is shown in Figure 10
Piling	• The barge landing ramp works will include Installation of mooring piles to a maximum depth of 10 m using a vibro hammer. • Construction of the ferry berth will require installation of piles using a vibro hammer rig operated from a barge located adjacent. The dimensions and number of piles is estimated at 16 × 610 mm that will be installed to a depth of 15 m. If the contractor does not install piles concurrently with construction of the breakwater, then 1200 mm sleeves will need to be installed in the rock armour so piles can be driven through the sleeves. • Construction of the small craft landing facility will include installation of piles using a vibro hammer rig operated from a barge located adjacent. The dimensions and number of piles is estimated at 6 × 500 mm that will be installed to a depth of 10 m. If the contractor does not install piles concurrently with construction of the breakwater, then 1200 mm sleeves will need to be installed in the rock armour so piles can be driven through the sleeves. As discussed in Table 14, all piling proposed will be undertaken using a vibro hammer. However, a contingency of using a hammer pile has been adopted should the vibro hammer meet refusal. Both the proposed piling method (vibro hammer) and contingency method (hammer piling) have been included in the impact assessment.	Piling locations will be determined during detailed engineering design
Other marine infrastructure and services	Hardstand and a shed structure will be constructed within the onshore component of the development envelope. Services will be installed conventionally using a combination of on island and imported small plant. Services consist of water, fire service, power, CCTV and fuel provisions.	All works will occur within the development envelope shown in Figure 10.
Operational elements		
Vessel movements	The proposed facility shall allow barge berthing, unloading and loading and departure for all conditions permitting safe transit across to Wadjemup / Rottnest Island. Typically barge and ferry operations are suspended when wind speed (ten-minute average) exceeds 40 kn and/or Hs >4 m for waters inshore of Wadjemup / Rottnest Island. The existing barge schedule, as per Pelagic Marine Services operations, is provided below. There may be exemptions to these times to accommodate for special deliveries.	N/A

Current barge activity	Time
Gates open (20 Rous Head Road, North Fremantle)	5:30 am
Same day perishable deliveries	6:15 am
Scheduled vessel departure	6:45 am
Scheduled arrival – Thomson Bay	8:30 am
Last time for arrival of vehicles and returning goods at the Thomson Bay wharf	10:30 am
Departure (Thomson Bay, depending on volumes, returning freight)	12:00 am to 1.00 pm
Gates close (16 Mews Road, Fremantle)	4:00 pm

Proposal element	Location / description	Maximum extent, capacity or range
Ongoing maintenance	There may be requirements for maintenance dredging during operations. Maintenance dredging (if required) will be undertaken in previously disturbed / sandy areas within the development envelope / project footprint. Maintenance dredging frequency, volumes and disposal will be determined as required.	This will be undertaken as required. Environmental management will be undertaken in a manner that is consistent with the document Maintenance Dredging Environmental Management Framework (BMT Oceanica, 2016) prepared for Department of Transport for similar types of maintenance dredging activities.
Other elements that affect extent of effects on the environment		
Proposal time	Maximum project life	Design life shall be 50 years in accordance with AS4997–2005 Normal commercial structure.
	Construction phase	Construction is proposed to be undertaken between 2026 and 2027.
	Operations phase	50 years.

Summary of environmental factors and proposed mitigation and management outcomes

This supporting document has been prepared to address the following EPA key environmental factors that are relevant to the proposal:

- Benthic communities and habitats (Table 5)
- Coastal processes (Table 6)
- Marine environmental quality (Table 7)
- Marine fauna (Table 8)
- Flora and vegetation (Table 9)
- Terrestrial fauna (Table 10)
- Social surroundings (Table 11).

Assessment of potential impacts to the environmental factors was undertaken based on the environmental investigations listed in Tables 5 to 11.

Appropriate management and mitigation measures have been developed to address potential impacts and ensure that the EPA's identified environmental objectives for each relevant environmental factor can be achieved. A range of measures will be implemented to provide certainty that the identified environmental objectives will be achieved. These measures and outcomes are summarised in Tables 5 to 11.

The assessment has concluded that the proposal is expected to be able to meet EPA's objectives for all environmental factors, subject to the implementation of the management and mitigations measures outlined in the following management plans:

- Dredging Environmental Monitoring and Management Plan (02 Environment, 2024) (Appendix O)
- Construction Environmental Management Plan (Emerge, 2024a) (Appendix P)
- Operational Environmental Management Plan (Emerge, 2024b) (Appendix Q).

Table 5: Summary of the potential impacts, proposed mitigation and outcomes – benthic communities and habitats

Benthic communities and habitats		
EPA environmental objective	To protect benthic communities and habitats so that biological diversity and ecological integrity are maintained.	
Relevant policy and guidance	• Environmental Factor Guideline: Benthic Communities and Habitats (EPA, 2016f) • Technical Guidance: Protection of Benthic Communities and Habitats (EPA, 2016h) • Technical Guidance: Environmental Impact Assessment of Marine Dredging Proposals (EPA, 2021a) and National Assessment Guidelines for Dredging (Australian Government, 2009)	
Supporting technical investigations and reports	• South Thomson Barge Landing Development; Marine fauna and benthic habitat assessment (RPS, 2024a) (Appendix B) • South Thomson Barge Landing; Benthic habitat assessment: Plume Extension Survey Area (RPS, 2023b) (Appendix C)	
Potential environmental impacts	**Direct impacts**	**Loss of benthic habitats** • Permanent loss of 3.23 ha of benthic communities and habitat, comprising: – 2.06 ha mixed seagrass. The loss of 2.06 ha of mixed seagrass represents 0.52% of seagrass within the Local Assessment Unit (LAU)) – 1.26 ha sand with wrack.
	Indirect impacts	**Reduced environmental quality** • Temporary decrease in light availability resulting from increased turbidity in the water column within the ZoI and ZoMI, leading to reduced primary productivity and potential increased mortality rates of primary producers under conditions of prolonged or acute exposure • Increased sedimentation rates, or burial, resulting in stress or increased mortality rates (under extreme conditions) • Accidental fuel spills resulting in reduced water quality and impacts on benthic communities and habitats **Loss of benthic habitats** • Recoverable loss of 3.71 ha of benthic habitats and communities within the ZoMI (the area within which predicted impacts on benthic organisms are recoverable within a period of five years following completion of the dredging activities): – Temporary loss of 2.62 ha mixed seagrass – Temporary loss of 1.09 ha sand with wrack. **Introduction of invasive marine species (IMS)** • Alteration of the natural benthic communities in the area caused by the introduction of IMS. **Impacts from marine infrastructure** • Altered water flows and sediment transport caused by the presence of new marine infrastructure.
Mitigation	**Avoid**	• Site selection includes an already disturbed area of 0.19 ha of disturbed seabed within the existing Army Groyne footprint. As benthic communities and habitats are widespread within South Thomson Bay, total avoidance of direct impacts is not possible. • RIA amended the project design to reduce the dredging requirements. By changing the berthing and barge turn pocket, the volume of required dredging was reduced from 26,000 m^3 to 16,050 m^3.
	Minimise	**Reduced environmental quality and loss of benthic communities and habitats** • The AECOM and PAEMAC value engineering works helped to not only reduce dredging requirements, but also reduce the footprint to the minimum possible to achieve the objectives of constructing a new barge landing. • Management and mitigation proposed during construction to minimise impacts to benthic communities and habitats is detailed in the Construction Environmental Management Plan (CEMP) (Emerge, 2024a) (Appendix P) and Dredging Environmental Monitoring and Management Plan (DEMMP) (02 Environment, 2024) (Appendix O). Implementation of these management plans will ensure that: – The area impacted by suspended sediments during dredging and construction will be limited (wherever possible) and will not extend past the modelled ZoHI, ZoMI and ZoI shown in Figure 15. – Implementation of the CEMP and DEMMP will ensure that permanent loss of benthic communities and habitats resulting from construction of the proposal does not exceed 3.32 ha. – The potential for indirect water quality impacts to adjacent areas will be mitigated through implementation of the Marine Water Quality Monitoring Program provided in Appendix B.2 of the DEMMP. This program is discussed in further detail in Section 9.6. • Implementation of the CEMP and DEMMP provides the monitoring and management framework to address potential indirect impacts to benthic communities and habitats from impacts to marine environmental quality during construction. Key management and monitoring measures include: – Implementation of the Marine Water Quality Monitoring Program (MWQMP) provided in the DEMMP for suspended sediment – Implementation of the tiered management framework provided in the DEMMP – Implement the Benthic Communities and Habitat Monitoring Program provided in the DEMMP, including: – Pre-disturbance Survey Report – Post-dredging Survey Report – Reactive Survey Report (if the trigger levels specified in the DEMMP and summarised in Section 9.6 of this report are exceeded) – Monitoring Close-out Report – Use of silt curtains which will minimise the potential impacts associated with increased suspended sediments – The placement of geofabric (such as Texcel 1200R) textile weave along the bund wall will ensure that the placement of dredge spoil during reclamation works will not impact or increase the dredge plume zones. • Maintenance dredging (if required) will be undertaken in previously disturbed / sandy areas within the development envelope / project footprint. Maintenance dredging frequency, volumes and disposal will be determined as required. Environmental management and monitoring will be undertaken in a manner that is consistent with the document Maintenance Dredging Environmental Management Framework (BMT Oceanica, 2016) prepared for Department of Transport for similar types of maintenance dredging activities. • The Operational Environmental Management Plan (OEMP) (Emerge, 2024b) (Appendix Q) outlines the mitigations and management measures to minimise impacts to marine environmental quality during operation. **Loss of benthic communities and habitats** • Management and mitigation proposed during construction to minimise impacts to benthic communities and habitats is detailed in the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O). Implementation of these management plans will ensure that the area of benthic communities and habitats permanently impacted by the proposal is limited to the development envelope and ZoHI. These measures include: – Employing high-resolution positioning system to control dredge operations to ensure that they do not occur outside the proposed dredging area – Implementing the management measures to minimise impacts to marine environmental quality as outlined in Section 9.6 of this report. **Introduction of invasive marine species** • Implementation of the CEMP (Emerge, 2024a) (Appendix P), DEMMP (02 Environment, 2024) (Appendix O) and OEMP (Appendix Q) will minimise the risk of introduction of IMS. • The proposal will be primarily used for barge operations to transport bulk cargo to and from Wadjemup / Rottnest Island. As such, the likelihood of vessels visiting the facility from international or interstate waters is low. However, any vessels from interstate or international waters will comply with commonwealth biosecurity requirements and complete the WA Department of Primary Industries and Regional Development 'Vessel Check' risk assessment (https://www.vessel-check.com/). • All vessels will have a ballast water management plan and ballast water exchanges will be in accordance with IMO requirements and the Commonwealth *Biosecurity Act 2015*. **Impacts from marine infrastructure** • Baird (2024) identified that, due to the presence of existing infrastructure within the project footprint (Army Jetty), changes to coastal processes as a result of the proposal would be minimal. • A five-metre buffer is notionally considered a reasonable estimate of the area surrounding marine infrastructure that may be subject to events causing additional habitat loss, including localised erosion, slumping of dredged area walls and backwash (the halo effect). The development envelope and ZoHI encompasses an area around the marine infrastructure ranging from 7 m to 125 m. Consequently, the development envelope encompasses the area that may be impacted by the halo effect and impacts outside the development envelope as a result of the halo effect are not anticipated.

Benthic communities and habitats		
	Rehabilitate	• Construction effects will be temporary and natural amelioration will mitigate or remove long-term impacts following cessation of construction activities. It is predicted that the temporary impacts within the ZoMI are recoverable within a period of five years following completion of the dredging activities (Baird, 2024b). • The 'halo effect' from the proposed marine infrastructure is included in the calculated direct impacts (within the development envelope and ZoHI). Areas of benthic communities and habitats which will be directly impacted are not proposed to be rehabilitated.
	Offset	Benthic communities and habitat offsets are not considered applicable to the proposal.
Residual impacts	• Permanent loss of mixed seagrass of up to 2.06 ha (or 0.52% of mixed seagrass within the LAU) • Permanent loss of sand / sand with wrack of up to 1.26 ha. Consideration of this as a residual impact is a conservative approach, as post-dredging activities, sand / sand with wrack is likely to accumulate and therefore this impact is likely to be temporary • Temporary loss of 2.62 ha of mixed seagrass and 1.09 ha of sand / sand with wrack within the ZoMI. Baird (2024b) predicts that impacts to these benthic communities and habitats will be recoverable within a period of five years following completion of the dredging activities.	
Environmental outcomes	**Environmental outcomes for construction of the proposal** • Direct disturbance of benthic communities and habitats from construction activities is confined to the development envelope and ZoHI. • Irreversible impacts to benthic communities and habitats from dredging and construction activities is confined to the development envelope and ZoHI. • No irreversible impacts to benthic communities and habitats from dredging activities within the ZoMI. • No observable impacts to benthic communities and habitats outside the ZoMI. **Environmental outcomes for operation of the proposal** • Maintain the health and cover of benthic communities and habitats outside the proposal footprint during operations associated with the proposal (excludes other RIA activities associated with other approvals e.g. mooring installation).	

Table 6: Summary of the potential impacts, proposed mitigation and outcomes – coastal processes

Coastal processes		
EPA environmental objective	To maintain the geophysical processes that shape coastal morphology so that the environmental values of the coast are protected.	
Relevant policy and guidance	• Environmental Factor Guideline: Coastal Processes (EPA, 2016i) • SPP No. 2.6: State Coastal Planning Policy (Western Australian Planning Commission, 2013a) and State Coastal Planning Policy Guidelines (Western Australian Planning Commission, 2013b) • Coastal Hazard Risk Management and Adaptation Planning Guidelines (Department of Planning and Western Australian Planning Commission, 2014) • Sea Level Change in Western Australia, Application to Coastal Planning (Department of Transport, 2010).	
Supporting technical investigations and reports	• South Thomson Barge Landing Development; Coastal processes assessment (Baird, 2024a) (Appendix D) • RIA Peer Review of Dredge Plume Modelling and Coastal Processes Reports (RPS, 2024c) (Appendix E).	
Potential environmental impacts	**Direct impacts**	**Interruption to longshore currents, resulting in changes to wrack and sediment accumulation** • Engineered marine structures have the potential to interrupt longshore currents, trapping sediments and wrack. • The Coastal Processes Assessment undertaken by Baird (2024) identified that longshore currents within South Thomson Bay are currently interrupted by the existing Army Groyne and the proposed extension of the existing groyne is unlikely to result in a significant change to these coastal processes. Although the proposed wharf will block longshore currents to a similar degree as the existing Army Groyne, there may be some potential for the following minor impacts: – Build-up of sediment on the eastern side of the proposed wharf when compared to the present condition – There is potential for the accumulation of seagrass to occur on the eastern side of the proposed wharf, which may lead to ingress of seagrass to the harbour footprint. **Reduction of wave energy in lee of structures** • Overall, the main changes in wave energy as a result of the proposed wharf is the reduction in wave height (when compared to the existing conditions) within the harbour basin area and some reduction in wave height along the shoreline on the western side of the wharf. Consequently, the proposal is unlikely to have a significant to coastal processes within the larger South Thomson Bay area. **Reflection of waves off structures resulting in increased wave energy in the structures vicinity** • The impact on wave conditions outside of the proposed wharf structure was determined to be minimal by Baird, with decreases in wave height being the main observation across each of the cases modelled. No detrimental increase in wave height caused by reflections from the breakwater structure is seen at the moorings managed by RIA (Baird, 2024).
Mitigation	**Avoid**	• The Army Groyne creates an existing barrier to longshore sediment transport. Therefore, as the proposed wharf will block longshore sediment transport to a similar degree to the existing Army Groyne, the proposal is not anticipated to result in a significant change in longshore sediment transport and significant impacts have been avoided. • Impacts on coastal process from marine structures cannot be completely avoided due to the nature of the proposal. • Overall, the main changes in wave energy as a result of the proposed wharf is the reduction in wave height (when compared to the existing conditions) within the harbour basin area and some reduction in wave height along the shoreline on the western side of the wharf.
	Minimise	**Interruption to longshore currents** • The proposed wharf structure has been subject to coastal processes modelling. • Monitoring of shoreline accretion and seagrass accumulating on the eastern side of the wharf will be undertaken during the operational phase. As outlined in the Operational Environmental Management Plan (OEMP) (Appendix Q), a coastal monitoring program will be implemented as required in the Coastal Hazard Risk Management and Adaptation Planning (CHRMAP) (Cardno, 2023). **Reduction of wave energy in lee of structures** • The proposed wharf structure has been subject to coastal processes modelling. This modelling identified that changes are likely to be limited to: – The reduction in wave height (when compared to the existing conditions) within the harbour basin area – A small reduction in wave height along the shoreline on the western side of the wharf • As the vessels manoeuvre into or away from the facility within the turning circle, the waves would be 90 degrees to the vessel and further investigation into potential implications of this on the barge will be investigated as part of future detailed design • Implementation of the Rottnest Island Coastal Hazard Risk Management and Adaptation Plan (Cardno, 2023). **Reflection of waves off structures resulting in increased wave energy in the structures vicinity** • The proposed wharf structure has been subject to coastal processes modelling and the impact on wave conditions outside of the proposed wharf structure was determined to be minimal by Baird (2024).
	Rehabilitate	• Depending on the accumulation volume of wrack and the reshaping of the shoreline towards the protection nib on the eastern side of the wharf, the above maintenance and monitoring activities may need to be actioned (Baird, 2024a).
	Offset	Coastal processes offsets are not considered applicable to the proposal.
Residual impacts	• Due to the presence of the existing Army Groyne, residual impacts to longshore currents from the proposed wharf are unlikely to be significant and are limited to: – Sediment accretion and wrack accumulating on the eastern side of the wharf – A reduction of wave energy in lee of the wharf.	
Environmental outcomes	• Changes to coastal processes resulting from the proposal will be limited to the accumulation of sediment and seagrass against the wharf structure.	

Table 7: Summary of the potential impacts, proposed mitigation and outcomes – marine environmental quality

Marine environmental quality		
EPA environmental objective		To maintain the quality of water, sediment and biota so that environmental values are protected.
Relevant policy and guidance		• Environmental Factor Guideline: Marine Environmental Quality (EPA, 2016e) • Environmental Factor Guideline: Benthic Communities and Habitats (EPA, 2016f) • Technical Guidance: Environmental Impact Assessment of Marine Dredging Proposals (EPA 2021a) • Technical Guidance: Environmental Impact Assessment of Marine Dredging Proposals (EPA 2021a) • Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand., 2018) • Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand., 2018) • Perth's Coastal Waters, Environmental Values and Objectives (EPA, 2000) • State Water Quality Management Strategy No.2, Implementation Plan: Status Report (Government of Western Australia, 2004) • Background quality for coastal marine waters of Perth, Western Australia (Department of Environment, 2004).
Supporting technical investigations and reports		• South Thomson Barge Landing Development; Dredge Plume Modelling Assessment (Baird, 2024b) (Appendix F) • RIA Peer Review of Dredge Plume Modelling and Coastal Processes Reports (RPS, 2024c) (Appendix E) • Rottnest Island Authority has undertaken baseline water quality monitoring to support the proposal (Appendix G) • Rottnest Island Army Jetty Dredging; SAP Implementation report (RPS, 2020) (Appendix H).
Potential environmental impacts	**Direct impacts**	**Temporary increase in total suspended solids** • Mobilisation of sediment during dredging activities, construction of the breakwater, reclamation and piling will result in a temporary increase in total suspended solids (TSS) within the following zones of impact. The zones of impact are shown in Figure 3: – Zone of High Impact (ZoHI) – The area where impacts on benthic communities or habitats are predicted to be irreversible. The term irreversible means 'lacking a capacity to return or recover to a state resembling that prior to being impacted within a timeframe of five years or less'. The ZoHI encompasses an area of 1.37 ha. The majority of the ZoHI is located within the development envelope – Zone of Moderate Impact (ZoMI) – The area within which predicted impacts on benthic communities or habitats are recoverable within a period of five years following completion of the dredging activities. This zone abuts, and lies immediately outside of, the ZoHI. The ZoMI encompasses an area of 4.5 ha – Zone of Influence (ZoI) – The area within which changes in environmental quality associated with dredge plumes are predicted and anticipated during the dredging operations, but where these changes would not result in a detectible impact on benthic biota. At any point in time, the dredge plumes are likely to be restricted to a relatively small portion of the ZoI. The ZoI encompasses an area of 13.44 ha.
	Indirect impacts	**Temporary increase in total suspended solids** • Disturbance of sediments from vessel operations (including propeller wash) in shallow water may result in a temporary increase in suspended sediments during operation of the proposal • Temporary decease in light availability for benthic communities and habitats due to increased TSS. **Increased risk of pollution incidents** • Increased boat numbers during operation, and to lesser degree construction, of the proposal has the potential to increase the risk of pollution, including from antifouling paints, anti-corrosion anodes, increased risk of accidental discharges (e.g. fuel spills, oils and greases) and sullage • A fuel facility, including underground storage tanks is proposed as part of the proposal. There is a risk for fuel spills to occur during refuelling or from fuel storage facilities. Fuel spills from the fuel facility have the potential to impact marine environmental quality. **Temporary release of contaminants from marine sediment during dredging and reclamation activities** • The proposed dredging activities and resulting suspension of sediments have the potential to result in the temporary release of contaminants from sediments.
Mitigation	**Avoid**	• Dredging to a depth of RL -3 m will significantly avoid vessel operations disturbing sediments. • RIA amended the project design to reduce the dredging requirements. By changing the berthing and barge turn pocket, the volume of required dredging was reduced from 26,000 m^3 to 16,050 m^3.
	Minimise	**Temporary increase in total suspended solids** • RIA amended the project design to reduce the dredging requirements. By changing the berthing and barge turn pocket, the volume of required dredging was reduced from 26,000 m^3 to 16,050 m^3 • Management and mitigation proposed during construction to minimise impacts to marine environmental quality is detailed in the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O). Implementation of these management plans will ensure that: – The area affected by suspended sediments during dredging and construction will be limited (wherever possible) and will not extend past the modelled ZoHI, ZoMI and ZoI shown in Figure 22. – Marine environmental quality will be maintained at a moderate level of ecological protection during dredging and return to a High Level of Ecological Protection within two weeks following completion of dredging • Implementation of the CEMP and DEMMP provides the monitoring and management framework to address potential impacts to marine environmental quality during construction. Key management and monitoring measures include: – Implementation of the Marine Water Quality Monitoring Program (MWQMP) provided in the DEMMP for suspended sediment. This program specifies that if the specified triggers are exceeded, then the following management actions will be implemented to ensure impacts to marine environmental quality do not extend past the modelled zone of influence: ○ If trigger 1 has been exceeded: – Investigate if trigger 2 has been exceeded for any sites – Sample again at the exceeded monitoring site and associated reference site each day until turbidity has decreased. ○ If trigger 2 has been exceeded: – Assess metocean and weather conditions – Investigate if dredging or disposal has been occurring and if that is likely to be attributable to the exceedance – Investigate results of the other parameters to determine if there is likely to be stress on the surrounding seagrass. – Sample again at that monitoring site and associated reference site each day until turbidity has decreased. ○ If the trigger levels are exceeded (or indicate a progressive increase towards the trigger levels) then modifications to the dredging program are to be considered, and may include, but not necessarily be limited to: – Reactive benthic communities and habitats survey – Temporary pause to dredging activities (e.g. if exceedance appears to be due to factors other than dredging vessel movements, then pausing dredging activities will minimise cumulative effects) – Relocate the dredge (e.g. to an area of coarser sediment) – Reduce the dredge cut depth, rate of swing-speed and/or increase the dredge pump flow – Reduce disposal of material if the plume is coming from the reclamation area. – Implementation of the tiered management framework provided in the DEMMP – Use of silt curtains which will minimise the potential impacts associated with increased suspended sediments – The placement of geofabric (such as Texcel 1200R®) textile weave along the bund wall will ensure that the placement of dredge spoil during reclamation works will not impact or increase the dredge plume zones.

Marine environmental quality		
		Increased risk of pollution incidents from vessels and underground fuel storage leading to degradation of marine environmental quality • Construction management measures to minimise impacts to marine environmental quality is detailed in the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O). Implementation of these management plans will ensure that the risk for hydrocarbon spills to the marine environment is minimal so that there are no adverse impacts to the marine environment • Implementation of the CEMP and DEMMP provides the monitoring and management framework to address potential impacts to marine environmental quality during construction. Key management and monitoring measures include: – Implement industry standard hydrocarbon management practices (chemical handling, storage, segregation, and spill response) – Any construction vessels including piling vessels/barges to establish a sewage and garbage disposal plan – Undertake vessel maintenance and bunkering in accordance with contractors approved vessel management systems – Hydrocarbon spills into the marine environment be immediately reported and appropriately remediated • Operational management to minimise impacts to the marine environment is detailed in the OEMP (Appendix Q). Implementation of this management plan will ensure that: – Fuel / oil spill contingency plans are included in the OEMP and includes the provision of clean-up equipment and appropriate disposal of contaminated water and sediment – Pollution incidents will be reported to the DoT's Marine Environmental Emergency Response (MEER) unit, with clean up managed and monitored in accordance with MEER's requirements – Pollution incidents will be monitored during operation in accordance with the OEMP, with contingency actions implemented should pollution triggers be breached on a reoccurring basis – The underground fuel storage facility will be constructed in accordance with AS1940 and as outlined in the OEMP have safety and leak detection equipment installed. **Disturbance of sediments from vessel operations (including propeller wash) in shallow water results in a temporary increase in suspended sediments** • Operational management measures to minimise impacts to the marine environment are detailed in the OEMP (Appendix Q). Implementation of this management plan will ensure that marine users comply with vessel operational restrictions required by DoT and RIA. **Temporary decease in light availability for benthic communities and habitats due to suspended sediments** • As discussed in Section 7, temporary impacts from suspended sediments on benthic communities are predicted in the ZoMI only. These impacts include temporary loss of 2.62 ha of mixed seagrass and 1.09 ha of sand / sand with wrack. Baird (2024b) predicts that impacts to these benthic communities and habitats within the ZoMI will be recoverable within a period of five years following completion of the dredging activities • Management and mitigation proposed during construction to minimise impacts to marine environmental quality is detailed in the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O). Implementation of these management plans will ensure that: – The area affected by suspended sediments during dredging and construction will be limited (wherever possible) and will not extend past the modelled ZoHI, ZoMI and ZoI shown in Figure 22 – Marine environmental quality will be maintained at a moderate level of ecological protection during dredging and return to a High Level of Ecological Protection within two weeks following completion of dredging • Maintenance dredging (if required) will be undertaken in previously disturbed / sandy areas within the development envelope / project footprint. Maintenance dredging frequency, volumes and disposal will be determined as required. Environmental management and monitoring will be undertaken in a manner that is consistent with the document Maintenance Dredging Environmental Management Framework (BMT Oceanica, 2016) prepared for Department of Transport for similar types of maintenance dredging activities. **Temporary release of contaminants from marine sediment during dredging and reclamation activities** • The risk of temporary release of contaminants from marine sediments during dredging and reclamation activities will be minimal as all baseline sediment results did not record contaminants above the assessment criteria • Management and mitigation proposed during construction to minimise impacts to marine environmental quality is detailed in the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O). Implementation of these management plans will ensure that the area affected by suspended sediments during dredging and construction will be limited (wherever possible) and will not extend past the modelled ZoHI, ZoMI and ZoI shown in Figure 22 • The CEMP and DEMMP provides the monitoring and management framework to address potential impacts to marine environmental quality during construction. **Disturbance of sediments from maintenance dredging during operation** • Maintenance dredging (if required) will be undertaken in previously disturbed / sandy areas within the development envelope / project footprint. Maintenance dredging frequency, volumes and disposal will be determined as required. Environmental management and monitoring will be undertaken in a manner that is consistent with the document Maintenance Dredging Environmental Management Framework (BMT Oceanica, 2016) prepared for Department of Transport for similar types of maintenance dredging activities.
	Rehabilitate	• Fuel and oil spills to be cleaned up in accordance with the contingency actions outlined in the DEMMP, CEMP and OEMP. • Impacts to marine water quality from an increase in TSS within the ZoMI and ZoI will be temporary only. • Impacts to marine water quality from operational activities will be temporary only (during vessel use) and due to the proposed design are considered unlikely to be significant. No rehabilitation is considered applicable.
	Offset	Marine environmental quality offsets are not considered applicable to the proposal.
Residual impacts	• Temporary suspended sediments within the ZoHI (1.37 ha), ZoMI (4.5 ha) and ZoI (13.44 ha) • Temporary reduction in light due to suspended sediments in the water column within the ZoMI (4.5 ha) may impact benthic communities and habitats. As impacts to benthic communities and habitats within the ZoMI will be recoverable within a period of five years following completion of the dredging activities, these residual impacts are not considered significant.	
Environmental outcomes	**Environmental outcomes for construction of the proposal:** • Marine environmental quality will be temporarily reduced to a Moderate Level of Ecological Protection during construction but will return to a High Level of Ecological Protection two weeks after completion of dredging and construction activities. • No reported hydrocarbon spills or release of waste into the marine environment from construction and dredging activities. • Maintain the marine environmental quality outside the predicted zones of influence as defined by dredge modelling (ZoHI, ZoMI and ZoI). **Environmental outcomes for operation of the proposal:** • Marine environmental quality is maintained at a High Level of Ecological Protection within and adjacent to the project footprint. • No reported hydrocarbon spills or release of waste into the marine environment from operational activities associated with the proposal.	

Table 8: Summary of the potential impacts, proposed mitigation and outcomes – marine fauna

Marine fauna		
EPA environmental objective	To protect marine fauna so that biological diversity and ecological integrity are maintained.	
Relevant policy and guidance	• *Environment Protection and Biodiversity Conservation Act 1999* • *Biodiversity Conservation Act 2016* • Environmental Factor Guideline: Marine Fauna (EPA, 2016j) • National Biofouling Management Guidelines for Non-trading Vessels (Commonwealth of Australia, 2009a) • National Biofouling Management Guidelines for Commercial Vessels (Commonwealth of Australia, 2009b).	
Supporting technical investigations and reports	• South Thomson Barge Landing Development; Marine fauna and benthic habitat assessment (RPS, 2024a) (Appendix B) • South Thomson Barge Landing Development; Underwater Acoustic Assessment (Tetra Tech, 2024) (Appendix S).	
Potential environmental impacts	**Direct impacts**	**Loss of benthic habitats** • Loss of marine fauna habitat, primarily the loss of seagrass species associated with construction of the proposal has the potential to result in impacts to marine fauna species through loss of foraging opportunities and changes to marine environmental quality. • The total predicted loss of marine fauna habitat from the proposal is summarised below: – Direct (permanent) impacts to 2.06 ha of mixed seagrass and 1.26 ha of sand / sand with wrack within the development envelope and ZoHI. The permanent loss of 2.06 ha of mixed seagrass accounts for 0.52% of mixed seagrass within the LAU – Indirect (recoverable) impacts to: ○ 2.62 ha of mixed seagrass and 1.09 ha of sand / sand with wrack within the ZoMI. It is predicted that benthic communities and habitats that are impacted within the ZoMI will recover within a five-year period ○ 5.13 ha of mixed seagrass, 1.13 ha macroalgae dominated community, 0.35 ha of limestone reef / pavement and 6.70 ha of sand / sand with wrack within the ZoI. Changes in environmental quality associated with dredge plumes in the ZoI are not predicted to result in a detectible impact on benthic biota. **Increased risk of entanglement and / or entrainment** • Entanglement of marine fauna with equipment and waste during construction and operation of the proposal may lead to injury, death, displacement, adverse behavioural and physiological changes. • Entrainment, the direct uptake of aquatic organisms by suction, during activities such as dredging has the potential to cause mortality to marine fauna species during construction. **Elevated underwater noise** • Elevated levels of anthropogenic underwater noise can have negative impacts, ranging from changes in acoustic communication, displacement from an area, and in more severe cases temporary hearing loss, physical injury or mortality (Richardson, 1995). The greatest source of noise from the proposal will be associated with piling during construction. Dredging is anticipated to emit similar, or lesser, levels of noise. Other construction noise generated, such as rock dumping and construction vessel movement, is likely to be considerably less than pile driving and the impact from these other sources would be very low. **Risk of vessel collision** • An increased risk of collision could result from an increase in the number of vessels using the South Thomson Bay Barge Landing during operation and to a lesser degree during construction. However, as barge movements already occur between the mainland and existing jetty in Thomson Bay, the proposal will not result in any changes in risk of vessel strike during the operational phase. • The risk of vessel strike during construction activities is low as the construction vessels will operate slowly and within the development envelope only. **Risk of injury or death from rock dumping during breakwater construction** • Increased risk of injury/mortality of marine fauna. **Potential impacts from artificial lighting** • Increased light emissions during operation of the proposal could lead to disturbance to marine fauna in the vicinity, especially shorebirds and seabirds. • The potential for artificial light emissions to impact shorebirds and seabirds during construction is considered to be low, as construction works will be undertaken during nominated daylight hours, with lighting requirements limited to security / safety installations.
	Indirect impacts	**Increased risk of introduction of Introduced Marine Species (IMS)** • There is a risk of IMS introduction or spread during construction and operation of the proposal from vessel ballast water and hull fouling. Marine pests may threaten biodiversity through a number of mechanisms such as predation, competition for habitat and altering ecosystems. • Implementation of the proposal would not result in a major change in the activities that already exist on Wadjemup / Rottnest Island as the proposal involves moving the barging facilities to the proposed location from the existing jetty, rather than introducing a new activity to the island. **Increased risk of pollution incidents** • Increased boat numbers during operation, and to lesser degree construction, of the proposal has the potential to increase the risk of pollution, including from antifouling paints, anti-corrosion anodes, increased risk of accidental discharges (e.g. fuel spills, oils and greases) and sullage. • A fuel facility, including underground storage tanks is proposed as part of the proposal. There is a risk for fuel spills to occur during refuelling or from fuel storage facilities. Fuel spills from the fuel facility have the potential to impact marine environmental quality. • Likely effects of release of contaminants into the marine environment may result in direct impacts through ingestion, inhalation and absorption through the skin, and abandonment of polluted feeding habitat and potentially longer-term impacts from bioaccumulation in the food chain. **Loss of benthic habitats** • Loss of marine fauna habitat, primarily the loss of seagrass species associated with construction of the proposal has the potential to result in impacts to marine fauna species through loss of foraging opportunities and changes to marine environmental quality. The temporary loss of 2.62 ha of mixed seagrass and 1.09 ha of sand / sand with wrack within the ZoMI from an increase in TSS.
Mitigation	**Avoid**	• Avoiding construction activities during known critical spatial and temporal windows of marine environmental sensitivity will avoid significant impacts to marine fauna species. These critical windows are outlined in Table 49. However, it is not anticipated that impacts to marine species can be fully avoided during construction activities. • Site selection includes an already disturbed area of 0.19 ha of seabed within the existing Army Groyne footprint. As benthic communities and habitats are widespread within South Thomson Bay, total avoidance of direct impacts is not possible. • RIA amended the project design to reduce the dredging requirements. By changing the berthing and barge turn pocket, the volume of required dredging was reduced from 26,000 m^3 to 16,050 m^3 • Using vibro hammer piling methods (rather than hammer piling) will eliminate sources of impulsive underwater noise. • General construction work will be limited to daylight hours only, minimising potential disturbance from marine fauna from artificial light.
	Minimise	**Temporary / permanent loss or degradation of benthic habitat** • Management and mitigation proposed during construction to minimise impacts to marine fauna habitat such as benthic communities and habitats is detailed in the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O). Implementation of these management plans will ensure that: – The area of benthic habitat affected by suspended sediments during dredging and construction will be limited (wherever possible) and will not extend past the modelled ZoHI, ZoMI and ZoI. – Marine environmental quality will be maintained at a moderate level of ecological protection during dredging and return to a High Level of Ecological Protection within two weeks following completion of dredging. • Implementation of the CEMP and DEMMP provides the monitoring and management framework to address potential impacts to marine environmental quality during construction. Key management and monitoring measures include: – Implementation of the Marine Water Quality Monitoring Program (MWQMP) provided in the DEMMP for suspended sediment. • Operational management to minimise impacts to marine fauna is detailed in the OEMP (Emerge, 2024b) (Appendix Q).

Marine fauna

- Maintenance dredging (if required) will be undertaken in previously disturbed / sandy areas within the development envelope / project footprint where possible. Maintenance dredging frequency, volumes and disposal will be determined as required. Environmental management and monitoring will be undertaken in a manner that is consistent with the document Maintenance Dredging Environmental Management Framework (BMT Oceanica, 2016) prepared for Department of Transport for similar types of maintenance dredging activities.

Increased risk of entanglement and / or entrainment

- Implementation of the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O) provides the monitoring and management framework to address increased risk of entanglement and entrainment during construction. Management measures to minimise the risk of injury to fauna during construction includes:
  - Dedicated MFOs during dredging will implement management measures to minimise the risk of injury to fauna. Where marine fauna are observed within an Exclusion Zone, dredging will cease immediately.
  - Prior to commencing dredging or excavating, dedicated MFOs will check for marine fauna within the exclusion and observation zones outlined in the CEMP.
  - Dredging activities will be undertaken during daylight hours only to improve visibility.
  - Measures to minimise the risk for entanglement of marine fauna with waste and equipment during construction.
- Implementation of the OEMP (Emerge, 2024b) (Appendix Q) provides the monitoring and management framework to address increased risk of entanglement during operation.
- During operation of the proposal, the risk of entanglement will be minimised through installation of information-boards to encourage appropriate disposal of litter and the inform of the dangers of entanglement.

Elevated underwater noise

- Implementation of the CEMP (Emerge, 2024a) (Appendix P) provides the monitoring and management framework to address elevated underwater noise generated from construction activities, such as dredging and piling. Implementation of this management plan will ensure that:
  - There is no injury or death of marine fauna associated with underwater noise generated during construction of the proposal.
  - There is no injury or death of marine fauna from underwater noise.
- Key management and monitoring measures included in the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O). are:
  - Trained marine fauna observers (MFOs) will minimise the risk of injury to marine fauna during piling.
  - A reduction in underwater noise impacts to marine fauna will be achieved through the use of vibration piling rather than hammer piling during construction. The reduction in underwater noise levels can be seen in the comparison of the underwater noise modelling shown in Figure 29 and Figure 30.
  - Hammer piling will only be used as a contingency if there is a refusal during vibro-piling. Exclusion zones for this contingency are included in the CEMP.
  - Pre-start, soft-start, shut-down and low-visibility procedures will be implemented as outlined in the CEMP. These are summarised below and detailed in Appendix A of the CEMP:
  - Prior to piling works each day and for each pile the dedicated MFOs will commence continuous visual observation within the observation and exclusion zones for 30 minutes.
  - Soft-start procedures involve the commencement of piling at low vibro-hammer energy, gradually increasing to full energy over a 30-minute period. Where target marine fauna are not observed in the observation and exclusion zones during the soft-start procedures, then normal piling can commence.
  - Where marine fauna is observed by the MFO within the observation zone (but outside the exclusion zone) during piling activities (including soft-start procedures), then the shutdown procedures outlined in the CEMP will be implemented.
  - During periods of low visibility (i.e. where a distance of 500 m cannot be clearly viewed), then piling operations may commence with soft-start procedures, unless one of the triggers provided in the CEMP occurs.
  - Implementation of observation and exclusion zones. These zones have been based on the underwater received sound levels and distances from the underwater noise assessment (Appendix S) and are provided in the CEMP. The management zones are depicted in Appendix A (Marine Fauna Provisions) of the CEMP.
  - Piling will only be undertaken during daylight hours to ensure visibility of the observation and exclusion zones for the MFO.
- Trained MFOs will be on duty (as outlined in Appendix A of the CEMP) on vessels during construction

Risk of vessel collision

- Implementation of the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O) provides the monitoring and management framework to address increased vessel collision risk during construction. Implementation of this management plan will ensure that there is no death or injury to marine fauna from vessel strike. Management measures that will be implemented include:
  - Implementation of vessel speed limits
  - All vessels are to adhere to standards set in the National Whale Watching Guidelines
  - A MFO on all construction vessels when in transit
  - Implementation of vessel approach distances to marine fauna
  - Implementation of the marine fauna monitoring and management program provided in Appendix B.3 of the DEMMP.
- Implementation of the OEMP (Emerge, 2024b) (Appendix Q) provides the monitoring and management framework to address increased vessel collision risk during operation. Implementation of this management plan will ensure that:
  - Marine users to comply with vessel operational restrictions required by DoT and RIA

Risk of injury or death from rock dumping during breakwater construction

The CEMP (Emerge, 2024a) (Appendix P) outlines the management and monitoring measures to mitigate the potential impacts of rock dumping and excavation on conservation significant marine fauna. These measures include:

- Dedicated MFOs during rock dumping activities will implement management measures to minimise the risk of injury to fauna as outlined in Appendix A (Marine Fauna Provisions) of the CEMP, including:
  - Prior to rock dumping and excavation works, the dedicated MFOs will commence continuous visual observation within the specified Management Zones for 30 minutes. If target marine fauna is observed within the management zone during this time, rock dumping and excavation shall be delayed until the marine fauna has been observed exiting the Observation Zone or have not been seen for 30 minutes.
  - Once rock dumping has commenced, if the dedicated MFOs observe a target marine fauna species within the Exclusion Zones then shut-down procedures will be implemented.
  - During periods of low visibility (i.e. where a distance of 500 m cannot be clearly viewed), then rock dumping and excavation activities may commence with soft-start procedures.
  - Rock dumping, dredging and excavation activities will be undertaken during daylight hours only to improve visibility.

Potential impacts from artificial lighting

- Implementation of the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O) provides the monitoring and management framework to minimise impacts to marine fauna from increased light emissions during construction. The key management measure to ensure no disturbance to marine fauna from artificial light during construction is:
  - Construction activities will be restricted to daylight hours.
- Operational management to minimise impacts to marine fauna is detailed in the OEMP (Emerge, 2024b) (Appendix Q). Implementation of this management plan will ensure that:
  - Artificial lighting will be of lowest allowable intensity to meet legislative and regulatory requirements for human safety / navigational purposes.
- Best practice lighting design consistent with the National Light Pollution Guidelines for Wildlife (DCCEEW 2023) will be employed to reduce light pollution on marine fauna during operation, including:
  - Only add light for specific purposes (e.g. navigational and safety).
  - Use adaptive light controls to manage light timing, intensity and colour.
  - Light only the object or area intended – keep lights close to the ground, directed and shielded to avoid light spill.
  - Use the lowest intensity lighting appropriate for the task.
  - Use non-reflective, dark-coloured surfaces.
  - Use lights with reduced or filtered blue, violet and ultra-violet wavelengths.

Marine fauna		
		Increased risk of introduction of IMS • Implementation of the CEMP (Emerge, 2024a) (Appendix P), DEMMP (02 Environment, 2024) (Appendix O) and OEMP (Appendix Q) will minimise the risk of introduction of IMS. • The proposal will be primarily used for barge operations to transport bulk cargo to and from Wadjemup / Rottnest Island. As such, the likelihood of vessels visiting the facility from international or interstate waters is low. However, any vessels from interstate or international waters will comply with Commonwealth biosecurity requirements and complete the WA Department of Primary Industries and Regional Development 'Vessel Check' risk assessment (https://www.vessel-check.com/). • All vessels will have a ballast water management plan and ballast water exchanges will be in accordance with IMO requirements and the *Commonwealth Biosecurity Act 2015*. **Increased risk of pollution incidents** • Construction management measures to minimise the risk of pollution incidents which may impact marine fauna is detailed in the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O). Implementation of these management plans will ensure that the risk for hydrocarbon spills to the marine environment is minimal so that there are no adverse impacts to marine fauna. • Key management and monitoring measures include: – Implement industry standard hydrocarbon management practices (chemical handling, storage, segregation, and spill response). – Any construction vessels including piling vessels/barges is to establish a sewage and garbage disposal plan. – Undertake vessel maintenance and bunkering in accordance with contractors approved vessel management systems. – Hydrocarbon spills into the marine environment be immediately reported and appropriately remediated. • Operational management to minimise impacts to the marine environment is detailed in the OEMP (Appendix Q). Implementation of this management plan will ensure that: – Fuel / oil spill contingency plans are included in the OEMP, and includes the provision of clean-up equipment and appropriate disposal of contaminated water and sediment. – Pollution incidents will be reported to the DoT's MEER unit, with clean up managed and monitored in accordance with MEER's requirements. – Pollution incidents will be monitored during operation in accordance with the OEMP, with contingency actions implemented should pollution triggers be breached on a reoccurring basis. • The underground fuel storage facility will be constructed in accordance with AS1940 and as outlined in the OEMP have safety and leak detection equipment installed.
	Rehabilitate	• There is no opportunity to rehabilitate the impacted area due to operation and maintenance of the proposal. Construction effects (outside the development envelope and ZoHI) to marine fauna habitat (benthic communities and habitats) will be temporary and natural amelioration will mitigate or remove long-term impacts following cessation of construction activities. • Sick and/or injured fauna shall be managed by appropriately qualified personnel and any injury or death of marine fauna will be reported to the Department of Biodiversity, Conservation and Attractions (DBCA). • Fuel and oil spills to be cleaned up in accordance with the contingency actions outlined in the DEMMP, CEMP and OEMP.
	Offset	Marine fauna offsets are not considered applicable to the proposal.
Residual impacts	• Impacts to the following benthic communities and habitats within the ZoI, ZoMI and ZoHI from an increase in suspended sediments results in a decrease in potential marine fauna habitat available: – Permanent impacts to 2.06 ha mixed seagrass and 1.26 ha sand with wrack – Temporary loss of 2.62 ha of mixed seagrass and 1.09 ha of sand / sand with wrack within the ZoMI. • Underwater noise emissions from construction activities such as piling and dredging operations causing temporary disturbance to marine fauna species.	
Environmental outcomes	**Environmental outcomes for construction of the proposal** • No irreversible loss of marine fauna habitat (e.g. benthic communities and habitats) from dredging and construction activities outside the development envelope and ZoHI • No reported introduction or establishment of IMS as a result of construction activities associated with the proposal • No reported impacts to marine fauna as a result of hydrocarbon spill or release of waste associated with construction activities including entanglement or ingestion of waste • No reported death or injury to marine fauna from vessel strike associated with construction activities • No reported death, injury or behavioural change to marine fauna as a result of underwater noise associated with construction activities • No reported negative impacts on marine fauna attributable to the construction lighting requirements of the proposal. **Environmental outcomes for operation of the proposal** • No reported loss of marine fauna habitat outside of the approved project footprint attributable to the operation of the proposal • No reported introduction or establishment of IMS as a result of operational activities associated with the proposal • No reported impacts to marine fauna as a result of hydrocarbon spill or release of waste associated with operational activities including entanglement or ingestion of waste • No reported death or injury to marine fauna from vessel strike associated with operational activities • No reported negative impacts on marine fauna attributable to the lighting requirements of the proposal associated with operation of the proposal.	

Table 9: Summary of the potential impacts, proposed mitigation and outcomes – flora and vegetation

Flora and vegetation		
EPA environmental objective	To protect flora and vegetation so that biological diversity and ecological integrity is maintained.	
Relevant policy and guidance	• Environmental Factor Guideline – Flora and Vegetation (EPA, 2016a) • Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA, 2016b) • *Environment Protection and Biodiversity Conservation Act 1999* • *Biodiversity Conservation Act 2016*	
Supporting technical investigations and reports	• Flora and vegetation survey; South Thomson and Kingstown, Rottnest Island (FVC, 2023) (Appendix I) • South Thomson Barge Redevelopment Flora and Vegetation Survey (RPS, 2024d) (Appendix J)	
Potential environmental impacts	**Direct impacts**	**Removal of native vegetation** • Removal of 0.46 ha of native vegetation in Good to Degraded condition • Of the native vegetation being cleared, 0.23 ha is analogous with the threatened ecological community (TEC); *Callitris preissii (or Melaleuca lanceolata*) forests and woodlands of the Swan Coastal Plain.
	Indirect impacts	**Introduction of invasive species (pests and weeds)** • There is potential for the movement of construction machinery to result in the introduction of weed and pest species. **Introduction of disease** • There is potential for the movement of construction machinery to result in the introduction of disease. **Accidental clearing** • During construction activities, there is a risk that native vegetation outside the areas directly impacted will be accidentally cleared. **Localised erosion** • There is a risk for localised erosion to occur adjacent to cleared areas or due to surface water run-off. Localised erosion may impact vegetation adjacent to the development envelope. **Incorrect waste disposal** • Potential vegetation degradation through the incorrect disposal of rubbish and waste.

Flora and vegetation

Mitigation	**Avoid**	• Avoidance of impacts to the 0.8 ha of native vegetation analogous with the TEC (MIAp*Td) surveyed outside the development envelope.
	Minimise	**Removal of native vegetation** • A CEMP (Emerge, 2024a) (Appendix P) will be implemented to ensure impacts to native vegetation is limited to the 0.46 ha within the development envelope. Management measures to limit impacts outside the development envelope include: – Extent of authorised disturbance will be clearly defined and demarcated on appropriate plans. The demarcated terrestrial construction works area to be surveyed prior to the commencement of vegetation removal works. Movement of construction vehicles within vegetation outside this area will be limited to avoid accidental clearing or disturbance of surrounding vegetation – All identified populations of MIAp*Td will be delineated using highly visible flagging or similar around all identified populations to avoid impacts to the 0.8 ha of MIAp*Td surveyed outside the development envelope – Establishment of clearly delineated access points to prevent unauthorised disturbance and access – Installation of temporary fencing, inclusive of sediment controls, along the boundary of the terrestrial construction works area to restrict machinery access to be within the approved disturbance area – Daily inspections to visually check / review clearing boundaries and compliance during clearing activities – Photographic records of the clearing area pre- and post-clearing activities – Inspection to verify no degradation or disturbance beyond approved clearing boundary from erosion. • Operational management to minimise impacts to flora and vegetation is detailed in the OEMP (Emerge, 2024b) (Appendix Q). Implementation of this management plan will ensure that: – Vehicle access is controlled to designated roads and access. – There is no introduction of weed species to the site as a result of operation. **Introduction of invasive species (pests and weeds)** • Construction management and monitoring measures to minimise impacts to terrestrial flora and vegetation is detailed in the CEMP (Emerge, 2024a) (Appendix P) and includes: – Implementation of the weed management protocol as outlined in the CEMP – Weekly inspections and photographic records during clearing and construction activities – Inspections to verify no degradation or disturbance has occurred beyond the development envelope – Appropriate hygiene measures to minimise the risk of the spread and introduction of weed species, including: – Weekly spot checks of mobile equipment and vehicles – hygiene points at key road entry points – Implementation of the weed management protocol outlined in the CEMP – Stockpile management, including stockpile locations (within the development envelope), erosion and stabilisation techniques and height limits – Designated areas for the temporary placement of cleared vegetation (within the development envelope) to minimise the increased risk of weed and disease spread and bushfire – The contractor will supply weed and weed certificates prior to mobilising vehicles and machinery. • Operational management to minimise impacts to flora and vegetation is detailed in the OEMP (Emerge, 2024b) (Appendix Q). Implementation of this management plan will ensure that: – Vehicle access is controlled to designated roads and access – There is no introduction of weed species to the site as a result of operation. **Introduction of disease** • Construction management measures to minimise impacts to terrestrial flora and vegetation is detailed in the CEMP (Emerge, 2024a) (Appendix P) and includes: – Appropriate hygiene measures to minimise the risk of the spread and introduction of disease – Extent of authorised disturbance will be clearly defined and demarcated on appropriate plans. The demarcated terrestrial construction works area to be surveyed prior to the commencement of vegetation removal works. Movement of construction vehicles within vegetation outside this area will be limited to avoid the risk of disease spread • Monitoring during construction to minimise impacts to terrestrial flora and vegetation is detailed in the CEMP (Emerge, 2024a) (Appendix P) and includes: – Daily inspections and photographic records during clearing and construction activities – Inspections to verify no degradation or disturbance has occurred beyond the development envelope • Operational management to minimise impacts to flora and vegetation is detailed in the OEMP (Emerge, 2024b) (Appendix Q). Implementation of this management plan will ensure that: – Vehicle access is controlled to designated roads and access – There is no introduction of disease to the site as a result of operation **Accidental clearing** • Construction management measures to minimise impacts to terrestrial flora and vegetation is detailed in the CEMP (Emerge, 2024a) (Appendix P) and includes: – Vehicles, plant, and equipment to be restricted within development envelope – The extent of authorised disturbance will be clearly defined and demarcated on appropriate plans. The demarcated terrestrial construction works area to be surveyed prior to the commencement of vegetation removal works – Installation of temporary fencing, inclusive of sediment controls, along the boundary of the terrestrial construction works area to restrict machinery access to be within the approved disturbance area • Monitoring during construction to minimise impacts to terrestrial flora and vegetation is detailed in the CEMP (Emerge, 2024a) (Appendix P) and includes: – Daily inspections and photographic records during clearing and construction activities – Inspections to verify no degradation or disturbance has occurred beyond the development envelope. **Localised erosion** • Construction management measures to minimise impacts to terrestrial flora and vegetation is detailed in the CEMP (Emerge, 2024a) (Appendix P) and includes: – Installation of temporary fencing, inclusive of sediment controls, along the boundary of the terrestrial construction works will minimise localised erosion – Establishment of clearly delineated access points to prevent unauthorised disturbance and access • Monitoring during construction to minimise impacts to terrestrial flora and vegetation is detailed in the CEMP (Emerge, 2024a) (Appendix P) and includes: – Daily inspections and photographic records during clearing and construction activities – Inspections to verify no degradation or disturbance has occurred beyond the development envelope. **Degradation through incorrect waste disposal** • A CEMP (Emerge, 2024a) (Appendix P) will be implemented to ensure impacts to native vegetation is limited to the 0.46 ha within the development envelope. Measures to manage waste disposal will be implemented as per the CEMP to minimise the risk for degradation of the surrounding vegetation. • Operational management to minimise impacts to flora and vegetation is detailed in the OEMP (Emerge, 2024b) (Appendix Q). Implementation of this management plan will ensure that waste disposal measures are implemented to prevent rubbish and litter degrading surrounding vegetation.
	Rehabilitate	• Should the proposal result in the introduction of weed species, appropriate management and control measures will be implemented. • Should the proposal result in the introduction of disease, appropriate management measures will be implemented. • There is no opportunity to rehabilitate the areas directly impacted by construction of the proposal. However, any accidental clearing will be rehabilitated. • If daily inspections during construction identifies areas of erosion outside the development envelope which impacts vegetation condition, these areas will be rehabilitated.
	Offset	Terrestrial flora and vegetation offsets are not proposed for terrestrial flora and vegetation as only 0.52% of the TEC identified in the surrounding area will be directly impacted.

Flora and vegetation	
Residual impacts	• Removal of 0.46 ha of native vegetation in Good to Degraded condition. Of the native vegetation being cleared, 0.23 ha is analogous with the TEC, *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands of the Swan Coastal Plain.
Environmental outcomes	• Direct impacts to native vegetation resulting from the proposal will not exceed 0.46 ha. • Direct impacts to native vegetation (MIAp*Td) analogous with the TEC, *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands of the Swan Coastal Plain does not exceed 0.23 ha. • No introduction of new weed species attributable to the proposal.

Table 10: Summary of the potential impacts, proposed mitigation and outcomes – terrestrial fauna

Terrestrial fauna		
EPA environmental objective	To protect terrestrial fauna so that biological diversity and ecological integrity are protected (EPA, 2016d).	
Relevant policy and guidance	• Environmental Factor Guideline: Terrestrial Fauna (EPA, 2016d) • Technical Guidance: Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA, 2020) • *Environment Protection and Biodiversity Conservation Act 1999* • *Biodiversity Conservation Act 2016.*	
Supporting technical investigations and reports	• Rottnest Island Basic Fauna Survey (EcoLogical, 2024) (Appendix K).	
Potential environmental impacts	Direct impacts	**Loss of terrestrial fauna habitat** • Construction of the proposal will result in the removal of 0.46 ha of potential terrestrial fauna habitat. Conservation significant species that may occur within this habitat includes: – *Lerista lineata* (Perth slider) – *Pandion haliaetus* (osprey) – *Pseudonaja affinis exilis* (Rottnest Island dugite) – *Tiliqua rugosa konowi* (Rottnest Island bobtail) – *Setonix brachyurus* (quokka). **Injury and / or mortality of terrestrial fauna** • Construction of the proposal may result in increased vehicle movements within the development envelope, resulting in vehicle strike. • It is unlikely operation of the proposal will significantly increase the potential for fauna strike, given the existing presence of roads within the area.
	Indirect impacts	**Alteration of fauna behaviour** • During construction, there will be noise and vibration emissions due to vehicles movements and construction activities. Noise and vibration associated with construction of the proposal have the potential to result in short-term disturbance to fauna on a local scale. **Indirect loss or impact to terrestrial fauna habitat from habitat degradation** • Indirect loss or impact to terrestrial fauna habitat from habitat degradation as a result of: – The introduction or spread of invasive species (pests and weeds) due to construction machinery and vehicles – The introduction or spread of disease (for example, dieback) due to construction machinery and vehicles – Inappropriate disposal of waste. **Accidental clearing of potential fauna habitat** • During construction activities, there is a risk that terrestrial fauna habitat outside the areas directly impacted will be accidentally cleared.
Mitigation	Avoid	Complete avoidance of impacts to terrestrial fauna and habitat cannot be achieved.
	Minimise	**Loss of terrestrial fauna habitat** • A CEMP (Emerge, 2024a) (Appendix P) will be implemented to ensure impacts to terrestrial fauna habitat is limited to the 0.46 ha within the development envelope. Management measures to minimise potential impacts outside the development envelope are discussed in this table. **Habitat degradation from the introduction and spread of weeds and disease and incorrect waste disposal** • Construction management and monitoring measures to minimise impacts to terrestrial fauna habitat are detailed in the CEMP (Emerge, 2024a) (Appendix P) and includes: – Appropriate hygiene measures to minimise the risk of the spread and introduction of weed species – Extent of authorised disturbance will be clearly defined and demarcated on appropriate plans. The demarcated terrestrial construction works area to be surveyed prior to the commencement of vegetation removal works. Movement of construction vehicles within vegetation outside this area will be limited to avoid the risk of weed spread – Daily inspections and photographic records during clearing and construction activities – Inspections to verify no degradation or disturbance has occurred beyond the development envelope – Appropriate hygiene measures to minimise the risk of the spread and introduction of weed species: – Weekly spot checks of mobile equipment and vehicles – Hygiene points at key road entry points – Implementation of the weed management protocol outlined in the CEMP – Stockpile management, including stockpile locations (within the development envelope), erosion and stabilisation techniques and height limits – Designated areas for the temporary placement of cleared vegetation (within the development envelope) to minimise the increased risk of weed and disease spread and bushfire • Operational management to minimise impacts to flora and vegetation is detailed in the OEMP (Emerge, 2024b) (Appendix Q). Implementation of this management plan will ensure that: – Vehicle access is controlled to designated roads and access – There is no introduction of weed species to the site as a result of operation. **Accidental clearing of potential fauna habitat** • Construction management measures to minimise impacts to terrestrial fauna habitat is detailed in the CEMP (Emerge, 2024a) (Appendix P) and includes: – Vehicles, plant, and equipment to be restricted within development envelope – The extent of authorised disturbance will be clearly defined and demarcated on appropriate plans. The demarcated terrestrial construction works area to be surveyed prior to the commencement of vegetation removal works – Installation of temporary fencing, inclusive of sediment controls, along the boundary of the terrestrial construction works area to restrict machinery access to be within the approved disturbance area • Monitoring during construction to minimise impacts to terrestrial fauna is detailed in the CEMP (Emerge, 2024a) (Appendix P) and includes: – Daily inspections and photographic records during clearing and construction activities – Inspections to verify no degradation or disturbance has occurred beyond the development envelope. **Injury and / or mortality of terrestrial fauna** • Construction management measures to minimise impacts to terrestrial fauna is detailed in the CEMP (Emerge, 2024a) (Appendix P) and includes: – Vehicles, plant, and equipment to be restricted within development envelope – The extent of authorised disturbance will be clearly defined and demarcated on appropriate plans. The demarcated terrestrial construction works area to be surveyed prior to the commencement of vegetation removal works – Vegetation clearing will be undertaken progressively and towards retained vegetation – Vehicle speed limits will be implemented in accordance with the CEMP – If native fauna is encountered during clearing works it should, initially, be allowed to make its own way from the works area. However, if this is not possible or practicable, a qualified wildlife handler will be contacted to relocate it • It is unlikely operation of the proposal will significantly increase the potential for fauna strike, given the existing presence of roads within the area. The OEMP (Appendix Q) outlines measures to minimise the risk of injury to terrestrial fauna during operation.

Terrestrial fauna		
	Rehabilitate	• Should the proposal result in the introduction of weed species, appropriate management and control measures will be implemented. • There is no opportunity to rehabilitate the areas directly impacted by construction of the proposal. Any accidental clearing outside the approved area will be rehabilitated. • Injured animals will be provided with first aid and handled on advice from the Wildcare Helpline and Rottnest Island Authority rangers.
	Offset	Terrestrial fauna offsets are not considered applicable to the proposal.
Residual impacts	• Removal of 0.46 ha of potential terrestrial fauna habitat in Good to Degraded condition.	
Environmental outcomes	• Direct impacts to potential fauna habitat resulting from the proposal will not exceed 0.46 ha of native vegetation. • No introduction of new weed species attributable to the proposal. • No increase in incidents of terrestrial fauna injury or death during construction associated with the proposal works.	

Table 11: Summary of the potential impacts, proposed mitigation and outcomes – social surroundings

Social surroundings		
EPA environmental objective	To protect social surroundings from significant harm (EPA, 2023).	
Relevant policy and guidance	• *Aboriginal Heritage Act 1972* • Environmental Factor Guideline – Social Surroundings (EPA, 2023) • Technical Guidance Environmental impact assessment of Social Surroundings – Aboriginal cultural heritage (EPA, 2023b) • *Historic Shipwrecks Act 1976* • *Maritime Archaeology Act 1973* • *Heritage Act 2018.*	
Supporting technical investigations and reports	• Report of an Ethnographic Aboriginal Heritage Survey of the Army Jetty, Rottnest Island, Western Australia (Brad Goode and Associates, 2019) (Appendix M) • Marine Magnetic survey at proposed barge landing site, South Thomson Bay (Surrich, 2019) (Appendix T) • Acoustic assessment Rottnest Barge Facility Rottnest Island (Herring Storer, 2024) (Appendix U).	
Potential environmental impacts	Direct impacts	**Potential impacts to heritage** • There are no registered Aboriginal Cultural Heritage (ACH) sites within or adjacent to the development envelope. However, there is a risk for previously unearthed artefacts or burials to be identified during ground disturbing activities. • Although not a registered heritage site, there are community concerns regarding impacts to potential heritage values of the existing Arm Groyne. **Impacts to recreational values** • Construction and operation of the proposal will require the temporary and permanent relocation of some moorings during construction and operation as summarised below: – Temporary relocation of eight moorings during construction of the proposal – Permanent relocation of four moorings during operation of the proposal. **Potential disturbance of unexploded ordnance (UXO)** • The marine component of the development envelope was not mapped as having a risk of UXO occurring. However, the marine environment approximately 3 km to the north-west of the site is at risk of UXO occurring. • Surrich Hydrographics (Surrich) undertook a magnetic field survey for UXO to delineate the risks within the development envelope. The survey identified 48 ferrous debris targets, six of which were confirmed to be debris and not UXO.
	Indirect impacts	**Impacts to recreational values** • Loss of marine habitat, primarily the loss of seagrass associated with construction of the proposal has the potential to result in indirect impacts to marine fauna species through loss of foraging opportunities and changes to marine environmental quality. This loss of marine habitat may impact recreational fisheries in the South Thomson Bay through the loss of potential feeding and spawning habitat. • Construction of the proposal has potential to impact public safety. **Impact to amenity** • Construction and implementation of the proposal has the potential to impact amenity within vicinity of the development envelope from noise emissions. • Construction of the proposal has the potential to impact visual amenity within vicinity of the development envelope.
Mitigation	Avoid	• The proposed upgrades to the Army Groyne will reduce public safety risks and improve the overall visitor arrival experience. • The Department of Transport (DoT) determined that a navigational channel and markers were not required and that the risk to boating users from the relocation of barge traffic is not expected to be significant. • There are no registered Aboriginal cultural heritage (ACH) sites within the development envelope. • Consultation with representatives of the Whadjuk NTC group confirmed that the proposal can proceed without undue risk of breaching the *Aboriginal Heritage Act 1972* in relation to ethnographic sites and places.
	Minimise	**Potential impacts to previously unidentified Aboriginal cultural heritage** • To minimise potential impacts to any previously unidentified subsurface ACH, the following actions will be implemented as per the recommendations from the representatives of the Whadjuk NTC group: – Archaeological monitors are present during all ground disturbing works and that archaeological techniques, such as test pitting and sieving, are employed if artefacts are found • Ongoing consultation will be undertaken with traditional owners as required to determine additional Aboriginal heritage information about potential sites. **Impacts to recreational values (recreational fishing)** • Management and mitigation proposed during construction to minimise impacts to benthic communities and habitats is detailed in the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O). Implementation of these management plans will ensure that the area of benthic communities and habitats permanently impacted by the proposal is limited to the development envelope and ZoHI. • Management and mitigation proposed during construction to minimise impacts to marine environmental quality, which may result in impacts to recreational fishing, is detailed in the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O). Implementation of these management plans will ensure that: – The area affected by reduced water quality (suspended sediments) during dredging and construction will be limited (wherever possible) and will not extend past the modelled ZoHI, ZoMI and ZoI – Marine environmental quality will be maintained at a moderate level of ecological protection during dredging and return to a High Level of Ecological Protection within 2 weeks following completion of dredging • Implementation of the CEMP and DEMMP provides the monitoring and management framework to address potential impacts to marine environmental quality during construction which may indirectly impact recreational fishing values. Key management and monitoring measures include: – Implementation of the Marine Water Quality Monitoring Program (MWQMP) provided in the DEMMP for suspended sediment – Inspections of all dredge equipment to check for leaks or damage • Operational management to minimise impacts to the marine environment is detailed in the OEMP (Emerge, 2024b) (Appendix Q). • Maintenance dredging (if required) will be undertaken in previously disturbed / sandy areas within the development envelope / project footprint where possible. Maintenance dredging frequency, volumes and disposal will be determined as required. Environmental management and monitoring will be undertaken in a manner that is consistent with the document Maintenance Dredging Environmental Management Framework (BMT Oceanica, 2016) prepared for Department of Transport for similar types of maintenance dredging activities. • Marine users to comply with vessel operational restrictions required by DoT and RIA.

Social surroundings

		Impacts to recreational values (public safety) • Implementation of the CEMP provides the monitoring and management framework to minimise risks to public safety during construction. Key management and monitoring measures include: – Equipment will be fitted with noise control devices where possible and appropriate. – Implementation of vehicle speed limits. – Installation of floating markers and signs to limit access to the construction areas within both the marine and terrestrial environment. • Operational management to minimise impacts to the marine environment is detailed in the OEMP (Emerge, 2024b) (Appendix Q). Implementation of this management plan will ensure that: – Installation of floating markers and signs at the entrance to the barge landing (within development footprint) to prevent boat anchorage and swimming in peak season. This will ensure that an increase in vessel movements does not impact public safety – Physical inspections during operations – Maintenance of a complaints register – Public safety risk (i.e. traffic along Parker Point Rd) is addressed by policing and road regulations applicable to Wadjemup / Rottnest Island roads – Marine users to comply with vessel operational restrictions required by DoT and RIA. **Relocation of moorings (permanent and temporary)** • No moorings will be permanently removed and disruption to moorings users will be minimised through: – Temporary relocation of eight moorings during construction of the proposal. The temporary relocation will be undertaken prior to construction commencing to minimise disruption to users. The relocation will be for the duration of construction, for approximately 18 months – The permanent relocation of four moorings will be undertaken prior to construction to minimise disruption to users. • Ongoing stakeholder consultation with the local community regarding the proposal and potential impacts on social surroundings. **Impacts to amenity** • Ongoing stakeholder consultation with the local community regarding the proposal and potential impacts on social surroundings. • As there is an existing groyne within the development envelope, extension of this groyne to support the proposal is unlikely to result in a significant change to visual amenity. • An airborne noise assessment was undertaken of the current barge operations (Appendix U). Noise emissions from the existing operations at the Rottnest Barge Facility comply with the criteria set out by the Environmental Protection (Noise) Regulations 1997 at all times (Herring Storer, 2024). As the existing barge operations comply with the criteria set out by the Environmental Protection (Noise) Regulations 1997, it is predicted that the relocated operations will also comply with the regulations and no significant noise impacts from the proposal are anticipated. • Management targets and actions to minimise potential impacts to amenity from increase in noise, lighting, odour and dust from construction of the proposal are outlined in the CEMP (Appendix P). The management targets include: – Noise emissions do not exceed assigned noise levels as prescribed in the Environmental Protection (Noise) Regulations 1997 – No fugitive dust emission outside of the development envelope – Zero incidences of fire resulting from the proposal. • Key management measures outlined in the CEMP to achieve these targets include: – Construction contractor specifications will require that all construction work will be carried out in accordance with control of noise practices set out in Section 4 of Australian Standard 2436 Guide to Noise Control on Construction, Maintenance and Demolition Sites – Vehicle operation will occur during prescribed hours (between 7.:00 am and 7.00 pm) – Equipment will be fitted with noise control devices where possible and appropriate – Implement dust suppression measures – Enforce speed limits – Provision of facilities to ensure waste is appropriately disposed of. • Management targets and actions to minimise potential impacts to amenity from increase in noise, lighting, odour and dust from construction of the proposal are outlined in the OEMP (Emerge, 2024b) (Appendix Q). The management targets include: – Limit the impact on social surroundings, including noise, dust and visual intrusion through controlled vehicle movement procedures, to avoid public and community issues. – Limit issues related to freight operations that may cause potential negative impacts on social surroundings. – Ensure waste disposal measures and prevent rubbish and litter impact on visual amenity. – Ensure local amenity is protected and public safety measures are undertaken. • Key management measures outlined in the OEMP to achieve these targets include: – Dust management measures: ○ Vehicle movements will be restricted to the designated access roads to minimise dust impacts to surrounding users. ○ Vehicle speeds will be restricted to minimise the generation of dust. – Waste management measures: ○ Ensure all waste is either recycled or moved off site to the Island disposal facility. – Noise management measures: ○ Equipment will be fitted with noise control devices where possible and appropriate. – Lighting management measures: ○ The use of lighting at night will be for safety purposes only and will be designed to minimise impacts to surrounding users as much as possible. ○ Adaptive light controls to manage light timing, intensity and colour will be implemented to minimise impacts from lighting. ○ Only add light for specific purposes such as navigational and safety ○ Light only the object or area intended through lighting placement and design (e.g. placement of lights close to the ground, ensuring lights are directed and shielded to avoid light spill). ○ Use the lowest intensity lighting appropriate for the task. ○ Use non-reflective, dark-coloured surfaces. ○ Use lights with reduced or filtered blue, violet and ultra-violet wavelengths. – Odour management measures: ○ Odour generated from waste compactors will be managed through short transfer intervals, which are currently removed on Tuesdays and Thursdays between 11.00 am and 3.00 pm. The remainder of items transported through the new facility are inert with low potential for odour. **Disturbance of UXO** • Surrich (2019) and TAMS Group (2019) undertook a magnetic field survey for UXO to delineate the risks of disturbing UXO. An additional UXO survey, prior to construction works, will be undertaken to further assess anomalies identified during the initial UXO survey • Management targets and actions to minimise potential impacts to social surroundings from the risk of disturbance to UXOs from construction of the proposal are outlined in the CEMP (Appendix P). The management targets include: – Minimise risk of disturbance to UXO site.
	Rehabilitate	• If the resurveyed ferrous debris targets are identified as UXO, appropriate remediation and management will be undertaken. • Construction effects (outside the development envelope and ZoHI) on recreational fishing will be temporary and natural amelioration will mitigate or remove long-term impacts following cessation of construction activities. • All impacted moorings are proposed for relocation (rather than removal).
	Offset	Social surroundings offsets are not considered applicable to the proposal.
Residual impacts	• The permanent relocation of four moorings.	
Environmental outcomes	• Noise emissions do not exceed assigned noise levels as prescribed in the Environmental Protection (Noise) Regulations 1997 • Maintain recreational fishing values by ensuring there are no observable impacts to benthic communities and habitats outside the ZoMI. • Minimise risk of disturbance to UXO • No permanent loss or change to the total number of moorings as a result of implementation of the proposal. • No impacts to registered Aboriginal cultural heritage sites. • Maintain amenity values during construction and operation.	

1 INTRODUCTION

In 2019, Rottnest Island Authority (RIA) commenced technical investigations to support the proposed South Thomson Barge Landing Development (the proposal) Wadjemup / Rottnest Island. At the end of 2020, the project was paused and no further works were undertaken. RIA has now recommenced the South Thomson Barge Landing Development project.

Ferry berthing and barge operations currently occur at the Main Jetty, at central Thomson Bay, on Wadjemup / Rottnest Island. RIA is proposing to relocate the existing barge operations from the Main Jetty, at central Thomson Bay, to the proposed development envelope located at the existing Army Groyne, South Thomson Bay. This will separate barge operations from public passenger transfer activities and ease congestion at the ferry terminal at the Main Jetty.

Figure 4 provides an overview of the location of the proposed South Thomson Barge Landing Development and the location of the existing barge operations at the ferry terminal at central Thomson Bay.

Figure 4: Regional overview

1.1 Purpose and scope of this document

The purpose of this Environmental Supporting Document is to describe and assess the significance of the environmental impacts to the environmental values associated with the implementation of the proposal. This report provides information on the proposal, local and regional setting, key stakeholders, potential environmental impacts, cumulative impacts and proposed mitigation measures associated with the construction and operation of the proposal.

This document has been prepared to provide a detailed description of the proposal to inform an environmental impact assessment and support the following environmental approvals:

- Referral of the proposal to the Environmental Protection Authority (EPA) under Section 38 of the *Environmental Protection Act 1986* (EP Act) to describe and assess the potential impacts to the EPA's environmental factors
- Referral of the proposal to the Department of Climate Change, Energy, the Environment and Water (DCCEEW) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) to address potential impacts to matters of national environmental significance (MNES).

This supporting document has been prepared to reflect the state framework for environmental impact assessment under the *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2016* and the associated *Procedures Manual (Part IV Divisions 1 and 2)*.

Section 14.2 addresses the potential for the proposal to have a significant impact on federal MNES in accordance with the Significant Impact Guidelines 1.1 – Matters of National Environmental Significance (Department of the Environment, 2013).

1.2 Proponent information

Rottnest Island Authority is the proponent for the South Thomson Barge Landing Development, as summarised below.

Name:	Rottnest Island Authority
Postal address:	PO Box 693, Fremantle WA 6959
ABN:	38836160172

The key contact is:

Name:	David Pond
Position:	Environment Compliance and Approvals Coordinator
Phone:	(08) 9432 9300
Email:	david.pond@dbca.wa.gov.au

Further information on the proponent can be sourced from RIA's website: https://www.ria.wa.gov.au/projects-and-developments/significant-projects/marine-logistics-hub.

2 PROPOSAL

2.1 Justification

2.1.1 Key benefits

The key benefits that are anticipated from implementation of the proposal are summarised in Table 12. These benefits are discussed further in Sections 2.1.2.1 to 2.1.2.2.

Table 12: Key benefits from implementation of the proposal

Benefit	Description
Enhanced visitor amenity from a ferry improvement, and barge improvement.	This benefit captures an improvement in visitor satisfaction over time, measured through an increase in visitor willingness to pay for enhanced amenity on the island. Enhanced amenity is achieved through the removal of the barge landing and ferry luggage operations from the Main Jetty to the South Thomson Development, and therefore captures a benefit from both a 'ferry improvement' and a 'barge improvement'.
Avoided future operations and maintenance costs.	This benefit captures the avoided future operations and maintenance costs incurred by RIA due to the requirement to maintain the current Army Groyne to a safe and workable standard.
Avoided safety costs.	This benefit captures the avoided safety costs associated with near-miss and the risk of more serious incidents at the Main Jetty, associated with the conflicted uses of the Main Jetty in its current configuration.
Avoided personal injury and death costs.	This benefit captures the avoided personal injury and death costs associated with inappropriate use of the Army Groyne by visitors to Wadjemup / Rottnest Island, by converting the Army Groyne to an operational area with no public access.
Cost savings from modifying the current barging operation.	This benefit captures the cost savings from the modification of barging operations through the use of more efficient barge sizes, reducing the number of trips required between the island and Perth for a given level of activity at the island.

(ACIL Allen, 2024)

2.1.2 Rottnest Island Management Plan 2023–2028

The *Rottnest Island Authority Act 1987* and Rottnest Island Regulations 1988 require that RIA manage the island in accordance with the Rottnest Island Management Plan 2023–2028 (Rottnest Island Authority, 2023). The Rottnest Island Management Plan 2023–2028 is centred on the following five Strategic Focus Areas (ACIL Allen, 2024):

1. Diversify the visitor base and enhance visitor experience
2. Deliver sustainable infrastructure and services
3. Respect and engage with the island's cultural heritage
4. Explore and conserve the island's heritage
5. Foster strong partnerships.

Under Strategic Focus Areas, RIA has defined a number of Key Initiatives. Key Initiatives that relate directly to the proposal are discussed in Table 13 and Sections 2.1.2.1 and 2.1.2.2.

Table 13: Rottnest Island Management Plan 2023–2028 Strategic Focus Areas

Strategic focus area	Key initiatives	Relevance to proposal
1. Diversify the visitor base and enhance visitor experience	**1.1** Target new visitor segments **1.2** Enhance visitor experience **1.3** Facilitate new accommodation and hospitality developments **1.4** Renew and expand RIA visitor accommodation – Stay Rottnest **1.5** Improve RIA's affordable visitor accommodation – Stay Rottnest **1.6** Realise Kingstown Barracks' vision **1.7** Encourage new recreational offerings **1.8** Upgrade Pedal & Flipper Hire facility **1.9** Improve accessible tourism.	**1.2 Enhance visitor experience** RIA has plans to transition the island's barging operations away from the main jetty to the former Army Groyne in South Thomson Bay. This will help reduce visitor congestion, improve safety and improve the arrival experience.
2. Deliver sustainable infrastructure and services	**2.1** Support renewable energy and electrical infrastructure upgrades **2.2** Support drinking water production, supply, and retention **2.3** Support ablutions and wastewater upgrades **2.4** Assess and upgrade transport infrastructure **2.5** Maintain maritime infrastructure **2.6** Review moorings policies and management **2.7** Review the Facilities, Utilities and Support Services contract **2.8** Improve asset management.	**2.5 Maintain maritime infrastructure** Wadjemup / Rottnest Island is a favourite hotspot for Western Australia's boating and sailing community and caters for commercial and recreational marine vessels visiting the island for day trips or extended visits. RIA is responsible for the construction, management, and operation of the island's maritime structures including a main operating commercial jetty, five recreational jetties, a commercial barge landing ramp, a rock groyne and associated boat ramp and the newly constructed limestone seawall at South Thomson Bay to minimise ongoing erosion of the dune area. RIA has developed a Maritime Infrastructure Asset Management Plan to implement the following projects: 1. Main jetty berth 1–3 refurbishment 2. Barge landing ramp refurbishment 3. Hotel jetty refurbishment 4. Geordie Bay jetty refurbishment 5. Main jetty firefighting facility 6. General maintenance.

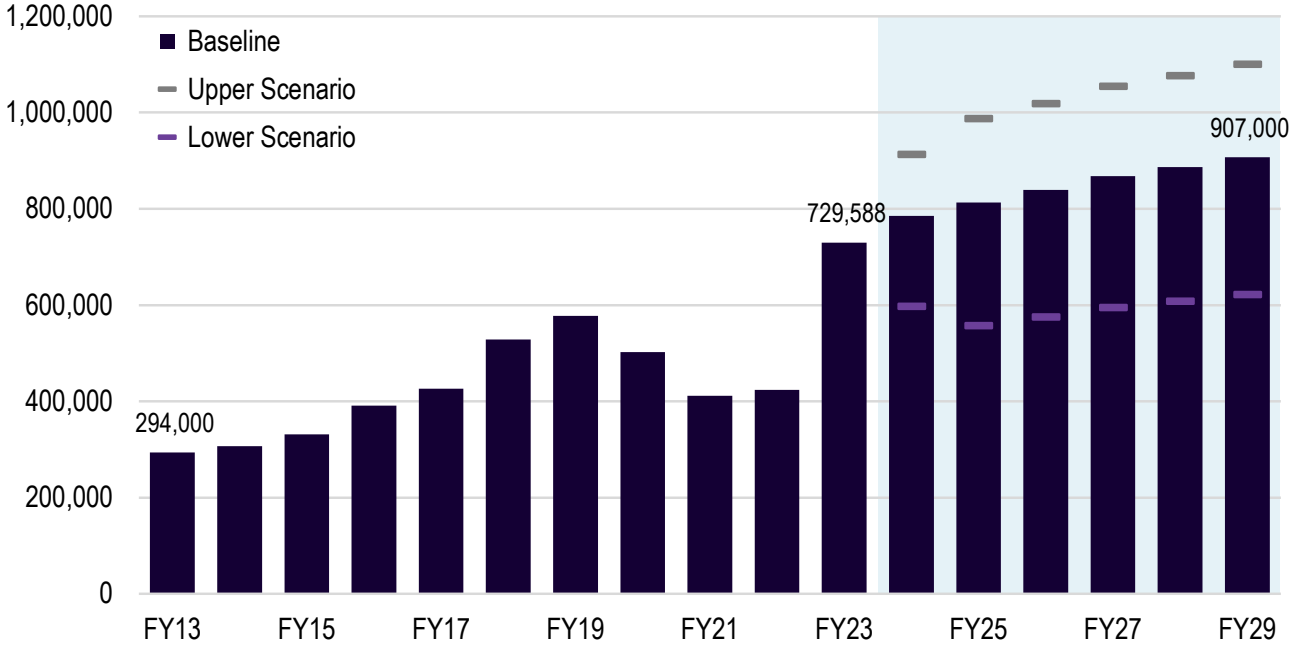
2.1.2.1 Enhancing visitor experience

2.1.2.1.1 Conflicts in use at the Main Jetty

The Main Jetty is the primary marine infrastructure asset on Wadjemup / Rottnest Island, providing both passenger and logistics services. There is an inherent conflict in this approach, as visitors to the island are required to walk past a busy logistics hub. This situation is compounded by the operating structure and contracts associated with the activities that occur on the Main Jetty, as detailed below:

- Movement of Wadjemup / Rottnest Island visitors (including their bicycles) and staff on and off the island by ferry operators including Rottnest Fast Ferries, Rottnest Express and SeaLink
- Movement of island accommodation guest luggage on to and off the island by Programmed Facilities Management
- Operations of the barge landing and logistics services for all island businesses including RIA by Pelagic Marine Services.

An increase in visitation to Wadjemup / Rottnest Island has resulted in increased utilisation of all marine assets, particularly the Main Jetty, which accommodates ferry arrivals and departures. Graph 1 provides the ferry-based visitation to Wadjemup / Rottnest Island under lower and upper scenarios.



Graph 1: Total ferry-based visitation to Wadjemup / Rottnest Island, visitors by financial year, and lower and upper scenario (ACIL Allen, 2024)

A significant increase in RIA's capital works program has also contributed to an increase in activity at the Main Jetty and current barge landing site. Future expenditure on capital works is also expected to contribute to an elevated level of activity at the Main Jetty and current barge landing site over the next three to five years (ACIL Allen, 2024).

Barging operations attributable to third party developments (e.g. The Lodge Wadjemup) have also contributed to congestion during construction activity. As detailed in the Rottnest Island Management Plan, there are a number of potential developments that are expected to result in further increases in congestion at the current barge landing and tourist receival site, including:

- Golf Course Precinct revitalisation and Mount Herschel provision for visitor accommodation
- Staff accommodation along Parker Point Road, north of Kingstown
- New and infill visitor accommodation at South Thomson Bay, North Thomson Bay and Bathurst.

2.1.2.1.2 Safety issues

There are potential risks arising from the interaction of the barge servicing activities (servicing vehicles, which use Henderson Avenue to access the Barge Landing Area) and Wadjemup / Rottnest Island visitors (pedestrians and cyclists). This risk is due to the location of the barge landing area, which is at the base of the Main Jetty, where visitors embark and disembark the ferry. Over 23 safety incidents have been reported between 2017 and 2023 (ACIL Allen, 2024).

It is anticipated that relocating the existing barge operations away from the Main Jetty will reduce the frequency of these safety incidents.

2.1.2.1.3 Inefficiencies associated with the current barging area

The current location of barging operations is constrained and there are limited means by which the existing operating envelope of barging operations can increase without impacting on other uses of the Main Jetty or without incurring higher costs.

An options assessment identified that the current barge landing infrastructure at the Main Jetty does not cater for any growth in vessel size over time. This is due to the depth of the berth pocket at the current barge landing, and the height of the barge ramp relative to the tidal range of the area around the Main Jetty. This eliminates the ability for growth in the demand for in-bound and out-bound logistics to be met by larger barge vessels; growth is instead met by the relatively less efficient method of an increase in the number of barge movements.

The proposal has been designed to allow for larger barge vessels than are currently accommodated at the Main Jetty.

2.1.2.2 Maintain maritime infrastructure

The key outcome in regard to maritime infrastructure, as outlined in the Rottnest Island Management Plan 2023–2028 (Rottnest Island Authority, 2023), is for the island's maritime infrastructure to be maintained to a high standard. RIA is responsible for the construction, management, and operation of the island's maritime structures, including a main operating commercial jetty, five recreational jetties, a commercial barge landing ramp, a rock groyne and associated boat ramp, and the newly constructed limestone seawall at South Thomson Bay (which is mitigating ongoing erosion of the dune area).

Since 2020, three jetties have been reconstructed or replaced, including the fuel jetty (2020), Stark and T jetty (2021), and Main Jetty berths 4/5 (December 2022).

Implementation of the proposal at the existing Army Groyne avoids the requirement for ongoing maintenance of the Army Groyne.

2.1.3 Rottnest Island Land Use Plan

The Rottnest Island Land Use Plan classifies the site as an infrastructure and support services zone, which is compatible with the proposal (Figure 5).

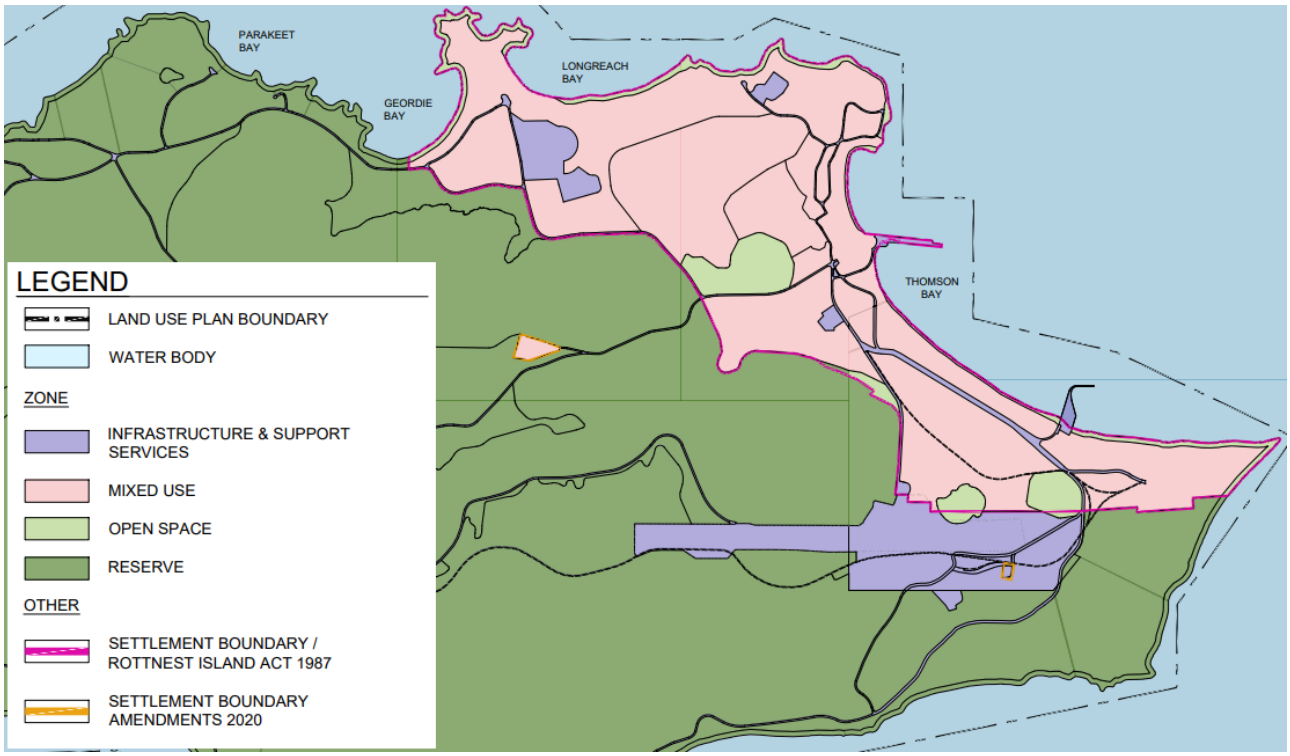


Figure 5: Rottnest Island Land Use Plan (RIA, 2024)

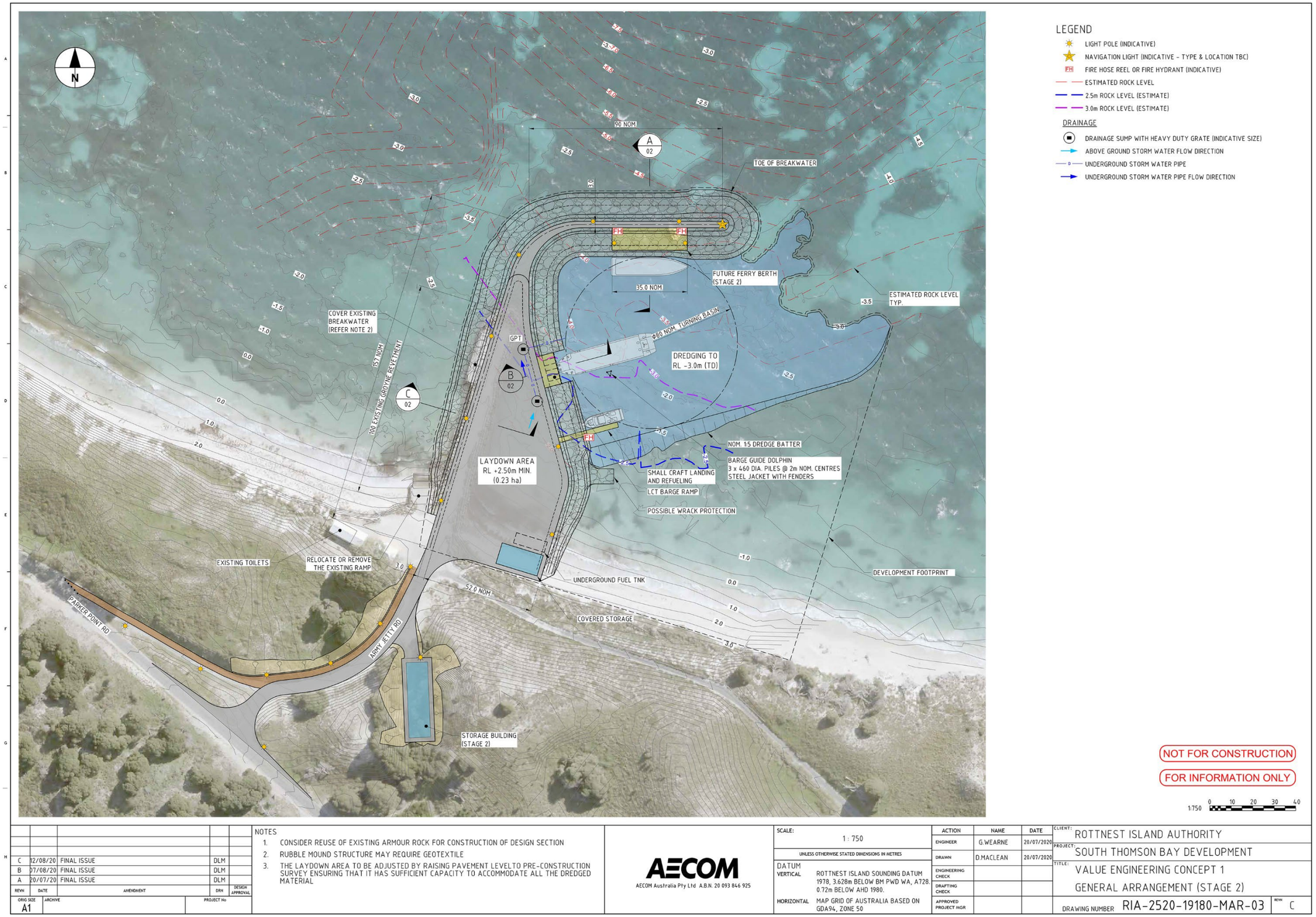
2.2 Proposal description

The South Thomson Barge Landing Development is proposed to be developed at the location of the existing Army Groyne in South Thomson Bay (Figure 4 and Figure 10).

The proposal will be primarily used for barge operations, which will be relocated from the existing ferry terminal at the Main Jetty in central Thomson Bay to the proposed location at the Army Groyne in South Thomson Bay. This will separate barge operations from public passenger transfer activities and ease congestion at the ferry terminal. The proposed development will improve the functionality and efficiency of transporting bulk cargo to and from Wadjemup / Rottnest Island and improve safety and amenities for visitors to the island.

The proposed development will include the following key aspects, as depicted in Figure 6:

- The relocation of critical barging operations from the Main Jetty to the existing Army Groyne (Figure 4)
- Construction of the proposed facility, which will include both onshore and offshore components as summarised below:
  - Extension of the existing Army Groyne
  - Construction of maritime infrastructure including a barge landing ramp, ferry berth and small craft landing facility
  - The establishment of new fuelling facilities as back up vessel refuelling facilities
  - Construction of a storage facility
  - Construction of hardstand and roads
- Installation of services including water, firefighting, electrical, communications and fuel.



REVN	DATE	AMENDMENT	DRN	DESIGN APPROVAL
C	12/08/20	FINAL ISSUE	DLM	
B	07/08/20	FINAL ISSUE	DLM	
A	20/07/20	FINAL ISSUE	DLM	

ORIG SIZE A1 | ARCHIVE | PROJECT No

NOTES
1. CONSIDER REUSE OF EXISTING ARMOUR ROCK FOR CONSTRUCTION OF DESIGN SECTION
2. RUBBLE MOUND STRUCTURE MAY REQUIRE GEOTEXTILE
3. THE LAYDOWN AREA TO BE ADJUSTED BY RAISING PAVEMENT LEVELTO PRE-CONSTRUCTION SURVEY ENSURING THAT IT HAS SUFFICIENT CAPACITY TO ACCOMMODATE ALL THE DREDGED MATERIAL

AECOM
AECOM Australia Pty Ltd A.B.N. 20 093 846 925

SCALE: 1 : 750
UNLESS OTHERWISE STATED DIMENSIONS IN METRES
DATUM
VERTICAL: ROTTNEST ISLAND SOUNDING DATUM 1978, 3.628m BELOW BM PWD WA, A728. 0.72m BELOW AHD 1980.
HORIZONTAL: MAP GRID OF AUSTRALIA BASED ON GDA94, ZONE 50

ACTION	NAME	DATE
ENGINEER	G.WEARNE	20/07/2020
DRAWN	D.MACLEAN	20/07/2020
ENGINEERING CHECK		
DRAFTING CHECK		
APPROVED PROJECT MGR		

CLIENT: ROTTNEST ISLAND AUTHORITY
PROJECT: SOUTH THOMSON BAY DEVELOPMENT
TITLE: VALUE ENGINEERING CONCEPT 1
GENERAL ARRANGEMENT (STAGE 2)
DRAWING NUMBER RIA-2520-19180-MAR-03 REVN C

Figure 6: Barge Landing design concept

Construction of the above will be undertaken in two stages as described in Table 14 and shown Figure 7 and Figure 8. The proposed constriction methods are described in further detail in Appendix A.

All construction activities will be undertaken within the development envelope shown in Figure 9.

Table 14: Description of construction stages

Construction stage	Construction method	Details
Stage 1 (Figure 7)	Preliminary actions	This includes all planning, design and preparation works including plant and equipment and fabrication activities. This will also include verification of the site (seabed survey) as well as any underground service location.
	Mobilisation and site set up	This includes installation of site sheds, preparation of laydown areas, erection of marine traffic management, site signage, public advertisements and mobilisation of equipment.
	Temporary works construction	A temporary roll-on, roll-off (RORO) facility will be constructed to off load equipment and materials. The RORO will be constructed either through localised improvements to the Army Groyne or a bespoke structure and may located on the western side of the Army Groyne. The RORO will be suitable for unloading of large equipment and/or materials such as precast concrete, piles, earthmoving equipment, temporary structures, and also dredge spoil for use in reclamation. The existing small boat landing may be utilised by the contractor during construction for launching small craft.
	Dredging	Dredging must be undertaken across the dredge footprint prior to construction of the wharf and new laydown area. Dredging methodologies are described in Table 17 and Appendix A of this report and summarised below: • An estimated 14,000 m^3 of sand and 2,017 m^3 of rock will be dredged. Once loosened or dislodged, these materials will be raised to the water's surface, to be undertaken mechanically via raising the bucket or grab of a backhoe dredge (BHD). • Excavated material is placed onto a flat-top barge moored alongside the BHD. When the barge is filled to its safe working capacity, it will drive to the RORO facility to be unloaded. • A silt curtain will be placed around the BHD to mitigate the potential environmental impact due to the dredge plume.
	Reclamation	The laydown area shall incorporate reclaimed dredged fill material and shall be constructed as described in Table 17 and Appendix A of this report.
	Extension of the existing Army Groyne	On completion of the reclamation processes, the existing Army Groyne will be upgraded and extended through: • Removal of excess rock and materials and reshaping the existing Army Groyne • Placing core materials, a filter layer (geotextile) and rock armour to shape and extend the existing groyne.
	Maritime infrastructure	Maritime infrastructure constructed in Stage 1 includes the Barge Landing Ramp. The Barge Landing Ramp works include: • Installation of a precast concrete gravity retaining wall below the water level at the dredge level • Installation of the deck slab • Installation of mooring piles using a vibro hammer (a contingency for the use of hammer piling has been allowed in the impact assessment undertaken in this document should the vibro hammer hit refusal. If the vibro hammer hits refusal, hammer piling will be undertaken).
	Services	Underground services will be installed and connected to onshore underground services. Services consist of: • Water • Firefighting services • Electrical services • Communications • Fuel tank. The fuel tank will be installed in the south-east corner of the reclamation zone and will be installed within the compacted dredge spoil. Installation of the fuel tank will be in accordance with all Dangerous Goods regulations (i.e. double lined tank, leak detection systems, tank pit/groundwater monitoring wells).

Construction stage	Construction method	Details
	Storage shed	These works consist of construction of the shed structure and hardstand in the south-east corner of the reclamation zone.
	Road works	Road work construction required to complete any sections of the new facility and the road section linking to the Army Jetty Road.
	Demobilisation	Demobilisation will be undertaken at completion of construction works as outlined in Appendix A.
Stage 2 (Figure 8)	Ferry berth	The ferry berth will be constructed through: • Installation of piles using a vibro hammer. As outlined in Stage 1, a contingency for the use of a hammer pile has been allowed in the construction methodology and impact assessment should the vibro hammer meet refusal • Installation of a precast concrete deck and surface • Fit out of the wharf with fenders, fender chains, mooring bollards, signage, lighting.
	Small craft landing	The Small Craft Landing works include: • Installation of piles using a vibro hammer rig. A contingency for the use of a hammer pile has been allowed in the construction methodology and impact assessment should the vibro hammer meet refusal. • Installation of abutment • Installation of floating deck units • Installation of navigational aids.
	Storage building	Construction of the storage shed structure and hardstand to the east of Army Jetty Road.

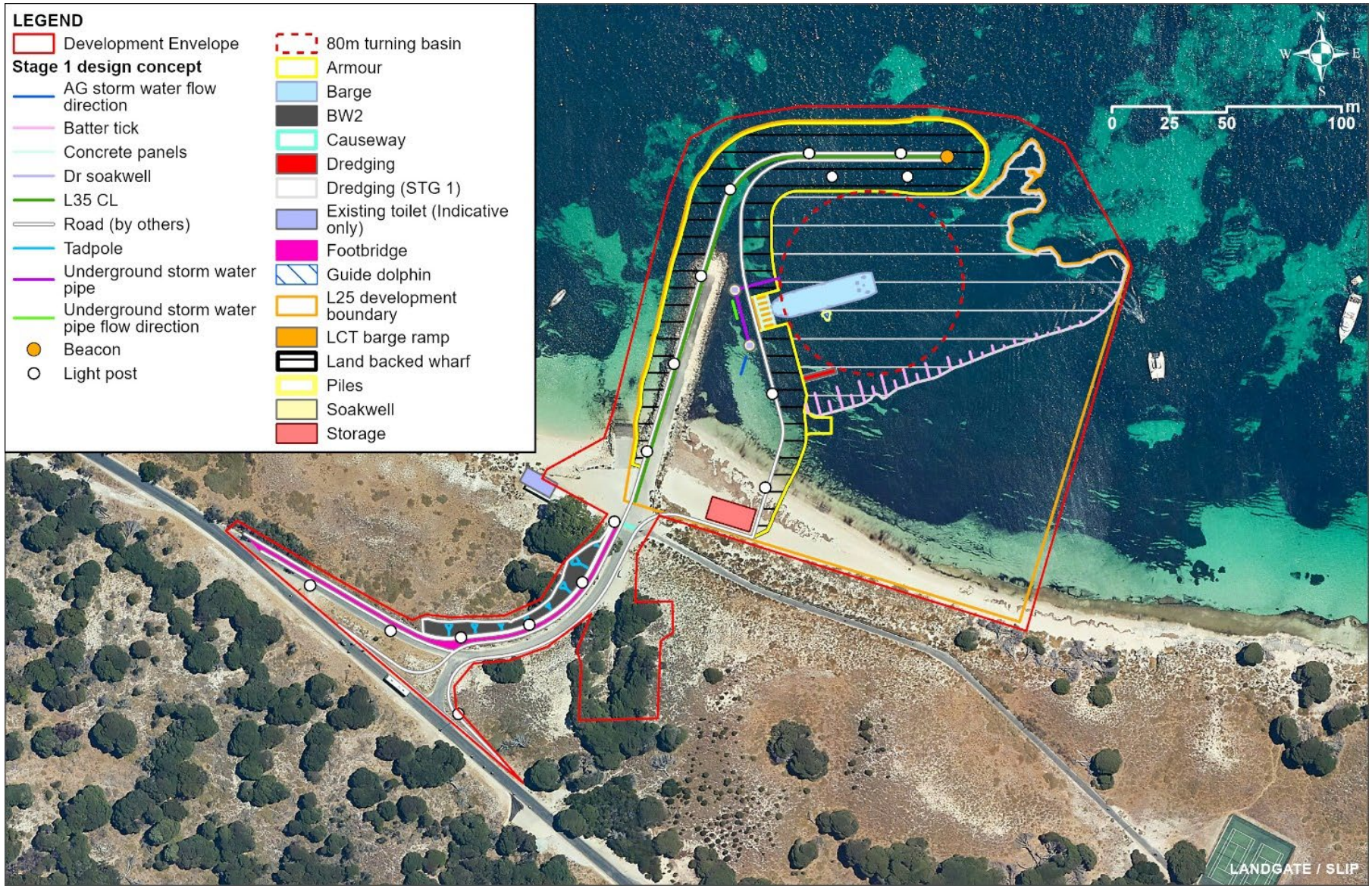


Figure 7: Proposal development plan (Stage 1)

Figure 8: Proposal development plan (Stage 2)

2.2.1 Proposal content

The proposal comprises an onshore component and offshore component (an area of reclamation and an extension of the existing Army Groyne to form the proposed wharf) as summarised below:

- **Indicative disturbance footprint**: The indicative disturbance footprint encompasses the onshore and offshore physical infrastructure associated with proposal and dredge areas (Figure 9).
  - The onshore component comprises approximately 1 hectare (ha).
  - The offshore component comprises a wharf area (extension of the existing Army Groyne) (1.13 ha) and a dredge area (1.02 ha) (Table 17), resulting in a combined indicative disturbance footprint of up to 3.15 ha.
- **Development envelope**: Comprises 4.6 ha and encompasses the indicative disturbance footprint and a buffer area (the majority of which comprises the dredge Zone of High Impact (ZoHI)) (Figure 9).

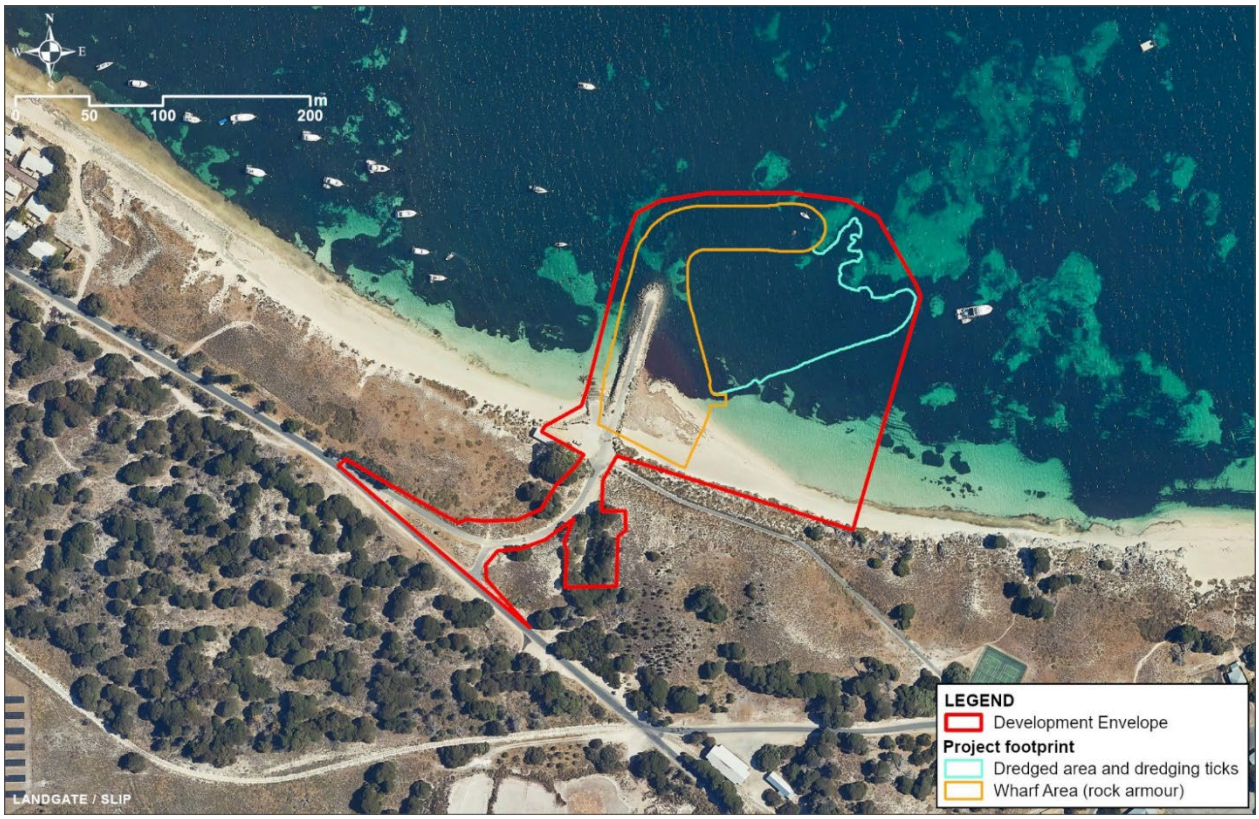


Figure 9: Development envelope

In addition to the development envelope, the environmental impact assessment presented in this report has also included the predicted zone of impact from the proposed dredging activities. A Dredge Plume Modelling Assessment was undertaken by Baird (2024b) that calculated the zones of impact, these are shown in Figure 10 and summarised in Table 15.

Table 15: Predicted zones of impact (Baird, 2024b)

Zone of impact	Definition
Zone of High Impact (ZoHI)	The area where impacts on benthic communities or habitats are predicted to be irreversible. The term irreversible means 'lacking a capacity to return or recover to a state resembling that prior to being impacted within a timeframe of five years or less'.
Zone of Moderate Impact (ZoMI)	The area within which predicted impacts on benthic communities or habitats are recoverable within a period of five years following completion of the dredging activities. This zone abuts, and lies immediately outside of, the ZoHI.
Zone of Influence (ZoI)	The area within which changes in environmental quality associated with dredge plumes are predicted and anticipated during the dredging operations, but where these changes would not result in a detectible impact on benthic biota. At any point in time, the dredge plumes are likely to be restricted to a relatively small portion of the ZoI.

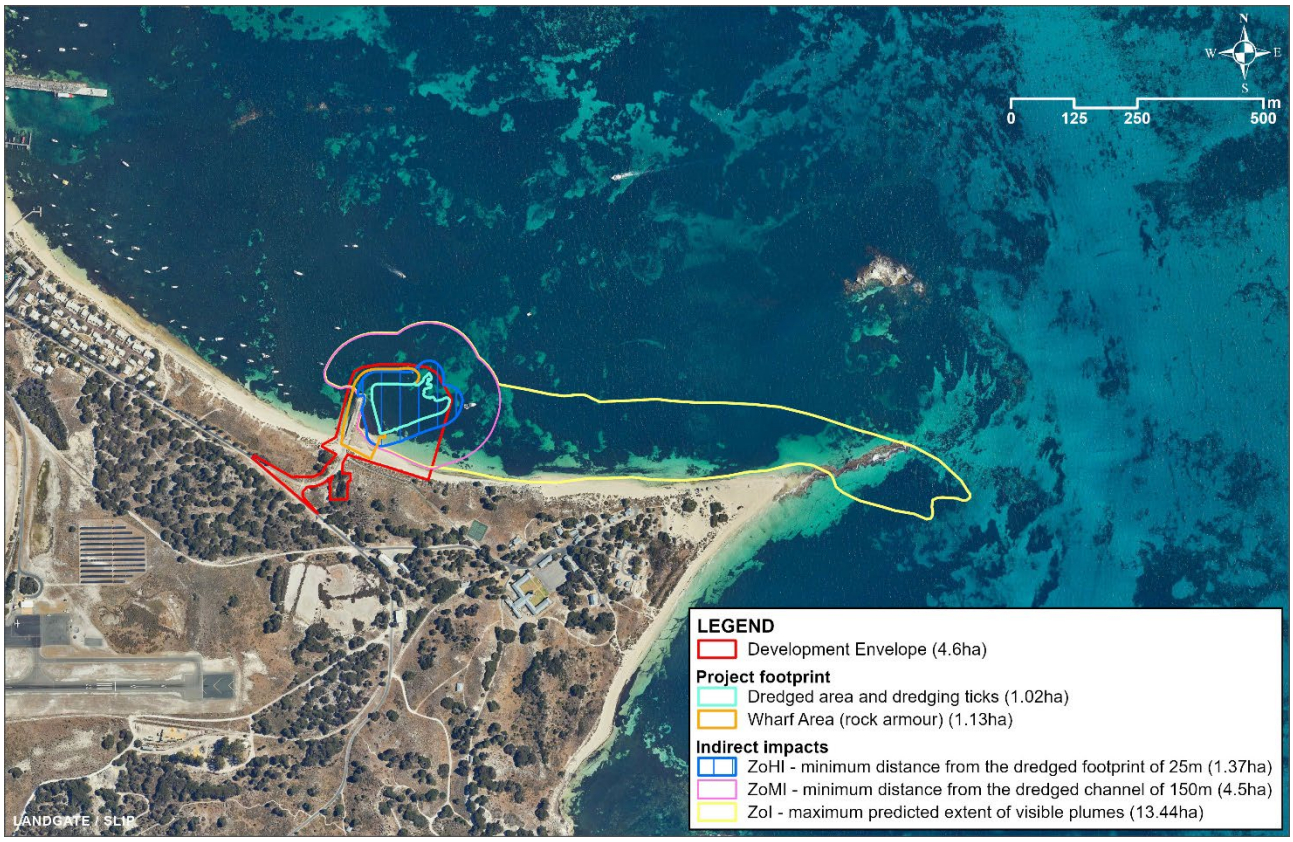


Figure 10: Development envelope and predicted zones of impact

A summary of the proposal is provided in Table 16 and a description and identification of the proposal elements is provided in Table 17.

Table 16: Summary of the proposal

Proposal title	South Thomson Development Barge Landing Project
Proponent name	Rottnest Island Authority
Short description	Rottnest Island Authority is proposing to relocate the island's existing barging operations away from the Main Jetty to the existing Army Groyne in South Thomson Bay. This will help reduce congestion and improve the arrival experience to the island. To support the relocation of the barge operations, Rottnest Island Authority is proposing to extend and redevelop the existing Army Groyne.

Table 17: Description and identification of proposal elements

Proposal element	Location / description	Maximum extent, capacity or range
Physical elements		
Development envelope	Figure 10 Encompasses the indicative disturbance footprint and a buffer area, the majority of which comprises the dredge Zone of High Impact (ZoHI)).	4.6 ha
Indicative disturbance footprint	Figure 10 The indicative disturbance footprint encompasses the onshore and offshore physical infrastructure associated with proposal and dredge areas.	Total area: 3.15 ha Terrestrial disturbance footprint: 1 ha Wharf and laydown area (marine footprint): 1.13 ha Dredge area (marine footprint): 1.02 ha
Construction elements		
Dredging	Construction methodologies are provided as Appendix A. Dredging and piling are likely to be undertaken in the winter months of 2026. Dredge plume modelling by Baird (2024b) estimates that dredging may take up to 7.5 weeks to complete. The dredging methodology is summarised below: • Dredging will be undertaken with the use of a Backhoe Dredge (BHD). • The BHD is positioned with a support tug and then using its spud piles and excavator arm it manoeuvres into the required dredging location. • The loosening or cutting process breaks the in-situ materials' cohesion, allowing these materials to be removed. The process will be carried out mechanically using the cutting edge of a bucket on a BHD. Once loosened or dislodged, these materials will be raised to the water's surface mechanically via raising the bucket or grab of a BHD. • Excavated material is placed onto a flat-top barge moored alongside the BHD. When the barge is filled to its safe working capacity, it will drive to the RORO facility to be unloaded. • A silt curtain around BHD will be installed to mitigate the potential environmental impact from the dredge plume. • The dredged material will be reused as fill material in the laydown/hardstand and reclamation area.	The proposed dredge area is shown in Figure 10 and comprises 1.02 ha. Dredging will be undertaken to a declared depth of – 3.0 m Chart Datum, which will include a turning basin with a nominal diameter of 80 m. An estimated 14,000 m^3 of sand and 2,017 m^3 of rock will be dredged.
Reclamation	Construction methodologies are provided as Appendix A. The reclamation methodology depicted in Figure 11 is summarised below: • Existing armour from the eastern side of the Army Groyne will be removed and used for construction of bunding. Bunding will be constructed along the eastern and northern sides of the reclamation zone to allow dredge spoil to settle and remain in place. This bunding will prevent dredge spoil from being washed away into the marine environment. Figure 11 provides an indication of the bund wall location. • The bunding will be constructed using core materials, followed by a geotextile filter layer and an armour layer. Figure 12 provides a conceptual cross-section of the bunding, reclamation fill and then adjacent dredge zone. • As reclamation progresses, the bunding on the marine side of the reclamation zone will need to be progressively moved to the north to ensure that each successive round of dredge spoil placed will remain in place. • Using the dredged spoil, the contractor will establish a tip head to place the dredged material into the water in the south-west corner of the reclamation area. Dredge spoil will be placed and spread in a north and east direction. • Material will be tipped from the articulated dump truck and pushed out over the tip head using a wheel loader or similar. • Material will be compacted using a static pad foot roller. • Reclamation will continue until all dredge spoil has been placed. AECOM (2020) and PAEMAC (2024) estimated that the dredge spoil will be sufficient to complete the laydown area. There is not expected to be a requirement to import fill to complete the laydown area.	The proposed reclamation area is shown in Figure 10
Construction of the wharf	Construction methodologies are provided as Appendix A. On completion of the reclamation works summarised above, the wharf will be constructed through extending the existing Army Groyne with rock armour as outlined below: • Remove excess rock and materials and reshape the existing Army Groyne. • Import all rock and core materials from the mainland using a conventional barge converted for handling rock. • Place core materials along exposed batter. • Place filter layer (geotextile). • Place class 2 rock armour along exposed batter and class 1 rock armour along the northern breakwater. The proposed rock armour classes are shown in Figure 13. • Place a layer of crushed rock basecourse and asphalt along the Army Groyne extension to match that placed in the reclamation area.	The proposed wharf area is shown in Figure 10
Piling	• The barge landing ramp works will include Installation of mooring piles to a maximum depth of 10 m using a vibro hammer. • Construction of the ferry berth will require installation of piles using a vibro hammer rig operated from a barge located adjacent. The dimensions and number of piles is estimated at 16 × 610 mm that will be installed to a depth of 15 m. If the contractor does not install piles concurrently with construction of the breakwater, then 1200 mm sleeves will need to be installed in the rock armour so piles can be driven through the sleeves. • Construction of the small craft landing facility will include installation of piles using a vibro hammer rig operated from a barge located adjacent. The dimensions and number of piles is estimated at 6 × 500 mm that will be installed to a depth of 10 m. If the contractor does not install piles concurrently with construction of the breakwater, then 1200 mm sleeves will need to be installed in the rock armour so piles can be driven through the sleeves. As discussed in Table 14, all piling proposed will be undertaken using a vibro hammer. However, a contingency of using a hammer pile has been adopted should the vibro hammer meet refusal. Both the proposed piling method (vibro hammer) and contingency method (hammer piling) have been included in the impact assessment.	Piling locations will be determined during detailed engineering design
Other marine infrastructure and services	Hardstand and a shed structure will be constructed within the onshore component of the development envelope. Services will be installed conventionally using a combination of on island and imported small plant. Services consist of water, fire service, power, CCTV and fuel provisions.	All works will occur within the development envelope shown in Figure 10.
Operational elements		
Vessel movements	The proposed facility shall allow barge berthing, unloading and loading and departure for all conditions permitting safe transit across to Wadjemup / Rottnest Island. Typically barge and ferry operations are suspended when wind speed (ten-minute average) exceeds 40kn and/or Hs >4 m for waters inshore of Wadjemup / Rottnest Island. The existing barge schedule, as per Pelagic Marine Services operations, is provided below. There may be exemptions to these times to accommodate for special deliveries.	N/A

Current barge activity	Time
Gates open (20 Rous Head Road, North Fremantle)	5:30 am
Same day perishable deliveries	6:15 am
Scheduled vessel departure	6:45 am
Scheduled arrival – Thomson Bay	8:30 am
Last time for arrival of vehicles and returning goods at the Thomson Bay wharf	10:30 am
Departure (Thomson Bay, depending on volumes, returning freight)	12:00 am to 1.00 pm
Gates close (16 Mews Road, Fremantle)	4:00 pm

Proposal element	Location / description	Maximum extent, capacity or range
Ongoing maintenance	There may be requirements for maintenance dredging during operations. Maintenance dredging (if required) will be undertaken in previously disturbed / sandy areas within the development envelope / project footprint. Maintenance dredging frequency, volumes and disposal will be determined as required.	This will be undertaken as required. Environmental management will be undertaken in a manner that is consistent with the document Maintenance Dredging Environmental Management Framework (BMT Oceanica, 2016) prepared for Department of Transport for similar types of maintenance dredging activities.
Other elements which affect extent of effects on the environment		
Proposal time	Maximum project life	Design life shall be 50 years in accordance with AS4997-2005 Normal commercial structure.
	Construction phase	Construction is proposed to be undertaken between 2026 and 2027.
	Operations phase	50 years.

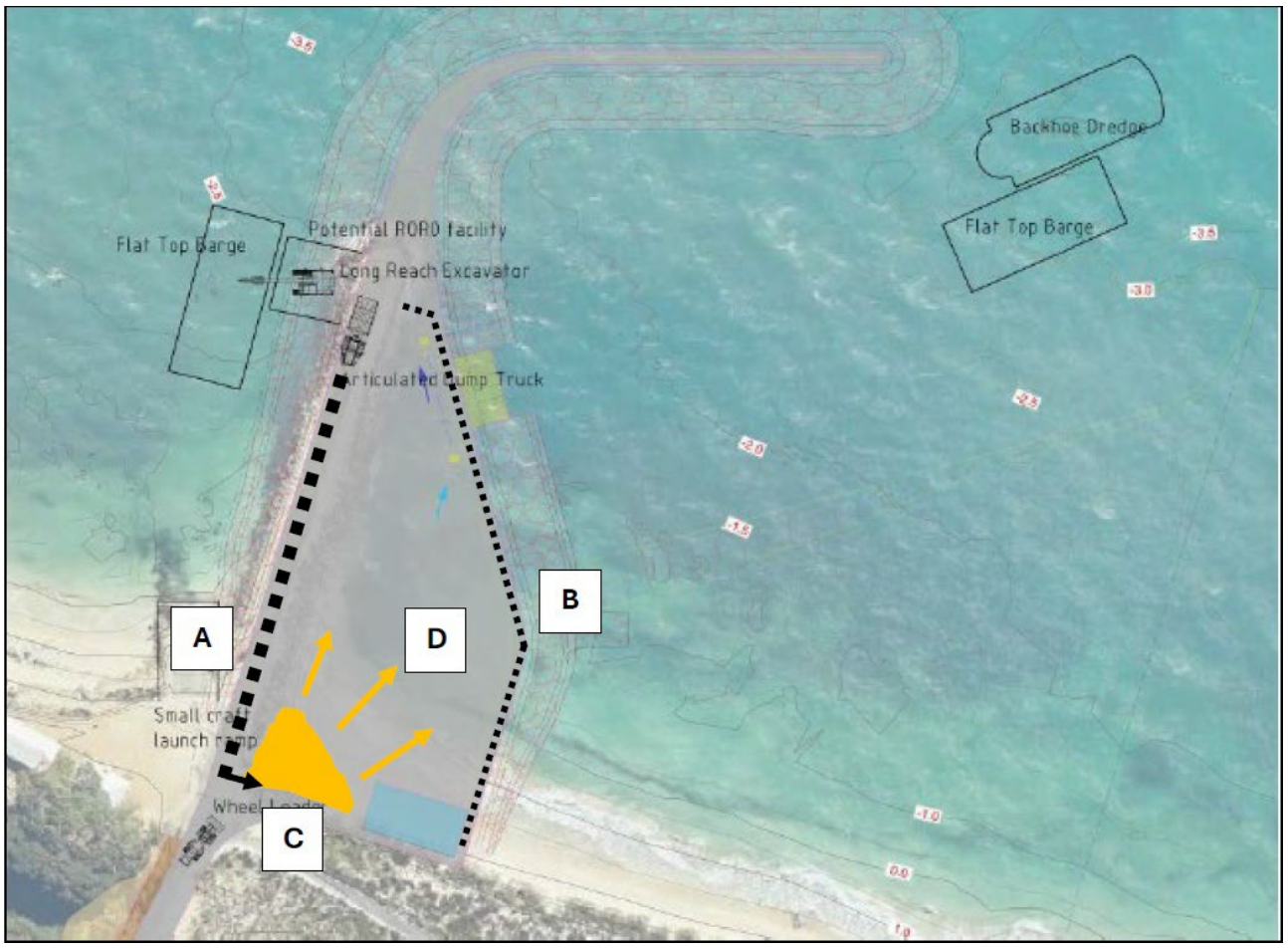


Figure 11: **Indicative process for reclamation showing the Army Groyne (A), bund wall (B), placement of dredge spoil in the south-west corner of the area (C) and direction dredge spoil will be placed and spread (D) (PAEMAC, 2024)**

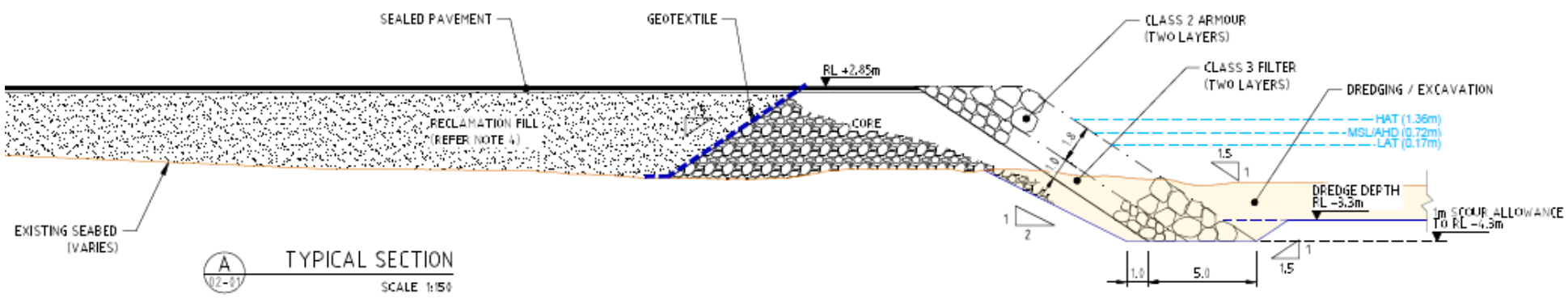


Figure 12: **Conceptual cross-section of the reclamation fill, bunding and adjacent dredge zone**

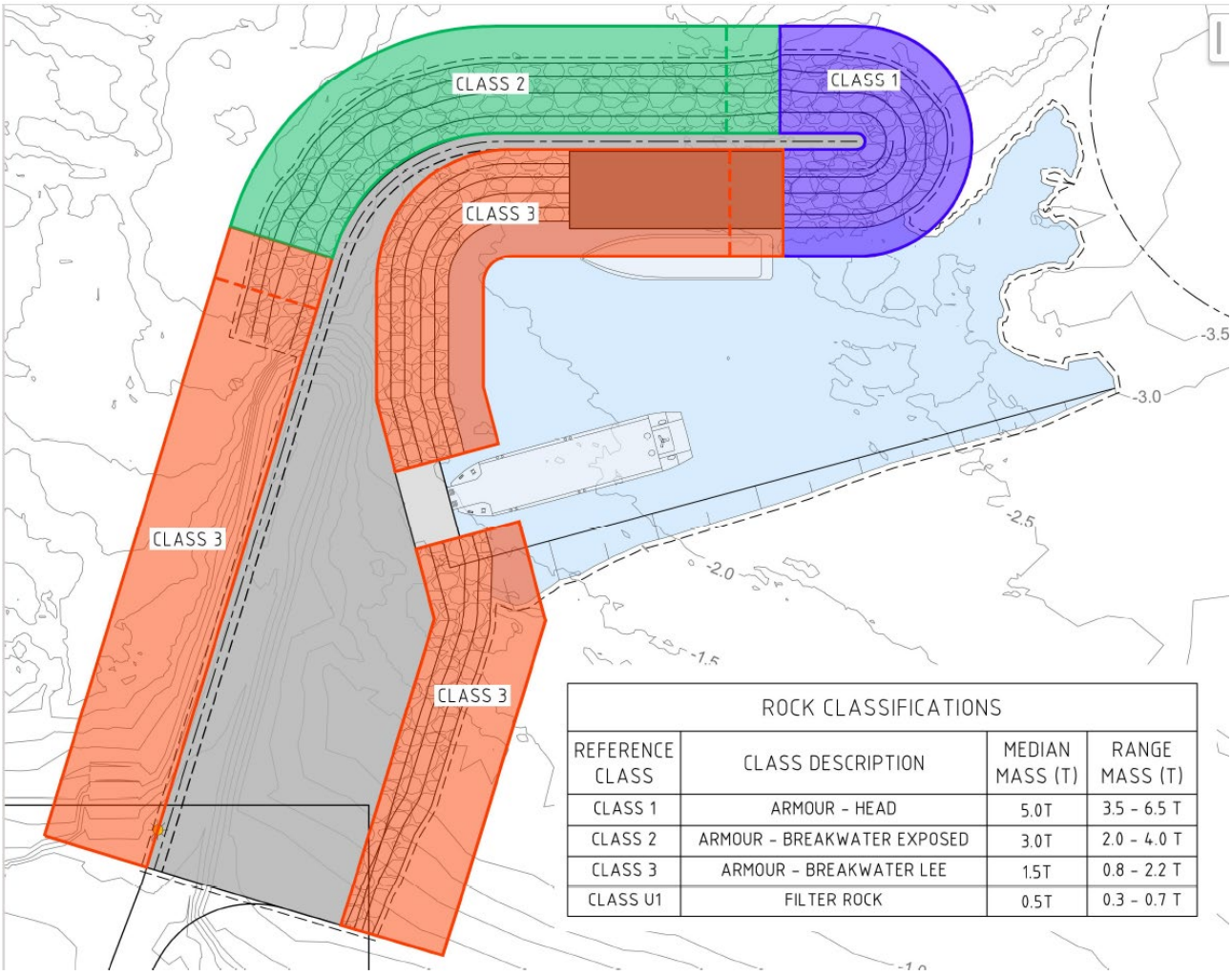


Figure 13: Rock armour classes proposed for construction of the wharf (AECOM, 2020)

2.3 Proposal alternatives

No acceptable alternatives to the proposal have been identified as discussed in Sections 2.3.1 to 2.3.3.

2.3.1 Not implementing the proposal

The current barge landing infrastructure at the Main Jetty does not cater for any growth in vessel size or movements over time. This is due to the depth of the berth pocket at the barge landing, and the height of the barge ramp relative to the tidal range of the area around the Main Jetty. This eliminates the ability for growth in the demand for in-bound and out-bound logistics to be met by larger barge vessels; growth is instead met by the relatively less efficient method of an increase in the number of barge movements. Due to the anticipated growth in visitors to the island, not upgrading the barge facilities is not an option.

The structural integrity of the Army Groyne in its current form is at risk in the event of a severe storm and it is likely that the Army Groyne would incur a level of damage that would require significant repair, or demolition. In addition to the potential repair costs from storm damage, the Army Groyne requires an existing level of operational maintenance. In 2022–2023, RIA incurred around $50,000 in maintenance expenditure and have budgeted these costs at around $60,000 per annum for the foreseeable future. Longer term, however, it is expected that the structural integrity of the groyne will be unable to be maintained and RIA will have to demolish the structure, which would result in a large one-off expense.

Redeveloping the Army Groyne and relocating the current barge operations provides a solution to both of the above issues.

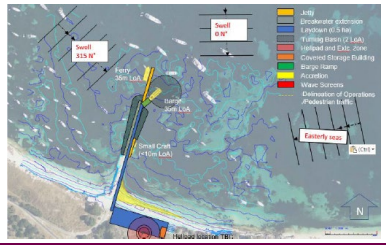
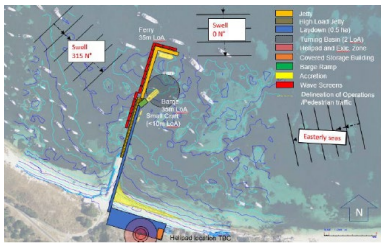
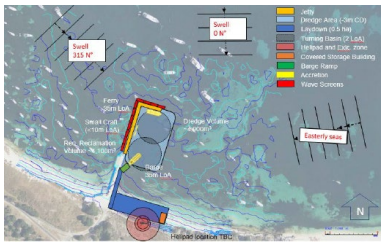
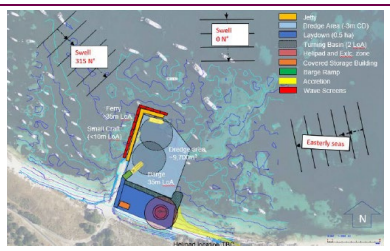
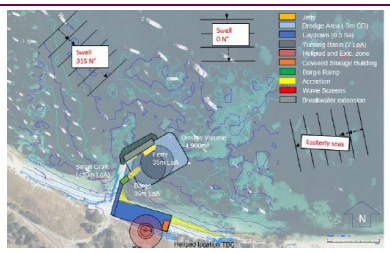
2.3.2 Alternative locations

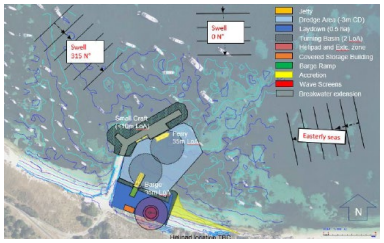
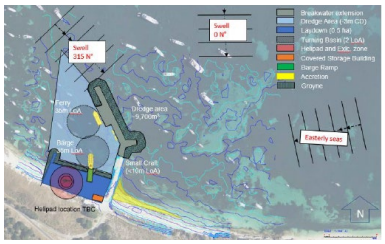
There is limited coastline available within Thomson Bay to construct a new barge landing and it was considered that implementing the proposal at a greenfield site would result in an increased risk of environmental impacts, when compared to the proposed already disturbed location. As such, the current Army Groyne location, which include an already disturbed area was considered the best location.

2.3.3 Options analysis

A number of different design options were considered during the project development phase. Overall, the assessment did not identify a clear preferred option and a design which combined the attributes of Option 3, Option 4 and Option 5 was adopted. This design has since been refined through value engineering design by AECOM and PAEMAC in 2020.

Table 18: Options assessment

Option	Concept design	Key strengths	Key weaknesses
Option 1: Extension of the existing Groyne with no dredging		• No dredging • Allows for staged development	• Low operability • High effect on coastal processes • Separation of barge and laydown areas • Impact on moorings
Option 2: Jetty with wave protection and no dredging		• No dredging • Lower operating costs • Limited impact on coastal processes	• Low operability • High capital cost • Challenging, complex construction method • Impact on moorings
Option 3: Jetty with wave protection and minimised dredging		• Low capital expenditure • Low operating costs • Limited impact on coastal processes	• Requirement for maintenance dredging • Separation of barge and laydown areas • Impact on moorings
Option 4: Jetty with wave protection and dredging		• Low capital expenditure • Low site footprint • Low impact on coastal processes	• Moderate operating costs • Requirement for maintenance dredging • Moderate operability
Option 5: Small groyne extension and minimised dredging		• High operability • Lower capital expenditure • Low site footprint	• High operating costs • Separation of barge and laydown areas • Impact on coastal processes

Option	Concept design	Key strengths	Key weaknesses
Option 6: Breakwater and dredging		• High operability • Higher serviceability • Reduced landside environmental impacts	• Impact on coastal processes • Capital and maintenance dredging required • High capital expenditure • Large site footprint
Option 7: Western-facing facility		• Low capital expenditure • Low impact on coastal processes • Low site footprint • Reduced landside impacts	• Dredging required • High operating costs • Impact on moorings • Replacement of Wadjemup / Rottnest Island boat ramp (to west of existing groyne)

Source: (ACIL Allen, 2024)

2.4 Local and regional context

2.4.1 Site history

The following site history has been sourced from *Maritime Archaeological Assessment of the Army Groyne Thomson Bay, Rottnest Island* (Department of Maritime Archaeology, Western Australian Museum, 2012).

The Thomson Bay South Development project covers the former the Army Groyne, an integral part of the island's military and recreational heritage. The original Army Groyne was built in 1906 and was used as a terminal for passengers arriving and departing the island, then referred to as the 'excursionist jetty'. The jetty was constructed to allow for horse-drawn trams to take passengers into Thomson Bay settlement and was the first public jetty on the island.

Plate 1: *Zephyr* ported at the 'excursionist jetty', 1924 (RIA 2012.239)

Plate 2: 'Excursionist jetty', 1930 (RIA 2012.96)

From 1914 to 1915, during World War I (WWI), the island was run by the military and all tourist activities ceased. The jetty, henceforth dubbed the 'Army Jetty', was used to unload troops and supplies and for prisoner transport to shore as the island was utilised as a Prisoner of War Camp. Following WWI the island was reopened to the public and the jetty returned to its original use.

During World War II (WWII), areas of the island were once again utilised for military activities. The island was developed as the primary defence for Fremantle and Perth by 1937, with works including the reinforcing and extension of the Army Jetty and a gantry being constructed just off the south end of the jetty. Between 1924 and 1945 the island was only used as a military base, with all recreational use ceased. The Army Jetty provided troop and provision movements to and from the island. In 1942 the jetty was further extended to allow for larger vessel access.

Plate 3: Original timber jetty with gantry on the right, facing west (RIA 2012.265)

Plate 4: Original timber jetty facing west to shore (National Archives Australia (NAA))

The end of WWII in 1945 returned the jetty to its primary tourist use until 1961, when the main jetty was built closer to the settlement. In 1969 the Army inspected the jetty and observed the jetty to be in poor condition, with vehicle access being banned. In 1970, plans were in place to demolish the original structure and reconstruct the jetty with rock fill and compacted limestone base, inclusive of a barge hardstand ramp. In 1972 the demolition and reconstruction had occurred. In 1984 all Army land holdings and buildings were bought back by the state government and the jetty remained for recreational uses such as snorkelling and fishing, however no boats were to dock along the jetty platform due to its fragility.

Plate 5: Reconstruction works, 1971 (NAA)

Plate 6: Reconstruction works, rockfill and barge hardstand (NAA)

It was observed in National Archives of Australia (NAA) and the State Library of Western Australia literature that much of the old materials were buried beneath the subsequent extensions of the rock fill. The structure was inspected by the Western Australia Maritime in 2012 and the jetty was measured at 120 m length and 1,700 m^2 in area. In October 2018, the jetty underwent platform removal and conversion into a rock groyne as a result of a partial collapse.

2.4.2 Historical photography

A review of online historic aerial photography held by Landgate was undertaken that yielded limited aerials of the site dating back to 1955. The historic development activities of the site and surrounds are summarised in Table 19.

Table 19: Historic photography summary

Year	Site and surrounding area	Historical aerial
1941	Site: The site is already developed with the former Army Jetty. Multiple tracks and trails are identified surrounding the site. South-east: Kingstown Barracks. South: Bickley Swamp. West: Rottnest Island Lakes.	
1955	Site: The site is already developed with the former Army Jetty. Multiple tracks and trails are identified surrounding the site. South-east: Kingstown Barracks. South: Bickley Swamp and Rottnest Island aerodrome. West: Rottnest Island Lakes and the main settlement and tourist hub.	
2000	Site: The site is already developed with the former Army Jetty. Minor infrastructure appears to be located immediately south of the jetty. Multiple tracks and trails are identified surrounding the site. Moorings are located within the marine environment to the north. South-east: Kingstown Barracks. South: Bickley Swamp and Rottnest Island aerodrome. West: Rottnest Island Lakes and the main settlement and tourist hub. Surrounding marine environment: The presence of moorings.	

Year	Site and surrounding area	Historical aerial
2002	Site: Infrastructure has been constructed adjacent to the south-west of the jetty, identified as public toilets and an undercover seating area. Surrounding marine environment: The presence of moorings.	
2004	Site: The minor infrastructure to the south has been removed. Surrounding marine environment: The presence of moorings.	
2017	West: The presence of a solar farm is observed 400 m from the site. Surrounding marine environment: The presence of moorings.	

3 LEGISLATIVE CONTEXT

3.1 South Thomson Bay Barge environmental assessment process

This Environmental Supporting Document has been prepared to support both the state and federal environmental approvals required to implement the proposed South Thomson Bay Barge Development as outlined in Table 20.

Table 20: Environmental assessment process summary

Relevant legislation		Addressed in this report
State	Refer to Section 3.2	The environmental impact assessment process under state legislation is outlined in Sections 7 to 13.
Federal	Refer to Section 3.3	The environmental impact assessment process under federal legislation is outlined in Section 14.2.

3.2 Environmental impact assessment process – state legislation

3.2.1 Environmental Protection Act 1986

The *Environmental Protection Act 1986* (EP Act) is the key legislative tool for environmental protection in Western Australia. The EP Act provides for the prevention, control and abatement of pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment. The EP Act is administered by the EPA and the Minister for the Environment.

3.2.1.1 Part IV of the *Environmental Protection Act 1986*

The environmental impact assessment process is regulated under Part IV of the EP Act, with Divisions 1 and 2 dealing with proposals and Divisions 3 and 4 dealing with planning schemes. The EP Act sets out the essential requirements of environmental impact assessment, while the specific practices of environmental impact assessment are covered in the Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures (2021) (the Administrative Procedures) (EPA, 2021c).

The Administrative Procedures provide the overarching framework for the EPA to undertake environmental impact assessment. The Administrative Procedures are grouped according to the following key stages:

- Stage 1: Referral of a proposal to the EPA
- Stage 2: EPA to decide whether or not to assess a referred proposal
- Stage 3: Assessment of proposals
- Stage 4: EPA report on the assessment of proposal
- Stage 5: Deciding if proposal may be implemented and implementation of proposals.

The referral of this supporting document and accompanying Section 38 referral form to the EPA under Section 38 of the EP Act allows for the EPA to determine if the referral is valid under the EPA's Administrative Procedures and decide whether or not to assess the proposal.

If the EPA decide not to assess the proposal, any clearing of native vegetation and seagrass required for construction of the proposal will need a permit under Part V Division 2 of the EP Act except where:

- An exemption applies under Schedule 6 of the EP Act; or
- Is prescribed by regulation in the Environmental Protection (Clearing of Native Vegetation) Regulation 2004 and the proposed clearing area is not mapped as an Environmentally Sensitive Area (ESA); or
- Department of Water and Environmental Regulation (DWER) determines that a permit is not required because the proposed clearing satisfies all the referral criteria.

3.2.1.2 EPA guidance and technical reports

The proposal is subject to compliance with applicable guidelines and technical reports that have been developed to assist proponents and the general public, in understanding the minimum requirements for the protection of the environment that the EPA expects to be met during the assessment process.

Table 21 details the EPA's environmental factors and technical guidelines relevant to the proposal.

Table 21: Applicable EPA guidance and technical reports

EPA environmental factor guidelines
Environmental Factor Guideline: Benthic Communities and Habitats (EPA, 2016f)
Environmental Factor Guideline: Coastal Processes (EPA, 2016i)
Environmental Factor Guideline: Marine Environmental Quality (EPA, 2016e)
Environmental Factor Guideline: Marine Fauna (EPA, 2016j)
Environmental Factor Guideline: Flora and Vegetation (EPA, 2016a)
Environmental Factor Guideline: Terrestrial Environmental Quality (EPA, 2016c)
Environmental Factor Guideline: Terrestrial Fauna (EPA, 2016d)
Environmental Factor Guideline: Inland Waters (EPA, 2018a)
Environmental Factor Guideline: Social Surroundings (EPA, 2023)
EPA technical guidance
Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment (EPA, 2016b)
Technical Guidance: Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA, 2020)
Technical Guidance - Protecting the Quality of Western Australia's Marine Environment (EPA, 2016g)
Technical Guidance - Protection of Benthic Communities and Habitats (EPA, 2016f)
Technical guidance - Environmental Impact Assessment of Marine Dredging Proposals (EPA, 2021a)

3.3 Other state approvals and regulations

The proposal is required to comply with the requirements of other relevant state legislation, regulation and policy. Table 22 provides an overview of other potential key state-based approval requirements relevant to the proposal.

Table 22: Other approval requirements

Proposal activities	Type of approval	Legislation regulating the activity	Approval agency
Potential impacts to Aboriginal heritage during vegetation clearing, construction and dredging activities.	There are different types of approval under the *Aboriginal Heritage Act 1972* and in the Aboriginal Heritage Regulations 1974. Approval may be required from either the Minister for Aboriginal Affairs or the Registrar of Aboriginal Sites for any activity which may harm an Aboriginal site. There are four types of authorisations: • Section 18 consent – for more significant impacts and harm to Aboriginal sites • Section 16 authorisation – for excavation purposes (generally related to research) • Regulation 7 approval – to bring plant and equipment to an Aboriginal site • Regulation 10 consent – for more minor activities and impacts. If impact to an Aboriginal site is proposed, the proponent will, in consultation with traditional owners, determine the appropriate approvals pathway under the *Aboriginal Heritage Act 1972.* This process will meet the EPA's objective for Social Surroundings by protecting Aboriginal sites from significant harm.	*Aboriginal Heritage Act 1972* Aboriginal Heritage Regulations 1974	Department of Planning, Lands and Heritage

Proposal activities	Type of approval	Legislation regulating the activity	Approval agency
Storage and handling of hazardous materials may be required during / after construction	A Dangerous Goods Licence sets standards for the way in which dangerous goods are stored on-site. These standards are aimed at ensuring dangerous goods are stored safely and in such a way that will not result in impacts to the environment.	*Dangerous Goods Safety Act 2004*	Department of Energy, Mines, Industry Regulation and Safety
Activities undertaken by RIA on Wadjemup / Rottnest Island.	Any activities undertaken will be in accordance with this environmental approval and the *Rottnest Island Authority Act 1987*.	*Rottnest Island Authority Act 1987*	RIA

3.4 Environmental impact assessment process – federal legislation

3.4.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) protects matters of national environmental significance (MNES) and is administered by the Commonwealth Minister of the Environment. If an action is likely to have a significant impact on any MNES a referral to the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCEEW) is required. MNES are defined as:

- Listed threatened species and ecological communities
- Migratory species protected under international agreements
- Ramsar wetlands of international importance
- The Commonwealth marine environment
- World Heritage properties
- The Great Barrier Reef Marine Park
- National heritage places
- Nuclear actions
- A water resource, in relation to coal seam gas development and large coal mining development.

A summary of MNES relevant to the proposed is provided in Table 23.

Table 23: Matters of national environmental significance

EPBC matter	Matters returned	Description	Relevant to the proposal
World heritage properties	None	There are no world heritage properties located within or near the site.	N/A
National heritage places	None	There are no national heritage properties within or near the site.	N/A
Wetlands of international significance	None	There are no wetlands of international significance within or near the site.	N/A
Great Barrier Reef Marine Park (GBRMP)	None	Not relevant to the proposed action as the GBRMP is located off the east coast of Australia.	N/A
Commonwealth marine area	None	The proposed action is not located within a Commonwealth marine area. The Commonwealth marine area is mapped over 7 km from the development envelope and the proposal is not considered likely to impact a Commonwealth marine area.	N/A
Listed threatened ecological communities (TEC)	One	The Protected Matters Search Tool (PMST) search identified the Banksia Woodlands of the Swan Coastal Plain ecological community within the search radius. This ecological community is only recorded from the Western Australian mainland and vegetation present on Wadjemup / Rottnest Island is not associated with this TEC. This TEC is not relevant to the proposal and is not discussed further.	N/A

EPBC matter	Matters returned	Description	Relevant to the proposal
Listed threatened species	44	Birds – 23 Fish – 1 Mammals – 4 Plants – 1 Reptiles – 4 Sharks – 5 Insect - 1	Yes Discussed in Section 14.2
Listed migratory species	102	Migratory Marine Birds – 19 Migratory Marine Species – 17 Migratory Terrestrial Species – 1 Migratory Wetlands Species – 29	Yes Discussed in Section 14.2
Nuclear actions	None	The proposal does not relate to this MNES.	N/A
Water resources in relation to coal seam gas and large coal mining development	None	The proposal does not relate to this MNES.	N/A

Green – MNES not applicable to the proposal.

Orange – MNES considered relevant to the proposal and addressed in this report.

3.4.2 EPBC Act assessment context

3.4.2.1 Accredited assessment

The intention to develop a bilateral agreement with Western Australia under Section 45 of the EP Act and EPBC Act was published in 2019. The draft bilateral agreement is intended to revoke and replace the current bilateral agreement (2014) between the Commonwealth of Australia and the State of Western Australia. Until the agreement is amended, the assessment of any new proposals that would otherwise have been assessed by the EPA under the agreement will be individually accredited by the Commonwealth Government. If significant impacts to a MNES are identified because of the proposal, a separate EPBC Act referral will be submitted to the Commonwealth DCCEEW to ‘turn on’ the accredited assessment process.

The environmental impact assessment of MNES is outlined in Section 14.2.

4 STAKEHOLDER ENGAGEMENT

4.1 Key stakeholders

RIA understands and acknowledges that any changes to the infrastructure on Wadjemup / Rottnest Island is of interest to the community. Engagement regarding the project commenced in 2019.

Key stakeholders for the proposal are summarised below:

- State government agencies and regulators
  - Department of Biodiversity, Conservation and Attractions (DBCA)
  - Department of Water and Environmental Regulation (DWER)
  - Department of Planning, Lands and Heritage (DPLH)
  - Department of Transport (DoT)
- Traditional owners
- Local community, local businesses and non-government organisations (NGOs).

4.2 Stakeholder engagement process

Consultation has occurred with the key stakeholders listed in Section 4.1. RIA has sought to engage on major issues through in-person briefings where possible, with written updates provided to support a timely flow of information to stakeholders (Table 24).

Engagement with government agencies and regulators and traditional owners will remain ongoing throughout the project.

Table 24: Stakeholder engagement process

Issue for engagement	Level of engagement	Timing	Scope
Justification for the proposal.	Inform	Underway / ongoing	Consultation undertaken with the EPA and local community to provide information and justification for the need for the proposal.
Foster community advocacy for the project.	Inform	March–April 2024	Community engagement to understand community expectations for the proposal and any key concerns that may need to be addressed.
Environmental referrals to support the proposal.	Consult	Underway / ongoing	Ongoing liaison with key regulators to obtain input into project design and technical investigations to ensure that RIA is not unduly impacting the environment.

4.3 Stakeholder consultation outcomes

Table 25 presents a summary of the key stakeholder consultation undertaken to date for the proposal.

Table 25: Summary of consultation with state government agencies and regulators, local government and the local community

Stakeholder	Date	Type of consultation	Purpose of engagement / issues and topics raised	Proponent response / outcome
DWER's EPA Services	October 2019	Site Visit	RIA and EPA undertook a site visit at the site, with discussion on the plans and potential environmental issues. The investigations to be undertaken were outlined, including dredge plume modelling and jet probing.	DWER EPA were satisfied with the update and the planned works and investigations.
DWER's EPA Services	14/2/2020	Email and meeting	Advice was sought on management measures to be implemented for per- and poly-fluoroalkyl substances (PFAS) during dredging, based on elevated PFAS results in elutriate samples.	DWER EPA was in agreement that the PFAS results in elutriate samples were a result of laboratory contamination. Subsequently, RPS undertook further sediment and surface water sampling and did not identify PFAS at concentrations that would pose a risk to environment and human health. RPS then revised its report with the conclusion that no management measures needed to be considered during dredging.
EPA	12/6/2023	Meeting	RIA and EPA discussed the recommencement of the project and outlined the baseline studies and management plans to be undertaken/developed as part of the progression to referral.	DWER EPA was satisfied with the update and the proposed studies, management plans and timeframes. EPA noted that a Marine Environmental Quality Monitoring and Management Plan (MEQMMP) would be required in addition to the proposed suite of management plans. Further consultation regarding this requirement was undertaken on 19/02/2024 as outlined below.
EPA	13/6/2023	Email	Advice sought on the *Aboriginal Heritage Act 1972* and the relationship with the EP Act.	DWER EPA provided links to published guidance on Aboriginal Cultural Heritage (ACH) matters and the impacts that would be dealt with under *Aboriginal Heritage Act 1972* and EP Act.
EPA	19/2/2024	Email	O2 Marine proposed preparation of an Operational Environmental Management Plan (OMEP) instead of a Marine Environmental Quality Monitoring and Management Plan (MEQMMP) requested by EPA on 12/6/2023 based on the limited ongoing risk to water quality.	The EPA agreed to the proposed change to the management plans supporting the proposal.
Rottnest Foundation	1/3/2024	Email	Included a link to project information website page to inform of the proposal and request feedback. No response received.	No further action.
Fishing groups: BoatingWA / Recfishwest	1/3/2024	Email	Included a link to project information website page to inform of the proposal and request feedback. No response received.	No further action.
Marine groups: UWA/WADDI/ Reef life/AMCS /Pew Trust / Save Our Seas	1/3/2024	Email	Included a link to project information website page to inform of the proposal and request feedback. No response received.	No further action.
DPLH	1/3/2024	Email	DPLH was issued a link to the South Thomson Barge Landing Consultation materials, with a note that if any potential impacts to the Kingstown Barracks (P525) registered place be identified during detailed planning for the site, formal referrals will be progressed.	DPLH acknowledged receipt of notification on 5/03/2024, stating that it appreciated the works do not directly affect a registered place, but it is of interest to the Council given that the island is on its assessment program
DPLH	1/3/2024	Email	Included a link to project information website to inform of the proposal and request feedback. DPLH only requested to be informed of project updates.	No further action. Key project updates will be provided to DPLH as required.
General public submission	1/3/2024–29/3/2024	General public consultation	Completed via RIA website with feedback received via email. The key submissions received from the public that were in opposition to the proposal included: • Potential impacts to the terrestrial and marine environment, such as seagrass loss, land clearing, impact on quokka population, noise, water, and light pollution. • The impact to local boat users, island residents and local visitors. • Impact to the built-heritage value of the Army Groyne. • Concern for the loss of suitable anchoring grounds. • Concern for the increase in traffic along Parker Point Rd and associated public safety risk. • Support for refurbishment of the current jetty and barge landing instead of constructing new facility.	• Project justification is included within this document. • The impact assessment undertaken as part of this documents indicates that the residual impacts to the marine and terrestrial environment are unlikely to be at variance to the EPA's environmental objectives. • Public amenity (noise, lighting, marine traffic and loss of anchoring grounds) context and mitigations are discussed in this document. • Public safety risk (i.e. traffic along Parker Pt Rd) will be addressed by policing and road regulations applicable to Wadjemup / Rottnest Island roads. • Built heritage context of the Army Groyne addressed in separate submission to DPLH.
Rottnest Island Chamber of Commerce (RICC)	6/3/2024	Meeting	Presentation to RICC via a monthly meeting with all business representatives present. Questions and comments were raised in relation to: • In general, there was support for the proposal. • The logistics of ferry operations and luggage deliveries. • General questions about the status of baseline environmental studies. • General questions about project cost and timeframes. • Impacts to moorings and anchorage. • Upgrades to the access road.	• Workshop to be held to discuss ferry operations and logistics once funding and detailed designs are known. • RIA provided verbal responses to the other questions based on information known at the time.
Quokka coaches	7/03/2024	Email	Email received following general consultation: In support of the proposal stating: • Project will benefit the barge operators who currently work in a confined area. • Project will enhance overall visitor impression on arrival.	Noted
Pinnacle Travel Group	20/03/2024	Email	Email received following general consultation. The Pinnacle Travel Group was support of the proposal stating: • Project will increase the experience and amenity for tourists and improve the ability of ferry companies to operate. • Significantly reduce traffic around the jetty and main bus stop, easing congestion.	Noted
EPA	21/3/2024	Email	Advice was sought on the need to do underwater noise modelling or an underwater noise desktop assessment due to the reduced underwater noise impacts from utilisation of vibro hammer piling methodology as opposed to impact hammer.	No response from EPA. RIA decided to undertake the noise modelling instead of a desktop assessment.

Stakeholder	Date	Type of consultation	Purpose of engagement / issues and topics raised	Proponent response / outcome
The Rottnest Society	29/03/2024	Meeting	Presentation to The Rottnest Society on the proposal and to request feedback. Questions and comments were raised in relation to: • Concern for the terrestrial and marine environmental impact. • Concern for lack of proposed revegetation and restoration. • Recommendation that evaluation of current barge landing is undertaken to effectively reduce conflicts with pedestrians. • Notes that information was difficult to source as a result of RIA website being upgraded.	• Project justification is included within this document. • The impact assessment undertaken as part of this documents indicates that the residual impacts to the marine and terrestrial environment are unlikely to be at variance to EPA's environmental objectives.
Wadjemup Aboriginal Reference Group (WARG)	4/04/2024	Meeting	Presentation to WARG to inform of the proposal and seek feedback. Questions and comments were raised in relation to: • In general, there was support for the proposal. • Concern for marine species impacted by the noise from piling, in particular whales. • Enquiry about heritage values in the project area • Works should stop should Aboriginal cultural material be disturbed. • Enquiry about incorporation of renewable energy in the design.	• Cultural heritage (disturbance of Aboriginal heritage) is addressed in this document. • Cultural heritage mitigations identified within the Report of an Ethnographic Aboriginal Heritage Survey of Army Jetty (provided in Appendix M).
Mooring licensees	9/4/2024–24/4/2024	Targeted consultation	Completed via letters and telephone calls to inform licensees about: • Permanent and temporary relation of moorings (where applicable). • General notification of the proposal. • Overall, the responses were opposed to the proposal with general references to: – The impact to current vessel mooring licensees, local boat users, island residents and local visitors. – Impact to the built-heritage value of the Army Groyne. – Concerns about the increased risk/safety to swimmers as a result of increasing marine traffic and boat wash. – Requests for relocation and clarification on the relocation process. – Concern for the loss of suitable anchoring grounds. – Potential impacts to the terrestrial and marine environment (seagrass loss, land clearing, impact on quokka population, noise, water, odour and light pollution).	• Project justification is included within this document. • The impact assessment undertaken as part of this documents indicates that the residual impacts to the marine and terrestrial environment are unlikely to be at variance to the EPA's environmental objectives. • Public amenity (noise, lighting, marine traffic and loss of anchoring grounds) context and mitigations is discussed in this document. • Public safety risk to swimmers and mitigations identified within this document. • Public safety risk (i.e. traffic along Parker Pt Rd) is addressed by policing and road regulations applicable to Wadjemup / Rottnest Island roads. • Built heritage context of the Army Groyne addressed in separate submission to DPLH.
DPLH	24/04/2024	Email	DPLH contacted RIA for an update on the project, including information on the potential heritage implications on built fabric and archaeology.	• RIA's project manager responded on 30/04/2024.
Department of Transport (DoT)	1/5/204	Email	Included a link to project information website to inform of the proposal and request feedback. DoT stated that: • A navigational safety channel is not required. • No additional navigational lights are required.	No changes to the marine safety infrastructure required. No further action.

5 OBJECT AND PRINCIPLES OF THE EP ACT

Section 4A of the EP Act establishes that the objective of the Act is to protect Western Australia's environment, having regard for the following principles:

1. The precautionary principle
2. The principle of intergenerational equity
3. Principles relating to improved valuation, pricing and incentive mechanisms
4. The principle of the conservation of biological diversity and ecological integrity
5. The principle of waste minimisation.

Table 26 identifies how these five EP Act principles have been considered for the proposal and provides a holistic description of how the objective of the EP Act has been met.

Table 26: Object and principles of the EP Act

Principle	Consideration
The precautionary principle	
Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In application of this precautionary principle, decisions should be guided by: • Careful evaluation to avoid, where practicable, serious or irreversible damage to the environment • An assessment of the risk-weighted consequences of various options	Studies and investigations have been undertaken to assess the potential impacts to key environmental factors relevant to the proposal as summarised in Section 6 to ensure that full scientific certainty supports this impact assessment. The proposal will not cause threat of serious or irreversible damage through avoidance of impacts where possible and the identification and implementation of management measures to address residual impacts.
The principle of intergenerational equity	
The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for benefit of future generations.	The proposal has been designed to meet the EPA's objectives for the relevant environmental factors, with mitigation measures to reduce residual environmental impacts, ensuring sensitive environmental values, their health, function and productivity are maintained for future generations. The proposed relocation of the barge operations takes into consideration the proposed operation of the barge facilities for the life of the project (50 years).
Principles relating to improved valuation, pricing and incentive mechanisms	
1. Environmental factors should be included in the valuation of assets and services.	The proponent accepts that any costs for environmental mitigation, management or offsets are part of the overall proposal costs. This includes residual impact management actions that will be addressed within corresponding management plans.
2. The polluter pays principle – those who generate pollution and waste should bear the cost of containment, avoidance and abatement.	
3. The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste.	
4. Environmental goals, have been established, should be pursued in the most cost-effective way, by establishing incentive structure, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solution and response to environmental problems.	

Principle	Consideration
The principle of the conservation of biological diversity and ecological integrity	
Conservation of biological diversity and ecological integrity should be a fundamental consideration.	Seven key environmental factors (benthic communities and habitats, coastal processes, marine environmental quality, marine fauna, flora and vegetation, terrestrial fauna and social surroundings) relevant to the proposal have been identified in this report. Site investigations have been undertaken to identify potential impacts and mitigation options to minimise the impact of the proposal and align with the EPA's objective for each environmental factor.
The principle of waste minimisation	
All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	Waste will be minimised by adopting the hierarchy of waste controls; avoid, minimise, reuse, recycle and safe disposal during construction and operation of the proposal.

6 ENVIRONMENTAL FACTORS AND OBJECTIVES

This Environmental Supporting Document has been prepared to address the EPA key environmental factors that are relevant to the proposal. Assessment of potential impacts to the environmental factors was undertaken based on the environmental investigations listed in Table 27.

Environmental factors that would potentially be impacted by the proposal are addressed in Sections 7 to 13, as outlined in Table 27.

Table 27: EPA key environmental factors and their relevance to the proposal

Theme	EPA factor	Relevance to proposal	Supporting technical investigations and reports			
			Survey summary	Report	Survey timing	Appendix to this report
Sea	Benthic communities and habitats	There are benthic communities and habitats present within South Thomson Bay.	RPS undertook a benthic habitat assessment to support a previous design of the project in 2019 (RPS, 2019). In 2023, RPS has reviewed and updated this benthic habitat mapping to support the current project design. Sites surveyed in 2023 replicated those surveyed by RPS in 2019, except where habitat of specific interest for ground-truthing were identified in the aerial images.	South Thomson Barge Landing Development; Marine fauna and benthic habitat assessment (RPS, 2024a).	The main field survey was completed between 0830 and 1630 hrs on 24 November 2023 The supplementary field survey was completed on 29 January 2024 between 0830 and 1330 hrs	Appendix B
			Habitat mapping was undertaken using aerial photography and information collected by Rottnest Island Authority, who visually surveyed the benthic habitat at six sites within the 2.54 ha survey extension area.	South Thomson Barge Landing; Benthic habitat assessment: Plume Extension Survey Area (RPS, 2023b).	22 March 2024	Appendix C
	Coastal processes	Construction of the marine component of the proposal has the potential to result in changes to coastal processes.	Baird undertook a coastal processes assessment of the proposal to assess the potential impact the proposed marine infrastructure will have on coastal processes.	South Thomson Barge Landing Development; Coastal processes assessment (Baird, 2024a).	NA	Appendix D
			RPS' Ocean Science & Technology team undertook a peer review of the two reports prepared by Baird to support the proposal.	RIA Peer Review of Dredge Plume Modelling and Coastal Processes Reports (RPS, 2024c)	NA	Appendix E
			A Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) has been prepared for Wadjemup / Rottnest Island to provide strategic guidance for coordinated, integrated and sustainable land use planning and management along the Wadjemup / Rottnest Island coastline. The CHRMAP will inform RIA's future decision-making with respect to areas and assets identified as being at risk of coastal hazards.	Rottnest Coastal Hazard and Risk Management and Adaptation Plan (Cardno, 2023).	NA	-
	Marine environmental quality	Construction and operation of the proposal has potential to impact marine environmental quality.	Baird undertook a dredge plume modelling assessment to identify the potential impacts from dredging activities associated with construction of the proposal.	South Thomson Barge Landing Development; Dredge Plume Modelling Assessment (Baird, 2024b).	NA	Appendix F
			RPS' Ocean Science & Technology team undertook a peer review of the two reports prepared by Baird to support the proposal.	RIA Peer Review of Dredge Plume Modelling and Coastal Processes Reports (RPS, 2024c)	NA	Appendix E
			Rottnest Island Authority has undertaken baseline water quality monitoring to support the proposal.	The results from this monitoring are discussed in this report.	Water quality sampling was undertaken in November and December 2023 and January 2024	Appendix G
			RPS undertook sediment sampling to support the project in 2020.	Rottnest Island Army Jetty Dredging; SAP Implementation report (RPS, 2020).	Sediment sampling was undertaken in November 2019	Appendix H
	Marine fauna	The proposal will result in direct and temporary impacts to marine fauna habitat, while construction and operational activities has the potential to impact marine fauna.	RPS prepared a desktop marine fauna assessment to support the proposal and identify conservation significant marine fauna species likely to occur within vicinity of the proposal.	South Thomson Barge Landing Development; Marine fauna and benthic habitat assessment (RPS, 2024a).	NA	Appendix B
			Tetra Tech prepared an underwater noise assessment to assess potential impacts to marine fauna from piling activities during construction of the proposal.	South Thomson Barge Landing Development; Underwater Acoustic Assessment (Tetra Tech, 2024)	NA	Appendix S
Land	Flora and vegetation	Approximately 0.46 ha of terrestrial vegetation will be directly impacted by the proposal.	Focused Vision Consulting (FVC) undertook a flora and vegetation survey of the South Thomson and Kingstown, areas of Wadjemup / Rottnest Island (Figure 32). The FVC survey encompassed the development envelope and surrounding area.	Flora and vegetation survey; South Thomson and Kingstown, Rottnest Island (FVC, 2023)	Initial reconnaissance flora and vegetation survey – 2 May 2022 Secondary reconnaissance flora and vegetation survey – 30 August 2022	Appendix I
			A reconnaissance survey was undertaken by RPS within the terrestrial survey area shown in Figure 31. EPA's Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016) states that 'a reconnaissance survey is required where flora and vegetation values are well defined, the area is not likely to support significant flora or vegetation and the scale and nature of the potential impacts are not likely to be significant.' RPS considered these criteria to be met and furthermore that the small size of the site precluded the implementation of a detailed survey using quadrats. As part of the reconnaissance survey, a review of the report Flora and Vegetation Survey South Thomson and Kingstown, Wadjemup / Rottnest Island (FVC, 2023) was undertaken. The FVC survey encompassed the development envelope and surrounding area. The flora and vegetation data collected by RPS during the reconnaissance survey has been used to support this Environmental Supporting Document.	South Thomson Barge Redevelopment Flora and Vegetation Survey (RPS, 2024d)	Reconnaissance flora and vegetation survey – 23 November 2023 Targeted flora survey – 23 to 27 November 2023	Appendix J
	Landforms	No significant landforms are located within or adjacent to the development envelope. Potential impacts to landforms from the proposal is discussed in Section 14.1.				
	Subterranean fauna	The proposal does not involve ongoing groundwater abstraction or dewatering activities. Potential impacts to subterranean fauna from the proposal are not anticipated as discussed in Section 14.1.				

Theme	EPA factor	Relevance to proposal	Supporting technical investigations and reports			
			Survey summary	Report	Survey timing	Appendix to this report
	Terrestrial environmental quality	The site is not mapped as being at risk of acid sulfate soils. The site is not a registered contaminated site. Terrestrial environmental quality is discussed in Section 14.1.				
	Terrestrial fauna	Approximately 0.46 ha of terrestrial fauna habitat will be directly impacted by the proposal.	Eco Logical undertook a basic terrestrial fauna survey within the terrestrial survey area (Figure 36) in accordance with EPA Technical Guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment.	Rottnest Island Basic Fauna Survey (EcoLogical, 2024)	31 October 2023	Appendix K
Water	Inland waters	There are no surface water features within or directly adjacent to the development envelope. The proposal does not involve ongoing groundwater abstraction or dewatering activities. Construction and operational activities will be managed to prevent potential impacts to groundwater. The proposal is not considered likely to have a significant impact on inland waters. Potential minor impacts from the proposal are discussed in Section 14.1.				
Air	Air quality	The proposal has the potential to temporarily impact air quality during construction activities from exhaust emissions from construction machinery and dust emissions. Operational activities have the potential to impact air quality through greenhouse gas emissions, which are discussed below. The proposal is not considered likely to have a significant impact on air quality. Potential minor impacts to air quality from the proposal are discussed in Section 14.1.				
	Greenhouse gas emissions	A greenhouse gas assessment was undertaken by Kewan Bond Pty Ltd (Appendix L). This assessment identified that greenhouse gas emissions from construction and operation of the proposal will be below the 100,000 tCO_{2-e} per year threshold where a proposal is required to prepare a greenhouse gas management plan as outlined in the Environmental Factor Guideline: Greenhouse Gas Emissions (EPA 2020). On this basis significant greenhouse gas emissions are not anticipated as discussed in Section 14.1.				
People	Social Surroundings	The proposal is at risk of impacting social surroundings (heritage, bushfire and amenity).	A desktop assessment and stakeholder consultation has been undertaken to support the assessment of potential impacts to social surroundings.	Report of an Ethnographic Aboriginal Heritage Survey of the Army Jetty, Rottnest Island, Western Australia (Brad Goode and Associates, 2019)	Undertaken in 2019. (Advice from the South West Aboriginal Land and Sea Council (SWALSC) confirmed that a more recent survey was not required). Relevant correspondence regarding the Activity Notice is provided in Appendix M.	Appendix M
		There is a slight risk for residual unexploded ordnance (UXO) within vicinity of the development envelope.	Surrich Hydrographics undertook a UXO survey over the previously proposed dredge area.	Marine magnetic survey at proposed barge landing site, South Thomson Bay (Surrich, 2019)	November 2019	Appendix T
			TAMS was engaged by Rottnest Island Authority to supply a vessel and dive team to complete geotechnical investigation at Thompsons Bay South, which included an UXO Assessment.	Rottnest Island Authority - Geological Investigation - Thomson Bay South and UXO investigation / anomaly recovery (TAMS Group, 2019)	December 2019	Appendix T
		There is a risk for the proposal to impact the amenity of South Thomson Bay.	Herring Storer Acoustics undertook an acoustic assessment of noise emissions associated with the existing barge operations to ascertain the potential impacts from the proposal within South Thomson Bay.	Acoustic assessment Rottnest Barge Facility Rottnest Island (Herring Storer, 2024)	May 2024	Appendix U
	Human health	There are no known sources of radiation within the development envelope and there are no stages of the project where exposure to radiation is anticipated. Human health is discussed in Section 14.1.				

7 BENTHIC COMMUNITIES AND HABITATS

7.1 EPA objective

To protect benthic communities and habitats so that biological diversity and ecological integrity are maintained.

7.2 Policy and guidance

The proposal will be subject to compliance with applicable policies and guidance developed by the EPA to assist proponents and the public to understand the minimum requirements for the protection of elements of the environment that the EPA expects to be met during the assessment process. Relevant guidance and policies which have been considered in preparation of this document are discussed in Table 28.

Table 28: Relevant policy and guidance; benthic communities and habitats

Policy and guidance	Consideration
Environmental Factor Guideline: Benthic Communities and Habitats (EPA, 2016f)	The environmental factor guideline provides guidance on the area of assessment (i.e. Local Assessment Unit (LAU)), and the requirement for describing benthic communities and habitats, determining the cumulative loss of benthic communities and habitats including baseline characteristics, area of historic loss, current extent and areas of approved losses, and additional impacts associated with the proposal. A Benthic habitat assessment (RPS, 2024a) has been undertaken to support the proposal and an impact assessment, including discussion of the LAU and cumulative impact assessment have been undertaken in accordance with this guideline.
Technical Guidance: Protection of Benthic Communities and Habitats (EPA, 2016h)	The EPA's technical guidance is intended to encompass both the current benthic communities that live in or on the seabed and are important for primary or secondary production as well as recognised areas of benthic habitat that have the necessary attributes, such as substrate type, water depth and clarity, degree of exposure to wave energy, to support these communities in the future. When assessing potential impacts to benthic communities and habitats, the EPA focusses on the extent, severity and duration of impacts and requires that proponents use a spatial assessment framework to determine and describe recoverable impacts and cumulative losses of benthic communities and habitats within a defined area. This technical guidance has been considered in assessing impacts to benthic communities.
Technical Guidance: Environmental Impact Assessment of Marine Dredging Proposals (EPA, 2021a) and National Assessment Guidelines for Dredging (Australian Government, 2009)	The EPA's technical guidance focuses on describing the effects on benthic habitats caused by removal or burial at the sites of dredging and disposal, and the effects of suspended and deposited sediments further afield. The technical guidance provides a methodology for impact prediction, assessment and management of dredging proposal and marine biota – particularly benthic communities.

7.3 Environmental investigations

RPS undertook a benthic habitat assessment to support a previous design of the project in 2019 (RPS, 2019). In 2023, RPS reviewed and updated the 2019 benthic habitat mapping to support the proposal. As part of the 2023 benthic communities and habitat mapping, RPS undertook the following:

- Confirmed the suitability of the LAU defined by RPS (2019) in assessment of benthic impacts from the proposal
- Confirmed the suitability of benthic habitat mapping by Harvey (2009) and its suitability for LAU-scale estimates
- Updated the South Thomson Bay area benthic habitat map previously developed by RPS (2019)
- Confirmed estimates of benthic habitat loss due to the proposed development
- Estimated the cumulative loss of benthic habitat as a consequence of historic activities.

The 2019 Assessment of Benthic Habitats report is provided in Appendix N and the updated Marine Fauna and Benthic Habitat Assessment (RPS, 2024a) is provided in Appendix B.

Baird (2024b) undertook a dredge plume modelling assessment and identified zones of impact from the proposed dredging activities. The eastern extent of the modelled zone of influence was outside the 2019 and 2023 survey area. Therefore, an additional benthic habitat assessment was undertaken of this previously unsurveyed area through an assessment of aerial photography and a visual assessment at six sites. This plume extension survey area comprised 2.54 ha. The Benthic Habitat Assessment: Plume Extension Survey Area (RPS, 2023b) is provided as Appendix C.

The benthic habitat survey areas are provided in Figure 14.

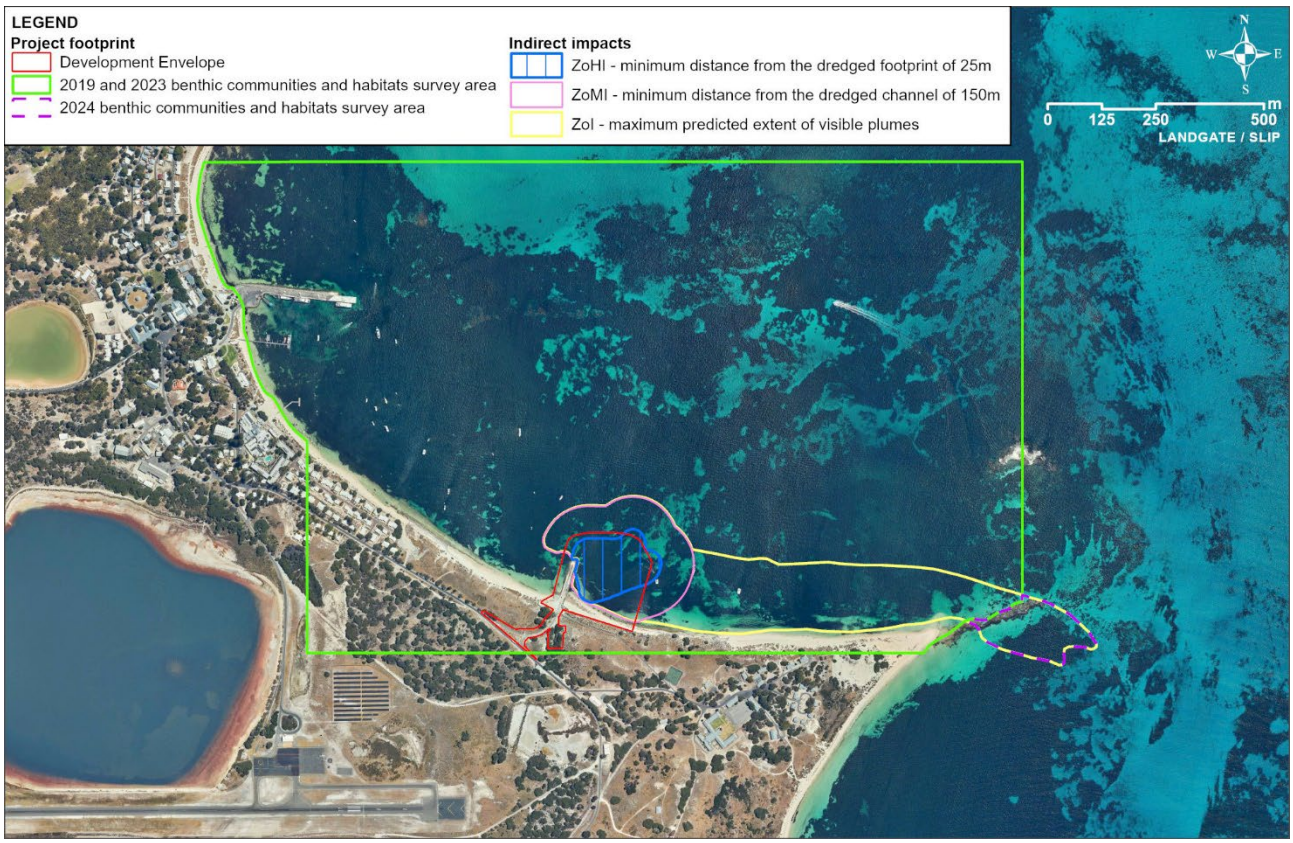


Figure 14: Benthic habitat survey area and plume extension survey area

7.4 Receiving environment

7.4.1 Benthic habitats

Benthic habitat within South Thomson Bay is varied and includes seagrass meadows (*Posidonia* spp.) that comprise approximately 30% of the total seagrass area within the Wadjemup / Rottnest Island / nearshore habitats (RIA, 2023; Harvey, 2009). These meadows, which include *P. sinuosa* and *P. australis*, are recognised as a Priority 3 Western Australian Priority Ecological Community (PEC) by the DBCA due to their importance as a climax community that can take decades to centuries to develop, and their vulnerability to climate change. Other benthic habitat within Thomson Bay includes macroalgae and bare sand, the latter which may be covered by wrack that accumulates seasonally (RPS, 2024a).

Ten species of seagrasses and 347 species of macroalgae have been recorded off Wadjemup / Rottnest Island. The seagrasses are largely restricted to sandy substrates and generally grow in sheltered bays and areas protected by reef. The dominant meadow-forming seagrass genera are *Amphibolis* spp. and *Posidonia* spp. (RPS, 2019). Seagrass meadows provide habitat, nursery areas, food and refuge from predation for fish and invertebrate populations. They also stabilise sediments.

Benthic habitats identified within the benthic habitat survey area (Figure 14) includes mixed seagrass, limestone reef / pavement, macro algae dominated and sand / sand with wrack. Seagrasses are dominated by *Posidonia* spp. with a minor component of *Amphibolis* spp. often in healthy meadows. An example of the benthic habitats present within the survey area are shown in Plate 7 and Plate 8.

Benthic habitats mapped within the plume extension survey area (Figure 14) comprised presumed mixed seagrass, limestone reef / pavement and sand / sand with wrack (Figure 15).

Table 29 and Figure 15 show that the dominant benthic communities within the development envelope comprise mixed seagrass and sand / sand with wrack.

Table 29: Benthic communities and habitats present within the survey area and development envelope

	Benthic habitats and communities (hectares)			
	Mixed seagrass	**Macroalgae dominated**	**Sand/sand with wrack**	**Limestone reef/pavement**
Survey area (2019 / 2023 survey area)	108.10	10.80	42.43	1.79
Survey area (2024 plume extension survey area)	0.92[1]	0	1.27[1]	0.35[2]
Total survey area	**109.02**	**10.80**	**43.70**	**2.14**
Development envelope	1.65	0	1.44	0
Development envelope and modelled Zone of High Impact (ZoHI)	2.06	0	1.26	0

[1]Presumed mixed seagrass and sand/sand with wrack identified by aerial image classification and RIA ground-truth data

[2]Limestone reef pavement identified by aerial image classification only

The areas of benthic communities and habitats within the overall survey area, zones of predicted indirect impact and development envelope are discussed further in Section 7.5.1.1.

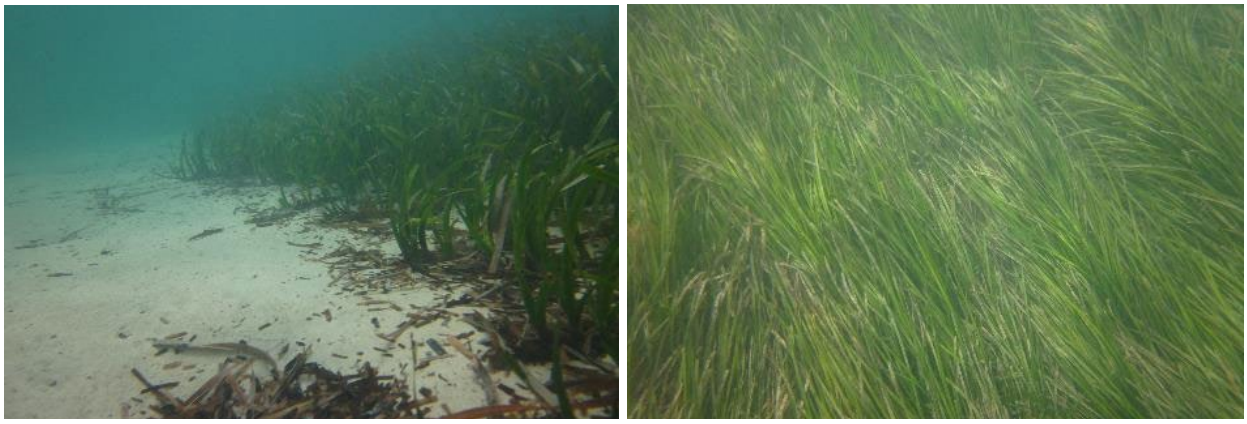


Plate 7: Edge of Posidonia spp. seagrass meadow (first) and Posidonia spp. meadow (second)

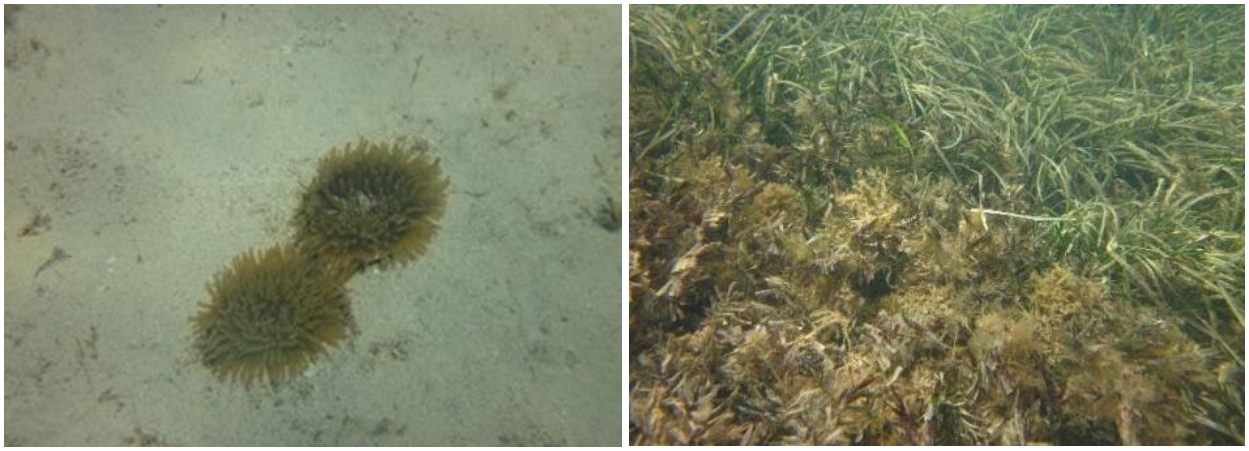


Plate 8: Sea anemones on bare sandy sediment (first) and *Posidonia* and *Amphibolis* spp. epiphytic brown algae (second)

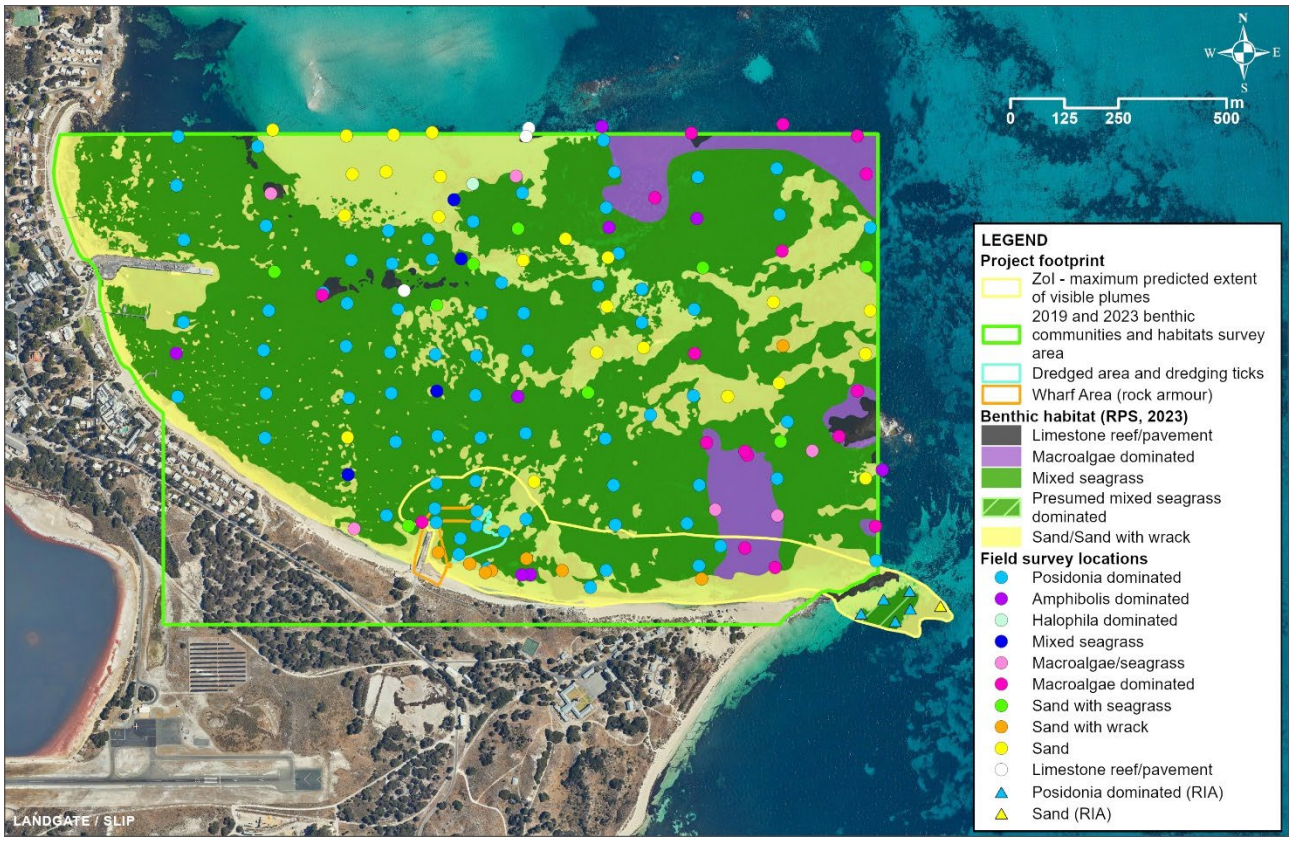


Figure 15: Benthic habitats within the development envelope and modelled dredge plume

7.4.2 Local Assessment Unit

A LAU is a geographical area that establishes the spatial context for the calculation and assessment of recoverable impacts and cumulative losses. LAUs are location specific and should reflect local physical, ecological, administrative and jurisdictional considerations.

There is no standard size or shape to a LAU, and they need to be defined on a situation-specific basis (EPA 2016). Guidance on LAU size by the EPA (2016f) indicates that they are typically defined as a ten km stretch of coastline extending five km offshore, although other size LAUs will be considered if justified.

RPS has identified the most appropriate LAU for the proposal as the area mapped by Harvey (2009) (Figure 16) because this area:

- Comprises 2,746 ha of described habitat in which historic habitat loss from anthropogenic impacts have been estimated
- Represents a complete island ecosystem
- Is consistent with EPA (2016f) guidance on the size of an LAU.

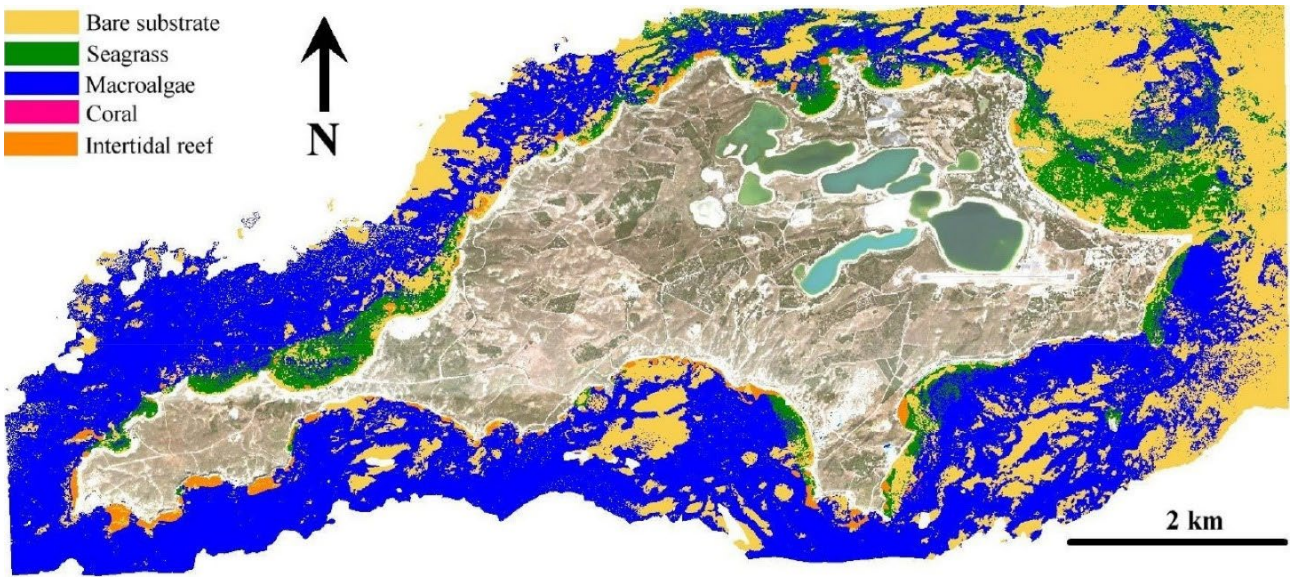


Figure 16: Benthic habitat map of Wadjemup / Rottnest Island (Harvey, 2009)

The benthic habitat map of Wadjemup / Rottnest Island (Figure 16) was developed using hyperspectral imagery obtained in 2004 and based on spectral signatures of the dominant habitat components. At the broadest scale, areas of bio-substrate were separated from bare substrates in the image with an overall accuracy of 95%, whereas at the finest scale, bare substrates and dominant species or genera were separated with an accuracy of 70% (Harvey 2009). This benthic habitat modelling technique has the highest accuracy (84%; validated in field) and is able to identify small patches of habitats (RPS, 2024a).

When comparing the benthic habitat map by Harvey (2009) to aerial images taken in August 2014 and 2018 and observations from the site visit, RPS (2019) identified discrepancies in areas of seagrass and sand habitat, considered most likely to be due to fine-scale misclassification of habitats by Harvey (2009). In particular, RPS (2019) observed that misclassification of mobile wrack as seagrass by Harvey (2009) would result in an overestimate of the amount of seagrass loss within the development envelope.

Due to the potential for fine-scale misclassification of habitat, additional sites were added to the 2023 benthic habitat survey to further clarify high risk wrack accumulation areas, such as the shallows and habitat edges where misclassification is more likely, and supplementary observations were noted detailing when wrack was present, and if it occurred at the edge of a benthic habitat. This information assisted in the aerial footage comparisons to predict areas of benthic habitat and calculate benthic habitat losses more accurately.

A comparison of the habitat maps developed in 2019 and 2023 by RPS and the benthic habitat map developed by Harvey (2009) for the same area, indicates that the map by Harvey (2009) underestimates the amount of seagrass in south Thomson Bay and overestimates the macroalgae dominated habitat. The map by Harvey (2009) also indicates more areas of sand than the current study. The two RPS survey results (2019 and 2023) were more similar to each other than Harvey (2009), however there was an increase in macroalgae/limestone pavement and an increase in seagrass and sand / sand with wrack observed. These were relatively small differences though and may be accounted for with the alteration of site locations (and the additional sites) in the 2023 survey.

Based on RPS' assessment of the suitability of the LAU (Appendix B) and considering the guidance by EPA (2016f) that the understanding of benthic communities and their habitats should be proportional to the scale of the proposed development, it is considered reasonable that the habitat map developed by Harvey (2009) is satisfactory for description of habitat within the LAU defined for the proposed development. However, because the Harvey (2009) map underestimates the amount of seagrass habitat within the survey area it is more appropriate to base assessment of seagrass habitat loss due to the proposed development on the habitat map developed during the 2023 study.

7.5 Potential environmental impacts

Table 30 provides the potential key impacts to benthic communities and habitats from the proposal. For the purposes of the impact assessment, the following assumptions have been made:

Direct impacts:

- All benthic habitats and communities within the development envelope will be directly impacted. The development envelope encompasses:
  - The wharf area and a buffer of 7 m to 125 m around the proposed marine infrastructure to encompass potential impacts from the halo effect
  - Dredge area
  - A portion of the Zone of High Influence (ZoHI) and a portion of the Zone of Moderate Influence (ZoMI)
- All of the ZoHI (a portion of which occurs outside the development envelope) will be directly impacted.

Indirect impacts:

- Indirect impacts to the benthic habitats and communities within the ZoMI and Zone of Influence (ZoI), which is located outside the development envelope and ZoHI.

Table 30: Potential impacts on benthic communities and habitats

Phase	Impact class	Works / operations	Potential impacts
Construction	Direct	• Dredging • Construction of the wharf • Reclamation	**Loss of benthic habitats** • Permanent loss of 3.32 ha of benthic communities and habitat, comprising: – 2.06 ha mixed seagrass. The loss of 2.06 ha of mixed seagrass represents 0.52% of seagrass within the Local Assessment Unit (LAU)). – 1.26 ha sand with wrack.
	Indirect	• Dredging	**Reduced environmental quality** • Temporary decrease in light availability resulting from increased turbidity in the water column within the ZoI and ZoMI, leading to reduced primary productivity and potential increased mortality rates of primary producers under conditions of prolonged or acute exposure. • Increased sedimentation rates, or burial, resulting in stress or increased mortality rates (under extreme conditions). • Accidental fuel spills resulting in reduced water quality and impacts on benthic communities and habitats. **Loss of benthic habitats** • Recoverable loss of 3.71 ha of benthic habitats and communities within the ZoMI (the area within which predicted impacts on benthic organisms are recoverable within a period of five years following completion of the dredging activities): – Temporary loss of 2.62 ha mixed seagrass – Temporary loss of 1.09 ha sand with wrack **Introduction of invasive marine species** • Alteration of the natural benthic communities in the area caused by the introduction of invasive marine species (IMS).
Operation	Direct	No additional loss of benthic communities and habitats relative to the construction period are anticipated from operation of the proposal.	
	Indirect	• Barge movements • Maintenance dredging (potential contingency)	**Introduction of invasive marine species** • Alteration of the natural benthic communities in the area caused by the introduction of IMS. **Impacts from marine infrastructure** • Altered water flows and sediment transport caused by the presence of new marine infrastructure. **Reduced environmental quality** • Accidental fuel spills to water resulting in reduced water quality and impacts on benthic communities and habitats.

7.5.1 Assessment of impacts

7.5.1.1 Loss of benthic habitat

Construction of the proposal will result in the direct removal of benthic communities and habitats comprising mixed seagrass and sand / sand with wrack through dredging activities and construction of the marine infrastructure. The generation of a suspended sediment plume from construction activities such as dredging will result in indirect impacts to benthic communities and habitats.

7.5.1.1.1 Dredge plume modelling assessment

A Dredge Plume Modelling Assessment was undertaken by Baird (2024b) (Appendix F) for the project. The modelling assessment calculated the zones of impact which are expected to have an impact on benthic communities and habitats. The zones of impact are shown in Figure 15 and summarised in Table 31.

Table 31: Predicted zones of impact (Baird, 2024b)

Zone of impact	Definition	Boundary thresholds
Zone of High Impact (ZoHI)	The area where impacts on benthic communities or habitats are predicted to be irreversible. The term irreversible means 'lacking a capacity to return or recover to a state resembling that prior to being impacted within a timeframe of five years or less'.	Boundary of the dredging and placement area. Where sedimentation/burial is >10 cm or 10,000 g/m^2.
Zone of Moderate Impact (ZoMI)	The area within which predicted impacts on benthic communities or habitats are recoverable within a period of five years following completion of the dredging activities. This zone abuts, and lies immediately outside of, the ZoHI.	The 95th percentile of the area where a TSS concentration of >10 mg/L was exceeded. Where sedimentation / burial is 5–10 cm or 5,000–10,000 g/m^2.
Zone of Influence (ZoI)	The area within which changes in environmental quality associated with dredge plumes are predicted and anticipated during the dredging operations, but where these changes would not result in a detectible impact on benthic biota. At any point in time, the dredge plumes are likely to be restricted to a relatively small portion of the ZoI.	The 100th percentile of the area where a TSS concentration of >2 mg/L above background was exceeded (representing the maximum predicted extent of visible plumes).

Consultation was undertaken with Baird regarding potential for increased suspended sediment resulting from other constructions activities proposed, such as the placement of dredge spoil in the reclamation area. Baird confirmed that proposed reclamation activities will not impact the modelled zones of impact.

7.5.1.1.2 Impact assessment

Construction of the proposal will result in direct and indirect impacts to benthic communities and habitats comprising mixed seagrass and sand / sand with wrack through dredging activities and construction of the marine infrastructure. As indicated in Table 29, the following impacts to benthic communities and habitats are predicted as a result of construction of the proposal (Figure 17):

- Direct (permanent) impacts to 2.06 ha of mixed seagrass and 1.26 ha of sand / sand with wrack within the development envelope and ZoHI. The loss of 2.06 ha of mixed seagrass represents 0.52% of seagrass within the LAU.
- Indirect (recoverable) impacts to:
  - 2.62 ha of mixed seagrass and 1.09 ha of sand / sand with wrack within the ZoMI. It is predicted that benthic communities and habitats that are impacted within the ZoMI will recover within a five-year period.
  - 5.13 ha of mixed seagrass, 1.13 ha macroalgae dominated community, 0.35 ha of limestone reef / pavement and 6.70 ha of sand / sand with wrack within the ZoI. Changes in environmental quality associated with dredge plumes in the ZoI are not predicted to result in a detectible impact on benthic biota.

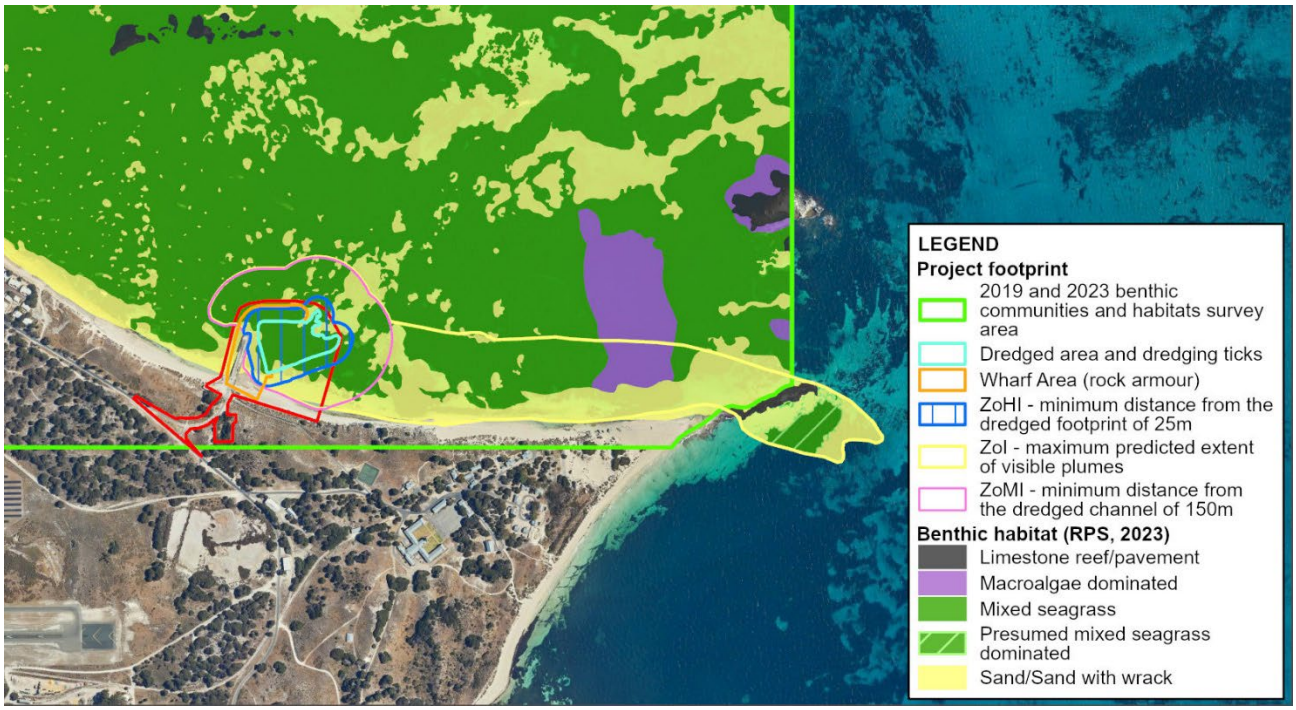


Figure 17: Predicted indirect (within the ZoMI and ZoI) and direct impacts (within the development envelope and ZoHI) to benthic communities and habitats

Table 32: Predicted direct and indirect impacts to benthic communities and habitats

Area	Habitat (hectares)			
	Mixed seagrass	Macroalgae dominated	Sand/sand with wrack	Limestone reef/ pavement
Survey area	**109.02**	**10.80**	**43.70**	**2.14**
Direct (permanent) impacts				
Development envelope	1.65	0	1.44	0
Development envelope and modelled Zone of High Impact (ZoI)	2.06	0	1.26	0
Total area directly impacted	**2.06**	**0**	**1.26**	**0**
Indirect (recoverable) impacts				
Zone of Moderate Impact (ZoMI)	2.62	0	1.09	0
Zone of Influence (ZoI)	5.13	1.13	6.70	0.35
Total area indirectly impacted	**7.76**	**1.13**	**7.79**	**0.35**

7.5.1.1.3 Cumulative environmental effects

The spatial extent of the LAU is discussed in Section 7.4.2. Calculation of cumulative benthic habitat loss within a defined LAU requires the following estimates of the extent of benthic habitat (EPA, 2016). A summary of how these estimates were determined is provided below:

- Prior to all human-induced disturbance
- At the time of the proposed development
- Remaining after the development is completed.

Oceanica (2013) estimated the historic benthic habitat loss associated with vessel moorings (mooring scars) and jetties from a review of aerial imagery taken in March 2008 (RPS, 2024a). These estimates are only for seagrass because there was insufficient data for other habitat types such as coral and macroalgae, and because seagrass meadows typically occur within sheltered, shallow bays where this marine infrastructure is located. This is considered acceptable for the current study because seagrass is the key impacted habitat.

The estimates by Oceanica (2013) are considered conservative as it did not consider other potential sources of anthropogenic stressors such as eutrophication, propeller scour and sedimentation, and assumed that areas of bare sand around marine infrastructure and moorings were previously 100% seagrass. Oceanica's estimate also did not take into account the potential seagrass regrowth that was observed by RPS when comparing the 2019 and 2023 survey data.

These estimates use the data by Harvey (2009) to estimate the 'current' extent of seagrass habitat as 398.70 hectares which, when combined with the amount lost due to human-induced disturbance (7.95 hectares) results in an estimated 406.65 hectares of seagrass habitat within the LAU prior to impacts due to human activities (RPS, 2024a).

Based on the above estimates, the permanent loss of seagrass habitat as a consequence of the proposal (2.06 ha, 0.52% of the LAU) results in a cumulative (historical (1.95% of the LAU) and projected (0.52% of the LAU)) loss of seagrass within the LAU of 2.47%.

7.5.1.2 Reduced marine environmental quality

Increased suspended sediment from dredging and construction activities has the potential to result in the following indirect impacts to benthic communities and habitats.

- Decreased light availability, leading to reduced primary productivity and potential increased mortality rates of primary producers under conditions of prolonged or acute exposure.
- The increased turbidity has the potential to result in increased scour (abrasion) of membranes and/or blockage of breathing or filter feeding structures, resulting in stress or increased mortality rates.
- Increased sedimentation rates, or burial, resulting in stress or increased mortality rates (under extreme conditions).

Based on the dredge plume modelling assessment undertaken by Baird (2024b), these indirect impacts are expected within the ZoMI. However, a detectable impact on benthic communities and habitats from increased turbidity resulting from the project within the ZoI is not predicted (Baird, 2024b).

Benthic communities and habitats located within the ZoMI that may be impacted by changes in marine environmental quality include:

- 2.62 ha of mixed seagrass
- 1.09 ha of sand / sand with wrack.

Accidental fuel spills from fuel storage and refuelling, resulting in reduced water quality, may impact on benthic communities and habitats.

Impacts to marine environmental quality are discussed further in Section 9 of this document.

7.5.1.3 Impacts from marine infrastructure

Baird (2024a) undertook a coastal processes assessment to determine the effect of the proposed marine infrastructure on coastal processes. The assessment identified that due to the presence of the existing Army Groyne, which already influences the coastal processes within South Thomson Bay, it was predicted that changes to coastal processes as a result of the proposal would be minimal. Impacts to coastal processes from the proposal are discussed further in Section 8.

A five-metre buffer is notionally considered a reasonable estimate of the area surrounding marine infrastructure that may be subject to events causing additional habitat loss, including localised erosion, slumping of dredged area walls and backwash (the halo effect). The development envelope and ZoHI encompasses an area around the proposed marine infrastructure ranging from 7 m to 125 m. Consequently, the development envelope encompasses the area which may be affected by the halo effect and impacts outside the development envelope as a result of the halo effect are not anticipated.

Potential impacts to coastal processes from the proposed marine infrastructure is discussed in more detail in Section 8 of this report.

7.5.1.4 Introduction of invasive marine species

There is potential for vessels used during construction and implementation of the proposal to result in the introduction or spread of IMS. This impact is discussed further in Section 10.5.1.5.

7.6 Mitigation

Table 33 demonstrates how the EPA's mitigation hierarchy (avoid, minimise and rehabilitate) has been applied to the environmental factor of benthic communities and habitats to address the key potential impacts.

Table 33: Application of mitigation hierarchy to benthic communities and habitats

Potential impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impacts
Loss of benthic communities and habitat	Direct	Avoid	• Site selection includes an already disturbed area of 0.19 ha of disturbed seabed within the existing Army Groyne footprint. As benthic communities and habitats are widespread within South Thomson Bay, total avoidance of direct impacts is not possible • RIA amended the project design to reduce the dredging requirements. By changing the berthing and barge turn pocket, the volume of required dredging was reduced from 26,000 m^3 to 16,050 m^3.	**Residual impacts to benthic communities and habitats include the permanent removal of 3.32 ha of benthic communities and habitats.**
		Minimise	• The AECOM and PAEMAC value engineering works helped to not only reduce dredging requirements, but also reduce the footprint to the minimum possible to achieve the objectives of constructing a new barge landing. • Management and mitigation proposed during construction to minimise impacts to benthic communities and habitats is detailed in the Construction Environmental Management Plan (CEMP) (Emerge, 2024a) (Appendix P) and Dredging Environmental Monitoring and Management Plan (DEMMP) (02 Environment, 2024) (Appendix O). Implementation of these management plans will ensure that the area of benthic communities and habitats permanently impacted by the proposal is limited to the development envelope and ZoHI. These measures include: – Employing high-resolution positioning system to control dredge operations to ensure that they do not occur outside the proposed dredging area – Implementing the management measures to minimise impacts to marine environmental quality as outlined in Section 9.6 of this report.	
		Rehabilitate	Areas of benthic communities and habitats within the development envelope and ZoHI which will be directly impacted are not proposed to be rehabilitated.	
		Offset	Benthic communities and habitat offsets are not considered applicable to the proposal.	
	Indirect	Avoid	Discussed under 'Reduced marine environmental quality (i.e. increased turbidity and sedimentation rates)'.	
		Minimise		
		Rehabilitate		
		Offset		
Reduced marine environmental quality (i.e. increased turbidity and sedimentation rates)	Indirect	Avoid	Total avoidance of indirect impacts to marine environmental quality and benthic communities and habitats is not possible.	**The temporary loss of 2.62 ha of mixed seagrass and 1.09 ha of sand / sand with wrack within the ZoMI.** Baird (2024b) predicts that impacts to these benthic communities and habitats will be recoverable within a period of five years following completion of the dredging activities. Implementation of the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O) provides the monitoring and management framework to address a temporary increase in TSS / turbidity during construction. Implementation of these management plans ensures that residual impacts to benthic habitats and communities from indirect impacts will not be significant.
		Minimise	• Management and mitigation proposed during construction to minimise impacts to benthic communities and habitats is detailed in the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O). Implementation of these management plans will ensure that: – The area impacted by suspended sediments during dredging and construction will be limited (wherever possible) and will not extend past the modelled ZoHI, ZoMI and ZoI shown in Figure 15 – Implementation of the CEMP and DEMMP will ensure that permanent loss of benthic communities and habitats resulting from construction of the proposal does not exceed 3.32 ha – The potential for indirect water quality impacts to adjacent areas will be mitigated through implementation of the Marine Water Quality Monitoring Program provided in Appendix B.2 of the DEMMP. This program is discussed in further detail in Section 9.6 • Implementation of the CEMP and DEMMP provides the monitoring and management framework to address potential indirect impacts to benthic communities and habitats from impacts to marine environmental quality during construction. Key management and monitoring measures include: – Implementation of the Marine Water Quality Monitoring Program (MWQMP) provided in the DEMMP for suspended sediment – Implementation of the tiered management framework provided in the DEMMP – Implement the Benthic Communities and Habitat Monitoring Program provided in the DEMMP, including: ○ Pre-disturbance Survey Report ○ Post-dredging Survey Report ○ Reactive Survey Report (if the trigger levels specified in the DEMMP and summarised in Section 9.6 of this report are exceeded) ○ Monitoring Close-out Report – Use of silt curtains which will minimise the potential impacts associated with increased suspended sediments – The placement of geofabric (such as Texcel 1200R) textile weave along the bund wall will ensure that the placement of dredge spoil during reclamation works will not impact or increase the dredge plume zones • Maintenance dredging (if required) will be undertaken in previously disturbed / sandy areas within the development envelope / project footprint. Maintenance dredging frequency, volumes and disposal will be determined as required. Environmental management and monitoring will be undertaken in a manner that is consistent with the document Maintenance Dredging Environmental Management Framework (BMT Oceanica, 2016) prepared for Department of Transport for similar types of maintenance dredging activities.	
		Rehabilitate	Construction effects will be temporary and natural amelioration will mitigate or remove long-term impacts following cessation of construction activities. It is predicted that the temporary impacts within the ZoMI are recoverable within a period of five years following completion of the dredging activities (Baird, 2024b).	
		Offset	Benthic communities and habitat offsets are not considered applicable to the proposal.	
Alteration of the natural benthic communities in the area caused by the introduction of invasive marine species.	Indirect	Avoid	Total avoidance of vectors for the potential introduction and distribution of IMS is not possible. The construction and implementation of the proposal requires marine vessels to be used in the area.	**No residual impacts expected.** Implementation of the CEMP (Emerge, 2024a) (Appendix P) and OEMP (Appendix Q) will ensure there is no introduction of IMS.
		Minimise	• Implementation of the CEMP (Emerge, 2024a) (Appendix P), DEMMP (02 Environment, 2024) (Appendix O) and Operational Environmental Management Plan (OEMP) (Appendix Q) will minimise the risk of introduction of IMS • The proposal will be primarily used for barge operations to transport bulk cargo to and from Wadjemup / Rottnest Island. As such, the likelihood of vessels visiting the facility from international or interstate waters is low. However, any vessels from interstate or international waters will comply with Commonwealth biosecurity requirements and complete the WA Department of Primary Industries and Regional Development 'Vessel Check' risk assessment (https://www.vessel-check.com/) • All vessels will have a ballast water management plan and ballast water exchanges will be in accordance with IMS requirements and the Commonwealth *Biosecurity Act 2015*.	
		Rehabilitate	Rehabilitation is not considered applicable to this impact.	
		Offset	Benthic communities and habitat offsets are not considered applicable to the proposal.	
Altered water flows and sediment transport caused by the presence of new marine infrastructure	Indirect	Avoid	Complete avoidance of effects on coastal processes from the proposal is not avoidable.	**Additional residual impacts from those discussed under 'loss of benthic communities and habitat' are not anticipated.**
		Minimise	• Baird (2024) identified that, due to the presence of existing infrastructure within the project footprint (Army Jetty), changes to coastal processes as a result of the proposal would be minimal • A five-metre buffer is notionally considered a reasonable estimate of the area surrounding marine infrastructure that may be subject to events causing additional habitat loss, including localised erosion, slumping of dredged area walls and backwash (the halo effect). The development envelope and ZoHI encompasses an area around the marine infrastructure ranging from 7 m to 125 m. Consequently, the development envelope encompasses the area that may be impacted by the halo effect and impacts outside the development envelope as a result of the halo effect are not anticipated.	
		Rehabilitate	The 'halo effect' from the proposed marine infrastructure is included in the calculated direct impacts (within the development envelope and ZoHI). Areas of benthic communities and habitats which will be directly impacted are not proposed to be rehabilitated.	
		Offset	Benthic communities and habitat offsets are not considered applicable to the proposal.	

7.7 Assessment and significance of residual impact

The residual impacts to benthic communities and habitats following the implementation of mitigation measures are summarised below:

- Permanent loss of mixed seagrass of up to 2.06 ha (or 0.52% of mixed seagrass within the LAU)
- Permanent loss of sand / sand with wrack of up to 1.26 ha. It should be noted, that post-dredging activities, sand / sand with wrack is likely to accumulate and therefore this impact is unlikely to be permanent.
- Temporary loss of 2.62 ha of mixed seagrass and 1.09 ha of sand / sand with wrack within the ZoMI. Baird (2024b) predicts that impacts to these benthic communities and habitats will be recoverable within a period of five years following completion of the dredging activities.

Consideration of the significance of the residual impacts on benthic communities and habitats is discussed in Table 34.

Table 34: Consideration of the significance of the residual impacts on benthic communities and habitats

Matters for consideration	Response
Object and principles of the EP Act	RPS undertook a benthic habitat assessment to support a previous design of the project in 2019 (RPS, 2019). In 2023, RPS reviewed and updated the 2019 benthic habitat mapping to support the proposal. These benthic communities and habitat assessments were undertaken to address the EPA's Benthic Communities and Habitat objective and the principles of the EP Act have been specifically addressed in relation to the proposal.
Values, sensitivity and quality of the environment which is likely to be impacted	Baseline investigations have been undertaken to determine the existing benthic communities and habitat values and sensitivity of the receiving marine environment. Investigations identified the presence of seagrass within the development envelope, ZoHI, ZoMI and ZoI. Seagrass is sensitive to impacts from dredging activities, including the generation of suspended sediments in the water column which can result in smothering and reduce light reaching the seagrass meadows. Implementation of the CEMP, DEMMP and OEMP will avoid and minimise environmental impacts on the more sensitive benthic communities and habitats receptors (e.g. seagrass). With implementation of these management plans, the residual impacts are limited to: • Permanent loss of mixed seagrass of up to 2.06 ha (or 0.52% of mixed seagrass within the LAU) • Permanent loss of sand / sand with wrack of up to 1.26 ha. It should be noted, that after dredging activities, sand / sand with wrack is likely to accumulate and therefore this impact is unlikely to be permanent. • Temporary loss of 2.62 ha of mixed seagrass and 1.09 ha of sand / sand with wrack within the ZoMI. Baird (2024b) predicts that impacts to these benthic communities and habitats will be recoverable within a period of five years following completion of the dredging activities.
All stages and components of the proposal (such as any infrastructure required for the proposal to be practicably implemented, or a proposal life cycle)	All stages of the proposal (i.e. construction and operation) have been included in this impact assessment.
Extent (intensity, duration, magnitude, and geographic footprint) of the likely impacts	Impacts to benthic communities and habitats from the proposal will be managed through implementation of the CEMP, DEMMP and OEMP. With implementation of these management plans, the residual impacts are limited to: • Permanent loss of mixed seagrass of up to 2.06 ha (or 0.52% of mixed seagrass within the LAU) • Permanent loss of sand / sand with wrack of up to 1.26 ha. • Temporary loss of 2.62 ha of mixed seagrass and 1.09 ha of sand / sand with wrack within the ZoMI. Baird (2024b) predicts that impacts to these benthic communities and habitats will be recoverable within a period of five years following completion of the dredging activities.

Matters for consideration	Response
Resilience of the environment	Benthic communities and habitats are susceptible to impacts from the proposal. Direct impacts will result in the permanent loss of 2.06 ha of seagrass within the development envelope and ZoHI. Indirect impacts within the ZoMI will be recoverable within a period of five years and impacts within the ZoI are not predicted to be observable. As such, it is considered that the marine environment is resilient to the indirect impacts from the proposal.
Consequence of the application of the mitigation hierarchy to the proposal.	The construction and operation of the proposal will result in the removal or disturbance of benthic communities and habitats within South Thomson Bay. However, habitat removal will be limited to the development envelope and ZoHI, and it is considered a small proportion (2.06 ha) of the total habitat within the South Thomson survey area and the broader LAU (0.52% of the LAU). Additionally, the temporary disturbance of benthic habitats and communities during construction will not have lasting impacts from construction outside the development envelope and ZoHI. As such, there will be no significant consequences from the proposal on benthic communities and habitats in the LAU. Any changes to benthic community population dynamics are likely to be temporary and reversable and the habitat to be directly removed is a very small proportion of the habitat available in the broader LAU and is well represented in the area. Following the application of the mitigation hierarchy (Table 33) and taking into consideration the above significance of residual impacts, RPS considers that permanent impacts to 0.52% of the LAU will not result in a species or ecosystem requiring protection under statute or increase the cumulative impact to a critical level.
Level of confidence in the prediction of residual impacts and the success of proposed mitigation	The impact assessment has been completed with a high level of confidence and in accordance with relevant legislation and guidelines as per Table 28.
Public interest about the likely effect of the proposal or scheme, if implemented, on the environment, and relevant public information	RIA has facilitated regular meetings / dialogue with the local community and key stakeholders (Table 25) as part of the project.

Cumulative impacts from the proposal have been considered in relation to other proposals within 5 km of the proposal and are discussed in Section 18.

Holistic impacts are discussed in Section 17.

7.8 Environmental outcomes

In consideration of the proposed avoidance and management measures and likely residual impacts associated with the proposal, the environmental outcomes that apply to benthic communities and habitats are:

- Environmental outcomes for construction of the proposal:
  - Direct disturbance of benthic communities and habitats from construction activities is confined to the development envelope and ZoHI and will not exceed 2.06 ha mixed seagrass and 1.26 ha sand with wrack.
  - Irreversible impacts to benthic communities and habitats from dredging and construction activities is confined to the development envelope and ZoHI.
  - No irreversible impacts to benthic communities and habitats from dredging activities within the ZoMI.
  - No observable impacts to benthic communities and habitats outside the ZoMI.
- Environmental outcomes for operation of the proposal:
  - Maintain the health and cover of benthic communities and habitats outside the proposal footprint during operations associated with the proposal (excludes other RIA activities associated with other approvals, e.g. mooring installation).

As the impact assessment identified low residual risks to benthic communities and habitats following the application of mitigation actions identified herein, it is considered that the proposal will successfully meet the EPA's objective for benthic communities and habitats (i.e. to protect benthic communities and habitats so that biological diversity and ecological integrity are maintained).

8 COASTAL PROCESSES

8.1 EPA objective

To maintain the geophysical processes that shape coastal morphology so that the environmental values of the coast are protected.

8.2 Policy and guidance

The proposal will be subject to compliance with applicable policies and guidance developed to assist proponents and the public to understand the minimum requirements for the protection of elements of the environment that the EPA expects to be met during the assessment process. Table 35 lists the relevant EPA guidance, other state policy and planning documents that have been considered in preparation of this document.

Table 35: Relevant policy and guidance; coastal processes

Policy and guidance	Consideration
Environmental Factor Guideline: Coastal Processes (EPA, 2016i)	The environmental factor guideline identifies the dynamic nature of coastal processes and key linkage with benthic communities and habitats, influencing both community types and distribution. The guideline recognises that changes to coastal processes resulting from a proposal may not cause impacts at that location, but impacts may occur further along the coastline or offshore. These considerations have underpinned a holistic assessment of total potential impacts and cumulative environmental effects of the proposal on coastal processes. A Coastal Processes Assessment (Baird, 2024a) has been undertaken to support the project and is summarised in Sections 8.3 and 8.4.
SPP No. 2.6: State Coastal Planning Policy (Western Australian Planning Commission, 2013a) and State Coastal Planning Policy Guidelines (Western Australian Planning Commission, 2013b)	The objective of the SPP No. 2.6, and its associated guidelines that is most relevant to the proposal is 'to ensure that the location of coastal facilities takes into account coastal processes, landform stability, coastal hazards, climate change and biophysical criteria'. SPP 2.6 has been addressed in the Coastal Processes Assessment (Baird, 2024a) and the Rottnest Island CHRMAP (Cardno, 2023).
Coastal Hazard Risk Management and Adaptation Planning Guidelines (Department of Planning and Western Australian Planning Commission, 2014)	The Rottnest Island CHRMAP (Cardno, 2023) addresses potential long-term impacts to coastal processes (including climate change) and has been used to inform this report.
Sea Level Change in Western Australia, Application to Coastal Planning (Department of Transport, 2010)	The Intergovernmental Panel on Climate Change (IPCC) has developed four representative concentration pathway scenarios for different population sizes, economic activity, lifestyle, energy use, land use patterns, technology and climate policy pathway trajectories and their possible resulting emissions. The sea level rise assessment for the Rottnest Island CHRMAP (Cardno, 2023) adopted the following sea level rise allowances (metres):

Source	2022	2030	2050	2080	2122
DoT 2010 and IPCC 2021	0.00	0.05	0.18	0.48	0.94

8.3 Environmental investigations

8.3.1 Coastal processes assessment

A detailed Coastal Processes Assessment (Baird, 2024a) (Appendix D) has been prepared to predict the potential impacts of the new infrastructure on coastal processes within South Thomson Bay. Due to the dynamic nature of coastal processes and linked interdependencies associated with coastal variables, this section assesses the cumulative impacts to coastal processes from the barge development.

8.4 Receiving environment

8.4.1 Regional setting

Wadjemup / Rottnest Island is located approximately 20 km west of the port of Fremantle. The island is 11 km long with 63 sheltered beaches and 20 bays and is the remnant of the Pleistocene dune ridges that is surrounded by large quantities of coral reefs and rock formations. The coastline contains cells that are spatially discrete sections of coastline that include the intersection of both marine and land-based structures that connect through the exchange of sediment (Stul T, 2015).

8.4.2 Wave climate

The wave climate of the coastline from Bunbury to Perth is dominated by deep-water waves that are generated by large-scale weather systems over the Indian and Southern oceans. Seasonal variability in the wave climate generally peaks during the winter months (Baird, 2024a). The wave conditions in Thomson Bay are generated by two principal sources:

- Long period swell waves (>8 seconds) that are generated in the Southern Ocean and which travel around the north side and south side of the island by diffraction and refraction to enter Thomson Bay as low amplitude swell.
- Short period (<8 seconds) wind sea waves approach the bay from an easterly direction. These short period waves are generated by easterly winds acting over the fetch between the Perth coastline and Wadjemup / Rottnest Island.

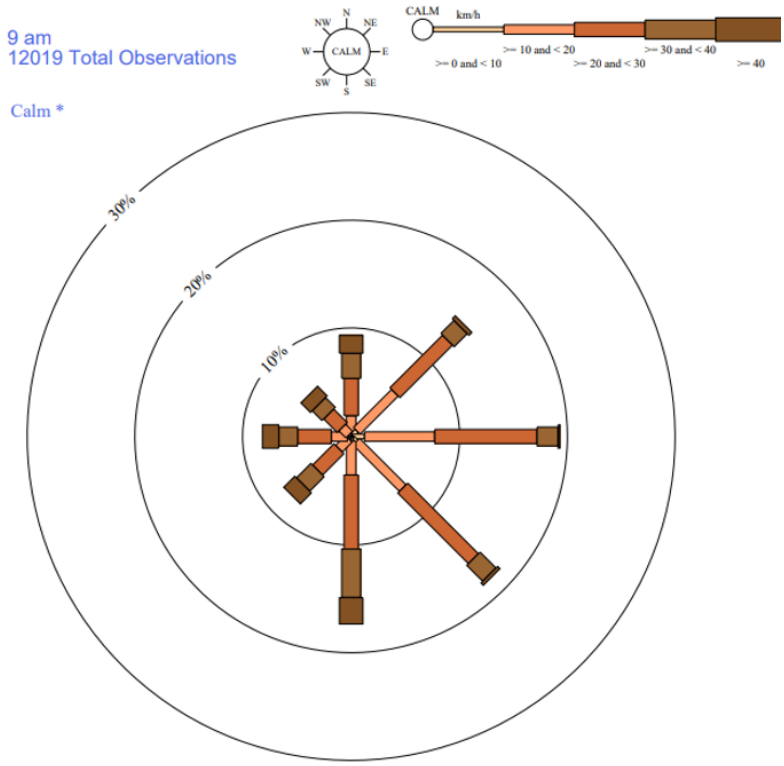
8.4.3 Water levels and tides

Seasonal variability of surges and mean sea level (peaking around June–July and May respectively) interacts with the twice annual tidal cycle (peaking in June and December) to cause a distinct seasonal peak to water levels around June, although high water levels are possible from frequent winter storms from May to September, or through rare impact of extratropical cyclones.

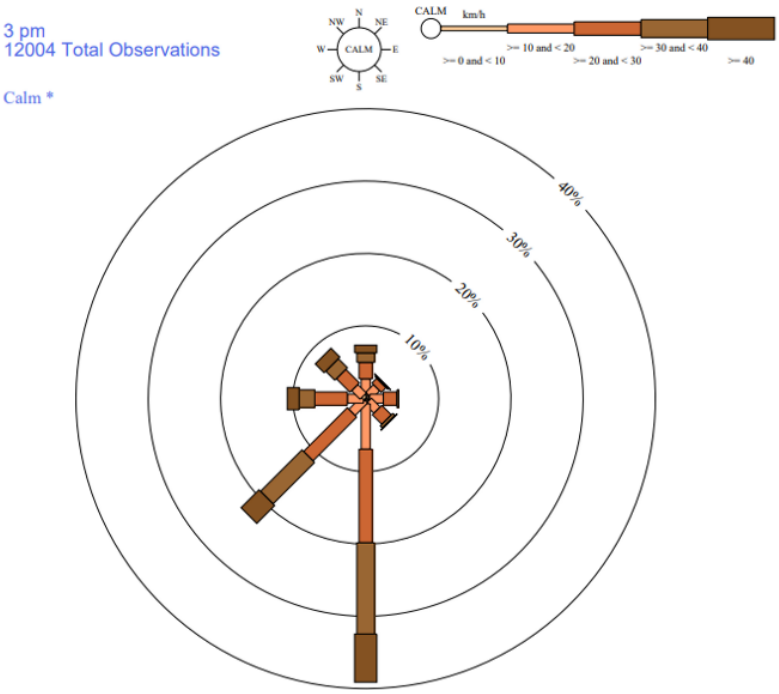
The tides at Wadjemup / Rottnest Island are mainly diurnal with a spring tide range of approximately 0.7 m and neap tide range of 0.5 m. The water level peaks during the June solstice. There is no tide gauge on Wadjemup / Rottnest Island with the nearest measured data location being the tide gauge at the Fremantle boat harbour, which is considered generally representative of the tidal regime on Wadjemup / Rottnest Island in Thomson Bay. Tidal planes are summarised in Baird (2024).

8.4.4 Wind conditions

The land – sea breeze cycle is a dominant local feature of the wind climate of the area, typically with easterly winds in the morning and southerly to westerly winds in the afternoon. Predominant wind patterns recorded at Rottnest Island weather station (009193) are shown in Graph 2 and Graph 3. Typical spring–summer wind patterns are predominantly south-easterly to south-westerly winds, while winter wind patterns are generally westerly with periods of elevated winds that correspond with storm fronts.



Graph 2: Rose of wind direction versus wind speed in km/h (29 Nov 1987 to 10 Aug 2023); 9.00 am conditions (Commonwealth of Australia, 2023)



Graph 3: Rose of wind direction versus wind speed in km/h (29 Nov 1987 to 10 Aug 2023); 3.00 pm conditions (Commonwealth of Australia, 2023)

8.4.5 Bathymetry and reefs

Bathymetric data has been captured in high resolution by the Department of Transport (DoT) from the shoreline out to approximately 30 m depth (Figure 18). There are high resolution local bathymetric surveys in Thomson Bay around the Army Groyne captured in 2017 and 2020 (Baird, 2024a) (Figure 18).Bathymetry data sourced from the Department of Transport within and adjacent to the development envelope indicates that the bathymetry ranges from approximately 0 mAHD to -5.8 mAHD (Figure 19).

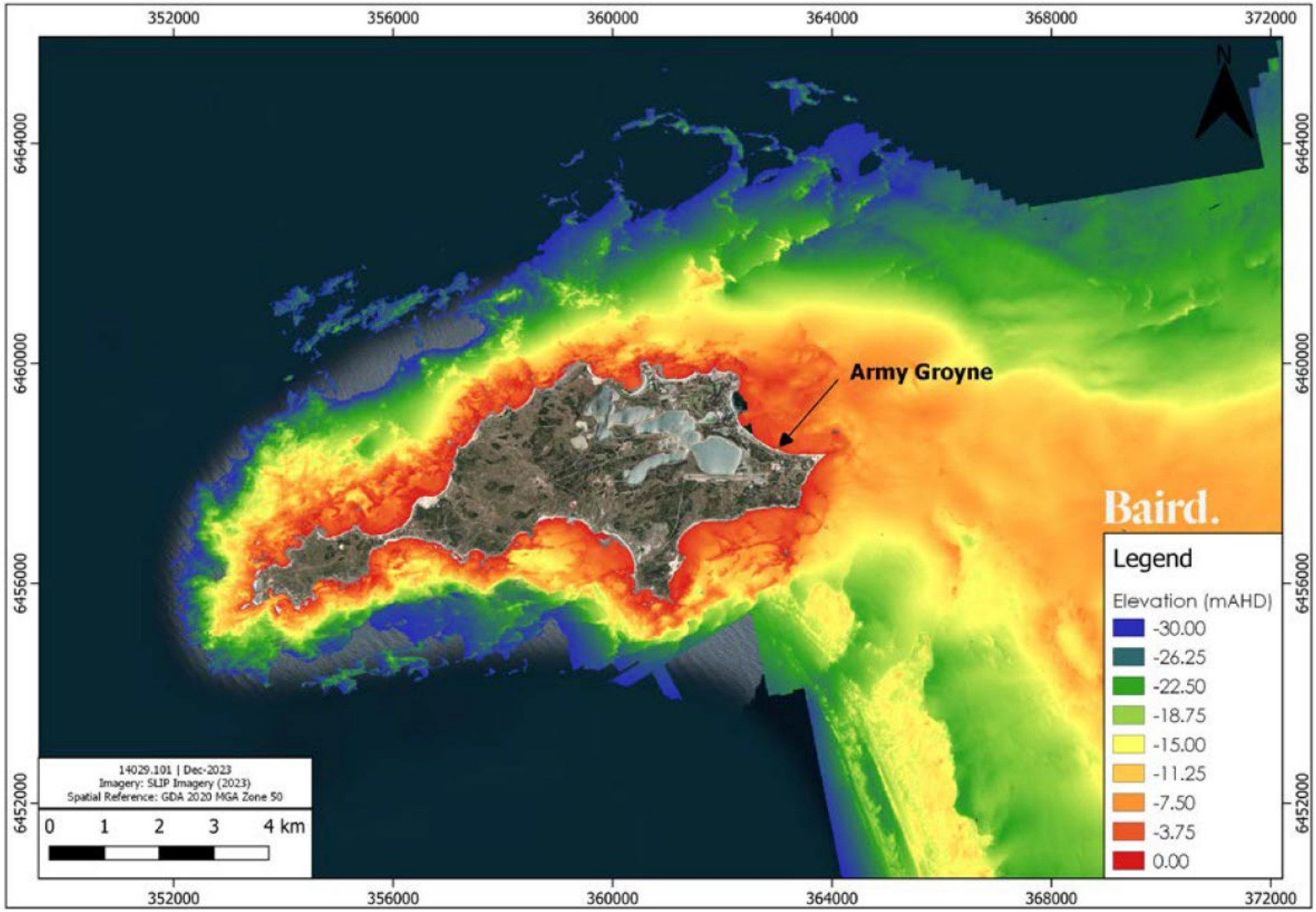


Figure 18: Bathymetry

Figure 19: Bathymetry proximate to the development envelope

8.4.6 Sediment cells

Sediment cells are mapped by Stul et al. (2015) for three spatio-temporal scales along the coast between Cape Naturaliste and Moore River:

- Primary Cells – these relate to large landforms and consider potential changes to the coastline over timescales of more than 50 years.
- Secondary Cells – these incorporate contemporary sediment movement on the shoreline and potential landform responses to inter-decadal changes in coastal processes.
- Tertiary Cells – these are defined by the reworking and movement of sediment in the nearshore and are relevant for seasonal and inter-annual changes to the beach face.

The sediment cell most relevant to the proposed facility at South Thomson Bay is the R14b tertiary cell extending from Bathurst Point to Philip Point (Figure 19), with due consideration made to its position within the R14 and the secondary cell between North Point and Philip Point and the R06D Primary cell extending from Fremantle to Safety Bay and out to Wadjemup / Rottnest Island along the Garden island Ridge.

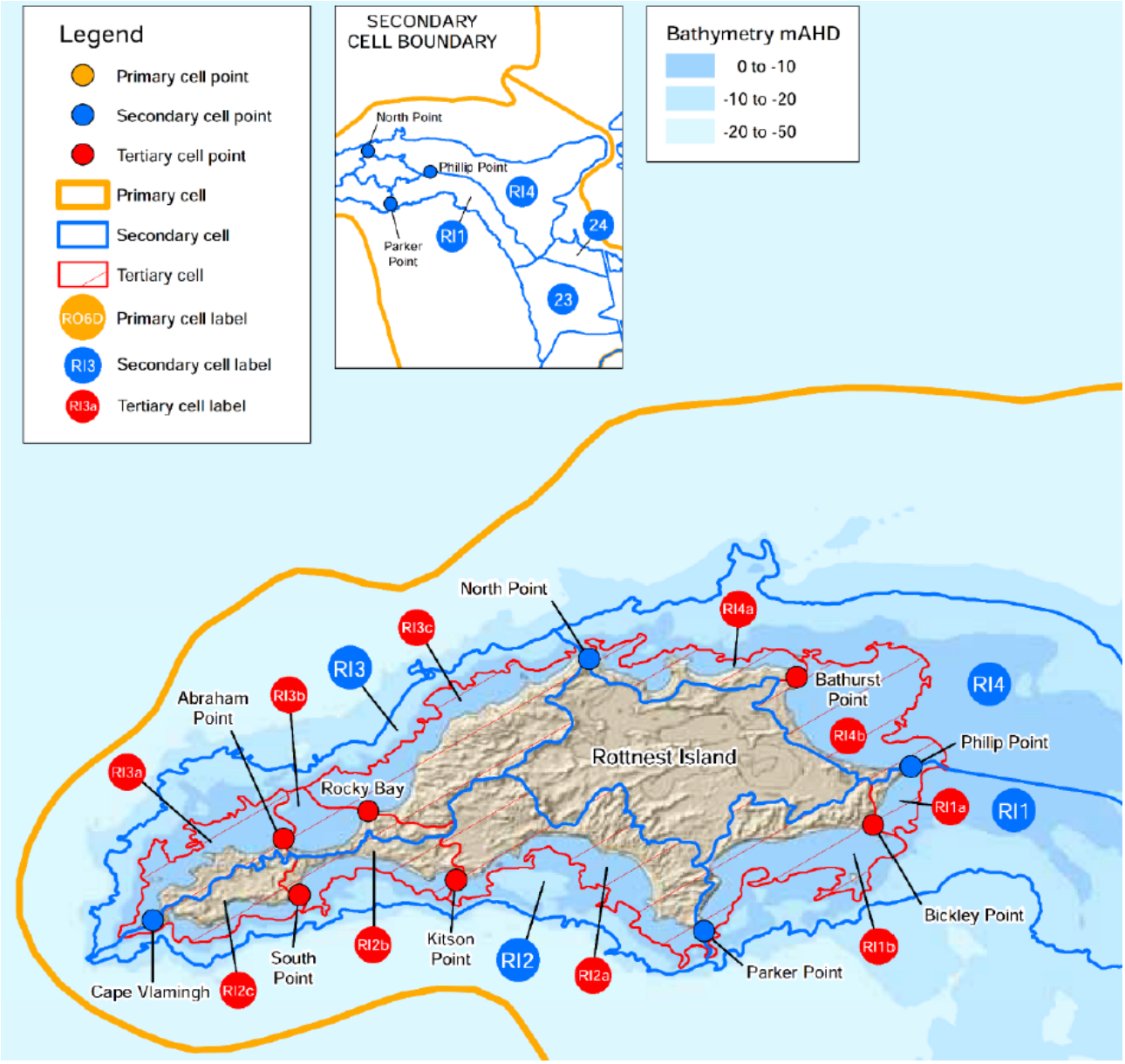


Figure 20: Secondary and Tertiary sediment cells around Wadjemup / Rottnest Island (Stul et al. 2015)

8.4.7 Shoreline characteristics and coastal structures

The shoreline of Thomson Bay follows an arcuate shape between Bathurst Point and Philip Point, truncated in places by the construction of impermeable land attached structures including the Main Passenger Ferry Jetty and the Army Groyne (Plate 9 and Plate 10). The shoreline consists mainly of sandy perched beaches, with much of the beach sitting on top of rock platforms or pavements (Seashore Engineering, 2019) and interspersed with rocky outcrops and limestone cliffs (Short, 2005).

Plate 9: Public boat ramp at the Army Groyne

Plate 10: Army Groyne structure with a view of Thomson Bay to the west and view of the groyne from the eastern seaward side

8.4.8 Wrack accumulation

Seagrass wrack is the accumulation of detached macrophytes and seagrass in the surf zone and on beaches and is primarily comprised of seagrasses and macroalgae in south-western Australia. The accumulation of seagrass wrack has the potential to impact the amenity of marinas, boat harbours and beaches due to physical obstruction, and decay. Historical imagery shows that wrack has and continues to accumulate primarily on the eastern side of the existing Army Groyne where the groyne meets the shoreline.

8.5 Potential environmental impacts

Construction processes are unlikely to result in impacts to coastal processes.

Engineered structures can influence coastal processes through interruption of currents, waves and sediment transport that can change the morphology of the seabed, beach and/or coast. The proposed wharf has potential to impact coastal processes during the operational phase.

Table 36 provides the potential key impacts to coastal processes from the proposal.

Table 36: Potential impacts on coastal processes

Phase	Impact class	Works/ operations	Potential impacts
Construction	Construction activities are unlikely to result in significant impacts to coastal processes.		
Operation	Direct	Wharf	• Interruption to longshore currents • Interruption to longshore sediment transport • Interruption to seagrass wrack transport trajectories and deposition sites • Reduction of wave energy in lee of structures • Reflection of waves off structures resulting in increased wave energy in the structures vicinity. In the Coastal Processes Assessment (Baird, 2024a) (Appendix D), Baird noted that the reflection of waves off structures, potentially resulting in increased wave energy, was unlikely to impact adjacent moorings and this increase in energy is anticipated to be minimal.

8.5.1 Assessment of impacts

8.5.1.1 Interruption to longshore currents

8.5.1.1.1 Interruption to longshore sediment transport

The existing Army Groyne comprises a limestone armoured groyne that is approximately 100 m in length and features a 7 m wide compacted limestone crest. The existing groyne compartmentalises the shoreline by interrupting longshore sediment transport within Thomson Bay. This is demonstrated by seasonal accretion and erosion of the shoreline on either side of the groyne (Cardno, 2023).

The majority of longshore sediment transport is currently blocked by the existing Army groyne, and it is predicted that the proposed wharf will block longshore sediment transport to a similar degree (Baird, 2024a). Therefore, due to the existing impacts to coastal processes, the proposal is not expected to result in a significant change in longshore sediment transport.

Based on existing coastal processes around the Army Groyne and the Coastal Processes Assessment undertaken by Baird, it is predicted that there may be some potential for build-up of sediment on the eastern side of the proposed wharf. This build up may be slightly greater than existing conditions, but this is not considered substantial enough to have a significant impact on the overall shoreline position along South Thomson Bay (Figure 20).

Considering the above analyses, it is unlikely that the proposed barge development would have a significant impact on the sediment dynamics along South Thomson Bay (Baird, 2024a) and therefore the proposal is not expected to result in a significant change in longshore sediment transport.

8.5.1.1.2 Interruption to seagrass wrack transport trajectories and deposition sites

The proposed development of the South Thomson Barge Landing Development will not have a significant impact on the timing or volume of wrack accumulation across the beaches of Thomson Bay than the impact that the Army Groyne already has on the dynamics in South Thomson Bay (Baird, 2024a).

However, there is potential for the accumulation of seagrass to occur on the eastern side of the proposed development structure, which may lead to ingress of seagrass to the harbour footprint (Figure 21). A review of existing seagrass accumulation on the eastern side of the Army Groyne indicates that this predicted accumulation against the proposed structure will not be a significant change to that already experienced (Plate 11).

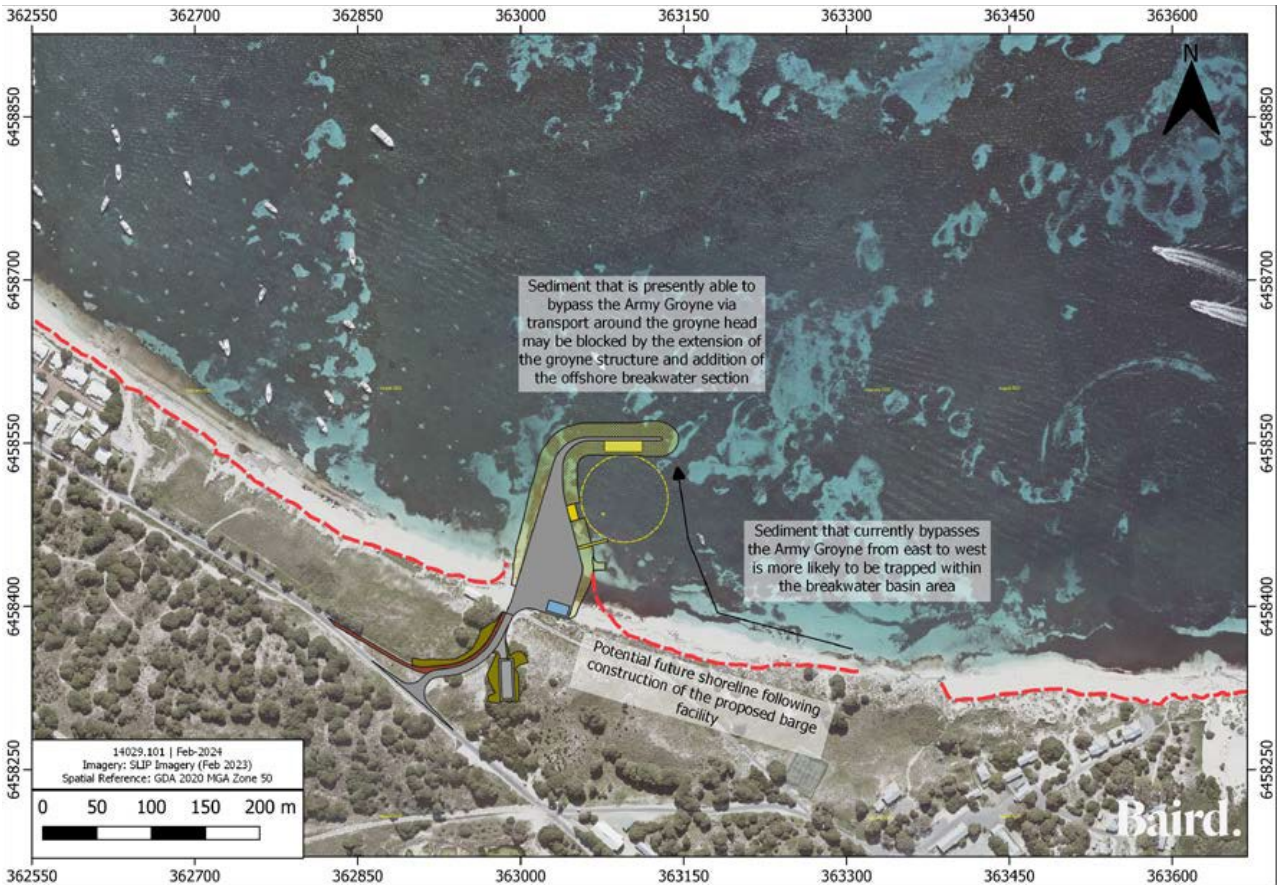


Figure 21: Potential impact of proposed facility on sediment dynamics in South Thomson Bay

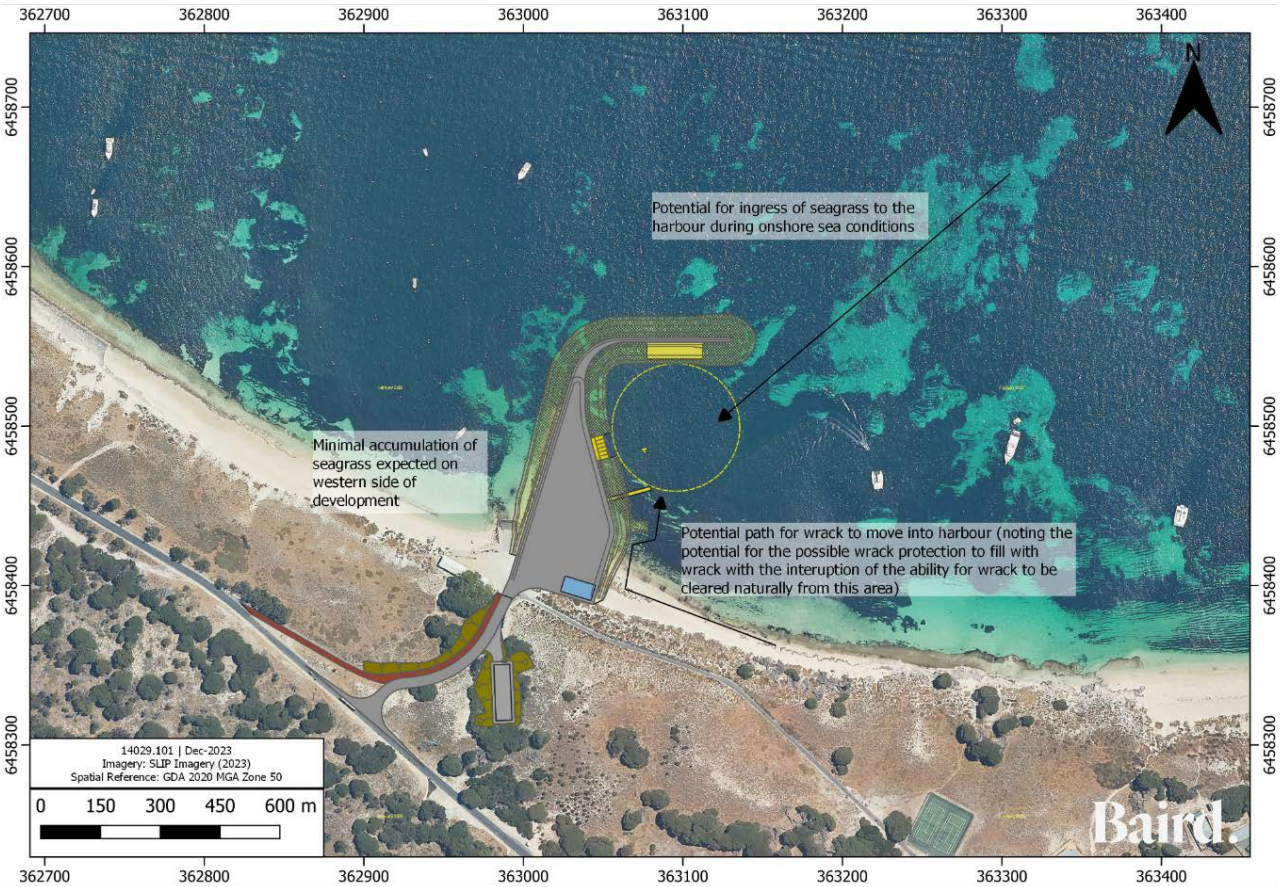


Figure 22: Potential wrack dynamic associated with the proposal

Plate 11: Existing wrack accumulation on the eastern side of the Army Groyne looking seaward (top, mid) and looking landward (bottom) (Baird, 2024a)

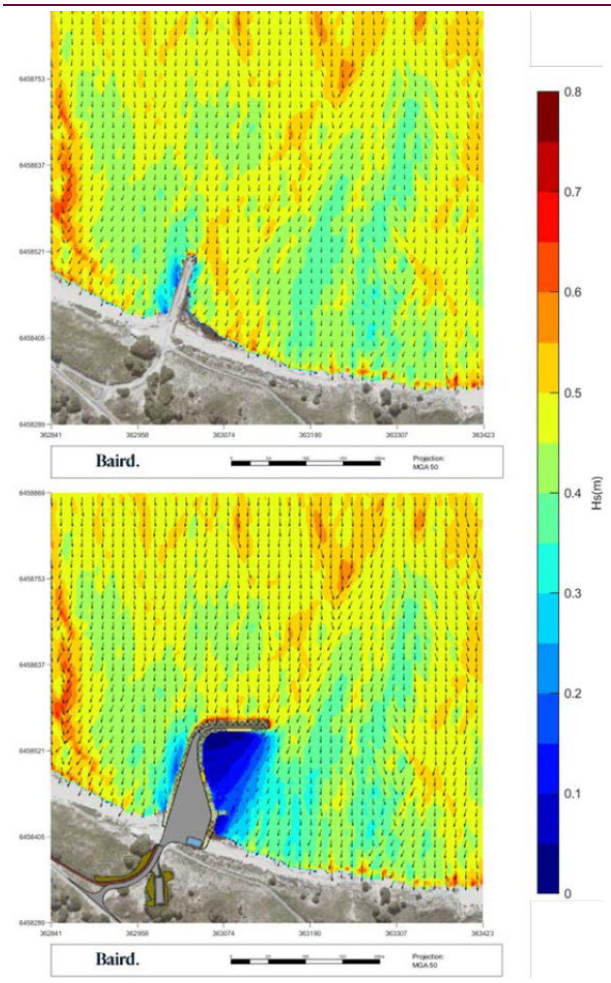
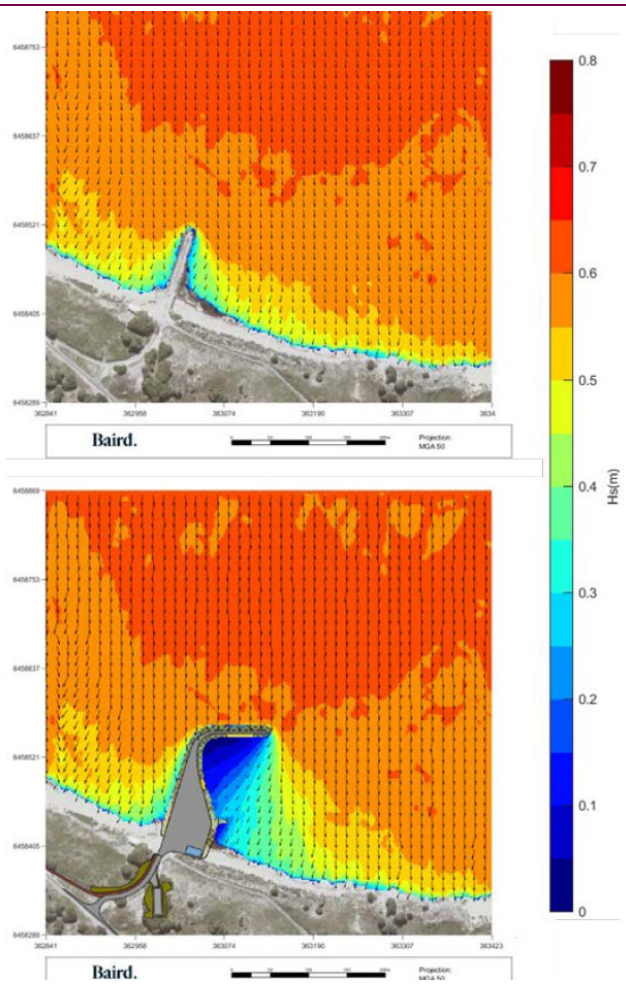
8.5.1.2 Reduction of wave energy in lee of structures

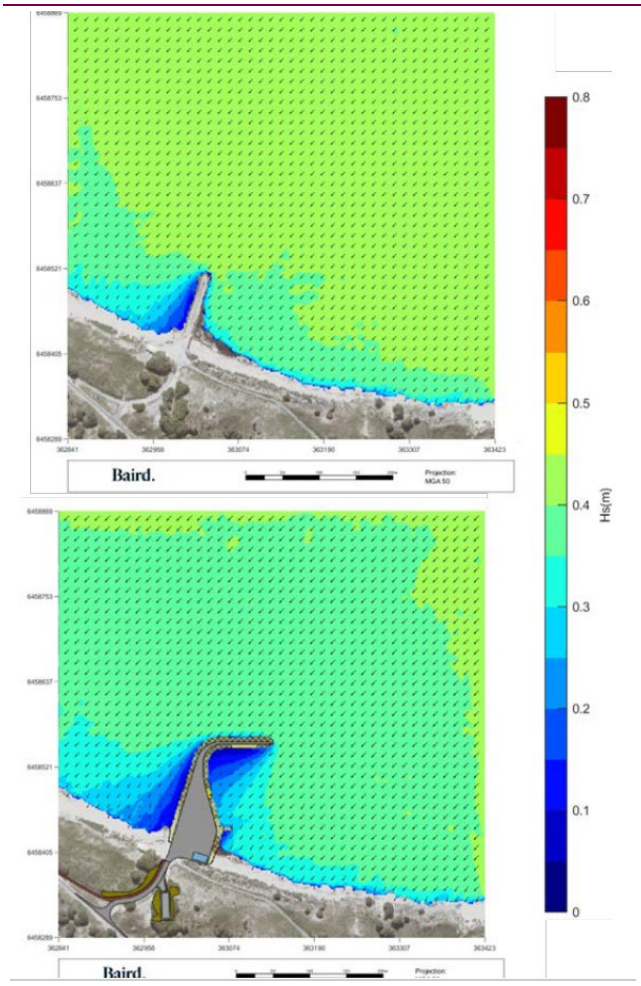
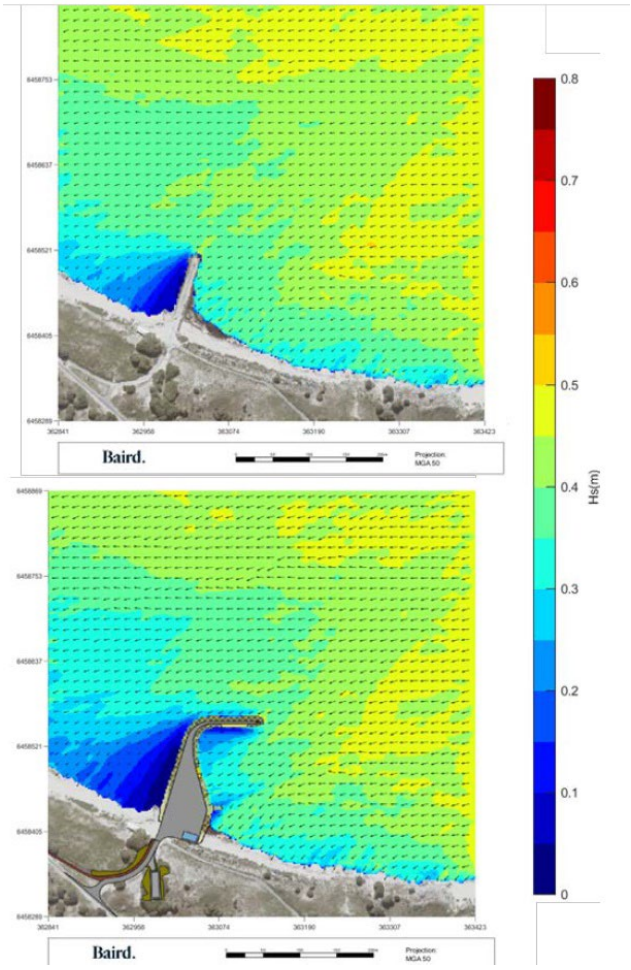
Baird plotted a number of different wave scenarios showing the change in the wave impacts with and without the proposed wharf (Table 37). Based on this, the following observations of changes to the wave impacts with and without the structures in place have been made (Baird, 2024a):

- The wave shadowing seen at the shoreline on the western side of the wharf is minimal, with a difference of <0.1 m in each wave case when compared to the existing condition. This is due to the impact that the existing Army Groyne structure has on waves on its western side when arriving at the structure from the predominant directions experienced at this location (i.e. from the northern to eastern sector).
- The greatest reduction in wave height, when compared to the existing conditions, is seen within the harbour basin area. Although, some reduction in wave height along the shoreline on the eastern side of the wharf is also evident, with wave shadowing increasing up to 0.4 m a short distance to the east from the wharf structure. This is most prominent, and has the greatest spatial impact, in the northerly wave cases.
- The wave shadowing seen within the harbour structure (most prominent with the northerly wave condition cases) creates a reduction between 0.1 m and 0.4 m across the scenarios considered, with the expectation that some wave direction conditions could produce a reduction in wave climate of up to 0.4 m within the harbour basin.

Overall, the main changes in wave energy as a result of the proposed wharf is the reduction in wave height (when compared to the existing conditions) within the harbour basin area and some reduction in wave height along the shoreline on the western side of the wharf.

Table 37: Wave scenarios showing the change in the wave impacts with and without the proposed wharf

Northern swell event wave plots showing wave conditions at the Army Groyne (top) and at the proposed barge landing facility (bottom)	Northern wind sea event wave plots showing wave conditions at the Army Groyne (top) and at the proposed barge landing facility (bottom)
	

North-eastern wind sea event wave plots showing wave conditions at the Army Groyne (top) and at the proposed barge landing facility (bottom)	Eastern wind sea event wave plots showing wave conditions at the Army Groyne (top) and at the proposed barge landing facility (top right)
	

8.5.1.3 Reflection of waves off structures

An assessment of wave penetration into the harbour basin has been undertaken by Baird, the analysis indicates that the wave conditions are reduced by the proposed wharf structure for waves approaching from the north and northeast, which are the dominant wave conditions at the location. The outcomes of the assessment are summarised below:

- Waves approach the site from the north for approximately 50% of the year. The analysis of diffracted wave conditions indicate that the barge landing location is well sheltered from swell wave conditions that arrive from the north. The breakwater is effective at reducing the wave conditions at the barge ramp to approximately 40% of the incoming wave conditions, with the diffracted swell wave arriving at the stern of the vessel.
- Wind sea conditions arrive at the site from the northeast for approximately 30% of the year. These wave conditions cover waves that have wave periods of typically less than 4 seconds and are generated by local wind conditions. The assessment identified that the wharf structure reduces the incident waves by approximately 30%.
- Wave conditions from the east represent a small proportion of the annual sea state, at approximately 2% of the yearly record. The proposed wharf does not provide protection from waves from this direction and it is assumed these conditions would reach the barge ramp unchanged. The waves will approach the barge ramp approximately in line with the vessel stern at 0.44 m to 0.5 m significant wave height. It is noted these conditions are infrequent over the course of the annual record in the measured data and are concentrated in the winter months.

The impact on wave conditions outside of the proposed wharf structure was determined to be minimal by Baird, with decreases in wave height being the main observation across each of the cases modelled. No detrimental increase in wave height caused by reflections from the breakwater structure is seen at the moorings managed by RIA (Baird, 2024a).

8.6 Mitigation

Table 38 demonstrates how the EPA's mitigation hierarchy (avoid, minimise and rehabilitate) has been applied to the environmental factor of coastal processes to address the key potential impacts.

Table 38: Application of mitigation hierarchy to coastal processes

Potential impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impacts
Interruption of longshore currents	Direct	Avoid	The Army Groyne creates an existing barrier to longshore sediment transport. Therefore, as the proposed wharf will block longshore sediment transport to a similar degree to the existing Army Groyne, the proposal is not anticipated to result in a significant change in longshore sediment transport and significant impacts have been avoided.	**Sediment accretion and seagrass accumulating on the eastern side of the wharf** Due to the presence of the existing Army Groyne, changes to longshore currents due to the proposed wharf are not considered likely to be significant. Any accumulation volume of wrack and the reshaping of the shoreline will be monitored and maintained as outlined in the OEMP.
		Minimise	• The proposed wharf structure has been subject to coastal processes modelling. • Monitoring of shoreline accretion and seagrass accumulating on the eastern side of the wharf will be undertaken during the operational phase. As outlined in the Operational Environmental Management Plan (OEMP) (Appendix Q), a coastal monitoring program will be implemented as required in the Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) (Cardno, 2023). • Implementation of the Rottnest Island CHRMAP (Cardno, 2023).	
		Rehabilitate	Depending on the accumulation volume of wrack and the reshaping of the shoreline towards the protection nib on the eastern side of the wharf, the above maintenance and monitoring activities may need to be actioned (Baird, 2024a).	
		Offset	Coastal processes offsets are not considered applicable to the proposal.	
Reduction of wave energy in lee of structures	Direct	Avoid	• Impacts on coastal process from marine structures cannot be completely avoided due to the nature of the proposal. • Overall, the main changes in wave energy as a result of the proposed wharf is the reduction in wave height (when compared to the existing conditions) within the harbour basin area and some reduction in wave height along the shoreline on the western side of the wharf.	**A reduction of wave energy in lee of the proposed wharf** This residual impact is not considered likely to have a significant impact on surrounding coastal process and the marine environment.
		Minimise	• The proposed wharf structure has been subject to coastal processes modelling. This modelling identified that changes are likely to be limited to: – The reduction in wave height (when compared to the existing conditions) within the harbour basin area – A small reduction in wave height along the shoreline on the western side of the wharf. • As the vessels manoeuvre into or away from the facility within the turning circle, the waves would be 90 degrees to the vessel and further investigation into potential implications of this on the barge will be investigated as part of future detailed design. • Implementation of the Rottnest Island CHRMAP (Cardno, 2023).	
		Rehabilitate	Rehabilitation activities due to a reduction in wave energy is not considered applicable.	
		Offset	Coastal processes offsets are not considered applicable to the proposal.	
Reflection of waves off structures	Direct	Avoid	Impacts on coastal process from marine structures cannot be completely avoided due to the nature of the proposal.	**No residual impacts expected**
		Minimise	The proposed wharf structure has been subject to coastal processes modelling and the impact on wave conditions outside of the proposed wharf structure was determined to be minimal by Baird (2024).	
		Rehabilitate	Rehabilitation activities due to a reduction in wave energy is not considered applicable.	
		Offset	Coastal processes offsets are not considered applicable to the proposal.	

8.7 Assessment and significance of residual impact

Following the application of the mitigation hierarchy (Table 38), RPS considers that there are no significant residual impacts to coastal processes from the proposal. The residual impacts are limited to:

- Sediment accretion and wrack accumulating on the eastern side of the wharf
- A reduction of wave energy in lee of the wharf.

The residual impacts are not considered significant as discussed in Table 39.

Table 39: Consideration of the significance of the residual impacts on coastal processes

Matters for consideration	Response
The object and principles of the EP Act	A Coastal Processes Assessment (Baird, 2024a) (Appendix D) was undertaken to address the EPA's Coastal Processes objective and the principles of the EP Act have been specifically addressed in relation to the proposal (Table 26).
Values, sensitivity and quality of the environment which is likely to be impacted	A Coastal Processes Assessment (Baird, 2024a) was undertaken to support the proposal to determine the potential impacts from the proposal on coastal processes. Due to the presence of the existing Army Groyne, changes to coastal processes due to the proposed wharf are not considered likely to be significant.
All stages and components of the proposal (such as any infrastructure required for the proposal to be practicably implemented, or a proposal life cycle)	All stages of the proposal (i.e. construction and operation) have been addressed in this report. However, as construction activities are unlikely to result in impacts to coastal processes, only impacts from the operational phase has been addressed in Sections 8.5 to 8.7.
Extent (intensity, duration, magnitude, and geographic footprint) of the likely impacts	Due to the presence of the existing Army Groyne, changes to coastal processes due to the proposed wharf are not considered likely to be significant. Therefore, residual impacts from the proposal are limited to: • Sediment accretion and wrack accumulating on the eastern side of the wharf • A reduction of wave energy in lee of structures.
Resilience of the environment	The majority of longshore sediment transport is currently blocked by the existing Army Groyne, and the proposed wharf will block longshore sediment transport to a similar degree (Baird, 2024). As there are no significant changes to coastal processes, the coastal environment will not need to be resilient to changes resulting from the proposal.
Consequence of the application of the mitigation hierarchy to the proposal.	Only minor changes to coastal process are predicted and these will be constrained to South Thomson Bay, in the immediate locale of the proposal. RPS considers that the residual impacts to coastal processes listed below are not significant: • Sediment accretion and wrack accumulating on the eastern side of the wharf • A reduction of wave energy in lee of structures
Level of confidence in the prediction of residual impacts and the success of proposed mitigation	The impact assessment has been based on a Coastal Processes Assessment (Baird 2024) which was peer reviewed by RPS to confirm that the modelling and assessment was fit for purposes. As such, the prediction of the residual impacts has been completed with a high level of confidence.
Public interest about the likely effect of the proposal or scheme, if implemented, on the environment, and relevant public information	RIA has facilitated regular meetings / dialogue with the local community and key stakeholders (Table 25) as part of the project.

Cumulative impacts from the proposal have been considered in relation to other proposals within 5 km of the proposal and are discussed in Section 18.

Holistic impacts are discussed in Section 17.

8.8 Environmental outcomes

In consideration of the proposed avoidance and management measures and likely residual impacts associated with the proposal, the environmental outcomes that apply to coastal processes are:

- Changes to coastal processes resulting from the proposal will be limited to the accumulation of sediment and seagrass against the wharf structure.

Based on the outcomes of the Coastal Processes Assessment (Baird 2024), it is considered that the implementation of the proposal will successfully meet the EPA's objective for coastal processes (i.e. to maintain the geophysical processes that shape coastal morphology so that the environmental values of the coast are protected).

Adaptive management measures will be implemented in accordance with the OEMP to ensure residual impacts are not significant and that the environmental outcomes are met.

9 MARINE ENVIRONMENTAL QUALITY

9.1 EPA objective

To maintain the quality of water, sediment and biota so that environmental values are protected.

9.2 Policy and guidance

The proposal will comply with applicable guidance developed by the EPA to assist proponents and the public to understand the minimum requirements for the protection of elements of the environment that the EPA expects to be met during the assessment process.

Table 40 lists relevant EPA guidance, other state and Commonwealth policy documents, and provides consideration for how these documents informed the proposal.

Table 40: Relevant policy and guidance; marine environmental quality

Policy and guidance	Consideration
Environmental Factor Guideline: Marine Environmental Quality (EPA, 2016e)	The environmental factor guideline identifies the environmental values associated with marine environmental quality (i.e. ecosystem health, fishing and aquaculture, recreation and aesthetics, industrial water supply and cultural and spiritual) and their significance, identifies the level of ecological protection requirements and identifies development activities that have the potential to impact on marine environmental quality. Marine environmental quality studies undertaken to support the proposal include: • South Thomson Barge Landing Development; Dredge Plume Modelling Assessment (Baird, 2024b) (Appendix F) • Rottnest Island Army Jetty Dredging; SAP Implementation report (RPS, 2020) (Appendix H) • Baseline marine water quality sampling undertaken by RIA (Appendix G).
Environmental Factor Guideline: Benthic Communities and Habitats (EPA, 2016f)	Changes in marine environmental quality have the potential to impact benthic communities and habitats. Potential impacts to benthic communities and habitats from the proposal are addressed in this Section (Section 9) and Section 7; Benthic communities and habitats.
Technical Guidance: Environmental Impact Assessment of Marine Dredging Proposals (EPA, 2021a)	The technical guidance provides the general approach for describing impacts from dredging proposals, generating predictions, describing impact zones and integrating predictions with monitoring and management requirements which has been applied to the proposal. As outlined in Section 2, dredging activities will be undertaken during the construction phase of the proposal. The following has been undertaken to support the project and assess potential impacts from the proposed dredging activities: • South Thomson Barge Landing Development; Dredge Plume Modelling Assessment (Baird, 2024b) (Appendix F) • Peer Review of Dredge Plume Modelling and Coastal Processes Reports (RPS, 2024c) (Appendix E) • Dredging Environmental Monitoring and Management Plan (DEMMP) (02 Environment, 2024) (Appendix O). During operations, maintenance dredging (of previously dredged areas) may also be undertaken (as a contingency / as required) consistent with the document Maintenance Dredging Environmental Management Framework (BMT Oceanica, 2016).
Technical Guidance: Protecting the Quality of Western Australia's Marine Environment (EPA, 2016g)	The technical guidance provides the environmental quality management frameworks for protecting the environmental values associated with marine environmental quality (i.e. ecosystem health, fishing and aquaculture, recreation and aesthetics, industrial water supply and cultural and spiritual) and provides the approach to setting levels of ecological protection and environmental quality criteria. The marine environmental quality technical studies prepared to inform the proposal have been underpinned by the technical guidance.

Policy and guidance	Consideration
Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand., 2018)	The guidelines provide authoritative guidance on the management of water quality for natural and semi-natural water resources in Australia to inform impact predictions and assessments. The assessment of marine environmental quality undertaken to inform the proposal acknowledges and follows the guidelines' criteria and trigger values where applicable.
National Assessment Guidelines for Dredging (Australian Government, 2009)	The guidelines set out the framework for the environmental impact assessment and permitting for the ocean disposal of dredged material. As no dredged material is proposed for disposal at sea, these guidelines are not applicable to the proposal and no Commonwealth *Environment Protection (Sea Dumping) Act 1981* permit is required. This is discussed further in Section 14.3.4.
Perth's Coastal Waters, Environmental Values and Objectives (EPA, 2000)	The guidelines identify environmental values and environmental quality objectives for Perth's coastal water. Much of the information set out in this document has been incorporated into / superseded by the EPA's Marine Environmental Quality factor and technical guidance. The environmental quality criteria and trigger values for the proposal have considered this document.
State Water Quality Management Strategy No.2, Implementation Plan: Status Report (Government of Western Australia, 2004)	The plan provides the overarching framework to inform the implementation of future water quality management plans. The following management plans have been prepared to broadly align with Government of Western Australia (2004): • Dredging Environmental Monitoring and Management Plan (02 Environment, 2024) (Appendix O) • Construction Environmental Management Plan (CEMP) (Emerge, 2024a) (Appendix P) • Operational Environmental Management Plan (OEMP) (Emerge, 2024b) (Appendix Q).
Background quality for coastal marine waters of Perth, Western Australia (Department of Environment, 2004)	This guidance details the findings of water quality surveys undertaken in Perth's coastal waters in 2003 to determine dissolved concentrations of a range of contaminants in the marine nearshore environments. It provides a broad overview of contaminant concentrations and ecological protection levels the findings of which are of relevance to the proposal.

9.3 Environmental investigations

Baseline marine water quality and sediment monitoring has been undertaken to support the proposal as summarised below:

- Rottnest Island Authority has undertaken baseline water quality monitoring in November and December 2023 and January 2024 (Appendix G).
- Sediment sampling was undertaken in November 2019 as part of the Rottnest Island Army Jetty Dredging; SAP Implementation report (RPS, 2020) (Appendix H).

These investigations are discussed in Sections 9.3.1 and 9.3.2. In addition to this, an unexploded ordnance (UXO) survey was conducted. The presence/absence of UXOs is discussed further in Section 13, Social surroundings.

9.3.1 Water quality monitoring

The baseline water quality monitoring locations have been situated within the ZoHI, ZoMI and ZoI as depicted in Figure 22 and summarised below:

- ST-01 is located within the ZoHI.
- ST-02 is located within the ZoMI
- ST-03 is located outside eastern edge of the ZoMI and within ZoI.
- ST-04 is located outside western edge of the ZoMI and down-gradient of any disturbance from the Main Jetty.

- ST-05 is located at the eastern end of the ZoI.
- ST-06 is located outside the development envelope and zone of influence and provide background water quality levels.

Sampling was undertaken in December 2023 (suite A) and January 2024 (suite B). The two different suites of analytes that were collected are:

- **Suite A**: Metals, nutrients, total recoverable hydrocarbons (TRH), Benzene, toluene, ethylbenzene, xylenes (as BTEX), chlorophyll-a, major anions and cations, alkalinity and hardness, TSS, TDS, enterococci, *E. coli*, faecal coliforms, field parameters (temperature, pH, dissolved oxygen, electrical conductivity, salinity, turbidity, ORP, light attenuation coefficient/Secchi depth)
- **Suite B**: Chlorophyll-a, TSS, TDS, field parameters (temperature, pH, dissolved oxygen, electrical conductivity, salinity, turbidity, ORP, light attenuation coefficient/Secchi depth).

Figure 23: Baseline marine water quality monitoring locations

9.3.2 Sediment sampling

Sediments were sampled at seven locations across the proposed dredge area and ZoHI to a maximum depth of approximately 1.2 m or until refusal was reached. Sampling locations are presented in Figure 23.

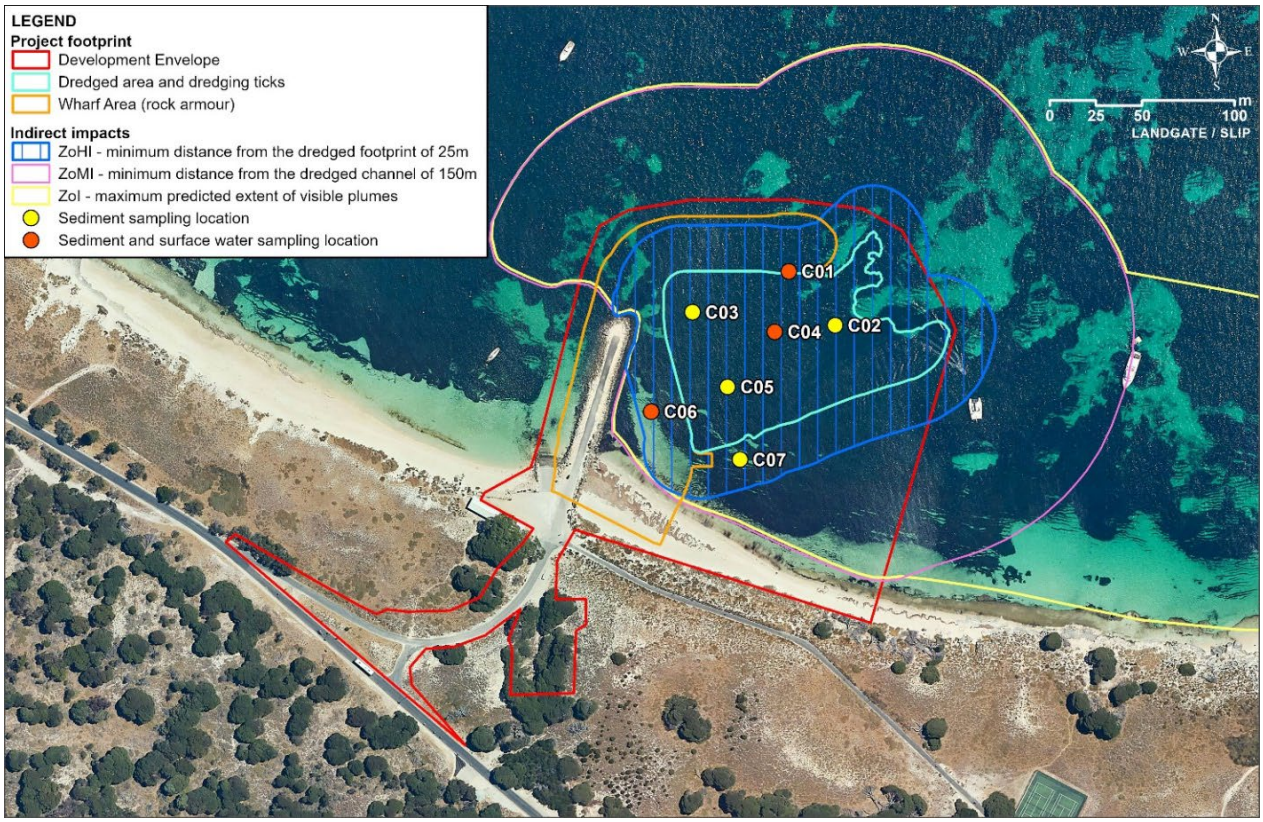


Figure 24: Baseline marine sediment sampling locations

9.4 Receiving environment

9.4.1 Historical land uses

With reference to the activities identified within the DWER *Contaminated Sites Management Series, Assessment and Management of Contaminated Sites* (DWER, 2014) the following surrounding site activities were considered potential sources of contamination:

- Port/wharf/dock activities and recreational boating activities have the potential to contaminate the marine environment through accidental fuel spills and boat sullage.
- Defence works and Defence establishments
- UXOs.

Based upon the aforementioned surrounding site activities, the following potential contaminants of concern have been identified:

- Metals (Ag, Cd, Se, Co, Sb, Cu, Pb, Zn, Cr, Ni, As, V, Mn and Hg)
- Organochlorine and organophosphate (OC/OP) pesticides
- TRH
- BTEX
- Polycyclic aromatic hydrocarbons (PAHs)
- Asbestos fibres
- Tributyl tin (TBT)
- Nutrients – total nitrogen, ammonia, nitrate, nitrite, total phosphorus and reactive phosphorus
- Per- and poly-fluoroalkyl substances (PFAS)
- Explosives.

Whilst PFAS is identified as a contaminant of potential concern due to historical land uses, the potential for significant use at the Army Groyne and nearby barracks is considered unlikely based upon the following (RPS, 2020):

- The island was essentially only used for training exercises after WWII.
- Given the location of the site (i.e. off the mainland) it is considered unlikely that significant training operations with firefighting foams would have been undertaken on the island.
- Firefighting training for Defence personal was undertaken at other facilities in Perth including Garden Island and RAAF Base Pearce, with army training likely undertaken at Campbell, Irwin and Leeuwin barracks and or the Bindoon training area.
- The barracks were handed over to the state in 1984, essentially ending military operations on the island
- Vessels were not allowed to dock at the jetty.
- Firefighting foams containing PFAS (PFOS and PFOA) entered use in the Department of Defence in the 1970s (Department of Defence, https://www.defence.gov.au/environment/pfas/).

9.4.2 Sediment quality

9.4.2.1 Screening values

Analysis of the sediment results was undertaken relevant to reclamation activities. The assessment concluded that from a contamination perspective, the sediments are suitable for reclamation activities, with all results below the following assessment criteria:

- Ecological investigation levels (EILs) and ecological screening levels (ESLs) for areas of ecological significance and public open space (NEPM, 2013)
- Health Investigation Levels for residential soil access (HIL-A) (CRC CARE, 2011).

9.4.2.2 Analytical results

All results were reported below relevant Default Guideline Value (DGV) and the sediments are not considered to pose a significant risk during dredging and are considered suitable for reclamation activities.

Analysis of the sediment sampling results and laboratory reporting is provided in Appendix H. A summary of the results is provided below:

- All metals were below relevant interim sediment quality guidelines. Where sediments did not exceed DGV guidelines and or no guidelines exist concentrations were relatively consistent across the dredge area.
- All sediment samples were reported less than the limit of reporting (LOR) (0.5 µgSn/kg) and thus complied with the DGV (5 µgSn/kg).
- All polycyclic aromatic hydrocarbons (PAH), organochlorine and organophosphate (OC/OP) pesticides and explosives were reported as below relevant LORs and thus below relevant DGV.
- All benzene, toluene, ethyl benzene and xylenes (BTEX) and total recoverable hydrocarbons (TRH) results were below the relevant LORs in all samples with the exception of minor TPH detects in two samples. Samples C06S01 and C07S03 complied with the DGV (280 mg/kg) for the sum C10-C36, with non-normalised concentrations of 5 and 7 mg/kg, respectively.
- With the exception of PFOS in three samples during November 2019 and one sample in March 2020, no other PFAS was reported above the LOR within any of the samples during either sampling event. However, the concentrations of PFOS were:
  - Only marginally above the LOR
  - An order of magnitude below the lowest screening criteria
  - Consistent during both sampling events.

- No guidelines for nutrients (phosphorus or nitrogen) exist in Western Australia. Concentrations were predominately consistent across the sampling area. Phosphorus was predominantly in total forms (i.e. non-reactive forms) and as such was bound up with the sediment. Nitrogen is also predominantly bound to sediments and in organic forms (i.e. Kjeldahl nitrogen). Ammonia was the dominant inorganic form of nitrogen however inorganic concentrations are significantly lower than organic forms of nitrogen.

9.4.3 Water quality

9.4.3.1 Screening values

To assist with monitoring of water quality, trigger values have been adopted from the following guidance documentation:

- *Assessment and Management of Contaminated Sites* (DWER, 2021)
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (WQA, 2024).

Trigger values used in Table 41 and Table 42 are colour coded to show where each trigger has been exceeded, using the following definitions:

- MWG-95; marine water guidelines for slightly–moderately disturbed lowland river systems, at the 95% species protection level
- MWG-99; marine water guidelines for high conservation/ecological value systems, at the 99% species protection level.

9.4.3.2 Analytical results

Comprehensive analysis was undertaken in December 2023 and January 2024 by a National Association of Testing Authorities accredited laboratory on water samples collected from South Thomson Bay, with sampling locations and analytes discussed in Section 9.3.1.

The laboratory reports are provided in Appendix G with the results presented in Table 41 and Table 42.

Table 41: Water quality within South Thomson Bay; metals

Parameter	Dissolved metals										
	Al	As	Cd	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Zn
Units	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
MWG-95	-	-	5.5	27	1.3	-	0.4	80	70	4.4	8.0
MWG-99	-	-	0.7	7.7	0.3	-	0.1	80	7.0	2.2	3.3
December 2023											
ST-01	---	1.6	<0.10	<1.0	<1.0	---	<0.05	<1.0	<1.0	<1.0	<1.0
ST-02	---	1.6	<0.10	9.6	<1.0	---	<0.05	<1.0	<1.0	<1.0	620
ST-03	---	1.8	<0.10	<1.0	<1.0	---	<0.05	<1.0	<1.0	<1.0	<1.0
ST-04	---	2.0	<0.10	<1.0	<1.0	---	<0.05	<1.0	<1.0	<1.0	11
ST-05	---	1.8	<0.10	<1.0	<1.0	---	<0.05	<1.0	<1.0	<1.0	<1.0
ST-06	---	2.0	<0.10	<1.0	<1.0	---	<0.05	<1.0	<1.0	<1.0	<1.0

- denotes no guideline, --- denotes not tested.

Table 42: Water quality within South Thomson Bay; other parameters

Parameter	TSS	Chl-a	FRP	TN	TKN	NOX-N	Thermotol. coliforms	Enterococci	E. coli
Units	**mg/L**	**mg/L**	**mg /L**	**mg /L**	**mg /L**	**mg /L**	**cfu/mL**	**cfu/mL**	**cfu/mL**
MWG-95	**-**	**0.3**	**5**	**230**	**-**	**5**	**-**	**-**	**-**
MWG-99	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
December 2023									
ST-01	<5.0	<1.0	<0.005	0.16	0.16	<0.005	1	1	<1
ST-02	<5.0	<1.0	<0.005	0.12	0.12	<0.005	<1	<1	<1
ST-03	<5.0	<1.0	<0.005	0.15	0.14	<0.005	<1	<1	<1
ST-04	<5.0	<1.0	<0.005	0.13	0.13	<0.005	1	<1	1
ST-05	<5.0	<1.0	<0.005	0.15	0.14	<0.005	<1	1	<1
ST-06	<5.0	<1.0	<0.005	0.15	0.15	<0.005	1	<1	<1
January 2024									
ST-01	<5.0	<1.0	---	---	---	---	---	---	---
ST-02	<5.0	<1.0	---	---	---	---	---	---	---
ST-03	<5.0	<1.0	---	---	---	---	---	---	---
ST-04	<5.0	<1.0	---	---	---	---	---	---	---
ST-05	<5.0	<1.0	---	---	---	---	---	---	---
ST-06	<5.0	<1.0	---	---	---	---	---	---	---

- denotes no guideline, --- denotes not tested

The majority of the analytes were below practical quantitation limits set by the laboratories and typically below the adopted screening levels, with the exceptions discussed as follows:

- Chromium concentrations marginally exceeded the MWG-99 (7.7 µg/L) at ST-02 (9.6 µg/L).
- Zinc concentrations exceeded both the MWG-95 (8.0 µg/L) and MWG-99 (3.3 µg/L) at ST-02 (620 µg/L) and ST-03 (11 µg/L).
- The chlorophyll-a levels were below the LOR for all samples, noting however that the LOR was above the screening levels.
- Whilst no screening levels were adopted for microbiological parameters or total dissolved solids, concentrations are considered low.

The elevated concentration of chromium and zinc at ST-02 are considered an anomaly, and either represent an analysis error or sampling error where fine sediment was introduced into the sample. The latter is considered unlikely as the TSS values indicate that the sample contained little sediment.

9.5 Potential environmental impacts

Table 43 provides the potential key impacts to marine environmental quality from the proposal.

Table 43: Potential impacts on marine environmental quality

Phase	Impact class	Works / operations	Potential impacts
Construction	Direct	• Dredging • Breakwater construction • Reclamation (decant from reclamation area) • Piling • Vessel operations.	**Increase in total suspended solids (TSS)** • Mobilisation of sediment during dredging activities, construction of the breakwater, reclamation and piling will result in a temporary increase in TSS within the following modelled areas: – ZoHI – ZoMI – ZoI.
	Indirect	• Dredging • Breakwater construction • Reclamation (decant from reclamation area) • Piling • Vessel operations.	**Temporary release of contaminants from marine sediment during dredging and reclamation activities** • The proposed dredging activities and resulting suspension of sediments have the potential to result in the temporary release of contaminants from sediments. **Increased risk of pollution incidents** • Accidental fuel spills to marine environment during construction resulting in hydrocarbon contamination of water, sediment and biota. **Increase in total suspended solids** • Temporary decease in light availability for benthic communities and habitats due to increased TSS.
Operation	Indirect	• Vessel operations • Maintenance dredging (potential contingency).	**Increase in total suspended solids** • Temporary increase in sedimentation • Temporary decease in light availability for benthic communities and habitats due to increased TSS. **Increased risk of pollution incidents** • Increased risk of pollution incidents from vessels and fuel storage facilities leading to degradation of marine environmental quality.

9.5.1 Assessment of impacts

9.5.1.1 Increase in total suspended solids

9.5.1.1.1 Predicted zones of impact

A dredge plume modelling assessment was undertaken by Baird (2024b) (Appendix F) to support the proposal. The dredge plume model simulated the dredge plume generation from the proposed dredging to determine the fate of fine sediments in suspension, as suspended sediment concentration (SSC) both spatially and vertically through the water column.

The calculation of the zones of impact defined by the dredge plume modelling determined nominal values of SSC that would have detrimental impact on local seagrass species. The calculated zones of impact were determined based on the complete winter dredging program and are shown in Figure 24. The zones of impact determined by Baird (2024b) and the predicted impacts on benthic communities and habitats are summarised below:

- **Zone of High Impact (ZoHI)** – The area where impacts on benthic communities or habitats are predicted to be irreversible. The term irreversible means 'lacking a capacity to return or recover to a state resembling that prior to being impacted within a timeframe of five years or less'. The ZoHI encompasses an area of 1.37 ha. The majority of the ZoHI is located within the development envelope.
- **Zone of Moderate Impact (ZoMI)** – The area within which predicted impacts on benthic communities or habitats are recoverable within a period of five years following completion of the dredging activities. This zone abuts, and lies immediately outside of, the ZoHI. The ZoMI encompasses an area of 4.5 ha.
- **Zone of Influence (ZoI)** – The area within which changes in environmental quality associated with dredge plumes are predicted and anticipated during the dredging operations, but where these changes would not result in a detectible impact on benthic biota. At any point in time, the dredge plumes are likely to be restricted to a relatively small portion of the ZoI. The ZoI encompasses an area of 13.44 ha.

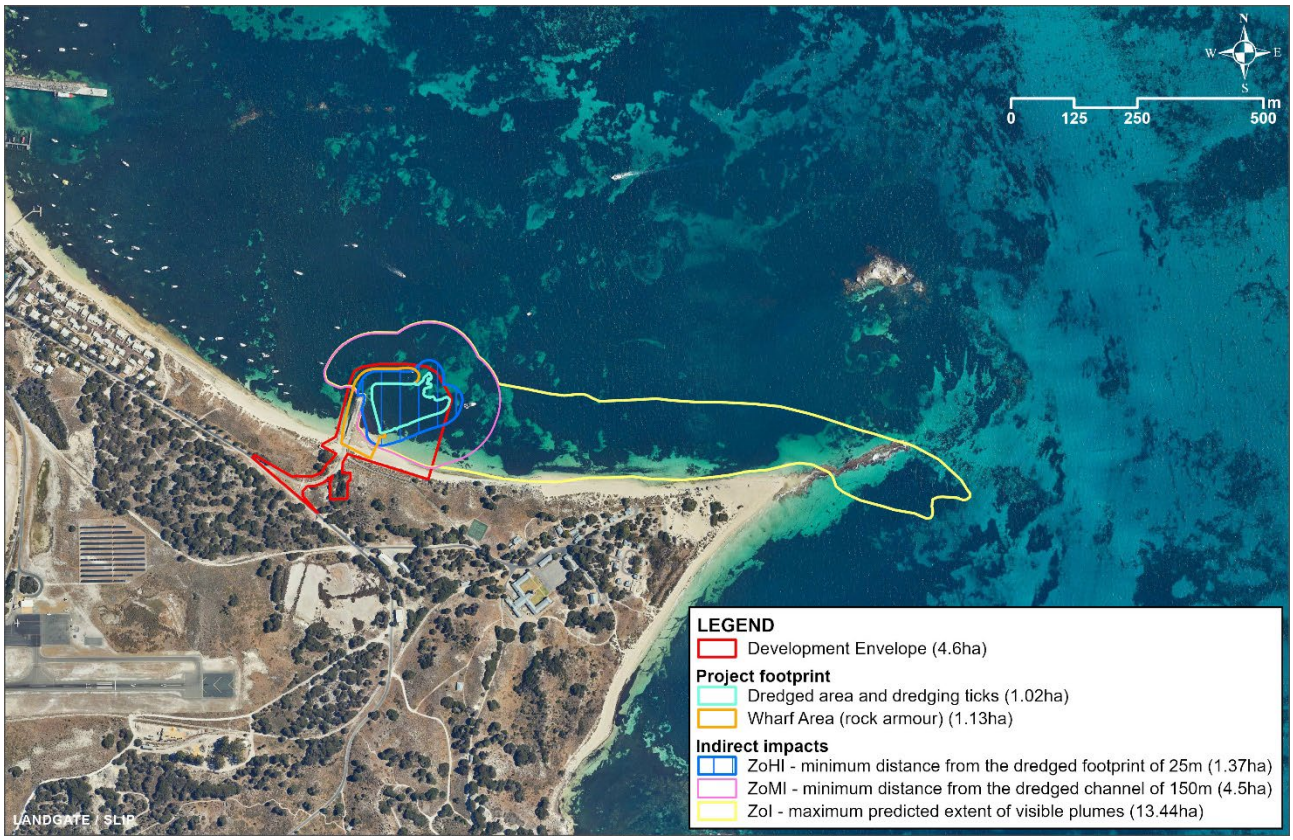


Figure 25: Zones of influence from dredging activities

9.5.1.1.2 Predicted plume behaviour

The overall current direction within South Thomson Bay trends from west to east, resulting in the modelled plume being generally directed east along South Thomson Bay, away from the existing Army Groyne, with occasional periods of direction change causing the plume to move west and around the Army Groyne. This is demonstrated in the spatial plots taken from specific points in time shown in Figure 25, with plots shown at three hourly timesteps from 18:00 on 26 June 2020 to 03:00 on 27 June 2020. These plots show:

- The plume being directed strongly to the east away from the Army Groyne (top left plot)
- The plume being directed less strongly away from the Army Groyne in the middle of a flood tide (top right plot)
- The plume being directed weakly to the west around the Army Groyne as the flood tide gets closer to its peak water level (bottom left plot)
- As the flood tide is close to its peak water level and remaining close to the point of discharge in the peak of a tidal cycle as the tide turns from flood to ebb (bottom right plot).

These plots indicate that the suspended sediment plume from the proposed dredging activities is predicted to be localised to the area of South Thomson Bay around the development envelope.

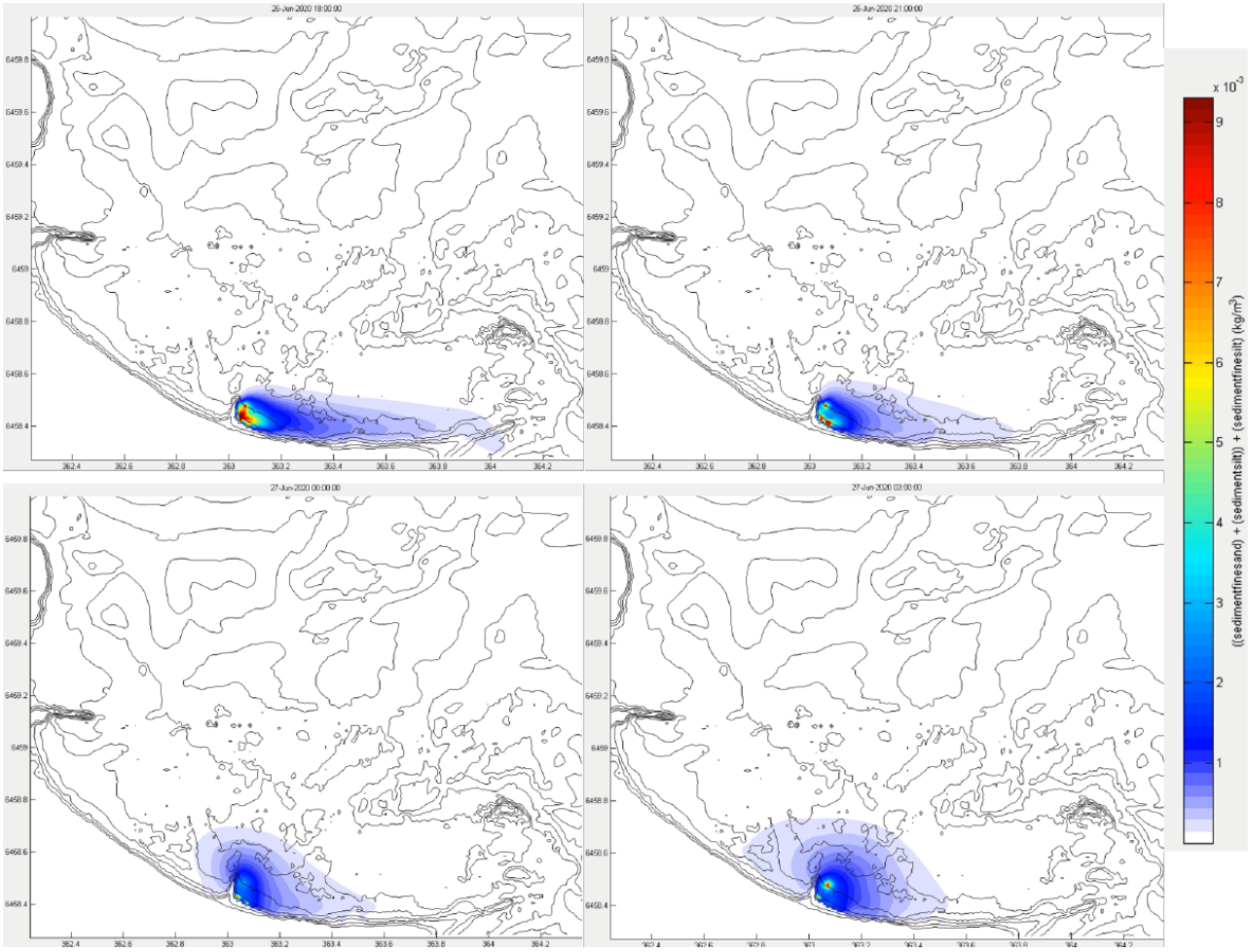
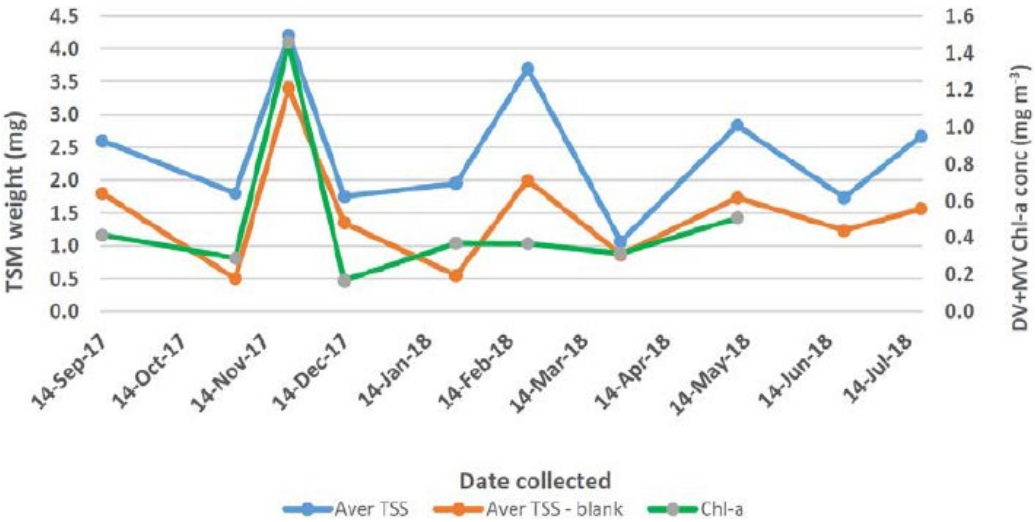


Figure 26: Spatial plots of the dredge plume model (Baird, 2024b)

9.5.1.1.3 Suspended sediment concentration

The dredge plume model simulations were executed with no background SSC and the model results represent excess above the adopted background SSC of 3 mg/L. Data from the Rottnest IMOS National Reference Station provides measured TSS offshore of Wadjemup / Rottnest Island (Graph 4). The TSS values measures ranged between 0.5 mg/L and 3.5 mg/L, indicating that the adopted background level of 3 mg/L is a conservative approach.



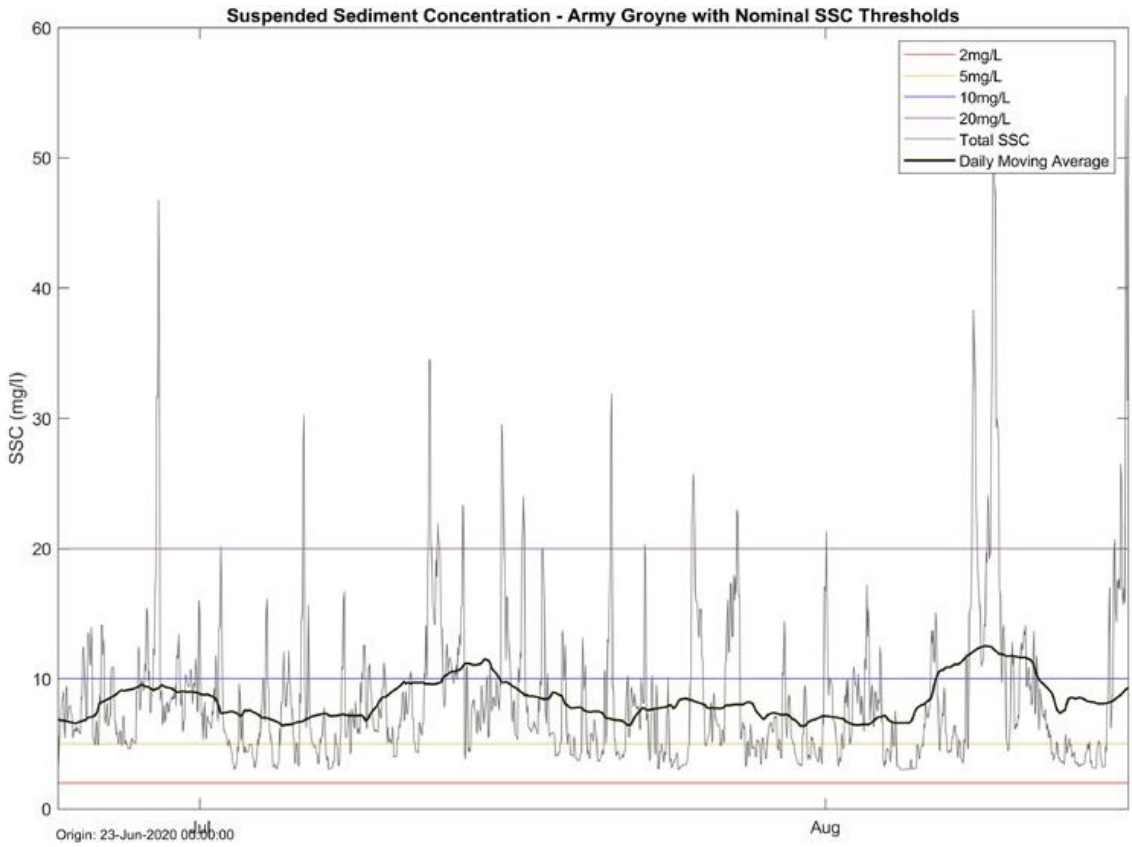
Graph 4: Average post-July 2017 TSM values with (orange line) and without (blue line) a data correction for the blank at Wadjemup / Rottnest Island between September 2017 and July 2018 (Baird, 2024b)

Examples of the analysis for winter of the total SSC and daily running mean SSC at the locations provided in Figure 26 against the following nominal thresholds adopted for the zones of impact are shown in Graphs 5 to 8.

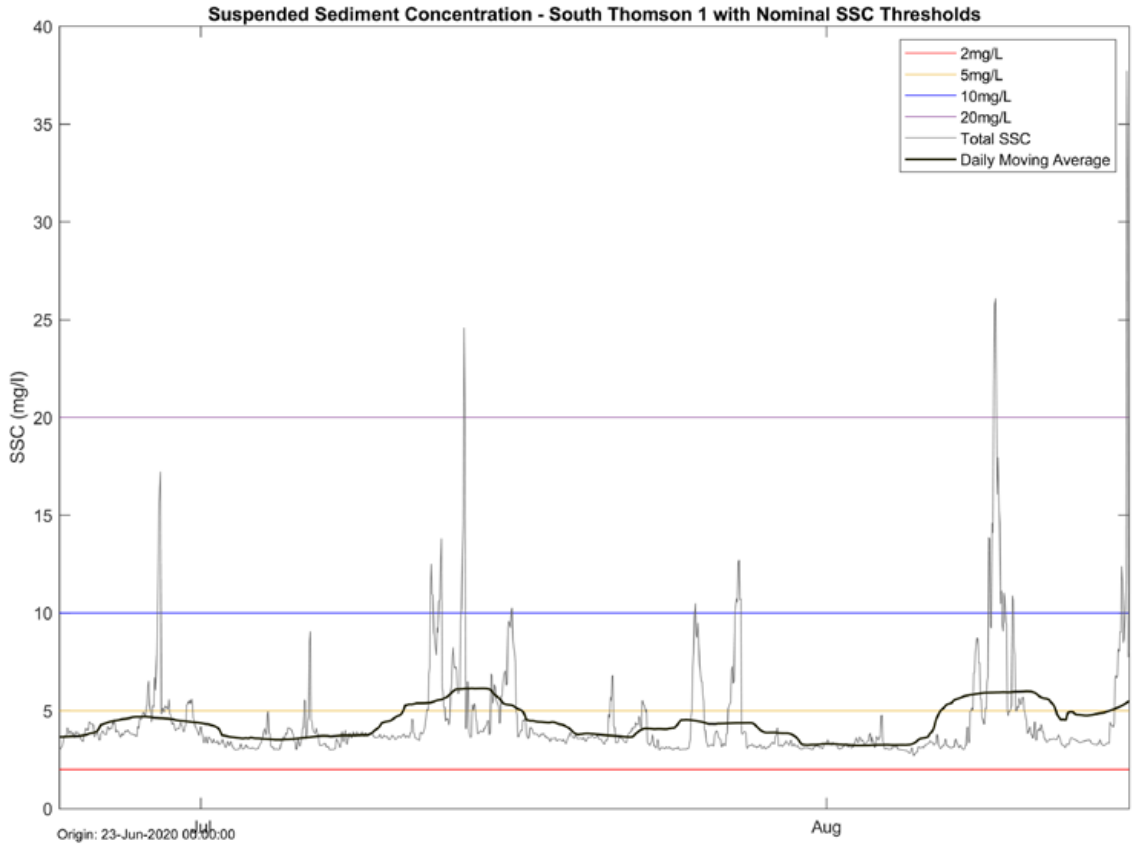
- ZoHI – where sedimentation/burial is >10 cm or 10,000 g/m^2
- ZoMI – where a TSS concentration of >10 mg/L was exceeded and sedimentation burial is 5–10 cm or 5,000–10,000 g/m^2
- ZoI – where a TSS concentration of >2 mg/L above background was exceeded (representing the maximum predicted extent of visible plumes).

Graph 5 demonstrates the relatively high level of SSC likely to be experienced at the dredge footprint, while Graph 6 indicates that there are likely to be occasional periods of exceedance of the nominal thresholds related to moderate risk (10 mg/L) and high risk (20 mg/L) at the South Thomson Bay 1 location (Figure 26). The Aquadopp profiler equipment location immediately north of the dredge footprint only experiences levels of SSC that would result in a visible sediment plume, but with no measurable impact on benthic communities and habitats.

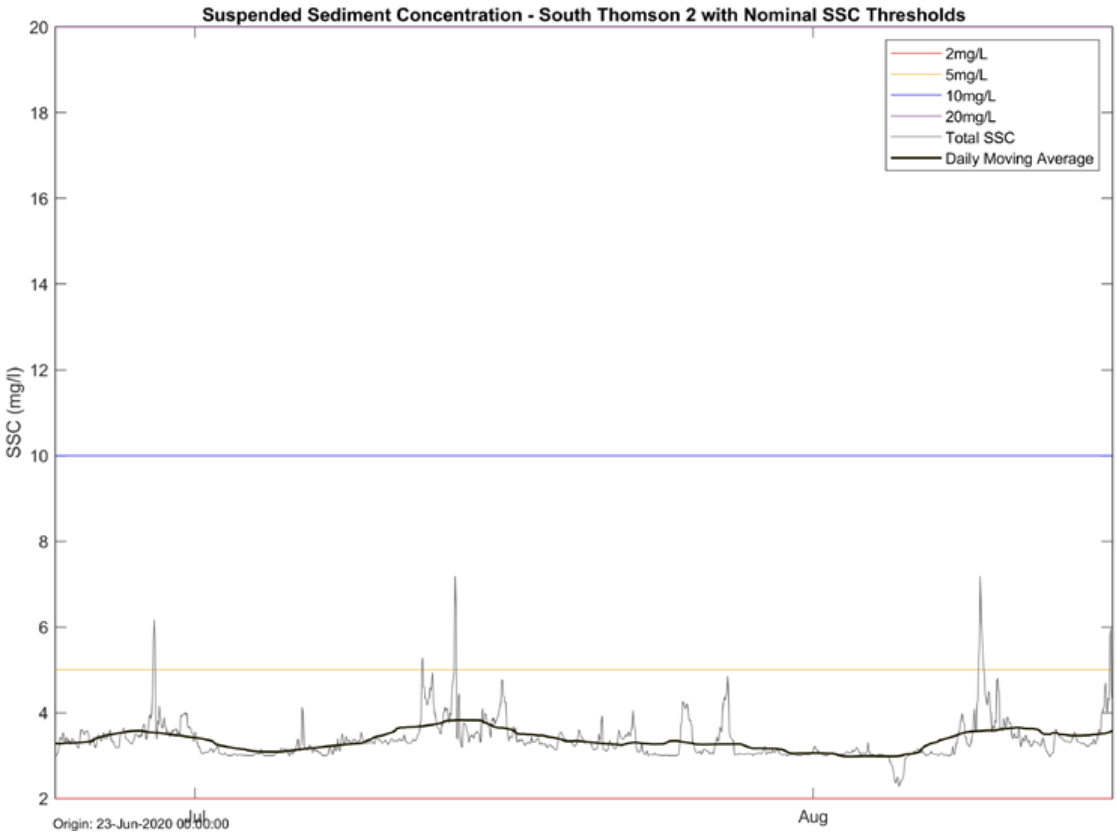
Figure 27: Locations where timeseries SSC data is presented (Baird, 2024b)



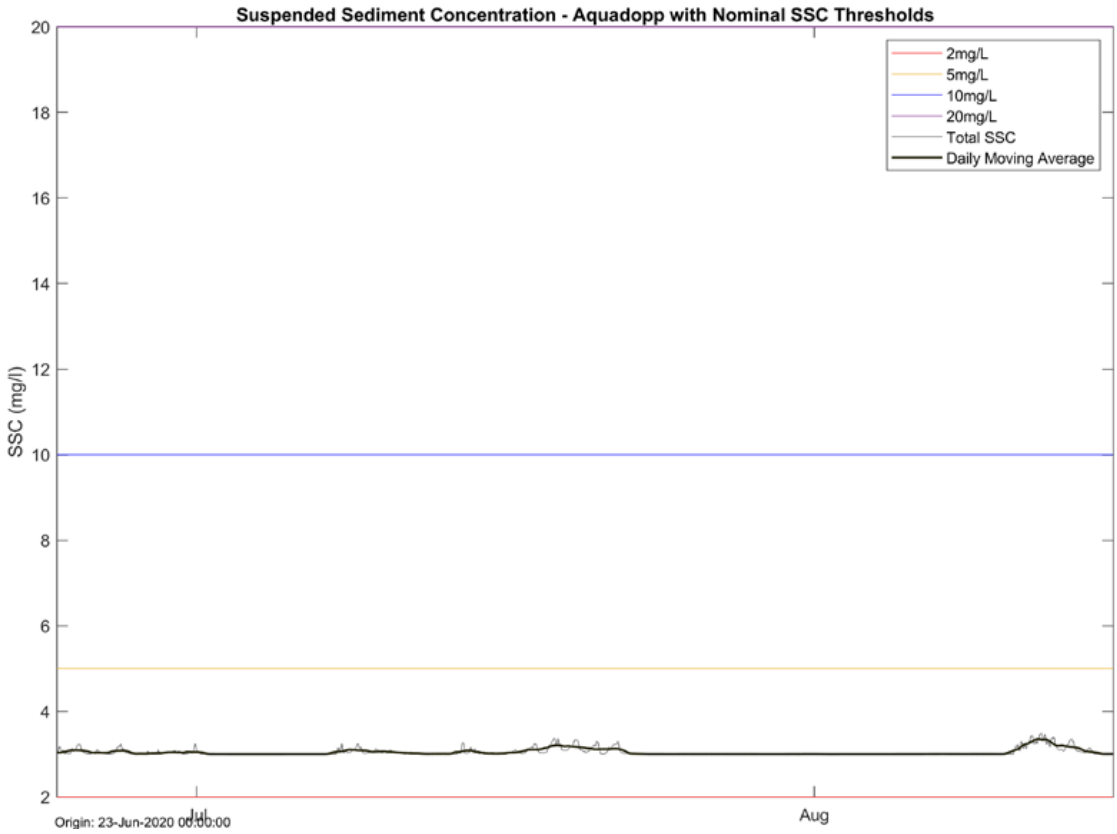
Graph 5: **Calculation of total SSC and daily mean values of modelled SSC analysed against nominal seagrass impact thresholds at the Army Groyne location (Baird, 2024b)**



Graph 6: **Calculation of total SSC and daily mean values of modelled SSC analysed against nominal seagrass impact thresholds at the South Thomson Bay 1 location. Analysis shown for the background SSC of 3 mg/L (Baird, 2024b)**



Graph 7: **Calculation of total SSC and daily mean values of modelled SSC analysed against nominal seagrass impact thresholds at the South Thomson Bay 2 location. Analysis shown for the background SSC of 3 mg/L (Baird, 2024b)**



Graph 8: **Calculation of total SSC and daily mean values of modelled SSC analysed against nominal seagrass impact thresholds at the Aquadopp location. Analysis shown for the background SSC of 3 mg/L (Baird, 2024b)**

9.5.1.1.4 Potential release of contaminants from sediments

The proposed dredging activities and resulting suspension of sediments have the potential to result in the temporary release of contaminants from sediments. However, as discussed in Section 9.4.2, baseline sediment results were below the following assessment criteria.

- EILs and ESLs for areas of ecological significance and public open space (NEPM, 2013)
- Health Investigation Levels for residential soil access (HIL-A) (CRC CARE, 2011).

As all results were below the Default Guideline Value, the sediments are not considered to pose a significant risk to ecological receptors and human health during dredging and reclamation activities.

9.5.1.2 Increased risk of pollution incidents

9.5.1.2.1 Vessel operations

Increased boat numbers during operation, and to lesser degree construction, of the proposal has the potential to increase the risk of pollution, including from antifouling paints, anti-corrosion anodes, increased risk of accidental discharges (e.g. fuel spills, oils and greases) and sullage.

An increase in vessels using South Thomson Bay is expected during the operational phase. Quantities and types of material that might enter the marine environment are limited to spills relating to these vessels. The magnitude of this impact is dependent on the quantities and nature of the spillage, the dilution and dispersal properties of the waters and the bioavailability of the contaminant to species.

9.5.1.2.2 Fuel storage

A fuel facility, including underground storage fuel storage is proposed as part of the proposal (Figure 27). There is a risk for fuel spills to occur during refuelling or from fuel storage facilities. Fuel spills from the fuel facility have the potential to impact marine environmental quality.

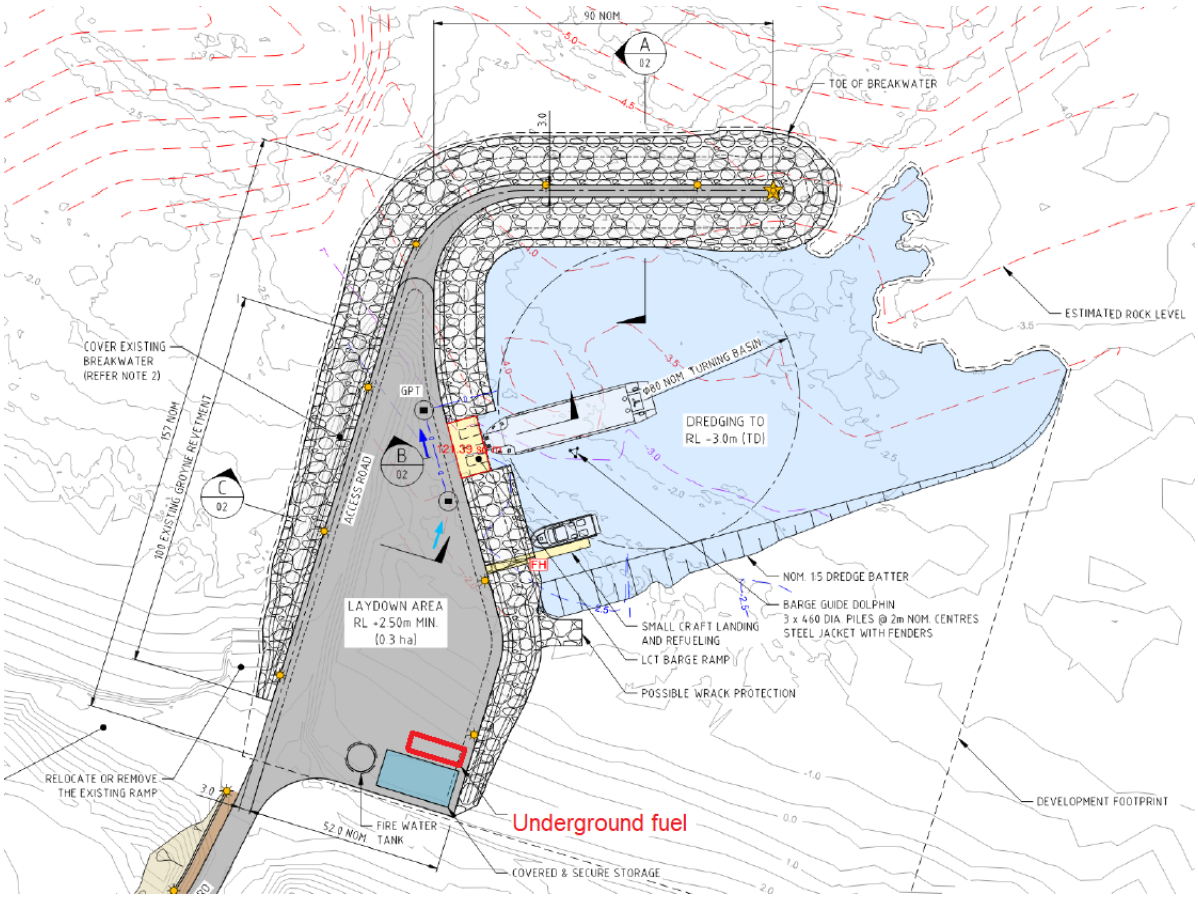


Figure 28: Location of underground fuel storage

9.6 Mitigation

Table 44 demonstrates how the EPA's mitigation hierarchy (avoid, minimise and rehabilitate) has been applied to the environmental factor of marine environmental quality to address the key potential impacts.

Table 44: Application of mitigation hierarchy to marine environmental quality

Potential impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impacts
Temporary increase in suspended sediments during construction and dredging activities.	Direct	Avoid	As dredging activities are a requirement for construction of the proposal, an increase in suspended sediments during construction cannot be avoided.	**A temporary increase in suspended sediments within the ZoI, ZoMI and ZoHI** Implementation of the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O) provides the monitoring and management framework to address a temporary increase in TSS / turbidity during construction. Implementation of these management plans ensures that significant impacts to marine environmental quality outside the ZoMI and ZoHI from a temporary increase in suspended sediments are unlikely.
		Minimise	• RIA amended the project design to reduce the dredging requirements. By changing the berthing and barge turn pocket, the volume of required dredging was reduced from 26,000 m^3 to 16,050 m^3 • Management and mitigation proposed during construction to minimise impacts to marine environmental quality is detailed in the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O). Implementation of these management plans will ensure that: – The area affected by suspended sediments during dredging and construction will be limited (wherever possible) and will not extend past the modelled ZoHI, ZoMI and ZoI shown in Figure 22 – Marine environmental quality will be maintained at a moderate level of ecological protection during dredging and return to a High Level of Ecological Protection within two weeks following completion of dredging • Implementation of the CEMP and DEMMP provides the monitoring and management framework to address potential impacts to marine environmental quality during construction. Key management and monitoring measures include: – Implementation of the Marine Water Quality Monitoring Program (MWQMP) provided in the DEMMP for suspended sediment. This program specifies that if the specified triggers are exceeded, then the following management actions will be implemented to ensure impacts to marine environmental quality do not extend past the modelled zone of influence: ○ If trigger 1 has been exceeded: • Investigate if Trigger 2 has been exceeded for any sites • Sample again at the exceeded monitoring site and associated reference site each day until turbidity has decreased ○ If trigger 2 has been exceeded: • Assess metocean and weather conditions • Investigate if dredging or disposal has been occurring and if that is likely to be attributable to the exceedance • Investigate results of the other parameters to determine if there is likely to be stress on the surrounding seagrass • Sample again at that monitoring site and associated reference site each day until turbidity has decreased ○ If the trigger levels are exceeded (or indicate a progressive increase towards the Trigger Levels) then modifications to the dredging program are to be considered, and may include, but not necessarily be limited to: • Reactive benthic communities and habitats survey • Temporary pause to dredging activities (e.g. if exceedance appears to be due to factors other than dredging vessel movements, then pausing dredging activities will minimise cumulative effects) • Relocate the dredge (e.g. to an area of coarser sediment) • Reduce the dredge cut depth, rate of swing-speed and/or increase the dredge pump flow • Reduce disposal of material if the plume is coming from the reclamation area – Implementation of the tiered management framework provided in the DEMMP – Use of silt curtains which will minimise the potential impacts associated with increased suspended sediments – The placement of geofabric (such as Texcel 1200R) textile weave along the bund wall will ensure that the placement of dredge spoil during reclamation works will not impact or increase the dredge plume zones	
		Rehabilitate	Impacts to marine water quality from an increase in TSS within the ZoMI and ZoI will be temporary only.	
		Offset	Marine environmental quality offsets are not considered applicable to the proposal.	
Increased risk of pollution incidents from vessels and underground fuel storage leading to degradation of marine environmental quality	Indirect	Avoid	Construction and operation of the proposal includes vectors which have the potential to result in pollution incidents and risk of this impact cannot be avoided.	**No residual impacts expected** Implementation of the management and monitoring measures in the CEMP (Emerge, 2024a) (Appendix P), DEMMP (02 Environment, 2024) (Appendix O) and OEMP (Emerge, 2024b) (Appendix Q) will ensure that the residual pollution incident risk is low.
		Minimise	• Construction management measures to minimise impacts to marine environmental quality is detailed in the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O). Implementation of these management plans will ensure that the risk for hydrocarbon spills to the marine environment is minimal so that there are no adverse impacts to the marine environment • Implementation of the CEMP and DEMMP provides the monitoring and management framework to address potential impacts to marine environmental quality during construction. Key management and monitoring measures include: – Implement industry standard hydrocarbon management practices (chemical handling, storage, segregation, and spill response) – Any construction vessels including piling vessels/barges to establish a sewage and garbage disposal plan – Undertake vessel maintenance and bunkering in accordance with contractors approved vessel management systems – Hydrocarbon spills into the marine environment be immediately reported and appropriately remediated • Operational management to minimise impacts to the marine environment is detailed in the OEMP (Appendix Q). Implementation of this management plan will ensure that: – Fuel / oil spill contingency plans are included in the OEMP and includes the provision of clean-up equipment and appropriate disposal of contaminated water and sediment – Pollution incidents will be reported to the DoT's Marine Environmental Emergency Response (MEER) unit, with clean up managed and monitored in accordance with MEER's requirements – Pollution incidents will be monitored during operation in accordance with the OEMP, with contingency actions implemented should pollution triggers be breached on a reoccurring basis – The underground fuel storage facility will be constructed in accordance with AS1940 and as outlined in the OEMP have safety and leak detection equipment installed.	
		Rehabilitate	Fuel and oil spills to be cleaned up in accordance with the contingency actions outlined in the DEMMP, CEMP and OEMP.	
		Offset	Marine environmental quality offsets are not considered applicable to the proposal.	

Potential impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impacts
Disturbance of sediments from vessel operations (including propeller wash) in shallow water results in a temporary increase in suspended sediments.	Indirect	Avoid	Dredging to a depth of RL -3 m will significantly avoid vessel operations disturbing sediments.	**No residual impacts expected** The project design (proposed of the barge turning basin) and implementation of the OEMP (Appendix Q) ensures that residual impacts to marine environmental quality from a temporary increase in sediments during operation are unlikely.
		Minimise	Operational management measures to minimise impacts to the marine environment are detailed in the OEMP (Appendix Q). Implementation of this management plan will ensure that marine users comply with vessel operational restrictions required by DoT and RIA.	
		Rehabilitate	Impacts to marine water quality from operational activities will be temporary only (during vessel use) and due to the proposed design are considered unlikely to be significant. No rehabilitation is considered applicable.	
		Offset	Marine environmental quality offsets are not considered applicable to the proposal.	
Temporary decease in light availability for benthic communities and habitats due to suspended sediments.	Indirect	Avoid	As dredging activities are a requirement for construction of the proposal, a decrease in light availability due to an increase in suspended sediments during construction cannot be avoided.	**A temporary decrease in light available to benthic communities and habitats due to an increase in suspended sediments is predicted within the ZoMI only** As impacts to benthic communities and habitats within the ZoMI will be recoverable within a period of five years following completion of the dredging activities, significant residual impacts are not considered likely. Implementation of the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O) provides the monitoring and management framework to address a temporary increase in TSS / turbidity during construction. Implementation of these management plans ensures that impacts to marine environmental quality outside the zones of influence from a temporary increase in suspended sediments are unlikely.
		Minimise	• As discussed in Section 7, temporary impacts from suspended sediments on benthic communities are predicted in the ZoMI only. These impacts include temporary loss of 2.62 ha of mixed seagrass and 1.09 ha of sand / sand with wrack. Baird (2024b) predicts that impacts to these benthic communities and habitats within the ZoMI will be recoverable within a period of five years following completion of the dredging activities • Management and mitigation proposed during construction to minimise impacts to marine environmental quality is detailed in the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O). Implementation of these management plans will ensure that: – The area affected by suspended sediments during dredging and construction will be limited (wherever possible) and will not extend past the modelled ZoHI, ZoMI and ZoI shown in Figure 22 – Marine environmental quality will be maintained at a moderate level of ecological protection during dredging and return to a High Level of Ecological Protection within two weeks following completion of dredging • Maintenance dredging (if required) will be undertaken in previously disturbed / sandy areas within the development envelope / project footprint. Maintenance dredging frequency, volumes and disposal will be determined as required. Environmental management and monitoring will be undertaken in a manner that is consistent with the document Maintenance Dredging Environmental Management Framework (BMT Oceanica, 2016) prepared for Department of Transport for similar types of maintenance dredging activities.	
		Rehabilitate	Impacts to marine water quality from an increase in TSS within the ZoMI and ZoI will be temporary only.	
		Offset	Marine environmental quality offsets are not considered applicable to the proposal.	
Temporary release of contaminants from marine sediment during dredging and reclamation activities.	Indirect	Avoid	• As dredging activities are a requirement for construction of the proposal, an increase in suspended sediments during construction cannot be avoided • RIA amended the project design to reduce the dredging requirements. By changing the berthing and barge turn pocket, the volume of required dredging was reduced from 26,000 m^3 to 16,050 m^3.	**No residual impacts expected** As all baseline sediment results were below the assessment criteria, residual impacts from the temporary release of contaminants from suspended sediments is considered unlikely.
		Minimise	• The risk of temporary release of contaminants from marine sediments during dredging and reclamation activities will be minimal as all baseline sediment results did not record contaminants above the assessment criteria • Management and mitigation proposed during construction to minimise impacts to marine environmental quality is detailed in the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O). Implementation of these management plans will ensure that the area affected by suspended sediments during dredging and construction will be limited (wherever possible) and will not extend past the modelled ZoHI, ZoMI and ZoI shown in Figure 22 • The CEMP and DEMMP provides the monitoring and management framework to address potential impacts to marine environmental quality during construction.	
		Rehabilitate	Impacts to marine water quality from a potential release of contaminants from suspended sediments will be temporary only.	
		Offset	Marine environmental quality offsets are not considered applicable to the proposal.	
Disturbance of sediments from maintenance dredging during operation.	Direct	Avoid	The requirement for maintenance dredging will only be undertaken when required.	**No residual impacts expected** Maintenance dredging will be undertaken in accordance with Maintenance Dredging Environmental Management Framework (BMT Oceanica, 2016) prepared for Department of Transport. This will ensure that the residual risk of increased TSS from the disturbance of sediments from maintenance dredging is low.
		Minimise	• Maintenance dredging (if required) will be undertaken in previously disturbed / sandy areas within the development envelope / project footprint. Maintenance dredging frequency, volumes and disposal will be determined as required. Environmental management and monitoring will be undertaken in a manner that is consistent with the document Maintenance Dredging Environmental Management Framework (BMT Oceanica, 2016) prepared for Department of Transport for similar types of maintenance dredging activities.	
		Rehabilitate	Impacts to marine water quality from an increase in TSS will be temporary only.	
		Offset	Marine environmental quality offsets are not considered applicable to the proposal.	

9.7 Assessment and significance of residual impact

The anticipated significance of the residual impacts from the proposal following the implementation of mitigation measures are low and the residual impacts are summarised below:

- Temporary suspended sediments within the ZoHI (1.37 ha), ZoMI (4.5 ha) and ZoI (13.44 ha)
- Temporary reduction in light due to suspended sediments in the water column within the ZoMI (4.5 ha) may impact benthic communities and habitats. As impacts to benthic communities and habitats within the ZoMI will be recoverable within a period of five years following completion of the dredging activities, these residual impacts are not considered significant.

The predicted residual impacts to marine environmental quality from the proposal is considered manageable through implementation of the CEMP, DEMMP and OEMP. With implementation of the mitigation measures proposed in these management plans, the residual impacts are not considered significant as discussed in Table 45.

Table 45: Consideration of the significance of the residual impacts on marine environmental quality

Matters for consideration	Response
The object and principles of the EP Act	The principles of the EP Act have been addressed in relation to the proposal (Table 26). Implementation of the CEMP, DEMMP and OEMP provides monitoring and management actions to identify and to address potential impacts during construction and operation.
Values, sensitivity and quality of the environment which is likely to be impacted	Baseline marine sediment and water quality investigations have been undertaken to determine the existing marine environmental quality values and sensitivity of the receiving marine environment. Given the low levels of contaminants of potential concern in the sediments, it is not expected that the suspension of contaminants within these sediments will have a significant impact on the marine environment. As discussed in Section 7, benthic communities and habitats may be sensitive to changes in marine environmental quality. This is discussed further in Section 7. With the proposed construction and operation mitigation management framework outlined in the CEMP, DEMMP and OEMP, the residual impact of the proposal is considered to be manageable.
All stages and components of the proposal (such as any infrastructure required for the proposal to be practicably implemented, or a proposal life cycle)	All stages of the proposal (i.e. construction and operation) have been included in this impact assessment
Extent (intensity, duration, magnitude, and geographic footprint) of the likely impacts	During the construction phase of the proposal, the following activities and resulting impacts have the potential to adversely affect marine environmental quality: • Construction, dredging and reclamation activities have the potential to: – Temporary increase in suspended solids, as discussed in Section 9.5.1.1. – Reduce light within the ZoHI and ZoMI. This impact is discussed further in Section 7, benthic communities and habitats. – Result in unplanned release of chemicals and / or hydrocarbons from fuel leaks from vessels, accidental vessel collision and ship grounds as discussed in Section 9.5.1.2. During operation of the proposal, potential impacts to marine environmental quality are limited to the following activities: • Unplanned release of chemicals and / or hydrocarbons from onshore fuel storage, fuel leaks from vessels, accidental vessel collision and ship grounds as discussed in Section 9.5.1.2. • Vessel operations (including propeller wash) in shallow water may disturb sediments, resulting in a temporary decrease in light availability for benthic communities and habitats. This impact is discussed further in Section 7 Benthic communities and habitats.

Matters for consideration	Response
	These impacts to marine environmental quality from the proposal are considered to be manageable through implementation of the CEMP, DEMMP and OEMP. With implementation of these management plans, the residual impacts are limited to: • Temporary suspended sediments within the ZoMI (4.5 ha) and ZoI (13.44 ha) • Temporary reduction in light due to suspended sediments in the water column within the ZoMI (4.5 ha). As impacts to benthic communities and habitats within the ZoMI will be recoverable within a period of five years following completion of the dredging activities, these residual impacts are not considered significant.
Resilience of the environment	Existing boating facilities within Thomson Bay includes the existing jetty and moorings. Baseline marine sediment and water investigations indicate that these activities do not have a significant impact on the marine environment within Thomson Bay. Therefore, it is considered that the marine environment will be resilient to potential changes from implementation of the proposal
Consequence of the application of the mitigation hierarchy to the proposal.	The WA Offsets Guidelines (Government of Western Australia 2014) identifies four levels of significance for residual impacts: • Unacceptable impacts – those impacts that are environmentally unacceptable or where no offset can be applied to reduce the impact. Offsets are not appropriate in all circumstances, as some environmental values cannot be offset. • Significant impacts requiring an offset – any significant residual impact of this nature will require an offset. These generally relate to any impacts to species, ecosystems, or reserve areas protected by statute or where the cumulative impact is already determined to be at a critical level. • Potentially significant impact which may require an offset – the residual impact may be significant depending on the context and extent of the impact. These relate to impacts that are likely to result in a species or ecosystem requiring protection under statute or increasing the cumulative impact to a critical level. Whether these impacts require an offset will be determined by the decision-maker based on information provided by the proponent or applicant and expert judgement • Impacts which are not significant – impacts that do not trigger the above categories are not expected to have a significant impact on the environment and therefore do not require an offset Following the application of the mitigation hierarchy (Table 44) and taking into consideration the above significance of residual impacts model, RPS considers that there are no significant residual impacts to marine environmental quality from the proposal.
Level of confidence in the prediction of residual impacts and the success of proposed mitigation	The impact assessment has been completed with a high level of confidence in the predictions of residual impacts on marine environmental quality with the required scientific assessments conducted (e.g. baseline marine sediment and water investigations) in accordance with relevant guidelines (Table 40).
Public interest about the likely effect of the proposal or scheme, if implemented, on the environment, and relevant public information	RIA has facilitated regular meetings / dialogue with the local community and key stakeholders (Table 25) as part of the project.

Cumulative impacts from the proposal have been considered in relation to other proposals within 5 km of the proposal and are discussed in Section 18.

Holistic impacts are discussed in Section 17.

9.8 Environmental outcomes

In consideration of the proposed avoidance and management measures and likely residual impacts associated with the proposal, the environmental outcomes that apply to marine environmental quality are:

- Environmental outcomes for construction of the proposal:
  - Marine environmental quality will be temporarily reduced to a Moderate Level of Ecological Protection during construction but will return to a High Level of Ecological Protection two weeks after completion of dredging and construction activities.

  - No reported hydrocarbon spills or release of waste into the marine environment from construction and dredging activities.
  - Maintain the marine environmental quality outside the predicted zones of influence as defined by dredge modelling (ZoHI, ZoMI and ZoI).
- Environmental outcomes for operation of the proposal:
  - Marine environmental quality is maintained at a High Level of Ecological Protection within and adjacent to the project footprint.
  - No reported hydrocarbon spills or release of waste into the marine environment from operational activities associated with the proposal.

As the impact assessment identified low residual risks to marine environmental quality following the application of mitigation actions identified herein, it is considered that the proposal will successfully meet the EPA's objective to maintain the quality of water, sediment and biota so that environmental values are protected.

10 MARINE FAUNA

10.1 EPA objective

To protect marine fauna so that biological diversity and ecological integrity are maintained.

10.2 Policy and guidance

The proposal will be subject to compliance with applicable policies and guidance developed to assist proponents and the public to understand the minimum requirements for the protection of elements of the environment that the EPA expects to be met during the assessment process.

Table 46 lists relevant EPA guidance, other state and Commonwealth legislation / policy, and provides consideration for how these documents informed the proposal.

Table 46: Relevant legislation, policy and guidance

Legislation, policy and guidance	Consideration
Environment Protection and Biodiversity Conservation Act 1999	A search of DCCEEW's PMST was undertaken within a 5 km radius of the proposal to determine the MNES that are either known or likely to occur proximate to the proposal (Appendix R). Information contained in Commonwealth conservation advice, recovery plans and species profile and threats database records have been referenced to inform the assessment of impacts to marine species. A discussion of potential impacts on MNES is discussed in Section 14.2.
Biodiversity Conservation Act 2016	A search of the DBCA's NatureMap database was undertaken to determine a list of conservation significant fauna and flora species that have been recorded within 10 km of the proposal (Appendix R).
Environmental Factor Guideline: Marine Fauna (EPA, 2016j)	The environmental factor guideline identifies the highly diversity of marine fauna and acknowledges the importance of protecting marine fauna for their ecological roles, iconic nature and importance society places on them. These considerations were underpinned as part of the marine fauna desktop analysis provided in Appendix B and summarised in Section 10 of this report. Implementation of the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O) provides the monitoring and management framework to address an increase in threats from human interaction during construction and operation of the proposal.
National Biofouling Management Guidelines for Non-trading Vessels (Commonwealth of Australia, 2009a)	Implementation of the CEMP (Emerge, 2024a) (Appendix P) and OEMP (Emerge, 2024b) (Appendix Q) provides the management framework to mitigate risks posed by accidental marine species introduction during construction and operation activities. The IMS mitigation measures outlined in the management plans are consistent with the guidelines.
National Biofouling Management Guidelines for Commercial Vessels (Commonwealth of Australia, 2009b)	Implementation of the CEMP (Emerge, 2024a) (Appendix P) and OEMP (Emerge, 2024b) (Appendix Q) provides the management framework to mitigate risks posed by accidental marine species introduction during construction and operation activities. The IMS mitigation measures outlined in the management plans are consistent with the guidelines.

10.3 Environmental investigations

10.3.1 Marine fauna

A desktop marine fauna assessment was undertaken as part of the South Thomson Barge Landing Development Marine Fauna and Benthic Habitat Assessment (RPS, 2024a) and included assessment of conservation (national and WA state listed species) and non-conservation important marine species, that may be present in the Thomson Bay area. Fauna protected under the EPBC Act and BC Act was identified via desktop searches, as described below:

- A desktop search of the DBCA Threatened, Specially Protected and priority fauna database (DBCA database) was undertaken on request of RPS by the DBCA on 3 November 2023

- A search of DCCEEW's PMST
- The online literature search utilised the following resources to identify fish species recorded in the waters in and around Thomson Bay:
  - Hoschke, A. Whisson, G. & Moore, G. I. 2019. Complete list of fishes from Rottnest Island 2019. Compiled from a range of sources (including previous literature, ALA records and Reef Life Survey data)
  - iNaturalist citizen science observation platform: Fishes of Rottnest Island (iNaturalist, 2023), which compiles up-to-date citizen science observations of marine fishes around Wadjemup / Rottnest Island
  - Reef Life Survey (RLS) citizen science program data (AODN, 2023). Utilises trained scuba-divers to undertake standardised visual surveys in areas around Australia, including Wadjemup / Rottnest Island.

10.3.2 Marine fauna habitat

A benthic communities and habitat assessment was undertaken to support the proposal. Site investigations and results are discussed further in Section 7.3.

10.3.3 Underwater noise assessment

An underwater acoustic assessment was undertaken by Tetra Tech (2024) (Appendix S) for two piling methodologies at the piling locations shown in Figure 28.

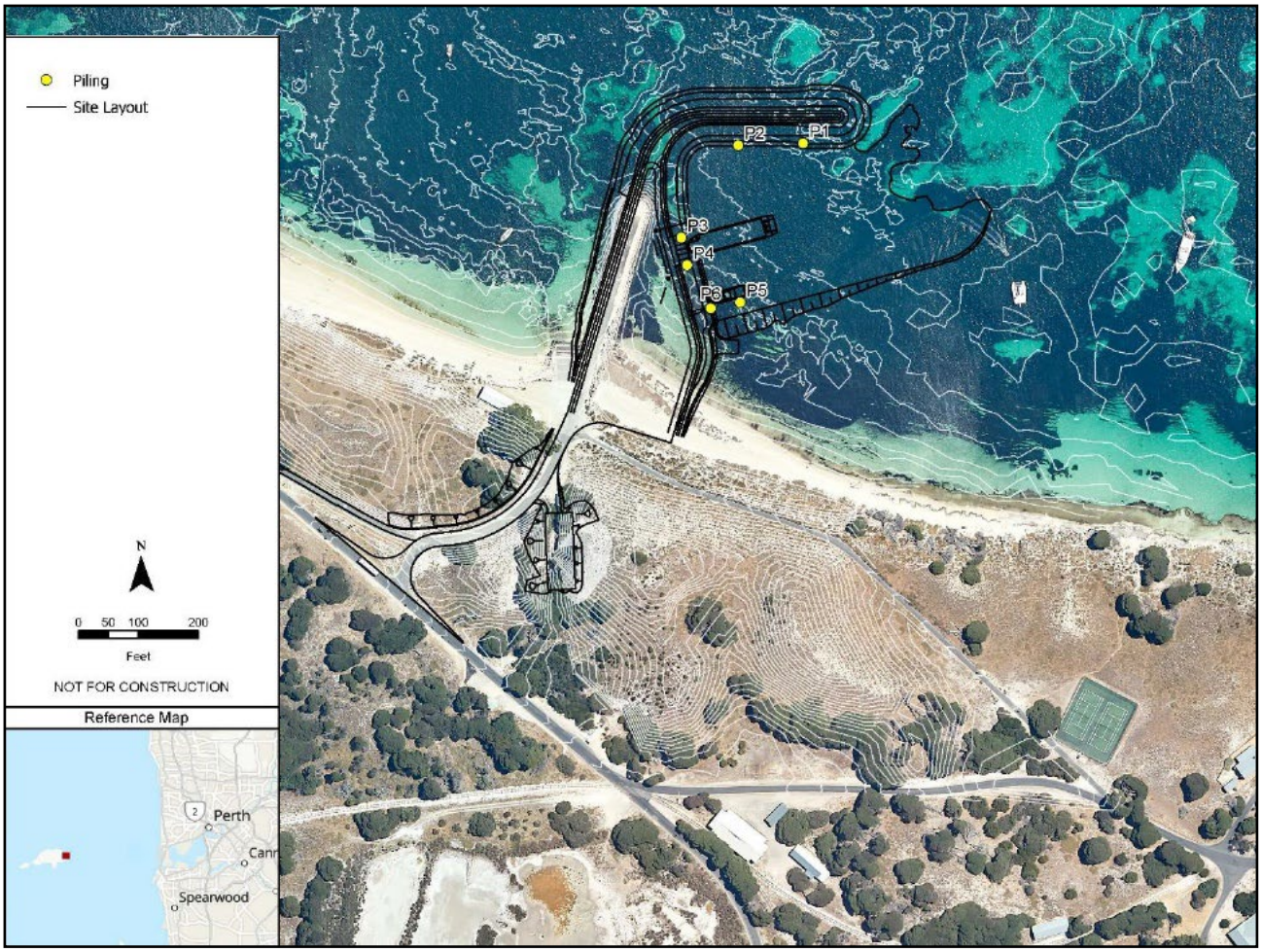


Figure 29: Underwater noise modelling – piling locations

10.4 Receiving environment

10.4.1 Benthic communities and habitats

Benthic habitat within South Thomson Bay is varied and includes seagrass meadows that include *P. sinuosa* and *P. australis.* Other benthic habitat within Thomson Bay includes macroalgae and bare sand, the latter which may be covered by wrack that accumulates seasonally (RPS, 2024a).

Benthic habitats are discussed further in Section 7 of this report.

10.4.2 Biologically important areas

The development envelope is within the Biologically Important Areas (BIA) for the species listed below. BIAs are regions where aggregations of individuals of a particular species are known or likely to display behaviours such as breeding, foraging, nesting or migration. BIAs were created to inform decision making under the EPBC Act.

- Bridled tern (the development envelope is within the foraging BIA for this species)
- Caspian tern (the development envelope is within the foraging BIA for this species)
- Fairy tern (the development envelope is within the foraging BIA for this species)
- Flesh footed shearwater (the development envelope is within the aggregation BIA for this species)
- Little penguin (the development envelope is within the foraging BIA for this species)
- Little shearwater (the development envelope is within the foraging BIA for this species)
- Pacific gull (the development envelope is within the foraging BIA for this species)
- Roseate tern (the development envelope is within the foraging BIA for this species)
- Wedge-tailed shearwater (the development envelope is within the foraging BIA for this species)
- Australian sea lion (the development envelope is within the foraging BIA for this species)
- Pygmy blue whale (the development envelope is within the distribution BIA for this species)
- Southern right whale (the development envelope is within the migration BIA for this species).

The potential for these species to occur within or adjacent to the development envelope is discussed further in the following sections.

10.4.3 Conservation significant marine fauna species

Based on the database searches and literature review undertaken to support the proposal (Appendix B), the species listed in (Table 47) may occur within South Thomson Bay (RPS, 2024a). Those species considered most likely to occur proximate to the development envelope are discussed in the following sections.

Marine and migratory species listed under the EPBC Act are discussed in Section 14.2.

Table 47: Conservation significant marine fauna species (RPS, 2024a)

Name		Conservation status		Distribution at Wadjemup / Rottnest Island and surrounding waters*	Habitat and seasonal preferences
Species	Common	EPBC Act	BC Act		
Fish					
Acentronura australe	Southern pygmy pipehorse	Listed (Marine)	Not included	Species or species habitat may occur within area	Inhabit algal reefs and seagrass beds, to depths of up to 30 m (Fishes of Australia (FoA), 2024).
Campichthys galei	Gale's pipefish	Listed (Marine)	Not included	Species or species habitat may occur within area	Inhabit shelly or rubble substrates and sparse seagrass beds, to depths of up to 18 m (FoA, 2024).
Choeroichthys suillus	Pig-snouted pipefish	Listed (Marine)	Not included	Species or species habitat may occur within area	Inhabit rubble habitats of inshore coral reefs, to depths of up to 15 m (FoA, 2024).
Halicampus brocki	Brock's pipefish	Listed (Marine)	Not included	Species or species habitat may occur within area	Inhabit coral and algal reefs, to depths of up to 45 m (FoA, 2024).
Heraldia nocturna	Upside-down pipefish	Listed (Marine)	Not included	Species or species habitat may occur within area	Inhabit sheltered inshore rocky reefs, to depths of up to 30 m (FoA, 2024).
Hippocampus angustus	Western spiny seahorse	Listed (Marine)	Not included	Species or species habitat may occur within area	Inhabit sheltered algal reefs and seagrass beds, to depths of up to 30 m (FoA, 2024).
Hippocampus breviceps	Short-head seahorse	Listed (Marine)	Not included	Species or species habitat may occur within area	Inhabit shallow seagrass and macroalgal beds, to depths of up to 15 m (FoA, 2024).
Hippocampus subelongatus	West Australian seahorse	Listed (Marine)	Not included	Species or species habitat may occur within area	Inhabit macroalgal beds, muddy substrates, jetty pylons and moorings to depths of up to 25 m (FoA, 2024).
Histiogamphelus cristatus	Rhino pipefish	Listed (Marine)	Not included	Species or species habitat may occur within area	Inhabit seagrass beds and adjacent sandy areas, to depths of up to 17 m (FoA, 2024).
Lissocampus caudalis	Australian smooth pipefish	Listed (Marine)	Not included	Species or species habitat may occur within area	Inhabit rubble habitats, macroalgal beds and seagrass beds and rocky reefs, to depths of up to 15 m (FoA, 2024).
Lissocampus fatiloquus	Prophet's pipefish	Listed (Marine)	Not included	Species or species habitat may occur within area	Inhabit rocky and sand habitats, and seagrass and macroalgal beds, to depths of up to 10 m (FoA, 2024).
Lissocampus runa	Javelin pipefish	Listed (Marine)	Not included	Species or species habitat may occur within area	Inhabit seagrass and macroalgal beds and rubble substrates, to depths of up to 20 m (FoA, 2024).
Maroubra perserrata	Sawtooth pipefish	Listed (Marine)	Not included	Species or species habitat may occur within area	Inhabit coral reefs, to depths of up to 25 m (FoA, 2024).
Mitotichthys meraculus	Western crested pipefish	Listed (Marine)	Not included	Species or species habitat may occur within area	Inhabit seagrass beds to depths of up to 10 m (FoA, 2024).
Nannocampus subosseus	Bony-headed pipefish	Listed (Marine)	Not included	Species or species habitat may occur within area	Inhabit a range of habitats including seagrass and macroalgal beds, sandy and coral reef habitats, to depths of up to 14 m (FoA, 2024).
Phycodurus eques	Leafy seadragon	Listed (Marine)	Not included	Species or species habitat may occur within area	Inhabit seagrass beds and algal reefs, to depths of up to 50 m (FoA, 2024).
Phyllopteryx taeniolatus	Common seadragon	Listed (Marine)	Not included	Species or species habitat may occur within area	Inhabit seagrass beds and algal reefs, to depths of up to 50 m (FoA, 2024).
Pugnaso curtirostris	Pugnose pipefish	Listed (Marine)	Not included	Species or species habitat may occur within area	Inhabit shallow seagrass and macroalgal beds, to depths of up to 11 m (FoA, 2024).
Solegnathus lettiensis	Gunther's pipefish	Listed (Marine)	Not included	Species or species habitat may occur within area	Little is known about the habitat for this species.
Stigmatopora argus	Spotted pipefish	Listed (Marine)	Not included	Species or species habitat may occur within area	Inhabit seagrass beds, to depths of up to 8 m (FoA, 2024).
Stigmatopora nigra	Widebody pipefish	Listed (Marine)	Not included	Species or species habitat may occur within area	Inhabit sheltered seagrass and macroalgal beds, to depths of up to 35 m (FoA, 2024).
Syngnathoides biaculeatus	Double-end pipefish	Listed (Marine)	Not included	Species or species habitat may occur within area	Inhabit seagrass and macroalgal beds, to depths of up to 10 m (FoA, 2024).
Urocampus carinirostris	Hairy pipefish	Listed (Marine)	Not included	Species or species habitat may occur within area	Inhabit seagrass beds, to depths of up to 6 m (FoA, 2024).
Vanacampus margaritifer	Mother-of-pearl pipefish	Listed (Marine)	Not included	Species or species habitat may occur within area	Inhabit seagrass and macroalgal beds, rocky and sandy substrates, to depths of up to 15 m (FoA, 2024).
Vanacampus phillipi	Port Phillip pipefish	Listed (Marine)	Not included	Species or species habitat may occur within area	Inhabit seagrass and macroalgal beds, to depths of up to 25 m (FoA, 2024).
Vanacampus poecilolaemus	Longsnout pipefish	Listed (Marine)	Not included	Species or species habitat may occur within area	Inhabit shallow seagrass and macroalgal beds, to depths of up to 18 m (FoA, 2024).
Sharks					
Sphyrna lewini	Scalloped hammerhead	Conservation Dependent	Not included	Species or species habitat likely to occur within area	Undertake annual foraging and breeding migrations. Known to aggregate in the Shoalwater Islands Marine Park, where peak numbers are observed during January and February (López, 2023).
Carcharias taurus (west coast population)	Grey nurse shark (west coast population)	Vulnerable	Vulnerable	Congregation or aggregation known to occur within area	Year-round presence. Seasonal migration patterns have not been observed (DCCEEW, 2023b).
Carcharodon carcharias	White shark	Vulnerable, Migratory	Vulnerable	Species or species habitat known to occur within area	Have been shown to undertake migrations north along the WA coast during spring and return in summer; however, coastal movements are not synchronous. They are frequently recorded in waters around fur seal and sea lion colonies, including in the Perth region (DCCEEW, 2023b), where they are more likely to be present during spring and early summer and least likely to be present during late summer and autumn (SharkSmart, 2018).

Name		Conservation status		Distribution at Wadjemup / Rottnest Island and surrounding waters*	Habitat and seasonal preferences
Species	**Common**	**EPBC Act**	**BC Act**		
Mammals					
Neophoca cinerea	Australian sea lion	Endangered	Endangered	Species or species habitat likely to occur within area. The development footprint is located within the foraging BIA for this species.	Has an asynchronous non-annual breeding cycle with cycles ranging from 16 to 20 months and pupping occurring at different times throughout the South-West Marine Region (DCCEEW, 2023b).
Eubalaena australis	Southern right whale	Endangered, Migratory	Vulnerable	The development footprint is located within the migratory BIA for this species†	Southern temperate to subpolar waters including marine areas of southern Australia from May to October. The migratory period within the migration BIA up the west coast of WA is April to October (National Conservation Values Atlas, 2023).
Balaenoptera musculus brevicauda	Pygmy blue whale	Endangered	Endangered (as *Balaenoptera musculus)*	Known to occur in the area. The development footprint is located within the distribution BIA for this species.	The northbound migration past Perth Canyon occurs between April and July (peak May to June), with the return migration from October to January (peak November to early December.
Megaptera novaeangliae	Humpback whale	Migratory	Conservation Dependent, Migratory	Species or species habitat known to occur within area. The development footprint is located within the migratory BIA for this species.	The annual peak northbound migration along the Jurien Bay to Carnarvon migration route occurs between June and July, while the southbound migration peak occurs between September and October (DCCEEW, 2023b).
Orcinus orca	Killer whale, orca	Migratory	Migratory	Species or species habitat may occur within area	Mating is known to occur all year round, whilst the calving season spans several months. However, no areas of significance and no determined migration routes have been identified for this species within waters off WA (DCCEEW, 2023b). They are typically present on the south coast of WA between January to April.
Arctocephalus forsteri	New Zealand fur seal	Listed (Marine)	Other Specially Protected	Species or species habitat may occur within area. The New Zealand fur seal colony on Wadjemup / Rottnest Island is located at Cathedral Rocks on the west end of Wadjemup / Rottnest Island.	Present year round (ALA, 2023)
Balaenoptera acutorostrata	Minke whale	Listed (Cetacean)	Migratory	Species or species habitat may occur within area	May migrate from high latitude areas in the summer to low latitude areas in the winter. The detailed pattern of seasonal migration is generally poorly understood (ALA, 2023).
Tursiops aduncus	Indian Ocean bottlenose dolphin	Listed (Cetacean)	Not included	Species or species habitat likely to occur within area	Present year-round. Movement patterns in Australia are variable.
Tursiops truncatus s. str.	Bottlenose dolphin	Listed (Cetacean)	Not included	Species or species habitat may occur within area	Seasonal movements are variable, and may include residency in small areas, long-range movements, and migration (DCCEEW, 2023b).
Stenella longirostris	Spinner dolphin	Listed (Cetacean)	Priority 4, Migratory	Sighted in field survey in DBCA database data. Assumed species or species habitat may occur within area.	No seasonal differences, but mostly offshore species (ALA, 2023)
Reptiles					
Caretta caretta	Loggerhead turtle	Endangered, Migratory	Endangered	Foraging, feeding or related behaviour known to occur within area	Generally nesting in summer at nesting grounds in northern WA (not necessarily every year; ALA, 2023).
Dermochelys coriacea	Leatherback turtle	Endangered, Migratory	Vulnerable	Species or species habitat known to occur within area	Migrates from foraging areas to nesting beaches in tropical and subtropical regions during summer (ALA, 2023; DCCEEW, 2023b).
Chelonia mydas	Green turtle	Vulnerable, Migratory	Vulnerable	Foraging, feeding or related behaviour known to occur within area	Migrates from foraging areas to nesting beaches in tropical regions during summer, typically between November and March (DCCEEW, 2023b).
Pelamis platurus	Yellow-bellied sea snake	Listed (Marine)	Not included	Species or species habitat may occur within area	Seasonal movements have not been observed in Australia hence may be present year-round.
Birds					
Limosa lapponica menzbieri	Northern Siberian bar-tailed godwit	Critically Endangered	Critically Endangered	Species or species habitat known to occur within area	The northern Siberian bar-tailed godwit occurs mainly in coastal habitats such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays (TSCC, 2016).
Calidris tenuirostris	Great knot	Critically Endangered	Critically Endangered	Roosting known to occur within area	The great knot has been recorded around the entirety of the Australian coast and is common on the coasts of the Pilbara and Kimberley, from the Dampier Archipelago to the Northern Territory border. Great knots prefer sheltered coastal habitats with large intertidal mudflats or sandflats. This includes inlets, bays, harbours, estuaries and lagoons (DCCEEW, 2023).
Calidris ferruginea	Curlew sandpiper	Critically Endangered	Critically Endangered	Species or species habitat known to occur within area	In Western Australia, the curlew sandpiper is widespread around coastal and subcoastal plains from Cape Arid to south-west Kimberley Division. They mainly occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons.
Numenius madagascariensis	Eastern curlew	Critically Endangered	Critically Endangered	Species or species habitat likely to occur within area	The eastern curlew is most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass (Cornel University 2023).
Charadrius mongolus	Lesser sand plover	Endangered	Endangered	Roosting known to occur within area	The lesser plover mainly occurs in northern and eastern Australia, rare in south-western Australia. The species is almost strictly coastal, preferring sandy beaches, mudflats of coastal bays and estuaries, sand flats and dunes near the coast (Cornell University, 2023).

Name		Conservation status		Distribution at Wadjemup / Rottnest Island and surrounding waters*	Habitat and seasonal preferences
Species	Common	EPBC Act	BC Act		
Calidris canutus	Red knot	Endangered	Endangered	Species or species habitat known to occur within area	The red knot mainly inhabits intertidal mudflats, sandflats and sandy beaches of sheltered coasts and sometimes on sandy ocean beaches or shallow pools on exposed rock platforms (Higgins, 1996)
Rostratula australis	Australian painted snipe	Endangered	Endangered	Species or species habitat may occur within area	The Australian painted snipe lives in shallow freshwater (occasionally brackish) wetlands, both ephemeral and permanent, such as lakes, swamps, claypans, inundated or waterlogged grassland/saltmarsh (TSSC, 2013)
Charadrius leschenaultii	Greater sand plover	Vulnerable	Vulnerable	Species or species habitat known to occur within area	Mainly occurs on sheltered sandy, shelly or muddy beaches, large intertidal mudflats, sandbanks, salt marshes, estuaries, coral reefs, rocky islands rock platforms, tidal lagoons and dunes near the coast (Cornel University 2023).
Sternula nereis nereis	Australian fairy tern	Vulnerable	Vulnerable	Foraging, feeding or related behaviour known to occur within area. Migrant breeding, breeding habitat present within the area.	In south-western Australia, the fairy tern breeds between October and March with peak breeding between December and January. The natural jetty at the end of Philip Point is an important roost site for fairy terns.
Eudyptula minor	Little penguin	Marine		Breeding known to occur within area.	In the Perth region, it breeds in seawalls, in limestone rock cavities and underneath vegetation. The closest known breeding colonies are Garden Island and Penguin Island. No known breeding occurs on Wadjemup / Rottnest Island; however South Thomson Bay is within the foraging BIA for this species
Onychoprion anaethetus	Bridled tern	Marine Migratory		Breeding known to occur within area.	The bridled tern is a common visitor to Rottnest to breed (Rottnest Island Authority, 2019). It forms small colonies and nests on the ground usually in areas sheltered by plants, ledges or caves. There are no known breeding colonies within the vicinity of the proposal and due to the high level of disturbances from recreational users at Thomson Bay, there are unlikely to be any significant roosting sites within vicinity of the proposal. Consequently, impacts as a result of the proposal are unlikely.
Hydroprogne caspia	Caspian tern	Marine Migratory		Breeding known to occur within area.	The proposal is located within the foraging BIA for the Caspian tern and a small number of Caspian terns roost at Natural Jetty. As there are no known breeding colonies or roosting habitat for this species within the development envelope, significant direct impacts are unlikely.
Thalasseus bergii	Crested tern	Marine Migratory		Breeding known to occur within area.	The crested tern is the most common tern on the island, with the main nesting colonies located on Lake Baghdad and Herschel Lake (Rottnest Island Authority, 2019b). The crested tern may roost at the Natural Jetty. As there are no known breeding colonies or roosting habitat for this species within the development envelope, significant direct impacts are unlikely.
Sterna dougallii	Roseate tern	Marine Migratory		Breeding known to occur within area.	The proposal is located within the foraging BIA for the roseate tern. As there are no known breeding colonies or roosting habitat for this species within the development envelope, significant direct impacts are unlikely. However, as roseate terns roost at Natural Jetty, potential indirect impacts to this species have been considered.
Ardenna pacifica	Wedge-tailed shearwater	Marine Migratory		Breeding known to occur within area.	The wedge tailed shearwater is known to breed in burrows on Wadjemup / Rottnest Island between August to May (DCCEEW, 2023). Significant breeding habitat for this species is located on the west end of the island, such as on Cape Vlamingh, and impacts to this species or its habitat are unlikely as a result of the proposal.
Pandion haliaetus	Osprey	Marine Migratory		Breeding known to occur within area	The osprey is known to breed on stacks at the west end of the island (Holsworth, 1965) and is not known to breed within or proximate to the development envelope.

*As listed in the PMST search results and/or Atlas of Living Australia (ala.org.au)

† Although the PMST search indicates that breeding by *E. australis* may occur within the PMST search area, a review of the online National Conservation Values Atlas indicates that this is not the case and only the migration BIA for the species overlaps Thomson Bay

Definitions: BC Act = *Biodiversity Conservation Act 2016* (WA), BIA = Biologically Important Area, DBCA = Department of Biodiversity, Conservation and Attractions (WA), EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)

Priority 4 = Rare, Near Threatened and other species in need of monitoring (BC Act)

Other Specially Protected = Species otherwise in need of special protection (BC Act)

10.4.3.1 Marine mammals

10.4.3.1.1 New Zealand fur seal

There is a colony of New Zealand fur seal located on the west end of Wadjemup / Rottnest Island. Therefore, although the development envelope is not located within vicinity of any important breeding habitat for this species, the New Zealand fur seal is likely to forage in the waters around the development envelope.

10.4.3.1.2 Australia sea lion

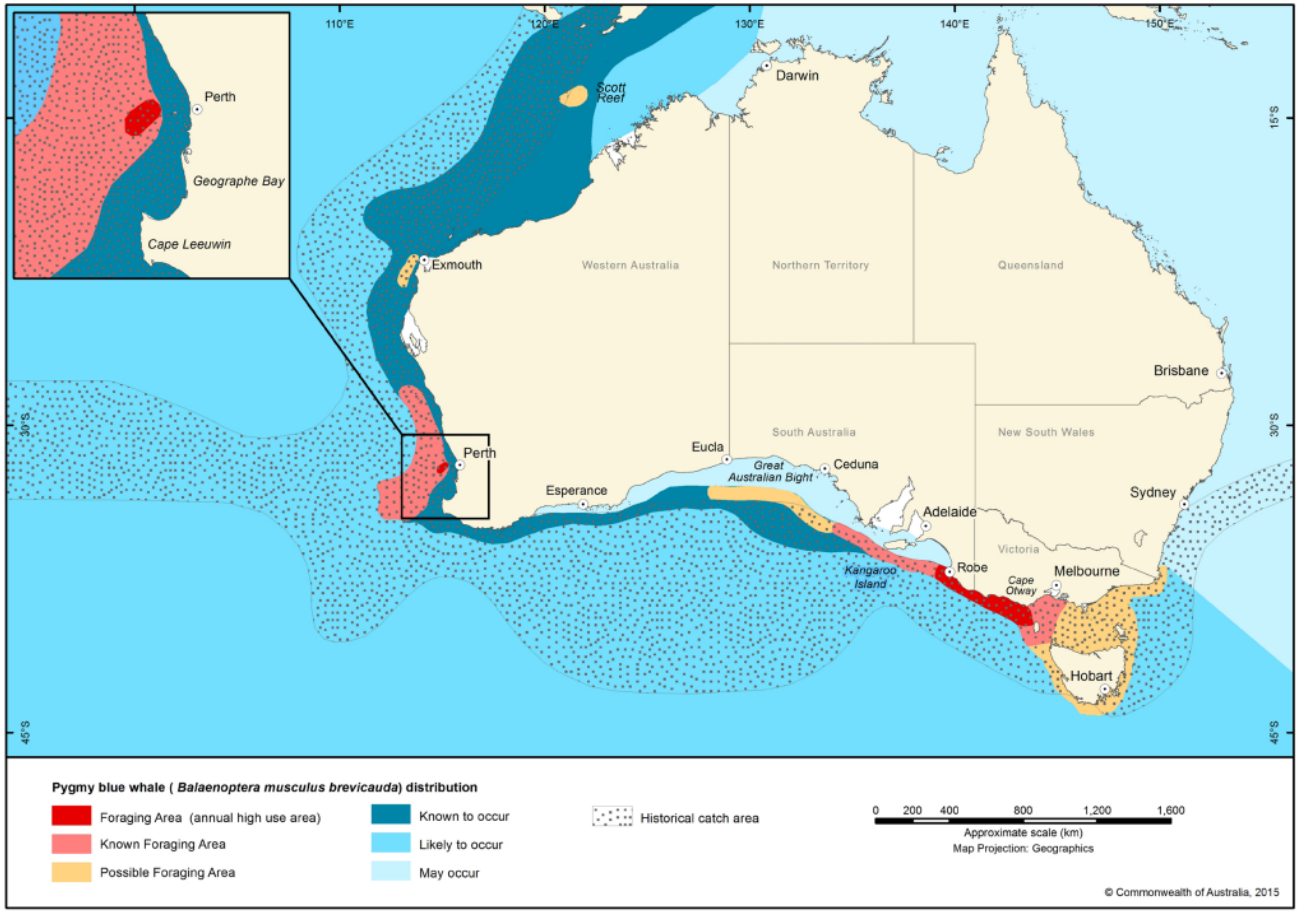
The South West Marine Region is an important foraging and breeding region for Australian sea lions, with 99% of the population occurring within the SWMR (McClatchie, 2006).

The Australia sea lion foraging BIA extends along the west coast of Australia, south of Geraldton down to Perth. The development envelope overlaps the foraging BIA for this species. As such, this species is likely to occasionally occur within or within vicinity of the development envelope. There are no known breeding or haul out sites on the island.

10.4.3.1.3 Whales

Cetacean species, such as the pygmy blue whale (*Balaenoptera musculus brevicauda*), southern right whale (*Eubalaena australis*) and humpback whale (*Megaptera novaeangliae*), are known to transit between Southern Ocean feeding grounds and tropical water breeding grounds. Consideration of the important of critical habitats for whale species which may occur proximate to South Thomson Bay (Table 47):

- Humpback whale (Migratory)
  - The humpback whale migration, breeding, and calving BIA extend along the length of the WA coast, to its northernmost extent offshore of the Kimberley. The migration BIA overlaps the development envelope and this species may occur proximate to the development envelope.
- Pygmy blue whale (Endangered, Migratory)
  - Wadjemup / Rottnest Island is located within the known distribution of this species, but outside of the known foraging areas (Figure 29). Pygmy blue whale migration and known foraging area BIAs pass along the shelf edge at depths between 500 m and 1,000 m. Although the development envelope does not occur within the known foraging BIA or migration BIA for this species, the west end of Wadjemup / Rottnest Island is located within a BIA and it is therefore likely that this species occurs proximate to the development envelope during migration. The northern migration of the pygmy blue whale (from Augusta to Derby) occurs between April and July (peak periods in May and June), with a return southbound migration from October to January (peak periods in November and December) (McCauley R.D. and Jenner, 2010).
- Southern right whale (Endangered, Migratory).
  - The southern right whale migration BIA, which extends all the way up the west coast of WA as far north as Ningaloo Reef, overlaps the development envelope (Figure 30). The nearest reproductive BIA is over 1,000 km away.



Foraging Area (Annual high use area)	Blue whales are regularly observed feeding on a seasonal basis
Known Foraging Area	Known foraging occurs in these areas but is highly variable both between and within seasons
Possible Foraging Area	Evidence for feeding is based on limited direct observations or through indirect evidence, such as occurrence of krill in close proximity of whales, or satellite tagged whales showing circling tracks. Blue whales travel through on a seasonal basis, possibly as part of their migratory route

Known to occur	Blue whales are known to occur based on direct observations, satellite tagged whales or based on acoustic detections
Likely to occur	Blue whales are likely to occur based on occasional observations in the area and nearby areas
May occur	Evidence for the presence of blue whales through strandings or rare observations
Historical catch area	Blue whales were caught during the whaling period based on whaling data

Figure 30: Pygmy blue whale distribution (DoE, 2015)

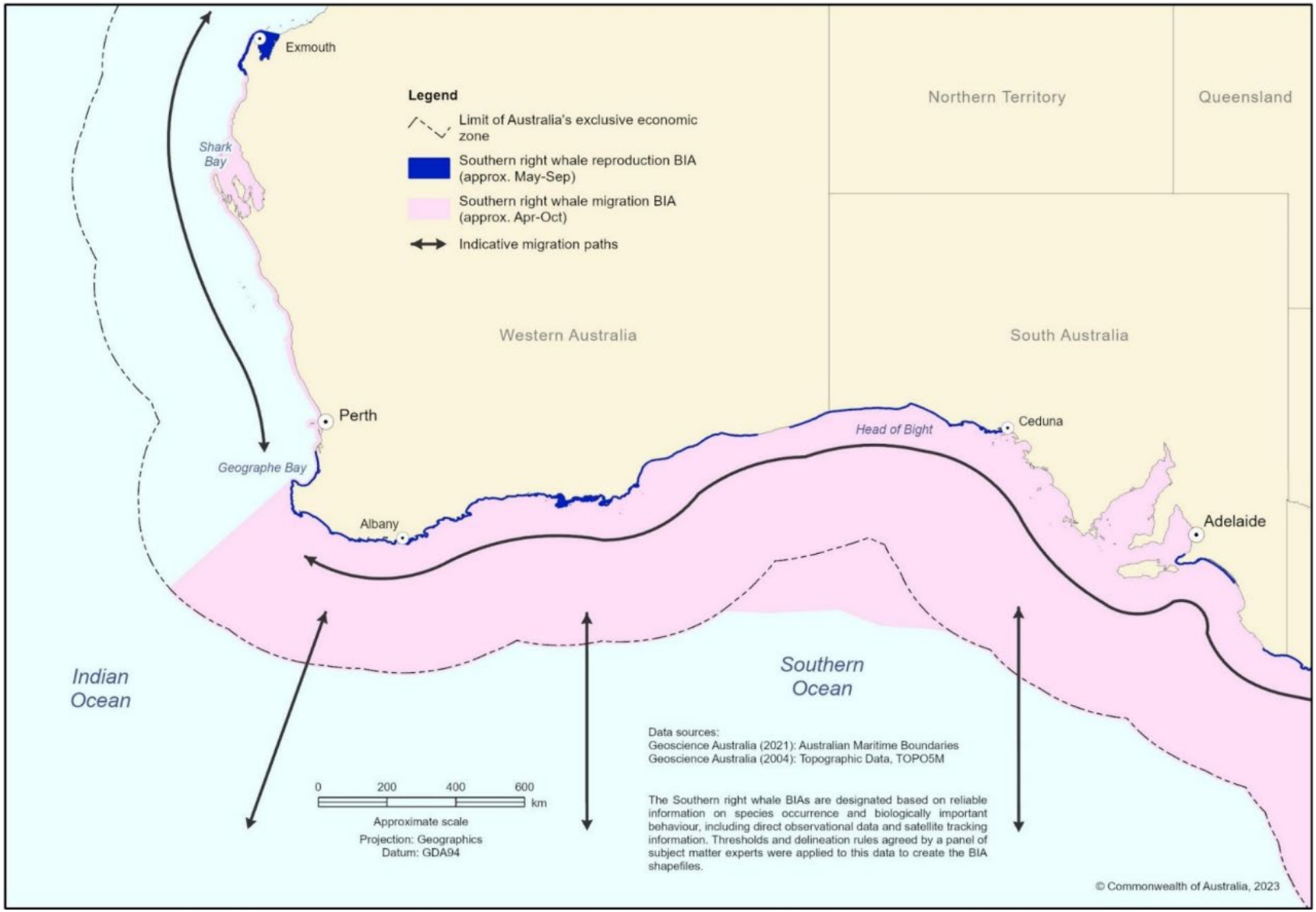


Figure 31: Southern right whale Biologically Important Areas and habitat critical to the survival (reproduction BIA) in Western Australia (DCCEEW, 2024)

10.4.3.2 Shark species

The development envelope does not overlap with any known BIAs for shark or ray species. However, the following conservation significant shark species are considered likely to occasionally occur proximate to the development envelope:

- White shark
  - White sharks can be found from close inshore around rocky reefs, surf beaches and shallow coastal bays to outer continental shelf and slope areas. Areas where white shark observations are more frequent include waters in and around some fur seal and sea lion colonies (DSEWPC, 2012). It is likely that this species may occasionally occur proximate to the development envelope due to the presence of the New Zealand fur seal colony at the west end of the island
- Scalloped hammerhead
  - Scalloped hammerheads migrate yearly for foraging and breeding purposes and the closest aggregation area for the species to the development envelope is the Shoalwater Islands Marine Park, when peak numbers are observed during January and February (López, 2023)
- Grey nurse shark.
  - In Australia, the grey nurse shark has an inshore coastal distribution primarily in sub-tropical to cool temperate waters on the continental shelf. Grey nurse sharks are often observed aggregating around inshore rocky reefs or islands. At these locations they are typically found near the seabed (at depths of 10–40 m) in deep sandy or gravel filled gutters, or in rocky caves. These sites are considered habitat critical to the survival of the species. There are no confirmed aggregation sites in W.A. waters, however it is considered possible that this species may occasionally occur proximate to the development envelope (DoEE, 2014).

10.4.3.3 Marine bird species

Conservation significant marine bird species that may occur proximate to the development envelope are discussed below. There is potential for other marine bird species to opportunistically occur proximate to the site, these species are listed in Table 47:

- Little penguin (Marine)
  - The development envelope overlaps with a foraging BIA for this species. The little penguin is endemic to Australia and New Zealand and found along the southern coast of Australia from Carnac Island (WA) to Broughton Island (NSW), including Shoalwater Islands Marine Park, Penguin Island, and the Geographe Bay area (DoEE 2019). This species is known to breed at Garden Island and Penguin Island, over 20 km south of the development envelope, and may forage proximate to the development envelope. There is no known breeding habitat proximate to the development envelope, and although these species may occasionally occur within South Thomson Bay, the development envelope is not considered likely to provide critical habitat for this species
- Shearwaters. wedge-tailed shearwaters (*Ardenna pacifica*), little shearwaters (*Puffinus assimilis tunneyi*), flesh-footed shearwaters (*Ardenna caneipes*) and short-tailed shearwaters (*Ardenna tenuirostris*) are regularly found within the South-west Marine Region and breed in the south-west of WA.
  - Wedge-tailed shearwater
    - The wedge-tailed shearwater is known to breed on the west end of Wadjemup / Rottnest Island (DSEWPC, 2012). Although there are no known breeding colonies proximate to the development envelope, this species may forage in the water proximate to the development envelope
  - Little shearwater
    - The development envelope overlaps with a foraging BIA for this species. The little shearwater is found along the entire southern coast of Australia, including the Houtman Abrolhos Islands, the Recherche Archipelago, and the islands of the Dampier Archipelago in WA (DAWE 2020b). The species inhabits offshore waters and breed on small islands, in burrows or rocky

crevices. Little shearwaters spend most of their lives at sea but return to breeding colonies on islands to mate and raise their young. They are known for their long-distance migrations, with some individuals traveling from their breeding grounds in south-western WA to the north Pacific and Arctic oceans (Commonwealth of Australia, 2020). The fauna assessment undertaken by RPS (2024a) and EcoLogical (2024) did not identify any important habitat for this species within the development envelope, although it may occassioanlly forage within or proximate to South Thomson Bay

  - Flesh footed shearwater
    - The development envelope overlaps with an aggregation BIA for this species. In Australia, the flesh-footed shearwater is commonly found along the southern continental shelf (south-west WA to south-east QLD). The species breed on islands off the coast of south-west WA and are nocturnally active at breeding grounds (Department of the Environment and Energy, 2024). The fauna assessment undertaken by RPS (2024a) and EcoLogical (2024) did not identify any important habitat for this species within the development envelope, although it may occassioanlly forage within or proximate to South Thomson Bay
  - Short tailed shearwater
    - This species breeds on Tasmanian offshore islands and off the coast of southern Australia, with the bulk of the population in the south-east. Breeding occurs mainly on coastal islands, typically in areas of grassland or other vegetation, but sometimes cliffs or bare ground (Commonwealth of Australia, 2020). The fauna assessment undertaken by RPS (2024a) and EcoLogical (2024) did not identify any important habitat for this species within the development envelope, although it may occassioanlly forage within or proximate to South Thomson Bay
- Caspian tern (Marine, Migratory)
  - The development envelope overlaps with a foraging BIA for this species. In WA, the species is widespread along coastal regions, from the Great Australian Bight to the Dampier Peninsula. Breeding occurs along the entire south-west region (Higgins, 2003). The closest breeding populations are found on islands of the Turquoise Coast and Houtman Abrolhos. These birds are likely to be largely sedentary or make only short-range movements within the region. Caspian terns are a diurnal coastal foraging species that predominantly feed on whiting and mullets, and roost on land at night. This species may roost at the natural jetty, approximately 800 m to the east of the development envelope and may occasionally forage in the area. There is no critical habitat for this species present in the development envelope
- Bridled tern (Marine, Migratory)
  - The development envelope overlaps with a foraging BIA for this species. This species is known to breed on Penguin Island, over 20 km south of the development envelope and may forage proximate to the development envelope. This species may also roost at the natural jetty, approximately 800 m to the east of the development envelope. There is no critical habitat for this species present in the development envelope
- Crested tern (Marine, Migratory)
  - The species breeds in colonies or groups on offshore islands, low-lying coral reefs, sandy or rocky coastal islets and coastal spits (Commonwealth of Australia, 2020). The fauna assessment undertaken by RPS (2024a) and EcoLogical (2024) did not identify any important habitat for this species within the development envelope. However, this species may also roost at the natural jetty, approximately 800 m to the east of the development envelope. There is no critical habitat for this species present in the development envelope

- Roseate tern (Marine, Migratory)
  - The development envelope overlaps with a foraging BIA for this species. The roseate tern occurs in both coastal and marine subtropical/tropical areas. The species inhabits rocky and sandy beaches, coral reefs, sand cays and offshore islands (Department of Agriculture, Water and Environment, 2021). Roseate terns are a diurnal coastal foraging species that feed on small schooling bait fish, often brought to the surface by predatory fish, such as tuna. This species roosts on land at night. In WA, roseate terns are regularly recorded north from Mandurah to Eighty Mile Beach, in the Pilbara Region (DAWE 2021a). This species may roost at the natural jetty, approximately 800 m to the east of the development envelope and may occasionally forage in the area. There is no critical habitat for this species present in the development envelope
- Fairy tern (Vulnerable)
  - The development envelope overlaps with a foraging BIA for this species. Within Australia, fairy terns occur along the coasts of VIC, TAS, SA, and WA. In WA, there are two populations of fairy terns. The first is a semi-migratory population that breeds between Israelite Bay on the south-eastern coast and Northwest Cape, and overwinter at the Houtman Abrolhos. The second, probably sedentary population occurs on Pilbara islands, as far north as the Dampier Archipelago near Karratha (Dunlop, 2022). This species may roost at the natural jetty, approximately 800 m to the east of the development envelope and may occasionally forage in the area. There is no critical habitat for this species present in the development envelope.

10.4.3.4 Turtles

Turtle species which may occur within or proximate to South Thomson Bay are discussed in Table 47 and include the green turtle, leatherback turtle and loggerhead turtle. As shown in Figure 31 to Figure 33, South Thomson Bay is within the known range of these species, however there are no nesting or internesting areas proximate to the site.

Turtles migrate to and from their nesting grounds in northern WA during summer (typically between November and March) and their common distribution is north of the development envelope. However, they are known to forage on and in seagrass meadows and may occasionally occur in the area.

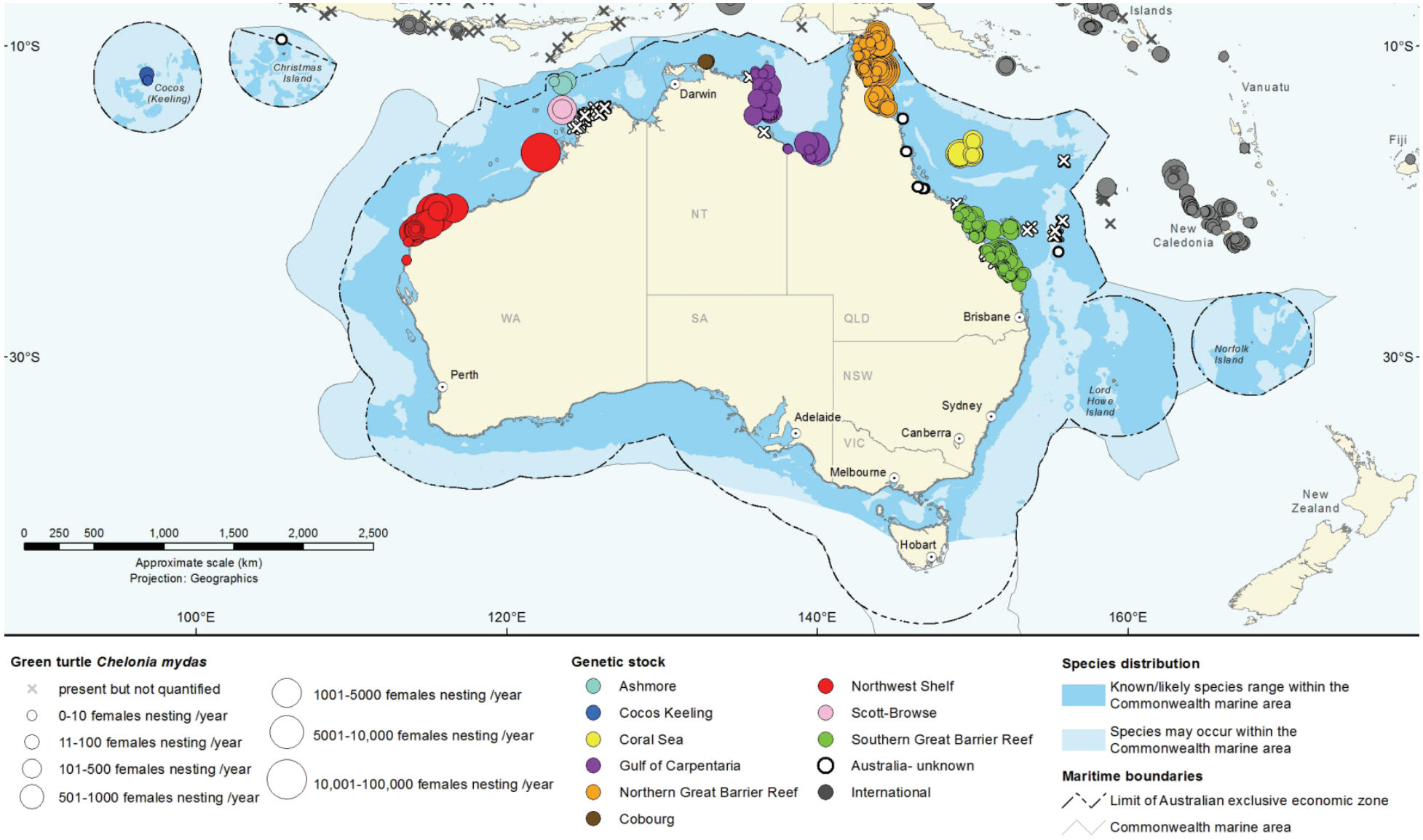


Figure 32: Green turtle habitat in Australia (DoEE, 2017)

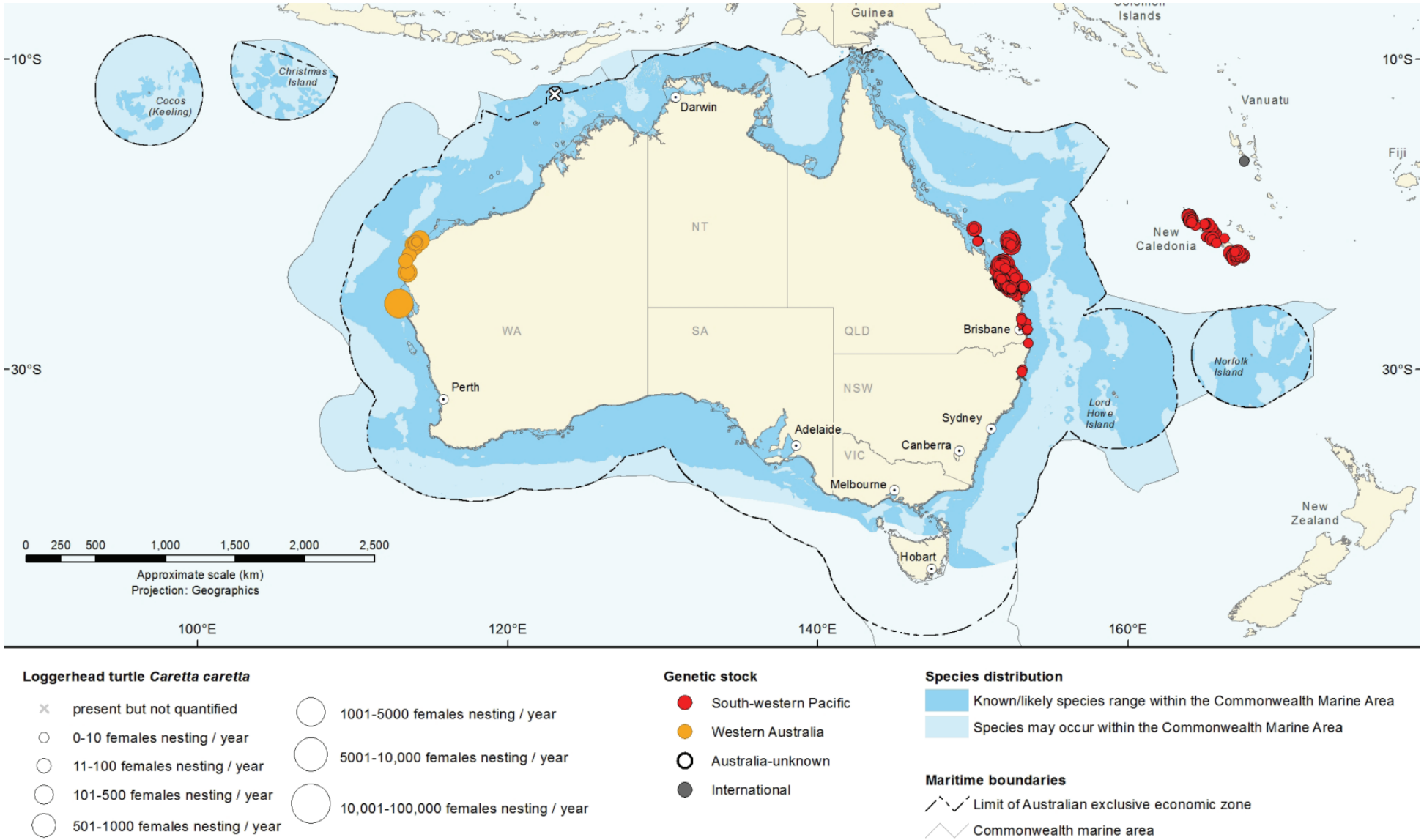


Figure 33: Loggerhead turtle habitat in Australia (DoEE, 2017)

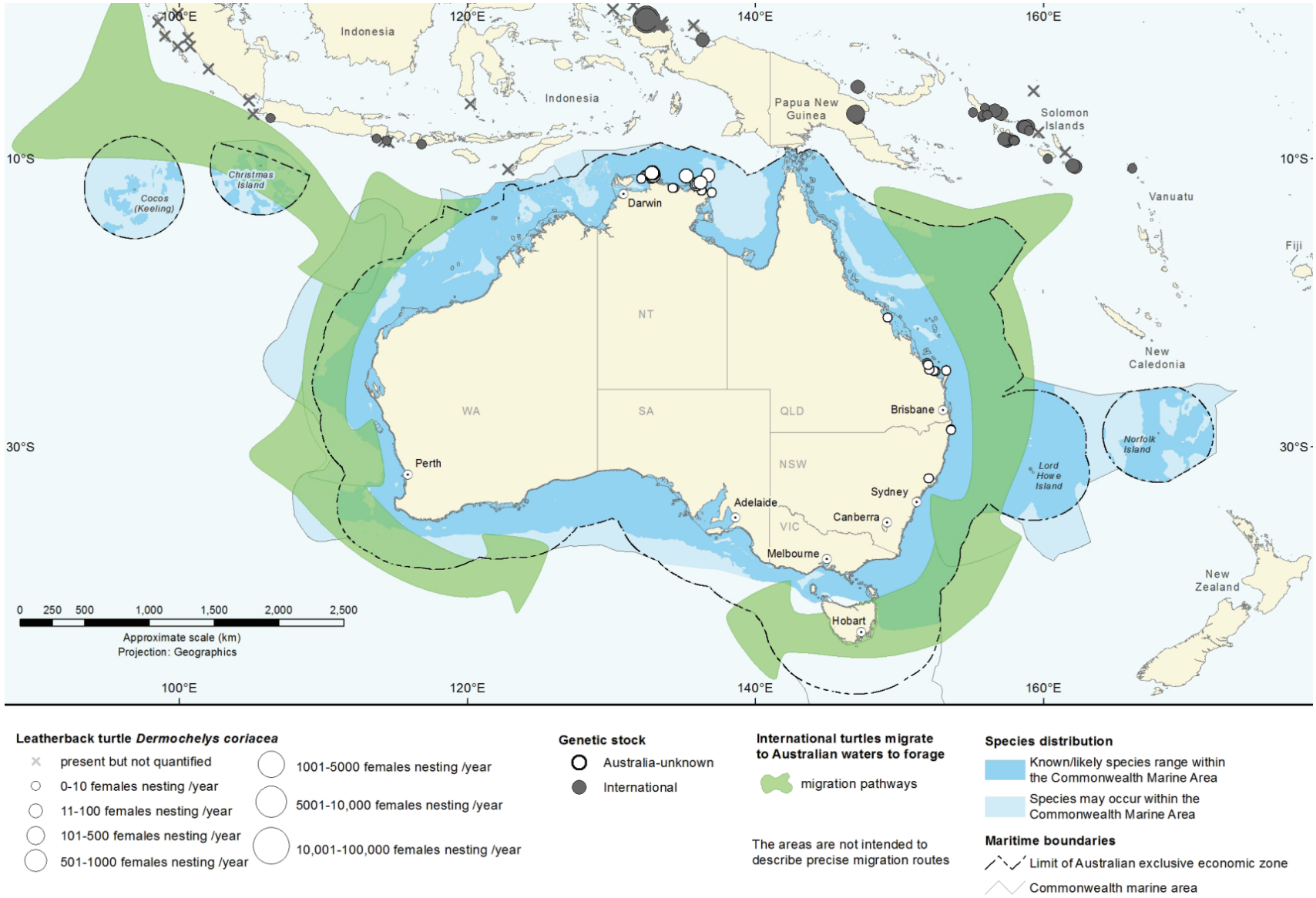


Figure 34: Leatherback turtle habitat in Australia (DoEE, 2017)

10.5 Potential environmental impacts

Table 48 provides the potential key impacts to marine fauna from the proposal. These impacts are discussed in further detail in Sections 10.5.1.1 to 10.5.1.7.

Table 48: Potential impacts on marine fauna

Phase	Impact class	Works / operations	Potential impacts
Construction	Direct	• Dredging • Breakwater construction • Reclamation (decant from reclamation area)	**Loss of benthic habitats** • Removal of 3.32 ha of potential marine fauna habitats as a result of the construction of the proposal (e.g. dredging). Indirect (and recoverable) impacts from dredging are discussed later in this table: – Permanent loss of 2.06 ha mixed seagrass – Permanent loss of 1.26 ha sand with wrack
		• Piling	**Elevated underwater noise from activities such as piling and dredging**
		• Dredging (including the use of silt curtains).	**Increased risk of entanglement or entrainment** • Risk of entrainment during dredging with the potential to cause injury, death, displacement, adverse behavioural and physiological changes.
		• Vessel operations	**Risk of vessel collision** • Increased collision risk leading to injury/mortality of marine fauna.
		• Breakwater construction	**Risk of injury or death from rock dumping during breakwater construction** • Increased risk of injury/mortality of marine fauna.
		• Artificial lighting from moored/inactive construction vessels (low impact lighting for navigational safety). • Artificial lighting from onshore construction areas (low impact lighting for security / safety)	**Potential impacts from artificial lighting** • Potential temporary and localised impacts from artificial lighting on areas surrounding the moored vessels and adjacent to the construction area, affecting movements and behaviours of marine fauna.
	Indirect	• Construction vessels movement and activities	**Increased risk of introduction of Introduced Marine Species (IMS)** • Increased risk of introduction of IMS could change the local ecology, impacting marine fauna species. **Increased risk of pollution incidents** • Increased risk of pollution incidents from vessels leading to degradation of marine environment has the potential to indirectly impact marine fauna.
		• Dredging • Breakwater construction • Reclamation (decant from reclamation area)	**Loss of benthic habitats** • The temporary loss of 2.62 ha of mixed seagrass and 1.09 ha of sand / sand with wrack within the ZoMI from an increase in TSS. **Temporary increase in turbidity** • Reduction in marine environmental quality (e.g. increased suspended sediment / turbidity) may impact on marine fauna behaviours.
Operation	Direct	• Increase in vessel activity	**Risk of vessel collision** • Increase collision risk with vessels leading to injury/mortality of marine fauna.
		• Maintenance dredging (if required)	**Increased risk of entanglement or entrainment** • Risk of entrainment during dredging with the potential to cause injury, death, displacement, adverse behavioural and physiological changes.

Phase	Impact class	Works / operations	Potential impacts
	Indirect	• Increase in vessel activity	**Increased risk of introduction of IMS** • Increased risk of introduction of IMS could change the local ecology. **Increased risk of pollution incidents** • Increased risk of pollution incidents from vessels leading to degradation of marine environment.
		• Artificial and permanent lighting along the marine structure	**Potential impacts from artificial lighting** • Localised, permanent source of potential disruption to marine fauna that alter behaviours / movements.

10.5.1 Assessment of impacts

10.5.1.1 Summary of key marine fauna receptors

Some marine fauna species are likely to occur with Thomson Bay year-round, while others are migratory visitors. There are critical times of the year where marine fauna species are undergoing key stages of their life cycle and are therefore more susceptible to disturbance. Table 49 summarises the conservation significant fauna species that may occur proximate to the proposal.

Key ecological windows for marine fauna species that may occur within or proximate to South Thomson Bay are provided in Table 49.

Table 49: Key marine fauna receptors and associated ecological windows

Sensitivity	January	February	March	April	May	June	July	August	September	October	November	December
Humpback whale (north migration)[1]												
Humpback whale (south migration)[1]												
Pygmy blue whale (north migration)[2]												
Pygmy blue whale (south migration)[2]												
Southern right whale migration[2]												
Australian sea lion												
New Zealand fur seal												
White shark foraging BIA[3]												
Scalloped hammerhead migration[4]												
Little penguin foraging[5]												
Wedge-tailed shearwater foraging[5]												
Caspian tern foraging[5]												
Pacific gull foraging[5]												
Bridled tern foraging[5]												
Roseate tern foraging[5]												
Fairy tern foraging[5]												
Green turtle												
Leatherback turtle												
Loggerhead turtle												

1 (Source: DoEE 2019), 2 (Source: McCauley & Jenner 2010; McCauley & Duncan 2011; Double et al. 2012; Double et al. 2014). 3 (DoE, 2019), 4 (Source: Lopez et al 2022), 5 (Source: DAWE 2021b, Higgins 2003, DoEE 2019).

Peak period | Mammals | Fish | Birds | Reptiles

10.5.1.1.1 Potential pressures to key marine fauna species

Although a number of conservation significant marine fauna species may occur in or proximate to South Thomson Bay, some of these species may either only occur within or within vicinity of the development envelope occasionally due to the lack of critical habitat for these species. While other species are unlikely to be susceptible to impacts or pressures from construction of the proposal.

Analysis of the potential pressures on selected protected species in the South-west Marine Region is provided in the Marine bioregional plan for the South-west Marine Region (DSEWPC, 2013). Of these species, those that potentially occur within vicinity of the development envelope are discussed in Table 50.

Table 50: Summary of pressures on selected protected species in the South-west Marine Region (DSEWPC, 2013)

Species group	Species addressed in Marine bioregional plan for the South-west Marine Region (DSEWPC, 2013)	Pressure relevant to the proposal										
		Physical habitat modification	Change in oceanography	Chemical pollution/ contaminants	Changes in turbidity	Noise pollution	Light pollution	Oil pollution	Entanglement with infrastructure	Changes in turbidity	Invasive species	Vessel collision
	Pressure of less or no concern											
	Pressure of potential concern											
	Pressure of concern											
Cetaceans	Humpback whale											
	Pygmy blue whale											
	Southern right whale											
Marine reptiles	Green turtle											
	Leatherback turtle											
	Loggerhead turtle											
Pinnipeds	Australian sea lion											
	New Zealand fur seal											
Seabirds	Fairy tern, Caspian tern and crested tern*											
	Wedgetailed shearwater											
	Little penguin											
Sharks	Grey nurse											
	White shark											

*It is considered likely, that although not included in the risk assessment, the Roseate tern is susceptible to similar pressures

DSEWPC 2013

10.5.1.2 Temporary / permanent loss or degradation of habitat

Loss of marine habitat, primarily the loss of seagrass species, associated with construction of the proposal has the potential to result in indirect impacts to marine fauna species through loss of foraging opportunities and changes to marine environmental quality. Loss of marine habitat may also impact recreational fisheries in the bay through the loss of potential feeding, spawning and predator avoidance habitat.

The total predicted loss of potential marine fauna habitat from implementation of the proposal is summarised below:

- Direct (permanent) impacts to 2.06 ha of mixed seagrass and 1.26 ha of sand / sand with wrack within the development envelope and ZoHI
- Indirect (recoverable) impacts to:

- 2.62 ha of mixed seagrass and 1.09 ha of sand / sand with wrack within the ZoMI. It is predicted that benthic communities and habitats that are impacted within the ZoMI will recover within a five-year period
- 5.13 ha of mixed seagrass, 1.13 ha macroalgae dominated community, 0.35 ha of limestone reef / pavement and 6.70 ha of sand / sand with wrack within the ZoI. Changes in environmental quality associated with dredge plumes in the ZoI are not predicted to result in a detectible impact on benthic biota.

The permanent loss of 2.06 ha of mixed seagrass accounts for 0.52% of mixed seagrass within the LAU. Therefore, the overall change of marine fauna habitat resulting from the proposal is low in a regional context and the potential impacts to marine fauna species which use these benthic environments for habitat is also predicted to be low.

The ZoMI is the area within which predicted impacts on benthic organisms are recoverable within a period of five years following completion of the dredging activities. The mixed seagrass habitat within the ZoMI comprises 2.62 ha, which accounts for 0.65% of the LAU. Given the limited extent of the ZoMI in comparison to the LAU, the temporary changes to marine environmental quality within the ZoMI are unlikely to significantly reduce the abundance of marine fauna species regionally in the LAU.

The ZoI is associated with temporary changes in environmental quality from dredge plumes. Although marine fauna habitats within the modelled extent of the ZoI will be exposed to effects of dredging and construction, these will be minor and no observable impacts are predicted.

10.5.1.3 Temporary increase in turbidity

In addition to the temporary and recoverable impacts to benthic communities and habitats discussed in Section 10.5.1.1, a temporary increase in TSS within the ZoMI and ZoI has the potential to result in behavioural changes to marine fauna. These behavioural changes may include avoidance behaviours and changes in foraging behaviour. As outlined in Section 10.5.1.1.1, this is considered a pressure of less or no concern for the key marine fauna species considered. As such, this is considered unlikely to comprise a significant impact.

10.5.1.4 Risk of injury or death from rock dumping during breakwater construction

Rock dumping during the breakwater construction has the potential to result in the following impacts (EPA, 2016j):

- Rock dumping may impact marine fauna through increases in turbidity and the mobilisation of contaminants located within the sediment. These impacts are discussed further in Section 9 of this report and are not considered likely to have a significant impact on marine fauna.
- Underwater noise generated from rock dumping may negatively impact marine fauna either through physical injury or avoidance behaviours. Underwater noise generated from rock dumping is anticipated to be less than that generated by piling and dredging activities. Potential underwater noise impacts on marine fauna are discussed further in Section 10.5.1.5.

Further impacts to marine fauna from construction of the breakwater includes the potential for injury or death from rock dumping.

10.5.1.5 Elevated underwater noise

Some marine fauna species use sound for foraging, orientation, communication, navigation, echo-location of prey and predator avoidance (Richardson, 1995) and therefore may be affected by high levels of underwater noise. High levels of anthropogenic underwater sound can have negative impacts, ranging from changes in acoustic communication, displacement from an area, and in more severe cases temporary hearing loss, physical injury or mortality (Richardson, 1995).

As outlined in Section 10.5.1.1.1, the Australian sea lion, whales (humpback whale, pygmy blue whale, southern right whale) and sea turtles (green turtle, leatherback turtle, loggerhead turtle) may be susceptible to underwater noise impacts. Other species that may occur within vicinity of the development envelope and which may be impacted by underwater noise but are not listed as conservation significant species includes dolphins and fish.

10.5.1.5.1 Underwater noise sources from the proposal

The greatest source of noise from the proposal will be associated with piling during construction. Pile driving will be required as part of the construction of the proposal. Other construction activities proposed are expected to emit similar levels of underwater noise (e.g. dredging) or less (e.g. vessel movements and rock dumping) to that modelled for the piling activities. As such, the underwater noise assessment included assessment of the activities most likely to impact marine fauna.

It is estimated that approximately 20 piles will be driven into the seabed on the leeward side of the rock groyne. The piles will be driven using a vibro hammer with a ram weight of 2.06 tonnes and a maximum vibration frequency of 3,000/minute. The steel tubular piles are likely to be approximately 500 mm to 600 mm in diameter and the rate of installation is estimated to be one to two piles per day. The estimated duration of pile driving is approximately 15 days.

Piling is proposed to be undertaken using a vibro hammer rather than impact piling methods to minimise potential impacts to marine fauna. Piling noise varies depending on the piling method and size of the pile being installed. A summary of the vibro hammer and impact hammer methods is provided below:

- Impact hammer – impulsive in character with multiple pulses occurring at blow rates in the order of 30 to 60 impacts per minute. Typical source levels range from sound exposure level (SEL) 170–225 dB re 1 µPa2s for a single pulse, and peak level 190–245 dB re 1 µPa. Most of the sound energy usually occurs at lower frequencies between 100 Hz and 1 kHz. Factors that influence the source level include the size, shape, length and material of the pile, the weight and drop height of the hammer, and the seabed material and depth
- Vibro-hammer – continuous in character and usually of a much lower level than impact piling. Typical source levels range from sound pressure level (SPL) 160–200 dB re 1 µPa, with most of the sound energy occurring between 100 Hz and 2 kHz. Strong tones at the driving frequency and associated harmonics may occur with the driving frequency typically ranging between 10 and 60 Hz. Sound propagation at such low frequencies is often poor in shallow water environments, such that the tones may not be noticeable at greater distances from the source (Government of South Australia, 2012).

Although vibro-piling is proposed, there is contingency for conventional impact hammer pile driving of some piles if they reach the point of refusal before the target depth is achieved. The probability of needing conventional pile driving is very low given that the recent pile driving work conducted on Rottnest Island jetty (approximately 800 m north-west of this project) was successfully completed to similar target depths only using a vibro hammer pile driver.

Both the proposed vibro-piling (scenario 2) and contingency hammer piling (scenario 1) were modelled in the underwater acoustic assessment ((Tetra Tech, 2024) (Appendix S) in case the contingency of hammer piling is required during construction of the proposal. The results from modelling these scenarios are discussed in Section 10.5.1.2.4.

As outlined in Section 10.5.1.1.1, the Australian sea lion, whales (humpback whale, pygmy blue whale, southern right whale) and sea turtles (green turtle, leatherback turtle, loggerhead turtle) may be susceptible to underwater noise impacts. Other species that may occur within vicinity of the development envelope and which may be impacted by underwater noise but are not listed as conservation significant species includes dolphins and fish.

10.5.1.5.2 Assessment criteria

The assessment criteria used in this assessment includes:

- The National Oceanic and Atmospheric Administration's (NOAA's) 'Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing' (NOAA, 2018)
- Criteria and Thresholds for U.S. Navy Acoustics and Explosive Effect Analysis (Jenkins, 2017).

The assessment criteria for each fauna type are divided into noise levels that may result in Temporary Threshold Shift (TTS), Permanent Threshold Shift (PTS) and behavioural shifts. The noise levels at which TTS and PTS occur is dependent on whether the noise being generated is impulsive or non-impulsive. The definitions of these two categories are:

- Impulsive – sounds produced are typically transient, brief (less than one second), broadband and consist of high peak pressure with rapid rise time and rapid decay. This noise source is associated with activities such as pile driving, seismic activities and underwater blasting and results in some of the most powerful sounds produced underwater.
- Non-impulsive – sounds produced can be broadband, narrowband or tonal, brief or prolonged, continuous or intermittent and typically do not have the high peak sound pressure with rapid rise / decay times that impulsive sounds do. This noise is associated with activities such as dredging, vessel operations, drilling and some construction activities.

The assessment criteria used for the marine fauna likely to occur within vicinity of the proposal in the underwater noise assessment are summarised in Table 51 and Table 52.

Table 51: Thresholds for non-impulsive and impulsive noise – marine mammals

Marine fauna type	Hearing group	Hearing bandwidth	Impulsive sounds			Non-impulsive sounds		
			PTS onset	TTS onset	Behaviour	PTS onset	TTS onset	Behaviour
Whales	Low frequency (LF) cetaceans. This group consists of the baleen whales (masticates).	7 Hz to 35 kHz	219 dB ($L_{p,pk}$) 183 ($L_{E, LF, 24h}$)	213 dB ($L_{p,pk}$) 168 dB ($L_{E, LF, 24h}$)	160 dB (L_p)	199 dB ($L_{E, LF, 24h}$)	179 dB ($L_{E, LF, 24h}$)	120 dB (L_p)
Dolphins and toothed whales	Mid frequency cetaceans (MF) Includes most of the dolphins, all toothed whales except for Kogia spp. and all the beaked and bottlenose whales.	150 Hz to 160 kHz.	230 dB ($L_{p,pk}$) 185 dB ($L_{E, MF, 24h}$)	224 dB ($L_{p,pk}$) 170 dB ($L_{E, MF, 24h}$)		198 dB ($L_{E, MF, 24h}$)	178 dB ($L_{E, MF, 24h}$)	
Sea lions	Otariids Underwater Includes sea lions and fur seals.	60 Hz to 39 kHz	232 dB ($L_{p,pk}$) 203 dB ($L_{E, OW, 24h}$)	226 dB ($L_{p,pk}$) 188 dB ($L_{E, OW, 24h}$)		219 dB ($L_{E, OW, 24h}$)	199 dB ($L_{E, OW, 24h}$)	

LE, 24h = cumulative sound exposure over a 24-hour period (dB re 1 μPa2·s).

Lp,pk = peak sound pressure (dB re 1 μPa).

Lp = root mean square sound pressure (dB re 1 μPa)

(Tetra Tech, 2024)

Table 52: Thresholds for non-impulsive and impulsive noise – fish and sea turtles

Marine fauna type	Impulsive sounds		Non-impulsive sounds		
	Injury	TTS onset	Injury	TTS onset	Behaviour
Fishes	206 dB ($L_{p,pk}$) 187 dB ($L_{E, 24h}$)	-	-	-	150 dB (L_p)
Sea turtles	232 dB ($L_{p,pk}$) 204 dB (LE, TUW, 24h)	226 dB ($L_{p,pk}$) 189 dB (LE, TUW, 24h)	220 dB (LE, TUW, 24h)	200 dB (LE, TUW, 24h)	175 dB (Lp)
	Impulsive sounds			Non-impulsive sounds	
	Mortality and potential mortal injury	Recoverable injury	TTS	Recoverable injury	TTS
Fishes without swim bladders	> 213 dB ($L_{p,pk}$) > 219 dB ($L_{E, 24h}$)	> 213 dB ($L_{p,pk}$) > 216 dB ($L_{E, 24h}$)	> 186 dB ($L_{E, 24h}$)	–	–
Fishes with swim bladder not involved in hearing	207 dB ($L_{p,pk}$) 210 dB ($L_{E, 24h}$)	207 dB ($L_{p,pk}$) 203 dB ($L_{E, 24h}$)	>186 dB ($L_{E, 24h}$)	–	–
Fishes with swim bladder involved in hearing	207 dB ($L_{p,pk}$) 207 dB ($L_{E, 24h}$)	207 dB ($L_{p,pk}$) 203 dB ($L_{E, 24h}$)	186 dB ($L_{E, 24h}$)	170 dB (L_p)	158 dB (L_p)
Eggs and larvae	207 dB ($L_{p,pk}$) 210 dB ($L_{E, 24h}$)	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	–	–

LE, 24h = cumulative sound exposure over a 24-hour period (dB re 1 μPa2·s).

Lp,pk = peak sound pressure (dB re 1 μPa).

Lp = root mean square sound pressure (dB re 1 μPa)

PTS = permanent threshold shift.

N = near (10s of meters).

I = intermediate (100s of metres).

F = far (1000s of metres).

– = not applicable

(Tetra Tech, 2024)

10.5.1.5.3 Underwater noise assessment

The underwater acoustic assessment was undertaken for two separate scenarios:

- **Proposed piling method**: Vibratory hammer installation for a 24-inch pile diameter
  - Vibratory piling reduces the potential underwater noise impacts to marine fauna species during the installation of piles when compared to using impact hammers. The type and classification of the sound that is generated with vibratory versus impact pile driving is different. The sound generated from vibratory pile driving is a more non-impulsive, continuous sound as opposed to the impulsive and sharp sounds produced from impact pile driving. A vibratory hammer will be used for the installation of new piles
- **Contingency piling method**: Impact pile driving installation for a 24-inch pile diameter
  - Impact pile-driving involves weighted hammers that pile drive foundations into the sea floor
  - The acoustic energy is created upon impact, where the energy travels into the water along different paths. Near the pile, acoustic energy arrives from different paths with different associated stage and time lags, which creates a pattern of destructive and constructive interference. Further away from the pile, the water- and sea floor-borne energy are the dominant pathways
    - From the top of the pile where the hammer hits, through the air, into the water
    - From the top of the pile, down the pile, radiating into the air while traveling down the pile, from air into water
    - From the top of the pile, down the pile, radiating directly into the water from the length of pile below the waterline
    - Down the pile radiating into the ground, traveling through the ground and radiating back into the water.

It is likely that the piling will be undertaken after construction of the proposed breakwater. As such, the underwater noise assessment provides a worst-case scenario, as it is likely that the underwater noise will be somewhat dampened by the infrastructure.

The outcomes from the underwater acoustic assessment are summarised in Table 53. Figure 29 and Figure 30 show the unweighted and unmitigated underwater received sound pressure levels for each scenario. Underwater sound pressure level ranges are displayed in 5 dB increments and sound propagation characteristics are shown, as applicable.

Table 53: Injury and Behavioural Onset Criteria Threshold Distances (meters) for Vibratory Hammer Pile Installation (proposed method) and Impact Pile-Driving (contingency method)

Hearing group	Metric	PTS		TTS		
		Threshold (dB)	Distance (m)	Threshold (dB)	Distance (m)	
Proposed piling method **Vibratory hammer installation for a 24-inch pile diameter**						
Low-frequency cetaceans	$L_{E,24hr}$ [1,2]	199	The threshold level is greater than the source level; therefore, distances are not generated.	179	19	For the PTS thresholds, the smallest distances to thresholds were observed for the SEL acoustic thresholds while the largest distances were observed for the 120 dB SPL Marine Mammal criteria. The largest distance was modelled to be 167 m corresponding to the 120 dB SPL criterion. For the TTS thresholds, the largest distances were observed for the 179 dB SPL low frequency cetacean criteria. The largest distance was modelled to be 179 m.
Mid-frequency cetaceans	$L_{E,24hr}$ [1,2]	198		178	The threshold level is greater than the source level; therefore, distances are not generated.	
Otariid pinnipeds underwater	$L_{E,24hr}$ [1,2]	219		199		
Marine mammal behaviour	L_p [1,3]	120	167	-	-	
Sea turtle temporary threshold shift	$L_{E,24hr}$ [1/,2/]	200	The threshold level is greater than the source level; therefore, distances are not generated.	-	-	There were not associated distances because the thresholds are greater than the source level.
Sea turtle permanent threshold shift	$L_{E,24hr}$ [1/,2/]	220		-	-	
Sea turtle behavioural	L_p [2/]	175		-	-	
Small fish	$L_{E,24hr}$ [3,4]	183	16	-	-	All distance to threshold values were low (i.e. less than 50 metres). The largest distance of 21 metres occurred for unmitigated distance to the 183 dB SEL acoustic threshold for the vibratory installation.
	L_p [5]	150	6	-	-	
Large fish	$L_{E,24hr}$ [3,4]	187	21	-	-	
	L_p [5]	150	6	-	-	
Contingency piling method **Impact pile driving installation for a 24-inch pile diameter. Impact Hammer Energy: 70 kJ**						
Low-frequency cetaceans	$L_{E,24hr}$ [1,3]	183	73	168	404	For the PTS criteria, the smallest distances to thresholds were observed for the peak sound pressure (Lpk) acoustic thresholds while the largest distances were observed for the 160 dB SPL for the marine mammal behavioural criteria. The largest distance was modelled to be 84 metres corresponding to the 160 dB SPL marine mammal behavioural criterion without mitigation for the impact installation of the 24-inch pile diameter. For the TTS criteria, the smallest distances to thresholds were observed for the Lpk acoustic thresholds. The largest distance was modelled to be 404 metres corresponding to the 168 dB threshold.
	$L_{p,pk}$ [1,3]	219	The threshold level is greater than the source level; therefore, distances are not generated.	213	The threshold level is greater than the source level; therefore, distances are not generated.	
Mid-frequency cetaceans	$L_{E,24hr}$ [1/,3/]	185		170	36	
	$L_{p,pk}$ [1/,3/]	230		224	The threshold level is greater than the source level; therefore, distances are not generated.	
Otariid pinnipeds underwater	$L_{E,24hr}$ [1/,3/]	203		188	25	
	$L_{p,pk}$ [1/,3/]	232		226	The threshold level is greater than the source level; therefore, distances are not generated.	
Marine mammal behaviour	L_p [2,4]	160	84	-	-	
Sea turtle temporary threshold shift	$L_{E,24hr}$ [1/,2/]	189	30	-	-	All distance to threshold values were low (i.e. less than 50 metres). The largest distance was modelled to be 37 metres.
	$L_{p,pk}$ [1/,2/]	226	The threshold level is greater than the source level; therefore, distances are not generated.	-	-	
Sea turtle permanent threshold shift	$L_{E,24hr}$ [1/,2/]	204	3	-	-	
	$L_{p,pk}$ [1/,2/]	232	The threshold level is greater than the source level; therefore, distances are not generated.	-	-	
Sea turtle behavioural	L_p [2/]	175	37	-	-	
Fish: no swim bladder	$L_{E,24hr}$ [1,2]	219	The threshold level is greater than the source level; therefore, distances are not generated.	-	-	All distance to threshold values were low (i.e. less than 100 metres) except for the distance to the 150 dB SPL behavioural threshold criteria. The largest distance was modelled to be 348 metres.
	$L_{p,pk}$ [1,2]	213		-	-	
Fish: swim bladder is not involved in hearing	$L_{E,24hr}$ [1,2]	210		-	-	
	$L_{p,pk}$ [1,2]	207		-	-	
Fish: swim bladder involved in hearing	$L_{E,24hr}$ [1,2]	207	4	-	-	
	$L_{p,pk}$ [1,2]	207	The threshold level is greater than the source level; therefore, distances are not generated.	-	-	
Eggs and larvae	$L_{E,24hr}$ [1,2]	210		-	-	
	$L_{p,pk}$ [1,2]	207		-	-	
Small fish	$L_{E,24hr}$ [3,4]	183	76	-	-	
	$L_{p,pk}$ [3,4]	206	2	-	-	
	L_p [5]	150	348	-	-	
Large fish	$L_{E,24hr}$ [3,4]	187	52	-	-	
	$L_{p,pk}$ [3,4]	206	2	-	-	
	L_p [5]	150	348	-	-	

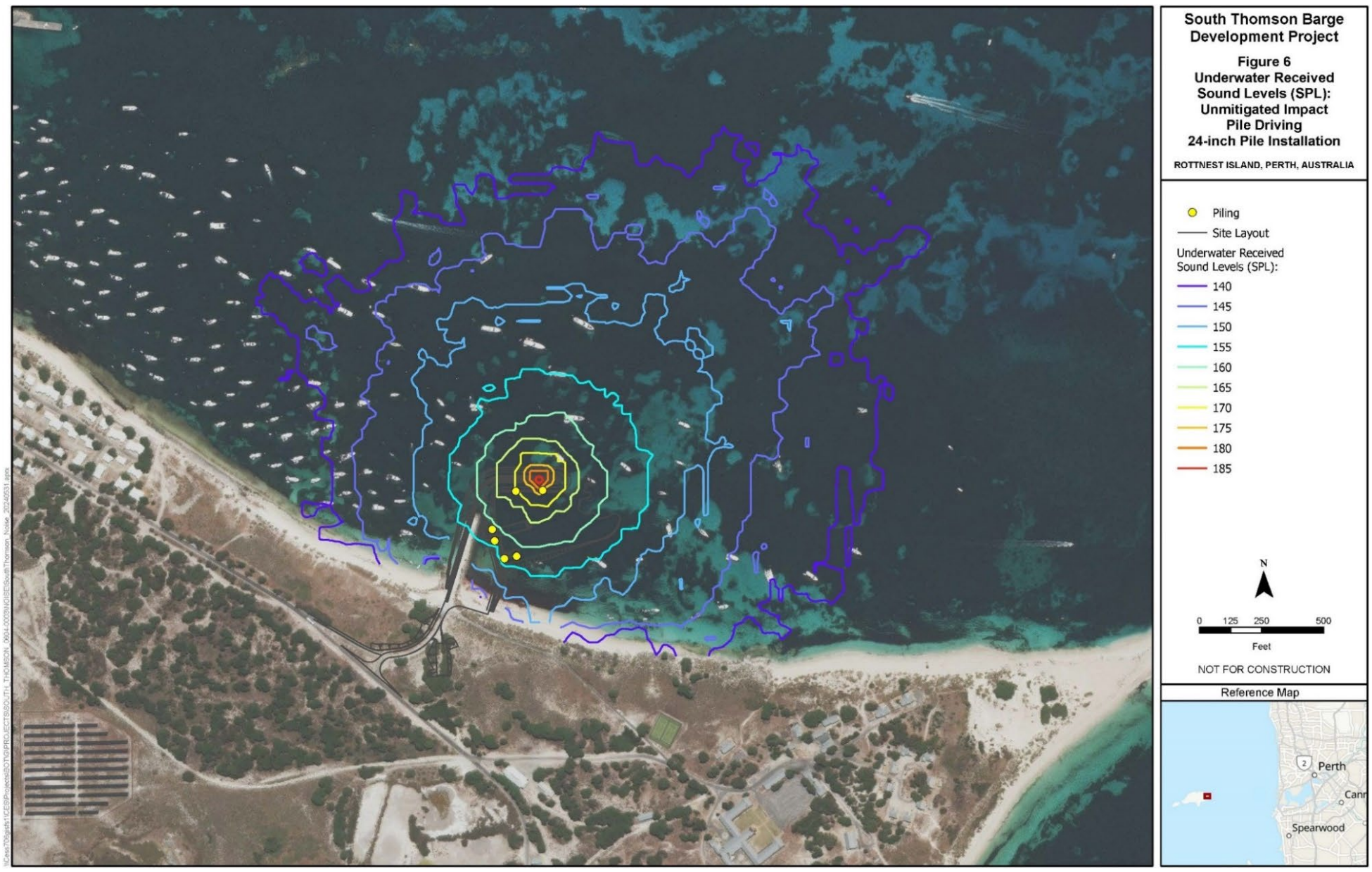


Figure 35: Underwater Received Sound Levels (SPL): Unmitigated impact pile driving 24-inch pile installation (contingency piling method)

Figure 36: Underwater Received Sound Levels (SPL): Unmitigated vibratory 24-inch pile installation (proposed piling method)

10.5.1.6 Increased vessel collision risk

An increased risk of collision could result from an increase in the number of vessels using the South Thomson Bay Barge Landing during operation and to a lesser degree during construction of the proposal. As outlined in Section 10.5.1.1.1, marine fauna species that may be susceptible to vessel strike includes turtle and whale species. As discussed previously, marine turtle species are considered likely to only occasionally occur within or proximate to the development envelope and the risk of whale species occurring in these shallow waters is low. As such, the risk of vessel strike impacting these species within the development envelope is low. There is however a risk of strikes between whales and vessels during vessel movements between the mainland and island.

The operation of the proposal will result in an increase in vessel activity within and within vicinity of the development envelope. Vessel collisions with marine fauna have the potential to result in injury or death to the affected animal. Vessels travelling at 14 knots or faster are those most likely to cause death or serious injury to marine mammals (Wilson, 2007). In addition, there is the potential for the increase in vessel activity to disturb marine fauna, potentially interrupting key activities (e.g. foraging) or displacing animals from preferred habitat.

The risk of vessel strike during construction activities is low as the construction vessels will operate slowly and within the development envelope only. The CEMP will outline speed limits and other management measures to ensure the risk of vessel strike during construction is minimised.

Barge movements already occur between the mainland and Main Jetty in Thomson Bay. Therefore, the proposal will not result in any increased risk of vessel strike. The OEMP outlines measures to further reduce this risk (Appendix Q).

10.5.1.7 Increased risk of entanglement or entrainment

Activities involved in the construction and operation of the proposal have the potential to cause both entanglement and entrainment to marine fauna. Entanglement may lead to injury, death, displacement, adverse behavioural and physiological changes. As outlined in Section 10.5.1.1.1, marine fauna species that may be susceptible to injury from entanglement includes the Australian sea lion and southern right whale. Sea turtles are likely to be susceptible to entrainment, however as discussed previously, marine turtles are unlikely to frequent the area.

Building materials and general litter associated with the construction and operational phases of the proposal have the potential to cause entanglement. Several factors including the visibility, dimensions, how important the location is for feeding or breeding and the extent of close-range evasion all interact to determine the likelihood of entanglement.

Entrainment, the direct uptake of aquatic organisms by suction, during activities such as dredging has the potential to cause mortality to marine fauna species (Dabble, 2012).

10.5.1.8 Increased risk of introduced marine species

There is a risk of introduced marine species (IMS) during construction and operation of the proposal from vessel ballast water and hull fouling. IMS may threaten biodiversity through a number of mechanisms such as predation, competition for habitat and altering ecosystems.

Implementation of the proposal would not result in a major change in the activities that already exist on Wadjemup / Rottnest Island as the proposal involves moving the barging facilities to the proposed location from the existing jetty, rather than introducing a new activity to the island. The CEMP and OEMP outlines management measures to ensure that the risk of IMS is minimised and as such there would not be any increase in the existing level of IMS occurring proximate to the proposal.

10.5.1.9 Increased light emissions

Increased light emissions during operation of the proposal could lead to disturbance to marine fauna in the vicinity, especially shorebirds and seabirds. Fairy terns roost at Phillip Point, approximately 800 m to the east of the proposal. Lighting has not been shown to impact fairy terns, however night-time lighting near fairy tern habitat can increase feeding opportunities for silver gulls, resulting in competition for food sources (DEWHA, 2011).

The potential for artificial light emissions to impact shorebirds and seabirds during construction is considered to be low, as construction works will be undertaken during nominated daylight hours, with likely lighting requirements limited to security / safety installations.

The OEMP will ensure light emission impacts on shorebirds and seabirds is minimised and in accordance with the National Light Pollution Guidelines for Wildlife (DCEEW, 2023).

10.5.1.10 Increased risk of pollution incidents

Increased boat numbers during operation, and to lesser degree construction, of the proposal has the potential to increase the risk of pollution, including from antifouling paints, anti-corrosion anodes, increased risk of accidental discharges (e.g. fuel spills, oils and greases) and sullage.

An increase in vessels using South Thomson Bay is expected during the operational phase, and quantities and types of material that might enter the marine environment are limited to spills relating to these vessels. The magnitude of this impact is entirely dependent upon the quantities and nature of the spillage, the dilution and dispersal properties of the waters and the bioavailability of the contaminant to species. The more toxic components of fuel spills are volatile and relatively short-lived. Heavier hydrocarbons, while less toxic, may persist for longer in the marine environment.

Whilst marine fauna such as seabirds, marine mammals and elasmobranchs are likely to be able to detect and avoid pollutants, sessile species of shellfish are potentially more vulnerable. Likely effects of release of contaminants into the marine environment may result in direct impacts through ingestion, inhalation and absorption through the skin, and abandonment of polluted feeding habitat and potentially longer-term impacts from bioaccumulation in the food chain.

10.6 Mitigation

Table 54 demonstrates how the EPA’s mitigation hierarchy (avoid, minimise and rehabilitate) has been applied to the environmental factor of marine fauna to address the key potential impacts.

Table 54: Application of mitigation hierarchy to marine fauna

Potential environmental impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impacts
Temporary / permanent loss or degradation of benthic habitat	Direct and Indirect	Avoid	• Avoiding construction activities during known critical spatial and temporal windows of marine environmental sensitivity will avoid significant impacts to marine fauna species. These critical windows are outlined in Table 49. However, it is not anticipated that impacts to marine species can be fully avoided during construction activities. • Site selection includes an already disturbed area of 0.19 ha of seabed within the existing Army Groyne footprint. As benthic communities and habitats are widespread within South Thomson Bay, total avoidance of direct impacts is not possible. • RIA amended the project design to reduce the dredging requirements. By changing the berthing and barge turn pocket, the volume of required dredging was reduced from 26,000 m^3 to 16,050 m^3	**Permanent impacts to 2.06 ha mixed seagrass and 1.26 ha sand with wrack within the ZoI, ZoMI and ZoHI from an increase in suspended sediments** **The temporary loss of 2.62 ha of mixed seagrass and 1.09 ha of sand / sand with wrack within the ZoMI** Baird (2024b) predicts that temporary impacts to benthic communities and habitats will be recoverable within a period of five years following completion of the dredging activities. • Implementation of the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O) provides the monitoring and management framework to address a temporary increase in TSS / turbidity during construction. • Implementation of these management plans ensures that impacts to marine environmental quality outside the ZoMI and ZoHI from a temporary increase in suspended sediments are unlikely. • Significant residual impacts to marine fauna from temporary/ permanent loss of potential fauna habitat and from reduced marine environmental quality are considered unlikely.
		Minimise	• Management and mitigation proposed during construction to minimise impacts to marine fauna habitat such as benthic communities and habitats is detailed in the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O). Implementation of these management plans will ensure that: – The area of benthic habitat affected by suspended sediments during dredging and construction will be limited (wherever possible) and will not extend past the modelled ZoHI, ZoMI and ZoI. – Marine environmental quality will be maintained at a moderate level of ecological protection during dredging and return to a High Level of Ecological Protection within two weeks following completion of dredging. • Implementation of the CEMP and DEMMP provides the monitoring and management framework to address potential impacts to marine environmental quality during construction. Key management and monitoring measures include: – Implementation of the Marine Water Quality Monitoring Program (MWQMP) provided in the DEMMP for suspended sediment. • The OEMP provides the monitoring and management framework to potential environmental impacts to marine fauna from the implementation of the proposal over the long-term operational life span of the marine structures. • Maintenance dredging (if required) will be undertaken in previously disturbed / sandy areas within the development envelope / project footprint. Maintenance dredging frequency, volumes and disposal will be determined as required. Environmental management and monitoring will be undertaken in a manner that is consistent with the document Maintenance Dredging Environmental Management Framework (BMT Oceanica, 2016) prepared for Department of Transport for similar types of maintenance dredging activities.	
		Rehabilitate	There is no opportunity to rehabilitate the impacted area due to operation and maintenance of the proposal. Construction effects (outside the development envelope and ZoHI) to marine fauna habitat (benthic communities and habitats) will be temporary and natural amelioration will mitigate or remove long-term impacts following cessation of construction activities.	
		Offset	Marine fauna offsets are not considered applicable to the proposal.	
Elevated underwater noise	Direct	Avoid	• Avoiding construction activities, such as dredging and piling, which generate underwater noise during known critical spatial and temporal windows of marine environmental sensitivity. Key windows of sensitivity, such as periods of whale migration, are discussed in Table 49. • Using vibro hammer piling methods (rather than hammer piling) will eliminate sources of impulsive noise.	**Underwater noise emissions from activities such as piling and dredging causing temporary disturbance to marine fauna species** • Potential for elevated underwater noise to impact marine fauna is limited to construction works. • Implementation of the CEMP provides the monitoring and management framework to address elevated underwater noise during piling. Significant residual impacts to marine fauna from elevated underwater noise are considered unlikely.

		Minimise	• Implementation of the CEMP (Emerge, 2024a) (Appendix P) provides the monitoring and management framework to address elevated underwater noise generated from construction activities, such as dredging and piling. Implementation of this management plan will ensure that:
			– There is no injury or death of marine fauna associated with underwater noise generated during construction of the proposal.
			– There is no injury or death of marine fauna from underwater noise.
			• Key management and monitoring measures included in the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O). are:
			– Trained marine fauna observers (MFOs) will minimise the risk of injury to marine fauna during piling.
			– A reduction in underwater noise impacts to marine fauna will be achieved through the use of vibration piling rather than hammer piling during construction. The reduction in underwater noise levels can be seen in the comparison of the underwater noise modelling shown in Figure 29 and Figure 30.
			– Hammer piling will only be used as a contingency if there is a refusal during vibro-piling. Exclusion zones for this contingency are included in the CEMP.
			– Pre-start, soft-start, shut-down and low-visibility procedures will be implemented as outlined in the CEMP. These are summarised below and detailed in Appendix A of the CEMP:
			  • Prior to piling works each day and for each pile the dedicated MFOs will commence continuous visual observation within the observation and exclusion zones for 30-minutes.
			  • Soft-start procedures involve the commencement of piling at low vibro-hammer energy, gradually increasing to full energy over a 30-minute period. Where target marine fauna are not observed in the observation and exclusion zones during the soft-start procedures, then normal piling can commence.
			  • Where marine fauna is observed by the MFO within the observation zone (but outside the exclusion zone) during piling activities (including soft-start procedures), then the shutdown procedures outlined in the CEMP will be implemented.
			  • During periods of low visibility (i.e. where a distance of 500 m cannot be clearly viewed), then piling operations may commence with soft-start procedures, unless one of the triggers provided in the CEMP occurs.
			– Implementation of observation and exclusion zones. These zones have been based on the underwater received sound levels and distances from the underwater noise assessment (Appendix S) and are provided in the CEMP. The management zones are depicted in Appendix A (Marine Fauna Provisions) of the CEMP.
			– Piling will only be undertaken during daylight hours to ensure visibility of the observation and exclusion zones for the MFO.
			– Trained MFOs will be on duty (as outlined in Appendix A of the CEMP) on vessels during construction.	

Potential environmental impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impacts
		Rehabilitate	There is no opportunity to rehabilitate underwater noise impacts	
		Offset	Marine fauna offsets are not considered applicable to the proposal.	
Increased vessel collision risk	Direct	Avoid	Marine vessels will be used during the construction and operation of the proposal. As such, there is no opportunity to completely avoid the risk of vessel collision.	**No residual impacts expected** • Implementation of the CEMP provides the monitoring and management framework to minimise the risk of increased vessel collision risk during construction. • Implementation of the OEMP provides the monitoring and management framework to address increased vessel collision risk during operation. • There is a low residual risk to marine fauna from vessel collision during construction and operation.
		Minimise	• Implementation of the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O) provides the monitoring and management framework to address increased vessel collision risk during construction. Implementation of this management plan will ensure that there is no death or injury to marine fauna from vessel strike. Management measures that will be implemented include: – Implementation of vessel speed limits. – All vessels are to adhere to standards set in the National Whale Watching Guidelines. – A MFO on all construction vessels when in transit. – Implementation of vessel approach distances to marine fauna. – Implementation of the marine fauna monitoring and management program provided in Appendix B.3 of the DEMMP. • Implementation of the OEMP (Emerge, 2024b) (Appendix Q) provides the monitoring and management framework to address increased vessel collision risk during operation. Implementation of this management plan will ensure that marine users to comply with vessel operational restrictions required by DoT and RIA.	
		Rehabilitate	There is no opportunity to rehabilitate increased vessel collision risks. Sick and/or injured fauna shall be managed by appropriately qualified personnel and any injury or death of marine fauna will be reported to DBCA.	
		Offset	Marine fauna offsets are not considered applicable to the proposal.	
Increased risk of entanglement and entrainment	Direct	Avoid	Dredging will be undertaken during construction and may also be required during operation. There is no opportunity to completely avoid increased risk of entrainment. Dredging will be undertaken during construction and may also be required during operation. Silt curtain sill be used during dredging to manage sediment plumes. There is the potential for entanglement of marine fauna in silt curtains and as such, there is no opportunity to completely avoid increased risk of entanglement.	**No residual impacts expected** • Potential for increased risk of entrainment to impact marine fauna limited to construction and maintenance dredging during operation. • Potential for increased risk of entanglement to impact marine fauna during construction and operations will be minimised through implementation of the CEMP, DEMMP and OEMP. • With implementation of the CEMP and OEMP, residual impacts to marine fauna from increased risk of entanglement and entrainment are not anticipated.
		Minimise	• Implementation of the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O) provides the monitoring and management framework to address increased risk of entanglement and entrainment during construction. Management measures to minimise the risk of injury to fauna during construction includes: – Dedicated MFOs during dredging will implement management measures to minimise the risk of injury to fauna. Where marine fauna are observed within an Exclusion Zone, dredging will cease immediately. – Prior to commencing dredging or excavating, dedicated MFOs will check for marine fauna within the exclusion and observation zones outlined in the CEMP. – Dredging activities will be undertaken during daylight hours only to improve visibility. – Measures to minimise the risk for entanglement of marine fauna with waste during construction. – Measures to minimise the risk for entanglement of marine fauna with construction equipment. • Implementation of the OEMP (Emerge, 2024b) (Appendix Q) provides the monitoring and management framework to address increased risk of entanglement during operation. During operation of the proposal, the risk of entanglement will be minimised through: – Installation of information-boards to encourage appropriate disposal of litter and the inform of the dangers of entanglement. – Waste disposal measures and prevent rubbish and litter.	
		Rehabilitate	There is no opportunity to rehabilitate increased risk of entanglement and entrainment. Sick and/or injured fauna shall be managed by appropriately qualified personnel and any injury or death of marine fauna will be reported to DBCA.	
		Offset	Marine fauna offsets are not considered applicable to the proposal	
Risk of injury or death from rock dumping during breakwater construction.	Direct	Avoid	The risk for injury or mortality during rock dumping activities cannot be completely avoided.	**No residual impacts expected** • Potential for injury or mortality of marine fauna from rock dumping is limited to the construction phase. • With implementation of the CEMP, residual impacts to marine fauna from rock dumping are not anticipated.
		Minimise	• The CEMP (Emerge, 2024a) (Appendix P) outlines the management and monitoring measures to mitigate the potential impacts of rock dumping and excavation on conservation significant marine fauna. These measures include: – Dedicated MFOs during rock dumping activities will implement management measures to minimise the risk of injury to fauna as outlined in Appendix A (Marine Fauna Provisions) of the CEMP, including: ○ Prior to rock dumping and excavation works, the dedicated MFOs will commence continuous visual observation within the specified Management Zones for 30 minutes. If target marine fauna is observed within the management zone during this time, rock dumping and excavation shall be delayed until the marine fauna has been observed exiting the Observation Zone or have not been seen for 30 minutes. ○ Once rock dumping has commenced, if the dedicated MFOs observe a target marine fauna species within the Exclusion Zones then shut-down procedures will be implemented. ○ During periods of low visibility (i.e. where a distance of 500 m cannot be clearly viewed), then rock dumping and excavation activities may commence with soft-start procedures. – Rock dumping, dredging and excavation activities will be undertaken during daylight hours only to improve visibility.	
		Rehabilitate	There is no opportunity to rehabilitate increased risk of injury or mortality from rock dumping. However, sick and/or injured fauna shall be managed by appropriately qualified personnel and any injury or death of marine fauna will be reported to DBCA.	
		Offset	Marine fauna offsets are not considered applicable to the proposal	
Increased risk of introduced marine species	Indirect	Avoid	Marine vessels will be used during the construction and operation of the proposal and the risk of IMS cannot be completely avoided.	**No residual impacts expected** • With implementation of the CEMP and OEMP, residual impacts to marine fauna from increased risk of IMS are not anticipated.
		Minimise	• Implementation of the CEMP (Emerge, 2024a) (Appendix P), DEMMP (02 Environment, 2024) (Appendix O) and OEMP (Appendix Q) will minimise the risk of introduction of IMS. • The proposal will be primarily used for barge operations to transport bulk cargo to and from Wadjemup / Rottnest Island. As such, the likelihood of vessels visiting the facility from international or interstate waters is low. However, any vessels from interstate or international waters will comply with Commonwealth biosecurity requirements and complete the WA Department of Primary Industries and Regional Development 'Vessel Check' risk assessment (https://www.vessel-check.com/). • All vessels will have a ballast water management plan and ballast water exchanges will be in accordance with IMS requirements and the *Commonwealth Biosecurity Act 2015*.	
		Rehabilitate	There is no opportunity to rehabilitate increased risk of introduced marine species	
		Offset	Marine fauna offsets are not considered applicable to the proposal.	

Potential environmental impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impacts
Increased risk of pollution incidents	Indirect	Avoid	Construction and operation of the proposal includes vectors which have the potential to result in pollution incidents and risk of this impact cannot be avoided.	**No residual impacts expected** • Management and monitoring measures in the CEMP (Emerge, 2024a) (Appendix P), DEMMP (02 Environment, 2024) (Appendix O) and OEMP (Emerge, 2024b) (Appendix Q) will ensure that the residual pollution incident risk is low.
		Minimise	• Construction management measures to minimise the risk of pollution incidents which may impact marine fauna is detailed in the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O). Implementation of these management plans will ensure that the risk for hydrocarbon spills to the marine environment is minimal so that there are no adverse impacts to marine fauna. • Key management and monitoring measures include: – Implement industry standard hydrocarbon management practices (chemical handling, storage, segregation, and spill response) – Any construction vessels including piling vessels/barges to establish a sewage and garbage disposal plan – Undertake vessel maintenance and bunkering in accordance with contractors approved vessel management systems – Hydrocarbon spills into the marine environment be immediately reported and appropriately remediated. • Operational management to minimise impacts to the marine environment is detailed in the OEMP (Appendix Q). Implementation of this management plan will ensure that: – Fuel / oil spill contingency plans are included in the OEMP and includes the provision of clean-up equipment and appropriate disposal of contaminated water and sediment – Pollution incidents will be reported to the DoT's MEER unit, with clean up managed and monitored in accordance with MEER's requirements – Pollution incidents will be monitored during operation in accordance with the OEMP, with contingency actions implemented should pollution triggers be breached on a reoccurring basis. • The underground fuel storage facility will be constructed in accordance with AS1940 and as outlined in the OEMP have safety and leak detection equipment installed.	
		Rehabilitate	Fuel and oil spills to be cleaned up in accordance with the contingency actions outlined in the DEMMP, CEMP and OEMP (Emerge, 2024b) (Appendix Q). Sick and/or injured fauna shall be managed by appropriately qualified personnel.	
		Offset	Marine fauna offsets are not considered applicable to the proposal.	
Increased light emissions	Indirect	Avoid	• General construction work will be limited to daylight hours only.	**No residual impacts expected** • With implementation of the CEMP and OEMP, residual impacts to marine fauna from increased light emissions are considered low.
		Minimise	• Implementation of the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O) provides the monitoring and management framework to minimise impacts to marine fauna from increased light emissions during construction. The key management measure to ensure no disturbance to marine fauna from artificial light during construction is: – Construction activities will be restricted to daylight hours. • Operational management to minimise impacts to marine fauna is detailed in the OEMP (Emerge, 2024b) (Appendix Q). Implementation of this management plan will ensure that: – Artificial lighting will be of lowest allowable intensity to meet legislative and regulatory requirements for human safety / navigational purposes. • Best practice lighting design consistent with the National Light Pollution Guidelines for Wildlife (DCCEEW 2023) will be employed to reduce light pollution on marine fauna during operation, including: – Only add light for specific purposes (e.g. navigational and safety) – Use adaptive light controls to manage light timing, intensity and colour – Light only the object or area intended – keep lights close to the ground, directed and shielded to avoid light spill – Use the lowest intensity lighting appropriate for the task – Use non-reflective, dark-coloured surfaces – Use lights with reduced or filtered blue, violet and ultra-violet wavelengths.	
		Rehabilitate	There is no opportunity to rehabilitate increased light emissions.	
		Offset	Marine fauna offsets are not considered applicable to the proposal.	

10.7 Assessment and significance of residual impact

The predicted residual impacts to marine fauna from the proposal are considered manageable through implementation of the CEMP, DEMMP and OEMP. With implementation of these management plans, the residual impacts are not considered significant and are limited to:

- Impacts to the following benthic communities and habitats within the ZoI, ZoMI and ZoHI from an increase in suspended sediments results in a decrease in potential marine fauna habitat available:
  - Permanent impacts to 2.06 ha mixed seagrass and 1.26 ha sand with wrack
  - Temporary loss of 2.62 ha of mixed seagrass and 1.09 ha of sand / sand with wrack within the ZoMI
- Underwater noise emissions from construction activities such as piling and dredging causing temporary disturbance to marine fauna species.

These residual impacts are not considered significant as discussed in Table 55.

Table 55: Consideration of the significance of the residual impacts on marine fauna

Matters for consideration	Response
The object and principles of the EP Act	A Marine Fauna and Benthic Habitat Assessment (RPS, 2024a) was undertaken to address the EPA's marine fauna objective and the principles of the EP Act have been specifically addressed in relation to the proposal (Table 26).
Values, sensitivity and quality of the environment which is likely to be impacted	Sensitive receptors include marine fauna species, such as whales, which are known to transit through the marine environment during important breeding periods as discussed further in the Marine Fauna Desktop Study (Appendix B). Loss of 3.32 ha of marine fauna habitat (benthic communities and habitats) will occur from construction of the proposal. This impact is considered small scale when considered regionally (loss of mixed seagrass of 2.06 ha accounts for 0.52% of mixed seagrass within the LAU). Implementation of the CEMP, DEMMP and OEMP will avoid and minimise environmental impacts on the more sensitive benthic communities and habitats receptors (e.g. seagrass). With the proposed mitigation and management framework outlined in these management plans, the residual impact from the proposal is considered manageable.
All stages and components of the proposal (such as any infrastructure required for the proposal to be practicably implemented, or a proposal life cycle)	All stages of the proposal (i.e. construction and operation) have been included in this impact assessment.
Extent (intensity, duration, magnitude, and geographic footprint) of the likely impacts	The predicted residual impacts to marine fauna from the proposal are considered to be manageable through implementation of the CEMP, DEMP and OEMP.
Resilience of the environment	The impact assessment identified that the marine fauna populations within vicinity of the proposal will be resilient to any changes as: • Best practice lighting design consistent with the National Light Pollution Guidelines for Wildlife (DCCEEW 2023) will be employed to reduce light pollution on marine fauna. • Potential underwater noise impacts from piling are restricted to temporary behavioural responses of individuals, such as avoidance. This avoidance is not expected to displace individuals from critical habitat and therefore, impacts are not considered likely to be significant and marine fauna will be resilient to potential impacts from the proposal. • With implementation of the CEMP, no significant impacts are expected from entanglement or entrainment and therefore the environment is considered resilient. • Significant impacts from IMS are not predicted, due to the management measures outlined in the CEMP and OEMP. Therefore, the environment is considered resilient.

Matters for consideration	Response
	• Direct impacts to benthic communities and habitats are limited to 0.52% of mixed seagrass within the LAU. Indirect impacts within the ZoMI will be recoverable within a period of five years and impacts within the ZoI are not predicted to be observable. As such, it is considered that the marine environment is resilient to the indirect impacts from the proposal.
Consequence of the application of the mitigation hierarchy to the proposal.	The WA Offsets Guidelines (Government of Western Australia 2014) identifies four levels of significance for residual impacts: • Unacceptable impacts – those impacts which are environmentally unacceptable or where no offset can be applied to reduce the impact. Offsets are not appropriate in all circumstances, as some environmental values cannot be offset. • Significant impacts requiring an offset – any significant residual impact of this nature will require an offset. These generally relate to any impacts to species, ecosystems, or reserve areas protected by statute or where the cumulative impact is already determined to be at a critical level. • Potentially significant impact which may require an offset – the residual impact may be significant depending on the context and extent of the impact. These relate to impacts that are likely to result in a species or ecosystem requiring protection under statute or increasing the cumulative impact to a critical level. Whether these impacts require an offset will be determined by the decision-maker based on information provided by the proponent or applicant and expert judgement • Impacts which are not significant – impacts which do not trigger the above categories are not expected to have a significant impact on the environment and therefore do not require an offset Following the application of the mitigation hierarchy (Table 54) and taking into consideration the above significance of residual impacts model, RPS considers that there are no significant residual impacts to marine fauna from the proposal.
Level of confidence in the prediction of residual impacts and the success of proposed mitigation	The impact assessment and investigations relevant to marine fauna has been undertaken in accordance with relevant legislation and guidelines as per Table 46. A such, there is a high level of confidence in the predictions of residual impacts on marine fauna.
Public interest about the likely effect of the proposal or scheme, if implemented, on the environment, and relevant public information	RIA has facilitated regular meetings / dialogue with the local community and key stakeholders (Table 25) as part of the project.

Cumulative impacts from the proposal have been considered in relation to other proposals within 5 km of the proposal and are discussed in Section 18.

Holistic impacts are discussed in Section 17.

10.8 Environmental outcomes

In consideration of the proposed avoidance and management measures and likely residual impacts associated with the proposal, the environmental outcomes that apply to marine fauna are:

- Environmental outcomes for construction of the proposal:
  - No irreversible loss of marine fauna habitat (e.g. benthic communities and habitats) from dredging and construction activities outside the development envelope and ZoHI
  - No reported introduction or establishment of IMS as a result of construction activities associated with the proposal
  - No reported impacts to marine fauna as a result of hydrocarbon spill or release of waste associated with construction activities including entanglement or ingestion of waste
  - No reported death or injury to marine fauna from vessel strike associated with construction activities

  - No reported death, injury or behavioural change to marine fauna as a result of underwater noise associated with construction activities
  - No reported negative impacts on marine fauna attributable to the construction lighting requirements of the proposal.
- Environmental outcomes for operation of the proposal:
  - No reported loss of marine fauna habitat outside of the approved project footprint attributable to the operation of the proposal
  - No reported introduction or establishment of IMS as a result of operational activities associated with the proposal
  - No reported impacts to marine fauna as a result of hydrocarbon spill or release of waste associated with operational activities including entanglement or ingestion of waste
  - No reported death or injury to marine fauna from vessel strike associated with operational activities
  - No reported negative impacts on marine fauna attributable to the lighting requirements of the proposal associated with operation of the proposal.

Monitoring will be undertaken, and adaptive management measures implemented in accordance with the CEMP, DEMMP and OEMP to ensure these environmental outcomes are met.

As the impact assessment identified low residual risks to marine fauna following the application of mitigation actions identified herein, it is considered that the proposal will successfully meet this the EPA's objective to protect marine fauna so that biological diversity and ecological integrity are maintained.

11 FLORA AND VEGETATION

11.1 EPA objective

To protect flora and vegetation so that biological diversity and ecological integrity is maintained.

11.2 Policy and guidance

The proposal will be subject to compliance with applicable policies and guidance developed to assist proponents and the public to understand the minimum requirements for the protection of elements of the environment that the EPA expects to be met during the assessment process.

Table 56 lists relevant EPA guidance, other state and Commonwealth legislation / policy, and provides consideration for how these documents informed the proposal.

Table 56: Relevant legislation, policy and guidance

Legislation, policy and guidance	Consideration
Environmental Factor Guideline – Flora and Vegetation (EPA, 2016a)	The environmental factor guideline identifies the environmental values of flora and vegetation, and their significance. These considerations were underpinned as part of the impact assessment on terrestrial flora and vegetation summarised in Section 11 of this report. Implementation of the CEMP (Emerge, 2024a) (Appendix P) and OEMP (Emerge, 2024b) (Appendix Q) provides the monitoring and management framework to address potential impacts to flora and vegetation from construction and operation of the proposal.
Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA, 2016b)	Flora and vegetation surveys, as summarised in Section 11.3, have been undertaken within the development in accordance with Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA, 2016b). The EPA's Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016) states that 'a reconnaissance survey is required where flora and vegetation values are well defined, the area is not likely to support significant flora or vegetation and the scale and nature of the potential impacts are not likely to be significant'. RPS considered these criteria to be met and that the small size of the site precluded the implementation of a detailed survey using quadrats.
Environment Protection and Biodiversity Conservation Act 1999	A search of DCCEEW's PMST was undertaken within a 5 km radius of the proposal to determine the MNES that are either known or likely to occur proximate to the proposal (Appendix R). A discussion of potential impacts on MNES is discussed in Section 14.2.
Biodiversity Conservation Act 2016	A search of the DBCA's NatureMap database was undertaken to determine a list of conservation significant terrestrial flora species and ecological communities that have been recorded within 10 km of the proposal (Appendix R).

11.3 Environmental investigations

A reconnaissance survey was undertaken by RPS within the terrestrial survey area shown in Figure 31 (Appendix J). As part of the reconnaissance survey, a review of the Focused Vision Consulting (FVC, 2023) report; Flora and Vegetation Survey South Thomson and Kingstown, Wadjemup / Rottnest Island (Appendix I) was undertaken. The FVC survey encompassed the development envelope and surrounding areas as shown in Figure 32.

The flora and vegetation data collected by RPS during the reconnaissance survey has been used to support this referral document and Section 11.5 provides a summary of this information.

Figure 37: Terrestrial flora and vegetation survey area

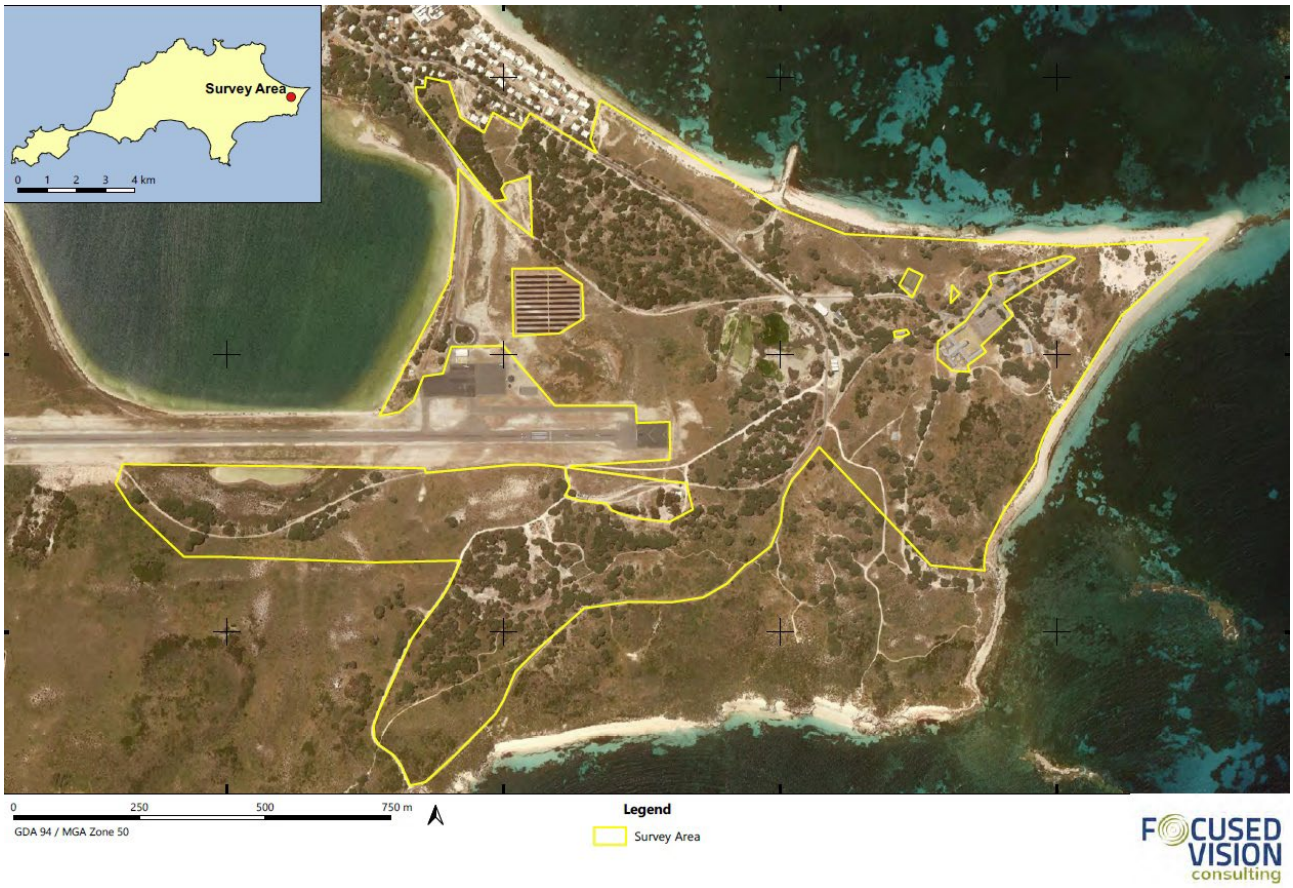


Figure 38: Terrestrial flora and vegetation surveys undertaken within vicinity of the proposal (Focused Vision Consulting survey area)

11.4 Receiving environment

11.4.1 Regional vegetation

Vegetation complexes within the terrestrial survey have defined by Heddle et al. (1980) as the Quindalup Complex. This complex is described as coastal dune consisting of two alliances: the strand and fore-dune alliance and the mobile and stable dune alliance. Local variations include the low, closed forest of *Melaleuca lanceolata* (Rottnest teatree) – *Callitris preissii* (Rottnest Island pine), the closed scrub of *Acacia rostellifera* (summer-scented wattle) and the low, closed *Agonis flexuosa* (peppermint) forest of Geographe Bay (FVC, 2023).

The pre-European extent and current known extent of this complex is summarised in Table 57. In the absence of specific data for Wadjemup / Rottnest, information relevant to the Swan Coastal Plain and the City of Cockburn, as the island falls within the district of the City of Cockburn

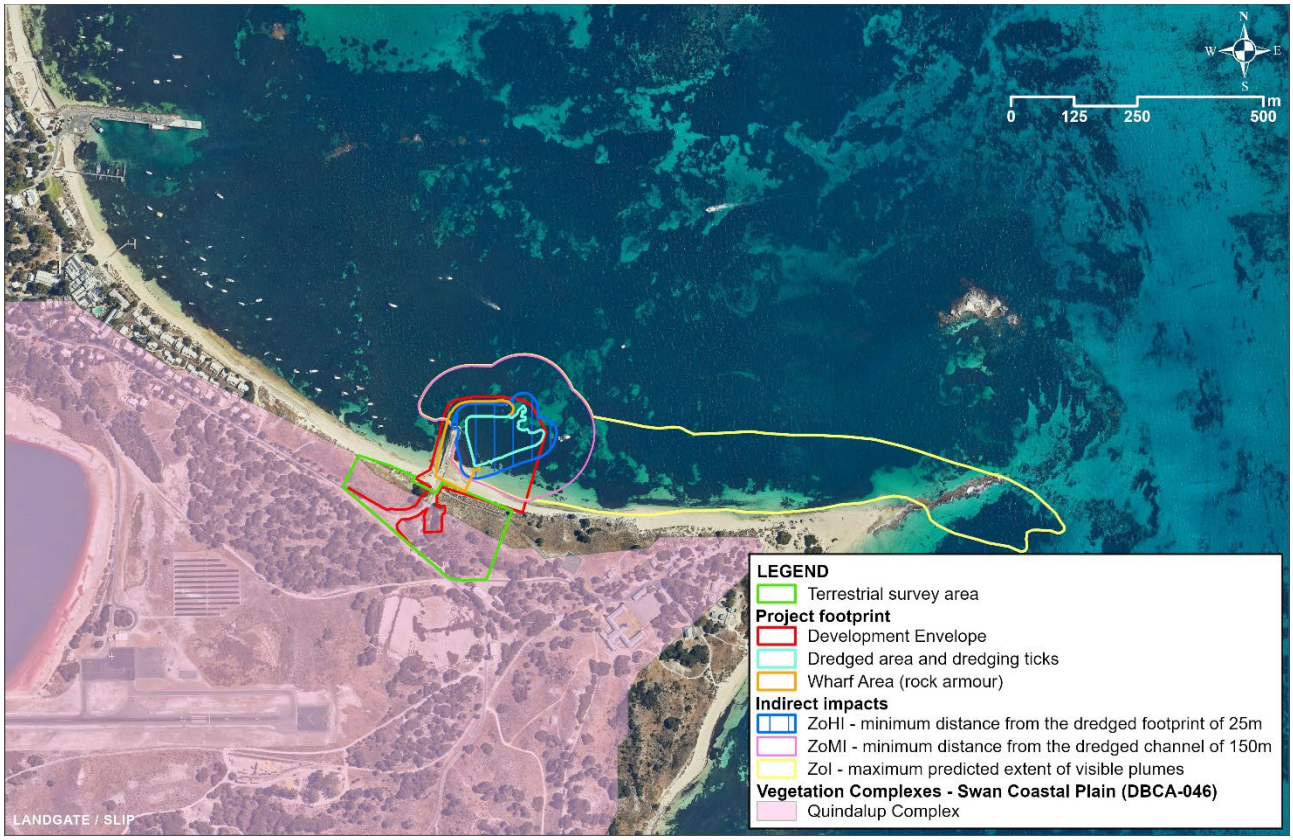


Figure 39: Vegetation complexes

Table 57: Extent of vegetation complexes within the terrestrial survey area

Regional extent	Vegetation complex	Pre-European extent	Current extent	Pre-European extent remaining
Swan Coastal Plain	Quindalup Complex	54,573.87 ha	33,011.64 ha	60.49%
City of Cockburn	Quindalup Complex	1,021.62 ha	728.23 ha	71.28%

(FVC, 2023)

The Commonwealth's National Targets and Objectives for Biodiversity Conservation (Environment Australia 2001) recognises that the retention of 30%, or more, of the preclearing extent of each ecological community is necessary if Australia's biological diversity is to be protected. The EPA uses vegetation complexes as the basis for regional representation of biodiversity and has an objective to seek to retain at least 30% of the pre-clearing extent of each vegetation community (EPA 2015). Due to extensive clearing this target is not achievable for many of the vegetation complexes on the Swan Coastal Plain, making the remaining remnants regionally significant (EPA 2015).

The remaining extent for the Heddle et al. (1980) Quindalup complex exceeds 30% threshold for the Swan Coastal Plain IBRA region and City of Cockburn extents (Table 57).

11.4.2 Vegetation units

Three vegetation units were described over the terrestrial survey area. These vegetation units are shown in Figure 34 and described in Table 58.

Table 58: Vegetation units

Vegetation unit code	Description	Plate
ApAf*Td	*Acanthocarpus preissii, Scaevola crassifolia* low-mid shrubland/open shrubland over *Austrostipa flavescens* mid grassland/open grassland over **Trachyandra divaricata, Conostylis candicans* subsp. *calcicola* low forbland/open forbland.	
MlAp*Td	*Melaleuca lanceolata (Callitris preissii)* open woodland over *Acanthocarpus preissii, Rhagodia baccata* shrubland/low shrubland over **Trachyandra divaricata, Conostylis candicans* subsp. *calcicola* low very open forbland. NB Some of the *Melaleuca lanceolata* and *Callitris preissii* in this unit have been planted.	
Sc*TdSl	*Scaevola crassifolia* low open shrubland over **Trachyandra divaricata* low forbland over *Spinifex longifolius, Austrostipa flavescens* low-mid open grassland.	

Figure 40: Vegetation units

The areas of vegetation units present within the terrestrial survey area and development envelope are provided in Table 59.

Table 59: Areas of vegetation units within the development envelope

Vegetation unit code	Condition	Area of vegetation unit within survey area	Area of vegetation unit within development envelope
ApAf*Td	Good to Degraded	2.35 ha	0.17 ha
MlAp*Td	Degraded to Good	1.03 ha	0.23 ha
Sc*TdSl	Good to Degraded	0.38 ha	0.06 ha
cleared	Completely Degraded	0.40 ha	0.22 ha
Total area		**4.16 ha**	**0.68 ha**

11.4.3 Vegetation condition

Vegetation condition was assessed by the scale of Keighery (1996) as largely Good, mixed with patches of Degraded vegetation. In areas around taller shrubs and trees condition was assessed as Degraded with patches of Good condition (Figure 35).

The condition of the vegetation units described in Section 11.4.2 is provided in Table 59.

Figure 41: Vegetation condition

11.4.4 Flora species

Seventeen taxa were recorded in the survey area, 13 of these species were endemic taxa and the remaining four species were introduced. The endemic taxa belong to ten different families and thirteen different genera (Table 60).

Table 60 Endemic taxa in the survey area

Family	Taxon
Asparagaceae	*Acanthocarpus preissii*
Asteraceae	*Olearia axillaris*
Chenopodiaceae	*Rhagodia baccata*
Cupressaceae	*Callitris preissii*
Cyperaceae	*Ficinia nodosa*
Cyperaceae	*Gahnia trifida*
Goodeniaceae	*Scaevola crassifolia*
Haemodoraceae	*Conostylis candicans* subsp. *candicans*
Malvaceae	*Guichenotia ledifolia*
Myrtaceae	*Melaleuca lanceolata*
Poaceae	*Austrostipa flavescens*
Poaceae	*Spinifex longifolia*
Poaceae	*Sporobolus virginicus*

11.4.4.1 Weed species

Introduced flora species identified within the terrestrial survey area are listed in Table 61.

None of these introduced taxa are Declared Pests under the *Biosecurity and Agriculture Management Act 2007* (BAM Act) or Weeds of National Significance (RPS, 2024d).

Table 61: Introduced taxa in the survey area

Family	Introduced taxon	Common name
Poaceae	*Avena barbata*	Bearded oat
Poaceae	*Bromus diandrus*	Great brome
Poaceae	*Lagurus ovatus*	Hare's tail grass
Asphodelaceae	*Trachyandra divaricata*	Onion weed

11.4.4.2 Conservation significant flora

All of the flora species identified within the terrestrial survey area are relatively common in similar habitats (RPS, 2024d).

No conservation significant taxa were recorded within the terrestrial survey area or development envelope.

11.4.5 Ecological communities

The vegetation unit MlAp*Td is analogous to the Threatened Ecological Community (TEC) *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands of the Swan Coastal Plain (floristic community type 30c as originally described by Gibson *et. al.* 1994). This TEC is listed as Critically Endangered under the state BC Act but is not listed under the EPBC Act.

1.03 ha of this vegetation unit was recorded within the survey area, of which 0.23 ha is located within the development envelope.

11.5 Potential environmental impacts

Table 62 provides the potential key impacts to terrestrial flora and vegetation from the proposal. These impacts are discussed in further detail in Sections 11.5.1.1 to 11.5.1.4.

Table 62: Potential impacts on terrestrial flora and vegetation

Phase	Impact class	Works / operations	Potential impacts
Construction	Direct	• Construction of the onshore project components.	**Removal of native vegetation** • Removal of 0.46 ha of native vegetation in Good to Degraded condition. • Of the native vegetation being cleared, 0.23 ha is analogous to the TEC; *Callitris preissii (or Melaleuca lanceolata*) forests and woodlands of the Swan Coastal Plain.
	Indirect	• Construction of the onshore project components.	**Introduction of invasive species (pests and weeds)** • Indirect loss or impact to flora and vegetation as a result of the introduction or spread of invasive species (pests and weeds) due to construction machinery and vehicles. **Introduction of disease** • Indirect loss or impact to flora and vegetation as a result of the introduction or spread of disease (for example, *Phytophthora* dieback) due to construction machinery and vehicles. **Accidental clearing** • During construction activities, there is a risk that native vegetation outside the areas directly impacted will be accidentally cleared. **Localised erosion** • During construction activities, there is for localised erosion to occur adjacent to cleared areas.

Phase	Impact class	Works / operations	Potential impacts
Operation	Indirect	• Vehicle / personnel movement	**Introduction of invasive species (pests and weeds)** • Indirect loss or impact to flora and vegetation as a result of the introduction or spread of invasive species (pests and weeds) due to vehicle and personnel movement during operation. **Introduction of disease** • Indirect loss or impact to flora and vegetation from the introduction or spread of disease due to vehicle and personnel movement during operation. **Degradation through incorrect waste disposal**

11.5.1 Assessment of impacts

11.5.1.1 Direct loss of native vegetation

Construction of the proposal will result in the removal of 0.46 ha of native vegetation. Conservation flora and vegetation values within this vegetation is summarised below:

- No conservation significant flora is present within the vegetation proposed to be cleared.
- Vegetation impacted comprises 0.23 ha of vegetation, which is analogous with the TEC, *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands of the Swan Coastal Plain.

The Commonwealth's National Targets and Objectives for Biodiversity Conservation (Environment Australia 2001) recognises that the retention of 30%, or more, of the pre-clearing extent of each ecological community is necessary if Australia's biological diversity is to be protected. Section 11.4.1 identifies that the vegetation present within the development envelope is above the 30% threshold.

11.5.1.1.1 Assessment against the ten clearing principles

Clearing principles against which proposals to clear vegetation are assessed are listed under Schedule 5 of the EP Act. An assessment of the proposal against the ten clearing principles is provided in Table 63.

Table 63: Assessment against the clearing principles for native vegetation under Schedule 5 of the EP Act

Principle	Assessment	Variance
Principle (a) – native vegetation should not be cleared if it comprises a high level of biological diversity	Seventeen taxa were recorded in the survey area, thirteen of these species were endemic taxa and the remaining four species were introduced. All of the flora species identified within the terrestrial survey area are relatively common in similar habitats (RPS, 2024d). Therefore, vegetation within the site does not comprise a high level of biological diversity and is well represented elsewhere on the island. Biological diversity is considered likely to be reduced from the condition of the site. Vegetation assessments within the site identified the vegetation condition as Good to Degraded, mixed with patches of Degraded vegetation.	**Not at variance** Clearing of vegetation at this site is not at variance with this Principle
Principle (b) – Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a significant habitat for, fauna indigenous to Western Australia	The fauna survey undertaken by EcoLogical (2024) recorded 14 native vertebrate fauna species within the site. One conservation significant fauna species was recorded within the site, the Quokka (*Setonix brachyurus*), listed as Vulnerable (VU) under the EPBC Act and BC Act. EcoLogical (2024) undertook a post survey likelihood of occurrence assessment and determined that of the conservation significant species identified from the desktop assessment, two are considered as having the potential to occur within the site; *Pandion haliaetus* (Osprey) and *Lerista lineata* (Perth slider). **Quokka** The Quokka was observed foraging under *Melaleuca lanceolata* and adjacent to *Acanthocarpus preissii* within the site. It is considered likely that the Quokka would use both habitat types within the site (Table 67). The Quokka is widespread across the island and the site does not comprise critical habitat for this species. **Osprey** The Osprey exhibits a preference for coastal cliffs and elevated islands but have also been known to occur over atypical habitats such as heath, woodland or forest when travelling to and from foraging sites. The Osprey is considered as having the potential to occur within the survey area as a vagrant visitor, due to the availability of adjacent foraging habitat (saline water, beaches). However, the site is not necessary for the maintenance of significant habitat for this species. **Perth slider** This species occurs on sandy, coastal heath and shrubland and has the potential to occur within the site based on availability of suitable habitat. However, as sandy, coastal heath and shrubland is widespread across the island, the site is not necessary for the maintenance of significant habitat for this species.	**Not at variance** While these conservation significant species may occur within the site, the site is not considered likely to comprise habitat critical to the species survival. As such, clearing 0.46 ha of vegetation is unlikely to have a significant impact on these species.
Principle (c) Native vegetation should not be cleared if it includes or is necessary for the continued existence of rare flora	No conservation significant taxa were recorded within the terrestrial survey area or development envelope.	**Not at variance** The proposal is not at variance with this Principle
Principle (d) – Native vegetation should not be cleared if it comprises the whole or part of, or is necessary for the maintenance of, a Threatened Ecological Community (TEC)	The vegetation unit MlAp*Td is analogous to the TEC *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands of the Swan Coastal Plain (floristic community type 30c as originally described by Gibson et. al. 1994). This TEC is listed as Critically Endangered under the state BC Act but is not listed under the EPBC Act. 1.03 ha of this TEC was recorded within the survey area, of which 0.23 ha is located within the development envelope. Focused Vision Consulting also identified this TEC in the area surrounding the development envelope, considering vegetation units MlAp and CpMl to be representative of the TEC (Appendix I). Focused Vision Consulting identified 44.39 ha of MlAp and 0.6 ha of CpMl within vicinity of the development envelope. As the proposed clearing of 0.23 ha of the TEC will result in a loss of 0.52% of the TEC identified in the Focused Vision survey area, impacts to vegetation analogous with this TEC are not considered significant. It should also be noted that this vegetation type is likely to be more widespread across the island that the survey area.	**May be at variance** The proposal will result in the clearing of 0.23 ha of vegetation that is analogous with the TEC. However, as this only comprises 0.52% of the TEC identified in the area, the vegetation within the site is unlikely to be necessary for the maintenance of the TEC. Especially as the vegetation within the site is in a Good to Degraded condition.
Principle (e) – Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared	The Commonwealth's National Targets and Objectives for Biodiversity Conservation (Environment Australia 2001) recognises that the retention of 30%, or more, of the preclearing extent of each ecological community is necessary if Australia's biological diversity is to be protected. The EPA uses vegetation complexes as the basis for regional representation of biodiversity and has an objective to seek to retain at least 30% of the pre-clearing extent of each vegetation community (EPA 2015). Due to extensive clearing this target is not achievable for many of the vegetation complexes on the Swan Coastal Plain, making the remaining remnants regionally significant (EPA 2015). Section 11.4.1 identifies that the vegetation present within the development envelope is above the 30% threshold.	**Not at variance** The remaining extent for the Heddle et al. (1980) Quindalup complex exceeds 30% threshold for the Swan Coastal Plain IBRA region and City of Cockburn extents.
Principle (f) – Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.	There are no wetlands or watercourses within or adjacent to the site. As such, the 0.46 ha of vegetation proposed to be cleared is not growing in association with a watercourse or wetland.	**Not at variance** The 0.46 ha of vegetation proposed to be cleared is not growing in association with a watercourse or wetland.
Principle (g) – Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation	The substrate of the site is unconsolidated sand formed into a dune. Sandy soils are prone to wind erosion, however as the site is proposed to be developed and will be managed as outlined in the CEMP, it will not contribute to land degradation on or adjacent to the site.	**Not at variance** The potential for erosion will be managed as outlined in the CEMP.
Principle (h) – Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation areas	There are no significant environmental or conservation values adjacent to the site which will be impacted by the proposed clearing. Implementation of the CEMP will minimise potential impacts to surrounding vegetation.	**Not at variance** The proposal is not at variance with this Principle.
Principle (i) – Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water	The small area of the proposed clearing would not be expected to contribute towards or cause deterioration in the quality of underground or surface water. Implementation of the CEMP and OEMP will minimise the risk of impacts to surface and groundwater quality.	**Not at variance** The proposal is not at variance with this Principle.
Principle (j) – Native vegetation should not be cleared if the clearing of the vegetation is likely to cause, or exacerbate, the incidence of flooding	Wadjemup / Rottnest Island receives a mean rainfall of 564.6 mm per annum, with the local climate consisting of cool wet winters and warm dry summers. Maximum mean rainfall occurs in July, with 111.5 mm. Flooding is not an issue as the soil is sandy and porous, and given the small area subject to this proposal this is not likely to change.	**Not at variance** The proposal is not at variance with this Principle.

11.5.1.2 Accidental clearing

During construction activities, there is a risk that native vegetation outside the areas directly impacted will be accidentally cleared. The implementation of the CEMP will reduce the risk of this occurring.

11.5.1.3 Localised erosion

There is a risk for localised erosion to occur adjacent to cleared areas or due to surface water run-off. Localised erosion may impact vegetation adjacent to the development envelope.

11.5.1.4 Introduction and spread of weeds

Four introduced flora species were identified within the terrestrial survey area. None of these species were listed as Declared Pests under the BAM Act or Weeds of National Significance. The presence of weeds adjacent to the development envelope has the potential to increase as a result of construction activities.

The implementation of the weed hygiene management measures outlined in the CEMP is expected to reduce the risk of spread as a result of the proposal. The proposal is not expected to result in the spread of weeds that could result in significant vegetation and flora impacts.

11.5.1.5 Introduction and spread of disease

There is potential for the movement of construction machinery to result in the introduction of disease (e.g. *Phytophthora* dieback). The implementation of the hygiene management measures outlined in the CEMP is expected to reduce the risk of disease introduction or spread as a result of the proposal.

11.5.1.6 Degradation through incorrect waste disposal

An increase in litter due to incorrect waste disposal has the potential to impact the surrounding vegetation.

11.6 Mitigation

Table 64 demonstrates how the EPA's mitigation hierarchy (avoid, minimise and rehabilitate) has been applied to the environmental factor of terrestrial flora and vegetation to address the key potential impacts.

Table 64: Application of mitigation hierarchy to terrestrial flora and vegetation

Potential environmental impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impacts
Removal of native vegetation	Direct	Avoid	Avoidance of impacts to the 0.8 ha of the TEC (MIAp*Td) surveyed outside the development envelope.	**Removal of 0.46 ha of native vegetation in Good to Degraded condition** Of the native vegetation being cleared, 0.23 ha comprises the state listed TEC; *Callitris preissii (or Melaleuca lanceolata*) forests and woodlands of the Swan Coastal Plain.
		Minimise	• A CEMP (Emerge, 2024a) (Appendix P) will be implemented to ensure impacts to native vegetation is limited to the 0.46 ha within the development envelope. Management measures to limit impacts outside the development envelope include: – Extent of authorised disturbance will be clearly defined and demarcated on appropriate plans. The demarcated terrestrial construction works area to be surveyed prior to the commencement of vegetation removal works. Movement of construction vehicles within vegetation outside this area will be limited to avoid accidental clearing or disturbance of surrounding vegetation – All identified populations of MIAp*Td will be delineated using highly visible flagging or similar around all identified populations to avoid impacts to the 0.8 ha of MIAp*Td surveyed outside the development envelope – Establishment of clearly delineated access points to prevent unauthorised disturbance and access – Installation of temporary fencing, inclusive of sediment controls, along the boundary of the terrestrial construction works area to restrict machinery access to be within the approved disturbance area – Daily inspections to visually check / review clearing boundaries and compliance during clearing activities – Photographic records of the clearing area pre- and post-clearing activities – Inspection to verify no degradation or disturbance beyond approved clearing boundary from erosion • Operational management to minimise impacts to flora and vegetation is detailed in the OEMP (Emerge, 2024b) (Appendix Q). Implementation of this management plan will ensure that: – Vehicle access is controlled to designated roads and access – There is no introduction of weed species to the site as a result of operation.	
		Rehabilitate	There is no opportunity to rehabilitate the areas directly impacted by construction of the proposal.	
		Offset	Terrestrial flora and vegetation offsets are not proposed for terrestrial flora and vegetation as only 0.52% of the TEC identified in the surrounding area will be directly impacted.	
Introduction and spread of weeds	Indirect	Avoid	There is no opportunity to avoid the movement of construction vehicles within the area, as such the risk for the spread and introduction of weed species cannot be completely avoided.	**No residual impacts expected** With the implementation of the CEMP and OEMP, residual impacts to terrestrial flora and vegetation resulting from the spread and introduction of weeds during construction are not considered significant.
		Minimise	• Construction management and monitoring measures to minimise impacts to terrestrial flora and vegetation is detailed in the CEMP (Emerge, 2024a) (Appendix P) and includes: – Implementation of the weed management protocol as outlined in the CEMP – Weekly inspections and photographic records during clearing and construction activities – Inspections to verify no degradation or disturbance has occurred beyond the development envelope – Appropriate hygiene measures to minimise the risk of the spread and introduction of weed species, including: ○ Weekly spot checks of mobile equipment and vehicles ○ hygiene points at key road entry points ○ Implementation of the weed management protocol outlined in the CEMP – Stockpile management, including stockpile locations (within the development envelope), erosion and stabilisation techniques and height limits – Designated areas for the temporary placement of cleared vegetation (within the development envelope) to minimise the increased risk of weed and disease spread and bushfire – The contractor will supply weed and weed certificates prior to mobilising vehicles and machinery • Operational management to minimise impacts to flora and vegetation is detailed in the OEMP (Emerge, 2024b) (Appendix Q). Implementation of this management plan will ensure that: – Vehicle access is controlled to designated roads and access – There is no introduction of weed species to the site as a result of operation.	
		Rehabilitate	Should the proposal result in the introduction of weed species, appropriate management and control measures will be implemented.	
		Offset	Terrestrial flora and vegetation offsets are not considered applicable to the proposal.	
Introduction and spread of disease	Indirect	Avoid	There is no opportunity to avoid the movement of construction vehicles within the area, as such the risk for the spread and introduction of disease cannot be completely avoided.	**No residual impacts expected** With the implementation of the CEMP and OEMP, residual impacts to terrestrial flora and vegetation resulting from the spread and introduction of disease during construction are not considered significant.
		Minimise	• Construction management measures to minimise impacts to terrestrial flora and vegetation is detailed in the CEMP (Emerge, 2024a) (Appendix P) and includes: – Appropriate hygiene measures to minimise the risk of the spread and introduction of disease – Extent of authorised disturbance will be clearly defined and demarcated on appropriate plans. The demarcated terrestrial construction works area to be surveyed prior to the commencement of vegetation removal works. Movement of construction vehicles within vegetation outside this area will be limited to avoid the risk of disease spread • Monitoring during construction to minimise impacts to terrestrial flora and vegetation is detailed in the CEMP (Emerge, 2024a) (Appendix P) and includes: – Daily inspections and photographic records during clearing and construction activities – Inspections to verify no degradation or disturbance has occurred beyond the development envelope • Operational management to minimise impacts to flora and vegetation is detailed in the OEMP (Emerge, 2024b) (Appendix Q). Implementation of this management plan will ensure that: – Vehicle access is controlled to designated roads and access – There is no introduction of disease to the site as a result of operation.	
		Rehabilitate	Should the proposal result in the introduction of disease, appropriate management measures will be implemented.	
		Offset	Terrestrial flora and vegetation offsets are not considered applicable to the proposal.	

Potential environmental impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impacts
Accidental clearing	Indirect	Avoid	The risk for accidental vegetation clearing cannot be completely avoided.	**No residual impacts expected** With the implementation of the CEMP, residual impacts to terrestrial flora and vegetation resulting from accidental clearing are not considered significant.
		Minimise	• Construction management measures to minimise impacts to terrestrial flora and vegetation is detailed in the CEMP (Emerge, 2024a) (Appendix P) and includes: – Vehicles, plant, and equipment to be restricted within development envelope – The extent of authorised disturbance will be clearly defined and demarcated on appropriate plans. The demarcated terrestrial construction works area to be surveyed prior to the commencement of vegetation removal works – Installation of temporary fencing, inclusive of sediment controls, along the boundary of the terrestrial construction works area to restrict machinery access to be within the approved disturbance area • Monitoring during construction to minimise impacts to terrestrial flora and vegetation is detailed in the CEMP (Emerge, 2024a) (Appendix P) and includes: – Daily inspections and photographic records during clearing and construction activities – Inspections to verify no degradation or disturbance has occurred beyond the development envelope.	
		Rehabilitate	There is no opportunity to rehabilitate the areas directly impacted by construction of the proposal. Any accidental clearing will be rehabilitated.	
		Offset	Terrestrial flora and vegetation offsets are not considered applicable to the proposal.	
Localised erosion	Indirect	Avoid	The risk for erosion cannot be completely avoided.	**No residual impacts expected** With the implementation of the CEMP, residual impacts to terrestrial flora and vegetation resulting from accidental clearing are not considered significant.
		Minimise	• Construction management measures to minimise impacts to terrestrial flora and vegetation is detailed in the CEMP (Emerge, 2024a) (Appendix P) and includes: – Installation of temporary fencing, inclusive of sediment controls, along the boundary of the terrestrial construction works will minimise localised erosion – Establishment of clearly delineated access points to prevent unauthorised disturbance and access • Monitoring during construction to minimise impacts to terrestrial flora and vegetation is detailed in the CEMP (Emerge, 2024a) (Appendix P) and includes: – Daily inspections and photographic records during clearing and construction activities – Inspections to verify no degradation or disturbance has occurred beyond the development envelope.	
		Rehabilitate	Any areas of erosion outside the development envelope which impacts vegetation condition will be rehabilitated.	
		Offset	Terrestrial flora and vegetation offsets are not considered applicable to the proposal.	
Degradation through incorrect waste disposal.	Indirect	Avoid	Complete avoidance for the risk of litter is unavoidable.	**No residual impacts expected** With the implementation of the CEMP and OEMP, residual impacts to terrestrial flora and vegetation resulting from degradation from waste and litter are not considered significant.
		Minimise	• A CEMP (Emerge, 2024a) (Appendix P) will be implemented to ensure impacts to native vegetation is limited to the 0.46 ha within the development envelope. Measures to manage waste disposal will be implemented as per the CEMP to minimise the risk for degradation of the surrounding vegetation • Operational management to minimise impacts to flora and vegetation is detailed in the OEMP (Emerge, 2024b) (Appendix Q). Implementation of this management plan will ensure that waste disposal measures are implemented to prevent rubbish and litter degrading surrounding vegetation.	
		Rehabilitate	As outlined in the OEMP, litter cleanup will be undertaken if required to prevent an increase in litter impact on surrounding vegetation.	
		Offset	Terrestrial flora and vegetation offsets are not considered applicable to the proposal.	

11.7 Assessment and significance of residual impact

The residual impacts to flora and vegetation after the application of the mitigation hierarchy outlined in Table 64 are summarised below:

- Removal of 0.46 ha of native vegetation in Good to Degraded condition. Of the native vegetation being cleared, 0.23 ha is analogous with the TEC, *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands of the Swan Coastal Plain.

The predicted residual impacts to flora and vegetation from the proposal are not considered significant as discussed in Table 65.

Table 65: Consideration of the significance of the residual impacts on terrestrial flora and vegetation

Matters for consideration	Response
The object and principles of the EP Act	A reconnaissance survey was undertaken by RPS within the terrestrial survey area shown in Figure 31 (Appendix J) in accordance with Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA, 2016b). The principles of the EP Act have been specifically addressed in relation to the proposal (Table 26).
Values, sensitivity and quality of the environment which is likely to be impacted	All of the flora species identified within the terrestrial survey area are relatively common in similar habitats (RPS, 2024d) and no conservation significant flora species were identified within the development envelope. Therefore, impacts to flora from implementation of the proposal are not considered significant. 0.23 ha of the vegetation within the development envelope is analogous with the TEC, *Callitris preissii (*or *Melaleuca lanceolata*) forests and woodlands of the Swan Coastal Plain. This TEC is listed as Critically Endangered under the BC Act. Focused Vision Consulting identified this TEC in the area surrounding the development envelope, considering vegetation units MIAp and CpMI to be representative of the TEC (Appendix I). Focused Vision Consulting identified 44.39 ha of MIAp and 0.6 ha of CpMI within vicinity of the development envelope. As the proposed clearing of 0.23 ha of the TEC will result in a loss of 0.52% of the TEC identified in the area, impacts to vegetation from implementation of the proposal are not considered significant.
All stages and components of the proposal (such as any infrastructure required for the proposal to be practicably implemented, or a proposal life cycle)	All stages of the proposal (i.e. construction and operation) have been included in this impact assessment.
Extent (intensity, duration, magnitude, and geographic footprint) of the likely impacts	Construction of the proposal will result in the removal of 0.46 ha of native vegetation in Good to Degraded condition. Of the native vegetation being cleared, 0.23 ha comprises the TEC; *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands of the Swan Coastal Plain.
Resilience of the environment	All of the flora species identified within the terrestrial survey area are relatively common in similar habitats (RPS, 2024d). The vegetation within the development envelope ranges from Degraded (32.2% of vegetation in the development envelope) to Good to Degraded (67.8% of vegetation in the development envelope). As there is vegetation in better condition outside the development envelope and flora species present are relatively common on the island, the environment is considered resilient to the clearing proposed as part of this Proposal.
Consequence of the application of the mitigation hierarchy to the proposal.	The WA Offsets Guidelines (Government of Western Australia 2014) identifies four levels of significance for residual impacts: • Unacceptable impacts – those impacts which are environmentally unacceptable or where no offset can be applied to reduce the impact. Offsets are not appropriate in all circumstances, as some environmental values cannot be offset. • Significant impacts requiring an offset – any significant residual impact of this nature will require an offset. These generally relate to any impacts to species, ecosystems, or reserve areas protected by statute or where the cumulative impact is already determined to be at a critical level.

Matters for consideration	Response
	• Potentially significant impact which may require an offset – the residual impact may be significant depending on the context and extent of the impact. These relate to impacts that are likely to result in a species or ecosystem requiring protection under statute or increasing the cumulative impact to a critical level. Whether these impacts require an offset will be determined by the decision-maker based on information provided by the proponent or applicant and expert judgement • Impacts which are not significant – impacts which do not trigger the above categories are not expected to have a significant impact on the environment and therefore do not require an offset. Following the application of the mitigation hierarchy outlined in Table 64 and taking into consideration the above significance of residual impacts model, RPS considers that there are no significant residual impacts to terrestrial flora and vegetation from the proposal.
Level of confidence in the prediction of residual impacts and the success of proposed mitigation	The impact assessment has been completed with a high level of confidence in the predictions of residual impacts on terrestrial flora and vegetation, with the required scientific assessments conducted as discussed in Section 11.3. The EPA's Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016) states that 'a reconnaissance survey is required where flora and vegetation values are well defined, the area is not likely to support significant flora or vegetation and the scale and nature of the potential impacts are not likely to be significant'. RPS considered these criteria to be met and that the small size of the site precluded the implementation of a detailed survey using quadrats.
Public interest about the likely effect of the proposal or scheme, if implemented, on the environment, and relevant public information	RIA has facilitated regular meetings / dialogue with the local community and key stakeholders (Table 25) as part of the project.

Cumulative impacts from the proposal have been considered in relation to other proposals within 5 km of the proposal and are discussed in Section 18.

Holistic impacts are discussed in Section 17.

11.8 Environmental outcomes

In consideration of the proposed avoidance and management measures and likely residual impacts associated with the proposal, the environmental outcomes that apply to terrestrial flora and vegetation are:

- Direct impacts to native vegetation resulting from the proposal will not exceed 0.46 ha
- Direct impacts to native vegetation (MlAp*Td) analogous with the TEC, *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands of the Swan Coastal Plain does not exceed 0.23 ha
- No introduction of new weed species attributable to the proposal.

Adaptive management measures will be implemented in accordance with the CEMP to ensure this environmental outcome is met. As the impact assessment identified low residual risks to terrestrial flora and vegetation following the application of mitigation actions identified herein, it is considered that the proposal will successfully meet this the EPA's objective to protect terrestrial flora and vegetation.

12 TERRESTRIAL FAUNA

12.1 EPA objective

To protect terrestrial fauna so that biological diversity and ecological integrity are protected.

12.2 Policy and guidance

The proposal will be subject to compliance with applicable policies and guidance developed to assist proponents and the public to understand the minimum requirements for the protection of elements of the environment that the EPA expects to be met during the assessment process.

Table 66 lists relevant EPA guidance, other state and Commonwealth legislation / policy, and provides consideration for how these documents informed the proposal.

Table 66: Relevant legislation, policy and guidance

Legislation, policy and guidance	Consideration
Environmental Factor Guideline: Terrestrial Fauna (EPA, 2016d)	The environmental factor guideline identifies the environmental values of terrestrial fauna. These considerations were underpinned as part of the impact assessment on terrestrial fauna summarised in Section 12.5 of this report.
Technical Guidance: Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA, 2020)	This technical guidance guides the appropriate obtainment and collation of terrestrial fauna data to be used for environmental impact assessments. The Rottnest Island Basic Fauna Survey (Eco Logical 2024) (Appendix K) was undertaken with regard for this guidance document.
Environment Protection and Biodiversity Conservation Act 1999	A search of DCCEEW's PMST was undertaken within a 5 km radius of the proposal to determine the MNES that are either known or likely to occur proximate to the proposal (Appendix R). A discussion of potential impacts on MNES is discussed in Section 14.2.
Biodiversity Conservation Act 2016	A search of the DBCA's NatureMap database was undertaken to determine a list of conservation significant terrestrial fauna species that have been recorded within 10 km of the proposal (Appendix R).

12.3 Environmental investigations

Eco Logical (2024) undertook a basic terrestrial fauna survey within the terrestrial survey area (Figure 36) in accordance with EPA Technical Guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020). The Basic terrestrial fauna survey report is provided in Appendix K and included:

- A desktop assessment
- A site survey undertaken on 31 October 2023 to delineate and map fauna habitats and record opportunistic sightings of fauna.

Figure 42: Terrestrial fauna survey area and survey effort

12.4 Receiving environment

12.4.1 Fauna habitat

Two fauna habitat types were recorded within the survey area, as described in Table 67.

Table 67: Fauna habitat

Fauna habitat description	Conservation significant fauna species potentially utilising the habitat	Area surveyed	Plate
Habitat type 1: Trees and tall shrubs over low shrubs, grasses and herbs on sand dunes.	• *Lerista lineata* (Perth slider) • *Pandion haliaetus* (osprey) • *Pseudonaja affinis exilis* (Rottnest Island dugite) • *Tiliqua rugosa konowi* (Rottnest Island bobtail) • *Setonix brachyurus* (quokka).	0.87 ha	
Habitat type 2: Low shrubs over grasses and herbs on sand dunes.	• *Lerista lineata* (Perth slider) • *Pandion haliaetus* (osprey) • *Pseudonaja affinis exilis* (Rottnest Island dugite) • *Tiliqua rugosa konowi* (Rottnest Island bobtail) • *Setonix brachyurus* (quokka).	3.00 ha	

(Eco Logical Australia, 2024)

12.4.2 Fauna species

A total of 14 native vertebrate fauna species were recorded within the survey area during the field survey undertaken by Eco Logical (2024). No introduced (feral) fauna species were recorded within the survey area.

12.4.2.1 Conservation significant fauna species

A likelihood of occurrence assessment was undertaken by Eco Logical (2024) as part of the fauna assessment. Those species that have been recorded within the survey area or were identified as having the potential to occur within the survey area based on species distributions and habitat present are summarised in Table 68.

Species considered unlikely to occur within the development envelope are not discussed in Table 68, however are discussed in the Basic fauna survey report provided in Appendix K.

Refer to Section 10 for marine fauna species.

Table 68: Conservation significant fauna species with the potential to occur within the development envelope

Species	Common name	Conservation status		Habitat description	Likelihood assessment
		EPBC Act	BC Act / DBCA		
Setonix brachyurus	Quokka	Vulnerable	Vulnerable	The quokka is a habitat specialist. In the north of its range it prefers dense understorey, less than ten years since fire, adjacent vegetation age that is greater than 25 years and the absence of feral predators. The understorey structure of the habitats currently inhabited by the quokka consist of dense, low vegetation that provides refuge from predation by owls, the fox (*Vulpes vulpes*) and the cat (*Felis catus*). These covered/shady microhabitats may also be important during the hotter months, particularly on Wadjemup / Rottnest Island, where animals converge in dense thickets of *Gahnia* spp. and *Acanthocarpus* spp. The main habitat for mainland populations of the quokka is dense riparian vegetation, but the species also uses a range of other habitat, including heath and shrubland on the mainland coast and offshore islands, swampy shrublands, swordgrass dominated understorey, paperbark (*Melaleuca* spp.) swamp.	**Recorded** Suitable habitat is present within development envelope.
Pandion haliaetus	Osprey	Migratory	Migratory	Eastern ospreys occur in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia and offshore islands. They are mostly found in coastal areas but occasionally travel inland along major rivers, particularly in northern Australia. They require extensive areas of open fresh, brackish or saline water for foraging.	**Potential** Marginal habitat for this species is present within the development envelope (coastal areas, trees for perching, adjacent ocean for foraging). Species is highly mobile and may utilise the development envelope as a transient visitor.
Tiliqua rugosa konowi	Rottnest Island bobtail	-	Vulnerable	Rottnest Island bobtails are common around limestone rocks and prefer limestone heath, woodland, and coastal habitats, but also be found around the Settlement Area.	**Recorded** Previously recorded by RIA (RIA; pers comms 5 January 2024)
Lerista lineata	Perth slider, lined skink	-	P3	The species was found in summer-scented wattle (*Acacia rostellifera*) scrub on Wadjemup / Rottnest Island in 2016. Occurs in white sand.	**Potential** Suitable habitat is present within development envelope.
Pseudonaja affinis exilis	Rottnest Island dugite	-	P4	Dugites live in abandoned burrows or hollow logs and prefer coastal habitat, limestone heath, woodland, and the Settlement areas of the island.	**Recorded** Previously recorded by RIA (RIA; pers comms 5 January 2024)

(Eco Logical Australia, 2024)

12.5 Potential environmental impacts

Table 69 provides the potential key impacts to terrestrial fauna from the proposal. These impacts are discussed in further detail in Sections 12.5.1 to 12.5.4.

Table 69: Potential impacts on terrestrial fauna

Phase	Impact class	Works / operations	Potential impacts
Construction	Direct	• Construction of the onshore project components	**Loss of terrestrial fauna habitat** • Removal of 0.46 ha of potential terrestrial fauna habitat. **Injury and / or mortality of terrestrial fauna** • Risk of injury of terrestrial fauna during vegetation clearing and ground disturbing activities.
		• Construction machinery and vehicles.	**Injury and / or mortality of terrestrial fauna** • Risk of collision risk with construction vehicles leading to injury/mortality of terrestrial fauna.
	Indirect	• Construction of the onshore project components.	**Alteration of fauna behaviour** • Altered fauna behaviour due to noise, lighting and increased human presence during construction of the proposal. **Indirect loss or impact to terrestrial fauna habitat from habitat degradation** • Indirect loss or impact to terrestrial fauna habitat from habitat degradation as a result of: – The introduction or spread of invasive species (pests and weeds) due to construction machinery and vehicles – The introduction or spread of disease (for example, dieback) due to construction machinery and vehicles. – Inappropriate disposal of waste. **Loss of terrestrial fauna habitat** • During construction activities, there is a risk that terrestrial fauna habitat outside the areas directly impacted will be accidentally cleared. **Localised erosion** • During construction activities, there is potential for localised erosion to occur adjacent to cleared areas.
Operation	Indirect	• Operation	**Indirect loss or impact to terrestrial fauna habitat from habitat degradation** • Indirect loss or impact to terrestrial fauna habitat from habitat degradation as a result of: – The introduction or spread of invasive species (pests and weeds) due to construction machinery and vehicles – The introduction or spread of disease (for example, *Phytophthora* dieback) due to construction machinery and vehicles. – Inappropriate disposal of waste. **Injury and / or mortality of terrestrial fauna** • Risk of collision risk with construction vehicles leading to injury/mortality of terrestrial fauna.

12.5.1 Assessment of impacts

12.5.1.1 Direct loss of terrestrial fauna habitat

Construction of the proposal will result in the removal of 0.46 ha of potential terrestrial fauna habitat. Conservation significant species which may occur within this habitat includes:

- *Lerista lineata* (Perth slider)

- *Pandion haliaetus* (osprey)
- *Pseudonaja affinis exilis* (Rottnest Island dugite)
- *Tiliqua rugosa konowi* (Rottnest Island bobtail)
- *Setonix brachyurus* (quokka).

12.5.1.2 Habitat degradation

Four introduced flora species were identified within the terrestrial survey area. None of these species were listed as Declared Pests under the BAM Act or Weeds of National Significance. The presence of weeds adjacent to the development envelope has the potential to increase as a result of construction activities. The presence of weeds has the potential to impact and degrade the terrestrial fauna habitat present.

The implementation of the weed hygiene management measures outlined in the CEMP is expected to reduce the risk of spread as a result of the proposal. The proposal is not expected to result in the spread of weeds that could have a significant vegetation and flora impacts.

There is potential for the movement of construction machinery to result in the introduction of disease (e.g. *Phytophthora* dieback). The implementation of the hygiene management measures outlined in the CEMP is expected to reduce the risk of disease introduction or spread as a result of the proposal.

An increase in litter due to incorrect waste disposal has the potential to impact the surrounding vegetation.

12.5.1.3 Injury and mortality of fauna species

Construction of the proposal may result in increased vehicle movements within the development envelope, which would increase the risk associated with vehicle strike. There is also potential for injury or mortality of displaced fauna during vegetation clearing activities. Construction activities will be undertaken in accordance with measures identified in the CEMP to ensure that the risk of these impacts is minimised.

It is unlikely operation of the proposal will significantly increase the potential for fauna strike, given the existing presence of roads within the area.

12.5.1.4 Altered fauna behaviour

During construction, there will be noise and vibration emissions due to vehicles movements and construction activities. Noise and vibration associated with construction of the proposal have the potential to result in short-term disturbance to fauna on a local scale. It is unlikely operation of the proposal will significantly alter fauna behaviour.

12.6 Mitigation

Table 70 demonstrates how the EPA’s mitigation hierarchy (avoid, minimise and rehabilitate) has been applied to the environmental factor of terrestrial fauna to address the key potential impacts.

Table 70: Application of mitigation hierarchy to terrestrial fauna

Potential environmental impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impacts
Removal of potential terrestrial fauna habitat	Direct	Avoid	Complete avoidance of direct impacts to fauna habitat is not possible.	**Removal of 0.46 ha of potential fauna habitat**
		Minimise	A CEMP (Emerge, 2024a) (Appendix P) will be implemented to ensure impacts to terrestrial fauna habitat is limited to the 0.46 ha within the development envelope. Management measures to minimise potential impacts outside the development envelope are discussed in this table.	
		Rehabilitate	There is no opportunity to rehabilitate the areas directly impacted by construction of the proposal.	
		Offset	Terrestrial fauna offsets are not considered applicable to the proposal.	
Habitat degradation from the introduction and spread of weeds and disease and incorrect waste disposal.	Indirect	Avoid	There is no opportunity to avoid the movement of construction vehicles within the area, as such the risk for the spread and introduction of weed species cannot be completely avoided.	**No residual impacts expected** With the implementation of the CEMP and OEMP, residual impacts to terrestrial fauna habitat resulting from the spread and introduction of weeds during construction are not considered significant.
		Minimise	• Construction management and monitoring measures to minimise impacts to terrestrial fauna habitat are detailed in the CEMP (Emerge, 2024a) (Appendix P) and includes: – Appropriate hygiene measures to minimise the risk of the spread and introduction of weed species – Extent of authorised disturbance will be clearly defined and demarcated on appropriate plans. The demarcated terrestrial construction works area to be surveyed prior to the commencement of vegetation removal works. Movement of construction vehicles within vegetation outside this area will be limited to avoid the risk of weed spread – Daily inspections and photographic records during clearing and construction activities – Inspections to verify no degradation or disturbance has occurred beyond the development envelope – Appropriate hygiene measures to minimise the risk of the spread and introduction of weed species: ○ Weekly spot checks of mobile equipment and vehicles ○ hygiene points at key road entry points ○ Implementation of the weed management protocol outlined in the CEMP – Stockpile management, including stockpile locations (within the development envelope), erosion and stabilisation techniques and height limits – Designated areas for the temporary placement of cleared vegetation (within the development envelope) to minimise the increased risk of weed and disease spread and bushfire • Operational management to minimise impacts to flora and vegetation is detailed in the OEMP (Emerge, 2024b) (Appendix Q). Implementation of this management plan will ensure that: – Vehicle access is controlled to designated roads and access – There is no introduction of weed species to the site as a result of operation.	
		Rehabilitate	Should the proposal result in the introduction of weed species, appropriate management and control measures will be implemented.	
		Offset	Terrestrial flora and vegetation offsets are not considered applicable to the proposal.	
Accidental clearing of potential fauna habitat	Indirect	Avoid	The risk for accidental vegetation clearing cannot be completely avoided.	**No residual impacts expected** With the implementation of the CEMP, residual impacts to terrestrial fauna habitat resulting from accidental clearing are not considered significant.
		Minimise	• Construction management measures to minimise impacts to terrestrial fauna habitat is detailed in the CEMP (Emerge, 2024a) (Appendix P) and includes: – Vehicles, plant, and equipment to be restricted within development envelope – The extent of authorised disturbance will be clearly defined and demarcated on appropriate plans. The demarcated terrestrial construction works area to be surveyed prior to the commencement of vegetation removal works – Installation of temporary fencing, inclusive of sediment controls, along the boundary of the terrestrial construction works area to restrict machinery access to be within the approved disturbance area • Monitoring during construction to minimise impacts to terrestrial fauna is detailed in the CEMP (Emerge, 2024a) (Appendix P) and includes: – Daily inspections and photographic records during clearing and construction activities – Inspections to verify no degradation or disturbance has occurred beyond the development envelope.	
		Rehabilitate	There is no opportunity to rehabilitate the areas directly impacted by construction of the proposal. Any accidental clearing outside the approved area will be rehabilitated.	
		Offset	Terrestrial fauna offsets are not considered applicable to the proposal.	
Injury and mortality of fauna species	Direct	Avoid	The risk for injury and / or mortality of fauna cannot be completely avoided.	**No residual impacts expected** With the implementation of the CEMP and OEMP, residual impacts to the injury or mortality of terrestrial fauna are not considered significant.
		Minimise	• Construction management measures to minimise impacts to terrestrial fauna is detailed in the CEMP (Emerge, 2024a) (Appendix P) and includes: – Vehicles, plant, and equipment to be restricted within development envelope – The extent of authorised disturbance will be clearly defined and demarcated on appropriate plans. The demarcated terrestrial construction works area to be surveyed prior to the commencement of vegetation removal works – Vegetation clearing will be undertaken progressively and towards retained vegetation – Vehicle speed limits will be implemented in accordance with the CEMP – If native fauna is encountered during clearing works it should, initially, be allowed to make its own way from the works area. However, if this is not possible or practicable, a qualified wildlife handler will be contacted to relocate it • It is unlikely operation of the proposal will significantly increase the potential for fauna strike, given the existing presence of roads within the area. The OEMP (Appendix Q) outlines measures to minimise the risk of injury to terrestrial fauna during operation.	
		Rehabilitate	Injured animals will be provided with first aid and handled on advice from the Wildcare Helpline and Rottnest Island Authority rangers.	
		Offset	Terrestrial fauna offsets are not considered applicable to the proposal.	

12.7 Assessment and significance of residual impact

The anticipated significance of the residual impacts of the proposal on terrestrial fauna following the implementation of mitigation measures are low as detailed in Table 71. The residual impacts are summarised below:

- Removal of 0.46 ha of potential terrestrial fauna habitat in Good to Degraded condition.

Table 71: Consideration of the significance of the residual impacts on terrestrial fauna

Matters for consideration	Response
The object and principles of the EP Act	Eco Logical (2024) undertook a basic terrestrial fauna survey within the terrestrial survey area (Figure 34) in accordance with EPA Technical Guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020). The Basic terrestrial fauna survey report is provided in Appendix K. The principles of the EP Act have been specifically addressed in relation to the proposal (Table 26).
Values, sensitivity and quality of the environment which is likely to be impacted	Conservation significant fauna species which were identified within the site or are likely to utilise the habitat present include: • *Lerista lineata* (Perth slider) • *Pandion haliaetus* (osprey) • *Pseudonaja affinis exilis* (Rottnest Island dugite) • *Tiliqua rugosa konowi* (Rottnest Island bobtail) • *Setonix brachyurus* (quokka). Focused Vision Consulting undertook flora and vegetation surveys within the area shown in Figure 32. The vegetation surveyed by Focused Vision Consulting that was most analogous to the vegetation present within the development envelope comprised the vegetation units MIAp and MIGl with a combined area of 67.39 ha. As such, it has been assumed that there is approximately 67.39 ha of similar fauna habitat to the 0.46 ha being directly impacted within vicinity of the proposal. It is also considered likely that the vegetation and associated fauna habitat is not restricted locally to the FVC and RPS survey areas and is more widespread on the island. The direct impacts to 0.46 ha of potential fauna habitat comprises 0.68% of the larger area surveyed by Focused Vision Consulting. Wadjemup / Rottnest Island encompasses approximately 1,800 ha, most of which is vegetated. If a conservative estimate is adopted, with an assumption that half of the island remains vegetated, clearing 0.46 ha of vegetation comprising potential fauna habitat would comprise 0.05% of the vegetation present on the island. Direct impacts to habitat suitable for these species are limited to 0.46 ha and is not considered significant when considering the terrestrial fauna habitat present outside the development envelope.
All stages and components of the proposal (such as any infrastructure required for the proposal to be practicably implemented, or a proposal life cycle)	All stages of the proposal (i.e. construction and operation) have been included in this impact assessment.
Extent (intensity, duration, magnitude, and geographic footprint) of the likely impacts	Construction of the proposal will result in the removal of 0.46 ha of potential fauna habitat in Good to Degraded condition. Implementation of the CEMP will ensure that indirect impacts to terrestrial fauna species will be minimal and localised to the development envelope.
Resilience of the environment	The vegetation comprising potential habitat for terrestrial fauna species within the development envelope ranges from Degraded (32.2% of vegetation in the development envelope) to Good to Degraded (67.8% of vegetation in the development envelope). As there is vegetation in better condition outside the development envelope, the environment is considered resilient to the clearing proposed as part of this proposal.

Matters for consideration	Response
Consequence of the application of the mitigation hierarchy to the proposal.	The WA Offsets Guidelines (Government of Western Australia 2014) identifies four levels of significance for residual impacts: • Unacceptable impacts – those impacts which are environmentally unacceptable or where no offset can be applied to reduce the impact. Offsets are not appropriate in all circumstances, as some environmental values cannot be offset. • Significant impacts requiring an offset – any significant residual impact of this nature will require an offset. These generally relate to any impacts to species, ecosystems, or reserve areas protected by statute or where the cumulative impact is already determined to be at a critical level. • Potentially significant impact which may require an offset – the residual impact may be significant depending on the context and extent of the impact. These relate to impacts that are likely to result in a species or ecosystem requiring protection under statute or increasing the cumulative impact to a critical level. Whether these impacts require an offset will be determined by the decision-maker based on information provided by the proponent or applicant and expert judgement • Impacts which are not significant – impacts which do not trigger the above categories are not expected to have a significant impact on the environment and therefore do not require an offset. Following the application of the mitigation hierarchy outlined in Table 70 and taking into consideration the above significance of residual impacts model, RPS considers that there are no significant residual impacts to terrestrial fauna from the proposal.
Level of confidence in the prediction of residual impacts and the success of proposed mitigation	The impact assessment has been completed with a high level of confidence in the predictions of residual impacts on terrestrial fauna, with the required scientific assessments conducted in accordance with relevant guidance and legislation (Table 66).
Public interest about the likely effect of the proposal or scheme, if implemented, on the environment, and relevant public information	RIA has facilitated regular meetings / dialogue with the local community and key stakeholders (Table 25) as part of the project.

Cumulative impacts from the proposal have been considered in relation to other proposals within 5 km of the proposal and are discussed in Section 18.

Holistic impacts are discussed in Section 17.

12.8 Environmental outcomes

In consideration of the proposed avoidance and management measures and likely residual impacts associated with the proposal, the environmental outcomes that apply to terrestrial fauna are:

- Direct impacts to potential fauna habitat resulting from the proposal will not exceed 0.46 ha of native vegetation.
- No introduction of new weed species attributable to the proposal.
- No increase in incidents of terrestrial fauna injury or death during construction associated with the proposal works.

Adaptive management measures will be implemented in accordance with the CEMP to ensure this environmental outcome is met. As the impact assessment identified low residual risks to terrestrial fauna following the application of mitigation actions identified herein, it is considered that the proposal will successfully meet this the EPA's objective to protect terrestrial fauna.

13 SOCIAL SURROUNDINGS

13.1 EPA objective

To protect social surroundings from significant harm.

13.2 Policy and guidance

The proposal will be subject to compliance with applicable policies and guidance developed to assist proponents and the public to understand the minimum requirements for the protection of elements of the environment that the EPA expects to be met during the assessment process.

Table 72 lists relevant EPA guidance, other state and Commonwealth legislation / policy, and provides consideration for how these documents informed the proposal.

Table 72: Relevant legislation, policy and guidance

Legislation, policy and guidance	Consideration
Aboriginal Heritage Act 1972	The *Aboriginal Cultural Heritage Act 2021* superseded the *Aboriginal Heritage Act 1972* on 1 July 2023 but was repealed and the 1972 Act reinstated on 15 November 2023. The *Aboriginal Heritage Act 1972* is the legislation that manages Aboriginal cultural heritage (ACH) in Western Australia. Approval is required where there is potential for any harm to an Aboriginal site. Approval may be required from either the Minister for Aboriginal Affairs or the Registrar of Aboriginal Sites for any activity which may harm ACH. There are four types of authorisations: • Section 18 consent – for more significant impacts and harm to Aboriginal sites • Section 16 authorisation – for excavation purposes (generally related to research) • Regulation 7 approval – to bring plant and equipment to an Aboriginal site • Regulation 10 consent – for more minor activities and impacts. Brad Goode and Associates Pty Ltd conducted a Site Identification Ethnographic Aboriginal Heritage Survey to determine potential impacts to any sites or places of Aboriginal heritage significance as defined by section 5 of the *Aboriginal Heritage Act 1972* (Brad Goode and Associates, 2019).
Environmental Factor Guideline – Social Surroundings (EPA, 2023)	The purpose of this guideline is to identify how the factor social surroundings is considered by the EPA in the environmental impact. The proposal considers the mitigation hierarchy; direct and indirect impacts; implications of cumulative impacts; predicted residual impacts associated within social surroundings. Section 13.4 provides a detailed review of social surrounding aspects likely to be impacted by the proposal, including Aboriginal heritage, natural and historical heritage (including shipwrecks), and recreational values. The environmental factor guideline identifies the key social surrounding aspects and their significance, provides an overview of the key issues and identifies development activities likely to impacts social surroundings values. The EPA considers that many impacts to ACH may be mitigated by the *Aboriginal Heritage Act 1972* processes, provided those processes are likely to result in avoidance or minimisation of harm to those sites. Where *Aboriginal Heritage Act 1972* processes are not reasonably likely to meet the EPA's objectives for social surrounding and ACH values, an EPA assessment may still be required.
Technical Guidance Environmental impact assessment of Social Surroundings – Aboriginal cultural heritage (EPA, 2023b)	The EPA acknowledges the repealed *Aboriginal Cultural Heritage Act 2021* and has adjusted its Environmental Factor Guideline - Social Surroundings and related Technical Guidance to reflect the role of the amended and restored *Aboriginal Heritage Act 1972*. The Technical Guidance provides additional information on procedures and the EPA's environmental impact assessment process for Social Surroundings under the *Environmental Protection Act 1986* (EPA, 2023b).
Underwater Cultural Heritage Act 2018	Provides for the protection of Australia's shipwrecks and has broadened protection to sunken aircraft and other types of underwater cultural heritage including Australia's Aboriginal and Torres Strait Islander Underwater Cultural Heritage in Commonwealth waters.
Maritime Archaeology Act 1973	The state *Maritime Archaeology Act 1973* protects pre-1900 maritime archaeological sites on state lands and in state waters. Maritime archaeological site types include shipwrecks and relics associated with historic ships

Legislation, policy and guidance	Consideration
Heritage Act 2018	State legislation that recognises and promotes historic heritage by defining principles for conservation, use, development or adaptation for heritage places. A search of the Heritage Council's Inherit database was undertaken to identify any state and local government listed heritage places proximate to the proposal.

13.3 Environmental investigations

13.3.1 Ethnographic Aboriginal Heritage Survey

Brad Goode and Associates undertook an Ethnographic Aboriginal Heritage Survey of the area shown in Figure 37 to support the proposal (a previous project design) in 2019 (Appendix W). As part of the survey, Brad Goode and Associates undertook the following:

- A search of the DPLH Aboriginal Heritage Inquiry System conducted on 22 January 2019
- Archival research
- Consultations with seven representatives of the Whadjuk NTC group on 5 February 2019.

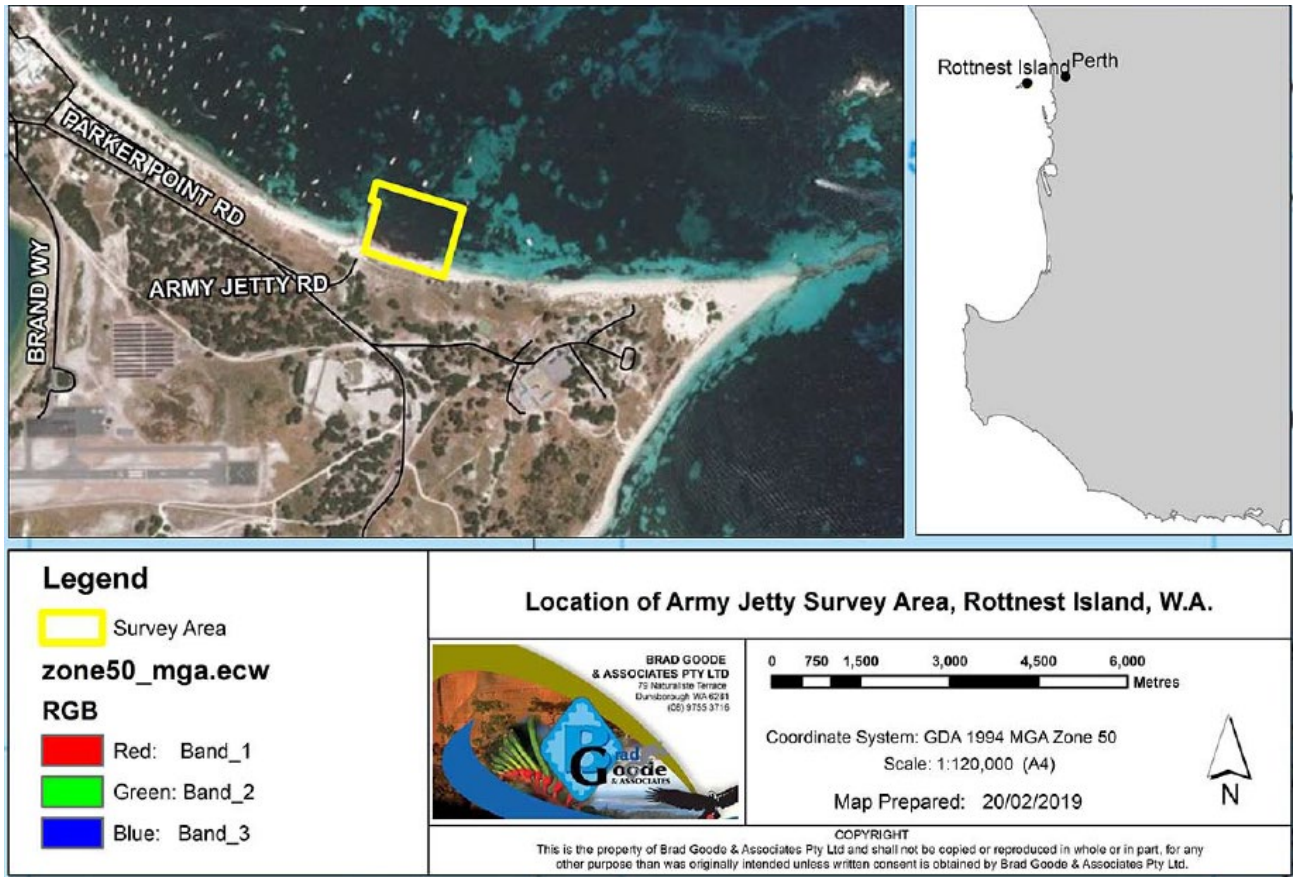


Figure 43: Ethnographic Aboriginal heritage survey area

13.3.2 UXO survey

Surrich Hydrographics undertook a UXO survey in November 2019 over the previously proposed dredge area. The survey area is shown in Figure 38. The survey used the marine magnetic method, which responds to artificial ferrous objects above and below the seabed, as well as magnetic minerals in the seabed geology.

Based on the outcomes of the survey undertaken by Surrich, a follow up survey was undertaken in December 2019 by TAMS Group to resolve the anomalies identified by Surrich.

The South Thomson Bay Magnetic Survey (Surrich, 2019) and Rottnest Island Authority – Geological Investigation – Thomson Bay South and UXO investigation/anomaly recovery report (TAMS Group, 2019) are provided as Appendix T.

Figure 44: UXO survey area (red boundary)

13.3.3 Stakeholder engagement

Stakeholder engagement undertaken to support the proposal is discussed in Section 4 and has included potential impacts to social surroundings such as tourism and recreational values.

13.3.4 Airborne noise assessment

Herring Storer Acoustics undertook an acoustical assessment of noise emissions associated with the existing barge operations at the Main Jetty to ascertain the noise impact that operations at the facility have on surrounding commercial and residential premises. As the only change proposed to the existing barge operations is relocation, the noise assessment can be used to address potential airborne noise impacts from barge activities at the new location.

The criteria considered in the assessment are the Environmental Protection (Noise) Regulations 1997 requirements. These regulations stipulate maximum allowable external noise levels at various types of premises. The baseline assigned outdoor noise levels are provided in the noise assessment report provided in Appendix U.

13.4 Receiving environment

13.4.1 Tourism, recreation and fishing

Wadjemup / Rottnest Island is a popular tourist destination and the Wadjemup / Rottnest Island marine environment is widely used for swimming, boating and fishing. Although swimming is prohibited between the Main Jetty and the Fuel Jetty in South Thomson Bay, recreational swimming occurs elsewhere in the bay, including the development envelope.

Wadjemup / Rottnest Island and the surrounding marine waters are protected by a reserve for public recreation and conservation. The marine waters within the development envelope are within the Rottnest Island Marine Reserve boundary and can be used for recreational fishing, however it is closed to spear fishing and commercial or amateur net fishing (Figure 39). Recreational fishing undertaken in the area (depending on the season) includes rock lobster, abalone, squid, cuttlefish and octopus fishing, crabbing and line fishing.

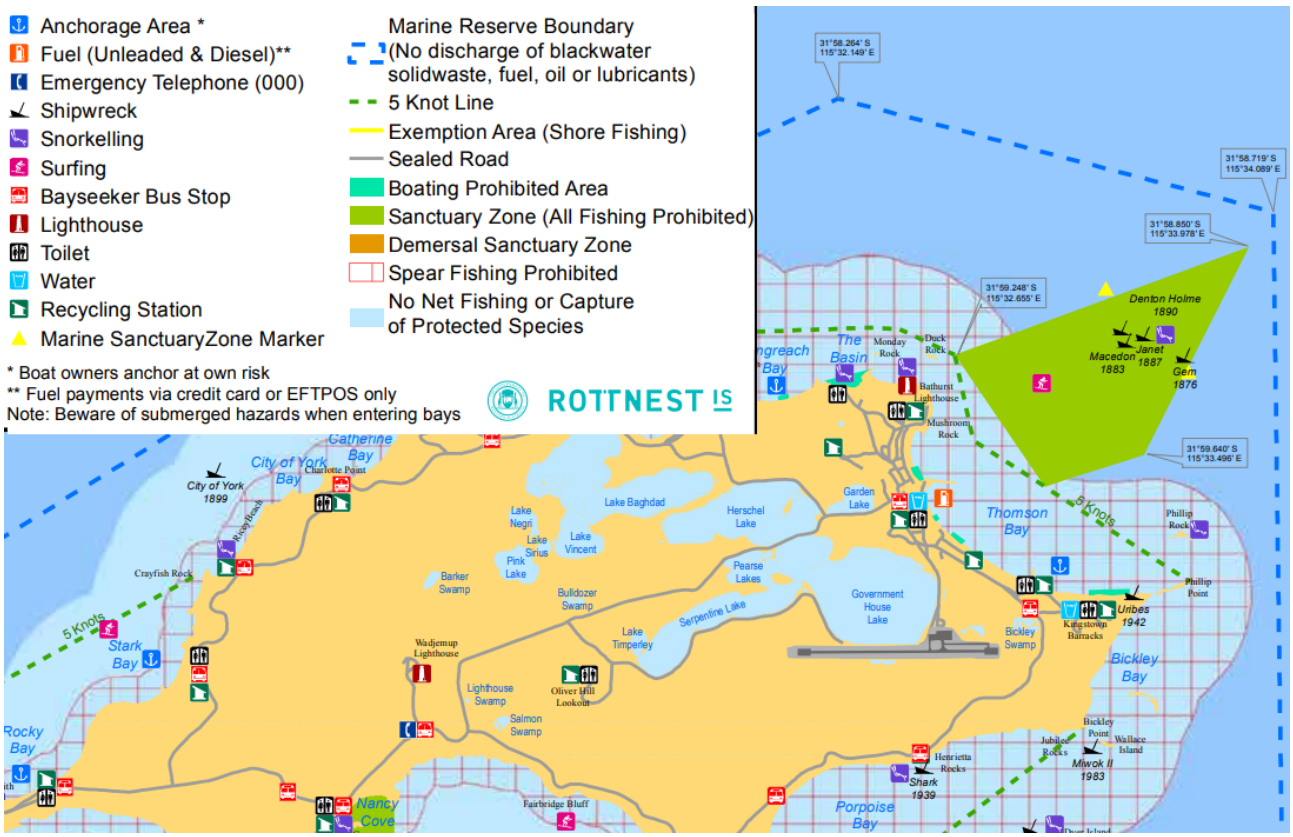


Figure 45: Rottnest Island marine and boating guide reserve map (Rottnest Island Authority 2023)

Recreational boating is a popular activity with the Wadjemup / Rottnest Island marine waters. There are no designated water ski areas within the Rottnest Island Marine Reserve. However, a five-knot speed limit applies in most bays around the island, including South Thomson Bay (Figure 40).

Rottnest Island Authority provides 37 beach anchoring points, 27 of which are located within Thomson Bay. There are also private mooring buoys, which are privately leased and part of the Shared Mooring System and emergency mooring buoys. The location of moorings within vicinity of the site are shown in Figure 45.

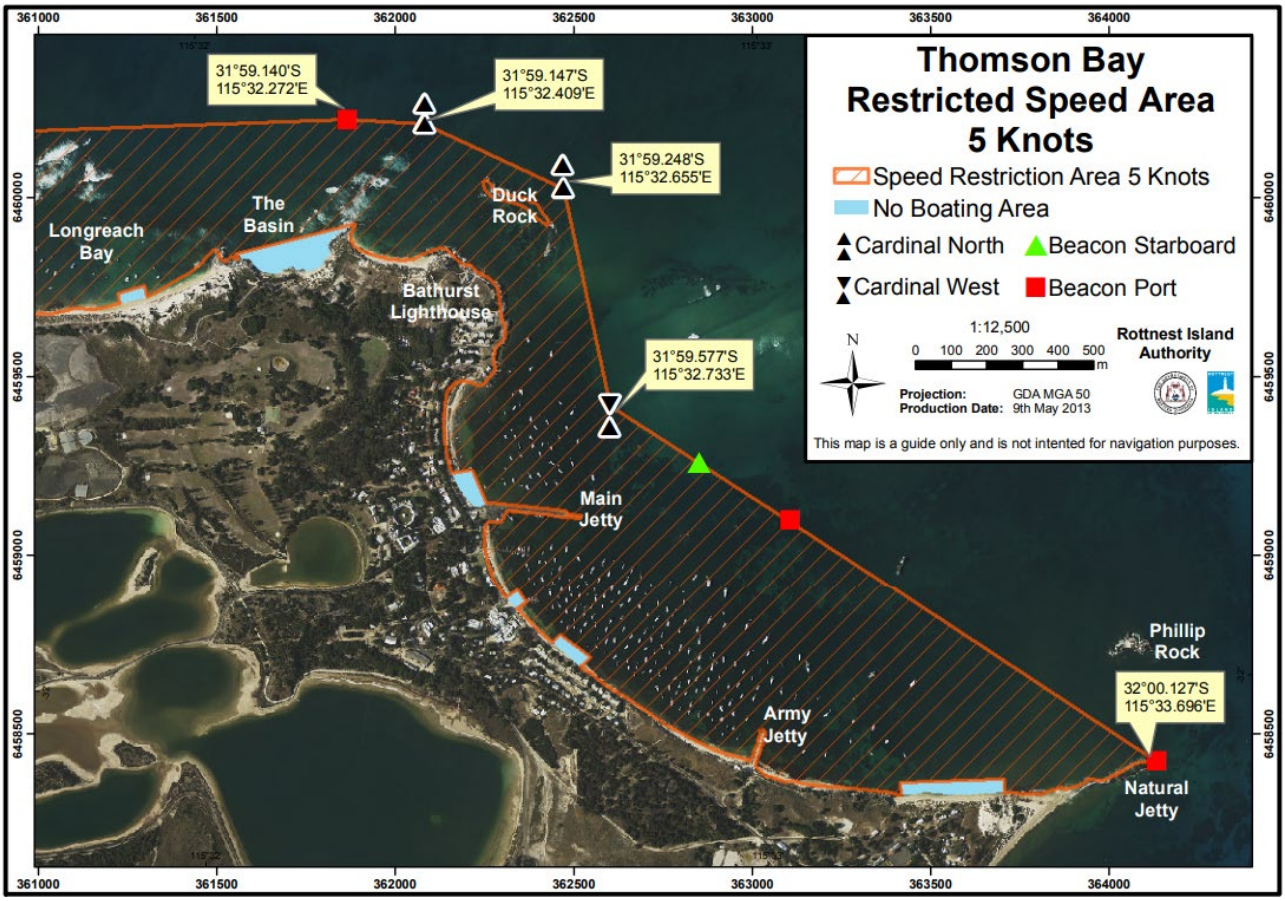


Figure 46: Restricted speed area within Thomson Bay (Rottnest Island Authority, 2013)

13.4.2 Aboriginal heritage

A search of the DPLH's Aboriginal Heritage Inquiry System database was undertaken in April 2024 and did not identify any Aboriginal cultural heritage (ACH) within or adjacent to the development envelope. The closest registered ACH to the development envelope is Aboriginal Cultural Heritage Register Place 39697. This ACH Place is located over 400 m from the development envelope and will not be impacted by the proposal.

During the Ethnographic Aboriginal Heritage Survey undertaken by Brad Goode and Associates (2019), consultation was undertaken with seven representatives of the Whadjuk NTC group, the outcomes of this consultation are summarised below (Brad Goode and Associates, 2019):

- No new ethnographic sites, as defined by section 5 of the *Aboriginal Heritage Act 1972* were identified. However, the group representatives identified the potential for artefacts to occur in the subsurface and potential burials could be located in the dunes close to the development envelope.
- As no ethnographic sites of significance as defined by section 5 of the *Aboriginal Heritage Act 1972* were identified, it is recommended that Rottnest Island Authority can proceed with the proposal without undue risk of breaching the *Aboriginal Heritage Act 1972* in relation to ethnographic sites and places.

Additional consultation was undertaken in 2024 with SWALSC to confirm whether a more recent survey was required. SWALSC recommended that as long as the actions outlined in Section 13.5.1.2.1 are implemented, then additional heritage surveys are not necessary.

13.4.3 Natural and historic heritage

A search of the Heritage Council's Inherit database was undertaken in April 2024, the results are shown in Figure 41.

Wadjemup / Rottnest Island is mapped as a heritage place (place number 03650) by the Heritage Council and is also listed as a heritage place by the Register of the National Estate (indicative place) and National Trust. The values of this heritage place are summarised below:

- The place is rare as a whole island significant for its role in the early establishment of farming, Defence, and imprisonment of Indigenous.
- Significant role in history of contact with Aboriginals and imprisonment.
- The place plays a significant role in Western Australia's early pioneer history and pastoral industry.
- The place has aesthetic value as it contributes to Perth's Sense of place and it is visible from a large portion of Western Australia's coastline.

Kingstown Barracks (Place Number 00525) is located east of the site, although the barracks are not located within or adjacent to the development envelope, the heritage place mapping is located along the eastern boundary of the development envelope as shown in Figure 41. Any impacts to infrastructure and buildings associated with this heritage place have been avoided.

The Commonwealth Heritage List is a list of Indigenous, historic and natural heritage places owned or controlled by the Commonwealth Government that are of significant heritage value. There are no world, national or Commonwealth heritage places within vicinity of the proposal.

Although not a registered heritage site, the Army Groyne was built in 1906 and stakeholder consultation indicates potential community concerns over protection of the heritage values of the jetty (refer to Section 4).

Figure 47: Historic heritage

13.4.4 Shipwrecks

Australia protects its shipwrecks, sunken aircraft and other types of underwater heritage and their associated artefacts through the *Underwater Cultural Heritage Act 2018*. A search of the Australasian Underwater Cultural Heritage Database (DCCEEW, 2023b) identified no historic shipwrecks within or adjacent to the development envelope listed under the Commonwealth *Underwater Cultural Heritage Act 2018*. Furthermore, a search of the Western Australia Shipwrecks Database did not identify any shipwrecks within or adjacent to the development envelope. The closest shipwreck is the *Uribes* (1942/07), which is located approximately 500 m from the eastern edge of the development envelope, and within the ZoI (Figure 42).

As there are no shipwrecks occurring within the development envelope and potential impacts within the ZoI includes temporary increased suspended sediments, impacts to the *Uribes* are not likely to significant and no further mitigation or management is considered necessary.

Figure 48: Social surroundings

13.4.5 Unexploded ordnance

As a result of military training and live firing undertaken by Australian and Allied forces, there are areas throughout Australia (outside Commonwealth land) that may be subject to residual UXO contamination. The Department of Defence has mapped areas at risk of UXO contamination. A review of this mapping indicates that the terrestrial component of the development envelope is mapped as having a slight potential for UXO to occur, while there is a defence sea dumping site approximately 3 km north of the development envelope (Figure 43).

Sites categorised as having a slight potential for UXO to occur are those that have a confirmed history of military activities that often results in numerous residual hazardous munitions, components or constituents; but where confirmed UXO affected areas cannot be defined. Alternatively, sites categorised as slight may have a confirmed history of military activities of a type that sometimes results in occasional residual UXO.

The Department of Defence recommends that, although current land use may continue without further UXO investigation or remediation, consideration should be given to obtaining specialist advice and undertaking a detailed UXO Risk Assessment and developing a UXO Management Plan, as necessary. Consequently, due to the risk for UXOs to occur in the area (Figure 43), Surrich (2019) undertook a magnetic field survey for UXO.

The survey identified 48 ferrous debris targets, six of which were confirmed to be debris and not UXO. Further assessment undertaken by TAMS Group identified that at least ten anomalies require revisits for further confirmation of the UXO risk.

Liaison with RIA has been undertaken to further identify the ferrous targets. Historical photography indicates that the rectangular area to the east of the proposal is likely to be a historical mooring area or enclosed swimming area (Plate 12). The results of the magnetic field survey are provided in Appendix U and shown in Figure 44.

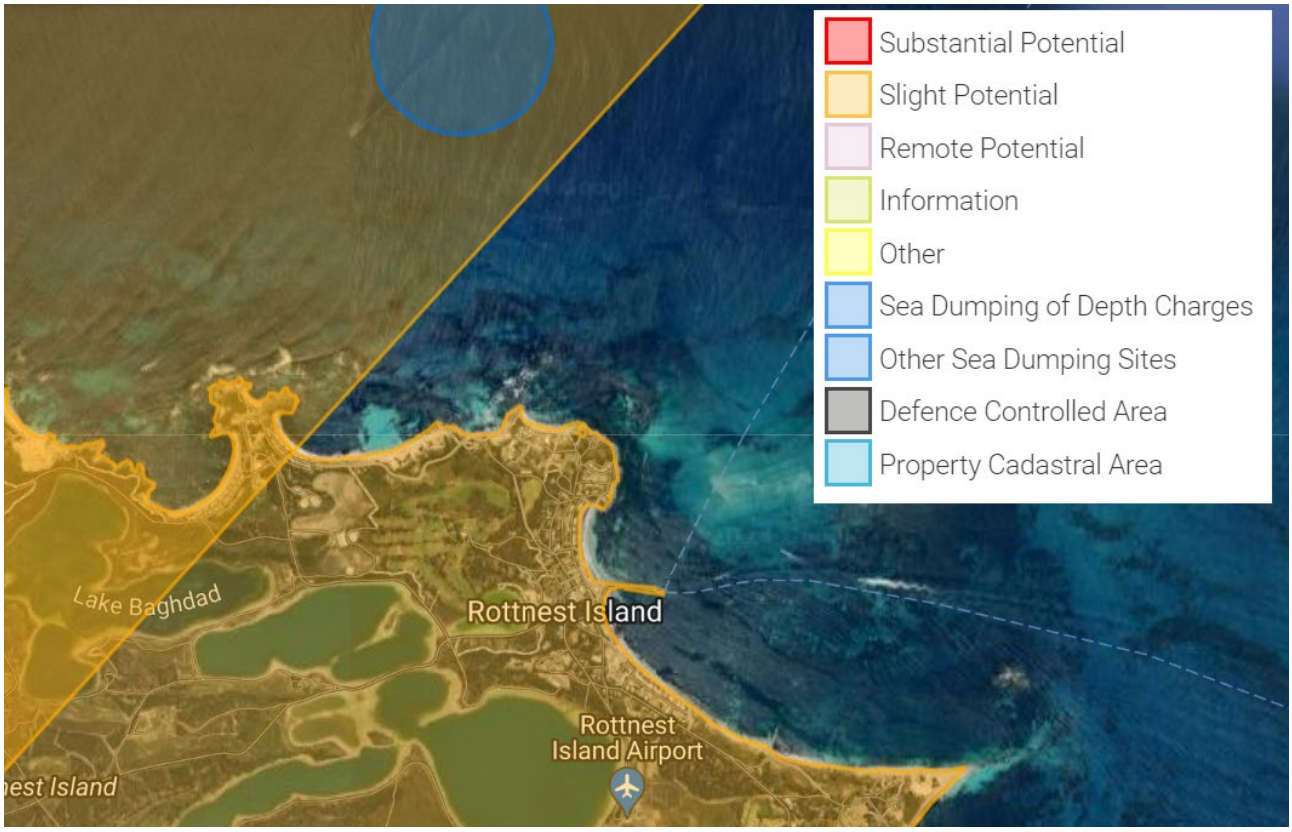


Figure 49: UXO risk mapping

Plate 12: Historical mooring area or enclosed swimming area to the east of the proposal

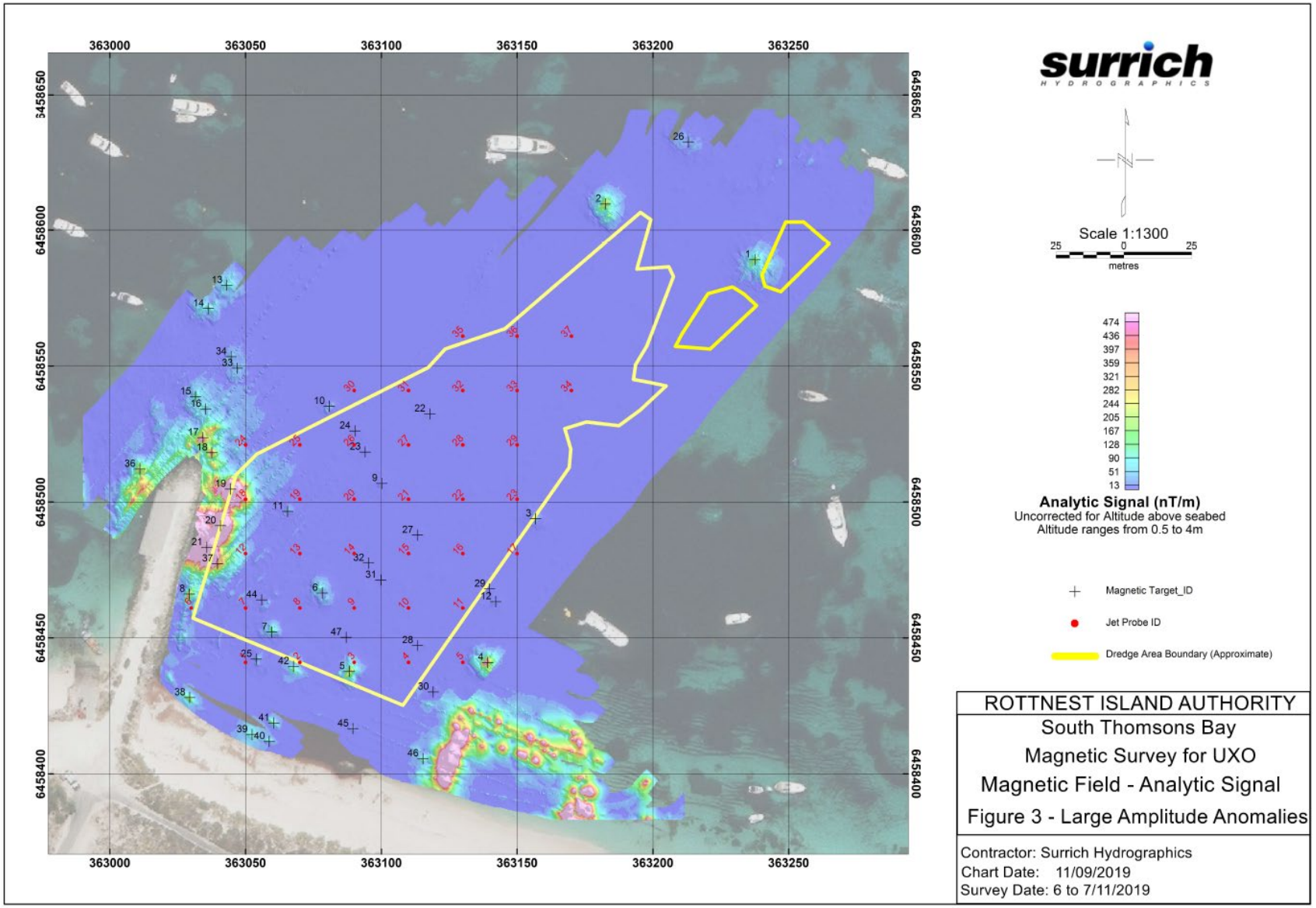


Figure 50: Magnetic field survey for UXO

13.5 Potential environmental impacts

Table 73 provides the potential key impacts to social surroundings from the proposal.

Table 73: Potential impacts on social surroundings

Phase	Impact class	Works/operations	Potential impacts
Construction	Direct	• Ground disturbing activities • Dredging activities	**Potential impacts heritage** • Potential impacts to previously unidentified ACH • Community concerns regarding heritage values of the Army Groyne **Impacts to recreational values** • Construction of the proposal will require the temporary relocation of some moorings **Potential disturbance of UXO** • There is a risk for dredging and ground disturbing activities to disturb UXO.
	Indirect	• Construction of the offshore project components	**Impacts to recreational values** • The minor loss of marine habitat may have consequences for recreational fisheries in the South Thomson Bay through the loss of potential feeding and spawning habitat • Construction of the proposal has potential to impact public safety, such as swimmers and recreational beach users **Impact to amenity** • Construction of the proposal has the potential to impact amenity.
Operation	Indirect	• Offshore project components	**Impacts to recreational values** • Implementation of the proposal will result in the relocation of some moorings and loss of informal moorings • Operation of the proposal has potential to impact public safety, such as swimmers and recreational beach users **Impact to amenity** • The proposal has the potential to impact amenity.

13.5.1 Assessment of impacts

13.5.1.1 Impacts to recreational values

13.5.1.1.1 Relocation of moorings

Construction and operation of the proposal will require the temporary and permanent relocation of some moorings during construction and operation as summarised below and shown in Figure 45:

- Temporary relocation of eight moorings during construction of the proposal. The temporary relocation will be undertaken prior to construction commencing to minimise disruption to users. The relocation will be for the duration of construction, for approximately 18 months.
- The permanent relocation of four moorings will be undertaken prior to construction to minimise disruption to users.
- No moorings will be permanently removed.

Rottnest Island Authority has undertaken consultation with the mooring licensees regarding the proposal and will work with the impacted mooring licensees. Consultation undertaken to date regarding relocation of moorings is provided in Section 4.

13.5.1.1.2 Impacts to recreational fishing

Loss of marine habitat, primarily the loss of seagrass associated with construction of the proposal has the potential to result in indirect impacts to marine fauna species through loss of foraging opportunities and changes to marine environmental quality. This minor loss of marine habitat may have consequences for recreational fisheries in the bay through the loss of potential feeding and spawning habitat.

Potential impacts to marine fauna and habitat as a result of changes in water quality are discussed in more detail in Sections 7.5.1.1, 9.5.1.1 and 10.5.1.1 and is summarised below:

- Direct (permanent) impacts to 2.06 ha of mixed seagrass and 1.26 ha of sand / sand with wrack within the development envelope and ZoHI
- 2.62 ha of mixed seagrass and 1.09 ha of sand / sand with wrack within the ZoMI. It is predicted that benthic communities and habitats that are impacted within the ZoMI will recover within a five-year period
- 5.13 ha of mixed seagrass, 1.13 ha macroalgae dominated community, 0.35 ha of limestone reef / pavement and 6.70 ha of sand / sand with wrack within the ZoI. Changes in environmental quality associated with dredge plumes in the ZoI are not predicted to result in a detectible impact on benthic biota.

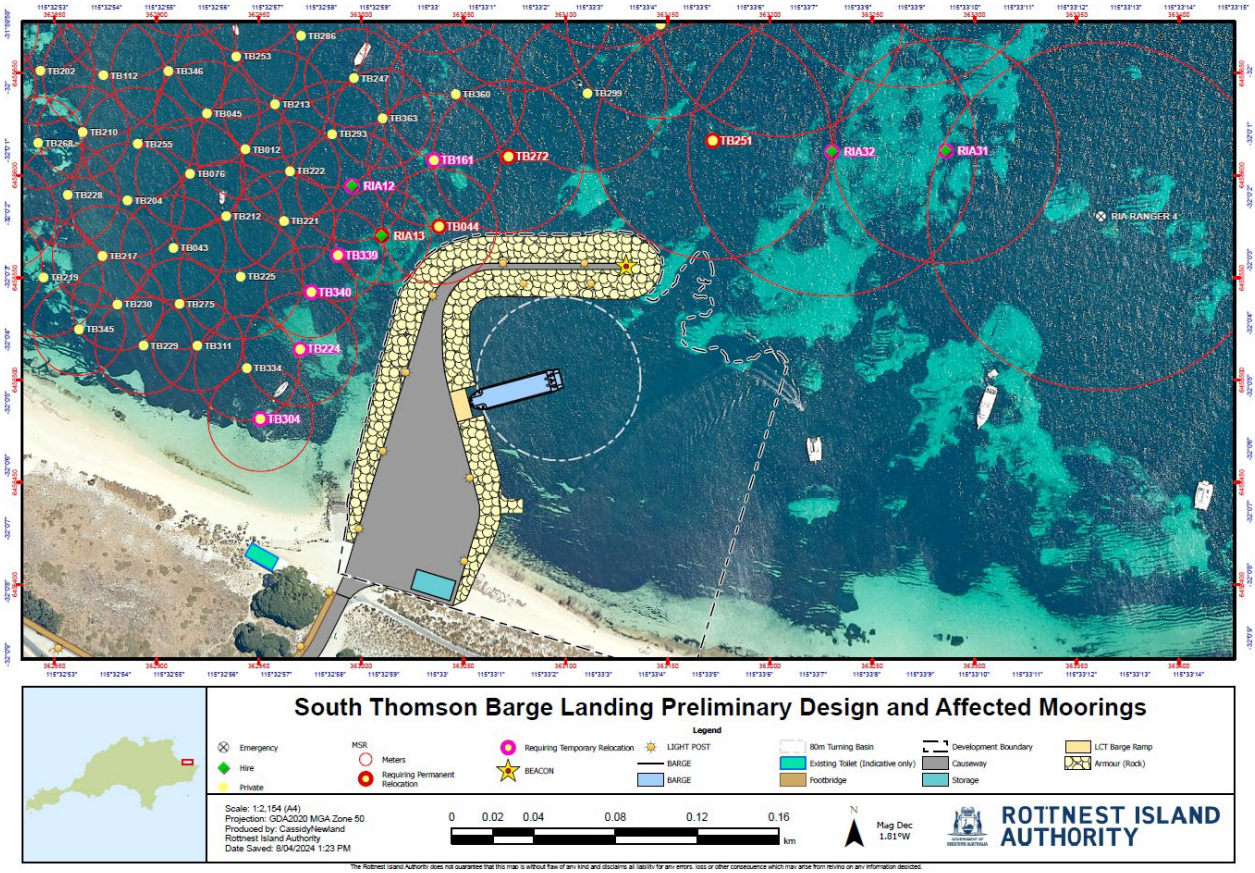


Figure 51: Location of impacted moorings

13.5.1.1.3 Impacts to public safety

There is potential for impacts to public safety during construction and operation of the proposal as summarised below:

- There is a risk to marine traffic during construction and operation of the proposal. However, as the Department of Transport (DoT) determined that a navigational channel and markers were not required, the risk to boating users from the relocation of barge traffic is not expected to be significant.
- Potential safety risks to swimmers within vicinity of the proposal. However, as RIA will install floating markers and signs at the entrance to the barge landing (within the development envelope) to prevent boat anchorage and swimming in peak season, this risk is unlikely to be significant.

13.5.1.2 Heritage

13.5.1.2.1 Aboriginal heritage

There are no registered ACH sites within the development envelope and the consultation was undertaken with seven representatives of the Whadjuk NTC group confirmed that Rottnest Island Authority can proceed with the proposal without undue risk of breaching the *Aboriginal Heritage Act 1972* in relation to ethnographic sites and places.

There is risk for previously unearthed artefacts or burials to be identified during ground disturbing activities. The risk of this will be managed through implementation of the CEMP which includes the requirement for archaeological monitors to be present during all ground disturbing works.

Consultation undertaken with representatives of the Whadjuk NTC group recommended the following:

- Archaeological monitors are present during all ground disturbing works and that archaeological techniques, such as test pitting and sieving, are employed if artefacts are found.
- Due to the spiritual sentiment associated with the area, the Whadjuk NTC group representatives requested that a proprietary ritual be performed prior to the works occurring.
- The Whadjuk NTC group representatives requested that interpretative signage be installed at the site to provide people visiting the island with more information about Aboriginal history of the area.

13.5.1.2.2 Historic heritage

There are no registered cultural heritage sites within the development envelope and the Army Groyne is not registered as a heritage site. Therefore, there will be no significant impacts to registered cultural heritage as a result of implementing the proposal. However, the Army Groyne was constructed in 1906 and there are community concerns regarding impacts to the heritage values of the site. These concerns will be addressed in ongoing consultation regarding the proposal.

Ongoing stakeholder engagement has been undertaken with the Heritage Council as summarised in Section 4. This engagement indicates that the Heritage Council has no significant concerns regarding the proposal, as long as impacts to the Kingstown Barracks are avoided (David Pond, personal communication, 12 July 2024).

13.5.1.3 Impacts to amenity

Potential impacts to amenity resulting from the proposal are summarised below:

- Potential noise emissions to air from construction and operation of the proposal.
  - Kingston Barracks and the South Thomson Bay units are located approximately 500 m from the proposal. The construction and operation of the proposal will generate noise emissions that may result in a reduction of amenity in the immediate area of the source.
  - An airborne noise assessment was undertaken of the current barge operations (Appendix U). Noise emissions from the existing operations at the Rottnest Barge Facility comply with the criteria set out by the Environmental Protection (Noise) Regulations 1997 at all times (Herring Storer, 2024).
  - As the existing barge operations comply with the criteria set out by the Environmental Protection (Noise) Regulations 1997, it is predicted that the relocated operations will also comply with the regulations and no significant noise impacts from the proposal are anticipated.
- Changes to visual amenity within the vicinity of the proposal.
  - As there is an existing groyne within the development envelope, extension of this groyne to support the proposal is unlikely to result in a significant change to visual amenity.
- Potential for items or materials (e.g. waste) to be transported through the proposed facility during operations which may result in odour emissions. The risk of significant impacts from odour emissions is low as the majority of materials transported through the new facility are inert with low potential for odour. The transport of waste compactors through the facility will be limited to set times to further reduce the risk of impacts to amenity.

- Potential visual amenity impacts from artificial lighting will be minimised where safety allows. Lighting will be limited to specific purposes such as to ensure the safety of vessels and public at night and will be in accordance with the following:
  - Australian Standard DR AS/NZS 1158.3.1:2018 Lighting for roads and public spaces pedestrian area (Category P) lighting
  - Australian Standard AS/NZS 4282:2019 Control of the obtrusive effects of outdoor lighting
  - National light pollution guidelines for wildlife (DCEEW, 2023).

13.5.1.4 Disturbance of UXOs

As discussed in Section 13.4.5, Wadjemup / Rottnest Island has been categorised by the Department of Defence with a residual UXO potential as slight.

Although the marine component of the development envelope was not mapped as having a risk of UXO occurring, the marine environment approximately 3 km to the north-west of the site is at risk of UXO occurring. Due to the risk of UXO in the area, Surrich (2019) undertook a magnetic field survey for UXO to further delineate the risks. The survey identified 48 ferrous debris targets, six of which were confirmed to be debris and not UXO.

As there are ferrous debris targets within the development envelope that may be UXO, there is a risk for dredging and ground disturbing activities to disturb UXO.

13.6 Mitigation

Table 74 demonstrates how the EPA's mitigation hierarchy (avoid, minimise and rehabilitate) has been applied to the environmental factor of social surroundings to address the key potential impacts.

Table 74: Application of mitigation hierarchy to social surroundings

Potential environmental impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impacts
Impacts to recreational values (recreational fishing)	Indirect	Avoid	• Complete avoidance of indirect impacts to potential marine fauna habitat is not avoidable.	**No residual impacts expected** Implementation of the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O) provides the monitoring and management framework to address potential impacts to marine fauna habitat that may indirectly impact recreational fishing. Implementation of these management plans ensures that impacts to marine environmental quality outside the ZoI, ZoMI and ZoHI from a temporary increase in suspended sediments are unlikely and residual impacts to recreational fishing are not considered significant.
		Minimise	• Management and mitigation proposed during construction to minimise impacts to benthic communities and habitats is detailed in the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O). Implementation of these management plans will ensure that the area of benthic communities and habitats permanently impacted by the proposal is limited to the development envelope and ZoHI • Management and mitigation proposed during construction to minimise impacts to marine environmental quality, which may result in impacts to recreational fishing, is detailed in the CEMP (Emerge, 2024a) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O). Implementation of these management plans will ensure that: – The area affected by reduced water quality (suspended sediments) during dredging and construction will be limited (wherever possible) and will not extend past the modelled ZoHI, ZoMI and ZoI – Marine environmental quality will be maintained at a moderate level of ecological protection during dredging and return to a High Level of Ecological Protection within two weeks following completion of dredging • Implementation of the CEMP and DEMMP provides the monitoring and management framework to address potential impacts to marine environmental quality during construction that may indirectly impact recreational fishing values. Key management and monitoring measures include: – Implementation of the Marine Water Quality Monitoring Program (MWQMP) provided in the DEMMP for suspended sediment – Inspections of all dredge equipment to check for leaks or damage • Operational management to minimise impacts to the marine environment is detailed in the OEMP (Emerge, 2024b) (Appendix Q). • Maintenance dredging (if required) will be undertaken in previously disturbed / sandy areas within the development envelope / project footprint where possible. Maintenance dredging frequency, volumes and disposal will be determined as required. Environmental management and monitoring will be undertaken in a manner that is consistent with the document Maintenance Dredging Environmental Management Framework (BMT Oceanica, 2016) prepared for Department of Transport for similar types of maintenance dredging activities. • Marine users to comply with vessel operational restrictions required by DoT and RIA.	
		Rehabilitate	Construction effects (outside the development envelope and ZoHI) on recreational fishing will be temporary and natural amelioration will mitigate or remove long-term impacts following cessation of construction activities.	
		Offset	Social surroundings offsets are not considered applicable to the proposal.	
Impacts to recreational values (public safety)	Direct	Avoid	• The proposed upgrades to the Army Groyne will reduce public safety risks and improve the overall visitor arrival experience • The Department of Transport (DoT) determined that a navigational channel and markers were not required and that the risk to boating users from the relocation of barge traffic is not expected to be significant • Complete avoidance of impacts to recreational values during construction and operation of the project cannot be achieved.	**No residual impacts expected** Significant residual impacts to social surroundings (recreational values; public safety) from implementation of the proposal are considered unlikely and will be minimised through implementation of the CEMP and OEMP
		Minimise	• Implementation of the CEMP provides the monitoring and management framework to minimise risks to public safety during construction. Key management and monitoring measures include: – Equipment will be fitted with noise control devices where possible and appropriate – Implementation of vehicle speed limits – Installation of floating markers and signs to limit access to the construction areas within both the marine and terrestrial environment • Operational management to minimise impacts to the marine environment is detailed in the OEMP (Emerge, 2024b) (Appendix Q). Implementation of this management plan will ensure that: – Installation of floating markers and signs at the entrance to the barge landing (within development footprint) to prevent boat anchorage and swimming in peak season. This will ensure that an increase in vessel movements does not impact public safety – Physical inspections during operations – Maintenance of a complaints register – Public safety risk (i.e. traffic along Parker Point Rd) is addressed by policing and road regulations applicable to Wadjemup's / Rottnest Island's roads – Marine users to comply with vessel operational restrictions required by DoT and RIA.	
		Rehabilitate	Rehabilitation is not considered applicable to social surroundings.	
		Offset	Social surroundings offsets are not considered applicable to the proposal.	
Relocation of moorings	Direct	Avoid	Complete avoidance of disruption to mooring users is not possible.	**Permanent relocation of four moorings** Disruption to moorings users has been minimised through relocating all impacted moorings, rather than removing them. Significant residual impacts to social surroundings (impacts to moorings) from implementation of the proposal are considered unlikely.
		Minimise	• No moorings will be permanently removed and disruption to moorings users will be minimised through: – Temporary relocation of eight moorings during construction of the proposal. The temporary relocation will be undertaken prior to construction commencing to minimise disruption to users. The relocation will be for the duration of construction, for approximately 18 months – The permanent relocation of four moorings will be undertaken prior to construction to minimise disruption to users • Ongoing stakeholder consultation with the local community regarding the proposal and potential impacts on social surroundings.	
		Rehabilitate	All impacted moorings are proposed for relocation (rather than removal).	
		Offset	Social surroundings offsets are not considered applicable to the proposal.	
Impacts to previously unidentified ACH	Direct	Avoid	• There are no registered ACH sites within the development envelope • Consultation with representatives of the Whadjuk NTC group confirmed that the proposal can proceed without undue risk of breaching the *Aboriginal Heritage Act 1972* in relation to ethnographic sites and places.	**No residual impacts expected** Significant residual impacts to social surroundings (ACH) from implementation of the proposal are considered unlikely.
		Minimise	• To minimise potential impacts to any previously unidentified subsurface ACH, the following actions will be implemented as per the recommendations from the representatives of the Whadjuk NTC group: – Archaeological monitors are present during all ground disturbing works and that archaeological techniques, such as test pitting and sieving, are employed if artefacts are found • Ongoing consultation will be undertaken with traditional owners as required to determine additional Aboriginal heritage information about potential sites.	
		Rehabilitate	Rehabilitation is not considered applicable to social surroundings.	
		Offset	Social surroundings offsets are not considered applicable to the proposal.	

Potential environmental impacts	Impact class	Mitigation hierarchy	Proposed mitigation measures	Residual impacts
Impacts to amenity	Indirect	Avoid	Complete avoidance of impacts to amenity is not possible.	**No residual impacts expected** Significant residual impacts to social surroundings (amenity) from implementation of the proposal are considered unlikely to be significant with implementation of the CEMP and OEMP.
		Minimise	• Ongoing stakeholder consultation with the local community regarding the proposal and potential impacts on social surroundings • As there is an existing groyne within the development envelope, extension of this groyne to support the proposal is unlikely to result in a significant change to visual amenity • An airborne noise assessment was undertaken of the current barge operations (Appendix U). Noise emissions from the existing operations at the Rottnest Barge Facility comply with the criteria set out by the Environmental Protection (Noise) Regulations 1997 at all times (Herring Storer, 2024). As the existing barge operations comply with the criteria set out by the Environmental Protection (Noise) Regulations 1997, it is predicted that the relocated operations will also comply with the regulations and no significant noise impacts from the proposal are anticipated • Management targets and actions to minimise potential impacts to amenity from increase in noise, lighting, odour and dust from construction of the proposal are outlined in the CEMP (Appendix P). The management targets include: – Noise emissions do not exceed assigned noise levels as prescribed in the Environmental Protection (Noise) Regulations 1997 – No fugitive dust emission outside of the development envelope – Zero incidences of fire resulting from the proposal • Key management measures outlined in the CEMP to achieve these targets include: – Construction contractor specifications will require that all construction work will be carried out in accordance with control of noise practices set out in Section 4 of Australian Standard 2436 Guide to Noise Control on Construction, Maintenance and Demolition Sites – Vehicle operation will occur during prescribed hours (between 07:00 and 19:00) – Equipment will be fitted with noise control devices where possible and appropriate – Implement dust suppression measures – Enforce speed limits – Provision of facilities to ensure waste is appropriately disposed • Management targets and actions to minimise potential impacts to amenity from increase in noise, lighting, waste and odour and dust from construction of the proposal are outlined in the OEMP (Emerge, 2024b) (Appendix Q). The management targets include: – Limit the impact on social surroundings, including noise, dust and visual intrusion through controlled vehicle movement procedures, to avoid public and community issues – Limit issues related to freight operations that may cause potential negative impacts on social surroundings – Ensure waste disposal measures and prevent rubbish and litter impact on visual amenity Ensure local amenity is protected and public safety measures are undertaken • Key management measures outlined in the OEMP to achieve these targets include: – Dust management measures: ○ Vehicle movements will be restricted to the designated access roads to minimise dust impacts to surrounding users ○ Vehicle speeds will be restricted to minimise the generation of dust – Waste management measures: ○ Ensure all waste is either recycled or moved off site to the Island disposal facility – Noise management measures: ○ Equipment will be fitted with noise control devices where possible and appropriate – Lighting management measures: ○ The use of lighting at night will be for safety purposes only and will be designed to minimise impacts to surrounding users as much as possible ○ Adaptive light controls to manage light timing, intensity and colour will be implemented to minimise impacts from lighting ○ Only add light for specific purposes such as navigational and safety ○ Light only the object or area intended through lighting placement and design (e.g. placement of lights close to the ground, ensuring lights are directed and shielded to avoid light spill) ○ Use the lowest intensity lighting appropriate for the task ○ Use non-reflective, dark-coloured surfaces ○ Use lights with reduced or filtered blue, violet and ultra-violet wavelengths – Odour management measures: ○ Odour generated from waste compactors will be managed through short transfer intervals, which are currently removed on Tuesdays and Thursdays between 11.00 am and 3.00 pm. The remainder of items transported through the new facility are inert with low potential for odour.	
		Rehabilitate	Rehabilitation is not considered applicable to social surroundings.	
		Offset	Social surroundings offsets are not considered applicable to the proposal.	
Disturbance of UXO	Direct	Avoid	As dredging and ground disturbing activities are required as part of the proposal, complete avoidance of risks is not possible.	**No residual impacts expected** With implementation of the measures in the CEMP, significant residual impacts to social surroundings (UXO risk) are considered unlikely.
		Minimise	• Surrich (2019) and TAMS Group (2019) undertook a magnetic field survey for UXO to delineate the risks of disturbing UXO. An additional UXO survey, prior to construction works, will be undertaken to further assess anomalies identified during the initial UXO survey • Management targets and actions to minimise potential impacts to social surroundings from the risk of disturbance to UXOs from construction of the proposal are outlined in the CEMP (Appendix P). The management targets include: – Minimise risk of disturbance to UXO site.	
		Rehabilitate	If the resurveyed ferrous debris targets are identified as UXO, appropriate remediation and management will be undertaken.	
		Offset	Social surroundings offsets are not considered applicable to the proposal.	

13.7 Assessment and significance of residual impact

The residual impacts to social surroundings after the application of the mitigation hierarchy outlined in Table 74 are summarised below:

- The permanent relocation of four moorings.

The predicted residual impacts to social surroundings from the proposal are not considered significant as discussed in Table 75.

Table 75: Consideration of the significance of the residual impacts on social surroundings

Matters for consideration	Response
The object and principles of the EP Act	Ongoing stakeholder consultation has been undertaken to address potential impacts to social surroundings and the following technical investigations undertaken: • Report of an Ethnographic Aboriginal Heritage Survey of the Army Jetty, Rottnest Island, Western Australia (Brad Goode and Associates, 2019) • Marine magnetic survey at proposed barge landing site, South Thomson Bay (Surrich, 2019) and Rottnest Island Authority – Geological Investigation – Thomson Bay South and UXO investigation/anomaly recovery (TAMS Group, 2019) • Acoustic assessment Rottnest Barge Facility Rottnest Island (Herring Storer, 2024). The principles of the EP Act have been specifically addressed in relation to the proposal (Table 26).
Values, sensitivity and quality of the environment which is likely to be impacted	Direct impacts to social surroundings include the relocation of four moorings. There will be no loss or removal of any moorings. Apart from the recreational values (boating and fishing), there are no other significant social surroundings within or directly adjacent to the development envelope.
All stages and components of the proposal (such as any infrastructure required for the proposal to be practicably implemented, or a proposal life cycle)	All stages of the proposal (i.e. construction and operation) have been included in this impact assessment.
Extent (intensity, duration, magnitude, and geographic footprint) of the likely impacts	Construction of the proposal will result in the relocation of four moorings. Implementation of the CEMP and OEMP will ensure that indirect impacts to social surroundings will be minimal and localised to the development envelope.
Resilience of the environment	There are no ACH or registered heritage sites within or adjacent to the development envelope. Apart from the recreational values, there are no other significant social values within or directly adjacent to the development envelope. Given no significant impacts to social values are expected, the environment is expected to be resilient to change. Therefore, the social values within and adjacent to the development envelope are considered resilient to potential impacts and changes.
Consequence of the application of the mitigation hierarchy to the proposal.	The WA Offsets Guidelines (Government of Western Australia 2014) identifies four levels of significance for residual impacts: • Unacceptable impacts – those impacts which are environmentally unacceptable or where no offset can be applied to reduce the impact. Offsets are not appropriate in all circumstances, as some environmental values cannot be offset. • Significant impacts requiring an offset – any significant residual impact of this nature will require an offset. These generally relate to any impacts to species, ecosystems, or reserve areas protected by statute or where the cumulative impact is already determined to be at a critical level. • Potentially significant impact which may require an offset – the residual impact may be significant depending on the context and extent of the impact. These relate to impacts that are likely to result in a species or ecosystem requiring protection under statute or increasing the cumulative impact to a critical level. Whether these impacts require an offset will be determined by the decision-maker based on information provided by the proponent or applicant and expert judgement • Impacts which are not significant – impacts which do not trigger the above categories are not expected to have a significant impact on the environment and therefore do not require an offset. Following the application of the mitigation hierarchy outlined in Table 74 and taking into consideration the above significance of residual impacts model, RPS considers that there are no significant residual impacts to social surroundings from the proposal.

Matters for consideration	Response
Level of confidence in the prediction of residual impacts and the success of proposed mitigation	Stakeholder consultation will be ongoing to ensure the success of the proposed mitigation, resulting in a high level of confidence in the prediction of residual impacts.
Public interest about the likely effect of the proposal or scheme, if implemented, on the environment, and relevant public information	RIA has facilitated regular meetings / dialogue with the local community and key stakeholders (Table 25) as part of the project.

Cumulative impacts from the proposal have been considered in relation to other proposals within 5 km of the proposal and are discussed in Section 18.

Holistic impacts are discussed in Section 17.

13.8 Environmental outcomes

In consideration of the proposed avoidance and management measures and likely residual impacts associated with the proposal, the environmental outcomes that apply to social surroundings are:

- Noise emissions do not exceed assigned noise levels as prescribed in the Environmental Protection (Noise) Regulations 1997
- Maintain recreational fishing values by ensuring there are no observable impacts to benthic communities and habitats outside the ZoMI
- Minimise risk of disturbance to UXO
- No permanent loss or change to the total number of moorings as a result of implementation of the proposal
- No impacts to registered Aboriginal cultural heritage sites
- Maintain amenity values during construction and operation.

Adaptive management measures will be implemented in accordance with the CEMP, DEMMP and OEMP to ensure these environmental outcomes are met.

As the impact assessment identified no significant residual risks to social surroundings following the application of mitigation actions identified herein, it is considered that the proposal will successfully meet the EPA’s objective to protect social surroundings from significant harm.

14 OTHER ENVIRONMENTAL FACTORS OR MATTERS

14.1 EPA environmental factors

This Environmental Supporting Report addresses the following key environmental factors in Sections 7 to 13:

- Benthic communities and habitats (Section 7 of this document)
- Coastal processes (Section 8 of this document)
- Marine environmental quality (Section 9 of this document)
- Marine fauna (Section 10 of this document)
- Terrestrial flora and vegetation (Section 11 of this document)
- Terrestrial fauna (Section 12 of this document)
- Social surroundings (Section 13 of this document).

Other environmental factors which are unlikely to be significantly impacted by the proposal, and how they relate to the proposal, is discussed in Table 76.

Table 76: Overview of other environmental factors

Environmental factor	Objective	Relevance to the proposal
Land		
Landforms	To maintain the variety and integrity of significant physical landforms so that environmental values are protected.	No significant landforms are present within the development envelope that would be impacted by the proposal.
Subterranean fauna	To protect subterranean fauna so that biological diversity and ecological integrity are maintained.	The proposal will not involve the abstraction of groundwater or significant excavations. Impacts on subterranean fauna are unlikely.
Terrestrial environmental quality	To maintain the quality of land and soils so that environmental values are protected.	A search of DWER's Contaminated Sites Database identified that no known contaminated sites are within the development envelope. The closest registered contaminated site is located approximately 0.9 km west of the development envelope and is described below: • Site ID 39676 (portion of Lot 10976 on Deposited Plan 216860); hydrocarbons are present in groundwater below the registered contaminated site. • Marine water in Thomson Bay has been sampled between August 2000 and July 2005, and in the majority of these sampling events no contaminants were detected. Minor concentrations of hydrocarbons were detected during three sampling events in June 2002, June 2004 and December 2004. However, contaminants have never been detected in Thomson Bay at concentrations exceeding marine water guidelines. • The registered site has been remediated such that it is suitable for public open space and public roads but may not be suitable for the construction of enclosed buildings, as such, the site is classified as 'remediated for restricted use'. As no groundwater abstraction will occur as part of the proposal and hydrocarbons were not detected in Thomson Bay at concentrations exceeding marine water guidelines, this contaminated site is unlikely to impact the proposal. Implementation of the CEMP, DEMMP and OEMP will minimise risk to terrestrial environmental quality resulting from construction and operation of the proposal.

Environmental factor	Objective	Relevance to the proposal
		Acid sulfate soils (ASS) are naturally occurring soils containing iron sulfide minerals formed under saturated anoxic conditions. In an undisturbed state below the water table, these soils are benign and non-acidic. However, if the soils are exposed to the atmosphere through activities such as drainage, excavation or dewatering, the sulfides may react with oxygen to form sulfuric acid. A review of DWER's ASS mapping indicates that there is a low risk of ASS occurring within the development envelope.
Water		
Inland waters	To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.	There are no surface water features within the development envelope. Surface water features within vicinity of the proposal includes: • Bickley Swamp, approximately 180 m to the south, across Parker Point Road and Kingstown Road • Government House Lake is approximately 500 m to the west across Parker Point Road and Brand Way. As no groundwater abstraction will occur as part of the proposal and there are no surface water features within or directly adjacent to the development envelope, impacts to inland waters are unlikely. Impacts will be further minimised through implementation of the CEMP, DEMMP and OEMP.
Air		
Air quality	To maintain air quality and minimise emissions so that environmental values are protected	The proposal is unlikely to significantly impact air quality as summarised below: • As the barge operations are already undertaken at the Main Jetty and are proposed to be relocated to the development envelope, the proposal will not result in a change in emissions and air quality within the area. • Implementation of the CEMP will ensure impacts to air quality are minimised during construction.
Greenhouse gas emissions	To reduce net greenhouse gas emissions in order to minimise the risk of environmental harm associated with climate change	A greenhouse gas assessment was undertaken by Kewan Bond (2024) (Appendix L) to support the proposal. The findings of the assessment are summarised below: • As the proposal is for the relocation of existing barge operations, rather than new operations and activities, only minimal changes to the existing operational greenhouse gas emissions are anticipated. • A minor increase in operational emissions is expected due to the additional distance of the proposed barge landing from the main island settlement and the expected future increase in barge activities, which would involve an increase in fuel consumption and greenhouse gas emissions. However, the increase in barge activities would occur at the existing barge facilities and therefore, these increased emissions would occur even if the proposal were not implemented. • The EPA considers greenhouse gas emissions a significant factor if Scope 1 or Scope 2 emissions are reasonably likely to exceed 100,000 tonnes CO2-e of emissions in any year (EPA, 2023d). • A summary of the scope 1, 2 and 3 emissions estimated from construction and operation of the proposal are summarised below. – Construction of the proposal will result in a temporary increase of greenhouse gas emissions as outlined in Appendix L. These temporary emissions are broken down as follows: – Scope 1 emissions: 2,328 tonnes CO2-e – There are no Scope 2 emissions associated with the project because there is no consumption of electricity from the WA state grid supply. – Scope 3 emissions: 713 tonnes CO2-e. – The total emissions from operation of the proposal over a 50-year period (the estimated life of the project) are estimated as 23,446 tonnes CO2-e. Thes equates to 469 tonnes CO2-e per annum from operation of the proposal. These emissions are broken down as follows: – Scope 1 emissions: 392 tonnes CO2-e per annum

Environmental factor	Objective	Relevance to the proposal
		– There are no Scope 2 emissions associated with the project because there is no consumption of electricity from the WA state grid supply – Scope 3 emissions: 77 tonnes CO2-e. • Based on the above emission estimates, the overall emissions from construction (3,041.51 CO2-e) and the annual emissions from operation (469.51 tonnes CO2-e) are below the EPAs trigger of 100,000 tonnes CO2-e of emissions in any year.
People		
Human health	To protect human health from significant harm	This factor primarily relates to projects where radiation occurs within materials in a manner that could pose a risk to human health. The proposal is not expected to present any human health risk.

14.2 Matters of national environmental significance

Under the EPBC Act, if a proposal involves an action that is likely to result in a significant impact on a MNES, the proposal must be referred to the DCCEEW. The DCCEEW defines a significant impact as an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment that is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts (Department of the Environment, 2013).

A desktop search of the PMST for MNES was undertaken on 14 September 2023 to identify any MNES with the potential to occur within 10 km of the proposal (Appendix R). A summary of the search results is provided in Table 23, identifying the number of matters returned and the relevance of the search results to the proposal.

As outlined in Table 23, the proposal has potential to impact listed threatened species and listed migratory species. The proposal has been assessed against the significant impact criteria for these MNES in the sections below.

14.2.1 Listed threatened species

14.2.1.1 Flora

The PMST search of the area within a 10 km radius of the proposal identified that the dwarf bee-orchid (*Diuris micrantha*) is recorded within the area. The dwarf bee-orchid is generally associated with Banksia woodlands and other vegetation communities that occur on the mainland. It is not associated with the vegetation units identified within the development envelope (Section 11.4.2 of this report) and is unlikely to occur within the development envelope.

The flora and vegetation surveys undertaken by RPS (2024) and Focused Vision Consulting (FVC) (2023) did not identify any conservation significant flora species within the development envelope.

As the dwarf bee-orchid does not occur within the development envelope, significant impacts as a result of the proposal are highly unlikely.

14.2.1.2 Fauna

The PMST search identified 43 threatened fauna species within a 10 km radius of the development envelope. Results of the search are provided in Appendix R and Table 23.

14.2.1.2.1 Terrestrial fauna species

A likelihood of occurrence assessment was undertaken by Eco Logical (2024) as part of the fauna assessment. Fauna species listed under the EPBC Act that were considered likely to occur within the development envelope was the quokka.

14.2.1.2.1.1 Significant impact assessment

An assessment of the proposal against the significant impact criteria for the quokka (Vulnerable, EPBC Act) is provided in Table 77.

Table 77: Significant impact criteria – Listed threatened species (terrestrial fauna)

Significant impact guidelines	Summary of impacts on MNES	Variance to guidelines
Lead to a long-term decrease in the size of a population	Construction of the terrestrial components of the proposal will result in removal of 0.46 ha of native vegetation providing potential habitat to the quokka. Vegetation clearing and habitat fragmentation have been identified as potential threats to the survival and recovery of quokka populations. Although the quokka populations present on Wadjemup / Rottnest Island are resilient to the current levels of disturbance (DCCEEW, 2024). Focused Vision Consulting undertook flora and vegetation surveys within the area shown in Figure 32. The vegetation surveyed by Focused Vision Consulting that was most analogous to the vegetation present within the development envelope comprised the vegetation units MlAp and MlGl with a combined area of 67.39 ha. As such, it has been assumed that there is approximately 67.39 ha of similar fauna habitat to the 0.46 ha being directly impacted within vicinity of the proposal. The direct impacts to 0.46 ha of potential fauna habitat comprises 0.68% of the larger area surveyed by Focused Vision Consulting. Wadjemup / Rottnest Island encompasses approximately 1,800 ha, most of which is vegetated. If a conservative estimate is adopted, with an assumption that half of the island remains vegetated, clearing 0.46 ha of vegetation comprising potential fauna habitat would comprise 0.05% of the vegetation present on the island. As the total loss of terrestrial fauna habitat resulting from the proposal is low in a regional context, the proposal is considered unlikely to lead to a long-term decrease in the size of a population.	**Not at variance** The proposal will not lead to a long-term decrease in the size of the quokka population.
Reduce the area of occupancy of the species	As discussed above, direct impacts to 0.46 ha of potential fauna habitat comprises 0.68% of that present in the surrounding area surveyed by Focused Vision Consulting. As the total loss of terrestrial fauna habitat resulting from the proposal is low in a regional context, the proposal is considered unlikely to reduce the area of occupancy of the quokka. Furthermore, none of the vegetation within the development envelope was considered to have a limited local extent or distribution (Focused Vision, 2023) and is not considered to comprise habitat critical to the survival of the quokka or any other terrestrial species.	**Not at variance** The proposal will not lead to reduction in the area of occupancy of the quokka.
Fragment an existing population into two or more populations	The terrestrial component of the development envelope comprises the existing Army Jetty Road. Consequently, the proposal will not result in further fragmentation of an existing population into two or more populations.	**Not at variance** The proposal will not result in the fragmentation of an existing quokka population into two or more populations.
Adversely affect habitat critical to the survival of a species	None of the vegetation within the development envelope was considered to have a limited local extent or distribution (Focused Vision, 2023) and is not considered to comprise habitat critical to the survival of the quokka or any other terrestrial species. Clearing 0.46 ha of potential habitat will not adversely affect habitat critical to the survival of the quokka.	**Not at variance** The proposal will not adversely affect habitat critical to the survival of the quokka.
Disrupt the breeding cycle of a population	The vegetation within the development envelope is not considered to comprise habitat critical for the quokka. Clearing 0.46 ha of this vegetation will not disrupt the breeding cycle of the population.	**Not at variance** The proposal will not disrupt the breeding cycle of the quokka.

Significant impact guidelines	Summary of impacts on MNES	Variance to guidelines
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	The proposal will result in clearing 0.46 ha of potential habitat within the development envelope. Focused Vision Consulting (2023) identified 67.39 ha of habitat similar to that present within the development envelope in the Focused Vision Consulting survey area (Figure 32). Consequently, direct impacts to 0.46 ha of potential fauna habitat comprises 0.68% of the larger area surveyed by Focused Vision Consulting and is unlikely to result in a decrease in the availability or quality of habitat to the extent that the species is likely to decline.	**Not at variance** The proposal will not modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the vulnerable species' habitat.	The CEMP details hygiene protocols to ensure the proposal does not result in the introduction of an invasive species during construction.	**Not at variance** Implementation of the CEMP and OEMP will ensure that the proposal will not result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.
Introduce disease that may cause the species to decline	The CEMP details hygiene protocols and will ensure no diseases are introduced to the proposal area as a result of the proposal.	**Not at variance** Implementation of the CEMP and OEMP will ensure that the proposal will not introduce disease that may cause the species to decline.
Interfere with the recovery of the species	The vegetation within the development envelope is not considered to comprise habitat critical for the quokka. Clearing 0.46 ha of this vegetation will not interfere with the recovery of the quokka.	**Not at variance** The proposal is unlikely to interfere with the recovery of the quokka.

14.2.1.2.2 Marine fauna species

Based on the database searches and literature review undertaken to support the proposal (Appendix B), the listed threatened marine fauna species listed in Table 78 may occur within South Thomson Bay (RPS, 2024a).

Table 78: Listed threatened marine fauna species (RPS, 2024a)

Name		Conservation status		Distribution at Wadjemup/ Rottnest Island and surrounding waters*	Habitat and seasonal preferences
Species	Common	EPBC Act	BC Act		
Sharks					
Sphyrna lewini	Scalloped hammerhead	Conservation Dependent	Not included	Species or species habitat likely to occur within area	Undertake annual foraging and breeding migrations. Known to aggregate in the Shoalwater islands Marine Park, where peak numbers are observed during January and February (López, 2023).
Carcharias taurus (west coast population)	Grey nurse shark (west coast population)	Vulnerable	Vulnerable	Congregation or aggregation known to occur within area	Year-round presence. Seasonal migration patterns have not been observed (DCCEEW, 2023b).
Carcharodon carcharias	White shark	Vulnerable, Migratory	Vulnerable	Species or species habitat known to occur within area	Have been shown to undertake migrations north along the WA coast during spring and return in summer; however, coastal movements are not synchronous. They are frequently recorded in waters around fur seal and sea lion colonies, including in the Perth region (DCCEEW, 2023b), where they are more likely to be present during spring and early summer and least likely to be present during late summer and autumn (SharkSmart, 2018).
Mammals					
Neophoca cinerea	Australian sea lion	Endangered	Endangered	Species or species habitat likely to occur within area. The development footprint is located within the foraging BIA for this species.	Has an asynchronous non-annual breeding cycle with cycles ranging from 16 to 20 months and pupping occurring at different times throughout the South-West Marine Region (DCCEEW, 2023b).
Eubalaena australis	Southern right whale	Endangered, Migratory	Vulnerable	The development footprint is located within the migratory BIA for this species†	Southern temperate to subpolar waters including marine areas of southern Australia from May to October. The migratory period within the migration BIA up the west coast of WA is April to October (National Conservation Values Atlas, 2023).
Balaenoptera musculus brevicauda	Pygmy blue whale	Endangered	Endangered (as *Balaenoptera musculus)*	Known to occur in the area. The development footprint is located within the distribution BIA for this species.	The northbound migration past Perth Canyon occurs between April and July (peak May to June), with the return migration from October to January (peak November to early December.
Reptiles					
Caretta caretta	Loggerhead turtle	Endangered, Migratory	Endangered	Foraging, feeding or related behaviour known to occur within area	Generally nesting in summer at nesting grounds in northern WA (not necessarily every year; ALA, 2023).
Dermochelys coriacea	Leatherback turtle	Endangered, Migratory	Vulnerable	Species or species habitat known to occur within area	Migrates from foraging areas to nesting beaches in tropical and subtropical regions during summer (ALA, 2023; DCCEEW, 2023b).
Chelonia mydas	Green turtle	Vulnerable, Migratory	Vulnerable	Foraging, feeding or related behaviour known to occur within area	Migrates from foraging areas to nesting beaches in tropical regions during summer, typically between November and March (DCCEEW, 2023b).
Birds					
Limosa lapponica menzbieri	Northern Siberian bar-tailed godwit	Critically Endangered	Critically Endangered	Species or species habitat known to occur within area	The northern Siberian bar-tailed godwit occurs mainly in coastal habitats such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays (TSCC, 2016).
Calidris tenuirostris	Great knot	Critically Endangered	Critically Endangered	Roosting known to occur within area	The great knot has been recorded around the entirety of the Australian coast and is common on the coasts of the Pilbara and Kimberley, from the Dampier Archipelago to the Northern Territory border. Great knots prefer sheltered coastal habitats with large intertidal mudflats or sandflats. This includes inlets, bays, harbours, estuaries and lagoons (DCCEEW, 2023).
Calidris ferruginea	Curlew sandpiper	Critically Endangered	Critically Endangered	Species or species habitat known to occur within area	In Western Australia, the curlew sandpiper is widespread around coastal and subcoastal plains from Cape Arid to south-west Kimberley Division. They mainly occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons.
Numenius madagascariensis	Eastern curlew	Critically Endangered	Critically Endangered	Species or species habitat likely to occur within area	The eastern curlew is most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass (Cornel University 2023).
Charadrius mongolus	Lesser sand plover	Endangered	Endangered	Roosting known to occur within area	The lesser plover mainly occurs in northern and eastern Australia, rare in south-western Australia. The species is almost strictly coastal, preferring sandy beaches, mudflats of coastal bays and estuaries, sand flats and dunes near the coast (Cornell University, 2023).
Calidris canutus	Red knot	Endangered	Endangered	Species or species habitat known to occur within area	The red knot mainly inhabits intertidal mudflats, sandflats and sandy beaches of sheltered coasts and sometimes on sandy ocean beaches or shallow pools on exposed rock platforms (Higgins, 1996)
Rostratula australis	Australian painted snipe	Endangered	Endangered	Species or species habitat may occur within area	The Australian painted snipe lives in shallow freshwater (occasionally brackish) wetlands, both ephemeral and permanent, such as lakes, swamps, claypans, inundated or waterlogged grassland/saltmarsh (TSSC, 2013)
Charadrius leschenaultii	Greater sand plover	Vulnerable	Vulnerable	Species or species habitat known to occur within area	Mainly occurs on sheltered sandy, shelly or muddy beaches, large intertidal mudflats, sandbanks, salt marshes, estuaries, coral reefs, rocky islands rock platforms, tidal lagoons and dunes near the coast (Cornel University 2023).
Sternula nereis nereis	Australian fairy tern	Vulnerable	Vulnerable	Foraging, feeding or related behaviour known to occur within area. Migrant breeding, breeding habitat present within the area.	In south-western Australia, the fairy tern breeds between October and March with peak breeding between December and January. The Natural Jetty at the end of Philip Point is an important roost site for fairy terns.

*As listed in the PMST search results and/or Atlas of Living Australia (ala.org.au)

†Although the PMST search indicates that breeding by *E. australis* may occur within the PMST search area, a review of the online National Conservation Values Atlas indicates that this is not the case and only the migration BIA for the species overlaps Thomson Bay

Definitions: BC Act = *Biodiversity Conservation Act 2016* (WA), BIA = Biologically Important Area, DBCA = Department of Biodiversity, Conservation and Attractions (WA), EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)

Priority 4 = Rare, Near Threatened and other species in need of monitoring (BC Act)

Other Specially Protected = Species otherwise in need of special protection (BC Act)

14.2.1.2.2.1 Significant impact assessment

An assessment of the potential impacts to these species from implementation of the proposal against the significant impact criteria in Table 79.

Table 79: Significant impact criteria – Listed threatened species (marine fauna)

Significant impact guidelines	Summary of impacts on MNES	Variance to guidelines
Lead to a long-term decrease in the size of a population	The proposal will result in the following potential impacts to listed threatened marine fauna species: • Predicted loss of 3.32 ha of habitat for marine fauna, which includes: – 2.06 ha mixed seagrass – 1.26 ha sand with wrack. • Reduction in marine environmental quality. The area affected by suspended sediments during dredging and construction will be limited to the modelled zones of impact. Silt curtains will be used for dredging and rock-dumping for breakwater construction, thereby limiting the impact from increased suspended sediments and minimising the indirect impact to marine fauna behaviours and potential habitat. With implementation of the CEMP, DEMP and OEMP, residual impacts to marine fauna from changes to marine environmental quality are considered low. • Underwater noise emissions from piling operations causing temporary disturbance to marine fauna species. The potential for these impacts to result in a long-term decrease in the size of a population of a listed threatened marine fauna species is discussed below. **Shark species** Three threatened shark species may occur within vicinity of the proposal. Scalloped hammerheads (EPBC Act listed conservation dependent) and white sharks (vulnerable) are typically seasonal and use the area for foraging and/or migration; however, may be present year-round. Scalloped hammerheads aggregate in the Shoalwater Islands Marine Park (approximately 30 km from the proposal), peaking during January and February. White sharks are more likely to be present in the Perth region during spring and early summer, and least likely to be present during late summer and autumn. The grey nurse shark (vulnerable) is known to congregate or aggregate in the area year-round. These shark species are known to utilise the following habitat types: • Grey nurse sharks (western population) are found in inshore waters, particularly sub-tropical to temperate waters. Grey nurse sharks are often observed aggregating around inshore rocky reefs or islands (Department of the Environment, 2014). There is likely to be habitat suitable for this species around the island, however the development envelope is unlikely to provide significant habitat for this species. • The scalloped hammerhead is predominately found along coastal shelves, though will occasionally travel into intertidal zones and inshore habitats may be important for immature hammerheads (DCCEEW, 2024). • Great white sharks are frequently recorded in waters around fur seal and sea lion colonies such as those to the west end of the island. There is likely to be habitat suitable for this species around the island, however the development envelope is unlikely to provide significant habitat for this species. The benthic communities and habitats within the development envelope is unlikely to provide critical habitat for these shark species. However, the benthic communities and habitats is likely to provide habitat for prey species for the shark species. An assessment of the shark species pressure analysis for the South-west Marine Region indicates that most of the shark species addressed in the species report group card for sharks are not susceptible to the pressure of habitat modification (DSEWPC, 2012). As such the proposed dredging and removal of benthic communities and habitats is unlikely to have a significant impact on the shark species present in South Thomson Bay. As the proposal will only result in the removal of 3.32 ha of benthic communities and habitats, including 2.06 ha of seagrass (0.52% of the LAU), direct impacts to potential habitat for these species are unlikely to result in a long-term decrease in the size of a population. Indirect impacts to marine habitats and environmental quality will be managed and mitigated through implementation of the CEMP, DEMP and OEMP. Implementation of these plans will ensure that indirect impacts are limited to 2.62 ha of mixed seagrass and 1.09 ha of sand / sand with wrack within the ZoMI. It is predicted that benthic communities and habitats that are impacted within the ZoMI will recover within five years. As such, indirect impacts to potential habitat for these species is unlikely to result in a long-term decrease in the size of a population of the above shark species. **Marine mammals** Seasonal migration of listed threatened whale species along the WA coast includes the southern right whale (endangered; migration April to October), pygmy blue whale (endangered; migration April to January), and the minke whale (may be present over winter). Other listed marine mammals that may be present year-round includes the Australian sea lion (endangered). The development envelope is within the following BIAs for these species: • Australian sea lion (the development envelope is within the foraging BIA for this species) • Pygmy blue whale (the development envelope is within the distribution BIA for this species) • Southern right whale (the development envelope is within the migration BIA for this species). The development envelope is located within the foraging BIA for the Australian sea lion. The closest known haul out area for these species is on Carnac Island and there is potential that these species forage within the development envelope. As the proposal will only result in the removal of 3.32 ha of benthic communities and habitats, including 2.06 ha of seagrass (0.52% of the LAU), direct impacts to potential habitat for these species are unlikely to result in a long-term decrease in the size of a population. Construction of the proposal will not result in impacts that lead to a long-term decrease in the size of a whale population. Potential behavioural impacts to whale species during construction from underwater noise are discussed later in this table. The proposed development envelope is located within the coastal area of South Thomson Bay and the infrastructure is unlikely to impact the migratory pathways of the whale species. Barge movements may traverse the migration route, however as these barge movements are existing, no additional impacts from operation of the proposal are anticipated. Construction and operation of this proposal will not result in a long-term decrease in the size of a marine mammal population. **Turtles** The site is not within a BIA for any turtle species and there are no nesting or internesting areas identified as habitat critical to the survival of marine turtle species (DoEE, 2017). However, seagrass meadows do provide the following habitat for turtle species and as such, there is potential that the loggerhead turtle (endangered), leatherback turtle (endangered), and green turtle (vulnerable) may occasionally occur in the area (DoEE, 2017): • The green turtle forages on algae and seagrass. • Juvenile and adult sea turtle species are known to forage where there are seagrass meadows present. Turtles migrate to/from their nesting grounds in northern WA during summer (typically between November and March); however, their common distribution is north of the development envelope and these species are not anticipated to frequent the area. As the development envelope is not located within a BIA for turtle species does not comprise any significant or critical habitat for these species, the impacts listed above are unlikely to result in a long-term decrease in the size of a population of the above turtle species. **Marine bird species** Listed threatened marine bird species which are known to occur within vicinity of the development envelope includes the Australian fairy tern. Other marine bird species, in particular the Caspian tern and crested tern, may occasionally occur within vicinity of the proposal. However, as there is no critical or significant habitat (such as roosting or breeding sites) present within or proximate to the development envelope, significant impacts from the proposal are unlikely. The Australian fairy tern is known to roost at the Natural Jetty at the end of Philip Point, approximately 900 m east of the proposal and may forage within the development envelope. Implementation of the proposal is unlikely to have significant direct impacts on the Australian fairy tern that would result in a long-term decrease in the size of the population. A coastal processes assessment has been undertaken to identify potential impacts of the proposal on coastal processes. This assessment identified that the proposal is unlikely to result in significant erosion of the roosting habitat present at Philip Point. Therefore, the proposal will not result in a long-term decrease in the size of this population.	**Not at variance** The proposal will not lead to a long-term decrease in the size of a population of listed threatened marine fauna species.

Significant impact guidelines	Summary of impacts on MNES	Variance to guidelines
Reduce the area of occupancy of the species	**Shark species** There is potential for the three threatened shark species listed above to occur within South Thomson Bay. However, as discussed above, it is considered unlikely that the development envelope comprises critical habitat for these species. The proposal will result in the removal of 3.32 ha of benthic communities and habitats, including 2.06 ha of seagrass. As the predicted loss of seagrass is only 0.52% of the LAU, direct impacts to potential habitat for these species is unlikely to result in a long-term decrease in the size of a population. With implementation of the CEMP and OEMP, indirect impacts to habitat for these species is unlikely to be significant. **Marine mammals** There is potential for the southern right whale, pygmy blue whale and minke whale to occur within or within vicinity of the development envelope. The proposal will not significantly reduce the area of occupancy of the wide-ranging migratory whale species. There is potential for the Australia sea lion to forage within and adjacent to the development envelope. The proposal will result in the removal of 3.32 ha of benthic communities and habitats, including 2.06 ha of seagrass that may be used by the Australia sea lion. As the loss predicted loss of seagrass is only 0.52% of the LAU, direct impacts to potential habitat for these species is unlikely to result in a long-term decrease in the size of a population. Underwater noise from piling activities has the potential to result in avoidance behaviours, thereby reducing the area of occupancy of marine fauna species. Implementation of the CEMP (Emerge, 2024) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O) provides the monitoring and management framework to address potential impacts to marine fauna during construction. Implementation of the measures outlined in these management plans will ensure there are no significant residual impacts to marine fauna from underwater noise (see Section 10.6 for further details). **Turtles** Turtle species that may forage in the area include the loggerhead turtle, leatherback turtle and green turtle. The development envelope is not within a BIA for these turtle species and their common distribution is north of the development envelope. Therefore, the proposal is unlikely to reduce the area of occupancy of these species. Underwater noise from piling activities has the potential to result in avoidance behaviours, thereby reducing the area of occupancy of marine fauna species. Implementation of the CEMP (Emerge, 2024) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O) provides the monitoring and management framework to address potential impacts to marine fauna during construction. Implementation of the measures outlined in these management plans will ensure there are no significant residual impacts to marine fauna from underwater noise (see Section 10.6 for further details). **Marine bird species** Listed threatened marine bird species that are known to occur within vicinity of the development envelope includes the Australian fairy tern. Other marine bird species may occasionally occur within vicinity of the development, however, are unlikely to be impacted by the proposal. The Australian fairy tern is known to roost at the Natural Jetty at the end of Philip Point, approximately 900 m east of the proposal and may forage within the development envelope. Implementation of the proposal is unlikely to have significant direct impacts on the area of occupancy of this species. A coastal processes assessment has been undertaken to identify potential impacts of the proposal on coastal processes. This assessment identified that the proposal is unlikely to result in significant erosion of the roosting habitat present at Philip Point. Therefore, the proposal will not result in a decrease in the area of occupancy of this species.	**Not at variance** The proposal will not lead to reduction in the area of occupancy of any listed threatened marine fauna species.
Fragment an existing population into two or more populations	The existing Army Groyne encompasses 2,527 m^2 and the proposed breakwater that will be constructed over the existing groyne, encompasses 4,357 m^2. The proposed breakwater extends approximately 130 m from the shoreline. Due to the small scale of the proposal and the fact that it is being constructed over an existing structure, the proposal does not result in a significant increase in barriers to marine fauna movements within the bay. Furthermore, the development envelope comprises a small part of the larger South Thomson Bay area that is the broader ecosystem, which may be used by marine fauna species. Therefore, it is not considered likely for the proposal to result in fragmentation of the local population of any protected marine fauna.	**Not at variance** The proposal will not result in the fragmentation of an existing population into two or more populations.
Adversely affect habitat critical to the survival of a species	The development envelope is within the BIA of the following threatened marine fauna species: • Fairy tern (the development envelope is within the foraging BIA for this species) • Australian sea lion (the development envelope is within the foraging BIA for this species) • Pygmy blue whale (the development envelope is within the distribution BIA for this species) • Southern right whale (the development envelope is within the migration BIA for this species). Loss of benthic habitats due to construction of the proposal may impact foraging habitat of the Australian fairy tern and Australian sea lion. However, as the proposal will result in the removal of 3.32 ha of benthic communities and habitats, including 2.06 ha of seagrass (0.52% of the LAU), direct impacts to potential foraging habitat for these species is not considered significant. Construction of the proposal is unlikely to adversely impact critical habitat to the wide-ranging migratory whale species which may occur in the area. Implementation of the CEMP and OEMP will ensure indirect impacts to habitat for these species is unlikely to be significant.	**Not at variance** The proposal will not adversely affect habitat critical to the survival of a species
Disrupt the breeding cycle of a population	The development envelope is not within a breeding BIA for any threatened marine species and is not known to provide critical breeding habitat for these species. Loss of 2.06 ha of seagrass (0.52% of the LAU) is not considered likely to disrupt the breeding cycle of a population. Underwater noise from piling activities has the potential to result in injury and changes in behaviours of marine fauna species. Implementation of the CEMP (Emerge, 2024) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O) provides the monitoring and management framework to address potential impacts to marine fauna during construction. Implementation of the measures outlined in these management plans will ensure there are no significant residual impacts to marine fauna from underwater noise (see Section 10.6 for further details).	**Not at variance** The proposal will not disrupt the breeding cycle of a population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The proposal will result in the permanent loss of 2.06 ha of seagrass. This loss of seagrass comprises 0.52% of the LAU. As the proposal will not result in the loss of significant amounts of benthic communities and habitats when compared to that present in the larger area, nor result in a significant increase of barriers to free movement of marine fauna, the proposal is not considered likely to result in the decline of a threatened marine species.	**Not at variance** The proposal will not modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	The proposal will result in the relocation of existing barge movements from the Main Jetty to the development envelope. As no new activities are proposed during operation of the proposal, the introduction of IMS is unlikely. There is potential for the introduction of IMS during construction of the proposal. Measures outlined in the CEMP and DEMMP will ensure that the risk for the introduction of IMS is low.	**Not at variance** Implementation of the CEMP and OEMP will ensure that the proposal will not result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.
Introduce disease that may cause the species to decline	Ballast water is a recognised potential vector for introduction of disease organisms in the marine environment. However, as indicated above, no new marine activities are proposed during operation and construction activities will be management in accordance with the CEMP.	**Not at variance** Implementation of the CEMP and OEMP will ensure that the proposal will not introduce disease that may cause the species to decline.
Interfere with the recovery of the species	Due to the small scale of the direct impacts anticipated from the proposal and the mitigations and management measures outlined in the CEMP and OEMP to minimise the risk of disturbance from spills and underwater noise, the proposal is unlikely to interfere with the recovery of any threatened marine species.	**Not at variance** The proposal is unlikely to interfere with the recovery of any threatened marine species.

14.2.2 Migratory species

Based on the database searches and desktop marine fauna assessment to support the proposal (Appendix B), the migratory species listed in Table 80 may occur within South Thomson Bay (RPS, 2024a).

Table 80: Migratory species

Name		Conservation status		Distribution at Wadjemup / Rottnest Island and surrounding waters*	Habitat and seasonal preferences
Species	Common	EPBC Act	BC Act		
Sharks					
Carcharodon carcharias	White shark	Vulnerable, Migratory	Vulnerable	Species or species habitat known to occur within area	Have been shown to undertake migrations north along the WA coast during spring and return in summer; however, coastal movements are not synchronous. They are frequently recorded in waters around fur seal and sea lion colonies, including in the Perth region (DCCEEW, 2023b), where they are more likely to be present during spring and early summer and least likely to be present during late summer and autumn (SharkSmart, 2018).
Mammals					
Eubalaena australis	Southern right whale	Endangered, Migratory	Vulnerable	The development footprint is located within the migratory BIA for this species†	Southern temperate to subpolar waters including marine areas of southern Australia from May to October. The migratory period within the migration BIA up the west coast of WA is April to October (National Conservation Values Atlas, 2023).
Megaptera novaeangliae	Humpback whale	Migratory	Conservation Dependent, Migratory	Species or species habitat known to occur within area. The development footprint is located within the migratory BIA for this species.	The annual peak northbound migration along the Jurien Bay to Carnarvon migration route occurs between June and July, while the southbound migration peak occurs between September and October (DCCEEW, 2023b).
Orcinus orca	Killer whale, Orca	Migratory	Migratory	Species or species habitat may occur within area	Mating is known to occur all year round, whilst the calving season spans several months. However, no areas of significance and no determined migration routes have been identified for this species within waters off WA (DCCEEW, 2023b). They are typically present on the south coast of WA between January to April.
Balaenoptera musculus brevicauda	Pygmy blue whale	Endangered Migratory		Known to occur in the area. The development envelope is located within the distribution BIA for this species.	The northbound migration past Perth Canyon occurs between April and July (peak May to June), with the return migration from October to January (peak November to early December).
Reptiles					
Caretta caretta	Loggerhead turtle	Endangered, Migratory	Endangered	Foraging, feeding or related behaviour known to occur within area	Generally nesting in summer at nesting grounds in northern WA (not necessarily every year; ALA, 2023).
Dermochelys coriacea	Leatherback turtle	Endangered, Migratory	Vulnerable	Species or species habitat known to occur within area	Migrates from foraging areas to nesting beaches in tropical and subtropical regions during summer (ALA, 2023; DCCEEW, 2023b).
Chelonia mydas	Green turtle	Vulnerable, Migratory	Vulnerable	Foraging, feeding or related behaviour known to occur within area	Migrates from foraging areas to nesting beaches in tropical regions during summer, typically between November and March (DCCEEW, 2023b).
Birds					
Limosa lapponica menzbieri	Northern Siberian bar-tailed godwit	Critically Endangered Migratory	Critically Endangered	Species or species habitat known to occur within area	The northern Siberian bar-tailed godwit occurs mainly in coastal habitats such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays (TSCC, 2016).
Calidris tenuirostris	Great knot	Critically Endangered Migratory	Critically Endangered	Roosting known to occur within area	The great knot has been recorded around the entirety of the Australian coast and is common on the coasts of the Pilbara and Kimberley, from the Dampier Archipelago to the Northern Territory border. Great knots prefer sheltered coastal habitats with large intertidal mudflats or sandflats. This includes inlets, bays, harbours, estuaries and lagoons. (DCCEEW, 2023).
Calidris ferruginea	Curlew sandpiper	Critically Endangered Migratory	Critically Endangered	Species or species habitat known to occur within area	In Western Australia, the curlew sandpiper is widespread around coastal and subcoastal plains from Cape Arid to south-west Kimberley Division. They mainly occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons.
Numenius madagascariensis	Eastern curlew	Critically Endangered Migratory	Critically Endangered	Species or species habitat likely to occur within area	The eastern curlew is most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass (Cornel University 2023).
Charadrius mongolus	Lesser sand plover	Endangered Migratory	Endangered	Roosting known to occur within area	The lesser plover mainly occurs in northern and eastern Australia, rare in south-western Australia. The species is almost strictly coastal, preferring sandy beaches, mudflats of coastal bays and estuaries, sand flats and dunes near the coast (Cornell University, 2023).
Calidris canutus	Red knot	Endangered Migratory	Endangered	Species or species habitat known to occur within area	The red knot mainly inhabits intertidal mudflats, sandflats and sandy beaches of sheltered coasts and sometimes on sandy ocean beaches or shallow pools on exposed rock platforms (Higgins, 1996)
Charadrius leschenaultii	Greater sand plover	Vulnerable Migratory	Vulnerable	Species or species habitat known to occur within area	Mainly occurs on sheltered sandy, shelly or muddy beaches, large intertidal mudflats, sandbanks, salt marshes, estuaries, coral reefs, rocky islands rock platforms, tidal lagoons and dunes near the coast (Cornel University 2023).
Sternula nereis nereis	Australian fairy tern	Vulnerable Migratory	Vulnerable	Foraging, feeding or related behaviour known to occur within area. Migrant breeding, breeding habitat present within the area.	In south-western Australia, the fairy tern breeds between October and March with peak breeding between December and January. The Natural Jetty at the end of Philip Point is an important roost site for fairy terns.
Ardenna pacifica	Wedge-tailed shearwater	Marine Migratory		Breeding known to occur within area.	The wedge tailed shearwater is known to breed in burrows on Wadjemup/Rottnest Island between August to May (DCCEEW, 2023). Significant breeding habitat for this species is located on the west end of the island, such as on Cape Vlamingh, and impacts to this species or its habitat are unlikely as a result of the proposal.
Onychoprion anaethetus	Bridled tern	Marine Migratory		Breeding known to occur within area.	The bridled tern is a common visitor to Rottnest to breed (Rottnest Island Authority, 2019). It forms small colonies and nests on the ground usually in areas sheltered by plants, ledges or caves. There are no known breeding colonies within the vicinity of the proposal and due to the high level of disturbances from recreational users at Thomson Bay, there are unlikely to be any significant roosting sites within vicinity of the proposal. Consequently, impacts as a result of the proposal are unlikely.
Hydroprogne caspia	Caspian tern	Marine Migratory		Breeding known to occur within area.	The proposal is located within the foraging BIA for the Caspian tern and a small number of Caspian terns roost at Natural Jetty. As there are no known breeding colonies or roosting habitat for this species within the development envelope, significant direct impacts are unlikely.
Thalasseus bergii	Crested tern	Marine Migratory		Breeding known to occur within area.	The crested tern is the most common tern on the island, with the main nesting colonies located on Lake Baghdad and Herschel Lake (Rottnest Island Authority, 2019b). The crested tern may roost at the Natural Jetty. As there are no known breeding colonies or roosting habitat for this species within the development envelope, significant direct impacts are unlikely.

Name		Conservation status		Distribution at Wadjemup / Rottnest Island and surrounding waters*	Habitat and seasonal preferences
Species	Common	EPBC Act	BC Act		
Sterna dougallii	Roseate tern	Marine Migratory		Breeding known to occur within area.	The proposal is located within the foraging BIA for the roseate tern. As there are no known breeding colonies or roosting habitat for this species within the development envelope, significant direct impacts are unlikely. However, as roseate terns roost at Natural Jetty, potential indirect impacts to this species have been considered.

*As listed in the PMST search results and/or Atlas of Living Australia (ala.org.au)

† Although the PMST search indicates that breeding by *E. australis* may occur within the PMST search area, a review of the online National Conservation Values Atlas indicates that this is not the case and only the migration BIA for the species overlaps Thomson Bay

Definitions: BC Act = *Biodiversity Conservation Act 2016* (WA), BIA = Biologically Important Area, DBCA = Department of Biodiversity, Conservation and Attractions (WA), EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)

Priority 4 = Rare, Near Threatened and other species in need of monitoring (BC Act)

Other Specially Protected = Species otherwise in need of special protection (BC Act)

14.2.2.1 Significant impact assessment

Assessment of the proposal against the significant impact criteria for listed migratory species is provided in Table 81.

Table 81: Significant impact criteria - Migratory species

Significant impact guidelines	Summary of impacts on MNES	Variance to guidelines
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.	**Migratory bird species** The development envelope is within the foraging BIA of a number of migratory bird species. Of these, the wedgetail shearwater, roseate tern, crested tern, Caspian tern, Australian fairy tern and bridled tern are considered likely to forage within the development envelope. Other migratory bird species may occasionally occur within vicinity of the development envelope, however, are unlikely to be impacted by the proposal. As the proposal will only result in the removal of 3.32 ha of benthic communities and habitats, including 2.06 ha of seagrass (0.52% of the LAU). Direct impacts to the foraging potential within the development envelope is unlikely to be significant. Potential habitat for these species is unlikely to result in a long-term decrease in the size of a population. A number of the tern species are known to roost at the Natural Jetty at the end of Philip Point, approximately 900 m east of the proposal and may forage within the development envelope. A coastal processes assessment has been undertaken to identify potential impacts of the proposal on coastal processes. This assessment identified that the proposal is unlikely to result in significant erosion of the roosting habitat present at Philip Point. Therefore, the proposal will not result in a significant modification of this roosting habitat. **Shark species** Three threatened shark species may occur within vicinity of the proposal. Scalloped hammerheads (EPBC Act listed conservation dependent) and white sharks (vulnerable) are typically seasonal and use the area for foraging and/or migration; however, may be present year-round. Scalloped hammerheads aggregate in the Shoalwater Islands Marine Park (approximately 30 km from the proposal), peaking during January and February. White sharks are more likely to be present in the Perth region during spring and early summer, and least likely to be present during late summer and autumn. The grey nurse shark (vulnerable) is known to congregate or aggregate in the area year-round. These shark species are known to utilise the following habitat types: • Grey nurse sharks (western population) are found in inshore waters, particularly sub-tropical to temperate waters. Grey nurse sharks are often observed aggregating around inshore rocky reefs or islands (Department of the Environment, 2014). There is likely to be habitat suitable for this species around the island, however the development envelope is unlikely to provide significant habitat for this species. • The scalloped hammerhead is predominately found along coastal shelves, though will occasionally travel into intertidal zones and inshore habitats may be important for immature hammerheads (DCCEEW, 2024). • Great white sharks are frequently recorded in waters around fur seal and sea lion colonies such as those to the west end of the island. There is likely to be habitat suitable for this species around the island, however the development envelope is unlikely to provide significant habitat for this species. The benthic communities and habitats within the development envelope is unlikely to provide critical habitat for these shark species. However, the benthic communities and habitats is likely to provide habitat for prey species for the shark species. An assessment of the shark species pressure analysis for the South-west Marine Region indicates that most of the shark species addressed in the species report group card for sharks are not susceptible to the pressure of habitat modification (DSEWPC, 2012). As such the proposed dredging and removal of benthic communities and habitats is unlikely to have a significant impact on the shark species present in South Thomson Bay. As the proposal will only result in the removal of 3.32 ha of benthic communities and habitats, including 2.06 ha of seagrass (0.52% of the LAU), direct impacts to potential habitat for these species are unlikely to result in a long-term decrease in the size of a population. Indirect impacts to marine habitats and environmental quality will be managed and mitigated through implementation of the CEMP, DEMP and OEMP. Implementation of these plans will ensure that indirect impacts are limited to 2.62 ha of mixed seagrass and 1.09 ha of sand / sand with wrack within the ZoMI. It is predicted that benthic communities and habitats that are impacted within the ZoMI will recover within five years. As such, indirect impacts to potential habitat for these species is unlikely to result in a long-term decrease in the size of a population of the above shark species. **Marine mammals** Seasonal migration whale species along the WA coast includes the southern right whale, pygmy blue whale, humpback whale and orca. Construction and implementation of the proposal will not result in the significant modification, destruction or isolation of important habitat for these species. Underwater noise from piling activities has the potential to result in avoidance behaviours, thereby reducing the area of occupancy of marine fauna species. Implementation of the CEMP (Emerge, 2024) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O) provides the monitoring and management framework to address potential impacts to marine fauna during construction. Implementation of the measures outlined in these management plans will ensure there are no significant residual impacts to marine fauna from underwater noise (see Section 10.6 for further details). **Turtles** Turtle species that may forage in the area include the loggerhead turtle, leatherback turtle and green turtle. The development envelope is not within a BIA for these turtle species and their common distribution is north of the development envelope. Therefore, the proposal is unlikely to reduce the area of occupancy of these species. Underwater noise from piling activities has the potential to result in avoidance behaviours, thereby reducing the area of occupancy of marine fauna species. Implementation of the CEMP (Emerge, 2024) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O) provides the monitoring and management framework to address potential impacts to marine fauna during construction. Implementation of the measures outlined in these management plans will ensure there are no significant residual impacts to marine fauna from underwater noise (see Section 10.6 for further details).	**Not at variance** The proposal will not substantially modify, destroy or isolate an area of important habitat for a migratory species.

Significant impact guidelines	Summary of impacts on MNES	Variance to guidelines
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species.	The proposal will result in the relocation of existing barge movements from the Main Jetty to the development envelope. As no new activities are proposed during operation of the proposal, the introduction of IMS is unlikely. There is potential for the introduction of IMS during construction of the proposal. Measures outlined in the CEMP will ensure that the risk for the introduction of IMS is low.	**Not at variance** Implementation of the CEMP and OEMP will ensure that the proposal will not result in invasive species that are harmful to a migratory species becoming established in an area of important habitat for the migratory species.
Seriously disrupt the life cycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	**Migratory bird species** The development envelope is within the foraging BIA of a number of migratory bird species. Of these, the wedgetail shearwater, roseate tern, crested tern, Caspian tern, Australian fairy tern and bridled tern are considered likely to forage within the development envelope. These tern species are also known to roost at the Natural Jetty at the end of Philip Point, approximately 900 m east of the proposal. There is no important breeding habitat for these species within the development envelope. As the proposal will only result in the removal of 3.32 ha of benthic communities and habitats, including 2.06 ha of seagrass (0.52% of the LAU). Direct impacts to the foraging potential within the development envelope is unlikely to be significant and will therefore not seriously disrupt the life cycle of an ecologically significant proportion of these populations. A coastal processes assessment has been undertaken to identify potential impacts of the proposal on coastal processes. This assessment identified that the proposal is unlikely to result in significant erosion of the roosting habitat present at Philip Point. Therefore, the proposal will not result in a significant modification of this roosting habitat. **Shark species** There is no habitat important to the breeding, feeding, migration or resting behaviours of the white shark within the development envelope and the proposal is considered unlikely to seriously disrupt the life cycle of this species. **Marine mammals** The proposed development envelope is located within the shallower waters of the coastal area of South Thomson Bay and the proposed infrastructure is unlikely to extend into the migratory pathways of the whale species. As such, the proposed infrastructure will not disrupt any existing migratory pathways. Barge movements may traverse the migration route, however as these barge movements are existing, no additional impacts from operation of the proposal are anticipated. Therefore, construction and implementation of the proposal will not significantly impact the migratory pathways of these species. Underwater noise from piling activities has the potential to result in injury or changes in behaviour of marine fauna. Implementation of the CEMP (Emerge, 2024) (Appendix P) and DEMMP (02 Environment, 2024) (Appendix O) provides the monitoring and management framework to address potential impacts to marine fauna during construction. Implementation of the measures outlined in these management plans will ensure there are no significant residual impacts to marine fauna from underwater noise (see Section 10.6 for further details). **Turtles** Turtle species that may forage in the area include the loggerhead turtle, leatherback turtle and green turtle. The development envelope is not within a BIA for these turtle species and their common distribution is north of the development envelope. Therefore, the proposal is unlikely to seriously disrupt the life cycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of a marine turtle population.	**Not at variance** The proposal will not seriously disrupt the life cycle of an ecologically significant proportion of the population of a migratory species.

14.3 Other Commonwealth obligations under the EPBC Act

14.3.1 Critical habitat

There is no critical habitat to the survival of a species within the range of predicted impacts from the proposal.

14.3.2 Recovery and threat abatement plans

The applicable Recovery and Threat Abatement Plans and their objectives relevant to the proposal are provided in Table 82.

Table 82: Compliance with recovery and threat abatement plans

Plan	Objectives relevant to proposal	Compliance
Conservation Management Plan for the Southern Right Whale (DSEWPC, 2012)	• Assessing and addressing the threat of anthropogenic noise on southern right whale. • Addressing infrastructure and coastal development impacts.	Implementation of the CEMP and OEMP ensures that the proposal is not inconsistent with the Conservation Management Plan for the Southern Right Whale.
Conservation Management Plan for the Blue Whale (DoE, 2015)	Anthropogenic noise in biologically important areas will be managed such that any blue whale continues to utilise the area without injury and is not displaced from the foraging area.	Implementation of the CEMP and OEMP ensures that the proposal is not inconsistent with the Conservation Management Plan for the Blue Whale.
Recovery Plan for the Australian Sea Lion (*Neophoca cinerea*) (DSEWPC, 2013)	• Mitigate the impacts of marine debris on Australian sea lion populations. • Investigate and mitigate other potential threats to Australian sea lion populations, including disease, vessel strike, pollution and tourism.	Implementation of the CEMP and OEMP ensures that the proposal is not inconsistent with the Recovery Plan for the Australian Sea Lion.
National Recovery Plan for the Australian Fairy Tern (*Sternula nereis nereis*) (DAWE, 2022)	• Manage and protect known Australian fairy tern breeding populations at the landscape scale • Reduce, or eliminate threats at breeding, non-breeding and foraging sites	Implementation of the CEMP and OEMP ensures that the proposal is not inconsistent with the Recovery Plan for the Australian Fairy Tern.
Threat abatement plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans (DoEE, 2018)	Mitigate the impacts of harmful marine debris on marine species	Implementation of the CEMP and OEMP ensures that the proposal is not inconsistent with the Threat abatement plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans.
Quokka (*Setonix brachyurus*) Recovery Plan (DEC, 2013)	The overall long-term objective of the recovery program is to at least maintain their current distribution and abundance.	Implementation of the CEMP and OEMP ensures that the proposal is not inconsistent with the Recovery Plan for the Quokka.

14.3.3 Wildlife Conservation Plans

The applicable Wildlife Conservation Plans and their objectives relevant to the proposal are discussed in Table 83.

Table 83: Wildlife Conservation Plans

Wildlife Conservation Plan	Objectives relevant to this report	Compliance
Wildlife Conservation Plan for Migratory Shorebirds (2015, 2015)	• Protection of important habitats for migratory shorebirds has occurred throughout the East Asian-Australasian Flyway. • Anthropogenic threats to migratory shorebirds in Australia are minimised or, where possible, eliminated.	Implementation of the CEMP and OEMP ensures that the proposal is not inconsistent with the Wildlife Conservation Plan for Migratory Shorebirds.
Wildlife Conservation Plan for Seabirds (DAWE, 2022)	• Seabirds and their habitats are identified, protected and managed in Australia. • The long-term survival of seabirds and their habitats is achieved through supporting priority research programs, coordinated monitoring, on-ground management and conservation. • Manage the effects of anthropogenic disturbance to seabird breeding and roosting areas.	Implementation of the CEMP and OEMP ensures that the proposal is not inconsistent with the Wildlife Conservation Plan for Seabirds.

14.3.4 Offshore dredge disposal

No offshore dredge disposal will be undertaken as part of the proposal, with all dredged material used for reclamation purposes within state waters. Activities that include the placement of matter for a purpose other than the disposal of material are not regulated under the *Environment Protection (Sea Dumping) Act 1981*.

Liaison with the Wildlife, Waste and Environmental Permits Branch of DCCEEW confirms that the utilisation of dredge material for land reclamation is considered placement for a purpose and therefore, does not require a sea dumping permit.

15 OFFSETS

The following policy and guidance have been reviewed as part of this assessment:

- WA Environmental Offsets Policy (Government of Western Australia, 2011)
- WA Environmental Offsets Guidelines (Government of Western Australia , 2014)
- EPBC Act environmental offsets policy (DSEWPC, 2012)
- Environmental Impact Assessment (Part IV Divisions 1 and 2) Procedures Manual (EPA, 2020b).

Consistent with Principle 1 of the WA Environmental Offsets Policy (Government of Western Australia 2011) Rottnest Island Authority has applied the mitigation hierarchy by identifying measures to avoid and minimise environmental impacts, as outlined in Sections 7 to 13 this report.

As discussed in Section 16, the environmental impacts from the proposal as a whole includes:

- Impacts to benthic communities and habitats and marine fauna habitats:
  - Permanent loss of mixed seagrass of up to 2.06 ha (or 0.52% of mixed seagrass within the LAU)
  - Permanent loss of sand / sand with wrack of up to 1.26 ha
  - Temporary loss of 2.62 ha of mixed seagrass and 1.09 ha of sand / sand with wrack within the ZoMI. Baird (2024b) predicts that impacts to these benthic communities and habitats will be recoverable within a period of five years following completion of the dredging activities
- Interruption to longshore currents may result in minor sediment accretion and seagrass accumulating on the eastern side of the wharf
- Temporary suspended sediments within the ZoMI (4.5 ha) and ZoI (13.44 ha)
- Temporary reduction in light due to suspended sediments in the water column within the ZoMI (4.5 ha). As impacts to benthic communities and habitats within the ZoMI will be recoverable within a period of five years following completion of the dredging activities, these residual impacts are not considered significant
- Underwater noise emissions from piling operations causing temporary disturbance to marine fauna species
- Removal of 0.46 ha of native vegetation and potential fauna habitat. Of the native vegetation being cleared, 0.23 ha comprises the TEC, *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands of the Swan Coastal Plain.

As the assessment of these residual impacts concluded that they are not significant, no environmental offsets are proposed as art of this proposal.

16 HOLISTIC IMPACT ASSESSMENT

This report provides an assessment of the potential environmental impacts associated with the proposal and the proposed mitigation measures and management strategies for each key environmental factor. This section provides an assessment of the connections and interactions between impacts, and the overall impact of the proposal on the environment as a whole.

RPS acknowledges the relationships between the key environmental factors addressed in this report and that those interrelationships may require synergistic consideration and management to achieve the proposed environmental outcomes. The key environmental factors that relate, to varying degrees, are demonstrated in Figure 46 and the combined impacts are summarised in Table 84.

Although social surroundings are only linked with coastal processes in this is assessment, due to the community perception and social values of Wadjemup / Rottnest Island, it is recognised that all key environmental factors are linked to social surroundings to a lesser degree.

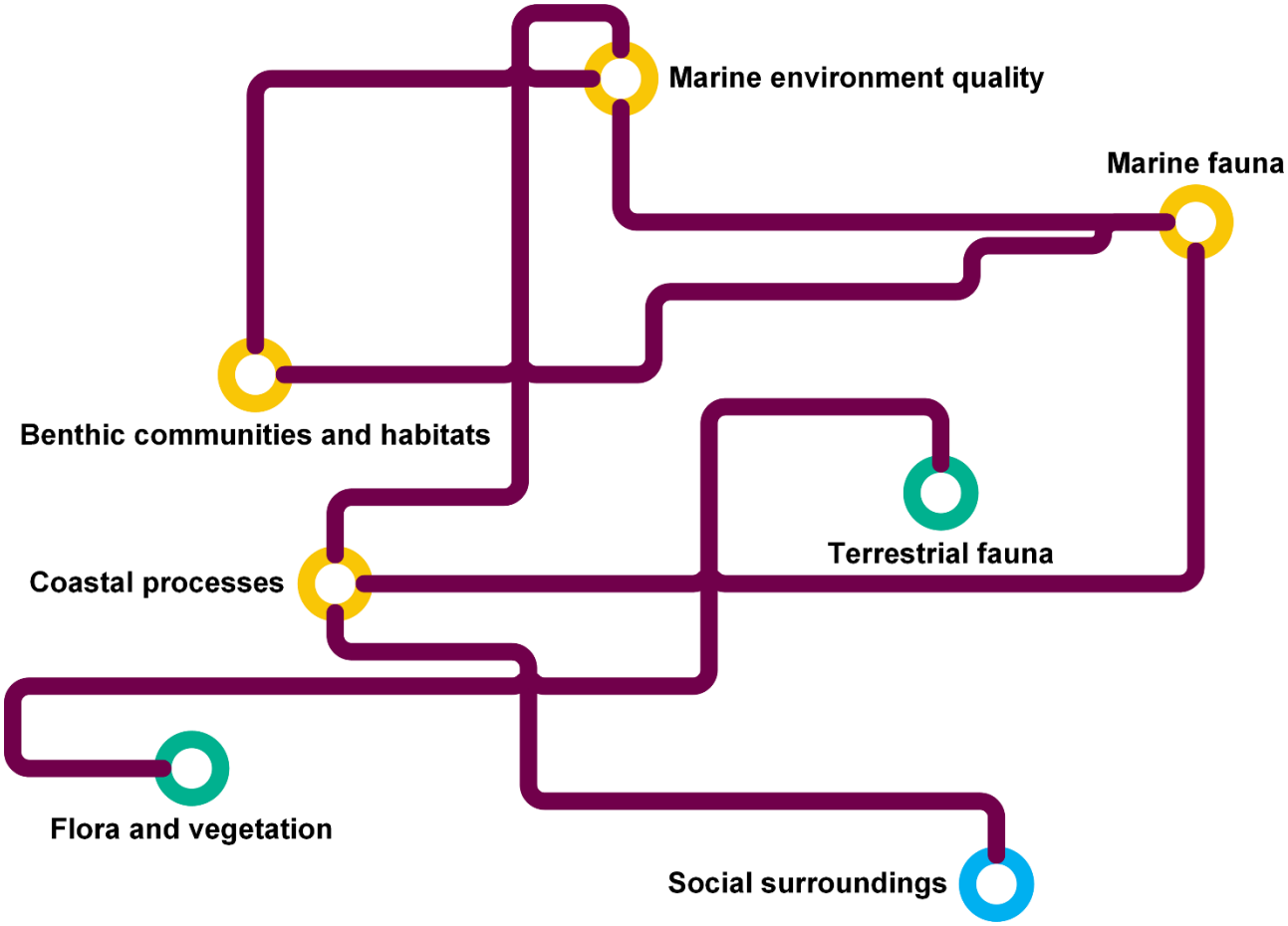


Figure 52: Relationship between key environmental factors

Table 84: Connections and interactions between key environmental factors relevant to the proposal

Environmental factor	Connection / interaction pathway	Combined impact
• Benthic communities and habitats • Marine environmental quality • Marine fauna • Coastal processes • Social surroundings	Construction of the proposal will result in a temporary increase in total suspended sediments.	• Reduced marine environmental quality • Decrease in light availability resulting from increased turbidity leading to reduced primary productivity. • Permanent and temporary (recoverable) loss benthic communities and habitat and marine fauna habitat. • Increased sedimentation rates, or burial, resulting in stress or increased mortality rates (under extreme conditions).
	Construction and operation of the proposal may result in the introduction of IMS	• Alteration of the natural benthic communities • Marine pests may threaten biodiversity through a number of mechanisms such as predation, competition for habitat and altering ecosystems.
	Impacts from marine infrastructure	• Altered water flows and sediment transport caused by the presence of new marine infrastructure potentially impacting marine bird roosting habitat. • Interruptions of longshore currents • Reduction of wave energy.
	Construction of the proposal may result in pollution incidents.	• Increased boat numbers during operation, and to lesser degree construction, of the proposal has the potential to increase the risk of pollution, including from antifouling paints, anti-corrosion anodes, increased risk of accidental discharges (e.g. fuel spills, oils and greases) and sullage. • A fuel facility, including underground storage tanks is proposed as part of the proposal. There is a risk for fuel spills to occur during refuelling or from fuel storage facilities. Fuel spills from the fuel facility have the potential to impact marine environmental quality.
	Construction and operation of the proposal.	• Impacts to amenity from noise, artificial lighting and odour.
• Flora and vegetation • Terrestrial fauna	Implementation of the proposal will result in clearing of native vegetation.	• Removal of native vegetation. • Loss of terrestrial fauna habitat.
	Implementation of the proposal will result in an increased risk of the spread or introduction of weeds and pests	• Degradation of native vegetation • Degradation of fauna habitat
	Implementation of the proposal will result in an increased risk of the spread or introduction of disease.	• Degradation of native vegetation • Degradation of fauna habitat

16.1 Residual impacts from the proposal as a whole

Overall, the residual impacts on these environmental factors are low due to the implementation of avoidance and mitigation measures.

The residual environmental impacts from the proposal as a whole include:

- Impacts to benthic communities and habitats and marine fauna habitats:
  - Permanent loss of mixed seagrass of up to 2.06 ha (or 0.52% of mixed seagrass within the LAU)
  - Permanent loss of sand / sand with wrack of up to 1.26 ha (including this as a residual impact is a conservative approach, as sand with wrack is likely to be present post dredging, resulting in only temporary unavailability of sand with wrack)
  - Temporary loss of 2.62 ha of mixed seagrass and 1.09 ha of sand / sand with wrack within the ZoMI. Baird (2024b) predicts that impacts to these benthic communities and habitats will be recoverable within a period of five years following completion of the dredging activities

- Interruption to longshore currents may result in minor sediment accretion and seagrass accumulating on the eastern side of the wharf
- A reduction of wave energy in lee of the wharf
- Temporary suspended sediments within the ZoHI (1.37 ha), ZoMI (4.5 ha) and ZoI (13.44 ha)
- Temporary reduction in light due to suspended sediments in the water column within the ZoMI (4.5 ha). As impacts to benthic communities and habitats within the ZoMI will be recoverable within a period of five years following completion of the dredging activities, these residual impacts are not considered significant
- Underwater noise emissions from construction activities such as piling operations and dredging causing temporary disturbance to marine fauna species
- Removal of 0.46 ha of native vegetation and potential fauna habitat. Of the native vegetation being cleared, 0.23 ha of vegetation that is analogous with the TEC, *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands of the Swan Coastal Plain.
- The permanent relocation of four moorings.

17 CUMULATIVE ENVIRONMENTAL IMPACT ASSESSMENT

Cumulative environmental impacts are the successive, incremental and interactive impacts on the environment of a proposal with one or more past, present and reasonably foreseeable future activities. RPS has undertaken a cumulative impact assessment that considers impacts to environmental factors relevant to the proposal from previous, current, and potential future projects that have been approved within 5 km of the proposal.

Cumulative impacts to benthic communities and habitats are discussed in Section 7.5.1.1.3 of this report. A summary of the predicted cumulative impacts to benthic communities and habitats is summarised below:

- Conservative estimates of seagrass loss undertaken by Oceanica (2013) estimated a human-induced disturbance of 7.95 hectares of seagrass.
- The 'current' extent of seagrass habitat is estimated as 398.70 hectare.
- Based on the above estimates, the permanent loss of seagrass habitat as a consequence of the proposal (2.06 ha, 0.52% of the LAU) results in a cumulative (historical (1.95% of the LAU) and projected (0.52% of the LAU)) loss of seagrass within the LAU of 2.47%.

Previously approved projects within 5 km of the proposal are shown in Figure 47. Those projects that impact environmental factors relevant to this proposal are discussed further in Table 85 and a summary of the cumulative impacts within 5 km of the proposal is provided below:

- **Marine fauna**
  - The underwater noise impacts from the Seismic Survey, Bremer Basin, Mentelle Basin and Zeewyck Sub-basin project has been completed. As the construction of the proposal and seismic survey will not be undertaken consecutively, cumulative impacts on marine fauna from underwater noise from these two projects will be limited to the individual proposal and not be significant.
- **Flora and vegetation**
  - Approximately 49.96 ha of native vegetation has been approved to be cleared within 5 km of the development envelope. The proposal, combined with this area comprises 50.42 ha of vegetation.
  - Wadjemup / Rottnest Island encompasses approximately 1,800 ha, most of which is vegetated. If a conservative estimate is adopted, with an assumption that half of the island remains vegetated, cumulative impacts from clearing 50.42 ha of vegetation would comprise 5.6% of the vegetation present on the island.
- **Terrestrial fauna**
  - Approximately 49.96 ha of native vegetation, providing potential terrestrial fauna habitat, has been approved to be cleared within 5 km of the development envelope. The proposal, combined with this area comprises 50.42 ha of potential terrestrial fauna habitat. Based on the above conservative estimate, this would comprise a cumulative impact of 5.6% of the potential terrestrial fauna habitat present on the island.

Overall, the proposal is unlikely to contribute to significant cumulative impacts combined with existing and reasonably foreseeable future activities.

Table 85: Assessment of cumulative impacts

Projects within 5 km of the proposal	Relevant environmental factor	Details and impact summary	Status
Native vegetation clearing permits			
7759/1	Flora and vegetation	Vegetation clearing of up to 1.99 ha.	Complete
9883/1	Flora and vegetation	Vegetation clearing of up to 2.78 ha.	Pending
7981/1	Flora and vegetation	Vegetation clearing of up to 3.35 ha.	Complete
8135/1	Flora and vegetation	Vegetation clearing of up to 1.27 ha.	Complete
5568/1	Flora and vegetation	Vegetation clearing of up to 0.002 ha.	Not progressed
5456/1	Flora and vegetation	Vegetation clearing of up to 0.23 ha.	Not progressed
5448/1	Flora and vegetation	Vegetation clearing of up to 0.90 ha.	Not progressed

Projects within 5 km of the proposal	Relevant environmental factor	Details and impact summary	Status
5641/4	Flora and vegetation	Vegetation clearing of up to 34.44 ha.	Completed as multiple walking trails.
6775/1	Flora and vegetation	Vegetation clearing of up to 2.59 ha.	Complete
8778/1	Flora and vegetation	Vegetation clearing of up to 0.40 ha.	Complete
7019/1	Flora and vegetation	Vegetation clearing of up to 0.46 ha.	Complete
Referral to the EPA and EPBC referrals			
Rottnest Island Golf Course Upgrade	• Flora and vegetation • Terrestrial fauna	Upgrade of golf course involving treatment of wastewater for irrigation of fairways and the construction and irrigation of greens (previously sand only). Residual impacts include: • Clearing up to 0.38 ha of vegetation • Clearing up to 0.38 ha of potential habitat for terrestrial fauna. The EPA assessed the proposal as 'Scheme Not Assessed – Public Advice Given'.	Complete
Pinky's Beach Eco Retreat	• Flora and vegetation • Terrestrial fauna	The Eco-Retreat is located west of the existing campground and directly adjacent to an existing Wastewater Treatment Plant (WWTP) to the east. Residual impacts include: • Clearing of 1.8 ha native coastal vegetation • Clearing up to 1.8 ha of potential habitat for terrestrial fauna • Increased human activity on the coastal area. The EPA assessed the proposal as 'Not Assessed - Public Advice Given'.	Complete
Rottnest Lodge Development	• Flora and vegetation • Terrestrial fauna	The proposal involves the demolition and/or refurbishment of existing accommodation, the construction of new accommodation and associated infrastructure. Residual impacts include: • Clearing of up to 0.5 ha of native vegetation • Clearing up to 0.5 ha of potential habitat for terrestrial fauna.	Complete
INDIGO Marine Cable Route Survey (2017/7996)	• NA	A cable route survey from the beach utility hole in the Dunningham Reserve north Coogee to the beach utility hole at Floreat Beach in Perth. No significant impacts were identified as part of the impact assessment.	Complete
Seismic Survey, Bremer Basin, Mentelle Basin and Zeewyck Sub-basin (2004/1700)	• Marine fauna	The proposed action was to conduct a marine acoustic survey from Coogee Beach, NSW, to Floreat Beach, WA, to the seaward boundary of the Australian Exclusive Economic Zone north of Christmas Island. Potential impacts include underwater noise impacts to marine fauna.	Complete
INDIGO Central Submarine Telecommunications Cable (2017/8127)	• NA	Installation of a submarine fibre optic cable from Perth to Sydney. No significant impacts were identified as part of the impact assessment.	Complete

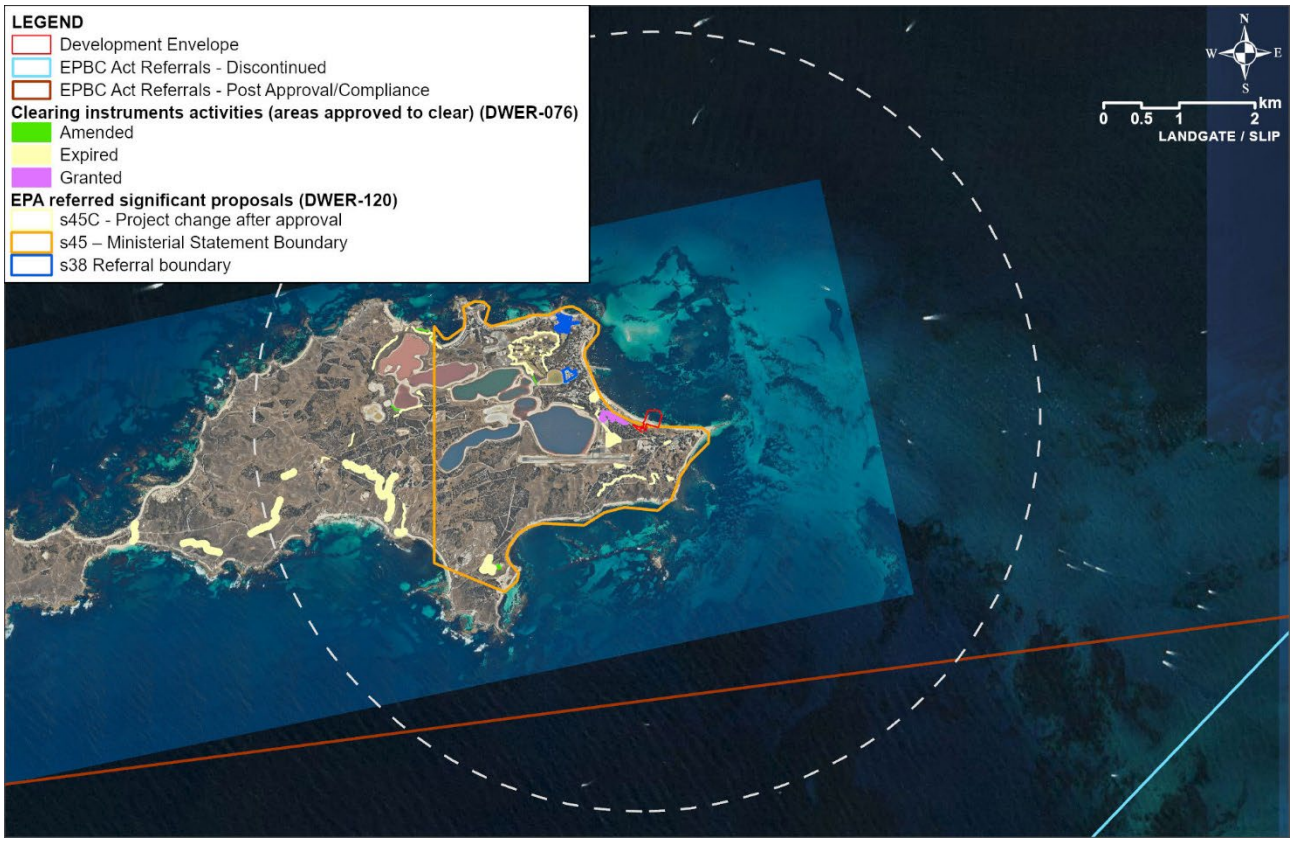


Figure 53: Projects and approvals within 5 km of the proposal

18 CONCLUSION

This Environmental Supporting Document provides an environmental impact assessment of the proposal in accordance with relevant state and federal policies and guidance. Cumulative impacts have been considered and assessed.

Significant baseline monitoring and site-specific studies have been undertaken. The footprint of the project (development envelope) is relatively small and replaces and expands an existing maritime infrastructure facility (Army Groyne) that cannot be adequately repaired or maintained.

There is a clear current and escalating future demand for the South Thomson Barge Landing Development, which will have demonstrated benefits for the wider community.

There has been significant consultation with relevant stakeholders, including traditional owners, which commenced in 2019.

18.1 Section 38 referral

The assessment has concluded that the proposal is expected to be able to meet EPA's objectives for all environmental factors, subject to the implementation of the management and mitigations measures outlined in the following management plans:

- Dredging Environmental Monitoring and Management Plan (02 Environment, 2024) (Appendix O)
- Construction Environmental Management Plan (Emerge, 2024a) (Appendix P)
- Operational Environmental Management Plan (Emerge, 2024b) (Appendix Q).

18.2 EPBC referral

MNES with the potential to occur within or proximate to the development envelope includes the following listed threatened species and migratory species:

- Listed threatened species:
  - Terrestrial fauna (quokka)
  - Marine fauna (scalloped hammerheads, white sharks and grey nurse shark, southern right whale, pygmy blue whale minke whale, Australian sea lion, loggerhead turtle, leatherback turtle and green turtle and marine bird species (in particular the Australian fairy tern, Caspian tern and crested tern)).
- Migratory species:
  - Marine fauna (scalloped hammerheads, white sharks and grey nurse shark, southern right whale, pygmy blue whale minke whale, Australian sea lion, loggerhead turtle, leatherback turtle and green turtle and migratory bird species (wedgetail shearwater, roseate tern, crested tern, Caspian tern, Australian fairy tern and bridled tern)).

No other MNES are considered relevant to the proposal. The assessment of potential impacts to MNES from the proposal identified the following:

- An assessment of the proposal against the Significant Impact Guidelines 1.1 – Matters of National Environmental Significance (Department of the Environment, 2013) for the Quokka identified that the proposal was not at variance to the guidelines.
- Assessment of the proposal against the Significant Impact Guidelines 1.1 – Matters of National Environmental Significance (Department of the Environment, 2013) for listed migratory species (including migratory marine birds, marine turtles and whale species) identified that the proposal was not at variance to the guidelines.

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Appendix A
Construction methodology

South Thomson Barge Development Landing

Construction Method and Sequence

The following information is based on the following documents:

- PAEMAC (2024) *Rottnest Island Authority South Thomson Bay Barge Facility, Basis of Estimate*.
- In2Dredging (2023) *South Thomson Bay Development, Dredging Budget and Schedule Estimates*.
- PAEMAC (2020) *South Thomson Bay Development - Value Engineering Assessment.*
- AECOM (2020) *South Thomson Bay Barge Facility, Value Engineering of Concept Design*.

In addition, further detail on construction methods and sequencing was provided by the RIA Infrastructure team.

Figures and cross-sections have been included in this document for ease of understanding the construction methods and sequence. Please refer to the above-mentioned reports for more figures and cross-sections.

The construction method and sequencing will consist of:

1.0 Stage 1 – Maritime Infrastructure

1.1 Preliminaries:

This includes all planning, design and preparation works including plant/ equipment and fabrication activities. This will also include verification of the site (seabed survey) as well as any underground service location.

1.2 Mobilisation and site setup:

This includes installation of site sheds, preparation of laydown areas A and B (see **Figure 4**), erection of marine traffic management, site signage, public advertisements and mobilisation of equipment. The preparation of laydown area B will require mechanical clearing of vegetation and cut and fill of the adjacent dune to level this area. It is noted Laydown area B is located in the footprint of the onshore storage shed in Stage 2 of the project.

1.3 Temporary Works Construction:

A temporary Roll On Roll Off (RORO) facility will be constructed to off load equipment and materials. The RORO:

- Will be constructed either through localised improvements to the Army Jetty groyne or a bespoke structure (see Figure 5 in PAEMAC (2024)).
- The RORO could be located on the western side of the Army Groyne, see **Figure 1** below.
- The RORO will be suitable for unloading of large equipment and/or materials such as precast concrete, piles, earthmoving equipment, temporary structures, and also dredge spoil for use in reclamation.
- The existing small boat landing may be utilised by the Contractor during construction for launching small craft.

1.4 Dredging:

Advice regarding the dredging methodology and equipment has been provided by In2Dredging (2023), who propose using a Backhoe Dredge (BHD). The process is outlined below:

- As per In2Dredging (2023) advice, dredging must be undertaken across the dredge footprint prior to construction of the breakwater and new laydown area.
- The BHD is positioned with a support tug and then using its spud piles and excavator arm it manoeuvres into the required dredging location.
- The loosening or cutting process breaks the in-situ materials' cohesion, allowing these materials to be removed. The process will be carried out mechanically using the cutting edge of a bucket on a BHD. In2Dredging (2023) indicate that both sand and rock can be removed using a BHD.
- An estimated 14,000 m^3 of sand and 2,017 m^3 of rock will be dredged.
- Once loosened or dislodged, these materials will be raised to the water's surface, to be undertaken mechanically via raising the bucket or grab of a BHD.
- Excavated material is placed onto a flat-top barge moored alongside the BHD. When the barge is filled to its safe working capacity, it will drive to the RORO facility to be unloaded.
- A silt curtain placed around the BHD may be required (pending the preparation of Dredge Management Plan) to mitigate the potential environmental impact due to the dredge plume (due to the disturbance of fine sediment fractions).
- The dredged material will be reused as fill material in the laydown/hardstand area.
- The dredging and disposal process will be repeated until the areas have been dredged completely to the required design depths.
- A dual function Survey/Crew Transfer Vessel will form part of the BHD dredging spread. The survey vessel will provide regular survey update to the BHD dredging operator and will also be used as crew transfer vessel to transport personnel from shore to vessel and vice versa.
- The excavated material will be transferred to Army Groyne via the barge at the RORO. The barge will be unloaded using a long reach excavator and loaded into 45t Articulated Dump Trucks (ADT).
- The sequence of dredging beneath future infrastructure areas (i.e. beneath the breakwater and reclamation area) will be determined by the contractor, but it is likely that dredging will occur in these area prior to construction of the new breakwater and new laydown area.

Figure 1 shows the indicative position of dredging equipment.

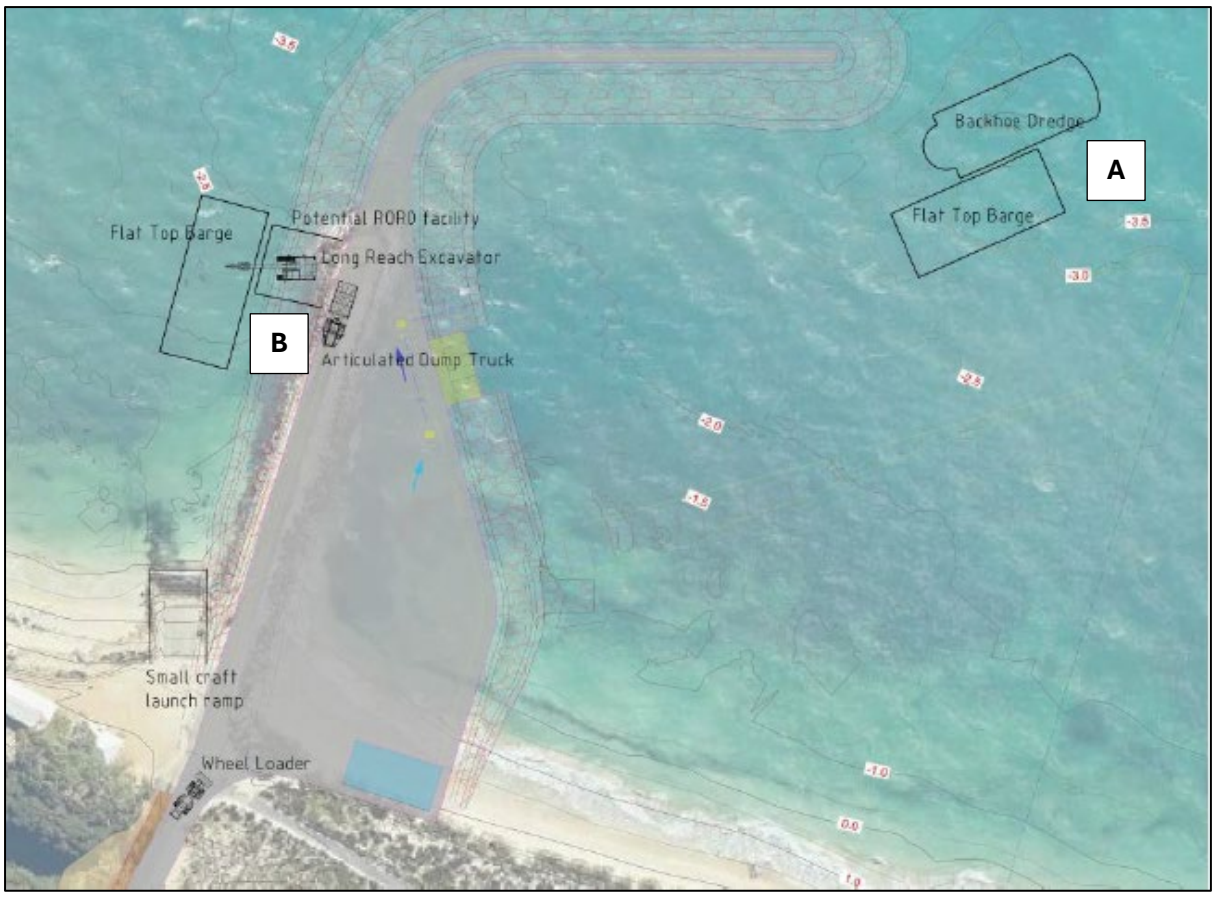


Figure 1: Indicative location of dredging equipment and barge for loading of dredge spoil (A), and location of barge and excavator on RORO facility for unloading dredge spoil into a ATD (B).

1.5 Reclamation:

The laydown area shall incorporate reclaimed dredged fill material and shall be constructed as per the process below:

- Existing armour from the eastern side of the Army Groyne will be removed and used for construction of bunding (see next step).
- Bunding will be constructed along the eastern and northern sides of the reclamation zone to allow dredge spoil to settle and remain in place. The bunding is to prevent dredge spoil from being washed away into the marine environment by waves or during high tides. **Figure 2** shows the bunding extent.
- The bunding will be constructed using core materials, followed by a geotextile filter layer and an armour layer. **Figure 3** shows a conceptual cross-section of the bunding, reclamation fill and then adjacent dredge zone.
- Using the dredged spoil, the Contractor will establish a tip head to place the dredged fill material onto the beach/into the water in the southwest corner.
- Dredge spoil will be unloaded from the ADT and pushed out over the tip head using a wheel loader or similar.
- Dredge spoil will be placed and spread in a north and east direction.
- Consistent with the progression of reclamation, the bunding on the marine side of the reclamation zone will need to progressively moved to the north to ensure that each successive round of dredge spoil placed will remain in place.
- Reclamation will continue until all dredge spoil has been placed. AECOM (2020) and PAEMAC (2024) estimated that the dredge spoil will be sufficient to complete the laydown area. There is not expected to be a requirement to import fill to complete the laydown area.

- Material will be compacted using a static pad foot roller until a pavement level of +2.5m CD is achieved. If required, the wheel loader will assist with material placement and wheel rolling.
- Stormwater drainage will be installed followed by a layer of crushed rock basecourse and asphalt.

Figure 2 shows the process of reclamation using the dredge spoil.

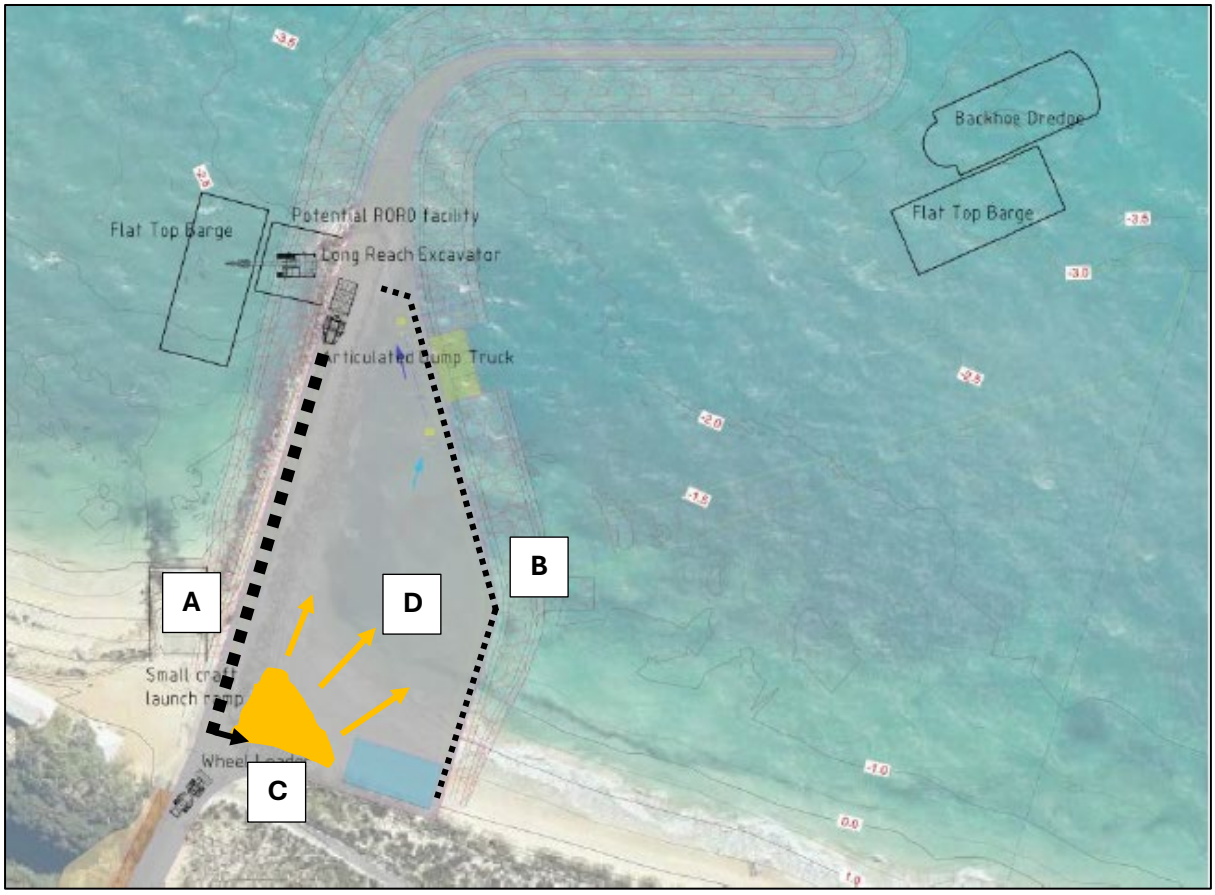


Figure 2: Indicative process for reclamation showing the Army Groyne (A), bund wall (B), placement of dredge spoil in the southwest corner of the area (C) and the direction that dredge spoil will be placed and spread (D).

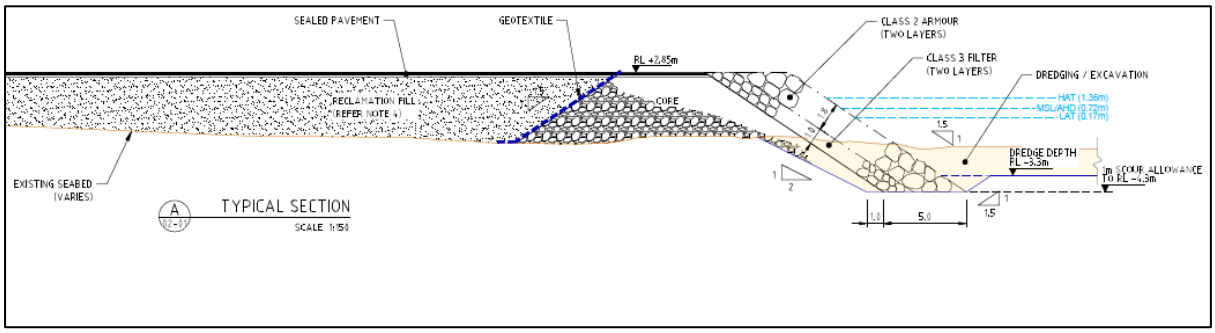


Figure 3: Conceptual cross-section of the reclamation fill, bunding and adjacent dredge zone.

1.6 Army Groyne Extension:

On completion of the reclamation works, the Army Groyne will be upgraded as per the following process:

- Remove excess rock/materials and reshape existing groyne.
- Import all rock and core materials from the mainland using a conventional barge converted for handling rock.
- Place core materials along exposed batter.
- Place filter layer (geotextile).
- Place rock armour (Class 2) along exposed batter.
- Place rock armour (Class 1) along northern breakwater.
- Place a layer of crushed rock basecourse and asphalt along the Army Groyne extension to match that placed in the reclamation area.
- The placement of rock will be largely undertaken from the marine side whereby rock is picked from an adjacent barge and put into place. Some rock may be placed from the land side (i.e. rock temporarily stored in the laydown are from the original Army Groyne wall). It is expected that other materials (crushed rock, bitumen) will also be loaded from the marine side onto the facility alleviating the need for use of the barge landing at the Main Jetty.

The various rock armour classes to be used in the structure are shown in **Figure 4**.

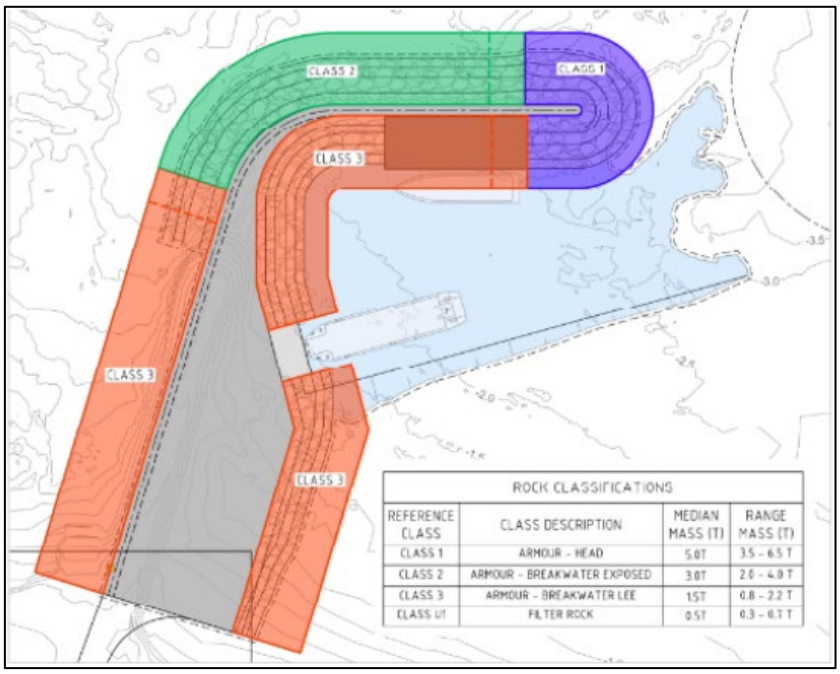


Figure 4: Conceptual cross-section of the reclamation fill, bunding and adjacent dredge zone.

1.7 Maritime Infrastructure:

Includes the Barge Landing Ramp. PAEMAC (2024) expected that these works would occur concurrently with construction of the rock armour revetments to allow piles to be installed prior to revetments being built. Should a staged approach be followed by the Contractor, 1200mm sleeves will need to be installed in the armour so the Stage 2 piles can be installed through the armour.

The Barge Landing Ramp works include:

- Installation of a precast concrete gravity retaining wall below the water level at the dredge level.
- Installation of the deck slab.
- Installation of No.4 (TBC) mooring piles to a maximum depth of 10 m (TBC) using a Vibro-Hammer.
- It is expected that the installation of the above-mentioned items will be undertaken either from the marine side or reclaimed area.

1.8 Services:

Underground services will be installed and connected to onshore underground services using small excavators/small plant via excavation of shallow trenches that will be backfilled. Services consist of:

- Water
- Firefighting services
- Electrical services
- Communications
- Fuel tank. The fuel tank will be installed in the south-east corner of the reclamation zone and will be installed within the compacted dredge spoil. Installation of the fuel tank will be in accordance with all Dangerous Goods regulations (i.e. double lined tank, leak detection systems, tank pit/groundwater monitoring wells).

1.9 Storage shed:

These works consist of construction of the shed structure and hardstand in the south-east corner of the reclamation zone**.** The extent of intrusive works for this scope of work is expected to be minimal.

1.10 Road works:

These works consist of road work construction including:

- Cut and fill of the Army Jetty Road using mechanical means
- Kerbing
- Signage
- Asphalt paving
- Line marking
- Drainage
- These works includes completing any sections of the new facility and the road section that links to the Army Jetty Road.

1.11 Demobilisation:

On completion of the works, a hydrographic survey of the site will be undertaken to ensure any debris on the seabed has been removed. Other activities include:

- Removal of site offices
- Dismantling RORO and equipment
- Removing all equipment from site.

2.0 Stage 2 – Onshore infrastructure and ferry berth

2.1 Ferry berth:

This structure is intended to be constructed during Stage 2 of the project and will comprise:

- Installation of piles using a Vibro-Hammer rig operated from a barge located adjacent. The dimensions and number of piles is estimated at 16 X 610mm (TBC) that will be installed to a depth of 15 m (TBC). As noted previously, if the Contractor does not install piles concurrently with construction of the breakwater, then 1200mm sleeves will need to installed in the rock armour so piles can be driven through the sleeves.
- Installation of a precast concrete deck and surface.
- Fit out of the wharf with fenders, fender chains, mooring bollards, signage, lighting.
- It is expected that the installation of the above-mentioned items will be undertaken from the marine side.

2.2 Small Craft Landing:

The Small Craft Landing works include:

- Installation of piles using a Vibro-Hammer rig operated from a barge located adjacent. The dimensions and number of piles is estimated at 6 X 500mm (TBC) that will be installed to a depth of 10 m (TBC). As noted above, if the Contractor does not install piles concurrently with construction of the breakwater, then 1200mm sleeves will need to installed in the rock armour so piles can be driven through the sleeves.
- Installation of abutment.
- Installation of floating deck units.
- Installation of navigational aids.
- It is expected that the installation of the above-mentioned items will be undertaken from the marine side or reclaimed area.

2.3 Storage building:

These works consist of construction of the storage shed structure and hardstand to the east of Army Jetty Road. Vegetation clearance, cut/fill and levelling of this area will have already been completed during the mobilisation phase in Stage 1. The extent of intrusive works for this scope of work is expected to be minimal.

3.0 Works schedule

Appendix C of PAEMAC (2024) provides an indicative works schedule.

4.0 Equipment

Please refer to PAEMAC (2024) for an indication of the equipment to be used.

5.0 Disturbance footprints

5.1 Laydown Areas:

It is proposed that two laydown areas will be required as shown in **Figure 5**. One laydown area will be located in the onshore storage shed that will be constructed in Stage 2 of the project. Shapefiles of the footprint can be provided.

Figure 5: Proposed laydown areas ‘A’ and ‘B’.

5.2 Proposed disturbance footprint:

The proposed disturbance footprint is shown below in **Figure 6**. Shapefiles of the footprint can be provided.

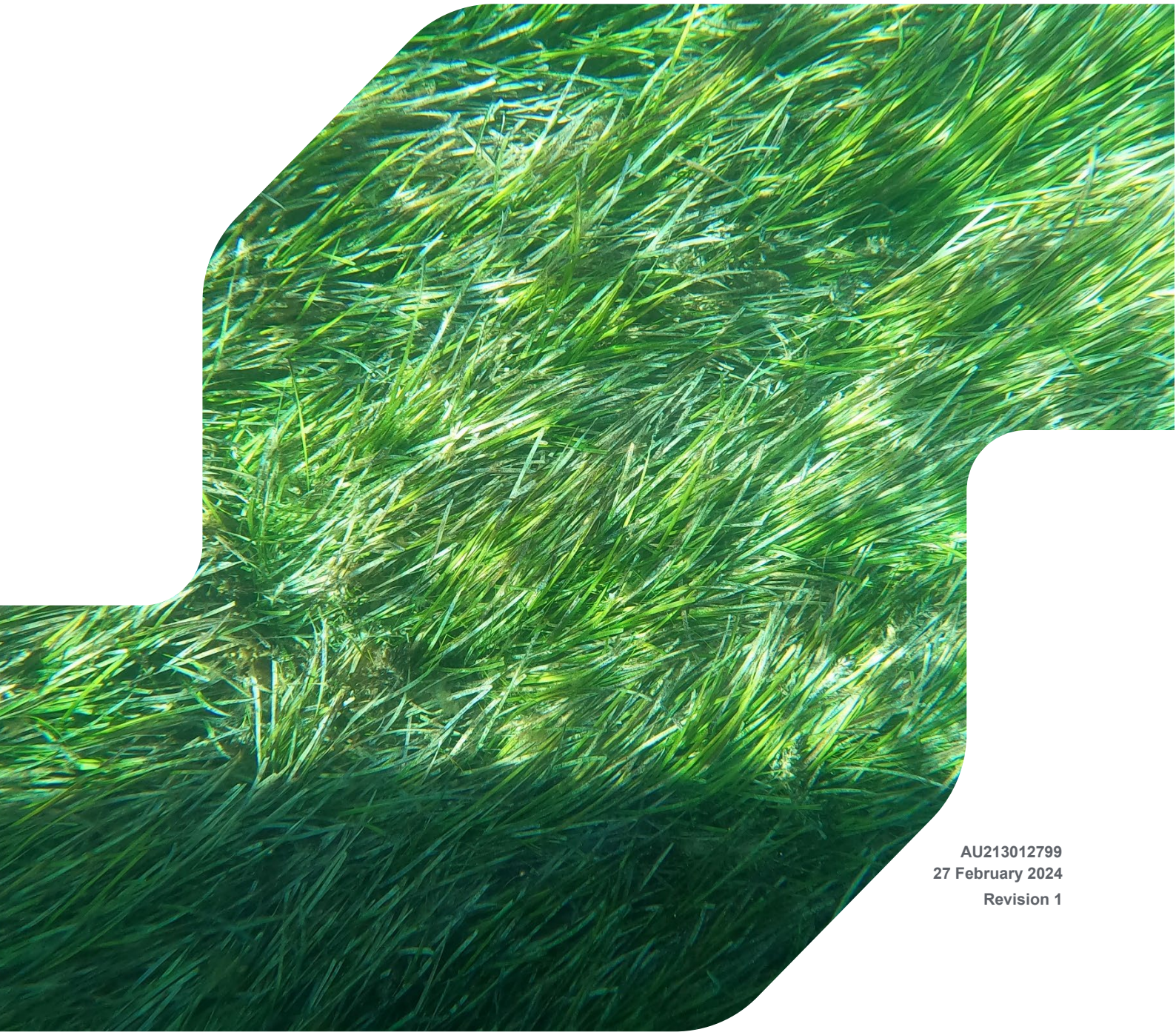
Figure 6: Proposed total disturbance footprint (Red line).

REPORT

Appendix B
Marine fauna and benthic habitat assessment, South Thomson Barge Landing Development (RPS 2024)

SOUTH THOMSON BARGE LANDING DEVELOPMENT

Marine Fauna and Benthic Habitat Assessment



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Revision 1

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Rottnest Island Authority kaadatj Wadjak Noongar moort. Baalap Wadjemup kaaradjiny, baalabang malayin nakolak-ngat wer wirn kalyakoorl noyinang koort boodja-k wer kep-ak.

Ngalak kaadatj nedingar, birdiya wer boordakan Noongar moort. Ngalak karnadjil kaadatj maaman wer noba wirn Ali kalka Nino noyiyang Wadjemup ngardak boodja-k.

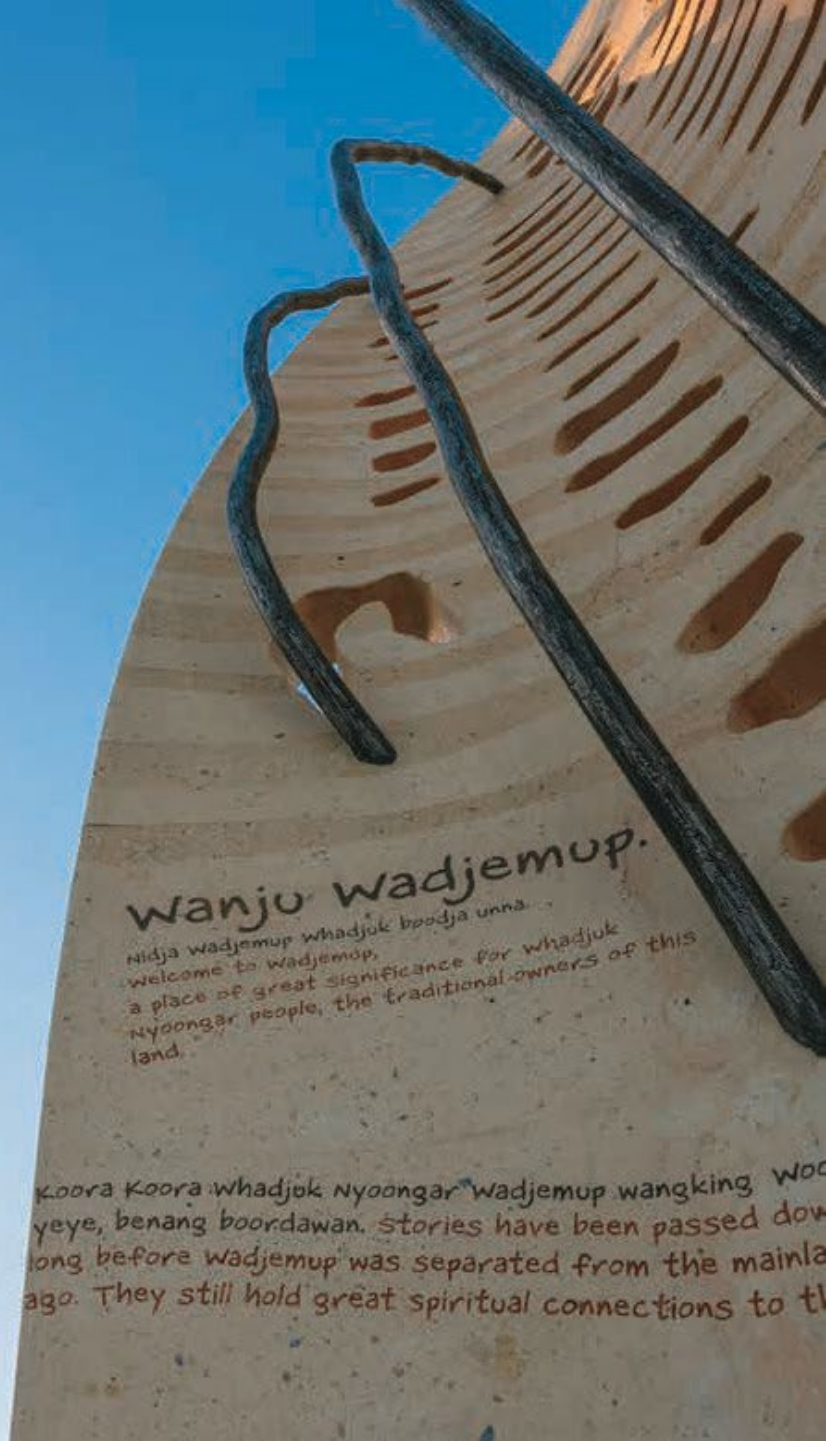
Baalabang moort maambart-boort, ngooni-boort,kongk-boort wer Birdiya-boort.

Rottnest Island Authority acknowledge Whadjuk Noongar families. They Wadjemup caring, their culture and spirits always connected Island-to and water-to.

We acknowledge ancestors, Elders and future Noongar families. We truly acknowledge men and boys' spirits who still remain connected Wadjemup under ground-in.

Their family's father-without, brother-without, uncle-without and Elder-without.

Translation courtesy of
Sharon Gregory, Noongar
Language Consultant.



Koora-Yeye-Boordawan-Kalyakoorl

(Past-Present-Future-Forever)
sculpture, Thomson Bay

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
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Rev 1	Update to include Supplementary Survey	RosMcC	MicMac	MicMac	16/02/2024

Approval for issue

Mike Mackie	Michael A Mackie	16/02/2024

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Contents

ABBREVIATIONS – KEY TERMS AND LEGISLATION IV

1 INTRODUCTION 1
1.1 Background and location 1
1.2 Scope of Work 1

2 MARINE FAUNA DESKTOP ANALYSIS 3
2.1 Objectives 3
2.2 Commonwealth legislation 3
2.3 State legislation 3
2.4 Methods 4
2.4.1 Conservation important species 4
2.4.2 Non-conservation important species 4
2.5 Results and Discussion 5
2.5.1 Conservation important species 5
2.5.2 Non-conservation important species 12
2.6 Conclusions 21

3 DESCRIPTION OF BENTHIC HABITAT 22
3.1 Objectives 22
3.2 Methods 22
3.2.1 Field surveys 22
3.2.2 Data processing 23
3.3 Results and Discussion 24
3.3.1 Review of the Local Assessment Unit and habitat mapping by Harvey (2009) 24
3.3.2 Development of a benthic habitat map within the FSA 26
3.3.3 Development of a benthic habitat map within the Main Jetty Survey Area 27
3.3.4 Habitat loss due to the proposed development 31
3.3.5 Cumulative habitat loss 31

REFERENCES 33

Tables

Table 2-1: Species of conservation importance identified in the PMST and DBCA database reports that may occur in Thomspon Bay 7
Table 2-2: Non-conservation important fish species that may occur in Thomson Bay 13
Table 3-1: Classification scheme used in analysis of benthic habitat 23
Table 3-2: Comparison of habitat area estimates within the FSA by RPS (2019 and current) and Harvey (2009), using habitat types described by Harvey (2009) 25
Table 3-3: Habitat class across sites in FSA and expressed as a percentage from the 2023 and 2019 surveys (RPS, 2019b) and the percentage difference between the two surveys. 26
Table 3-4: Habitat class across sites in the area west of the FSA and expressed as a percentage from the 2024 survey. 27
Table 3-5: Area of habitats within development-related footprints using data collected by RPS in 2023 31
Appendix Table 1: EPBC Act (PMST) and BC Act (DBCA database) listed threatened, marine or migratory marine species in the search radius around Thomson Bay 36

Plates

Plate 3-1: Individual living *Posidonia* shoots (site number T10A) (left); accumulation of *Posidonia* wrack and new growth of seagrass at edge of *Posidonia* meadow (site number T10D) (right) in the northwest of the FSA 32

Figures

Figure 1-1: Detail of the proposed South Thomson Bay Maritime Facilities Redevelopment 2
Figure 2-1: Reef Life Survey sites in close proximity to Thomson Bay 5
Figure 3-1: Habitat map of Rottnest Island by Harvey (2009) 25
Figure 3-2: Benthic habitat map of the Field Survey Area and Main Jetty Survey Area within Thomson Bay, Rottnest Island 28
Figure 3-3: Detail of the benthic habitat map within the proposed development area 29
Figure 3-4: Benthic habitat map within the Main Jetty Survey Area, west of the FSA 30

Appendices

Appendix A PMST and DBCA database search results 35

Appendix B Field survey sites and GPS tracks 40

Appendix C Field survey data 43

Appendix D Thomson Bay aerial images 59

ABBREVIATIONS – KEY TERMS AND LEGISLATION

Term	Definition
ALA	Atlas of Living Australia
BC Act	*Biodiversity Conservation Act 2016* (WA)
BCH	Benthic marine communities and habitats
BIA	Biologically Important Area
DBCA	Department of Biodiversity, Conservation and Attractions
DBCA database	DBCA Threatened, Specially Protected and Priority fauna database
DCCEEW	Department of Climate Change, Energy, the Environment and Water (Commonwealth)
EP Act	*Environmental Protection Act 1986* (WA)
EPA	Environment Protection Authority (WA)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
FSA	Field survey area
ha	Hectare
hrs	Hours
km	Kilometre
kn	Knot
LAU	Local assessment unit
m	Metre
MNES	Matters of National Environmental Significance (Commonwealth)
PMST	Protected Matters Search Tool
QAQC	Quality assurance and quality control
RIA	Rottnest Island Authority
RIMP	Rottnest Island Management Plan
RLS	Reef Life Survey
RPS	RPS AAP Consulting Pty Ltd
WA	Western Australia

1 INTRODUCTION

1.1 Background and location

Wadjemup/ Rottnest Island, Western Australia (WA) is an A-class reserve with significant ecological, cultural, and social values (RIA, 2023). The marine reserve is characterised by a unique blend of tropical and temperate species, and a diverse range of habitats and communities including coral reefs, macroalgal reefs and extensive seagrass meadows. These habitats support over 400 species of fish and are highly valued by the many visitors to the island each year. Conservation of this unique environment in the face of increasing visitor pressure is one of five strategic focus areas highlighted by the Rottnest Island Authority (RIA), the body incorporated within the Department of Biodiversity, Conservation and Attractions (DBCA) which is responsible for the management of Rottnest Island (RIA, 2023).

Thomson Bay, located on the northeastern corner of the island, is designated a multi-use area with a range of facilities including the main ferry jetty, old army jetty and over 200 private moorings. A marine sanctuary zone is also located in the north of the bay. Benthic habitat within the bay is varied and includes seagrass meadows (*Posidonia* spp.) that comprise approximately 30% of the total seagrass area within Rottnest Island's nearshore habitats (RIA, 2023; Harvey, 2009). These meadows, which include *P. sinuosa* and *P. australis* are recognised as a Priority 3 Western Australian Priority Ecological Community by the DBCA due to their importance as a climax community that can take decades to centuries to develop, and their vulnerability to climate change (DBCA, 2023a). Other benthic habitat within Thomson Bay includes macroalgae and bare sand, the latter which may be covered by wrack that accumulates seasonally (RIA, 2023).

The *Rottnest Island Management Plan* (RIMP) *2023 – 2028* (RIA, 2023) identifies the need to redevelop the old army groyne, jetty, and associated shore facilities in south Thomson Bay to alleviate increasing demand for commercial marine and barge services at the main jetty. Initially introduced in the 20-year master plan for Rottnest Island (RIA, 2014), the RIA now intends to progress with this development, known as the South Thomson Bay Maritime Facilities Redevelopment, which comprises a barge landing area, breakwater and groyne constructed from limestone boulders, with seabed spoil from associated dredging operations used as infill (RIA, 2023, Figure 1-1).

The RIA previously contracted RPS in 2018 to undertake preliminary assessment of the environmental impacts anticipated from the proposed development (RPS, 2019a). These impacts were primarily associated with dredging operations and the development footprint on marine benthic communities and habitats (BCH), in particular seagrass meadows, and the marine fauna which inhabit these areas. RPS conducted a desktop fauna survey and baseline benthic habitat surveys in Thomson Bay, delivering a draft report to the RIA in 2019 (RPS, 2019b). Findings of the survey, based on the previous design, determined that there was estimated to be a 1.43 ha direct loss of seagrass at that time. RIA has re-initiated actions towards the redevelopment in 2023, contracting RPS to compile up-to-date information on the Thomson Bay area to determine the potential impacts of the development on the benthic habitats and associated marine fauna.

1.2 Scope of Work

In accordance with the *South Thomson Barge Development – Baseline Study Updates – Scope of Work* and associated clarifications received from the RIA, the scope of marine work included:

- Desktop assessment of conservation (national and WA State listed species) and non-conservation important marine species, that may be present in the Thomson Bay area
- Update the benthic habitat assessment undertaken by RPS in 2019 for the calculation of habitat loss and cumulative habitat loss as a consequence of the proposed development
- Separate description of benthic habitat in the vicinity of the main and fuel jetties, adjacent to and west of the main survey area.

These scopes are addressed below in Sections 2 and 3.

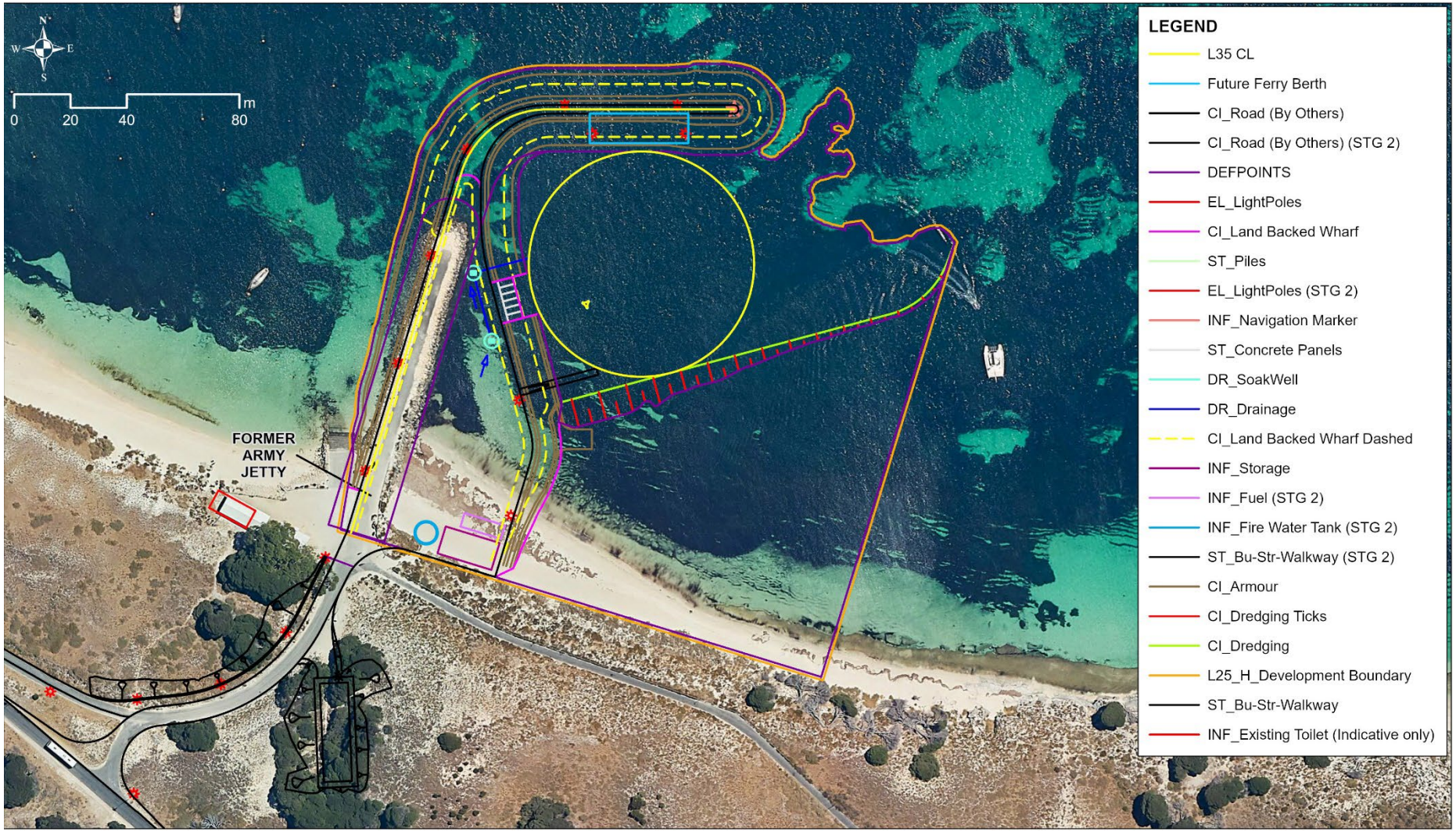

Figure 1-1: Detail of the proposed South Thomson Bay Maritime Facilities Redevelopment

2 MARINE FAUNA DESKTOP ANALYSIS

2.1 Objectives

Specific objectives of the marine fauna assessment were to:

- Identify and describe the seasonal presence of species that are protected under Commonwealth and WA legislation and likely to occur within a five kilometre (km) radius of the proposed development (noting this was revised to a 10 kilometre radius for species protected under WA legislation on advice from the DBCA)
- Identify non-conservation important fish species that have been recorded within or require habitat present in Thomson Bay, including description of habitat preferences and distribution of these species in Australian waters.

2.2 Commonwealth legislation

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Australian Government's central piece of environmental legislation that provides a legal framework to protect and manage Matters of National Environmental Significance (MNES). Under the EPBC Act, an action requires approval from the minister if it has, will have, or is likely to have, a significant impact on MNES. The *Matters of National Environmental Significance: Significant Impact Guidelines 1.1* (DoE 2013) outlines a self-assessment process to assist in determining whether the proposed action may have a 'significant' impact on MNES. If a proposal is likely to have a significant impact on MNES, then it must be referred for assessment under the EPBC Act.

MNES are defined as:

- Listed threatened species and ecological communities
- Migratory species protected under international agreements
- Ramsar wetlands of international importance
- The Commonwealth marine environment
- World Heritage properties
- The Great Barrier Reef Marine Park
- National Heritage places
- Nuclear actions
- A water resource, in relation to coal seam gas development and large coal mining development
- Protected marine species include species listed nationally as marine, threatened (Critically Endangered, Endangered, Vulnerable, Conservation Dependent), migratory, and all cetaceans (DCCEEW, 2023a).

2.3 State legislation

The *Biodiversity Conservation Act 2016* (BC Act) is the WA legislation that informs the environmental regulation process through providing a legal framework for protecting biodiversity, with an emphasis on threatened species and threatened ecological communities. The BC Act provides for species, subspecies, or populations of native animals (fauna) to be listed as Specially Protected, Threatened (Critically Endangered, Endangered or Vulnerable) or Extinct in WA, based on the national distribution of species that have been adequately searched for and are deemed to be, in the wild, threatened, extinct or in need of special protection, and have been gazetted as such (DBCA, 2023b).

Under the BC Act, a species or ecological community may be listed as threatened by the Minister for Environment. This gives special protection to the threatened species or threatened ecological community. Activities which may result in the taking or disturbance of all fauna requires lawful authority under the BC Act. Ministerial Authorisation under Section 40 of the BC Act is required to take or disturb threatened species.

2.4 Methods

2.4.1 Conservation important species

Fauna protected under the EPBC Act and BC Act was identified via desktop searches, as described below.

2.4.1.1 Commonwealth

A desktop search of the Department of Climate Change, Energy, the Environment and Water (DCCEEW) Protected Matters Search Tool (PMST) was undertaken on 26 October 2023, to identify MNES and other matters protected by the EPBC Act that may occur within a five-kilometre radius of the proposed development site (Appendix A).

2.4.1.2 State

A desktop search of the DBCA Threatened, Specially Protected and priority fauna database (DBCA database) was undertaken on request of RPS by the DBCA on 3 November 2023 (Appendix A). For this purpose, the DBCA recommended a 10 km 'buffer size' for waters around Rottnest Island, based on the number of records available in the general area and the range of local species. In data-rich areas, buffer sizes are reduced, whereas in data-deficient areas, buffer sizes are increased. This flexibility caters for complexity and ensure more meaningful results.

While originally stated in the scope of works (RPS DBCARIAQ1524, proposal to deliver the survey and assessment), the DBCA NatureMap search intended to supplement the above was not conducted because this online service is no longer available.

2.4.1.3 Determining likelihood of occurrence

The PMST and DBCA database reports were initially filtered to remove terrestrial and wetland species. For the remaining species the criteria for identifying those likely to occur within Thomson Bay and the development area were:

- Record of occurrence within five kilometres of Thomson Bay in the Atlas of Living Australia (ALA)
- Overlap with a Biologically Important Area (BIA).

Noting that all syngnathids listed in the PMST and/or DBCA database reports were considered likely to be present within Thomson Bay due to their cryptic nature and reduced likelihood of detection. Whilst seabirds and shorebirds were included in the list of species identified by the database reports (Appendix A) they were not assessed for likelihood of occurrence within Thomson Bay due to their mobility and capacity to move away from disturbance caused by development activities.

To provide further context for both the likelihood of the species being present and the potential impact of the proposed development on the population (if any), the distribution and/or habitat of each species within the search radius of Thomson Bay is described (as listed in the PMST results), together with their seasonal presence.

2.4.2 Non-conservation important species

The identity of non-conservation important species was achieved via a search of online literature. As described on the Wadjemup Rottnest Island website (https://www.rottnestisland.com/learn/sustainability/marine-sanctuary-zones), a large diversity of species is found in marine waters of Rottnest Island. Therefore, the online search focussed on marine species of fish that have been recorded or require habitat present in Thomson Bay (noting that marine mammals and reptiles are covered under the search of conservation-important species, and habitat forming species covered in the next section).

The online literature search utilised the following resources to identify fish species recorded in the waters in and around Thomson Bay:

- Hoschke, A., Whisson, G., & Moore, G. I. 2019. *Complete list of fishes from Rottnest Island 2019*. Compiled from a range of sources (including previous literature, ALA records and Reef Life Survey data)

- iNaturalist citizen science observation platform: *Fishes of Rottnest Island* (iNaturalist, 2023), which compiles up-to-date citizen science observations of marine fishes around Rottnest Island
- Reef Life Survey (RLS) citizen science program data (AODN, 2023). Utilises trained SCUBA divers to undertake standardised visual surveys in areas around Australia, including Rottnest Island.

Hoschke et al. (2019) compiled a list of 440 fish species recorded within the waters surrounding Rottnest Island. To refine this list to species that have been recorded in or that require habitat found within the development footprint or wider Thomson Bay, the iNaturalist resource was first searched, to identify all citizen science observations within this area. Then, the Reef Life Survey data, which utilises techniques that aim to capture both fish swimming within the water column as well as cryptobenthic fishes, were downloaded from across all survey years (2008 – 2023), for three nearshore sites in close proximity to Thomson Bay (Duck Rock South, Kingston Reef, The Count; Figure 2-1), in the absence of surveys occurring within the bay itself.

To provide further context for both the likelihood of the fish species being present, and the potential impact of the development on the population (if any), the habitat for which each species is typically associated and their broader distribution within Australian waters was described, using the Atlas of Living Australia (ALA, 2023), Fishes of Australia (FoA, 2024) and FishBase (Froese & Pauly, 2023) online resources.

Figure 2-1: Reef Life Survey sites in close proximity to Thomson Bay

2.5 Results and Discussion

A summary of the search results is provided below, identifying the conservation and non-conservation important matters returned and the relevance of the search results to the proposed development.

2.5.1 Conservation important species

Full results of the PMST and DBCA database searches are provided in Appendix A. These searches identified 41 threatened marine fauna species and 92 listed marine or migratory marine fauna species that may occur within Thomson Bay, including various marine megafauna (i.e., sharks, turtles, cetaceans), fish and seabirds. These species have diverse habitat preferences and lifestyles including highly mobile species (e.g., southern bluefin tuna), transient species that are not dependent on the habitat within Thomson Bay (e.g., cetaceans), and site-attached species such as syngnathids.

Based on criteria described in Section 2.4.1.3 and descriptions provided in the search results, 43 of those species listed in Appendix A are considered more likely to occur (conservatively at least) within Thomson Bay (Table 2-1), including the following species with overlapping BIAs:

- Australian sea lion (the development is within the foraging BIA for this species)
- Humpback whale (the development is within the migration BIA for this species)
- Pygmy blue whale (the development is within the distribution BIA for this species)
- Southern right whale (the development is within the migration BIA for this species.).

Of note is the potential presence of 26 syngnathid species, which are of relatively low (listed) conservation status but conservatively expected to be in the area due to their habitat preferences. Of these species, 20 may utilise seagrass habitats, during some of or all of their life history stages (Table 2-1). These species may also be more susceptible to impacts associated with development activities due to their small size and limited mobility.

Table 2-1: Species of conservation importance identified in the PMST and DBCA database reports that may occur in Thomspon Bay

Name		Conservation status		Distribution at Rottnest Island and surrounding waters*	Habitat and seasonal preferences
Species	**Common**	**EPBC Act**	**BC Act**		
Fish					
Acentronura australe	Southern pygmy pipehorse	Listed	Not included	Species or species habitat may occur within area	Inhabit algal reefs and seagrass beds, to depths of up to 30 m (FoA, 2024).
Campichthys galei	Gale's pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit shelly or rubble substrates and sparse seagrass beds, to depths of up to 18 m (FoA, 2024).
Choeroichthys suillus	Pig-snouted pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit rubble habitats of inshore coral reefs, to depths of up to 15 m (FoA, 2024).
Halicampus brocki	Brock's pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit coral and algal reefs, to depths of up to 45 m (FoA, 2024).
Heraldia nocturna	Upside-down pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit sheltered inshore rocky reefs, to depths of up to 30 m (FoA, 2024).
Hippocampus angustus	Western spiny seahorse	Listed	Not included	Species or species habitat may occur within area	Inhabit sheltered algal reefs and seagrass beds, to depths of up to 30 m (FoA, 2024).
Hippocampus breviceps	Short-head seahorse	Listed	Not included	Species or species habitat may occur within area	Inhabit shallow seagrass and macroalgal beds, to depths of up to 15 m (FoA, 2024).
Hippocampus subelongatus	West Australian seahorse	Listed	Not included	Species or species habitat may occur within area	Inhabit macroalgal beds, muddy substrates, jetty pylons and moorings to depths of up to 25 m (FoA, 2024).
Histiogamphelus cristatus	Rhino pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit seagrass beds and adjacent sandy areas, to depths of up to 17 m (FoA, 2024).
Lissocampus caudalis	Australian smooth pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit rubble habitats, macroalgal beds and seagrass beds and rocky reefs, to depths of up to 15 m (FoA, 2024).
Lissocampus fatiloquus	Prophet's pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit rocky and sand habitats, and seagrass and macroalgal beds, to depths of up to 10 m (FoA, 2024).
Lissocampus runa	Javelin pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit seagrass and macroalgal beds and rubble substrates, to depths of up to 20 m (FoA, 2024).

Name		Conservation status		Distribution at Rottnest Island and surrounding waters*	Habitat and seasonal preferences
Maroubra perserrata	Sawtooth pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit coral reefs, to depths of up to 25 m (FoA, 2024).
Mitotichthys meraculus	Western crested pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit seagrass beds to depths of up to 10 m (FoA, 2024).
Nannocampus subosseus	Bonyhead pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit a range of habitats including seagrass and macroalgal beds, sandy and coral reef habitats, to depths of up to 14 m (FoA, 2024).
Phycodurus eques	Leafy seadragon	Listed	Not included	Species or species habitat may occur within area	Inhabit seagrass beds and algal reefs, to depths of up to 50 m (FoA, 2024).
Phyllopteryx taeniolatus	Common seadragon	Listed	Not included	Species or species habitat may occur within area	Inhabit seagrass beds and algal reefs, to depths of up to 50 m (FoA, 2024).
Pugnaso curtirostris	Pugnose pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit shallow seagrass and macroalgal beds, to depths of up to 11 m (FoA, 2024).
Solegnathus lettiensis	Gunther's pipefish	Listed	Not included	Species or species habitat may occur within area	Little is known about the habitat for this species.
Stigmatopora argus	Spotted pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit seagrass beds, to depths of up to 8 m (FoA, 2024).
Stigmatopora nigra	Widebody pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit sheltered seagrass and macroalgal beds, to depths of up to 35 m (FoA, 2024).
Syngnathoides biaculeatus	Double-end pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit seagrass and macroalgal beds, to depths of up to 10 m (FoA, 2024).
Urocampus carinirostris	Hairy pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit seagrass beds, to depths of up to 6 m (FoA, 2024).
Vanacampus margaritifer	Mother-of-pearl pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit seagrass and macroalgal beds, rocky and sandy substrates, to depths of up to 15 m (FoA, 2024).
Vanacampus phillipi	Port Phillip pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit seagrass and macroalgal beds, to depths of up to 25 m (FoA, 2024).
Vanacampus poecilolaemus	Longsnout pipefish	Listed	Not included	Species or species habitat may occur within area	Inhabit shallow seagrass and macroalgal beds, to depths of up to 18 m (FoA, 2024).
Sharks					
Sphyrna lewini	Scalloped hammerhead	Conservation Dependent	Not included	Species or species habitat likely to occur within area	Undertake annual foraging and breeding migrations. Known to aggregate in the

Name		Conservation status		Distribution at Rottnest Island and surrounding waters*	Habitat and seasonal preferences
					Shoalwater Islands Marine Park, where peak numbers are observed during January and February (López et al. 2022; 2023).
Carcharias taurus (west coast population)	Grey nurse shark (west coast population)	Vulnerable	Not included	Congregation or aggregation known to occur within area	Year-round presence. Seasonal migration patterns have not been observed (Last & Stevens 2009, DCCEEW, 2023b).
Carcharodon carcharias	White shark	Vulnerable, Migratory	Vulnerable	Species or species habitat known to occur within area	Have been shown to undertake migrations north along the WA coast during spring and return in summer; however, coastal movements are not synchronous i.e., some sharks move north while others move south during the same period (McAuley et al. 2016). They are frequently recorded in waters around fur seal and sea lion colonies, including in the Perth region (ALA, 2023; DCCEEW, 2023b), where they are more likely to be present during spring and early summer and least likely to be present during late summer and autumn (SharkSmart 2018).
Mammals					
Neophoca cinerea	Australian sea lion	Endangered	Endangered	Species or species habitat likely to occur within area**.** The development footprint is located within the foraging BIA for this species.	Has an asynchronous non-annual breeding cycle with cycles ranging from 16 to 20 months and pupping occurring at different times throughout the South-West Marine Region (DCCEEW, 2023b).
Eubalaena Australis	Southern right whale	Endangered, Migratory	Vulnerable	The development footprint is located within the migratory BIA for this species**	Southern temperate to subpolar waters including marine areas of southern Australia from May to October. The migratory period within the migration BIA up the west coast of WA is April to October (ALA; NCVA, 2023).
Balaenoptera musculus brevicauda	Pygmy blue whale	Endangered	Not included	Known to occur in the area. The development footprint is located within the distribution BIA for this species.	The northbound migration past Perth Canyon occurs between April and July (peak May to June), with the return migration from October to January (peak

Name		Conservation status		Distribution at Rottnest Island and surrounding waters*	Habitat and seasonal preferences
					November to early December; Thums et al. 2022).
Megaptera novaeangliae	Humpback whale	Migratory	Conservation Dependent, Migratory	Species or species habitat known to occur within area. The development footprint is located within the migratory BIA for this species.	The annual peak northbound migration along the Jurien Bay to Carnarvon migration route occurs between June and July, while the southbound migration peak occurs between September and October (ALA, 2023; DCCEEW, 2023b; Jenner et al. 2001).
Orcinus orca	Killer whale, Orca	Migratory	Not included	Species or species habitat may occur within area	Mating is known to occur all year round, whilst the calving season spans several months. However, no areas of significance and no determined migration routes have been identified for this species within waters off WA (DCCEEW, 2023b). They are typically present on the south coast of WA between January to April.
Arctocephalus forsteri	New Zealand fur seal	Listed	Other Specially Protected	Species or species habitat may occur within area. The New Zealand fur seal colony on Rottnest Island is located at Cathedral Rocks on the west end of Rottnest Island.	Present year round (ALA, 2023).
Balaenoptera acutorostrata	Minke whale	Listed	Not included	Species or species habitat may occur within area	May migrate from high latitude areas in the summer to low latitude areas in the winter. The detailed pattern of seasonal migration is generally poorly understood (ALA, 2023).
Tursiops aduncus	Indian ocean bottlenose dolphin	Listed	Not included	Species or species habitat likely to occur within area	Present year-round. Movement patterns in Australia are variable.
Tursiops truncatus s. str.	Bottlenose dolphin	Listed	Not included	Species or species habitat may occur within area	Seasonal movements are variable, and may include residency in small areas, long-range movements, and migration (DCCEEW, 2023b).
Stenella longirostris	Spinner dolphin	Not included	Priority 4, Migratory	Sighted in field survey in DBCA database data. Assumed species or species habitat may occur within area.	No seasonal differences, but mostly offshore species (ALA)

Name		Conservation status		Distribution at Rottnest Island and surrounding waters*	Habitat and seasonal preferences
Reptiles					
Caretta caretta	Loggerhead turtle	Endangered, Migratory	Not included	Foraging, feeding or related behaviour known to occur within area	Generally nesting in summer at nesting grounds in northern WA (not necessarily every year; ALA, 2023).
Dermochelys coriacea	Leatherback turtle	Endangered, Migratory	Vulnerable	Species or species habitat known to occur within area	Migrates from foraging areas to nesting beaches in tropical and subtropical regions during summer (ALA, 2023; DCCEEW, 2023b).
Chelonia mydas	Green turtle	Vulnerable, Migratory	Vulnerable	Foraging, feeding or related behaviour known to occur within area	Migrates from foraging areas to nesting beaches in tropical regions during summer, typically between November and March (DCCEEW, 2023b).
Pelamis platurus	Yellow-bellied seasnake	Listed	Not included	Species or species habitat may occur within area	Seasonal movements have not been observed in Australia hence may be present year-round.

*As listed in the PMST search results and/or Atlas of Living Australia (ala.org.au)

** Although the PMST search indicates that breeding by *E. australis* may occur within the PMST search area, a review of the online National Conservation Values Atlas indicates that this is not the case and only the migration BIA for the species overlaps Thomson Bay

Definitions: BC Act = *Biodiversity Conservation Act 2016* (WA), BIA = Biologically Important Area, DBCA = Department of Biodiversity, Conservation and Attractions (WA), EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)

Priority 4 = Rare, Near Threatened and other species in need of monitoring (BC Act)

Other Specially Protected = Species otherwise in need of special protection (BC Act)

2.5.2 Non-conservation important species

The online literature review identified 440 species of fish species that are considered to have been reliably recorded within the waters surrounding Rottnest Island (Hoschke, et al., 2019). Of these species, recent surveys (2008 - 2023, RLS) and citizen science observations (2017 - 2022, iNaturalist) refined this number to 137 species that have been recorded in the vicinity of Thomson Bay and may occur or utilise habitat within the development footprint (Table 2-2). No species identified in the PMST were included in this list.

The fish listed in Table 2-2 include both cartilaginous fishes (benthic sharks and rays), as well as a broad suite of bony fishes, which encompass highly diverse habitat preferences and uses. These range from species that may occasionally pass through the bay but are unlikely to depend upon habitat within the development footprint (e.g., West Australian dhufish), to more site-attached species that are commonly found in habitat present in the development footprint (e.g., Germain's blenny). Many of the latter species are more strongly associated with hard substrate habitat such as reef which comprise only a small proportion of the Thomson Bay survey area. However, as shown in Section 3, the proposed development overlaps seagrass habitat with which 26 non-conservation important fish species are associated (Table 2-2). Of these, several utilise seagrass meadows primarily as a nursery habitat as juveniles, whilst others are associated with a broader range of habitats throughout their life history stages.

Table 2-2: Non-conservation important fish species that may occur in Thomson Bay

Name		Habitat*	Australian Distribution*
Species	Common		
Abudefduf sexfasciatus	Scissortail sergeant	Inhabit reefs, to depths of up to 15 m	Temperate to tropical waters Australia-wide
Abudefduf vaigiensis	Indo-Pacific sergeant	Inhabit reefs, to depths of up to 15 m	Temperate to tropical waters Australia-wide
Acanthaluteres brownii	Spinytail leatherjacket	Inhabit inshore reefs and adjacent seagrass beds, to depths up to 25 m	Endemic to southern Australia (Shark Bay, WA to Rapid Head, SA)
Acanthaluteres vittiger	Toothbrush leatherjacket	Inhabit shallow sheltered seagrass beds and rocky reefs, to depths up to 45 m	Endemic to southern Australia (Coffs Harbour, NSW to north of Leeman, WA)
Acanthistius serratus	Western wirrah	Inhabit reefs of coastal waters, often sheltering in caves, to depths of up to 40 m	Temperate to tropical waters (Ceduna, SA to Shark Bay, WA)
Achoerodus gouldii	Western blue groper	Inhabit coastal and offshore reefs, usually at depths of 5 to 40 m	Endemic to temperate coastal waters of southern Australia (Inverlock, VIC to Houtman Abrolhos Islands, WA)
Anampses caeruleopunctatus	Diamond wrasse	Inhabit reefs, to depths of up to 30 m	Temperate to tropical waters Australia-wide
Anampses geographicus	Scribbled wrasse	Inhabit shallow reefs	Temperate to tropical waters Australia-wide
Anampses meleagrides	Speckled wrasse	Inhabit areas of mixed coral rubble and sand on seaward reefs, to depths of up to 30 m	Temperate to tropical waters Australia-wide
Anoplocapros amygdaloides	Western smooth boxfish	Inhabit offshore reef and seagrass beds, to depths of up to 100 m	Endemic to temperate waters of southern and southwestern Australia (Shark Bay, WA to Great Australian Bight, SA)
Anoplocapros lenticularis	Whitebarred boxfish	Inhabit offshore reefs and jetty pylons, to depths of up to 250 m	Endemic to temperate waters of southern and southwestern Australia (Houtman Abrolhos Islands, WA to Western Port, VIC)
Aplodactylus westralis	Western seacarp	Inhabit rocky reefs with abundant macroalgae, to depths of up to 20 m	Temperate waters (Yorke Peninsula, SA to Rottnest Island, WA)
Apogon victoriae	Western striped cardinalfish	Nocturnal, inhabiting caves and ledges of shallow reefs	Endemic to Western Australia (Cape Leeuwin, WA to the Cobourg Peninsula, NT)
Arripis georgianus	Australian herring	Inhabit seagrass and macroalgal beds in inshore bays and estuaries, to depths of up to 50 m	Endemic to southern Australia (Forster, NSW to Swan River, WA, including Tasmania)
Aspidontus taeniatus	False cleanerfish	Inhabit reef flats and lagoons, to depths of up to 25 m	Temperate to tropical waters Australia-wide
Aulohalaelurus labiosus	Blackspotted catshark	Nocturnal, inhabiting reefs, to depths of up to 10 m	Endemic to south-western WA (Recherche Archipelago to the Houtman Abrolhos Islands)
Austrolabrus maculatus	Blackspotted wrasse	Inhabit exposed reefs, to depths of up to 40 m	Endemic to southern Australia (Fraser Island, QLD to Shark Bay, WA)

Name		Habitat*	Australian Distribution*
Bathytoshia brevicaudata	Smooth stingray	Inhabit sandy areas in coastal bays and reefs, to depths of up to 150 m	Temperate waters of southern Australia
Bodianus frenchii	Foxfish	Inhabit caves and ledges of deeper offshore reefs, to depths of up to 82 m	Temperate waters of southern Australia
Caesioscorpis theagenes	Blowhole perch	Inhabit offshore reefs, to depths of up to 30 m	Endemic to WA (Albany to Shark Bay)
Chaetodon assarius	Western butterflyfish	Inhabit reefs, to depths of up to 40 m	Endemic to WA (Israelite Bay to Northwest Shelf)
Chelmonops curiosus	Western talma	Inhabit coastal rocky reefs, to depths of up to 60 m	Endemic to south-western Australia (Victor Harbor, SA to Shark Bay, WA)
Chironemus maculosus	Silver spot	Inhabit rocky reefs, to depths of up to 10 m	Temperate waters of southern Australia (Jervis Bay, NSW to Rottnest Island, WA)
Chlorurus sordidus	Bullethead parrotfish	Inhabit reefs and lagoons, to depths of up to 50 m	Temperate to tropical waters Australia-wide
Choerodon rubescens	Baldchin groper	Inhabit coastal and offshore reefs and adjacent weedy areas, to depths of up to 30 m	Endemic to WA (Cape Leeuwin to Ningaloo Reef)
Chromis klunzingeri	Blackhead puller	Inhabit inshore and offshore reefs, to depths of up to 40 m	Endemic to southern WA (Recherche Archipelago to the Houtman Abrolhos Islands)
Chromis westAustralis	West Australian puller	Inhabit reefs, to depths of up to 75 m	Endemic to western and northern Australia (Recherche Archipelago, WA to Evans Shoal, NT)
Cirripectes hutchinsi	Hutchins' blenny	Inhabit shallow reefs, to depths of up to 22 m	Endemic to WA (Rottnest Island to North West Cape)
Cnidoglanis macrocephalus	Estuary cobbler	Nocturnal, inhabit sandy and muddy bottoms often amongst rocks, algae and wrack, to depths of up to 30 m	Endemic to temperate southern Australia (Moreton Bay, QLD to Houtman Abrolhos Islands, WA)
Cochleoceps bicolor	Western cleaner clingfish	Inhabit rocky reefs, to depths of up to 40 m	Endemic to southern Australia (Port Phillip, VIC to Lancelin, WA)
Coris auricularis	Western king wrasse	Inhabit sandy areas and seagrass beds around offshore reefs, to depths of up to 45 m	Temperate to subtropical waters of south-western Australia
Cristiceps aurantiacus	Yellow crested weedfish	Inhabit rock pools, subtidal rocky reefs, macroalgal beds and wrack on adjacent sandy areas, to depths of up to 30 m	Temperate to subtropical waters on Australia's east and west coasts
Dactylophora nigricans	Dusky morwong	Inhabit rocky reefs, seagrass beds and sandy lagoons, to depths of up to 20 m	Endemic to southern Australia (Clarence River, NSW to Houtman Abrolhos Islands, WA)
Dinolestes lewini	Longfin pike	Inhabit seagrass beds, reefs and bays, to depths of up to 65 m	Endemic to southern Australia (Newcastle, NSW to Perth region, WA)
Diodon nicthemerus	Globefish	Inhabit sheltered reefs and weedy habitats, to depths of up to 85 m	Endemic to southern Australia (Seal Rocks, NSW to Houtman Abrolhos Islands, WA)
Dotalabrus alleni	Little rainbow wrasse	Inhabit shallow rocky reefs, to depths of up to 15 m	Endemic to southern WA (Recherche Archipelago to the Houtman Abrolhos Islands)

Name		Habitat*	Australian Distribution*
Dotalabrus aurantiacus	Castelnau's wrasse	Inhabit seagrass beds, reefs and sheltered bays, to depths of up to 47 m	Endemic to southern Australia (Point Hicks, VIC to Rottnest Island, WA)
Enoplosus armatus	Old wife	Inhabit inshore reefs and macroalgal beds, to depths of up to 100 m	Endemic to southern Australia (Fraser Island, QLD to South Passage, WA)
Eocallionymus papilio	Painted stinkfish	Inhabit muddy and shelly bays, to depths of up to 50 m	Temperate and sub-tropical waters (Mudjimba Island, QLD to Kalbarri, WA)
Epinephelides armatus	Breaksea cod	Inhabit offshore reefs, to depths of up to 100 m	Endemic to WA (Recherche Archipelago to Shark Bay)
Eubalichthys cyanoura	Bluetail leatherjacket	Inhabit coastal reefs, to depths of up to 30 m	Endemic to southern Australia (York Peninsula, SA to Dongara, WA)
Eubalichthys gunnii	Gunn's leatherjacket	Inhabit bays and coastal reefs, to depths of up to 55 m	Temperate coastal waters
Eubalichthys mosaicus	Mosaic leatherjacket	Inhabit offshore and coastal reefs, to depths of up to 150 m	Endemic to southern Australia (Noosa, QLD to Dongara, WA)
Eupetrichthys angustipes	Snakeskin wrasse	Inhabit sheltered sandy areas adjacent to reefs, to depths of up to 40 m	Endemic to southern Australia (northern NSW to Houtman Abrolhos Islands, WA)
Eviota bimaculata	Twospot eviota	Inhabit rocky and coral reefs, to depths of up to 10 m	Temperate to subtropical waters of southwestern Australia (Ceduna, SA to North West Cape, WA)
Girella tephraeops	Western rock blackfish	Inhabit coastal reefs, to depths of up to 20 m	Endemic to WA (Israelite Bay to north of Shark Bay)
Girella zebra	Zebrafish	Inhabit bays and coastal reefs, to depths of up to 20 m	Endemic to southern Australia (Clarence River, NSW to Port Denison, WA)
Glaucosoma hebraicum	West Australian dhufish	Inhabit rocky outcrops and ledges, to depths of up to 200 m	Endemic to WA (Esperance to Shark Bay)
Goniistius gibbosus	Magpie morwong	Inhabit shallow protected reefs and sandy areas, to depths of up to 20 m	Endemic to WA (Recherche Archipelago to Shark Bay)
Goniistius rubrolabiatus	Redlip morwong	Inhabit inshore rocky reefs, to depths of up to 30 m	Endemic to WA (Recherche Archipelago to Coral Bay)
Halichoeres brownfieldi	Brownfield's wrasse	Inhabit macroalgal reefs and adjacent seagrass beds, to depths of up to 30 m	Endemic to WA (Israelite Bay to Exmouth Gulf)
Halichoeres nigrescens	Bubblefin wrasse	Inhabit shallow reefs, to depths of up to 10 m	Tropical waters (Dampier Archipelago, WA to Hervey Bay, QLD)
Helcogramma decurrens	Blackthroat threefin	Inhabit intertidal and subtidal macroalgal rocky reefs, to depths of up to 13 m	Temperate coastal waters of southern Australia
Heteroscarus acroptilus	Rainbow cale	Inhabit exposed rocky reefs and seagrass beds, to depths of up to 60 m	Endemic to southern Australia (Seal Rocks, NSW to Point Gregory, WA)
Hyperlophus vittatus	Sandy sprat	Inhabit shallow sandy areas and seagrass beds, to depths of up to 29 m	Temperate waters of southern Australia (Moreton Bay, QLD to Kalbarri, WA)

Name		Habitat*	Australian Distribution*
Hypoplectrodes nigroruber	Banded seaperch	Inhabit rocky reefs, to depths of up to 30 m	Endemic to southern Australia (Solitary Islands, NSW to Houtman Abrolhos Islands, WA)
Kyphosus cornelii	Western buffalo bream	Inhabit coral and rocky reefs, to depths of up to 20 m	Endemic to WA (Cape Naturaliste to Shark Bay)
Kyphosus gladius	Gladius drummer	Inhabit rocky substrates, to depths of up to 20 m	Endemic to temperate WA (Albany to Houtman Abrolhos Islands)
Kyphosus sydneyanus	Silver drummer	Inhabit exposed rocky reefs, to depths of up to 30 m	Temperate waters of southern Australia (Fraser Island, QLD to Houtman Abrolhos Islands, WA)
Labroides dimidiatus	Common cleanerfish	Inhabit coral reefs, to depths of up to 40 m	Temperate to tropical waters across northern Australia (Perth, WA to Sydney, NSW)
Latropiscis purpurissatus	Sergeant baker	Inhabit soft bottom habitats, rocky and coral reefs, to depths of up to 250 m	Endemic to southern Australia (Double Island Point, QLD to Shark Bay, WA)
Lethrinus genivittatus	Threadfin emperor	Inhabit outer reef slopes and shallow sandy and seagrass bed areas, to depths of up to 25 m	Temperate to tropical waters across northern Australia
Leviprora inops	Longhead flathead	Inhabit rocky reefs with abundant vegetation, to depths of up to 20 m	Southern Australia (Gulf St. Vincent, SA to Swan River, WA)
Lotella rhacina	Largetooth beardie	Nocturnal, inhabiting bays, harbours and exposed reefs, to depths of up to 90 m	Temperate waters of southern Australia (Coolangatta, QLD to Houtman Abrolhos Islands, WA)
Meuschenia flavolineata	Yellowstriped leatherjacket	Inhabit macroalgal reefs, to depths of up to 50 m	Endemic to southern Australia (Broughton Island, NSW to Dongara, WA)
Meuschenia freycineti	Sixspine leatherjacket	Inhabit reefs and seagrass beds, to depths of up to 45 m	Endemic to southern Australia (Coffs Harbour, NSW to Jurien Bay, WA)
Meuschenia galii	Bluelined leatherjacket	Inhabit coastal reefs, to depths of up to 30 m	Temperate waters of southern Australia (Inverloch, VIC to Shark Bay, WA)
Meuschenia hippocrepis	Horseshoe leatherjacket	Inhabit macroalgal rocky reefs, to depths of up to 120 m	Endemic to southern Australia (Wilsons Promontory, VIC to Shark Bay, WA)
Neatypus obliquus	Footballer sweep	Inhabit rocky reefs, to depths of up to 30 m	Endemic to southern Australia (Flinders Island, SA to Shark Bay, WA)
Notolabrus parilus	Brownspotted wrasse	Inhabit shallow algal-covered rocky reefs and seagrass beds, to depths of up to 20 m	Endemic to southern Australia (Port Phillip, VIC to Dirk Hartog Island, WA)
Olisthops cyanomelas	Herring cale	Inhabit rocky reefs and seagrass beds, to depths of up to 30 m	Temperate waters of southern Australia (Angourie Point, NSW to Houtman Abrolhos Islands, WA)
Omobranchus germaini	Germain's blenny	Inhabit shallow reefs and tide pools, to depths of up to 3 m	Temperate to tropical waters across northern Australia (One Tree Island, QLD to Rockingham, WA)
Ophthalmolepis lineolata	Southern maori wrasse	Inhabit exposed rocky reefs, to depths of up to 60 m	Endemic to southern Australia (Sunshine Coast, QLD to Houtman Abrolhos Islands, WA)

Name		Habitat*	Australian Distribution*
Ostorhinchus cookii	Cook's cardinalfish	Nocturnal, inhabiting rocky and coral reefs, to depths of up to 10 m	Temperate to tropical waters across northern Australia (Solitary Islands, NSW to Houtman Abrolhos Islands, WA)
Ostorhinchus doederleini	Fourline cardinalfish	Inhabit lagoons and reef slopes, to depths of up to 20 m	Temperate to tropical waters across northern Australia (Sydney, NSW to Perth, WA)
Ostorhinchus rueppellii	Western gobbleguts	Inhabit estuaries, inshore reefs and weedy areas, to depths of up to 10 m	Temperate to tropical waters across north-western Australia (Torres Strait, QLD to Albany, WA)
Othos dentex	Harlequin fish	Inhabit exposed reefs, drop-offs and caves, to depths of up to 30 m. Site-attached with relatively small home range	Southern Australia (Port Phillip Bay, VIC to Houtman Abrolhos Islands, WA)
Pagrus auratus	Snapper	Inhabit bays, inlets (juveniles) and offshore rocky reefs (adults), to depths of up to 200 m. Exhibit strong site fidelity	Temperate to tropical waters Australia across southern Australia (Townsville, QLD to Cape Cuvier, WA)
Parablennius postoculomaculatus	False Tasmanian blenny	Inhabit hard substrates in rocky regions and bays, including jetty pylons, to depths of up to 10 m	Endemic to WA (Two Peoples Bay to Muiron Islands)
Parapercis haackei	Wavy grubfish	Inhabit protected soft bottomed habitats near reefs, outcrops and jetties, to depths of up to 35 m	Endemic to south-western Australia (Kangaroo Island, SA to Shark Bay, WA)
Paraplesiops meleagris	Southern blue devil	Inhabit reefs and drop-offs, to depths of up to 45 m	Endemic to southern Australia (Port Phillip, VIC to Exmouth, WA)
Parapriacanthus elongatus	Elongate bullseye	Inhabit rocky reefs and jetties, to depths of up to 60 m	Endemic to southern Australia (Disaster Bay, NSW to Houtman Abrolhos Islands, WA)
Parascyllium variolatum	Varied carpetshark	Inhabit rocky reefs, seagrass beds and sandy areas, to depths of up to 180 m	Endemic to southern Australia (East Sister Island, VIC to Dongara, WA)
Parma bicolor	Bicolor scalyfin	Inhabit rocky reefs, to depths of up to 40 m	Temperate south-western WA (Recherche Archipelago to Rottnest Island)
Parma mccullochi	McCulloch's scalyfin	Inhabit rocky reefs, to depths of up to 25 m	Temperate south-western WA (Recherche Archipelago to Kalbarri)
Parma occidentalis	Western scalyfin	Inhabit rocky reefs, to depths of up to 15 m	Temperate WA (Cape Leeuwin to Coral Bay)
Parupeneus chrysopleuron	Rosy goatfish	Inhabit soft bottom habitats adjacent to reefs, to depths of up to 200 m	Temperate to tropical waters across western Australia
Parupeneus spilurus	Blacksaddle goatfish	Inhabit sandy habitats and rocky reefs, to depths of up to 80 m	Temperate to tropical waters Australia-wide
Pempheris klunzingeri	Rough bullseye	Inhabit rocky reefs, to depths of up to 40 m	Endemic to south-western Australia (Kangaroo Island, SA to Shark Bay, WA)
Pempheris multiradiata	Bigscale bullseye	Inhabit rocky reefs, to depths of up to 70 m	Temperate waters of southern Australia (Newcastle, NSW to Jurien Bay, WA)
Pictilabrus laticlavius	Senator wrasse	Inhabit coastal reefs and algal beds, to depths of up to 40 m	Endemic to southern Australia (Byron Bay, NSW to Houtman Abrolhos Islands, WA)

Name		Habitat*	Australian Distribution*
Pictilabrus viridis	False senator wrasse	Inhabit rocky reefs, to depths of up to 15 m	Endemic to southern WA (Recherche Archipelago to Jurien Bay)
Plagiotremus rhinorhynchos	Bluestriped fangblenny	Inhabit coral and rocky reefs, to depths of up to 40 m	Temperate to tropical waters across northern Australia (southern NSW to Albany, WA)
Plectorhinchus flavomaculatus	Goldspotted sweetlips	Inhabit sheltered reefs and lagoons, to depths of up to 25 m	Temperate to tropical waters across northern Australia (southern NSW to Perth, WA)
Pomacentrus coelestis	Neon damsel	Inhabit reefs and lagoons, to depths of up to 20 m	Temperate to tropical waters across northern Australia (Merimbula, NSW to Rottnest Island, WA)
Pomacentrus milleri	Miller's damsel	Inhabit shallow inshore reefs, to depths of up to 6 m	Temperate to tropical waters across northern Australia (Gulf of Carpentaria, QLD to Rottnest Island, WA)
Psammoperca waigiensis	Black sand bass	Inhabit coral reefs and vegetated rocky reefs, to depths of up to 12 m	Temperate to tropical waters across northern Australia (Moreton Bay, QLD to Busselton, WA)
Pseudocaranx georgianus	Silver trevally	Pelagic species. School over reefs and adjacent sandy areas. Juveniles more reef-associated. To depths of up to 240 m	Temperate southern Australia (north of Sydney, NSW to north of Perth, WA)
Pseudodax moluccanus	Chiseltooth wrasse	Inhabit coral reefs, to depths of up to 60 m	Temperate to tropical waters across northern Australia
Pseudolabrus biserialis	Redband wrasse	Inhabit macroalgal rocky reefs, to depths of up to 20 m	Temperate southern Australia (Port Lincoln, SA to Houtman Abrolhos Islands, WA)
Ptereleotris evides	Arrow dartgoby	Inhabit outer reef slopes and lagoons, to depths of up to 15 m	Temperate to tropical waters across northern Australia (Sydney, NSW to Rottnest Island, WA)
Rhabdosargus sarba	Tarwhine	Inhabit coastal waters, to depths of up to 60 m	Temperate to tropical waters on Australia's east and west coasts
Scarus ghobban	Bluebarred parrotfish	Inhabit lagoon reefs and sandy areas, to depths of up to 30 m	Temperate to tropical waters across northern Australia (Jervis Bay, NSW to Rottnest Island, WA)
Scarus prasiognathos	Greencheek parrotfish	Inhabit reefs and lagoons, to depths of up to 25 m	Temperate to tropical waters across northern Australia
Scarus schlegeli	Schlegel's parrotfish	Inhabit reefs and lagoons, to depths of up to 50 m	Temperate to tropical waters across northern Australia (southern Great Barrier Reef, QLD to Rottnest Island, WA)
Schuettea woodwardi	Western pomfred	Inhabit rocky reefs, to depths of up to 30 m	Endemic to southwestern Australia (Victor Harbor, SA to Shark Bay, WA)
Scobinichthys granulatus	Rough leatherjacket	Inhabit seagrass beds, to depths of up to 30 m	Temperate southern Australia (Maroochydore, QLD to Shark Bay, WA)
Scorpaena sumptuosa	Western red scorpionfish	Inhabit coastal reefs, to depths of up to 60 m	Endemic to WA (Albany to North West Cape)
Scorpis aequipinnis	Sea sweep	Inhabit rocky reefs, to depths of up to 25 m	Endemic to southern Australia (Currarong, NSW to Shark Bay, WA)

Name		Habitat*	Australian Distribution*
Scorpis georgiana	Banded sweep	Inhabit rocky reefs, to depths of up to 35 m	Temperate southern Australia (Kangaroo Island, SA to Kalbarri, WA)
Seriola lalandi	Yellowtail kingfish	Pelagic/benthopelagic species. Inhabit reefs and adjacent sandy areas, rocky outcrops, bays and around jetties. Usually to depths of up to 50 m.	Temperate to subtropical waters across southern Australia (Capricorn Group, QLD to Shark Bay, WA)
Siganus fuscescens	Black rabbitfish	Inhabit lagoons, rocky reefs and algal and seagrass flats, to depths of up to 50 m	Temperate to tropical waters across northern Australia (Nadgee, NSW to Busselton, WA)
Sillaginodes punctatus	King George whiting	Inhabit sandy habitats, algal areas and seagrass beds, to depths of up to 200 m	Endemic to southern Australia (Sydney, NSW to north of Rottnest Island, WA)
Siphamia cephalotes	Wood's siphonfish	Inhabit shallow coastal reefs and seagrass and algal beds, to depths of up to 30 m	Temperate to subtropical waters across southern Australia (Byron Bay, NSW to Exmouth Gulf, WA)
Siphonognathus attenuatus	Slender weed whiting	Inhabit rocky reefs and sandy areas adjacent to macroalgal and seagrass beds, to depths of up to 45 m	Endemic to southern Australia (Cape Conran, VIC to Rottnest Island, WA)
Siphonognathus beddomei	Pencil weed whiting	Inhabit kelp beds, to depths of up to 20 m	Endemic to southern Australia (Gippsland Lakes region, VIC to Rottnest Island, WA)
Siphonognathus caninis	Sharpnose weed whiting	Inhabit rocky reefs and algal-covered areas, to depths of up to 35 m	Endemic to southern Australia (Bass Strait, VIC to Port Denison, WA)
Siphonognathus radiatus	Long-rayed weed whiting	Inhabit seagrass and macroalgal beds, to depths of up to 18 m	Endemic to southern Australia (Port Phillip, VIC to Green Head, WA)
Sphyraena obtusata	Striped barracuda	Inhabit seagrass beds (juveniles), rocky reefs and bays, to depths of up to 200 m	Temperate to tropical waters across northern Australia.
Spratelloides gracilis	Slender sprat	Inhabit coastal reefs and lagoons, to depths of up to 40 m	Temperate to tropical waters across northern Australia.
Stegastes lacrymatus	Whitespotted damsel	Inhabit coastal reefs and lagoons, to depths of up to 40 m	Temperate to tropical waters across northern Australia
Stegastes obreptus	Western gregory	Inhabit coastal reefs, to depths of up to 10 m	Temperate to tropical waters across northern Australia (Bountiful Island, QLD to Rottnest Island, WA)
Stethojulis bandanensis	Redspot wrasse	Inhabit reefs and lagoons, to depths of up to 30 m	Temperate to tropical waters across northern Australia (Merimbula, NSW to Rottnest Island, WA)
Stethojulis strigiventer	Silverstreak wrasse	Inhabit seagrass beds, inner reefs and lagoons, to depths of up to 20 m	Temperate to tropical waters across northern Australia
Suezichthys cyanolaemus	Bluethroat rainbow wrasse	Inhabit seagrass beds adjacent to reefs and rubble areas, to depths of up to 40 m	Endemic to WA (Albany to Ningaloo Reef)
Sutorectus tentaculatus	Cobbler wobbegong	Inhabit rocky and coral reefs, to depths of up to 35 m	Temperate to subtropical waters of southern Australia (Gulf St Vincent, SA to Houtman Abrolhos Islands, WA)
Thalassoma lunare	Moon wrasse	Inhabit reefs, to depths of up to 20 m	Temperate to tropical waters across northern Australia
Thalassoma lutescens	Green moon wrasse	Inhabit reefs and lagoons, to depths of up to 30 m	Temperate to tropical waters on Australia's east and west coasts

Name		Habitat*	Australian Distribution*
Thalassoma septemfasciatum	Sevenband wrasse	Inhabit shallow coral, rocky and macroalgal reefs, to depths of up to 20 m	Endemic to WA (Point Samson to Rottnest Island)
Tilodon sexfasciatus	Moonlighter	Inhabit rocky reefs and areas around jetties, to depths of up to 30 m	Endemic to southern Australia (Wilsons Promontory, VIC to Jurien Bay, WA)
Trachinops brauni	Bluelined hulafish	Inhabit coastal reefs, to depths of up to 10 m	Endemic to south-western WA
Trachinops noarlungae	Yellowhead hulafish	Inhabit coastal reefs, to depths of up to 30 m	Endemic to southern Australia (Gulf St Vincent, SA to Houtman Abrolhos Islands, WA)
Trachurus novaezelandiae	Yellowtail scad	Inhabit rocky reefs and shallow, soft bottom habitats, to depths up to 500 m	Temperate to subtropical waters across southern Australia
Trinorfolkia clarkei	Clark's threefin	Inhabit coastal reefs and jetty pylons, to depths of up to 30 m	Endemic to southern Australia (Minnie Waters, NSW to Rottnest Island, WA)
Trygonoptera ovalis	Striped stingaree	Inhabit seagrass beds and adjacent sandy areas, to depths up to 88 m	Endemic to WA (Eucla to Houtman Abrolhos Islands)
Trygonoptera personata	Masked stingaree	Inhabit sandy areas and seagrass beds, typically offshore, to depths of up to 115 m	Endemic to WA (Geographe Bay to Shark Bay)

*Source: Atlas of Living Australia (2023); Fishes of Australia (2023); FishBase (Froese & Pauly, 2023)

2.6 Conclusions

A desktop study was conducted to identify and describe the seasonal presence of species protected under the Commonwealth EPBC Act and WA State BC Act that may be present in the vicinity of the proposed development.

26 listed syngnathid species (seahorses, seadragons, pipefishes, and pipehorses) may occur within a 5 km radius of the proposed development. These species are not listed as threatened under the EPBC and BC Acts but occupy diverse habitats including those found in Thomson Bay. Syngnathids are small, cryptic, and site-attached species that are likely to be present in the area year-round.

Three threatened shark species may occur within a 5 km radius of the proposed development. Scalloped hammerheads (EPBC Act listed conservation dependent) and white sharks (vulnerable) are typically seasonal and use the area for foraging and/or migration; however, may be present year-round. Scalloped hammerheads aggregate in the nearby Shoalwater Islands Marine Park, peaking during January and February. White sharks are more likely to be present in the Perth region during spring and early summer, and least likely to be present during late summer and autumn. The grey nurse shark (vulnerable) is known to congregate or aggregate in the area year-round.

10 listed marine mammal species may occur within a 5 km radius of the proposed development. Seasonal migration of whales along the WA coast includes the southern right whale (endangered; migration April to October), humpback whale (migration May to November), pygmy blue whale (endangered; migration April to January), and the minke whale (may be present over winter). Orcas may be present year-round but are more common on the south coast of WA between January and April. Other listed marine mammals that may be present year-round include the Australian sea lion (endangered), New Zealand fur seal, bottlenose dolphin, Indian ocean bottlenose dolphin, and the spinner dolphin.

Four listed marine reptile species may occur within a 5 km radius of the proposed development. Turtle species that may forage in the area include the loggerhead turtle (endangered), leatherback turtle (endangered), and green turtle (vulnerable). Turtles migrate to/from their nesting grounds in northern WA during summer (typically between November and March); however, their common distribution is north of the proposed development area. The yellow-bellied sea snake may be present year-round.

A second desktop study was conducted to identify non-conservation important fish species that have been recorded within the vicinity of the proposed development. 137 species of fish, sharks and rays were identified that may use habitats within Thomson Bay year-round. Most of these species are associated with hard substrate; however, several use seagrass meadows as nursery grounds (e.g., wrasse, barracuda, pike, herring and stingaree). As Thomson Bay has extensive seagrass meadows, these species may be more vulnerable to impacts from development activities.

3 DESCRIPTION OF BENTHIC HABITAT

The Rottnest Island Marine Reserve is characterised by a unique blend of tropical and temperate species and a diverse range of habitats and communities, including coral reef and extensive seagrass meadows. Protection of this unique environment is a strategic focus area for the RIA, with particular focus on seagrass meadows within Thomson Bay (RIA, 2014, 2020).

3.1 Objectives

The main objective of the benthic marine habitat mapping scope was to review and update the benthic habitat assessment undertaken by RPS in 2019, including:

- Confirm the suitability of the Local Assessment Unit (LAU) defined by RPS (2019b) in assessment of benthic impacts from the proposed development, and its update if required.
- Confirm the suitability of benthic habitat mapping by Harvey (2009) and its suitability for LAU-scale estimates.
- Update the south Thomson Bay area benthic habitat map previously developed by RPS (2019b).
- Confirm estimates of benthic habitat loss due to the proposed development.
- Estimate cumulative loss of benthic habitat as a consequence of historic activities.

An additional objective of the study was to describe benthic habitat adjacent the area previously surveyed by RPS (2019b), extending to the shoreline in the vicinity of the main and fuel jetties.

3.2 Methods

3.2.1 Field surveys

Two surveys were completed for this scope – the main survey which replicated the survey by RPS 2019b, and a supplementary survey of adjacent benthic habitat (Figure 3-2).

The purpose of the main field survey was to describe the benthic habitat present at specific sites within an area of south Thomson Bay that encompassed the proposed development. This area, referred to as the 'Field Survey Area' (FSA) measured 2.6 x 1.0 kilometres and was the same as that surveyed by RPS (2019b; Appendix B). Data obtained from the survey were then used to ground-truth habitat identified in recent aerial images so as to develop a habitat map used to meet objectives described in Section 3.1.

The main field survey was completed between 0830 and 1630 hrs on the 24 November 2023. Weather was fine with light cloud cover with five knot northerly winds in the morning and 15 knot south-westerly winds in the afternoon. Water visibility was good, with detailed benthic habitat classification (i.e., distinguish between elements of the habitat) reliable to a depth of approximately five metres and general classification (i.e., identify dominant habitat) to approximately seven metres. Tides on the day were: low tide (0322 hrs/0.11 m) and high tide (1740 hrs/0.59 m). The survey was conducted using an RIA vessel skippered by an RIA Ranger who navigated to pre-determined survey sites within the FSA (Appendix B). These sites replicated those surveyed by RPS in 2019, except where habitat of specific interest for ground-truthing were identified in the aerial images. Note that survey activities near the main jetty were restricted by ferry and barge activities on the day.

At each site an RPS field scientist experienced in benthic habitat identification lowered a glass bottomed viewing tube into the water and made a point assessment of the habitat type vertically below the viewing location near the rear of the vessel. The assessment area was approximately two by two metres. Data recorded were percent cover of seagrass (to genus), macroalgae, bare substrate (sand or limestone reef/platform) and wrack (unattached macroalgal thalli and dead seagrass leaves) (Appendix C). Data were recorded by a second RPS field scientist along with the GPS position, time, and relevant notes. The initial eight sites were independently assessed through the viewing tube by each RPS scientist, and the results compared and discussed to ensure consistency between habitat identification and percent cover estimations (Appendix C). The survey conditions (water clarity, shallow depth, and low wind) allowed for clear viewing of the benthic habitat from the vessel.

Both scientists undertaking the two field surveys were experienced in marine benthic habitat surveys. For quality control purposes the description of habitat at specific locations was compared between scientists prior to and regularly during the survey (Appendix C).

The supplementary field survey was completed on the 29 January 2024 between 0830 and 1330 hrs. The objective of this field survey was to describe benthic habitat in the near-shore area west of the FSA where vessel moorings and jetties (including the main jetty) are located (Figure 3-2; referred to as the 'Main Jetty Survey Area'). The additional field survey area was assessed in the same way as the FSA. The tides on the day were: low tides (0623 hrs/ 0.56 m and 1554 hrs/ 0.75 m) and high tide (1330 hrs/ 0.76 m). Independent assessment of habitat at the first site was again undertaken by the two RPS field scientists for quality control purposes. Snorkelling was used for this purpose and for assessment of sites close to the shoreline which were too shallow to be accessed via the RIA vessel. The benthic assessment followed the same protocols as outlined above for the November 2023 survey.

3.2.2 Data processing

Sampling locations recorded during the field survey were downloaded into GIS and correlated with habitat classes. These classes were derived from percent cover of biota and bare substrate obtained during the field survey, as described in Section 3.2.1. A map of benthic communities and habitat was subsequently developed using methods described in Section 3.2.2.1.

3.2.2.1 Habitat classification

The classification scheme used in the field component of this study was based on that developed for Seamap Australia (Butler et al., 2017). This is a dominance-based scheme, i.e., the classes are defined based on the dominant biota, or a mixture of one or more dominant species (Table 3-1). In this study the criterion for dominance is >50% cover. A mixed class is identified where the percentage cover of the two or more dominant classes are separated by ≤ 30% (relative to the percentage cover of the most dominant class). For example, a sampling location consisting of 25% macroalgae and 60% *Posidonia* spp., would be classed as *Posidonia*-dominated, whereas a location consisting of 40% macroalgae and 60% *Posidonia* spp., would be classed as mixed *Posidonia* / macroalgae habitat. The classification scheme was also designed to be compatible with the hierarchical scheme developed by Harvey (2009) for classifying marine benthic habitats of Rottnest Island, to enable extrapolation to broader spatial scales.

Table 3-1: Classification scheme used in analysis of benthic habitat

Habitat Class	Description
Sand	71 – 100% bare sand
Sand with seagrass	20 - 50% seagrass
Sand with wrack	> 30% wrack (note: wrack present with other biota is not classified)
Halophila dominated	> 50% *Halophila* (note: *Halophila* morphology allows for a high percentage of sand)
Posidonia dominated	> 50% *Posidonia*
Amphibolis dominated	> 50% *Amphibolis*
Macroalgae dominated	> 50% macroalgae
Mixed seagrass	% cover of dominant seagrasses separated by ≤ 30%
Mixed algae / seagrass	% cover of dominant seagrass/algae separated by ≤ 30%
Limestone reef / pavement	Limestone reef or platform with minor (< 30%) attached seagrass/macroalgae

3.2.2.2 Development of the benthic habitat map

Habitat mapping was undertaken using Esri's ArcGIS Pro to create a digitised image in vector shapefile format using select Landgate Web Map Service aerial photographs. For this purpose the February 2023 photograph was selected as the 'base map' due to its superior clarity of seabed features compared to other images available since August 2022 (Appendix D, Figure 3). Note that August would have been a preferred option for compatibility with the previous habitat mapping process by RPS (2019b), however whilst the August 2022 photograph provided good clarity of offshore seabed features compared to other recent aerial photographs the nearshore areas of this photograph were largely hidden by a plume (Appendix D, Figure 4). The August 2022 photograph nevertheless provided good comparison against the 'base map' for

identification of areas of wrack in these offshore areas (i.e., areas of dark seabed not common between the two images), so that these could be removed from the benthic habitat map, with other photographs used for comparison of nearshore areas. Noting also that the August 2023 aerial photograph was not available for initial mapping of the habitat within the FSA but subsequently became available for use during the mapping of habitat for the Main Jetty Survey Area. This photograph was therefore used to confirm the accuracy of the habitat map developed earlier for the FSA (Appendix D, Figure 5).

After completion of the habitat digitisation process and removal of wrack as described above, areas of habitat on the digitised image were classified into habitat classes (Table 3-1) using data from the RPS field surveys that was pooled where necessary to provide a more reliable description of habitat across the FSA. Note that isolated areas of habitat less than a few metres in diameter were generally too small for effective digitisation and mapping. It is also possible that minor errors in habitat description have been made due to limitations posed by photograph clarity, habitat complexity (for example mixing of wrack with live seagrass) and vessel/barge traffic near the main wharf (i.e., restricting site surveys). These are not expected to have meaningful effect on the results and conclusions, however.

3.3 Results and Discussion

3.3.1 Review of the Local Assessment Unit and habitat mapping by Harvey (2009)

A local assessment unit (LAU) is a geographical area that establishes the spatial context for the calculation and assessment of recoverable impacts and cumulative losses. LAUs are location specific and should reflect local physical, ecological, administrative and jurisdictional considerations. There is no standard size or shape to a LAU, and they need to be defined on a situation-specific basis (EPA 2016). Guidance on LAU size by the EPA (2016) indicates that they are typically defined as a ten kilometre stretch of coastline extending five kilometres offshore (i.e., 50 km^2), although other size LAUs will be considered if justified.

RPS (2019b) previously suggested that the most appropriate LAU for the proposed development in Thomson Bay is the area mapped by Harvey (2009) because this area:

- Comprises 2,746 ha of described habitat in which historic habitat loss from anthropogenic impacts have been estimated (Oceanica 2013; as explained further in RPS (2019b))
- Represents a complete island ecosystem
- Is consistent with EPA (2016) guidance on the size of an LAU.

Furthermore, there have been no further updates to the benthic habitat map of Rottnest Island by Harvey (2009; Figure 3-1). This map was developed using hyperspectral imagery obtained in 2004 and based on spectral signatures of the dominant habitat components. At the broadest scale, areas of bio-substrate were separated from bare substrates in the image with an overall accuracy of 95%, whereas at the finest scale, bare substrates and dominant species or genera were separated with an accuracy of 70% (Harvey 2009). In their comparison of benthic habitat modelling techniques, Davis (2011) concluded that the habitat modelling used by Harvey (2009) had the highest accuracy (84%; validated in field) and was able to identify small patches of habitats, providing additional technical review to support using the habitat map by Harvey (2009) to define the LAU for the proposed development.

In developing their habitat map, Harvey (2009), noted that a reason for the decrease in accuracy at the finer scale was the inherent spatial inaccuracy of the geo-location of both the image and the validation data collected in the field. Similarly, when comparing the benthic habitat map by Harvey (2009) to aerial images taken in August 2014/2018 and observations from the site visit, RPS (2019b) identified discrepancies in areas of seagrass and sand habitat, considered most likely to be due to fine-scale misclassification of habitats by Harvey (2009). In particular, RPS (2019b) observed that misclassification of mobile wrack as seagrass by Harvey (2009) would result in an overestimate of the amount of seagrass loss within the planned development footprint. Because of the potential for fine-scale misclassification of habitat, additional sites were added to the 2023 survey to further clarify high risk wrack accumulation areas, such as the shallows and habitat edges where misclassification is more likely, and supplementary observations were noted detailing when wrack was present, and if it occurred at the edge of a benthic habitat. This information assisted in the aerial footage comparisons (Section 3.3.2) to predict areas of benthic habitat and calculate benthic habitat losses more accurately.

The spatial scale of analysis is therefore critical in determining the accuracy of habitat maps - and in assessing the impacts associated with the proposed development. Table 3-2 highlights broad similarities

between the habitat map developed in 2019 and in this study for the FSA, and the Level 2 habitat map developed by Harvey (2009) for the same area. However, it also indicates that the map by Harvey (2009) underestimates the amount of seagrass in south Thomson Bay and overestimates the macroalgae dominated habitat, particularly in the area identified during the current study as comprising a mix of algae and seagrass (see Section 3.2). The map by Harvey (2009) also indicates more areas of sand than the current study. These findings remained true when comparing the Harvey (2009) habitat map to the 2023 survey. The two RPS surveys results (2019b and current) were more similar to each other than Harvey (2009), however there was an increase in macroalgae/ limestone pavement and an increase in seagrass and sand/ sand with wrack observed. These were relatively small differences though and may be accounted for with the alteration of site locations (and the additional sites) in the 2023 survey. Further, variation between images in the clarity of seabed features (e.g. Appendix D) is another source of discrepancy between habitat maps.

Based on the above and considering the guidance by EPA (2016) that the understanding of benthic communities and their habitats should be proportional to the scale of the proposed development, it is considered reasonable that the habitat map developed by Harvey (2009) is satisfactory for description of habitat within the LAU defined for the proposed development. However, because the Harvey (2009) map underestimates the amount of seagrass habitat within the FSA it is more appropriate to base assessment of seagrass habitat loss due to the proposed development on the habitat map developed during the current study (described in following sections).

Table 3-2: Comparison of habitat area estimates within the FSA by RPS (2019 and current) and Harvey (2009), using habitat types described by Harvey (2009)

Harvey (2009) category	RPS category	Harvey (2009) hectares	RPS (2019) hectares	Difference (Harvey & RPS 2019)	RPS hectares (2023)	Difference (Harvey & RPS 2023)	Difference RPS 2019 & 2023
Macroalgae / intertidal	Limestone reef / pavement & Macroalgae dominated	16.04	7.09	8.95	12.59	3.45	5.5
Seagrass	Mixed seagrass	91.69	110.28	-18.59	108.10	-16.41	-2.18
Sand	Sand / sand with wrack	55.12	46.09	9.03	42.43	12.69	-3.66
Unclassified	NA	0.56	NA	0.56	NA	NA	NA

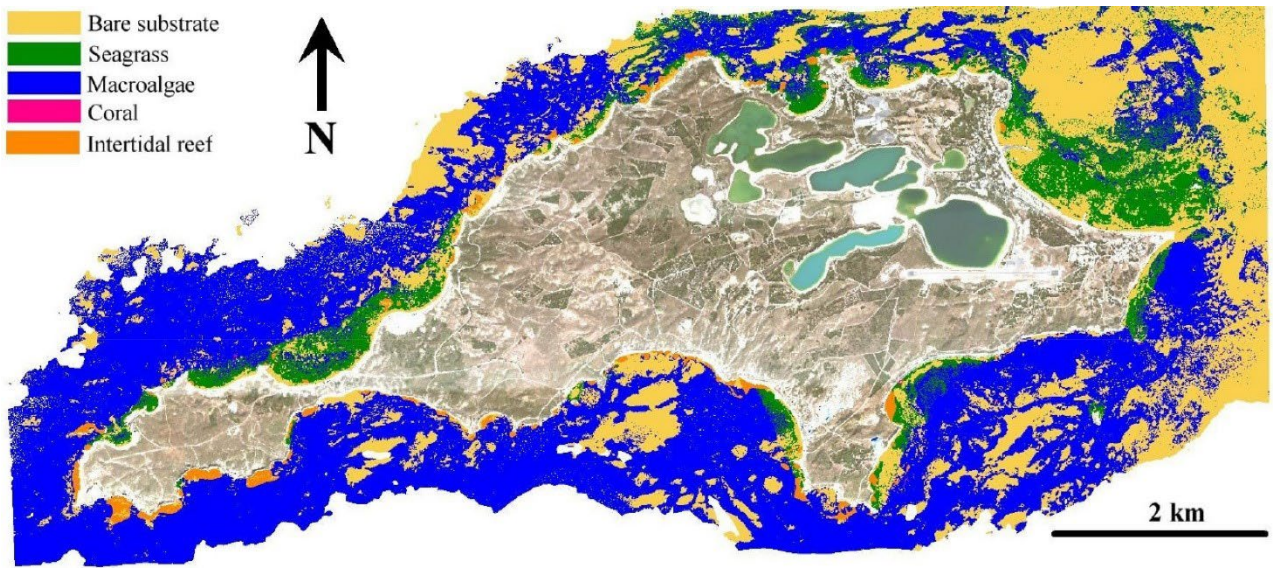

Figure 3-1: Habitat map of Rottnest Island by Harvey (2009)

3.3.2 Development of a benthic habitat map within the FSA

A benthic habitat map is required for estimating historic habitat loss and predicting additional losses from planned developments (EPA, 2016). The benthic habitats of Rottnest Island were mapped by Harvey (2009) using a combination of *in situ* observation and aerial hyperspectral imagery. Benthic habitats were classified at four levels by Harvey (2009), where Level 2 identified seagrass, macroalgae, coral, intertidal reef, sand and unclassified (typically beach). Approximately 399 ha or 14.5 % of the total mapped area of Rottnest Island (2,746 ha) was classified as seagrass meadows, with 119 ha located within Thomson Bay.

The benthic habitat map developed by RPS in 2023 for assessment of the south Thomson Bay development shows the distribution of seagrass in the vicinity of the proposed development and more broadly across southern Thomson Bay (Figure 3-2, Figure 3-3). The relative cover of the different habitat types shown in Table 3-2 and Table 3-3 confirms the dominance of seagrass, in particular *Posidonia* spp. which comprise the priority ecological community *Posidonia australis* complex meadows (DBCA 2023a). 'Bare' sand habitat (15% of sites; approximately 26 % of the FSA) also occupies a substantial part of the FSA, followed by macroalgae dominated habitat/ limestone reef/pavement recorded at 13 % of the sampling sites and covering 8 % of the FSA. Areas of mobile wrack over sand that might otherwise have been classified as seagrass or other habitat were identified by comparison of the August 2022 and February 2023 aerial images. These areas can be seen as darker areas of sand in aerial photos (Appendix D) and are common across the FSA, particularly around habitat edges and along the shoreline as confirmed by in-field ground-truthing in 2023. Areas of wrack are also evidenced in Figure 3-2 by its accumulation into parallel lines visible on the aerial image (Appendix C).

The Harvey (2009) benthic habitat map shown in Figure 3-1 also indicates an area dominated by macroalgae in the southeast part of the FSA. This was verified by several of the survey locations and the habitat edges were confirmed using the February 2023 aerial image, which was particularly clear (Appendix D). Similarly, a broad area in the northern part of the FSA appears to comprise a mix of seagrass and algae that could not be clearly defined from the aerial images.

There were some notable differences in the percentage of habitat cover identified between the 2019 and 2023 surveys, in particular an 8 % decrease in the number of sites classified as "Sand with wrack" and an 8 % increase in "Macroalgae dominated" habitat classification. However, because the location of additional sites of interest differed between surveys a difference in habitat percentages recorded at sites is to be expected. Nevertheless, as shown in Table 3-2 these differences at the site level are not reflected in the broader benthic habitat classification. The proportion of the FSA that was classified as Seagrass dominated decreased by 2.18 % from 2019 to 2023, Macroalgae dominated increased by 5.5 % and Sand/Sand with Wrack decreased by 3.66 % indicating that the FSA benthic habitat has remained relatively stable since the 2019 survey.

Table 3-3: Habitat class across sites in FSA and expressed as a percentage from the 2023 and 2019 surveys (RPS, 2019b) and the percentage difference between the two surveys.

Habitat class	Number of sites (2023)	Percentage of total sites (2023)	Percentage of total sites (2019)	Percentage difference (2019 to 2023)
Amphibolis dominated	8	5%	3%	+2%
Halophila dominated	1	1%	NA	+1
Limestone reef / pavement	3	2%	4%	-2%
Macroalgae dominated	17	11%	3%	+8%
Mixed algae / seagrass	7	4%	2%	+2%
Mixed seagrass	4	3%	6%	-3%
Posidonia dominated	76	48%	54%	-6%
Sand	24	15%	14%	+1%
Sand with seagrass	8	5%	2%	+3%
Sand with wrack	9	6%	14%	-8%
Grand Total	**157**	**100%**	**100%**	

3.3.3 Development of a benthic habitat map within the Main Jetty Survey Area

Thirty-two sites in a 10 ha area west of the FSA were assessed for the development of a benthic habitat map. The sites spanned the main ferry terminal and fuel jetty within Thomson Bay (Figure 3-2). *Posidonia* seagrass dominated 50 % of the survey sites and 57 % of the area (5.71 ha). The remaining sites and area were bare sand patches, and sand patches with wrack accumulations (4.27 ha; Figure 3-4, Table 3-4).

A significant amount of wrack was present along the shoreline and within the adjacent shallow waters (22 %, Table 3-4). There was a very low tide recorded the previous week (e.g., Friday 26 January 2024: low tide at 0632 hrs/0.46 m) and seagrass showed signs of stress (sunburn) including brown leaves with green (living) leaf near the thallus. There were also areas of live seagrass present underneath wrack e.g., *Posidonia* at site Extra 13 surrounded by wrack at sites Extra 11 and Extra 12 (Appendix B). Closer to the shoreline, small sand patches exist within the seagrass meadows (e.g., S13); however, the area of these sand patches was generally too small for effective digitisation and mapping (Appendix B). Observations near the ferry terminal (e.g., S10) were challenging due to high vessel traffic resuspending sediments and reducing water clarity. Visual confirmation of the edge of the seagrass meadow was attained near S11, and observations at site Extra 07 indicate there is not a substantial seagrass meadow located immediately south of the ferry terminal (Appendix B).

Table 3-4: Habitat class across sites in the area west of the FSA and expressed as a percentage from the 2024 survey.

Habitat class	Number of sites (2024)	Percentage of total sites (2024)
Amphibolis dominated	0	0%
Halophila dominated	0	0%
Limestone reef / pavement	0	0%
Macroalgae dominated	0	0%
Mixed algae / seagrass	0	0%
Mixed seagrass	0	0%
Posidonia dominated	16	50%
Sand	7	22%
Sand with seagrass	2	6%
Sand with wrack	7	22%
Grand Total	**32**	**100%**

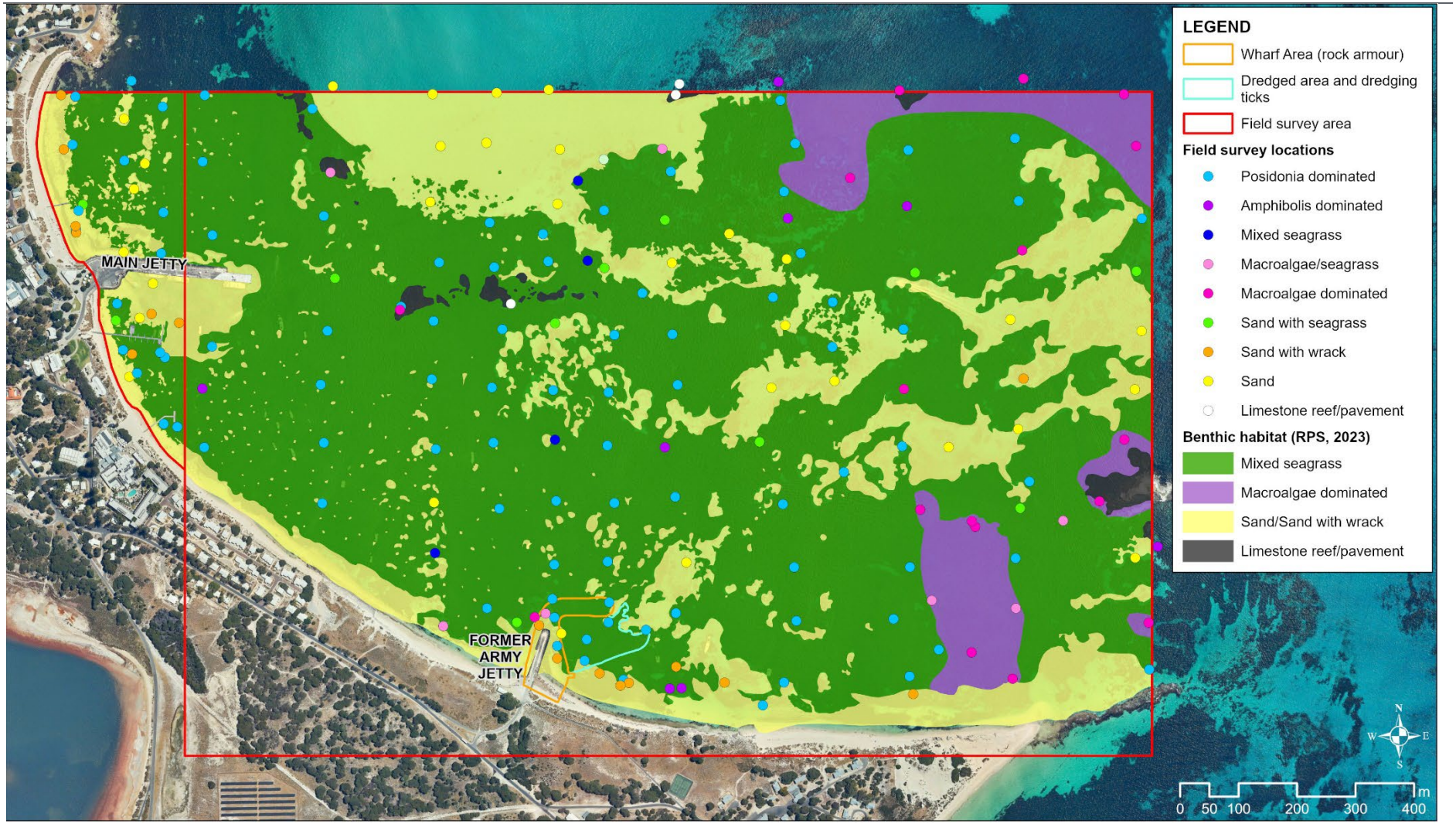

Figure 3-2: Benthic habitat map of the Field Survey Area and Main Jetty Survey Area within Thomson Bay, Rottnest Island

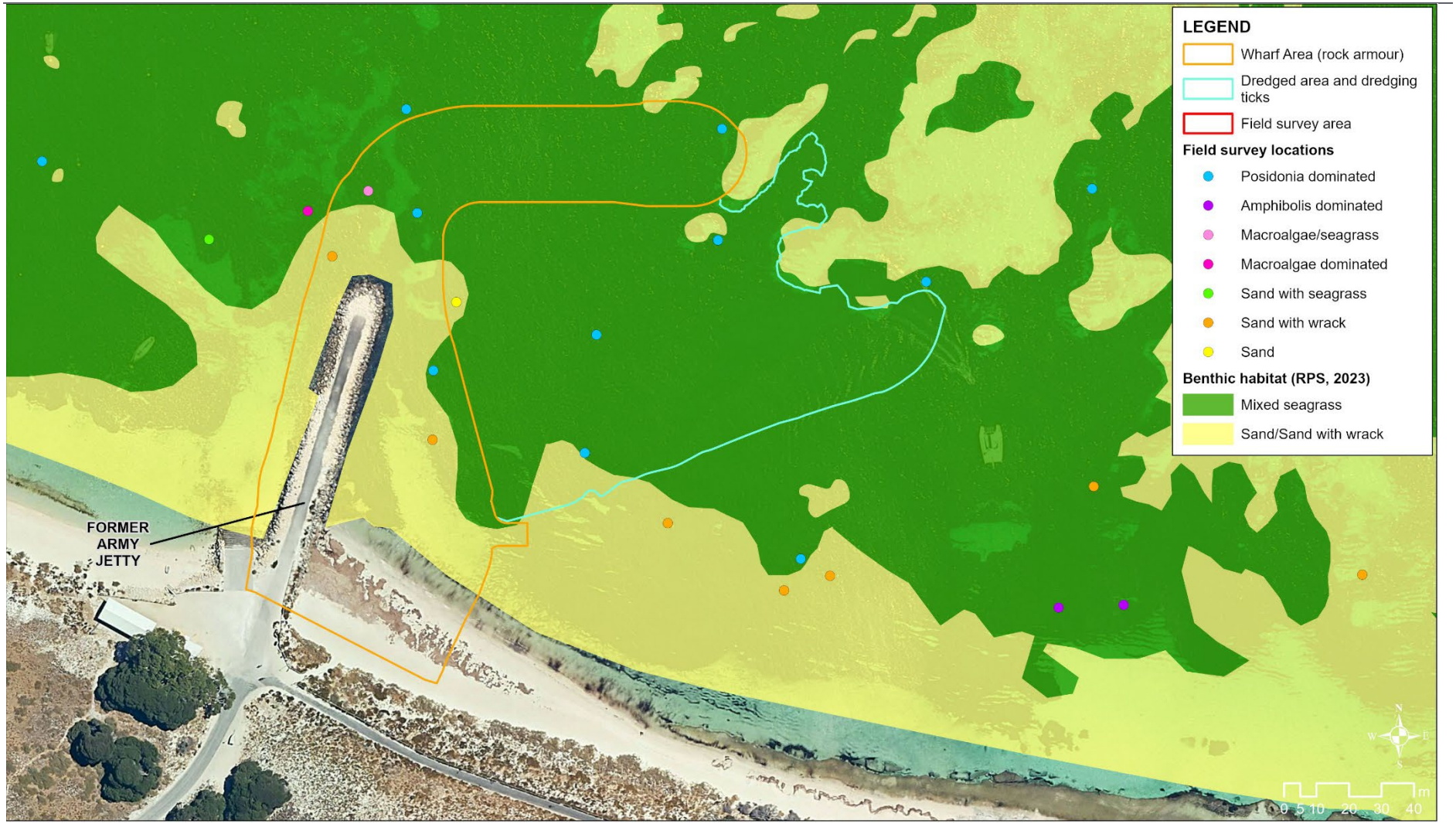

Figure 3-3: Detail of the benthic habitat map within the proposed development area

Figure 3-4: Benthic habitat map within the Main Jetty Survey Area, west of the FSA

3.3.4 Habitat loss due to the proposed development

Overlay of the proposed South Thomson Bay Maritime Facilities Redevelopment (Figure 1-1) on the benthic habitat map shown in Figure 3-2 indicates that installation of the wharf may result in the loss of 0.34 hectares (2,900 m^2) of *Posidonia* dominated seagrass (Table 3-5). Associated dredging of seabed may result in the loss of a further 0.96 hectares (9,200 m^2) of *Posidonia* dominated seagrass. As noted by the EPA (2016) assessment of direct impacts from activities such as dredging is relatively straightforward as these impacts are generally closely linked to the dredge area and immediate surrounding area. A five-metre buffer is notionally considered a reasonable estimate of the area surrounding the wharf and dredged area footprints that may be subject to events causing additional habitat loss, including localised erosion, slumping of dredged area walls and backwash. Addition of this buffer to the overall footprint (wharf and dredged areas combined) indicates that a total of 1.55 hectares (14,200 m^2) of *Posidonia* dominated seagrass may be directly lost by the proposed development (Table 3-5). The only other habitat lost by construction of the proposed development would be sand or sand with wrack (Table 3-5).

Table 3-5: Area of habitats within development-related footprints using data collected by RPS in 2023

Area	Habitat (hectares)			
	Mixed seagrass	Macroalgae dominated	Sand/Sand with wrack	Limestone reef/pavement
Field survey area	108.10	10.80	42.43	1.79
Wharf area	0.34	0	0.18	0
Dredged area	0.96	0	0.06	0
Development footprint (wharf area plus dredged area)	1.30	0	0.24	0
Development footprint + 5 m buffer	1.55	0	0.44	0
Total habitat remaining (field survey area minus development footprint)	106.80	10.80	42.19	1.79
Total habitat remaining inc. buffer (field survey area minus development footprint with 5 m buffer)	106.55	10.80	41.99	1.79

3.3.5 Cumulative habitat loss

Calculation of cumulative benthic habitat loss within a defined LAU requires estimates of the extent of benthic habitat (EPA, 2016):

- prior to all human-induced disturbance
- at the time of the proposed development
- remaining after the development is completed.

Oceanica (2013) provided estimates for the first two points above through calculations of historic benthic habitat loss within the defined LAU for Rottnest Island. These are reviewed below (Section 3.3.5.1). Preliminary estimates for the third point above (habitat loss due to the proposed development) are described in Section 3.3.5, with a combined calculation of cumulative benthic habitat (seagrass) loss described below.

3.3.5.1 Historic benthic habitat loss

Oceanica (2013) estimated historic benthic habitat loss associated with vessel moorings (mooring scars) and jetties from a review of aerial imagery taken in March 2008. These estimates are only for seagrass because there was insufficient data for other habitat types such as coral and macroalgae, and because seagrass meadows typically occur within sheltered, shallow bays where this marine infrastructure is located. This is acceptable for the current study because seagrass is the key impacted habitat. The estimates by Oceanica (2013) did not consider other potential sources of anthropogenic stressors such as eutrophication, propeller scour and sedimentation, and assumed that areas of bare sand around marine infrastructure and moorings were previously 100% seagrass. The latter may result in an over-estimate of seagrass loss as some areas may have historically been bare sand (RPS, 2019b). Further, there appears to have been some recovery of cleared seagrass due to the change to environmentally friendly mooring designs which has allowed some

seagrass regrowth (Oceanica 2013). RPS (2019b) found evidence of both degradation and regrowth of seagrass habitat to the east and west of Main Jetty in Thomson Bay, respectively, and noted that regrowth may be associated with a change in the species composition of seagrass. The 2023 survey also noted potential seagrass regrowth in the northwest of the FSA (Plate 3-1). Ultimately, estimations of historic anthropogenic losses are inherently difficult due to a lack of reliable baseline data and lack of understanding of loss due to natural events such as storms and alongshore sediment transport (RPS, 2019b). A conservative approach is therefore taken in this report by not accounting for areas of regrowth.

In considering the above, the estimate of seagrass loss around Rottnest Island by Oceanica (2013) is acceptable for LAU-scale calculations. These estimates use the data by Harvey (2009) to estimate the 'current' extent of seagrass habitat as 398.70 hectares which, when combined with the amount lost due to human-induced disturbance (7.95 hectares) results in an estimated 406.65 hectares of seagrass habitat within the LAU prior to impacts due to human activities. This represents a 1.95% loss of seagrass habitat within the LAU prior to the proposed development.

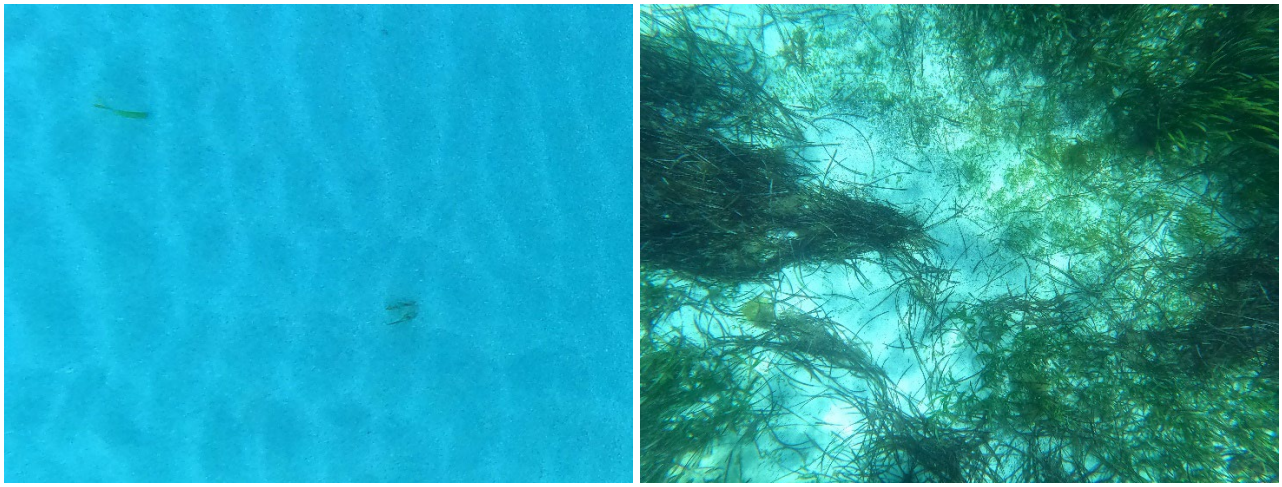

Plate 3-1: Individual living *Posidonia* shoots (site number T10A) (left); accumulation of *Posidonia* wrack and new growth of seagrass at edge of *Posidonia* meadow (site number T10D) (right) in the northwest of the FSA

3.3.5.2 Increase in cumulative benthic habitat loss due to the proposed development

Based on calculations described in Section 3.3.4 the loss of seagrass habitat as a consequence of the proposed development (1.55 ha) represents a 1.22 % loss of this habitat from the FSA (Table 3-5). In terms of the broader LAU, the development (wharf and dredged areas plus five m buffer) may decrease the amount of seagrass habitat estimated to be within the LAU (398.7 ha) by a further 0.39 %, resulting in a cumulative (projected plus historical) loss of 2.34 % seagrass habitat across the LAU.

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Appendix A
PMST and DBCA database search results

Appendix Table 1: EPBC Act (PMST) and BC Act (DBCA database) listed threatened, marine or migratory marine species in the search radius around Thomson Bay

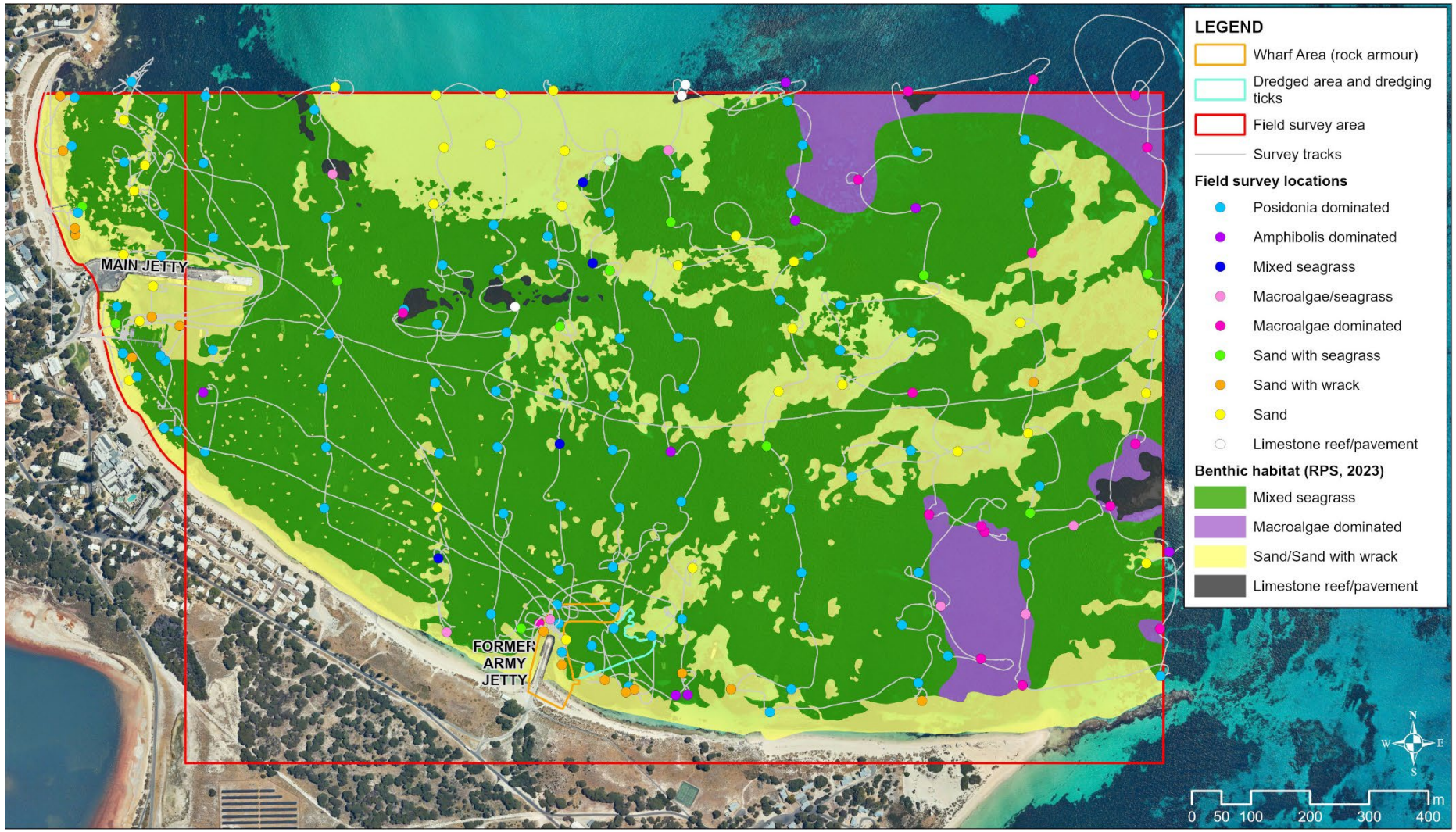
Name		Conservation status	
Species	**Common**	**EPBC Act**	**BC Act**
Birds			
Limosa lapponica menzbieri	Northern Siberian bar-tailed godwit	Critically Endangered	Not included
Calidris ferruginea	Curlew sandpiper	Critically Endangered, Migratory	Critically Endangered
Calidris tenuirostris	Great knot	Critically Endangered, Migratory	Critically Endangered
Numenius madagascariensis	Eastern curlew	Critically Endangered, Migratory	Not included
Rostratula Australis	Australian painted snipe	Endangered	Not included
Calidris canutus	Red knot	Endangered, Migratory	Endangered
Charadrius mongolus	Lesser sand plover	Endangered, Migratory	Endangered
Diomedea amsterdamensis	Amsterdam albatross	Endangered, Migratory	Not included
Diomedea dabbenena	Tristan albatross	Endangered, Migratory	Not included
Diomedea sanfordi	Northern royal albatross	Endangered, Migratory	Not included
Macronectes giganteus	Southern giant-petrel	Endangered, Migratory	Not included
Thalassarche cauta	Shy albatross	Endangered, Migratory	Not included
Anous tenuirostris melanops	Australian lesser noddy	Vulnerable	Not included
Halobaena caerulea	Blue petrel	Vulnerable	Not included
Pachyptila turtur subantarctica	Fairy prion (southern)	Vulnerable	Not included
Pterodroma mollis	Soft-plumaged petrel	Vulnerable	Not included
Sternula nereis	Fairy tern	Vulnerable	Vulnerable
Sternula nereis nereis	Australian fairy tern	Vulnerable	Vulnerable
Charadrius leschenaultii	Greater sand plover	Vulnerable, Migratory	Vulnerable
Diomedea epomophora	Southern royal albatross	Vulnerable, Migratory	Not included
Diomedea exulans	Wandering albatross	Vulnerable, Migratory	Vulnerable
Macronectes halli	Northern giant petrel	Vulnerable, Migratory	Not included
Phoebetria fusca	Sooty albatross	Vulnerable, Migratory	Not included
Thalassarche carteri	Indian yellow-nosed albatross	Vulnerable, Migratory	Not included
Thalassarche impavida	Campbell albatross	Vulnerable, Migratory	Not included
Thalassarche melanophris	Black-browed albatross	Vulnerable, Migratory	Not included
Thalassarche steadi	White-capped albatross	Vulnerable, Migratory	Not included
Anous stolidus	Common noddy	Migratory	Migratory
Ardenna carneipes	Flesh-footed shearwater	Migratory	Not included
Ardenna grisea	Sooty shearwater	Migratory	Not included
Ardenna pacifica	Wedge-tailed shearwater	Migratory	Migratory
Arenaria interpres	Ruddy turnstone	Migratory	Migratory
Calidris acuminata	Sharp-tailed sandpiper	Migratory	Migratory
Calidris alba	Sanderling	Migratory	Migratory
Calidris melanotos	Pectoral sandpiper	Migratory	Migratory
Calidris ruficollis	Red-necked stint	Migratory	Migratory
Hydroprogne caspia	Caspian tern	Migratory	Migratory
Limosa lapponica	Bar-tailed godwit	Migratory	Migratory

Numenius phaeopus	Whimbrel	Migratory	Migratory
Onychoprion anaethetus	Bridled tern	Migratory	Not included
Phaethon rubricauda	Red-tailed tropicbird	Migratory	Priority 4, Migratory
Phalaropus lobatus	Red-necked phalarope	Migratory	Migratory
Pluvialis fulva	Pacific golden plover	Migratory	Migratory
Pluvialis squatarola	Grey plover	Migratory	Migratory
Sterna dougallii	Roseate tern	Migratory	Migratory
Thalasseus bergii as Sterna bergii	Crested tern, Greater crested tern	Migratory	Migratory
Tringa nebularia	Common greenshank	Migratory	Migratory
Tringa stagnatilis	Marsh sandpiper	Migratory	Migratory
Actitis hypoleucos	Common sandpiper	Listed	Not included
Charadrius bicinctus	Double-banded plover	Listed	Not included
Charadrius ruficapillus	Red-capped plover	Listed	Not included
Chroicocephalus novaehollandiae as Larus novaehollandiae	Silver gull	Listed	Not included
Eudyptula minor	Little penguin	Listed	Not included
Gallinago megala	Swinhoe's snipe	Listed	Not included
Gallinago stenura	Pin-tailed snipe	Listed	Not included
Haliaeetus leucogaster	White-bellied sea-eagle	Listed	Not included
Halobaena caerulea	Pied stilt	Listed	Not included
Larus pacificus	Pacific gull	Listed	Not included
Limosa limosa	Black-tailed godwit	Listed	Not included
Motacilla cinerea	Grey wagtail	Listed	Not included
Numenius minutus	Little curlew	Listed	Not included
Onychoprion fuscatus as Sterna fuscata	Sooty tern	Listed	Not included
Pachyptila turtur	Fairy prion	Listed	Not included
Pandion haliaetus	Osprey	Listed	Not included
Puffinus assimilis	Little shearwater	Listed	Not included
Recurvirostra novaehollandiae	Red-necked avocet	Listed	Not included
Stercorarius antarcticus as Catharacta skua	Brown suka	Listed	Not included
Thinornis cucullatus	Hooded plover	Listed	Priority 4
Tringa brevipes as Heteroscelus brevipes	Grey-tailed tattler	Listed	Not included
Tringa totanus	Common redshank	Listed	Not included
Xenus cinereus	Terek sandpiper	Listed	Not included
Apus pacificus	Fork-tailed swift	Not included	Migratory
Charadrius dubius	Little ringed plover	Not included	Migratory
Fish			
Thunnus maccoyii	Southern bluefin tuna	Conservation Dependent	Not included
Mobula alfredi as Manta alfredi	Reef manta ray	Migratory	Not included
Mobula birostris as Manta birostris	Giant manta ray	Migratory	Not included
Acentronura australe	Southern pygmy pipehorse	Listed	Not included
Campichthys galei	Gale's pipefish	Listed	Not included
Choeroichthys suillus	Pig-snouted pipefish	Listed	Not included
Halicampus brocki	Brock's pipefish	Listed	Not included

Heraldia nocturna	Upside-down pipefish	Listed	Not included
Hippocampus angustus	Western spiny seahorse	Listed	Not included
Hippocampus breviceps	Short-head seahorse	Listed	Not included
Hippocampus subelongatus	West Australian seahorse	Listed	Not included
Histiogamphelus cristatus	Rhino pipefish	Listed	Not included
Lissocampus caudalis	Australian smooth pipefish	Listed	Not included
Lissocampus fatiloquus	Prophet's pipefish	Listed	Not included
Lissocampus runa	Javelin pipefish	Listed	Not included
Maroubra perserrata	Sawtooth pipefish	Listed	Not included
Mitotichthys meraculus	Western crested pipefish	Listed	Not included
Nannocampus subosseus	Bonyhead pipefish	Listed	Not included
Phycodurus eques	Leafy seadragon	Listed	Not included
Phyllopteryx taeniolatus	Common seadragon	Listed	Not included
Pugnaso curtirostris	Pugnose pipefish	Listed	Not included
Solegnathus lettiensis	Gunther's pipefish	Listed	Not included
Stigmatopora argus	Spotted pipefish	Listed	Not included
Stigmatopora nigra	Widebody pipefish	Listed	Not included
Syngnathoides biaculeatus	Double-end pipefish	Listed	Not included
Urocampus carinirostris	Hairy pipefish	Listed	Not included
Vanacampus margaritifer	Mother-of-pearl pipefish	Listed	Not included
Vanacampus phillipi	Port Phillip pipefish	Listed	Not included
Vanacampus poecilolaemus	Longsnout pipefish	Listed	Not included
Sharks			
Galeorhinus galeus	School shark	Conservation Dependent	Not included
Sphyrna lewini	Scalloped hammerhead	Conservation Dependent	Not included
Carcharias taurus (west coast population)	Grey nurse shark (west coast population)	Vulnerable	Not included
Carcharodon carcharias	White shark	Vulnerable, Migratory	Vulnerable
Pristis pristis	Freshwater sawfish	Vulnerable, Migratory	Not included
Rhincodon typus	Whale shark	Vulnerable, Migratory	Not included
Carcharhinus longimanus	Oceanic whitetip shark	Migratory	Not included
Lamna nasus	Porbeagle, Mackerel shark	Migratory	Not included
Mammals			
Neophoca cinerea	Australian sea lion	Endangered	Endangered
Balaenoptera musculus	Blue whale	Endangered, Migratory	Endangered, Migratory
Eubalaena Australis as Balaena glacialis Australis	Southern right whale	Endangered, Migratory	Vulnerable
Balaenoptera musculus brevicauda	Pygmy blue whale	Endangered	Not included
Balaenoptera edeni	Bryde's whale	Migratory	Not included
Caperea marginata	Pygmy right whale	Migratory	Not included
Megaptera novaeangliae	Humpback whale	Migratory	Conservation Dependent, Migratory
Orcinus orca	Killer whale, Orca	Migratory	Not included
Arctocephalus forsteri	New Zealand fur seal	Listed	Other Specially Protected
Balaenoptera acutorostrata	Minke whale	Listed	Not included
Delphinus delphis	Common dolphin	Listed	Not included
Grampus griseus	Risso's dolphin	Listed	Not included

Stenella attenuata	Spotted dolphin	Listed	Not included
Tursiops aduncus	Indian ocean bottlenose dolphin	Listed	Not included
Tursiops truncatus s. str.	Bottlenose dolphin	Listed	Not included
Stenella longirostris	Spinner dolphin	Not included	Priority 4, Migratory
Reptiles			
Caretta caretta	Loggerhead turtle	Endangered, Migratory	Not included
Dermochelys coriacea	Leatherback turtle	Endangered, Migratory	Vulnerable
Chelonia mydas	Green turtle	Vulnerable, Migratory	Vulnerable
Natator depressus	Flatback turtle	Vulnerable, Migratory	Not included
Aipysurus pooleorum	Shark Bay seasnake	Listed	Not included
Disteira kingii	Spectacled seasnake	Listed	Not included
Pelamis platurus	Yellow-bellied seasnake	Listed	Not included

Appendix B
Field survey sites and GPS tracks



Appendix Figure 1: Field survey sites and GPS tracks within the two survey areas

Appendix Figure 2: Field survey sites within the Main Jetty Survey Area west of the FSA

Appendix C
Field survey data

Appendix Table 2: Field survey data 24th November 2023 (FSA)

Site ID	Wpt	Lat	Long	Time	Depth (m)	Observer	Benthic Habitat Description	Notes	Classification
T11C	1671	-31.99674499	115.543965	8:56	2.9	JB/RM	JB - 80% Posidonia australis, 20% Sargassum RM - 80% Posidonia australis, 20% Sargassum	QAQC check	Posidonia dominated
T11D	1672	-31.99502897	115.544003	9:07	1.4	JB/RM	JB - 100% Posidonia sinuosa RM - 100% Posidonia sinuosa	QAQC	Posidonia dominated
T11E	1673	-31.99389397	115.54384	9:12	1.4	JB/RM	JB - 100% Posidonia sinuosa RM - 100% Posidonia sinuosa	QAQC	Posidonia dominated
T11F	1674	-31.99287096	115.543895	9:15	1.7	JB/RM	JB - 90% Posidonia sinuosa, 10% Sargassum RM - 90% Posidonia sinuosa, 10% Sargassum	QAQC	Posidonia dominated
T10A	1675	-31.99275898	115.546217	9:20	2.7	JB/RM	JB - 100% sand RM - 100% sand	QAQC Individual shoots of Posidonia	Sand
S01	1676	-31.99310197	115.545841	9:24	3.3	JB/RM	JB - 100% Posidonia sinuosa RM - 100% Posidonia sinuosa	QAQC No visible wrack	Posidonia dominated
T10B	1677	-31.99408801	115.546151	9:27	2.6	JB/RM	JB - 40% limestone, 40% Posidonia sinuosa, 20% Sargassum RM - 40% limestone, 40% Posidonia sinuosa, 20% Sargassum	QAQC Drifted for photo	Mixed algae / seagrass
T10C	1678	-31.99475798	115.546023	9:30	2.1	JB/RM	JB - 100% Posidonia sinuosa RM - 100% Posidonia sinuosa	QAQC	Posidonia dominated
T10D	1679	-31.99571997	115.54621	9:34	2.5	JB/RM	JB - 20% Posidonia sinuosa, 20% wrack, 10% brown algae, 50% sand RM - 20% Posidonia sinuosa, 20% wrack, 10% brown algae, 50% sand	QAQC	Sand with seagrass
T10E	1680	-31.99652798	115.546061	9:39	2.1	RM	95% Posidonia sinuosa, 5% Brown algae		Posidonia dominated
T10F	1681	-31.99735503	115.545924	9:41	2.5	JB	100% Posidonia sinuosa		Posidonia dominated

T10G	1682	-31.99825298	115.545968	9:43	2	JB	20% Amphibolis, 80% Posidonia sinuosa		Posidonia dominated
T10H	1683	-31.99918396	115.545924	9:46	1.6	RM	20% sand, 80% Posidonia sinuosa		Posidonia dominated
T9A	1684	-32.00110199	115.548084	9:50	1.7	RM	20% sand, 30% wrack, 30% Posidonia australis, 20% brown algae (likely Sargassum)		Mixed algae / seagrass
T9B	1685	-31.99997404	115.547952	9:54	2.3	RM	50% Posidonia australis/sinuosa, 20% Amphibolis, 20% sand, 10% brown algae	Photo reassessed. In field estimation: 30% Posidonia australis/sinuosa, 20% Amphibolis, 30% sand, 20% brown algae	Mixed seagrass
T9C	1686	-31.99919502	115.547946	9:57	2.6	RM	98% sand, 2% wrack		Sand
T9D	1687	-31.99837402	115.547992	9:59	2.7	RM	100% Posidonia sinuosa		Posidonia dominated
T9E	1688	-31.99729401	115.547939	10:01	2.5	JB	100% Posidonia sinuosa		Posidonia dominated
T9F	1689	-31.99639899	115.547983	10:03	2.8	JB	100% Posidonia sinuosa	Near reef	Posidonia dominated
T9G	1690	-31.99549701	115.548096	10:07	3.8	JB	100% Posidonia sinuosa	Only 2 photos	Posidonia dominated
T9H	1691	-31.99456402	115.547953	10:11	4.3	JB	100% sand		Sand
T9I	1692	-31.99370404	115.548152	10:12	4.4	RM	100% sand		Sand
T9J	1693	-31.99290097	115.548021	10:13	3	JB	100% sand		Sand
T1J	1694	-31.99289502	115.549179	10:15	3.3	RM	100% sand		Sand

T1I	1695	-31.99366297	115.548982	10:17	4.7	JB	100% sand		Sand
T1H	1696	-31.99489502	115.549022	10:20	4.1	JB	70% Posidonia sinuosa/australis, 30% brown algae		Posidonia dominated
T1G	1697	-31.995581	115.549095	10:23	4.1	JB	100% Posidonia sinuosa		Posidonia dominated
S02	1698	-31.99614996	115.549387	10:25	4	RM	50% Posidonia sinuosa/australis, 50% limestone	Photo may show 100% Posidonia ** edge of habitat** have marked as limestone to pick up that reef area.	Limestone reef / pavement
A06	1699	-31.99616999	115.547395	10:29	2.8	JB	100% Posidonia sinuosa		Posidonia dominated
Extra	1700	-31.99621802	115.547378			RM	100% Sargassum on limestone reef		Macroalgae dominated
T1F	1701	-31.99653997	115.549226	10:32	3.7	RM	100% Posidonia sinuosa		Posidonia dominated
T1E	1702	-31.99743398	115.549022	10:35	2.6	RM	95% Posidonia sinuosa, 5% brown algae		Posidonia dominated
T1D	1703	-31.99828601	115.549036	10:36	2.6	JB	90% Posidonia sinuosa, 10% Amphibolis		Posidonia dominated
T1B	1704	-31.99930298	115.549127	10:40	2.7	RM	100% Posidonia sinuosa		Posidonia dominated
T1A	1705	-32.00083603	115.548879	10:42	2.2	JB	100% Posidonia sinuosa		Posidonia dominated
A19	1706	-32.00077099	115.551096	10:46	3.6	RM	95% Posidonia sinuosa, 5% Amphibolis		Posidonia dominated
A20	1707	-32.00070502	115.550068	10:49	2.6	RM	5% Amphibolis, 95% Posidonia sinuosa	Wrack present around sand edges	Posidonia dominated
A21	1708	-32.00098397	115.549743	10:52	3.3	RM	95% brown algae (80% Sargassum, 15% Ecklonia), 5% Posidonia sinuosa		Macroalgae dominated

A22	1709	-32.00105899	115.549419	10:55	2.6	RM	50% sand, 40% Posidonia australis, 10% wrack		Sand with seagrass
A26	1710	-32.00162301	115.550139	10:58	1.2	RM	100% wrack	Mix seagrass and brown algae **sand under wrack**	Sand with wrack
A25	1711	-32.001665	115.550635	11:00	1.5	JB	90% Posidonia sinuosa, 10% Amphibolis		Posidonia dominated
A24	1712	-32.00133802	115.550678	11:03	2.5	RM	100% Posidonia sinuosa		Posidonia dominated
A27	1713	-32.001967	115.551334	11:05	1.9	JB	100% Posidonia sinuosa		Posidonia dominated
Extra	1714	-32.00201503	115.551429			RM	50% wrack, 50% sand		Sand with wrack
A23	1715	-32.00120299	115.551755	11:09	3.1	JB	80% Posidonia sinuosa, 20% mixed algae		Posidonia dominated
T2J	1716	-32.00099302	115.550099	11:20	2	RM	100% Posidonia sinuosa		Posidonia dominated
T2I	1717	-32.00017797	115.550109	11:23	2.7	RM	100% Posidonia sinuosa		Posidonia dominated
T2H	1718	-31.99919703	115.550157	11:25	2.9	RM	100% Posidonia sinuosa		Posidonia dominated
T2G	1719	-31.99825298	115.550154	11:26	2.7	JB	60% Posidonia sinuosa, 30% Amphibolis, 10% brown algae		Mixed seagrass
T2F	1720	-31.99748998	115.550132	11:30	4	RM	90% Posidonia sinuosa, 10% Amphibolis		Posidonia dominated
T2E	1721	-31.996458	115.55018	11:30	4.7	RM	20% Halophila ovalis, 10% Posidonia sinuosa, 10% mixed seagrass, 30% wrack, 30% sand		Sand with seagrass
T2D	1722	-31.99550296	115.550072	11:38	3.9	RM	80% Posidonia sinuosa, 20% Amphibolis	Camera changed - GoPro 3	Posidonia dominated

A04	1723	-31.99508102	115.549986	11:41	3.8	RM	90% Posidonia sinuosa/australis, 5% Amphibolis, 5% mixed seagrass		Posidonia dominated
T2C	1724	-31.99462102	115.550255	11:43	5.3	RM	100% sand	Individual shoots of Posidonia	Sand
T2B	1725	-31.99377897	115.55031	11:46	5	RM	80% sand, 15% wrack, 5% Halophila ovalis		Sand
T2A	1726	-31.99285696	115.550124	11:48	3.4	RM	80% sand, 20% Sargassum	Mostly bare sediment with algae patch	Sand
T3J	1727	-31.99394301	115.551103	11:51	5.4	RM	80% Halophila ovalis, 20% brown algae	Posidonia wrack floating around photo not useful. Sand with seagrass due to Halophila morphology	Halophila dominated
A02	1728	-31.99426504	115.550633	11:54	4.7	RM	60% Posidonia sinuosa, 40% Amphibolis		Mixed seagrass
T3I	1729	-31.99472898	115.551097	11:57	4.9	JB	90% Posidonia sinuosa, 10% Amphibolis		Posidonia dominated
A05	1730	-31.99550003	115.550789	11:59	3.5	JB	90% mixed seagrass, 10% sand		Mixed seagrass
T3H	1731	-31.99561704	115.551089	12:01	4.6	JB	40% sand, 40% Posidonia sinuosa, 10% Halophila ovalis, 10% mixed seagrass		Sand with seagrass
T3G	1732	-31.99665103	115.551255	12:05	3.4	JB	90% Posidonia sinuosa, 10% Amphibolis		Posidonia dominated
T3F	1733	-31.99753398	115.551133	12:07	3.3	JB	80% Posidonia sinuosa, 20% Amphibolis		Posidonia dominated
T3E	1734	-31.99835298	115.551099	12:09	2.9	JB	100% Posidonia sinuosa		Posidonia dominated
T3D	1735	-31.99924104	115.551212	12:11	3.6	JB	100% Posidonia sinuosa		Posidonia dominated
T3C	1736	-32.00014201	115.551075	12:13	3.4	JB	95% Posidonia sinuosa, 5% sand	Slight drift for photo	Posidonia dominated

	1737	-32.00017897	115.551114					Additional waypoint taken at T3C - unnecessary can ignore	
T3B	1738	-32.00108003	115.551078	12:23	3.1	JB	70% Posidonia sinuosa, 30% Posidonia australis	Bare sand next to meadow with wrack. Australis on edge of meadow.	Posidonia dominated
T3A	1739	-32.00205401	115.551278	12:27	1.8	RM	70% sand, 30% wrack		Sand with wrack
T11B	1740	-31.99739199	115.543782	12:34	1.5	RM	80% Amphibolis, 20% sand	Bits of wrack throughout	Amphibolis dominated
T11A	1741	-31.998299	115.5438	12:37	0.8	RM	100% Posidonia sinuosa		Posidonia dominated
T8A	1742	-31.99304497	115.56054	13:45	6.2	RM	20% Posidonia, 10% sand, 70% brown algae		Macroalgae dominated
T8B	1743	-31.99384603	115.560744	13:48	6.4	RM	70% brown algae, 20% Posidonia, 10% sand		Macroalgae dominated
T8C	1744	-31.99496602	115.56083	13:50	6.2	RM	100% Posidonia sinuosa		Posidonia dominated
T8D	1745	-31.99577697	115.56072	13:51	8.2	RM	80% sand, 20% Posidonia	Patches of Posidonia wrack	Sand with seagrass
T8E	1746	-31.99669898	115.560799	13:53	9.1	RM	10% wrack, 90% sand		Sand
T8F	1747	-31.99759802	115.560664	13:54	9.6	RM	10% Posidonia, 20% Posidonia wrack, 70% sand		Sand
T8G	1748	-31.99836899	115.56046	13:57	5.9	RM	80% Sargassum, 10% Posidonia sinuosa, 10% sand		Macroalgae dominated
A13	1749	-31.99931304	115.559995	13:59	4.6	RM	40% Sargassum, 20% Ecklonia, 40% wrack		Macroalgae dominated
S20	1750	-32.000025	115.561038	14:02	2.2	RM	100% Amphibolis		Amphibolis dominated

T8H	1751	-32.00019297	115.560629	14:04	3.1	RM	100% sand		Sand
T8I	1752	-32.00119603	115.560857	14:06	5.8	RM	10% sand, 70% brown algae, 20% Posidonia	Edge of Posidonia meadow	Macroalgae dominated
T8J	1753	-32.00191604	115.560858	14:08	2.4	RM	100% Posidonia		Posidonia dominated
T7A	1754	-32.00203104	115.55838	14:10	3.9	RM	60% brown algae (5% is Ecklonia), 40% Posidonia wrack	Edge of Posidonia meadow	Macroalgae dominated
T7B	1755	-32.00094701	115.558457	14:12	3.8	RM	50% Posidonia sinuosa, 30% wrack, 20% brown algae		Mixed algae / seagrass
T7C	1756	-32.00017604	115.558462	14:13	3.8	RM	90% Posidonia, 5% sand, 5% brown algae		Posidonia dominated
A15	1757	-31.99960599	115.559334	14:15	4	RM	10% Sargassum on limestone, 40% Posidonia, 50% brown algae (50% Ecklonia, 50% Sargassum)		Mixed algae / seagrass
T7D	1758	-31.99940398	115.55856	14:19	4.7	RM	30% Amphibolis, 20% Posidonia, 50% sand with wrack		Sand with seagrass
S19	1759	-31.99899402	115.558731	14:21	4.9	RM	100% Posidonia sinuosa		Posidonia dominated
T7E	1760	-31.998185	115.558541	14:23	6.6	RM	100% sand	Posidonia wrack outside quadrat	Sand
T7F	1761	-31.99740901	115.558648	14:24	7.3	RM	50% sand, 50% wrack (Posidonia and Ecklonia)		Sand with wrack
T7G	1762	-31.99649496	115.558428	14:26	6.3	RM	90% sand, 10% Halophila ovalis		Sand
T7H	1763	-31.99543096	115.558657	14:28	7	RM	100% Sargassum		Macroalgae dominated
T7I	1764	-31.99466896	115.558607	14:29	5.3	RM	100% Posidonia	Edge of meadow	Posidonia dominated

T7J	1765	-31.99370404	115.558555	14:31	4.4	RM	100% Posidonia		Posidonia dominated
T7K	1766	-31.99278496	115.558722	14:32	3.8	RM	70% Sargassum, 20% sand, 10% Posidonia		Macroalgae dominated
T6A	1767	-31.99294103	115.556474	14:35	2.7	RM	80% Sargassum, 10% limestone, 10% sand		Macroalgae dominated
T6B	1768	-31.99386296	115.556619	14:37	3.4	RM	100% Posidonia sinuosa		Posidonia dominated
A01	1769	-31.99428096	115.555559	14:39	2.3	RM	10% Posidonia, 70% Sargassum, 20% sand		Macroalgae dominated
T6C	1770	-31.99472596	115.556583	14:40	3.9	RM	100% Amphibolis	Posidonia wrack accumulated around Amphibolis meadow	Amphibolis dominated
T6D	1771	-31.995754	115.556711	14:42	4.5	RM	50% Posidonia, 50% sand with wrack		Sand with seagrass
A08	1772	-31.99618701	115.555212	14:45	4	RM	80% Posidonia, 20% Amphibolis	Not much wrack accumulated at edge of meadow	Posidonia dominated
A09	1773	-31.99688103	115.555194	14:46	4.7	RM	80% Posidonia, 20% Sargassum		Posidonia dominated
T6E	1774	-31.99662002	115.556488	14:48	4.3	RM	95% Posidonia sinuosa, 5% Amphibolis		Posidonia dominated
A10	1775	-31.99740498	115.555229	14:50	5	RM	100% sand		Sand
T6F	1776	-31.99754404	115.556483	14:52	4.7	RM	95% Sargassum, 5% Posidonia		Macroalgae dominated
A11	1777	-31.99844903	115.557278	14:54	8.3	RM	100% sand	Minor bits of Ecklonia and Posidonia wrack	Sand
A12	1778	-31.99881096	115.555377	14:57	5.9	RM	100% Posidonia	Edge of meadow - Posidonia wrack around edge of meadow	Posidonia dominated

T6G	1779	-31.99842598	115.556438	14:59	7.4	RM	100% Posidonia	Edge of meadow - minimal wrack	Posidonia dominated
T6H	1780	-31.999406	115.556746	15:02	3.9	RM	80% Sargassum, 10% Posidonia, 10% sand		Macroalgae dominated
S16	1781	-31.99968201	115.557738	15:04	4.1	RM	80% Sargassum, 20% Posidonia		Macroalgae dominated
A16	1782	-31.99959601	115.557681	15:05	2.9	RM	80% Sargassum on limestone reef, 20% limestone	Corals present	Macroalgae dominated
T6I	1783	-32.00028903	115.556549	15:08	3.9	RM	100% Posidonia		Posidonia dominated
A17	1784	-32.00080703	115.556935	15:10	3.7	RM	60% Posidonia, 30% brown algae, 10% sand	Some wrack	Mixed algae / seagrass
T6J	1785	-32.00108497	115.556239	15:13	3.9	RM	100% Posidonia		Posidonia dominated
A18	1786	-32.00161697	115.557645	15:15	3.8	RM	70% brown algae, 30% sand	Patchy	Macroalgae dominated
S17	1787	-32.00156702	115.557051	15:17	3.4	RM	70% Posidonia, 20% Sargassum, 10% sand		Posidonia dominated
T6K	1788	-32.00197203	115.556517	15:19	2.8	RM	100% Posidonia		Posidonia dominated
Extra	1789	-32.00224604	115.556578	15:20	2.8	RM	100% wrack - Posidonia & Ecklonia		Sand with wrack
A28	1790	-32.00238903	115.55385	15:24	3.2	RM	90% Posidonia australis, 10% Amphibolis	Sandy edge has Posidonia wrack	Posidonia dominated
S11	1791	-32.00203196	115.553163	15:26	2.7	RM	90% wrack (Posidonia & Ecklonia), 10% sand		Sand with wrack
T5A	1792	-32.00204101	115.554239	15:28	2.5	RM	100% Posidonia		Posidonia dominated

T5B	1793	-32.00109403	115.55448	15:29	3.5	RM	100% Posidonia		Posidonia dominated
T5C	1794	-32.00026799	115.554453	15:32	3.9	RM	100% Posidonia		Posidonia dominated
T5D	1795	-31.99929401	115.554263	15:33	3.6	RM	70% Posidonia, 30% Amphibolis		Posidonia dominated
T5E	1796	-31.998329	115.553854	15:35	4.1	RM	60% Posidonia, 40% sand with Posidonia wrack		Sand with seagrass
T5F	1797	-31.997495	115.554083	15:36	5.8	RM	100% sand	Around Posidonia meadow is Posidonia wrack	Sand
T5G	1798	-31.99653796	115.55435	15:37	4.9	RM	95% sand, 5% Posidonia	No wrack	Sand
S12	1799	-31.99610302	115.554135	15:39	3.1	RM	95% Posidonia, 5% Amphibolis		Posidonia dominated
T5H	1800	-31.99551797	115.554389	15:40	3.1	RM	100% sand		Sand
Extra	1801	-31.99543197	115.554649				100% Posidonia	No wrack on edge	Posidonia dominated
T5I	1802	-31.99488798	115.554422	15:41	2.3	RM	90% Amphibolis, 10% sand with minor Amphibolis wrack		Amphibolis dominated
S13	1803	-31.99447601	115.554359	15:43	2.3	RM	90% Posidonia, 10% Amphibolis		Posidonia dominated
T5J	1804	-31.99373798	115.554572	15:44	3.2	RM	100% Posidonia		Posidonia dominated
T5K	1805	-31.99307003	115.554314	15:45	3.9	RM	100% Posidonia	No wrack on edge of meadow	Posidonia dominated
S14	1806	-31.99278203	115.554286	15:47	3.6	RM	80% Amphibolis, 10% sand, 10% Sargassum		Amphibolis dominated

S09	1807	-31.99279502	115.55249	15:49	3.9	RM	40% limestone reef, 40% sand, 20% brown algae		Limestone reef / pavement
T4A	1808	-31.99296199	115.552423	15:51	3.2	RM	20% Amphobolis, 80% rubble with brown turf algae	Rubble is limestone reef	Limestone reef / pavement
T4B	1809	-31.99379297	115.552165	15:52	4.1	RM	50% Amphibolis, 40% brown algae, 10% sand		Mixed algae / seagrass
S10	1810	-31.994143	115.552313	15:53	4	RM	70% Posidonia, 30% Amphibolis		Posidonia dominated
T4C	1811	-31.99488899	115.552197	15:55	4	RM	50% Posidonia, 30% sand, 20% brown algae		Sand with seagrass
A3	1812	-31.99511496	115.553358	15:57	3.9	RM	100% sand with brown turf algae & wrack	100% Posidonia surrounding	Sand
T4D	1813	-31.995552	115.552314	15:59	4.8	RM	100% sand		Sand
A7	1814	-31.99601199	115.55177	16:01	3.2	RM	90% Posidonia, 10% Amphibolis		Posidonia dominated
T4E	1815	-31.99665296	115.552304	16:02	3.2	RM	100% Posidonia		Posidonia dominated
T4F	1816	-31.99743298	115.552387	16:03	3.4	RM	100% Posidonia		Posidonia dominated
T4G	1817	-31.99839296	115.552139	16:05	3.2	RM	80% Amphibolis, 20% Posidonia		Amphibolis dominated
T4H	1818	-31.99915898	115.552314	16:06	4	RM	90% Posidonia, 10% Amphibolis		Posidonia dominated
T4I	1819	-32.00017302	115.552504	16:08	5	RM	90% sand, 10% Posidonia wrack		Sand
T4J	1820	-32.00095103	115.5523	16:09	5.8	RM	100% Posidonia meadow	Minor Posidonia wrack on edge; photo shows edge	Posidonia dominated

T4K	1821	-32.00177698	115.552292	16:11	3	RM	100% wrack (Posidonia & Ecklonia)		Sand with wrack
Extra	1822	-32.00210698	115.552384	16:12	3	RM	80% Amphibolis, 20% Posidonia	Surrounded by Posidonia wrack	Amphibolis dominated
Extra	1823	-32.00211201	115.552172	16:15	2	RM	100% Amphibolis meadow onto sand	Patches of Posidonia	Amphibolis dominated
Extra	1824	-32.00186298	115.550902	16:17	1.5	RM	100% wrack (Posidonia & Sargassum)		Sand with wrack

Definitions: JB = James Brightmore, RM = Rosh McCallum, QAQC = Quality assurance and quality control

Appendix Table 3: Field survey data 29th January 2024 (Main Jetty Survey Area with several sites also in the FSA)

Site ID	Wpt	Lat	Long	Time	Depth (m)	Observer	Benthic Habitat Description	Notes	Classification
S01	1825	-31.99263501	115.54257402	9:15	0.8	JB/RM	100% Posidonia australis	Snorkel QA/QC. Halophila ovalis & zostera present, Posidonia wrack accumulated in sandy gaps	Posidonia dominated
S03	1826	-31.99304002	115.54312999	9:30	1.2	JB/RM	100% Posidonia (95% sinuosa, 5% australis)	QA/QC	Posidonia dominated
S05	1827	-31.99386296	115.54242197	9:35	0.8	JB/RM	100% Posidonia sinuosa	QA/QC. Posidonia wrack accumulated in the patches	Posidonia dominated
S07	1828	-31.99466896	115.54311901	9:37	1.3	JB/RM	100% Posidonia sinuosa	QA/QC	Posidonia dominated
S09	1829	-31.99530104	115.54306897	9:39	1	JB/RM	100% Posidonia (10% australis, 90% sinuosa)	QA/QC. High level of epiphytes	Posidonia dominated
S08	1830	-31.99527204	115.54238702	9:42	0.7	JB/RM	100% sand	Wrack accumulation along edge of sand patch	Sand
S10	1831	-31.99576297	115.54291299	9:47	4.9	JB/RM	Probable 100% sand (visibility low)		Sand
Extra01	1832	-31.99623001	115.54287904	9:49	1.6	JB/RM	100% Posidonia wrack with sand patches		Sand with wrack
S12	1833	-31.99637401	115.543376	9:52	2.3	JB/RM	50% sand, 50% wrack		Sand with wrack
S14	1834	-31.99690299	115.54310996	9:55	1.1	JB/RM	100% Posidonia sinuosa	Small sand patches	Posidonia dominated
Extra02	1835	-31.99682596	115.54302304	9:57	1.1	JB/RM	80% Posidonia mix, 20% sand	Sand patch, drifting along patchy bits	Posidonia dominated
S16	1837	-31.99792801	115.54307501	10:00	0.8	JB/RM	90% Posidonia australis, 10% brown algae (brown algae may be epiphytes)	High level of epiphytes	Posidonia dominated
S17	1838	-31.99797596	115.54331699	10:02	0.6	JB/RM	100% Posidonia australis, with epiphytes	Boundary appears living seagrass from distance	Posidonia dominated
DA01	1839, 1840	-32.00092999	115.54994004	10:09	2.8	JB/RM	40% mixed algae, 40% wrack, 20% Posidonia	Development area site	Mixed algae / seagrass
DA02	1841, 1842	-32.00111004	115.54982001	10:14	2.6	JB/RM	10% brown algae, 10% Posidonia, 80% wrack	Development area site	Sand with wrack

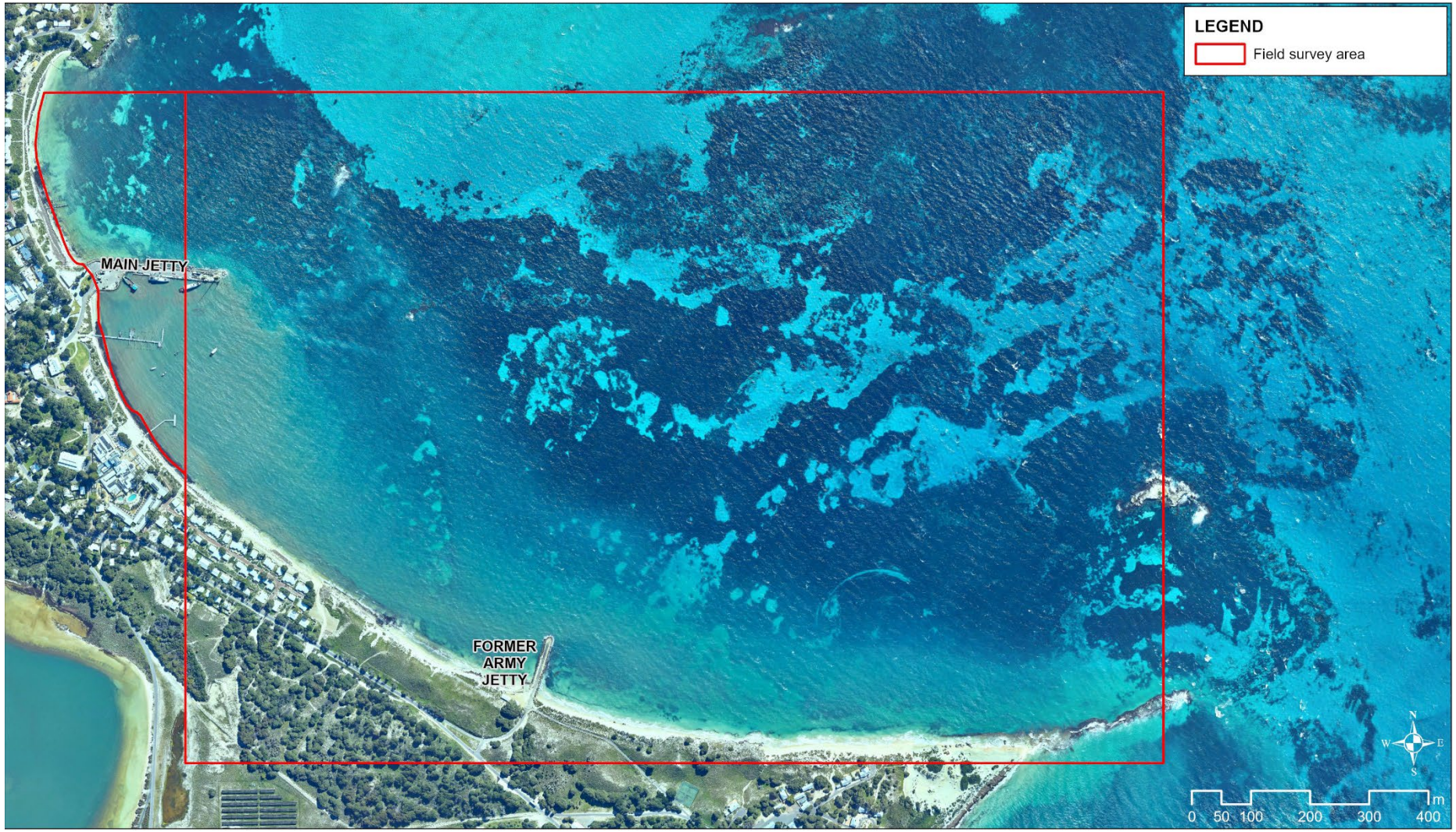
DA03	1844	-32.00143098	115.55014498	10:19	1.4	JB/RM	10% brown algae, 90% Posidoinia (90% sinuosa, 10% australis)	Development area site. Lots of wrack on nearby beach	Posidonia dominated
Extra03	1845	-32.00124197	115.55022301	10:22	1.9	JB/RM	100% sand	Wrack accumulated along edges	Sand
Extra04	1846	-31.99430301	115.54259196	10:32	0.8	JB/RM	Sand patch with Posidonia wrack around edges. Meadow is Posidonia australis		Sand
Extra05	1847	-31.99391199	115.54279304	10:36	1.9	JB/RM	Sand patch with Posidonia wrack on edges, 20% wrack in sand patches, 2% Halophila ovalis		Sand
Extra06	1848	-31.99321504	115.54243002	10:41	1.3	JB/RM	100% sand, 5% wrack (95% sand with 5% wrack)	Edges 50% wrack, 50% Posidonia australis	Sand
Extra07	1849	-31.99629002	115.54266103	10:46	1.4	JB/RM	100% sand	Posidonia australis meadow with wrack accumulated at edge	Sand
S02	1850	-31.99283802	115.54129503		1	RM	100% wrack	First wading/snorkelling site. All wrack on way out. Wrack on top of sparse meadow. 26th Jan = very low tide that likely exposed shallow sites - RIA.	Sand with wrack
Extra08	1851	-31.99286501	115.54155403		0.2 - 1	RM	100% Posidonia, small patches of Halophila	Wpt 1851 = boundary of seagrass	Posidonia dominated
S04	1852	-31.99367596	115.54132998		1	RM	100% wrack		Sand with wrack
Extra09	1853	-31.99360496	115.541491		1	RM	100% Posidonia, lots of epiphytes	Wpt 1852 = boundary of seagrass	Posidonia dominated
S06	1854	-31.99452999	115.54166199		1-1.5	RM	50% Posidonia australis, 50% sand		Sand with seagrass
Extra10	1855	-31.99462504	115.54158202		1-1.5	RM	100% Posidonia australis		Posidonia dominated
Extra11	1856	-31.99491204	115.54153098		1	RM	100% Posidonia australis	Surrounded by 100% wrack all around	Posidonia dominated
Extra12	1857	-31.99496099	115.54153299		1	RM	100% wrack		Sand with wrack
Extra13	1858	-31.99486099	115.54152402		1	RM	100% wrack		Sand with wrack
S11	1859	-31.99606497	115.54225802		1	RM	100% Posidonia australis, mixed with wrack	Green seagrass underneath wrack	Posidonia dominated

Extra14	1860	-31.99632296	115.54223296		1	RM	50% Posidonia australis, 50% sand	Edge of meadow	Sand with seagrass
S15	1861	-31.997193	115.54246296		1	RM	100% sand		Sand
Extra15	1862	-31.99713903	115.54260101		1	RM	100% Posidonia australis	Edge of meadow	Posidonia dominated
S13	1863	-31.99684599	115.54251602		1.5	RM	10% Posidonia australis, 10% sand, 80% wrack		Sand with wrack
Extra16	1864	-31.99677902	115.542354	12:15 (end)	0.8	RM	70% Posidonia (mixed), 30% sand	Edge of meadow	Posidonia dominated

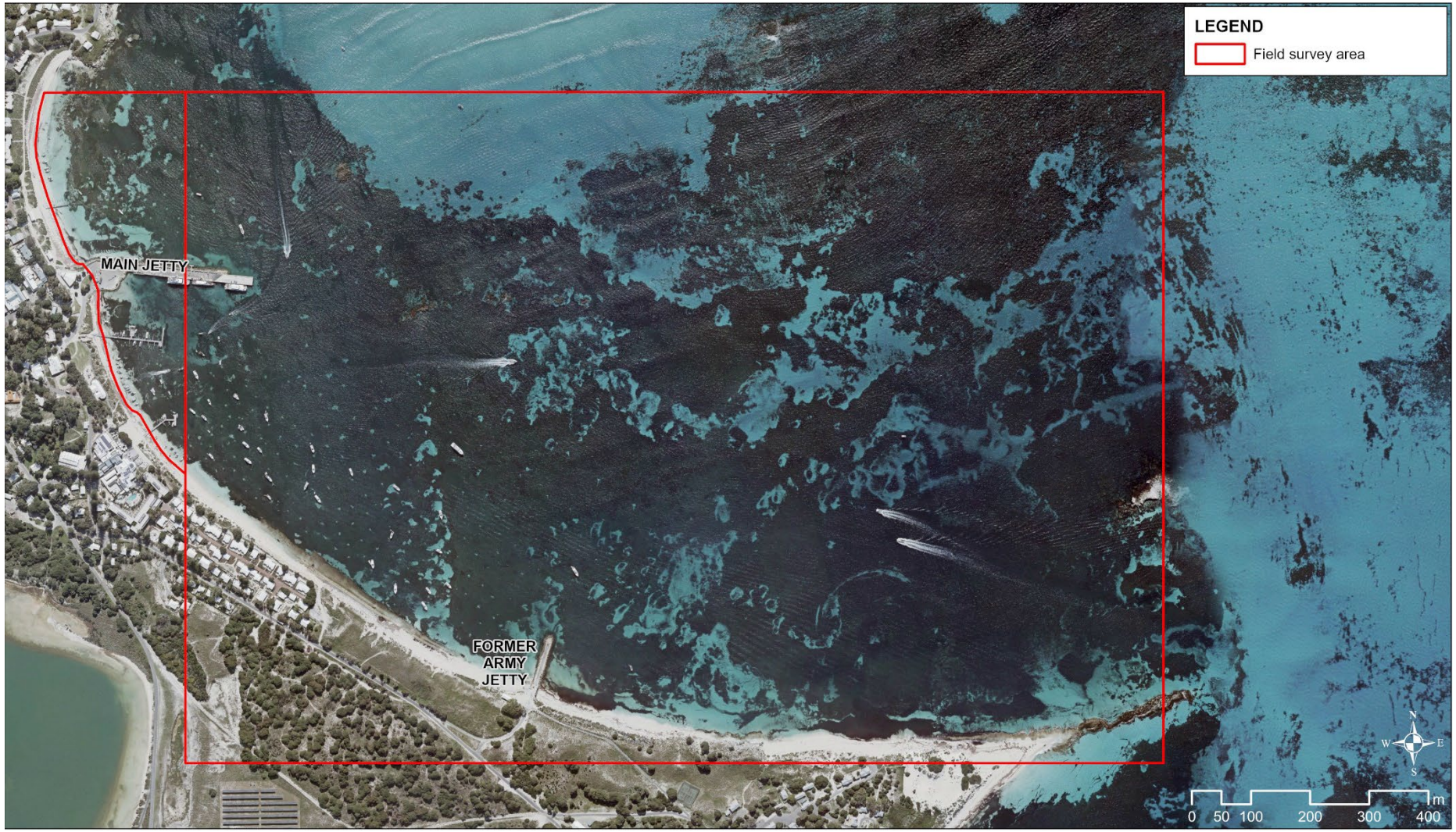
Definitions: JB = James Brightmore, RM = Rosh McCallum, QAQC = Quality assurance and quality control

Appendix D
Thomson Bay aerial images

Appendix Figure 3: Thomson Bay aerial image, February 2023 (source: Landgate)



Appendix Figure 4: Thomson Bay aerial image, August 2022 (source: Landgate)



Appendix Figure 5: Thomson Bay aerial image, August 2023 (source: Landgate)

REPORT

Appendix C
Benthic habitat assessment: Plume extension survey area, South Thomson Barge Landing Development (RPS 2024b)

SOUTH THOMSON BARGE LANDING DEVELOPMENT

Benthic habitat assessment: Plume Extension Survey Area

The Plume Extension Survey Area (PESA) represents the 2.54 hectare (ha) area southeast of the Thomson Bay Field Survey Area (FSA) and within the eastern extent of the dredge plume modelling Zone of Influence (maximum predicted extent of visible plumes; ZoI) (Figure 1, Figure 2). A benthic habitat map of the PESA was developed for assessing the estimated impacts of planned dredging activities in the development area of the FSA.

Methods

Habitat mapping was undertaken using methods described in the South Thomson Barge Landing Development: Marine Fauna and Benthic Habitat Assessment (RPS, 2024). Esri's ArcGIS Pro was used to create a digitised image in vector shapefile format, using select Landgate Web Map Service aerial photographs. The February 2023 image (summer; Figure 3) was used as the base-map to maintain consistency with the habitat map developed for the FSA. The August 2023 image (winter; Figure 4) was used as the reference image, which provided a clear comparison against the base-map for identifying areas of wrack that are not present year-round (i.e., areas of dark seabed not shared between the two images), so that these could be removed from the habitat map. Note that isolated areas of habitat less than a few metres in diameter were generally too small for effective digitisation and mapping; however, this is not expected to have a meaningful effect on the results.

The RIA visually surveyed the benthic habitat at six sites within the 2.54 ha PESA on 22 March 2024 (Figure 1, Figure 2). Five sites were assessed over the darker areas of habitat observed in the aerial images, and one site over the lighter area of habitat. For the purposes of developing the habitat map, benthic habitat data obtained from the RIA survey are assumed to be commensurate with the species identifications and dominance-based method used by RPS in the FSA (RPS, 2024).

Benthic habitat was then classified into categories based on the dominant habitat type observed in the aerial images and confirmed via ground truth survey data (Table 1). Habitat classifications may be limited by aerial image clarity and habitat complexity (e.g., mixing of wrack with living seagrass). Darker areas of habitat shared between the aerial images that have confirmed seagrass dominated habitat at RIA survey sites are classified as "mixed seagrass". Based on similar habitat in the FSA, habitats in this category are likely comprised of *Posidonia*, *Amphibolis*, and *Halophila* seagrass species, but may also include macroalgae and sand. As such, the area of seagrass may be overestimated. This classification of the non-sand habitat as "mixed seagrass" provides a conservative estimate of the dredge plume impact on seagrass habitat in the PESA.

Table 1: Classification scheme used in the analysis of benthic habitat in the PESA

Benthic habitat class	Description
Sand / Sand with wrack[1]	Sand dominated (majority bare sand) and/or wrack
Mixed seagrass[1]	Seagrass dominated (majority seagrass species)
Limestone reef / pavement[2]	Limestone reef or platform with minor attached seagrass/macroalgae

[1]Identified by aerial image classification and RIA ground-truth data

[2]Identified by aerial image classification only

Results

Six sites were surveyed by the RIA on 22 March 2024 for the development of the benthic habitat map. Five sites were identified as *Posidonia sinuosa* dominated, and one site as sand (Figure 1, Figure 2).

"Sand/Sand with wrack" dominated 50 % of the PESA (1.27 ha), while "mixed seagrass" and "limestone reef/pavement" covered 36.22 % (0.92 ha) and 13.78 % (0.35 ha) of the PESA, respectively (Table 2, Figure 1, Figure 2). Mixed seagrass dominated the central area of the PESA,

surrounded by sand and wrack. RIA survey data confirmed the presence of living seagrass at sites along the edge of the mixed seagrass habitat. A significant amount of wrack was present to the east of the mixed seagrass, as shown by the markedly different shaded areas between the February and August aerial images (Figure 3, Figure 4). Closer to the FSA, limestone reef/pavement habitat extended from the shoreline to the north of the PESA. Patches of mixed seagrass covered the southern and eastern edges of the limestone reef/pavement habitat, with sand and wrack between the reef/pavement and the FSA.

Table 2: Area of benthic habitats within the PESA

Benthic habitat class	Area (hectares)	Percentage of PESA (%)
Sand / Sand with wrack[1]	1.27	50
Mixed seagrass[1]	0.92	36.22
Limestone reef / pavement[2]	0.35	13.78
Sum	**2.54**	**100**

[1]Identified by aerial image classification and RIA ground-truth data

[2]Identified by aerial image classification only

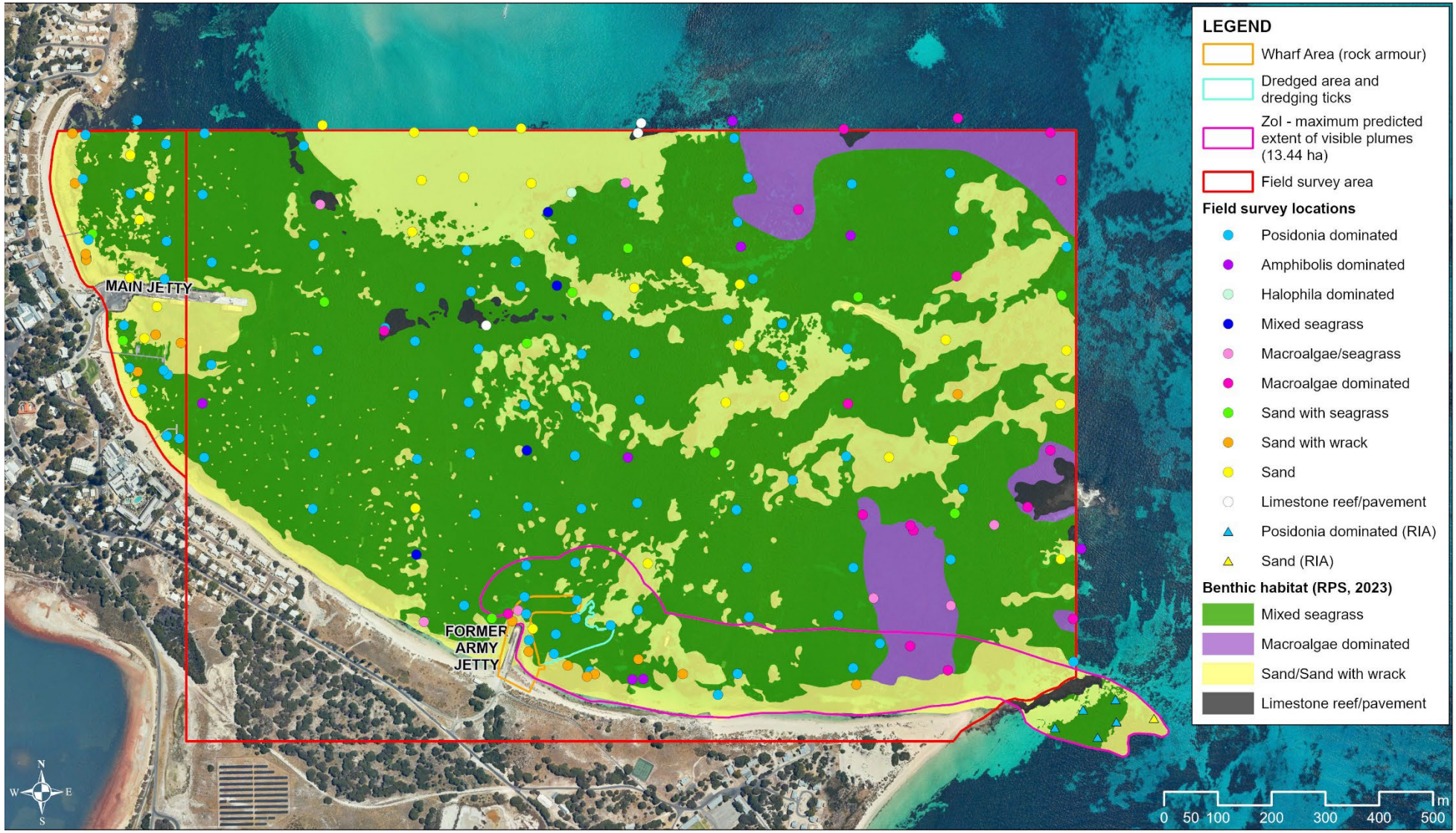


Figure 1: Benthic habitat map of the Field Survey Area, Main Jetty Survey Area, and Plume Extension Survey Area at Thomson Bay, Rottnest Island

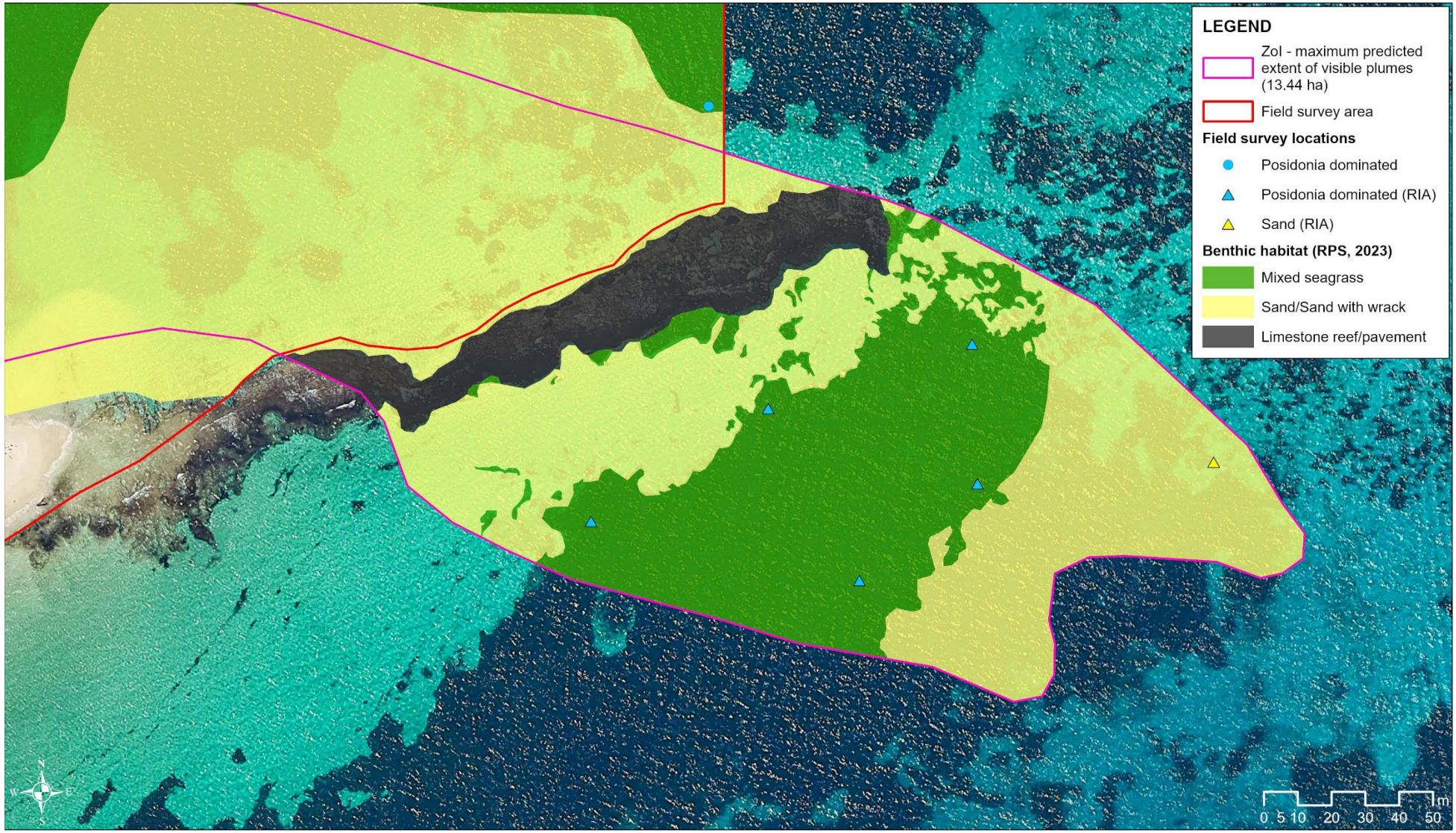


Figure 2: Benthic habitat map of the Plume Extension Survey Area at Thomson Bay, Rottnest Island

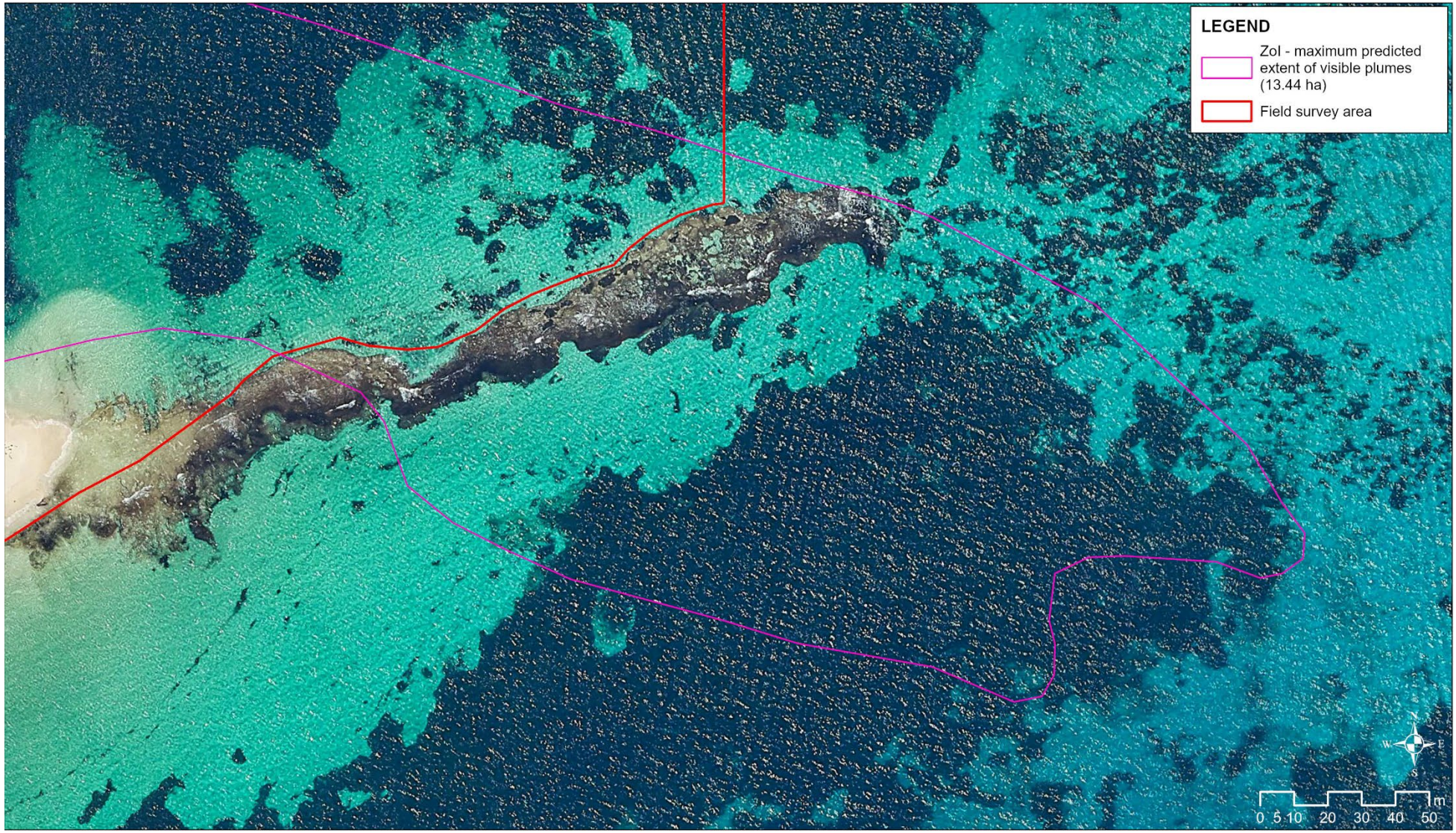


Figure 3: Aerial image of the Plume Extension Survey Area, Thomson Bay, February 2023 (source: Landgate)

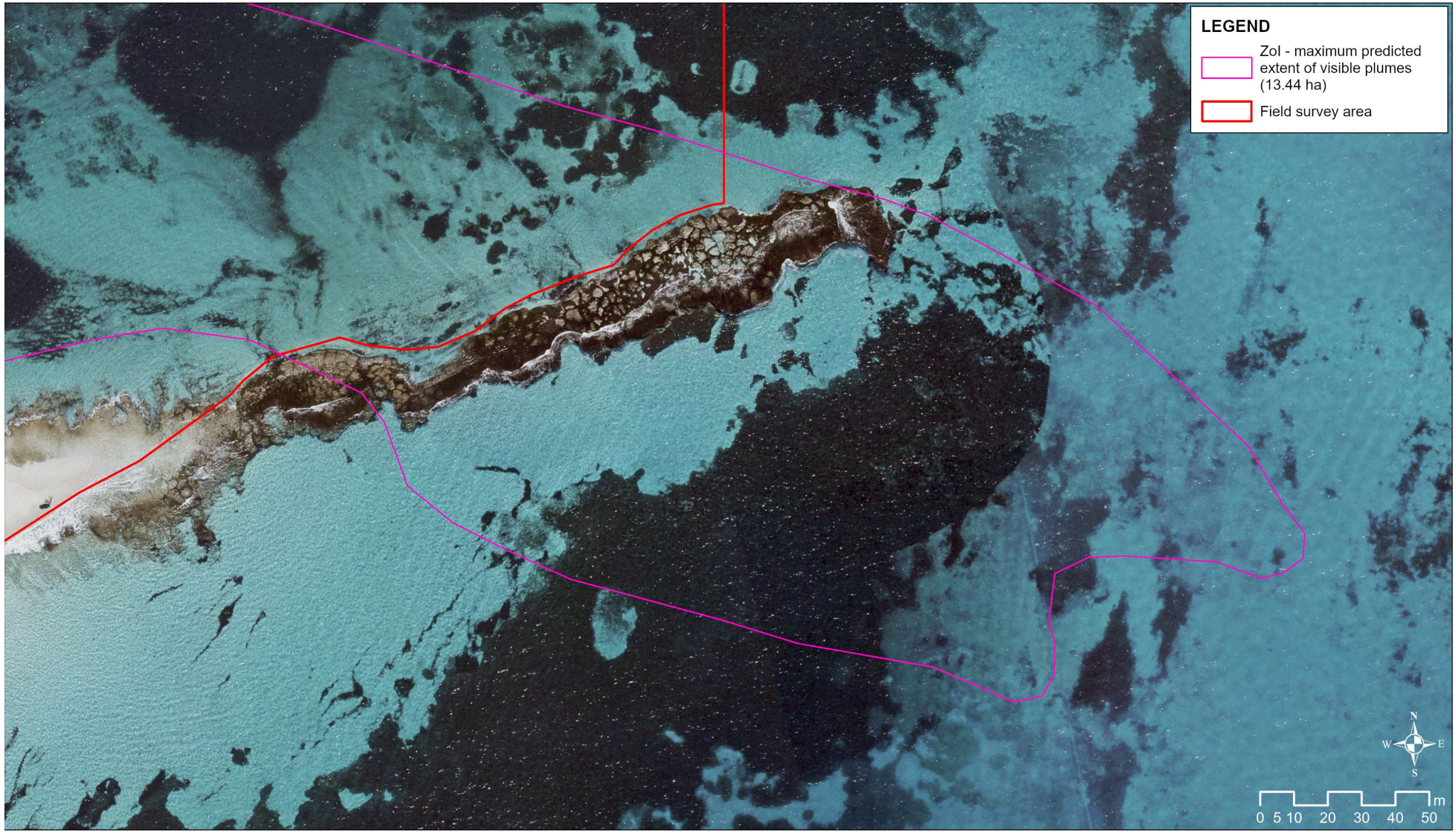


Figure 4: Aerial image of the Plume Extension Survey Area, Thomson Bay, August 2023 (source: Landgate)

References

RPS, 2024. South Thomson Barge Landing Development: Marine Fauna and Benthic Habitat Assessment. RPS AAP Consulting Pty Ltd.

Appendix D
South Thomson Bay Barge Development, Coastal Processes Assessment (Baird 2024)

South Thomson Bay Barge Development

Coastal Processes Assessment

14 February 2024 | 13029.101.R1.Rev1

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South Thomson Bay Barge Development

Coastal Processes Assessment

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Revision	Date	Status	Comments	Prepared	Reviewed	Approved
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Rev0	2/2/2024	Final	Issued Final	RW	JC	JC
Rev1	14/2/2024	Final	Issued following client comment	RW	JC	JC

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Executive Summary

We acknowledge the Traditional Custodians of this Island, the Whadjuk people of the Noongar Nation, their ancestors and their Elders past, present and emerging. We acknowledge and respect their continuing culture and the contribution they make to the life of this Island and this region.

Wadjemup (Rottnest Island) is an A-class nature reserve of ecological, cultural, and social significance, with the island currently supplied with bulk cargo via the roll-on-roll-off vessel which docks at the barge ramp located near the base of the Main Ferry Wharf. Following identification in the Rottnest Island Master Plan – 20 Year Vision (RIA 2019) of the need to improve the functionality and efficiency of transporting bulk cargo to and from Wadjemup, investigations and studies have been undertaken to determine a design and method to convert the former Army Jetty (currently Army Groyne) site in South Thomson Bay into a barge landing development to move these activities away from the Main Ferry Wharf site.

A range of concept designs have been formulated and investigated since, with the concept developed by AECOM in their Value Engineering of Concept Design reporting (AECOM 2020) to be assessed in this Coastal Processes Assessment report. Assessment has been made here of the impact of the proposed barge development on the coastal processes acting within South Thomson Bay, including wave conditions, sediment transport pathways, wrack dynamics and the impact of wave penetration within the proposed harbour basin of the barge development.

To assess the impacts of waves on the proposed South Thomson Bay Barge Development, review was undertaken of the modelling that was performed in MRA's 2019 coastal processes assessment, with further wave modelling undertaken for the option evaluated in this assessment subsequently carried out. Data from a four-year modelled hindcast was used to determine representative swell and sea conditions to be used in the comparison of wave climate with and without the proposed barge ramp structure at the Army Groyne. It was found that the difference in wave climate at the shoreline from that created by the existing Army Groyne structure can be expected to be minimal (<0.4m in each case, with the majority experiencing reductions of <0.15m), with the greatest influence seen in waves that approach the proposed site from the north.

The impact on wave conditions outside of the proposed barge facility breakwater structure is minimal, with decreases in wave height being the main observation across each of the cases. While no detrimental increase in wave height caused by reflections from the breakwater structure is seen at the moorings managed by RIA in these model results, further investigation of this should be undertaken in the detailed design phase using a wave phase resolving model, as a model of this kind is more suitable for investigating the complexity of reflected wave interactions.

An assessment of the sediment transport pathways that make up the sediment budget of the coastal compartment along South Thomson Bay is important for determining the impact that a coastal structure may have on these pathways, and therefore the overall function of this sediment compartment. Assessment was made of the cross-shore sediment transport pathways, the longshore sediment transport pathways, the aeolian sediment transport pathways, as well as the overall sediment budget expected when considering each of these pathways. Finally, an assessment of the impact of climate change on the sediment dynamics was carried out, along with the impact that the proposed barge development may have on the sediment dynamics of South Thomson Bay.

It is considered unlikely that the proposed barge development would have a significant impact on the sediment dynamics along South Thomson Bay as the existing Army Groyne has posed a barrier to sediment transport in this region since it's construction. It should be noted that there is presently the

potential for sediment to bypass the existing Army Groyne structure, so the extension of the proposed barge development offshore of the tip of the Army Groyne has the potential to trap more sediment than is being trapped presently. It should also be noted that, while the impacts to the wave climate along the shoreline in the vicinity of the proposed barge development are expected to be minimal, there is the potential for the sediment transport pathway that moves sediment away from the Army Groyne to be interrupted and for more sediment to build up in this area than does presently.

An assessment of the expected impacts of wrack accumulation on the proposed design layout was required to determine any negative effects that may be experienced through the interruption of regular wrack dynamics and movement along the beach in South Thomson Bay. It is considered that the proposed development of the South Thomson Barge Landing will not have a significant impact on the timing or volume of wrack accumulation across the beaches of Thomson Bay, further than the impact that the Army Groyne already has on the dynamics in South Thomson Bay. Despite this, the requirement to consider the impact the structures may have on the ability for wrack to be cleared from the structures following being trapped remains, as well as the consideration of the buildup of wrack within the footprint of the breakwater structure.

An assessment of wave penetration into the harbour basin has been undertaken based on the diffraction curves of Goda (2010). Waves approach the South Thomson Bay site from the north for approximately 50% of the year, and the analysis of diffracted wave conditions at the barge ramp indicate the barge landing location is well sheltered from swell wave conditions that arrive from the north. The breakwater reduces waves at the barge ramp by approximately 40%, with the diffracted swell wave arriving at the stern of the vessel. Wind sea waves arrive at the site from the northeast for approximately 30% of the year. The diffraction curves show the breakwater reduces these incident waves by approximately 30%, with waves arriving at the vessel stern. Wave conditions from the east represent a small proportion of the annual seastate (~2%). The configuration of the breakwater in the design layout does not provide protection from this direction and it is assumed these conditions would reach the barge ramp unchanged. The waves will approach the barge ramp approximately in line with the vessel stern at 0.44 to 0.5m significant wave height.

This analysis of wave penetration indicates the wave conditions are reduced by the structures for approach directions from the N and the NE which are the dominant wave conditions at the location. An understanding of the limiting conditions of the barge vessel would allow for further analysis of potential downtime at the barge ramp. The wave conditions at the landing are approximately in line with the barge ramp alignment, and it is expected that the vessel would manage these types of conditions when at the ramp. As the vessels manoeuvre into or away from the facility within the turning circle, the waves would be more ‘beam on’ to the barge (i.e., 90 degrees to the vessel) and this would be more problematic. This analysis does not consider reflection of waves from the structures or bi-modal seastates that can occur in the area during winter when swell waves from the north are coupled with sea waves from the east. Further assessment of these conditions as part of more detailed wave penetration modelling in the detailed design phase is recommended.

Table of Contents

1. Introduction 7

1.1 Study Site 7

1.2 Concept Designs 10

2. Local Setting 14

2.1 General Wave Climate 14

2.2 Bathymetry and Reefs 14

2.3 Local Datum 14

2.4 Measured Data Summary 1

2.5 Water Level 2

2.5.1 Tidal Planes 2

2.6 Wind Conditions 3

2.7 Wave Conditions 6

2.7.1 Rottnest Directional Wave Rider Dataset 6

2.7.2 Local ADCP Wave Measurements 9

2.8 Current Conditions 10

2.9 Shoreline Characteristics and Existing Coastal Structures 11

3. Wave Assessment 16

3.1 Wave Model Setup 16

3.1.1 Hindcast Model 16

3.1.2 Hindcast Model Analysis 17

3.1.3 High Resolution Model – South Thomson Bay 19

3.2 Impact of Facility on Wave Conditions 20

3.2.1 Impact on RIA Managed Moorings 28

4. Sediment Assessment 29

4.1 Sediment Transport Pathways 29

4.2 Cross-shore Sediment Transport 29

4.3 Longshore Sediment Transport 33

4.3.1 Historical Aerial Image Analysis 34

4.3.2 Shoreline Movement Plotting 37

4.4 Aeolian Sediment Transport 40

4.5 Sediment Budget 42

4.6 Impact of Climate Change on Sediment Dynamics 45

4.7 Impact of Proposed Facility on Sediment Dynamics 48

5. Wrack Accumulation 49

5.1 Wrack Generation and Transport 49

5.2 Historical Wrack Accumulation 51

5.3 Impact of Proposed Facility on Wrack Dynamics 55

6. Concept Design Review 57

6.1 Wave Penetration Assessment 57

6.2 Summary Recommendations 58

7. References 60

Appendix A Wave Model Validation Plots

Tables

Table 2.1: Measured Metocean Data from around Wadjemup and Thomson Bay 1

Table 2.2: Tidal Planes for Fremantle Boat Harbour (DoT 2016) and Thomson Bay (DoT 2011).....3

Table 2.3: Joint Frequency Table of measured wind speed and direction. Analysis of the Rottnest Island BOM0009193 station data 1983 - 2022.....3

Table 2.4: Joint Frequency Table of measured wave height and direction. Analysis of the Rottnest Island Directional Wave Rider Buoy Data 2004 - 2022 6

Table 2.5: Summary of Top 15 Events Measured by Hs from Measured Wave Record at Rottnest Directional Wave Rider Buoy (DWR).....7

Table 2.6: Joint Frequency Table of measured wave height and direction. Analysis of the Aquadopp and ADCP data collected between June 2020 and August 2021 (Water Technology 2021)..... 10

Table 2.7: Joint Frequency Table of measured wave height and wave period. Analysis of the Aquadopp and ADCP data collected between June 2020 and August 2021 (Water Technology 2021) 10

Table 3.1: Wave Height and Direction Joint Frequency Tables – 2017-2020 Hindcast Swell Conditions... 18

Table 3.2: Wave Height and Direction Joint Frequency Tables – 2017-2020 Hindcast Sea Conditions..... 18

Table 4.1: Wave conditions and sediment sizing adopted for SBEACH modelling in South Thomson Bay (adapted from Cardno 2022)..... 31

Table 4.2: Annual Transport Per Meter Shoreline..... 42

Table 5.1: Habitat type at each field survey site in RPS (2023) 50

Table 6.1: Wave conditions examined for wave penetration. 57

Figures

Figure 1.1: Site location showing Wadjemup and the location of Thomson Bay on the Northeast side of the Island.....8

Figure 1.2: Secondary and Tertiary Sediment Cells within the R06D Primary Sediment Cell around Wadjemup / Rottnest Island (Stul et al 2015).....9

Figure 1.3: Concept Option 1 (WGA 2018) used by MRA in their 2019 Coastal Processes Assessment .. 10

Figure 1.4: Concept Option 2 (WGA 2018) used by MRA in their 2019 Coastal Processes Assessment .. 11

Figure 1.5: Development of Concept Design Option 1 by BMT (RIA 1716-02-01 RevF, 2019), referred to in AECOM design report as the BMT base case. 12

Figure 1.6: Value Engineering Concept 1 General Arrangement (AECOM 2020, RIA-2520-19180-MAR-01 RevE) 13

Figure 2.1: Passage of waves into Thomson Bay (Seashore 2020) 15

Figure 2.2: High resolution multibeam bathymetry captured by DoT around Wadjemup.....1

Figure 2.3: Locations of Measured Data around the Wadjemup Site 2

Figure 2.4: Wind Rose plot of annual wind speed and direction - measured data from Rottnest Island BOM site 9193 over the period 1983 to 2022. 4

Figure 2.5: Wind Rose plot of annual wind speed and direction - measured data from Rottnest Island BOM site 9193 for the month of May (upper) and June (lower) over the entire measured data period 1983 to 2022. The influence of the winds from the easterly sector is clear during these months. 5

Figure 2.6: Wave Rose plot of annual wave height and direction - measured data from the Rottnest Island Directional Wave Rider Buoy Data 2004 - 2022 7

Figure 2.7: Wave Rose plots of Summer wave height and direction (left) and Winter wave height and direction (right) - measured data from the Rottnest Island Directional Wave Rider Buoy Data 2004 - 2022..8

Figure 2.8: Wave rose plots of wave heights and direction at the Aquadopp (left) and Signature 1000 ADCP (right).....9

Figure 2.9: Current rose plots of current speed and direction at the Aquadopp (left) and Signature 1000 ADCP (right)..... 11

Figure 2.10: View of Thomson Bay to the west of the Army Groyne structure 12

Figure 2.11: View of the dunes backing the beach east of the Army Groyne structure..... 12

Figure 2.12: View towards the Army Groyne structure, showing dune height east and west of the structure 13

Figure 2.13: Rock pavement/platform supporting the perched beaches of Thomson Bay, as seen in front of the South Thomson Bay seawall. 13

Figure 2.14: Shoreline characteristics and engineered modifications in Thomson Bay (modified from MRA 2019) 15

Figure 3.1: Model domain for the hindcast SWAN wave model 16

Figure 3.2: Location of hindcast analysis point in the vicinity of the proposed barge ramp facilities, as well as the nearby moorings managed by the Rottnest Island Authority. 17

Figure 3.3: Wave roses of 2017-2020 hindcast dataset, showing sea conditions on the left and swell conditions on the right. 18

Figure 3.4: 2m resolution wave grid with model bathymetry reflecting existing conditions..... 19

Figure 3.5: 2m resolution wave grid with model bathymetry reflecting the proposed structures and required dredged depth..... 19

Figure 3.6: Northern swell event wave plots showing wave conditions at the Army Groyne (top) and at the proposed barge landing facility (bottom)..... 21

Figure 3.7: Northern swell event wave plot showing the difference between incident waves with and without the proposed structures..... 22

Figure 3.8: Northern windsea event wave plots showing wave conditions at the Army Groyne (top) and at the proposed barge landing facility (bottom) 23

Figure 3.9: Northern windsea event wave plot showing the difference between incident waves with and without the proposed structures..... 24

Figure 3.10: Northeastern windsea event wave plots showing wave conditions at the Army Groyne (top) and at the proposed barge landing facility (bottom) 25

Figure 3.11: Northeastern windsea event wave plot showing the difference between incident waves with and without the proposed structures (bottom) 26

Figure 3.12: Eastern windsea event wave plots showing wave conditions at the Army Groyne (top) and at the proposed barge landing facility (top right, ... 27

Figure 3.13: Eastern windsea event wave plot showing the difference between incident waves with and without the proposed structures (bottom) 28

Figure 4.1: Components of a coastal sediment budget (WAPC 2013a) 29

Figure 4.2: Stages of cross-shore sediment movement prior to, during and following the passage of storm waves on a sandy shoreline (Herbich et al., 1982) 30

Figure 4.3: SBEACH profile locations from Cardno (2022) 31

Figure 4.4: Timeseries of Hs and Tp during the synthetic design storm event at the Rottnest DWR, taken from MRA 2018 to be used in the Rottnest Island CHRMAP (Cardno 2022) 32

Figure 4.5: SBEACH Profiles derived from the scaled synthetic storm at Transect 24 within South Thomson Bay 32

Figure 4.6: SBEACH Profiles derived from the scaled synthetic storm at Transect 25 within South Thomson Bay 33

Figure 4.7: Simplified diagram of longshore drift on sandy beaches (van Zyl 2018) 33

Figure 4.8: Historical aerial images from 2001 to 2023 in South Thomson Bay overlaid with the 2023 shoreline (proxied by the 2023 vegetation line) 34

Figure 4.9: Historical aerial images from 2001 to 2023 in close proximity to the Army Groyne overlaid with the 2023 shoreline (proxied by the 2023 vegetation line) 35

Figure 4.10: Historical aerial images from 2001 to 2023 at Point Phillip overlaid with the 2023 shoreline (proxied by the 2023 vegetation line) 36

Figure 4.11: Historical aerial images from 2001 to 2023 at Point Phillip overlaid with the 2023 shoreline (proxied by the 2023 vegetation line), zoomed into close proximity to the Point 36

Figure 4.12: Detail of the historic vegetation lines and chainages for Thomson Bay and Bickley Bay used by MRA in their assessment of historic shoreline movement in their 2019 assessment (MRA 2019) 37

Figure 4.13: Shoreline movement trends relative to the 1964 baseline (MRA 2019) 38

Figure 4.14: Chainages used by Cardno in their assessment of historic shoreline movement in their 2023 CHRMAP, with the inset showing the chainages used within Thomson Bay and Bickley Bay (Cardno 2022) 39

Figure 4.15: Shoreline movement plot relative to a 2005 baseline for Thomson Bay (Cardno 2022) 39

Figure 4.16: Overview of the latest shoreline movements, showing the 2019 and 2023 shorelines aligned to the 2016 shoreline 40

Figure 4.17: Progression of a minor dune blowout in South Thomson Bay, west of the Army Groyne, between 2016 and 2019..... 41

Figure 4.18: 9am and 3pm wind roses covering data from 1984 to 2023 at Rottnest Island (site no. 009193) (BOM 2023) 42

Figure 4.19: Conceptual Sediment Budget (1978-2023, adapted and updated from MRA (2019)) 44

Figure 4.20: Projected sea level rise for the Western Australian coastline (IPCC 2021)..... 45

Figure 4.21: Typical sandy shoreline cross shore response to sea level rise, adapted from Dubois (1992) (Seashore 2021)..... 46

Figure 4.22: Erosion Hazard Map for Coastal Sediment Cell R14b Bathurst Point to Philip Point (adapted from Cardno 2022) 47

Figure 4.23: Potential Impact of Proposed Facility on Sediment Dynamics in South Thomson Bay..... 48

Figure 5.1: Habitat map of the waters surrounding Wadjemup (from Harvey 2009) 50

Figure 5.2: South Thomson Bay benthic habitat map with the proposed development footprint of WGA's Option 1 overlaid..... 51

Figure 5.3: Aerial photography indicating the buildup of seagrass wrack between 2014 and 2023, largely on the eastern side of the Army Groyne (adapted from MRA 2019)..... 52

Figure 5.4: Wrack accumulation on the eastern side of the Army Groyne looking seaward (top, mid) and looking landward (bottom)..... 53

Figure 5.5: Wrack accumulation along South Thomson Bay on May 2nd 2019 (MRA 2019) 54

Figure 5.6: Wrack accumulation along South Thomson Bay on November 20th 2023..... 55

Figure 5.7: Minimal accumulation of wrack on western side of Army Groyne on November 20th 2023..... 55

Figure 5.8: Proposed development structure layout with potential wrack dynamic descriptions 56

Figure 6.1: Estimated diffraction coefficient for incident waves for northerly swell case (upper) and wind sea from the Northeast case (lower)..... 58

1. Introduction

Wadjemup (Rottnest Island) is an A-class nature reserve of ecological, cultural, and social significance. The island is currently supplied with bulk cargo via the roll-on-roll-off vessel which docks at the barge ramp located near the base of the Main Ferry Jetty. Following identification in the Rottnest Island Master Plan – 20 Year Vision (RIA 2019) of the need to improve the functionality and efficiency of transporting bulk cargo to and from Wadjemup, to reduce noise levels for residents, and to improve safety and amenities for visitors arriving at the island, investigations and studies have been undertaken at the Army Groyne. This includes studies to determine a design and method to convert the former Army Jetty (currently Army Groyne) site in South Thomson Bay into a barge landing, freight handling and associated storage area to aid in reducing heavy vehicle traffic around Wadjemup's main jetty in the Main Settlement area.

Initial concept designs prepared by Wallbridge Gilbert Aztec (WGA) in late 2018 were used by MP Rogers and Associates (MRA) in their South Thomson Bay Coastal Processes Assessment (MRA 2019), with further development of the first option being undertaken by BMT in 2020. Following these assessments, AECOM were engaged by the Rottnest Island Authority (RIA) to undertake a high-level value engineering assessment of this concept design, aiming to identify opportunities to reduce capital costs, while maintaining the key functional/user requirements achieved by the initial concept design.

The concept developed by AECOM in their Value Engineering of Concept Design reporting (AECOM 2020) is the concept that will be used in this updated Coastal Processes Assessment report.

1.1 Study Site

Wadjemup is located approximately 20 kilometres west of the port of Fremantle in Western Australia. The island is a remnant of the Pleistocene dune ridges and is surrounded by large quantities of coral reefs and rock formations. It is a popular tourist attraction with over 780,000 visitors to the Island annually enjoying short stay accommodation and recreational activities including snorkelling, bike riding and site seeing (WA Govt 2019). Tourists enter Wadjemup via ferry services disembarking on the island's Main Ferry Wharf located in Thomson Bay. Thomson Bay is located on the north east side of the island, spanning a distance of approximately 2.5 km and sheltered from the prevailing south westerly swell conditions (Figure 1.1).

Sediment cells, spatially discrete sections of coastline that include the intersection of both marine and land-based structures that connect through the exchange of sediment (Stul et al 2015), are important to consider in any coastal processes assessment as they allow for the identification of the spatial context most relevant to the coastal evaluation being undertaken. Stul et al (2015) presents a hierarchy of sediment cells for the Vlamingh coast, covering the Western Australian coastline between Cape Naturaliste to the south and Moore River to the north, to be used in the planning, management, engineering, science and governance of this coastline, including when making decisions around management of coastal infrastructure such as the Army Groyne.

Sediment cells are mapped by Stul et al for three spatio-temporal scales along the Vlamingh coast:

- Primary Cells – These relate to large landforms and consider potential changes to the coastline over timescales of more than 50 years.
- Secondary Cells – These incorporate contemporary sediment movement on the shoreline and potential landform responses to inter-decadal changes in coastal processes.
- Tertiary Cells – These are defined by the reworking and movement of sediment in the nearshore and are relevant for seasonal and inter-annual changes to the beach face.

The sediment cell most relevant to the proposed facility at South Thomson Bay is the R14b tertiary cell extending from Bathurst Point to Philip Point, with due consideration made to it's position within the R14

Secondary cell between North Point and Philip Point and the R06D Primary cell extending from Fremantle to Safety Bay and out to Wadjemup along the Garden Island Ridge.

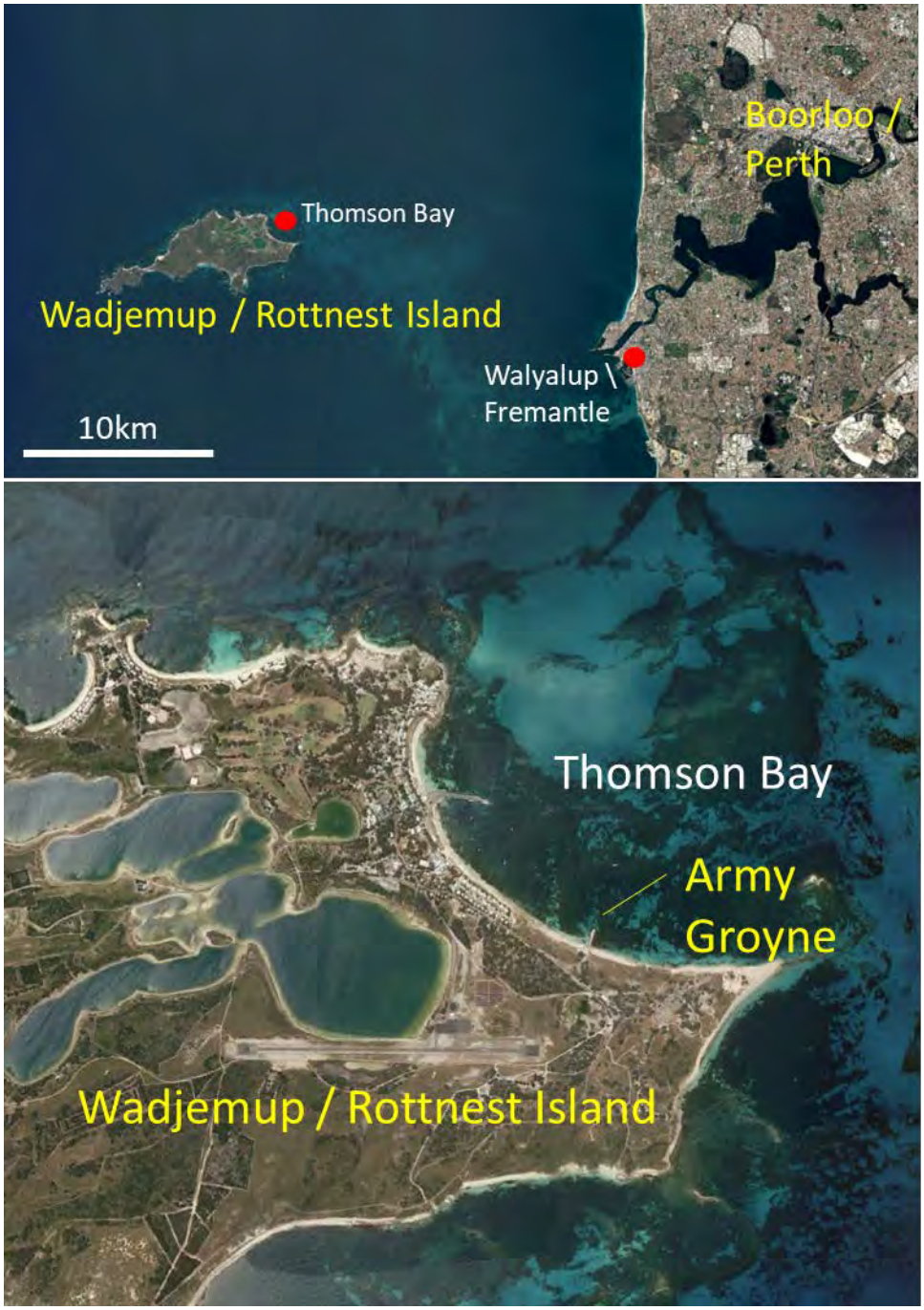

Figure 1.1: Site location showing Wadjemup and the location of Thomson Bay on the Northeast side of the Island

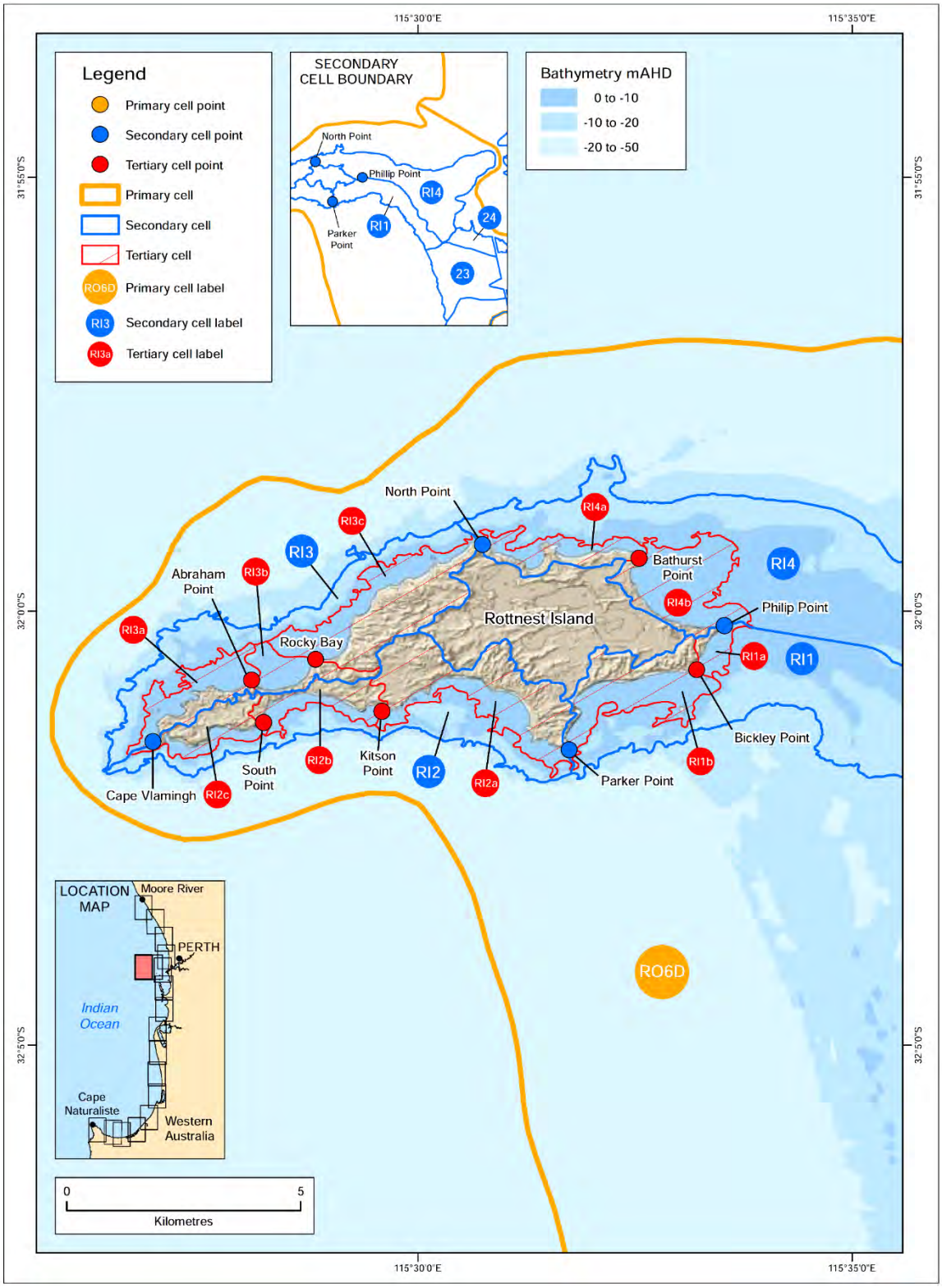

Figure 1.2: Secondary and Tertiary Sediment Cells within the R06D Primary Sediment Cell around Wadjemup / Rottnest Island (Stul et al 2015)

1.2 Concept Designs

Initial concept designs were developed by WGA in 2018, with the two identified options at that stage shown below for Option 1 (Figure 1.3) and Option 2 (Figure 1.4). These designs were used by MRA in their initial Coastal Processes Assessment reporting in 2019.

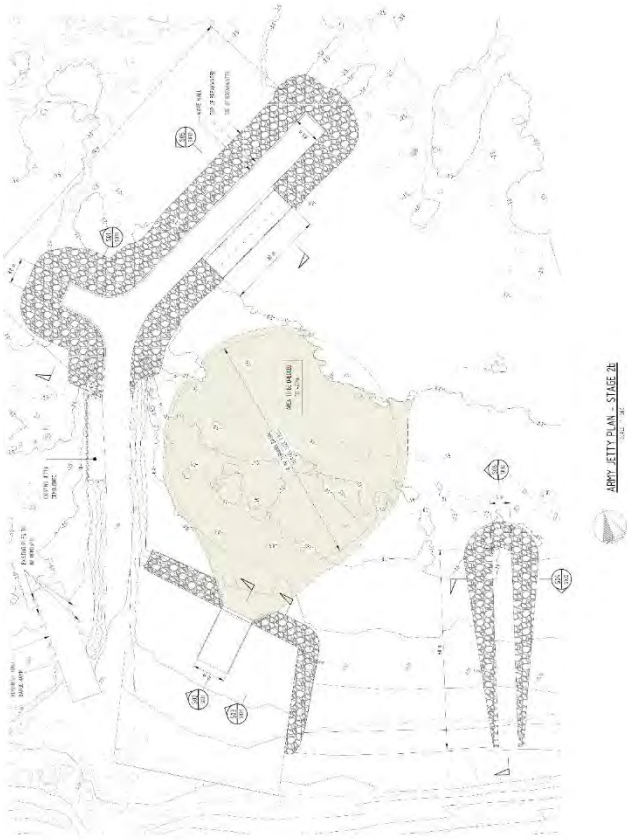

Figure 1.3: Concept Option 1 (WGA 2018) used by MRA in their 2019 Coastal Processes Assessment

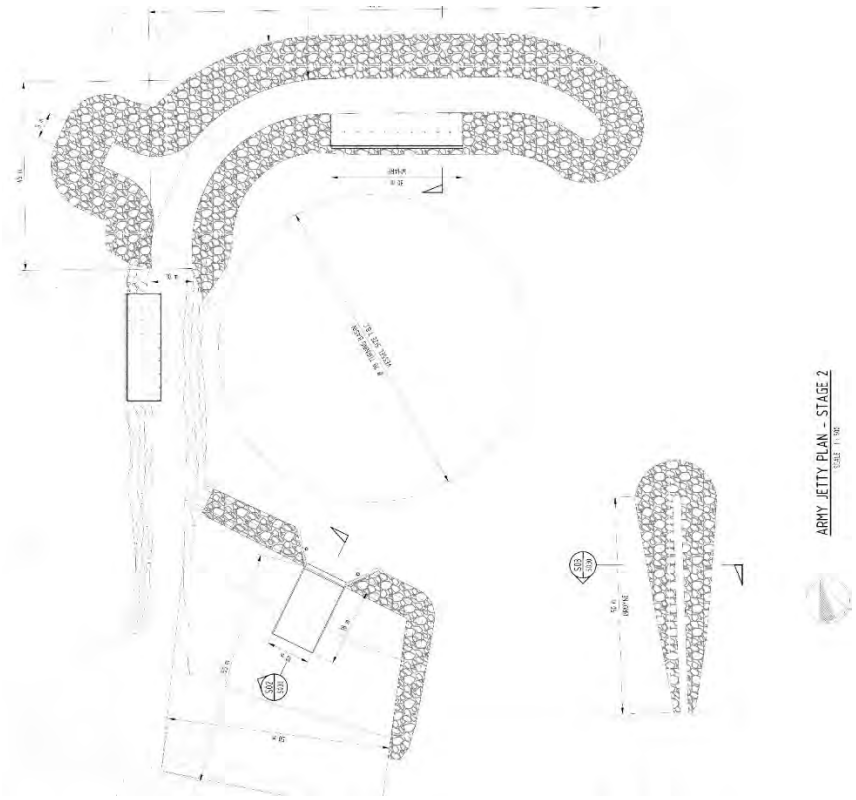

Figure 1.4: Concept Option 2 (WGA 2018) used by MRA in their 2019 Coastal Processes Assessment

The development of Option 1 from WGAs concept level designs that was undertaken by BMT in 2019, as shown in Figure 1.5.

Figure 1.5: Development of Concept Design Option 1 by BMT (RIA 1716-02-01 RevF, 2019), referred to in AECOM design report as the BMT base case.

This design was then used as a reference by AECOM when RIA requested that they undertake a value engineering assessment of the BMT concept design. The development of the Value Engineering Concept 1 by AECOM undertaken in 2020 is shown in Figure 1.6. This concept is the layout that this updated coastal assessment will be based upon.

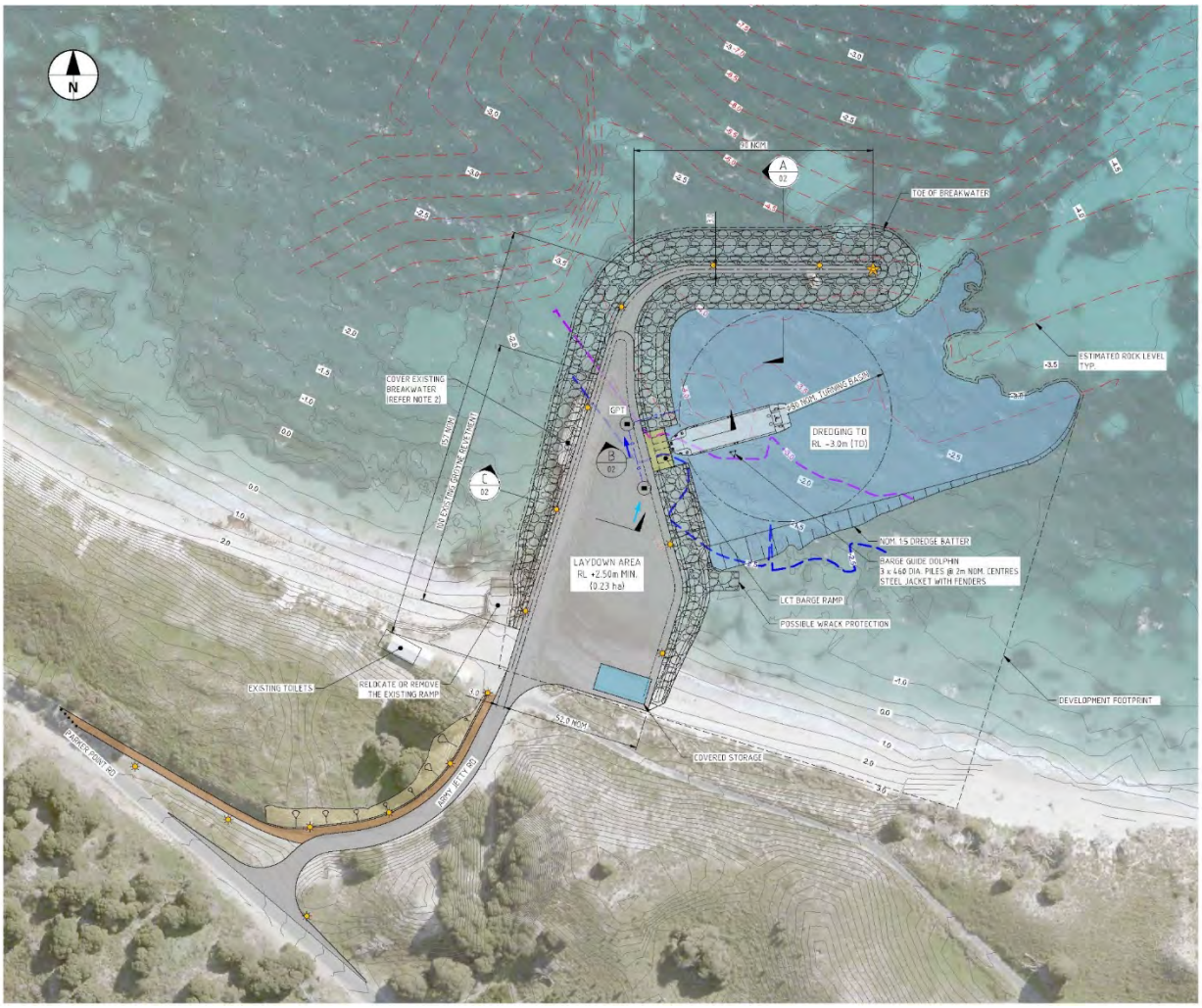

Figure 1.6: Value Engineering Concept 1 General Arrangement (AECOM 2020, RIA-2520-19180-MAR-01 RevE)

2. Local Setting

Analysis of the measured data from around Thomson Bay and Wadjemup is presented in this section and used to inform the understanding of the metocean conditions at the Thomson Bay Army Groyne and the basis for establishing the wave model.

2.1 General Wave Climate

The wave conditions in Thomson Bay are generated by two principal sources:

1. Long period swell waves (>8 seconds) that are generated in the Southern Ocean and which travel around the north side and south side of the Island by diffraction and refraction to enter Thomson Bay as low amplitude swell.
2. Short period (<8 seconds) wind sea waves approach the bay from an easterly direction. These short period waves are generated by easterly winds acting over the fetch between the Perth coastline and Wadjemup.

A general overview of wave processes in Thomson Bay is shown in Figure 2.1 from Seashore (2020):

The swell and wind sea wave conditions can occur simultaneously resulting in a bi-modal seastate in Thomson Bay, where low amplitude swell waves approach from the north at the same time as short period wind sea waves approach generally from the east sector.

Both wave modes are affected by the natural reef and rock structures surrounding the island. As waves travel over the reef structures, they lose wave energy through wave breaking and bed roughness reducing the amplitude of the waves. The natural wave protection offered by reef and the island's topography results in a relatively benign wave climate within Thomson Bay.

2.2 Bathymetry and Reefs

There is a very good description of the bathymetry from around the Island, with bathymetric data captured in high resolution by the Department of Transport (DoT) from the shoreline out to approximately 30m depth (Figure 2.2). There are high resolution local bathymetric surveys in Thomson Bay around the Army Groyne captured in 2017 and 2020 which provide an excellent description of the seabed for the study (Figure 2.2).

2.3 Local Datum

The Rottnest tidal planes and charts are based on Rottnest Sounding Datum which in this report is referred to as Chart Datum (CD). CD is the lowest low water recorded at Rottnest (Wadjemup) in 1978.

The bathymetry captured by the DoT in Thomson Bay used for this project is at CD with a vertical datum stated as 'Rottnest Island, Low Water Mark 1978, 3.628m below benchmark PWD AW A728. 0.72m below Australian Height Datum (AHD)'.

In the current report the vertical datum of CD has been adopted.

- To convert CD to mean sea level (MSL) an adjustment of -0.68m is applied.
- To convert CD to AHD an adjustment of -0.72m is applied.

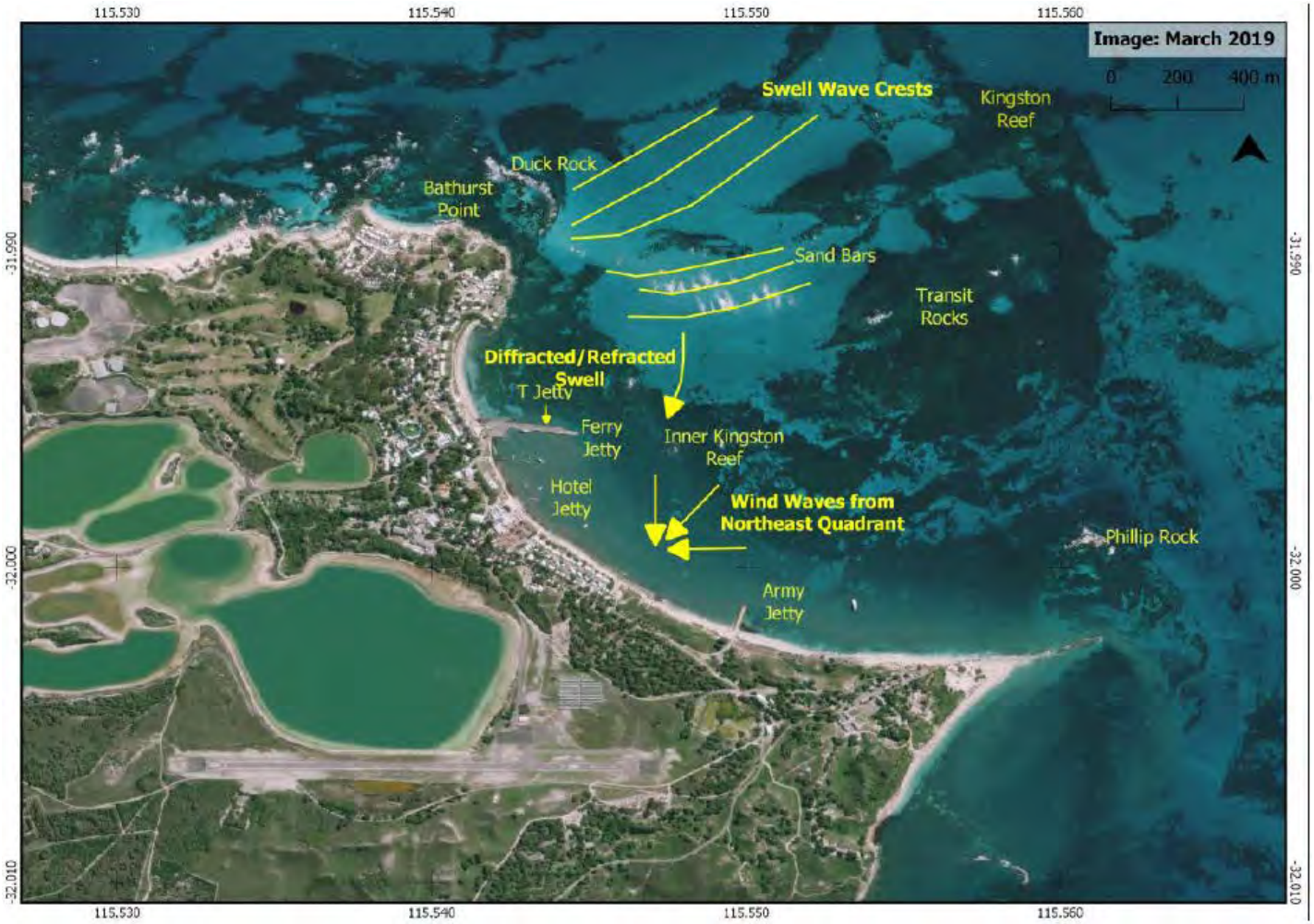

Figure 2.1: Passage of waves into Thomson Bay (Seashore 2020)

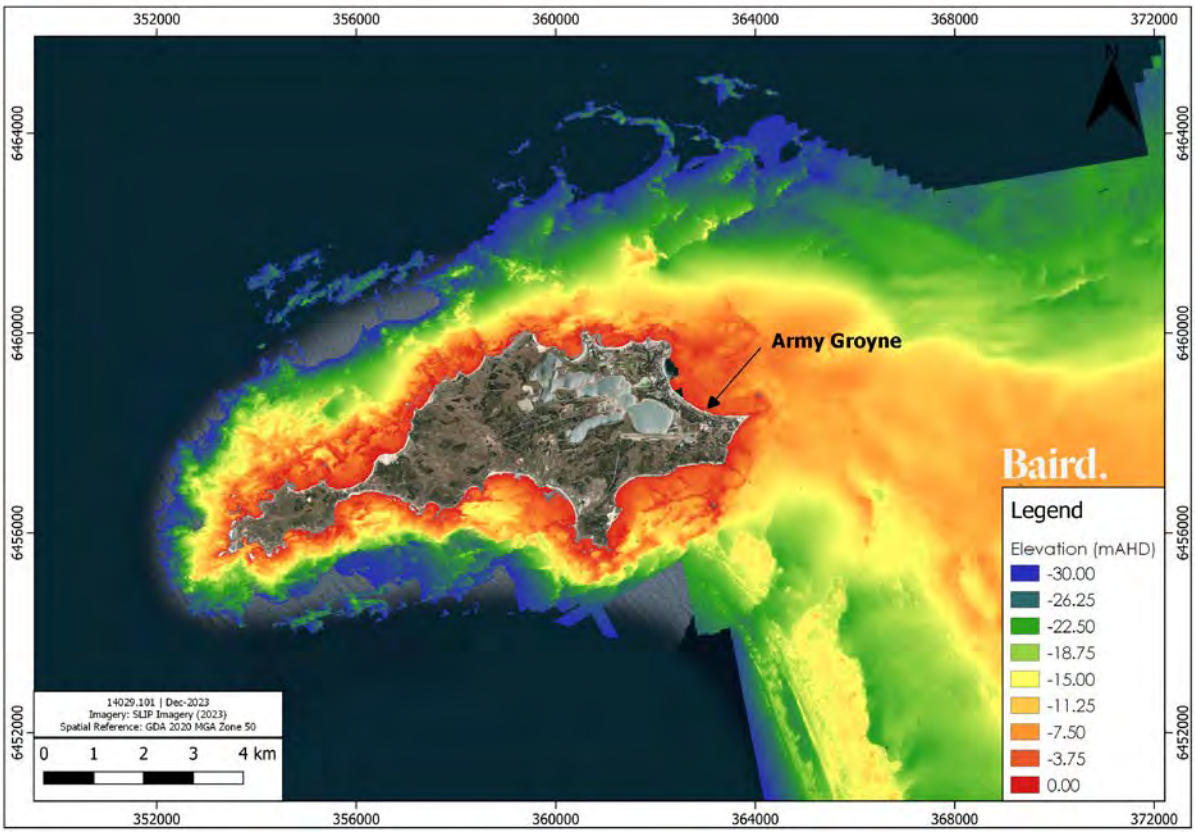

Figure 2.2: High resolution multibeam bathymetry captured by DoT around Wadjemup

2.4 Measured Data Summary

A summary of the measured data available around Wadjemup and locally adjacent the site in Thomson Bay is presented in Table 2.1 with locations shown in Figure 2.3.

Table 2.1: Measured Metocean Data from around Wadjemup and Thomson Bay

Instrument	Date Available	Depth (m CD)	Data
Fremantle Tide Gauge	1986 - 2022	2	Water level
Rottnest Island Wind	1983 - 2022	+43m	Wind Speed/Direction
Swanbourne Wind	1985 - 2022	+41m	Wind Speed/Direction
Rottnest Buoy DWR	2004 - 2022	48m	Wave (Hs, Tp, Dir)
Cottesloe Buoy DWR	1999 - 2022	17m	Wave (Hs, Tp, Dir)
Signature1000_Site1	25th June 2020 – 6th August 2021	3m	Wave (Hs, Tp, Dir, Spread)
Aquadopp_Site2	25th June 2020 – 6th August 2021	3m	Water Level, Currents

Instrument	Date Available	Depth (m CD)	Data
AWAC_R1_01	8th August – 3rd Oct 2012	13.3m	Wave (Hs, Tp, Dir)
AWAC_R1_02	8th August – 3rd Oct 2012	3.3m	Wave (Hs, Tp, Dir)
PressureSensor_R1_03	8th August – 3rd Oct 2012	2.7m	Waves (Non-Dir)
PressureSensor _R1_04	8th August – 3rd Oct 2012	4.7m	Waves (Non-Dir)

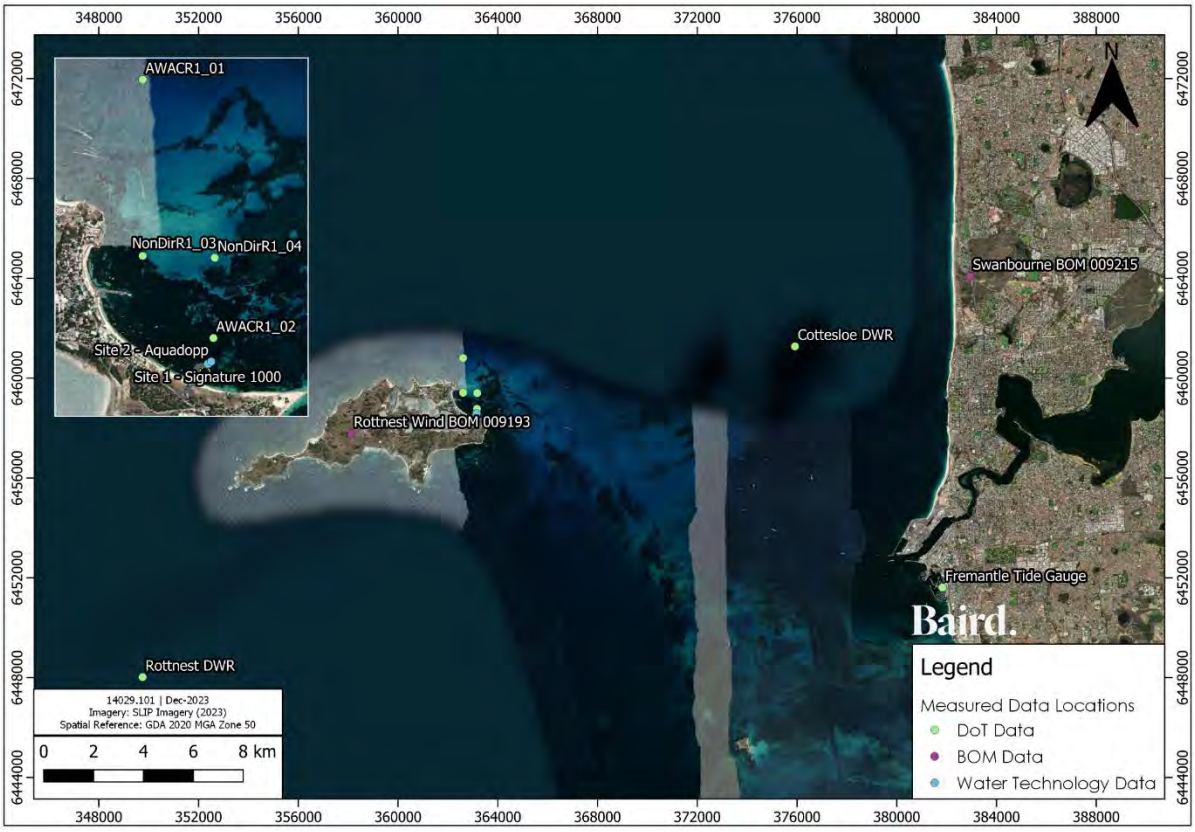

Figure 2.3: Locations of Measured Data around the Wadjemup Site

2.5 Water Level

2.5.1 Tidal Planes

The tidal planes for Thomson Bay have been taken from the nautical chart for Rottnest Island WA412 (DoT 2011) and are shown in Table 2.2. The vertical datum is to the Rottnest Island Sounding Datum which in this report is referred to as CD (refer Section 2.2.3). It is noted that the LAT level has not been established for Thomson Bay.

The tides at Wadjemup are mainly diurnal with a spring tide range of approximately 0.7m and neap tide range of 0.5m. The water level peaks during the June solstice (Eliot 2020).

There is no tide gauge on Wadjemup with the nearest measured data location being the tide gauge at the Fremantle boat harbour, which is considered generally representative of the tidal regime on Wadjemup in

Thomson Bay. Tidal planes are summarised in Table 2.2 from the Fremantle Boat Harbour location to the Fremantle Chart Datum (m CD).

Table 2.2: Tidal Planes for Fremantle Boat Harbour (DoT 2016) and Thomson Bay (DoT 2011)

	Fremantle[1]	Thomson Bay[2]
Tidal Plane	Level (m CD)	Level (m CD)
HAT	1.40	1.42
MHHW	1.15	1.03
MLHW	1.04	0.93
MSL	0.81	0.68
MHLW	0.57	0.43
MLLW	0.47	0.33
LAT	0.26	
CD	0.00	0.00

Source:

1. Submergence curve for Fremantle Boat Harbour Tide gauge (DoT 2016).
2. Nautical Chart WA412 Rottnest Island (DoT 2011).

2.6 Wind Conditions

The measured wind record from the Bureau of Meteorology (BoM) site on Rottnest Island (BOM Site 9193) was analysed over the period 1983 to 2020 to produce a joint frequency table and wind rose plot of the wind speed and wind direction shown in Table 2.3 and Figure 2.4.

Table 2.3: Joint Frequency Table of measured wind speed and direction. Analysis of the Rottnest Island BOM0009193 station data 1983 - 2022

WindSpeed (m/s)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	WNW	Total (%)
0.00-2.50	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.6
2.50-5.00	0.9	0.7	1.1	1.3	2.7	2.2	1.6	1.4	2.0	0.9	0.8	0.8	1.2	0.5	0.5	0.4	19.0
5.00-7.50	1.3	1.1	1.4	1.7	4.0	2.9	2.9	3.1	5.4	2.4	1.7	1.3	1.8	1.0	0.8	0.6	33.4
7.50-10.00	1.1	0.7	0.6	0.6	1.6	0.9	1.6	2.2	6.9	3.9	1.5	1.1	1.3	0.9	0.8	0.6	26.3
10.00-12.50	0.6	0.3	0.1	0.1	0.1	0.1	0.4	1.0	4.7	2.9	0.7	0.6	0.8	0.5	0.5	0.4	13.7
12.50-15.00	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.2	1.7	0.8	0.3	0.2	0.3	0.3	0.3	0.2	4.7
15.00-17.50	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.1	0.0	0.1	0.1	0.1	0.1	1.0
17.50-20.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
TOTAL	**4.4**	**3.1**	**3.3**	**3.7**	**8.6**	**6.3**	**6.6**	**8.1**	**21.3**	**11.0**	**5.1**	**4.3**	**5.5**	**3.5**	**3.0**	**2.3**	**100**

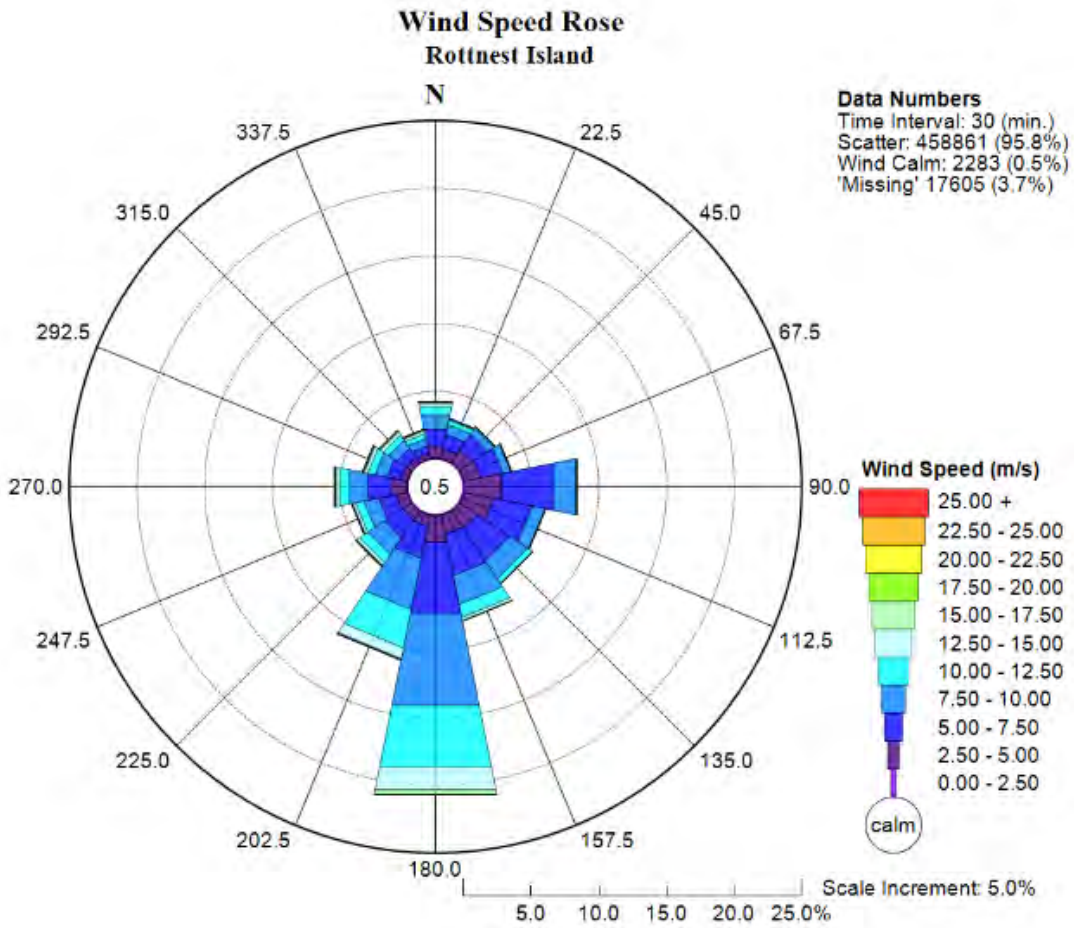

Figure 2.4: Wind Rose plot of annual wind speed and direction - measured data from Rottnest Island BOM site 9193 over the period 1983 to 2022.

The wind rose in Figure 2.4 show the winds approach from all directions with winds from the southerly sector dominant in the annual record and representing almost 40% of the data record.

The easterly approach sector is of key importance for the Thomson Bay Main Jetty as this generates wind sea waves that approach Thomson Bay (refer Figure 2.1). The easterly sector winds are well represented in the annual record in Figure 2.4 with the Army Groyne exposed to wind directions from NNE clockwise through SE. The easterly winds are most prevalent in the late autumn and early winter months with the wind roses for the months of May and June shown in Figure 2.5 from the full measured data record.

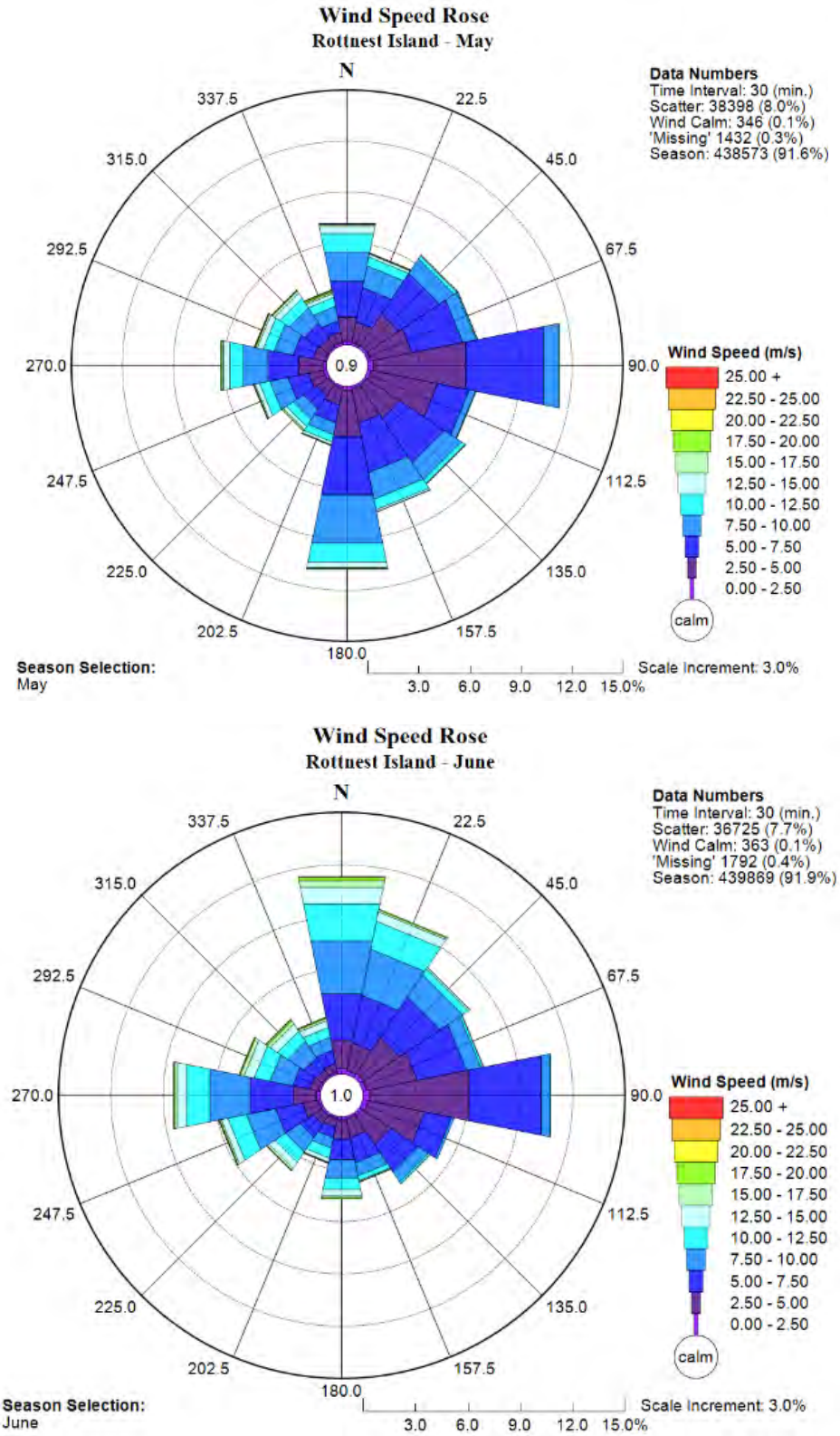

Figure 2.5: Wind Rose plot of annual wind speed and direction - measured data from Rottnest Island BOM site 9193 for the month of May (upper) and June (lower) over the entire measured data period 1983 to 2022. The influence of the winds from the easterly sector is clear during these months.

2.7 Wave Conditions

Wave conditions at the site have been assessed using both the long-term dataset available from the Rottnest Wave Rider Buoy when considering the regional wave climate offshore of Wadjemup (Rottnest Island) and the yearlong deployment by Water Technology from 25th June 2020 – 6th August 2021 when considering the local wave climate within South Thomson Bay.

2.7.1 Rottnest Directional Wave Rider Dataset

The measured wave record from the Rottnest Wave Rider Buoy (Rottnest DWR in Figure 2.3) was used to assess the wave climate offshore of Wadjemup (in approximately 50m depth). The Rottnest DWR dataset for the period 2004 to 2020 comprised 16-years of hourly wave conditions for significant wave height, peak period and direction. The data is provided as individual sea and swell components and as a combined total of sea and swell.

The measured wave record was analysed over the period 2004 to 2020 to produce a joint frequency table and wave rose plot of the wave height and wave direction offshore of Wadjemup over this period, shown in Table 2.4.

Table 2.4: Joint Frequency Table of measured wave height and direction. Analysis of the Rottnest Island Directional Wave Rider Buoy Data 2004 - 2022

Wave Height (m)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total (%)
0.0-0.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.03
0.5-1.0	0.05	0.01	0.04	0.16	0.22	0.11	0.06	0.06	0.15	0.27	1.68	0.69	0.13	0.04	0.08	0.08	3.83
1.0-1.5	0.32	0.10	0.21	0.72	0.86	0.70	0.22	0.15	0.48	1.86	8.37	4.56	0.75	0.24	0.33	0.47	20.32
1.5-2.0	0.36	0.08	0.16	0.40	0.46	0.60	0.20	0.12	0.39	3.71	11.01	8.04	1.21	0.30	0.47	0.63	28.15
2.0-2.5	0.14	0.02	0.04	0.10	0.13	0.15	0.07	0.05	0.19	2.76	7.58	7.39	1.29	0.28	0.41	0.46	21.05
2.5-3.0	0.04	0.00	0.00	0.02	0.03	0.03	0.01	0.01	0.05	1.03	3.40	4.98	1.20	0.32	0.31	0.20	11.63
3.0-3.5	0.01	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.02	0.25	1.40	3.42	1.08	0.22	0.21	0.09	6.72
3.5-4.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.52	1.89	0.79	0.21	0.13	0.03	3.63
4.0-4.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.25	1.07	0.61	0.15	0.07	0.02	2.18
4.5-5.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.12	0.56	0.40	0.09	0.02	0.00	1.20
5.0-5.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.29	0.26	0.05	0.01	0.00	0.65
5.5-6.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.13	0.12	0.04	0.00	0.00	0.32
6.0+	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.10	0.14	0.02	0.00	0.00	0.29
Total	0.92	0.23	0.44	1.40	1.71	1.59	0.55	0.40	1.29	9.96	34.42	33.13	7.98	1.96	2.04	1.97	100.00

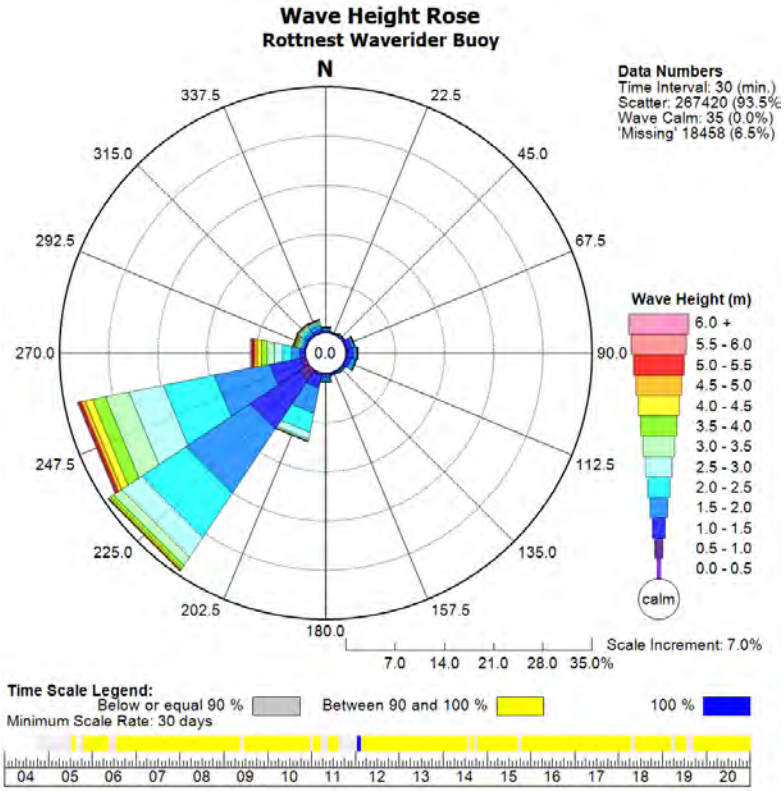

Figure 2.6: Wave Rose plot of annual wave height and direction - measured data from the Rottnest Island Directional Wave Rider Buoy Data 2004 - 2022

The top 15 events based on peak H_S from the Rottnest DWR data set occurring offshore, are summarised in Table 2.5 with the following noted:

- the majority of the extreme events in Table 2.5 are generated by winter storms.
- the largest event on record, an 8.9m offshore significant wave height (Hs) was measured in July 2009 associated with the passage of a severe winter storm.
- The fourth ranked event (25 May 2020) corresponds to Tropical Cyclone Mangga.

This analysis, as well as comparison of the overall wave climate during summer and winter months at the Wave Rottnest DWR (Figure 2.7) show that the greatest impact (i.e., the time when the largest waves are occurring) on facilities built on Wadjemup will be during winter months.

Table 2.5: Summary of Top 15 Events Measured by Hs from Measured Wave Record at Rottnest Directional Wave Rider Buoy (DWR)

Rank	Date	Peak Hs (m)
1.	21/07/2009 5:10	8.9
2.	2/08/2022 4:39	8.7
3.	25/05/2018 23:20	8.5
4.	25/05/2020 20:09	8.5
5.	22/07/2018 23:20	8.1

Rank	Date	Peak Hs (m)
6.	6/05/2020 7:09	7.8
7.	28/11/2012 22:46	7.8
8.	10/08/2021 13:55	7.8
9.	7/08/2006 23:05	7.6
10.	4/09/2012 18:16	7.5
11.	27/07/2021 6:55	7.5
12.	24/05/2022 0:39	7.5
13.	23/09/2013 5:28	7.4
14.	7/07/2014 15:41	7.4
15.	19/07/2017 22:29	7.4

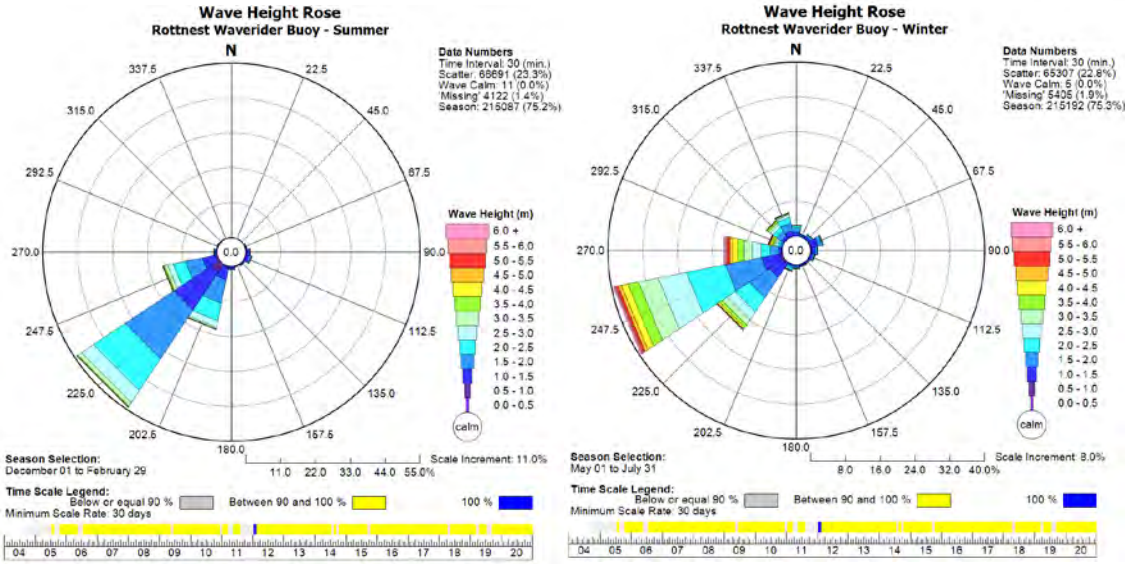

Figure 2.7: Wave Rose plots of Summer wave height and direction (left) and Winter wave height and direction (right) - measured data from the Rottnest Island Directional Wave Rider Buoy Data 2004 - 2022

2.7.2 Local ADCP Wave Measurements

Water Technology were engaged by RIA to undertake a wave and current data collection campaign in 2020, with data collected from two ADCP instruments in close proximity to the proposed development site between 25th June 2020 – 6th August 2021 (Figure 2.3). These deployments together produced a near continuous dataset between these dates, with each individual instrument covering different time periods:

- Site 1 (Aquadopp):
  - 25th June 2020 – 13th October 2020
  - 9th February 2021 – 6th August 2021
- Site 2 (ADCP, Signature 1000)
  - 5th November 2020 – 9th February 2021

Taken separately, the Aquadopp deployment largely covers winter and transitional months where wave heights within South Thomson Bay are greater, whereas the Signature 1000 deployment covers summer months when wave heights within South Thomson Bay are lower (Figure 2.8), noting that the directional approach of waves at both sites remains within the NNW to ENE bracket across the measured data signal.

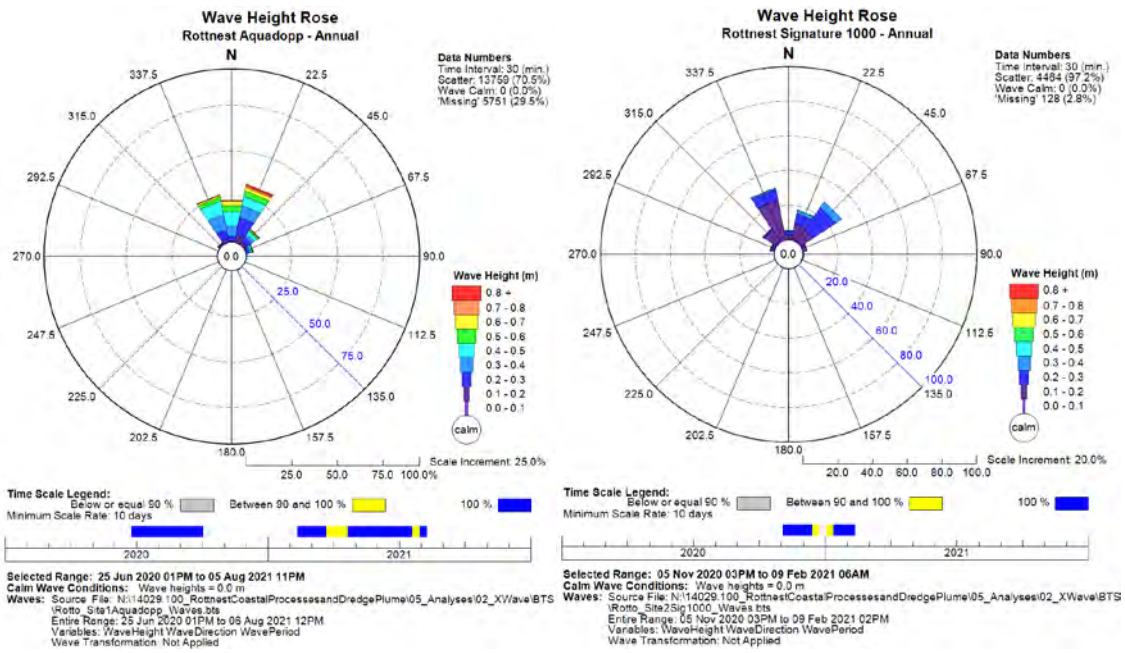

Figure 2.8: Wave rose plots of wave heights and direction at the Aquadopp (left) and Signature 1000 ADCP (right)

Joint frequency tables of these datasets, taken from the analysis undertaken by Water Technology in their 2021 Rottnest Island Wave and Current Monitoring report, show again that the majority of waves at these sites arrive from directions between NNW to ENE (Table 2.6), and also show that more than 50% of the waves arriving at these sites across the measurement year fell within the 12-16s wavelength range (i.e., swell waves) (Table 2.7). This aligns with the general wave climate described in Section 2.1 with a combination of swell waves generated offshore of Wadjemup in the Indian Ocean arriving at the site following refraction around Bathurst Point and Duck rock and refraction across the sand bars of Thomson Bay and Inner Kingston Reef, as well as wind waves generated from winds blowing across Thomson Bay from the easterly sector, predominantly in winter months (Figure 2.5).

Table 2.6: Joint Frequency Table of measured wave height and direction. Analysis of the Aquadopp and ADCP data collected between June 2020 and August 2021 (Water Technology 2021)

		Mean Wave Direction (oN)																
Hs (m)	blank	N - NNE	NNE - NE	NE - ENE	ENE - E	E - ESE	ESE - SE	SE - SSE	SSE - S	S - SSW	SSW - SW	SW - WSW	WSW - W	W - WNW	WNW - NW	NW - NNW	NNW - N	Total
<0 or (blank)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
0-0.1	0.0	0.8	0.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	**2.2**
0.1-0.2	0.0	8.9	5.8	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.2	5.3	**21.7**
0.2-0.3	0.1	8.7	6.8	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.0	6.1	**24.0**
0.3-0.4	0.0	5.1	2.9	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	9.2	**20.1**
0.4-0.5	0.0	3.7	1.5	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	9.8	**16.6**
0.5-0.6	0.0	2.9	0.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	5.2	**9.0**
0.6-0.7	0.0	1.8	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	**4.2**
0.7-0.8	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	**1.3**
0.8-0.9	0.0	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	**0.7**
0.9-1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.2**
Total	**0.1**	**33.3**	**18.8**	**4.2**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**4.8**	**38.5**	**100.0**

Table 2.7: Joint Frequency Table of measured wave height and wave period. Analysis of the Aquadopp and ADCP data collected between June 2020 and August 2021 (Water Technology 2021)

	Tp(s)								
Hs(m)	**<0 or (blank)**	**0-4**	**4-8**	**8-12**	**12-16**	**16-20**	**20-24**	**24-28**	**Total**
<0 or (blank)	0	0	0	0	0	0	0	0	**0**
0-0.1	0	0.2	0.1	0.9	0.9	0.1	0	0	**2.2**
0.1-0.2	0	1.9	0.1	5.7	13.3	0.7	0.1	0	**21.7**
0.2-0.3	0.1	5.9	0.1	1.5	14.1	2	0.3	0	**24**
0.3-0.4	0	2.7	0.3	0.6	14.2	2.3	0	0	**20.1**
0.4-0.5	0	2.2	0.5	0.3	10	3.7	0	0	**16.6**
0.5-0.6	0	1.1	0.5	0.5	4.5	2.5	0	0	**9**
0.6-0.7	0	0.3	1	0.7	1.7	0.5	0	0	**4.2**
0.7-0.8	0	0.1	0.2	0.4	0.6	0	0	0	**1.3**
0.8-0.9	0	0	0.4	0.2	0.1	0	0	0	**0.7**
0.9-1	0	0	0.1	0	0	0	0	0	**0.2**
Total	**0.2**	**14.3**	**3.1**	**10.9**	**59.3**	**11.8**	**0.4**	**0**	**100**

2.8 Current Conditions

Current conditions within South Thomson Bay have been assessed using the yearlong deployment by Water Technology from 25th June 2020 – 6th August 2021, with the same measurement periods available at each of the two instruments for the current data as for the wave data referenced in Section 2.7.2. With the different months of the year that each instrument measured (winter and transitional months for the aquadopp and summer months for the Signature 1000 ADCP), the predominant current directions experienced by each instrument are those shown in Figure 2.9. The pattern between instruments shows a stronger and more directional signal during the winter and transitional months of the measurement period, with currents of up to 0.3m/s predominantly coming from the ESE direction, and a weaker, more bi-directional signal during summer, with top current magnitudes of approximately 0.2m/s changing direction between east and west across that summer period.

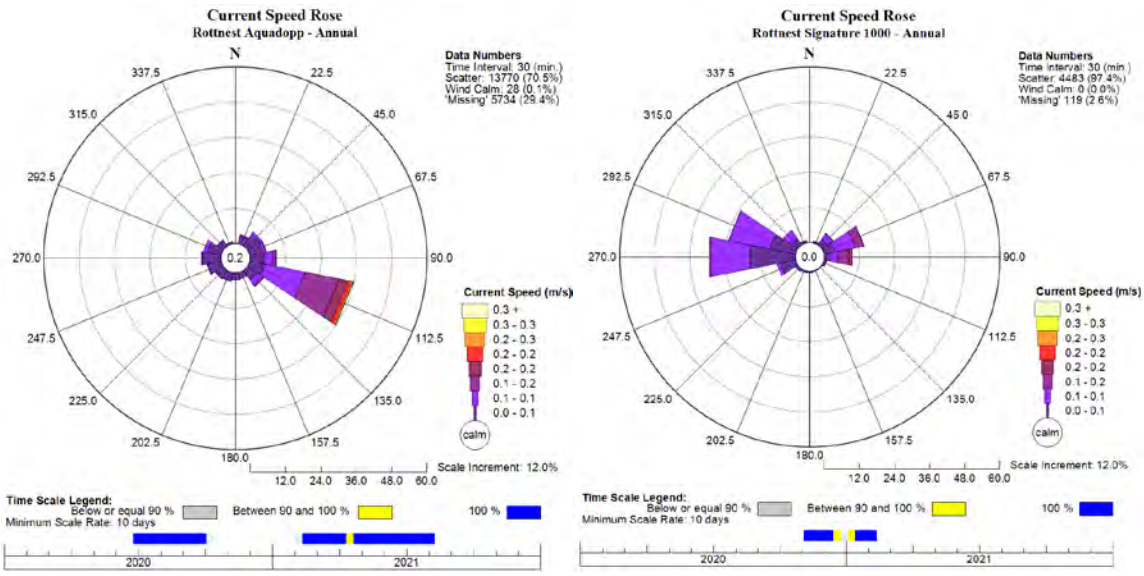

Figure 2.9: Current rose plots of current speed and direction at the Aquadopp (left) and Signature 1000 ADCP (right)

2.9 Shoreline Characteristics and Existing Coastal Structures

The shoreline of Thomson Bay follows an arcuate shape between Bathurst Point and Philip Point, truncated in places by the construction of impermeable land attached structures including the Main Passenger Ferry Jetty and the Army Groyne (see arcuate shape in Figure 2.10). The shoreline consists mainly of sandy perched beaches, with much of the beach sitting on top of rock platforms or pavements (Seashore Engineering 2019) and interspersed with rocky outcrops and limestone cliffs (Short 2005) (see Figure 2.13).

The dunes to the east of the Army Groyne are well vegetated and sit between approx 5m and 10m high (Figure 2.14), with the dunes to the west at a similar height immediately landward of the Army Groyne (Figure 2.12) and decreasing in height along the beach towards the Main Jetty (Figure 2.10).

Figure 2.10: View of Thomson Bay to the west of the Army Groyne structure

Figure 2.11: View of the dunes backing the beach east of the Army Groyne structure.

Figure 2.12: View towards the Army Groyne structure, showing dune height east and west of the structure

Figure 2.13: Rock pavement/platform supporting the perched beaches of Thomson Bay, as seen in front of the South Thomson Bay seawall.

Over approximately the last century a range of man-made/engineered structures have been built along the Thomson Bay shoreline, including the Main Ferry Wharf structure that still acts as the main point of travel to the island with several commercial ferry operators running services that dock at this wharf on a daily

basis. This structure, as well as the Army Groyne structure consist of rock structures that create largely impermeable barriers to sediment movement along Thomson Bay, creating a relatively significant impact upon the coastal processes in the bay compared to other piled structures that allow coastal processes to continue largely uninterrupted (e.g., Town Jetty, Hotel Jetty).

Historic dredging of the channel that services the ferries docking at the Main Ferry Wharf has also had an impact on the coastal processes influencing Thomson Bay, with dredged material used for land reclamation or for placement along the beach (DPI 2009). A summary of the major engineered interventions that have occurred along Thomson Bay have been included in Figure 2.14, with information included from DPI (2009), MRA (2019), along with details of recent works undertaken at the Main Ferry Wharf and South Thomson Bay.

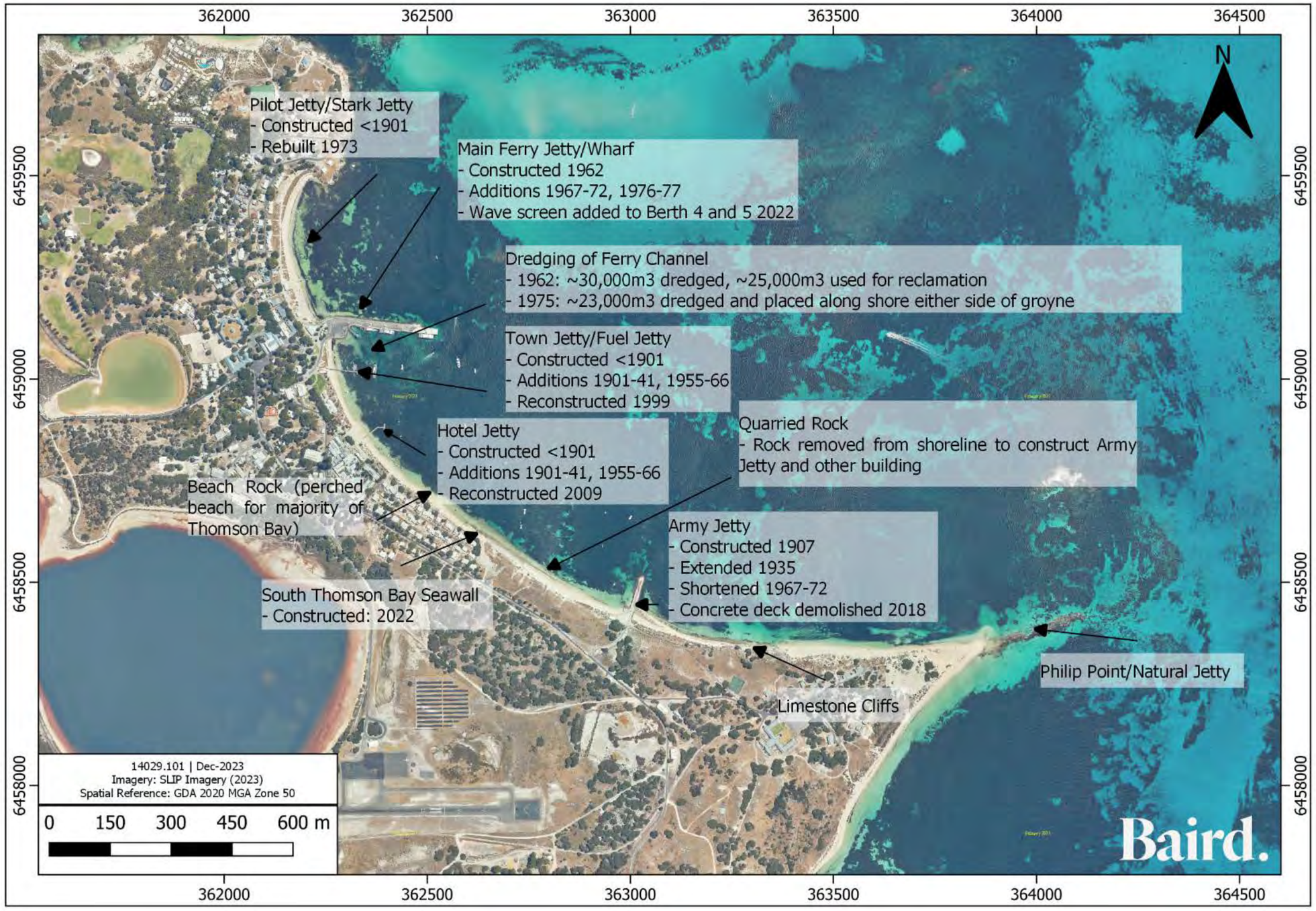

Figure 2.14: Shoreline characteristics and engineered modifications in Thomson Bay (modified from MRA 2019)

3. Wave Assessment

To assess the impacts of waves on the proposed South Thomson Bay Barge Development, review was undertaken of the modelling that was performed in MRA's 2019 coastal processes assessment, with further wave modelling undertaken for the option evaluated in this assessment (Figure 1.6) subsequently carried out.

3.1 Wave Model Setup

The wave modelling used to complete this wave assessment was based on two model setups, with one long term hindcast wave model used to determine typical conditions acting within South Thomson Bay in the vicinity of the proposed structures, and a second small-scale high-resolution wave model used to transfer those waves to the shoreline and determine the influence of the proposed structures on the wave conditions at the facility and the adjacent shoreline.

The long term hindcast model analysed here is based on work undertaken for the Rottnest Wave Screen project, covering 4 years of hindcast data from 2017 to 2020. This model setup and validation are presented in Section 3.1.1, with further model details available in Baird (2021). The representative swell and sea conditions chosen to be assessed using the SWAN comparison analysis (Section 3.2) are informed by the data presented in Figure 3.3, and Table 3.1 and Table 3.2.

3.1.1 Hindcast Model

The hindcast model grids consisted of 5 grids increasing in resolution approaching Thomson Bay. The outer model grid is at a resolution of 500m x 500m and extends from Alkimos in the North to Secret Harbour in the South. Successive nested model grids at 200m, 50m and 10m resolution approaching Thomson Bay were used to downscale waves into the Bay (Figure 3.1). The model forcing consists of:

- Wave conditions at the boundary are applied from the measured waves of the Rottnest DWR (Hs, Tp, wave direction).
- Water level is applied based on the measured data from the Fremantle tide gauge.
- Winds over the model domain are applied as a grid based on the measured winds at Swanbourne and Rottnest Island BoM stations and these develop local seas inside the model domain.

Figure 3.1: Model domain for the hindcast SWAN wave model

To calibrate the wave model, the time-period corresponding to the measured wave conditions from Thomson Bay in 2012 was simulated. Measured wave conditions were collected over the period 13 August to 3 October 2012 (Figure 2.3) at four locations in Thomson Bay. The wave breaking and bed friction in the model were adjusted to account for reef structures around Wadjemup and inside Thomson Bay as part of the calibration process, to ensure the model could closely represent the measured data. Time series plots of the wave conditions from the model vs measured data over the approximate 2-month period is presented in Appendix A.

In summary the model showed good agreement with the measured wave data for significant wave height, period and direction at locations in Thomson Bay. The modelled wave conditions at the key sites considered to be the northern approach to Thomson Bay (AWACR1_01) and the two non-directional measurement locations closest the Thomson Bay Main Passenger Ferry jetty (R1_03 and R1_04) was found to be in good agreement with the measured data albeit the wave height was biased high in the location closest the jetty on the north side (R1_03). At locations in the south of Thomson Bay wave conditions were reproduced well for R1_02.

The period of data collection from Thomson Bay in 2020 was then simulated in the model as a validation exercise. The comparison of the measured and modelled wave conditions was found to be in good agreement (Appendix A). Based on the outcomes of the model validation, the model system is considered to reproduce the wave conditions in Thomson Bay well and suitable for application for developing the hindcast used in this study.

3.1.2 Hindcast Model Analysis

Data from the hindcast location shown in Figure 3.2 was used to determine representative swell and sea conditions to be used in the comparison of wave climate with and without the proposed barge ramp structure at the Army Groyne.

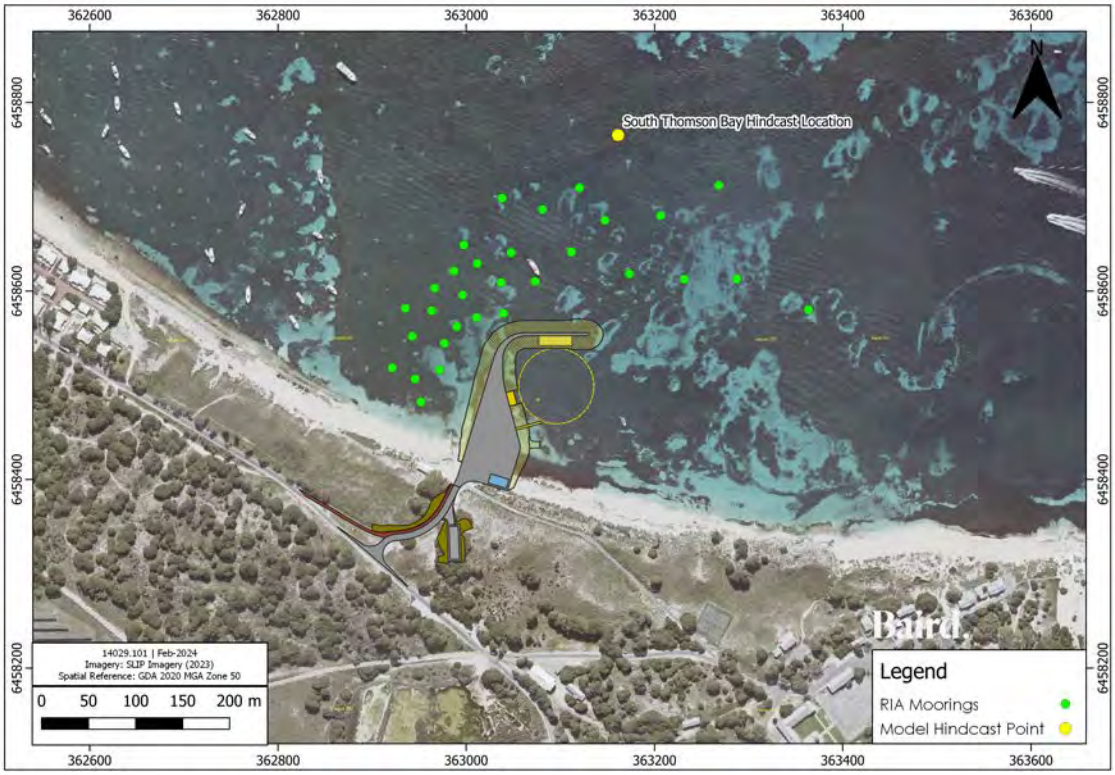

Figure 3.2: Location of hindcast analysis point in the vicinity of the proposed barge ramp facilities, as well as the nearby moorings managed by the Rottnest Island Authority.

Wave roses and joint frequency tables across the four year hindcast dataset for this location are shown for swell conditions in Table 3.1 and on the left in Figure 3.3 and windsea conditions in Table 3.2 and on the right in Figure 3.3.

This analysis shows that swell waves are consistently arriving at the site from the northern direction, with a very small scattering of swell waves from the eastern sector. Sea waves approach the site from a wider range of directions, predominantly from the northern to the eastern sector.

Table 3.1: Wave Height and Direction Joint Frequency Tables – 2017-2020 Hindcast Swell Conditions

Direction Hs (m)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total (%)
0.0-0.2	12.09	0.00	0.00	0.00	0.00	0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	12.98
0.2-0.4	34.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	34.60
0.4-0.6	34.38	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	34.52
0.6-0.8	15.34	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	15.45
0.8-1.0	2.37	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.40
1.0-1.2	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
1.2+	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	98.50	0.00	0.00	0.00	0.14	0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.72	100.00

Table 3.2: Wave Height and Direction Joint Frequency Tables – 2017-2020 Hindcast Sea Conditions

Direction Hs (m)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total (%)
0.0-0.2	16.26	0.01	0.05	0.36	2.76	10.92	0.00	0.00	0.00	0.00	0.01	0.00	0.14	0.01	0.05	1.64	32.21
0.2-0.4	20.52	0.18	1.75	2.40	8.87	22.46	0.00	0.00	0.00	0.09	0.02	0.00	0.03	0.00	0.01	1.81	58.14
0.4-0.6	4.31	0.00	0.75	0.92	1.38	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	7.99
0.6-0.8	1.16	0.00	0.06	0.09	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	1.41
0.8-1.0	0.22	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.24
1.0-1.2	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
1.2+	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	42.48	0.19	2.63	3.77	13.08	33.71	0.00	0.00	0.00	0.09	0.03	0.00	0.16	0.01	0.06	3.79	100.00

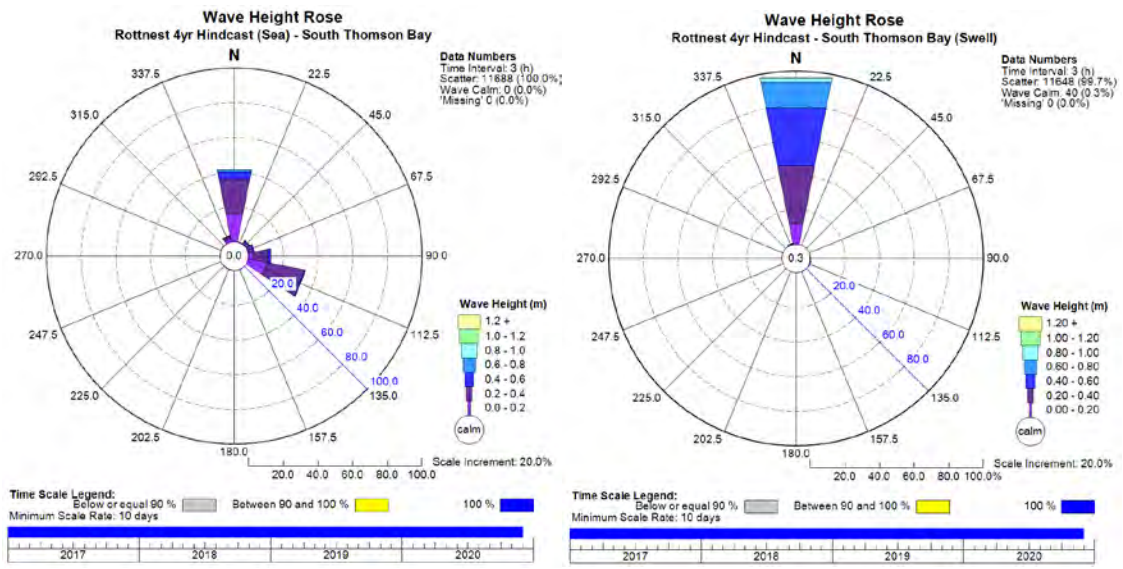

Figure 3.3: Wave roses of 2017-2020 hindcast dataset, showing sea conditions on the left and swell conditions on the right.

3.1.3 High Resolution Model – South Thomson Bay

A high resolution (2m x 2m) wave model was developed using SWAN to determine the difference in impact of a set of typical swell and sea conditions in the vicinity of the proposed barge facility, with and without the structures. The model grid setups without the proposed structures (i.e., to reflect existing conditions) is shown in Figure 3.4, with the grid setup with the proposed structures shown in Figure 3.5.

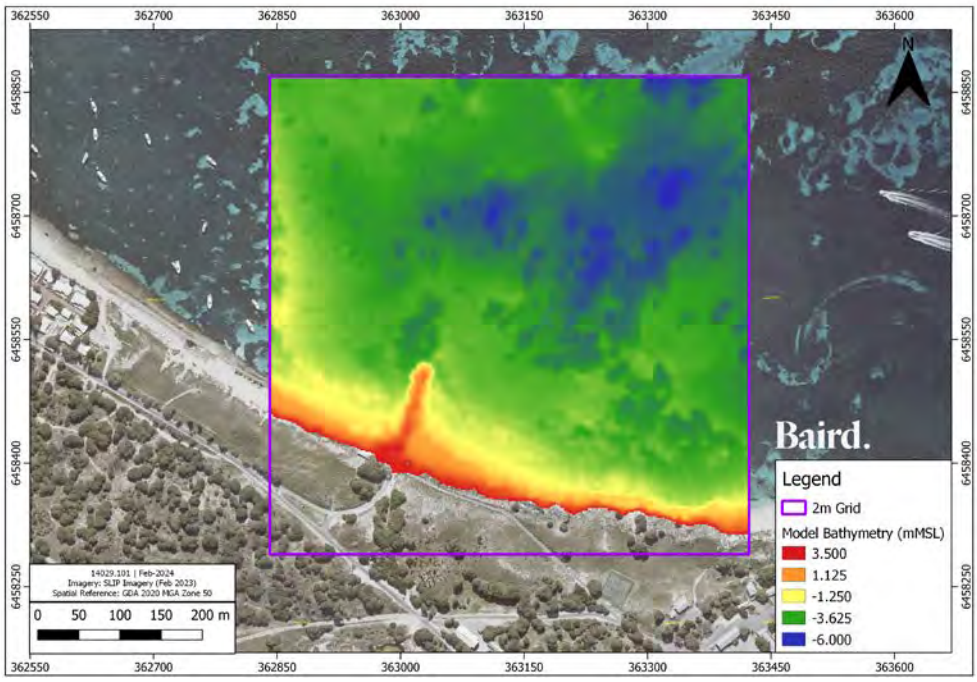

Figure 3.4: 2m resolution wave grid with model bathymetry reflecting existing conditions.

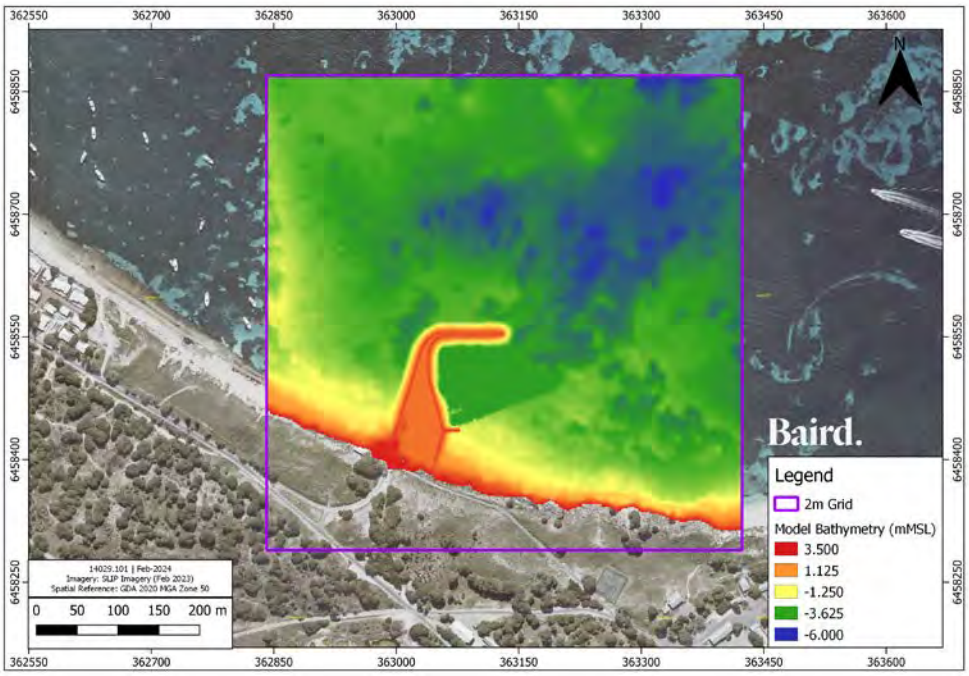

Figure 3.5: 2m resolution wave grid with model bathymetry reflecting the proposed structures and required dredged depth.

Boundary conditions were applied to the boundary of both model grids for each of the representative swell and sea cases determined from the 4-year hindcast data. The results of each model were then compared to determine the changes in wave conditions that were experienced in the vicinity of the proposed structures when compared to the wave conditions that would be experienced under the existing conditions at the Army Groyne.

3.2 Impact of Facility on Wave Conditions

To interpret the impact that the current concept may have on the wave conditions at the site in South Thomson Bay, interpretation of the changes to the wave conditions under a range of wave cases (e.g., incident wave height and direction) are shown below. The interpretation has been carried out on modelled cases based on:

- Swell event (Figure 3.6):
  - H_s = 0.5m
  - Dir = 0 °N
- Northern windsea event (Figure 3.8):
  - H_s = 0.6m
  - Dir = 0 °N
- Northeastern windsea event (Figure 3.10):
  - H_s = 0.4m
  - Dir = 45 °N
- Eastern windsea event (Figure 3.12):
  - H_s = 0.45m
  - Dir = 90 °N

Plots showing the impact of each of the wave cases outlined above are shown below, with difference plots showing the change in the wave impacts with and without the structures for the swell event in Figure 3.7, the northern windsea event in Figure 3.9, the northeastern windsea event in Figure 3.11, and the eastern windsea event in Figure 3.13. The following observations of changes to the wave impacts with and without the structures in place have been made:

- The wave shadowing seen at the shoreline on the western side of the breakwater is minimal, with a difference of <0.1m in each wave case when compared to the existing condition. This is due to the impact that the existing Army Groyne structure has on waves on its western side when arriving at the structure from the predominant directions experienced at this location (i.e., from the northern to eastern sector).
- While the greatest reduction in wave height when compared to the existing conditions is seen within the harbour basin area, some reduction in wave height along the shoreline on the eastern side of the breakwater is also evident, with wave shadowing increasing up to 0.4m a short distance to the east from the breakwater structure. This is most prominent, and has the greatest spatial impact, in the northerly wave cases.
- This reduction in wave height and its impact on the sediment transport pathways within South Thomson Bay are discussed further in Section 4.
- The wave shadowing seen within the harbour structure (most prominent with the northerly wave condition cases) create a reduction between 0.1m and 0.4m across the cases, with the expectation that some wave direction conditions could produce a reduction in wave climate of up to 0.4m within the harbour basin. Further discussion on the impact this may have on sediment dynamics and the transport of wrack in and around the harbour are discussed further in Section 4 and Section 5.

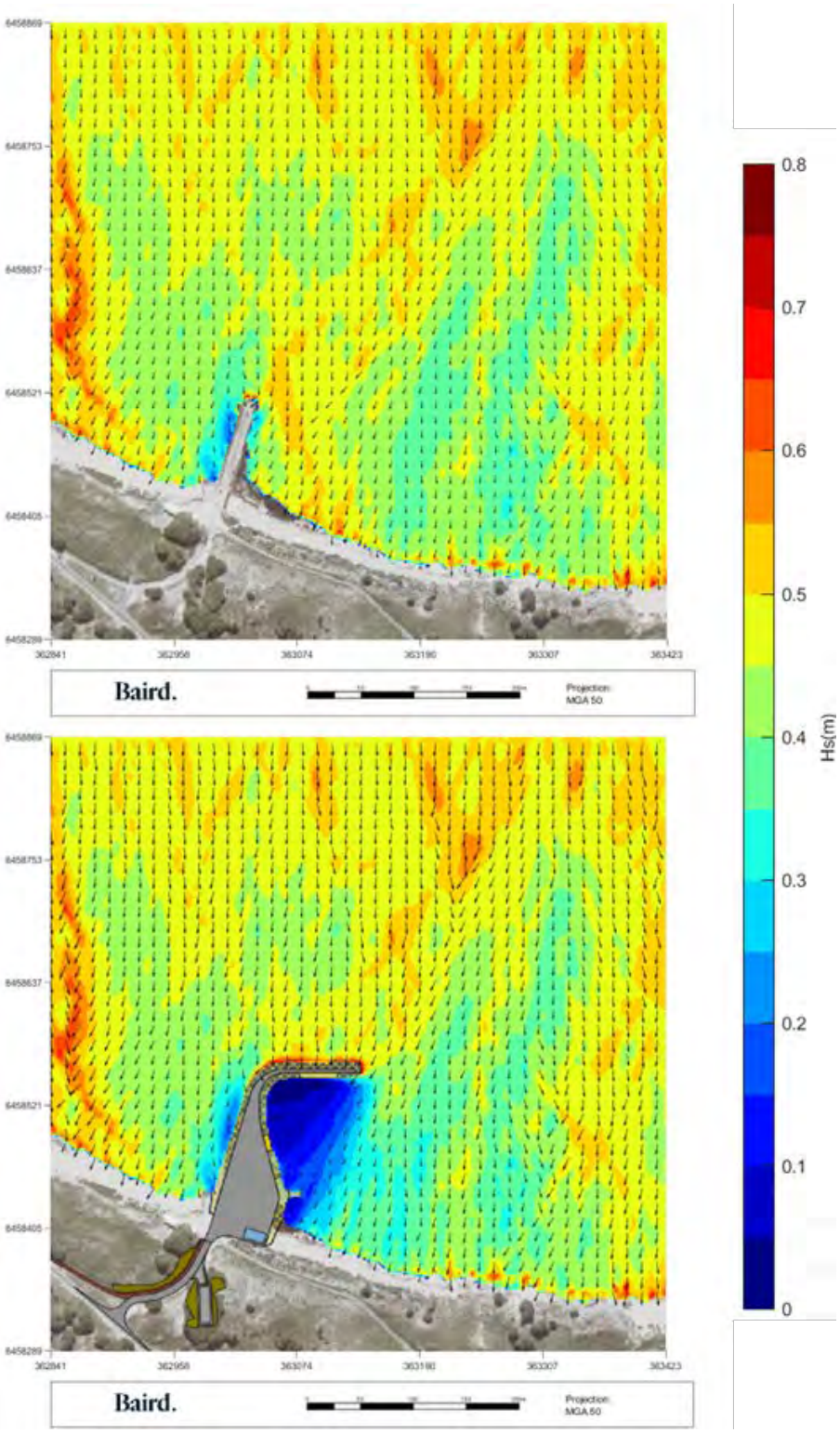

Figure 3.6: Northern swell event wave plots showing wave conditions at the Army Groyne (top) and at the proposed barge landing facility (bottom)

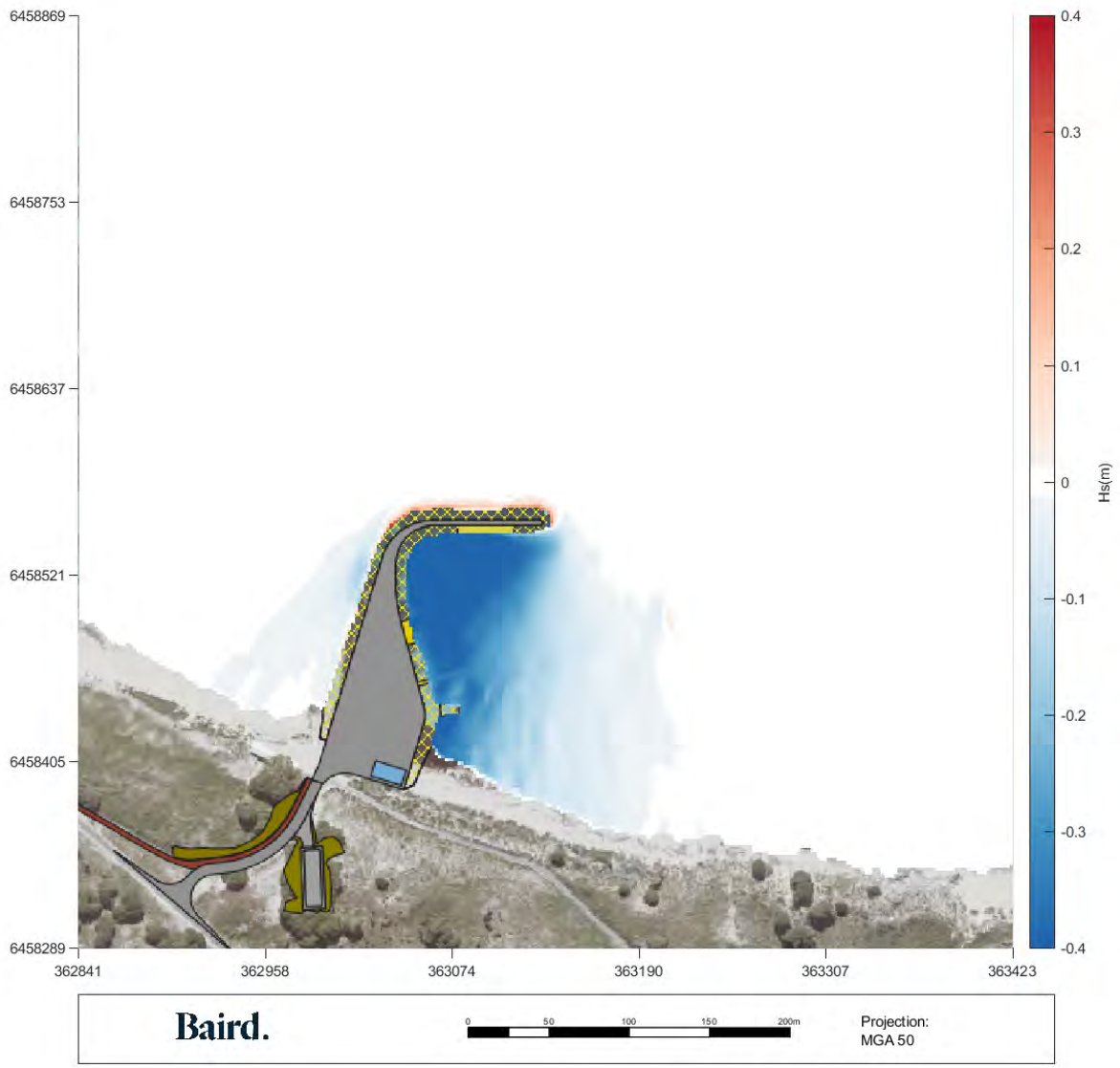

Figure 3.7: Northern swell event wave plot showing the difference between incident waves with and without the proposed structures

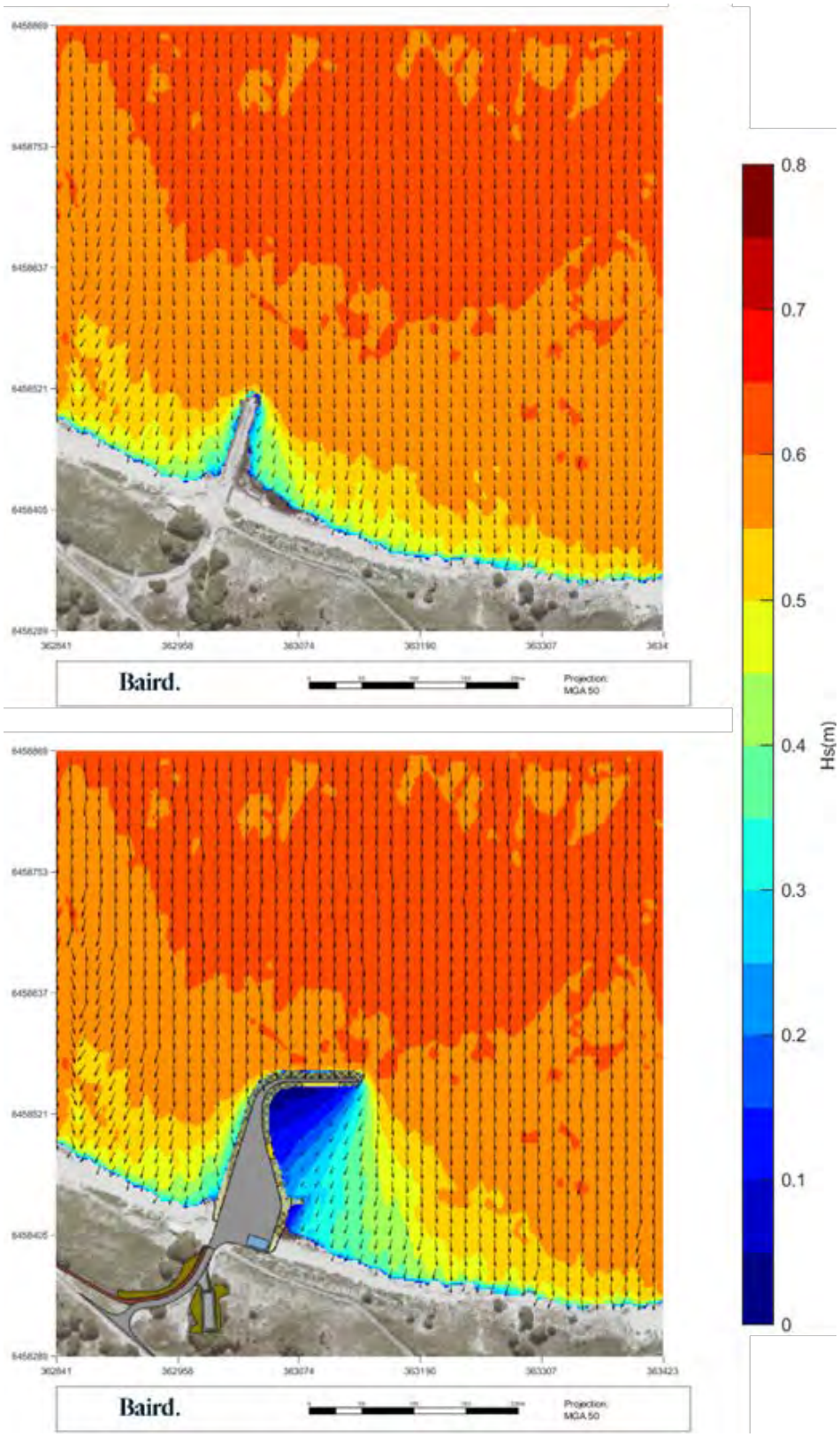

Figure 3.8: Northern windsea event wave plots showing wave conditions at the Army Groyne (top) and at the proposed barge landing facility (bottom)

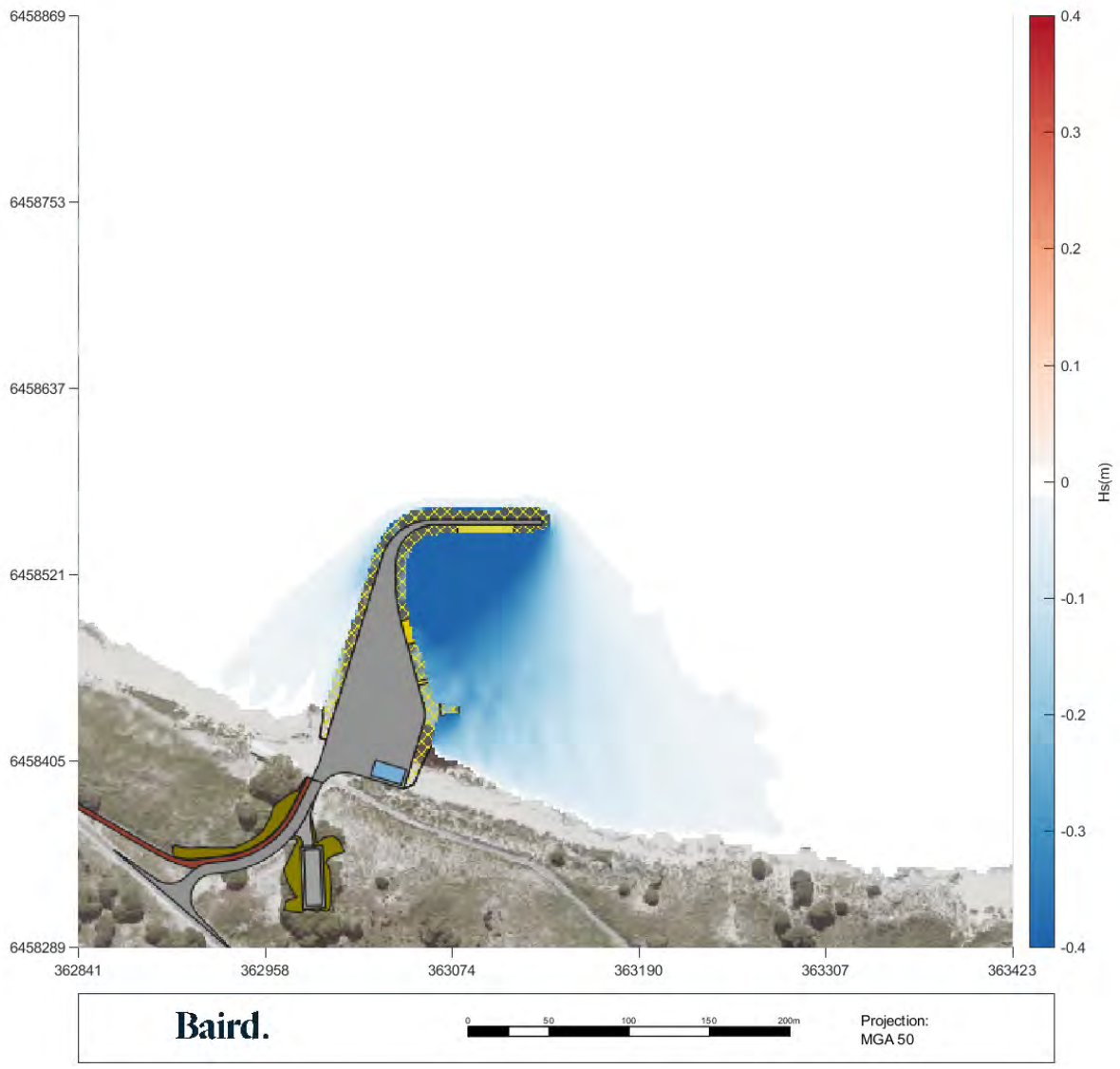

Figure 3.9: Northern windsea event wave plot showing the difference between incident waves with and without the proposed structures

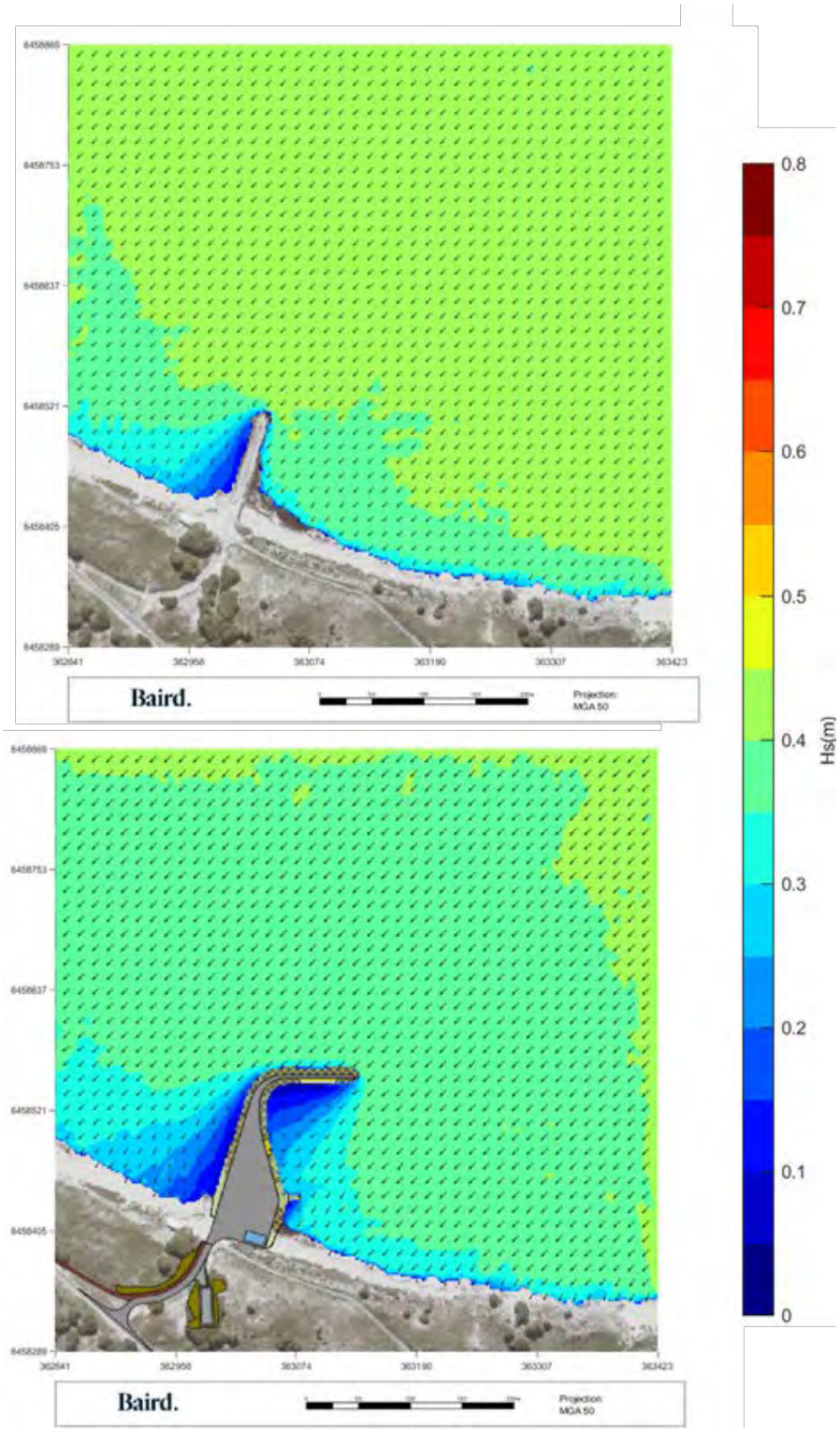

Figure 3.10: Northeastern windsea event wave plots showing wave conditions at the Army Groyne (top) and at the proposed barge landing facility (bottom)

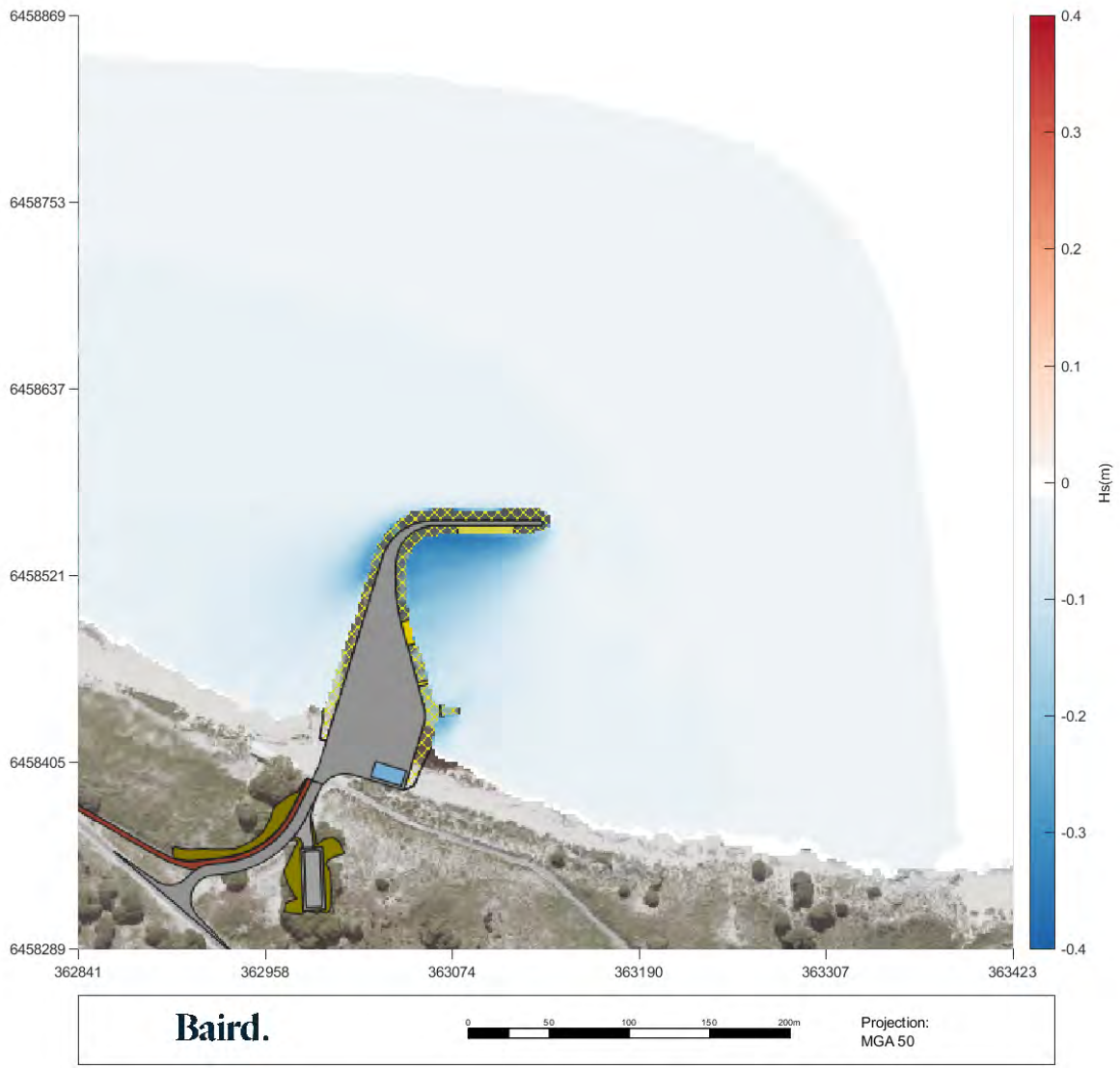

Figure 3.11: Northeastern windsea event wave plot showing the difference between incident waves with and without the proposed structures (bottom)

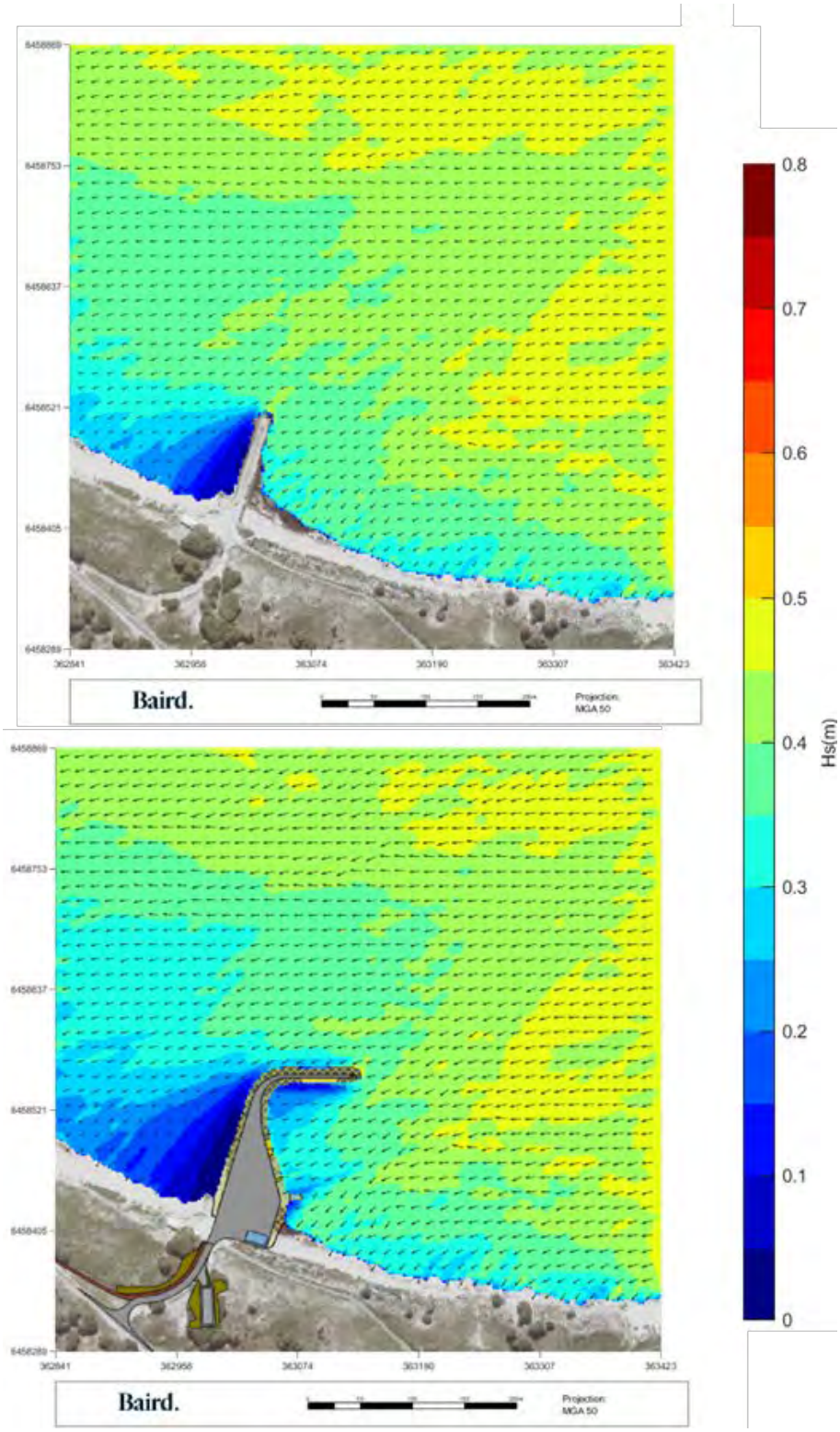

Figure 3.12: Eastern windsea event wave plots showing wave conditions at the Army Groyne (top) and at the proposed barge landing facility (top right,

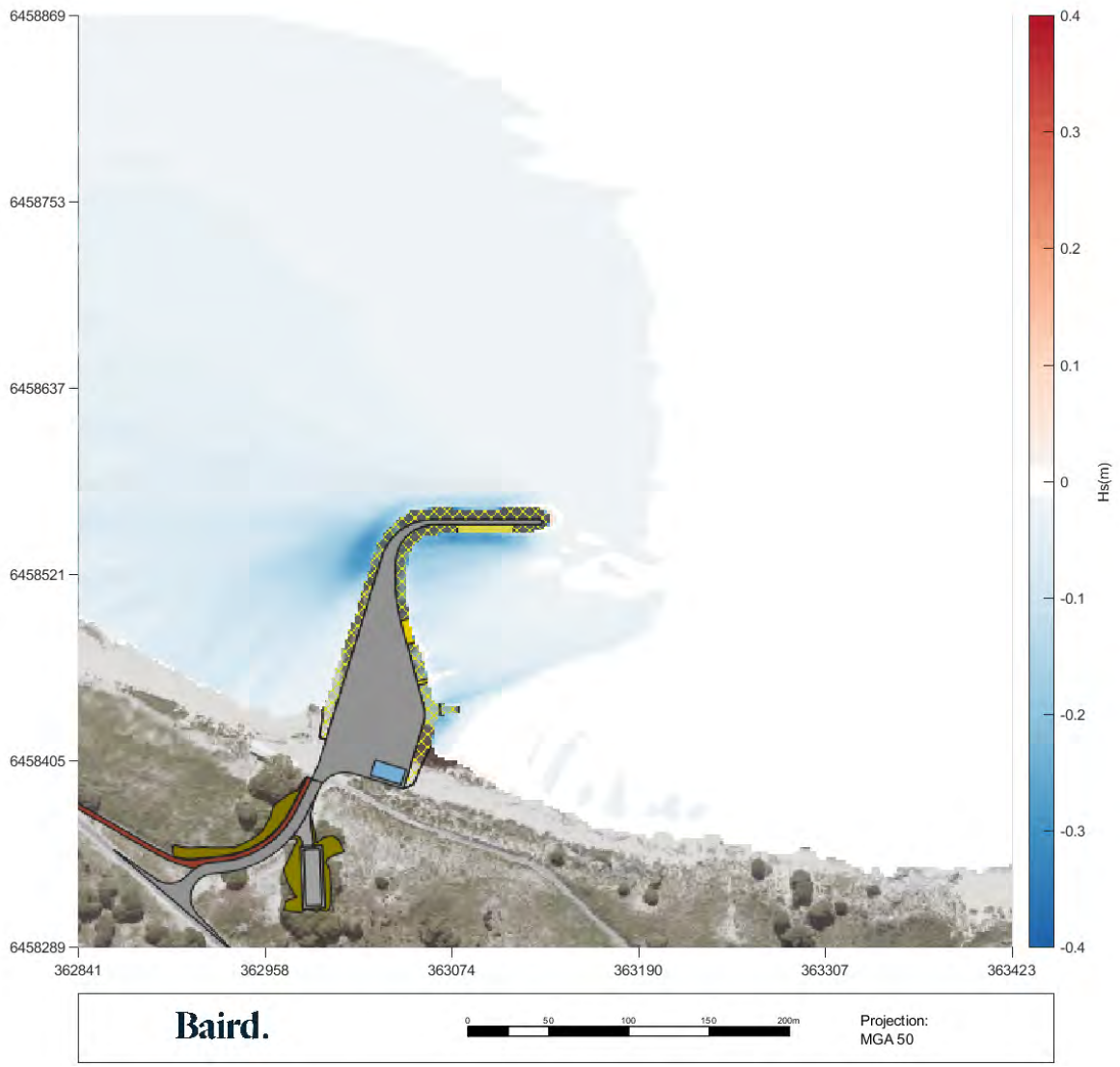

Figure 3.13: Eastern windsea event wave plot showing the difference between incident waves with and without the proposed structures (bottom)

3.2.1 Impact on RIA Managed Moorings

SWAN model cases were run with the inclusion of the influence of reflections at the structures, represented as a sheet structure at the crest of the breakwater that produces diffuse reflections (scattering of reflections will be caused by a rubble mound structure, Boshek 2009) with a reflection coefficient of 0.85 (Pratola et al 2021). As seen in each of the comparison plots from Figure 3.6 to Figure 3.13, the impact on wave conditions outside of the proposed barge facility breakwater structure is minimal, with decreases in wave height being the main observation across each of the cases. While no detrimental increase in wave height caused by reflections from the breakwater structure is seen at the moorings managed by RIA in these model results (the proximity of these moorings to the proposed structure is shown in Figure 3.2), further investigation of this should be undertaken in the detailed design phase using a wave phase resolving model, as a model of this kind is more suitable for investigating the complexity of reflected wave interactions.

4. Sediment Assessment

An assessment of the sediment transport pathways that make up the sediment budget of the coastal compartment along South Thomson Bay is important for determining the impact that a coastal structure may have on these pathways, and therefore the overall function of this sediment compartment.

4.1 Sediment Transport Pathways

There are three typically important sediment transport mechanisms that contribute to an overall coastal sediment budget (Figure 4.1), each of which will be described for South Thomson Bay in this section:

- Cross-shore Sediment Transport
- Longshore Sediment Transport
- Aeolian (wind-blown) Sediment Transport

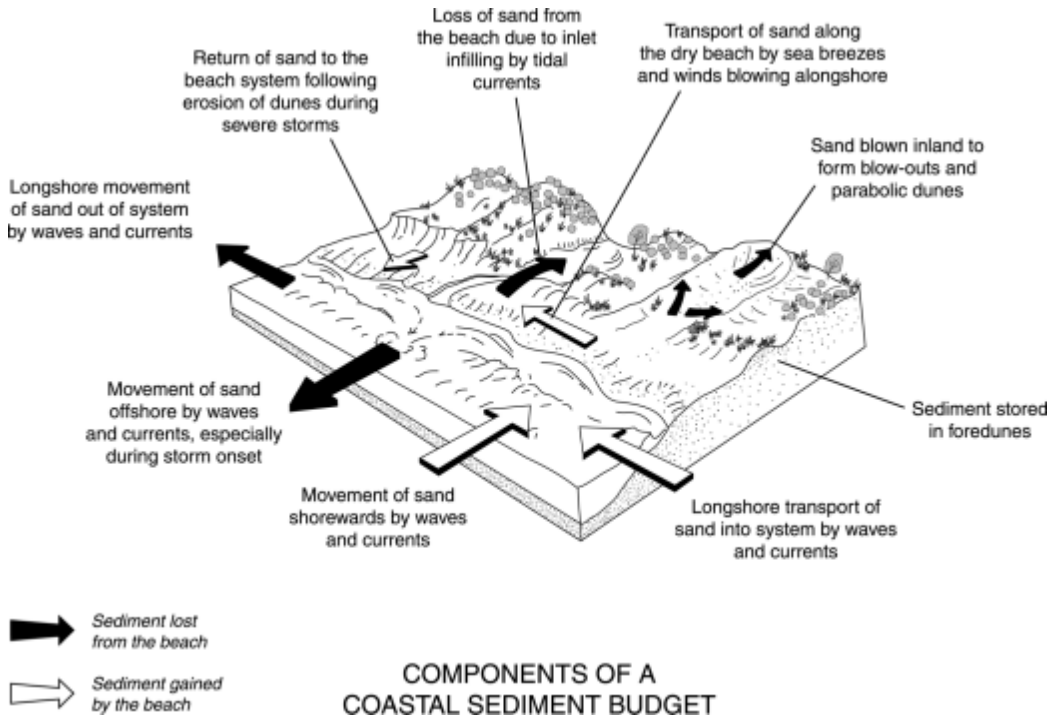

Figure 4.1: Components of a coastal sediment budget (WAPC 2013a)

4.2 Cross-shore Sediment Transport

The cross-shore movement of sediment within a coastal compartment, or sediment cell, has a significant contribution to the overall sediment budget within that compartment, as seen in Figure 4.1. Movement of sediment offshore by waves and currents during a storm reduces the volume of sediment in the dune system backing the beach (profile B and profile C in Figure 4.2), often forming offshore sand bars that can act as wave attenuators that cause waves to break further offshore and decreasing the wave energy that can reach the beach and dune system (CERC 1984). This erosion is typically followed by the return of sediment to the beach system following the passage of the storm through the onshore movement of sediment by waves and currents during calmer conditions.

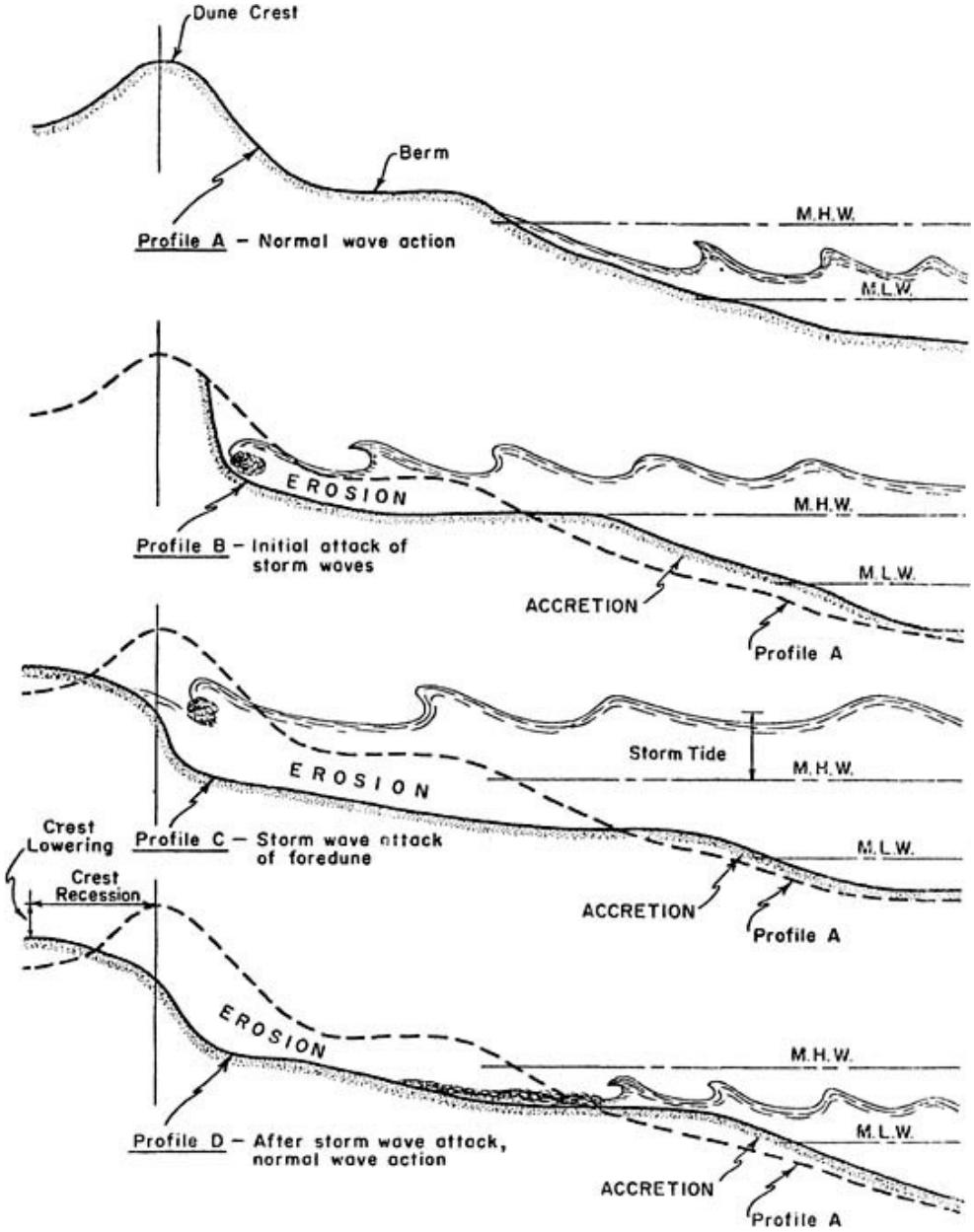

Figure 4.2: Stages of cross-shore sediment movement prior to, during and following the passage of storm waves on a sandy shoreline (Herbich et al., 1982)

Cross-shore sediment transport assessments used to determine the potential for the loss of sediment from the beach and dune system have recently been conducted for South Thomson Bay by MRA in their 2019 South Thomson Bay Coastal Processes Assessment, and by Cardno in their 2022 Coastal Hazard Risk Management and Adaptation Plan for Rottnest Island. An overview of Cardno's assessment is included here due to the more recent nature of the assessment, with due consideration and comparison to the assessment undertaken by MRA in 2019.

As recommended in the State Planning Policy No. 2.6: State Coastal Planning Policy (SPP2.6) (WAPC 2013b), the CHRMAP assessment investigated the impacts of short-term acute (storm-induced) erosion on various sites around Wadjemup (Rottnest Island), including within South Thomson Bay. The full set of transects included in the CHRAMP study are shown in Figure 4.3, with the inset at the top left-hand corner

showing the transects of interest within South Thomson Bay; Transect 24 and Transect 25 on either side of the existing Army Groyne.

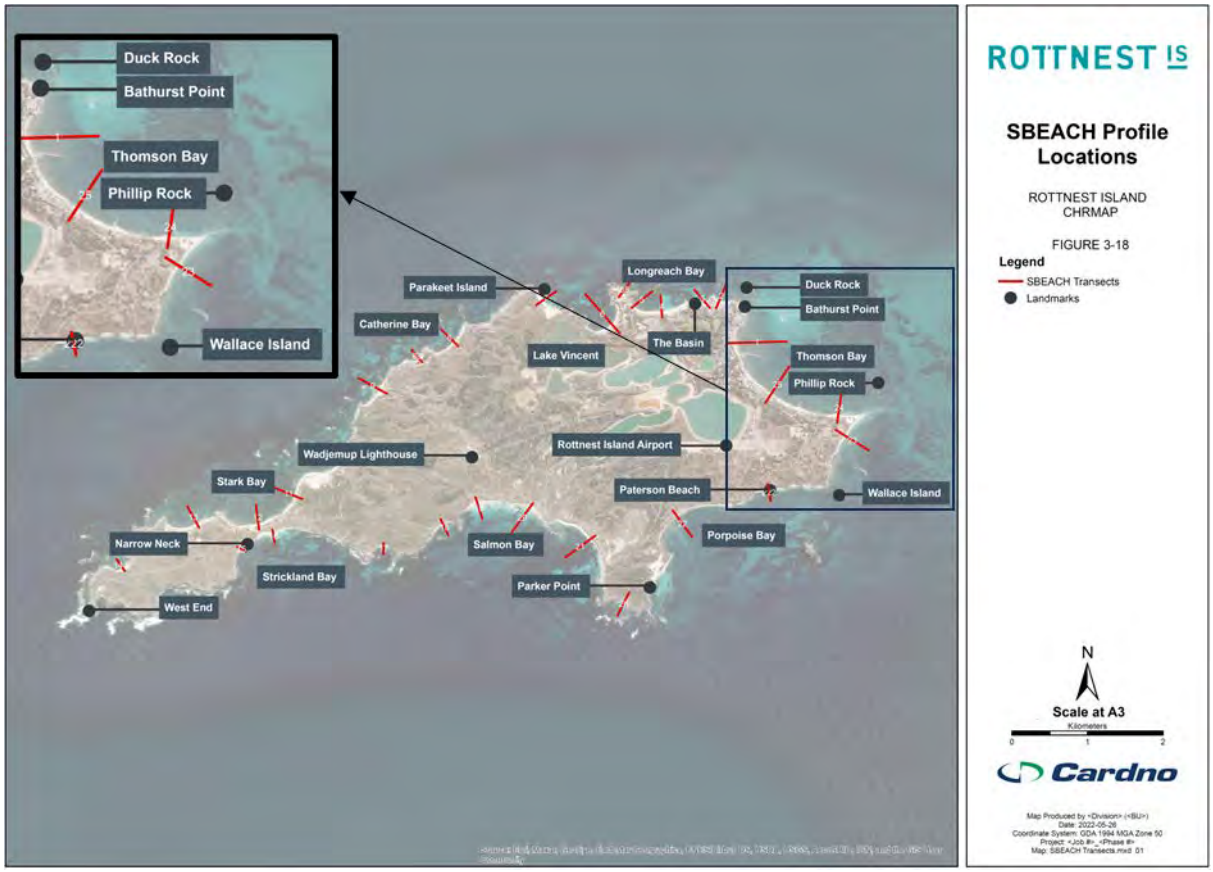

Figure 4.3: SBEACH profile locations from Cardno (2022)

SBEACH modelling was undertaken by Cardno based on a scaled design storm event defined in DoT's synthetic storm database (MRA 2018) at the Rottnest DWR, comprising of a large south westerly swell, coinciding with strong south-westerly through to north-westerly winds and a water level below that of the 1-year ARI at the Fremantle tide gauge. Due to the highly variable aspect of the beaches around Wadjemup, and most of the storms within the design storm event database being derived for Perth's western facing beach aspects, Cardno undertook subsequent wave modelling to derive more representative storm parameters for each of the transects included in the CHRMAP. The parameters that were derived from this modelling were used to scale the storm to be appropriate for use at South Thomson Bay, with these scaled H_s, T_p, and Peak Storm Dir defined for Transect 24 (T024) and Transect 25 (T025) shown in Table 4.1. The median sediment diameter (D_{50}) that was used as an input to the SBEACH modelling for the two transects in this region was based on sediment sampling undertaken by Cardno as part of the CHRMAP scope (Cardno 2022), shown in Table 4.1, with the timeseries applied in the SBEACH modelling shown in Figure 4.4.

Table 4.1: Wave conditions and sediment sizing adopted for SBEACH modelling in South Thomson Bay (adapted from Cardno 2022)

Transect	H_s (m)	T_p (s)	Peak Storm Dir	D_{50} (mm)
T024	1.68	7.4	N	0.39
T025	1.61	7.4	N	0.26

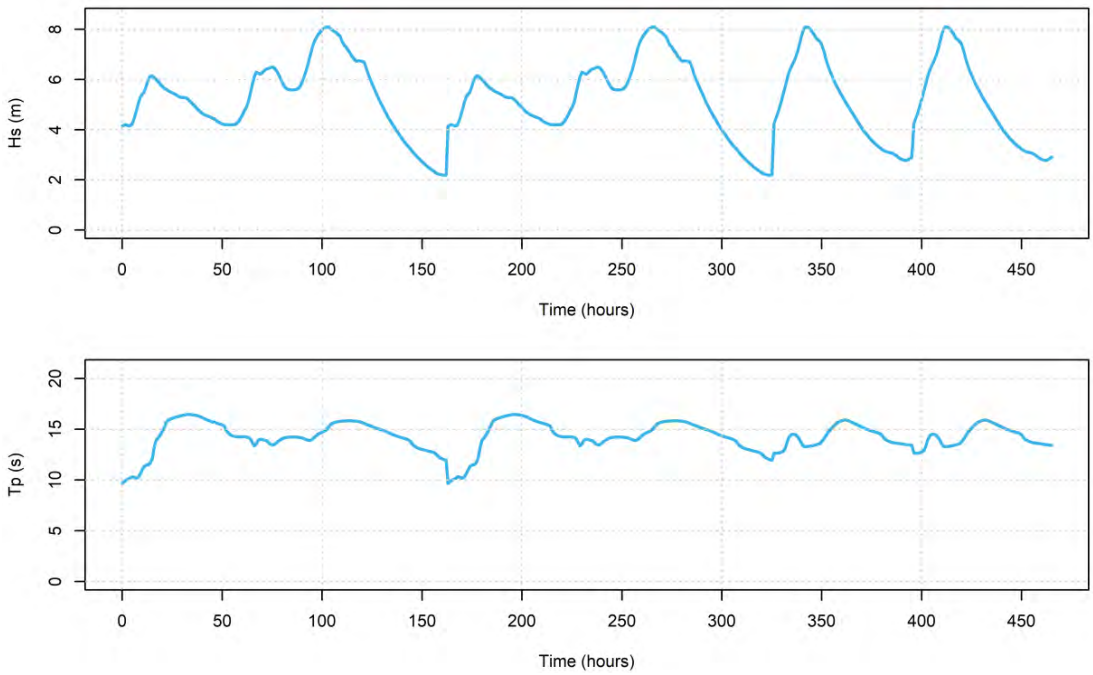

Figure 4.4: Timeseries of Hs and Tp during the synthetic design storm event at the Rottnest DWR, taken from MRA 2018 to be used in the Rottnest Island CHRMAP (Cardno 2022)

The results of the cross-shore erosion assessment using the SBEACH method outlined above are presented for Transect 24 in Figure 4.5 and for Transect 25 in Figure 4.6. These results show that there can be expected to be between 5m and 10m cross-shore erosion during the 100-year ARI design erosion event in South Thomson Bay, which is in line with the 5-10m expected erosion extent predicted by MRA in their 2019 assessment.

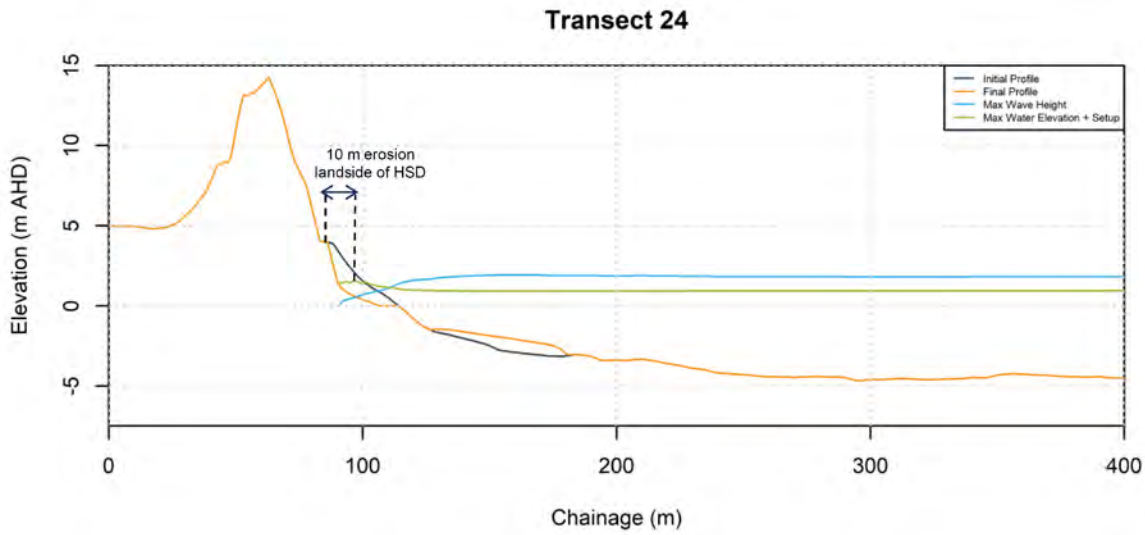

Figure 4.5: SBEACH Profiles derived from the scaled synthetic storm at Transect 24 within South Thomson Bay

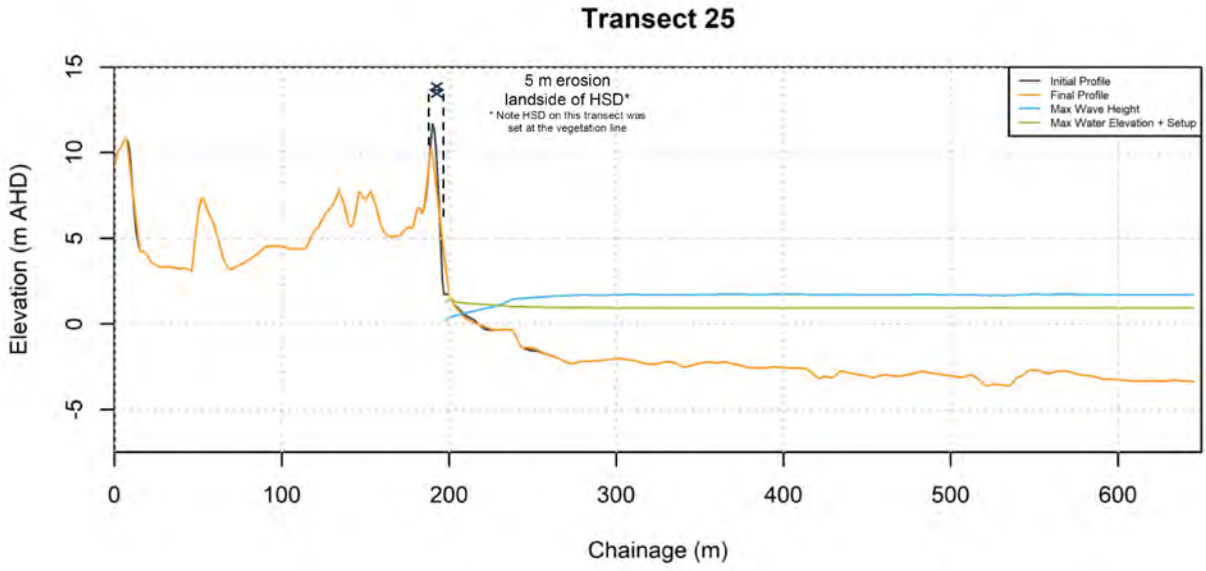

Figure 4.6: SBEACH Profiles derived from the scaled synthetic storm at Transect 25 within South Thomson Bay

4.3 Longshore Sediment Transport

Longshore sediment transport results from the agitation of sediments through wave and/or current action at the beachface and the subsequent movement of sediment along the shoreline via the component of the wave energy that is acting along the shoreline (as opposed to the cross-shore compenent of that energy) and the longshore current that is produced by this wave action (CERC 1984). A simplified diagram of the dynamics of longshore sediment transport is shown in Figure 4.7.

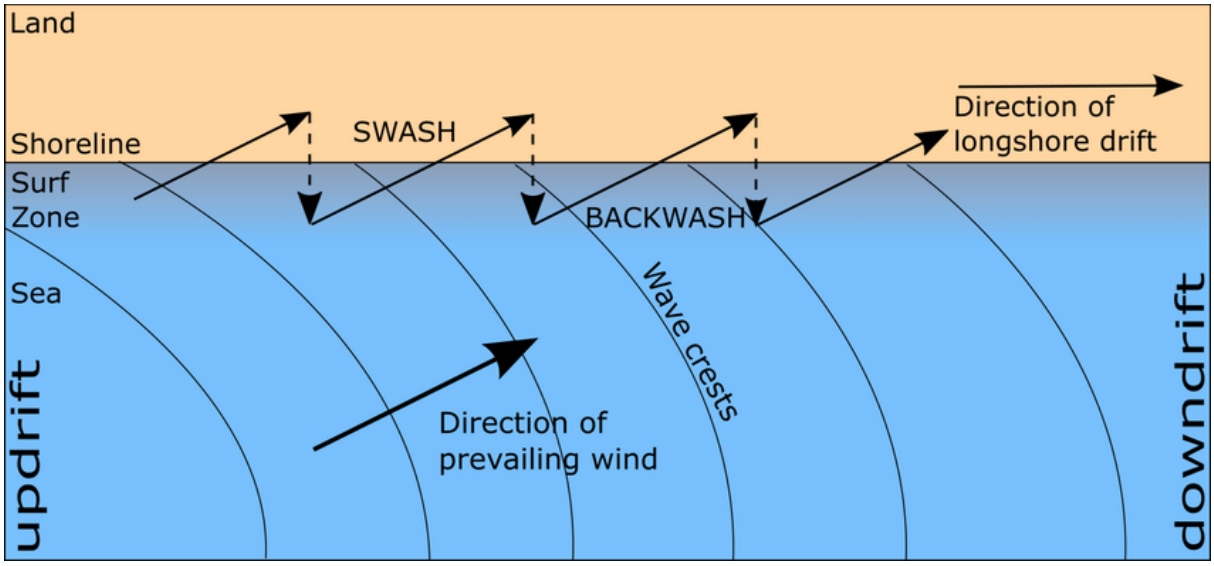

Figure 4.7: Simplified diagram of longshore drift on sandy beaches (van Zyl 2018)

There are a range of measurements and observational methods that are useful when looking to determine the rate of longshore sediment transport, including:

- Analysis of historical aerial imagery

- Analysis of changes to survey data
- Analysis of shoreline movements over time, noting that this estimate will also take into account cross-shore movements of sediment and so is an overall proxy for longterm shoreline movement rather than solely for the estimation of longshore sediment transport

4.3.1 Historical Aerial Image Analysis

Aerial imagery at approximate 10 year intervals dating back from 2023 (2001 is earliest aerial imagery available via the WA Government's SLIP database) at Thomson Bay (Figure 4.8) show that there has been little to no erosion in the vicinity of the Army Groyne since 2001. A version of this image comparison zoomed into close proximity to the Army Groyne (Figure 4.9) further shows that there is very little movement in the vegetation line to the west of the Army Groyne (minimal accretion in the dune is apparent), with greater evidence of accretion and vegetation growth to the east of the Army Groyne.

Seasonal accretion against the eastern side of the Army Groyne structure is evident, with each of the images from 2001, 2003, and 2023 taken in the period from December to February showing an accummulation of sediment. This is in contrast to the beach width seen on the eastern side of the Army Groyne structure in the 2013 image (also taken in February), with the beach shape during that year (i.e., narrow at the groyne and wider with distance east from the groyne) potentially explained by the preceding La Niña cycles from 2010-11 and 2011-12 producing greater positive sea level anomalies in the season's immediately prior to this image (CSIRO 2015).

Figure 4.8: Historical aerial images from 2001 to 2023 in South Thomson Bay overlaid with the 2023 shoreline (proxied by the 2023 vegetation line)

Figure 4.9: Historical aerial images from 2001 to 2023 in close proximity to the Army Groyne overlaid with the 2023 shoreline (proxied by the 2023 vegetation line)

Comparison of aerials from 2001 to 2023 was also undertaken for the area in the vicinity of Bickley Point due to the relative variability in the shoreline in this region since 1964 (see historic shoreline analysis in Section 4.3.2 below) and the influence this may have on the availability of sediment in South Thomson Bay.

Figure 4.10 indicates that the overall shoreline position around Phillip Point has experienced little fluctuation since 2001, with the shoreline within Bickley Bay experiencing an erosion event followed by recovery of the dune in this area evidenced by the sparser vegetation along this length of shoreline in 2023. Figure 4.11, zoomed in closer to the detail of Phillip Point, shows that the spit linking to the Natural Jetty at this location experiences periods of elongation and truncation, but with the overall position of the point held in place by the Natural Jetty. Evidence of potential future destabilisation of this area is seen through the growth of the dune blowout, progressing each decade up to 2023.

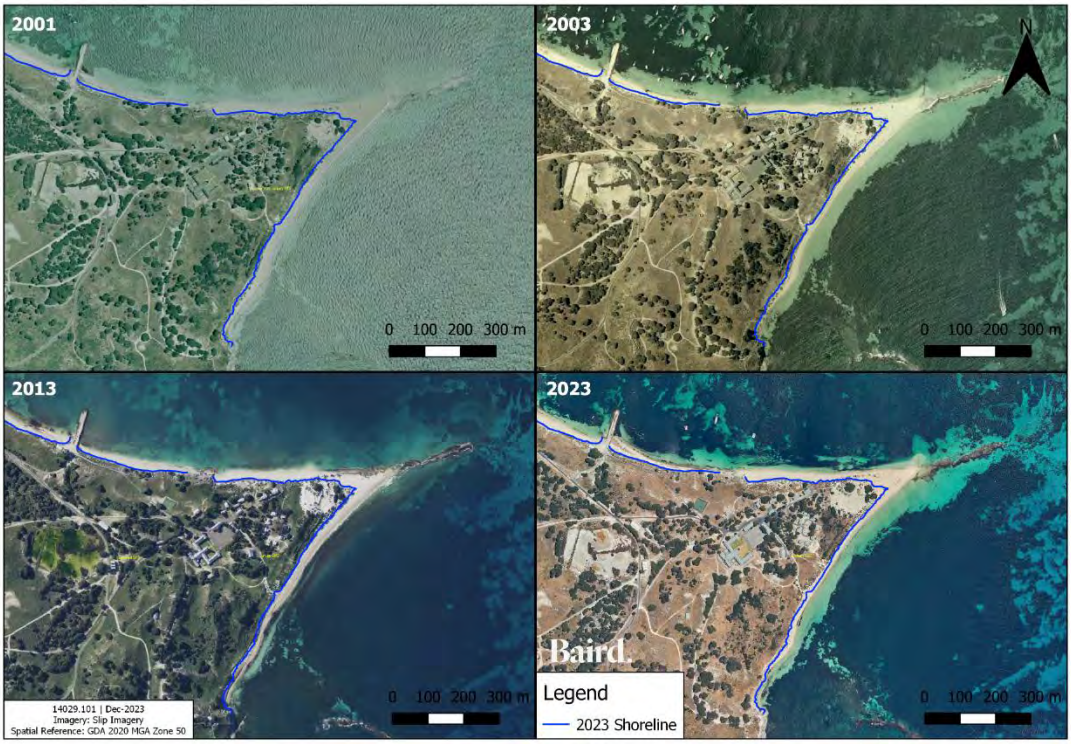

Figure 4.10: Historical aerial images from 2001 to 2023 at Point Phillip overlaid with the 2023 shoreline (proxied by the 2023 vegetation line)

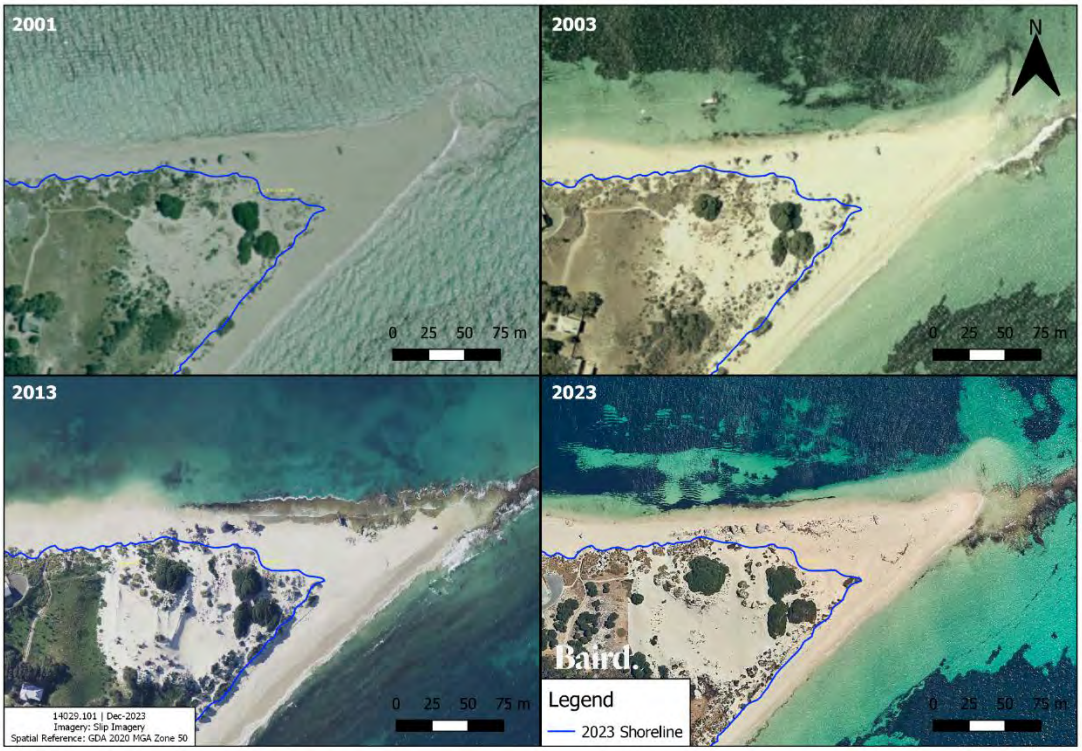

Figure 4.11: Historical aerial images from 2001 to 2023 at Point Phillip overlaid with the 2023 shoreline (proxied by the 2023 vegetation line), zoomed into close proximity to the Point

4.3.2 Shoreline Movement Plotting

Analysis of historical shoreline positions has been undertaken in previous investigations by MRA (2019) and Cardno (2022), with each of these assessments showing that the shoreline in the vicinity of the Barge Landing development site at the Army Groyne is experiencing some of the smallest fluctuations seen around Thomson Bay. The historic vegetation lines and chainages used by MRA in their assessment of historic shoreline movement in their 2019 coastal processes assessment are shown in Figure 4.12, with the plot of shoreline position at each chainage relative to the 1964 baseline year shown in Figure 4.13.

The largest movement seen around Thomson Bay by MRA is the accretionary pattern evident to the north towards Bathurst Point, and the erosion pattern seen south of Phillip Point in Bickley Bay, with the 2016 shoreline position at the Army Groyne either in line with the 1964 position (west of the Army Groyne) or further seaward of the 1964 position (east of the Army Groyne) indicating accretion.

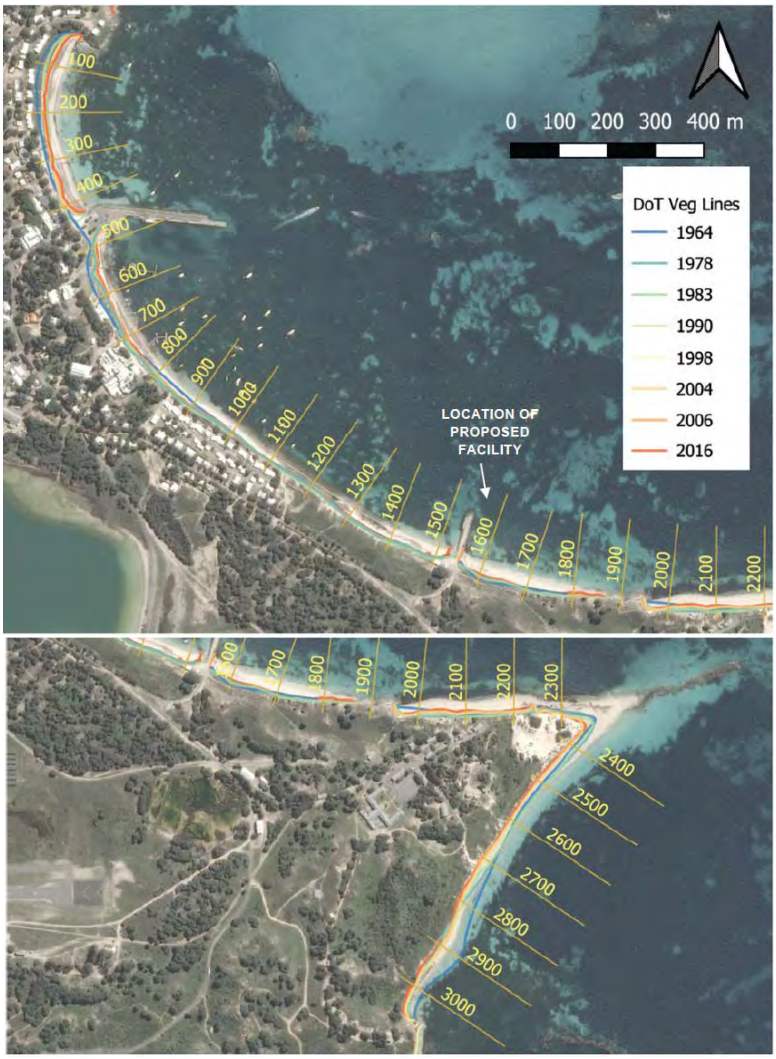

Figure 4.12: Detail of the historic vegetation lines and chainages for Thomson Bay and Bickley Bay used by MRA in their assessment of historic shoreline movement in their 2019 assessment (MRA 2019)

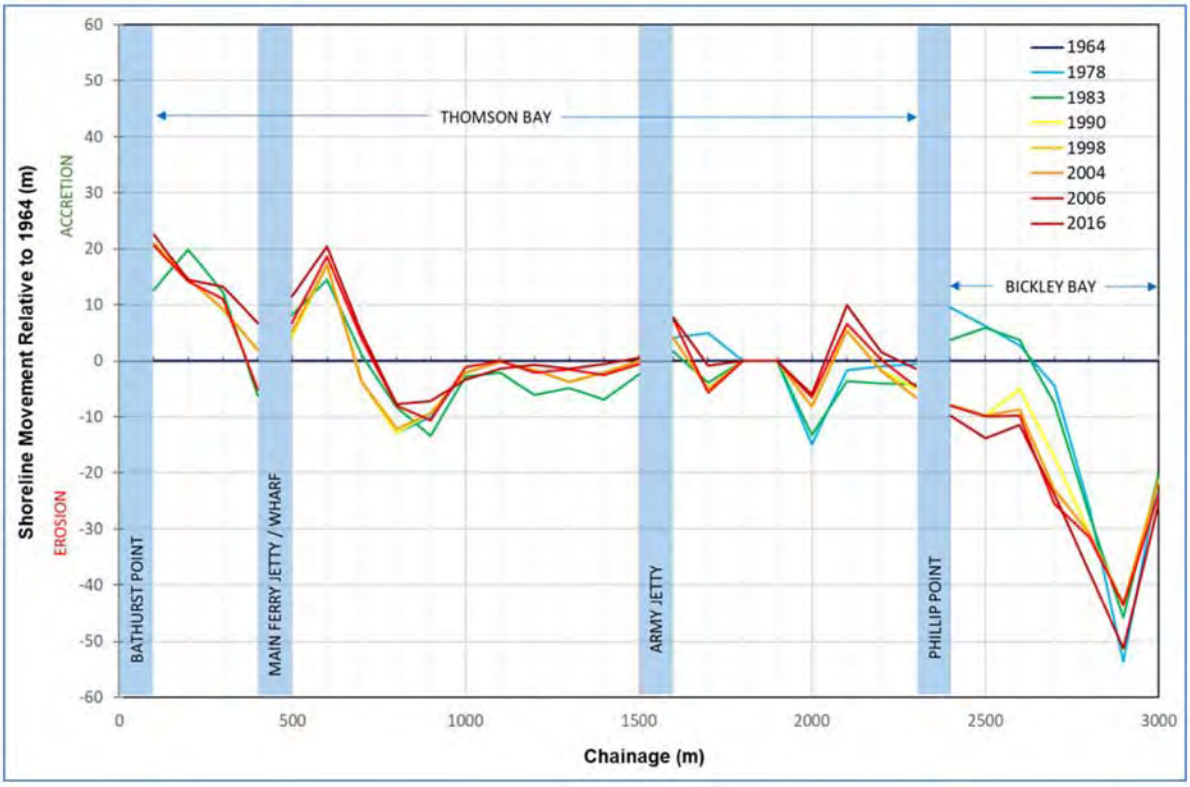

Figure 4.13: Shoreline movement trends relative to the 1964 baseline (MRA 2019)

A similiar assessment was carried out in Cardno (2022, with the chainages used within Thomson Bay shown in Figure 4.14 and the outcome of the shoreline movement analysis shown in Figure 4.15. The chainages closest to the Army Groyne in South Thomson Bay are between 120 and 122, showing an erosion/accretion pattern between 2005 and 2021 of ±5m, also indicating that the shorelines in this area are experiencing only small fluctuations in position across the timeframes investigated.

Update to the shoreline movement analysis has been undertaken here to determine if the trends identified by MRA (2019) and Cardno (2022) have continued into 2023, with Figure 4.16 showing shoreline position for 2016, 2019 and 2023 at the Army Groyne location in South Thomson Bay. This analysis shows that the shoreline position is largely unchanged between 2016 and 2023, with the largest region of erosion seen to the west of the Army Groyne at approx. 4m, and the largest region of accretion seen to the east of the Army Groyne at approx. 3m.

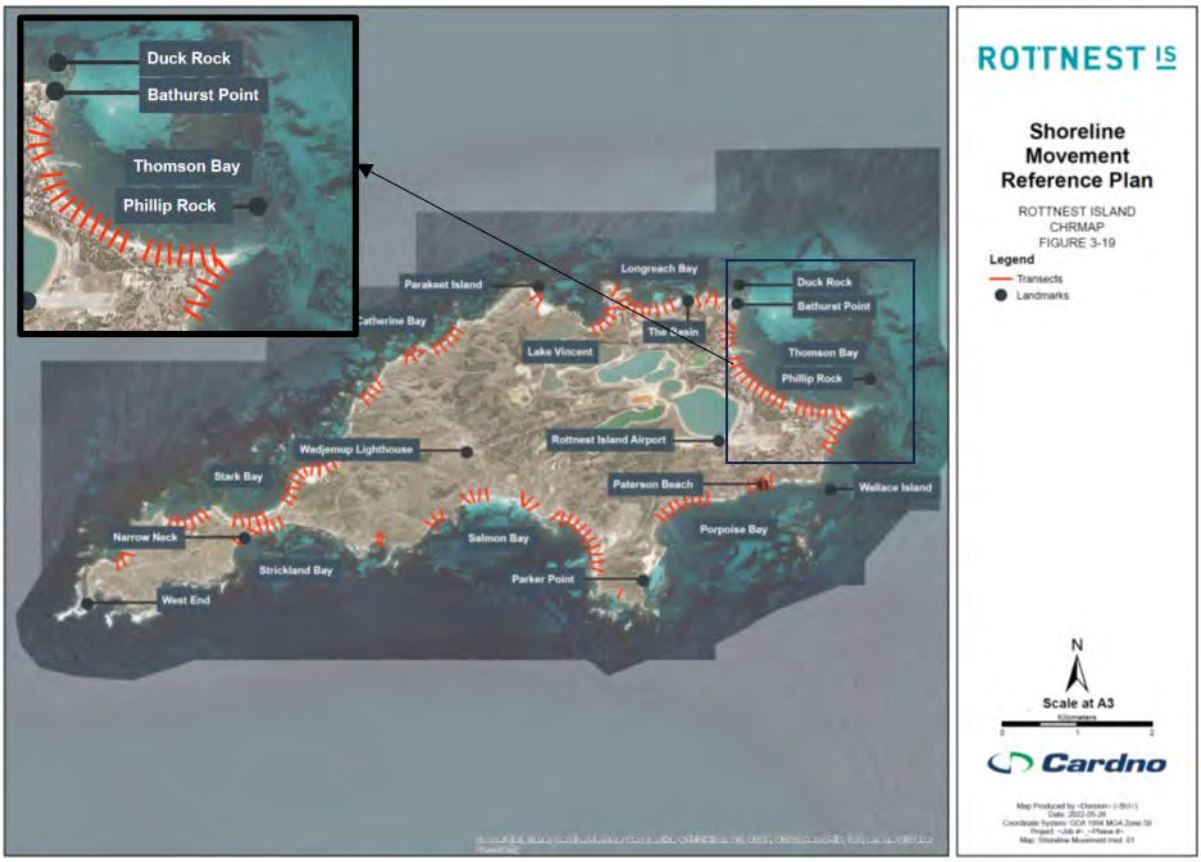

Figure 4.14: Chainages used by Cardno in their assessment of historic shoreline movement in their 2023 CHRMAP, with the inset showing the chainages used within Thomson Bay and Bickley Bay (Cardno 2022)

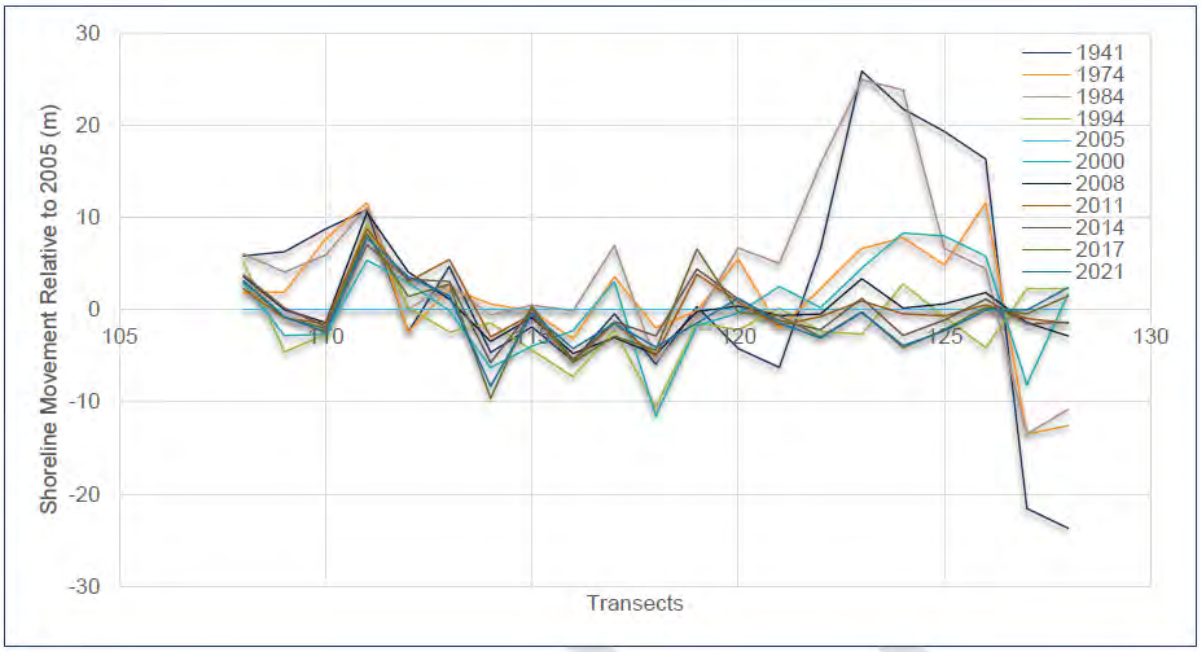

Figure 4.15: Shoreline movement plot relative to a 2005 baseline for Thomson Bay (Cardno 2022)

Figure 4.16: Overview of the latest shoreline movements, showing the 2019 and 2023 shorelines aligned to the 2016 shoreline

4.4 Aeolian Sediment Transport

Evidence of the movement of sediment through aeolian (wind-blown) transport is seen in the progression of blowouts, mostly minor, across the shoreline of South Thomson Bay. This is seen through the minor dune blowout progression between 2016 and 2023 in Figure 4.17 and the larger dune blowout progression between 2001 and 2023 at Point Phillip in Figure 4.11. Human access to the dunes also plays a part in the progression of this blowout, with children observed playing in this area due to the close proximity to popular tourist accommodation in South Thomson Bay.

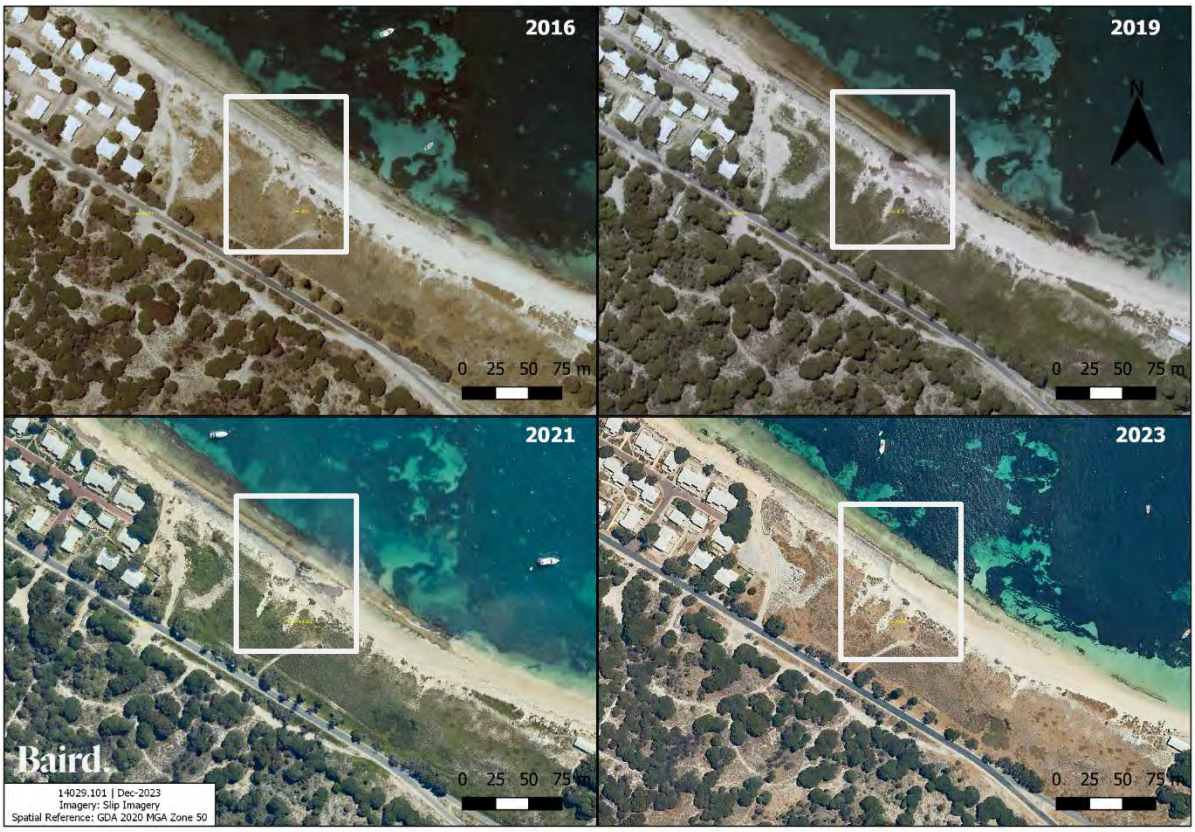

Figure 4.17: Progression of a minor dune blowout in South Thomson Bay, west of the Army Groyne, between 2016 and 2019

A calculation of the potential for windblown sand volumes along this section of the coast was undertaken based on the Hsu (1986) equation for windblown sand transport as summarised in the Coastal Engineering Manual (USACE, 2008). The calculation of transport potential was completed adopting a range of sediment sizes from measured data reported in Cardno (2022). The sediment sizes were D_{50}=0.39mm for the beach west of the Army Groyne, a D_{50}=0.26mm for the beach east of the Army Groyne, and a D_{50}=0.4mm for the beach south of Phillip Point. The analysis was completed using three-hourly data from Rottnest Airport for 2021.

Calculations were carried out to determine the potential for aeolian transport east and west along South Thomson Bay, as well as north across Phillip Point from Bickley Bay to South Thomson Bay due to the evidence of sediment moving through this pathway via the blowout in this area. As noted by MRA in their 2019 assessment, the strong seabreezes experienced from the south on Wadjemup (see the overall wind pattern with strong winds from the south in Figure 2.4 and the breakdown of the 9am and 3pm wind roses of data from 1984 to 2023 showing the strong southerly component of the afternoon seabreeze) are likely to be contributing to the windblown transport of sediment from the south to the north of Phillip Point.

Figure 4.18: 9am and 3pm wind roses covering data from 1984 to 2023 at Rottnest Island (site no. 009193) (BOM 2023)

Annual transport rates in cubic meters per unit meter width are summarised in Table 4.2, showing the potential for sediment to be transported around South Thomson Bay, noting that these potential rates are subject to the availability of sediment to be transported.

Table 4.2: Annual Transport Per Meter Shoreline

	(m3/m)
North-bound Transport	64
West-bound Transport	25
East-bound Transport	37

4.5 Sediment Budget

Based on the above updated analysis of the shoreline movements and the cross-shore and longshore sediment transport patterns, the sediment budget for Thomson Bay compiled in MRA (2019) has been updated to reflect more recent observations. This updated sediment budget provides the estimated annual sediment movement across the tertiary sediment cell covering Thomson Bay, the R14b Bathurst Point to Philip Point sediment cell.

Acknowledgement is given to the MRA (2019) analysis that the sediment budget should take into account the dredging of the channel that occurred adjacent to the Main Ferry Jetty in the 1960s and 1970s and the significant impact that these works had on the northern section of Thomson Bay, therefore the updates to the sediment budget provided here are based on the sediment budget provided from 1978 to 2018 in MRA (2019).

Updated observations that have contributed to differences between this sediment budget (1978 to 2023) and the sediment budget for 1978 to 2016 estimated by MRA in their 2019 assessment include:

- Observations of the growth of the dune blowout at Philip Point and quantification of the potential for wind-blown sand in the northward direction along Bickley Bay has led to differences in the estimated sediment fluxes along the Bickley Bay sector. It should be noted that the estimated annual loss of sediment in this area has remained the same due to the minimal change in shoreline position between 2016 and 2023 along this section of coast.
- Observation of the minimal change to shoreline position in the northern segment of the South Thomson sector has led to the update of the annual sediment volume change to ~0m^3/yr (rather than a negative volume)
- It is noted that the South Thomson Bay seawall has been constructed since MRA's 2019 assessment, and so shoreline recession in this area can be expected to be ~0 m^3/yr over the lifetime of that structure. Sediment flux along the beach fronting the seawall is still included in the sediment budget, allowing for the movement of sediment past the structure on an annual basis.

The boxes show the quantity of material estimated lost (shown in red) or gained (shown in green) in each compartment of the study site. The estimated annual sediment budget for the period from 1978 to 2016 is provided in Figure 4.19.

Figure 4.19: Conceptual Sediment Budget (1978-2023, adapted and updated from MRA (2019))

4.6 Impact of Climate Change on Sediment Dynamics

The sediment dynamics within South Thomson Bay will be impacted by climate change both through mean sea level rise and the intensification and change in frequency of storms. Further study is required to determine a quantified impact of the intensification of storm events on the Western Australian coastline, with the design storm outlined in Section 4.2 used to determine storm impacts in this assessment.

Consideration should also be given to the impact of raised sea levels resulting in the increased ability of waves to pass over the nearshore reefs within Thomson Bay (e.g., Kingston Reef), leading to more wave energy passing over these reefs and impacting on the shoreline. Some vertical reef growth may be expected to occur over the period of sea level rise, with current data showing that many reefs around the world have the capacity to grow with the current rates of sea level rise. However, it has also been seen that many reefs do not have the capacity to track with the projected rates of sea level rise expected over the next 100 years (Perry et al 2018).

The potential impacts of sea level rise on the sediment dynamics presented above will be discussed here.

Following the Department of Transport (DoT)'s publication on the application of sea level change to coastal planning in Western Australia (2010), which incorporated projections of sea level rise based on the upper bound of the global average projections from the IPCC's Fourth Assessment Report (2007), a Sixth Assessment Report has been released by the IPCC in 2021 with updated projections derived from their Shared Economic Pathways analysis. This places the expected amount of sea level rise over the next 100 years at approximately 0.94m when estimated from SSP5 in IPCC (2021) (Figure 4.20).

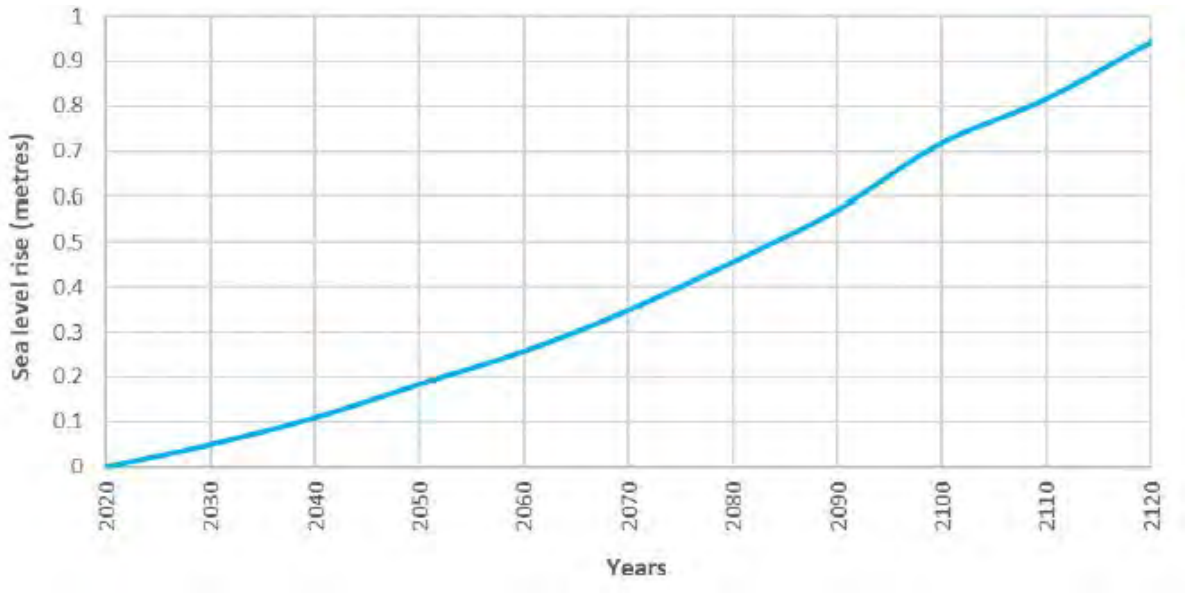

Figure 4.20: Projected sea level rise for the Western Australian coastline (IPCC 2021)

According to the guidelines and policy of the Western Australian Government (SPP2.6, WAPC 2013b), this rise in sea level can be expected to cause shoreline recession along the sandy shoreline of South Thomson Bay of up to 100 times the magnitude of sea level rise experienced, as based on the Bruun rule (Bruun 1962). In line with this rule, a 1cm rise if sea level can loosely be expected to cause a 1m landward recession of the average shoreline position of a sandy coast, as demonstrated through Figure 4.21). It is acknowledged that this rule is generally considered to be a conservative relationship between sea level rise and sandy shoreline recession (Rosati et al, 2013), but is adopted as a standard across Western Australia to date.

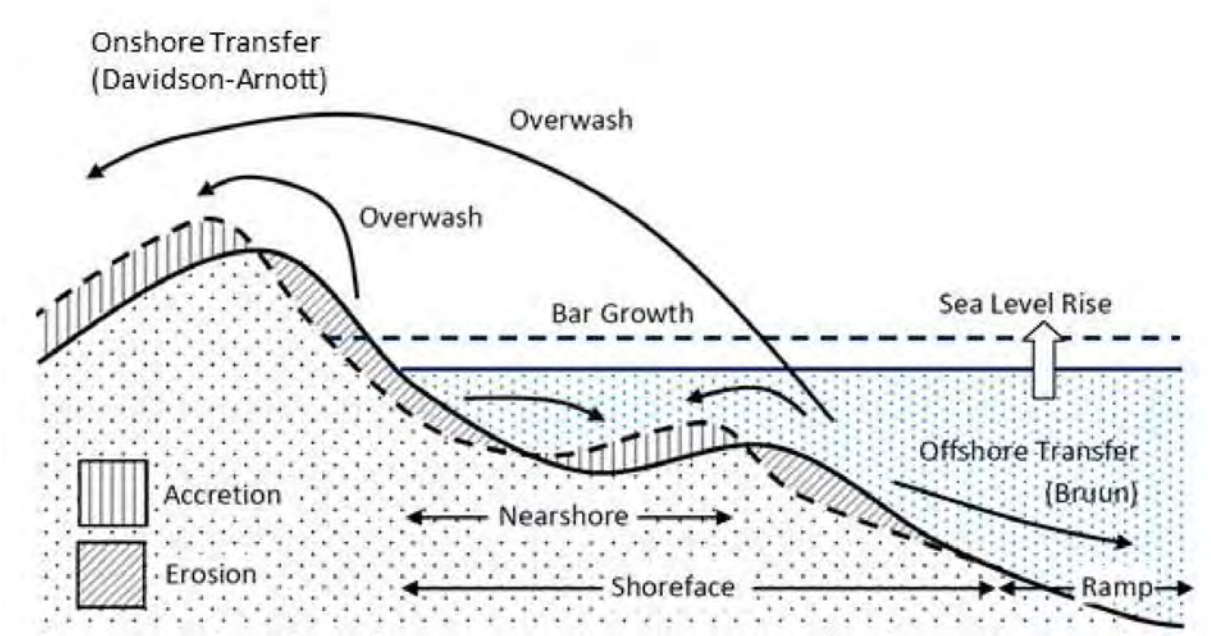

Figure 4.21: Typical sandy shoreline cross shore response to sea level rise, adapted from Dubois (1992) (Seashore 2021)

This assumption is incorporated into CHRMAP assessments via the S3 component of the assessment, the allowance for erosion caused by future sea level rise and has been calculated by Cardno in their 2022 CHRMAP assessment for Rottnest Island. A value for this expected shoreline erosion of 94m in 100 years was adopted for the whole of Rottnest Island in this assessment (Cardno 2022), with interim values adopted according to the timeframes of the intermediate assessments utilised in the study. This results in the following coastal erosion hazard lines for South Thomson Bay (Figure 4.22), which should be taken into consideration when considering the 50-year design life of the proposed development (e.g., the 2080 erosion hazard line can be expected to be relevant to the conditions expected along South Thomson Bay at the end of the proposed development design life).

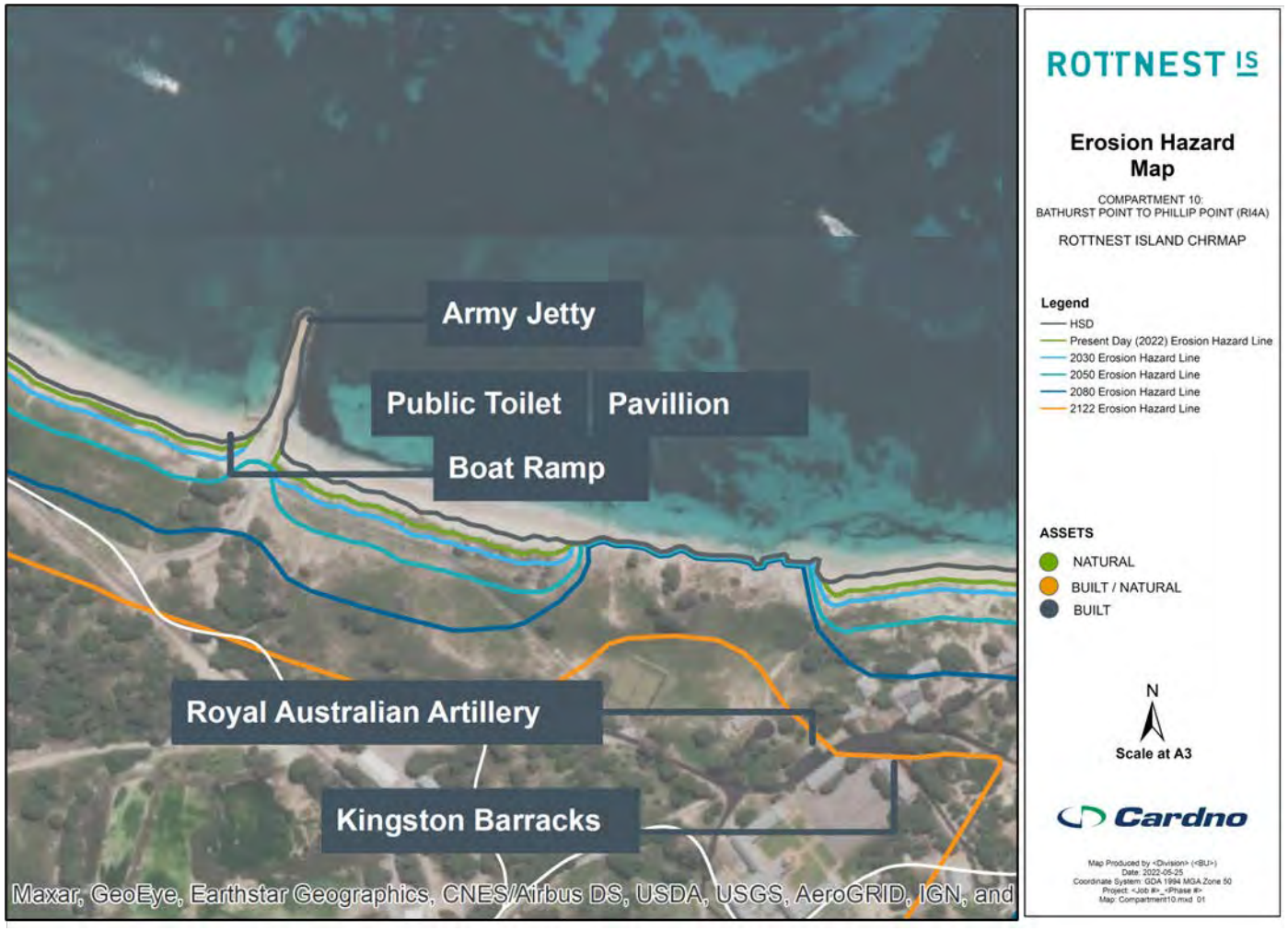

Figure 4.22: Erosion Hazard Map for Coastal Sediment Cell R14b Bathurst Point to Philip Point (adapted from Cardno 2022)

4.7 Impact of Proposed Facility on Sediment Dynamics

Considering the above analyses, it is unlikely that the proposed barge development would have a significant impact on the sediment dynamics along South Thomson Bay. As the existing Army Groyne has posed a barrier to sediment transport in this region since it's construction, and subsequent extension and shortening (Figure 2.14), since 1904, the shoreline in this region has had a significant amount of time to adjust to the impacts of an impermeable structure and therefore the addition of the proposed facility creating a similar barrier in the same location is expected to have minimal impact.

It should be noted that there is presently the potential for sediment to bypass the existing Army Groyne structure while the groyne structure is not fully saturated with sediment, so the extension of the proposed barge development offshore of the tip of the Army Groyne has the potential to trap more sediment than is being trapped presently. The curve towards the east of the offshore breakwater also creates the potential for any sediment that may be bypassing the Army Groyne from east to west at present has the greater potential to be trapped at the proposed barge development within the breakwater basin area (see Figure 4.23)

Sediment that is presently trapped on the eastern side of the Army Groyne does tend to only extend out to the point of the possible wrack protection spur, with a similar extent of trapping to be expected under the proposed concept. While the wave shadowing of the shoreline area under the range of wave conditions investigated in Section 3 is minimal, there is the potential for a greater seasonal build-up of sediment on the eastern side of the proposed barge development due to the interruption of the wave and wave induced current climate that may be presently acting to transport sediment away from the eastern side of the Army Groyne (see potential future shoreline arrangement in Figure 4.23).

Figure 4.23: Potential Impact of Proposed Facility on Sediment Dynamics in South Thomson Bay

5. Wrack Accumulation

An assessment of the expected impacts of wrack accumulation on the proposed design layout (Figure 1.6) is required to determine any negative effects that may be experienced through the interruption of regular wrack dynamics and movement along the beach in South Thomson Bay. Due to the prevalence of seagrass meadows off the coast of Western Australia, with 27 of the 60 known seagrass species found across Western Australia's 20,000 km^2 of seagrass meadows (Department of Fisheries 2011), consideration of wrack accumulation on Western Australian beaches has long been a requirement of coastal management assessments. Historic issues with wrack accumulation in the vicinity of coastal structures, including notable examples at Two Rocks and Port Geographe, have included odour, reduced water quality, reduced navigability and reduced access to beaches. Seagrass wrack, which may also include algae and kelp, has been known to present the issue of building up and decomposing within harbours and, in conjunction with low energy conditions (low tides and incident swell energy), contributing to low dissolved oxygen levels that may lead to fish kills in the vicinity (DPIRD 2023).

5.1 Wrack Generation and Transport

Seagrass wrack can be made up of a mixture of seagrass and macrophytes (largely macroalgae) that have been disconnected from the seabed and transported to the surf zone or beach to accumulate (Kirman and Kendrick 1997, Hansen 1984).

The MRA (2019) assessment of the coastal processes within South Thomson Bay cited the generalised lifecycle of seagrass that ends up in wrack accumulations on beaches and around coastal structures from Oldham et al (2010) that includes:

- The generation of seagrass and macrophyte wrack in offshore seagrass meadows from the ongoing shedding of leaves and stems that accumulate in the meadows and unvegetated zones due to the greater density of the wrack than seawater. This process occurs during calmer metocean conditions, up until autumn.
- The distribution of seagrass wrack through the water column during the first winter storms, where:
  - Some of the wrack becomes buoyant and accumulates at the surface of the water column.
  - Some of the wrack remains dense and remains near the seabed.
- The transportation of wrack towards shore, following this distribution throughout the water column where, generally, seagrass wrack is deposited on beaches during storm events with high water levels.
- The potential for wrack to be repeatedly washed (and transported) onto, across, or off the beaches depending on local metocean conditions. Seagrass wrack deposits high on the beach may become incorporated into the beach sand, compacted and difficult to remobilise into the water during subsequent storm events.
- The drying of seagrass wrack when it is stuck on beaches, leading it to become more buoyant and gain the potential to remobilise from the beach to the nearshore waters where it may be transported off the beach.

The presence of coastal structures or other formations may interrupt the remobilisation and natural clearing of seagrass wrack from beaches where those structure interrupt the natural transport pathway of the seagrass, as is the case in the notable locations mentioned above where seagrass is trapped on the western side of Port Geographe (Oldham et al 2010) and the southern side of the Two Rocks marina (MRA 2000).

An analysis of the benthic habitat surrounding Wadjemup was carried out in 2004, with a map of the prevalent species found presented in Figure 5.1 (Harvey 2009) showing a relatively high coverage of

seagrass within Thomson Bay. This creates a plentiful source of seagrass to contribute to potential wrack accumulation along the beach in this area.

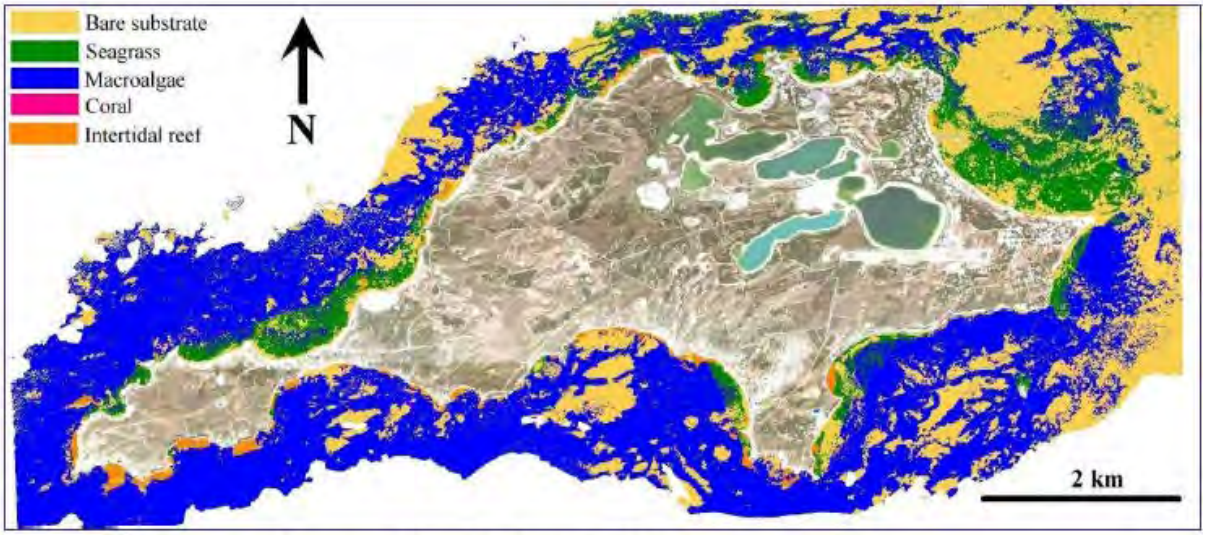

Figure 5.1: Habitat map of the waters surrounding Wadjemup (from Harvey 2009)

Assessment undertaken by RPS subsequent to this mapping showed the potential for discrepancies between the mapping undertaken by Harvey in 2009 and more recent benthic habitat surveys undertaken via aerial image analysis (RPS 2019). Following this, RPS undertook further assessment in Thomson Bay to allow for ground truthing of the aerial imagery-based habitat mapping, to enable more accurate assessment of impacts to benthic habitat due to the proposed development.

The combined assessment found the relative cover of the different habitat types identified by RPS to be that reported in Table 5.1, with a map of these habitat types overlaid with the proposed development footprint shown in Figure 5.2. These data sources provide an updated estimate of the prevalence of seagrass and macroalgae available to contribute to seagrass wrack along South Thomson Bay.

Table 5.1: Habitat type at each field survey site in RPS (2023)

Habitat Type	# of sites	Percent of total coverage
Amphibolis dominated	8	5%
Halophila dominated	1	1%
Limestone reef/pavement	3	2%
Macroalgae dominated	17	11%
Mixed algae/seagrass	6	4%
Mixed seagrass	4	3%
Posidonia dominated	75	49%
Sand	23	15%
Sand with seagrass	8	5%
Sand with wrack	8	5%

Habitat Type	# of sites	Percent of total coverage
Grand Total	**153**	**100%**

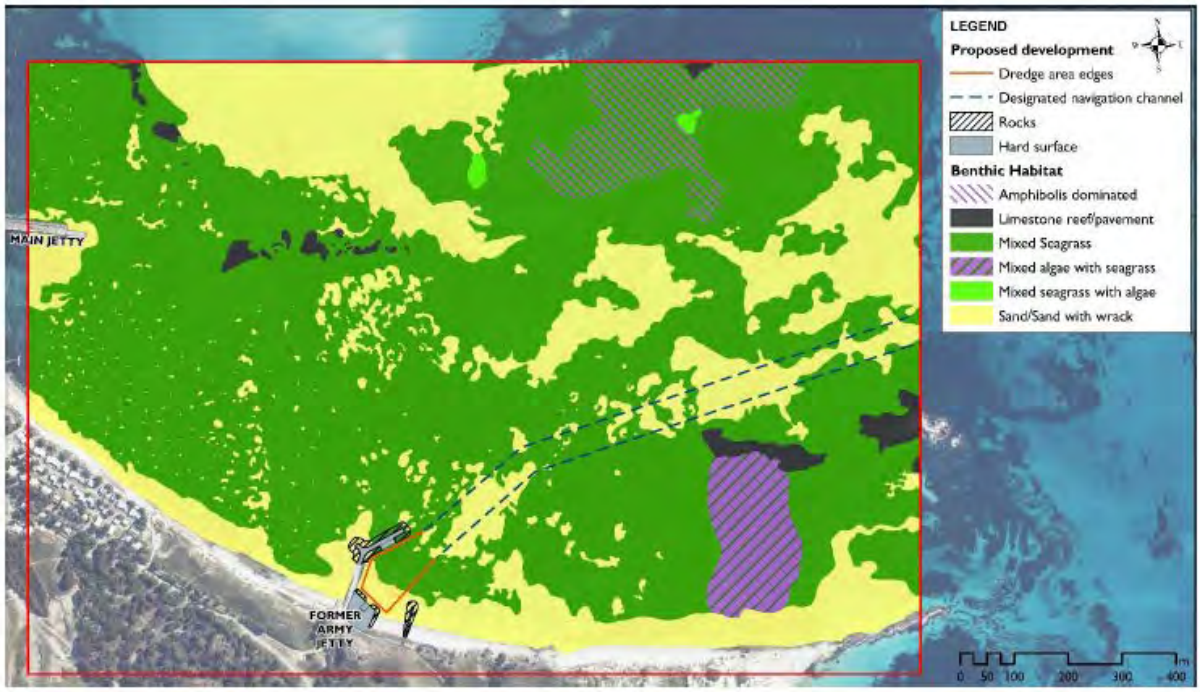

Figure 5.2: South Thomson Bay benthic habitat map with the proposed development footprint of WGA's Option 1 overlaid.

5.2 Historical Wrack Accumulation

Historic wrack accumulation along South Thomson Bay can be assessed through observations made through site photos and through historic aerial images. As presented in MRA (2019) :

- Wrack is shown to accumulate along a majority of the Thomson Bay shoreline at a range of intervals across an average year.
- It is most prominent on the eastern side of the Army Groyne and often collects up against the structure, while the western side of the structure is typically clear of wrack.
- Collection of wrack on the beach is usually during the summer months, while during the winter months it tends to clear from the beach naturally.
- Quantities of wrack on the beach within Thomson Bay at any one time are estimated to be in the range of 500 m^3 to 1,000 m^3.

Aerial imagery covering 2014 to 2023 shown in Figure 5.3 demonstrate these observations, with further images from recent and more historic site visits showing different aspects of accumulation along Thomson Bay in Figure 5.4 to Figure 5.7.

Figure 5.3: Aerial photography indicating the buildup of seagrass wrack between 2014 and 2023, largely on the eastern side of the Army Groyne (adapted from MRA 2019)

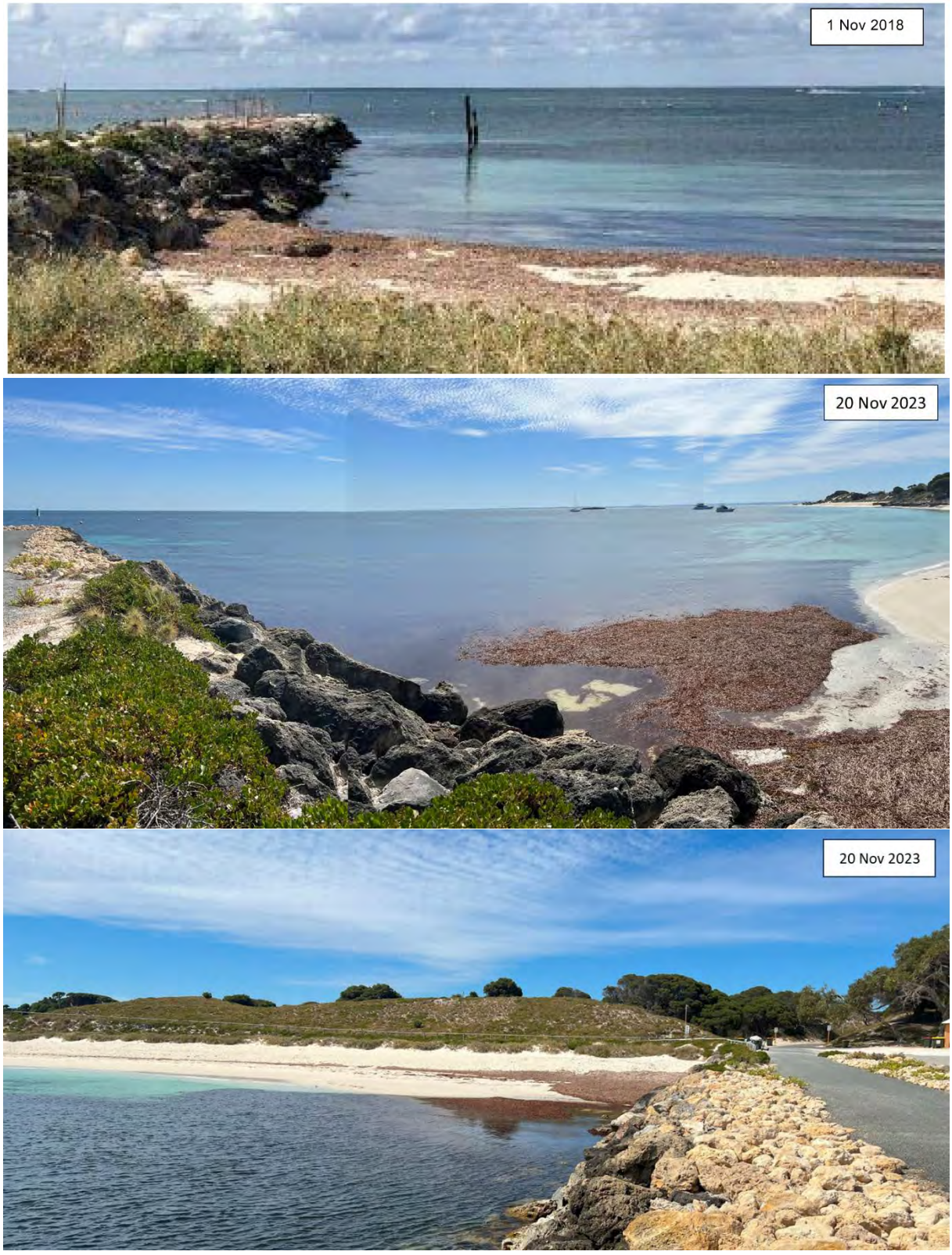

Figure 5.4: Wrack accumulation on the eastern side of the Army Groyne looking seaward (top, mid) and looking landward (bottom)

Figure 5.5: Wrack accumulation along South Thomson Bay on May 2nd 2019 (MRA 2019)

Figure 5.6: Wrack accumulation along South Thomson Bay on November 20th 2023

Figure 5.7: Minimal accumulation of wrack on western side of Army Groyne on November 20th 2023

5.3 Impact of Proposed Facility on Wrack Dynamics

Similarly, to the analysis outlined in MRA (2019), it is considered that the proposed development of the South Thomson Barge Landing will not have a significant impact on the timing or volume of wrack accumulation across the beaches of Thomson Bay, further than the impact that the Army Groyne already has on the dynamics in South Thomson Bay.

The requirement to consider the impact the structures may have on the ability for wrack to be cleared from the structures following being trapped remains. Elevated levels of accumulated seagrass wrack may be experienced in this area in summer due to the westward movement of seagrass along the shoreline being interrupted by the proposed development structure. Coupled with this is the wave shadowing caused by the extension of the breakwater from the current footprint of the Army Groyne reducing the ability for seagrass to be cleared through the dynamics currently acting along the eastern side of the Army Groyne structure. These two processes have the potential to cause elevated accumulation of seagrass on the

eastern side of the proposed development structure, which may lead to ingress of seagrass to the harbour footprint. These potential seagrass dynamics are shown in Figure 5.8.

The following is recommended:

- Ongoing monitoring of shoreline accretion and seagrass accumulating on the eastern side of the development during the summer period will be required post construction.
- Depending on the accumulation volume of wrack and the reshaping of the shoreline towards the protection nib on the eastern side of the groyne, maintenance activities (ie manual removal by excavator) may need to be actioned.
- The RIA may also be required to carry out periodic maintenance activities to remove seagrass that directly enters the harbour during onshore sea conditions from the north-east.

Figure 5.8: Proposed development structure layout with potential wrack dynamic descriptions

6. Concept Design Review

6.1 Wave Penetration Assessment

An assessment of wave penetration into the harbour basin has been undertaken based on the diffraction curves of Goda (2010). The analytical solutions from Goda (2010) are based on random waves and provide an estimate of the diffracted wave energy in the lee of the breakwater structure.

The measured wave conditions captured from the site (Section 2.7) were analysed to determine representative wave conditions for a swell and wind sea scenarios, as summarised in Table 6.1. Wave conditions at the barge ramp are presented in Table 6.1 for each case.

The respective diffraction curves have been selected based on assumed directional spreading for swell (long period waves of approximately 15s) and wind sea (short period waves typically less than 5s). The diffraction curves are shown overlaid on the concept in Figure 6.1.

Table 6.1: Wave conditions examined for wave penetration.

Wave Scenario	Wave Condition at entrance	Representative Condition	Wave Condition at Barge Ramp
Swell Case 1	H_s: 0.46m T_p: 15s Direction: N (from)	80th Percentile value for the northern sector, approximately 38 days per year	H_s: 0.18m T_p: 15s Direction: NE (from)
Swell Case 2	H_s: 0.59m T_p: 15s Direction: N (from)	95th Percentile value for the northern sector, approximately 9 days per year	H_s: 0.24m T_p: 15s Direction: NE (from)
Wind sea Case 1	H_s: 0.34m T_p: 4s Direction: NE (from)	80th Percentile value for the northeastern sector, approximately 23 days per year	H_s: 0.24 m T_p: 4s Direction: NE (from)
Wind Sea Case 2	H_s: 0.51m T_p: 4s Direction: NE (from)	95th Percentile value for the northeastern sector, approximately 6 days per year	H_s: 0.31 m T_p: 4s Direction: NE (from)
Wind sea Case 3	H_s: 0.44m T_p: 4s Direction: E (from)	80th Percentile value for the eastern sector, approximately 2 days per year	H_s: 0.44 m T_p: 4s Direction: E (from)
Wind Sea Case 4	H_s: 0.50m T_p: 4s Direction: E (from)	95th Percentile value for the eastern sector, approximately 0.5 days per year	H_s: 0.50 m T_p: 4s Direction: E (from)

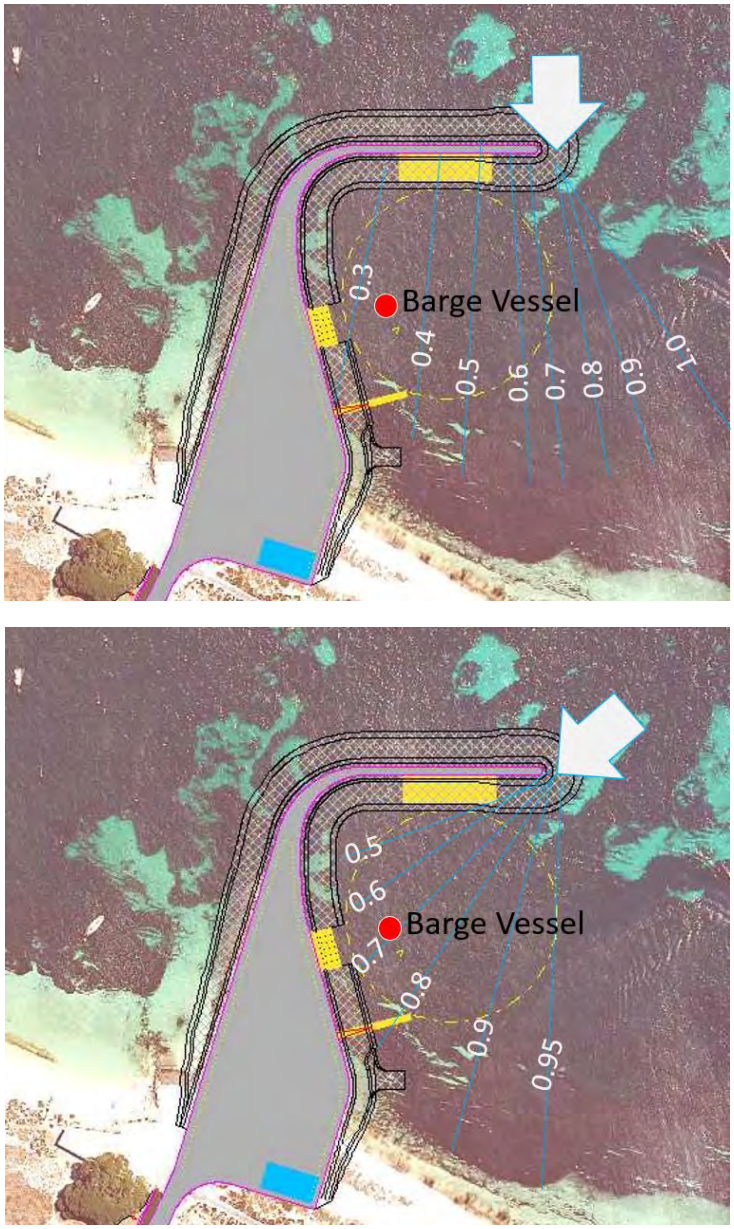

Figure 6.1: Estimated diffraction coefficient for incident waves for northerly swell case (upper) and wind sea from the Northeast case (lower).

6.2 Summary Recommendations

From the measured data at the site, waves approach the South Thomson Bay site from the northerly sector for approximately 50% of the year. The analysis of diffracted wave conditions at the barge ramp in Table 6.1 indicate the barge landing location is well sheltered from swell wave conditions that arrive from the north. The breakwater is effective at reducing the wave conditions at the barge ramp to approximately 40% of the incoming wave conditions, with the diffracted swell wave arriving at the stern of the vessel. For the 80th percentile wave height from the northern sector, the wave height at the breakwater is 0.46m, whilst the diffracted wave at the stern of the vessel is 0.18m. For the 95th percentile wave height from the northern sector, the wave height at the breakwater is 0.59m, with the diffracted wave at the stern of the vessel at 0.24m.

From the measured data at the site, wind sea conditions arrive at the site from the northeast quadrant for approximately 30% of the year. These wave conditions cover waves that have wave periods of typically less than 4s and are generated by local wind conditions. The diffraction curves (Figure 6.1) show the breakwater reduces the incident waves by approximately 30%. For the 80th percentile wave height from the northeast sector, the wave height at the breakwater is 0.34m whilst the diffracted wave at the stern of the vessel is 0.24m. For the 95th percentile wave height from the northern sector, the wave height at the breakwater is 0.51m whilst the diffracted wave at the stern of the vessel is 0.31m.

Eastern sector wave conditions present in the measured data record represent a small proportion of the annual seastate, at approximately 2% of the yearly record. The configuration of the breakwater in the design layout does not provide protection from this direction and it is assumed these conditions would reach the barge ramp unchanged. The waves will approach the barge ramp approximately in line with the vessel stern at 0.44 to 0.5m significant wave height. It is noted these conditions are infrequent over the course of the annual record in the measured data and are concentrated in the winter months.

This analysis of wave penetration indicates the wave conditions are reduced by the structures for approach directions from the N and the NE which are the dominant wave conditions at the location.

An understanding of the limiting conditions of the barge vessel would allow for further analysis of potential downtime at the barge ramp. The wave conditions at the landing are approximately in line with the barge ramp alignment, and it is expected that the vessel would manage these types of conditions when at the ramp. As the vessels manoeuvre into or away from the facility within the turning circle, the waves would be more ‘beam on’ to the barge (i.e., 90 degrees to the vessel) and this would be more problematic, potentially warranting further investigation.

This analysis does not consider reflection of waves from the structures or bi-modal seastates that can occur in the area during winter when swell waves from the north are coupled with sea waves from the east. Further assessment of these conditions as part of more detailed wave penetration modelling in the detailed design phase is recommended. This analysis should include use of a phase resolving wave model which can accurately account for the processes of diffraction and reflection in the lee of the breakwater. Assessment of the transformed wave conditions at the barge ramp for the typical barge vessel sizes and berthing operations can be undertaken to provide a detailed analysis of the overall availability of the ramp. This would provide a projected estimate of the downtime at the new ramp location i.e. the amount of time during the year where the wave conditions may preclude use of the barge ramp. As part of this assessment, mitigation measures could be examined (if required).

As a general comparison the sea wave conditions at the South Thomson Bay barge facility (which arrive from the east and northeast) would be expected to be consistent with the conditions experienced at the present location of the barge ramp adjacent the main passenger ferry jetty. The swell wave conditions whilst attenuated by the breakwater would likely be marginally higher at the new facility compared with the existing location. As noted above, this may not be an issue due to the orientation of the barge vessels. However, further examination to confirm this assumption is warranted as part of the detailed design process.

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Appendix A

Wave Model Validation Plots

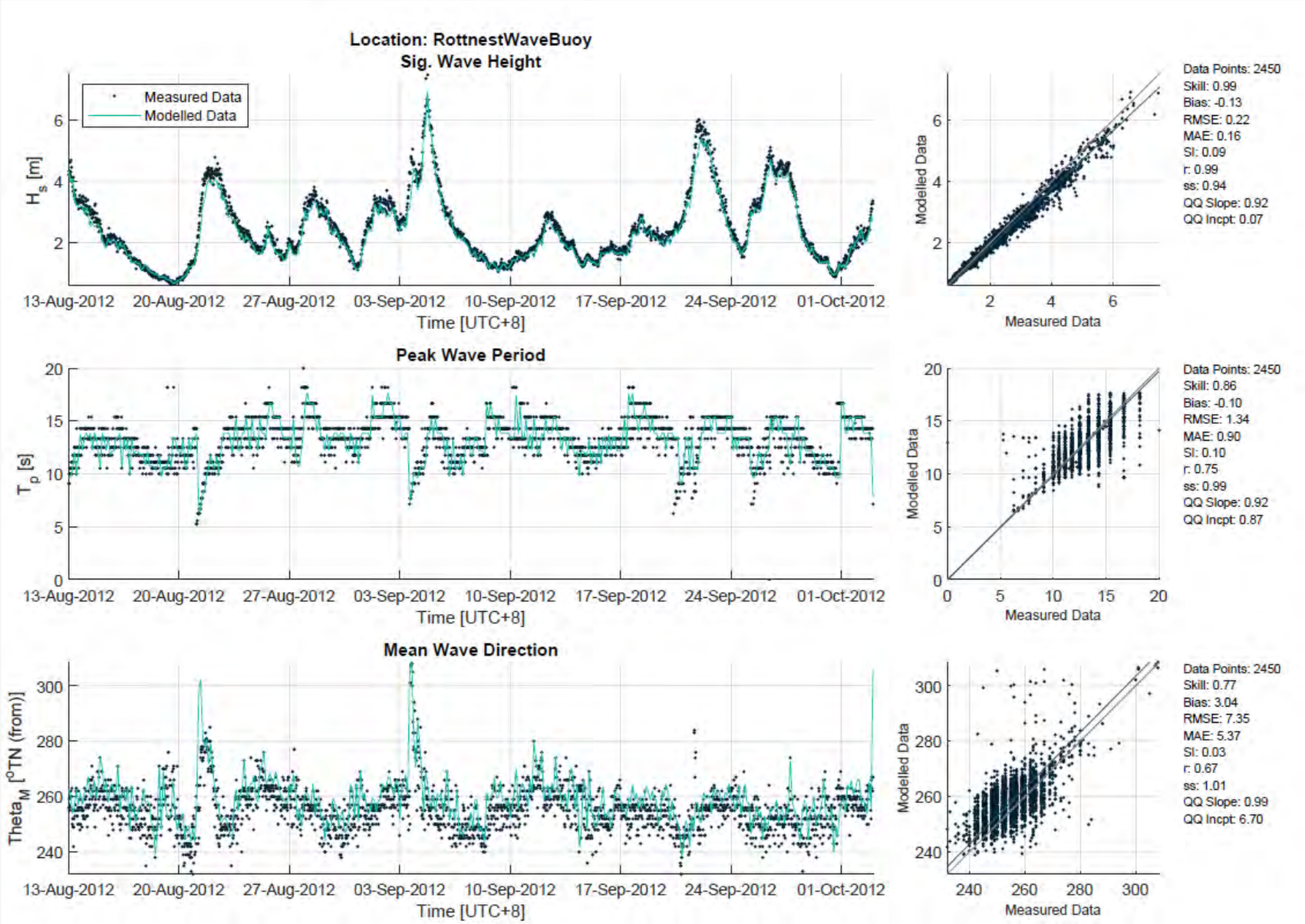
Model Validation

- 2012 Data
  - 4 locations, 2 months
- 2020 Data
  - 1 location, 3 months
- Calibration
  - reef features modelled as bed roughness
  - Wave Breaking

Model Bathymetry for NE Island 10m x 10m Grid.
2m x 2m Grid covers the Jetty and key area of interest

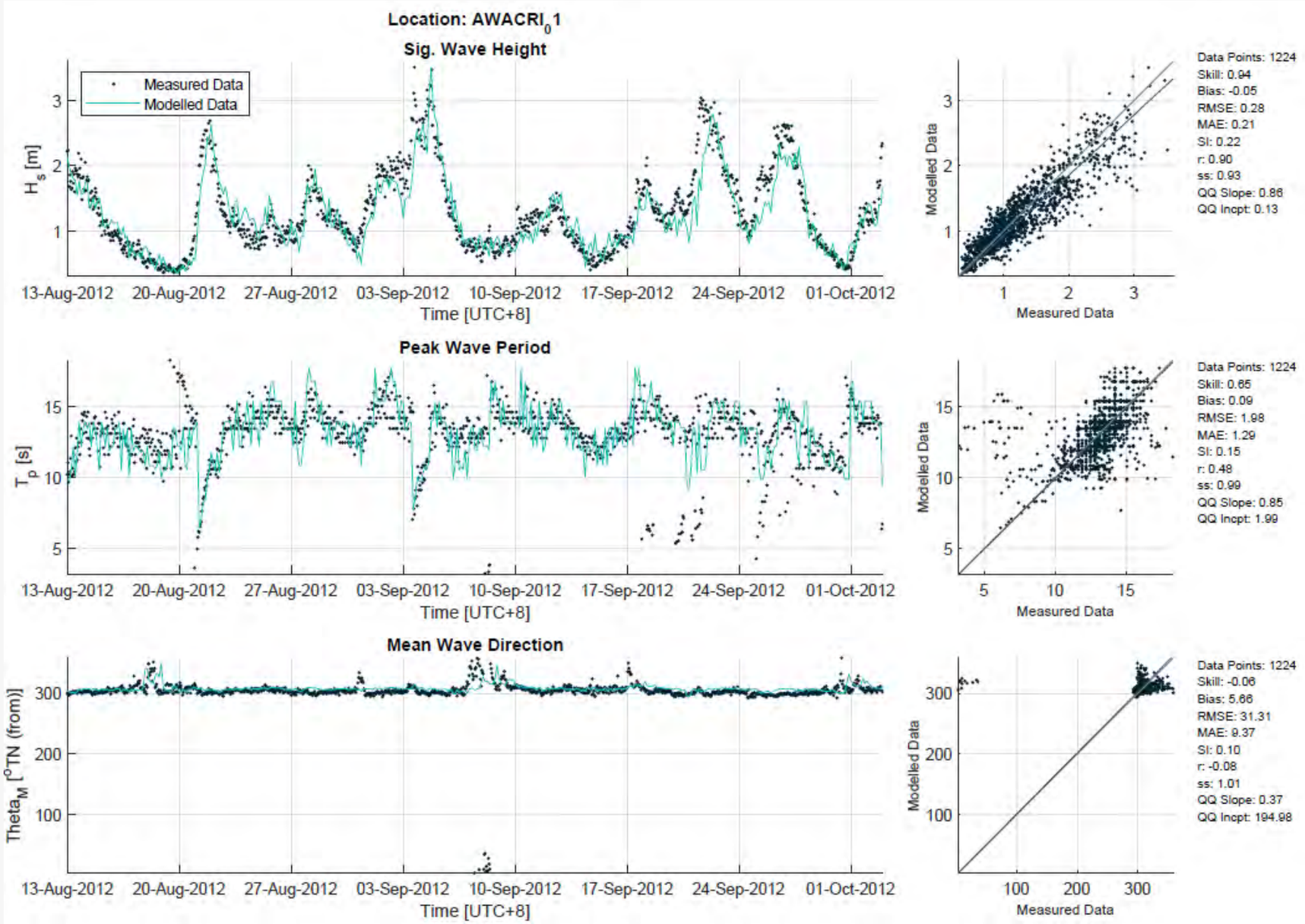
Model Validation

- Rottnest DWR
- Hs - Skill 0.99



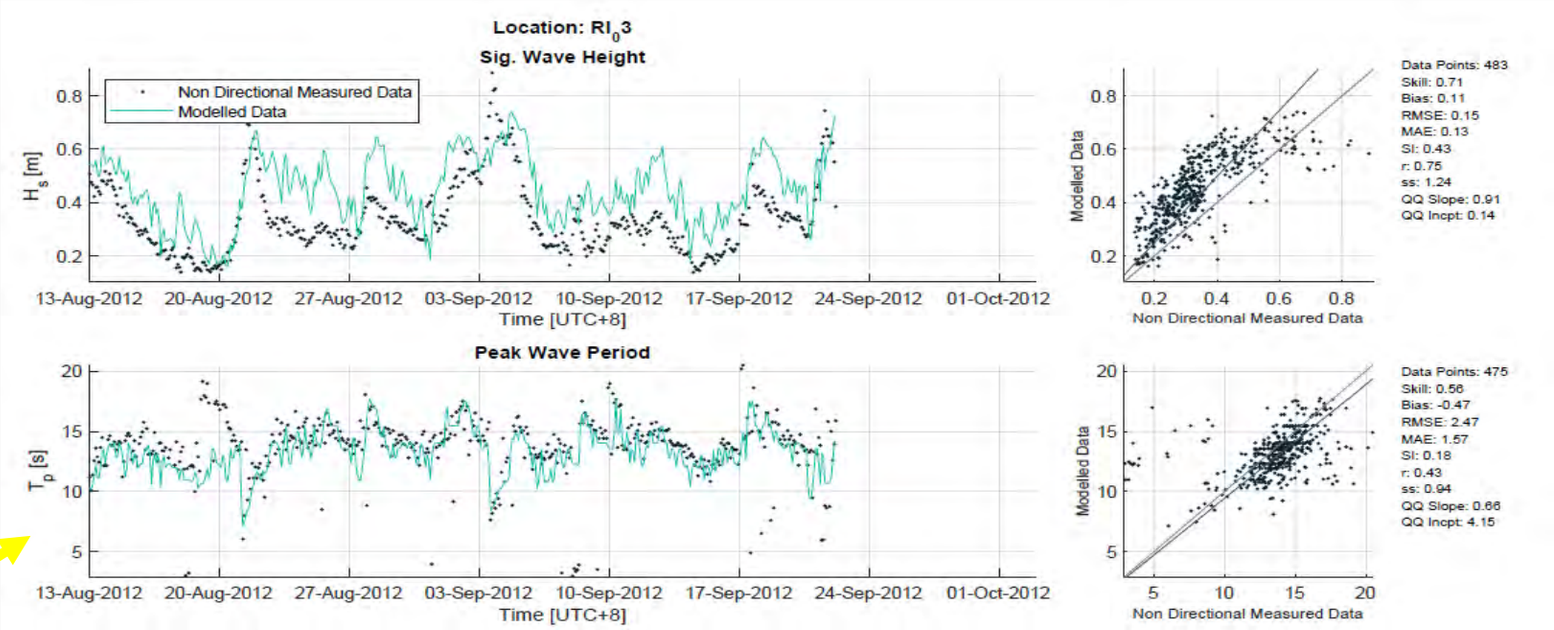
Model Validation

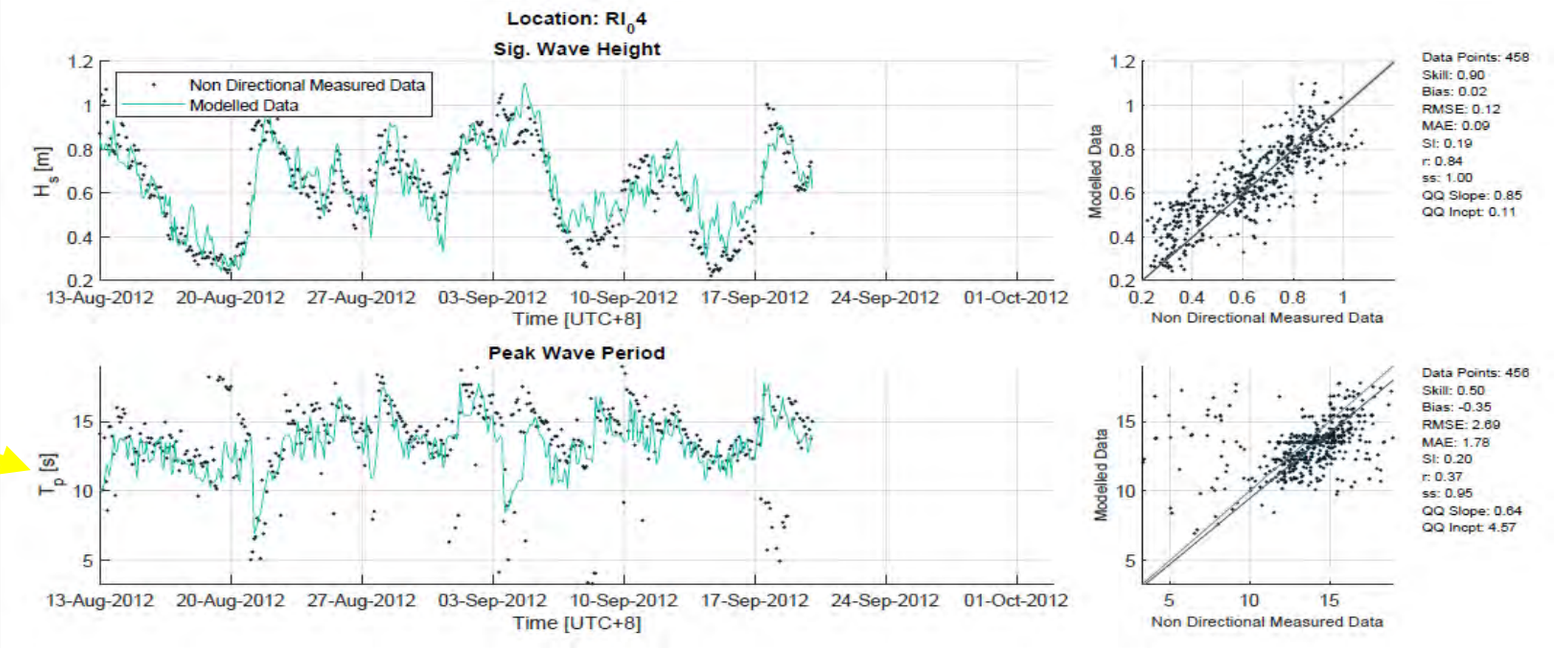
- AWAC Thomson Bay North
- Hs - Skill 0.94



Model Validation

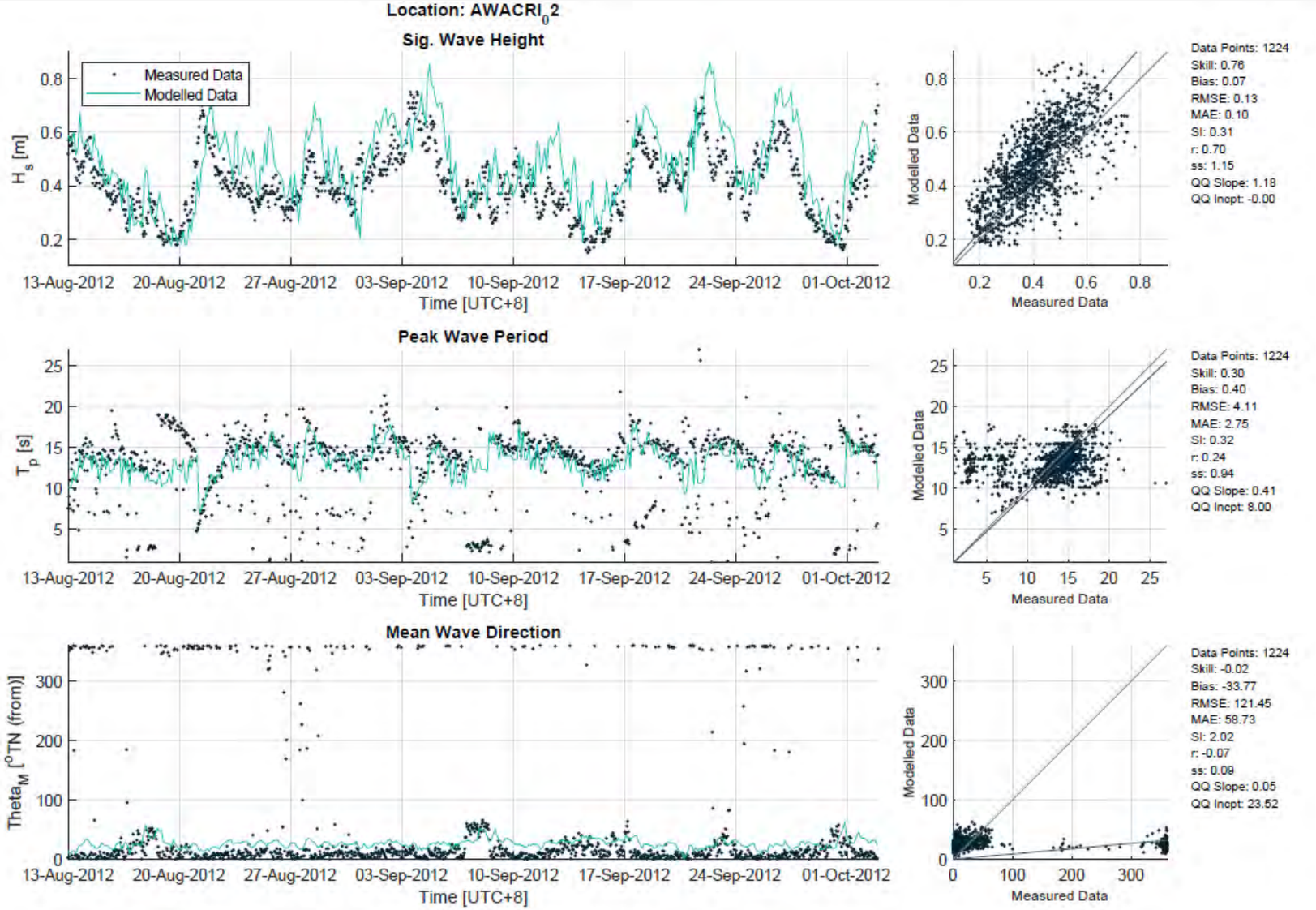
- AWAC Thomson Bay Mid Point Non-Directional
- Hs - Skill 0.71 – 0.90





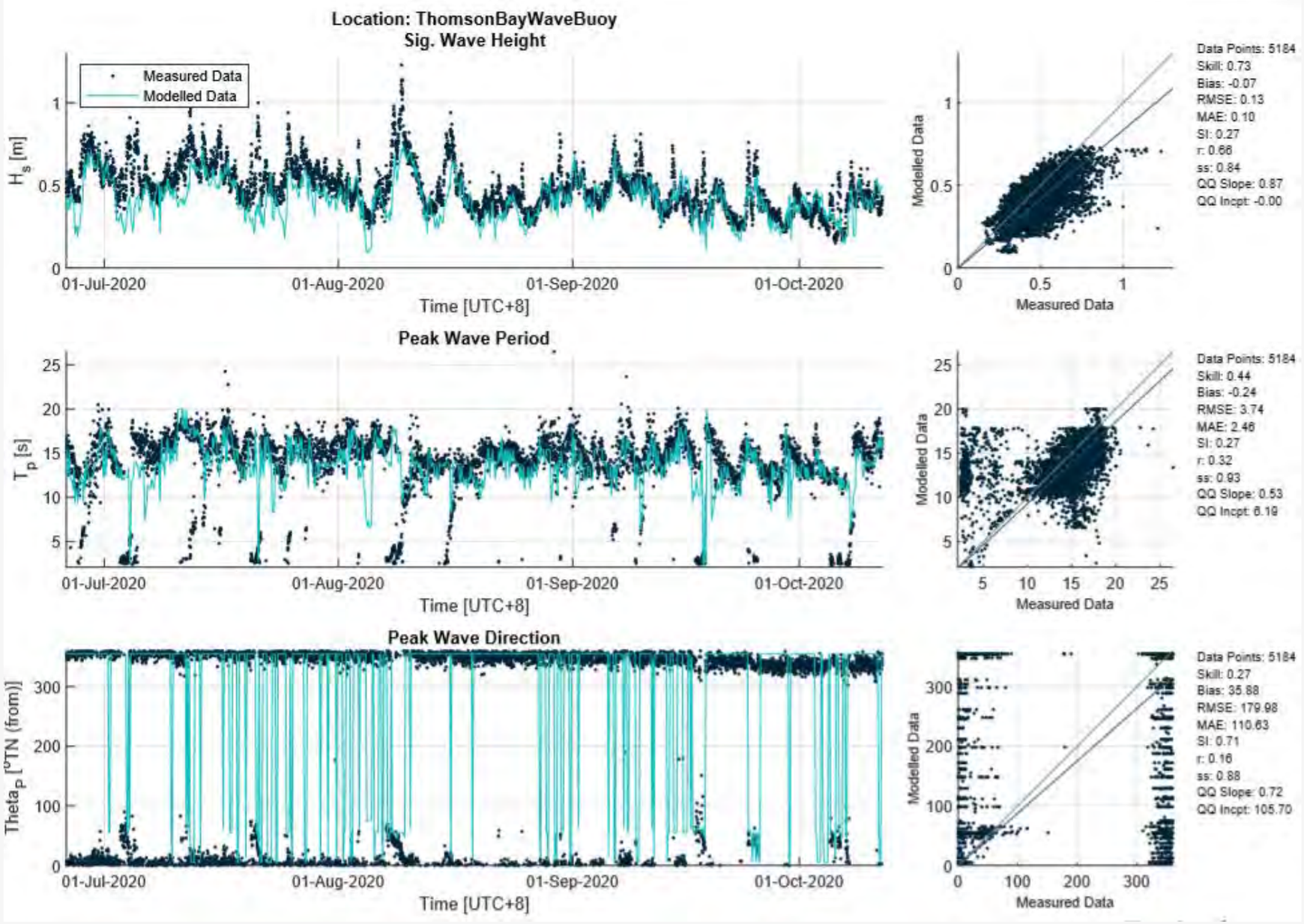
Model Validation

- AWAC Thomson Bay South
- Hs - Skill 0.76



Model Validation

- AWAC Army Jetty
- Hs – Skill 0.73



Appendix E
PER349327 – RIA peer review of dredge plume modelling and coastal processes reports (RPS 2024c)

MEMO

Date: 15 March 2024
To: Rebecca Dawson
From: David Wright
Pages: 5 inc. this page
Regarding: PER349327 – RIA Peer Review of Dredge Plume Modelling and Coastal Processes Reports

Background and Scope of Peer Review

RPS has been engaged by the Rottnest Island Authority (RIA) to prepare an environmental referral for RIA's proposed South Thomson Bay Barge Development. This development aims to convert the former Army Jetty (now Army Groyne) site in South Thomson Bay into a barge landing site, allowing bulk cargo transports to be landed here and thereby moved away from the Main Ferry Wharf site to the west.

To support development of this referral, RPS' Ocean Science & Technology (OST) team has been asked to peer review two reports provided to RIA by a third-party consultant, Baird Australia, assessing the impacts of dredge plumes and coastal processes as they each relate to the proposed barge development.

This peer review is a high-level evaluation with the primary aim of identifying key issues in approach, methodology and analysis that may pose the greatest risk to favourable assessment of the submitted referral. It is not intended as an exhaustive review of all technical aspects of each report.

Review of Dredge Plume Modelling Assessment Report

The following table contains comments following a review of Baird report *14029.101.R2.Rev0 – South Thomson Bay Barge Development: Dredge Plume Modelling Assessment* (dated 2 February 2024). We note that the filename contains a different identification number (14209), but we assume the one listed on the front cover and preface is correct.

The objective of this report is to assess the extent, severity and duration of sediment plumes from dredging activities associated with the proposed barge development.

Item no.	Report section	Comment
1	General	Many figures are small and contain text or other features that are difficult to read without zooming in, so readers would benefit from seeing these figures on separate pages and/or in landscape orientation.
2	Executive Summary	The following sentence is repeated from the Executive Summary of Baird's Coastal Processes Assessment (Baird report *13029.101.R1.Rev1*) and should be corrected to reflect the dredge plume modelling content: "*Assessment has been made here of the impact of the proposed barge development on the coastal processes acting within South Thomson Bay, including wave conditions, sediment transport pathways, wrack dynamics and the impact of wave penetration within the proposed harbour basin of the barge development.*"
3	Section 1.2	It is stated that "*… plume dispersion will be modelled in 5 to 10 vertical layers.*" Table 4.3 specifies that five layers of 20% thickness were used, so this sentence can be clarified.
4	Section 2.1	Considering the baseline metocean data sets listed in Table 2.1, please refer to item 4 in the '**Review of Coastal Processes Assessment**' comments table in this memo. It is noted there the 'Aquadopp Site 1' deployment is not continuous over the stated date range.

MEMO

Date: 15 March 2024
Regarding: PER349327 – RIA Peer Review of Dredge Plume Modelling and Coastal Processes Reports

Item no.	Report section	Comment
5	Section 2.1	Figure 2.1 shows measured data locations but is too small and too low in resolution for the sites to be clearly discerned – particularly the inset showing the nearshore locations.
6	Section 3	Through this chapter it is clear that the dredge plume modelling considered only dredging of an approach to, and a footprint within, the proposed breakwater structure. These activities generally appear to have been considered adequately, given the information available to inform their representation in a model. Handling of dredge spoil is not assessed, perhaps because at the time of modelling it was assumed (as described in an in2Dredging technical note; in2D report *i2D-BAIRD-TN-001*) that this material would be transferred onshore and trucked to a disposal site near the island's airport. At the time of the RPS peer review, it is now known that construction of the Barge Development structure's laydown area is likely to involve creation of a bunded area that is progressively backfilled with dredged material. Because this method has the potential for return of finer dredged material to the ocean through dewatering and disturbance of temporary bunds, this potential should be assessed for significance in the context of modelling already completed. Similarly, the potential for sediment losses to the ocean during construction of the breakwater itself should be assessed for significance in the context of modelling already completed.
7	Section 4.1 (first one)	It is not clear how the hydrodynamic model's flexible mesh arrangement in the vicinity of Rottnest Island, shown in Figure 4.2, relates to the domain-decomposition grid scheme shown in Figure 4.3. The latter figure and the discussion in this section implies regular grids have been used in downscaling a regional model (as shown in Figure 4.1) to the site of interest for dredge plume modelling, so this should be clarified.
8	Section 4.1 (second one)	Past validation of water levels in the "*… north-west region*" is cited but this was probably intended to be "*… south-west region*".
9	Section 4.2.1	It is stated that "*… the validation metrics are good for both the current speed and direction, with good model skill…*", but the data presented in Figure 4.6 shows otherwise. Measured current speeds during peak events are reproduced well, but the model tends to overpredict speeds during calm conditions. Model predictions of direction also seem most accurate during peak events but generally the measured variations in direction are not reproduced at all, and the model skill measure of 0.19 reflects this. The low-energy environment is noted here, and representation of such environments in models can be difficult to achieve, but the model performance issues should be discussed clearly and evaluated in terms of the potential impacts to predictions of sediment plume transport and fate.
10	Section 4.2.1	Table 4.1 presents statistics for the "*ADCP*" location, but these are for the "*Aquadopp*" location as presented in Figure 4.6.
11	Section 4.2.2	There is some discussion here about problems with Aquadopp wave direction data quality affecting validation of the wave model. These problems are not explained but the text suggests they are known to both Baird and RIA. With these problems known, validation time series and statistics are therefore also presented for an AWAC site located 200 m to the north. Although model performance is better at this location, there remains a common overprediction of significant wave height, and a consistent eastward shift in predicted wave direction, versus measurements. The cause of these issues should be discussed clearly and evaluated in terms of the potential impacts to predictions of sediment plume transport and fate.
12	Section 4.3.2	Table 4.3 lists parameters used to configure the sediment plume model (Delft3D-MOR), but two key dredging source terms are not included or discussed elsewhere: the loss rate of dredged sediment to the water column (i.e. what proportion of the in situ dredge quantity is assumed by the model to be 'mobile'); and the vertical distribution of sediment initially suspended in the water column (prior to far-field dispersion and settlement). Both of these parameters serve to relate sediment sources to the type of dredge plant being used and to the manner in which it brings sediment from seabed to surface. Without knowledge of how these source terms have been defined, the accuracy of the predicted dredge plume cannot be fully judged.

Item no.	Report section	Comment
13	Section 5.3	It may have been more appropriate (albeit less conservative) to assume an average background SSC only from the Rottnest IMOS NRS site data, regardless of its location further offshore, when it is considered that nearshore waters in Cockburn Sound are known to be more turbid than those in the vicinity of Rottnest.
14	Section 5.4.1	The lack of site-specific data notwithstanding, this section requires further justification of the use of a methodology previously applied at Port Beach, contextualising the relative similarity (or otherwise) of the local benthic environments. In the referenced BMT report (BMT report *R-10807-5*), nominal SSC values of 2, 5, 10 and 20 mg/L were selected to define 'visible', 'low risk', 'moderate-risk' and 'high-risk' categories on the basis of site-specific sampling allowing a relationship between SSC and light attenuation coefficient (LAC) to be derived. It is not clear from the current text why these SSC values are immediately applicable here. Table 5.1 has been reproduced from Table 5.14 of the referenced BMT report (BMT report *R-10807-5*), and its listing of sedimentation thresholds is not relevant as these are not used as criteria for the ZoHI/ZoMI calculated in this report.
15	Section 5.5	The contours of Figure 5.13 may offer more visual clarity for the reader if they were semi-transparent or hatched. Also, the ZoI contour is not included in the legend.

Review of Coastal Processes Assessment Report

The following table contains comments following a review of Baird report *13029.101.R1.Rev1 – South Thomson Bay Barge Development: Coastal Processes Assessment* (dated 14 February 2024). We note that the filename contains a different identification number (14209), but we assume the one listed on the front cover and preface is correct.

The objective of this report is to assess the impact of the proposed barge development on the coastal processes acting within South Thomson Bay, including wave conditions, sediment transport pathways, wrack dynamics and the impact of wave penetration within the proposed harbour basin of the barge development.

Item no.	Report section	Comment
1	General	Many figures are small and contain text or other features that are difficult to read without zooming in, so readers would benefit from seeing these figures on separate pages and/or in landscape orientation.
2	Executive Summary	Use of the word "minimal" to describe a difference in wave climate of <0.4 m or <0.15 m is questionable. Although these values seem small, the location has a low-energy wave climate: based on data presented in the report ~85% of the waves are below 0.5 m in height. These values represent differences of 30-80% of that wave height.
3	Section 2.4	Figure 2.3 shows measured data locations but is too small and too low in resolution for the sites to be clearly discerned – particularly the inset showing the nearshore locations.
4	Section 2.4	Table 2.1 lists the measured data sets utilised in various parts of the study, but some deployment dates stated here can be confusing when the data is discussed later in the report. In particular, when the 'Signature1000_Site1' and 'Aquadopp_Site2' data sets are discussed later in Section 2.7.2 it is clear that these deployments are not continuous and do not span the entire period, as a reader might assume from the start/end dates in Table 2.1.

MEMO

Date: 15 March 2024
Regarding: PER349327 – RIA Peer Review of Dredge Plume Modelling and Coastal Processes Reports

Item no.	Report section	Comment
5	Section 3.1	A four-year data set is not considered a long-term hindcast in the context of a structure with a 50-year design life. While the data set may contain a range of wave conditions at the site, processes that occur over longer timescales – variability in sea levels, wave heights and dominant wave directions from ENSO cycles – can also have relatively large influence. The four years selected for consideration need to be justified in the context of broader metocean conditions: why these years, by which measures are these years particularly representative of the site in question, etc.
6	Section 3.1.1	The statements about the calibration ("*… the model showed good agreement with the measured wave data for significant wave height, period and direction at locations in Thomson Bay…*") and about the validation ("*Based on the outcomes of the model validation, the model system is considered to reproduce the wave conditions in Thomson Bay well and suitable for application for developing the hindcast used in this study.*") are overly brief and not accurate. While the modelled significant wave height shows reasonable agreement with measurements, there are some clear problems in the wave period/direction calibration and validation plots and statistics presented in Appendix A. The poor statistical performance and clear shift in the wave direction at the nearshore sites need to be discussed further. It should be justified why, although there are problems with the calibration/validation, the model remains fit for purpose. Additionally, typically a validation period would be chosen to check the calibrated model is representative of a broad range of wave conditions/regimes at the site – particularly seasonal variability, which has been shown to be significant here. The validation period chosen was another winter period despite data being available during summer. If there is a reason for limiting all validation efforts to winter, it needs to be clearly stated.
7	Section 3.1.3	A 2 m grid scale in the phase-averaging SWAN model is very fine and lies outside the bounds of recommended resolution (50-1,000 m) outlined in the model's user manual. A phase-resolving model should be used if these scales are needed. Given the small area covered by the 2 m x 2 m grid, and the method applied to assess wave shadowing in Section 3.2, the problem perfectly lends itself to use of a phase-resolving model. The use of SWAN for this assessment needs to be justified.
8	Section 3.2	While the wave assessment at the RIA moorings (Section 3.2.1) notes that further investigation should be done using a phase-resolving model, this is also true for the assessment of wave conditions with and without the Barge Development structure. SWAN was used but it is not clear if or how its limited capabilities for wave reflection and, in particular, diffraction processes were applied here. Results should be noted as indicative only.
9	Section 4.2	A prediction of 5-10 m of cross-shore erosion for the 100-year ARI storm sequence has been made, but there is no discussion of how the presence of the proposed Barge Development impacts this prediction or how it needs to be considered in the concept design.
10	Section 4.3	The erosion hazard line that needs to be considered for the 50-year design life of the project structure is shown as being ~50 m behind the current shoreline position, but there is no discussion of how the presence of the proposed Barge Development impacts this prediction or how it needs to be considered in the concept design.
11	Section 4.7	The discussion here is confusing and very brief. The first two paragraphs are contradictory: the first says the structure is unlikely to have a significant impact, but the second says that the structure may cause more sediment to build up around it than presently. This needs to be clarified. The first line states "*Considering the above analyses, it is unlikely that the proposed barge development would have a significant impact on the sediment dynamics along South Thomson Bay.*" This is referring to previous sections but, without further discussion in those sections of the Barge Development structure's impact on the stated predictions of erosion and accretion, it is not clear that this statement is justified. While the longshore sediment transport assessment (Section 4.3) shows the present coastline is stable with relatively small volumes of net sediment transport in the vicinity of the Army Groyne, the cross-shore sediment transport (Section 4.2) and climate change

MEMO

Date: 15 March 2024
Regarding: PER349327 – RIA Peer Review of Dredge Plume Modelling and Coastal Processes Reports

Item no.	Report section	Comment
		(Section 4.6) lack linking discussions to state what impact the project structure will have on predictions. It is not clear how the red dashed line on Figure 4.23 has been derived; no explanation or calculation is provided. If it is a conceptual line based on experience and judgement rather than calculation, then it should be referred to only as such and made clearer that it is not a derived forecast of potential impacts. Additionally, within previous sections there is no detail or calculation provided as to whether sediment is, or is not, transported past the tip of the existing Army Groyne. It should be shown whether or not the tip of the groyne – or of the proposed Barge Development – is outside the active transport zone and therefore beyond the point where sediment transport can occur.
12	Appendix A	The wave model validation plots presented here appear to have been reproduced from a previous report or presentation. This raises points of confusion, as the 2 m x 2 m grid shown on the maps is focused around the Main Ferry Terminal rather than the Army Groyne, and the labelling of the measurement sites is not consistent with those in the main body of the report.

Yours sincerely,

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REPORT

Appendix F
South Thomson Bay Barge Development, Dredge Plume Modelling Assessment (Baird 2024b)

South Thomson Bay Barge Development

Dredge Plume Modelling Assessment

2 February 2024 | 14029.101.R2.Rev0

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South Thomson Bay Barge Development

Dredge Plume Modelling Assessment

Prepared for:

Prepared by:

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14029.101.R2.Rev0

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Revision	Date	Status	Comments	Prepared	Reviewed	Approved
RevA	22/01/2024	Draft	For Client Review	RW	JC	JC
Rev0	2/2/2024	Final	Issued Final	RW	JC	JC

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Executive Summary

We acknowledge the Traditional Custodians of this Island, the Whadjuk people of the Noongar Nation, their ancestors and their Elders past, present and emerging. We acknowledge and respect their continuing culture and the contribution they make to the life of this Island and this region.

Wadjemup (Rottnest Island) is an A-class nature reserve of ecological, cultural, and social significance, with the island currently supplied with bulk cargo via the roll-on-roll-off vessel which docks at the barge ramp located near the base of the Main Ferry Wharf. Following identification in the Rottnest Island Master Plan – 20 Year Vision (RIA 2019) of the need to improve the functionality and efficiency of transporting bulk cargo to and from Wadjemup, investigations and studies have been undertaken to determine a design and method to convert the former Army Jetty site in South Thomson Bay into a barge landing development to move these activities away from the Main Ferry Wharf site.

A range of concept designs have been formulated and investigated since, with the concept developed by AECOM in their Value Engineering of Concept Design reporting (AECOM 2020) to be assessed in this Coastal Processes Assessment report. Assessment has been made here of the impact of the proposed barge development on the coastal processes acting within South Thomson Bay, including wave conditions, sediment transport pathways, wrack dynamics and the impact of wave penetration within the proposed harbour basin of the barge development.

The area to be included in this dredge plume modelling assessment is based on the Value Engineering Concept Design reported by AECOM in 2020 and includes the following design aspects:

- Extending the existing groyne by approximately 150m, which includes a 90m (nominal) breakwater that will run approximately parallel to the shoreline.
- A RoRo facility, consisting of an LCT Barge Ramp in the lee of the shore perpendicular section of the new breakwater structure, and including a laydown area of approximately 2,300 m^2.
- Dredging the approach to and footprint within the new breakwater structure to a declared depth of -3.0m Chart Datum (CD), which will include a turning basin with a nominal diameter of 80 m, resulting in a required dredging volume of approx. 16,000 m^3 when considering an overdredge requirement of 0.6m

Prior to commencement of the dredge plume modelling, Baird liaised with the specialist dredging consultancy in2Dredging Pty Ltd (i2D) to determine the most suitable methodology to dredge the material, as well as to determine the required schedule and budget estimate related to the chosen methodologies The dredging methodology used in this assessment relates to the use of a backhoe dredger BH EX05 setup and the P50 rock quality parameters assumed in i2D's reporting. The dredging requirements are considered in relation to the proposed barge landing footprint to be dredged in 6 sections across the dredge footprint according to the proximity of these areas to the sediment samples captured by Douglas Partners in their 2019 reporting.

The dredge plume model simulations were executed with no background suspended sediment concentration (SSC) and the raw model results represent excess above the background SSC. For the analysis of the model results and predicted extent, severity and duration of dredging impacts a background SSC was applied in the post processing of results. With no long-term dataset available within Thomson Bay to determine the most appropriate background SSC to use during a winter dredging campaign, analysis has been made of data available offshore of Wadjemup and at a location closer to shore within Cockburn Sound to make an estimate of the most appropriate background SSC to assume for this investigation. The background SSC taken from this interpretation is 3 mg/L.

The modelling process simulates dredge plume generation from their source and examines the fate of fine sediments in suspension, as suspended sediment concentration (SSC) both spatially and vertically through the water column in 3D. Sediment plumes are driven in the model by the hydrodynamic forcing (water levels, winds, waves, currents) with erosion, resuspension and deposition of the dredge material permitted in the model based on bed shear stress. The overall current direction trend from west to east along Thomson Bay has had an impact upon the dredge plume generated in the modelling program, with plumes generally directed east along South Thomson Bay away from the existing Army Groyne, with occasional periods of direction change directing the plume west and around the Army Groyne.

The calculation of the Zones of Impact (ZoI) defined by this study follow the method of calculation used by BMT in their analysis of the dredge plume and passive plume impacts from the placement of dredged sediments on Port Beach. This assessment determined nominal values of SSC that would have detrimental impact on local seagrass species, including the predominant species within South Thomson Bay, Posidonia.

The calculated zones of impact (ZoI, ZoMI and ZoHI) have been compiled based on the complete winter dredging program and are presented spatially in Section 5.5. Each of the zones that are considered to have an impact on benthic communities and habitat (BCH, including seagrasses), the ZoHI and ZoMI, are contained to small spatial extents adjacent to the dredge footprint, with extents based on conservative buffers around the dredge footprint as well as impacts from the modelling. It should be noted that the model impacts only influenced the spatial extents landward of the dredge footprint (i.e., impacts do not extend into Thomson Bay and are bounded by the dredge footprint, the Army Groyne and the Beach. The extent and coverage of the ZoI (representing the maximum predicted extent of visible plumes with the important consideration that these changes would not result in a measurable impact on BCH) stretching east along the beach in South Thomson Bay demonstrates the influence of the prevailing currents on this side of Wadjemup.

Table of Contents

1. Introduction 8

1.1 Project Location Summary 9

1.2 Dredge Plume Modelling Scope 9

2. Background Information 11

2.1 Measured Data Sources 11

3. Dredging Method 14

3.1 in2Dredging Methodology and Schedule 15

3.2 Dredging Approach and Methodology 16

3.3 Dredging Program 18

3.4 Sediment Classifications in Model 19

3.5 Dredge Material - Sediment Sampling and Analysis 20

4. Dredge Plume Modelling 22

4.1 Hydrodynamic Model (Delft3D FLOW-WAVE-FLOW) 22

4.1 Validation of Regional Model 25

4.2 Validation of Local Model 26

4.2.1 Model Validation – Water Levels and Currents 27

4.2.2 Model Validation – Waves 28

4.3 Dredge Plume Model Setup 31

4.3.1 Sediment Transport Model - Delft3D Morphology Module (Online-MOR) 31

4.3.2 Summary of Dredge Plume Model Parameters 31

5. Modelling Outcomes 33

5.1 General Plume Behaviour 33

5.2 Modelled Time Series Data through the Dredge Program 35

5.2.1 Modelled Time Series – Winter 35

5.3 Background Suspended Sediment Concentration 38

5.4 Zones of Impact Calculation 39

5.4.1 Calculation Method for Zones of Impact 40

5.5 Calculated Zones of Impact 44

6. Conclusions 46

7. References 47

Tables

Table 2.1: Data Summary – Key Datasets 11

Table 3.1: Production Overview (adapted from i2D 2023) 15

Table 3.2: Dredging Method - Summary Statement 16

Table 3.3: Proposed Dredging Schedules Adopted in Model Program 18

Table 3.4: Summary of Sediment Classes in Model (from Wentworth Scale) 19

Table 3.5: Sediment Composition of dredged material by area – based on Douglas Partners 2019 20

Table 4.1: Model Metrics for water level, depth-averaged current velocity and direction 28

Table 4.2: Model Metrics for wave height, period and direction for the Rottnest DWR and aquadopp locations 30

Table 4.3: Delft3D Dredge Plume Model Settings 31

Table 5.1: Impact zones, definitions and boundary thresholds (BMT 2021a) 41

Figures

Figure 1.1: Site location showing Wadjemup /Rottnest Island and location of Thomson Bay on the Northeast side of the Island, with the Army Groyne location shown in the southern section of Thomson Bay 8

Figure 2.1: Measured Data Locations 12

Figure 2.2: High resolution multibeam bathymetry captured by DoT around Wadjemup 13

Figure 3.1: Value Engineering Concept 1 General Arrangement (AECOM 2020, RIA-2520-19180-MAR-01 RevE) 14

Figure 3.2: Backhoe dredger vessel example, the TAMS FT3 BHD (left), with associated hopper barge (right) (TAMS 2024) 15

Figure 3.3: Geotechnical sediment sampling locations included in particle size distribution (PSD) analysis (Douglas Partners 2019) and adopted in dredge plume modelling program, with locations of samples included in PSD analysis shown in green. 17

Figure 3.4:Dredge footprint split according to the closest sediment sample collected by Douglas Partners in 2019, showing the sediment size classification used for each section of the dredge footprint in the dredge plume modelling. 19

Figure 3.5: Core Samples for sample 2 (top) and sample 27 (bottom) (Douglas Partners, 2019). Cores are collected to the target depth below seabed of 1m, and demonstrate very low fines content and non-cohesive nature of the sediments at these locations 21

Figure 4.1: Regional Hydrodynamic Model Domain (DFM) covering southwest Western Australia. 23

Figure 4.2: Local scale Delft3D model area developed for the South Thomson Bay Project with boundary conditions defined from the Regional model. 23

Figure 4.3: Local Delft3D Hydrodynamic Model grid setup applied for dredge plume modelling. 24

Figure 4.4: Local Delft3D Hydrodynamic Model grid setup applied for dredge plume modelling, zoomed into the smallest grid (10m x 10m grid resolution) at South Thomson Bay. 25

Figure 4.5: Regional Model Tidal Validation at nearby Port locations 26

Figure 4.6: Comparison of Inshore Location Measured vs Modelled Data for Depth Averaged Current. Winter Validation Period, 16 July 2020 – 16 August 2020. 27

Figure 4.7: Winter Validation Case - Comparison of Wave Data Measured vs Modelled at the Rottnest Directional Waverider Buoy 29

Figure 4.8: Winter Validation Case - Comparison of Wave Data Measured vs Modelled at the Aquadopp Location. Directional statistics are not included due to the uncertainty around the accuracy of the direction reported in the measured data. 29

Figure 4.9: Winter Validation Case Previously Completed for 2012 - Comparison of Wave Data Measured vs Modelled at the AWACR1_02 Location 30

Figure 5.1: Spatial plots at three hourly spaced timepoints in the dredge program model, showing the plume directed strongly to the east away from the Army Groyne (top left), less strongly away from the Army Groyne (top right), directed weakly to the west around the Army Groyne (bottom left) and remaining close to the point of discharge in the peak of a tidal cycle as the tide turns from flood to ebb (bottom right) 34

Figure 5.2: Locations where timeseries suspended sediment concentration (SSC) data is presented 35

Figure 5.3: Modelled Suspended Sediment Concentration (mg/L) in close proximity to the dredge footprint (Army Groyne) over winter, with associated wind speed and direction and water level at the dredge footprint. 36

Figure 5.4: Modelled Suspended Sediment Concentration (mg/L) just east of the dredge footprint (South Thomson Bay 1) over winter, with associated wind speed and direction and water level at the dredge footprint. 36

Figure 5.5: Modelled Suspended Sediment Concentration (mg/L) further east of the dredge footprint (South Thomson Bay 2) over winter, with associated wind speed and direction and water level at the dredge footprint. 37

Figure 5.6: Modelled Suspended Sediment Concentration (mg/L) immediately north of the dredge footprint (aquadopp) over winter, with associated wind speed and direction and water level at the dredge footprint. 37

Figure 5.7: Average post-July 2017 TSM values with (orange line) and without (blue line) correction for the blank at Wadjemup between September 2017 and July 2018 (Clementson et al 2020) 38

Figure 5.8: Weekly and rolling four-weekly median total suspended solids (TSS) concentration in the intake seawater for the Perth Seawater Desalination Plant between July 2020 and June 2021 (Cockburn Sound Management Council 2023) 39

Figure 5.9: Calculation of total SSC and daily mean values of modelled SSC analysed against nominal seagrass impact thresholds (based on BMT 2021a) at the Army Groyne location. Analysis shown for the background SSC of 3mg/L. 42

Figure 5.10: Calculation of total SSC and daily mean values of modelled SSC analysed against nominal seagrass impact thresholds (based on BMT 2021a) at the South Thomson Bay 1 location. Analysis shown for the background SSC of 3mg/L. 42

Figure 5.11: Calculation of total SSC and daily mean values of modelled SSC analysed against nominal seagrass impact thresholds (based on BMT 2021a) at the South Thomson Bay 2 location. Analysis shown for the background SSC of 3mg/L. 43

Figure 5.12: Calculation of total SSC and daily mean values of modelled SSC analysed against nominal seagrass impact thresholds (based on BMT 2021a) at the Aquadopp location. Analysis shown for the background SSC of 3mg/L. 43

Figure 5.13: Calculated Zones of Impact (ZoI, ZoMI and ZoHI) based on a background SSC of 3mg/L for the 7.5 week winter dredging program. 45

1. Introduction

Wadjemup (Rottnest Island), located approximately 20 kilometres west of the port of Fremantle in Western Australia, is an A-class nature reserve of ecological, cultural, and social significance. The island is a remnant of southwest Western Australia's Pleistocene dune ridges and is surrounded by large quantities of reef platforms and rock formations. It is a popular tourist attraction with over 780,000 visitors to the Island annually enjoying short stay accommodation and recreational activities including snorkelling, bike riding and site seeing (WA Govt 2019). Tourists enter Wadjemup via ferry services disembarking on the island's Main Ferry Wharf located in Thomson Bay, with the Bay located on the north east side of the island, spanning approximately 2.5 km, and sheltered from the prevailing south westerly swell conditions (Figure 1.1).

The island is currently supplied with bulk cargo via the roll-on-roll-off vessel which docks at the barge ramp located near the base of the Main Ferry Jetty. Following identification in the Rottnest Island Master Plan – 20 Year Vision (RIA 2019) of the need to improve the functionality and efficiency of transporting bulk cargo to and from Wadjemup, to reduce noise levels for residents, and to improve safety and amenities for visitors arriving at the island, investigations and studies have been undertaken at the Army Groyne. This includes studies to determine a design and method to convert the former Army Jetty site in South Thomson Bay into a barge landing, freight handling and associated storage area to aid in reducing heavy vehicle traffic around Wadjemup's main jetty in the Main Settlement area.

Figure 1.1: Site location showing Wadjemup /Rottnest Island and location of Thomson Bay on the Northeast side of the Island, with the Army Groyne location shown in the southern section of Thomson Bay

Initial concept designs for the proposed new barge landing site prepared by Wallbridge Gilbert Aztec (WGA) in late 2018 were used by MP Rogers and Associates (MRA) in their South Thomson Bay Coastal Processes Assessment (MRA 2019), with further development of the first option being undertaken by BMT in 2020. Following these assessments, AECOM were engaged by the Rottnest Island Authority (RIA) to undertake a high-level value engineering assessment of this concept design, aiming to identify opportunities to reduce capital costs, while maintaining the key functional/user requirements achieved by the initial concept design.

The concept developed by AECOM in their Value Engineering of Concept Design reporting (AECOM 2020) is the concept that has been used by Baird to develop an updated Coastal Processes Report (Baird 2023) and will be used in the dredge plume modelling scope covered in this report.

1.1 Project Location Summary

The local setting and metocean conditions for the project location are described in detail in Baird (2023). A brief summary follows.

The tides at Wadjemup are mainly diurnal with a spring tide range of approximately 0.7m and neap tide range of 0.5m. The tidal planes for Thomson Bay have been taken from the nautical chart for Rottnest Island WA412 (DoT 2011) with the vertical datum set to the Rottnest Island Sounding Datum. It is noted that the LAT level has not been established for Thomson Bay.

Wadjemup is the largest island along the Garden Island Ridge, a rocky remnant Pleistocene ridge forming a chain of submarine reef platforms and emergent islands approximately 12km offshore of the Swan Coastal Plain, with Wadjemup forming the northern terminus of the Ridge (Searle et al 1985). The Island sits on the middle shelf region of the narrow Rottnest Shelf (Brooke 2010), with bathymetry west of the island dropping to -55m MSL within 2km of the western most point of the island (Cape Vlamingh at West End). Flows around the island are largely driven by swell energy from the Indian Ocean that wrap around the island from west to east as they encounter the surrounding shallower waters and the emergent island itself.

The measured currents at the proposed barge landing site show:

- Depth averaged peak current speed of $0.05ms^{-1}$ - $0.1ms^{-1}$ in neaps and $0.1ms^{-1}$ – $0.15ms^{-1}$ in springs.
- Current direction (direction to) is relatively consistent across the tidal cycle at 80˚ - 100˚, with occasional brief changes in direction to come from more northerly directions.
- The low current speeds seen in this area appear to be strongly affected by increased wind speeds, with current speed peaks seen during periods of increased wind speed at Wadjemup.

In general, wave conditions at the proposed barge landing site are dominated by diffracted and refracted swell waves within the range of 0.4m to 0.7m (significant wave height) at peak wave periods around 12 to 18s arriving from the northern sector, with intermittent influence of wind sea resulting in higher waves around 0.8 to 0.9m at peak wave periods of 5 to 10s arriving from the northwestern sector.

1.2 Dredge Plume Modelling Scope

The methodology used to provide the requirements of scope is outlined here.

- A site visit was conducted to examine the key features at the project location that are important for consideration in the delivery of the study.
- A coupled hydrodynamic and wave mode was developed I at appropriate resolution for project site at south Thomson Bay (high resolution) and surrounding area of influence (lower resolution areas offshore). Model validation was provided to available measured water level, currents and wave data in Thomson Bay.

- Model was developed in 3D around the area of interest where dredge plumes are generated – plume dispersion will be modelled in 5 to 10 vertical layers.
- The dredging program characteristics was determined in discussion with dredge contractor and RIA. Inputs to the model were co-ordinated, specifying sources of dredge plume generation (incorporating dredge method, timing, production rates, schedule). Dredge volumes and sediment classification of dredged material (sand, fine sand, silt, clay content) were confirmed with RIA for input to the modelling process.
- The dredge program was executed in the model, adopting continuous simulation of hydrodynamics and wave conditions and dredge plume source/s. The model adopted a representative winter season condition in Thomson Bay.
- Analysis of the dredge plume impacts around the site based was carried out based on the methods detailed in the EPA and supported by analysis in BMT (2021) spatially based zonation scheme to describe the predicted extent, severity and duration of impacts associated with dredging proposals (EPA, 2016). The scheme consists of three zones that represent different levels of impact:
  1. Zone of High Impact (ZoHI) is the area where impacts on benthic communities or habitats are predicted to be irreversible.
  2. Zone of Moderate Impact (ZoMI) is the area within which predicted impacts on benthic organisms are recoverable within a period of five years following completion of the dredging activities.
  3. Zone of Influence (ZoI) is the area within which changes in environmental quality associated with dredge plumes are predicted and anticipated during the dredging operations, but where these changes would not result in a detectible impact on benthic biota.
- The calculation of the ZoMI and ZoHI areas from the dredge plume modelling was completed based on analysis of the running mean of modelled SSC against different thresholds taken from BMT (2021). Baird would analyse dredge plume zones of impact (ZoMI, ZoHI, ZoI) based on receptor communities for seagrass consistent with threshold levels outlined in BMT (2021). The Zones of impact would be determined in GIS format and presented in spatial mapping to support the approvals process.

2. Background Information

The background reports referenced in the development of the hydrodynamic model and application in the dredge plume modelling program are outlined in Appendix A.

2.1 Measured Data Sources

The key measured data sources which have been applied in the Dredge Plume model program are summarised in Table 2.1.

Table 2.1: Data Summary – Key Datasets

Dataset	Description
Sediment Sampling	Geotechnical core samples with sediment sampling from seabed areas within and adjacent to the proposed dredging footprint were reported in Douglas Partners (2019). Further sediment samples from the same dredge footprint area with similar PSD results were collected by RPS in 2020.
Bathymetry Ordered Highest to lowest priority	There is a very good description of the bathymetry from around the Island captured in high resolution for the Department of Transport (DoT) in 2009 to approximately 30m depth (Figure 2.2). There are high resolution local bathymetric surveys in Thomson Bay captured in 2017 and 2020 by DoT which provide an excellent description of the seabed for the study (Figure 2.2).

Baseline Metocean Data	Measured data relevant to the site and this modelling scope is available for a range of data types and dates. The full set of measured data is detailed in Baird's Coastal Processes Report (Baird 2023), with the location of each of these datasets shown in Figure 2.1. The key metocean datasets used for model setup and validation in this scope include:
	• Rottnest Island Wind
	  • 1983 – 2023
	  • Wind Speed and Direction
	• Rottnest Buoy DWR
	  • 2004 – 2023
	  • Waves (Hs, Tp, Dir)
	• Aquadopp Site 1
	  • 25th June 2020 – 8th Aug 2021
	  • Waves (Hs, Tp, Dir, Spread)
	  • Currents (Speed, Direction)
	  • Water Depth
	• Signature 1000 Site 2 ADCP
	  • 5th Nov 2020 – 9th Feb 2021
	  • Waves (Hs, Tp, Dir, Spread)
	  • Currents (Speed, Direction)

Dataset	Description

	• Water Depth
	• AWAC_R1_01
	  • 8th Aug – 3rd Oct 2012
	  • Waves (Hs, Tp, Dir)

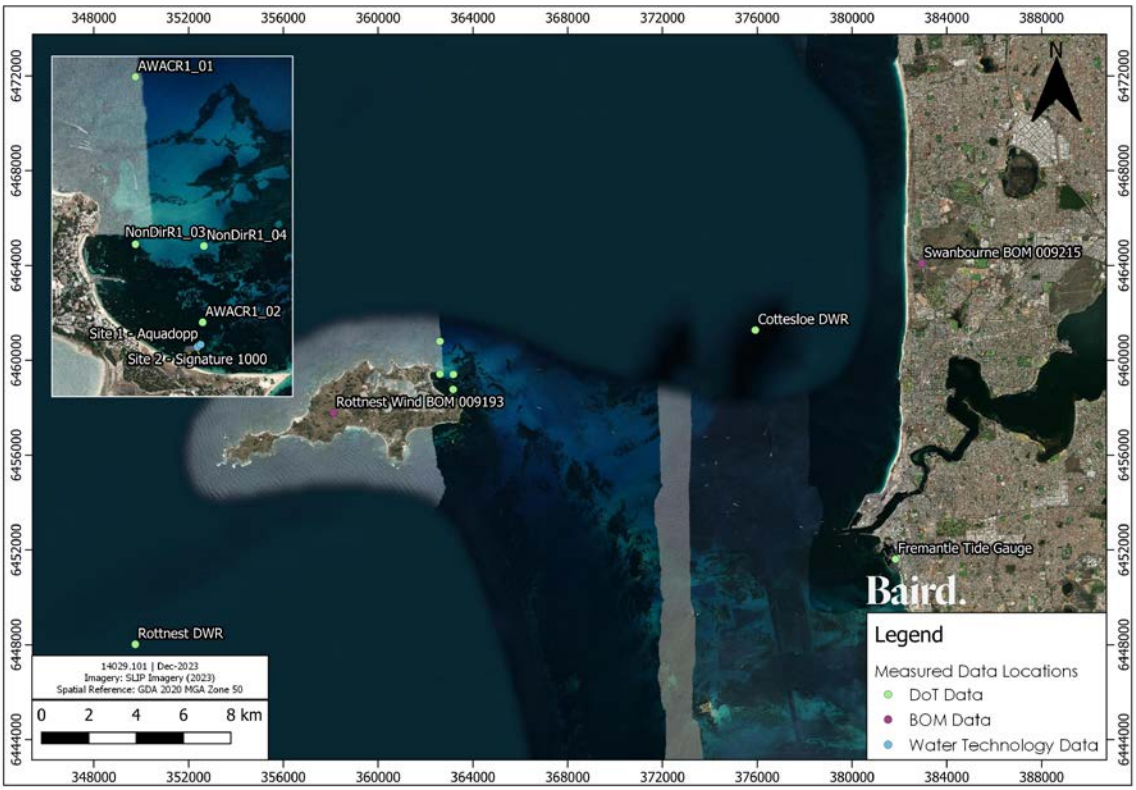

Figure 2.1: Measured Data Locations

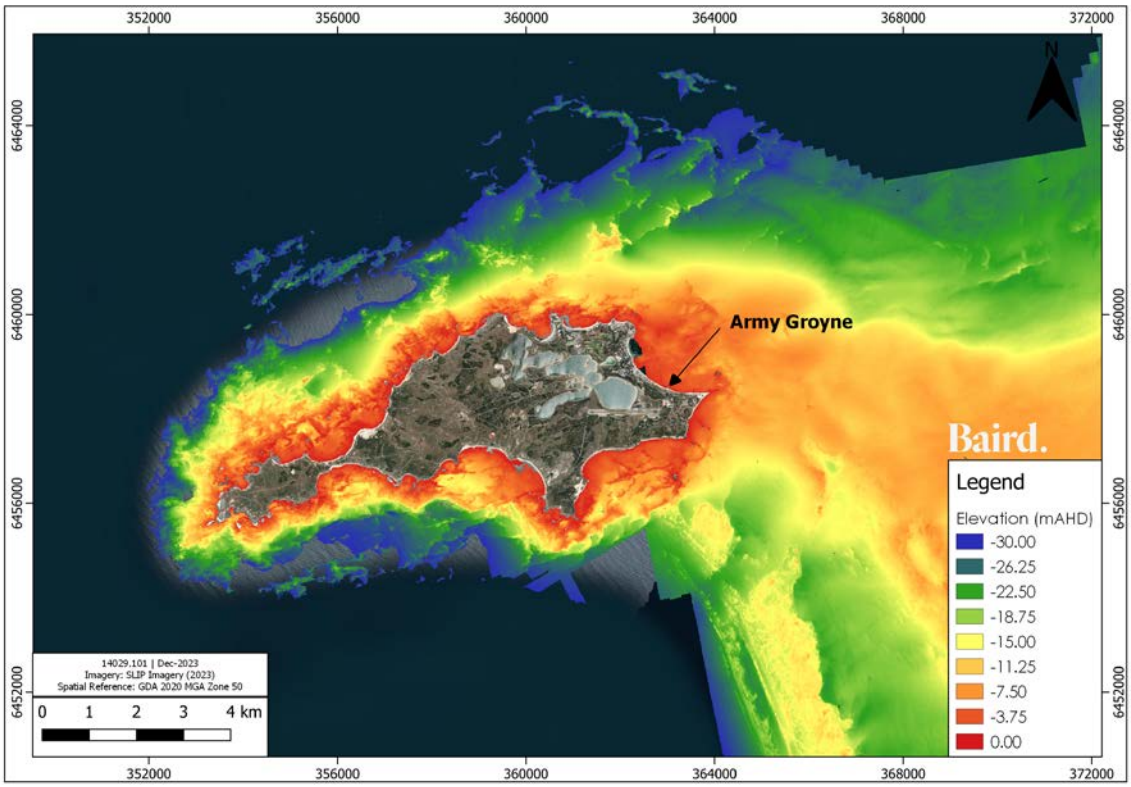

Figure 2.2: High resolution multibeam bathymetry captured by DoT around Wadjemup

3. Dredging Method

The area to be included in this dredge plume modelling assessment is based on the Value Engineering Concept Design reported by AECOM in 2020, shown below in Figure 3.1, and includes the following design aspects:

- Extending the existing groyne by approximately 150m, which includes a 90m (nominal) breakwater that will run approximately parallel to the shoreline.
- A RoRo facility, consisting of an LCT Barge Ramp in the lee of the shore perpendicular section of the new breakwater structure, and including a laydown area of approximately 2,300 m^2.
- Dredging the approach to and footprint within the new breakwater structure to a declared depth of -3.0m Chart Datum (CD), which will include a turning basin with a nominal diameter of 80 m.

This will require a volume of material to be removed from the site of approximately 16,000m^3, including an overdredging depth of 0.6m vertically, and accounting for the removal of both loose sediment and rock.

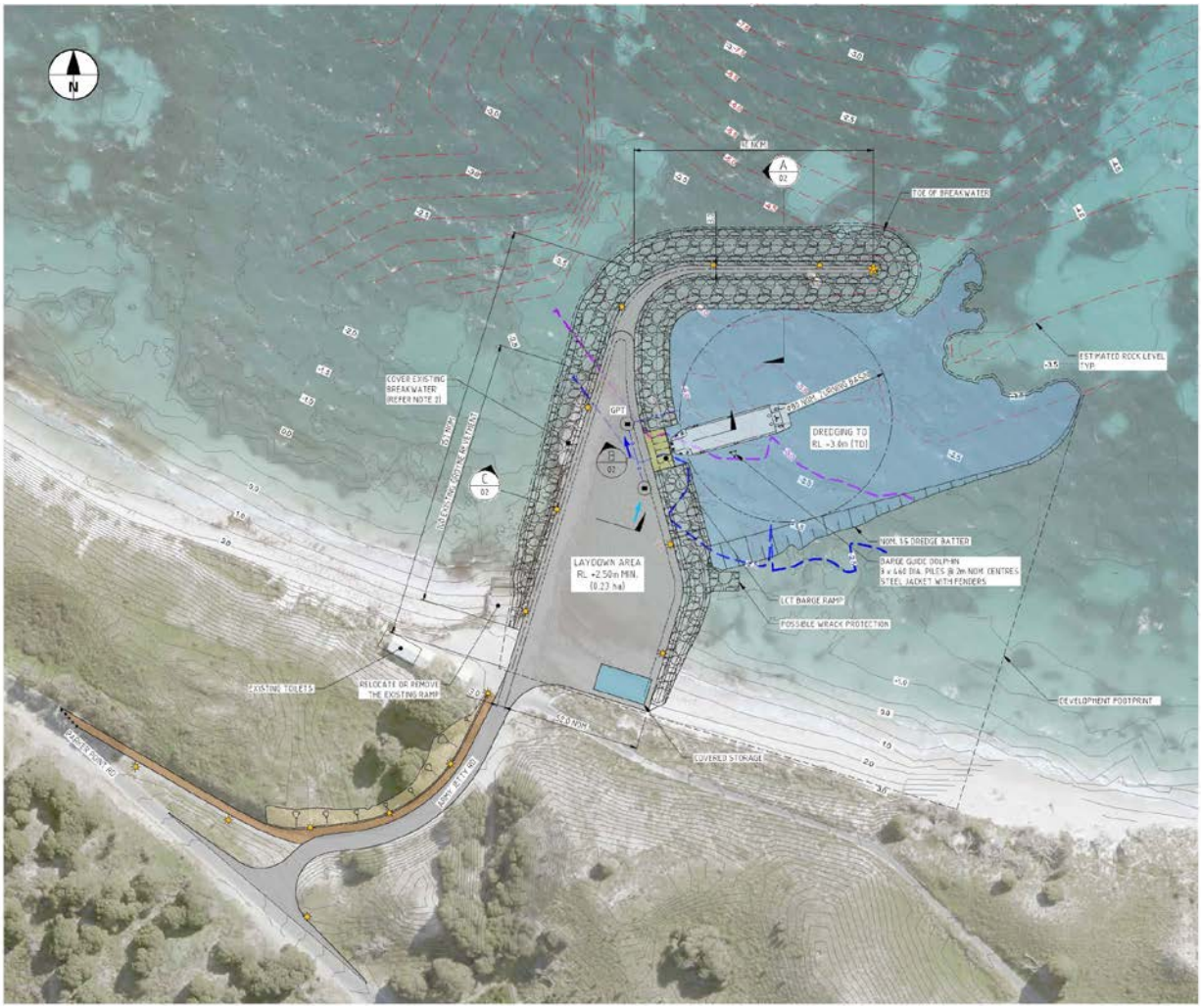

Figure 3.1: Value Engineering Concept 1 General Arrangement (AECOM 2020, RIA-2520-19180-MAR-01 RevE)

3.1 in2Dredging Methodology and Schedule

Prior to commencement of the dredge plume modelling, Baird liaised with the specialist dredging consultancy in2Dredging Pty Ltd (i2D) to determine the most suitable methodology to dredge the material, as well as to determine the required schedule and budget estimate related to the chosen methodologies outlined in i2D (2023). This analysis and reporting resulted in the estimation of dredging rates and schedules based on the use of a backhoe dredger (BHD), as shown in Figure 3.2, with dredging and schedule estimates for two small to medium BHDs included.

Figure 3.2: Backhoe dredger vessel example, the TAMS FT3 BHD (left), with associated hopper barge (right) (TAMS 2024)

This estimate resulted in the following production overview for the two selected example BHDs.

Table 3.1: Production Overview (adapted from i2D 2023)

Parameter	Unit	Sand		Rock (P50)		Rock (P80)	
		BHD FT3	BH EX05	BHD FT3	BH EX05	BHD FT3	BH EX05
Gross Volume	in situ m^3	14,033		2,017			
Operability	OH/wk	26	37	58	57	61	60
Productivity	in situ m^3/OH	150	67	21	20	3	3
Weekly Production	in situ m^3/wk	3,948	2,479	1,230	1,135	207	331
Duration per unit	weeks	3.6	5.7	1.6	1.8	9.7	6.1
Total duration for both units	weeks	N/A		5.2	7.5	13.6	11.8

3.2 Dredging Approach and Methodology

The dredging methodology has been defined based on the information provided by i2D, with the dredge plume model case developed based on a case in the mid-range of the timing estimates provided in the i2D reporting. The dredge plume modelling assumes the use of the BH EX05 setup and the P50 rock quality parameters outlined in Table 3.1 above, a realistic worst case scenario that considers the longer dredging campaign with rock parameters that are the most likely to be present at the site. If further investigation shows that the rock quality is closer to the P80 parameter update can be made to the dredging program to determine the impact of this on the predicted plumes. Inputs to be model are summarised in Table 3.2.

Table 3.2: Dredging Method - Summary Statement

Dredge Design	
Target Dredging	12,069 m^2 (Area, inc. batters) 16,000 m^3 (Volume, inc. overdredge requirement)
Design Depth	-3.0m CD
Batters (nom.)	1V:5H
Dredge Volume	A dredge volume of approximately 16,000m^3 has been included in model, using the schedule calculated for the BH EX05 scenario of 7.5 weeks. As the timing of the dredging operations across this 7.5 weeks is not yet decisively determined, the potential worst-case scenario of discharging sediment continuously into the marine environment has been assumed. This results in a target production rate of 302 m^3/day. Sediment is classified by volume in sediment fractions in the categories: • Gravel, Cobbles >2mm. • Medium to coarse Sand 0.25mm – 2mm. • Fine sand 62µm – 0.25mm. • Coarse Silt 16µm to 62µm. • Fine Silt 2µm to 16µm. • Clay < 2µm. The proportion of the respective sediment classes that will be modelled as a source term will be based on the information from latest sediment sampling, shown in Figure 3.3.
Over Dredge Allowance	Allowance of 0.6m over dredge in all areas being dredged (i.e., not where natural seabed level is already at design depth).
Dredge Method	
Dredge Plant	Backhoe Dredger BH EX05
Excavation Rate	302m^3/day, assumed to be undertaken on a 24/7 basis.
Dredge Disposal Sequence	Dredging undertaken by moving from the nearshore area (requires greater volume of dredging due to shallower natural seabed depth and therefore more material to be removed to reach design depth) to the offshore, as detailed in Section 3.3 and Figure 3.4.

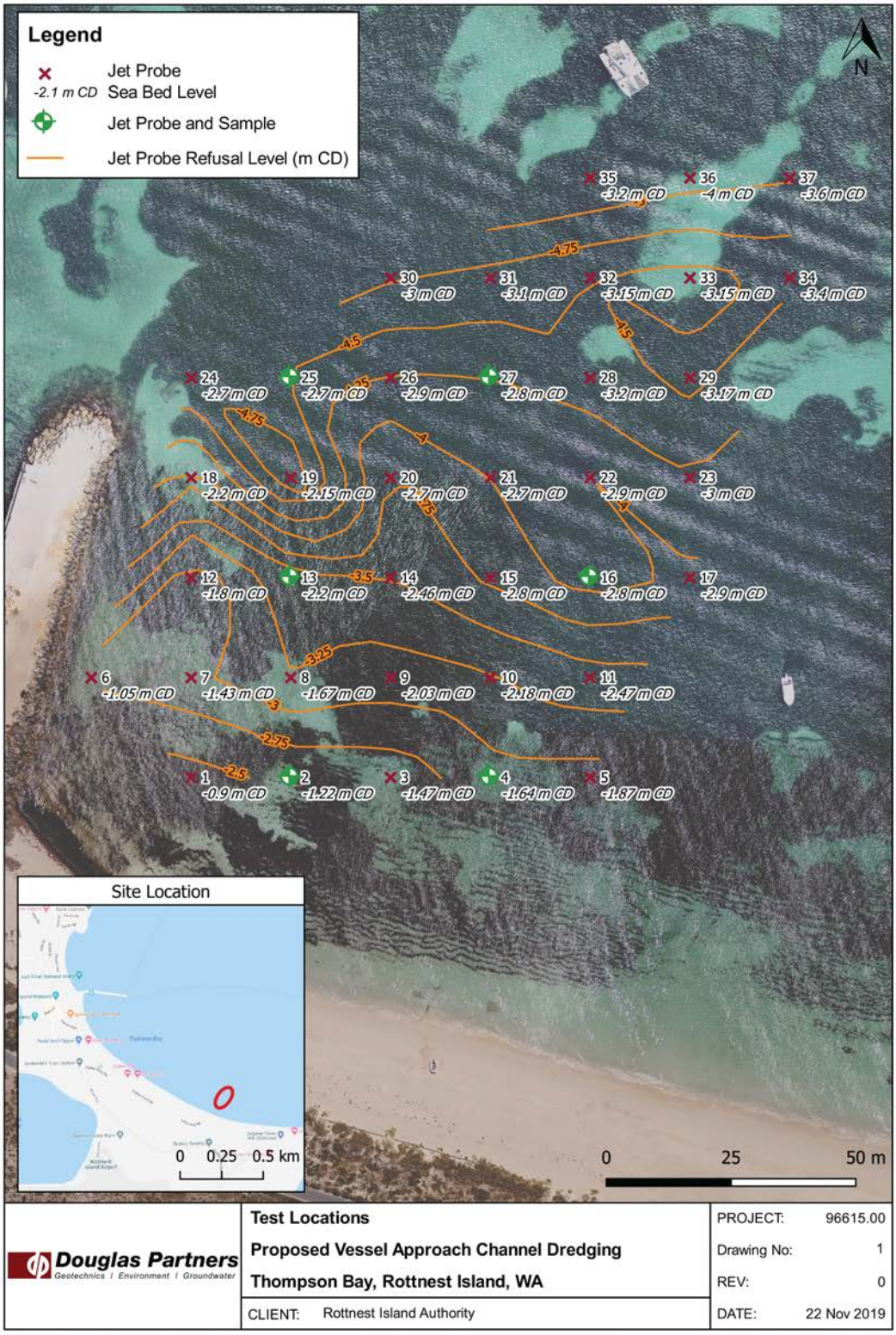

Figure 3.3: Geotechnical sediment sampling locations included in particle size distribution (PSD) analysis (Douglas Partners 2019) and adopted in dredge plume modelling program, with locations of samples included in PSD analysis shown in green.

3.3 Dredging Program

The dredging schedule included in this modelling program has been developed based on the schedule outlined in i2D (2023), and taking the assumptions related to use of the BH EX05 dredging plant, which includes the assumption that the dredging will take place prior to the construction of the breakwater structure due to difficulties in manoeuvring plant within the breakwater following construction, and the potential for impacts upon the structure toe if materials are removed from the vicinity following placement. The schedules aim to complete the requirements of the project in one continuous dredging program between late June to mid-August (nominal winter), with discussions held with RIA confirming that the winter period is the optimal time to complete dredging works as it avoids the peak tourist season of summer. The dredging program incorporates a range of assumptions for the plant and equipment (e.g., production rates, working hours) as shown in Table 3.2.

The dredging requirements are considered in relation to the proposed barge landing footprint to be dredged in 6 sections across the dredge footprint according to the proximity of these areas to the sediment samples shown in Figure 3.3 (dredge areas shown in Figure 3.4).

Within each dredge area, the sediment composition of dredge spoil is determined from available geotechnical information (Douglas Partners 2019) closest to each respective section. The dredge volume in each section to be included in the dredge plume model is then calculated in terms of fine sand and silt components, noting that no clay component was found in any of the 6 PSD samples, and assigned to plume sources in the numerical model based on the assumed dredging method of the BH EX05, as discussed above.

Table 3.3: Proposed Dredging Schedules Adopted in Model Program

Area Covered	Dredge Volume	Modelled Dates		Days
		Start	End	
Sample 2	2,114 m^3	24/06/2020	30/06/2020	7
Sample 4	2,114 m^3	01/07/2020	07/07/2020	7
Sample 13	4,530 m^3	08/07/2020	22/07/2020	15
Sample 16	2,718 m^3	23/07/2020	31/07/2020	9
Sample 25	3,020 m^3	01/08/2020	10/08/2020	10
Sample 27	1,510 m^3	11/08/2020	15/08/2020	5
TOTAL	**16,006 m^3**			**53**

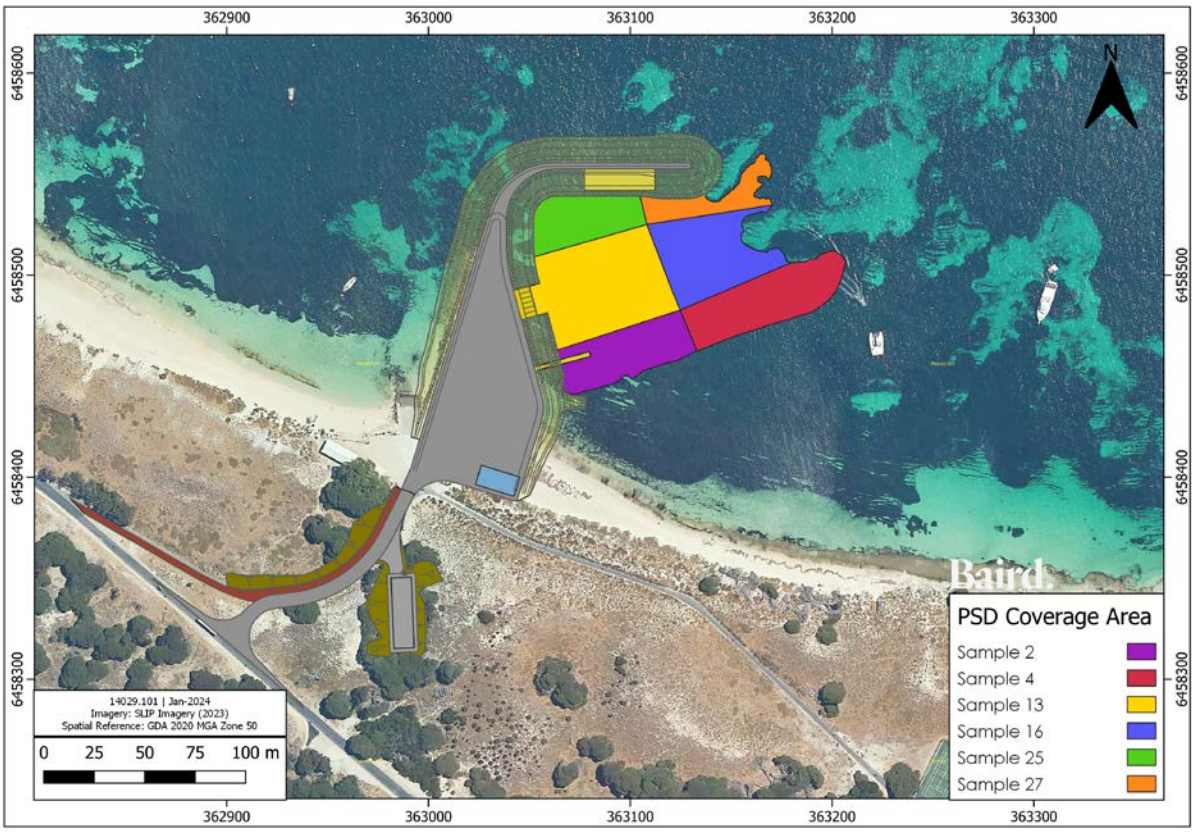

Figure 3.4:Dredge footprint split according to the closest sediment sample collected by Douglas Partners in 2019, showing the sediment size classification used for each section of the dredge footprint in the dredge plume modelling

3.4 Sediment Classifications in Model

Douglas Partners' (2019) detailed geotechnical investigation and sediment sampling program has informed understanding of the composition of the seabed material which will be dredged.

The sediment classifications considered in the modelling are based on the range of sizes described in Table 3.4. The dredge plume modelling examines fine cohesive sediments (silts only as no clays are present at the site) while also considering non-cohesive fine sand.

Table 3.4: Summary of Sediment Classes in Model (from Wentworth Scale)

Sediment Class	Size Range (µm)	Model Assumptions
Fine sand	62µm – 0.25mm	Modelled as non-cohesive sediment with Median Sediment D_{50} = 200µm
Coarse Silt	16µm to 62µm	Modelled as cohesive sediment, Settling Velocity 1.7mm/s
Fine Silt	2µm to 16µm	Modelled as cohesive sediment, Settling Velocity 0.06 mm/s

A key determinant of the dredge plume dispersion and settlement in the model is the settlement rate parameter for the fine fractions. According to Stokes' Law, the settling rate of particles is affected by the

gravitational force exerted on the particle, the density of the particle relative to the density of the medium, and the viscosity (resistance to flow-settling) of the medium.

For the modelled fine fractions, the following settlement rates has been adopted according to Stokes' Law:

- Coarse Silt = 1.7 mm/s
- Fine Silt = 0.06 mm/s

These values fall within the ranges of settling velocity adopted in similar modelling studies as noted in Sun et al, 2016.

3.5 Dredge Material - Sediment Sampling and Analysis

The sediment sample locations collected through the alignment of the proposed barge landing dredge footprint are shown in Figure 3.3, with the interpretation of the areas covered by each sediment sample in the model shown in Figure 3.4. The sediment samples are taken from various depths, from -1.22m CD to -2.8m CD. The boreholes are considered to represent the sediment conditions of the dredged material in the channel.

There are six respective dredge areas shown as coloured polygon areas in Figure 3.4. The sequences are distinct areas considered across the dredging footprint in which the sediment composition and volume has been assessed and input into the model to determine the dredge plume impacts. The area covered by sample 13 is the largest due to the relative amount of the dredge footprint that aligns closely to this sediment sample location. This location is also relatively shallow requiring a greater volume of material to be removed to reach design depth, corresponding to an assumed 15 days of the dredge program being informed by the PSD from this location (Table 3.3). Conversely, as dredging operations move offshore to the area of the footprint informed by sample 27, the spatial area reduces as the dredging volume required to reach the design depth decreases and the days spent in this part of the dredge footprint will also be reduced (5 days of dredging are assumed to be informed by the PSD from this location).

Within each of the dredge areas informed by each sediment sample, sample 2 to sample 27, the particle size distribution of the dredged material for application in the model has been calculated based on the measured sediment size data. This process is summarised in Table 3.5, outlining the samples that have been considered for each of the areas and the calculation of the respective sediment fractions (silt, fine silt, and sand).

Table 3.5: Sediment Composition of dredged material by area – based on Douglas Partners 2019

Area Covered	Depth of Sample	Fine Silt %	Silt %	Fine Sand %
Sample 2	-1.22m CD	1	2	36
Sample 4	-1.64m CD	0	0	47
Sample 13	-2.2m CD	2	1	68
Sample 16	-2.8m CD	0	0	73
Sample 25	-2.7m CD	0	0	84
Sample 27	-2.8m CD	2	1	79

An overview of the incorporation of the Douglas Partners' (2019) sediment sampling results into the model is provided as follows:

- The sediment sampling has been applied to the model based on determining the most appropriate number of days spent in each part of the proposed dredge footprint and the most appropriate sediment sample PSD to use as input to the model for those respective days.
- The sediment samples show that the fines content is very low across all of the sample PSDs, with no clay content found in any sample. Silt content is also zero for half of the sample PSDs, with the combined silt fraction content at 3% for the other half of the sample PSDs. Fine sand (included in the model source terms), coarse sand and gravel (not included in the model source terms as these fractions are so large that they do not contribute to the generation of plumes) make up the majority of the sediment samples.

To illustrate the application of the geotechnical information, the core samples from sample 2 and sample 27 are shown below in Figure 3.5, demonstrating the very low fines content of the samples and the overall non-cohesive nature of the samples collected within the proposed dredge footprint.

Figure 3.5: Core Samples for sample 2 (top) and sample 27 (bottom) (Douglas Partners, 2019). Cores are collected to the target depth below seabed of 1m, and demonstrate very low fines content and non-cohesive nature of the sediments at these locations

4. Dredge Plume Modelling

Hydrodynamic, wave and sediment transport models have been developed for the South Thomson Bay project to model dredge plume development and dispersal. The model system is used for predicting the likely extent, severity, and persistence of environmental impacts by the proposed dredging activity. For this project the Delft3D modelling system (Deltares, 2020) has been adopted.

Delft3D is an industry leading integrated modelling suite, which simulates two-dimensional (in either the horizontal or a vertical plane) and three-dimensional flow, sediment transport and morphology, waves, water quality, and ecology and can handle the interactions between these processes. The model has been applied in many similar studies of dredging impacts at sites around Australia with modules for investigation of far-field water quality, mid-field water quality, ecological modelling, and cohesive and non-cohesive sediment transport (Sun et al 2016).

Prior to modelling the dredge plume impacts, the coupled hydrodynamic and wave model was validated to the measured data made available to this study. The details of these models, as well as the validation achieved for the coupled model systems, are presented below, followed by overview of the details of the sediment transport model that allows for the investigation of the dredge plume impacts that can be expected from the dredging program described in Section 3.

4.1 Hydrodynamic Model (Delft3D FLOW-WAVE-FLOW)

The hydrodynamic and wave models established for this phase of the South Thomson Bay project are summarised as follows:

1. A regional scale hydrodynamic model extending across the southwest of Australia using Delft-Flow Flexible Mesh (D-Flow FM) model (grid setup shown in Figure 4.1). The model is driven by tidal constituents along its open boundaries with bathymetry defined from hydrographic chart data and local scale bathymetry sources where available. For this project, winds and atmospheric pressure have been sourced from the NCEP Climate Forecast System (CFSR). The climatic conditions were then applied spatially in D-Flow FM and updated hourly across the regional model in conjunction with the tides, so their influence was captured in the determination of hydrodynamic forces acting in the domain.
2. A local scale Delft3D hydrodynamic model is established over the Wadjemup area with boundary conditions defined by the Regional model (Figure 4.1).
3. The local hydrodynamic model is setup in a domain decomposition grid arrangement to optimise the efficiency of the model performance. The outer grid extends along the shoreline approximately 84 km with a cross shore extent of approximately 40km. The outer grid is setup on a 500 m grid size, with smaller grids at resolutions of 250m and 50m included in the domain decomposition arrangement to balance required model resolution and computational efficiency. The model grids and model bathymetry are shown for the full model setup in Figure 4.2. For the dredge plume analysis, a smaller domain sized at 10 m resolution describes the area around the dredge footprint within South Thomson Bay (model grid coverage and bathymetry at Figure 4.4). This local scale model is setup with the following attributes:
   - The model is forced along the boundary of the outer grid by water level boundaries along the northern, western and southern boundaries as derived from the regional scale model described above. Water levels at the boundary are updated every 10 minutes.
   - The model is driven by local wind conditions derived from the Bureau of Meteorology (BoM) site on Rottnest Island (BOM Site 9193), scaled down from the height they are measured at (~43m MSL) to the standard 10m above mean sea level.
4. A SWAN wave model was developed to cover the local scale domain with the following attributes:

- The model grids are setup to align with the four hydrodynamic grids described above, with model grid cell resolution increasing approaching the project site in Thomson Bay (500m x 500m, 200m x 200m, 50m x 50m, 10m x 10m). The grid and bathymetry setup is as shown in Figure 4.3.
- The wave conditions inside the SWAN model develop under forcing from boundary conditions based on the Rottnest Directional WaveRider Buoy, with local seas for the South Thomson Bay model generated by input winds in the FLOW model.
- Wave conditions are updated in the local hydrodynamic model every half hour using Delft3D coupled FLOW-WAVE-FLOW module.

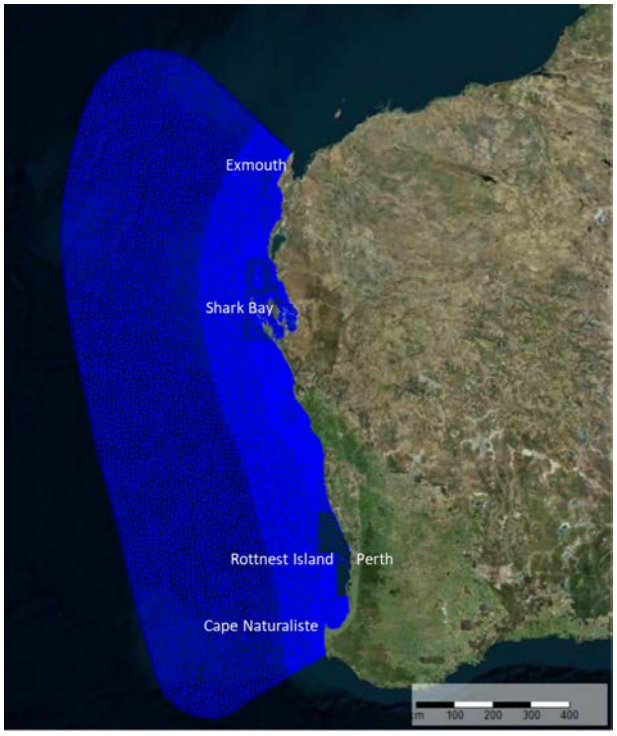

Figure 4.1: Regional Hydrodynamic Model Domain (DFM) covering southwest Western Australia.

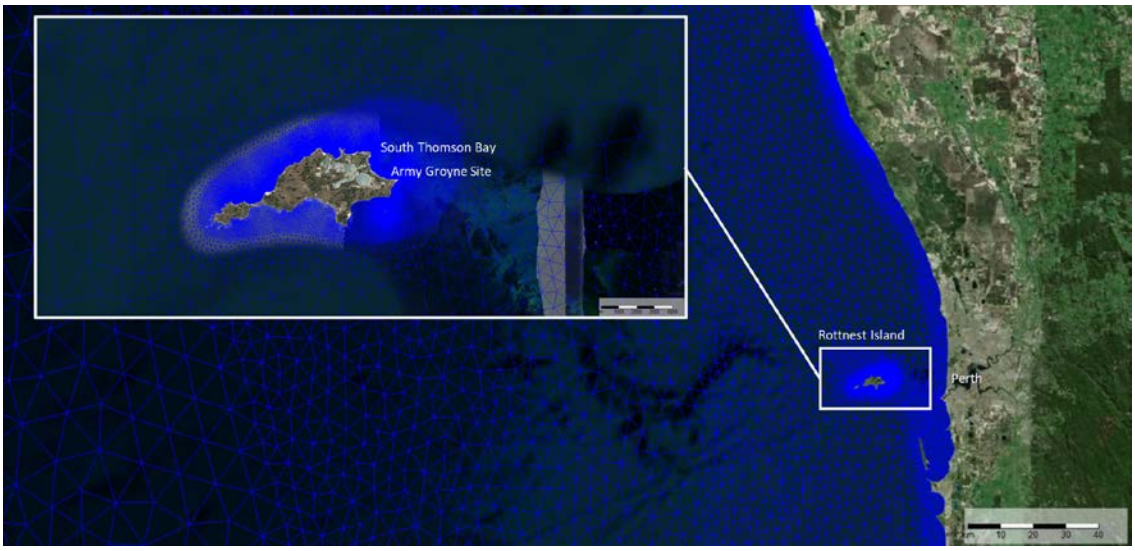

Figure 4.2: Local scale Delft3D model area developed for the South Thomson Bay Project with boundary conditions defined from the Regional model.

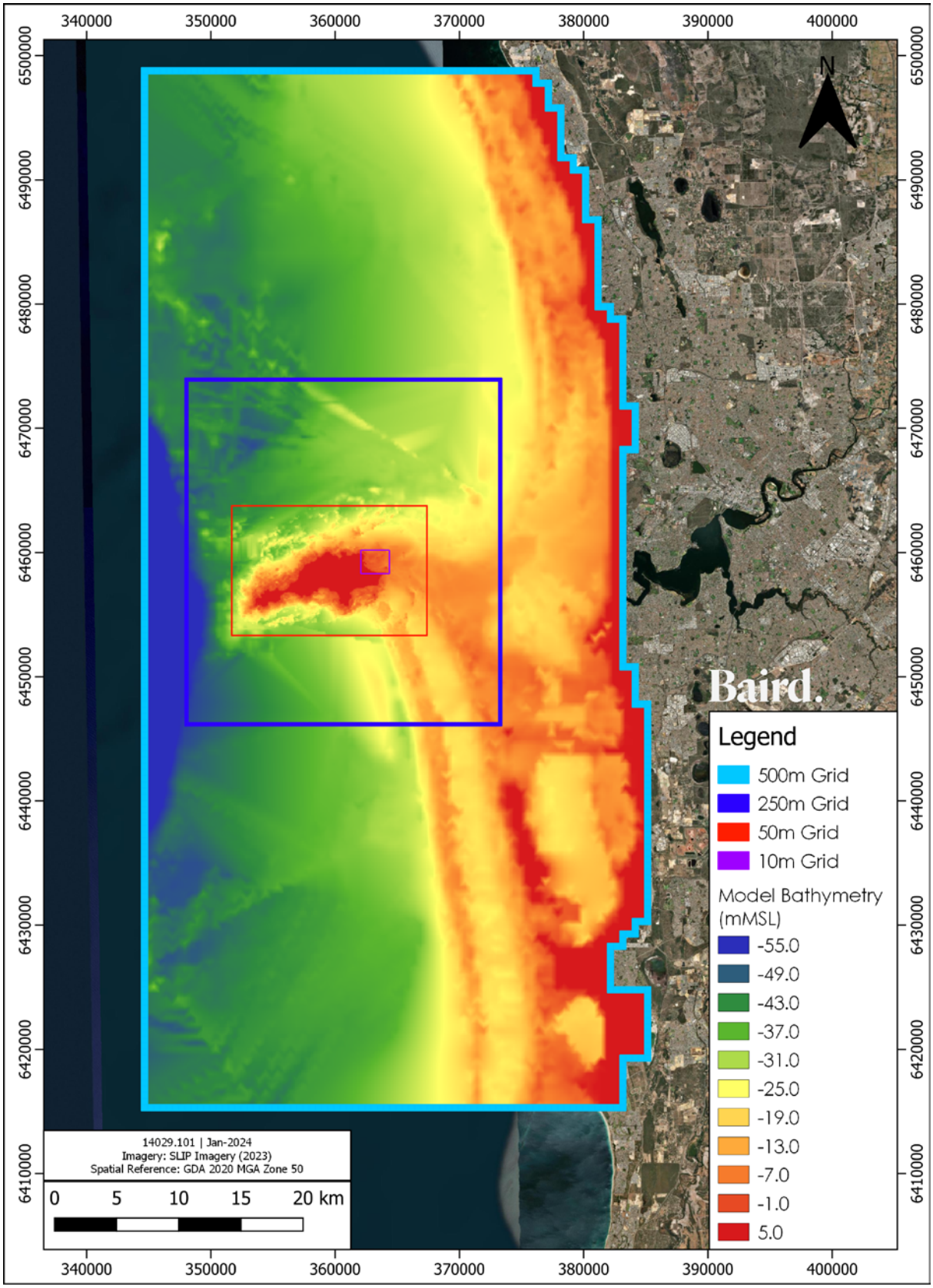

Figure 4.3: Local Delft3D Hydrodynamic Model grid setup applied for dredge plume modelling.

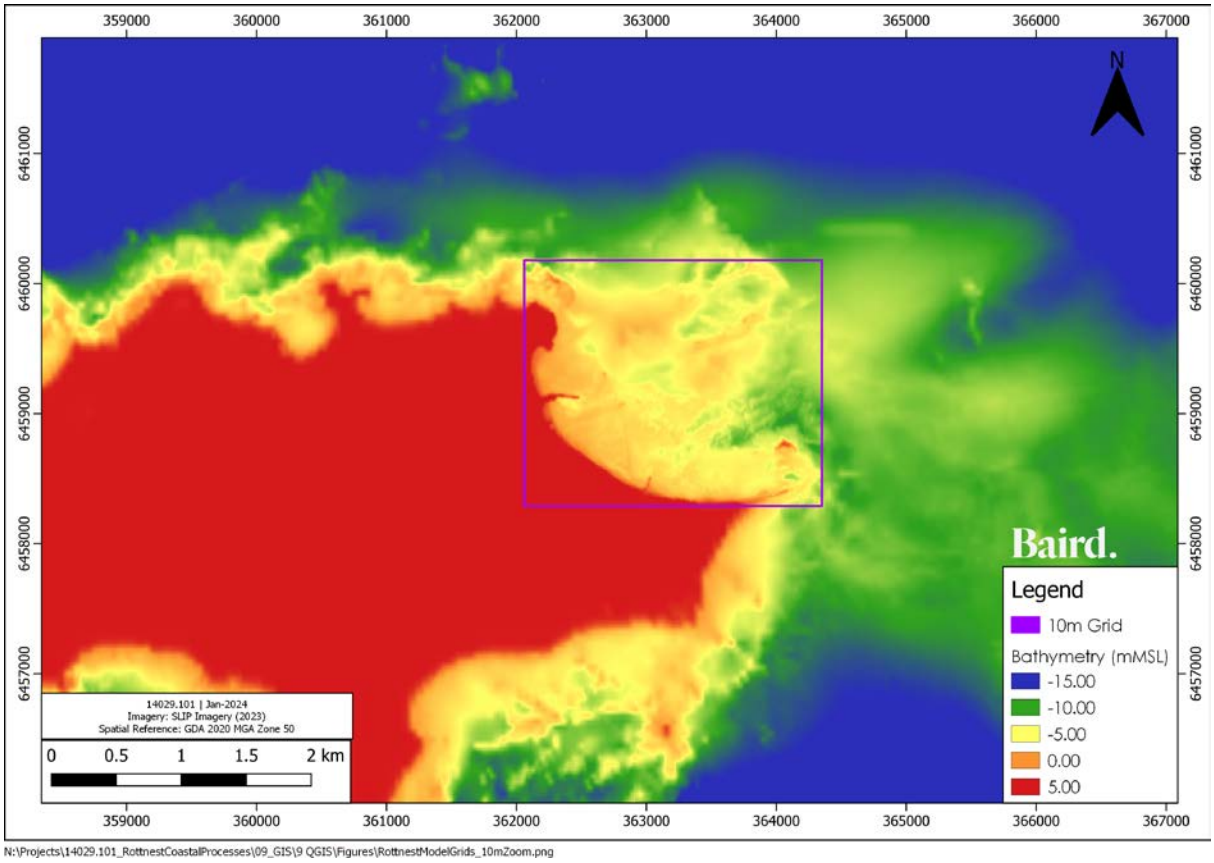

Figure 4.4: Local Delft3D Hydrodynamic Model grid setup applied for dredge plume modelling, zoomed into the smallest grid (10m x 10m grid resolution) at South Thomson Bay.

4.1 Validation of Regional Model

Baird's regional scale hydrodynamic model has been applied in numerous projects across the southwest of Western Australia and comparison of the modelled water levels against the predicted astronomical tide at standard port locations across the north-west region shows very good agreement to tidal constants in both amplitude and phase.

A comparison of the modelled water level against predicted water levels (based on tidal constituents) for the full year of 2011 are shown in Figure 4.5. The modelling undertaken for this full year signal was carried out for a previous project, with the model validation undertaken for that project shown here to demonstrate the high level of accuracy that use of this regional model brings to this dredge plume model program. The comparisons for port locations nearby the South Thomson Bay site at Hillarys, Jurien Bay, Lancelin and Two Rocks Marina show excellent agreement.

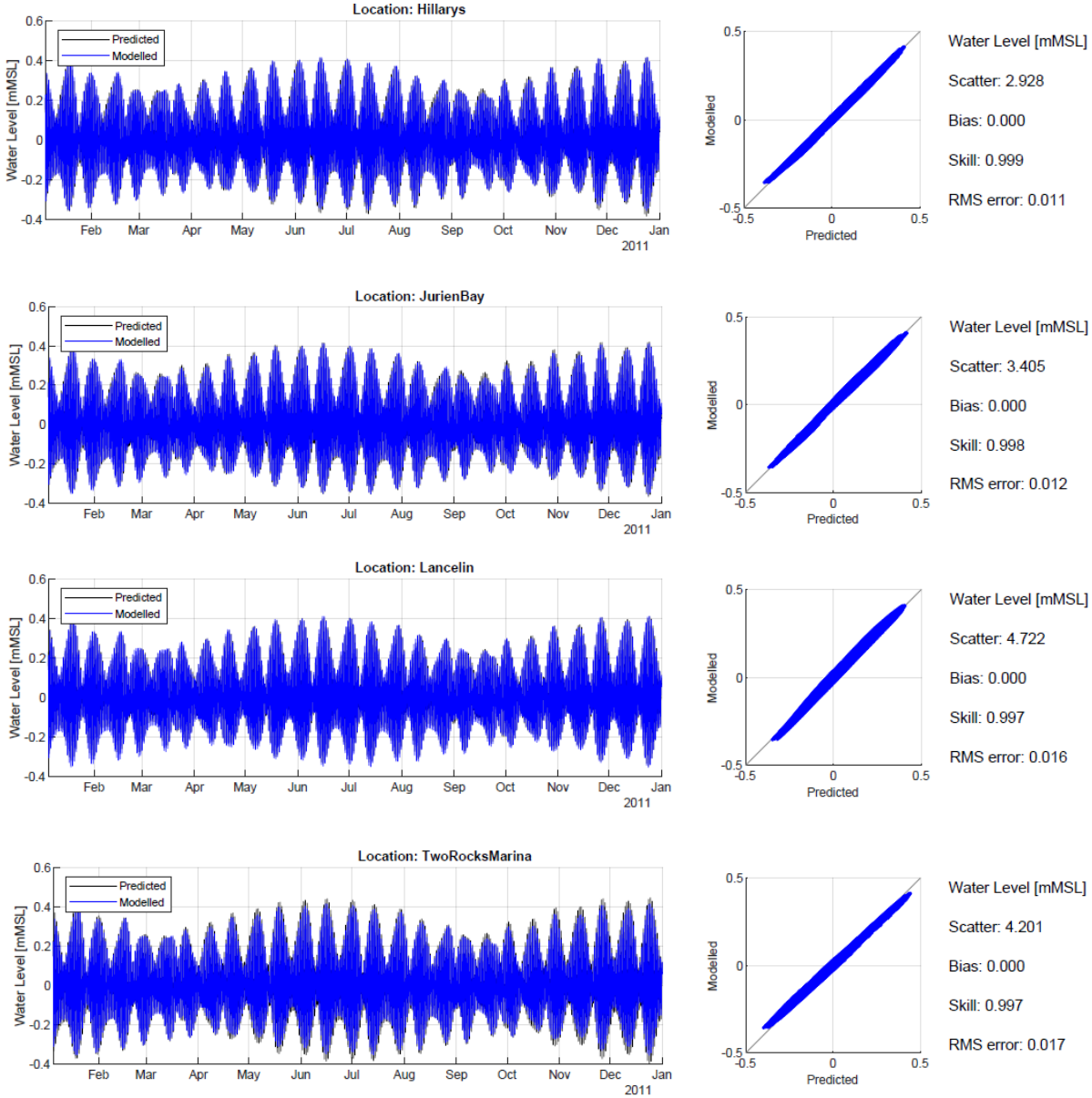

Figure 4.5: Regional Model Tidal Validation at nearby Port locations

The regional scale model was updated and executed over the 2018 – 2019 period to coincide with the metocean data collection campaign by Water Technology (2020). The regional model uses the TOPEX8 tidal constituents on the boundary with spatial wind and pressure fields from the NCEP Climate Forecast System (CFSR) updated across the model domain hourly throughout the entire model period.

4.2 Validation of Local Model

It is noted that the coupled hydrodynamic and wave model detailed in this report will be used as a basis for assessing impacts from dredging at the proposed South Thomson Bay barge facility site, which has been modelled based on the schedule related to the dredging of P50 rock and BH EX05 dredging plant referenced in i2D (2023) over a period of 7.5 weeks. Validation of the model has been completed for the winter of 2020, when measured data is available for both currents and waves, in this report.

The validation for both the hydrodynamic and wave model components of the coupled model has been undertaken over a 7.5-week period in the Winter where contemporaneous data was available from both the offshore and inshore locations (Aquadopp within South Thomson Bay and Rottnest DWR offshore of Wadjemup respectively).

The adopted period was:

- Winter: 16 July 2020 – 16 August 2020 with model warm-up period of 2 days prior.

The metocean data collection, detailed in Section 2.1, provides measured winds, waves, currents and water levels covering the validated model period. The selected date range for the modelled season validation period corresponds with a time where metocean data is available from both inshore and offshore sites (Figure 2.1) and where two full spring tides and two full neap tide cycles are completed through the duration.

For the validation of the model, the modelled and measured data is presented as graphical times series in the sections to follow.

4.2.1 Model Validation – Water Levels and Currents

The comparison of the modelled data against the measured data for the current speed (depth averaged) and direction is shown in Figure 4.6 for the nearshore location. The current speed has been separated into the X and Y components for the analysis shown in Figure 4.6.

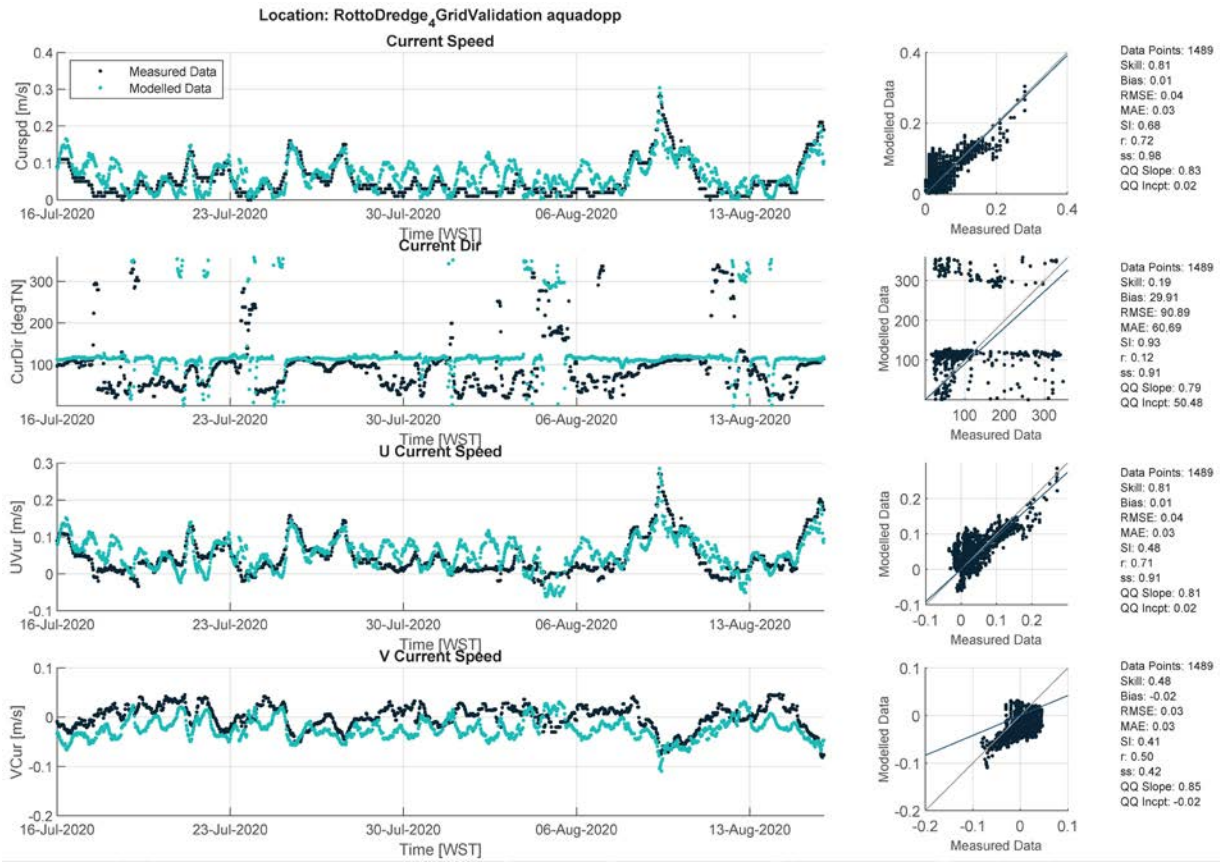

Figure 4.6: Comparison of Inshore Location Measured vs Modelled Data for Depth Averaged Current. Winter Validation Period, 16 July 2020 – 16 August 2020.

The model metrics have been calculated for the current speed and direction components (including X and Y directionality) against the measured data in the model cases presented in Figure 4.6 and are presented in Table 4.1. Given the low current speeds in this nearshore area, the validation metrics are good for both the current speed and direction, with good model skill and low bias and error metrics, indicating the suitability of this model for modelling of dredge spoil impacts related to the proposed barge facility dredging activities.

Table 4.1: Model Metrics for water level, depth-averaged current velocity and direction

Location	Component	Skill	Bias	Scatter	RMS Error
Offshore Location ADCP WINTER	Current Speed	**0.81**	0.01	0.68	0.04
	Current x axis (E-W)	**0.81**	0.01	0.41	0.04
	Current y axis (N-S)	**0.46**	-0.02	0.41	0.04

4.2.2 Model Validation – Waves

The wave conditions from the SWAN model developed through the winter validation case has been compared against the measured data from both the offshore directional waverider location and the nearshore aquadopp location (Figure 2.1).

The winter results are compared from the model against the waverider data offshore in Figure 4.7. There is good agreement between the modelled and measured wave data at this location, with good validation metrics across wave height, period and direction.

The model results have also been compared to the measured data at the nearshore aquadopp location in South Thomson Bay, shown in Figure 4.8. There is also good agreement here between the modelled and measured wave data for this nearshore location, with consideration to be made of the complex nearshore reef structures that influence the transformation of waves from the offshore to the nearshore environment in this area. Note should be made that there has been discussion around the accuracy of the wave directions across the measured data campaign used in this validation analysis, with the modelled wave direction seen in the model sitting relatively consistently within the NNW sector, while the Water Technology (2020) measured data oscillates between the NNE to the NNW. Comparison can be made to wave model validation completed for previous work within Thomson Bay at the Department of Transport's directional AWAC measurement point (Figure 2.1) sitting approximately 200m north of the aquadopp site, shown in Figure 4.9. This location shows a good comparison of wave direction largely coming from the NNW in both the measured and modelled data, further supporting the possibility that wave directions in the Water Technology (2020) data measured at the aquadopp may be erroneously biased towards the NNE.

The model metrics have been calculated for the wave height, period and direction components against the measured data in the model cases presented in Figure 4.7 and Figure 4.8 and are presented in Table 4.1, showing overall good agreement between the measured and modelled data, indicating that the wave model component of the coupled hydrodynamic and wave system is suitable for modelling the dredge spoil impacts related to the proposed barge facility dredging activities.

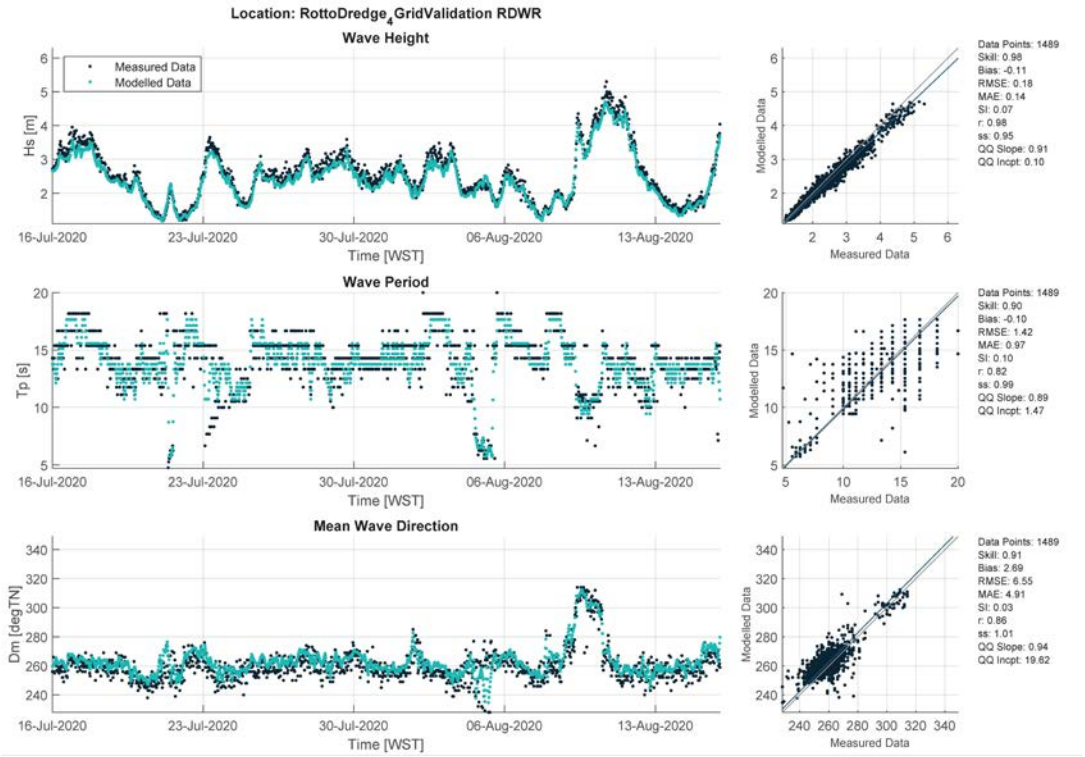

Figure 4.7: Winter Validation Case - Comparison of Wave Data Measured vs Modelled at the Rottnest Directional Waverider Buoy

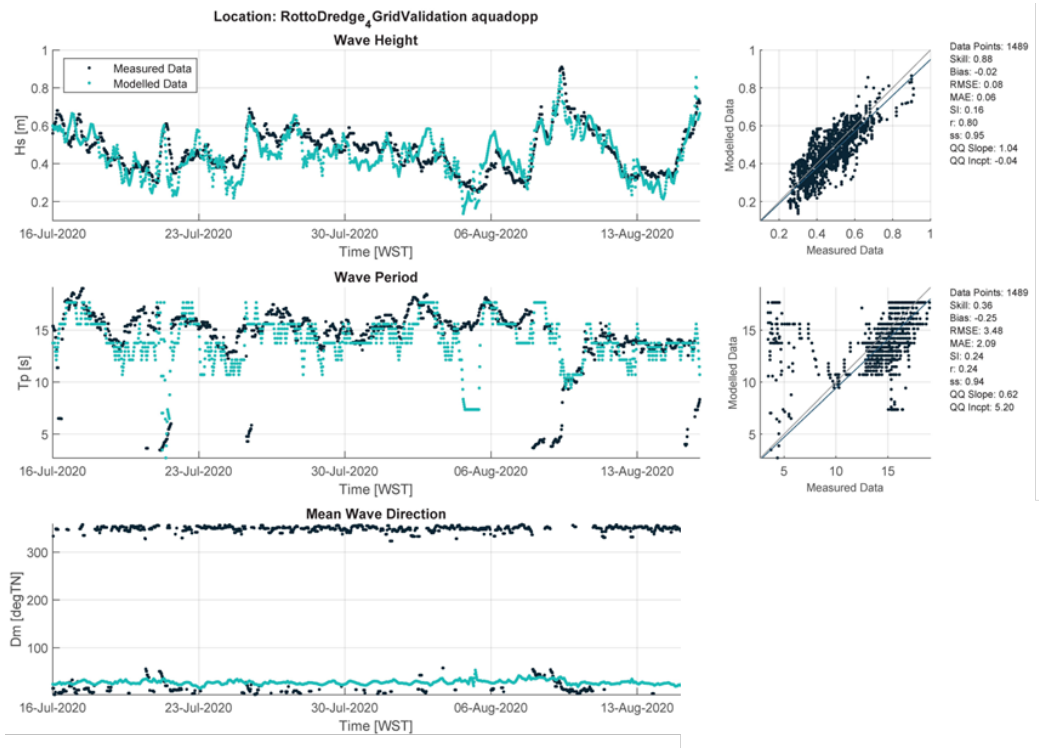

Figure 4.8: Winter Validation Case - Comparison of Wave Data Measured vs Modelled at the Aquadopp Location. Directional statistics are not included due to the uncertainty around the accuracy of the direction reported in the measured data.

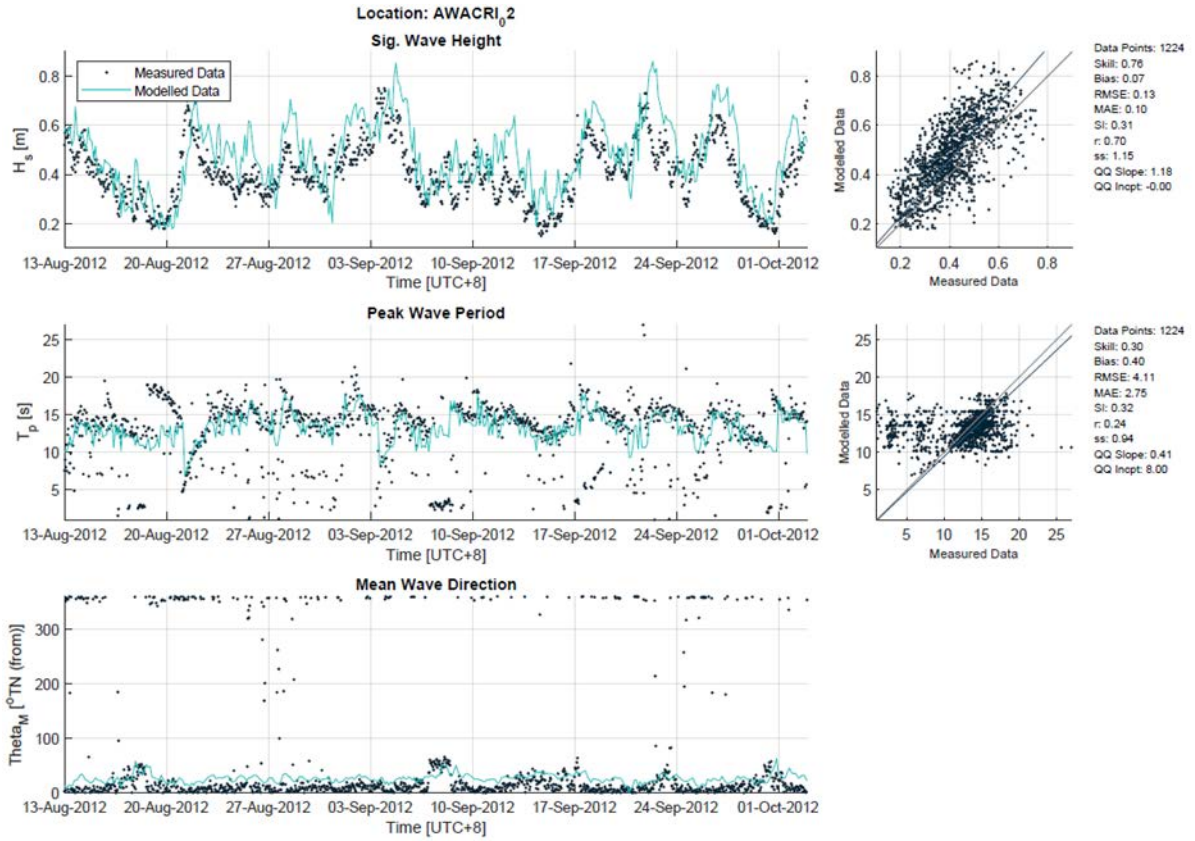

Figure 4.9: Winter Validation Case Previously Completed for 2012 - Comparison of Wave Data Measured vs Modelled at the AWACR1_02 Location

Table 4.2: Model Metrics for wave height, period and direction for the Rottnest DWR and aquadopp locations

Location	Component	Skill	Bias	Scatter	RMS Error
Offshore Location DWR	Wave Height	**0.98**	-0.11	0.07	0.18
	Wave Period	**0.90**	-0.10	0.10	1.42
	Wave Direction	**0.91**	2.69	0.03	6.55**
Nearshore Location Aquadopp	Wave Height	**0.88**	-0.02	0.16	0.08
	Wave Period	**0.36***	-0.25	0.24	3.48

* Note that while the wave period skill appears to be relatively low, this is due to the strong scatter in wave periods seen in the measured data. Overall patterns of sea and swell wave period across the measured data are replicated in the modelled data, ensuring that both energy types are reproduced in the model.

** note that this RMS error appears to be relatively high, but is due to the relatively narrow band of directions the waves are arriving from at the RDWR (largely around 240-280 degN) and the large number of datapoints in the measured data signal.

4.3 Dredge Plume Model Setup

Following validation of the coupled hydrodynamic and wave model, as presented above, the model system was updated to include the sediment transport module required to input sediment source terms to the model, as well as to run the inner grid (covering Thomson Bay where the dredge plumes will be generated) in 3D to allow for determination of the impacts of vertical sediment transport as well as horizontal.

Sediment inputs to the model have been schematised based on the dredging program outlined in Section 3.3 and the sediment fractions defined in Table 3.5, and the sediment transport module has been activated in the model to allow for inclusion of this parameter in the dredge plume modelling.

4.3.1 Sediment Transport Model - Delft3D Morphology Module (Online-MOR)

The Delft3D Online Sediment model (Online-MOR) is used to investigate the transport and fate of sediments released into the water column through the dredging program. The sediment transport module is part of the Delft3D suite developed by Deltares in the Netherlands and designed to simulate sediment transport of non-cohesive (sandy) or cohesive (silt) sediments under combined processes of wave propagation, currents and morphological developments in coastal, river and estuarine areas (Deltares 2020).

The Delft3D model system is one of the passive plume models reviewed in Sun et al (2016) and the model has been applied in similar dredging studies completed in Western Australia and many locations globally. The passive plume dispersal is managed through three separate model components, namely a hydrodynamic model, a sediment transport model and surface wave model. The validated Delft3D hydrodynamic and wave model system outlined in Section 4.1 has been adopted as the platform for hydrodynamics and waves, with the sediment transport module (Online-MOR) activated to investigate the release of sediments from dredge plume sources (mobilisation of fine material by the action of the BHD operations) and examine the diffusion, dispersion and resuspension processes of the plume.

The sediments released through the dredging program are assessed in the model in three sediment fractions –coarse silt, fine silt, and clay as discussed in Section 3.

4.3.2 Summary of Dredge Plume Model Parameters

An overview of the key model settings and characteristics is provided in Table 4.3.

Table 4.3: Delft3D Dredge Plume Model Settings

Feature	Description
Grid size / type	Domain Decomposition - Regular Grids at: - 500m - 250m - 50m - 10m
Grid Extent	Outer Grid: 84km x 40km
3D sigma layer model	Inner (10m) grid: 5-vertical sigma layers with layer thicknesses of 20% all the way through the water column.
Vertical Datum	Mean Sea Level (m MSL), 0.68m CD at Thomson Bay
Horizontal eddy diffusivity coefficient	Across the DD Grids 500m / 250m / 50m / 10m: 50 / 25 / 1 / 1 m^2/s

Feature	Description
Horizontal eddy viscosity coefficient	Across the DD Grids 500m / 250m / 50m / 10m: 50 / 25 / 1 / 1 m^2/s
Vertical eddy viscosity / diffusivity	k-ε turbulence closure model
Time step (3D sigma-layer)	0.1 mins (6 secs)
Bed friction	500m, 250m Grids: Chezy $65m^{1/2}/s$ 50m, 10m Grids: Chezy $55m^{1/2}/s$
Sediments Specific Density	2,650 kg/m^3
Fine Sand	D_{50} = 0.200mm, Dry Bed Density 1600kg/m^3
Silt	Settling Velocity 1.7mm/s, Dry Bed Density 500kg/m^3
Fine Silt	Settling Velocity 0.06mm/s, Dry Bed Density 500kg/m^3
Van Rijn's reference height factor	1
Threshold sediment thickness	0.005 m
Critical Bed Shear Stress for Sedimentation	0.1 N/m^2
Critical Bed Shear Stress for Erosion	0.5 N/m^2
Background Suspended Sediment	Modelled as zero. Background SSC is added into model results in post processing (refer Section 5)

5. Modelling Outcomes

5.1 General Plume Behaviour

The overall current direction trend from west to east along Thomson Bay has had an impact upon the dredge plume generated in the modelling program, with plumes generally directed east along South Thomson Bay away from the existing Army Groyne, with occasional periods of direction change directing the plume west and around the Army Groyne. This is demonstrated in the spatial plots taken from specific points in time shown in Figure 5.1, with plots shown at three hourly timesteps from 26th June 2020 18:00 to 27th June 2020 3:00. These plots show the plume being directed strongly to the east away from the Army Groyne (top left) in the middle of a flood tide, less strongly away from the Army Groyne (top right) as the flood tide gets closer to its peak water level, directed weakly to the west around the Army Groyne (bottom left) as the flood tide is close to its peak water level and remaining close to the point of discharge in the peak of a tidal cycle as the tide turns from flood to ebb (bottom right). This behaviour is observed during both the neap and spring tidal cycles included in the full dredge model program.

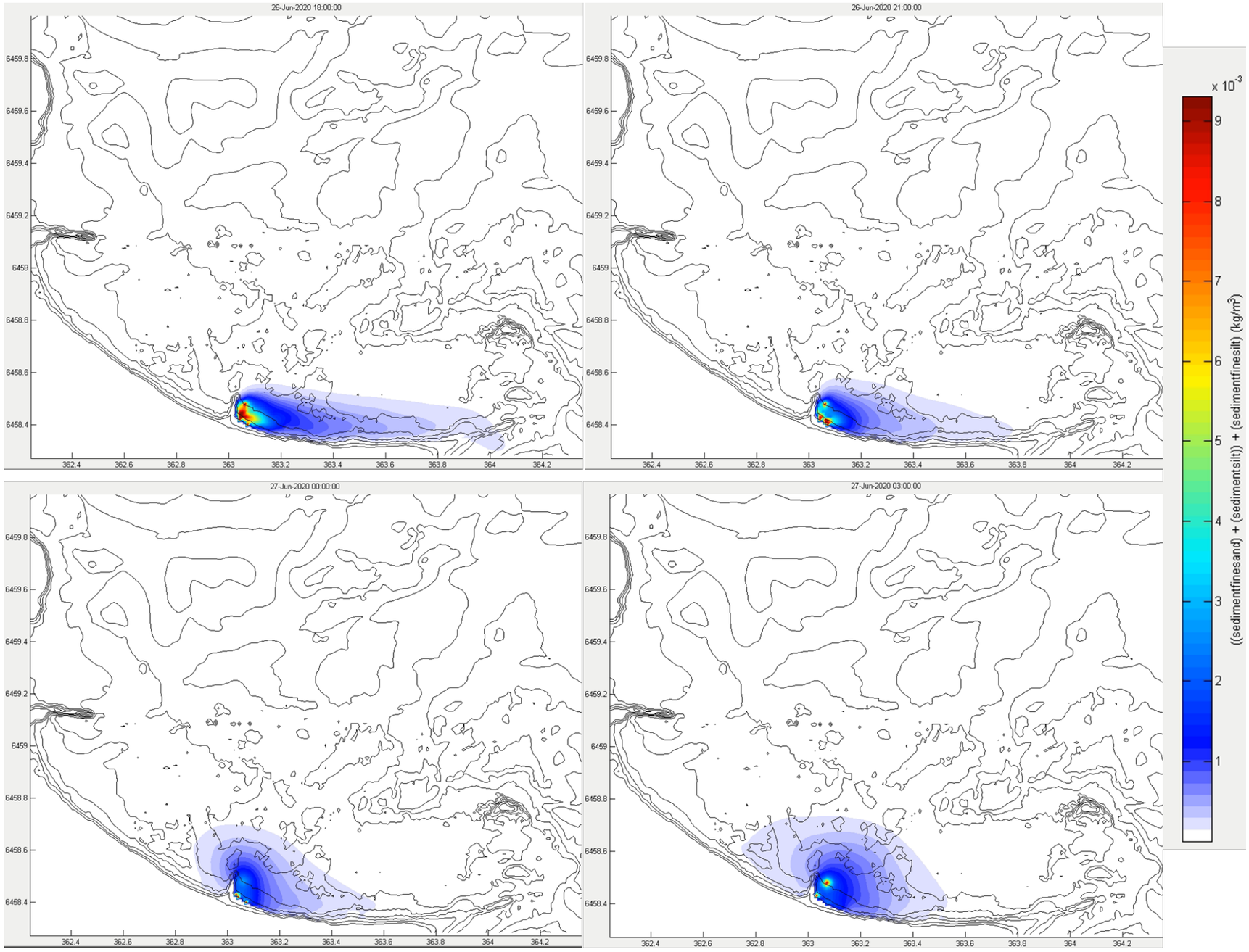

Figure 5.1: Spatial plots at three hourly spaced timepoints in the dredge program model, showing the plume directed strongly to the east away from the Army Groyne (top left), less strongly away from the Army Groyne (top right), directed weakly to the west around the Army Groyne (bottom left) and remaining close to the point of discharge in the peak of a tidal cycle as the tide turns from flood to ebb (bottom right)

5.2 Modelled Time Series Data through the Dredge Program

The modelled dredge sequence was evaluated in one continuous model simulation covering the dredging program based on the assumptions for the BH EX05 and the P50 rock quality (i2D 2023) and being carried out during the winter of 2020.

Timeseries data at four locations (Figure 5.2) in the vicinity of the dredge footprint are presented below, demonstrating the distribution of suspended sediments directly in the vicinity of the Army Groyne and dredge footprint, east along South Thomson Bay away from the Army Groyne, and at the Aquadopp location.

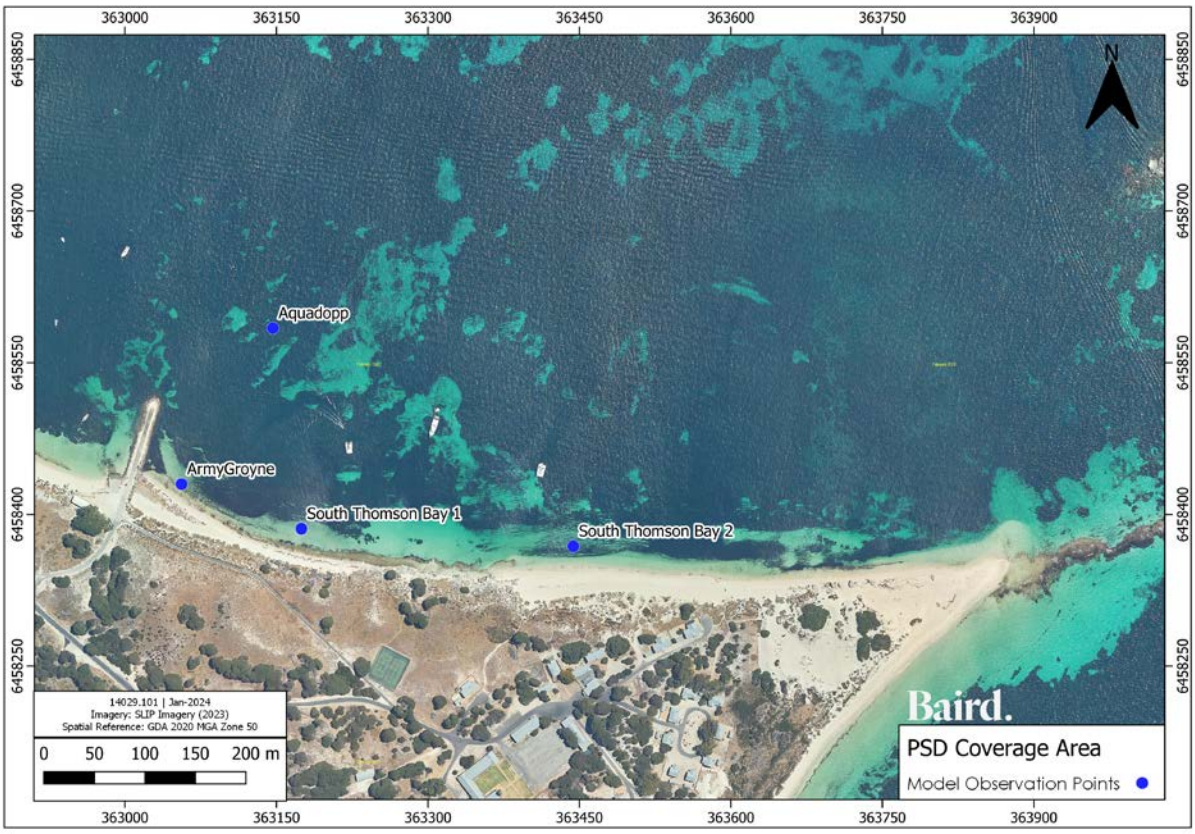

Figure 5.2: Locations where timeseries suspended sediment concentration (SSC) data is presented

5.2.1 Modelled Time Series – Winter

Time series data from the offshore disposal plume models across the 7.5 week winter program has been extracted close to the Army Groyne, two locations east along South Thomson Bay from the Army Groyne, and at the aquadopp location, as seen in Figure 5.2. The modelled SSC from the sediment fractions (sand and silts) for winter are combined in the time series plots shown in Figure 5.3 to Figure 5.6. Background SSC have been applied to the timeseries data from each island according to the chosen background SSC (discussed further in Section 5.3).

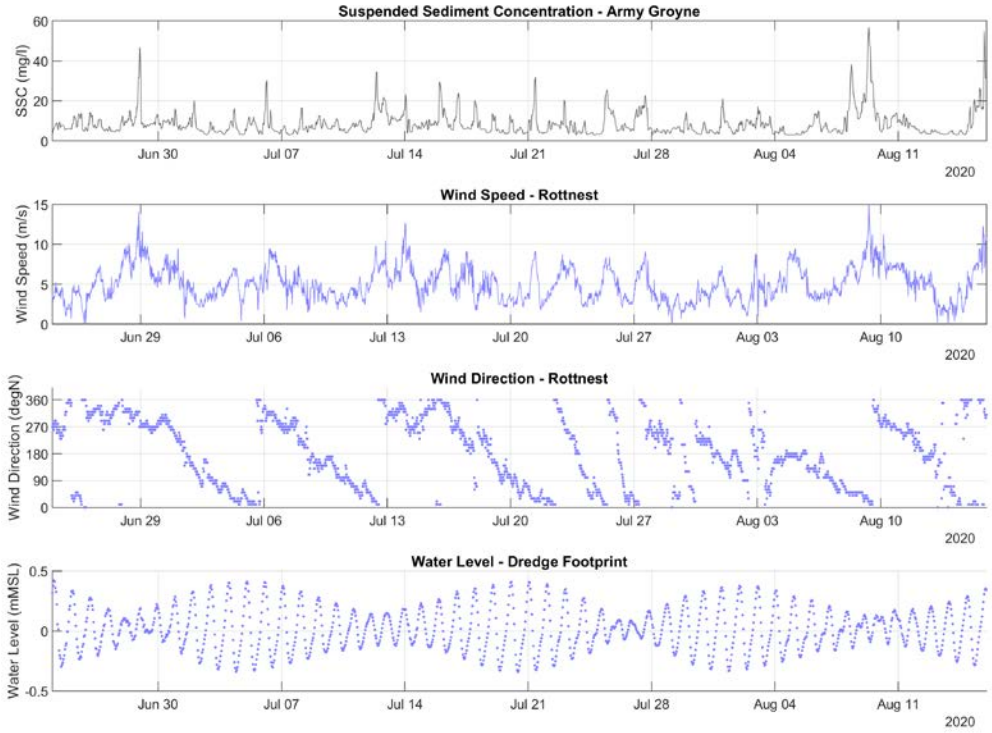

Figure 5.3: Modelled Suspended Sediment Concentration (mg/L) in close proximity to the dredge footprint (Army Groyne) over winter, with associated wind speed and direction and water level at the dredge footprint.

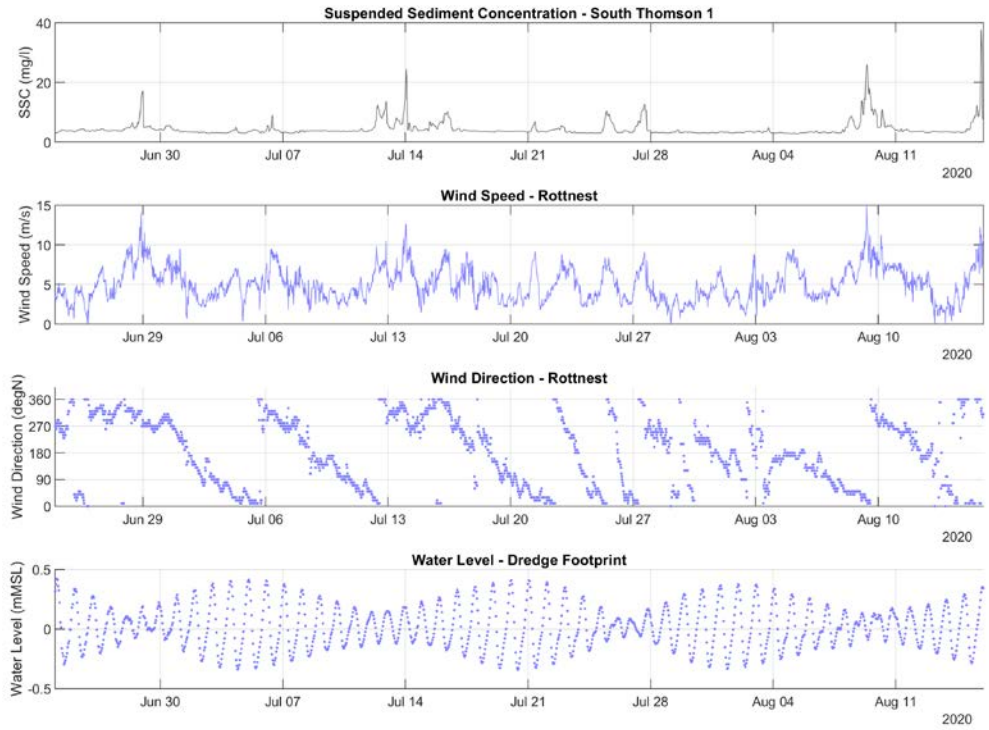

Figure 5.4: Modelled Suspended Sediment Concentration (mg/L) just east of the dredge footprint (South Thomson Bay 1) over winter, with associated wind speed and direction and water level at the dredge footprint.

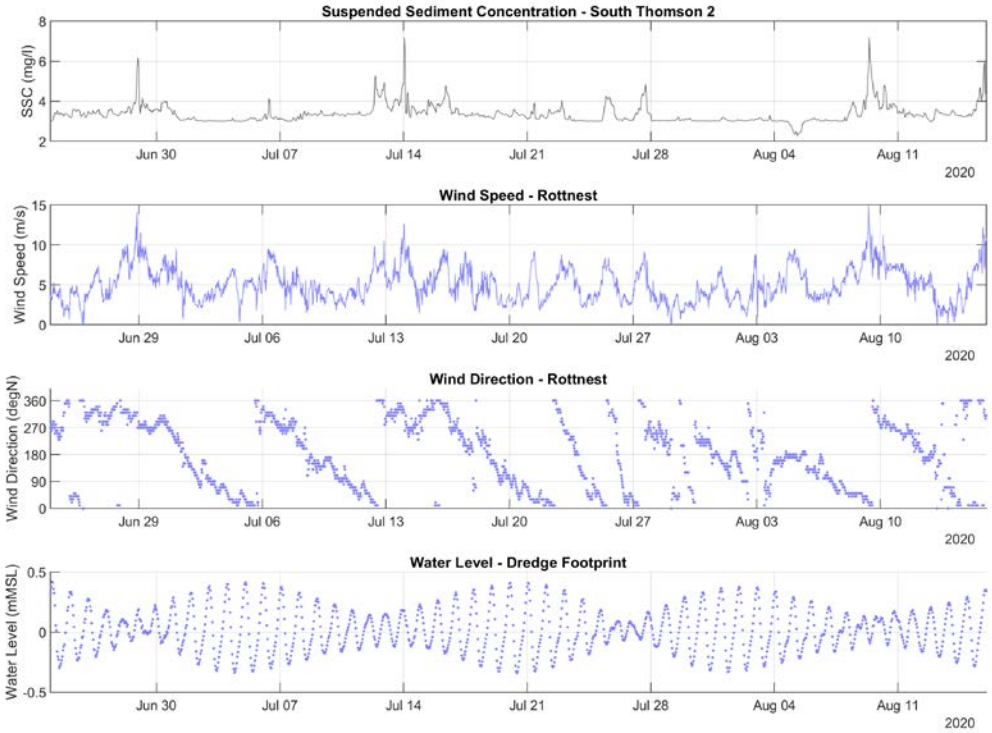

Figure 5.5: Modelled Suspended Sediment Concentration (mg/L) further east of the dredge footprint (South Thomson Bay 2) over winter, with associated wind speed and direction and water level at the dredge footprint.

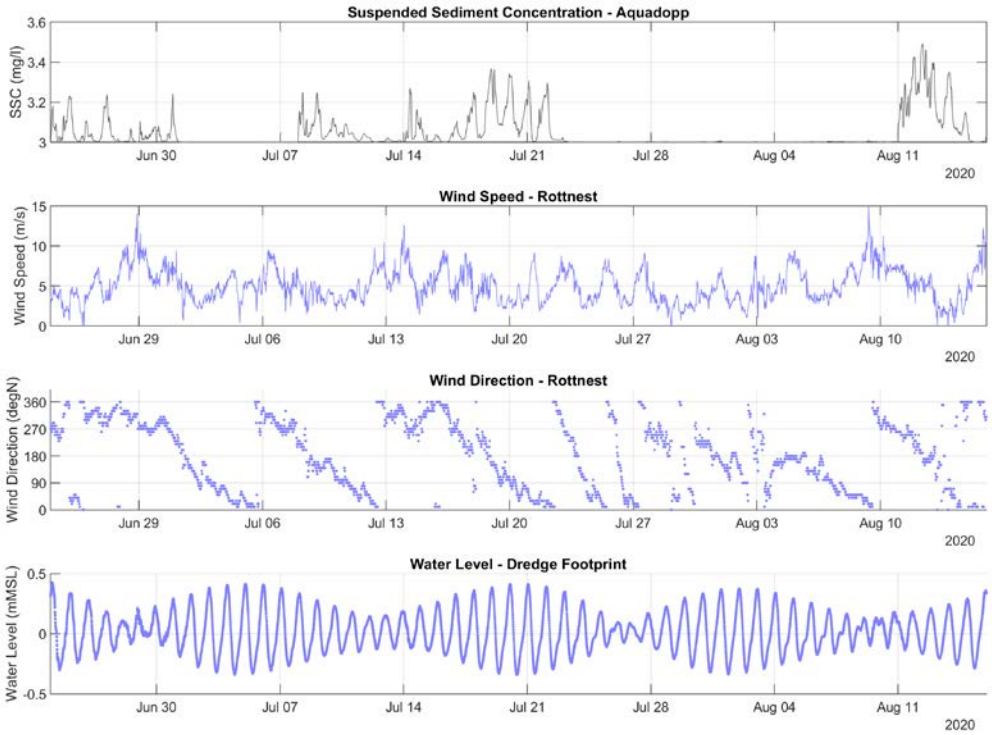

Figure 5.6: Modelled Suspended Sediment Concentration (mg/L) immediately north of the dredge footprint (aquadopp) over winter, with associated wind speed and direction and water level at the dredge footprint.

5.3 Background Suspended Sediment Concentration

The dredge plume model simulations were executed with no background suspended sediment concentration (SSC) and the raw model results represent excess above the background SSC. For the analysis of the model results and predicted extent, severity and duration of dredging impacts a background SSC was applied in the post processing of results.

As there is no long-term dataset available within Thomson Bay to determine the most appropriate background SSC to use during a winter dredging campaign, analysis has been made of data available offshore of Wadjemup and at a location closer to shore within Cockburn Sound to make an estimate of the most appropriate background SSC to assume for this investigation.

Data from the Rottnest IMOS National Reference Station (NRS) provides measured total suspended solids (TSS) offshore of Wadjemup, in approximately 35m water depth (Clementson et al 2020). The values included in that study are shown in the plot in Figure 5.7, with the range of measured TSS following normalising using a blank sample (orange line) sitting between 0.5 mg/L and 3.5mg/L.

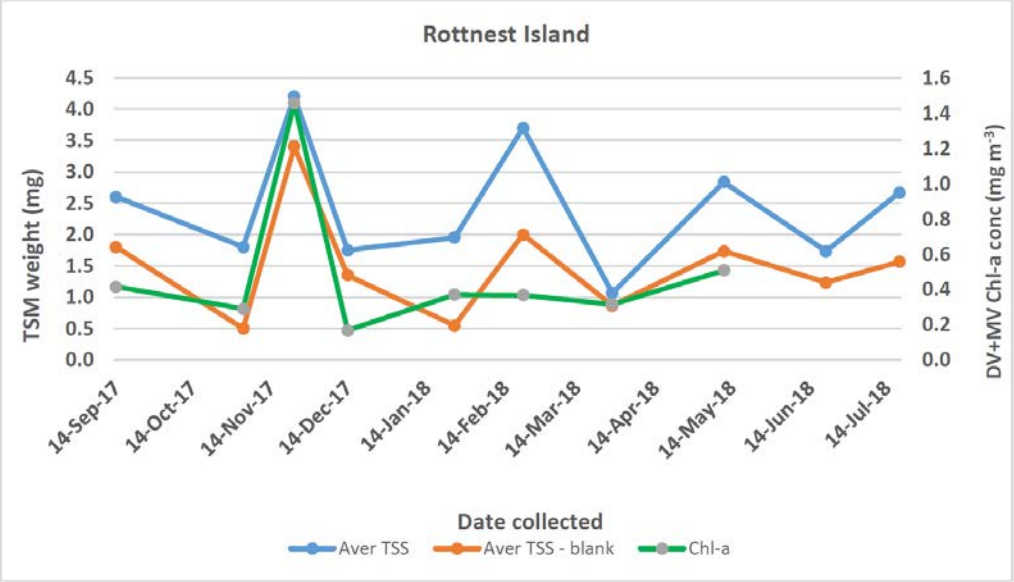

Figure 5.7: Average post-July 2017 TSM values with (orange line) and without (blue line) correction for the blank at Wadjemup between September 2017 and July 2018 (Clementson et al 2020)

Data from Cockburn Sound has been taken from an analysis of TSS data measured at the Perth Seawater Desalination Plant (PSDP) in approximately 10m water depth (Cockburn Sound Management Council 2023). The values included in that study are shown in Figure 5.8, with the range of TSS sitting between 2.5mg/L and 6.5mg/L.

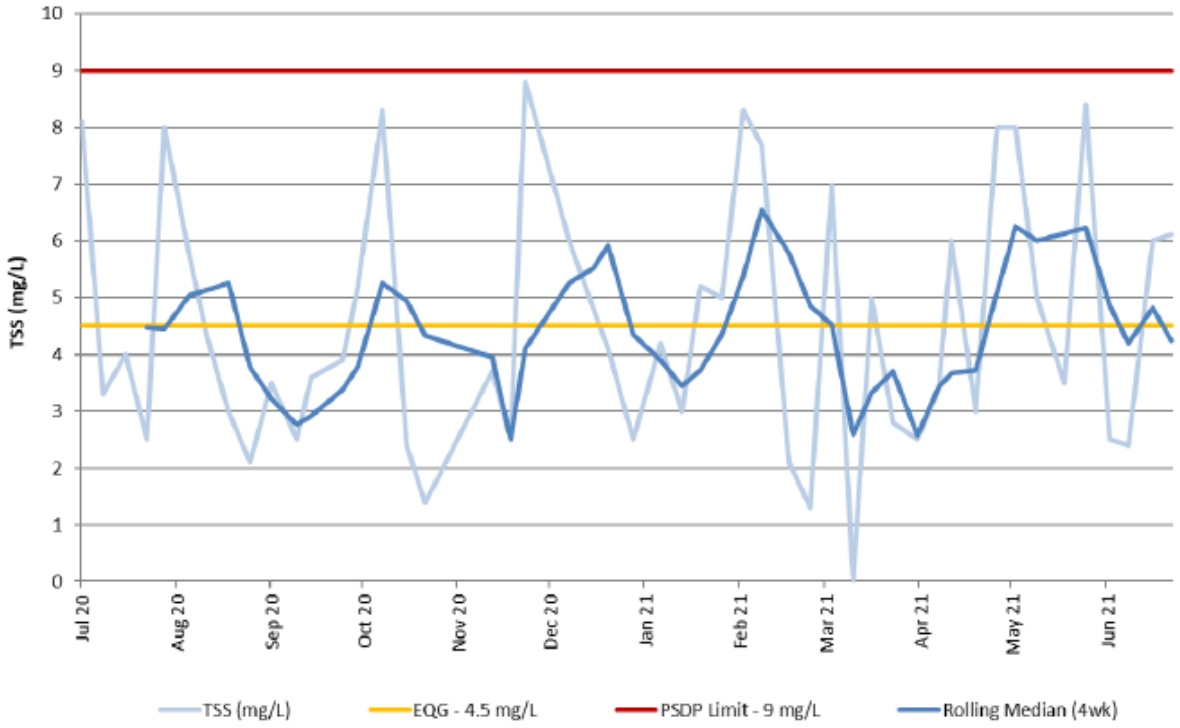

Figure 5.8: Weekly and rolling four-weekly median total suspended solids (TSS) concentration in the intake seawater for the Perth Seawater Desalination Plant between July 2020 and June 2021 (Cockburn Sound Management Council 2023)

Comparison of the PSD analysis of data collected in South Thomson Bay by Douglas Partners in 2019 and data collected in Cockburn Sound as part of the PSDP study in 2021 shows that the average fines percentage in South Thomson Bay sits at 2.2%, while the average fines found in Cockburn Sound sits at 27%. When this analysis is taken to just look at the clay fraction, South Thomson Bay experiences 0% clay, while Cockburn Sound experiences 46% clay.

In line with this, while the Wadjemup data is taken from a relatively pristine offshore location and the location within Cockburn Sound where the TSS data was collected may seem to be a more representative location for South Thomson Bay (e.g., closer to shore), it can be seen that sediments close to shore within South Thomson Bay contain much less fines than Cockburn Sound and so a background SSC value between those measured offshore of Wadjemup and within Cockburn Sound will be the most appropriate for this study. The background SSC value chosen is 3mg/L and has been used for the timeseries analysis presented in Section 5.2.1 and the spatial plots presented below in Section 5.5.

5.4 Zones of Impact Calculation

The EPA has developed a spatially based zonation scheme for proponents to use as a common basis to describe the predicted extent, severity and duration of impacts associated with their dredging proposals (EPA, 2016g). The scheme consists of three zones that represent different levels of impact:

1. Zone of High Impact (ZoHI) is the area where impacts on benthic communities or habitats are predicted to be irreversible. The term irreversible means 'lacking a capacity to return or recover to a state resembling that prior to being impacted within a timeframe of five years or less'. Areas within and immediately adjacent to proposed dredge and disposal sites are typically within zones of high impact.
2. Zone of Moderate Impact (ZoMI) is the area within which predicted impacts on benthic organisms are recoverable within a period of five years following completion of the dredging activities. This zone

abuts, and lies immediately outside of, the zone of high impact. The outer boundary of this zone is coincident with the inner boundary of the next zone, the Zone of Influence.

3. Zone of Influence (ZoI) is the area within which changes in environmental quality associated with dredge plumes are predicted and anticipated during the dredging operations, but where these changes would not result in a detectible impact on benthic biota. These areas can be large, but at any point in time the dredge plumes are likely to be restricted to a relatively small portion of the Zone of Influence.

5.4.1 Calculation Method for Zones of Impact

Consideration of the impacts from the dredge plume modelling on the most important benthic species within South Thomson Bay, seagrass, is calculated in the work carried out by Statton et al (2017) from the Dredging Science Node of the WAMSI via the measurement of Daily Light Integral (DLI), a measurement of the cumulative amount of light that is experienced during daylight hours (EPA 2021). As dredge plume modelling is undertaken by determining the extent of suspended sediment plumes generated via a source of sediment in the water column, a relationship would need to be derived between SSC and DLI to be able to interpret the results of dredge plume modelling and their impact upon seagrass species using the thresholds defined by Statton et al (2017). As this is a highly site-specific relationship (EPA 2021), calculations carried out for other locations would not be suitable for interpretation of the relationship at South Thomson Bay.

In the absence of site-specific measurements to define the SSC and DLI relationship in Thomson Bay, the calculation of the Zones of Impact (ZoI) defined by this study will follow the method of calculation used by BMT in their analysis of the dredge plume and passive plume impacts from the placement of dredged sediments on Port Beach (BMT 2021a). This assessment determined nominal values of SSC that would have detrimental impact on local benthic communities and habitat (BCH) (e.g., seagrass species), including the predominant species within South Thomson Bay, Posidonia, as follows:

- 2 mg/L, approximating a potentially visible plume.
- 5 mg/L, approximating a value that may post a low risk to seagrasses.
- 10 mg/L, approximating a value that may post a moderate risk to seagrasses.
- 20 mg/L, approximating a value that poses a high risk of impacts to seagrass health.

From the above nominal values, the Zones of Influence used within this study are defined in Table 5.1.

Table 5.1: Impact zones, definitions and boundary thresholds (BMT 2021a)

Impact Zone	Definition	Boundary Threshold(s)
Zone of High Impact (ZoHI)	The area where impacts on benthic communities and habitats (BCH) are predicted to be irreversible. The term irreversible means 'lacking a capacity to return or recover to a state resembling that prior to being impacted within a timeframe of five years or less'. Areas within and immediately adjacent to proposed dredge and disposal sites are typically within the ZoHI.	• Boundary of the dredging and placement area. • Where sedimentation/burial is >10 cm or 10,000 g/m2.
Zone of Moderate Impact (ZoMI)	The area within which predicted impacts on BCH are recoverable within a period of five years following completion of the dredging and placement activities. The ZoMI abuts and lies immediately outside of the ZoHI.	• The 95th percentile of the area where a TSS concentration of >10 mg/L was exceeded. • Where sedimentation / burial is 5 – 10 cm or 5,000 – 10,000 g/m2.
Zone of Influence (ZoI)	The area within which changes in environmental quality associated with turbid plumes are predicted and anticipated during dredging and placement activities, but where these changes would not result in a measurable impact on BCH.	• The 100th percentile of the area where a TSS concentration of >2 mg/L above background was exceeded (representing the maximum predicted extent of visible plumes).

Examples of the analysis for winter of the total SSC and daily running mean SSC against the nominal thresholds outlined above are presented in Figure 5.9 to Figure 5.12, using the chosen background SSC. The locations analysed are the points shown in Figure 5.2 as 'Army Groyne, 'South Thomson Bay 1, 'South Thomson Bay 2' and 'Aquadopp'. From the analysis of these figures:

- The observation location in closest proximity to the dredge footprint, Army Groyne (Figure 5.9), demonstrates the relatively high level of SSC experienced at the dredge footprint, and finds the SSC in this location to exceed the nominal thresholds related to moderate risk (i.e., the 10mg/L threshold that places this location within the ZoMI) and on occasional to high risk (20mg/L). It should be noted that this location is within the buffer zone used for to conservatively apply the boundary of the ZoMI.
- The South Thomson Bay 1 location immediately east of the dredge footprint along South Thomson Bay (Figure 5.10) also experiences occasional periods of exceedance of the nominal thresholds related to moderate risk (10mg/L) and high risk (20mg/L). It should be noted that this location is also within the buffer zone used for to conservatively apply the boundary of the ZoMI;
- The South Thomson Bay 2 location further east of the dredge footprint along South Thomson Bay (Figure 5.11) crosses the two lower thresholds of 5mg/L and 2mg/L, with the 5 mg/L threshold demonstrating that this location may occasionally experience sediment plumes that could pose moderate risk to seagrass.
- The Aquadopp location immediately north of the dredge footprint into wider Thomson Bay (Figure 5.12) only experiences levels of SSC that cross the threshold related to the potential for a visible sediment plume but with no measurable impact on BCH (seagrass).

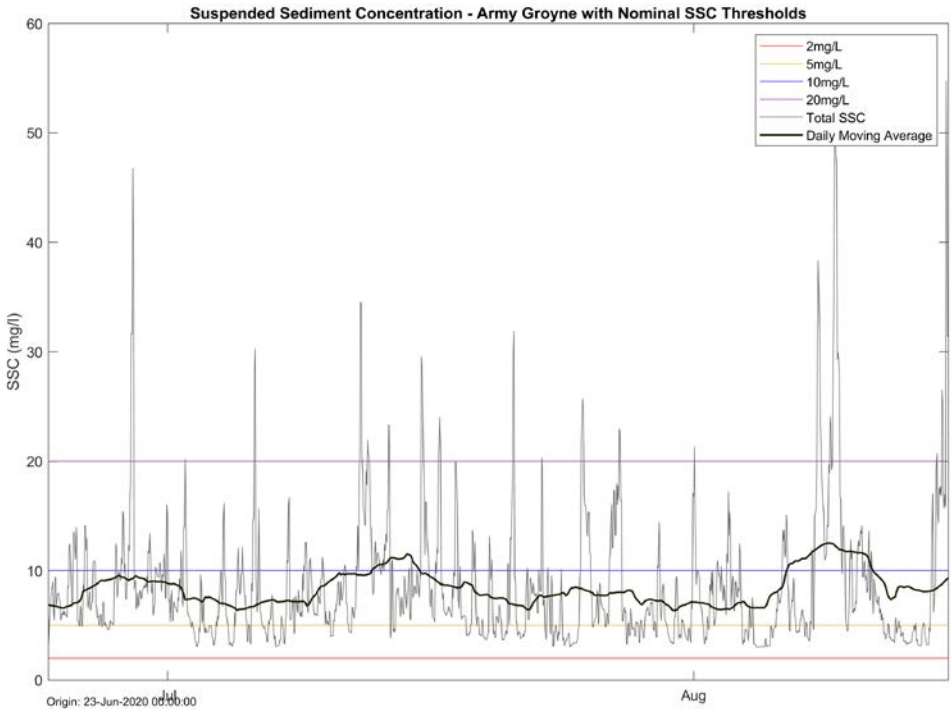

Figure 5.9: Calculation of total SSC and daily mean values of modelled SSC analysed against nominal seagrass impact thresholds (based on BMT 2021a) at the Army Groyne location. Analysis shown for the background SSC of 3mg/L.

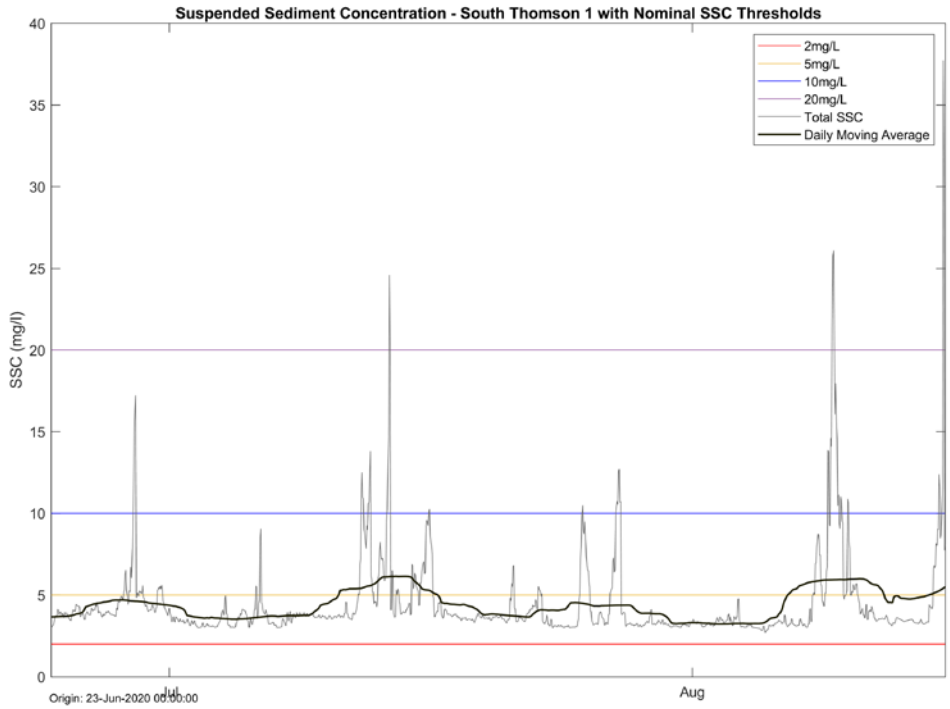

Figure 5.10: Calculation of total SSC and daily mean values of modelled SSC analysed against nominal seagrass impact thresholds (based on BMT 2021a) at the South Thomson Bay 1 location. Analysis shown for the background SSC of 3mg/L.

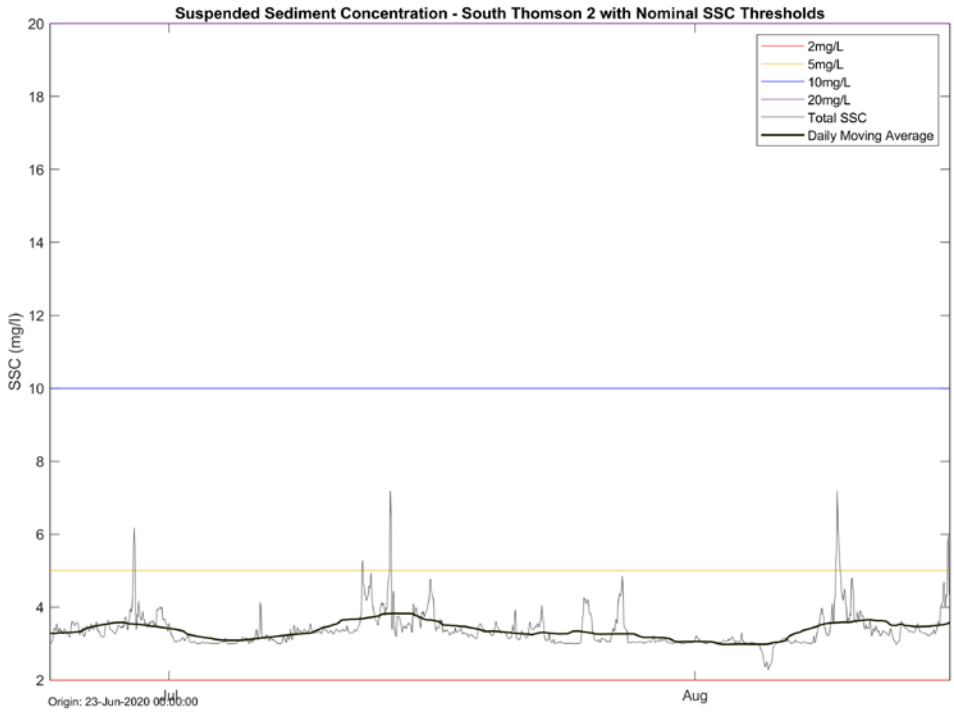

Figure 5.11: Calculation of total SSC and daily mean values of modelled SSC analysed against nominal seagrass impact thresholds (based on BMT 2021a) at the South Thomson Bay 2 location. Analysis shown for the background SSC of 3mg/L.

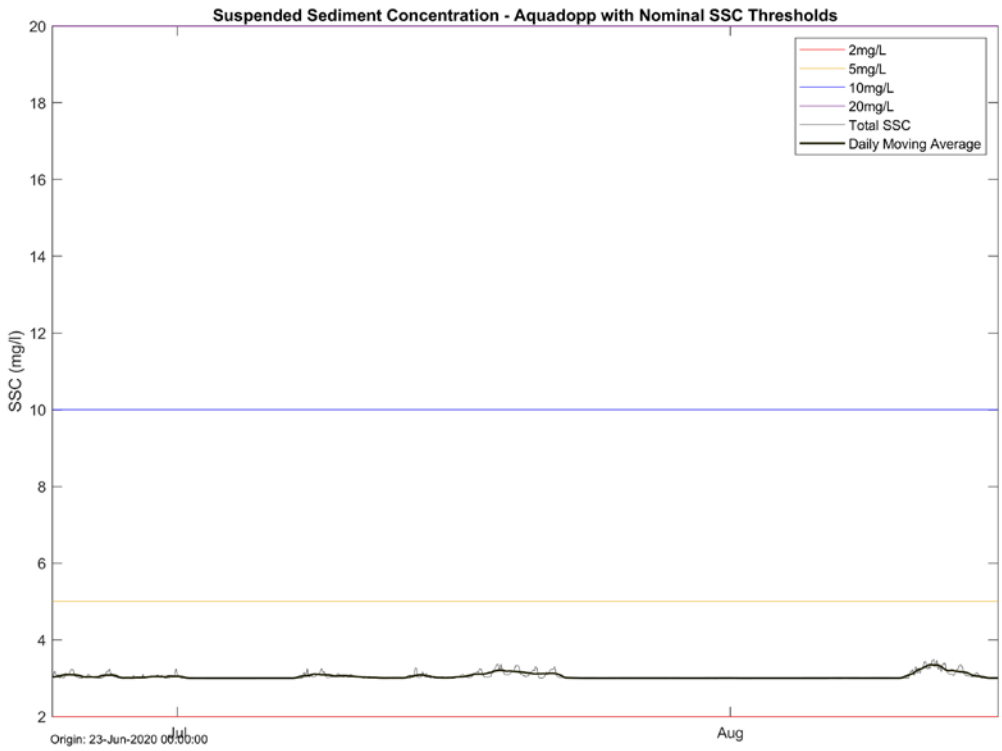

Figure 5.12: Calculation of total SSC and daily mean values of modelled SSC analysed against nominal seagrass impact thresholds (based on BMT 2021a) at the Aquadopp location. Analysis shown for the background SSC of 3mg/L.

5.5 Calculated Zones of Impact

The calculated zones of impact (ZoI, ZoMI and ZoHI) have been compiled based on the complete winter dredging program. The zones of impact are presented in Figure 5.13 with consideration of the chosen background SSC of 3mg/L. It should be noted that the ZoHI spatial extent adopts a minimum distance from the dredged footprint of 25m, and the ZoMI adopts a minimum distance from the dredged channel of 150m. These distances have been set as a conservative basis for including consideration of the coarse sand fractions assumed to fall out of suspension close to the source of dredging. Both the ZoHI and ZoMI have made consideration of the depositional thresholds defined in Table 5.1, but noting that the majority of sedimentation takes places in the swash zone or on the beach to the east of the Army Groyne, at distances from the dredged footprint that fall within the conservative buffers mentioned for each zone. The ZoI, shown in yellow in Figure 5.13, represents the maximum predicted extent of visible plumes with the important consideration that these changes would not result in a measurable impact on BCH. The extent and coverage of the ZoI stretching east along the beach in South Thomson Bay demonstrates the influence of the prevailing currents on this side of Wadjemup.

The areas encompassed by each of the zones are:

- ZOI: 0.17 km^2
- ZOMI: 0.07 km^2
- ZOHI: 0.02 km^2

The standard buffers used to formulate the ZOMI and the ZOHI areas have a much more significant impact upon the areas detailed above and shown in Figure 5.13 due to the relatively low impact of the dredge plume itself. As shown in Figure 5.9 to Figure 5.12, the only locations that showed SSC signals that regularly reached the SSC thresholds outlined in Table 5.1 sat within the dredge footprint itself. Figure 5.1 also shows that elevated SSC levels within the dredge plume were only regularly seen to the south (landward) of the dredge footprint, away from the sensitive seagrass receptors further out in Thomson Bay. The significantly greater influence of the conservative buffers when compared to the dredge plume itself on the ZOHI and ZOMI areas demonstrates that these zones are not going to be sensitive to marginal changes in the key assumptions, including the background SSC assumed and the season in which the dredging takes place (the season used in this dredging campaign can be considered a worst case scenario as it takes place during the winter, typically more stormy and higher energy than summer or transitional periods – see further discussion of seasonality at Wadjemup in Baird's Coastal Processes Assessment (2023a)).

As the calculation method for the ZOI does not include consideration of what the background SSC is, but just looks at the plume that experiences an SSC of 2mg/L above the background at any one time in the dredge program, this zone is not sensitive to changes in the background SSC assumption. Similar to the ZOHI and ZOMI, as this dredge program was undertaken during a winter period, it can be considered that this ZOI area is a worst case scenario in regards to seasonal influence.

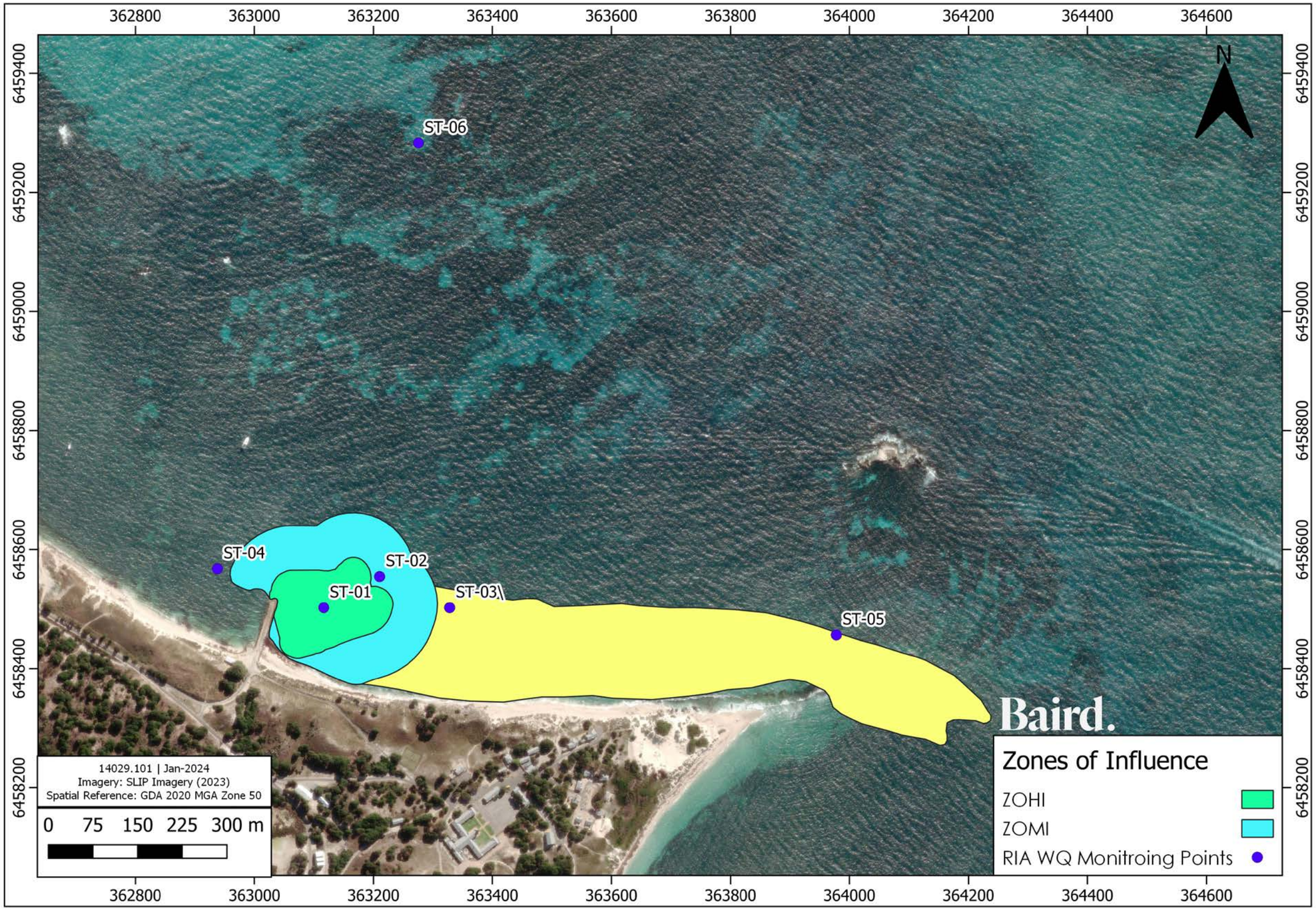

Figure 5.13: Calculated Zones of Impact (ZoI, ZoMI and ZoHI) based on a background SSC of 3mg/L for the 7.5 week winter dredging program.

6. Conclusions

This report presents the analysis of the comprehensive numerical modelling campaign that has been undertaken to determine the potential extent of impacts from dredging activities in South Thomson Bay related to the proposed South Thomson Barge Development at the Army Groyne site. Modelling has been undertaken based on a set of assumptions taken from reporting provided by in2Dredging Pty Ltd (i2D), a specialist dredging consultancy that was engaged to determine the most suitable methodology to dredge the material, as well as to provide an estimated required schedule for the dredging method. A range of potential methods were outlined in the reporting, with the assumptions related to the use of the backhoe dredger BH EX05 and the requirement to dredge rock at an assumed P50 rock quality based on available geotechnical data used in the modelling and analysis presented in this report. The dredging program used in this modelling study covered 7.5 weeks in winter.

Following the modelling of the potential dredge plume that may be generated as a result of dredging activities in South Thomson Bay as part of the proposed South Thomson Bay Barge Development, analysis to determine the zones of influence (ZoIs) was carried out following the method of calculation used by BMT in their analysis of the dredge plume and passive plume impacts from the placement of dredged sediments on Port Beach. This assessment determined nominal values of SSC that would have detrimental impact on local seagrass species, including the predominant species within South Thomson Bay, Posidonia.

The calculated zones of impact (ZoI, ZoMI and ZoHI) have been compiled based on the complete winter dredging program and are presented spatially in Section 5.5. Each of the zones that are considered to have an impact on benthic communities and habitat (BCH, including seagrasses), the ZoHI and ZoMI, are contained to small spatial extents adjacent to the dredge footprint, with extents based on conservative buffers around the dredge footprint as well as impacts from the modelling. It should be noted that the model impacts only influenced the spatial extents landward of the dredge footprint (i.e., impacts do not extend into Thomson Bay and are bounded by the dredge footprint, the Army Groyne and the Beach. The extent and coverage of the ZoI (representing the maximum predicted extent of visible plumes with the important consideration that these changes would not result in a measurable impact on BCH) stretching east along the beach in South Thomson Bay demonstrates the influence of the prevailing currents on this side of Wadjemup.

The areas encompassed by each of the zones are:

- ZOI: 0.17 km^2
- ZOMI: 0.07 km^2
- ZOHI: 0.02 km^2

7. References

AECOM (2020), South Thomson Bay Barge Facility; Value Engineering of Concept Design. Doc. No. 606370980-MA-REP-0001 Rev 0.

ANZECC & ARMCANZ (2000), Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ).

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BMT (2021b) Port Beach Nourishment – Plume Dispersion Modelling. Prepared for the City of Fremantle, R-10807-2.

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Water Technology (2021), Rottnest Island Wave & Current Monitoring, Data Report. Report prepared for Rottnest Island Authority, 31 August 2021

Appendix A

Key Reports

A.1 Key Reports

A.1.1 Site Specific Reports Prepared for the South Thomson Barge Development

- AECOM (2020), South Thomson Bay Barge Facility; Value Engineering of Concept Design. Doc. No. 606370980-MA-REP-0001 Rev 0.
- Douglas Partners (2019). Geotechnical Investigation, Proposed Vessel Approach Channel Dredging. Prepared for Rottnest Island Authority, R.001.Rev0
- in2Dredging (2023). South Thomson Bay Development: Dredging Budget and Schedule Estimate. Technical Note prepared for Baird, i2D-BAIRD-TN-001.
- Baird (2023) South Thomson Barge Development Coastal Processes Assessment. Prepared for RIA, 14029.101.R1.RevA.
- RPS (2020) SAP Implementation Report, Rottnest Island Army Jetty Dredging. Prepared for RIA, EEC19032.011
- Water Technology (2021), Rottnest Island Wave & Current Monitoring, Data Report. Report prepared for Rottnest Island Authority, 31 August 2021

A.1.2 Western Australian Marine Science Institution (WAMSI) Dredging Node

- Statton J, McMahon KM, Armstrong P, Strydom S, McCallum R, Kendrick GA, Lavery PS (2017) Determining light stress bio-indicators and thresholds for a tropical multi-species seagrass assemblage. Report of Theme 5 - Project 5.5.1 prepared for the Dredging Science Node, Western Australian Marine Science Institution, Perth, Western Australia, 50 pp.
- Statton J, McMahon KM, McCallum R, Kendrick GA, Lavery PS (2017). Sediment burial stress response, bio-indicators and thresholds for a tropical multi-species seagrass assemblage. Report of Theme 5 - Project 5.5.2 prepared for the Dredging Science Node, Western Australian Marine Science Institution, Perth, Western Australia, 38 pp.
- Lavery P, McMahon K, Statton J, Vanderklift M, Strydom S, Kendrick G. (2018) Synthesis Report: Defining thresholds and indicators of primary producer response to dredging-related pressures. Report of Theme 5 prepared for the Dredging Science Node, Western Australian Marine Science Institution, Perth, Western Australia, 32 pp.
- Fisher R, Jones R, Bessell-Browne P, (2019). Effects of dredging and dredging related activities on water quality: Impacts on coral mortality and threshold development Report of Theme 4 - Project 4.9, prepared for the Dredging Science Node, Western Australian Marine Science Institution, Perth, Western Australia, 94 pp.
- Kemps H and Masini R (2017) Estimating dredge source terms – a review of contemporary practice in the context of Environmental Impact Assessment in Western Australia. Report of Theme 2 – Project 2.2, prepared for the Dredging Science Node, Western Australian Marine Science Institution. Perth, Western Australia, 29pp.
- Mills D (2019) Predicting and measuring the characteristics of sediments generated by dredging. Synthesis Report of Theme 2 – prepared for the Dredging Science Node, Western Australian Marine Science Institution, Perth, Western Australia, 12 pp.
- Sun C, Shimizu K, Symonds G (2016) Numerical modelling of dredge plumes: a review. Report of Theme 3 - Project 3.1.3, prepared for the Dredging Science Node, Western Australian Marine Science Institution, Perth, Western Australia, 55 pp.
- Sun C, Lowe R, Fearns P, Ghisalberti M, Branson P (2019), WAMSI Dredging Science Node Theme 3 I Synthesis Report: Characterisation and prediction of dredge-generated sediment plume dynamics

and fate, prepared for the Dredging Science Node, Western Australian Marine Science Institution, Perth, Western Australia.

A.1.3 Key EPA Documents

- EPA (2016a), Statement of Environmental Principles, Factors and Objectives, EPA, Western Australia.
- EPA (2016b), Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2016.
- EPA (2018a), Environmental Impact Assessment (Part IV Divisions 1 and 2) Procedures Manual, EPA, Western Australia.
- EPA (2016c), Environmental Factor Guideline – Marine Environmental Quality, EPA, Western Australia.
- EPA (2016d), Environmental Factor Guideline – Benthic Communities and habitat, EPA, Western Australia.
- EPA (2016e), Environmental Factor Guideline – Marine Fauna, EPA, Western Australia.
- EPA (2018b), Instructions on how to prepare Environmental Protection Act Part IV Environmental Management Plans.
- EPA (2016f), Technical Guidance – Protecting the Quality of Western Australia's Marine Environment, EPA, Western Australia.
- EPA (2016g), Technical Guidance - Environmental Impact Assessment of Marine Dredging Proposals, EPA, Western Australia.

A.1.4 Other Policy and Guidance

- BMT (2021a) Port Beach Sand Nourishment via Dredging – Environmental Review Document. Prepared for the City of Fremantle, R-10807-5.
- BMT (2021b) Port Beach Nourishment – Plume Dispersion Modelling. Prepared for the City of Fremantle, R-10807-2.
- ANZECC & ARMCANZ (2000), Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ).
- Clementson, L, Wojtasiewicz, B, Lara-Lopes, A (2020). IMOS – TSM Report.
- Cockburn Sound Management Council (2023) Cockburn Sound environmental monitoring report, July 2020 – December 2021. Assessment against the environmental quality objectives and criteria set in the State Environmental (Cockburn Sound) Policy.

Appendix G
Baseline water quality laboratory results

Envirolab Services (WA) Pty Ltd trading as MPL Laboratories
ABN 53 140 099 207
16-18 Hayden Court Myaree WA 6154
ph +61 8 9317 2505
lab@mpl.com.au
www.mpl.com.au

Certificate of Analysis PEK1822

Client Details

Client	Rottnest Island Authority
Contact	David Pond
Address	PO Box 693, FREMANTLE, WA, 6959

Sample Details

Your Reference	South Thomson Barge Development
Number of Samples	3 Water
Date Samples Received	24/11/2023
Date Instructions Received	24/11/2023

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date Results Requested by	29/11/2023
Date of Issue	28/11/2023

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Accredited for compliance with ISO/IEC 17025. Tests not covered by NATA are denoted with *.

Authorisation Details

Results Approved By	Lien Tang, Assistant Operations Manager
Laboratory Manager	Michael Kubiak

Certificate of Analysis PEK1822

Samples in this Report

Envirolab ID	Sample ID	Matrix	Date Sampled	Date Received
PEK1822-01	ArmyJetty1-20231120	Water	20/11/2023	24/11/2023
PEK1822-02	ArmyJetty2-20231120	Water	20/11/2023	24/11/2023
PEK1822-03	ArmyJetty3-20231123	Water	23/11/2023	24/11/2023

Certificate of Analysis PEK1822

Inorganics - Physical Parameters (Water)

Envirolab ID	Units	PQL	PEK1822-01	PEK1822-02	PEK1822-03
Your Reference			ArmyJetty1-202 31120	ArmyJetty2-202 31120	ArmyJetty3-202 31123
Date Sampled			20/11/2023	20/11/2023	23/11/2023
Total Suspended Solids	mg/L	5.0	<5.0	<5.0	<5.0
Turbidity	NTU	0.10	[NA]	[NA]	0.66

Method Summary

Method ID	Methodology Summary
INORG-019	Suspended Solids - determined gravimetrically by filtration of the sample. The solids are dried at 104±5°C
INORG-022	Turbidity - measured nephelometrically using a turbidimeter, in accordance with APHA latest edition, 2130-B.

Result Definitions

Identifier	Description
NR	Not reported
NEPM	National Environment Protection Measure
NS	Not specified
LCS	Laboratory Control Sample
RPD	Relative Percent Difference
>	Greater than
<	Less than
PQL	Practical Quantitation Limit
INS	Insufficient sample for this test
NA	Test not required
NT	Not tested
DOL	Samples rejected due to particulate overload (air filters only)
RFD	Samples rejected due to filter damage (air filters only)
RUD	Samples rejected due to uneven deposition (air filters only)
##	Indicates a laboratory acceptance criteria outlier, for further details, see Result Comments and/or QC Comments

Quality Control Definitions

Blank

This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, and is determined by processing solvents and reagents in exactly the same manner as for samples.

Surrogate Spike

Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

LCS (Laboratory Control Sample)

This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Matrix Spike

A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

Duplicate

This is the complete duplicate analysis of a sample from the process batch. The sample selected should be one where the analyte concentration is easily measurable.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria. Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction. Spikes for Physical and Aggregate Tests are not applicable. For VOCs in water samples, three vials are required for duplicate or spike analysis.

General Acceptance Criteria (GAC) - Analyte specific criteria applies for some analytes and is reflected in QC recovery tables.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% - see ELN-P05 QAQC tables for details (available on request); <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase. Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was typically insufficient in order to satisfy laboratory QA/QC protocols.

Miscellaneous Information

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached. We have taken the sampling date as being the date received at the laboratory.

Two significant figures are reported for the majority of tests and with a high degree of confidence, for results <10*PQL, the second significant figure may be in doubt i.e. has a relatively high degree of uncertainty and is provided for information only.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, Total Recoverable metals and PFAS where sediment/solids are included by default.

Urine Analysis - The BEI values listed are taken from the 2022 edition of *TLVs and BEIs Threshold Limits by ACGIH*.

Air volume measurements are not covered by Envirolab's NATA accreditation.

Data Quality Assessment Summary PEK1822

Client Details

Client	Rottnest Island Authority
Your Reference	South Thomson Barge Development
Date Issued	28/11/2023

Recommended Holding Time Compliance

No recommended holding time exceedances

Quality Control and QC Frequency

QC Type	Compliant	Details
Blank	Yes	No Outliers
LCS	Yes	No Outliers
Duplicates	Yes	No Outliers
Matrix Spike	Yes	No Outliers
Surrogates / Extracted Internal Standards	Yes	No Outliers
QC Frequency	Yes	No Outliers

Surrogates/Extracted Internal Standards, Duplicates and/or Matrix Spikes are not always relevant/applicable to certain analyses and matrices. Therefore, said QC measures are deemed compliant in these situations by default. See Laboratory Acceptance Criteria for more information

Data Quality Assessment Summary PEK1822

Recommended Holding Time Compliance

Analysis	Sample Number(s)	Date Sampled	Date Extracted	Date Analysed	Compliant
TSS | Water	1-2	20/11/2023	24/11/2023	24/11/2023	Yes
	3	23/11/2023	24/11/2023	24/11/2023	Yes
Turbidity | Water	3	23/11/2023	24/11/2023	27/11/2023	Yes

Quality Control PEK1822

INORG-022 | Inorganics - Physical Parameters (Water) | Batch BEK2969

Analyte	Units	PQL	Blank	DUP1 BEK2969-DUP1# Samp | QC | RPD %	LCS %
Turbidity	NTU	0.10	<0.10	0.210 | 0.200 | 4.88	95.0

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-019 | Inorganics - Physical Parameters (Water) | Batch BEK3045

Analyte	Units	PQL	Blank	DUP1 BEK3045-DUP1# Samp | QC | RPD %	DUP2 BEK3045-DUP2# Samp | QC | RPD %	LCS %
Total Suspended Solids	mg/L	5.0	<5.0	353 | 320 | 9.90	192 | 185 | 3.97	86.0

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

Envirolab Services (WA) Pty Ltd trading as MPL Laboratories
ABN 53 140 099 207
16-18 Hayden Court Myaree WA 6154
ph +61 8 9317 2505
lab@mpl.com.au
www.mpl.com.au

Certificate of Analysis PEL1754

Client Details

Client	Rottnest Island Authority
Contact	David Pond
Address	PO Box 693, FREMANTLE, WA, 6959

Sample Details

Your Reference	South Thomson Barge Landing - Baseline Water Quality Monitoring
Number of Samples	6 Water
Date Samples Received	29/12/2023
Date Instructions Received	29/12/2023

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date Results Requested by	09/01/2024
Date of Issue	09/01/2024

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Accredited for compliance with ISO/IEC 17025. Tests not covered by NATA are denoted with *.

Authorisation Details

Results Approved By	Diego Bigolin, Supervisor, Inorganics Heram Halim, Operations Manager Lien Tang, Assistant Operations Manager Michael Mowle, Inorganics Supervisor Sally Rogers, Senior Microbiological Analyst Travis Carey, Organics Supervisor
Laboratory Manager	Michael Kubiak

Certificate of Analysis PEL1754

Samples in this Report

Envirolab ID	Sample ID	Matrix	Date Sampled	Date Received
PEL1754-01	ST-01	Water	29/12/2023	29/12/2023
PEL1754-02	ST-02	Water	29/12/2023	29/12/2023
PEL1754-03	ST-03	Water	29/12/2023	29/12/2023
PEL1754-04	ST-04	Water	29/12/2023	29/12/2023
PEL1754-05	ST-05	Water	29/12/2023	29/12/2023
PEL1754-06	ST-06	Water	29/12/2023	29/12/2023

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Volatile TRH and BTEX (Water)

Envirolab ID **Your Reference** **Date Sampled**	**Units**	**PQL**	PEL1754-01 ST-01 29/12/2023	PEL1754-02 ST-02 29/12/2023	PEL1754-03 ST-03 29/12/2023	PEL1754-04 ST-04 29/12/2023	PEL1754-05 ST-05 29/12/2023
TRH C6-C9	µg/L	10	<10	<10	<10	<10	<10
TRH C6-C10	µg/L	10	<10	<10	<10	<10	<10
TRH C6-C10 less BTEX (F1)	µg/L	10	<10	<10	<10	<10	<10
Methyl tert butyl ether (MTBE)	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzene	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Toluene	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ethylbenzene	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
meta+para Xylene	µg/L	2.0	<2.0	<2.0	<2.0	<2.0	<2.0
ortho-Xylene	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total Xylene	µg/L	3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Naphthalene (value used in F2 calc)	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Surrogate Dibromofluoromethane	%		*96.7*	*94.5*	*95.8*	*94.9*	*97.6*
Surrogate Toluene-D8	%		*95.8*	*94.6*	*94.3*	*96.7*	*96.4*
Surrogate 4-Bromofluorobenzene	%		*105*	*103*	*104*	*105*	*100*

Envirolab ID **Your Reference** **Date Sampled**	**Units**	**PQL**	PEL1754-06 ST-06 29/12/2023
TRH C6-C9	µg/L	10	<10
TRH C6-C10	µg/L	10	<10
TRH C6-C10 less BTEX (F1)	µg/L	10	<10
Methyl tert butyl ether (MTBE)	µg/L	1.0	<1.0
Benzene	µg/L	1.0	<1.0
Toluene	µg/L	1.0	<1.0
Ethylbenzene	µg/L	1.0	<1.0
meta+para Xylene	µg/L	2.0	<2.0
ortho-Xylene	µg/L	1.0	<1.0
Total Xylene	µg/L	3.0	<3.0
Naphthalene (value used in F2 calc)	µg/L	1.0	<1.0
Surrogate Dibromofluoromethane	%		*97.8*
Surrogate Toluene-D8	%		*93.6*
Surrogate 4-Bromofluorobenzene	%		*105*

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Semi-volatile TRH (Water)

Envirolab ID **Your Reference** **Date Sampled**	**Units**	**PQL**	PEL1754-01 ST-01 29/12/2023	PEL1754-02 ST-02 29/12/2023	PEL1754-03 ST-03 29/12/2023	PEL1754-04 ST-04 29/12/2023	PEL1754-05 ST-05 29/12/2023
TRH C10-C14	µg/L	50	<50	<50	<50	<50	<50
TRH C15-C28	µg/L	100	<100	<100	<100	<100	<100
TRH C29-C36	µg/L	100	<100	<100	<100	<100	<100
Total +ve TRH C10-C36	µg/L	50	<50	<50	<50	<50	<50
TRH >C10-C16	µg/L	50	<50	<50	<50	<50	<50
TRH >C10-C16 less Naphthalene F2	µg/L	50	<50	<50	<50	<50	<50
TRH >C16-C34 (F3)	µg/L	100	<100	<100	<100	<100	<100
TRH >C34-C40 (F4)	µg/L	100	<100	<100	<100	<100	<100
Total +ve TRH >C10-C40	µg/L	50	<50	<50	<50	<50	<50
Surrogate o-Terphenyl	%		*70.8*	*69.9*	*76.8*	*73.3*	*76.4*

Envirolab ID **Your Reference** **Date Sampled**	**Units**	**PQL**	PEL1754-06 ST-06 29/12/2023
TRH C10-C14	µg/L	50	<50
TRH C15-C28	µg/L	100	<100
TRH C29-C36	µg/L	100	<100
Total +ve TRH C10-C36	µg/L	50	<50
TRH >C10-C16	µg/L	50	<50
TRH >C10-C16 less Naphthalene F2	µg/L	50	<50
TRH >C16-C34 (F3)	µg/L	100	<100
TRH >C34-C40 (F4)	µg/L	100	<100
Total +ve TRH >C10-C40	µg/L	50	<50
Surrogate o-Terphenyl	%		*87.6*

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Acid Extractable Metals (Water)

Envirolab ID	Units	PQL	PEL1754-01	PEL1754-02	PEL1754-03	PEL1754-04	PEL1754-05
Your Reference			ST-01	ST-02	ST-03	ST-04	ST-05
Date Sampled			29/12/2023	29/12/2023	29/12/2023	29/12/2023	29/12/2023
Phosphorus	mg/L	0.050	<0.10 [4]	<0.25 [4]	<0.25 [4]	<0.25 [4]	<0.25 [4]

Envirolab ID	Units	PQL	PEL1754-06
Your Reference			ST-06
Date Sampled			29/12/2023
Phosphorus	mg/L	0.050	<0.25 [4]

Certificate of Analysis PEL1754

Dissolved Low Level Metals (Water)

Envirolab ID Your Reference Date Sampled	Units	PQL	PEL1754-01 ST-01 29/12/2023	PEL1754-02 ST-02 29/12/2023	PEL1754-03 ST-03 29/12/2023	PEL1754-04 ST-04 29/12/2023	PEL1754-05 ST-05 29/12/2023
Arsenic	µg/L	1.0	1.6	1.6	1.8	2.0	1.8
Boron	µg/L	20	4600	4400	4400	4400	4400
Barium	µg/L	1.0	5.5	5.7	5.4	5.9	6.0
Beryllium	µg/L	0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Cobalt	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chromium	µg/L	1.0	<1.0	9.6	<1.0	<1.0	<1.0
Copper	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Manganese	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Nickel	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Lead	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Selenium	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Vanadium	µg/L	1.0	2.2	2.3	2.2	2.1	2.1
Zinc	µg/L	1.0	<1.0	620	<1.0	11	<1.0

Envirolab ID Your Reference Date Sampled	Units	PQL	PEL1754-06 ST-06 29/12/2023
Arsenic	µg/L	1.0	2.0
Boron	µg/L	20	4300
Barium	µg/L	1.0	5.8
Beryllium	µg/L	0.50	<0.50
Cadmium	µg/L	0.10	<0.10
Cobalt	µg/L	1.0	<1.0
Chromium	µg/L	1.0	<1.0
Copper	µg/L	1.0	<1.0
Mercury	µg/L	0.050	<0.050
Manganese	µg/L	1.0	<1.0
Nickel	µg/L	1.0	<1.0
Lead	µg/L	1.0	<1.0
Selenium	µg/L	1.0	<1.0
Vanadium	µg/L	1.0	2.0
Zinc	µg/L	1.0	<1.0

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Inorganics - Physical Parameters (Water)

Envirolab ID	**Units**	**PQL**	PEL1754-01	PEL1754-02	PEL1754-03	PEL1754-04	PEL1754-05
Your Reference			ST-01	ST-02	ST-03	ST-04	ST-05
Date Sampled			29/12/2023	29/12/2023	29/12/2023	29/12/2023	29/12/2023
Total Dissolved Solids	mg/L	5.0	40000	41000	41000	41000	41000
Total Suspended Solids	mg/L	5.0	<5.0	<5.0	<5.0	<5.0	<5.0

Envirolab ID	**Units**	**PQL**	PEL1754-06
Your Reference			ST-06
Date Sampled			29/12/2023
Total Dissolved Solids	mg/L	5.0	40000
Total Suspended Solids	mg/L	5.0	<5.0

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Inorganics - Ionic Balance and Indexes (Water)

Envirolab ID Your Reference Date Sampled	Units	PQL	PEL1754-01 ST-01 29/12/2023	PEL1754-02 ST-02 29/12/2023	PEL1754-03 ST-03 29/12/2023	PEL1754-04 ST-04 29/12/2023	PEL1754-05 ST-05 29/12/2023
Bicarbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	130	130	130	130	130
Carbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Hydroxide OH- as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Total Alkalinity as CaCO3	mg/L as CaCO3	5.0	130	130	130	130	130
Chloride	mg/L	1.0	19000	19000	19000	20000	19000
Sulfate	mg/L	1.0	2600	2800	2800	2800	2800
Calcium	mg/L	0.50	390	400	400	400	400
Magnesium	mg/L	0.50	1200	1200	1300	1200	1200
Potassium	mg/L	0.50	370	380	380	380	390
Sodium	mg/L	0.50	11000	11000	12000	12000	12000
Hardness as CaCO3	mg/L	3.0	6000	6100	6200	6100	6100
Ionic Balance	%		2.1	1.9	2.3	1.6	2.3
Total Anions	mg/L	7.0	22000	22000	22000	22000	22000
Anions as meq	meq/L	0.59	600	610	610	610	610
Total Cations	mg/L	2.0	13000	13000	14000	14000	14000
Cations as meq	meq/L	0.10	620	630	640	630	640

Envirolab ID Your Reference Date Sampled	Units	PQL	PEL1754-06 ST-06 29/12/2023
Bicarbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	130
Carbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0
Hydroxide OH- as CaCO3	mg/L as CaCO3	5.0	<5.0
Total Alkalinity as CaCO3	mg/L as CaCO3	5.0	130
Chloride	mg/L	1.0	20000
Sulfate	mg/L	1.0	2900
Calcium	mg/L	0.50	400
Magnesium	mg/L	0.50	1300
Potassium	mg/L	0.50	390
Sodium	mg/L	0.50	12000
Hardness as CaCO3	mg/L	3.0	6200
Ionic Balance	%		2.2
Total Anions	mg/L	7.0	23000
Anions as meq	meq/L	0.59	610
Total Cations	mg/L	2.0	14000
Cations as meq	meq/L	0.10	640

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Inorganics - Nutrients (Water)

Envirolab ID Your Reference Date Sampled	Units	PQL	PEL1754-01 ST-01 29/12/2023	PEL1754-02 ST-02 29/12/2023	PEL1754-03 ST-03 29/12/2023	PEL1754-04 ST-04 29/12/2023	PEL1754-05 ST-05 29/12/2023
Ammonia as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrate as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrate as NO3 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	<0.020
NOx as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
TKN as N by calculation	mg/L	0.10	0.16	0.12	0.14	0.13	0.14
Organic Nitrogen by calc.	mg/L	0.10	0.15	0.12	0.14	0.12	0.14
Total Nitrogen	mg/L	0.10	0.16	0.12	0.15	0.13	0.15
Phosphate as P	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Envirolab ID Your Reference Date Sampled	Units	PQL	PEL1754-06 ST-06 29/12/2023
Ammonia as N	mg/L	0.0050	<0.0050
Nitrate as N	mg/L	0.0050	<0.0050
Nitrate as NO3 by calculation	mg/L	0.020	<0.020
Nitrite as N	mg/L	0.0050	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020
NOx as N	mg/L	0.0050	<0.0050
TKN as N by calculation	mg/L	0.10	0.15
Organic Nitrogen by calc.	mg/L	0.10	0.15
Total Nitrogen	mg/L	0.10	0.15
Phosphate as P	mg/L	0.0050	<0.0050

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Inorganics - Nutrients (Water) - Analysed By Envirolab Services Sydney

Envirolab ID	**Units**	**PQL**	PEL1754-01	PEL1754-02	PEL1754-03	PEL1754-04	PEL1754-05
Your Reference			ST-01	ST-02	ST-03	ST-04	ST-05
Date Sampled			29/12/2023	29/12/2023	29/12/2023	29/12/2023	29/12/2023
Chlorophyll a	mg/m3	1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Envirolab ID	**Units**	**PQL**	PEL1754-06
Your Reference			ST-06
Date Sampled			29/12/2023
Chlorophyll a	mg/m3	1.0	<1.0

Certificate of Analysis PEL1754

Microbiological Suite (Water)

Envirolab ID Your Reference Date Sampled	Units	PQL	PEL1754-01 ST-01 29/12/2023	PEL1754-02 ST-02 29/12/2023	PEL1754-03 ST-03 29/12/2023	PEL1754-04 ST-04 29/12/2023	PEL1754-05 ST-05 29/12/2023
Thermotolerant Coliforms	cfu/100mL	1	1	<1	<1	1	<1
Enterococci	cfu/100mL	1	1	<1	<1	<1	<1
E.coli	cfu/100mL	1	<1	<1	<1	1	<1

Envirolab ID Your Reference Date Sampled	Units	PQL	PEL1754-06 ST-06 29/12/2023
Thermotolerant Coliforms	cfu/100mL	1	<1
Enterococci	cfu/100mL	1	<1
E.coli	cfu/100mL	1	<1

Result Comments

Identifier	Description
[4]	PQL(s) has/have been raised due to suppression of the internal standard, which required the sample(s) to be diluted. This is likely due to the high level of salts in the sample.

Method Summary

Method ID	Methodology Summary
Calc	Calculation
Calc - TKN	TKN determined by calculation (Total Nitrogen - NOx).
INORG-006	Alkalinity - determined titrimetrically based on APHA latest edition 2320-B. Solids reported from a 1:5 water extract unless otherwise specified. Total Carbon Dioxide - determined by calculation in accordance with APHA latest edition,4500-CO2 D.
INORG-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180±10°C. NOTE: Where the EC of the sample is <100µS/cm, the TDS will typically be below 70mg/L (as the sample is very likely to be at least drinking water quality). Therefore to ensure data quality for TDS, the TDS is typically calculated as per the equation: TDS = EC*0.6
INORG-019	Suspended Solids - determined gravimetrically by filtration of the sample. The solids are dried at 104±5°C
INORG-040	The concentrations of the major ions (mg/L) are converted to milliequivalents and summed. The ionic balance should be within +/- 15% i.e. total anions = total cations +/-15%.
INORG-055	Nitrate/Nitrite/NOx/TKN - determined colourimetrically. Waters samples are filtered on receipt prior to analysis. Soils/solids are analysed following a water extraction.
INORG-057	Ammonia - determined colourimetrically. Water samples are filtered on receipt prior to analysis. Soils and OHS media are analysed following a water extraction. Alternatively, Ammonia can be extracted from soil using 1M KCl.
INORG-060	Phosphate - determined colourimetrically using APHA latest edition 4500 P E. Water samples are filtered on receipt prior to analysis. Soils are analysed from a water extract.
INORG-081	Anions determined by Ion Chromatography. Waters samples are filtered on receipt prior to analysis. Solids are analysed from a water extract. Alternatively determined by colourimetry/turbidity using Discrete Analyser.
INORG-119	Chlorophyll A based on APHA 10200 H latest edition.
INORG-127	Total Nitrogen by high temperature catalytic combustion with chemiluminescence detection. Organic Carbon forms (inorganic, organic, total) determined using a TOC/NDIR analyser via combustion. Dissolved forms require filtering prior to determination.
METALS-020	Determination of various metals by ICP-OES.
METALS-021	Determination of Mercury by Cold Vapour AAS.
METALS-022	Determination of various metals by ICP-MS. Please note for Bromine and Iodine, any forms of these elements that are present are included together in the one result reported for each of these two elements.
MICRO-001B	E. coli/Thermotolerant coliforms: Microbial Water Analysis - in accordance with MICRO-001 (AS4276.5-latest edition). Recommended maximums based on NHMRC Australian Drinking Water Guidelines. Please note that results for this test derived from counts outside of the range 10-100 are considered approximate as per AS4276.1.
MICRO-001DE	Enterococci: Microbial Water Analysis - in accordance with MICRO-001 (AS 4276.9: latest edition). Please note that results for this test derived from counts outside of the range 10-100 are concidered approximate as per AS 4276.1.
ORG-020	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis. Note, the Total +ve TRH PQL is reflective of the lowest individual PQL and is therefore "Total +ve TRH" is simply a sum of the positive individual TRH fractions (>C10-C40).
ORG-023_F1_TOT	Determination of volatile organic compounds (VOCs) by P&T-GC-MS. Water samples are analysed directly by purge and trap GC-MS. Solids are extracted with Methanol, diluted and analysed by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater. Note, the Total +ve Xylene PQL is reflective of the lowest individual PQL and is therefore "Total +ve Xylenes" is simply a sum of the positive individual Xylenes.

Result Definitions

Identifier	Description
NR	Not reported
NEPM	National Environment Protection Measure
NS	Not specified
LCS	Laboratory Control Sample
RPD	Relative Percent Difference
>	Greater than
<	Less than
PQL	Practical Quantitation Limit
INS	Insufficient sample for this test
NA	Test not required
NT	Not tested
DOL	Samples rejected due to particulate overload (air filters only)
RFD	Samples rejected due to filter damage (air filters only)
RUD	Samples rejected due to uneven deposition (air filters only)
##	Indicates a laboratory acceptance criteria outlier, for further details, see Result Comments and/or QC Comments

Quality Control Definitions

Blank

This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, and is determined by processing solvents and reagents in exactly the same manner as for samples.

Surrogate Spike

Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

LCS (Laboratory Control Sample)

This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Matrix Spike

A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

Duplicate

This is the complete duplicate analysis of a sample from the process batch. The sample selected should be one where the analyte concentration is easily measurable.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria. Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction. Spikes for Physical and Aggregate Tests are not applicable. For VOCs in water samples, three vials are required for duplicate or spike analysis.

General Acceptance Criteria (GAC) - Analyte specific criteria applies for some analytes and is reflected in QC recovery tables.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% - see ELN-P05 QAQC tables for details (available on request); <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase. Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was typically insufficient in order to satisfy laboratory QA/QC protocols.

Miscellaneous Information

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached. We have taken the sampling date as being the date received at the laboratory.

Two significant figures are reported for the majority of tests and with a high degree of confidence, for results <10*PQL, the second significant figure may be in doubt i.e. has a relatively high degree of uncertainty and is provided for information only.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, Total Recoverable metals and PFAS where sediment/solids are included by default.

Urine Analysis - The BEI values listed are taken from the 2022 edition of *TLVs and BEIs Threshold Limits by ACGIH*.

Air volume measurements are not covered by Envirolab's NATA accreditation.

Data Quality Assessment Summary PEL1754

Client Details

Client	Rottnest Island Authority
Your Reference	South Thomson Barge Landing - Baseline Water Quality Monitoring
Date Issued	09/01/2024

Recommended Holding Time Compliance

Recommended holding time exceedances exist - See detailed list below

Quality Control and QC Frequency

QC Type	Compliant	Details
Blank	Yes	No Outliers
LCS	No	LCS Outliers Exist - See detailed list below
Duplicates	No	Duplicate Outliers Exist - See detailed list below
Matrix Spike	No	Matrix Spike Outliers Exist - See detailed list below
Surrogates / Extracted Internal Standards	Yes	No Outliers
QC Frequency	No	QC Frequency Outliers Exist - See detailed list below

Surrogates/Extracted Internal Standards, Duplicates and/or Matrix Spikes are not always relevant/applicable to certain analyses and matrices. Therefore, said QC measures are deemed compliant in these situations by default. See Laboratory Acceptance Criteria for more information

Data Quality Assessment Summary PEL1754

Recommended Holding Time Compliance

Analysis	Sample Number(s)	Date Sampled	Date Extracted	Date Analysed	Compliant
vTRH&MBTEXN | Water	1-6	29/12/2023	02/01/2024	02/01/2024	Yes
sTRH | Water	1-6	29/12/2023	02/01/2024	03/01/2024	Yes
Total Phosphorus | Water	1	29/12/2023	02/01/2024	02/01/2024	Yes
	2-6	29/12/2023	02/01/2024	04/01/2024	Yes
Dissolved Metals (LL) | Water	1-6	29/12/2023	02/01/2024	03/01/2024	Yes
Dissolved Metals (LL)-Hg | Water	1-6	29/12/2023	02/01/2024	02/01/2024	Yes
TDS | Water	1-6	29/12/2023	02/01/2024	02/01/2024	Yes
TSS | Water	1-6	29/12/2023	02/01/2024	02/01/2024	Yes
Alkalinity Suite | Water	1-6	29/12/2023	02/01/2024	02/01/2024	Yes
Chloride | Water	1-6	29/12/2023	02/01/2024	05/01/2024	Yes
Dissolved Cations | Water	1-6	29/12/2023	02/01/2024	03/01/2024	Yes
Ion Balance | Water	1-6	29/12/2023	03/01/2024	08/01/2024	Yes
Sulfate | Water	1-6	29/12/2023	02/01/2024	05/01/2024	Yes
Chlorophyll a | Water	1-6	29/12/2023	05/01/2024	08/01/2024	No
Nitrogen - Ammonia | Water	1-6	29/12/2023	02/01/2024	02/01/2024	Yes
Nitrogen - Nitrate | Water	1-6	29/12/2023	02/01/2024	02/01/2024	Yes
Nitrogen - Nitrite | Water	1-6	29/12/2023	02/01/2024	02/01/2024	No
Nitrogen - NOx | Water	1-6	29/12/2023	02/01/2024	02/01/2024	Yes
Nitrogen - Total N | Water	1-6	29/12/2023	04/01/2024	01/08/2024	Yes
Phosphate as P | Water	1-6	29/12/2023	02/01/2024	02/01/2024	No
TKN as N calc | Water	1-6	29/12/2023	03/01/2024	09/01/2024	Yes
E. coli & T.T.coli | Water	1-6	29/12/2023	29/12/2023	29/12/2023	Yes
Enterococci | Water	1-6	29/12/2023	29/12/2023	29/12/2023	Yes

Outliers: Laboratory Control Samples

ORG-020|Semi-volatile TRH (Water)| Batch BFA0023

Sample ID	Analyte	% Limits	% Recovery
BFA0023-BS1	o-Terphenyl	60 - 140	##[3]

Data Quality Assessment Summary PEL1754

Outliers: Duplicates

INORG-019 | Inorganics - Physical Parameters (Water) | Batch BFA0064

Sample ID	Duplicate ID	Analyte	% Limits	RPD
BFA0064-DUP1#	DUP1	Total Suspended Solids	20.00	200[5]
BFA0064-DUP2#	DUP2	Total Suspended Solids	20.00	200[5]

METALS-022 | Dissolved Low Level Metals (Water) | Batch BFA0019

Sample ID	Duplicate ID	Analyte	% Limits	RPD
BFA0019-DUP1#	DUP1	Selenium	20.00	92.1[6]

Outliers: Matrix Spike

METALS-020 | Inorganics - Ionic Balance and Indexes (Water) | Batch BFA0020

Sample ID	Analyte	% Limits	% Recovery
BFA0020-MS1#	Sodium	70 - 130	##[1]

METALS-022 | Dissolved Low Level Metals (Water) | Batch BFA0019

Sample ID	Analyte	% Limits	% Recovery
BFA0019-MS1#	Barium	70 - 130	##[2]
BFA0019-MS1#	Boron	70 - 130	##[1]
BFA0019-MS1#	Manganese	70 - 130	##[1]
BFA0019-MS1#	Vanadium	70 - 130	##[2]

ORG-020 | Semi-volatile TRH (Water) | Batch BFA0023

Sample ID	Analyte	% Limits	% Recovery
BFA0023-MS1#	o-Terphenyl	60 - 140	##[3]

Outliers: QC Frequency

INORG-119 | Inorganics - Nutrients (Water) | Batch BFA0344

Analysis	QC Type	Expected	Reported
Chlorophyll a	Duplicate	1	0

ORG-023_F1_TOT | Volatile TRH and BTEX (Water) | Batch BFA0072

Analysis	QC Type	Expected	Reported
vTRH&MBTEXN	Duplicate	2	0
	Matrix Spike	1	0

Quality Control PEL1754

ORG-023_F1_TOT|Volatile TRH and BTEX (Water) | Batch BFA0072

Analyte	Units	PQL	Blank	LCS %
TRH C6-C9	µg/L	10	<10	92.3
TRH C6-C10	µg/L	10	<10	90.0
TRH C6-C10 less BTEX (F1)	µg/L	10	<10	[NA]
Methyl tert butyl ether (MTBE)	µg/L	1.0	<1.0	[NA]
Benzene	µg/L	1.0	<1.0	102
Toluene	µg/L	1.0	<1.0	84.2
Ethylbenzene	µg/L	1.0	<1.0	88.6
meta+para Xylene	µg/L	2.0	<2.0	93.1
ortho-Xylene	µg/L	1.0	<1.0	88.9
Total Xylene	µg/L	3.0	<3.0	[NA]
Naphthalene (value used in F2 calc)	µg/L	1.0	<1.0	[NA]
Surrogate Dibromofluoromethane	*%*		*93.1*	*90.0*
Surrogate Toluene-D8	*%*		*98.5*	*92.2*
Surrogate 4-Bromofluorobenzene	*%*		*98.6*	*101*

ORG-020|Semi-volatile TRH (Water) | Batch BFA0023

Analyte	Units	PQL	Blank	DUP1 BFA0023-DUP1# Samp | QC | RPD %	DUP2 PEL1754-01 Samp | QC | RPD %	LCS %	Spike % BFA0023-MS1#
TRH C10-C14	µg/L	50	<50	<50 | <50 | [NA]	<50 | <50 | [NA]	90.4	89.7
TRH C15-C28	µg/L	100	<100	<100 | <100 | [NA] [6]	<100 | <100 | [NA]	98.3	94.5
TRH C29-C36	µg/L	100	<100	<100 | <100 | [NA]	<100 | <100 | [NA]	83.7	78.4
TRH >C10-C16	µg/L	50	<50	<50 | <50 | [NA]	<50 | <50 | [NA]	94.1	92.8
TRH >C16-C34 (F3)	µg/L	100	<100	<100 | <100 | [NA] [6]	<100 | <100 | [NA]	97.1	93.0
TRH >C34-C40 (F4)	µg/L	100	<100	<100 | <100 | [NA]	<100 | <100 | [NA]	82.1	78.6
Surrogate o-Terphenyl	*%*		*82.8*	*82.7 | 73.6*	*70.8 | 79.2*	*## [3]*	*##[3]*

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

METALS-020|Acid Extractable Metals (Water) | Batch BFA0022

Analyte	Units	PQL	Blank	DUP1 BFA0022-DUP1# Samp | QC | RPD %	DUP2 PEL1754-01 Samp | QC | RPD %	LCS %	Spike % BFA0022-MS1#
Phosphorus	mg/L	0.050	<0.050	22.5 | 22.7 | 1.17	<0.10 | <0.10 | [NA]	102	93.0

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

METALS-022|Dissolved Low Level Metals (Water) | Batch BFA0019

Analyte	Units	PQL	Blank	DUP1 BFA0019-DUP1# Samp | QC | RPD %	DUP2 PEL1754-01 Samp | QC | RPD %	LCS %	Spike % BFA0019-MS1#
Arsenic	µg/L	1.0	<1.0	<2.0 | <2.0 | [NA]	1.55 | 1.77 | 13.3	104	128
Barium	µg/L	1.0	<1.0	185 | 190 | 2.29	5.52 | 5.78 | 4.60	93.3	##[2]
Beryllium	µg/L	0.50	<0.50	<1.0 | <1.0 | [NA]	<0.50 | <0.50 | [NA]	86.0	112
Boron	µg/L	20	<20	3030 | 3040 | 0.540	4620 | 4400 | 4.72	101	##[1]
Cadmium	µg/L	0.10	<0.10	<0.20 | <0.20 | [NA]	<0.10 | <0.10 | [NA]	101	120
Chromium	µg/L	1.0	<1.0	<2.0 | <2.0 | [NA]	<1.0 | <1.0 | [NA]	103	123
Cobalt	µg/L	1.0	<1.0	4.78 | 5.06 | 5.69	<1.0 | <1.0 | [NA]	104	119
Copper	µg/L	1.0	<1.0	<2.0 | <2.0 | [NA]	<1.0 | <1.0 | [NA]	103	111
Lead	µg/L	1.0	<1.0	3.02 | 2.60 | 14.9	<1.0 | <1.0 | [NA]	94.3	110
Manganese	µg/L	1.0	<1.0	4840 | 4960 | 2.43	<1.0 | <1.0 | [NA]	101	##[1]
Nickel	µg/L	1.0	<1.0	28.0 | 33.6 | 18.3	<1.0 | <1.0 | [NA]	103	115
Selenium	µg/L	1.0	<1.0	6.82 | 2.52 | 92.1 [6]	<1.0 | <1.0 | [NA]	98.4	120
Vanadium	µg/L	1.0	<1.0	<2.0 | <2.0 | [NA]	2.16 | 2.22 | 2.74	103	##[2]
Zinc	µg/L	1.0	<1.0	<2.0 | <2.0 | [NA]	<1.0 | <1.0 | [NA]	103	111

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

Quality Control PEL1754

METALS-021 | Dissolved Low Level Metals (Water) | Batch BFA0021

Analyte	Units	PQL	Blank	DUP1 BFA0021-DUP1# Samp | QC | RPD %	LCS %	Spike % BFA0021-MS1#
Mercury	µg/L	0.050	<0.050	<0.050 | <0.050 | [NA]	90.0	80.4

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-018 | Inorganics - Physical Parameters (Water) | Batch BFA0063

Analyte	Units	PQL	Blank	DUP1 BFA0063-DUP1# Samp | QC | RPD %	DUP2 BFA0063-DUP2# Samp | QC | RPD %	LCS %
Total Dissolved Solids	mg/L	5.0	<5.0	142000 | 145000 | 2.28	2350 | 2380 | 1.35	111

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-019 | Inorganics - Physical Parameters (Water) | Batch BFA0064

Analyte	Units	PQL	Blank	DUP1 BFA0064-DUP1# Samp | QC | RPD %	DUP2 BFA0064-DUP2# Samp | QC | RPD %	LCS %
Total Suspended Solids	mg/L	5.0	<5.0	## | ## | [NA] [5]	## | ## | [NA] [5]	112

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

METALS-020 | Inorganics - Ionic Balance and Indexes (Water) | Batch BFA0020

Analyte	Units	PQL	Blank	DUP1 BFA0020-DUP1# Samp | QC | RPD %	DUP2 BFA0020-DUP2# Samp | QC | RPD %	LCS %	Spike % BFA0020-MS1#
Calcium	mg/L	0.50	<0.50	834 | 827 | 0.832	436 | 438 | 0.431	90.4	89.6
Magnesium	mg/L	0.50	<0.50	456 | 455 | 0.228	1480 | 1490 | 0.394	93.9	96.3
Potassium	mg/L	0.50	<0.50	112 | 109 | 2.67	116 | 117 | 0.793	91.4	90.4
Sodium	mg/L	0.50	<0.50	2950 | 2930 | 0.714	10500 | 10600 | 1.36	95.1	##[1]
Hardness as CaCO3	mg/L	3.0	<3.0	3960 | 3940 | 0.545	7190 | 7220 | 0.400	[NA]	[NA]

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-006 | Inorganics - Ionic Balance and Indexes (Water) | Batch BFA0027

Analyte	Units	PQL	Blank	DUP1 BFA0027-DUP1# Samp | QC | RPD %	DUP2 BFA0027-DUP2# Samp | QC | RPD %	LCS %
Bicarbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	258 | 260 | 0.733	336 | 346 | 2.96	[NA]
Carbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0 | <5.0 | [NA]	<5.0 | <5.0 | [NA]	[NA]
Hydroxide OH- as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0 | <5.0 | [NA]	<5.0 | <5.0 | [NA]	[NA]
Total Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	258 | 260 | 0.733	336 | 346 | 2.96	[NA]

Analyte	Units	PQL	Blank	LCS %
Total Alkalinity as CaCO3	mg/L as CaCO3	5		104

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-081 | Inorganics - Ionic Balance and Indexes (Water) | Batch BFA0081

Analyte	Units	PQL	Blank	DUP1 BFA0081-DUP1# Samp | QC | RPD %	DUP2 PEL1754-01 Samp | QC | RPD %	LCS %	Spike % BFA0081-MS1#
Chloride	mg/L	1.0	<1.0	<1.0 | <1.0 | [NA]	19200 | 19400 | 1.05	89.1	87.2
Sulfate	mg/L	1.0	<1.0	<1.0 | <1.0 | [NA]	2600 | 2640 | 1.44	91.7	97.5

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

Quality Control PEL1754

INORG-057 | Inorganics - Nutrients (Water) | Batch BFA0031

Analyte	Units	PQL	Blank	DUP1 PEL1754-01 Samp | QC | RPD %	LCS %	Spike % PEL1754-02
Ammonia as N	mg/L	0.0050	<0.0050	<0.0050 | <0.0050 | [NA]	94.6	107
Nitrate as N	mg/L	0.0050	<0.0050	<0.0050 | <0.0050 | [NA] [6]	99.9	110
Nitrate as NO3 by calculation	mg/L	0.020	<0.020		[NA]	[NA]
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050 | <0.0050 | [NA]	[NA]	[NA]
Nitrite as NO2 by calculation	mg/L	0.020	<0.020		[NA]	[NA]
NOx as N	mg/L	0.0050	<0.0050	<0.0050 | <0.0050 | [NA] [6]	99.9	110
Phosphate as P	mg/L	0.0050	<0.0050	<0.0050 | <0.0050 | [NA] [6]	112	126

Analyte	Units	PQL	Blank	LCS %	Spike % PEL1754-02
Nitrite as N	mg/L	0.005		99.9	118

INORG-127 | Inorganics - Nutrients (Water) | Batch BFA0225

Analyte	Units	PQL	Blank	DUP1 PEL1754-01 Samp | QC | RPD %	DUP2 BFA0225-DUP2# Samp | QC | RPD %	LCS %	Spike % PEL1754-02
Total Nitrogen	mg/L	0.10	<0.10	0.160 | 0.138 | 14.9	24.3 | 23.9 | 1.79	120	126

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-119 | Inorganics - Nutrients (Water) | Batch BFA0344

Analyte	Units	PQL	Blank	LCS %
Chlorophyll a	mg/m3	1.0	<1.0	101

MICRO-001B | Microbiological Suite (Water) | Batch BEL3276

Analyte	Units	PQL	Blank	DUP1 BEL3276-DUP1# Samp | QC | RPD %	DUP2 BEL3276-DUP2# Samp | QC | RPD %	LCS %
Thermotolerant Coliforms	cfu/100mL	1	<1	<1 | <1 | [NA]	<1 | <1 | [NA]	[NA]
E.coli	cfu/100mL	1	<1	<1 | <1 | [NA]	<1 | <1 | [NA]	[NA]

Analyte	Units	PQL	Blank	DUP3 BEL3276-DUP3# Samp | QC | RPD %	DUP4 BEL3276-DUP4# Samp | QC | RPD %	LCS %
Thermotolerant Coliforms	cfu/100mL	1		<1 | <1 | [NA]	<1 | <1 | [NA]	[NA]
E.coli	cfu/100mL	1		<1 | <1 | [NA]	<1 | <1 | [NA]	[NA]

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

MICRO-001DE | Microbiological Suite (Water) | Batch BEL3277

Analyte	Units	PQL	Blank	LCS %
Enterococci	cfu/100mL	1	<1	[NA]

Quality Control PEL1754

QC Comments

Identifier	Description
[1]	Spike recovery is not applicable due to the relatively high analyte background in the sample (>3* spike level). However, the LCS recovery is within acceptance criteria.
[2]	Spike recovery is outside routine acceptance criteria (70-130%), this may be due to suspected non-homogeneity and/or matrix interference effects. However, an acceptable recovery was achieved for the LCS.
[3]	Surrogate recovery is outside routine acceptance criteria (60-140%) as a result of the high concentration of analyte(s) in the sample.
[5]	Note: There was insufficient sample to perform all QC according to our internal guidelines.
[6]	Duplicate %RPD may be flagged as an outlier to routine laboratory acceptance, however, where one or both results are <10*PQL, the RPD acceptance criteria increases exponentially.

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Certificate of Analysis PFA1208

Client Details

Client	Rottnest Island Authority
Contact	David Pond
Address	PO Box 693, FREMANTLE, WA, 6959

Sample Details

Your Reference	South Thomson Barge Landing - Baseline Water Quality Monitoring
Number of Samples	6 Water
Date Samples Received	24/01/2024
Date Instructions Received	24/01/2024

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date Results Requested by	01/02/2024
Date of Issue	01/02/2024

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Authorisation Details

Results Approved By	Diego Bigolin, Supervisor, Inorganics Lien Tang, Assistant Operations Manager
Laboratory Manager	Michael Kubiak

Certificate of Analysis PFA1208

Samples in this Report

Envirolab ID	Sample ID	Matrix	Date Sampled	Date Received
PFA1208-01	ST-01	Water	23/01/2024	24/01/2024
PFA1208-02	ST-02	Water	23/01/2024	24/01/2024
PFA1208-03	ST-03	Water	23/01/2024	24/01/2024
PFA1208-04	ST-04	Water	23/01/2024	24/01/2024
PFA1208-05	ST-05	Water	23/01/2024	24/01/2024
PFA1208-06	ST-06	Water	23/01/2024	24/01/2024

Sample Comments

General Comment Insufficient volume for low level TSS - Testing routine level

Certificate of Analysis PFA1208

Inorganics - Physical Parameters (Water)

Envirolab ID Your Reference Date Sampled	Units	PQL	PFA1208-01 ST-01 23/01/2024	PFA1208-02 ST-02 23/01/2024	PFA1208-03 ST-03 23/01/2024	PFA1208-04 ST-04 23/01/2024	PFA1208-05 ST-05 23/01/2024
Total Dissolved Solids	mg/L	5.0	41000	49000	41000	41000	41000
Total Suspended Solids	mg/L	5.0	<5.0	<5.0	<5.0	<5.0	<5.0

Envirolab ID Your Reference Date Sampled	Units	PQL	PFA1208-06 ST-06 23/01/2024
Total Dissolved Solids	mg/L	5.0	41000
Total Suspended Solids	mg/L	5.0	<5.0

Certificate of Analysis PFA1208

Inorganics - Nutrients (Water) - Analysed By Envirolab Services Sydney

Envirolab ID	**Units**	**PQL**	PFA1208-01	PFA1208-02	PFA1208-03	PFA1208-04	PFA1208-05
Your Reference			ST-01	ST-02	ST-03	ST-04	ST-05
Date Sampled			23/01/2024	23/01/2024	23/01/2024	23/01/2024	23/01/2024
Chlorophyll a	mg/m3	1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Envirolab ID	**Units**	**PQL**	PFA1208-06
Your Reference			ST-06
Date Sampled			23/01/2024
Chlorophyll a	mg/m3	1.0	<1.0

Method Summary

Method ID	Methodology Summary
INORG-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180±10°C. NOTE: Where the EC of the sample is <100µS/cm, the TDS will typically be below 70mg/L (as the sample is very likely to be at least drinking water quality). Therefore to ensure data quality for TDS, the TDS is typically calculated as per the equation: TDS = EC*0.6
INORG-019	Suspended Solids - determined gravimetrically by filtration of the sample. The solids are dried at 104±5°C
INORG-119	Chlorophyll A based on APHA 10200 H latest edition.

Result Definitions

Identifier	Description
NR	Not reported
NEPM	National Environment Protection Measure
NS	Not specified
LCS	Laboratory Control Sample
RPD	Relative Percent Difference
>	Greater than
<	Less than
PQL	Practical Quantitation Limit
INS	Insufficient sample for this test
NA	Test not required
NT	Not tested
DOL	Samples rejected due to particulate overload (air filters only)
RFD	Samples rejected due to filter damage (air filters only)
RUD	Samples rejected due to uneven deposition (air filters only)
##	Indicates a laboratory acceptance criteria outlier, for further details, see Result Comments and/or QC Comments

Quality Control Definitions

Blank

This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, and is determined by processing solvents and reagents in exactly the same manner as for samples.

Surrogate Spike

Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

LCS (Laboratory Control Sample)

This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Matrix Spike

A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

Duplicate

This is the complete duplicate analysis of a sample from the process batch. The sample selected should be one where the analyte concentration is easily measurable.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria. Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction. Spikes for Physical and Aggregate Tests are not applicable. For VOCs in water samples, three vials are required for duplicate or spike analysis.

General Acceptance Criteria (GAC) - Analyte specific criteria applies for some analytes and is reflected in QC recovery tables.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% - see ELN-P05 QAQC tables for details (available on request); <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase. Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was typically insufficient in order to satisfy laboratory QA/QC protocols.

Miscellaneous Information

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached. We have taken the sampling date as being the date received at the laboratory.

Two significant figures are reported for the majority of tests and with a high degree of confidence, for results <10*PQL, the second significant figure may be in doubt i.e. has a relatively high degree of uncertainty and is provided for information only.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, Total Recoverable metals and PFAS where sediment/solids are included by default.

Urine Analysis - The BEI values listed are taken from the 2022 edition of *TLVs and BEIs Threshold Limits by ACGIH*.

Air volume measurements are not covered by Envirolab's NATA accreditation.

Data Quality Assessment Summary PFA1208

Client Details

Client	Rottnest Island Authority
Your Reference	South Thomson Barge Landing - Baseline Water Quality Monitoring
Date Issued	01/02/2024

Recommended Holding Time Compliance

No recommended holding time exceedances

Quality Control and QC Frequency

QC Type	Compliant	Details
Blank	Yes	No Outliers
LCS	Yes	No Outliers
Duplicates	Yes	No Outliers
Matrix Spike	Yes	No Outliers
Surrogates / Extracted Internal Standards	Yes	No Outliers
QC Frequency	No	QC Frequency Outliers Exist - See detailed list below

Surrogates/Extracted Internal Standards, Duplicates and/or Matrix Spikes are not always relevant/applicable to certain analyses and matrices. Therefore, said QC measures are deemed compliant in these situations by default. See Laboratory Acceptance Criteria for more information

Data Quality Assessment Summary PFA1208

Recommended Holding Time Compliance

Analysis	Sample Number(s)	Date Sampled	Date Extracted	Date Analysed	Compliant
TDS | Water	1-6	23/01/2024	29/01/2024	29/01/2024	Yes
TSS | Water	1-6	23/01/2024	29/01/2024	29/01/2024	Yes
Chlorophyll a-Frozen | Water	1-6	23/01/2024	23/01/2024	01/02/2024	Yes

Outliers: QC Frequency

INORG-119 | Inorganics - Nutrients (Water) | Batch BFA2461

Analysis	QC Type	Expected	Reported
Chlorophyll a-Frozen	Duplicate	1	0

Quality Control PFA1208

INORG-018 | Inorganics - Physical Parameters (Water) | Batch BFA2535

Analyte	Units	PQL	Blank	DUP1 PFA1208-06 Samp | QC | RPD %	DUP2 BFA2535-DUP2# Samp | QC | RPD %	LCS %
Total Dissolved Solids	mg/L	5.0	<5.0	40800 | 40600 | 0.466	380 | 380 | 0.00	113

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-019 | Inorganics - Physical Parameters (Water) | Batch BFA2536

Analyte	Units	PQL	Blank	DUP1 PFA1208-06 Samp | QC | RPD %	DUP2 BFA2536-DUP2# Samp | QC | RPD %	LCS %
Total Suspended Solids	mg/L	5.0	<5.0	<5.0 | <5.0 | [NA] [1]	<5.0 | <5.0 | [NA] [1]	102

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-119 | Inorganics - Nutrients (Water) | Batch BFA2461

Analyte	Units	PQL	Blank	LCS %
Chlorophyll a	mg/m3	1.0	<1.0	80.4

QC Comments

Identifier	Description
[1]	Note: There was insufficient sample to perform all QC according to our internal guidelines.

ROTTNEST ISLAND AUTHORITY

Water Quality Field Parameters

Date	Site	T	DO	Cond	TDS	SAL	pH	ORP	Turbidity	Secchi depth
		°C	mg/L	mS/cm	g/L	ppt	-	mV	NTU	m
20/11/2023 - 10.00am	ST-01	25.12	7.2	56.176	36.51	37.32	8	67.6	0	-
	ST-02	25.49	7	56.272	36.58	37.38	7.01	91.5	3.5	-
	Samples collected:	TSS								
	Weather:	Sunny, light to moderate SSE winds at 15km/hr, tide low at 0.20m, slightly choppy seas from the south-east, swell 1.0m. Water quality reasonable. Moderate number of boats moored around Army Groyne.								
23/11/2023 - 10.00am	ST-01	no readings collected								-
	Samples collected:	TSS, turbidity								
	Weather:	Partly cloudy, strong E winds at 25km/hr, tide low at 0.24m, choppy seas from the east, swell 1.5m. Water quality poor-fair. Few boats moored around Army Groyne.								
29/12/2023 - 09.30am	ST-01	25.3	7.2	55.958	36.37	37.15	8.08	44.8	0	-
	ST-02	25.4	7.3	55.775	36.25	37.01	8.16	54.3	0	-
	ST-03	25.6	7.3	55.65	36.17	36.91	8.22	56.6	0	-
	ST-04	25.1	7.1	56.151	36.5	37.3	7.64	52.8	0	-
	ST-05	25.7	7.3	55.579	36.13	36.86	8.26	54.3	0	-
	ST-06	25.8	7.5	55.458	36.05	36.76	8.33	60.5	0	-
	Samples collected:	Suite A.								
	Weather:	Partly cloudy, strong E winds at 22km/hr, tide low at 0.16m, choppy seas from the east, swell 1.5m. Water quality fair. Many boats moored around Army Groyne.								
23/01/2024 - 13.00pm	ST-01	24	8.3	57.22	37.2	38.14	8.15	159	0	2.4 (bottom)
	ST-02	23.8	8.2	57.16	37.16	38.11	8.11	154	0	3.8 (bottom)
	ST-03	23.96	8.6	57.22	37.19	38.13	8.16	156	0	3.2 (bottom)
	ST-04	24.01	8.7	57.26	37.2	38.12	8.2	165	0	1.9 (bottom)
	ST-05	24.39	8.9	57.29	37.24	38.19	8.19	162	0	2.8 (bottom)
	ST-06	23.64	8.5	57.13	37.13	38.06	8.23	181	0	3.0 (bottom)
	Samples collected:	Suite B								
	Weather:	Sunny, light to moderate SW winds at 15km/hr, tide mid at 0.80m, slightly choppy seas from the south, swell 1.0m. Water quality good. Moderate number of boats moored around Army Groyne.								

Water Quality Analytical Results - December 2023

						Volatile TRH and BTEX	Volatile TRH and BTEX	Volatile TRH and BTEX	Volatile TRH and BTEX	Volatile TRH and BTEX	Volatile TRH and BTEX	Volatile TRH and BTEX	Volatile TRH and BTEX	Volatile TRH and BTEX
						TRH C6-C9	TRH C6-C10	TRH C6-C10 less BTEX (F1)	Methyl tert butyl ether (MTBE)	Benzene	Toluene	Ethylbenzene	meta+para Xylene	ortho-Xylene
RptUnits						µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
PQL						10	10	10	1.0	1.0	1.0	1.0	2.0	1.0
Matrix						Water	Water	Water	Water	Water	Water	Water	Water	Water
Method						ORG-023_F1_TOT	ORG-023_F1_TOT	ORG-023_F1_TOT	ORG-023_F1_TOT	ORG-023_F1_TOT	ORG-023_F1_TOT	ORG-023_F1_TOT	ORG-023_F1_TOT	ORG-023_F1_TOT
Trigger values for Marine Water 99%						-	-	-	-	-	-	-	-	-
Groundwater Investigation level for Marine Water						-	-	-	-	-	-	-	-	-
ANZECC Trigger value for slightly disturbed ecosystems (SW Australia - Marine - Inshore)						-	-	-	-	-	-	-	-	-
Reference	**Sample**	**Sample No.**	**Replicat**	**Date**	**Type of Sample**	-	-	-	-	-	-	-	-	-
PEL1754	ST-01	01	0	29/12/2023	Water	<10	<10	<10	<1.0	<1.0	<1.0	<1.0	<2.0	<1.0
PEL1754	ST-02	02	0	29/12/2023	Water	<10	<10	<10	<1.0	<1.0	<1.0	<1.0	<2.0	<1.0
PEL1754	ST-03	03	0	29/12/2023	Water	<10	<10	<10	<1.0	<1.0	<1.0	<1.0	<2.0	<1.0
PEL1754	ST-04	04	0	29/12/2023	Water	<10	<10	<10	<1.0	<1.0	<1.0	<1.0	<2.0	<1.0
PEL1754	ST-05	05	0	29/12/2023	Water	<10	<10	<10	<1.0	<1.0	<1.0	<1.0	<2.0	<1.0
PEL1754	ST-06	06	0	29/12/2023	Water	<10	<10	<10	<1.0	<1.0	<1.0	<1.0	<2.0	<1.0
BFA0019	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-	-	-	-
BFA0022	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-	-	-	-
BFA0023	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-	-	-	-
BFA0031	ST-01	DUP1	1	29/12/2023	Water	-	-	-	-	-	-	-	-	-
BFA0081	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-	-	-	-
BFA0225	ST-01	DUP1	1	29/12/2023	Water	-	-	-	-	-	-	-	-	-

 # - Indicates this is the combined value of Chromium (Cr III) and Chromium CrVI)

Water Quality Analytical Results - December 2023

						Volatile TRH and BTEX	Volatile TRH and BTEX	Volatile TRH and BTEX	Volatile TRH and BTEX	Volatile TRH and BTEX	Semi-volatile TRH	Semi-volatile TRH	Semi-volatile TRH	Semi-volatile TRH	Semi-volatile TRH
						Total Xylene	Naphthalene (value used in F2 calc)	Dibromofluoromethane	Toluene-D8	4-Bromofluorobenzene	TRH C10-C14	TRH C15-C28	TRH C29-C36	Total +ve TRH C10-C36	TRH >C10-C16
RptUnits						µg/L	µg/L	%	%	%	µg/L	µg/L	µg/L	µg/L	µg/L
PQL						3.0	1.0	-	-	-	50	100	100	50	50
Matrix						Water	Water	Water	Water	Water	Water	Water	Water	Water	Water
Method						ORG-023_F1_TOT	ORG-023_F1_TOT	ORG-023_F1_TOT	ORG-023_F1_TOT	ORG-023_F1_TOT	ORG-020	ORG-020	ORG-020	ORG-020	ORG-020
Trigger values for Marine Water 99%						-	-	-	-	-	-	-	-	-	-
Groundwater Investigation level for Marine Water						-	-	-	-	-	-	-	-	-	-
ANZECC Trigger value for slightly disturbed ecosystems (SW Australia - Marine - Inshore)						-	-	-	-	-	-	-	-	-	-
Reference	**Sample**	**Sample No.**	**Replicat**	**Date**	**Type of Sample**	-	-	-	-	-	-	-	-	-	-
PEL1754	ST-01	01	0	29/12/2023	Water	<3.0	<1.0	96.7	95.8	105	<50	<100	<100	<50	<50
PEL1754	ST-02	02	0	29/12/2023	Water	<3.0	<1.0	94.5	94.6	103	<50	<100	<100	<50	<50
PEL1754	ST-03	03	0	29/12/2023	Water	<3.0	<1.0	95.8	94.3	104	<50	<100	<100	<50	<50
PEL1754	ST-04	04	0	29/12/2023	Water	<3.0	<1.0	94.9	96.7	105	<50	<100	<100	<50	<50
PEL1754	ST-05	05	0	29/12/2023	Water	<3.0	<1.0	97.6	96.4	100	<50	<100	<100	<50	<50
PEL1754	ST-06	06	0	29/12/2023	Water	<3.0	<1.0	97.8	93.6	105	<50	<100	<100	<50	<50
BFA0019	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-	-	-	-	-
BFA0022	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-	-	-	-	-
BFA0023	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	<50	<100	<100	-	<50
BFA0031	ST-01	DUP1	1	29/12/2023	Water	-	-	-	-	-	-	-	-	-	-
BFA0081	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-	-	-	-	-
BFA0225	ST-01	DUP1	1	29/12/2023	Water	-	-	-	-	-	-	-	-	-	-

 # - Indicates this is the combined value of Chromium (Cr III) and Chromium CrVI)

Water Quality Analytical Results - December 2023

						Semi-volatile TRH	Semi-volatile TRH	Semi-volatile TRH	Semi-volatile TRH	Semi-volatile TRH	Acid Extractable Metals	Dissolved Low Level Metals	Dissolved Low Level Metals	Dissolved Low Level Metals
						TRH >C10-C16 less Naphthalene F2	TRH >C16-C34 (F3)	TRH >C34-C40 (F4)	Total +ve TRH >C10-C40	o-Terphenyl	Phosphorus	Arsenic	Barium	Beryllium
RptUnits						µg/L	µg/L	µg/L	µg/L	%	mg/L	µg/L	µg/L	µg/L
PQL						50	100	100	50	-	0.050	1.0	1.0	0.50
Matrix						Water	Water	Water	Water	Water	Water	Water	Water	Water
Method						ORG-020	ORG-020	ORG-020	ORG-020	ORG-020	METALS-020	METALS-022	METALS-022	METALS-022
Trigger values for Marine Water 99%						-	-	-	-	-	-	-	-	-
Groundwater Investigation level for Marine Water						-	-	-	-	-	-	-	-	-
ANZECC Trigger value for slightly disturbed ecosystems (SW Australia - Marine - Inshore)						-	-	-	-	-	0.02	-	-	-
Reference	**Sample**	**Sample No.**	**Replicat**	**Date**	**Type of Sample**	-	-	-	-	-	-	-	-	-
PEL1754	ST-01	01	0	29/12/2023	Water	<50	<100	<100	<50	70.8	<0.10	1.6	5.5	<0.50
PEL1754	ST-02	02	0	29/12/2023	Water	<50	<100	<100	<50	69.9	<0.25	1.6	5.7	<0.50
PEL1754	ST-03	03	0	29/12/2023	Water	<50	<100	<100	<50	76.8	<0.25	1.8	5.4	<0.50
PEL1754	ST-04	04	0	29/12/2023	Water	<50	<100	<100	<50	73.3	<0.25	2.0	5.9	<0.50
PEL1754	ST-05	05	0	29/12/2023	Water	<50	<100	<100	<50	76.4	<0.25	1.8	6.0	<0.50
PEL1754	ST-06	06	0	29/12/2023	Water	<50	<100	<100	<50	87.6	<0.25	2.0	5.8	<0.50
BFA0019	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-	1.77	5.78	<0.50
BFA0022	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	<0.10	-	-	-
BFA0023	ST-01	DUP2	1	29/12/2023	Water	-	<100	<100	-	79.2	-	-	-	-
BFA0031	ST-01	DUP1	1	29/12/2023	Water	-	-	-	-	-	-	-	-	-
BFA0081	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-	-	-	-
BFA0225	ST-01	DUP1	1	29/12/2023	Water	-	-	-	-	-	-	-	-	-

 # - Indicates this is the combined value of Chromium (Cr III) and Chromium CrVI

Water Quality Analytical Results - December 2023

						Dissolved Low Level Metals	Dissolved Low Level Metals	Dissolved Low Level Metals	Dissolved Low Level Metals	Dissolved Low Level Metals	Dissolved Low Level Metals	Dissolved Low Level Metals	Dissolved Low Level Metals
						Boron	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Mercury
RptUnits						µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
PQL						20	0.10	1.0	1.0	1.0	1.0	1.0	0.050
Matrix						Water	Water	Water	Water	Water	Water	Water	Water
Method						METALS-022	METALS-022	METALS-022	METALS-022	METALS-022	METALS-022	METALS-022	METALS-021
Trigger values for Marine Water 99%						-	-	7.84#	-	-	-	-	-
Groundwater Investigation level for Marine Water						-	-	31.8#	-	-	-	-	-
ANZECC Trigger value for slightly disturbed ecosystems (SW Australia - Marine - Inshore)						-	-	-	-	-	-	-	-
Reference	**Sample**	**Sample No.**	**Replicat**	**Date**	**Type of Sample**	-	-	-	-	-	-	-	-
PEL1754	ST-01	01	0	29/12/2023	Water	4600	<0.10	<1.0	<1.0	<1.0	<1.0	<1.0	<0.050
PEL1754	ST-02	02	0	29/12/2023	Water	4400	<0.10	9.6	<1.0	<1.0	<1.0	<1.0	<0.050
PEL1754	ST-03	03	0	29/12/2023	Water	4400	<0.10	<1.0	<1.0	<1.0	<1.0	<1.0	<0.050
PEL1754	ST-04	04	0	29/12/2023	Water	4400	<0.10	<1.0	<1.0	<1.0	<1.0	<1.0	<0.050
PEL1754	ST-05	05	0	29/12/2023	Water	4400	<0.10	<1.0	<1.0	<1.0	<1.0	<1.0	<0.050
PEL1754	ST-06	06	0	29/12/2023	Water	4300	<0.10	<1.0	<1.0	<1.0	<1.0	<1.0	<0.050
BFA0019	ST-01	DUP2	1	29/12/2023	Water	4400	<0.10	<1.0	<1.0	<1.0	<1.0	<1.0	-
BFA0022	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-	-	-
BFA0023	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-	-	-
BFA0031	ST-01	DUP1	1	29/12/2023	Water	-	-	-	-	-	-	-	-
BFA0081	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-	-	-
BFA0225	ST-01	DUP1	1	29/12/2023	Water	-	-	-	-	-	-	-	-

 # - Indicates this is the combined value of Chromium (Cr III) and Chromium CrVI

Water Quality Analytical Results - December 2023

						Dissolved Low Level Metals	Dissolved Low Level Metals	Dissolved Low Level Metals	Dissolved Low Level Metals	Inorganics - Physical Parameters	Inorganics - Physical Parameters	Inorganics - Ionic Balance and Indexes
						Nickel	Selenium	Vanadium	Zinc	Total Dissolved Solids	Total Suspended Solids	Bicarbonate Alkalinity as CaCO3
RptUnits						µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L as CaCO3
PQL						1.0	1.0	1.0	1.0	5.0	5.0	5.0
Matrix						Water	Water	Water	Water	Water	Water	Water
Method						METALS-022	METALS-022	METALS-022	METALS-022	INORG-018	INORG-019	INORG-006
Trigger values for Marine Water 99%						-	-	50	7	-	-	-
Groundwater Investigation level for Marine Water						-	-	100	15	-	-	-
ANZECC Trigger value for slightly disturbed ecosystems (SW Australia - Marine - Inshore)						-	-	-	-	-	-	-
Reference	**Sample**	**Sample No.**	**Replicat**	**Date**	**Type of Sample**	-	-	-	-	-	-	-
PEL1754	ST-01	01	0	29/12/2023	Water	<1.0	<1.0	2.2	<1.0	40000	<5.0	130
PEL1754	ST-02	02	0	29/12/2023	Water	<1.0	<1.0	2.3	620	41000	<5.0	130
PEL1754	ST-03	03	0	29/12/2023	Water	<1.0	<1.0	2.2	<1.0	41000	<5.0	130
PEL1754	ST-04	04	0	29/12/2023	Water	<1.0	<1.0	2.1	11	41000	<5.0	130
PEL1754	ST-05	05	0	29/12/2023	Water	<1.0	<1.0	2.1	<1.0	41000	<5.0	130
PEL1754	ST-06	06	0	29/12/2023	Water	<1.0	<1.0	2.0	<1.0	40000	<5.0	130
BFA0019	ST-01	DUP2	1	29/12/2023	Water	<1.0	<1.0	2.22	<1.0	-	-	-
BFA0022	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-	-
BFA0023	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-	-
BFA0031	ST-01	DUP1	1	29/12/2023	Water	-	-	-	-	-	-	-
BFA0081	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-	-
BFA0225	ST-01	DUP1	1	29/12/2023	Water	-	-	-	-	-	-	-

 # - Indicates this is the combined value of Chromium (Cr III) and Chromium CrVI

Water Quality Analytical Results - December 2023

						Inorganics - Ionic Balance and Indexes	Inorganics - Ionic Balance and Indexes	Inorganics - Ionic Balance and Indexes	Inorganics - Ionic Balance and Indexes	Inorganics - Ionic Balance and Indexes	Inorganics - Ionic Balance and Indexes
						Carbonate Alkalinity as CaCO3	Hydroxide OH- as CaCO3	Total Alkalinity as CaCO3	Chloride	Sulfate	Calcium
RptUnits						mg/L as CaCO3	mg/L as CaCO3	mg/L as CaCO3	mg/L	mg/L	mg/L
PQL						5.0	5.0	5.0	1.0	1.0	0.50
Matrix						Water	Water	Water	Water	Water	Water
Method						INORG-006	INORG-006	INORG-006	INORG-081	INORG-081	METALS-020
Trigger values for Marine Water 99%						-	-	-	-	-	-
Groundwater Investigation level for Marine Water						-	-	-	-	-	-
ANZECC Trigger value for slightly disturbed ecosystems (SW Australia - Marine - Inshore)						-	-	-	-	-	-
Reference	**Sample**	**Sample No.**	**Replicat**	**Date**	**Type of Sample**	-	-	-	-	-	-
PEL1754	ST-01	01	0	29/12/2023	Water	<5.0	<5.0	130	19000	2600	390
PEL1754	ST-02	02	0	29/12/2023	Water	<5.0	<5.0	130	19000	2800	400
PEL1754	ST-03	03	0	29/12/2023	Water	<5.0	<5.0	130	19000	2800	400
PEL1754	ST-04	04	0	29/12/2023	Water	<5.0	<5.0	130	20000	2800	400
PEL1754	ST-05	05	0	29/12/2023	Water	<5.0	<5.0	130	19000	2800	400
PEL1754	ST-06	06	0	29/12/2023	Water	<5.0	<5.0	130	20000	2900	400
BFA0019	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-
BFA0022	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-
BFA0023	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-
BFA0031	ST-01	DUP1	1	29/12/2023	Water	-	-	-	-	-	-
BFA0081	ST-01	DUP2	1	29/12/2023	Water	-	-	-	19400	2640	-
BFA0225	ST-01	DUP1	1	29/12/2023	Water	-	-	-	-	-	-

 # - Indicates this is the combined value of Chromium (Cr III) and Chromium CrVI

Water Quality Analytical Results - December 2023

						Inorganics - Ionic Balance and Indexes	Inorganics - Ionic Balance and Indexes	Inorganics - Ionic Balance and Indexes	Inorganics - Ionic Balance and Indexes	Inorganics - Ionic Balance and Indexes	Inorganics - Ionic Balance and Indexes
						Magnesium	Potassium	Sodium	Hardness as CaCO3	Ionic Balance	Total Anions
RptUnits						mg/L	mg/L	mg/L	mg/L	%	mg/L
PQL						0.50	0.50	0.50	3.0	-	-
Matrix						Water	Water	Water	Water	Water	Water
Method						METALS-020	METALS-020	METALS-020	METALS-020	INORG-040	Calc
Trigger values for Marine Water 99%						-	-	-	-	-	-
Groundwater Investigation level for Marine Water						-	-	-	-	-	-
ANZECC Trigger value for slightly disturbed ecosystems (SW Australia - Marine - Inshore)						-	-	-	-	-	-
Reference	**Sample**	**Sample No.**	**Replicat**	**Date**	**Type of Sample**	-	-	-	-	-	-
PEL1754	ST-01	01	0	29/12/2023	Water	1200	370	11000	6000	2.1	22000
PEL1754	ST-02	02	0	29/12/2023	Water	1200	380	11000	6100	1.9	22000
PEL1754	ST-03	03	0	29/12/2023	Water	1300	380	12000	6200	2.3	22000
PEL1754	ST-04	04	0	29/12/2023	Water	1200	380	12000	6100	1.6	22000
PEL1754	ST-05	05	0	29/12/2023	Water	1200	390	12000	6100	2.3	22000
PEL1754	ST-06	06	0	29/12/2023	Water	1300	390	12000	6200	2.2	23000
BFA0019	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-
BFA0022	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-
BFA0023	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-
BFA0031	ST-01	DUP1	1	29/12/2023	Water	-	-	-	-	-	-
BFA0081	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-
BFA0225	ST-01	DUP1	1	29/12/2023	Water	-	-	-	-	-	-

 # - Indicates this is the combined value of Chromium (Cr III) and Chromium CrVI

Water Quality Analytical Results - December 2023

						Inorganics - Ionic Balance and Indexes	Inorganics - Ionic Balance and Indexes	Inorganics - Ionic Balance and Indexes	Inorganics - Nutrients	Inorganics - Nutrients	Inorganics - Nutrients	Inorganics - Nutrients	Inorganics - Nutrients
						Anions as meq	Total Cations	Cations as meq	Ammonia as N	Nitrate as N	Nitrate as NO3 by calculation	Nitrite as N	Nitrite as NO2 by calculation
RptUnits						meq/L	mg/L	meq/L	mg/L	mg/L	mg/L	mg/L	mg/L
PQL						-	-	-	0.0050	0.0050	0.020	0.0050	0.020
Matrix						Water	Water	Water	Water	Water	Water	Water	Water
Method						Calc	Calc	Calc	INORG-057	INORG-055	INORG-055	INORG-055	INORG-055
Trigger values for Marine Water 99%						-	-	-	-	-	-	-	-
Groundwater Investigation level for Marine Water						-	-	-	-	-	-	-	-
ANZECC Trigger value for slightly disturbed ecosystems (SW Australia - Marine - Inshore)						-	-	-	-	-	-	-	-
Reference	**Sample**	**Sample No.**	**Replicat**	**Date**	**Type of Sample**	-	-	-	-	-	-	-	-
PEL1754	ST-01	01	0	29/12/2023	Water	600	13000	620	<0.0050	<0.0050	<0.020	<0.0050	<0.020
PEL1754	ST-02	02	0	29/12/2023	Water	610	13000	630	<0.0050	<0.0050	<0.020	<0.0050	<0.020
PEL1754	ST-03	03	0	29/12/2023	Water	610	14000	640	<0.0050	<0.0050	<0.020	<0.0050	<0.020
PEL1754	ST-04	04	0	29/12/2023	Water	610	14000	630	<0.0050	<0.0050	<0.020	<0.0050	<0.020
PEL1754	ST-05	05	0	29/12/2023	Water	610	14000	640	<0.0050	<0.0050	<0.020	<0.0050	<0.020
PEL1754	ST-06	06	0	29/12/2023	Water	610	14000	640	<0.0050	<0.0050	<0.020	<0.0050	<0.020
BFA0019	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-	-	-
BFA0022	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-	-	-
BFA0023	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-	-	-
BFA0031	ST-01	DUP1	1	29/12/2023	Water	-	-	-	<0.0050	<0.0050	-	<0.0050	-
BFA0081	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-	-	-
BFA0225	ST-01	DUP1	1	29/12/2023	Water	-	-	-	-	-	-	-	-

 # - Indicates this is the combined value of Chromium (Cr III) and Chromium CrVI)

Water Quality Analytical Results - December 2023

						Inorganics - Nutrients	Inorganics - Nutrients	Inorganics - Nutrients	Inorganics - Nutrients	Inorganics - Nutrients	Inorganics - Nutrients	Microbiological Suite	Microbiological Suite	Microbiological Suite
						NOx as N	TKN as N by calculation	Organic Nitrogen by calc.	Total Nitrogen	Phosphate as P	Chlorophyll a	Enterococci	Thermotolerant Coliforms	E.coli
RptUnits						mg/L	mg/L	mg/L	mg/L	mg/L	mg/m3	cfu/100mL	cfu/100mL	cfu/100mL
PQL						0.0050	0.10	0.10	0.10	0.0050	1.0	1	1	1
Matrix						Water	Water	Water	Water	Water	Water	Water	Water	Water
Method						INORG-055	Calc - TKN	Calc	INORG-127	INORG-060	INORG-119	MICRO-001DE	MICRO-001B	MICRO-001B
Trigger values for Marine Water 99%						-	-	-	-	-	-	-	-	-
Groundwater Investigation level for Marine Water						-	-	-	-	-	-	-	-	-
ANZECC Trigger value for slightly disturbed ecosystems (SW Australia - Marine - Inshore)						-	-	-	0.23	-	0.7	-	-	-
Reference	**Sample**	**Sample No.**	**Replicat**	**Date**	**Type of Sample**	-	-	-	-	-	-	-	-	-
PEL1754	ST-01	01	0	29/12/2023	Water	<0.0050	0.16	0.15	0.16	<0.0050	<1.0	1	1	<1
PEL1754	ST-02	02	0	29/12/2023	Water	<0.0050	0.12	0.12	0.12	<0.0050	<1.0	<1	<1	<1
PEL1754	ST-03	03	0	29/12/2023	Water	<0.0050	0.14	0.14	0.15	<0.0050	<1.0	<1	<1	<1
PEL1754	ST-04	04	0	29/12/2023	Water	<0.0050	0.13	0.12	0.13	<0.0050	<1.0	<1	1	1
PEL1754	ST-05	05	0	29/12/2023	Water	<0.0050	0.14	0.14	0.15	<0.0050	<1.0	<1	<1	<1
PEL1754	ST-06	06	0	29/12/2023	Water	<0.0050	0.15	0.15	0.15	<0.0050	<1.0	<1	<1	<1
BFA0019	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-	-	-	-
BFA0022	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-	-	-	-
BFA0023	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-	-	-	-
BFA0031	ST-01	DUP1	1	29/12/2023	Water	<0.0050	-	-	-	<0.0050	-	-	-	-
BFA0081	ST-01	DUP2	1	29/12/2023	Water	-	-	-	-	-	-	-	-	-
BFA0225	ST-01	DUP1	1	29/12/2023	Water	-	-	-	0.138	-	-	-	-	-

 # - Indicates this is the combined value of Chromium (Cr III) and Chromium CrVI

Water Quality Analytcal Results - January 2024

						Inorganics - Physical Parameters	Inorganics - Physical Parameters	Inorganics - Nutrients
						Total Dissolved Solids	Total Suspended Solids	Chlorophyll a
RptUnits						mg/L	mg/L	mg/m3
PQL						5.0	5.0	1.0
Matrix						Water	Water	Water
Method						INORG-018	INORG-019	INORG-119
Trigger values for Marine Water 99%						-	-	-
Groundwater Investigation level for Marine Water						-	-	-
ANZECC Trigger value for slightly disturbed ecosystems (SW Australia - Marine - Inshore)						-	-	0.7
Reference	**Sample**	**Sample No.**	**Replicate**	**Date Sampled**	**Type of Sample**	-	-	-
PFA1208	ST-01	01	0	23/01/2024	Water	41000	<5.0	<1.0
PFA1208	ST-02	02	0	23/01/2024	Water	49000	<5.0	<1.0
PFA1208	ST-03	03	0	23/01/2024	Water	41000	<5.0	<1.0
PFA1208	ST-04	04	0	23/01/2024	Water	41000	<5.0	<1.0
PFA1208	ST-05	05	0	23/01/2024	Water	41000	<5.0	<1.0
PFA1208	ST-06	06	0	23/01/2024	Water	41000	<5.0	<1.0
BFA2535	ST-06	DUP1	1	23/01/2024	Water	40600	-	-
BFA2536	ST-06	DUP1	1	23/01/2024	Water	-	<5.0	-

REPORT

Appendix H
SAP implementation report, Rottnest Island Army Jetty dredging (RPS 2020)

SAP IMPLEMENTATION REPORT

ROTTNEST ISLAND ARMY JETTY DREDGING

EEC19032.011
SAP Implementation Report
Rev 0
11 May 2020

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Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
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Rev 0	Final for Issue	AlaFol	ColCor	ColCor	11/05/2020

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Alan Foley		11/05/2020

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Contents

EXECUTIVE SUMMARY **1**

1 BACKGROUND **4**
1.1 Introduction 4
1.2 Purpose of the Report 4
1.3 Objectives 5

2 SITE DESCRIPTION AND HISTORY **6**
2.1 Site Identification and Regional Setting 6
2.2 Site and Surrounding Land uses 7
2.2.1 Marine Uses 7
2.2.2 Terrestrial Land Uses 7
2.3 Proposed Development 7
2.4 Dredging Requirements 8
2.5 Dredge History 8
2.6 Site Description 8
2.7 Site History 9
2.7.1 Historical Photography 11
2.8 Previous Investigations 11
2.8.1 Factual Report on Site Investigation 2012 11
2.8.2 Thomson Bay Habitat Survey 2019 12
2.9 Contaminated Sites 12
2.10 Unexploded Ordinance 12
2.11 Contaminants of Potential Concern 13

3 PRELIMINARY CONCEPTUAL SITE MODEL **15**

4 SAMPLING AND ANALYSIS PLAN **16**
4.1 Sampling Objectives 16
4.2 Guidelines 16
4.3 Sediment Sampling Locations and Frequency 16
4.4 Sediment Sampling Methodology 17
4.4.1 UXO Survey 17
4.4.2 Overview 17
4.4.3 Sampling Intervals 17
4.5 Assessment Levels 17
4.5.1 Reuse 17
4.5.2 Dredging and Disposal 19
4.5.3 Surface Water and Elutriate 19
4.5.4 Australian Standard Leachate Procedure 20
4.6 Variations to the Sampling and Analysis Plan 20

5 HEALTH AND SAFETY **22**

6 RESULTS **23**
6.1 Sediments 23
6.1.1 Profile Description 23
6.1.2 Particle Distribution 23
6.1.3 Onshore Reuse Results 23
6.1.4 Offshore Disposal 25
6.1.5 Elutriate Analysis 26
6.2 Surface Water 27
6.2.1 PFAS 27

7 RISK ASSESSMENT **28**

7.1 Contaminants Identified 28
7.2 Revised Conceptual Site Model 28
7.3 Human Health Risk Assessment....28
7.4 Environmental Risk Assessment....28
7.4.1 Contaminant Leaching from Sediments 28

8 CONCLUSIONS AND RECOMMENDATIONS 30
8.1 Summary of Findings 30
8.2 Suitability for Use and Recommendations 31
8.3 Assumptions and Uncertainties....31

9 REFERENCES 33

Tables

(contained within the report text)

Table 1: Site Summary 6
Table 2: Site Description....9
Table 3: Historic Photography Summary....11
Table 4: Preliminary Conceptual Site Model Overview – Dredging and Onshore Reuse 15
Table 5: DWER ASS Management Action Criteria....19
Table 6: ASS results summary 25
Table 7: Revised Conceptual Site Model 28

(compiled at the end of the report)

Table A Sediment Analytical Results - Particle Size Distribution
Table B Sediment Analytical Results - Metals, Metalloids, Inorganics and Nutrients - Onshore Reuse
Table C Sediment Analytical Results - PAHs - Onshore Reuse
Table D Sediment Analytical Results - TRH and BTEX - Onshore Reuse
Table E Sediment Analytical Results - OC/OP Pesticides - Onshore Reuse
Table F Sediment Analytical Results - PFAS - Onshore Reuse
Table G Sediment Analytical Results - Explosives - Onshore Reuse
Table H Sediment Analytical Results - Acid Sulfate Soil Results
Table I Sediment Analytical Results - Metals, Metalloids, Inorganics and Nutrients - Dredging/Offshore Disposal
Table J Sediment Analytical Results - Sediment Analytical Results - PAHs - Dredging/Offshore Disposal
Table K Sediment Analytical Results - TRH and BTEX - Dredging/Offshore Disposal
Table L Sediment Analytical Results - OC/OP Pesticides - Dredging/Offshore Disposal
Table M Sediment Analytical Results - PFAS - Dredging/Offshore Disposal
Table N Sediment Analytical Results - Explosives - Dredging/Offshore Disposal
Table O Elutriate Analytical Results - Metals, Metalloids and Nutrients
Table P Elutriate Analytical Results - PFAS

Plates

Plate 1 *Zephyr* ported at the ‘excursionist jetty’, 1924 (RIA 2012.239) 10
Plate 2 ‘Excursionist jetty’, 1930 (RIA 2012.96) 10
Plate 3 Original timber jetty with gantry on the right, facing west (RIA 2012.265) 10
Plate 4 Original timber jetty facing west to shore (National Archives Australia (NAA))....10
Plate 5 Reconstruction works, 1971 (NAA) 11
Plate 6 Reconstruction works, rockfill and barge hardstand (NAA) 11

Figures

(contained within the report text)

Figure 1 Indicative Concept Design.....8
Figure 2 Unexploded Ordinance Mapping.....13

(compiled at the end of the report)

Figure A Site location
Figure B Development area – Proposed barge ramp and cargo handling facilities
Figure C Seagrass mapping and bathymetry
Figure D Sampling locations and proposed dredge design

Appendices

Appendix A Sediment Sampling Logs
Appendix B Laboratory Reporting
Appendix C Quality Control and Assurance Evaluation

EXECUTIVE SUMMARY

The Rottnest Island Authority (RIA) proposes the Thomson Bay South Development Project, situated around the former Army Jetty on Rottnest Island ("the site"), approximately 30 km west of Perth, Western Australia (Figure A). The development project is to:

- facilitate increasing demand for commercial marine services arising from planned infrastructure works
- manage barge and logistical movement away from the settlement areas
- improve visitor experience and reduce safety risk

The project forms part of the 20-year master plan for Rottnest Island (RIA, 2014a). As part of the revised proposed works (April 2020), approximately 26,300 m^3 of material is required to be dredged, i.e. capital dredging, to a depth of -3.3 m Chart Datum (CD) (with an additional over dredge allowance of 0.3 m and volume of ~5,300 m^3) in the vicinity of the former army jetty. The dredged sediments are proposed to be reused onshore for fill requirements as part of the development or as potential capping to the old landfill on the island at Forbes Hill.

Given the historical use of the area and jetty, i.e. historical army operations, there remains the potential for contamination to be present in the sediments proposed to be dredged. The contamination may pose a risk to the surrounding marine environment during capital dredging and potentially pose a risk to human health and or the environment when reused as fill.

As such RIA has requested RPS Australia West Pty Ltd (RPS) to undertake a contamination assessment of the sediments to determine:

- the current contamination status of the sediment, and
- whether any contamination within the site will adversely affect the environment or pose a risk to human health during dredging, and
- the suitability of the material for reuse on the island as fill as part of the development works.

A Sampling and Analysis Plan (RPS, July 2019) was prepared to detail methodologies for proposed sampling and testing of sediments, from an environmental perspective only, proposed to be dredged at the former Army Jetty for the Thomson Bay South Development Project. The SAP was approved by the Department of Biodiversity, Conservation and Attractions (DBCA) and Department of Water and Environmental Regulation (DWER) in August 2019

This SAP Implementation Report (SAPIR) details the findings of the sampling and analysis undertaken on the sediments and has been prepared to support the Section 38 referral under the *Environmental Protection Act 1986* to the Western Australian Office of the Environmental Protection Agency (OEPA).

This SAP Implementation Report relates specifically to sediment quality results proposed to be dredged and reused onshore as part of the Thomson Bay South Development Project, situated around the former Army Jetty on Rottnest Island.

This Summary Report has been prepared in general accordance with the procedures outlined in the DWER (DWER 2014) Contaminated Sites Guidelines.

A total of seven sediment cores were aligned to the proposed dredging requirements to a maximum depth of 1.2 m. Sediments were analysed for the contaminants of concern identified, including metals and metalloids, ASS parameters, OC/OP pesticides, PAHs, nutrients, PFAS and TRH/BTEX with elutriates analysed for metals, nutrients and PFAS. Due to PFAS elutriates from November 2019 being contaminated within the laboratory during the analysis, the results were not considered usable, the sediment sampling exercise for PFAS was therefore completed again in March 2020. Surface water was also sampled within the marine environment and analysed for PFAS during the March 2020 exercise.

RPS notes that the whilst the revised proposed works (16 April 2020) has resulted in an increased dredging volume, which would require additional sampling locations under the *National Assessment Guidelines for Dredging* (Commonwealth of Australia, 2009), the sampling undertaken is considered sufficient to characterise the sediments in the area and thus remains valid, based upon the following:

- the main dredge area (~1.2 ha) remains relatively consistent with the previous area (~1.3 ha),
- the increase in the area relates to dredging (0.6 ha) beneath the proposed breakwater and is further offshore and therefore less likely to have been impacted by onshore activities
- whilst the depth of dredging has increased, contamination is more likely to be associated with the shallow sediments rather than at depth.

The assessment concluded that from contamination perspective the sediments are suitable for reuse onshore for reclamation, with all results below the following assessment criteria:

- Ecological Investigation Levels (EILs) and Ecological Screening Levels (ESLs) for areas of ecological significance and public open space (NEPM 2013)
- Health Investigation Levels for residential soil access (HIL-A) (NEPM 2013 and CRC CARE 2011).

All results were reported below relevant Default Guideline Value (DGV) and the sediments are not considered to pose a significant risk during dredging and are considered suitable for offshore disposal.

Only one sediment is classified Potential Acid Sulfate Soils (PASS), based upon the DWER guidelines, i.e. Acid Neutralising Capacity (ANC) is not included, with only inorganic acidity detected. Although there is inorganic acidity detected above the relevant guidelines, there is a significant amount of ANC in the sediments which has been shown to be kinetically available through undertaking a modified ANC method. As such additional lime treatment of the material is not required when the sediment is disturbed and used for reclamation activities. The ANC is sufficiently kinetically available to safeguard against acidification over the long term.

Whilst concentrations of metals within the elutriate for several metals were higher than those in Indian Ocean water (used in the elutriate analysis), the majority of the results were below the Marine Ecological Protection Guideline. Nutrient concentrations were also higher in the elutriate. Whilst a minor exceedance of the PFOS[1] guideline was observed in one elutriate sample, the concentration was below the highest concentration observed in surface water at the site and the mean and median concentrations of PFOS in the elutriates at the site were below the 99% protection level Marine Ecological Protection Guideline.

The copper concentrations identified in the sediments do not pose a potential risk to human health or the environment when considered for reuse onshore as all concentrations were below relevant criteria, however there is a potential risk to the marine environment during dredging. Copper was observed above relevant MEPG within the elutriates however the exceedance was minimal, and the concentrations are likely associated with sediments suspended in the elutriate.

The increase was not considered significant due to the following:

- Copper concentrations were significantly below the DGV. The natural movement of sediments within the ocean would also likely result in a release of metals similar to that observed in the elutriate.
- The majority of the metals present are likely bound to sediments, thus reducing bioavailability. Controlling the distribution of sediments, via silt curtains, and within dredge return water would further reduce any potential risk to marine ecology.

[1] PFOS: Perfluorooctane sulfonic acid

The nutrient concentrations identified in the sediments pose a low and acceptable risk to human health or the environment when considered for reuse onshore. Nutrient concentrations were observed to increase within the elutriate analysis. As per the metal results, the nutrients in the form of organic matter would be bound to sediments. Therefore, the potential risk from elevated nutrients in the dredge return can be removed by reducing the sediment loading in the return water. Additionally, similar concentrations would be anticipated to elute from sediments naturally disturbed in the marine environment.

PFOS concentrations were observed within one PFOS elutriate analysis however PFOS was also observed in the surface water at the site, indicating the presence of low level PFOS within the existing environment. In addition, only very low concentrations of PFOS were observed in sediments. Given the very low concentrations of PFOS observed in the elutriates, it is expected that the concentrations would be diluted quickly within the marine environment during the works. As such the concentrations would reduce to further below the concentrations observed within the marine waters of the surrounding environment and thereby not changing the risk profile currently presented by marine waters to the surrounding environment. Additionally, the detectable PFOS concentration was within the surface sediment, which has the potential to be mobilised and elute during ongoing natural marine processes onsite i.e. tidal movement or storm events.

Based upon the observed concentrations, there is a low and acceptable risk to human health or the environment from the sediments or surface water during dredging or upon development of the site using the sediments for reclamation. As such the sediments from contamination perspective are determined to be suitable for reuse onshore for reclamation. Additionally, the sediments do not require additional lime treatment once disturbed from an ASS perspective and used for reclamation activities, as the ANC is considered to be sufficiently kinetically available to safeguard against acidification over the long term. No surface water monitoring for PFAS is considered to be required.

Should offshore disposal be considered then as all results were reported below relevant DGV and the sediments do not pose a significant risk during dredging and or if were proposed for offshore disposal.

1 BACKGROUND

1.1 Introduction

The Rottnest Island Authority (RIA) proposes the Thomson Bay South Development Project, situated around the former Army Jetty on Rottnest Island ("the site"), approximately 30 km west of Perth, Western Australia (Figure A). The development project is to:

- facilitate increasing demand for commercial marine services arising from planned infrastructure works
- manage barge and logistical movement away from the settlement areas
- improve visitor experience and reduce safety risk

The project forms part of the 20-year master plan for Rottnest Island (RIA, 2014a). As part of the revised proposed works (April 2020), approximately 26,300 m^3 of material is required to be dredged, i.e. capital dredging, to a depth of -3.3 m Chart Datum (CD) (with an additional over dredge allowance of 0.3 m and volume of ~5,300 m^3) in the vicinity of the former army jetty. The dredged sediments are proposed to be reused onshore for fill requirements as part of the development or as potential capping to the old landfill on the island at Forbes Hill.

Given the historical use of the area and jetty, i.e. historical army operations, there remains the potential for contamination to be present in the sediments proposed to be dredged. The contamination may pose a risk to the surrounding marine environment during capital dredging and potentially pose a risk to human health and or the environment when reused as fill.

As such RIA has requested RPS Australia West Pty Ltd (RPS) to undertake a contamination assessment of the sediments to determine:

- the current contamination status of the sediment,
- whether any contamination within the site will adversely affect the environment or pose a risk to human health during dredging, and
- the suitability of the material for reuse on the island as fill as part of the development works.

A Sampling and Analysis Plan (RPS, July 2019) was prepared to detail methodologies for proposed sampling and testing of sediments, from an environmental perspective only, proposed to be dredged at the former Army Jetty for the Thomson Bay South Development Project. The SAP was approved by the Department of Biodiversity, Conservation and Attractions (DBCA) and Department of Water and Environmental Regulation (DWER) in August 2019.

This SAP Implementation Report (SAPIR) details the findings of the sampling and analysis undertaken on the sediments and has been prepared to support the Section 38 referral under the *Environmental Protection Act 1986* to the Western Australian Office of the Environmental Protection Agency (OEPA).

1.2 Purpose of the Report

A Sampling and Analysis Plan (SAP) (RPS, July 2019) was prepared to detail methodologies for the sampling and testing of sediments, (from an environmental / Contaminated Sites Act perspective only), within the proposed former Army Jetty dredge areas.

The dredged sediments are proposed to be reused onshore for fill requirements as part of the development or as potential capping to the old landfill on the island at Forbes Hill.

The SAP was prepared in general accordance with the *National Assessment Guidelines for Dredging* (NAGD) (Commonwealth of Australian, 2009) and Department of Water and Environmental Regulation (DWER, formerly the Department of Environment Regulation) Contaminated Sites Guidelines (DWER, 2014).

This SAP Implementation Report relates specifically to sediment quality results proposed to be dredged from around the former Rottnest Island Army Jetty and reused onshore as part of the development derived proposal.

This Summary Report has been prepared in general accordance with the procedures outlined in the DWER (DWER, 2014) Contaminated Sites Guidelines.

1.3 Objectives

The objectives of the investigation are to:

- Determine the quality of sediment proposed to be dredged from the development.
- Determine whether any contamination within the site will adversely affect the environment during dredging.
- Determine whether the sediments are suitable for reclamation reuse.

2 SITE DESCRIPTION AND HISTORY

2.1 Site Identification and Regional Setting

A detailed site summary is provided in Table 1. The site locality is provided in Figure A, while Figure B provides a site plan detailing the layout of various features of the site.

Table 1: Site Summary

Reference Name	Rottnest Island Army Jetty		
Address	Army Jetty Road, Rottnest Island		
Certificate of Title	**Lot on Plan Address – Volume/Folio**		
	P216860 10976[2]		
Local Government Authority	City of Cockburn / Rottnest Island Authority		
Current Zoning	Terrestrial: no zoning. Marine: A-class marine reserve		
Area, Elevation and Bathymetry	**Area**	**Land elevation**	**Bathymetry**
	2 ha	3 to 5 m AHD	0.0 to -4.0 m Chart Datum (m CD)
Site Location	Figure A		
Site Layout and References	Figure B		
General Coordinates of Site Area	**Reference Point**	**Easting**	**Northing**
	North-east	363.200	6,458,600
	North-west	362,950	6,458,600
	South-west	362,950	6,458,300
	South-east	363,200	6,458,300

1. Landgate (2020) indicates the entire island is located within Lot 10976 on Plan 216860

Thomson Bay, on Rottnest Island, is host to the following existing facilities, generally located between the main jetty and the Army Jetty:

- An anchorage area located east of the Army Jetty
- Over 200 private mooring locations
- 25 hire mooring locations
- 55 jetty boat pens (free, for hire, and not for public use)
- One local beach pen
- Wadjemup public walking trail running along the coast

[2] Landgate (2019) indicates the entire island is located within Lot 10976 on Plan 216860.

- Public toilets and an undercover seating area located adjacent the Army Jetty and beach area
- Snorkelling locations, in particular at the shipwreck of Uribes to the east.

2.2 Site and Surrounding Land uses

The existing marine and onshore land uses within and immediately adjacent to the project area include marine and terrestrial elements.

2.2.1 Marine Uses

- Recreational Use
- Marine sanctuary zone, located north (Prohibition on Fishing (Rottnest Island) Order 2007, *Fish Resources Management Act 1994*)
- Two wooden finger jetties
- Boat moorings
- Snorkelling areas
- Terrestrial Land Uses.

2.2.2 Terrestrial Land Uses

- Recreational use
- Kingstown Barracks, located southeast
- Solar farm, located southwest
- Rottnest Island airport, located southwest
- Tourist accommodations, located west

2.3 Proposed Development

A summary of the proposed development (based upon a revised concept in April 2020) is presented below and Figure B:

- Construction of a 10 m wide barge ramp immediately east of the existing army groyne.
- Development of the area (up to 10,000 m^2) immediately behind and either side of the barge ramp as a lay down hardstand area.
- Construction of an undercover storage area (200 m^2) on the lay down area.
- Fuelling facilities for small vessels including a fuel tank within lay down area.
- Repairs of the rock armour (breakwater) over the existing army groyne and a 100 m extension, with a 40 m concrete deck on steel piles (contingency ferry jetty).
- Construction of a ~80 m beach groyne on the eastern side of the lay down area.
- Area within the groynes is approximately 1.3 ha.
- Imported limestone rock material (approximately 14,300 m^3) for the construction of the groynes

- dredging requirements:
  - dredge area accounting for potential overdredge: ~1.8 ha (includes dredging under the proposed breakwaters).
  - dredge volume at design CD -3.3 m including batters (1:5): ~21,000 m^3
  - overdredge volume at nominal CD -3.6 m including batters (1:5): up to 5,300 m^3
- dredged material is proposed to be reused for:
  - laydown area and volume of dredge spoil used: about 17,700 m^3
  - remaining dredge spoil for disposal over designated location elsewhere on the Island: up to 3,300 m^3
  - overdredge spoil for disposal over designated location elsewhere on the Island: up to 5,300 m^3

An indicative concept design is presented in Figure 1 below:

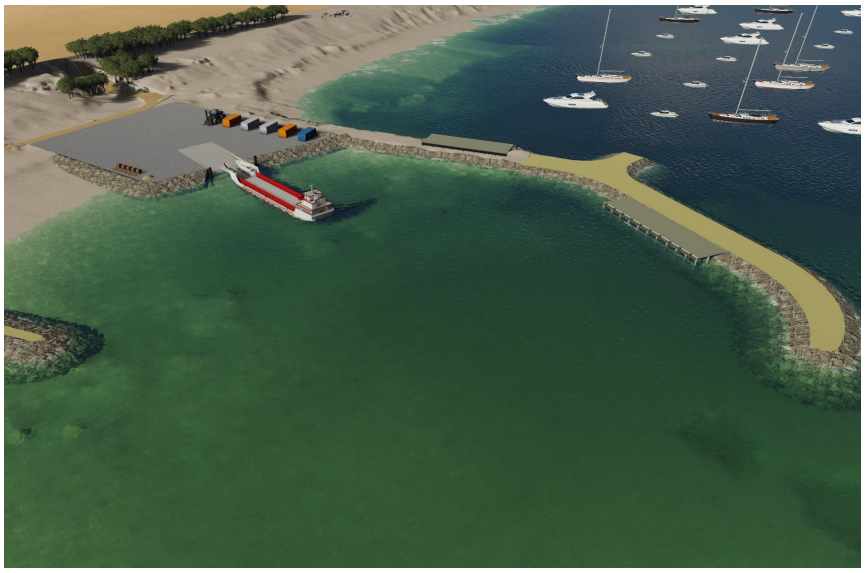

Figure 1 Indicative Concept Design

2.4 Dredging Requirements

At the time of sampling (November 2019 and March 2020) an estimated 11,000 m^3 of sediment was proposed to be dredged, to a depth of -3 m CD. There was the potential for overdredging to occur to a depth of -3.3 m CD which equated up to an additional 5,000 m^3.

The revised proposed works (16 April 2020) estimates approximately 26,300 m^3 of material is required to be dredged, i.e. capital dredging, to a depth of -3.3 m Chart Datum (CD) (with an additional over dredge allowance of 0.3 m and volume of ~5,300 m^3).

2.5 Dredge History

No known dredging has occurred in Thomson Bay in the vicinity of the Army Jetty.

2.6 Site Description

Table 2 presents a summary of the bathymetry, geology, wetlands and marine flora and fauna of the area surrounding the subject site.

Table 2: Site Description

Element	Comments
Protected Areas	Rottnest Island is a Class A Reserve govern by the *Rottnest Island Authority Act 1987* (www.ria.wa.gov.au). The marine and terrestrial environments are protected for both recreation and conservation. All flora, fauna and landforms are protected for both purposes of conservation and recreation. The site is located within this protection zone which includes the entire Island which measures 11 km by 4.5 km at its widest point and about 1,900 hectares in area and the surrounding marine environment (www.rottnestisland.com).
Topography and Bathymetry	The topography of the foreshore adjacent to the Army Jetty is approximately 3 to 5 m AHD. The bathymetry of the marine footprint of the site ranges between approximately 0.0 to -4.0 m CD. Bathymetry contours are provided in Figure C.
Regional Geology	Regional geological mapping at 1:50,000 scale (Department of Mines, Industry Regulation and Safety, 2020) indicates that the site geology consists of S17 sand: white medium-grained, well-sorted, sub-angular quartz and shell debris, locally shelly and lithoclastic.
Acid Sulfate Soil Mapping	The site is not considered an ASS risk, however less than 500 m south of the site, Bickley Swamp was identified as an area of high to moderate risk of ASS occurring within three metres of natural soil surface. The lake formations to the east and northeast have also been identified as an ASS risk (www.nationalmap.gov.au).
Groundwater Quality	Salinity is found to fluctuate seasonally in response to groundwater abstraction and rainfall recharge, with values ranging between approximately 450 and 900 mg/L. Saltwater intrusion may result where over-pumping occurs. According to the RIA, Rottnest Island is experiencing an increasing salinity in some bores of the Wadjemup Aquifer (RIA, 2014b).
Wetlands	No wetlands are located within the site. Multiple wetlands were identified on the Directory of Important Wetlands of Australia (DIWA), referred to as "*Rottnest Island Lakes*", which incorporate 18 lakes and swamps in total, including Bickley Swamp (200 m south of site) and Government House Lake (<1 km west of site). The wetland is classed as a *Wetland of National Importance* and combines inland wetlands of permanent saline/brackish lakes, seasonal saline lakes, and seasonal saline marshes (DoEE, 2019a).
Regional Benthic Habitats	According to the Thomson Bay Habitat Survey (RPS, April 2019), Thomson Bay supports approximately 119 ha of seagrass meadows, *Posidonia* species most commonly found. Bare sand and sand with wrack habitat also occupies a substantial area. An area was also identified to be dominated by macroalgae.
Regional Fauna	Rottnest Island provides habitat to a range of fauna species, including several species listed as conservation significant under State and Commonwealth legislation. Two endemic mammals are found on Rottnest Island, the Quokka and the White-Striped Free-tail Bat. The island also provides habitat to numerous migratory and resident shorebird and bushbird species and has a listing of "*Important Bird Area*" (BirdLife International, 2019). Morphologically unique frogs and genetically distinct reptiles also habitat the island. Marine fauna consists of 135 tropical fish species, as well as dolphins, sea lions and migratory whales (Government of WA, 2018).
Threatened Ecological Communities	No Threaten Ecological Communities (TECs) are located within the site however *Melaleuca lanceolate* stands listed as a TEC is located approximately 150 m south of the site (NatureMap 2019).

2.7 Site History

The following site history has been sourced from *Maritime Archaeological Assessment of the Army Jetty Thompson Bay, Rottnest Island* (Department of Maritime Archaeology, Western Australian Museum, 2012).

The Thomson Bay South Development Project covers the former the Army Jetty, an integral part of the Island's military and recreational heritage. The original Army Jetty was built in 1906 and was used as a terminal for passengers arriving and departing the island, then referred to as the "excursionist jetty". The jetty was constructed to allow for horse-drawn trams to take passengers into Thomson Bay settlement and was the first public jetty on the island.

Plate 1 *Zephyr* ported at the 'excursionist jetty', 1924 (RIA 2012.239)

Plate 2 'Excursionist jetty', 1930 (RIA 2012.96)

From 1914 to 1915, during World War I (WWI), the Island was run by the military and all tourist activities ceased. The jetty, henceforth dubbed the "Army Jetty", was used to unload troops and supplies, however was predominantly used for prisoner transport to shore as the island was utilised as a Prisoner of War Camp. Following WWI the island was reopened to the public and the jetty returned to its original use.

The return of war, World War II (WWII), in the 1930's meant areas of the island were once again utilised for military activities. The island was developed as the primary defence for Fremantle and Perth by 1937, with works including the reinforcing and extension of the Army Jetty and a gantry being constructed just off the south end of the jetty. During 1924 and 1945 the island was only used as a military base, with all recreational use ceased. The Army Jetty provided troop and provision movements to and from the island. In 1942 the jetty was further extended to allow for larger vessel access.

Plate 3 Original timber jetty with gantry on the right, facing west (RIA 2012.265)

Plate 4 Original timber jetty facing west to shore (National Archives Australia (NAA))

The end of WWII in 1945 returned the jetty to its primary tourist use until 1961, when the main jetty was built closer to the settlement. In 1969 the Army inspected the jetty and observed the jetty to be in poor condition, with vehicle access being banned. In 1970, plans were in place to demolish the original structure and reconstruct the jetty with rock fill and compacted limestone base, inclusive of a barge hardstand ramp. In 1972 the demolition and reconstruction had occurred. In 1984 all Army land holdings and buildings were bought back by the State Government and the jetty remained for recreational uses such as snorkelling and fishing, however no boats were to dock along the jetty platform due to its fragility.

Plate 5 Reconstruction works, 1971 (NAA)

Plate 6 Reconstruction works, rockfill and barge hardstand (NAA)

It was observed in National Archives of Australia (NAA) and the State Library of Western Australia literature that much of the old materials were buried beneath the subsequent extensions of the rock fill. The structure was inspected by the Western Australia Maritime in 2012 and the jetty was measured at 120 m length and 1,700 m in area. In October 2018, the jetty underwent platform removal and conversion into a rock groyne as a result of a partial collapse.

2.7.1 Historical Photography

A review of online historic aerial photography held by Landgate was undertaken which yielded limited aerials of the site dating back to 2000. The historic development activities of the site and surrounds are summarised in Table 3.

Table 3: Historic Photography Summary

Year	Site and Surrounding Area
2000	Site: The site is already developed with the former Army Jetty. Minor infrastructure appears to be located immediately south of the jetty. Multiple tracks and trails are identified surrounding the site. Southeast: Kingstown Barracks. South: Bickley Swamp and Rottnest Island aerodrome. West: Rottnest Island Lakes and the main settlement and tourist hub.
2002	Site: Infrastructure has been constructed adjacent to the southwest of the jetty, identified as public toilets and an undercover seating area.
2004	Site: The minor infrastructure to the south has been removed.
2017	West: The presence of a solar farm is observed 400 m from the site.

2.8 Previous Investigations

2.8.1 Factual Report on Site Investigation 2012

An investigation was undertaken by Douglas Partners Pty Ltd (DP, 2012), located in the area off the northern end former Army Jetty. The investigation area was approximately 150 m from the island shoreline and was limited to approximately 200 m by 380 m in size. Works undertaken in this investigation were generally further off-shore (approximately -2 to -4 m CD) than the proposed dredging area for the site.

Field work undertaken included limited jet probing to determine the presence or absence of cemented material or rock, to a maximum depth of 8.0 m below seabed.

The seabed conditions encountered generally comprised light grey/off-white, fine to medium grained sand covered by week and in place, fragments of rock. No limestone outcrops, including pinnacles were observed. Refusal on rock, inferred to be limestone occurred at varying depths between 0.5 m and 6.1 m from the seabed.

2.8.2 Thomson Bay Habitat Survey 2019

The assessment was undertaken by RPS (RPS, April 2019) to establish a preliminary assessment of the environmental impacts associated with the proposed development. These are primarily associated with impacts of dredging and development footprints on benthic marine communities and habitats (BCH), in particular the seagrass meadows that dominate Thomson Bay and comprise approximately 30% of the total seagrass area around Rottnest Island.

The benthic habitat map developed identified the distribution of seagrass in the vicinity of the proposed development and more broadly across southern Thomson Bay and found that the relative cover of the different habitat types confirms the dominance of seagrass, in particular Posidonia spp. 'Bare' sand habitat also occupies a substantial part of the area, and the presence of mobile wrack over sand was observed by way of aerial imaging comparison. The habitat also indicates an area dominated by macroalgae in the southeast, and mixed seagrass and algae in a broad area to the north.

As a consequence of the proposed development activities, a total of 1.9 ha of irreversible loss of seagrass was estimated and represents a 0.35% cumulative loss of seagrass habitat.

General seagrass mapping is found on Figure C.

2.9 Contaminated Sites

A search of the DWER Contaminated Sites online database was completed, however the site was not classified as any of the following under the *Contaminated Sites Act 2003*:

- Remediated Restricted Use
- Contaminated Restricted Use
- Contaminated Remediation Required.

A search of the surrounding land indicated that there was one contaminated site, within the above classifications, within a 2 km radius of the site. The contaminated site is located approximately 1.25 km west of the site and classified as '*remediated for restricted use*', known as Subject A on Deposited Plan 72329 (BSR 39676. Classification is due to a diesel leak from an underground storage tank (UST), impacting the local groundwater. Subject A is managed in accordance with *Rottnest Island Management Plan* as required by the *Rottnest Island Authority Act 1987*. Subject A has been deemed suitable for public open space, however is not suited to construction of enclosed buildings. As Subject A is located at an appreciable distance from the site and the BSR 39676 has identified that Thomson Bay has not been impacted, as such the presence of this registered contaminated site is not considered to pose a potential risk to the subject site.

2.10 Unexploded Ordinance

Department of Defence (http://www.defence.gov.au/UXO/Where/MapAppInfo.asp) indicates Rottnest Island as having a "slight occurrence" of unexploded ordinances (UXO) (Figure 2) with the following description; *Rottnest Island was used as an impact, training and storage area for artillery shells, mortar bombs, underwater demolition exercises, unexploded depth charges and aerial bombing at sea*.

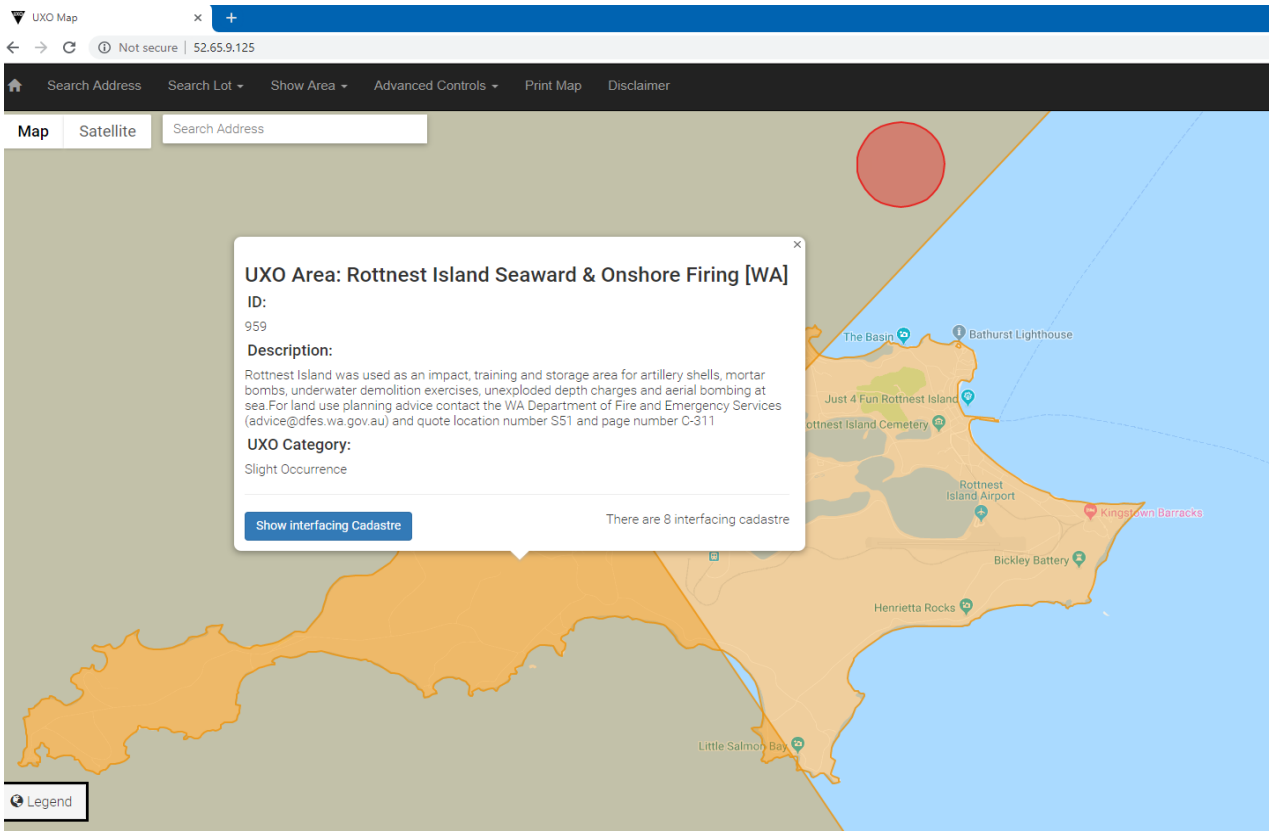

Figure 2 Unexploded Ordinance Mapping

2.11 Contaminants of Potential Concern

With reference to the activities identified within the DWER *Contaminated Sites Management Series, Assessment and Management of Contaminated Sites* (DWER, 2014) the following surrounding site activities were considered potential sources of contamination:

- port/wharf/dock activities
- Defence works and Defence establishments
- UXOs

Based upon the aforementioned surrounding site activities, the following potential contaminants of concern (PCoC) have been identified:

- metals (Ag, Cd, Se, Co, Sb, Cu, Pb, Zn, Cr, Ni, As, V, Mn and Hg)
- organochlorine and organophosphate (OC/OP) pesticides
- total recoverable hydrocarbons (TRH)
- benzene, toluene, ethyl benzene and xylenes (BTEX)
- polycyclic aromatic hydrocarbons (PAHs)
- asbestos fibres
- Tributyl Tin (TBT).

- Nutrients – Total nitrogen, ammonia, nitrate, nitrite, total phosphorus and reactive phosphorus.
- Per- and poly-fluoroalkyl substances (PFAS)
- Explosives.

Whilst PFAS is identified as PCoC, the potential for significant use at the Barracks is considered unlikely based upon the following:

- the island was essentially only used for training exercises post WWII,
- given the location of the site, i.e. off the mainland, it is considered unlikely that significant training operations with firefighting foams would have been undertaken on the island,
- firefighting training for Defence personal was undertaken at other facilities in Perth including Garden Island and RAAF Base Pearce, with army training likely undertaken at Campbell, Irwin and Leeuwin Barracks and or the Bindoon training area.
- the barracks were handed over to the state in 1984, essentially ending military operations on the island,
- vessels were not allowed to dock at the jetty,
- firefighting foams containing PFAS (PFOS and PFOA) entered use in the Department of Defence in the 1970s (Department of Defence, https://www.defence.gov.au/environment/pfas/).

3 PRELIMINARY CONCEPTUAL SITE MODEL

Consistent with *National Environment Protection (Assessment of Site Contamination) Measure* (NEPM, 2013), a preliminary overarching conceptual site model (CSM) has been developed for the site. The CSM has been developed based upon the proposed dredging and onshore disposal of the reclamation sediments.

RPS has adopted a risk-based approach to the assessment of the site. An important thread throughout the overall process of risk assessment is the need to formulate and develop a conceptual model, which supports the identification and assessment of pollutant linkages. A CSM represents the characteristics of the site in a diagrammatic or written form that shows the possible relationships between contaminants, pathways and receptors (pollutant linkages). In this context, the following definitions apply:

- A **contaminant source** – a substance that is in, on or under the land and has the potential to cause harm to human health or the environment, or cause pollution of controlled waters.
- A **pathway** – a route or means by which a receptor can be exposed to, or affected by, a contaminant.
- A **receptor** – in general terms, something that could be adversely affected by a contaminant, such as people, an ecological system, property, or a water body.

Each of these elements can exist independently, however they create a risk only in instances where a plausible linkage exists, such that a particular contaminant may affects a particular receptor through a particular pathway; referred as a pollutant linkage.

The preliminary CSM for the site is presented below in Table 4.

Table 4: Preliminary Conceptual Site Model Overview – Dredging and Onshore Reuse

Source	Potential Pathway	Receptor
Human Health		
Surface Water	Dermal contact of surface water	Future/current site users/workers
	Bioaccumulation and biomagnification in the food chain	Future recreational fishing
Sediments	Dermal contact of sediments (during dredging and following onshore reuse)	Future/current site users/workers
	Vapour inhalation (following onshore reuse)	Future site users
	Dust inhalation (following onshore reuse)	Future/current site users Site construction workers Off-site residents
	Leaching to groundwater/surface water (following onshore reuse)	Off-site groundwater users Site groundwater users On and Off-site surface water users Site construction workers
Ecological		
Sediment	Leaching (from sediment to surface water and or groundwater)	Aquatic flora and fauna Terrestrial flora and fauna
	Sediment ingestion/dermal contact	
	Bioaccumulation and biomagnification in the food chain	
Surface Water	Direct contact and ingestion after leaching from sediment to surface water	
	Bioaccumulation and biomagnification in the food chain	
	Direct contact and ingestion	

4 SAMPLING AND ANALYSIS PLAN

4.1 Sampling Objectives

The objectives of the sediment sampling program were to assess the presence and nature of potential sediment contamination identified in Section 2.10, identify if any management measures are required to protect relevant receptors during the proposed dredging works and whether the material suitable to be used in reclamation works.

4.2 Guidelines

Sampling and analysis were undertaken with reference to the following documents:

- *National Assessment Guidelines for Dredging* (NAGD). Commonwealth of Australian, 2009.
- *Handbook for Sediment Quality Assessment*. CSIRO, Bangor, NSW. (Simpson et al. 2005)
- *National Environment Protection (Assessment of Site Contamination) Measure.* National Environmental Protection Council. 1999, as amended 2013 (NEPM, 2013)
- *PFAS National Environmental Management Plan* (NEMP). January 2018 (HEPA, 2018[3]).
- *Assessment and Management of Contaminated Sites*. Department of Environment Regulation, 2014 (DWER, 2014).
- *Identification and Investigation of Acid Sulfate Soils and Acid Landscapes*. Department of Environment Regulation. June 2015a.
- *Treatment and Management of Soil and Water in Acid Sulfate Soil Landscapes*. Department of Environment Regulation. June 2015b.
- *National Acid Sulfate Soils Guidance – Guidelines for the dredging of acid sulfate soil sediments and associated dredge spoil management* (Water Quality Australia, 2018b)
- *Guidelines for Fresh & Marine Water Quality* (Water Quality Australia, 2018a).

4.3 Sediment Sampling Locations and Frequency

Based upon the volume of the proposed dredging operations at the time of sampling (November 2011 and March 2020), ~11,000 m^3, with up to an additional overdredge volume of 5,000 m^3 (up to 16,000 m^3) the *National Assessment Guidelines for Dredging* (Commonwealth of Australia, 2009), required a total of seven (7) sampling locations. NEPM (2013) and DER (DWER, 2014) guidelines do not explicitly state the number of samples required.

Sediments were sampled at seven (7) locations across the proposed dredge area, with the depth of sampling aligned to the proposed dredging requirements to a maximum depth of ~1.2 m or until refusal was reached. Sampling locations based upon the revised concept are presented on Figure D.

Sampling was proposed to be limited to a depth of ~1.2 m as this is the maximum anticipated depth of potential contamination. This depth was assumed as there has been no historical dredging in the area, especially close to shore where the deepest area of dredging is required, due to historical wooden jetty extending offshore.

[3] RPS notes the release of revised NEMP (HEPA, 2020) in early May 2020, however all site works were completed prior to release of the report. As such all data has been compared to guidelines within revision 1 of the NEMP (HEPA, 2018).

RPS notes that the whilst the revised proposed works (16 April 2020) has resulted in an increased dredging volume, which would require additional sampling locations under the *National Assessment Guidelines for Dredging* (Commonwealth of Australia, 2009), the sampling undertaken is considered sufficient to characterise the sediments in the area and thus remains valid, based upon the following:

- the main dredge area (~1.2 ha) remains relatively consistent with the previous area (~1.3 ha),
- the increase in the area relates to dredging (0.6 ha) beneath the proposed breakwater and is further offshore and therefore less likely to have been impacted by onshore activities
- whilst the depth of dredging has increased, contamination is more likely to be associated with the shallow sediments rather than at depth.

4.4 Sediment Sampling Methodology

4.4.1 UXO Survey

An underwater UXO survey was conducted prior to any seabed disturbance. The survey was undertaken by a suitability qualified by a third-party contractor to the dive contractor to determine the presence/absence of UXOs.

4.4.2 Overview

The geographic co-ordinates of each sampling location were recorded using a handheld GPS. Samples were collected by divers via push-cores with a PVC outer casing.

4.4.3 Sampling Intervals

The sampling intervals were generally as follows:

- 0 to 0.20 m
- 0.20 to 0.50 m
- 0.50 to 1.00 m.

Geological units typically conformed to the sampling intervals outlined above with one sample taken per lithological unit. Refusal occurred at several locations, due to hard sediment layers around 1 m below the sea bed. No additional samples were taken as no visual or olfactory evidence of contamination was identified. Sediment sampling logs are presented in Appendix A.

4.5 Assessment Levels

4.5.1 Reuse

With the proposed reuse of the dredged material for reclamation purposes and also the potential for reuse at the Rottnest Island landfill and or other areas on the island, sediment results will be compared with the following criteria:

- National Environment Protection (Assessment of Site Contamination) Measure. Schedule B1 Guideline on Investigation Levels for Soils and Groundwater (NEPM, 2013), specifically
  - Ecological Investigation Levels (EILs) and Ecological Screening Levels (ESLs) for areas of ecological significance (based upon the Class A reserve nature of the entire island)
  - Health Investigation Levels for:
    - Residential (HIL-A)

    - Residential with minimal soil access (HIL-B)
    - Public Open Space (HIL-C)
    - Health Investigation Levels for Commercial / Industrial (HIL-D)
  - Health Screening Levels for Vapour Intrusion for:
    - Residential (HSL-A) or Residential with minimal soil access (HSL-B)
    - Public Open Space (HSL-C)
    - Commercial / Industrial (HSL-D)
- PFAS National Environmental Management Plan. (HEPA, 2018).
  - Health Screening Levels for:
    - Residential with garden/accessible soil
    - Residential with minimal soil access
    - Public Open Space
    - Commercial / Industrial
  - Ecological Investigation Levels:
    - ecological direct exposure - public open space
    - indirect exposure - residential
- Health Screening Levels for Petroleum Hydrocarbons in Soils and Groundwater (CRC CARE, 2011), specifically
  - Soil Health Screening Levels for Direct Contact for:
    - Low density residential (HSL-A DC)
    - high density residential (HSL-B DC)
    - recreational/open space (HSL-C DC)
    - commercial/industrial (HSL-D DC)
    - intrusive maintenance workers (HSL-MW DC)
- DWER (2015a and b) Acid Sulfate Soils Guideline Series

Assessment criteria have been adopted in recognition that the proposed use of material for reclamation/filling beneath a future barge ramp and cargo handling facility, the proximity of the site to sensitive environmental receptors, i.e. Thomson Bay and the Indian Ocean and also the potential for material to be reused elsewhere on the island.

Where contaminants do not have assessment levels and or alternative assessment levels cannot be sourced, i.e. international guidance from Canada or the Netherlands (ANZECC 2000), contaminant levels within the site will be compared with results from the background sampling locations and or reported literature concentrations for the area.

Assessment criteria for ASS were adopted from the DWER guideline, *Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes* (DWER, June 2015a) and *Treatment and Management of Soil and Water in Acid Sulfate Soils Landscapes* (DWER, June 2015b).

Table 5 below presents the texture-based ASS action criteria for management. For excavation volumes for <1,000 tonnes ASS with ≥0.03%S or ≥18.7 mol H+/tonne equivalent acidity requires a detailed management plan.

Table 5: DWER ASS Management Action Criteria

Type of Material		Action Criteria (<1,000 tonnes) Existing + Potential Acidity		Action Criteria (>1,000 tonnes) Existing + Potential Acidity	
Texture	Approx. Clay Content	Equivalent Sulfur	Equivalent Acidity	Equivalent Sulfur	Equivalent Acidity
	(%<0.002 mm)	(%S)	(H+/tonne)	(%S)	(H+/tonne)
Coarse Texture (sands to loamy sands)	≤5	0.03	18	0.03	18
Medium Texture (sandy loams to light clays)	5–40	0.06	36	0.03	18
Fine Texture (medium to heavy clays and silty clays)	≥40	0.10	62	0.03	18

4.5.2 Dredging and Disposal

Sediment analysis results will also be compared with the following criteria:

- WQA (2018a) Guidelines for Fresh and Marine Water Quality – Sediment Quality Guidelines
  - Default Guideline Values (DGVs)
  - Upper Guideline Values (GV-high).

4.5.3 Surface Water and Elutriate

Elutriate results will be compared against:

- Water Quality Australia (2018a)
  - Marine Water Guidelines (MWG) 95% species protection level
  - In-shore Waters (nutrients and pH only).
- PFAS National Environmental Management Plan. (HEPA, 2018).
  - Interim Marine Guidelines 99% species protection level[4]

Where contaminants did not have assessment levels and or alternative assessment levels could not be sourced, contaminant levels within the site were compared with results from the background sampling locations and or reported literature concentrations for the area.

[4] The 99% species protection value is considered to most appropriate as PFAS is known bioaccumulate in aquatic organisms.

MWG guidelines define assessment values for consideration of ecological risk in surface water bodies.

4.5.4 Australian Standard Leachate Procedure

In instances where elevated concentrations of contaminants were observed and it was considered necessary to assess the potential mobility of the contaminants as part of the HHRA and ERA, samples were submitted for analysis via the Australian Standard Leachate Procedure (ASLP). Soil leachate results were compared to criteria presented in Section 4.5.3, elutriate assessment levels and Australian Standard Leachate Procedure Limits (ASLPLs).

In additional due to the potential reuse of material on the island away from the Army Jetty the following guidelines were used (where required):

- Water Quality Australia (2018a)
  - Fresh water guidelines (FWG) – 95% species protection level
  - Marine Ecological Protection Guidelines (MEPG)
  - Long-term Irrigation Water Guidelines (LIWG)
- Drinking Water Guidelines (DWG) (NHMRC, 2018)
- Non-potable Drinking Water Guidelines (DNP) (DoH, 2014)
- PFAS National Environmental Management Plan. (HEPA, 2018).
  - Freshwater Guidelines 99% species protection level[5]
  - Drinking water
  - Recreational Water.

4.6 Variations to the Sampling and Analysis Plan

The following variations to the SAP were observed:

- Sampling of sediments during the November 2019 event was only undertaken to 1 m at C04 and C05 due to refusal. Sampling of sediment during the March 2020 event was only undertaken to 1.1 at C02 and C04 due to refusal. Multiple attempts were made however refusal was encountered each time.
- Due to PFAS elutriates from November 2019 being contaminated within the laboratory during the analysis, the results were not considered usable, the sediment sampling exercise was therefore completed again in March 2020. The following is noted from the additional sampling event:
  - Sediment sampling was undertaken from the same location and the same sampling intervals at each location as per the November 2019 event, analysed for PFAS including elutriate analysis.
  - Surface water samples were collected and analysed for PFAS
  - Additional quality assurance and quality control (QAQC) samples, i.e. duplicates, triplicates (sediment, surface water and elutriate), rinsates, blank and trip blanks, were collected and analysed for PFAS.

[5] The 99% species protection value is considered to most appropriate as PFAS is known bioaccumulate in aquatic organisms.

  - Additional PFAS analysis of the elutriate water, prior to undergoing the elutriate method, (matrix blank) was undertaken by the prior laboratory.

- Surface water sampling at three sediment locations (C01, C04 and C06) was undertaken with a grab or snap sampler containing no Teflon™, with the sample collected from the surface water body and collocated with the sediment sampling locations. A multi-parameter meter was employed that measured pH, electrical conductivity (EC), redox potential, dissolved oxygen (DO) and temperature. The results were recorded on the surface water sampling log. Surface water sampling was undertaken as per the relevant guidelines in Section 4.2, with the addition of the following:

  - *Standards Australia. 1998. Water Quality—Sampling. Part 9: Guidance on sampling from marine waters* (AS/NZS 5667.9:1998).

5 HEALTH AND SAFETY

A Job Hazard Analysis (JHA) was prepared for all the different aspects of site investigation works conducted at the site.

During the investigation continuous attention was given to safety issues that arose while on site, and any concerns were addressed as soon as the risk was identified. Toolbox meetings were scheduled every morning before commencement of investigation activities, to aid in ensuring that all personnel and subcontractors were aware of safety practices on a day to day basis.

6 RESULTS

6.1 Sediments

6.1.1 Profile Description

The sediment profile across the site was typically sediments, pale grey with shell fragments and some grass roots/detritus in the upper profile. Sediment sampling logs are presented in Appendix A.

6.1.2 Particle Distribution

The results of the particle size distribution analysis are presented in Table A with laboratory documentation presented in Appendix B. A summary of the results is presented below.

The soils are classified predominantly as sand being between 0.06 and 2 mm, with the mean median particle size being 0.242 mm (242 µm). Minimal sediment was identified as >2 mm.

6.1.3 Onshore Reuse Results

6.1.3.1 Overview

The results of the laboratory sediment analysis for onshore reuse are presented in Tables B to G, with locations based upon the revised concept presented on Figure D. Laboratory reporting is presented in Appendix B. Quality control and assurance results and assessment are presented in Appendix C.

6.1.3.2 Contamination

6.1.3.2.1 Metals, Organotin, and Organics

All results were below the relevant guidelines for onshore reuse and were relatively consistent across the investigation area.

All the organic compounds, i.e. TRH/BTEX/PAH, OC/OP, explosives, were reported as below relevant limits of report (LOR) with the exception of several higher TRH factions in a couple of samples. Concentrations were however only marginally above the LOR, and significantly below reuse criteria.

6.1.3.2.2 PFAS

With the exception of PFOS[6] in three samples during November 2019 and one sample in March 2020, no other PFAS was reported above the (LOR) within any of the samples during either sampling event. The concentrations of PFOS were however,

- only marginally above the LOR
- an order of magnitude below the lowest screening criteria, and
- were consistent during both sampling events.

6.1.3.2.3 Asbestos

No asbestos fibres were identified in any of the sediments analysed.

[6] PFOS: Perfluorooctane sulfonic acid

6.1.3.2.4 Nutrients

No guidelines for nutrients (phosphorus and or nitrogen) exist in Western Australia. Concentrations for nitrogen and phosphorus were relatively consistent through the sediment profile.

Phosphorus was predominantly in total forms (i.e. non-reactive forms) and as such was bound up with the sediment.

Nitrogen is also predominantly bound to sediments and in organic forms (i.e. kjeldahl nitrogen). Ammonia was the dominant inorganic form of nitrogen however inorganic concentrations were significantly lower than organic forms of nitrogen.

6.1.3.2.5 Summary

From a contamination perspective and based upon the observed concentrations, the sediments are determined to be suitable for reclamation and reuse onshore in any landuse.

6.1.3.3 Acid Sulfate Soils

Conclusions drawn from the ASS laboratory results (Table H) are:

- Eight of the nine samples tested were found to have net acidity values[7] below the DWER ASS management action criteria of 0.03%S.
- The highest net acidity value[5] recorded was 0.05%S (C01S01) and the highest potential acidity (CRS) value was 0.054%S (C01S01).
- All Titratable Potential Acidity (TPA) results were below the LOR and as such are lower than the concentrations of pyritic sulfur (measured as S_{CR}) indicating that the sediments contain shell grit and other acid-buffering material.
- All Titratable Actual Acidity (TAA) results were below the LOR and as such below the DWER management criteria (0.03%S). This is due to the Acid Neutralising Capacity (ANC) present in the samples and also potentially due to the saturated state of the sediment and the high alkalinity that would present in the pore water and Indian Ocean water.
- Only one of the seven sites had positive ASS test results; above the DWER action criterion of 0.03%S.
- The calculated mean net acidity across all samples is 0.02%S and the mean + standard deviation is equivalent to 0.03%S (excluding ANC).
- All samples were found to contain levels of ANC. The highest ANC value recorded was 28%S; the mean across the samples containing ANC was 26.9%S. In all cases the amount of ANC present buffered the inorganic sulfur acidity within the samples.
- Although significant amounts of ANC are present in all samples; these are potentially an over estimation of ANC due to the crushing of large shell grit and other carbonate material during analysis – increasing the reactive surface area.
- Of the two samples submitted for a modified ANC method[8], both samples contained significant concentrations of ANC-mod. The ANC-mod results were either marginally below the ANC, indicating that either the majority of ANC present in the samples is available to buffer any acidity present. The results also indicate that there is minimal variance in the size, nature and abundance of neutralising material within sediments across the site.

[7] Excluding acid neutralising capacity (ANC)

[8] The modified ANC method was completed on an uncrushed sample, screened to 0.6 mm.

Table 6 below provides a summary of the analytical data obtained.

Table 6: ASS results summary

Analyte	Unit	DWER management criteria (treatment)	Maximum result*	Average result
CRS	%S	>0.03	0.05	0.02
TAA	%S	>0.03	<0.02	<0.02
TPA	%S	>0.03	<0.02	<0.02
pH_{KCl}	pH Units	Not Defined	10.1	9.9
pH_{OX}	pH Units	Not Defined	7.9	8.0
ANC	%S	Not Defined	28	26.9
mod-ANC	%S	Not Defined	25.9	25.4

* The minimum pH result has been reported, representing most acidic (maximum) sample

The data supports a conclusion that although inorganic sulfur is present in the sediments there is significant ANC kinetically available to neutralise the oxidation products from the inorganic sulfur.

6.1.3.3.1 Summary

Only one sediment is classified PASS, based upon the DWER guidelines, i.e. ANC is not included, with only inorganic acidity detected. Although there is inorganic acidity detected above the relevant guidelines, there is a significant amount of ANC in the sediments which has been shown to be kinetically available through undertaking a modified ANC method. As such additional lime treatment of the material is not required when the sediment is disturbed and used for reclamation activities. The ANC is sufficiently kinetically available to safeguard against acidification over the long term.

6.1.4 Offshore Disposal

6.1.4.1 Overview

The results of the laboratory sediment analysis for offshore disposal are presented in Tables G to J, with locations based upon the revised concept presented on Figure D. Laboratory reporting is presented in Appendix B. Quality control and assurance results and assessment is presented in Appendix C.

As the vast majority of results were report less than the relevant limits of reporting; sediment results for PAHs, TRH/BTEX and OC/OP pesticides have not been normalised to 1% TOC. A mean TOC of 0.28% was observed across the samples. Normalising the results to 1% TOC will not change the outcomes of the assessment.

6.1.4.2 Metals

All metals were below relevant ISQG guidelines. Where sediments did not exceed DGV guidelines and or no guidelines exist concentrations were relatively consistent across the dredge area.

6.1.4.3 TBT

All samples were reported less than the LOR (0.5 µgSn/kg) thus complied with the DGV (5 µgSn/kg).

6.1.4.4 PAH, OC/OP Pesticides and Explosives

All PAH, OC/OP pesticides and explosives were reported as below relevant LORs and thus below relevant DGV.

6.1.4.5 TRH/TPH and BTEX

All BTEX and TRH/TPH results were below the relevant LORs in all samples with the exception of minor TPH detects in two samples.

Samples C06S01 and C07S03 complied with the DGV (280 mg/kg) for the sum C_{10}-C_{36}, with non-normalised concentrations of 5 and 7 mg/kg respectively.

6.1.4.6 PFAS

With the exception of PFOS in three samples during November 2019 and one sample in March 2020, no other PFAS was reported above the (LOR) within any of the samples during either sampling event. The concentrations of PFOS were however,

- only marginally above the LOR
- an order of magnitude below the lowest screening criteria, and
- were consistent during both sampling events.

6.1.4.7 Nutrients

No guidelines for nutrients (phosphorus or nitrogen) exist in Western Australia. Concentrations were predominately consistent across the sampling area.

Phosphorus was predominantly in total forms (i.e. non-reactive forms) and as such was bound up with the sediment.

Nitrogen is also predominantly bound to sediments and in organic forms (i.e. kjeldahl nitrogen). Ammonia was the dominant inorganic form of nitrogen however inorganic concentrations are significantly lower than organic forms of nitrogen.

6.1.4.8 Summary

All results were reported below relevant DGV and as such to do not pose a significant risk during dredging and or if were proposed for offshore disposal.

6.1.5 Elutriate Analysis

Tables O and P present the elutriate analysis results for the sediments. Note only the PFAS results from the March 2020 event are presented, as the original results were contaminated within the laboratory. A total of seven samples were submitted for elutriate analysis during each event.

Samples were leached using the United States Environmental Protection Agency (USEPA) standard elutriate procedure as outlined in the National Assessment Guidelines for Dredging (Australian Government 2009) with Indian Ocean water from the site collected over the sampling period and used as the elutriate solution.

6.1.5.1 Metals

All metals were below relevant MEPG criteria within the elutriate water, i.e. Indian Ocean water.

There are some increases from the Indian Ocean water for various metals and isolated exceedances of MEPG guidelines (Cu, V and Zn). The mean and median concentrations of metals were typically below relevant MEPG guidelines with the exception of copper.

The mean copper concentration (0.0017 mg/L) marginally exceeded the MEPG (0.0013 mg/L) though the increase over the Indian Ocean water (0.001 mg/L), i.e. background levels, is minimal. Only two of the elutriate samples exceeded the MEPG (0.0013 mg/L) with a maximum concentration of 0.005 mg/L.

All other mean and median concentrations for the metals were below the relevant guidelines.

Increases in elutriate water concentrations were observed for several metals (antimony, arsenic, manganese and) above Indian Ocean water concentrations i.e. background levels, however no guidelines are available for these metals.

6.1.5.2 Nutrient

Nutrient concentrations in elutriate water increased above the Indian Ocean water quality for all parameters. This was likely due to the suspension of fine particles into the elutriate which are then included in the analysis. Concentrations in elutriate water typically exceeded relevant MEPG guidelines no exceedances observed in the Indian Ocean water.

6.1.5.3 PFAS

All elutriate samples, including the elutriate water sampled prior to (matrix blank) and post elutriate process (EW), observed PFAS concentrations below the limits of reporting with the exception of PFOS in the triplicate of C02S01. A PFOS concentration of 0.0005 µg/L (C02S01) was reported which marginally exceeds the 99%MEPG (0.00023 µg/L). The concentration is however below the highest concentration observed in surface water at the site (C06-SW, 0.0006 µg/L), with the mean and median concentrations of PFOS in the elutriates at the site below the 99%MEPG (0.00023 µg/L).

Given only three minor detections of PFAS were observed in the sediments and all PFAS within the elutriates were below the PFAS concentrations from the Indian Ocean water samples, it is considered that the risk presented via leaching of PFAS into the water from the sediments is low and acceptable.

6.1.5.4 Summary

Whilst concentrations of several metals within the elutriate were higher than those in Indian Ocean water (used in the elutriate analysis), the majority of the results were below the MEPG. Nutrient concentrations were also higher in the elutriate likely as a result of the presence of fine particulate matter in the elutriate sample. Whilst a minor exceedance of the PFOS guideline was observed in one elutriate sample, the concentration was below the highest concentration observed in surface water at the site and the mean and median concentrations of PFOS in the elutriates at the site were below the 99%MEPG.

6.2 Surface Water

The results of the laboratory surface water analysis are presented in Table P, with locations based upon the revised concept presented on Figure D. Sampling logs are presented in Appendix A, laboratory reporting is presented in Appendix B and QAQC and assessment presented in Appendix C.

6.2.1 PFAS

With the exception of PFOS in two samples (C04-SW and C06-SW) no PFAS was reported above the (LOR) within any of the samples. All other PFAS compounds were below relevant LORs.

PFOS was observed in the duplicates for C04-SW and C06-SW with concentrations of 0.0003 and 0.0006 µg/L which are marginally above the 99%MEPG (0.00023 µg/L). A mean PFOS concentration of 0.0004 µg/L was observed across the three surface water samples.

7 RISK ASSESSMENT

The risk assessment has been undertaken based upon the preliminary CSM (Section 3.0) which was developed upon the proposed dredging and onshore reuse/disposal of the reclamation sediments. If the proposed enduse is changed then the following risk assessment is required to be reviewed and revised.

7.1 Contaminants Identified

The following types of environmental contamination were identified during the course of this investigation over portions of the site:

- sediment elutriate concentrations of copper, PFOS and nutrients above MEPGs.
- surface water concentrations of PFOS above MEPGs.

7.2 Revised Conceptual Site Model

Based upon the results of the investigation the preliminary CSM (Section 3) has been revised to reflect the pollutant linkages that remain following the sediment sampling program. The revised CSM is presented below in Table 7.

Table 7: Revised Conceptual Site Model

Source	Potential Pathway	Receptor
Ecological		
Surface Water contamination Copper, PFOS, nutrients	Direct contact and ingestion after leaching from sediment to surface water	Aquatic flora and fauna
	Bioaccumulation (copper and PFOS only) and biomagnification in the food chain (PFOS only)	

7.3 Human Health Risk Assessment

Based upon the observed concentrations, there is no risk to human health from the sediments or surface water during dredging or upon development of the site using the sediments for reclamation.

7.4 Environmental Risk Assessment

The assessment considers contaminants liberated from the sediments (by leaching).

7.4.1 Contaminant Leaching from Sediments

7.4.1.1 Metals

The copper concentrations identified in the sediments do not pose a potential risk to human health or the environment when considered for reuse onshore as all concentrations were below relevant criteria, however there is a potential risk to the marine environment during dredging.

Copper was observed above relevant MEPG within the elutriates however the exceedance was minimal, and the concentrations are likely associated with sediments suspended in the elutriate. The increase was not considered significant for the following reasons:

- Copper concentrations were significantly below the DGV. The natural movement of sediments within the ocean would also likely result in a release of metals similar to that observed in the elutriate.
- The majority of the metals present are likely bound to sediments, thus reducing bioavailability. Controlling the distribution of sediments, via silt curtains, and within dredge return water would further reduce any potential risk to marine ecology.

- The concentrations of mobilised contaminants would be diluted quickly within the marine environment.
- Copper can bioaccumulate in aquatic organisms but, as it is an essential element, it is commonly regulated by the organisms (Water Quality Australia, 2018a) and thus considered not to pose a significant risk.

Therefore, the risk presented by the release of copper during dredging if properly managed is considered low and acceptable.

7.4.1.2 Nutrients

The nutrient concentrations identified in the sediments do not pose a potential risk to the environment when considered for reuse onshore.

Nutrient concentrations were observed to increase within the elutriate analysis. As per the metal results, the nutrients in the form of organic matter would be bound to sediments. Therefore, the potential risk from elevated nutrients in the dredge return can be removed by reducing the sediment loading in the return water. Additionally, similar concentrations would be anticipated to elute from sediments naturally disturbed in the marine environment.

On this basis the risk from nutrients released from sediments during dredging if properly managed via the use of silt curtains and management of sediment load in the dredge return water, is considered low and acceptable.

7.4.1.3 PFOS

The PFOS concentrations identified in the sediments do not pose a potential risk to the environment when considered for reuse onshore.

PFOS concentrations were observed within one PFOS elutriate analysis however PFOS was also observed in the surface water at the site, indicating the presence of low level PFOS within the existing environment. In addition, only very low concentrations of PFOS were observed in sediments. Given the very low concentrations of PFOS observed in the elutriates, it is expected that the concentrations would be diluted quickly within the marine environment during the works. As such the concentrations would reduce to further below the concentrations observed within the marine waters of the surrounding environment and thereby not changing the risk profile currently presented by marine waters to the surrounding environment.

The risk to the environment from the proposed works is considered low and acceptable, with no monitoring for PFAS considered to be required during the works, based upon the following:

- the elutriate PFOS concentration in the one sample was below the surface water PFOS concentrations and the mean and median PFOS concentrations,
- no other PFAS compounds identified above relevant limits of reporting across all elutriates were below the relevant guidelines,
- concentrations would be diluted quickly within the marine environment during the works,
- the potential for higher concentrations of PFAS to be present at the site and not identified by the assessment is considered very low based upon the site history and extent of sampling conducted over the two events,
- only very low concentrations were observed in the sediments with no significant source identified in the vicinity of the site, and
- owing to the distance from the site, potential PFAS sources on the island, i.e. landfill and golf course, would not be expected to directly impact the site,
- the detectable PFOS concentration was within the surface sediment, which has the potential to be mobilised and elute during ongoing natural marine processes onsite.

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 Summary of Findings

A contamination assessment was completed on sediments proposed to be dredged from the Thomson Bay South Development Project, situated around the former Army Jetty on Rottnest Island. The dredged sediments are proposed to be reused during reclamation works for the development.

A total of seven sediment cores were aligned to the proposed dredging requirements to a maximum depth of 1.2 m. Sediments were analysed for the contaminants of concern identified, including metals and metalloids, ASS parameters, OC/OP pesticides, PAHs, nutrients, PFAS and TRH/BTEX with elutriates analysed for metals, nutrients and PFAS. Due to PFAS elutriates from November 2019 being contaminated within the laboratory during the analysis, the results were not considered usable, the sediment sampling exercise for PFAS was therefore completed again in March 2020. Surface water was also sampled within the marine environment and analysed for PFAS during the March 2020 exercise.

RPS notes that the whilst the revised proposed works (16 April 2020) has resulted in an increased dredging volume, which would require additional sampling locations under the *National Assessment Guidelines for Dredging* (Commonwealth of Australia, 2009), the sampling undertaken is considered sufficient to characterise the sediments in the area and thus remains valid, based upon the following:

- the main dredge area (~1.2 ha) remains relatively consistent with the previous area (~1.3 ha),
- the increase in the area relates to dredging (0.6 ha) beneath the proposed breakwater and is further offshore and therefore less likely to have been impacted by onshore activities
- whilst the depth of dredging has increased, contamination is more likely to be associated with the shallow sediments rather than at depth.

The assessment concluded that from contamination perspective the sediments are suitable for reuse onshore for reclamation, with all results below the following assessment criteria:

- Ecological Investigation Levels (EILs) and Ecological Screening Levels (ESLs) for areas of ecological significance and public open space (NEPM 2013)
- Health Investigation Levels for residential soil access (HIL-A) (NEPM 2013 and CRC CARE 2011).

All results were reported below relevant DGV and the sediments are not considered to pose a significant risk during dredging and are considered suitable for offshore disposal.

Only one sediment is classified PASS, based upon the DWER guidelines, i.e. ANC is not included, with only inorganic acidity detected. Although there is inorganic acidity detected above the relevant guidelines, there is a significant amount of ANC in the sediments which has been shown to be kinetically available through undertaking a modified ANC method. As such additional lime treatment of the material is not required when the sediment is disturbed and used for reclamation activities. The ANC is sufficiently kinetically available to safeguard against acidification over the long term.

Whilst concentrations of metals within the elutriate for several metals were higher than those in Indian Ocean water (used in the elutriate analysis), the majority of the results were below the MEPG. Nutrient concentrations were also higher in the elutriate. Whilst a minor exceedance of the PFOS guideline was observed in one elutriate sample, the concentration was below the highest concentration observed in surface water at the site and the mean and median concentrations of PFOS in the elutriates at the site were below the 99%MEPG.

The copper concentrations identified in the sediments do not pose a potential risk to human health or the environment when considered for reuse onshore as all concentrations were below relevant criteria, however there is a potential risk to the marine environment during dredging. Copper was observed above relevant MEPG within the elutriates however the exceedance was minimal, and the concentrations are likely associated with sediments suspended in the elutriate.

The increase was not considered significant due to the following:

- Copper concentrations were significantly below the DGV. The natural movement of sediments within the ocean would also likely result in a release of metals similar to that observed in the elutriate.

- The majority of the metals present are likely bound to sediments, thus reducing bioavailability. Controlling the distribution of sediments, via silt curtains, and within dredge return water would further reduce any potential risk to marine ecology.

The nutrient concentrations identified in the sediments do not pose a potential risk to human health or the environment when considered for reuse onshore. Nutrient concentrations were observed to increase within the elutriate analysis. As per the metal results, the nutrients in the form of organic matter would be bound to sediments. Therefore, the potential risk from elevated nutrients in the dredge return can be removed by reducing the sediment loading in the return water. Additionally, similar concentrations would be anticipated to elute from sediments naturally disturbed in the marine environment.

PFOS concentrations were observed within one PFOS elutriate analysis however PFOS was also observed in the surface water at the site, indicating the presence of low level PFOS within the existing environment. In addition, only very low concentrations of PFOS were observed in sediments. Given the very low concentrations of PFOS observed in the elutriates, it is expected that the concentrations would be diluted quickly within the marine environment during the works. As such the concentrations would reduce to further below the concentrations observed within the marine waters of the surrounding environment and thereby not changing the risk profile currently presented by marine waters to the surrounding environment. Additionally, the detectable PFOS concentration was within the surface sediment, which has the potential to be mobilised and elute during ongoing natural marine processes onsite i.e. tidal movement or storm events.

Based upon the observed concentrations, the risk to human health or the environment from the sediments or surface water during dredging or upon development of the site using the sediments for reclamation is considered low and acceptable.

8.2 Suitability for Use and Recommendations

Based upon the observed concentrations the sediments from contamination perspective are determined to be suitable for reuse onshore for reclamation. Additionally, the sediments do not require additional lime treatment once disturbed from an ASS perspective and used for reclamation activities, as the ANC is considered to be sufficiently kinetically available to safeguard against acidification over the long term. No surface water monitoring for PFAS is considered to be required.

Should offshore disposal be considered then, as all results were reported below relevant DGV and the sediments do not pose a significant risk during dredging, the sediments are likely suitable for offshore disposal however a suitable disposal ground would be required to be found and approved by relevant regulators.

8.3 Assumptions and Uncertainties

The conclusions made here have been developed on the assumption that the data collected accurately represents the conditions at the site.

Uncertainties pertaining to the data collected include the following:

- Temporal uncertainty: contaminants may not have been present in the tested medium at the time of sampling, however, may be present within the site at other times.

- Spatial uncertainty: no sampling program can provide complete certainty that no contamination exists anywhere on the site.

Assumptions pertaining to the data collected include the following:

- Sediment samples were taken at a density and to a depth, sufficient to allow an adequate spatial characterisation of the sediment at the site. This assumption is based on statistical methods which allow reasonable confidence levels to be determined.

Although uncertainties exist, the assumptions made are well founded and give confidence that the conclusions and recommendations reached regarding the site are sound.

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Tables

Table A: Sediment Analytical Results - Particle Size Distribution

Definitions:

LOR (Limits of Reporting)

Notes:

All values in %

deontes <LOR

Sample ID	Date Sampled	Top	Bottom	PSD	Soil Classification					Particle Sizing											
					Clay (<2 µm)	Silt (2-60 µm)	Sand (0.06-2.00 mm)	Gravel (>2 mm)	Cobbles (>6 cm)	Grain Size +75 µm	Grain Size +150 µm	Grain Size +300 µm	Grain Size +425 µm	Grain Size +600 µm	Grain Size +1180 µm	Grain Size +2.36 mm	Grain Size +4.75 mm	Grain Size +9.5 mm	Grain Size +19.0 mm	Grain Size +37.5 mm	Grain Size +75.0 mm
				LOR	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C01S01	12/11/2019	0.00	0.25		4	1	95	1	1	96	73	13	6	3	1	1	1	1	1	1	1
C02S01	12/11/2019				3	1	96	1	1	96	82	15	6	3	1	1	1	1	1	1	1
C03S01	12/11/2019				2	2	95	1	1	95	60	9	5	3	2	1	1	1	1	1	1
C04S01	12/11/2019				3	1	96	1	1	96	67	10	5	3	1	1	1	1	1	1	1
C05S02	12/11/2019				3	1	96	1	1	96	62	15	10	6	2	1	1	1	1	1	1
C06S03	12/11/2019				2	1	95	3	1	97	82	48	30	12	4	2	2	1	1	1	1
C07S02	12/11/2019				2	1	97	1	1	97	84	68	48	17	1	1	1	1	1	1	1
				MEAN	3	1	96	1	1	96	73	25	16	7	2	1	1	1	1	1	1
				MEDIAN	3	1	96	1	1	96	73	15	6	3	1	1	1	1	1	1	1
				STDEV	1	0	1	1	0	1	10	23	17	6	1	0	0	0	0	0	0
				COUNT	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
				95%UCL	3	1	96	2	1	97	80	42	28	11	3	1	1	1	1	1	1

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Table B: Sediment Analytical Results - Metals, Metalloids, Inorganics and Nutrients - Onshore Reuse

Definitions:

LOR (Limits of Reporting), NEPM (2013) - Health Investigation Levels for residential (HIL-A), high density residential (HIL-B), public open space(HIL-C), Commercial/industrial (HIL-D), Ecological Investigation/Screening Levels - Areas of Ecological Significance (EIL/ESL)

ND denotes not detected. NG denotes no guideline. --- denotes not tested

Notes:

All values in mg/kg except TOC which is in %, asbestos %w/w and Tributyl Tin in µg Sn/kg. Table uses colour coding for data interpretation. All guideline values from NEPM (2013) except Antimony, Silver and Vandium taken from Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health

denotes <LOR

TBT results have not been normalised based upoon the TOC of the samples

Sample ID	Date Sampled	Top	Bottom	Trigger	Total Metals														Tributyl Tin	Asbestos	TOC	Nutrients					
					Antimony	Arsenic	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Vanadium	Zinc			Total Organic Carbon	Total Phosphorus	Phosphorous Reactive	Total Nitrogen	Nitrogen Kjeldahl Total	Ammonia (as N)	NO_X
				HIL-A	20	100	20	100	100	6000	300	3800	40	400	200	20	130	7400	50000	0.001	NG	NG	NG	NG	NG	NG	NG
				HIL- B	20	300	900	3600	600	240000	1500	60000	730	6000	1400	20	130	40000	300000	0.001	NG	NG	NG	NG	NG	NG	NG
				HIL-C	20	300	90	300	300	17000	600	19000	80	1200	700	20	130	30000	50000	0.001	NG	NG	NG	NG	NG	NG	NG
				HIL-D	40	3000	900	3600	4000	240000	1500	60000	730	6000	10000	40	130	400000	300000	0.001	NG	NG	NG	NG	NG	NG	NG
				EIL/ESL	NG	40	NG	80	70	270	470	NG	470	5	NG	NG	NG	50	NG	NG	NG	210	NG	NG	NG	NG	NG
				LOR	0.5	1	0.1	1	0.5	1	1	10	0.01	1	0.1	0.1	2	1	0.5	0.001	0.02	2	0.1	20	20	20	0.1
C01S01	12/11/2019	0.00	0.25		1.47	2	0.3	11	1	1	1	10	0.01	2	0.3	0.2	11	2	0.5	0.001	0.46	303	0.1	330	330	4.1	0.1
C01S03	12/11/2019	0.50	1.20		0.5	1	0.2	10	1	1	1	10	0.01	1	0.1	0.1	11	1	0.5	0.001	0.32	232	0.1	310	310	0.2	0.1
C02S01	12/11/2019	0.00	0.20		0.5	1	0.1	11	1	1	1	10	0.01	1	0.3	0.2	6	2	0.5	0.001	0.48	280	0.6	230	230	0.7	0.1
C02S02	12/11/2019	0.20	0.50		0.85	1	0.2	10	1	1	1	10	0.01	1	0.2	0.1	13	1	----	----	----	----	----	----	----	----	----
C03S01	12/11/2019	0.00	0.20		0.5	1	0.1	10	1	1	1	10	0.01	1	0.2	0.1	4	4	0.5	0.001	0.34	269	0.3	260	260	0.2	0.1
C03S03	12/11/2019	0.50	1.20		0.77	1	0.1	10	1	1	1	10	0.01	1	0.2	0.1	12	4	----	----	----	----	----	----	----	----	----
C04S01	13/11/2019	0.00	0.20		0.61	1	0.2	10	1	1	1	10	0.01	1	0.2	0.1	11	2	0.5	0.001	0.72	254	0.8	330	330	20.6	0.1
C04S02	13/11/2019	0.20	0.50		0.5	1	0.2	11	1	1	1	10	0.01	1	0.2	0.1	12	1	----	----	----	----	----	----	----	----	----
C05S01	13/11/2019	0.00	0.25		0.5	1	0.1	9	1	1	1	10	0.01	1	0.1	0.1	2	2	0.5	0.001	0.23	274	0.2	250	250	0.2	0.1
C05S02	13/11/2019	0.25	0.50		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C05S03	13/11/2019	0.50	1.00		0.5	1	0.1	10	1	1	1	10	0.01	1	0	0.1	3	4	----	----	----	----	----	----	----	----	----
C06S01	12/11/2019	0.00	0.25		0.5	1	0.1	9	1	1	1	10	0.01	1	0	0.1	2	2	0.5	0.001	0.05	311	0.2	190	190	0.4	0.1
C06S02	12/11/2019	0.25	0.50		0.5	1	0.1	9	1	1	1	10	0.01	1	0	0.1	3	3	----	----	----	----	----	----	----	----	----
C06S03	12/11/2019	0.50	1.20		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C07S01	12/11/2019	0.00	0.20		0.5	1	0.1	9	1	1	1	10	0.01	1	0	0.1	2	2	0.5	0.001	0.04	327	0.3	210	210	1	0.1
C07S02	12/11/2019	0.20	0.70		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C07S03	12/11/2019	0.70	1.20		0.5	2	0.1	9	1	1	1	10	0.01	1	0	0.1	2	1	----	----	----	----	----	----	----	----	----
				MEAN	0.538	1	0.1	10	1	1	1	10	0.01	1	0	0.1	5	2	0.5	0.0	0.28	287	0	248	248	4	0.1
				MEDIAN	0.5	1	0.1	9	1	1	1	10	0.01	1	0	0.1	3	2	0.5	0.0	0.23	274	0	250	250	0	0.1
				STDEV	0.089	0	0.0	1	0	0	0	0	0.00	0	0	0.0	5	1	0.0	0.0	0.28	31	0	54	54	9	0.0
				COUNT	10	10	10	10	10	10	10	10	10	10	10	10	10	10	5	5	5	5	5	5	5	5	5
				95%UCL	0.588	1	0.1	10	1	1	1	10	0.01	1	0	0.1	8	3	0.5	0.0	0.50	311	1	291	291	12	0.1

Table C: Sediment Analytical Results - PAHs - Onshore Reuse

Definitions:

Levels - Areas of Ecological Significance (EIL/ESL) , Health Screening Levels for vapour intrusion for residential (HSL-A), high density residential (HSL-B), public open space(HSL-C), Commercial/industrial (HSL-D), BaP - Benz(a)pyrene, TEQ - Toxic Equivalent Quotient

ND denotes not detected. NG denotes no guideline. --- denotes not tested

Notes:

All values in mg/kg. Table uses colour coding for data interpretation. All guideline values from NEPM (2013)

deontes <LOR

Concentrations have not been normalised to 1% based upon the Total Organic Carbon of the samples

Sample ID	Date Sampled	Top	Bottom	Trigger	PAHs																					
					2-methyl-naphthalene	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benz(a)pyrene	Benz(b)fluoranthene	Benz(e)pyrene	Benz(ghi)perylene	Benz(k)fluoranthene	Chrysene	Coronene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Perylene	Phenanthrene	Pyrene	TEQ BaP	Total PAH
				HIL-A	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	3	300
				HSL-A	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	3	NG	NG	NG	NG	NG
				HIL- B	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	4	400
				HSL-B	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				HIL-C	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	3	300
				HSL-C	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				HIL-D	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	40	4000
				HSL-D	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				EIL/ESL	NG	NG	NG	NG	NG	NG	NG	0.7	NG	NG	NG	NG	NG	NG	NG	NG	10	NG	NG	NG	NG	NG
				LOR	0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004
C01S01	12/11/2019	0.00	0.25		0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004
C01S03	12/11/2019	0.50	1.20		0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004
C02S01	12/11/2019	0.00	0.20		0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004
C02S02	12/11/2019	0.20	0.50		0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004
C03S01	12/11/2019	0.00	0.20		0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004
C03S03	12/11/2019	0.50	1.20		0.005	0.004	0.008	0.020	0.020	0.020	0.020	0.020	0.004	0.020	0.020	0.005	0.004	0.020	0.004	0.020	0.005	0.004	0.004	0.020	0.004	0.004
C04S01	13/11/2019	0.00	0.20		0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004
C04S02	13/11/2019	0.20	0.50		0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004
C05S01	13/11/2019	0.00	0.25		0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004
C05S02	13/11/2019	0.25	0.50		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C05S03	13/11/2019	0.50	1.00		0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004
C06S01	12/11/2019	0.00	0.25		0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004
C06S02	12/11/2019	0.25	0.50		0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004
C06S03	12/11/2019	0.50	1.20		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C07S01	12/11/2019	0.00	0.20		0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004
C07S02	12/11/2019	0.20	0.70		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C07S03	12/11/2019	0.70	1.20		0.005	0.004	0.200	0.040	0.024	0.060	0.028	0.020	0.060	0.020	0.004	0.005	0.004	0.004	0.004	0.040	0.005	0.020	0.004	0.008	0.004	0.004

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Table D: Sediment Analytical Results - TRH and BTEX - Onshore Reuse

Definitions:

LOR (Limits of Reporting), NEPM (2013) - Health Investigation Levels for residential (HIL-A), high density residential (HIL-B), public open space(HIL-C), Commercial/industrial (HIL-D), Ecological Investigation/Screening Levels - Areas of Ecological Significance (EIL/ESL) , Health Screening Levels for vapour intrusion for residential (HSL-A), high density residential (HSL-B), public open space(HSL-C), Commercial/industrial (HSL-D), Health Screening Level for residential direct contact (HSL-A DC); Maintenance Worker (HSL-MW DC)

ND denotes not detected. NG denotes no guideline. --- denotes not tested

Notes:

All values in mg/kg. Table uses colour coding for data interpretation. All guideline values from NEPM (2013) or CRC Care (2011)

deontes <LOR

Concentrations have not been normalised to 1% based upon the Total Organic Carbon of the samples

Sample ID	Date Sampled	Top	Bottom	Trigger	BTEX							TPH					TRH						
					Benzene	Ethyl Benzene	Toluene	ortho-Xylene	meta,para-Xylene	Xylene	Sum of BTEX	C6 - C9	C10 - C14	C15 - C28	C29 - C36	C10 - C36 (sum)	C6 - C10	C6 - C10 minus BTEX (F1)	>C10 - C16	>C10 - C16 minus Naphthalene (F2)	>C16 - C34	>C34 - C40	>C10 - C40 (sum)
				HIL-A	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				HSL-A	0.5	55	160	40			NG	NG	NG	NG	NG	NG	45	45	110	110	NG	NG	NG
				HIL- B	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				HSL-B	0.5	55	160	40			NG	NG	NG	NG	NG	NG	45	45	110	110	NG	NG	NG
				HIL-C	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				HSL-C	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				HIL-D	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				HSL-D	3	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				HSL-A DC	100	4500	14000	12000			NG	NG	NG	NG	NG	NG	4400	NG	3300	NG	4500	NG	6300
				HSL - MW DC	1100	85000	12000	130000			NG	NG	NG	NG	NG	NG	82000	NG	62000	NG	85000	120000	NG
				EIL/ESL	10	1.5	10	10			NG	0.7	NG	NG	NG	NG	125	125	25	25	NG	NG	NG
				LOR	0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
C01S01	12/11/2019	0.00	0.25		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
C01S03	12/11/2019	0.50	1.20		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
C02S01	12/11/2019	0.00	0.20		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
C02S02	12/11/2019	0.20	0.50		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
C03S01	12/11/2019	0.00	0.20		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
C03S03	12/11/2019	0.50	1.20		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
C04S01	13/11/2019	0.00	0.20		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
C04S02	13/11/2019	0.20	0.50		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
C05S01	13/11/2019	0.00	0.25		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
C05S02	13/11/2019	0.25	0.50		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C05S03	13/11/2019	0.50	1.00		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
C06S01	12/11/2019	0.00	0.25		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	5	5	5	3	3	3	3	5	5	5
C06S02	12/11/2019	0.25	0.50		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
C06S03	12/11/2019	0.50	1.20		----	----	----	----	----	----	----	----	----	----	----	----	----	3	----	----	----	----	----
C07S01	12/11/2019	0.00	0.20		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
C07S02	12/11/2019	0.20	0.70		----	----	----	----	----	----	----	----	----	----	----	----	----	3	----	----	----	----	----
C07S03	12/11/2019	0.70	1.20		0.20	0.20	0.20	0.20	0.20	0.50	0.20	3	3	3	7	7	3	3	3	3	6	7	13

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Table E: Sediment Analytical Results - OC/OP Pesticides - Onshore Reuse

Definitions:

LOR (Limits of Reporting), OC - Organochlorine, OP - Organophosphate NEPM (2013) - Health Investigation Levels for residential (HIL-A), high density residential (HIL-B), public open space(HIL-C), Commercial/industrial (HIL-D), Ecological Investigation/Screening Levels - Areas of Ecological Significance (EIL/ESL)
ND denotes not detected. NG denotes no guideline. --- denotes not tested

Notes:

All values in mg/kg. Table uses colour coding for data interpretation. All guideline values from NEPM (2013)
deontes <LOR
Concentrations have not been normalised to 1% based upon the Total organic Carbon of the samples

Sample ID	Date Sampled	Top	Bottom	Trigger	OCs																								
					Aldrin	Aldrin+Dieldrin	Alpha-BHC	Beta-BHC	Chlordane	cis-Chlordane	DDD	DDE	DDT	Delta-BHC	Dieldrin	Endosulfan (sum)	alpha-Endosulfan	beta-Endosulfan	Endosulphan Sulfate	Endrin	Endrin Aldehyde	Endrin Ketone	gamma-BHC (Lindane)	HCB	Heptachlor	Heptachlor Epoxide	Methoxychlor	Oxychlordane	trans-Chlordane
				HIL-A	NG	6	NG	NG	50	50	240			NG	NG	270	270	270	270	10	NG	NG	NG	10	6	NG	300	NG	50
				HIL- B	NG	10	NG	NG	90	90	600			NG	NG	400	400	400	400	20	NG	NG	NG	15	10	NG	500	NG	90
				HIL-C	NG	10	NG	NG	70	70	400			NG	NG	340	340	340	340	20	NG	NG	NG	10	10	NG	400	NG	70
				HIL-D	NG	45	NG	NG	530	530	3600			NG	NG	2000	2000	2000	2000	100	NG	NG	NG	80	50	NG	2500	NG	530
				EIL/ESL	NG	NG	NG	NG	NG	NG	NG	NG	3	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				LOR	0.0005	0.0005	0.0005	0.0005	0.00025	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005
C01S01	12/11/2019	0.00	0.25		0.0005	0.0005	0.0005	0.0005	0.0003	0.0003	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005
C01S03	12/11/2019	0.50	1.20		0.0005	0.0005	0.0005	0.0005	0.0003	0.0003	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005
C02S01	12/11/2019	0.00	0.20		0.0005	0.0005	0.0005	0.0005	0.0003	0.0003	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005
C02S02	12/11/2019	0.20	0.50		0.0005	0.0005	0.0005	0.0005	0.0003	0.0003	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005
C03S01	12/11/2019	0.00	0.20		0.0005	0.0005	0.0005	0.0005	0.0003	0.0003	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005
C03S03	12/11/2019	0.50	1.20		0.0005	0.0005	0.0005	0.0005	0.0003	0.0003	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005
C04S01	13/11/2019	0.00	0.20		0.0005	0.0005	0.0005	0.0005	0.0003	0.0003	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005
C04S02	13/11/2019	0.20	0.50		0.0005	0.0005	0.0005	0.0005	0.0003	0.0003	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005
C05S01	13/11/2019	0.00	0.25		0.0005	0.0005	0.0005	0.0005	0.0003	0.0003	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005
C05S02	13/11/2019	0.25	0.50		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C05S03	13/11/2019	0.50	1.00		0.0005	0.0005	0.0005	0.0005	0.0003	0.0003	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005
C06S01	12/11/2019	0.00	0.25		0.0005	0.0005	0.0005	0.0005	0.0003	0.0003	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005
C06S02	12/11/2019	0.25	0.50		0.0005	0.0005	0.0005	0.0005	0.0003	0.0003	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005
C06S03	12/11/2019	0.50	1.20		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C07S01	12/11/2019	0.00	0.20		0.0005	0.0005	0.0005	0.0005	0.0003	0.0003	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005
C07S02	12/11/2019	0.20	0.70		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C07S03	12/11/2019	0.70	1.20		0.0005	0.0005	0.0005	0.0005	0.0003	0.0003	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005	0.0005	0.0005	0.0005	0.0003	0.0005

Sample ID	Date Sampled	Top	Bottom	Trigger	OPs																			
					Bromophos-ethyl	Carbophenothion	Chlorfenvinphos (E)	Chlorfenvinphos (Z)	Chlorpyrifos	Chlorpyrifos-methyl	Demeton-S-methyl	Diazinon	Dichlorvos	Dimethoate	Ethion	Fenamiphos	Fenthion	Malathion	Azinphos Methyl	Monocrotophos	Parathion	Parathion-methyl	Pirimphos-ethyl	Prothiofos
				HIL-A	NG	NG	NG	NG	160	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				HIL- B	NG	NG	NG	NG	340	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				HIL-C	NG	NG	NG	NG	250	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				HIL-D	NG	NG	NG	NG	2000	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				EIL/ESL	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				LOR	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C01S01	12/11/2019	0.00	0.25		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C01S03	12/11/2019	0.50	1.20		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C02S01	12/11/2019	0.00	0.20		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C02S02	12/11/2019	0.20	0.50		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C03S01	12/11/2019	0.00	0.20		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C03S03	12/11/2019	0.50	1.20		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C04S01	13/11/2019	0.00	0.20		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C04S02	13/11/2019	0.20	0.50		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C05S01	13/11/2019	0.00	0.25		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C05S02	13/11/2019	0.25	0.50		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C05S03	13/11/2019	0.50	1.00		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C06S01	12/11/2019	0.00	0.25		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C06S02	12/11/2019	0.25	0.50		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C06S03	12/11/2019	0.50	1.20		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C07S01	12/11/2019	0.00	0.20		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C07S02	12/11/2019	0.20	0.70		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C07S03	12/11/2019	0.70	1.20		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

MAKING COMPLEX EASY

Table F: Sediment Analytical Results - PFAS - Onshore Reuse

Definitions:

LOR (Limits of Reporting), EIL (Ecological Investigation Level) - DE (Direct Exposure, Public Open Space) -IE R (Indirect Exposure Residential) IE I (Indirect Exposure Industrial) , HSL (Health Screening Level) -A (Residential with garden) -B (Residential minimal soil access) -C (Public Open Space) -D (Industrial / Commercial)
ND denotes not detected. NG denotes no guideline. --- denotes not tested

Notes:

All values in mg/kg unless indicated. Table uses colour coding for data interpretation. All guideline values from NEMP (2019)
deontes <LOR
** denotes triplicate result

Sample ID	Date Sampled	Top	Bottom	Trigger	PFAS																													
					Perfluorobutane sulfonic acid (PFBS)	Perfluoropentane sulfonic acid (PFPeS)	Perfluorohexane sulfonic acid (PFHxS)	Perfluoroheptane sulfonic acid (PFHpS)	Perfluorooctane sulfonic acid (PFOS)	Sum of PFHxS and PFOS	Perfluorodecane sulfonic acid (PFDS)	Perfluorobutanoic acid (PFBA)	Perfluoropentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnDA)	Perfluorododecanoic acid (PFDoDA)	Perfluorotridecanoic acid (PFTrDA)	Perfluorotetradecanoic acid (PFTeDA)	Perfluorooctane sulfonamide (FOSA)	N-methyl perfluorooctane sulfonamide (MeFOSA)	N-ethyl perfluorooctane sulfonamide (EtFOSA)	N-methyl perfluorooctane sulfonamidoethanol (MeFOSE)	N-ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	N-methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	N-ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	4:2 Fluorotelomer sulfonic acid (4:2 FTS)	6:2 Fluorotelomer sulfonic acid (6:2 FTS)	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	10:2 Fluorotelomer sulfonic acid (10:2 FTS)	Total PFAS
				HSL-A	NG	NG	NG	NG	NG	0.009	NG	NG	NG	NG	NG	0.1	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				HSL- B	NG	NG	NG	NG	NG	2	NG	NG	NG	NG	NG	20	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				HSL-C	NG	NG	NG	NG	NG	1	NG	NG	NG	NG	NG	10	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				HSL-D	NG	NG	NG	NG	NG	20	NG	NG	NG	NG	NG	50	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				EIL - DE	NG	NG	NG	NG	1	NG	NG	NG	NG	NG	NG	10	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				EIL - IE R	NG	NG	NG	NG	0.01	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				EIL- IE I	NG	NG	NG	NG	0.14	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				LOR	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
Secondary Assessment																																		
C01S01	23/03/2020	0.00	0.20		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C01S03	23/03/2020	0.40	1.20		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C02S01	23/03/2020	0.00	0.20		0.0002	0.0002	0.0002	0.0002	0.0005**	0.0005**	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0005**
C02S02	23/03/2020	0.20	0.50		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C03S01	23/03/2020	0.00	0.20		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C03S03	23/03/2020	0.50	1.20		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C04S01	23/03/2020	0.00	0.20		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C04S02	23/03/2020	0.20	0.50		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C05S01	23/03/2020	0.00	0.20		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C05S03	23/03/2020	0.50	1.20		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C06S01	23/03/2020	0.00	0.20		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C06S02	23/03/2020	0.20	0.50		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C07S01	23/03/2020	0.00	0.20		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C07S03	23/03/2020	0.50	1.10		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
				MEAN	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
				MEDIAN	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
				STDEV	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
				COUNT	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
				95%UCL	0.0002	0.0002	0.0002	0.0002	0.0003	0.0003	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0003

Table G: Sediment Analytical Results - Explosives - Onshore Reuse

Definitions:

LOR (Limits of Reporting), NEPM (2013) - Health Investigation Levels for residential (HIL-A), high density residential (HIL-B), public open space(HIL-C), Commercial/industrial (HIL-D), Ecological Investigation/Screening Levels - Areas of Ecological Significance (EIL/ESL)
ND denotes not detected. NG denotes no guideline. --- denotes not tested

Notes:

All values in mg/kg. Table uses colour coding for data interpretation. All guideline values from NEPM (2013)
deontes <LOR

Sample ID	Date Sampled	Top	Bottom	Trigger	Explosives																	
					HMX	RDX	1.3.5-Trinitrobenzene	1.3-Dinitrobenzene	Tetryl	2.4.6-TNT	4-Amino.2.6-DNT	2-Amino-4.6-DNT	4-& 2-Am-DNT(Isomeric Mixture)	2.4-Dinitrotoluene	2.6-Dinitrotoluene	2.4-& 2.6-DNT(Isomeric Mixture)	Nitrobenzene	2-Nitrotoluene	3-Nitrotoluene	4-Nitrotoluene	Nitroglycerine	PETN
				HIL-A	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				HIL- B	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				HIL-C	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				HIL-D	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				EIL/ESL	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				LOR	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1
C01S01	12/11/2019	0.00	0.25		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1
C01S03	12/11/2019	0.50	1.20		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1
C02S01	12/11/2019	0.00	0.20		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1
C02S02	12/11/2019	0.20	0.50		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C03S01	12/11/2019	0.00	0.20		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1
C03S03	12/11/2019	0.50	1.20		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C04S01	13/11/2019	0.00	0.20		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1
C04S02	13/11/2019	0.20	0.50		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C05S01	13/11/2019	0.00	0.25		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1
C05S02	13/11/2019	0.25	0.50		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C05S03	13/11/2019	0.50	1.00		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C06S01	12/11/2019	0.00	0.25		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1
C06S02	12/11/2019	0.25	0.50		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C06S03	12/11/2019	0.50	1.20		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C07S01	12/11/2019	0.00	0.20		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1
C07S02	12/11/2019	0.20	0.70		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C07S03	12/11/2019	0.70	1.20		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

MAKING COMPLEX EASY

Table H: Sediment Analytical Results - Acid Sulfate Soil Results

Definitions:

- (No Guideline), --- not tested, LOR (Limit of Reporting),

Notes:

This table utilises colour coding to aid data interpretation, avoid black and white reproduction
Units are as shown

Denotes less than LOR

Denotes sample exceeds DWER Action Criteria of 0.03 (%S) or 18 mol H^+ / tonne, for excavations of >1,000 tonnes

Sample ID	Date	Interval (m)	Sample Descrption	Trigger	Acidity Trail						CRS		Net Acidity		ANC		
					pH_{KCl}	pH_{OX}	TAA	S_{TAA}	TPA	S_{TPA}	aSCR	SCR	SCR + STAA	SCR + STAA	ANC	ANC	ANC (seived to 0.6 mm)
				Units	pH	pH	mht	%S	mht	%S	mht	%S	mht	%S	mht	%S	%S
				ASS	<4.0	<4.0	18	0.03	18	0.03	18	0.03	18	0.03	-	-	-
				LOR	0.1	0.1	5	0.005	5	0.005	5	0.005	5	0.005	5	0.02	0.02
C01S01	12/11/2019	0.0-0.25	Sediment, Pale Grey, MFG, abundant sea grass, roots, rootlets, some shell fragments		9.7	7.9	<2	<0.02	<2	<0.02	34	0.054	34	0.050	16,700	26.8	25.9
C01S03	12/11/2019	0.25-1.20	Sediment, pale grey, some sea grass roots, rootlets + shell fragments		10.0	7.9	<2	<0.02	<2	<0.02	<10	0.007	<10	<0.02	17,500	28.0	---
C02S01	12/11/2019	0.0-0.20	Sediment, pale grey, MFG is abundant, sea grass roots/detritus, some shell fragments		9.6	8.0	<2	<0.02	<2	<0.02	<10	0.007	<10	<0.02	16,800	26.9	---
C03S01	12/11/2019	0.0-0.20	Sediment, Pale Grey, MFG, some sea grass, roots/detritus + shell fraction		9.9	7.9	<2	<0.02	<2	<0.02	<10	0.009	<10	<0.02	16,600	26.6	---
C04S01	13/11/2019	0.0-0.20	Sediment, Pale Grey, MFG is abundant, some sea grass, roots/detritus + shell fraction		9.7	8.0	<2	<0.02	<2	<0.02	<10	0.008	<10	<0.02	17,100	27.5	---
C05S01	13/11/2019	0.0-0.25	Sediment, Pale Grey/Grey, MFG, abundant sea grass, detritus and roots.		10.0	8.0	<2	<0.02	<2	<0.02	<10	0.005	<10	<0.02	17,100	27.4	---
C06S01	12/11/2019	0.0-0.25	Sediment, Pale Grey/Grey, MFG, brown/grey lens at 0.6mbgl, shell fraction + trace seagrass/weed/detritus, H2S odour from 0.50 mbgl, compact, trace gravels/ cobbles		10.1	8.1	<2	<0.02	<2	<0.02	<10	0.008	<10	<0.02	16,700	26.8	---
C06S03	12/11/2019	0.5-1.20			10.0	8.1	<2	<0.02	<2	<0.02	15	0.024	15	0.020	15,700	25.2	24.9
C07S01	12/11/2019	0.0-0.20	Sediment, Pale Grey compact, MFG, shell fraction		10.1	8.1	<2	<0.02	<2	<0.02	<10	0.007	<10	<0.02	17,000	27.3	---

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Table I: Sediment Analytical Results - Metals, Metalloids, Inorganics and Nutrients - Dredging/Offshore Disposal

Definitions:

LOR (Limits of Reporting), DGV (Default guideline value), GV-High (Guideline Value High)
ND denotes not detected. NG denotes no guideline. --- denotes not tested

Notes:

All values in mg/kg except TOC which is in %, asbestos %w/w and Tributyl Tin in µg Sn/kg. Table uses colour coding for data interpretation. All guideline values from WQA (2018)
denotes <LOR

Sample ID	Date Sampled	Top	Bottom	Trigger	Total Metals														Tributyl Tin	Asbestos	TOC	Nutrients					
					Antimony	Arsenic	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Vanadium	Zinc			Total Organic Carbon	Total Phosphorus	Phosphorous Reactive	Total Nitrogen	Nitrogen Kjeldahl Total	Ammonia (as N)	NO_X
				GV-High	25	70	10	370	270	270	220	NG	1	52	NG	4	NG	410	70	NG	NG	NG	NG	NG	NG	NG	NG
				DGV	2	20	1.5	80	65	65	50	NG	0.15	21	NG	1	NG	200	9	NG	NG	NG	NG	NG	NG	NG	NG
				LOR	0.5	1	0.1	1	1	0.5	1	10	0.01	1	0.1	0.1	2	1	0.5	0.001	0.02	2	0.1	20	20	0.2	0.1
C01S01	12/11/2019	0.00	0.25		1.47	2	0.3	11	1	1	1	10	0.01	2	0.3	0.2	11	2	0.5	0.001	0.46	303	0.1	330	330	4.1	0.1
C01S03	12/11/2019	0.50	1.20		0.5	1	0.2	10	1	1	1	10	0.01	1	0.1	0.1	11	1	0.5	0.001	0.32	232	0.1	310	310	0.2	0.1
C02S01	12/11/2019	0.00	0.20		0.5	1	0.1	11	1	1	1	10	0.01	1	0.3	0.2	6	2	0.5	0.001	0.48	280	0.6	230	230	0.7	0.1
C02S02	12/11/2019	0.20	0.50		0.85	1	0.2	10	1	1	1	10	0.01	1	0.2	0.1	13	1	----	----	----	----	----	----	----	----	----
C03S01	12/11/2019	0.00	0.20		0.5	1	0.1	10	1	1	1	10	0.01	1	0.2	0.1	4	4	0.5	0.001	0.34	269	0.3	260	260	0.2	0.1
C03S03	12/11/2019	0.50	1.20		0.77	1	0.1	10	1	1	1	10	0.01	1	0.2	0.1	12	4	----	----	----	----	----	----	----	----	----
C04S01	13/11/2019	0.00	0.20		0.61	1	0.2	10	1	1	1	10	0.01	1	0.2	0.1	11	2	0.5	0.001	0.72	254	0.8	330	330	20.6	0.1
C04S02	13/11/2019	0.20	0.50		0.5	1	0.2	11	1	1	1	10	0.01	1	0.2	0.1	12	1	----	----	----	----	----	----	----	----	----
C05S01	13/11/2019	0.00	0.25		0.5	1	0.1	9	1	1	1	10	0.01	1	0.1	0.1	2	2	0.5	0.001	0.23	274	0.2	250	250	0.2	0.1
C05S02	13/11/2019	0.25	0.50		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C05S03	13/11/2019	0.50	1.00		0.5	1	0.1	10	1	1	1	10	0.01	1	0	0.1	3	4	----	----	----	----	----	----	----	----	----
C06S01	12/11/2019	0.00	0.25		0.5	1	0.1	9	1	1	1	10	0.01	1	0	0.1	2	2	0.5	0.001	0.05	311	0.2	190	190	0.4	0.1
C06S02	12/11/2019	0.25	0.50		0.5	1	0.1	9	1	1	1	10	0.01	1	0	0.1	3	3	----	----	----	----	----	----	----	----	----
C06S03	12/11/2019	0.50	1.20		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C07S01	12/11/2019	0.00	0.20		0.5	1	0.1	9	1	1	1	10	0.01	1	0	0.1	2	2	0.5	0.001	0.04	327	0.3	210	210	1	0.1
C07S02	12/11/2019	0.20	0.70		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C07S03	12/11/2019	0.70	1.20		0.5	2	0.1	9	1	1	1	10	0.01	1	0	0.1	2	1	----	----	----	----	----	----	----	----	----
				MEAN	0.5	1.2	0.1	9.5	1.0	0.5	1.0	10	0.01	1	0.1	0.1	5	2	0.5	0.001	0.28	287	0.4	248	248	4.5	0.1
				MEDIAN	0.5	1.2	0.1	9.5	1.0	0.5	1.0	10	0.01	1	0.1	0.1	3	2	0.5	0.001	0.23	274	0.3	250	250	0.4	0.1
				STDEV	0.1	0.3	0.0	0.7	0.0	0.0	0.0	0.0	0.00	0	0.1	0.0	5	1	0.0	0.0	0.28	31	0.3	54	54	9.0	0.0
				COUNT	10	10	10	10	10	10	10	10	10	10	10	10	10	10	5	5	5	5	5	5	5	5	5
				95%UCL	0.6	1	0.1	10	1	1	1	10	0.01	1	0.2	0.1	8	3	0.5	0.001	0.50	311	0.6	291	291	11.6	0.1

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Table J: Sediment Analytical Results - PAHs - Dredging/Offshore Disposal

Definitions:

LOR (Limits of Reporting), DGV (Default guideline value), GV-High (Guideline Value High), PAH - Polycyclic Aromatic Hydrocarbons, LMW: Low Molecular Weight, HMW: High Molecular Weight
ND denotes not detected. NG denotes no guideline. --- denotes not tested

Notes:

All values in mg/kg unless indicated. Table uses colour coding for data interpretation. All guideline values from WQA (2018)
deontes <LOR
Concentrations have been normalised to 1% based upon the Total Organic Carbon of the samples

Sample ID	Date Sampled	Top	Bottom	Trigger	PAHs																						
					2-methyl-naphthalene	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benz(a)pyrene	Benz(b)fluoranthene	Benz(e)pyrene	Benz(ghi)perylene	Benz(k)fluoranthene	Chrysene	Coronene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Perylene	Phenanthrene	Pyrene	LMW PAHs	HMW PAHs	Total PAH
				GV-High	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	50
				DGV	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	0.20	10
				LOR	0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004	0.004
C01S01	12/11/2019	0.00	0.25		0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004	0.004
C01S03	12/11/2019	0.50	1.20		0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004	0.004
C02S01	12/11/2019	0.00	0.20		0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004	0.004
C02S02	12/11/2019	0.20	0.50		0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004	0.004
C03S01	12/11/2019	0.00	0.20		0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004	0.004
C03S03	12/11/2019	0.50	1.20		0.005	0.004	0.008	0.020	0.020	0.020	0.020	0.020	0.004	0.020	0.020	0.005	0.004	0.020	0.004	0.020	0.005	0.004	0.004	0.020	0.004	0.004	0.004
C04S01	13/11/2019	0.00	0.20		0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004	0.004
C04S02	13/11/2019	0.20	0.50		0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004	0.004
C05S01	13/11/2019	0.00	0.25		0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004	0.004
C05S02	13/11/2019	0.25	0.50		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C05S03	13/11/2019	0.50	1.00		0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004	0.004
C06S01	12/11/2019	0.00	0.25		0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004	0.004
C06S02	12/11/2019	0.25	0.50		0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004	0.004
C06S03	12/11/2019	0.50	1.20		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C07S01	12/11/2019	0.00	0.20		0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004	0.004
C07S02	12/11/2019	0.20	0.70		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C07S03	12/11/2019	0.70	1.20		0.005	0.004	0.200	0.040	0.024	0.060	0.028	0.020	0.060	0.020	0.004	0.005	0.004	0.004	0.004	0.040	0.005	0.020	0.004	0.008	0.004	0.004	0.004

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Table K: Sediment Analytical Results - TRH and BTEX - Dredging/Offshore Disposal

Definitions:

LOR (Limits of Reporting), DGV (Default guideline value), GV-High (Guideline Value High)
ND denotes not detected. NG denotes no guideline. --- denotes not tested

Notes:

All values in mg/kg unless indicated. Table uses colour coding for data interpretation. All guideline values from WQA (2018)
deontes <LOR
Concentrations have been normalised to 1% based upon the Total Organic Carbon of the samples

Sample ID	Date Sampled	Top	Bottom	Trigger	BTEX							TPH					TRH						
					Benzene	Ethyl Benzene	Toluene	ortho-Xylene	meta,para-Xylene	Xylene	Sum of BTEX	C6 - C9	C10 - C14	C15 - C28	C29 - C36	C10 - C36 (sum)	C6 - C10	C6 - C10 minus BTEX (F1)	>C10 - C16	>C10 - C16 minus Naphthalene (F2)	>C16 - C34	>C34 - C40	>C10 - C40 (sum)
				GV-High	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	550	NG	NG	NG	NG	NG	NG	NG
				DGV	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	280	NG	NG	NG	NG	NG	NG	NG
				LOR	0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
C01S01	12/11/2019	0.00	0.25		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
C01S03	12/11/2019	0.50	1.20		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
C02S01	12/11/2019	0.00	0.20		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
C02S02	12/11/2019	0.20	0.50		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
C03S01	12/11/2019	0.00	0.20		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
C03S03	12/11/2019	0.50	1.20		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
C04S01	13/11/2019	0.00	0.20		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
C04S02	13/11/2019	0.20	0.50		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
C05S01	13/11/2019	0.00	0.25		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
C05S02	13/11/2019	0.25	0.50		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C05S03	13/11/2019	0.50	1.00		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
C06S01	12/11/2019	0.00	0.25		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	5	5	5	3	3	3	3	5	5	5
C06S02	12/11/2019	0.25	0.50		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
C06S03	12/11/2019	0.50	1.20		----	----	----	----	----	----	----	----	----	----	----	----	----	3	----	----	----	----	----
C07S01	12/11/2019	0.00	0.20		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
C07S02	12/11/2019	0.20	0.70		----	----	----	----	----	----	----	----	----	----	----	----	----	3	----	----	----	----	----
C07S03	12/11/2019	0.70	1.20		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	7	7	3	3	3	3	6	7	13

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Table L: Sediment Analytical Results - OC/OP Pesticides - Dredging/Offshore Disposal

Definitions:

LOR (Limits of Reporting), DGV (Default guideline value), GV-High (Guideline Value High)
ND denotes not detected. NG denotes no guideline. --- denotes not tested

Notes:

All values in mg/kg unless indicated. Table uses colour coding for data interpretation. All guideline values from WQA (2018)
deontes <LOR
Concentrations have been normalised to 1% based upon the Total organic Carbon of the samples

Sample ID	Date Sampled	Top	Bottom	Trigger	OCs																								
					Aldrin	Aldrin+Dieldrin	Alpha-BHC	Beta-BHC	Chlordane	cis-Chlordane	DDD	DDE	DDT	Delta-BHC	Dieldrin	Endosulfan (sum)	alpha-Endosulfan	beta-Endosulfan	Endosulphan Sulfate	Endrin	Endrin Aldehyde	Endrin Ketone	gamma-BHC (Lindane)	HCB	Heptachlor	Heptachlor Epoxide	Methoxychlor	Oxychlordane	trans-Chlordane
				GV-High	NG	NG	NG	NG	0.009	0.006	0.009	0.007	0.005	NG	0.007	NG	NG	NG	NG	0.06	NG	NG	0.0014	NG	NG	NG	NG	NG	0.006
				DGV	NG	NG	NG	NG	0.0045	0.0005	0.0035	0.0014	0.0012	NG	0.0028	NG	NG	NG	NG	0.0027	NG	NG	0.0009	NG	NG	0.2	NG	NG	0.0005
				LOR	0.0005	0.0005	0.0005	0.0005	0.00025	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005
C01S01	12/11/2019	0.00	0.25		0.0005	0.0005	0.0005	0.0005	0.00025	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005
C01S03	12/11/2019	0.50	1.20		0.0005	0.0005	0.0005	0.0005	0.00025	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005
C02S01	12/11/2019	0.00	0.20		0.0005	0.0005	0.0005	0.0005	0.00025	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005
C02S02	12/11/2019	0.20	0.50		0.0005	0.0005	0.0005	0.0005	0.00025	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005
C03S01	12/11/2019	0.00	0.20		0.0005	0.0005	0.0005	0.0005	0.00025	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005
C03S03	12/11/2019	0.50	1.20		0.0005	0.0005	0.0005	0.0005	0.00025	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005
C04S01	13/11/2019	0.00	0.20		0.0005	0.0005	0.0005	0.0005	0.00025	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005
C04S02	13/11/2019	0.20	0.50		0.0005	0.0005	0.0005	0.0005	0.00025	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005
C05S01	13/11/2019	0.00	0.25		0.0005	0.0005	0.0005	0.0005	0.00025	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005
C05S02	13/11/2019	0.25	0.50		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C05S03	13/11/2019	0.50	1.00		0.0005	0.0005	0.00050	0.00050	0.00025	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005
C06S01	12/11/2019	0.00	0.25		0.0005	0.0005	0.00050	0.00050	0.00025	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005
C06S02	12/11/2019	0.25	0.50		0.0005	0.0005	0.00050	0.00050	0.00025	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005
C06S03	12/11/2019	0.50	1.20		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C07S01	12/11/2019	0.00	0.20		0.0005	0.0005	0.0005	0.0005	0.00025	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005
C07S02	12/11/2019	0.20	0.70		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C07S03	12/11/2019	0.70	1.20		0.0005	0.0005	0.0005	0.0005	0.0003	0.0003	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005

Sample ID	Date Sampled	Top	Bottom	Trigger	OPs																			
					Bromophos-ethyl	Carbophenothion	Chlorfenvinphos (E)	Chlorfenvinphos (Z)	Chlorpyrifos	Chlorpyrifos-methyl	Demeton-S-methyl	Diazinon	Dichlorvos	Dimethoate	Ethion	Fenamiphos	Fenthion	Malathion	Azinphos Methyl	Monocrotophos	Parathion	Parathion-methyl	Pirimphos-ethyl	Prothiofos
				GV-High	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				DGV	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				LOR	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C01S01	12/11/2019	0.00	0.25		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C01S03	12/11/2019	0.50	1.20		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C02S01	12/11/2019	0.00	0.20		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C02S02	12/11/2019	0.20	0.50		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C03S01	12/11/2019	0.00	0.20		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C03S03	12/11/2019	0.50	1.20		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C04S01	13/11/2019	0.00	0.20		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C04S02	13/11/2019	0.20	0.50		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C05S01	13/11/2019	0.00	0.25		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C05S02	13/11/2019	0.25	0.50		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C05S03	13/11/2019	0.50	1.00		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C06S01	12/11/2019	0.00	0.25		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C06S02	12/11/2019	0.25	0.50		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C06S03	12/11/2019	0.50	1.20		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C07S01	12/11/2019	0.00	0.20		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C07S02	12/11/2019	0.20	0.70		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C07S03	12/11/2019	0.70	1.20		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

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Table M: Sediment Analytical Results - PFAS - Dredging/Offshore Disposal

Definitions:

LOR (Limits of Reporting), DGV (Default guideline value), GV-High (Guideline Value High)
ND denotes not detected. NG denotes no guideline. --- denotes not tested

Notes:

All values in mg/kg unless indicated. Table uses colour coding for data interpretation. All guideline values from WQA (2018)
deontes <LOR
** denotes triplicate result

Sample ID	Date Sampled	Top	Bottom	Trigger	PFAS																													
					Perfluorobutane sulfonic acid (PFBS)	Perfluoropentane sulfonic acid (PFPeS)	Perfluorohexane sulfonic acid (PFHxS)	Perfluoroheptane sulfonic acid (PFHpS)	Perfluorooctane sulfonic acid (PFOS)	Sum of PFHxS and PFOS	Perfluorodecane sulfonic acid (PFDS)	Perfluorobutanoic acid (PFBA)	Perfluoropentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnDA)	Perfluorododecanoic acid (PFDoDA)	Perfluorotridecanoic acid (PFTrDA)	Perfluorotetradecanoic acid (PFTeDA)	Perfluorooctane sulfonamide (FOSA)	N-methyl perfluorooctane sulfonamide (MeFOSA)	N-ethyl perfluorooctane sulfonamide (EtFOSA)	N-methyl perfluorooctane sulfonamidoethanol (MeFOSE)	N-ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	N-methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	N-ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	4:2 Fluorotelomer sulfonic acid (4:2 FTS)	6:2 Fluorotelomer sulfonic acid (6:2 FTS)	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	10:2 Fluorotelomer sulfonic acid (10:2 FTS)	Total PFAS
				GV-High	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				DGV	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				LOR	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
Secondary Assessment																																		
C01S01	23/03/2020	0.00	0.20		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C01S03	23/03/2020	0.40	1.20		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C02S01	23/03/2020	0.00	0.20		0.0002	0.0002	0.0002	0.0002	0.0005**	0.0005**	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0005**
C02S02	23/03/2020	0.20	0.50		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C03S01	23/03/2020	0.00	0.20		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C03S03	23/03/2020	0.50	1.20		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C04S01	23/03/2020	0.00	0.20		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C04S02	23/03/2020	0.20	0.50		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C05S01	23/03/2020	0.00	0.20		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C05S03	23/03/2020	0.50	1.20		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C06S01	23/03/2020	0.00	0.20		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C06S02	23/03/2020	0.20	0.50		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C07S01	23/03/2020	0.00	0.20		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C07S03	23/03/2020	0.50	1.10		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
				MEAN	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
				MEDIAN	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
				STDEV	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
				COUNT	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	13
				95%UCL	0.0002	0.0002	0.0002	0.0002	0.0003	0.0003	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
Original Assessment																																		
C01S01	12/11/2019	0.00	0.25		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C01S03	12/11/2019	0.50	1.20		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C02S01	12/11/2019	0.00	0.20		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C02S02	12/11/2019	0.20	0.50		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C03S01	12/11/2019	0.00	0.20		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C03S03	12/11/2019	0.50	1.20		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C04S01	13/11/2019	0.00	0.20		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C04S02	13/11/2019	0.20	0.50		0.0002	0.0002	0.0002	0.0002	0.0004	0.0004	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0004
C05S01	13/11/2019	0.00	0.25		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C05S02	13/11/2019	0.25	0.50		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C05S03	13/11/2019	0.50	1.00		0.0002	0.0002	0.0002	0.0002	0.0006	0.0006	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0006
C06S01	12/11/2019	0.00	0.25		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C06S02	12/11/2019	0.25	0.50		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C06S03	12/11/2019	0.50	1.20		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C07S01	12/11/2019	0.00	0.20		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C07S02	12/11/2019	0.20	0.70		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C07S03	12/11/2019	0.70	1.20		0.0002	0.0002	0.0002	0.0002	0.0003	0.0003	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0003
				MEAN	0.0002	0.0002	0.0002	0.0002	0.0003	0.0003	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0003
				MEDIAN	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
				STDEV	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
				COUNT	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
				95%UCL	0.0002	0.0002	0.0002	0.0002	0.0003	0.0003	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0003

Table N: Sediment Analytical Results - Explosives - Dredging/Offshore Disposal

Definitions:

LOR (Limits of Reporting), DGV (Default guideline value), GV-High (Guideline Value High)
ND denotes not detected. NG denotes no guideline. --- denotes not tested

Notes:

All values in mg/kg unless indicated. Table uses colour coding for data interpretation. All guideline values from WQA (2018)
denotes <LOR
Concentrations have been normalised to 1% based upon the Total Organic Carbon of the samples

Sample ID	Date Sampled	Top	Bottom	Trigger	Explosives																	
					HMX	RDX	1.3.5-Trinitrobenzene	1.3-Dinitrobenzene	Tetryl	2.4.6-TNT	4-Amino.2.6-DNT	2-Amino-4.6-DNT	4-& 2-Am-DNT(Isomeric Mixture)	2.4-Dinitrotoluene	2.6-Dinitrotoluene	2.4-& 2.6-DNT(Isomeric Mixture)	Nitrobenzene	2-Nitrotoluene	3-Nitrotoluene	4-Nitrotoluene	Nitroglycerine	PETN
				GV-High	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				DGV	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
				LOR	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1
C01S01	12/11/2019	0.00	0.25		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1
C01S03	12/11/2019	0.50	1.20		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1
C02S01	12/11/2019	0.00	0.20		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1
C02S02	12/11/2019	0.20	0.50		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C03S01	12/11/2019	0.00	0.20		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1
C03S03	12/11/2019	0.50	1.20		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C04S01	13/11/2019	0.00	0.20		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1
C04S02	13/11/2019	0.20	0.50		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C05S01	13/11/2019	0.00	0.25		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1
C05S02	13/11/2019	0.25	0.50		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C05S03	13/11/2019	0.50	1.00		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C06S01	12/11/2019	0.00	0.25		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1
C06S02	12/11/2019	0.25	0.50		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C06S03	12/11/2019	0.50	1.20		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C07S01	12/11/2019	0.00	0.20		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1
C07S02	12/11/2019	0.20	0.70		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
C07S03	12/11/2019	0.70	1.20		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

MAKING COMPLEX EASY

Table O: Elutriate Analytical Results - Metals, Metalloids and Nutrients

Definitions:

LOR (Limits of Reporting), MEPG (Marine Ecological Protection Guideline)
ND denotes not detected. NG denotes no guideline. --- denotes not tested

Notes:

All elutriate values in mg/L, with total results (bottom) in mg/kg. Table uses colour coding for data interpretation. All guideline values from ANZECC 2000 or WQA 2018
denotes <LOR

Sample ID	Date Sampled	Trigger	Total Metals														Nutrients					
			Antimony	Arsenic	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Vanadium	Zinc	Total Phosphorus	Phosphorous Reactive	Total Nitrogen	Nitrogen Kjeldahl Total	Ammonia (as N)	NO_X
		MEPG	NG	NG	0.0007	0.0044	0.001	0.0013	0.0044	NG	0.0001	0.007	NG	0.0014	0.1	0.015	0.02 [c]	0.005	0.23	NG	0.005	0.005
		LOR	0.0002	0.0002	0.00005	0.0002	0.0001	0.0005	0.0001	0.0005	0.00004	0.0005	0.0002	0.0001	0.0002	0.001	0.005	0.001	0.05	0.05	0.005	0.002
EW	13/11/2019		0.0005	0.0013	0.0002	0.0005	0.0002	0.0010	0.0002	0.0005	0.00004	0.0005	0.002	0.0001	0.0005	0.007	0.005	0.001	0.1	0.09	0.005	0.003
C01S01	12/11/2019		0.0049	0.0097	0.0003	0.0005	0.0002	0.0050	0.0003	0.0028	0.00004	0.0008	0.002	0.0001	0.0459	0.028	0.054	0.047	1.0	0.97	0.472	0.004
C02S01	12/11/2019		0.0032	0.024	0.0002	0.0005	0.0002	0.0020	0.0002	0.0005	0.00004	0.0005	0.002	0.0001	0.0453	0.010	0.102	0.086	0.9	0.90	0.327	0.006
C03S03	12/11/2019		0.0052	0.0088	0.0002	0.0005	0.0002	0.0010	0.0002	0.0005	0.00004	0.0005	0.002	0.0001	0.1360	0.005	0.010	0.004	0.3	0.26	0.005	0.002
C04S02	13/11/2019		0.0016	0.0078	0.0002	0.0005	0.0002	0.0010	0.0002	0.0005	0.00004	0.0005	0.002	0.0001	0.1020	0.005	0.019	0.001	0.5	0.50	0.005	0.002
C05S03	13/11/2019		0.0096	0.0148	0.0002	0.0005	0.0002	0.0010	0.0002	0.0005	0.00004	0.0005	0.002	0.0001	0.1750	0.006	0.017	0.015	0.4	0.36	0.056	0.004
C06S02	12/11/2019		0.0005	0.0039	0.0002	0.0005	0.0002	0.0010	0.0002	0.0005	0.00004	0.0005	0.002	0.0001	0.0162	0.005	0.050	0.053	0.3	0.28	0.11	0.005
C07S01	12/11/2019		0.0005	0.003	0.0002	0.0005	0.0002	0.0010	0.0002	0.0007	0.00	0.0005	0.002	0.0001	0.0005	0.014	0.005	0.004	0.2	0.17	0.005	0.009
		MEAN	0.0036	0.0103	0.00021	0.0005	0.0002	0.0017	0.0002	0.0009	0.00004	0.0005	0.002	0.0001	0.0744	0.010	0.037	0.030	0.5	0.5	0.14	0.005
		MEDIAN	0.0032	0.0088	0.00020	0.0005	0.0002	0.0010	0.0002	0.0005	0.00004	0.0005	0.002	0.0001	0.0459	0.006	0.019	0.015	0.4	0.4	0.06	0.004
Sample ID	**Date Sampled**	GV-High	25	70	10	370	270	270	220	NG	1	52	NG	4	NG	410	NG	NG	NG	NG	NG	NG
		DGV	2	20	1.5	80	65	65	50	NG	0.15	21	NG	1	NG	200	NG	NG	NG	NG	NG	NG
		LOR	0.5	1	0.1	1	1	0.5	1	10	0.01	1	0.1	0.1	2	1	2	0.1	20	20	20	0.1
C01S01	12/11/2019		1.47	2	0.3	11	1	1	1	10	0.01	2	0.3	0.2	11	2	303	0.1	330	330	4.1	0.1
C02S01	12/11/2019		0.5	1	0.1	11	1	1	1	10	0.01	1	0.3	0.2	6	2	280	0.6	230	230	0.7	0.1
C03S03	12/11/2019		0.77	1	0.1	10	1	1	1	10	0.01	1	0.2	0.1	12	4	----	----	----	----	----	----
C04S02	13/11/2019		0.5	1	0.2	11	1	1	1	10	0.01	1	0.2	0.1	12	1	----	----	----	----	----	----
C05S03	13/11/2019		0.5	1	0.1	10	1	1	1	10	0.01	1	0	0.1	3	4	----	----	----	----	----	----
C06S02	12/11/2019		0.5	1	0.1	9	1	1	1	10	0.01	1	0	0.1	3	3	----	----	----	----	----	----
C07S01	12/11/2019		0.5	1	0.1	9	1	1	1	10	0.01	1	0	0.1	2	2	327	0.3	210	210	1	0.1

Table P: Elutriate Analytical Results - PFAS

Definitions:

LOR (Limits of Reporting), MEPG (Marine Ecological Protection Guideline)
ND denotes not detected. NG denotes no guideline. N asbestos not identified. --- denotes not tested

Notes:

All values in µg/L. Table uses colour coding for data interpretation. All guideline values from HEPA (2018)
deontes <LOR
* denotes duplicate result, ** denotes triplicate result

Sample ID	Date Sampled	Trigger	PFAS																													
			Perfluorobutane sulfonic acid (PFBS)	Perfluoropentane sulfonic acid (PFPeS)	Perfluorohexane sulfonic acid (PFHxS)	Perfluoroheptane sulfonic acid (PFHpS)	Perfluorooctane sulfonic acid (PFOS)	Sum of PFHxS and PFOS	Perfluorodecane sulfonic acid (PFDS)	Perfluorobutanoic acid (PFBA)	Perfluoropentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnDA)	Perfluorododecanoic acid (PFDoDA)	Perfluorotridecanoic acid (PFTrDA)	Perfluorotetradecanoic acid (PFTeDA)	Perfluorooctane sulfonamide (FOSA)	N-Methyl perfluorooctane sulfonamide (MeFOSA)	N-Ethyl perfluorooctane sulfonamide (EtFOSA)	N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	4:2 Fluorotelomer sulfonic acid (4:2 FTS)	6:2 Fluorotelomer sulfonic acid (6:2 FTS)	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	10:2 Fluorotelomer sulfonic acid (10:2 FTS)	Total PFAS
		MEPG	NG	NG	NG	NG	0.00023	NG	NG	NG	NG	NG	NG	19	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
		LOR	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.002	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0002
Secondary Assessment																																
C01-SW	23/03/2020		0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.002	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0002
C04-SW	23/03/2020		0.0005	0.0005	0.0005	0.0005	0.0003*	0.0003	0.0005	0.002	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0003
C06-SW	23/03/2020		0.0005	0.0005	0.0005	0.0005	0.0006*	0.0006	0.0005	0.002	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0006
EW	23/03/2020		0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.002	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0002
Matrix Blank	23/03/2020		0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.002	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0002
C01S01	23/03/2020		0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.002	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0002
C02S01	23/03/2020		0.0005	0.0005	0.0005	0.0005	0.0005**	0.0005**	0.0005	0.002	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005**
C03S03	23/03/2020		0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.002	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0002
C04S02	23/03/2020		0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.002	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.000
C05S03	23/03/2020		0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.002	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.000
C06S02	23/03/2020		0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.002	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.000
C07S01	23/03/2020		0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.002	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.000
		MEAN	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0020	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0010	0.0010	0.0010	0.0010	0.0005	0.0005	0.0010	0.0010	0.0010	0.0010	0.0002
		MEDIAN	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0020	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0010	0.0010	0.0010	0.0010	0.0005	0.0005	0.0010	0.0010	0.0010	0.0010	0.0002
Sample ID	**Date Sampled**	GV-High	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	550	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
		DGV	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	280	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
		LOR	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C01S01	23/03/2020		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C02S01	23/03/2020		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C03S03	23/03/2020		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C04S02	23/03/2020		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0004
C05S03	23/03/2020		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0006
C06S02	23/03/2020		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
C07S01	23/03/2020		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002

Figures

Figure A

Site location

GDA 1994 MGA Zone 50

0 250 500 1,000 m

Job Number: C19032-011 (N)
Doc Number: 001
Date: 11.05.20
Scale: 1:30,000 @ A3
Created by: MA
Source: Orthophoto - Landgate, 2017 Proposed development - RIA Dec 2019

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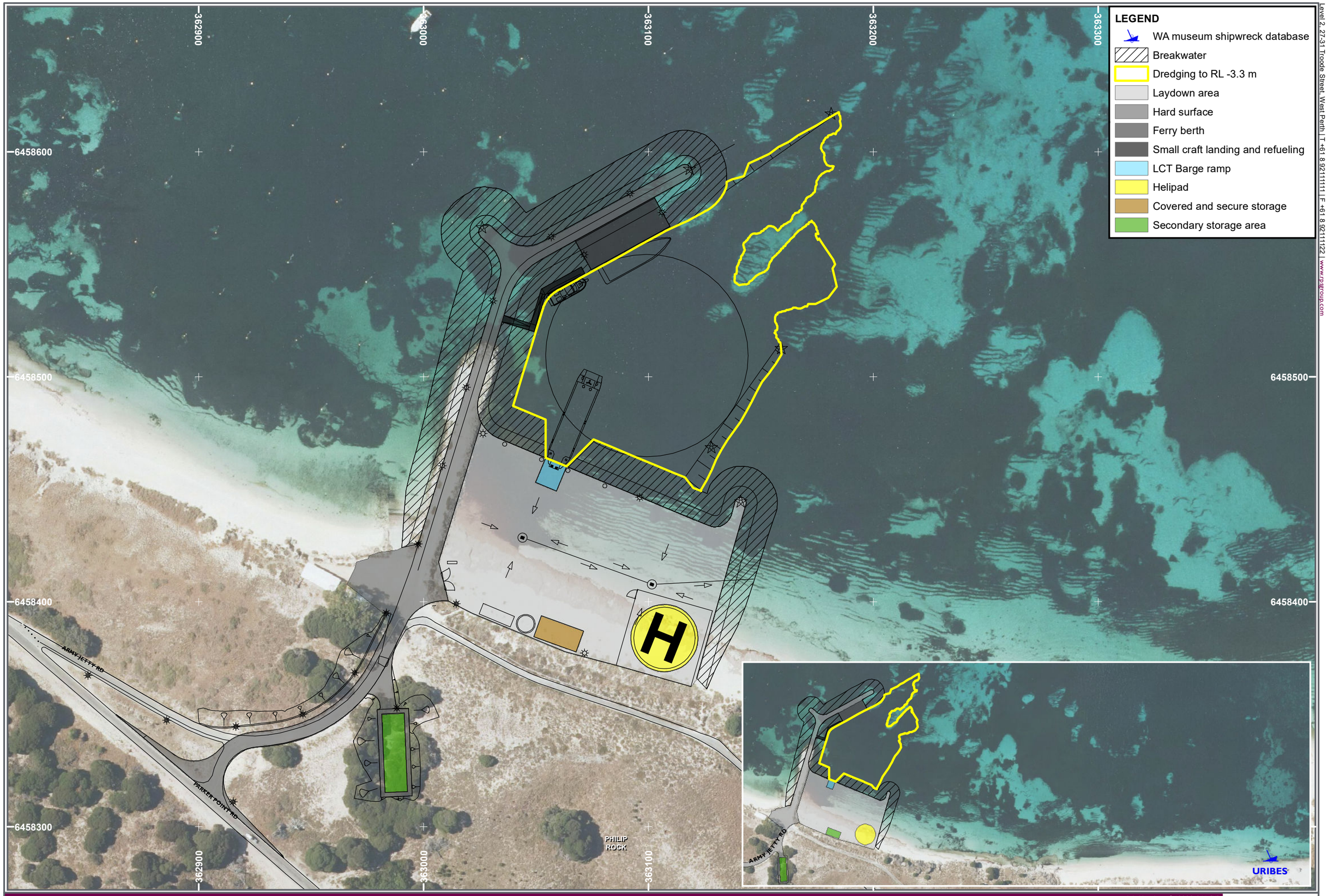

Figure B

Development area - Proposed barge ramp and cargo handling facilities

GDA 1994 MGA Zone 50

0 10 20 40 m

Source: Orthophoto - Landgate, 2017

Proposed development - RIA Dec 2019

Job Number: C19032-011 (N)
Doc Number: 002
Date: 11.05.20
Scale: 1:4,872 @ A3
Created by: MA

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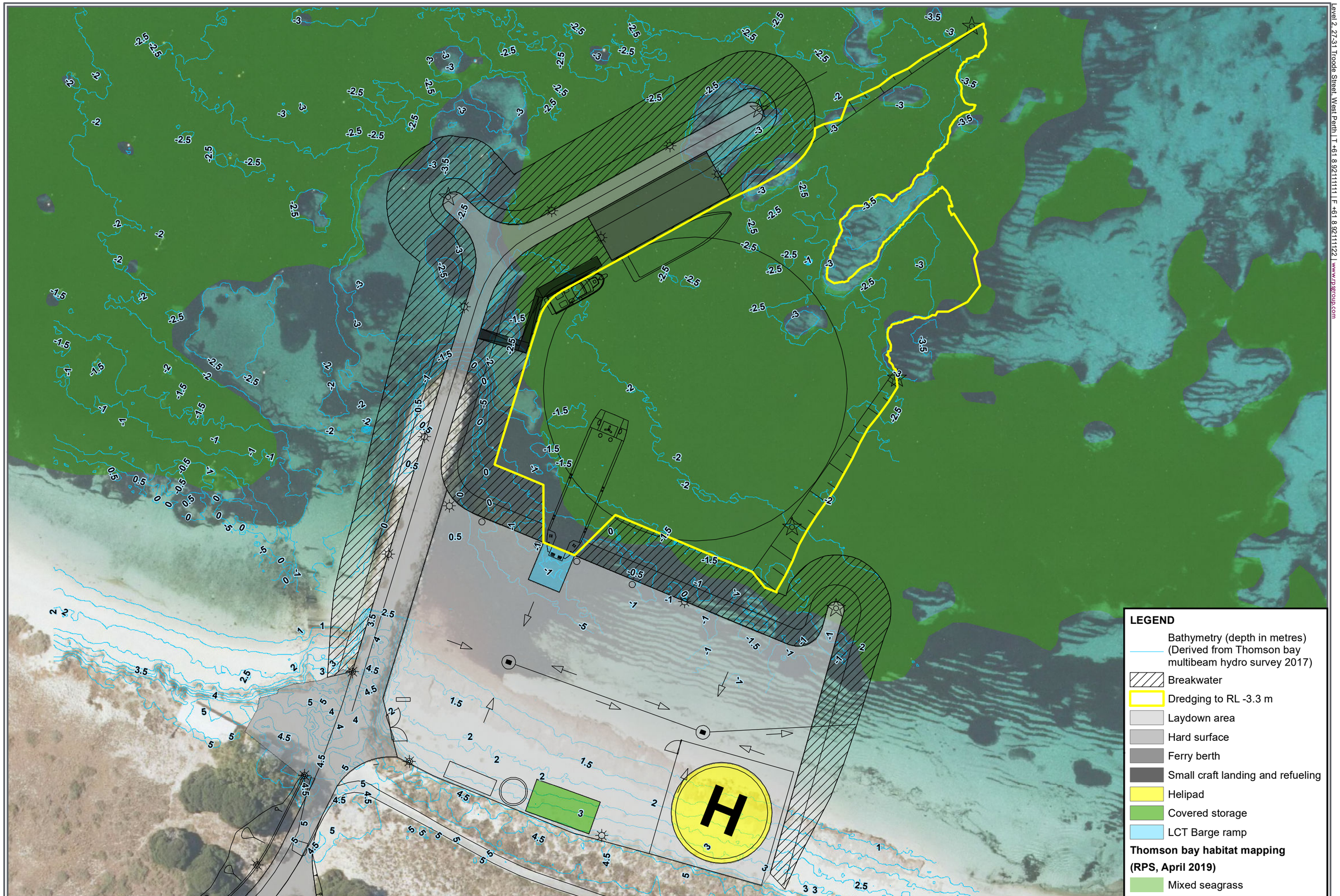

Figure C

Seagrass mapping and bathymetry

0 5 10 20 m

Horizontal: GDA 1994 MGA Zone 50
Vertical: Chart Datum (0.72 m below AHD)

Source: Orthophoto - Landgate, 2017

Proposed development - RIA Dec 2019 (RIA 1716-02-01 vF)

Job Number: C19032-011 (N)
Doc Number: 003
Date: 11.05.20
Scale: 1:1,000 @ A3
Created by: MA

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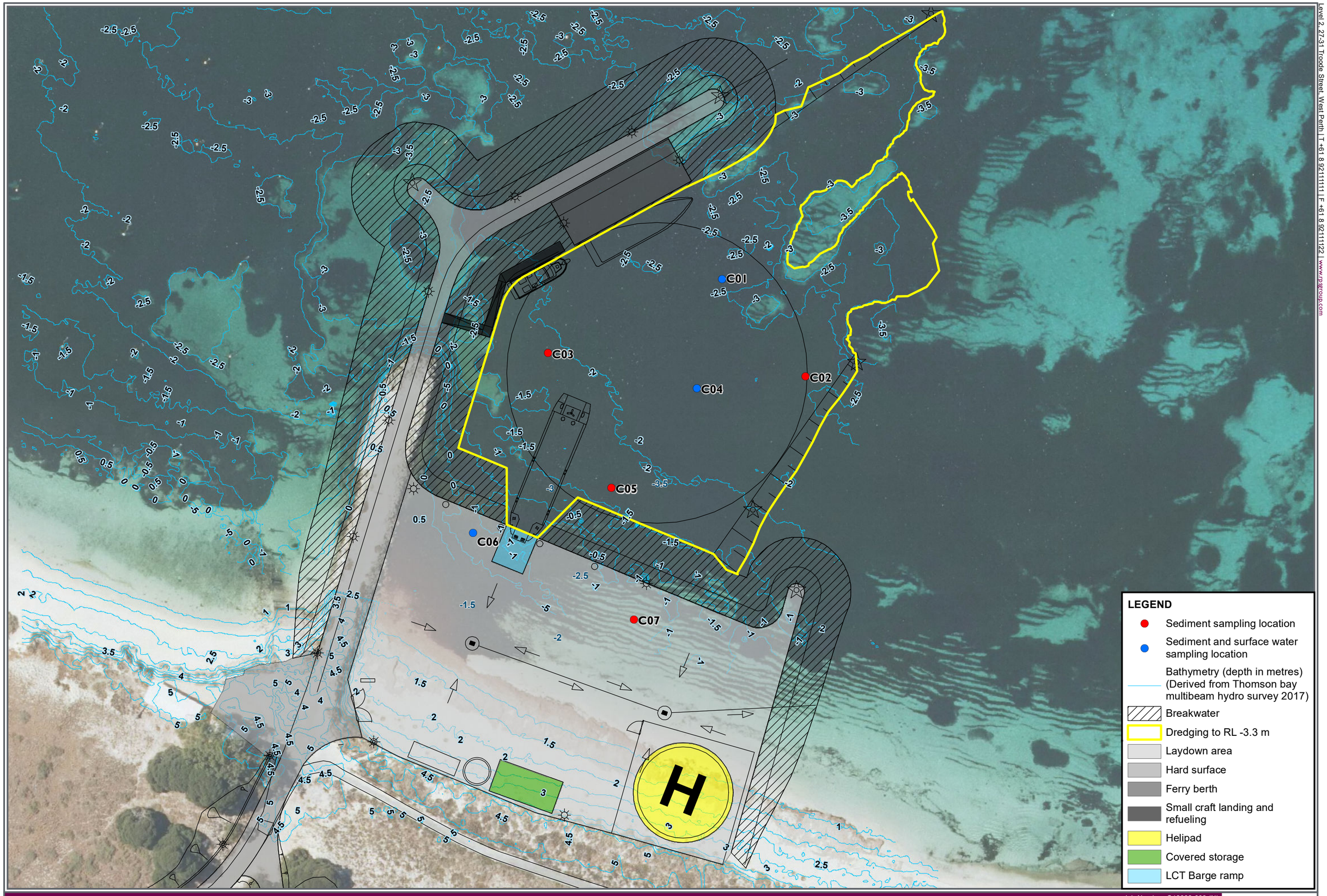

Figure D

Sediment sampling locations and proposed dredge design

0 5 10 20 m

Horizontal: GDA 1994 MGA Zone 50
Vertical: Chart Datum (0.72 m below AHD)

Job Number: C19032-003 (N)
Doc Number: 004
Date: 11.05.20
Scale: 1:1,000 @ A3
Created by: MA

Source: Orthophoto - Landgate, 2017 Proposed development - RIA Dec 2019

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Document Path: G:\Jobs\N Jobs\N19032 - DBCA Rottnest\Figures C19032-011 Jetty Sed Assess\C19032-011_G_004_FigD_Sediment and Proposed Design_200511.mxd

Appendix A
Sediment Sampling Logs

SEDIMENT PROFILE LOG

Project number:	EEC19032.011	**Weather:**	Fine
Site name:	Rottnest Army Jetty	**Sampling method:**	Push Probe
Sampling area:	Army Jetty	**Total depth (mbgl):**	1.2
Sampling location:	C01	**Refusal (Y/N):**	N
Scientist(s)	SMW	**Fill present (Y/N):**	N
Date	12/11/2019	**Fill thickness (m):**	-
Time:	825	**Water Column**	3 m
QAQC samples:	Dup: S21 + Trip: S221 Sampled at C01S0	**Easting / northing:**	363114/6458535

Soil depth (m)	Soil description (soil type, odour, texture, etc.)	Sample I.D.	Interval (m)
0-0.25	Sediment, Pale Grey, MFG, abundant sea grass, roots, rootlets, no odour/staining, some shell fragments	C01S01	0-0.25
0.25-1.20	Sediment, pale grey, some sea grass roots, rootlets + shell fragments, no odour/ staining	C01S02	0.25-0.50
		C01S03	0.50-1.20

Additional details / comments:

Elutriate Sample

SEDIMENT PROFILE LOG

Project number:	EEC19032.011	**Weather:**	Fine
Site name:	Rottnest Army Jetty	**Sampling method:**	Push Probe
Sampling area:	Army Jetty	**Total depth (mbgl):**	1.2
Sampling location:	C02	**Refusal (Y/N):**	1.1
Scientist(s)	SMW	**Fill present (Y/N):**	N
Date	12/11/2019	**Fill thickness (m):**	-
Time:	1120	**Water Column:**	2.5 m
QAQC samples:	-	**Easting / northing:**	363136/6458503

Soil depth (m)	Soil description (soil type, odour, texture, etc.)	Sample I.D.	Interval (m)
0-0.5	Sediment, pale grey, MFG is abundant, sea grass roots/detritus, some shell fragments, no odour/staining	C02S01	0-0.20
		C02S02	0.20-0.50
0.50-1.10	Sediment, Pale grey, MFG, some sea grass, detritus and shell fragments, no odour/staining	C02S03	0.50-1.10

Additional details / comments:

Elutriate Sample

SEDIMENT PROFILE LOG

Project number:	EEC19032.011	**Weather:**	Fine
Site name:	Rottnest Army Jetty	**Sampling method:**	Push Probe
Sampling area:	Army Jetty	**Total depth (mbgl):**	1.2
Sampling location:	C03	**Refusal (Y/N):**	N
Scientist(s)	SMW	**Fill present (Y/N):**	N
Date	12/11/2019	**Fill thickness (m):**	-
Time:	1440	**Water Column:**	2.5 m
QAQC samples:	Dup: S22 + Trip: S222	**Easting / northing:**	363067/6458515

Soil depth (m)	Soil description (soil type, odour, texture, etc.)	Sample I.D.	Interval (m)
0-0.25	Sediment, Pale Grey, MFG, some sea grass, roots/detritus + shell fraction, no odour/staining,	C03S01	0-0.20
0.25-1.20	Sediment, pale grey, some sea grass roots, rootlets + shell fragments, no odour/ staining	C03S02	0.20-0.50
		C03S03	0.50-1.20

Additional details / comments:

Elutriate Sample

SEDIMENT PROFILE LOG

Project number:	EEC19032.011	**Weather:**	Fine
Site name:	Rottnest Army Jetty	**Sampling method:**	Push Probe
Sampling area:	Army Jetty	**Total depth (mbgl):**	1
Sampling location:	C04	**Refusal (Y/N):**	Y @ 1.0m (hard layer)
Scientist(s)	SMW	**Fill present (Y/N):**	N
Date	13/11/2019	**Fill thickness (m):**	-
Time:	830	**Water Column:**	1.5 m
QAQC samples:	-	**Easting / northing:**	363109/6458487

Soil depth (m)	Soil description (soil type, odour, texture, etc.)	Sample I.D.	Interval (m)
0-1.0	Sediment, Pale Grey, MFG is abundant, some sea grass, roots/detritus + shell fraction, no odour/staining	C04S01	0-0.20
		C04S02	0.20-0.50
		C04S03	0.50-1.0

Additional details / comments:

Elutriate Sample

SEDIMENT PROFILE LOG

Project number:	EEC19032.011	**Weather:**	Fine
Site name:	Rottnest Army Jetty	**Sampling method:**	Push Probe
Sampling area:	Army Jetty	**Total depth (mbgl):**	1.2
Sampling location:	C05	**Refusal (Y/N):**	N
Scientist(s)	SMW	**Fill present (Y/N):**	N
Date	13/11/2019	**Fill thickness (m):**	N
Time:	1000	**Water Column:**	1.5 m
QAQC samples:	-	**Easting / northing:**	363073/6458469

Soil depth (m)	Soil description (soil type, odour, texture, etc.)	Sample I.D.	Interval (m)
0-1.2	Sediment, Pale Grey/Grey, MFG, abundant sea grass, detritus and roots, shell fraction, no odour/staining	C05S01	0-0.25
		C05S02	0.25-0.50
		C05S03	0.50-1.0

Additional details / comments:

Elutriate Sample

SEDIMENT PROFILE LOG

Project number:	EEC19032.011	**Weather:**	Fine
Site name:	Rottnest Army Jetty	**Sampling method:**	Push Probe
Sampling area:	Army Jetty	**Total depth (mbgl):**	1.2
Sampling location:	C06	**Refusal (Y/N):**	N
Scientist(s)	SMW	**Fill present (Y/N):**	N
Date	12/11/2019	**Fill thickness (m):**	-
Time:	1230	**Water Column:**	1.5 m
QAQC samples:	-	**Easting / northing:**	363035/6458455

Soil depth (m)	Soil description (soil type, odour, texture, etc.)	Sample I.D.	Interval (m)
0-1.2	Sediment, Pale Grey/Grey, MFG, brown/grey lens at 0.6mbgl, shell fraction + trace seagrass/weed/detritus, H_2S odour from 0.50 mbgl, compact, trace gravels/ cobbles	C06S01	0-0.25
		C06S02	0.25-0.50
		C06S03	0.50-1.2

Additional details / comments:

Elutriate Sample

SEDIMENT PROFILE LOG

Project number:	EEC19032.011	**Weather:**	Fine
Site name:	Rottnest Army Jetty	**Sampling method:**	Push Probe
Sampling area:	Army Jetty	**Total depth (mbgl):**	1.2
Sampling location:	C07	**Refusal (Y/N):**	N
Scientist(s)	SMW	**Fill present (Y/N):**	N
Date	12/11/2019	**Fill thickness (m):**	-
Time:	1345	**Water Column:**	1 m
QAQC samples:	-	**Easting / northing:**	363069/6458422

Soil depth (m)	Soil description (soil type, odour, texture, etc.)	Sample I.D.	Interval (m)
0-0.70	Sediment, Pale Grey compact, MFG, shell fraction, H_2S odour from 0.50mbgl	C07S01	0-0.20
		C07S02	0.20-0.70
0.7-1.20	Sediment, Grey, compact, F-CG,	C07S03	0.70-1.20

Additional details / comments:

Elutriate Sample

MULTI-PARAMETER METER CALIBRATION RECORD

Project number: EEC19032.001

Site location: Rottnest Island - Army Jetty

Date	pH 7		pH 4		EC buffer µs/cm		Temp. °C		D.O. ppm		Redox		Scientist
	Pre-cal	Post-cal	Pre-cal	Post-cal	Pre-cal	Post-cal	Pre-cal	Post-cal	Zero	Air	Temp. °C	Measurement	
11/11/2019	7.02	7	3.98	4	12825	12880	24.7	24	0	9.9	25	226	SMW

SEDIMENT PROFILE LOG

Project number:	EEC19032.011	**Weather:**	Fine
Site name:	Rottnest Army Jetty	**Sampling method:**	Push Probe
Sampling area:	Dredge Grounds	**Total depth (mbgl):**	1.2
Sampling location:	C01	**Refusal (Y/N):**	N
Scientist(s)	SMW	**Fill present (Y/N):**	N
Date	23-Mar	**Fill thickness (m):**	---
Time:	15:10	**Water Column**	2.5 - 2.7
QAQC samples:	Duplicate - SZ1, Triplicate - SZZ1	**Easting / northing:**	SAP

Soil depth (m)	Soil description (soil type, odour, texture, etc.)	Sample I.D.	Interval (m)
0.00 - 0.40	Sediment: Pale Grey/Grey - mfg, abundant seagrass and detritus (decaying seagrass), shell fraction, no odour or staining.	C01_S01	0.00 - 0.20
		C01_S02	0.20 - 0.40
0.40 - 1.20	Sediment: Pale Grey - mfg with some detritus (decaying seagrass), some shell fractions, no odour or staining.	C01_S03	0.40 - 1.20

Additional details / comments:

SEDIMENT PROFILE LOG

Project number:	EEC19032.011	**Weather:**	Fine
Site name:	Rottnest Army Jetty	**Sampling method:**	Push Probe
Sampling area:	Dredge Grounds	**Total depth (mbgl):**	1.1
Sampling location:	C02	**Refusal (Y/N):**	Y - hard layer at 1.10 mbgl
Scientist(s)	SMW	**Fill present (Y/N):**	N
Date	23-Mar	**Fill thickness (m):**	---
Time:	16:00	**Water Column**	2.8
QAQC samples:	Duplicate - SZ2, Triplicate - SZZ2	**Easting / northing:**	SAP

Soil depth (m)	Soil description (soil type, odour, texture, etc.)	Sample I.D.	Interval (m)
0.00 - 1.10	Sediment: Pale Grey/Grey - mfg, abundant to some seagrass and detritus (decreasing with depth), shell fraction, no odour or staining.	C02_S01	0.00 - 0.20
		C02_S02	0.20 - 0.50
		C02_S03	0.50 - 1.10

Additional details / comments:

SEDIMENT PROFILE LOG

Project number:	EEC19032.011	**Weather:**	Fine
Site name:	Rottnest Army Jetty	**Sampling method:**	Push Probe
Sampling area:	Dredge Grounds	**Total depth (mbgl):**	1.2
Sampling location:	C03	**Refusal (Y/N):**	N
Scientist(s)	SMW	**Fill present (Y/N):**	N
Date	23-Mar	**Fill thickness (m):**	---
Time:	14:30	**Water Column**	2
QAQC samples:	---	**Easting / northing:**	SAP

Soil depth (m)	Soil description (soil type, odour, texture, etc.)	Sample I.D.	Interval (m)
0.00 - 1.20	Sediment: Pale Grey/Grey - mfg, abundant detritus (decaying seagrass), shell fraction, compact at base.	C03_S01	0.00 - 0.20
		C03_S02	0.20 - 0.50
		C03_S03	0.50 - 1.20

Additional details / comments:

SEDIMENT PROFILE LOG

Project number:	EEC19032.011	**Weather:**	Fine
Site name:	Rottnest Army Jetty	**Sampling method:**	Push Probe
Sampling area:	Dredge Grounds	**Total depth (mbgl):**	1.1
Sampling location:	C04	**Refusal (Y/N):**	Y - hard layer at 1.10 m
Scientist(s)	SMW	**Fill present (Y/N):**	N
Date	23-Mar	**Fill thickness (m):**	---
Time:	13:30	**Water Column**	1.5 m
QAQC samples:	---	**Easting / northing:**	SAP

Soil depth (m)	Soil description (soil type, odour, texture, etc.)	Sample I.D.	Interval (m)
0.00 - 1.10	Sediment: Pale Grey/Grey - mfg, abundant detritus (decaying seagrass and roots), shell fractions, no odour or staining.	C04_S01	0.00 - 0.20
		C04_S02	0.20 - 0.50
		C04_S03	0.50 - 1.10

Additional details / comments:

SEDIMENT PROFILE LOG

Project number:	EEC19032.011	**Weather:**	Fine
Site name:	Rottnest Army Jetty	**Sampling method:**	Push Probe
Sampling area:	Dredge Grounds	**Total depth (mbgl):**	1.2
Sampling location:	C05	**Refusal (Y/N):**	N
Scientist(s)	SMW	**Fill present (Y/N):**	N
Date	23-Mar	**Fill thickness (m):**	---
Time:	11:30	**Water Column**	1.50 - 1.80
QAQC samples:	---	**Easting / northing:**	SAP

Soil depth (m)	Soil description (soil type, odour, texture, etc.)	Sample I.D.	Interval (m)
0.00 - 1.20	Sediment: Pale Grey/Grey - mfg, abundant detritus (seagrass deposits throughout/roots within to 0.40 m), shell grit fraction, no odour or staining.	C05_S01	0.00 - 0.20
		C05_S02	0.20 - 0.50
		C05_S03	0.50 - 1.20

Additional details / comments:

SEDIMENT PROFILE LOG

Project number:	EEC19032.011	**Weather:**	Fine
Site name:	Rottnest Army Jetty	**Sampling method:**	Push Probe
Sampling area:	Main Site	**Total depth (mbgl):**	1
Sampling location:	C06	**Refusal (Y/N):**	Y - hard layer at 1.00 m
Scientist(s)	SMW	**Fill present (Y/N):**	N
Date	23-Mar	**Fill thickness (m):**	---
Time:	9:45	**Water Column**	1.00 - 1.20
QAQC samples:	---	**Easting / northing:**	SAP

Soil depth (m)	Soil description (soil type, odour, texture, etc.)	Sample I.D.	Interval (m)
0.00 - 1.00	Sediment: Pale Grey/Grey - mfg, abundant seaweed detritus and trace deposits throughout shell fraction, H_2S odour.	C06_S01	0.00 - 0.20
		C06_S02	0.20 - 0.50
		C06_S03	0.50 - 1.00

Additional details / comments:

SEDIMENT PROFILE LOG

Project number:	EEC19032.011	**Weather:**	Fine
Site name:	Rottnest Army Jetty	**Sampling method:**	Push Probe
Sampling area:	Main Site	**Total depth (mbgl):**	1.2
Sampling location:	C07	**Refusal (Y/N):**	N
Scientist(s)	SMW	**Fill present (Y/N):**	N
Date	23-Mar	**Fill thickness (m):**	---
Time:	10:50	**Water Column**	1.2
QAQC samples:	---	**Easting / northing:**	SAP

Soil depth (m)	Soil description (soil type, odour, texture, etc.)	Sample I.D.	Interval (m)
0.00 - 1.10	Sediment: Pale Grey/Grey - mfg, abundant seaweed detritus and trace deposits throughout shell fraction, H_2S odour.	C07_S01	0.00 - 0.20
		C07_S02	0.20 - 0.50
		C07_S03	0.50 - 1.10
1.10 - 1.20	Sediment: Pale Grey - mfg, shell and sediment fractions, compact.	C07_S04	1.10 - 1.20

Additional details / comments:

MULTI-PARAMETER METER CALIBRATION RECORD

Project number: EEC19032.012

Site location: Rottnest Sediment Program Resample

Date	pH 7		pH 4		EC buffer µs/cm		Temp. °C		D.O. ppm		Redox		Scientist
	Pre-cal	Post-cal	Pre-cal	Post-cal	Pre-cal	Post-cal	Pre-cal	Post-cal	Zero	Air	Temp. °C	Measurement	
23/03/2020	6.45	7	3.31	4	12692	12880	---	25.4	0	9.01	25.4	226	SMW

Multi-parameter meter details		Solution	Batch / lot	Expiry date	Zobell B solution, for Ag/AgCl saturated KCl electrode				Calibration notes:
Manufacturer:	YSI - Pro Series	pH 4 buffer			T °C	mV	T °C	mV	
Model number:		pH 7 buffer			5	273	20	240	
Serial number:	19B100163	EC buffer			10	262	25	229	
		Zobell B			15	251	30	218	

SURFACE WATER SAMPLING LOG

Project number:	EEC19032.012	**Weather:**	Fine
Site name:	Rottnest Army Jetty	**Sampling method:**	Bailer
Sampling area:	Dredge Grounds	**Easting / northing:**	SAP
Sampling location:	C01	**0.45 micron filter used (Y/N):**	N
Scientist:	SMW	**Sample preservation (ice/esky):**	Y
Date:	23/03/2020	**QAQC samples:**	---
Time:	15:40		

Sample I.D.	Appearance	Colour	Temp. (°C)	pH	E.C. (µS/cm)	Redox. (mV)	D.O. (ppm)
C01-SW	Clear	Colourless	23.7	8.06	54,763	152.2	7.05

Additional details / comments:

Odour (Y/N):	**Other:**
Staining (Y/N):	
Sheen (Y/N):	
Total titratable acidity (mg/L $CaCO_3$ equivalents):	
Total alkalinity (mg/L $CaCO_3$ equivalents):	

SURFACE WATER SAMPLING LOG

Project number:	EEC19032.012	**Weather:**	Fine
Site name:	Rottnest Army Jetty	**Sampling method:**	Bailer
Sampling area:	Dredge Grounds	**Easting / northing:**	SAP
Sampling location:	C04	**0.45 micron filter used (Y/N):**	N
Scientist:	SMW	**Sample preservation (ice/esky):**	Y
Date:	23/03/2020	**QAQC samples:**	Duplicate - WZ2, Triplicate - WZZ2
Time:	14:00		

Sample I.D.	Appearance	Colour	Temp. (°C)	pH	E.C. (µS/cm)	Redox. (mV)	D.O. (ppm)
C04-SW	Clear	Colourless	24.1	8.02	54,786	126.4	6.7

Additional details / comments:

Odour (Y/N):	**Other:**
Staining (Y/N):	
Sheen (Y/N):	
Total titratable acidity (mg/L $CaCO_3$ equivalents):	
Total alkalinity (mg/L $CaCO_3$ equivalents):	

SURFACE WATER SAMPLING LOG

Project number:	EEC19032.012	**Weather:**	Fine
Site name:	Rottnest Army Jetty	**Sampling method:**	Bailer
Sampling area:	Main Site	**Easting / northing:**	SAP
Sampling location:	C06	**0.45 micron filter used (Y/N):**	N
Scientist:	SMW	**Sample preservation (ice/esky):**	Y
Date:	23/03/2020	**QAQC samples:**	Duplicate - WZ1, Triplicate - WZZ1
Time:	10:00		

Sample I.D.	Appearance	Colour	Temp. (°C)	pH	E.C. (µS/cm)	Redox. (mV)	D.O. (ppm)
C06-SW	Clear	Colourless	23.1	7.89	54,122	-6.8	6.26

Additional details / comments:

Odour (Y/N):	**Other:**
Staining (Y/N):	
Sheen (Y/N):	
Total titratable acidity (mg/L $CaCO_3$ equivalents):	
Total alkalinity (mg/L $CaCO_3$ equivalents):	

Appendix B
Laboratory Reporting

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EP1911899**	Page	: 1 of 56
Client	: **RPS Australia West Pty Ltd**	Laboratory	: Environmental Division Perth
Contact	: SHAE MILLER-WHITE	Contact	: Rhiannon Steere
Address	: PO BOX 170 WEST PERTH WA 6872	Address	: 26 Rigali Way Wangara WA Australia 6065
Telephone	: 9211 1111	Telephone	: 08 9406 1306
Project	: EEC19032.011	Date Samples Received	: 13-Nov-2019 14:45
Order number	: ----	Date Analysis Commenced	: 13-Nov-2019
C-O-C number	: ----	Issue Date	: 06-Dec-2019 17:06
Sampler	: ----		
Site	: Rottnest Army Jetty		
Quote number	: EP/705/19		
No. of samples received	: 30		
No. of samples analysed	: 25		

ilac-MRA NATA

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Descriptive Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Alex Rossi	Organic Chemist	Sydney Organics, Smithfield, NSW
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Canhuang Ke	Inorganics Supervisor	Perth Inorganics, Wangara, WA
Chris Lemaitre	Laboratory Manager (Perth)	Perth Inorganics, Wangara, WA
Daniel Fisher	Inorganics Analyst	Perth ASS, Wangara, WA
David Viner	SENIOR LAB TECH	Perth Organics, Wangara, WA
Dian Dao		Sydney Inorganics, Smithfield, NSW
Diana Mesa	2IC Organic Chemist	Brisbane Organics, Stafford, QLD
Dianne Blane	Laboratory Coordinator (2IC)	Newcastle - Inorganics, Mayfield West, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW
Evie Sidarta	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Franco Lentini	LCMS Coordinator	Sydney Organics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW
Uyen Dalkin	Approved Asbestos Identifier	Melbourne Asbestos, Springvale, VIC

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- TOC and TBT conducted by ALS Brisbane, NATA Site No. 818.
- Asbestos conducted by ALS Melbourne, NATA accreditation no. 825, site no 13778
- PSD conducted by ALS Newcastle, NATA accreditation no. 825, site no 1656.
- Elutriate, UT Organics and UT nutrients conducted by ALS Sydney, NATA accreditation no. 825, site no 10911.
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) per the NEPM (2013) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- EG020T: Positive results for copper, zinc for samples EP1911899-025, 027 have been confirmed by re-digestion and re-analysis.
- EK267PA-SW, EK271A-SW: It has been noted that Reactive Phosphorus is greater than Total Phosphorus for sample no:17, however this difference is within the limits of experimental variation.
- EP132-SD: LOR has been raised for EP1911899-009, 021 due to suspected matrix effects and interferences.
- ASS: EA033 (CRS Suite): Retained Acidity not required because pH KCl greater than or equal to 4.5
- EP090 Organotin: High surrogate recovery deemed acceptable as all associated analyte results are less than LOR
- ASS: EA033 (CRS Suite): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime ($CaCO_3$) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from 'kg/t dry weight' to 'kg/m3 in-situ soil', multiply 'reported results' x 'wet bulk density of soil in t/m3'.
- EA200N: Asbestos weights and percentages are not covered under the Scope of NATA Accreditation.
  Weights of Asbestos are based on extracted bulk asbestos, fibre bundles, and/or ACM and do not include respirable fibres (if present)
  The Asbestos (Fines and Fibrous) weight is calculated from the extracted Fibrous Asbestos and Asbestos Fines as an equivalent weight of 100% Asbestos
  Percentages for Asbestos content in ACM are based on the 2013 NEPM default values.
  All calculations of percentage Asbestos under this method are approximate and should be used as a guide only.
- EA200 'Am' Amosite (brown asbestos)
- EA200 'Cr' Crocidolite (blue asbestos)
- EA200 'Trace' - Asbestos fibres ("Free Fibres") detected by trace analysis per AS4964. The result can be interpreted that the sample contains detectable 'respirable' asbestos fibres
- EA200: Asbestos Identification Samples were analysed by Polarised Light Microscopy including dispersion staining.
- EA200 Legend
- EA200 'Ch' Chrysotile (white asbestos)
- EA200: 'UMF' Unknown Mineral Fibres. "-" indicates fibres detected may or may not be asbestos fibres. Confirmation by alternative techniques is recommended.

- EN68: This analysis in accordance with National Ocean Disposal Guidelines, Commonwealth of Australia, 2002 - (modified). Results reported are those determined on a 1:4 sediment/seawater elutriate without blank correction.
- EA200N: ALS laboratory procedures and methods used for the identification and quantitation of asbestos are consistent with AS4964-2004 and the requirements of the 2013 NEPM for Assessment of Site Contamination
- EA200: For samples larger than 30g, the <2mm fraction may be sub-sampled prior to trace analysis as outlined in ISO23909:2008(E) Sect 6.3.2-2
- EA200: 'Yes' - Asbestos detected by polarised light microscopy including dispersion staining.
- EA200: 'No*' - No asbestos found, at the reporting limit of 0.1g/kg, by polarised light microscopy including dispersion staining. Asbestos material was detected and positively identified at concentrations estimated to be below 0.1g/kg.
- EA200: 'No' - No asbestos found at the reporting limit 0.1g/kg, by polarised light microscopy including dispersion staining.
- EG093: Samples containing high levels of sulfate may precipitate barium under the acidic conditions of this method and may therefore bias results low.

Analytical Results

Sub-Matrix: ELUTRIATE (Matrix: WATER)			Client sample ID	C01S01	C02S01	C03S03	C04S02	C05S03
			Client sampling date / time	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-001	EP1911899-004	EP1911899-009	EP1911899-011	EP1911899-015
				Result	Result	Result	Result	Result
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.00004	mg/L	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG093T: Total Metals in Saline Water by ORC-ICPMS								
Antimony	7440-36-0	0.5	µg/L	**4.9**	**3.2**	**5.2**	**1.6**	**9.6**
Arsenic	7440-38-2	0.5	µg/L	**9.7**	**24.0**	**8.8**	**7.8**	**14.8**
Cadmium	7440-43-9	0.2	µg/L	**0.3**	<0.2	<0.2	<0.2	<0.2
Chromium	7440-47-3	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Cobalt	7440-48-4	0.2	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
Copper	7440-50-8	1	µg/L	**5**	**2**	<1	<1	<1
Lead	7439-92-1	0.2	µg/L	**0.3**	<0.2	<0.2	<0.2	<0.2
Manganese	7439-96-5	0.5	µg/L	**2.8**	<0.5	<0.5	<0.5	<0.5
Nickel	7440-02-0	0.5	µg/L	**0.8**	<0.5	<0.5	<0.5	<0.5
Selenium	7782-49-2	2	µg/L	<2	<2	<2	<2	**2**
Silver	7440-22-4	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	7440-62-2	0.5	µg/L	**45.9**	**45.3**	**136**	**102**	**175**
Zinc	7440-66-6	5	µg/L	**28**	**10**	<5	<5	**6**
EK255A: Ammonia								
Ammonia as N	7664-41-7	0.005	mg/L	**0.472**	**0.327**	<0.005	<0.005	**0.056**
EK257A: Nitrite								
Nitrite as N	14797-65-0	0.002	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002
EK258A: Nitrate								
Nitrate as N	14797-55-8	0.002	mg/L	**0.004**	**0.006**	<0.002	<0.002	**0.004**
EK259A: Nitrite and Nitrate (NOx)								
Nitrite + Nitrate as N	----	0.002	mg/L	**0.004**	**0.006**	<0.002	<0.002	**0.004**
EK261A: Total Kjeldahl Nitrogen								
Total Kjeldahl Nitrogen as N	----	0.050	mg/L	**0.971**	**0.895**	**0.264**	**0.504**	**0.361**
EK262A: Total Nitrogen								
Total Nitrogen as N	----	0.050	mg/L	**0.975**	**0.901**	**0.264**	**0.504**	**0.365**
EK267A: Total Phosphorus (Persulfate Digestion)								
Total Phosphorus as P	----	0.005	mg/L	**0.054**	**0.102**	**0.010**	**0.019**	**0.017**
EK271A: Reactive Phosphorus								
Reactive Phosphorus as P	14265-44-2	0.001	mg/L	**0.047**	**0.086**	**0.004**	**0.001**	**0.015**
EP231A: Perfluoroalkyl Sulfonic Acids								
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005

Analytical Results

Sub-Matrix: ELUTRIATE (Matrix: WATER)			Client sample ID	C01S01	C02S01	C03S03	C04S02	C05S03
			Client sampling date / time	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-001	EP1911899-004	EP1911899-009	EP1911899-011	EP1911899-015
				Result	Result	Result	Result	Result
EP231A: Perfluoroalkyl Sulfonic Acids - Continued								
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0005	µg/L	**0.0005**	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	µg/L	**0.263**	**0.0126**	**0.0087**	**0.0110**	**0.0070**
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0005	µg/L	**0.0010**	<0.0005	<0.0005	<0.0005	<0.0005
EP231B: Perfluoroalkyl Carboxylic Acids								
Perfluorobutanoic acid (PFBA)	375-22-4	0.0020	µg/L	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorohexanoic acid (PFHxA)	307-24-4	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorooctanoic acid (PFOA)	335-67-1	0.0005	µg/L	**0.0009**	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorononanoic acid (PFNA)	375-95-1	0.0005	µg/L	**0.0009**	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorodecanoic acid (PFDA)	335-76-2	0.0005	µg/L	**0.0011**	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EP231C: Perfluoroalkyl Sulfonamides								
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0005	µg/L	**0.0025**	<0.0005	<0.0005	<0.0005	<0.0005
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: ELUTRIATE (Matrix: WATER)			Client sample ID	C01S01	C02S01	C03S03	C04S02	C05S03
			Client sampling date / time	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-001	EP1911899-004	EP1911899-009	EP1911899-011	EP1911899-015
				Result	Result	Result	Result	Result
EP231C: Perfluoroalkyl Sulfonamides - Continued								
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EP231D: (n:2) Fluorotelomer Sulfonic Acids								
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.001	µg/L	**0.003**	<0.001	<0.001	<0.001	<0.001
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
EP231P: PFAS Sums								
^ Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	µg/L	**0.264**	**0.0126**	**0.0087**	**0.0110**	**0.0070**
^ Sum of PFAS (WA DER List)	----	0.0002	µg/L	**0.267**	**0.0126**	**0.0087**	**0.0110**	**0.0070**
^ Sum of PFAS	----	0.0002	µg/L	**0.273**	**0.0126**	**0.0087**	**0.0110**	**0.0070**
EP231S: PFAS Surrogate								
13C4-PFOS	----	0.0005	%	**63.8**	**61.8**	**65.2**	**69.9**	**73.0**
13C8-PFOA	----	0.0005	%	**82.4**	**80.3**	**82.9**	**83.9**	**81.3**

Analytical Results

Sub-Matrix: ELUTRIATE (Matrix: WATER)			Client sample ID	C06S02	C07S01	EW	----	----
			Client sampling date / time	12-Nov-2019 00:00	12-Nov-2019 00:00	13-Nov-2019 00:00	----	----
Compound	CAS Number	LOR	Unit	EP1911899-017	EP1911899-019	EP1911899-030	--------	--------
				Result	Result	Result	----	----
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.00004	mg/L	<0.00004	<0.00004	<0.00004	----	----
EG093T: Total Metals in Saline Water by ORC-ICPMS								
Antimony	7440-36-0	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Arsenic	7440-38-2	0.5	µg/L	**3.9**	**3.0**	**1.3**	----	----
Cadmium	7440-43-9	0.2	µg/L	<0.2	<0.2	<0.2	----	----
Chromium	7440-47-3	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Cobalt	7440-48-4	0.2	µg/L	<0.2	<0.2	<0.2	----	----
Copper	7440-50-8	1	µg/L	<1	<1	**1**	----	----
Lead	7439-92-1	0.2	µg/L	<0.2	<0.2	<0.2	----	----
Manganese	7439-96-5	0.5	µg/L	<0.5	**0.7**	<0.5	----	----
Nickel	7440-02-0	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Selenium	7782-49-2	2	µg/L	<2	<2	<2	----	----
Silver	7440-22-4	0.1	µg/L	<0.1	<0.1	<0.1	----	----
Vanadium	7440-62-2	0.5	µg/L	**16.2**	<0.5	<0.5	----	----
Zinc	7440-66-6	5	µg/L	<5	**14**	**7**	----	----
EK255A: Ammonia								
Ammonia as N	7664-41-7	0.005	mg/L	**0.110**	<0.005	<0.005	----	----
EK257A: Nitrite								
Nitrite as N	14797-65-0	0.002	mg/L	<0.002	<0.002	<0.002	----	----
EK258A: Nitrate								
Nitrate as N	14797-55-8	0.002	mg/L	**0.005**	**0.009**	**0.003**	----	----
EK259A: Nitrite and Nitrate (NOx)								
Nitrite + Nitrate as N	----	0.002	mg/L	**0.005**	**0.009**	**0.003**	----	----
EK261A: Total Kjeldahl Nitrogen								
Total Kjeldahl Nitrogen as N	----	0.050	mg/L	**0.283**	**0.170**	**0.089**	----	----
EK262A: Total Nitrogen								
Total Nitrogen as N	----	0.050	mg/L	**0.288**	**0.179**	**0.092**	----	----
EK267A: Total Phosphorus (Persulfate Digestion)								
Total Phosphorus as P	----	0.005	mg/L	**0.050**	<0.005	<0.005	----	----
EK271A: Reactive Phosphorus								
Reactive Phosphorus as P	14265-44-2	0.001	mg/L	**0.053**	**0.004**	<0.001	----	----
EN68: Seawater Elutriate Testing Procedure								
Seawater Sampling Date	----	-	-	----	----	**21/11/2019**	----	----

Analytical Results

Sub-Matrix: ELUTRIATE (Matrix: WATER)			Client sample ID	C06S02	C07S01	EW	----	----
			Client sampling date / time	12-Nov-2019 00:00	12-Nov-2019 00:00	13-Nov-2019 00:00	----	----
Compound	CAS Number	LOR	Unit	EP1911899-017	EP1911899-019	EP1911899-030	--------	--------
				Result	Result	Result	----	----
EP231A: Perfluoroalkyl Sulfonic Acids								
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	µg/L	**0.0132**	**0.0197**	**0.0348**	----	----
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
EP231B: Perfluoroalkyl Carboxylic Acids								
Perfluorobutanoic acid (PFBA)	375-22-4	0.0020	µg/L	<0.0020	<0.0020	<0.0020	----	----
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
Perfluorohexanoic acid (PFHxA)	307-24-4	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
Perfluorooctanoic acid (PFOA)	335-67-1	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
Perfluorononanoic acid (PFNA)	375-95-1	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
Perfluorodecanoic acid (PFDA)	335-76-2	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
EP231C: Perfluoroalkyl Sulfonamides								
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.001	µg/L	<0.001	<0.001	<0.001	----	----
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.001	µg/L	<0.001	<0.001	<0.001	----	----

Analytical Results

Sub-Matrix: ELUTRIATE (Matrix: WATER)			Client sample ID	C06S02	C07S01	EW	----	----
			Client sampling date / time	12-Nov-2019 00:00	12-Nov-2019 00:00	13-Nov-2019 00:00	----	----
Compound	CAS Number	LOR	Unit	EP1911899-017	EP1911899-019	EP1911899-030	--------	--------
				Result	Result	Result	----	----
EP231C: Perfluoroalkyl Sulfonamides - Continued								
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.001	µg/L	<0.001	<0.001	<0.001	----	----
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.001	µg/L	<0.001	<0.001	<0.001	----	----
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
EP231D: (n:2) Fluorotelomer Sulfonic Acids								
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.001	µg/L	<0.001	<0.001	<0.001	----	----
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.001	µg/L	<0.001	<0.001	<0.001	----	----
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.001	µg/L	<0.001	<0.001	<0.001	----	----
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.001	µg/L	<0.001	<0.001	<0.001	----	----
EP231P: PFAS Sums								
^ Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	µg/L	**0.0132**	**0.0197**	**0.0348**	----	----
^ Sum of PFAS (WA DER List)	----	0.0002	µg/L	**0.0132**	**0.0197**	**0.0348**	----	----
^ Sum of PFAS	----	0.0002	µg/L	**0.0132**	**0.0197**	**0.0348**	----	----
EP231S: PFAS Surrogate								
13C4-PFOS	----	0.0005	%	**74.3**	**94.5**	**94.4**	----	----
13C8-PFOA	----	0.0005	%	**88.0**	**93.9**	**89.1**	----	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C01S01	C01S03	C02S01	C02S02	C03S01
			Client sampling date / time	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-001	EP1911899-003	EP1911899-004	EP1911899-005	EP1911899-007
				Result	Result	Result	Result	Result
EA029-A: pH Measurements								
pH OX (23B)	----	0.1	pH Unit	7.9	7.9	8.0	----	7.9
EA029-B: Acidity Trail								
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	<2	<2	----	<2
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	9.7	10.0	9.6	----	9.9
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	----	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	----	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	0.054	0.007	0.007	----	0.009
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	34	<10	<10	----	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	83.7	87.4	83.9	----	83.2
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	16700	17500	16800	----	16600
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	26.8	28.0	26.9	----	26.6
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	----	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	----	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	----	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	----	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	0.05	<0.02	<0.02	----	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	34	<10	<10	----	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	3	<1	<1	----	<1
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	31.9	31.5	26.2	30.4	30.7
EA150: Particle Sizing								
+75µm	----	1	%	96	----	96	----	95
+150µm	----	1	%	73	----	82	----	60
+300µm	----	1	%	13	----	15	----	9
+425µm	----	1	%	6	----	6	----	5
+600µm	----	1	%	3	----	3	----	3
+1180µm	----	1	%	1	----	1	----	2

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C01S01	C01S03	C02S01	C02S02	C03S01
			Client sampling date / time	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-001	EP1911899-003	EP1911899-004	EP1911899-005	EP1911899-007
				Result	Result	Result	Result	Result
EA150: Particle Sizing - Continued								
+2.36mm	----	1	%	<1	----	<1	----	1
+4.75mm	----	1	%	<1	----	<1	----	<1
+9.5mm	----	1	%	<1	----	<1	----	<1
+19.0mm	----	1	%	<1	----	<1	----	<1
+37.5mm	----	1	%	<1	----	<1	----	<1
+75.0mm	----	1	%	<1	----	<1	----	<1
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	4	----	3	----	2
Silt (2-60 µm)	----	1	%	<1	----	<1	----	2
Sand (0.06-2.00 mm)	----	1	%	95	----	96	----	95
Gravel (>2mm)	----	1	%	1	----	1	----	1
Cobbles (>6cm)	----	1	%	<1	----	<1	----	<1
EA152: Soil Particle Density								
Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	2.70	----	2.68	----	2.69
EA200: AS 4964 - 2004 Identification of Asbestos in Soils								
Asbestos Detected	1332-21-4	0.1	g/kg	No	No	No	----	No
Asbestos (Trace)	1332-21-4	5	Fibres	No	No	No	----	No
Asbestos Type	1332-21-4	-	--	-	-	-	----	-
Sample weight (dry)	----	0.01	g	320	273	231	----	174
APPROVED IDENTIFIER:	----	-	--	U.DALKIN	U.DALKIN	U.DALKIN	----	U.DALKIN
Synthetic Mineral Fibre	----	0.1	g/kg	No	No	No	----	No
Organic Fibre	----	0.1	g/kg	Yes	Yes	Yes	----	Yes
EA200N: Asbestos Quantification (non-NATA)								
ø Asbestos (Fines and Fibrous <7mm)	1332-21-4	0.0004	g	<0.0004	<0.0004	<0.0004	----	<0.0004
ø Asbestos (Fines and Fibrous FA+AF)	----	0.001	% (w/w)	<0.001	<0.001	<0.001	----	<0.001
ø Weight Used for % Calculation	----	0.0001	kg	0.320	0.273	0.231	----	0.174
ø Fibrous Asbestos >7mm	----	0.0004	g	<0.0004	<0.0004	<0.0004	----	<0.0004
EG020-SD: Total Metals in Sediments by ICPMS								
Antimony	7440-36-0	0.50	mg/kg	1.47	<0.50	<0.50	0.85	<0.50
Arsenic	7440-38-2	1.00	mg/kg	1.79	<1.00	1.20	<1.00	<1.00
Cadmium	7440-43-9	0.1	mg/kg	0.3	0.2	0.1	0.2	0.1
Chromium	7440-47-3	1.0	mg/kg	11.2	9.7	11.0	10.1	9.9
Copper	7440-50-8	1.0	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C01S01	C01S03	C02S01	C02S02	C03S01
			Client sampling date / time	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-001	EP1911899-003	EP1911899-004	EP1911899-005	EP1911899-007
				Result	Result	Result	Result	Result
EG020-SD: Total Metals in Sediments by ICPMS - Continued								
Cobalt	7440-48-4	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Lead	7439-92-1	1.0	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0
Manganese	7439-96-5	10	mg/kg	<10	<10	<10	<10	<10
Nickel	7440-02-0	1.0	mg/kg	**1.6**	<1.0	<1.0	<1.0	<1.0
Selenium	7782-49-2	0.1	mg/kg	**0.3**	**0.1**	**0.3**	**0.2**	**0.2**
Silver	7440-22-4	0.1	mg/kg	**0.2**	<0.1	**0.2**	<0.1	<0.1
Vanadium	7440-62-2	2.0	mg/kg	**11.3**	**11.3**	**6.1**	**13.3**	**4.2**
Zinc	7440-66-6	1.0	mg/kg	**1.7**	**1.1**	**1.5**	**1.2**	**3.7**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.01	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	<0.1	<0.1	----	<0.1
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	<0.1	<0.1	<0.1	----	<0.1
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	<0.1	<0.1	<0.1	----	<0.1
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**330**	**310**	**230**	----	**260**
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	**330**	**310**	**230**	----	**260**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**303**	**232**	**280**	----	**269**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.1	mg/kg	**0.1**	<0.1	**0.6**	----	**0.3**
EK255A SD: Ammonia in Sediment								
Ammonia as N	7664-41-7	0.2	mg/kg	**4.1**	<0.2	**0.7**	----	<0.2
EN68: Seawater Elutriate Testing Procedure								
Seawater Sampling Date	----	-	-	**21/11/2019**	----	**21/11/2019**	----	----
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	**0.46**	**0.32**	**0.48**	----	**0.34**
EP070: Total Petroleum Hydrocarbons - Speciation								
Aliphatic C16-C35	----	100	mg/kg	<100	----	<100	----	<100
Aliphatic > C35	----	100	mg/kg	<100	----	<100	----	<100

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C01S01	C01S03	C02S01	C02S02	C03S01
			Client sampling date / time	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-001	EP1911899-003	EP1911899-004	EP1911899-005	EP1911899-007
				Result	Result	Result	Result	Result
EP070: Total Petroleum Hydrocarbons - Speciation - Continued								
Aromatic C16-C35	----	90	mg/kg	<90	----	<90	----	<90
Aromatic > C35	----	100	mg/kg	<100	----	<100	----	<100
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
>C10 - C16 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
>C16 - C34 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
>C34 - C40 Fraction	----	5	mg/kg	<5	<5	<5	<5	<5
>C10 - C40 Fraction (sum)	----	3	mg/kg	<3	<3	<3	<3	<3
>C10 - C16 Fraction minus Naphthalene (F2)	----	3	mg/kg	<3	<3	<3	<3	<3
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
C10 - C14 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
C15 - C28 Fraction	----	3	mg/kg	<3	<3	<3	<3	<3
C29 - C36 Fraction	----	5	mg/kg	<5	<5	<5	<5	<5
^ C10 - C36 Fraction (sum)	----	3	mg/kg	<3	<3	<3	<3	<3
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons								
C6 - C10 Fraction	C6_C10	3	mg/kg	<3	<3	<3	<3	<3
C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	3.0	mg/kg	<3.0	<3.0	<3.0	<3.0	<3.0
EP080-SD: BTEXN								
Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	108-88-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
^ Total Xylenes	----	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
^ Sum of BTEX	----	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Naphthalene	91-20-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
EP090: Organotin Compounds								
Tributyltin	56573-85-4	0.5	µgSn/kg	<0.5	<0.5	<0.5	----	<0.5
EP130A: Organophosphorus Pesticides (Ultra-trace)								
Bromophos-ethyl	4824-78-6	10	µg/kg	<10	<10	<10	<10	<10
Carbophenothion	786-19-6	10	µg/kg	<10	<10	<10	<10	<10
Chlorfenvinphos (E)	18708-86-6	10.0	µg/kg	<10.0	<10.0	<10.0	<10.0	<10.0

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C01S01	C01S03	C02S01	C02S02	C03S01
			Client sampling date / time	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-001	EP1911899-003	EP1911899-004	EP1911899-005	EP1911899-007
				Result	Result	Result	Result	Result
EP130A: Organophosphorus Pesticides (Ultra-trace) - Continued								
Chlorfenvinphos (Z)	18708-87-7	10	µg/kg	<10	<10	<10	<10	<10
Chlorpyrifos	2921-88-2	10	µg/kg	<10	<10	<10	<10	<10
Chlorpyrifos-methyl	5598-13-0	10	µg/kg	<10	<10	<10	<10	<10
Demeton-S-methyl	919-86-8	10	µg/kg	<10	<10	<10	<10	<10
Diazinon	333-41-5	10	µg/kg	<10	<10	<10	<10	<10
Dichlorvos	62-73-7	10	µg/kg	<10	<10	<10	<10	<10
Dimethoate	60-51-5	10	µg/kg	<10	<10	<10	<10	<10
Ethion	563-12-2	10	µg/kg	<10	<10	<10	<10	<10
Fenamiphos	22224-92-6	10	µg/kg	<10	<10	<10	<10	<10
Fenthion	55-38-9	10	µg/kg	<10	<10	<10	<10	<10
Malathion	121-75-5	10	µg/kg	<10	<10	<10	<10	<10
Azinphos Methyl	86-50-0	10	µg/kg	<10	<10	<10	<10	<10
Monocrotophos	6923-22-4	10	µg/kg	<10	<10	<10	<10	<10
Parathion	56-38-2	10	µg/kg	<10	<10	<10	<10	<10
Parathion-methyl	298-00-0	10	µg/kg	<10	<10	<10	<10	<10
Pirimphos-ethyl	23505-41-1	10	µg/kg	<10	<10	<10	<10	<10
Prothiofos	34643-46-4	10	µg/kg	<10	<10	<10	<10	<10
EP131A: Organochlorine Pesticides								
Aldrin	309-00-2	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	<0.50
alpha-BHC	319-84-6	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	<0.50
beta-BHC	319-85-7	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	<0.50
delta-BHC	319-86-8	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	<0.50
4.4`-DDD	72-54-8	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	<0.50
4.4`-DDE	72-55-9	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	<0.50
4.4`-DDT	50-29-3	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	<0.50
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	<0.50
Dieldrin	60-57-1	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	<0.50
alpha-Endosulfan	959-98-8	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	<0.50
beta-Endosulfan	33213-65-9	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	<0.50
Endosulfan sulfate	1031-07-8	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	<0.50
^ Endosulfan (sum)	115-29-7	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	<0.50
Endrin	72-20-8	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	<0.50
Endrin aldehyde	7421-93-4	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	<0.50
Endrin ketone	53494-70-5	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	<0.50

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C01S01	C01S03	C02S01	C02S02	C03S01
			Client sampling date / time	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-001	EP1911899-003	EP1911899-004	EP1911899-005	EP1911899-007
				Result	Result	Result	Result	Result
EP131A: Organochlorine Pesticides - Continued								
Heptachlor	76-44-8	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	<0.50
Heptachlor epoxide	1024-57-3	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	<0.50
Hexachlorobenzene (HCB)	118-74-1	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	<0.50
gamma-BHC	58-89-9	0.25	µg/kg	<0.25	<0.25	<0.25	<0.25	<0.25
Methoxychlor	72-43-5	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	<0.50
cis-Chlordane	5103-71-9	0.25	µg/kg	<0.25	<0.25	<0.25	<0.25	<0.25
trans-Chlordane	5103-74-2	0.25	µg/kg	<0.25	<0.25	<0.25	<0.25	<0.25
^ Total Chlordane (sum)	----	0.25	µg/kg	<0.25	<0.25	<0.25	<0.25	<0.25
Oxychlordane	27304-13-8	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	<0.50
EP132B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	5	µg/kg	<5	<5	<5	<5	<5
2-Methylnaphthalene	91-57-6	5	µg/kg	<5	<5	<5	<5	<5
Acenaphthylene	208-96-8	4	µg/kg	<4	<4	<4	<4	<4
Acenaphthene	83-32-9	4	µg/kg	<4	<4	<4	<4	<4
Fluorene	86-73-7	4	µg/kg	<4	<4	<4	<4	<4
Phenanthrene	85-01-8	4	µg/kg	<4	<4	<4	<4	<4
Anthracene	120-12-7	4	µg/kg	<4	<4	<4	<4	<4
Fluoranthene	206-44-0	4	µg/kg	<4	<4	<4	<4	<4
Pyrene	129-00-0	4	µg/kg	<4	<4	<4	<4	<4
Benz(a)anthracene	56-55-3	4	µg/kg	<4	<4	<4	<4	<4
Chrysene	218-01-9	4	µg/kg	<4	<4	<4	<4	<4
Benzo(b+j)fluoranthene	205-99-2 205-82-3	4	µg/kg	<4	<4	<4	<4	<4
Benzo(k)fluoranthene	207-08-9	4	µg/kg	<4	<4	<4	<4	<4
Benzo(e)pyrene	192-97-2	4	µg/kg	<4	<4	<4	<4	<4
Benzo(a)pyrene	50-32-8	4	µg/kg	<4	<4	<4	<4	<4
Perylene	198-55-0	4	µg/kg	<4	<4	<4	<4	<4
Benzo(g.h.i)perylene	191-24-2	4	µg/kg	<4	<4	<4	<4	<4
Dibenz(a.h)anthracene	53-70-3	4	µg/kg	<4	<4	<4	<4	<4
Indeno(1.2.3.cd)pyrene	193-39-5	4	µg/kg	<4	<4	<4	<4	<4
Coronene	191-07-1	5	µg/kg	<5	<5	<5	<5	<5
^ Sum of PAHs	----	4	µg/kg	<4	<4	<4	<4	<4
^ Benzo(a)pyrene TEQ (zero)	----	4	µg/kg	<4	<4	<4	<4	<4
^ Benzo(a)pyrene TEQ (half LOR)	----	4	µg/kg	**5**	**5**	**5**	**5**	**5**
^ Benzo(a)pyrene TEQ (LOR)	----	4	µg/kg	**10**	**10**	**10**	**10**	**10**

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C01S01	C01S03	C02S01	C02S02	C03S01
			Client sampling date / time	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-001	EP1911899-003	EP1911899-004	EP1911899-005	EP1911899-007
				Result	Result	Result	Result	Result
EP203A: Explosives								
HMX	2691-41-0	0.1	mg/kg	<0.1	<0.1	<0.1	----	<0.1
RDX	----	0.1	mg/kg	<0.1	<0.1	<0.1	----	<0.1
1.3.5-Trinitrobenzene	99-35-4	0.1	mg/kg	<0.1	<0.1	<0.1	----	<0.1
1.3-Dinitrobenzene	99-65-0	0.1	mg/kg	<0.1	<0.1	<0.1	----	<0.1
Tetryl	479-45-8	0.1	mg/kg	<0.1	<0.1	<0.1	----	<0.1
2.4.6-TNT	118-96-7	0.1	mg/kg	<0.1	<0.1	<0.1	----	<0.1
4-Amino.2.6-DNT	19406-51-0	0.1	mg/kg	<0.1	<0.1	<0.1	----	<0.1
2-Amino-4.6-DNT	35572-78-2	0.1	mg/kg	<0.1	<0.1	<0.1	----	<0.1
^ 4-& 2-AM-DNT(Isomeric Mixture)	----	0.1	mg/kg	<0.1	<0.1	<0.1	----	<0.1
2.4-Dinitrotoluene	121-14-2	0.1	mg/kg	<0.1	<0.1	<0.1	----	<0.1
2.6-Dinitrotoluene	606-20-2	0.1	mg/kg	<0.1	<0.1	<0.1	----	<0.1
^ 2.4-& 2.6-DNT(Isomeric Mixture)	121-14-2/606-20-2	0.1	mg/kg	<0.1	<0.1	<0.1	----	<0.1
Nitrobenzene	98-95-3	0.1	mg/kg	<0.1	<0.1	<0.1	----	<0.1
2-Nitrotoluene	88-72-2	0.1	mg/kg	<0.1	<0.1	<0.1	----	<0.1
3-Nitrotoluene	99-08-1	0.1	mg/kg	<0.1	<0.1	<0.1	----	<0.1
4-Nitrotoluene	99-99-0	0.1	mg/kg	<0.1	<0.1	<0.1	----	<0.1
Nitroglycerine	55-63-0	1	mg/kg	<1	<1	<1	----	<1
PETN	78-11-5	1	mg/kg	<1	<1	<1	----	<1
EP231A: Perfluoroalkyl Sulfonic Acids								
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
EP231B: Perfluoroalkyl Carboxylic Acids								
Perfluorobutanoic acid (PFBA)	375-22-4	0.001	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorohexanoic acid (PFHxA)	307-24-4	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C01S01	C01S03	C02S01	C02S02	C03S01
			Client sampling date / time	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-001	EP1911899-003	EP1911899-004	EP1911899-005	EP1911899-007
				Result	Result	Result	Result	Result
EP231B: Perfluoroalkyl Carboxylic Acids - Continued								
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorooctanoic acid (PFOA)	335-67-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorononanoic acid (PFNA)	375-95-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorodecanoic acid (PFDA)	335-76-2	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EP231C: Perfluoroalkyl Sulfonamides								
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
EP231D: (n:2) Fluorotelomer Sulfonic Acids								
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C01S01	C01S03	C02S01	C02S02	C03S01
			Client sampling date / time	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-001	EP1911899-003	EP1911899-004	EP1911899-005	EP1911899-007
				Result	Result	Result	Result	Result
EP231D: (n:2) Fluorotelomer Sulfonic Acids - Continued								
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EP231P: PFAS Sums								
Sum of PFAS	----	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Sum of PFAS (WA DER List)	----	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
EP070: Total Petroleum Hydrocarbons - Speciation								
2-Bromonaphthalene	580-13-2	1	%	103	----	75.6	----	89.7
2-Fluorobiphenyl	321-60-8	1	%	116	----	108	----	103
EP080-SD: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.2	%	78.2	95.6	88.6	91.6	89.0
Toluene-D8	2037-26-5	0.2	%	83.0	76.6	101	91.3	83.5
4-Bromofluorobenzene	460-00-4	0.2	%	72.1	85.1	72.2	72.7	76.1
EP090S: Organotin Surrogate								
Tripropyltin	----	0.5	%	106	102	94.9	----	114
EP130S: Organophosphorus Pesticide Surrogate								
DEF	78-48-8	10	%	57.8	49.4	69.0	71.4	73.3
EP131S: OC Pesticide Surrogate								
Dibromo-DDE	21655-73-2	0.50	%	74.6	56.3	67.4	74.9	68.4
EP132T: Base/Neutral Extractable Surrogates								
2-Fluorobiphenyl	321-60-8	10	%	99.4	97.8	104	88.6	85.9
Anthracene-d10	1719-06-8	10	%	97.4	106	104	91.5	96.4
4-Terphenyl-d14	1718-51-0	10	%	83.9	106	84.0	72.8	77.4
EP203S: Explosives Surrogate								
o-Dinitrobenzene	528-29-0	0.1	%	104	106	103	----	102
EP231S: PFAS Surrogate								
13C4-PFOS	----	0.0002	%	87.0	83.0	76.5	86.0	81.0
13C8-PFOA	----	0.0002	%	81.5	85.5	76.0	81.5	76.5

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C03S03	C04S01	C04S02	C05S01	C05S02
			Client sampling date / time	12-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-009	EP1911899-010	EP1911899-011	EP1911899-013	EP1911899-014
				Result	Result	Result	Result	Result
EA029-A: pH Measurements								
pH OX (23B)	----	0.1	pH Unit	----	8.0	----	8.0	----
EA029-B: Acidity Trail								
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	<2	----	<2	----
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	----	9.7	----	10.0	----
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	<2	----	<2	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	----	<0.02	----	<0.02	----
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	----	0.008	----	0.005	----
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	----	<10	----	<10	----
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	----	85.8	----	85.5	----
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	----	17100	----	17100	----
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	----	27.5	----	27.4	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	1.5	----	1.5	----
Net Acidity (sulfur units)	----	0.02	% S	----	<0.02	----	<0.02	----
Net Acidity (acidity units)	----	10	mole H+ / t	----	<10	----	<10	----
Liming Rate	----	1	kg CaCO3/t	----	<1	----	<1	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	<0.02	----	<0.02	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	<10	----	<10	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	<1	----	<1	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	----	----	----	----	28.5
Moisture Content	----	1.0	%	32.4	28.5	35.3	24.2	----
EA150: Particle Sizing								
+75µm	----	1	%	----	96	----	----	96
+150µm	----	1	%	----	67	----	----	62
+300µm	----	1	%	----	10	----	----	15
+425µm	----	1	%	----	5	----	----	10
+600µm	----	1	%	----	3	----	----	6

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C03S03	C04S01	C04S02	C05S01	C05S02
			Client sampling date / time	12-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-009	EP1911899-010	EP1911899-011	EP1911899-013	EP1911899-014
				Result	Result	Result	Result	Result
EA150: Particle Sizing - Continued								
+1180µm	----	1	%	----	1	----	----	2
+2.36mm	----	1	%	----	<1	----	----	1
+4.75mm	----	1	%	----	<1	----	----	<1
+9.5mm	----	1	%	----	<1	----	----	<1
+19.0mm	----	1	%	----	<1	----	----	<1
+37.5mm	----	1	%	----	<1	----	----	<1
+75.0mm	----	1	%	----	<1	----	----	<1
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	----	3	----	----	3
Silt (2-60 µm)	----	1	%	----	<1	----	----	<1
Sand (0.06-2.00 mm)	----	1	%	----	96	----	----	96
Gravel (>2mm)	----	1	%	----	1	----	----	1
Cobbles (>6cm)	----	1	%	----	<1	----	----	<1
EA152: Soil Particle Density								
Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	----	2.68	----	----	2.67
EA200: AS 4964 - 2004 Identification of Asbestos in Soils								
Asbestos Detected	1332-21-4	0.1	g/kg	----	No	----	No	----
Asbestos (Trace)	1332-21-4	5	Fibres	----	No	----	No	----
Asbestos Type	1332-21-4	-	--	----	-	----	-	----
Sample weight (dry)	----	0.01	g	----	323	----	299	----
APPROVED IDENTIFIER:	----	-	--	----	U.DALKIN	----	U.DALKIN	----
Synthetic Mineral Fibre	----	0.1	g/kg	----	No	----	No	----
Organic Fibre	----	0.1	g/kg	----	Yes	----	Yes	----
EA200N: Asbestos Quantification (non-NATA)								
ø Asbestos (Fines and Fibrous <7mm)	1332-21-4	0.0004	g	----	<0.0004	----	<0.0004	----
ø Asbestos (Fines and Fibrous FA+AF)	----	0.001	% (w/w)	----	<0.001	----	<0.001	----
ø Weight Used for % Calculation	----	0.0001	kg	----	0.323	----	0.299	----
ø Fibrous Asbestos >7mm	----	0.0004	g	----	<0.0004	----	<0.0004	----
EG020-SD: Total Metals in Sediments by ICPMS								
Antimony	7440-36-0	0.50	mg/kg	0.77	0.61	<0.50	<0.50	----
Arsenic	7440-38-2	1.00	mg/kg	1.21	1.18	<1.00	1.18	----
Cadmium	7440-43-9	0.1	mg/kg	0.1	0.2	0.2	<0.1	----
Chromium	7440-47-3	1.0	mg/kg	10.2	10.4	10.6	9.4	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C03S03	C04S01	C04S02	C05S01	C05S02
			Client sampling date / time	12-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-009	EP1911899-010	EP1911899-011	EP1911899-013	EP1911899-014
				Result	Result	Result	Result	Result
EG020-SD: Total Metals in Sediments by ICPMS - Continued								
Copper	7440-50-8	1.0	mg/kg	<1.0	<1.0	<1.0	<1.0	----
Cobalt	7440-48-4	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
Lead	7439-92-1	1.0	mg/kg	**1.0**	<1.0	<1.0	<1.0	----
Manganese	7439-96-5	10	mg/kg	<10	<10	<10	<10	----
Nickel	7440-02-0	1.0	mg/kg	<1.0	<1.0	**1.0**	<1.0	----
Selenium	7782-49-2	0.1	mg/kg	**0.2**	**0.2**	**0.2**	**0.1**	----
Silver	7440-22-4	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----
Vanadium	7440-62-2	2.0	mg/kg	**12.3**	**10.5**	**12.4**	<2.0	----
Zinc	7440-66-6	1.0	mg/kg	**3.5**	**2.2**	**1.3**	**2.0**	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.01	mg/kg	<0.01	<0.01	<0.01	<0.01	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	----	<0.1	----	<0.1	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	----	<0.1	----	<0.1	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	<0.1	----	<0.1	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	**330**	----	**250**	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	----	**330**	----	**250**	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	----	**254**	----	**274**	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.1	mg/kg	----	**0.8**	----	**0.2**	----
EK255A SD: Ammonia in Sediment								
Ammonia as N	7664-41-7	0.2	mg/kg	----	**20.6**	----	<0.2	----
EN68: Seawater Elutriate Testing Procedure								
Seawater Sampling Date	----	-	-	**21/11/2019**	----	**21/11/2019**	----	----
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	----	**0.72**	----	**0.23**	----
EP070: Total Petroleum Hydrocarbons - Speciation								
Aliphatic C16-C35	----	100	mg/kg	----	<100	----	----	<100

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C03S03	C04S01	C04S02	C05S01	C05S02
			Client sampling date / time	12-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-009	EP1911899-010	EP1911899-011	EP1911899-013	EP1911899-014
				Result	Result	Result	Result	Result
EP070: Total Petroleum Hydrocarbons - Speciation - Continued								
Aliphatic > C35	----	100	mg/kg	----	<100	----	----	<100
Aromatic C16-C35	----	90	mg/kg	----	<90	----	----	<90
Aromatic > C35	----	100	mg/kg	----	<100	----	----	<100
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
>C10 - C16 Fraction	----	3	mg/kg	<3	<3	<3	<3	----
>C16 - C34 Fraction	----	3	mg/kg	<3	<3	<3	<3	----
>C34 - C40 Fraction	----	5	mg/kg	<5	<5	<5	<5	----
>C10 - C40 Fraction (sum)	----	3	mg/kg	<3	<3	<3	<3	----
>C10 - C16 Fraction minus Naphthalene (F2)	----	3	mg/kg	<3	<3	<3	<3	----
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	3	mg/kg	<3	<3	<3	<3	----
C10 - C14 Fraction	----	3	mg/kg	<3	<3	<3	<3	----
C15 - C28 Fraction	----	3	mg/kg	<3	<3	<3	<3	----
C29 - C36 Fraction	----	5	mg/kg	<5	<5	<5	<5	----
^ C10 - C36 Fraction (sum)	----	3	mg/kg	<3	<3	<3	<3	----
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons								
C6 - C10 Fraction	C6_C10	3	mg/kg	<3	<3	<3	<3	----
C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	3.0	mg/kg	<3.0	<3.0	<3.0	<3.0	----
EP080-SD: BTEXN								
Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	----
Toluene	108-88-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	----
Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	----
meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	----
ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	----
^ Total Xylenes	----	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
^ Sum of BTEX	----	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	----
Naphthalene	91-20-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	----
EP090: Organotin Compounds								
Tributyltin	56573-85-4	0.5	µgSn/kg	----	<0.5	----	<0.5	----
EP130A: Organophosphorus Pesticides (Ultra-trace)								
Bromophos-ethyl	4824-78-6	10	µg/kg	<10	<10	<10	<10	----
Carbophenothion	786-19-6	10	µg/kg	<10	<10	<10	<10	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C03S03	C04S01	C04S02	C05S01	C05S02
			Client sampling date / time	12-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-009	EP1911899-010	EP1911899-011	EP1911899-013	EP1911899-014
				Result	Result	Result	Result	Result
EP130A: Organophosphorus Pesticides (Ultra-trace) - Continued								
Chlorfenvinphos (E)	18708-86-6	10.0	µg/kg	<10.0	<10.0	<10.0	<10.0	----
Chlorfenvinphos (Z)	18708-87-7	10	µg/kg	<10	<10	<10	<10	----
Chlorpyrifos	2921-88-2	10	µg/kg	<10	<10	<10	<10	----
Chlorpyrifos-methyl	5598-13-0	10	µg/kg	<10	<10	<10	<10	----
Demeton-S-methyl	919-86-8	10	µg/kg	<10	<10	<10	<10	----
Diazinon	333-41-5	10	µg/kg	<10	<10	<10	<10	----
Dichlorvos	62-73-7	10	µg/kg	<10	<10	<10	<10	----
Dimethoate	60-51-5	10	µg/kg	<10	<10	<10	<10	----
Ethion	563-12-2	10	µg/kg	<10	<10	<10	<10	----
Fenamiphos	22224-92-6	10	µg/kg	<10	<10	<10	<10	----
Fenthion	55-38-9	10	µg/kg	<10	<10	<10	<10	----
Malathion	121-75-5	10	µg/kg	<10	<10	<10	<10	----
Azinphos Methyl	86-50-0	10	µg/kg	<10	<10	<10	<10	----
Monocrotophos	6923-22-4	10	µg/kg	<10	<10	<10	<10	----
Parathion	56-38-2	10	µg/kg	<10	<10	<10	<10	----
Parathion-methyl	298-00-0	10	µg/kg	<10	<10	<10	<10	----
Pirimphos-ethyl	23505-41-1	10	µg/kg	<10	<10	<10	<10	----
Prothiofos	34643-46-4	10	µg/kg	<10	<10	<10	<10	----
EP131A: Organochlorine Pesticides								
Aldrin	309-00-2	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	----
alpha-BHC	319-84-6	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	----
beta-BHC	319-85-7	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	----
delta-BHC	319-86-8	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	----
4.4`-DDD	72-54-8	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	----
4.4`-DDE	72-55-9	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	----
4.4`-DDT	50-29-3	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	----
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	----
Dieldrin	60-57-1	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	----
alpha-Endosulfan	959-98-8	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	----
beta-Endosulfan	33213-65-9	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	----
Endosulfan sulfate	1031-07-8	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	----
^ Endosulfan (sum)	115-29-7	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	----
Endrin	72-20-8	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	----
Endrin aldehyde	7421-93-4	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C03S03	C04S01	C04S02	C05S01	C05S02
			Client sampling date / time	12-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-009	EP1911899-010	EP1911899-011	EP1911899-013	EP1911899-014
				Result	Result	Result	Result	Result
EP131A: Organochlorine Pesticides - Continued								
Endrin ketone	53494-70-5	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	----
Heptachlor	76-44-8	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	----
Heptachlor epoxide	1024-57-3	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	----
Hexachlorobenzene (HCB)	118-74-1	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	----
gamma-BHC	58-89-9	0.25	µg/kg	<0.25	<0.25	<0.25	<0.25	----
Methoxychlor	72-43-5	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	----
cis-Chlordane	5103-71-9	0.25	µg/kg	<0.25	<0.25	<0.25	<0.25	----
trans-Chlordane	5103-74-2	0.25	µg/kg	<0.25	<0.25	<0.25	<0.25	----
^ Total Chlordane (sum)	----	0.25	µg/kg	<0.25	<0.25	<0.25	<0.25	----
Oxychlordane	27304-13-8	0.50	µg/kg	<0.50	<0.50	<0.50	<0.50	----
EP132B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	5	µg/kg	<5	<5	<5	<5	----
2-Methylnaphthalene	91-57-6	5	µg/kg	<5	<5	<5	<5	----
Acenaphthylene	208-96-8	4	µg/kg	<8	<4	<4	<4	----
Acenaphthene	83-32-9	4	µg/kg	<4	<4	<4	<4	----
Fluorene	86-73-7	4	µg/kg	<4	<4	<4	<4	----
Phenanthrene	85-01-8	4	µg/kg	<4	<4	<4	<4	----
Anthracene	120-12-7	4	µg/kg	<20	<4	<4	<4	----
Fluoranthene	206-44-0	4	µg/kg	<20	<4	<4	<4	----
Pyrene	129-00-0	4	µg/kg	<20	<4	<4	<4	----
Benz(a)anthracene	56-55-3	4	µg/kg	<20	<4	<4	<4	----
Chrysene	218-01-9	4	µg/kg	<20	<4	<4	<4	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	4	µg/kg	<20	<4	<4	<4	----
Benzo(k)fluoranthene	207-08-9	4	µg/kg	<20	<4	<4	<4	----
Benzo(e)pyrene	192-97-2	4	µg/kg	<20	<4	<4	<4	----
Benzo(a)pyrene	50-32-8	4	µg/kg	<20	<4	<4	<4	----
Perylene	198-55-0	4	µg/kg	<4	<4	<4	<4	----
Benzo(g.h.i)perylene	191-24-2	4	µg/kg	<4	<4	<4	<4	----
Dibenz(a.h)anthracene	53-70-3	4	µg/kg	<4	<4	<4	<4	----
Indeno(1.2.3.cd)pyrene	193-39-5	4	µg/kg	<20	<4	<4	<4	----
Coronene	191-07-1	5	µg/kg	<5	<5	<5	<5	----
^ Sum of PAHs	----	4	µg/kg	<4	<4	<4	<4	----
^ Benzo(a)pyrene TEQ (zero)	----	4	µg/kg	<4	<4	<4	<4	----
^ Benzo(a)pyrene TEQ (half LOR)	----	4	µg/kg	**5**	**5**	**5**	**5**	----
^ Benzo(a)pyrene TEQ (LOR)	----	4	µg/kg	**10**	**10**	**10**	**10**	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C03S03	C04S01	C04S02	C05S01	C05S02
			Client sampling date / time	12-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-009	EP1911899-010	EP1911899-011	EP1911899-013	EP1911899-014
				Result	Result	Result	Result	Result
EP203A: Explosives								
HMX	2691-41-0	0.1	mg/kg	----	<0.1	----	<0.1	----
RDX	----	0.1	mg/kg	----	<0.1	----	<0.1	----
1.3.5-Trinitrobenzene	99-35-4	0.1	mg/kg	----	<0.1	----	<0.1	----
1.3-Dinitrobenzene	99-65-0	0.1	mg/kg	----	<0.1	----	<0.1	----
Tetryl	479-45-8	0.1	mg/kg	----	<0.1	----	<0.1	----
2.4.6-TNT	118-96-7	0.1	mg/kg	----	<0.1	----	<0.1	----
4-Amino.2.6-DNT	19406-51-0	0.1	mg/kg	----	<0.1	----	<0.1	----
2-Amino-4.6-DNT	35572-78-2	0.1	mg/kg	----	<0.1	----	<0.1	----
^ 4-& 2-AM-DNT(Isomeric Mixture)	----	0.1	mg/kg	----	<0.1	----	<0.1	----
2.4-Dinitrotoluene	121-14-2	0.1	mg/kg	----	<0.1	----	<0.1	----
2.6-Dinitrotoluene	606-20-2	0.1	mg/kg	----	<0.1	----	<0.1	----
^ 2.4-& 2.6-DNT(Isomeric Mixture)	121-14-2/606-20-2	0.1	mg/kg	----	<0.1	----	<0.1	----
Nitrobenzene	98-95-3	0.1	mg/kg	----	<0.1	----	<0.1	----
2-Nitrotoluene	88-72-2	0.1	mg/kg	----	<0.1	----	<0.1	----
3-Nitrotoluene	99-08-1	0.1	mg/kg	----	<0.1	----	<0.1	----
4-Nitrotoluene	99-99-0	0.1	mg/kg	----	<0.1	----	<0.1	----
Nitroglycerine	55-63-0	1	mg/kg	----	<1	----	<1	----
PETN	78-11-5	1	mg/kg	----	<1	----	<1	----
EP231A: Perfluoroalkyl Sulfonic Acids								
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	----
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	----
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	----
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	----
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	mg/kg	<0.0002	<0.0002	**0.0004**	<0.0002	----
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	----
EP231B: Perfluoroalkyl Carboxylic Acids								
Perfluorobutanoic acid (PFBA)	375-22-4	0.001	mg/kg	<0.001	<0.001	<0.001	<0.001	----
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	----
Perfluorohexanoic acid (PFHxA)	307-24-4	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C03S03	C04S01	C04S02	C05S01	C05S02
			Client sampling date / time	12-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-009	EP1911899-010	EP1911899-011	EP1911899-013	EP1911899-014
				Result	Result	Result	Result	Result
EP231B: Perfluoroalkyl Carboxylic Acids - Continued								
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	----
Perfluorooctanoic acid (PFOA)	335-67-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	----
Perfluorononanoic acid (PFNA)	375-95-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	----
Perfluorodecanoic acid (PFDA)	335-76-2	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	----
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	----
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	----
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	----
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	----
EP231C: Perfluoroalkyl Sulfonamides								
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	----
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	----
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	----
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	----
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	----
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	----
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	----
EP231D: (n:2) Fluorotelomer Sulfonic Acids								
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	----
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	----
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C03S03	C04S01	C04S02	C05S01	C05S02
			Client sampling date / time	12-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00	13-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-009	EP1911899-010	EP1911899-011	EP1911899-013	EP1911899-014
				Result	Result	Result	Result	Result
EP231D: (n:2) Fluorotelomer Sulfonic Acids - Continued								
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	----
EP231P: PFAS Sums								
Sum of PFAS	----	0.0002	mg/kg	<0.0002	<0.0002	0.0004	<0.0002	----
Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	mg/kg	<0.0002	<0.0002	0.0004	<0.0002	----
Sum of PFAS (WA DER List)	----	0.0002	mg/kg	<0.0002	<0.0002	0.0004	<0.0002	----
EP070: Total Petroleum Hydrocarbons - Speciation								
2-Bromonaphthalene	580-13-2	1	%	----	92.1	----	----	96.0
2-Fluorobiphenyl	321-60-8	1	%	----	105	----	----	111
EP080-SD: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.2	%	94.6	88.9	96.4	102	----
Toluene-D8	2037-26-5	0.2	%	86.2	93.3	75.8	79.2	----
4-Bromofluorobenzene	460-00-4	0.2	%	73.4	76.2	80.3	85.1	----
EP090S: Organotin Surrogate								
Tripropyltin	----	0.5	%	----	101	----	104	----
EP130S: Organophosphorus Pesticide Surrogate								
DEF	78-48-8	10	%	54.8	68.4	55.7	60.7	----
EP131S: OC Pesticide Surrogate								
Dibromo-DDE	21655-73-2	0.50	%	94.4	50.9	47.9	65.0	----
EP132T: Base/Neutral Extractable Surrogates								
2-Fluorobiphenyl	321-60-8	10	%	92.6	113	83.1	105	----
Anthracene-d10	1719-06-8	10	%	99.5	113	94.2	109	----
4-Terphenyl-d14	1718-51-0	10	%	84.9	103	80.2	86.4	----
EP203S: Explosives Surrogate								
o-Dinitrobenzene	528-29-0	0.1	%	----	108	----	101	----
EP231S: PFAS Surrogate								
13C4-PFOS	----	0.0002	%	74.0	75.0	88.5	90.5	----
13C8-PFOA	----	0.0002	%	81.0	83.5	81.5	83.0	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C05S03	C06S01	C06S02	C06S03	C07S01
			Client sampling date / time	13-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-015	EP1911899-016	EP1911899-017	EP1911899-018	EP1911899-019
				Result	Result	Result	Result	Result
EA029-A: pH Measurements								
pH OX (23B)	----	0.1	pH Unit	----	8.1	----	8.1	8.1
EA029-B: Acidity Trail								
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	<2	----	<2	<2
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	----	10.1	----	10.0	10.1
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	<2	----	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	----	<0.02	----	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	----	0.008	----	0.024	0.007
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	----	<10	----	15	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	----	83.8	----	78.5	85.2
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	----	16700	----	15700	17000
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	----	26.8	----	25.2	27.3
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	1.5	----	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	----	<0.02	----	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	----	<10	----	<10	<10
Liming Rate	----	1	kg CaCO3/t	----	<1	----	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	<0.02	----	0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	<10	----	15	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	<1	----	1	<1
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	----	----	----	22.4	----
Moisture Content	----	1.0	%	26.2	20.9	26.1	----	20.6
EA150: Particle Sizing								
+75µm	----	1	%	----	----	----	97	----
+150µm	----	1	%	----	----	----	82	----
+300µm	----	1	%	----	----	----	48	----
+425µm	----	1	%	----	----	----	30	----
+600µm	----	1	%	----	----	----	12	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C05S03	C06S01	C06S02	C06S03	C07S01
			Client sampling date / time	13-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-015	EP1911899-016	EP1911899-017	EP1911899-018	EP1911899-019
				Result	Result	Result	Result	Result
EA150: Particle Sizing - Continued								
+1180µm	----	1	%	----	----	----	4	----
+2.36mm	----	1	%	----	----	----	2	----
+4.75mm	----	1	%	----	----	----	2	----
+9.5mm	----	1	%	----	----	----	<1	----
+19.0mm	----	1	%	----	----	----	<1	----
+37.5mm	----	1	%	----	----	----	<1	----
+75.0mm	----	1	%	----	----	----	<1	----
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	----	----	----	2	----
Silt (2-60 µm)	----	1	%	----	----	----	<1	----
Sand (0.06-2.00 mm)	----	1	%	----	----	----	95	----
Gravel (>2mm)	----	1	%	----	----	----	3	----
Cobbles (>6cm)	----	1	%	----	----	----	<1	----
EA152: Soil Particle Density								
Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	----	----	----	2.70	----
EA200: AS 4964 - 2004 Identification of Asbestos in Soils								
Asbestos Detected	1332-21-4	0.1	g/kg	----	No	----	----	No
Asbestos (Trace)	1332-21-4	5	Fibres	----	No	----	----	No
Asbestos Type	1332-21-4	-	--	----	-	----	----	-
Sample weight (dry)	----	0.01	g	----	444	----	----	381
APPROVED IDENTIFIER:	----	-	--	----	U.DALKIN	----	----	U.DALKIN
Synthetic Mineral Fibre	----	0.1	g/kg	----	No	----	----	No
Organic Fibre	----	0.1	g/kg	----	Yes	----	----	Yes
EA200N: Asbestos Quantification (non-NATA)								
ø Asbestos (Fines and Fibrous <7mm)	1332-21-4	0.0004	g	----	<0.0004	----	----	<0.0004
ø Asbestos (Fines and Fibrous FA+AF)	----	0.001	% (w/w)	----	<0.001	----	----	<0.001
ø Weight Used for % Calculation	----	0.0001	kg	----	0.444	----	----	0.381
ø Fibrous Asbestos >7mm	----	0.0004	g	----	<0.0004	----	----	<0.0004
EG020-SD: Total Metals in Sediments by ICPMS								
Antimony	7440-36-0	0.50	mg/kg	<0.50	<0.50	<0.50	----	<0.50
Arsenic	7440-38-2	1.00	mg/kg	<1.00	1.26	1.14	----	1.32
Cadmium	7440-43-9	0.1	mg/kg	0.1	<0.1	0.1	----	0.1
Chromium	7440-47-3	1.0	mg/kg	9.5	8.8	8.8	----	9.2

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C05S03	C06S01	C06S02	C06S03	C07S01
			Client sampling date / time	13-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-015	EP1911899-016	EP1911899-017	EP1911899-018	EP1911899-019
				Result	Result	Result	Result	Result
EG020-SD: Total Metals in Sediments by ICPMS - Continued								
Copper	7440-50-8	1.0	mg/kg	<1.0	<1.0	<1.0	----	<1.0
Cobalt	7440-48-4	0.5	mg/kg	<0.5	<0.5	<0.5	----	<0.5
Lead	7439-92-1	1.0	mg/kg	<1.0	<1.0	<1.0	----	<1.0
Manganese	7439-96-5	10	mg/kg	<10	<10	<10	----	<10
Nickel	7440-02-0	1.0	mg/kg	<1.0	<1.0	<1.0	----	<1.0
Selenium	7782-49-2	0.1	mg/kg	**0.1**	<0.1	<0.1	----	<0.1
Silver	7440-22-4	0.1	mg/kg	<0.1	<0.1	<0.1	----	**0.1**
Vanadium	7440-62-2	2.0	mg/kg	**3.2**	<2.0	**2.7**	----	<2.0
Zinc	7440-66-6	1.0	mg/kg	**3.9**	**1.8**	**2.6**	----	**1.5**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.01	mg/kg	<0.01	<0.01	<0.01	----	<0.01
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	----	<0.1	----	----	<0.1
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	----	<0.1	----	----	<0.1
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	<0.1	----	----	<0.1
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	**190**	----	----	**210**
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	----	**190**	----	----	**210**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	----	**311**	----	----	**327**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.1	mg/kg	----	**0.2**	----	----	**0.3**
EK255A SD: Ammonia in Sediment								
Ammonia as N	7664-41-7	0.2	mg/kg	----	**0.4**	----	----	**1.0**
EN68: Seawater Elutriate Testing Procedure								
Seawater Sampling Date	----	-	-	**21/11/2019**	----	**21/11/2019**	----	**21/11/2019**
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	----	**0.05**	----	----	**0.04**
EP070: Total Petroleum Hydrocarbons - Speciation								
Aliphatic C16-C35	----	100	mg/kg	----	----	----	<100	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C05S03	C06S01	C06S02	C06S03	C07S01
			Client sampling date / time	13-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-015	EP1911899-016	EP1911899-017	EP1911899-018	EP1911899-019
				Result	Result	Result	Result	Result
EP070: Total Petroleum Hydrocarbons - Speciation - Continued								
Aliphatic > C35	----	100	mg/kg	----	----	----	<100	----
Aromatic C16-C35	----	90	mg/kg	----	----	----	<90	----
Aromatic > C35	----	100	mg/kg	----	----	----	<100	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
>C10 - C16 Fraction	----	3	mg/kg	<3	<3	<3	----	<3
>C16 - C34 Fraction	----	3	mg/kg	<3	**5**	<3	----	<3
>C34 - C40 Fraction	----	5	mg/kg	<5	<5	<5	----	<5
>C10 - C40 Fraction (sum)	----	3	mg/kg	<3	**5**	<3	----	<3
>C10 - C16 Fraction minus Naphthalene (F2)	----	3	mg/kg	<3	<3	<3	----	<3
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	3	mg/kg	<3	<3	<3	----	<3
C10 - C14 Fraction	----	3	mg/kg	<3	<3	<3	----	<3
C15 - C28 Fraction	----	3	mg/kg	<3	**5**	<3	----	<3
C29 - C36 Fraction	----	5	mg/kg	<5	<5	<5	----	<5
^ C10 - C36 Fraction (sum)	----	3	mg/kg	<3	**5**	<3	----	<3
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons								
C6 - C10 Fraction	C6_C10	3	mg/kg	<3	<3	<3	----	<3
C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	3.0	mg/kg	<3.0	<3.0	<3.0	----	<3.0
EP080-SD: BTEXN								
Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	<0.2	----	<0.2
Toluene	108-88-3	0.2	mg/kg	<0.2	<0.2	<0.2	----	<0.2
Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	<0.2	<0.2	----	<0.2
meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	<0.2	<0.2	----	<0.2
ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	<0.2	<0.2	----	<0.2
^ Total Xylenes	----	0.5	mg/kg	<0.5	<0.5	<0.5	----	<0.5
^ Sum of BTEX	----	0.2	mg/kg	<0.2	<0.2	<0.2	----	<0.2
Naphthalene	91-20-3	0.2	mg/kg	<0.2	<0.2	<0.2	----	<0.2
EP090: Organotin Compounds								
Tributyltin	56573-85-4	0.5	µgSn/kg	----	<0.5	----	----	<0.5
EP130A: Organophosphorus Pesticides (Ultra-trace)								
Bromophos-ethyl	4824-78-6	10	µg/kg	<10	<10	<10	----	<10
Carbophenothion	786-19-6	10	µg/kg	<10	<10	<10	----	<10

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C05S03	C06S01	C06S02	C06S03	C07S01
			Client sampling date / time	13-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-015	EP1911899-016	EP1911899-017	EP1911899-018	EP1911899-019
				Result	Result	Result	Result	Result
EP130A: Organophosphorus Pesticides (Ultra-trace) - Continued								
Chlorfenvinphos (E)	18708-86-6	10.0	µg/kg	<10.0	<10.0	<10.0	----	<10.0
Chlorfenvinphos (Z)	18708-87-7	10	µg/kg	<10	<10	<10	----	<10
Chlorpyrifos	2921-88-2	10	µg/kg	<10	<10	<10	----	<10
Chlorpyrifos-methyl	5598-13-0	10	µg/kg	<10	<10	<10	----	<10
Demeton-S-methyl	919-86-8	10	µg/kg	<10	<10	<10	----	<10
Diazinon	333-41-5	10	µg/kg	<10	<10	<10	----	<10
Dichlorvos	62-73-7	10	µg/kg	<10	<10	<10	----	<10
Dimethoate	60-51-5	10	µg/kg	<10	<10	<10	----	<10
Ethion	563-12-2	10	µg/kg	<10	<10	<10	----	<10
Fenamiphos	22224-92-6	10	µg/kg	<10	<10	<10	----	<10
Fenthion	55-38-9	10	µg/kg	<10	<10	<10	----	<10
Malathion	121-75-5	10	µg/kg	<10	<10	<10	----	<10
Azinphos Methyl	86-50-0	10	µg/kg	<10	<10	<10	----	<10
Monocrotophos	6923-22-4	10	µg/kg	<10	<10	<10	----	<10
Parathion	56-38-2	10	µg/kg	<10	<10	<10	----	<10
Parathion-methyl	298-00-0	10	µg/kg	<10	<10	<10	----	<10
Pirimphos-ethyl	23505-41-1	10	µg/kg	<10	<10	<10	----	<10
Prothiofos	34643-46-4	10	µg/kg	<10	<10	<10	----	<10
EP131A: Organochlorine Pesticides								
Aldrin	309-00-2	0.50	µg/kg	<0.50	<0.50	<0.50	----	<0.50
alpha-BHC	319-84-6	0.50	µg/kg	<0.50	<0.50	<0.50	----	<0.50
beta-BHC	319-85-7	0.50	µg/kg	<0.50	<0.50	<0.50	----	<0.50
delta-BHC	319-86-8	0.50	µg/kg	<0.50	<0.50	<0.50	----	<0.50
4.4`-DDD	72-54-8	0.50	µg/kg	<0.50	<0.50	<0.50	----	<0.50
4.4`-DDE	72-55-9	0.50	µg/kg	<0.50	<0.50	<0.50	----	<0.50
4.4`-DDT	50-29-3	0.50	µg/kg	<0.50	<0.50	<0.50	----	<0.50
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.50	µg/kg	<0.50	<0.50	<0.50	----	<0.50
Dieldrin	60-57-1	0.50	µg/kg	<0.50	<0.50	<0.50	----	<0.50
alpha-Endosulfan	959-98-8	0.50	µg/kg	<0.50	<0.50	<0.50	----	<0.50
beta-Endosulfan	33213-65-9	0.50	µg/kg	<0.50	<0.50	<0.50	----	<0.50
Endosulfan sulfate	1031-07-8	0.50	µg/kg	<0.50	<0.50	<0.50	----	<0.50
^ Endosulfan (sum)	115-29-7	0.50	µg/kg	<0.50	<0.50	<0.50	----	<0.50
Endrin	72-20-8	0.50	µg/kg	<0.50	<0.50	<0.50	----	<0.50
Endrin aldehyde	7421-93-4	0.50	µg/kg	<0.50	<0.50	<0.50	----	<0.50

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C05S03	C06S01	C06S02	C06S03	C07S01
			Client sampling date / time	13-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-015	EP1911899-016	EP1911899-017	EP1911899-018	EP1911899-019
				Result	Result	Result	Result	Result
EP131A: Organochlorine Pesticides - Continued								
Endrin ketone	53494-70-5	0.50	µg/kg	<0.50	<0.50	<0.50	----	<0.50
Heptachlor	76-44-8	0.50	µg/kg	<0.50	<0.50	<0.50	----	<0.50
Heptachlor epoxide	1024-57-3	0.50	µg/kg	<0.50	<0.50	<0.50	----	<0.50
Hexachlorobenzene (HCB)	118-74-1	0.50	µg/kg	<0.50	<0.50	<0.50	----	<0.50
gamma-BHC	58-89-9	0.25	µg/kg	<0.25	<0.25	<0.25	----	<0.25
Methoxychlor	72-43-5	0.50	µg/kg	<0.50	<0.50	<0.50	----	<0.50
cis-Chlordane	5103-71-9	0.25	µg/kg	<0.25	<0.25	<0.25	----	<0.25
trans-Chlordane	5103-74-2	0.25	µg/kg	<0.25	<0.25	<0.25	----	<0.25
^ Total Chlordane (sum)	----	0.25	µg/kg	<0.25	<0.25	<0.25	----	<0.25
Oxychlordane	27304-13-8	0.50	µg/kg	<0.50	<0.50	<0.50	----	<0.50
EP132B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	5	µg/kg	<5	<5	<5	----	<5
2-Methylnaphthalene	91-57-6	5	µg/kg	<5	<5	<5	----	<5
Acenaphthylene	208-96-8	4	µg/kg	<4	<4	<4	----	<4
Acenaphthene	83-32-9	4	µg/kg	<4	<4	<4	----	<4
Fluorene	86-73-7	4	µg/kg	<4	<4	<4	----	<4
Phenanthrene	85-01-8	4	µg/kg	<4	<4	<4	----	<4
Anthracene	120-12-7	4	µg/kg	<4	<4	<4	----	<4
Fluoranthene	206-44-0	4	µg/kg	<4	<4	<4	----	<4
Pyrene	129-00-0	4	µg/kg	<4	<4	<4	----	<4
Benz(a)anthracene	56-55-3	4	µg/kg	<4	<4	<4	----	<4
Chrysene	218-01-9	4	µg/kg	<4	<4	<4	----	<4
Benzo(b+j)fluoranthene	205-99-2 205-82-3	4	µg/kg	<4	<4	<4	----	<4
Benzo(k)fluoranthene	207-08-9	4	µg/kg	<4	<4	<4	----	<4
Benzo(e)pyrene	192-97-2	4	µg/kg	<4	<4	<4	----	<4
Benzo(a)pyrene	50-32-8	4	µg/kg	<4	<4	<4	----	<4
Perylene	198-55-0	4	µg/kg	<4	<4	<4	----	<4
Benzo(g.h.i)perylene	191-24-2	4	µg/kg	<4	<4	<4	----	<4
Dibenz(a.h)anthracene	53-70-3	4	µg/kg	<4	<4	<4	----	<4
Indeno(1.2.3.cd)pyrene	193-39-5	4	µg/kg	<4	<4	<4	----	<4
Coronene	191-07-1	5	µg/kg	<5	<5	<5	----	<5
^ Sum of PAHs	----	4	µg/kg	<4	<4	<4	----	<4
^ Benzo(a)pyrene TEQ (zero)	----	4	µg/kg	<4	<4	<4	----	<4
^ Benzo(a)pyrene TEQ (half LOR)	----	4	µg/kg	**5**	**5**	**5**	----	**5**
^ Benzo(a)pyrene TEQ (LOR)	----	4	µg/kg	**10**	**10**	**10**	----	**10**

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C05S03	C06S01	C06S02	C06S03	C07S01
			Client sampling date / time	13-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-015	EP1911899-016	EP1911899-017	EP1911899-018	EP1911899-019
				Result	Result	Result	Result	Result
EP203A: Explosives								
HMX	2691-41-0	0.1	mg/kg	----	<0.1	----	----	<0.1
RDX	----	0.1	mg/kg	----	<0.1	----	----	<0.1
1.3.5-Trinitrobenzene	99-35-4	0.1	mg/kg	----	<0.1	----	----	<0.1
1.3-Dinitrobenzene	99-65-0	0.1	mg/kg	----	<0.1	----	----	<0.1
Tetryl	479-45-8	0.1	mg/kg	----	<0.1	----	----	<0.1
2.4.6-TNT	118-96-7	0.1	mg/kg	----	<0.1	----	----	<0.1
4-Amino.2.6-DNT	19406-51-0	0.1	mg/kg	----	<0.1	----	----	<0.1
2-Amino-4.6-DNT	35572-78-2	0.1	mg/kg	----	<0.1	----	----	<0.1
^ 4-& 2-AM-DNT(Isomeric Mixture)	----	0.1	mg/kg	----	<0.1	----	----	<0.1
2.4-Dinitrotoluene	121-14-2	0.1	mg/kg	----	<0.1	----	----	<0.1
2.6-Dinitrotoluene	606-20-2	0.1	mg/kg	----	<0.1	----	----	<0.1
^ 2.4-& 2.6-DNT(Isomeric Mixture)	121-14-2/606-20-2	0.1	mg/kg	----	<0.1	----	----	<0.1
Nitrobenzene	98-95-3	0.1	mg/kg	----	<0.1	----	----	<0.1
2-Nitrotoluene	88-72-2	0.1	mg/kg	----	<0.1	----	----	<0.1
3-Nitrotoluene	99-08-1	0.1	mg/kg	----	<0.1	----	----	<0.1
4-Nitrotoluene	99-99-0	0.1	mg/kg	----	<0.1	----	----	<0.1
Nitroglycerine	55-63-0	1	mg/kg	----	<1	----	----	<1
PETN	78-11-5	1	mg/kg	----	<1	----	----	<1
EP231A: Perfluoroalkyl Sulfonic Acids								
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	----	<0.0002
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	----	<0.0002
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	----	<0.0002
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	----	<0.0002
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	mg/kg	**0.0006**	<0.0002	<0.0002	----	<0.0002
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	----	<0.0002
EP231B: Perfluoroalkyl Carboxylic Acids								
Perfluorobutanoic acid (PFBA)	375-22-4	0.001	mg/kg	<0.001	<0.001	<0.001	----	<0.001
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	----	<0.0002
Perfluorohexanoic acid (PFHxA)	307-24-4	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	----	<0.0002

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C05S03	C06S01	C06S02	C06S03	C07S01
			Client sampling date / time	13-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-015	EP1911899-016	EP1911899-017	EP1911899-018	EP1911899-019
				Result	Result	Result	Result	Result
EP231B: Perfluoroalkyl Carboxylic Acids - Continued								
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	----	<0.0002
Perfluorooctanoic acid (PFOA)	335-67-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	----	<0.0002
Perfluorononanoic acid (PFNA)	375-95-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	----	<0.0002
Perfluorodecanoic acid (PFDA)	335-76-2	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	----	<0.0002
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	----	<0.0002
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	----	<0.0002
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	----	<0.0002
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	----	<0.0005
EP231C: Perfluoroalkyl Sulfonamides								
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	----	<0.0002
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	----	<0.0005
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	----	<0.0005
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	----	<0.0005
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	----	<0.0005
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	----	<0.0002
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	----	<0.0002
EP231D: (n:2) Fluorotelomer Sulfonic Acids								
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	----	<0.0005
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	----	<0.0005
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	----	<0.0005

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C05S03	C06S01	C06S02	C06S03	C07S01
			Client sampling date / time	13-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-015	EP1911899-016	EP1911899-017	EP1911899-018	EP1911899-019
				Result	Result	Result	Result	Result
EP231D: (n:2) Fluorotelomer Sulfonic Acids - Continued								
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	----	<0.0005
EP231P: PFAS Sums								
Sum of PFAS	----	0.0002	mg/kg	**0.0006**	<0.0002	<0.0002	----	<0.0002
Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	mg/kg	**0.0006**	<0.0002	<0.0002	----	<0.0002
Sum of PFAS (WA DER List)	----	0.0002	mg/kg	**0.0006**	<0.0002	<0.0002	----	<0.0002
EP070: Total Petroleum Hydrocarbons - Speciation								
2-Bromonaphthalene	580-13-2	1	%	----	----	----	**97.4**	----
2-Fluorobiphenyl	321-60-8	1	%	----	----	----	**112**	----
EP080-SD: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.2	%	**94.9**	**95.7**	**99.0**	----	**106**
Toluene-D8	2037-26-5	0.2	%	**74.2**	**77.6**	**80.6**	----	**87.6**
4-Bromofluorobenzene	460-00-4	0.2	%	**77.2**	**82.2**	**86.1**	----	**92.2**
EP090S: Organotin Surrogate								
Tripropyltin	----	0.5	%	----	**172**	----	----	**107**
EP130S: Organophosphorus Pesticide Surrogate								
DEF	78-48-8	10	%	**54.3**	**52.7**	**54.7**	----	**61.1**
EP131S: OC Pesticide Surrogate								
Dibromo-DDE	21655-73-2	0.50	%	**50.2**	**65.6**	**62.3**	----	**84.4**
EP132T: Base/Neutral Extractable Surrogates								
2-Fluorobiphenyl	321-60-8	10	%	**95.1**	**91.8**	**90.4**	----	**111**
Anthracene-d10	1719-06-8	10	%	**102**	**99.0**	**104**	----	**118**
4-Terphenyl-d14	1718-51-0	10	%	**89.6**	**90.3**	**86.0**	----	**97.5**
EP203S: Explosives Surrogate								
o-Dinitrobenzene	528-29-0	0.1	%	----	**102**	----	----	**106**
EP231S: PFAS Surrogate								
13C4-PFOS	----	0.0002	%	**89.0**	**78.5**	**66.0**	----	**79.5**
13C8-PFOA	----	0.0002	%	**89.5**	**78.0**	**79.0**	----	**76.5**

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C07S02	C07S03	SZ1	SZ2	----
			Client sampling date / time	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	----
Compound	CAS Number	LOR	Unit	EP1911899-020	EP1911899-021	EP1911899-022	EP1911899-023	--------
				Result	Result	Result	Result	----
EA029-A: pH Measurements								
pH OX (23B)	----	0.1	pH Unit	----	----	8.0	----	----
EA029-B: Acidity Trail								
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	----	<2	----	----
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	----	----	10.0	----	----
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	----	<2	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	----	----	<0.02	----	----
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	----	----	0.007	----	----
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	----	----	<10	----	----
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	----	----	84.9	----	----
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	----	----	17000	----	----
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	----	----	27.2	----	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	----	1.5	----	----
Net Acidity (sulfur units)	----	0.02	% S	----	----	<0.02	----	----
Net Acidity (acidity units)	----	10	mole H+ / t	----	----	<10	----	----
Liming Rate	----	1	kg CaCO3/t	----	----	<1	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	----	<0.02	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	----	<10	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	----	<1	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	24.2	----	----	28.6	----
Moisture Content	----	1.0	%	----	20.5	34.6	----	----
EA150: Particle Sizing								
+75µm	----	1	%	97	----	----	----	----
+150µm	----	1	%	84	----	----	----	----
+300µm	----	1	%	68	----	----	----	----
+425µm	----	1	%	48	----	----	----	----
+600µm	----	1	%	17	----	----	----	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C07S02	C07S03	SZ1	SZ2	----
			Client sampling date / time	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	----
Compound	CAS Number	LOR	Unit	EP1911899-020	EP1911899-021	EP1911899-022	EP1911899-023	--------
				Result	Result	Result	Result	----
EA150: Particle Sizing - Continued								
+1180µm	----	1	%	1	----	----	----	----
+2.36mm	----	1	%	<1	----	----	----	----
+4.75mm	----	1	%	<1	----	----	----	----
+9.5mm	----	1	%	<1	----	----	----	----
+19.0mm	----	1	%	<1	----	----	----	----
+37.5mm	----	1	%	<1	----	----	----	----
+75.0mm	----	1	%	<1	----	----	----	----
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	2	----	----	----	----
Silt (2-60 µm)	----	1	%	<1	----	----	----	----
Sand (0.06-2.00 mm)	----	1	%	97	----	----	----	----
Gravel (>2mm)	----	1	%	1	----	----	----	----
Cobbles (>6cm)	----	1	%	<1	----	----	----	----
EA152: Soil Particle Density								
Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	2.70	----	----	----	----
EG020-SD: Total Metals in Sediments by ICPMS								
Antimony	7440-36-0	0.50	mg/kg	----	<0.50	0.60	----	----
Arsenic	7440-38-2	1.00	mg/kg	----	1.99	1.09	----	----
Cadmium	7440-43-9	0.1	mg/kg	----	<0.1	0.2	----	----
Chromium	7440-47-3	1.0	mg/kg	----	8.6	9.8	----	----
Copper	7440-50-8	1.0	mg/kg	----	<1.0	<1.0	----	----
Cobalt	7440-48-4	0.5	mg/kg	----	<0.5	<0.5	----	----
Lead	7439-92-1	1.0	mg/kg	----	<1.0	<1.0	----	----
Manganese	7439-96-5	10	mg/kg	----	<10	<10	----	----
Nickel	7440-02-0	1.0	mg/kg	----	<1.0	1.0	----	----
Selenium	7782-49-2	0.1	mg/kg	----	<0.1	0.2	----	----
Silver	7440-22-4	0.1	mg/kg	----	<0.1	<0.1	----	----
Vanadium	7440-62-2	2.0	mg/kg	----	<2.0	11.4	----	----
Zinc	7440-66-6	1.0	mg/kg	----	1.2	1.2	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.01	mg/kg	----	<0.01	<0.01	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	----	----	<0.1	----	----
EK058G: Nitrate as N by Discrete Analyser								

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C07S02	C07S03	SZ1	SZ2	----
			Client sampling date / time	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	----
Compound	CAS Number	LOR	Unit	EP1911899-020	EP1911899-021	EP1911899-022	EP1911899-023	--------
				Result	Result	Result	Result	----
EK058G: Nitrate as N by Discrete Analyser - Continued								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	----	----	<0.1	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	----	<0.1	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	----	**310**	----	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	----	----	**310**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	----	----	**305**	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.1	mg/kg	----	----	<0.1	----	----
EK255A SD: Ammonia in Sediment								
Ammonia as N	7664-41-7	0.2	mg/kg	----	----	**0.5**	----	----
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	----	----	**0.24**	----	----
EP070: Total Petroleum Hydrocarbons - Speciation								
Aliphatic C16-C35	----	100	mg/kg	<100	----	----	----	----
Aliphatic > C35	----	100	mg/kg	<100	----	----	----	----
Aromatic C16-C35	----	90	mg/kg	<90	----	----	----	----
Aromatic > C35	----	100	mg/kg	<100	----	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
>C10 - C16 Fraction	----	3	mg/kg	----	<3	<3	----	----
>C16 - C34 Fraction	----	3	mg/kg	----	**6**	<3	----	----
>C34 - C40 Fraction	----	5	mg/kg	----	**7**	<5	----	----
>C10 - C40 Fraction (sum)	----	3	mg/kg	----	**13**	<3	----	----
>C10 - C16 Fraction minus Naphthalene (F2)	----	3	mg/kg	----	<3	<3	----	----
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	3	mg/kg	----	<3	<3	----	----
C10 - C14 Fraction	----	3	mg/kg	----	<3	<3	----	----
C15 - C28 Fraction	----	3	mg/kg	----	<3	<3	----	----
C29 - C36 Fraction	----	5	mg/kg	----	**7**	<5	----	----
^ C10 - C36 Fraction (sum)	----	3	mg/kg	----	**7**	<3	----	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C07S02	C07S03	SZ1	SZ2	----
			Client sampling date / time	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	----
Compound	CAS Number	LOR	Unit	EP1911899-020	EP1911899-021	EP1911899-022	EP1911899-023	--------
				Result	Result	Result	Result	----
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons								
C6 - C10 Fraction	C6_C10	3	mg/kg	----	<3	<3	----	----
C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	3.0	mg/kg	----	<3.0	<3.0	----	----
EP080-SD: BTEXN								
Benzene	71-43-2	0.2	mg/kg	----	<0.2	<0.2	----	----
Toluene	108-88-3	0.2	mg/kg	----	<0.2	<0.2	----	----
Ethylbenzene	100-41-4	0.2	mg/kg	----	<0.2	<0.2	----	----
meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	----	<0.2	<0.2	----	----
ortho-Xylene	95-47-6	0.2	mg/kg	----	<0.2	<0.2	----	----
^ Total Xylenes	----	0.5	mg/kg	----	<0.5	<0.5	----	----
^ Sum of BTEX	----	0.2	mg/kg	----	<0.2	<0.2	----	----
Naphthalene	91-20-3	0.2	mg/kg	----	<0.2	<0.2	----	----
EP090: Organotin Compounds								
Tributyltin	56573-85-4	0.5	µgSn/kg	----	----	<0.5	----	----
EP130A: Organophosphorus Pesticides (Ultra-trace)								
Bromophos-ethyl	4824-78-6	10	µg/kg	----	<10	<10	----	----
Carbophenothion	786-19-6	10	µg/kg	----	<10	<10	----	----
Chlorfenvinphos (E)	18708-86-6	10.0	µg/kg	----	<10.0	<10.0	----	----
Chlorfenvinphos (Z)	18708-87-7	10	µg/kg	----	<10	<10	----	----
Chlorpyrifos	2921-88-2	10	µg/kg	----	<10	<10	----	----
Chlorpyrifos-methyl	5598-13-0	10	µg/kg	----	<10	<10	----	----
Demeton-S-methyl	919-86-8	10	µg/kg	----	<10	<10	----	----
Diazinon	333-41-5	10	µg/kg	----	<10	<10	----	----
Dichlorvos	62-73-7	10	µg/kg	----	<10	<10	----	----
Dimethoate	60-51-5	10	µg/kg	----	<10	<10	----	----
Ethion	563-12-2	10	µg/kg	----	<10	<10	----	----
Fenamiphos	22224-92-6	10	µg/kg	----	<10	<10	----	----
Fenthion	55-38-9	10	µg/kg	----	<10	<10	----	----
Malathion	121-75-5	10	µg/kg	----	<10	<10	----	----
Azinphos Methyl	86-50-0	10	µg/kg	----	<10	<10	----	----
Monocrotophos	6923-22-4	10	µg/kg	----	<10	<10	----	----
Parathion	56-38-2	10	µg/kg	----	<10	<10	----	----
Parathion-methyl	298-00-0	10	µg/kg	----	<10	<10	----	----
Pirimphos-ethyl	23505-41-1	10	µg/kg	----	<10	<10	----	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C07S02	C07S03	SZ1	SZ2	----
			Client sampling date / time	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	----
Compound	CAS Number	LOR	Unit	EP1911899-020	EP1911899-021	EP1911899-022	EP1911899-023	--------
				Result	Result	Result	Result	----
EP130A: Organophosphorus Pesticides (Ultra-trace) - Continued								
Prothiofos	34643-46-4	10	µg/kg	----	<10	<10	----	----
EP131A: Organochlorine Pesticides								
Aldrin	309-00-2	0.50	µg/kg	----	<0.50	<0.50	----	----
alpha-BHC	319-84-6	0.50	µg/kg	----	<0.50	<0.50	----	----
beta-BHC	319-85-7	0.50	µg/kg	----	<0.50	<0.50	----	----
delta-BHC	319-86-8	0.50	µg/kg	----	<0.50	<0.50	----	----
4.4`-DDD	72-54-8	0.50	µg/kg	----	<0.50	<0.50	----	----
4.4`-DDE	72-55-9	0.50	µg/kg	----	<0.50	<0.50	----	----
4.4`-DDT	50-29-3	0.50	µg/kg	----	<0.50	<0.50	----	----
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.50	µg/kg	----	<0.50	<0.50	----	----
Dieldrin	60-57-1	0.50	µg/kg	----	<0.50	<0.50	----	----
alpha-Endosulfan	959-98-8	0.50	µg/kg	----	<0.50	<0.50	----	----
beta-Endosulfan	33213-65-9	0.50	µg/kg	----	<0.50	<0.50	----	----
Endosulfan sulfate	1031-07-8	0.50	µg/kg	----	<0.50	<0.50	----	----
^ Endosulfan (sum)	115-29-7	0.50	µg/kg	----	<0.50	<0.50	----	----
Endrin	72-20-8	0.50	µg/kg	----	<0.50	<0.50	----	----
Endrin aldehyde	7421-93-4	0.50	µg/kg	----	<0.50	<0.50	----	----
Endrin ketone	53494-70-5	0.50	µg/kg	----	<0.50	<0.50	----	----
Heptachlor	76-44-8	0.50	µg/kg	----	<0.50	<0.50	----	----
Heptachlor epoxide	1024-57-3	0.50	µg/kg	----	<0.50	<0.50	----	----
Hexachlorobenzene (HCB)	118-74-1	0.50	µg/kg	----	<0.50	<0.50	----	----
gamma-BHC	58-89-9	0.25	µg/kg	----	<0.25	<0.25	----	----
Methoxychlor	72-43-5	0.50	µg/kg	----	<0.50	<0.50	----	----
cis-Chlordane	5103-71-9	0.25	µg/kg	----	<0.25	<0.25	----	----
trans-Chlordane	5103-74-2	0.25	µg/kg	----	<0.25	<0.25	----	----
^ Total Chlordane (sum)	----	0.25	µg/kg	----	<0.25	<0.25	----	----
Oxychlordane	27304-13-8	0.50	µg/kg	----	<0.50	<0.50	----	----
EP132B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	5	µg/kg	----	<5	<5	----	----
2-Methylnaphthalene	91-57-6	5	µg/kg	----	<5	<5	----	----
Acenaphthylene	208-96-8	4	µg/kg	----	<200	<4	----	----
Acenaphthene	83-32-9	4	µg/kg	----	<4	<4	----	----
Fluorene	86-73-7	4	µg/kg	----	<4	<4	----	----
Phenanthrene	85-01-8	4	µg/kg	----	<4	<4	----	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C07S02	C07S03	SZ1	SZ2	----
			Client sampling date / time	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	----
Compound	CAS Number	LOR	Unit	EP1911899-020	EP1911899-021	EP1911899-022	EP1911899-023	--------
				Result	Result	Result	Result	----
EP132B: Polynuclear Aromatic Hydrocarbons - Continued								
Anthracene	120-12-7	4	µg/kg	----	<40	<4	----	----
Fluoranthene	206-44-0	4	µg/kg	----	<4	<4	----	----
Pyrene	129-00-0	4	µg/kg	----	<8	<4	----	----
Benz(a)anthracene	56-55-3	4	µg/kg	----	<24	<4	----	----
Chrysene	218-01-9	4	µg/kg	----	<4	<4	----	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	4	µg/kg	----	<28	<4	----	----
Benzo(k)fluoranthene	207-08-9	4	µg/kg	----	<20	<4	----	----
Benzo(e)pyrene	192-97-2	4	µg/kg	----	<20	<4	----	----
Benzo(a)pyrene	50-32-8	4	µg/kg	----	<60	<4	----	----
Perylene	198-55-0	4	µg/kg	----	<20	<4	----	----
Benzo(g.h.i)perylene	191-24-2	4	µg/kg	----	<60	<4	----	----
Dibenz(a.h)anthracene	53-70-3	4	µg/kg	----	<4	<4	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	4	µg/kg	----	<40	<4	----	----
Coronene	191-07-1	5	µg/kg	----	<5	<5	----	----
^ Sum of PAHs	----	4	µg/kg	----	<4	<4	----	----
^ Benzo(a)pyrene TEQ (zero)	----	4	µg/kg	----	<4	<4	----	----
^ Benzo(a)pyrene TEQ (half LOR)	----	4	µg/kg	----	5	5	----	----
^ Benzo(a)pyrene TEQ (LOR)	----	4	µg/kg	----	10	10	----	----
EP203A: Explosives								
HMX	2691-41-0	0.1	mg/kg	----	----	<0.1	----	----
RDX	----	0.1	mg/kg	----	----	<0.1	----	----
1.3.5-Trinitrobenzene	99-35-4	0.1	mg/kg	----	----	<0.1	----	----
1.3-Dinitrobenzene	99-65-0	0.1	mg/kg	----	----	<0.1	----	----
Tetryl	479-45-8	0.1	mg/kg	----	----	<0.1	----	----
2.4.6-TNT	118-96-7	0.1	mg/kg	----	----	<0.1	----	----
4-Amino.2.6-DNT	19406-51-0	0.1	mg/kg	----	----	<0.1	----	----
2-Amino-4.6-DNT	35572-78-2	0.1	mg/kg	----	----	<0.1	----	----
^ 4-& 2-AM-DNT(Isomeric Mixture)	----	0.1	mg/kg	----	----	<0.1	----	----
2.4-Dinitrotoluene	121-14-2	0.1	mg/kg	----	----	<0.1	----	----
2.6-Dinitrotoluene	606-20-2	0.1	mg/kg	----	----	<0.1	----	----
^ 2.4-& 2.6-DNT(Isomeric Mixture)	121-14-2/606-20-2	0.1	mg/kg	----	----	<0.1	----	----
Nitrobenzene	98-95-3	0.1	mg/kg	----	----	<0.1	----	----
2-Nitrotoluene	88-72-2	0.1	mg/kg	----	----	<0.1	----	----
3-Nitrotoluene	99-08-1	0.1	mg/kg	----	----	<0.1	----	----
4-Nitrotoluene	99-99-0	0.1	mg/kg	----	----	<0.1	----	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C07S02	C07S03	SZ1	SZ2	----
			Client sampling date / time	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	----
Compound	CAS Number	LOR	Unit	EP1911899-020	EP1911899-021	EP1911899-022	EP1911899-023	--------
				Result	Result	Result	Result	----
EP203A: Explosives - Continued								
Nitroglycerine	55-63-0	1	mg/kg	----	----	<1	----	----
PETN	78-11-5	1	mg/kg	----	----	<1	----	----
EP231A: Perfluoroalkyl Sulfonic Acids								
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0002	mg/kg	----	<0.0002	<0.0002	<0.0002	----
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0002	mg/kg	----	<0.0002	<0.0002	<0.0002	----
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0002	mg/kg	----	<0.0002	<0.0002	<0.0002	----
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0002	mg/kg	----	<0.0002	<0.0002	<0.0002	----
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	mg/kg	----	**0.0003**	<0.0002	<0.0002	----
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0002	mg/kg	----	<0.0002	<0.0002	<0.0002	----
EP231B: Perfluoroalkyl Carboxylic Acids								
Perfluorobutanoic acid (PFBA)	375-22-4	0.001	mg/kg	----	<0.001	<0.001	<0.001	----
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0002	mg/kg	----	<0.0002	<0.0002	<0.0002	----
Perfluorohexanoic acid (PFHxA)	307-24-4	0.0002	mg/kg	----	<0.0002	<0.0002	<0.0002	----
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0002	mg/kg	----	<0.0002	<0.0002	<0.0002	----
Perfluorooctanoic acid (PFOA)	335-67-1	0.0002	mg/kg	----	<0.0002	<0.0002	<0.0002	----
Perfluorononanoic acid (PFNA)	375-95-1	0.0002	mg/kg	----	<0.0002	<0.0002	<0.0002	----
Perfluorodecanoic acid (PFDA)	335-76-2	0.0002	mg/kg	----	<0.0002	<0.0002	<0.0002	----
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0002	mg/kg	----	<0.0002	<0.0002	<0.0002	----
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0002	mg/kg	----	<0.0002	<0.0002	<0.0002	----
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0002	mg/kg	----	<0.0002	<0.0002	<0.0002	----
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	mg/kg	----	<0.0005	<0.0005	<0.0005	----
EP231C: Perfluoroalkyl Sulfonamides								
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0002	mg/kg	----	<0.0002	<0.0002	<0.0002	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C07S02	C07S03	SZ1	SZ2	----
			Client sampling date / time	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	----
Compound	CAS Number	LOR	Unit	EP1911899-020	EP1911899-021	EP1911899-022	EP1911899-023	--------
				Result	Result	Result	Result	----
EP231C: Perfluoroalkyl Sulfonamides - Continued								
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.0005	mg/kg	----	<0.0005	<0.0005	<0.0005	----
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.0005	mg/kg	----	<0.0005	<0.0005	<0.0005	----
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.0005	mg/kg	----	<0.0005	<0.0005	<0.0005	----
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.0005	mg/kg	----	<0.0005	<0.0005	<0.0005	----
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0002	mg/kg	----	<0.0002	<0.0002	<0.0002	----
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0002	mg/kg	----	<0.0002	<0.0002	<0.0002	----
EP231D: (n:2) Fluorotelomer Sulfonic Acids								
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.0005	mg/kg	----	<0.0005	<0.0005	<0.0005	----
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.0005	mg/kg	----	<0.0005	<0.0005	<0.0005	----
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.0005	mg/kg	----	<0.0005	<0.0005	<0.0005	----
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.0005	mg/kg	----	<0.0005	<0.0005	<0.0005	----
EP231P: PFAS Sums								
Sum of PFAS	----	0.0002	mg/kg	----	**0.0003**	<0.0002	<0.0002	----
Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	mg/kg	----	**0.0003**	<0.0002	<0.0002	----
Sum of PFAS (WA DER List)	----	0.0002	mg/kg	----	**0.0003**	<0.0002	<0.0002	----
EP070: Total Petroleum Hydrocarbons - Speciation								
2-Bromonaphthalene	580-13-2	1	%	**90.4**	----	----	----	----
2-Fluorobiphenyl	321-60-8	1	%	**106**	----	----	----	----
EP080-SD: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.2	%	----	**99.2**	**95.5**	----	----
Toluene-D8	2037-26-5	0.2	%	----	**80.4**	**76.3**	----	----
4-Bromofluorobenzene	460-00-4	0.2	%	----	**85.2**	**81.0**	----	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C07S02	C07S03	SZ1	SZ2	----
			Client sampling date / time	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	12-Nov-2019 00:00	----
Compound	CAS Number	LOR	Unit	EP1911899-020	EP1911899-021	EP1911899-022	EP1911899-023	--------
				Result	Result	Result	Result	----
EP090S: Organotin Surrogate								
Tripropyltin	----	0.5	%	----	----	116	----	----
EP130S: Organophosphorus Pesticide Surrogate								
DEF	78-48-8	10	%	----	56.0	54.1	----	----
EP131S: OC Pesticide Surrogate								
Dibromo-DDE	21655-73-2	0.50	%	----	68.0	49.2	----	----
EP132T: Base/Neutral Extractable Surrogates								
2-Fluorobiphenyl	321-60-8	10	%	----	91.6	106	----	----
Anthracene-d10	1719-06-8	10	%	----	101	98.5	----	----
4-Terphenyl-d14	1718-51-0	10	%	----	86.6	94.4	----	----
EP203S: Explosives Surrogate								
o-Dinitrobenzene	528-29-0	0.1	%	----	----	109	----	----
EP231S: PFAS Surrogate								
13C4-PFOS	----	0.0002	%	----	83.5	84.5	85.0	----
13C8-PFOA	----	0.0002	%	----	80.5	76.0	85.5	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	WR1	WR2	WB1	WB2	WTB1
			Client sampling date / time	12-Nov-2019 00:00	13-Nov-2019 00:00	12-Nov-2019 00:00	13-Nov-2019 00:00	12-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-024	EP1911899-025	EP1911899-026	EP1911899-027	EP1911899-028
				Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS								
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Copper	7440-50-8	0.001	mg/L	<0.001	**0.014**	<0.001	**0.014**	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Zinc	7440-66-6	0.005	mg/L	<0.005	**0.011**	<0.005	**0.012**	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	WR1	WR2	WB1	WB2	WTB1
			Client sampling date / time	12-Nov-2019 00:00	13-Nov-2019 00:00	12-Nov-2019 00:00	13-Nov-2019 00:00	12-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-024	EP1911899-025	EP1911899-026	EP1911899-027	EP1911899-028
				Result	Result	Result	Result	Result
EP068A: Organochlorine Pesticides (OC) - Continued								
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
beta-BHC	319-85-7	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
gamma-BHC	58-89-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
delta-BHC	319-86-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
Heptachlor	76-44-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
Aldrin	309-00-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
Dieldrin	60-57-1	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
4.4`-DDE	72-55-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
Endrin	72-20-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
4.4`-DDD	72-54-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
4.4`-DDT	50-29-3	2.0	µg/L	<2.0	<2.0	<2.0	<2.0	----
Endrin ketone	53494-70-5	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
Methoxychlor	72-43-5	2.0	µg/L	<2.0	<2.0	<2.0	<2.0	----
^ Total Chlordane (sum)	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
^ Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
EP068B: Organophosphorus Pesticides (OP)								
Dichlorvos	62-73-7	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
Monocrotophos	6923-22-4	2.0	µg/L	<2.0	<2.0	<2.0	<2.0	----
Dimethoate	60-51-5	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
Diazinon	333-41-5	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
Parathion-methyl	298-00-0	2.0	µg/L	<2.0	<2.0	<2.0	<2.0	----
Malathion	121-75-5	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
Fenthion	55-38-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	WR1	WR2	WB1	WB2	WTB1
			Client sampling date / time	12-Nov-2019 00:00	13-Nov-2019 00:00	12-Nov-2019 00:00	13-Nov-2019 00:00	12-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-024	EP1911899-025	EP1911899-026	EP1911899-027	EP1911899-028
				Result	Result	Result	Result	Result
EP068B: Organophosphorus Pesticides (OP) - Continued								
Parathion	56-38-2	2.0	µg/L	<2.0	<2.0	<2.0	<2.0	----
Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
Fenamiphos	22224-92-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
Prothiofos	34643-46-4	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
Ethion	563-12-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
Carbophenothion	786-19-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Acenaphthylene	208-96-8	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Acenaphthene	83-32-9	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Fluorene	86-73-7	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Phenanthrene	85-01-8	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Anthracene	120-12-7	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Fluoranthene	206-44-0	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Pyrene	129-00-0	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Benz(a)anthracene	56-55-3	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Chrysene	218-01-9	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Benzo(k)fluoranthene	207-08-9	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L	<50	<50	<50	<50	----
C15 - C28 Fraction	----	100	µg/L	<100	<100	<100	<100	----
C29 - C36 Fraction	----	50	µg/L	<50	<50	<50	<50	----
^ C10 - C36 Fraction (sum)	----	50	µg/L	<50	<50	<50	<50	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	WR1	WR2	WB1	WB2	WTB1
			Client sampling date / time	12-Nov-2019 00:00	13-Nov-2019 00:00	12-Nov-2019 00:00	13-Nov-2019 00:00	12-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-024	EP1911899-025	EP1911899-026	EP1911899-027	EP1911899-028
				Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L	<100	<100	<100	<100	----
>C16 - C34 Fraction	----	100	µg/L	<100	<100	<100	<100	----
>C34 - C40 Fraction	----	100	µg/L	<100	<100	<100	<100	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L	<100	<100	<100	<100	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L	<100	<100	<100	<100	----
EP080: BTEXN								
Benzene	71-43-2	1	µg/L	<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L	<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L	<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L	<2	<2	<2	<2	<2
^ Total Xylenes	----	2	µg/L	<2	<2	<2	<2	<2
^ Sum of BTEX	----	1	µg/L	<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L	<5	<5	<5	<5	<5
EP090: Organotin Compounds (Soluble)								
Tributyltin	56573-85-4	2	ngSn/L	<2	<2	<2	<2	----
EP203A: Explosives								
HMX	2691-41-0	20	µg/L	<20	<20	<20	<20	----
RDX	----	20	µg/L	<20	<20	<20	<20	----
1.3.5-Trinitrobenzene	99-35-4	20	µg/L	<20	<20	<20	<20	----
1.3-Dinitrobenzene	99-65-0	20	µg/L	<20	<20	<20	<20	----
Tetryl	479-45-8	20	µg/L	<20	<20	<20	<20	----
2.4.6-TNT	118-96-7	20	µg/L	<20	<20	<20	<20	----
4-Amino.2.6-DNT	19406-51-0	20	µg/L	<20	<20	<20	<20	----
2-Amino-4.6-DNT	35572-78-2	20	µg/L	<20	<20	<20	<20	----
^ 4-& 2-AM-DNT(Isomeric Mixture)	----	20	µg/L	<20	<20	<20	<20	----
2.4-Dinitrotoluene	121-14-2	20	µg/L	<20	<20	<20	<20	----
2.6-Dinitrotoluene	606-20-2	20	µg/L	<20	<20	<20	<20	----
^ 2.4-& 2.6-DNT(Isomeric Mixture)	121-14-2/606-20-2	20	µg/L	<20	<20	<20	<20	----
Nitrobenzene	98-95-3	20	µg/L	<20	<20	<20	<20	----
2-Nitrotoluene	88-72-2	20	µg/L	<20	<20	<20	<20	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	WR1	WR2	WB1	WB2	WTB1
			Client sampling date / time	12-Nov-2019 00:00	13-Nov-2019 00:00	12-Nov-2019 00:00	13-Nov-2019 00:00	12-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-024	EP1911899-025	EP1911899-026	EP1911899-027	EP1911899-028
				Result	Result	Result	Result	Result
EP203A: Explosives - Continued								
3-Nitrotoluene	99-08-1	20	µg/L	<20	<20	<20	<20	----
4-Nitrotoluene	99-99-0	20	µg/L	<20	<20	<20	<20	----
Nitroglycerine	55-63-0	200	µg/L	<200	<200	<200	<200	----
PETN	78-11-5	200	µg/L	<200	<200	<200	<200	----
EP231A: Perfluoroalkyl Sulfonic Acids								
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	µg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EP231B: Perfluoroalkyl Carboxylic Acids								
Perfluorobutanoic acid (PFBA)	375-22-4	0.0020	µg/L	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorohexanoic acid (PFHxA)	307-24-4	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorooctanoic acid (PFOA)	335-67-1	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorononanoic acid (PFNA)	375-95-1	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorodecanoic acid (PFDA)	335-76-2	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EP231C: Perfluoroalkyl Sulfonamides								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	WR1	WR2	WB1	WB2	WTB1
			Client sampling date / time	12-Nov-2019 00:00	13-Nov-2019 00:00	12-Nov-2019 00:00	13-Nov-2019 00:00	12-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-024	EP1911899-025	EP1911899-026	EP1911899-027	EP1911899-028
				Result	Result	Result	Result	Result
EP231C: Perfluoroalkyl Sulfonamides - Continued								
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EP231D: (n:2) Fluorotelomer Sulfonic Acids								
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
EP231P: PFAS Sums								
^ Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	µg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
^ Sum of PFAS (WA DER List)	----	0.0002	µg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
^ Sum of PFAS	----	0.0002	µg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
EP068S: Organochlorine Pesticide Surrogate								
Dibromo-DDE	21655-73-2	0.5	%	**99.5**	**102**	**101**	**87.2**	**----**
EP068T: Organophosphorus Pesticide Surrogate								
DEF	78-48-8	0.5	%	**92.2**	**83.0**	**92.9**	**77.7**	**----**
EP075(SIM)S: Phenolic Compound Surrogates								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	WR1	WR2	WB1	WB2	WTB1
			Client sampling date / time	12-Nov-2019 00:00	13-Nov-2019 00:00	12-Nov-2019 00:00	13-Nov-2019 00:00	12-Nov-2019 00:00
Compound	CAS Number	LOR	Unit	EP1911899-024	EP1911899-025	EP1911899-026	EP1911899-027	EP1911899-028
				Result	Result	Result	Result	Result
EP075(SIM)S: Phenolic Compound Surrogates - Continued								
Phenol-d6	13127-88-3	1.0	%	19.6	21.3	17.7	17.4	----
2-Chlorophenol-D4	93951-73-6	1.0	%	48.6	47.5	58.7	50.6	----
2.4.6-Tribromophenol	118-79-6	1.0	%	36.4	39.7	42.8	49.0	----
EP075(SIM)T: PAH Surrogates								
2-Fluorobiphenyl	321-60-8	1.0	%	62.8	66.2	83.0	74.5	----
Anthracene-d10	1719-06-8	1.0	%	83.4	88.2	87.9	72.3	----
4-Terphenyl-d14	1718-51-0	1.0	%	87.5	90.3	88.6	78.7	----
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	2	%	122	117	121	121	122
Toluene-D8	2037-26-5	2	%	114	113	111	105	107
4-Bromofluorobenzene	460-00-4	2	%	108	110	85.4	81.4	82.4
EP090S: Organotin Surrogate								
Tripropyltin	----	5	%	133	36.8	101	126	----
EP203S: Explosives Surrogate								
o-Dinitrobenzene	528-29-0	20	%	100	104	101	100	----
EP231S: PFAS Surrogate								
13C4-PFOS	----	0.0005	%	67.3	64.9	68.9	63.2	70.1
13C8-PFOA	----	0.0005	%	81.5	80.2	81.6	81.5	82.4

Analytical Results

Descriptive Results

Sub-Matrix: **SEDIMENT**

Method: Compound	Client sample ID - Client sampling date / time	Analytical Results
EA200: AS 4964 - 2004 Identification of Asbestos in Soils		
EA200: Disintegration	C01S01 - 12-Nov-2019 00:00	No
EA200: Disintegration	C01S03 - 12-Nov-2019 00:00	No
EA200: Disintegration	C02S01 - 12-Nov-2019 00:00	No
EA200: Disintegration	C03S01 - 12-Nov-2019 00:00	No
EA200: Disintegration	C04S01 - 13-Nov-2019 00:00	No
EA200: Disintegration	C05S01 - 13-Nov-2019 00:00	No
EA200: Disintegration	C06S01 - 12-Nov-2019 00:00	No
EA200: Disintegration	C07S01 - 12-Nov-2019 00:00	No
EA200: Description	C01S01 - 12-Nov-2019 00:00	White sandy soil with organic and shell like matter.
EA200: Description	C01S03 - 12-Nov-2019 00:00	White sandy soil with organic and shell like matter.
EA200: Description	C02S01 - 12-Nov-2019 00:00	White sandy soil with organic and shell like matter.
EA200: Description	C03S01 - 12-Nov-2019 00:00	White sandy soil with organic and shell like matter.
EA200: Description	C04S01 - 13-Nov-2019 00:00	White sandy soil with organic and shell like matter.
EA200: Description	C05S01 - 13-Nov-2019 00:00	White sandy soil with organic and shell like matter.
EA200: Description	C06S01 - 12-Nov-2019 00:00	White sandy soil with organic and shell like matter.
EA200: Description	C07S01 - 12-Nov-2019 00:00	White sandy soil with organic and shell like matter.

Surrogate Control Limits

Sub-Matrix: ELUTRIATE		Recovery Limits (%)	
Compound	CAS Number	Low	High
EP231S: PFAS Surrogate			
13C4-PFOS	----	60	120
13C8-PFOA	----	60	120

Sub-Matrix: SEDIMENT		Recovery Limits (%)	
Compound	CAS Number	Low	High
EP070: Total Petroleum Hydrocarbons - Speciation			
2-Bromonaphthalene	580-13-2	70	130
2-Fluorobiphenyl	321-60-8	70	130
EP080-SD: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	70	130
Toluene-D8	2037-26-5	70	130
4-Bromofluorobenzene	460-00-4	70	130
EP090S: Organotin Surrogate			
Tripropyltin	----	35	130
EP130S: Organophosphorus Pesticide Surrogate			
DEF	78-48-8	14	102
EP131S: OC Pesticide Surrogate			
Dibromo-DDE	21655-73-2	10	119
EP132T: Base/Neutral Extractable Surrogates			
2-Fluorobiphenyl	321-60-8	70	130
Anthracene-d10	1719-06-8	70	130
4-Terphenyl-d14	1718-51-0	70	130
EP203S: Explosives Surrogate			
o-Dinitrobenzene	528-29-0	50	144
EP231S: PFAS Surrogate			
13C4-PFOS	----	60	120
13C8-PFOA	----	60	120

Sub-Matrix: WATER		Recovery Limits (%)	
Compound	CAS Number	Low	High
EP068S: Organochlorine Pesticide Surrogate			
Dibromo-DDE	21655-73-2	67	111
EP068T: Organophosphorus Pesticide Surrogate			
DEF	78-48-8	67	111
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	44
2-Chlorophenol-D4	93951-73-6	14	94
2.4.6-Tribromophenol	118-79-6	17	125

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	20	104
Anthracene-d10	1719-06-8	27	113
4-Terphenyl-d14	1718-51-0	32	112
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	71	137
Toluene-D8	2037-26-5	79	131
4-Bromofluorobenzene	460-00-4	70	128
EP090S: Organotin Surrogate			
Tripropyltin	----	24	116
EP203S: Explosives Surrogate			
o-Dinitrobenzene	528-29-0	55	133
EP231S: PFAS Surrogate			
13C4-PFOS	----	60	120
13C8-PFOA	----	60	120

QUALITY CONTROL REPORT

Work Order	: **EP1911899**	Page	: 1 of 36
Client	: **RPS Australia West Pty Ltd**	Laboratory	: Environmental Division Perth
Contact	: SHAE MILLER-WHITE	Contact	: Rhiannon Steere
Address	: PO BOX 170 WEST PERTH WA 6872	Address	: 26 Rigali Way Wangara WA Australia 6065
Telephone	: 9211 1111	Telephone	: 08 9406 1306
Project	: EEC19032.011	Date Samples Received	: 13-Nov-2019
Order number	: ----	Date Analysis Commenced	: 13-Nov-2019
C-O-C number	: ----	Issue Date	: 06-Dec-2019
Sampler	: ----		
Site	: Rottnest Army Jetty		
Quote number	: EP/705/19		
No. of samples received	: 30		
No. of samples analysed	: 25		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Alex Rossi	Organic Chemist	Sydney Organics, Smithfield, NSW
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Canhuang Ke	Inorganics Supervisor	Perth Inorganics, Wangara, WA
Chris Lemaitre	Laboratory Manager (Perth)	Perth Inorganics, Wangara, WA
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David Viner	SENIOR LAB TECH	Perth Organics, Wangara, WA
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Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW
Evie Sidarta	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Franco Lentini	LCMS Coordinator	Sydney Organics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW
Uyen Dalkin	Approved Asbestos Identifier	Melbourne Asbestos, Springvale, VIC

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG035T: Total Recoverable Mercury by FIMS (Low Level) (QC Lot: 2707197)									
EP1911899-001	C01S01	EG035T-LL: Mercury	7439-97-6	0.01	mg/kg	<0.01	0.01	0.00	No Limit
EP1911899-016	C06S01	EG035T-LL: Mercury	7439-97-6	0.01	mg/kg	<0.01	<0.01	0.00	No Limit
EA029-A: pH Measurements (QC Lot: 2731245)									
EP1911899-001	C01S01	EA029-TPA: pH OX (23B)	----	0.1	pH Unit	7.9	8.0	0.00	0% - 20%
EA029-B: Acidity Trail (QC Lot: 2731245)									
EP1911899-001	C01S01	EA029-TPA: Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	<2	0.00	No Limit
EA033-A: Actual Acidity (QC Lot: 2731244)									
EP1911899-001	C01S01	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.00	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.00	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	9.7	9.8	0.00	0% - 20%
EA033-B: Potential Acidity (QC Lot: 2731244)									
EP1911899-001	C01S01	EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	0.054	0.052	3.77	0% - 50%
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	34	33	0.00	No Limit
EA033-C: Acid Neutralising Capacity (QC Lot: 2731244)									
EP1911899-001	C01S01	EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	83.7	83.8	0.0955	0% - 20%
		EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	26.8	26.8	0.112	0% - 20%
		EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	16700	16700	0.100	0% - 20%
EA033-E: Acid Base Accounting (QC Lot: 2731244)									
EP1911899-001	C01S01	EA033: Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	0.00	No Limit
		EA033: Net Acidity excluding ANC (sulfur units)	----	0.02	% S	0.05	0.05	0.00	No Limit
		EA033: Liming Rate	----	1	kg CaCO3/t	<1	<1	0.00	No Limit

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
				Laboratory Duplicate (DUP) Report					
EA033-E: Acid Base Accounting (QC Lot: 2731244) - continued									
EP1911899-001	C01S01	EA033: Liming Rate excluding ANC	----	1	kg CaCO3/t	3	2	40.0	No Limit
		EA033: Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	0.00	No Limit
		EA033: Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	34	33	2.98	No Limit
EA055: Moisture Content (Dried @ 105-110°C) (QC Lot: 2707423)									
EP1911833-001	Anonymous	EA055: Moisture Content	----	0.1	%	44.3	44.7	0.750	0% - 20%
EP1911833-009	Anonymous	EA055: Moisture Content	----	0.1	%	45.2	44.7	1.01	0% - 20%
EA055: Moisture Content (Dried @ 105-110°C) (QC Lot: 2707424)									
EP1911899-007	C03S01	EA055: Moisture Content	----	0.1	%	30.7	31.3	2.06	0% - 20%
EP1911899-018	C06S03	EA055: Moisture Content	----	0.1	%	22.4	23.7	5.81	0% - 20%
EA055: Moisture Content (Dried @ 105-110°C) (QC Lot: 2707432)									
EP1911901-002	Anonymous	EA055: Moisture Content	----	0.1	%	50.9	42.8	17.3	0% - 20%
ME1901509-008	Anonymous	EA055: Moisture Content	----	0.1	%	5.8	6.0	3.70	No Limit
EG020-SD: Total Metals in Sediments by ICPMS (QC Lot: 2707198)									
EP1911899-001	C01S01	EG020-SD: Cadmium	7440-43-9	0.1	mg/kg	0.3	0.2	0.00	No Limit
		EG020-SD: Selenium	7782-49-2	0.1	mg/kg	0.3	0.2	57.8	No Limit
		EG020-SD: Silver	7440-22-4	0.1	mg/kg	0.2	<0.1	76.7	No Limit
		EG020-SD: Antimony	7440-36-0	0.5	mg/kg	1.47	0.76	63.6	No Limit
		EG020-SD: Cobalt	7440-48-4	0.5	mg/kg	<0.5	<0.5	0.00	No Limit
		EG020-SD: Arsenic	7440-38-2	1	mg/kg	1.79	1.24	35.8	No Limit
		EG020-SD: Chromium	7440-47-3	1	mg/kg	11.2	11.1	0.00	0% - 50%
		EG020-SD: Copper	7440-50-8	1	mg/kg	<1.0	<1.0	0.00	No Limit
		EG020-SD: Lead	7439-92-1	1	mg/kg	<1.0	<1.0	0.00	No Limit
		EG020-SD: Nickel	7440-02-0	1	mg/kg	1.6	1.3	21.9	No Limit
		EG020-SD: Zinc	7440-66-6	1	mg/kg	1.7	1.4	16.6	No Limit
		EG020-SD: Manganese	7439-96-5	10	mg/kg	<10	<10	0.00	No Limit
		EG020-SD: Vanadium	7440-62-2	2	mg/kg	11.3	8.4	29.9	No Limit
EP1911899-016	C06S01	EG020-SD: Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG020-SD: Selenium	7782-49-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG020-SD: Silver	7440-22-4	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EG020-SD: Antimony	7440-36-0	0.5	mg/kg	<0.50	<0.50	0.00	No Limit
		EG020-SD: Cobalt	7440-48-4	0.5	mg/kg	<0.5	<0.5	0.00	No Limit
		EG020-SD: Arsenic	7440-38-2	1	mg/kg	1.26	1.15	8.94	No Limit
		EG020-SD: Chromium	7440-47-3	1	mg/kg	8.8	8.6	1.90	No Limit
		EG020-SD: Copper	7440-50-8	1	mg/kg	<1.0	<1.0	0.00	No Limit
		EG020-SD: Lead	7439-92-1	1	mg/kg	<1.0	<1.0	0.00	No Limit
		EG020-SD: Nickel	7440-02-0	1	mg/kg	<1.0	<1.0	0.00	No Limit
		EG020-SD: Zinc	7440-66-6	1	mg/kg	1.8	1.7	8.95	No Limit
		EG020-SD: Manganese	7439-96-5	10	mg/kg	<10	<10	0.00	No Limit
		EG020-SD: Vanadium	7440-62-2	2	mg/kg	<2.0	<2.0	0.00	No Limit

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
				Laboratory Duplicate (DUP) Report					
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 2707179)									
EP1911899-001	C01S01	EK057G: Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 2707177)									
EP1911899-001	C01S01	EK059G: Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 2742269)									
EP1911899-001	C01S01	EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	330	340	0.00	0% - 50%
EP1912343-062	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	750	680	10.3	0% - 20%
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 2742268)									
EP1911899-001	C01S01	EK067G: Total Phosphorus as P	----	2	mg/kg	303	277	8.83	0% - 20%
EP1912343-062	Anonymous	EK067G: Total Phosphorus as P	----	2	mg/kg	614	580	5.66	0% - 20%
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 2707178)									
EP1911899-001	C01S01	EK071G: Reactive Phosphorus as P	14265-44-2	0.1	mg/kg	0.1	0.2	0.00	No Limit
EK255A SD: Ammonia in Sediment (QC Lot: 2729942)									
EP1911584-010	Anonymous	EK255A: Ammonia as N	7664-41-7	0.2	mg/kg	<0.2	<0.2	0.00	No Limit
EP1911899-022	SZ1	EK255A: Ammonia as N	7664-41-7	0.2	mg/kg	0.5	<0.2	88.0	No Limit
EP003: Total Organic Carbon (TOC) in Soil (QC Lot: 2739227)									
EB1932126-001	Anonymous	EP003: Total Organic Carbon	----	0.02	%	1.50	1.48	1.01	0% - 20%
EP1911899-016	C06S01	EP003: Total Organic Carbon	----	0.02	%	0.05	0.02	72.2	No Limit
EP070: Total Petroleum Hydrocarbons - Speciation (QC Lot: 2701287)									
EP1911899-001	C01S01	EP070: Aliphatic C16-C35	----	100	mg/kg	<100	<100	0.00	No Limit
		EP070: Aliphatic > C35	----	100	mg/kg	<100	<100	0.00	No Limit
		EP070: Aromatic > C35	----	100	mg/kg	<100	<100	0.00	No Limit
		EP070: Aromatic C16-C35	----	90	mg/kg	<90	<90	0.00	No Limit
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (QC Lot: 2701281)									
EP1911899-001	C01S01	EP080-SD: C6 - C9 Fraction	----	3	mg/kg	<3	<3	0.00	0% - 3%
EP1911899-016	C06S01	EP080-SD: C6 - C9 Fraction	----	3	mg/kg	<3	<3	0.00	0% - 3%
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (QC Lot: 2701282)									
EP1911899-001	C01S01	EP071-SD: C10 - C14 Fraction	----	3	mg/kg	<3	<3	0.00	No Limit
		EP071-SD: C15 - C28 Fraction	----	3	mg/kg	<3	<3	0.00	No Limit
		EP071-SD: C10 - C36 Fraction (sum)	----	3	mg/kg	<3	<3	0.00	No Limit
		EP071-SD: C29 - C36 Fraction	----	5	mg/kg	<5	<5	0.00	No Limit
EP1911899-016	C06S01	EP071-SD: C10 - C14 Fraction	----	3	mg/kg	<3	<3	0.00	No Limit
		EP071-SD: C15 - C28 Fraction	----	3	mg/kg	5	<3	47.4	No Limit
		EP071-SD: C10 - C36 Fraction (sum)	----	3	mg/kg	5	<3	50.0	No Limit
		EP071-SD: C29 - C36 Fraction	----	5	mg/kg	<5	<5	0.00	No Limit
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons (QC Lot: 2701281)									
EP1911899-001	C01S01	EP080-SD: C6 - C10 Fraction	C6_C10	3	mg/kg	<3	<3	0.00	0% - 3%
EP1911899-016	C06S01	EP080-SD: C6 - C10 Fraction	C6_C10	3	mg/kg	<3	<3	0.00	0% - 3%
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons (QC Lot: 2701282)									

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
				Laboratory Duplicate (DUP) Report					
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons (QC Lot: 2701282) - continued									
EP1911899-001	C01S01	EP071-SD: >C10 - C16 Fraction	----	3	mg/kg	<3	<3	0.00	No Limit
		EP071-SD: >C16 - C34 Fraction	----	3	mg/kg	<3	<3	0.00	No Limit
		EP071-SD: >C10 - C40 Fraction (sum)	----	3	mg/kg	<3	<3	0.00	No Limit
		EP071-SD: >C34 - C40 Fraction	----	5	mg/kg	<5	<5	0.00	No Limit
EP1911899-016	C06S01	EP071-SD: >C10 - C16 Fraction	----	3	mg/kg	<3	<3	0.00	No Limit
		EP071-SD: >C16 - C34 Fraction	----	3	mg/kg	5	<3	43.0	No Limit
		EP071-SD: >C10 - C40 Fraction (sum)	----	3	mg/kg	5	<3	50.0	No Limit
		EP071-SD: >C34 - C40 Fraction	----	5	mg/kg	<5	<5	0.00	No Limit
EP080-SD: BTEXN (QC Lot: 2701281)									
EP1911899-001	C01S01	EP080-SD: Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	0.00	0% - .2%
		EP080-SD: Toluene	108-88-3	0.2	mg/kg	<0.2	<0.2	0.00	0% - .2%
		EP080-SD: Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	<0.2	0.00	0% - .2%
		EP080-SD: meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	<0.2	0.00	0% - .2%
		EP080-SD: ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	<0.2	0.00	0% - .2%
		EP080-SD: Total Xylenes	----	0.2	mg/kg	<0.5	<0.5	0.00	0% - .2%
		EP080-SD: Sum of BTEX	----	0.2	mg/kg	<0.2	<0.2	0.00	0% - .2%
		EP080-SD: Naphthalene	91-20-3	0.2	mg/kg	<0.2	<0.2	0.00	0% - .2%
EP1911899-016	C06S01	EP080-SD: Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	0.00	0% - .2%
		EP080-SD: Toluene	108-88-3	0.2	mg/kg	<0.2	<0.2	0.00	0% - .2%
		EP080-SD: Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	<0.2	0.00	0% - .2%
		EP080-SD: meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	<0.2	0.00	0% - .2%
		EP080-SD: ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	<0.2	0.00	0% - .2%
		EP080-SD: Total Xylenes	----	0.2	mg/kg	<0.5	<0.5	0.00	0% - .2%
		EP080-SD: Sum of BTEX	----	0.2	mg/kg	<0.2	<0.2	0.00	0% - .2%
		EP080-SD: Naphthalene	91-20-3	0.2	mg/kg	<0.2	<0.2	0.00	0% - .2%
EP090: Organotin Compounds (QC Lot: 2707442)									
EP1911899-001	C01S01	EP090: Tributyltin	56573-85-4	0.5	µgSn/kg	<0.5	<0.5	0.00	No Limit
EP130A: Organophosphorus Pesticides (Ultra-trace) (QC Lot: 2707412)									
EP1911899-001	C01S01	EP130: Bromophos-ethyl	4824-78-6	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Carbophenothion	786-19-6	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Chlorfenvinphos (E)	18708-86-6	10	µg/kg	<10.0	<10.0	0.00	No Limit
		EP130: Chlorfenvinphos (Z)	18708-87-7	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Chlorpyrifos	2921-88-2	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Chlorpyrifos-methyl	5598-13-0	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Demeton-S-methyl	919-86-8	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Diazinon	333-41-5	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Dichlorvos	62-73-7	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Dimethoate	60-51-5	10	µg/kg	<10	<10	0.00	No Limit

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP130A: Organophosphorus Pesticides (Ultra-trace) (QC Lot: 2707412) - continued									
EP1911899-001	C01S01	EP130: Ethion	563-12-2	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Fenamiphos	22224-92-6	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Fenthion	55-38-9	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Malathion	121-75-5	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Azinphos Methyl	86-50-0	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Monocrotophos	6923-22-4	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Parathion	56-38-2	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Parathion-methyl	298-00-0	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Pirimphos-ethyl	23505-41-1	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Prothiofos	34643-46-4	10	µg/kg	<10	<10	0.00	No Limit
EP1911899-016	C06S01	EP130: Bromophos-ethyl	4824-78-6	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Carbophenothion	786-19-6	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Chlorfenvinphos (E)	18708-86-6	10	µg/kg	<10.0	<10.0	0.00	No Limit
		EP130: Chlorfenvinphos (Z)	18708-87-7	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Chlorpyrifos	2921-88-2	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Chlorpyrifos-methyl	5598-13-0	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Demeton-S-methyl	919-86-8	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Diazinon	333-41-5	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Dichlorvos	62-73-7	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Dimethoate	60-51-5	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Ethion	563-12-2	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Fenamiphos	22224-92-6	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Fenthion	55-38-9	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Malathion	121-75-5	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Azinphos Methyl	86-50-0	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Monocrotophos	6923-22-4	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Parathion	56-38-2	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Parathion-methyl	298-00-0	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Pirimphos-ethyl	23505-41-1	10	µg/kg	<10	<10	0.00	No Limit
		EP130: Prothiofos	34643-46-4	10	µg/kg	<10	<10	0.00	No Limit
EP131A: Organochlorine Pesticides (QC Lot: 2707411)									
EP1911899-001	C01S01	EP131A: gamma-BHC	58-89-9	0.25	µg/kg	<0.25	<0.25	0.00	No Limit
		EP131A: cis-Chlordane	5103-71-9	0.25	µg/kg	<0.25	<0.25	0.00	No Limit
		EP131A: trans-Chlordane	5103-74-2	0.25	µg/kg	<0.25	<0.25	0.00	No Limit
		EP131A: Total Chlordane (sum)	----	0.25	µg/kg	<0.25	<0.25	0.00	No Limit
		EP131A: Aldrin	309-00-2	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: alpha-BHC	319-84-6	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: beta-BHC	319-85-7	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: delta-BHC	319-86-8	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: 4.4`-DDD	72-54-8	0.5	µg/kg	<0.50	<0.50	0.00	No Limit

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP131A: Organochlorine Pesticides (QC Lot: 2707411) - continued									
EP1911899-001	C01S01	EP131A: 4.4`-DDE	72-55-9	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: 4.4`-DDT	50-29-3	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: Dieldrin	60-57-1	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: alpha-Endosulfan	959-98-8	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: beta-Endosulfan	33213-65-9	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: Endosulfan sulfate	1031-07-8	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: Endosulfan (sum)	115-29-7	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: Endrin	72-20-8	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: Endrin aldehyde	7421-93-4	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: Endrin ketone	53494-70-5	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: Heptachlor	76-44-8	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: Heptachlor epoxide	1024-57-3	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: Hexachlorobenzene (HCB)	118-74-1	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: Methoxychlor	72-43-5	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
EP1911899-016	C06S01	EP131A: gamma-BHC	58-89-9	0.25	µg/kg	<0.25	<0.25	0.00	No Limit
		EP131A: cis-Chlordane	5103-71-9	0.25	µg/kg	<0.25	<0.25	0.00	No Limit
		EP131A: trans-Chlordane	5103-74-2	0.25	µg/kg	<0.25	<0.25	0.00	No Limit
		EP131A: Total Chlordane (sum)	----	0.25	µg/kg	<0.25	<0.25	0.00	No Limit
		EP131A: Aldrin	309-00-2	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: alpha-BHC	319-84-6	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: beta-BHC	319-85-7	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: delta-BHC	319-86-8	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: 4.4`-DDD	72-54-8	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: 4.4`-DDE	72-55-9	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: 4.4`-DDT	50-29-3	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: Dieldrin	60-57-1	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: alpha-Endosulfan	959-98-8	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: beta-Endosulfan	33213-65-9	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: Endosulfan sulfate	1031-07-8	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: Endosulfan (sum)	115-29-7	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: Endrin	72-20-8	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: Endrin aldehyde	7421-93-4	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: Endrin ketone	53494-70-5	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: Heptachlor	76-44-8	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: Heptachlor epoxide	1024-57-3	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
		EP131A: Hexachlorobenzene (HCB)	118-74-1	0.5	µg/kg	<0.50	<0.50	0.00	No Limit

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP131A: Organochlorine Pesticides (QC Lot: 2707411) - continued									
EP1911899-016	C06S01	EP131A: Methoxychlor	72-43-5	0.5	µg/kg	<0.50	<0.50	0.00	No Limit
EP132B: Polynuclear Aromatic Hydrocarbons (QC Lot: 2701283)									
EP1911899-001	C01S01	EP132B-SD: Acenaphthylene	208-96-8	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Acenaphthene	83-32-9	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Fluorene	86-73-7	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Phenanthrene	85-01-8	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Anthracene	120-12-7	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Fluoranthene	206-44-0	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Pyrene	129-00-0	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Benz(a)anthracene	56-55-3	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Chrysene	218-01-9	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Benzo(b+j)fluoranthene	205-99-2 205-82-3	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Benzo(k)fluoranthene	207-08-9	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Benzo(e)pyrene	192-97-2	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Benzo(a)pyrene	50-32-8	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Perylene	198-55-0	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Benzo(g.h.i)perylene	191-24-2	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Dibenz(a.h)anthracene	53-70-3	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Indeno(1.2.3.cd)pyrene	193-39-5	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Sum of PAHs	----	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Naphthalene	91-20-3	5	µg/kg	<5	<5	0.00	No Limit
		EP132B-SD: 2-Methylnaphthalene	91-57-6	5	µg/kg	<5	<5	0.00	No Limit
		EP132B-SD: Coronene	191-07-1	5	µg/kg	<5	<5	0.00	No Limit
EP1911899-016	C06S01	EP132B-SD: Acenaphthylene	208-96-8	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Acenaphthene	83-32-9	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Fluorene	86-73-7	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Phenanthrene	85-01-8	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Anthracene	120-12-7	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Fluoranthene	206-44-0	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Pyrene	129-00-0	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Benz(a)anthracene	56-55-3	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Chrysene	218-01-9	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Benzo(b+j)fluoranthene	205-99-2 205-82-3	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Benzo(k)fluoranthene	207-08-9	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Benzo(e)pyrene	192-97-2	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Benzo(a)pyrene	50-32-8	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Perylene	198-55-0	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Benzo(g.h.i)perylene	191-24-2	4	µg/kg	<4	<4	0.00	No Limit

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP132B: Polynuclear Aromatic Hydrocarbons (QC Lot: 2701283) - continued									
EP1911899-016	C06S01	EP132B-SD: Dibenz(a.h)anthracene	53-70-3	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Indeno(1.2.3.cd)pyrene	193-39-5	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Sum of PAHs	----	4	µg/kg	<4	<4	0.00	No Limit
		EP132B-SD: Naphthalene	91-20-3	5	µg/kg	<5	<5	0.00	No Limit
		EP132B-SD: 2-Methylnaphthalene	91-57-6	5	µg/kg	<5	<5	0.00	No Limit
		EP132B-SD: Coronene	191-07-1	5	µg/kg	<5	<5	0.00	No Limit
EP203A: Explosives (QC Lot: 2707316)									
EM1919349-001	Anonymous	EP203: HMX	2691-41-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: RDX	----	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: 1.3.5-Trinitrobenzene	99-35-4	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: 1.3-Dinitrobenzene	99-65-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: Tetryl	479-45-8	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: 2.4.6-TNT	118-96-7	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: 4-Amino.2.6-DNT	19406-51-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: 2-Amino-4.6-DNT	35572-78-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: 4-& 2-AM-DNT(Isomeric Mixture)	----	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: 2.4-Dinitrotoluene	121-14-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: 2.6-Dinitrotoluene	606-20-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: 2.4-& 2.6-DNT(Isomeric Mixture)	121-14-2/606-20-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: Nitrobenzene	98-95-3	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: 2-Nitrotoluene	88-72-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: 3-Nitrotoluene	99-08-1	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: 4-Nitrotoluene	99-99-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: Nitroglycerine	55-63-0	1	mg/kg	<1	<1	0.00	No Limit
		EP203: PETN	78-11-5	1	mg/kg	<1	<1	0.00	No Limit
EP1911899-004	C02S01	EP203: HMX	2691-41-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: RDX	----	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: 1.3.5-Trinitrobenzene	99-35-4	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: 1.3-Dinitrobenzene	99-65-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: Tetryl	479-45-8	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: 2.4.6-TNT	118-96-7	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: 4-Amino.2.6-DNT	19406-51-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: 2-Amino-4.6-DNT	35572-78-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: 4-& 2-AM-DNT(Isomeric Mixture)	----	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: 2.4-Dinitrotoluene	121-14-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: 2.6-Dinitrotoluene	606-20-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: 2.4-& 2.6-DNT(Isomeric Mixture)	121-14-2/606-20-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: Nitrobenzene	98-95-3	0.1	mg/kg	<0.1	<0.1	0.00	No Limit

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP203A: Explosives (QC Lot: 2707316) - continued									
EP1911899-004	C02S01	EP203: 2-Nitrotoluene	88-72-2	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: 3-Nitrotoluene	99-08-1	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: 4-Nitrotoluene	99-99-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
		EP203: Nitroglycerine	55-63-0	1	mg/kg	<1	<1	0.00	No Limit
		EP203: PETN	78-11-5	1	mg/kg	<1	<1	0.00	No Limit
EP231A: Perfluoroalkyl Sulfonic Acids (QC Lot: 2706601)									
EM1919294-001	Anonymous	EP231X: Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	mg/kg	0.0016	0.0015	0.00	No Limit
		EP231X: Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0002	mg/kg	0.0005	0.0006	0.00	No Limit
EP1911899-010	C04S01	EP231X: Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	mg/kg	<0.0002	0.0008	120	No Limit
		EP231X: Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
EP231B: Perfluoroalkyl Carboxylic Acids (QC Lot: 2706601)									
EM1919294-001	Anonymous	EP231X: Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorohexanoic acid (PFHxA)	307-24-4	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorooctanoic acid (PFOA)	335-67-1	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorononanoic acid (PFNA)	375-95-1	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorodecanoic acid (PFDA)	335-76-2	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
		EP231X: Perfluorobutanoic acid (PFBA)	375-22-4	0.001	mg/kg	<0.001	<0.001	0.00	No Limit
EP1911899-010	C04S01	EP231X: Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorohexanoic acid (PFHxA)	307-24-4	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorooctanoic acid (PFOA)	335-67-1	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorononanoic acid (PFNA)	375-95-1	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorodecanoic acid (PFDA)	335-76-2	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP231B: Perfluoroalkyl Carboxylic Acids (QC Lot: 2706601) - continued									
EP1911899-010	C04S01	EP231X: Perfluorobutanoic acid (PFBA)	375-22-4	0.001	mg/kg	<0.001	<0.001	0.00	No Limit
EP231C: Perfluoroalkyl Sulfonamides (QC Lot: 2706601)									
EM1919294-001	Anonymous	EP231X: Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
		EP231X: N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
		EP231X: N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
		EP231X: N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
EP1911899-010	C04S01	EP231X: Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
		EP231X: N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
		EP231X: N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
		EP231X: N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
EP231D: (n:2) Fluorotelomer Sulfonic Acids (QC Lot: 2706601)									
EM1919294-001	Anonymous	EP231X: 4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
		EP231X: 6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
		EP231X: 8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
		EP231X: 10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
EP1911899-010	C04S01	EP231X: 4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
		EP231X: 6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP231D: (n:2) Fluorotelomer Sulfonic Acids (QC Lot: 2706601) - continued									
EP1911899-010	C04S01	EP231X: 8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
		EP231X: 10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020T: Total Metals by ICP-MS (QC Lot: 2704610)									
EP1911893-001	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	0.0003	0.0004	0.00	No Limit
		EG020A-T: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	0.003	0.002	47.4	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	0.002	0.001	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.006	0.006	0.00	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.008	0.010	15.4	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.010	0.010	0.00	No Limit
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EP1911808-006	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-T: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.001	0.001	0.00	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	0.018	0.017	0.00	0% - 50%
		EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.843	0.824	2.34	0% - 20%
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.009	0.009	0.00	No Limit
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 2704611)									
EP1911808-006	Anonymous	EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
EG035T: Total Mercury by FIMS (QC Lot: 2718842)									
EP1911899-001	C01S01	EG035T-LL: Mercury	7439-97-6	0.00004	mg/L	<0.00004	0.00006	33.3	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 2704652)									
EP1911699-010	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EP1911804-001	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 2704653)									

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 2704653) - continued									
EP1911899-026	WB1	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG093T: Total Metals in Saline Water by ORC-ICPMS (QC Lot: 2720861)									
EP1911899-019	C07S01	EG093A-T: Silver	7440-22-4	0.1	µg/L	<0.1	<0.1	0.00	No Limit
		EG093A-T: Cadmium	7440-43-9	0.2	µg/L	<0.2	<0.2	0.00	No Limit
		EG093A-T: Cobalt	7440-48-4	0.2	µg/L	<0.2	<0.2	0.00	No Limit
		EG093A-T: Lead	7439-92-1	0.2	µg/L	<0.2	<0.2	0.00	No Limit
		EG093A-T: Antimony	7440-36-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EG093A-T: Arsenic	7440-38-2	0.5	µg/L	3.0	3.0	0.00	No Limit
		EG093A-T: Chromium	7440-47-3	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EG093A-T: Manganese	7439-96-5	0.5	µg/L	0.7	0.7	0.00	No Limit
		EG093A-T: Nickel	7440-02-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EG093A-T: Vanadium	7440-62-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EG093A-T: Copper	7440-50-8	1	µg/L	<1	<1	0.00	No Limit
		EG093A-T: Zinc	7440-66-6	5	µg/L	14	14	0.00	No Limit
EP1911899-001	C01S01	EG093A-T: Silver	7440-22-4	0.1	µg/L	<0.1	0.1	0.00	No Limit
		EG093A-T: Cadmium	7440-43-9	0.2	µg/L	0.3	0.4	0.00	No Limit
		EG093A-T: Cobalt	7440-48-4	0.2	µg/L	<0.2	<0.2	0.00	No Limit
		EG093A-T: Lead	7439-92-1	0.2	µg/L	0.3	0.3	0.00	No Limit
		EG093A-T: Antimony	7440-36-0	0.5	µg/L	4.9	4.7	3.64	No Limit
		EG093A-T: Arsenic	7440-38-2	0.5	µg/L	9.7	9.0	6.87	0% - 50%
		EG093A-T: Chromium	7440-47-3	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EG093A-T: Manganese	7439-96-5	0.5	µg/L	2.8	2.8	0.00	No Limit
		EG093A-T: Nickel	7440-02-0	0.5	µg/L	0.8	<0.5	42.8	No Limit
		EG093A-T: Vanadium	7440-62-2	0.5	µg/L	45.9	44.5	3.15	0% - 20%
		EG093A-T: Copper	7440-50-8	1	µg/L	5	5	0.00	No Limit
		EG093A-T: Zinc	7440-66-6	5	µg/L	28	27	3.93	No Limit
EG093T: Total Metals in Saline Water by ORC-ICPMS (QC Lot: 2720862)									
EP1911899-001	C01S01	EG093B-T: Selenium	7782-49-2	2	µg/L	<2	<2	0.00	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 2700453)									
EP1911894-002	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	2.15	2.19	2.23	0% - 20%
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 2700456)									
EP1911899-027	WB2	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EP1911885-002	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 2700454)									
EP1911894-002	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	1.58	1.57	0.881	0% - 20%
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 2710684)									
EP1911883-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.5	0.5	0.00	No Limit
EP1911899-024	WR1	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	0.00	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 2710683)									

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 2710683) - continued									
EP1911883-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EP1911899-024	WR1	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 2700459)									
EP1911899-027	WB2	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EP1911885-002	Anonymous	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK255A: Ammonia (QC Lot: 2720021)									
EP1911899-001	C01S01	EK255A-SW: Ammonia as N	7664-41-7	0.005	mg/L	0.472	0.467	1.17	0% - 20%
EK257A: Nitrite (QC Lot: 2720020)									
EP1911899-001	C01S01	EK257A-SW: Nitrite as N	14797-65-0	0.002	mg/L	<0.002	<0.002	0.00	No Limit
EK259A: Nitrite and Nitrate (NOx) (QC Lot: 2720023)									
EP1911899-001	C01S01	EK259A-SW: Nitrite + Nitrate as N	----	0.002	mg/L	0.004	0.004	0.00	No Limit
EK262A: Total Nitrogen (QC Lot: 2719099)									
EP1911899-001	C01S01	EK262PA-SW: Total Nitrogen as N	----	0.025	mg/L	0.975	0.989	1.44	0% - 50%
EW1905103-003	Anonymous	EK262PA-SW: Total Nitrogen as N	----	0.025	mg/L	0.153	0.159	3.78	No Limit
EK267A: Total Phosphorus (Persulfate Digestion) (QC Lot: 2719098)									
EP1911899-001	C01S01	EK267PA-SW: Total Phosphorus as P	----	0.005	mg/L	0.054	0.048	12.7	0% - 50%
EW1905103-003	Anonymous	EK267PA-SW: Total Phosphorus as P	----	0.005	mg/L	<0.005	<0.005	0.00	No Limit
EK271A: Reactive Phosphorus (QC Lot: 2720022)									
EP1911899-001	C01S01	EK271A-SW: Reactive Phosphorus as P	14265-44-2	0.001	mg/L	0.047	0.047	0.00	0% - 20%
EP068A: Organochlorine Pesticides (OC) (QC Lot: 2705846)									
EP1911899-024	WR1	EP068: alpha-BHC	319-84-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: beta-BHC	319-85-7	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: gamma-BHC	58-89-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: delta-BHC	319-86-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Heptachlor	76-44-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Aldrin	309-00-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Dieldrin	60-57-1	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: 4.4`-DDE	72-55-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Endrin	72-20-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: 4.4`-DDD	72-54-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Endrin ketone	53494-70-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP068A: Organochlorine Pesticides (OC) (QC Lot: 2705846) - continued									
EP1911899-024	WR1	EP068: 4.4`-DDT	50-29-3	2	µg/L	<2.0	<2.0	0.00	No Limit
		EP068: Methoxychlor	72-43-5	2	µg/L	<2.0	<2.0	0.00	No Limit
EP068B: Organophosphorus Pesticides (OP) (QC Lot: 2705846)									
EP1911899-024	WR1	EP068: Dichlorvos	62-73-7	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Dimethoate	60-51-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Diazinon	333-41-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Malathion	121-75-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Fenthion	55-38-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Fenamiphos	22224-92-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Prothiofos	34643-46-4	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Ethion	563-12-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Carbophenothion	786-19-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Monocrotophos	6923-22-4	2	µg/L	<2.0	<2.0	0.00	No Limit
		EP068: Parathion-methyl	298-00-0	2	µg/L	<2.0	<2.0	0.00	No Limit
		EP068: Parathion	56-38-2	2	µg/L	<2.0	<2.0	0.00	No Limit
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons (QC Lot: 2705844)									
EP1911899-024	WR1	EP075(SIM): Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP075(SIM): Naphthalene	91-20-3	1	µg/L	<1.0	<1.0	0.00	No Limit
		EP075(SIM): Acenaphthylene	208-96-8	1	µg/L	<1.0	<1.0	0.00	No Limit
		EP075(SIM): Acenaphthene	83-32-9	1	µg/L	<1.0	<1.0	0.00	No Limit
		EP075(SIM): Fluorene	86-73-7	1	µg/L	<1.0	<1.0	0.00	No Limit
		EP075(SIM): Phenanthrene	85-01-8	1	µg/L	<1.0	<1.0	0.00	No Limit
		EP075(SIM): Anthracene	120-12-7	1	µg/L	<1.0	<1.0	0.00	No Limit
		EP075(SIM): Fluoranthene	206-44-0	1	µg/L	<1.0	<1.0	0.00	No Limit
		EP075(SIM): Pyrene	129-00-0	1	µg/L	<1.0	<1.0	0.00	No Limit
		EP075(SIM): Benz(a)anthracene	56-55-3	1	µg/L	<1.0	<1.0	0.00	No Limit
		EP075(SIM): Chrysene	218-01-9	1	µg/L	<1.0	<1.0	0.00	No Limit
		EP075(SIM): Benzo(b+j)fluoranthene	205-99-2 205-82-3	1	µg/L	<1.0	<1.0	0.00	No Limit
		EP075(SIM): Benzo(k)fluoranthene	207-08-9	1	µg/L	<1.0	<1.0	0.00	No Limit
		EP075(SIM): Indeno(1.2.3.cd)pyrene	193-39-5	1	µg/L	<1.0	<1.0	0.00	No Limit
		EP075(SIM): Dibenz(a.h)anthracene	53-70-3	1	µg/L	<1.0	<1.0	0.00	No Limit
		EP075(SIM): Benzo(g.h.i)perylene	191-24-2	1	µg/L	<1.0	<1.0	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 2705845)									
EP1911899-024	WR1	EP071: C15 - C28 Fraction	----	100	µg/L	<100	<100	0.00	No Limit
		EP071: C10 - C14 Fraction	----	50	µg/L	<50	<50	0.00	No Limit
		EP071: C29 - C36 Fraction	----	50	µg/L	<50	<50	0.00	No Limit
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 2708918)									
EP1911885-001	Anonymous	EP080: C6 - C9 Fraction	----	20	µg/L	<20	<20	0.00	No Limit
EP1911899-026	WB1	EP080: C6 - C9 Fraction	----	20	µg/L	<20	<20	0.00	No Limit
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 2705845)									
EP1911899-024	WR1	EP071: >C10 - C16 Fraction	----	100	µg/L	<100	<100	0.00	No Limit
		EP071: >C16 - C34 Fraction	----	100	µg/L	<100	<100	0.00	No Limit
		EP071: >C34 - C40 Fraction	----	100	µg/L	<100	<100	0.00	No Limit
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 2708918)									
EP1911885-001	Anonymous	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	0.00	No Limit
EP1911899-026	WB1	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	0.00	No Limit
EP080: BTEXN (QC Lot: 2708918)									
EP1911885-001	Anonymous	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.00	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.00	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.00	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.00	No Limit
EP1911899-026	WB1	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.00	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.00	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.00	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.00	No Limit
EP203A: Explosives (QC Lot: 2707326)									
EP1911899-024	WR1	EP203-SL: HMX	2691-41-0	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: RDX	----	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 1.3.5-Trinitrobenzene	99-35-4	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 1.3-Dinitrobenzene	99-65-0	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: Tetryl	479-45-8	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 2.4.6-TNT	118-96-7	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 4-Amino.2.6-DNT	19406-51-0	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 2-Amino-4.6-DNT	35572-78-2	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 2.4-Dinitrotoluene	121-14-2	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 2.6-Dinitrotoluene	606-20-2	20	µg/L	<20	<20	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP203A: Explosives (QC Lot: 2707326) - continued									
EP1911899-024	WR1	EP203-SL: Nitrobenzene	98-95-3	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 2-Nitrotoluene	88-72-2	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 3-Nitrotoluene	99-08-1	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 4-Nitrotoluene	99-99-0	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: Nitroglycerine	55-63-0	200	µg/L	<200	<200	0.00	No Limit
		EP203-SL: PETN	78-11-5	200	µg/L	<200	<200	0.00	No Limit
ES1936704-001	Anonymous	EP203-SL: HMX	2691-41-0	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: RDX	----	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 1.3.5-Trinitrobenzene	99-35-4	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 1.3-Dinitrobenzene	99-65-0	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: Tetryl	479-45-8	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 2.4.6-TNT	118-96-7	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 4-Amino.2.6-DNT	19406-51-0	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 2-Amino-4.6-DNT	35572-78-2	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 2.4-Dinitrotoluene	121-14-2	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 2.6-Dinitrotoluene	606-20-2	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: Nitrobenzene	98-95-3	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 2-Nitrotoluene	88-72-2	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 3-Nitrotoluene	99-08-1	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 4-Nitrotoluene	99-99-0	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: Nitroglycerine	55-63-0	200	µg/L	<200	<200	0.00	No Limit
		EP203-SL: PETN	78-11-5	200	µg/L	<200	<200	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EG035T: Total Recoverable Mercury by FIMS (Low Level) (QCLot: 2707197)								
EG035T-LL: Mercury	7439-97-6	0.01	mg/kg	<0.01	2.154 mg/kg	105	80.0	120
EA029-B: Acidity Trail (QCLot: 2731245)								
EA029-TPA: Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	----	----	----	----
EA033-A: Actual Acidity (QCLot: 2731244)								
EA033: pH KCl (23A)	----	0.1	pH Unit	<0.1	----	----	----	----
EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	24.27 mole H+ / t	97.8	79.4	110
EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033-B: Potential Acidity (QCLot: 2731244)								
EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	0.202 % S	95.5	84.6	110
EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	----	----	----	----
EA033-C: Acid Neutralising Capacity (QCLot: 2731244)								
EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	<0.01	4.9 % CaCO3	104	98.1	108
EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	<10	----	----	----	----
EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	<0.01	----	----	----	----
EA033-E: Acid Base Accounting (QCLot: 2731244)								
EA033: Net Acidity (sulfur units)	----	0.02	% S	<0.02	----	----	----	----
EA033: Net Acidity (acidity units)	----	10	mole H+ / t	<10	----	----	----	----
EA033: Liming Rate	----	1	kg CaCO3/t	<1	----	----	----	----
EG020-SD: Total Metals in Sediments by ICPMS (QCLot: 2707198)								
EG020-SD: Antimony	7440-36-0	0.5	mg/kg	<0.50	----	----	----	----
EG020-SD: Arsenic	7440-38-2	1	mg/kg	<1.00	21.62091 mg/kg	111	74.0	130
EG020-SD: Cadmium	7440-43-9	0.1	mg/kg	<0.1	4.6838 mg/kg	105	97.0	113
EG020-SD: Chromium	7440-47-3	1	mg/kg	<1.0	33.904 mg/kg	119	72.0	152
EG020-SD: Copper	7440-50-8	1	mg/kg	<1.0	33.782 mg/kg	96.9	76.0	116
EG020-SD: Cobalt	7440-48-4	0.5	mg/kg	<0.5	----	----	----	----
EG020-SD: Lead	7439-92-1	1	mg/kg	<1.0	40.33169 mg/kg	95.1	74.0	124
EG020-SD: Manganese	7439-96-5	10	mg/kg	<10	----	----	----	----
EG020-SD: Nickel	7440-02-0	1	mg/kg	<1.0	51.10088 mg/kg	116	81.0	135
EG020-SD: Selenium	7782-49-2	0.1	mg/kg	<0.1	----	----	----	----
EG020-SD: Silver	7440-22-4	0.1	mg/kg	<0.1	----	----	----	----
EG020-SD: Vanadium	7440-62-2	2	mg/kg	<2.0	----	----	----	----
EG020-SD: Zinc	7440-66-6	1	mg/kg	<1.0	61.70999 mg/kg	118	81.0	143
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2707179)								

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2707179) - continued								
EK057G: Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	2.5 mg/kg	97.8	89.0	121
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2707177)								
EK059G: Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	<0.1	2.5 mg/kg	99.3	90.0	112
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2742269)								
EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	<20	1000 mg/kg	78.5	78.0	112
				<20	100 mg/kg	84.6	70.0	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2742268)								
EK067G: Total Phosphorus as P	----	2	mg/kg	<2	440 mg/kg	84.7	78.0	108
				<2	44 mg/kg	83.2	70.0	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 2707178)								
EK071G: Reactive Phosphorus as P	14265-44-2	0.1	mg/kg	<0.1	2.5 mg/kg	100	92.3	112
EK255A SD: Ammonia in Sediment (QCLot: 2729942)								
EK255A: Ammonia as N	7664-41-7	0.2	mg/kg	<0.2	1 mg/kg	99.3	79.0	121
EP003: Total Organic Carbon (TOC) in Soil (QCLot: 2739227)								
EP003: Total Organic Carbon	----	0.02	%	<0.02	0.11 %	121	70.0	130
				<0.02	0.48 %	97.3	70.0	130
EP070: Total Petroleum Hydrocarbons - Speciation (QCLot: 2701287)								
EP070: Aliphatic C16-C35	----	100	mg/kg	<100	1252 mg/kg	117	70.0	130
EP070: Aliphatic > C35	----	100	mg/kg	<100	----	----	----	----
EP070: Aromatic C16-C35	----	90	mg/kg	<90	374 mg/kg	104	70.0	130
EP070: Aromatic > C35	----	100	mg/kg	<100	----	----	----	----
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (QCLot: 2701281)								
EP080-SD: C6 - C9 Fraction	----	3	mg/kg	<3	32 mg/kg	122	70.0	130
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (QCLot: 2701282)								
EP071-SD: C10 - C14 Fraction	----	3	mg/kg	<3	252 mg/kg	93.0	70.0	130
EP071-SD: C15 - C28 Fraction	----	3	mg/kg	<3	634 mg/kg	83.6	70.0	130
EP071-SD: C29 - C36 Fraction	----	5	mg/kg	<5	99 mg/kg	75.4	70.0	130
EP071-SD: C10 - C36 Fraction (sum)	----	3	mg/kg	<3	----	----	----	----
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons (QCLot: 2701281)								
EP080-SD: C6 - C10 Fraction	C6_C10	3	mg/kg	<3	37 mg/kg	119	70.0	130
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons (QCLot: 2701282)								
EP071-SD: >C10 - C16 Fraction	----	3	mg/kg	<3	404 mg/kg	91.9	70.0	130
EP071-SD: >C16 - C34 Fraction	----	3	mg/kg	<3	567 mg/kg	76.6	70.0	130
EP071-SD: >C34 - C40 Fraction	----	5	mg/kg	<5	33 mg/kg	78.9	70.0	130
EP071-SD: >C10 - C40 Fraction (sum)	----	3	mg/kg	<3	----	----	----	----
EP080-SD: BTEXN (QCLot: 2701281)								
EP080-SD: Benzene	71-43-2	0.2	mg/kg	<0.2	2 mg/kg	126	70.0	130

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
EP080-SD: BTEXN (QCLot: 2701281) - continued								
EP080-SD: Toluene	108-88-3	0.2	mg/kg	<0.2	2 mg/kg	112	70.0	130
EP080-SD: Ethylbenzene	100-41-4	0.2	mg/kg	<0.2	2 mg/kg	118	70.0	130
EP080-SD: meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	<0.2	4 mg/kg	122	70.0	130
EP080-SD: ortho-Xylene	95-47-6	0.2	mg/kg	<0.2	2 mg/kg	110	70.0	130
EP080-SD: Total Xylenes	----	0.2	mg/kg	<0.2	----	----	----	----
EP080-SD: Sum of BTEX	----	0.2	mg/kg	<0.2	----	----	----	----
EP080-SD: Naphthalene	91-20-3	0.2	mg/kg	<0.2	0.5 mg/kg	80.4	70.0	130
EP090: Organotin Compounds (QCLot: 2707442)								
EP090: Tributyltin	56573-85-4	0.5	µgSn/kg	<0.5	1.25 µgSn/kg	106	52.0	139
EP130A: Organophosphorus Pesticides (Ultra-trace) (QCLot: 2707412)								
EP130: Bromophos-ethyl	4824-78-6	10	µg/kg	<10	50 µg/kg	88.1	49.0	117
EP130: Carbophenothion	786-19-6	10	µg/kg	<10	50 µg/kg	95.3	54.0	104
EP130: Chlorfenvinphos (E)	18708-86-6	10	µg/kg	<10.0	5 µg/kg	99.0	48.0	156
EP130: Chlorfenvinphos (Z)	18708-87-7	10	µg/kg	<10	50 µg/kg	91.1	53.0	119
EP130: Chlorpyrifos	2921-88-2	10	µg/kg	<10	50 µg/kg	99.2	54.0	112
EP130: Chlorpyrifos-methyl	5598-13-0	10	µg/kg	<10	50 µg/kg	98.8	52.0	108
EP130: Demeton-S-methyl	919-86-8	10	µg/kg	<10	50 µg/kg	78.2	51.0	109
EP130: Diazinon	333-41-5	10	µg/kg	<10	50 µg/kg	95.7	57.0	121
EP130: Dichlorvos	62-73-7	10	µg/kg	<10	50 µg/kg	82.5	48.0	104
EP130: Dimethoate	60-51-5	10	µg/kg	<10	50 µg/kg	82.2	52.0	120
EP130: Ethion	563-12-2	10	µg/kg	<10	50 µg/kg	89.7	51.0	121
EP130: Fenamiphos	22224-92-6	10	µg/kg	<10	50 µg/kg	101	50.0	120
EP130: Fenthion	55-38-9	10	µg/kg	<10	50 µg/kg	92.3	48.0	112
EP130: Malathion	121-75-5	10	µg/kg	<10	50 µg/kg	94.8	51.0	121
EP130: Azinphos Methyl	86-50-0	10	µg/kg	<10	50 µg/kg	87.3	45.0	127
EP130: Monocrotophos	6923-22-4	10	µg/kg	<10	50 µg/kg	91.6	48.0	128
EP130: Parathion	56-38-2	10	µg/kg	<10	50 µg/kg	105	49.0	125
EP130: Parathion-methyl	298-00-0	10	µg/kg	<10	50 µg/kg	96.0	51.0	119
EP130: Pirimphos-ethyl	23505-41-1	10	µg/kg	<10	50 µg/kg	102	48.0	120
EP130: Prothiofos	34643-46-4	10	µg/kg	<10	50 µg/kg	83.2	51.0	117
EP131A: Organochlorine Pesticides (QCLot: 2707411)								
EP131A: Aldrin	309-00-2	0.5	µg/kg	<0.50	5 µg/kg	80.6	38.0	139
EP131A: alpha-BHC	319-84-6	0.5	µg/kg	<0.50	5 µg/kg	68.1	17.6	136
EP131A: beta-BHC	319-85-7	0.5	µg/kg	<0.50	5 µg/kg	56.4	30.5	131
EP131A: delta-BHC	319-86-8	0.5	µg/kg	<0.50	5 µg/kg	57.4	37.0	140
EP131A: 4.4`-DDD	72-54-8	0.5	µg/kg	<0.50	5 µg/kg	92.0	25.9	141
EP131A: 4.4`-DDE	72-55-9	0.5	µg/kg	<0.50	5 µg/kg	86.7	35.0	129

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%) Low	Recovery Limits (%) High
EP131A: Organochlorine Pesticides (QCLot: 2707411) - continued								
EP131A: 4.4`-DDT	50-29-3	0.5	µg/kg	<0.50	5 µg/kg	92.3	23.4	138
EP131A: Sum of DDD + DDE + DDT	72-54-8/72-5 5-9/50-2	0.5	µg/kg	<0.50	----	----	----	----
EP131A: Dieldrin	60-57-1	0.5	µg/kg	<0.50	5 µg/kg	100	30.2	140
EP131A: alpha-Endosulfan	959-98-8	0.5	µg/kg	<0.50	5 µg/kg	81.1	38.0	140
EP131A: beta-Endosulfan	33213-65-9	0.5	µg/kg	<0.50	5 µg/kg	106	32.0	152
EP131A: Endosulfan sulfate	1031-07-8	0.5	µg/kg	<0.50	5 µg/kg	85.7	36.0	155
EP131A: Endosulfan (sum)	115-29-7	0.5	µg/kg	<0.50	----	----	----	----
EP131A: Endrin	72-20-8	0.5	µg/kg	<0.50	5 µg/kg	117	25.8	158
EP131A: Endrin aldehyde	7421-93-4	0.5	µg/kg	<0.50	5 µg/kg	90.0	20.1	118
EP131A: Endrin ketone	53494-70-5	0.5	µg/kg	<0.50	5 µg/kg	111	13.4	135
EP131A: Heptachlor	76-44-8	0.5	µg/kg	<0.50	5 µg/kg	78.8	39.0	155
EP131A: Heptachlor epoxide	1024-57-3	0.5	µg/kg	<0.50	5 µg/kg	83.7	34.0	148
EP131A: Hexachlorobenzene (HCB)	118-74-1	0.5	µg/kg	<0.50	5 µg/kg	88.2	26.1	152
EP131A: gamma-BHC	58-89-9	0.25	µg/kg	<0.25	5 µg/kg	66.8	31.2	137
EP131A: Methoxychlor	72-43-5	0.5	µg/kg	<0.50	5 µg/kg	92.4	36.0	152
EP131A: cis-Chlordane	5103-71-9	0.25	µg/kg	<0.25	5 µg/kg	86.3	36.0	142
EP131A: trans-Chlordane	5103-74-2	0.25	µg/kg	<0.25	5 µg/kg	91.7	29.5	138
EP131A: Total Chlordane (sum)	----	0.25	µg/kg	<0.25	----	----	----	----
EP132B: Polynuclear Aromatic Hydrocarbons (QCLot: 2701283)								
EP132B-SD: Naphthalene	91-20-3	5	µg/kg	<5	25 µg/kg	84.5	55.0	131
EP132B-SD: 2-Methylnaphthalene	91-57-6	5	µg/kg	<5	----	----	----	----
EP132B-SD: Acenaphthylene	208-96-8	4	µg/kg	<4	25 µg/kg	97.2	64.0	110
EP132B-SD: Acenaphthene	83-32-9	4	µg/kg	<4	25 µg/kg	96.4	62.0	112
EP132B-SD: Fluorene	86-73-7	4	µg/kg	<4	25 µg/kg	101	64.0	118
EP132B-SD: Phenanthrene	85-01-8	4	µg/kg	<4	25 µg/kg	99.8	59.0	117
EP132B-SD: Anthracene	120-12-7	4	µg/kg	<4	25 µg/kg	92.0	69.0	111
EP132B-SD: Fluoranthene	206-44-0	4	µg/kg	<4	25 µg/kg	88.9	66.0	118
EP132B-SD: Pyrene	129-00-0	4	µg/kg	<4	25 µg/kg	103	70.0	116
EP132B-SD: Benz(a)anthracene	56-55-3	4	µg/kg	<4	25 µg/kg	96.5	59.0	121
EP132B-SD: Chrysene	218-01-9	4	µg/kg	<4	25 µg/kg	92.1	68.0	116
EP132B-SD: Benzo(b+j)fluoranthene	205-99-2 205-82-3	4	µg/kg	<4	25 µg/kg	80.8	51.0	107
EP132B-SD: Benzo(k)fluoranthene	207-08-9	4	µg/kg	<4	25 µg/kg	93.6	52.0	118
EP132B-SD: Benzo(e)pyrene	192-97-2	4	µg/kg	<4	----	----	----	----
EP132B-SD: Benzo(a)pyrene	50-32-8	4	µg/kg	<4	25 µg/kg	89.1	55.0	111
EP132B-SD: Perylene	198-55-0	4	µg/kg	<4	----	----	----	----
EP132B-SD: Benzo(g.h.i)perylene	191-24-2	4	µg/kg	<4	25 µg/kg	88.4	62.0	106
EP132B-SD: Dibenz(a.h)anthracene	53-70-3	4	µg/kg	<4	25 µg/kg	104	35.0	141

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
EP132B: Polynuclear Aromatic Hydrocarbons (QCLot: 2701283) - continued								
EP132B-SD: Indeno(1.2.3.cd)pyrene	193-39-5	4	µg/kg	<4	25 µg/kg	99.5	48.0	122
EP132B-SD: Coronene	191-07-1	5	µg/kg	<5	----	----	----	----
EP132B-SD: Sum of PAHs	----	4	µg/kg	<4	----	----	----	----
EP203A: Explosives (QCLot: 2707316)								
EP203: HMX	2691-41-0	0.1	mg/kg	<0.1	1 mg/kg	105	54.0	122
EP203: RDX	----	0.1	mg/kg	<0.1	----	----	----	----
EP203: 1.3.5-Trinitrobenzene	99-35-4	0.1	mg/kg	<0.1	----	----	----	----
EP203: 1.3-Dinitrobenzene	99-65-0	0.1	mg/kg	<0.1	----	----	----	----
EP203: Tetryl	479-45-8	0.1	mg/kg	<0.1	----	----	----	----
EP203: 2.4.6-TNT	118-96-7	0.1	mg/kg	<0.1	1 mg/kg	111	61.0	1220
EP203: 4-Amino.2.6-DNT	19406-51-0	0.1	mg/kg	<0.1	1 mg/kg	81.0	53.0	127
EP203: 2-Amino-4.6-DNT	35572-78-2	0.1	mg/kg	<0.1	----	----	----	----
EP203: 2.4-Dinitrotoluene	121-14-2	0.1	mg/kg	<0.1	1 mg/kg	96.1	56.0	126
EP203: 2.6-Dinitrotoluene	606-20-2	0.1	mg/kg	<0.1	----	----	----	----
EP203: Nitrobenzene	98-95-3	0.1	mg/kg	<0.1	1 mg/kg	80.7	60.0	132
EP203: 2-Nitrotoluene	88-72-2	0.1	mg/kg	<0.1	----	----	----	----
EP203: 3-Nitrotoluene	99-08-1	0.1	mg/kg	<0.1	----	----	----	----
EP203: 4-Nitrotoluene	99-99-0	0.1	mg/kg	<0.1	----	----	----	----
EP203: Nitroglycerine	55-63-0	1	mg/kg	<1	----	----	----	----
EP203: PETN	78-11-5	1	mg/kg	<1	1 mg/kg	110	71.0	147
EP231A: Perfluoroalkyl Sulfonic Acids (QCLot: 2706601)								
EP231X: Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0002	mg/kg	<0.0002	0.00125 mg/kg	94.4	56.7	121
EP231X: Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0002	mg/kg	<0.0002	0.00125 mg/kg	85.2	55.2	125
EP231X: Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0002	mg/kg	<0.0002	0.00125 mg/kg	83.2	52.3	126
EP231X: Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0002	mg/kg	<0.0002	0.00125 mg/kg	78.4	53.5	123
EP231X: Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	mg/kg	<0.0002	0.00125 mg/kg	83.2	54.8	127
EP231X: Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0002	mg/kg	<0.0002	0.00125 mg/kg	75.2	54.0	125
EP231B: Perfluoroalkyl Carboxylic Acids (QCLot: 2706601)								
EP231X: Perfluorobutanoic acid (PFBA)	375-22-4	0.001	mg/kg	<0.001	0.00625 mg/kg	72.9	51.6	128
EP231X: Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0002	mg/kg	<0.0002	0.00125 mg/kg	77.2	54.0	129
EP231X: Perfluorohexanoic acid (PFHxA)	307-24-4	0.0002	mg/kg	<0.0002	0.00125 mg/kg	89.2	58.0	127
EP231X: Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0002	mg/kg	<0.0002	0.00125 mg/kg	90.0	57.1	128
EP231X: Perfluorooctanoic acid (PFOA)	335-67-1	0.0002	mg/kg	<0.0002	0.00125 mg/kg	81.2	60.3	134
EP231X: Perfluorononanoic acid (PFNA)	375-95-1	0.0002	mg/kg	<0.0002	0.00125 mg/kg	83.2	62.8	130
EP231X: Perfluorodecanoic acid (PFDA)	335-76-2	0.0002	mg/kg	<0.0002	0.00125 mg/kg	82.4	54.9	130
EP231X: Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0002	mg/kg	<0.0002	0.00125 mg/kg	84.4	62.0	130
EP231X: Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0002	mg/kg	<0.0002	0.00125 mg/kg	82.8	52.9	134
EP231X: Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0002	mg/kg	<0.0002	0.00125 mg/kg	69.6	48.5	129

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
EP231B: Perfluoroalkyl Carboxylic Acids (QCLot: 2706601) - continued								
EP231X: Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	mg/kg	<0.0005	0.00312 mg/kg	75.3	59.1	129
EP231C: Perfluoroalkyl Sulfonamides (QCLot: 2706601)								
EP231X: Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0002	mg/kg	<0.0002	0.00125 mg/kg	87.2	52.4	132
EP231X: N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.0005	mg/kg	<0.0005	0.00312 mg/kg	85.2	65.2	126
EP231X: N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.0005	mg/kg	<0.0005	0.00312 mg/kg	76.9	63.9	126
EP231X: N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.0005	mg/kg	<0.0005	0.00312 mg/kg	75.3	62.5	124
EP231X: N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.0005	mg/kg	<0.0005	0.00312 mg/kg	76.4	57.6	125
EP231X: N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0002	mg/kg	<0.0002	0.00125 mg/kg	85.2	60.8	130
EP231X: N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0002	mg/kg	<0.0002	0.00125 mg/kg	80.8	54.9	130
EP231D: (n:2) Fluorotelomer Sulfonic Acids (QCLot: 2706601)								
EP231X: 4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.0005	mg/kg	<0.0005	0.00125 mg/kg	71.6	54.1	130
EP231X: 6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.0005	mg/kg	<0.0005	0.00125 mg/kg	67.2	60.8	130
EP231X: 8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.0005	mg/kg	<0.0005	0.00125 mg/kg	62.8	62.3	130
EP231X: 10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.0005	mg/kg	<0.0005	0.00125 mg/kg	74.0	59.8	130

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
EG020T: Total Metals by ICP-MS (QCLot: 2704610)								
EG020A-T: Antimony	7440-36-0	0.001	mg/L	<0.001	0.02 mg/L	106	82.9	120
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	116	89.6	118
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	108	89.2	116
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	110	87.8	114
EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	109	89.0	115
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	105	85.8	115
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	106	88.4	111
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	108	88.5	115
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	103	87.4	116
EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	105	87.6	120
EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	110	89.5	116
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	112	88.1	120
EG020T: Total Metals by ICP-MS (QCLot: 2704611)								
EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	0.02 mg/L	101	66.8	120
EG035T: Total Mercury by FIMS (QCLot: 2718842)								
EG035T-LL: Mercury	7439-97-6	0.00004	mg/L	<0.00004	0.0001 mg/L	97.0	85.0	105

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2704652)								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	92.4	85.1	115
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2704653)								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	92.1	85.1	115
EG093T: Total Metals in Saline Water by ORC-ICPMS (QCLot: 2720861)								
EG093A-T: Antimony	7440-36-0	0.5	µg/L	<0.5	2 µg/L	114	70.0	130
EG093A-T: Arsenic	7440-38-2	0.5	µg/L	<0.5	10 µg/L	100	89.0	125
EG093A-T: Cadmium	7440-43-9	0.2	µg/L	<0.2	10 µg/L	101	82.0	122
EG093A-T: Chromium	7440-47-3	0.5	µg/L	<0.5	10 µg/L	97.0	85.0	123
EG093A-T: Cobalt	7440-48-4	0.2	µg/L	<0.2	10 µg/L	103	86.0	122
EG093A-T: Copper	7440-50-8	1	µg/L	<1	10 µg/L	95.0	84.0	128
EG093A-T: Lead	7439-92-1	0.2	µg/L	<0.2	10 µg/L	97.6	85.0	125
EG093A-T: Manganese	7439-96-5	0.5	µg/L	<0.5	10 µg/L	97.6	86.0	126
EG093A-T: Nickel	7440-02-0	0.5	µg/L	<0.5	10 µg/L	101	85.0	125
EG093A-T: Silver	7440-22-4	0.1	µg/L	<0.1	2 µg/L	110	70.0	130
EG093A-T: Vanadium	7440-62-2	0.5	µg/L	<0.5	10 µg/L	111	86.0	126
EG093A-T: Zinc	7440-66-6	5	µg/L	<5	10 µg/L	94.9	82.0	128
EG093T: Total Metals in Saline Water by ORC-ICPMS (QCLot: 2720862)								
EG093B-T: Selenium	7782-49-2	2	µg/L	<2	10 µg/L	102	80.0	138
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2700453)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	1 mg/L	100	86.2	111
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2700456)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	100	93.7	108
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2700454)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	99.1	90.5	110
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2710684)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	87.1	75.8	100
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2710683)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	76.6	70.0	110
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 2700459)								
EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	0.5 mg/L	97.7	89.4	109
EK255A: Ammonia (QCLot: 2720021)								
EK255A-SW: Ammonia as N	7664-41-7	0.005	mg/L	<0.005	0.1 mg/L	99.7	77.0	121
EK257A: Nitrite (QCLot: 2720020)								
EK257A-SW: Nitrite as N	14797-65-0	0.002	mg/L	<0.002	0.1 mg/L	97.5	91.0	127
EK259A: Nitrite and Nitrate (NOx) (QCLot: 2720023)								
EK259A-SW: Nitrite + Nitrate as N	----	0.002	mg/L	<0.002	0.1 mg/L	105	92.0	120
EK262A: Total Nitrogen (QCLot: 2719099)								

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
EK262A: Total Nitrogen (QCLot: 2719099) - continued								
EK262PA-SW: Total Nitrogen as N	----	0.025	mg/L	<0.025	1 mg/L	102	81.0	111
EK267A: Total Phosphorus (Persulfate Digestion) (QCLot: 2719098)								
EK267PA-SW: Total Phosphorus as P	----	0.005	mg/L	<0.005	0.44 mg/L	102	88.0	112
EK271A: Reactive Phosphorus (QCLot: 2720022)								
EK271A-SW: Reactive Phosphorus as P	14265-44-2	0.001	mg/L	<0.001	0.1 mg/L	98.1	72.0	118
EP068A: Organochlorine Pesticides (OC) (QCLot: 2705846)								
EP068: alpha-BHC	319-84-6	0.5	µg/L	<0.5	5 µg/L	91.7	64.9	107
EP068: Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	5 µg/L	83.6	58.3	111
EP068: beta-BHC	319-85-7	0.5	µg/L	<0.5	5 µg/L	104	69.0	117
EP068: gamma-BHC	58-89-9	0.5	µg/L	<0.5	5 µg/L	95.8	70.0	112
EP068: delta-BHC	319-86-8	0.5	µg/L	<0.5	5 µg/L	104	68.9	110
EP068: Heptachlor	76-44-8	0.5	µg/L	<0.5	5 µg/L	102	65.2	108
EP068: Aldrin	309-00-2	0.5	µg/L	<0.5	5 µg/L	105	65.8	109
EP068: Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	5 µg/L	102	67.1	107
EP068: trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	5 µg/L	99.7	64.1	110
EP068: alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	5 µg/L	101	66.7	112
EP068: cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	5 µg/L	95.5	63.2	111
EP068: Dieldrin	60-57-1	0.5	µg/L	<0.5	5 µg/L	80.7	65.2	113
EP068: 4.4`-DDE	72-55-9	0.5	µg/L	<0.5	5 µg/L	91.2	66.0	112
EP068: Endrin	72-20-8	0.5	µg/L	<0.5	5 µg/L	86.5	65.2	113
EP068: beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	5 µg/L	84.6	67.3	114
EP068: 4.4`-DDD	72-54-8	0.5	µg/L	<0.5	5 µg/L	77.4	72.0	122
EP068: Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	5 µg/L	77.4	66.9	109
EP068: Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	5 µg/L	96.1	65.2	112
EP068: 4.4`-DDT	50-29-3	2	µg/L	<2.0	5 µg/L	88.2	65.2	112
EP068: Endrin ketone	53494-70-5	0.5	µg/L	<0.5	5 µg/L	87.0	63.8	110
EP068: Methoxychlor	72-43-5	2	µg/L	<2.0	5 µg/L	88.6	61.1	114
EP068B: Organophosphorus Pesticides (OP) (QCLot: 2705846)								
EP068: Dichlorvos	62-73-7	0.5	µg/L	<0.5	5 µg/L	89.1	65.6	114
EP068: Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	5 µg/L	76.9	63.7	113
EP068: Monocrotophos	6923-22-4	2	µg/L	<2.0	5 µg/L	24.2	19.7	48.0
EP068: Dimethoate	60-51-5	0.5	µg/L	<0.5	5 µg/L	97.2	69.5	110
EP068: Diazinon	333-41-5	0.5	µg/L	<0.5	5 µg/L	103	71.1	110
EP068: Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	5 µg/L	102	77.0	119
EP068: Parathion-methyl	298-00-0	2	µg/L	<2.0	5 µg/L	101	70.0	124
EP068: Malathion	121-75-5	0.5	µg/L	<0.5	5 µg/L	107	68.4	116
EP068: Fenthion	55-38-9	0.5	µg/L	<0.5	5 µg/L	101	68.6	112
EP068: Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	5 µg/L	103	75.0	119

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
EP068B: Organophosphorus Pesticides (OP) (QCLot: 2705846) - continued								
EP068: Parathion	56-38-2	2	µg/L	<2.0	5 µg/L	99.7	67.0	121
EP068: Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	5 µg/L	100	69.0	121
EP068: Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	5 µg/L	105	71.8	110
EP068: Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	5 µg/L	98.3	67.5	112
EP068: Fenamiphos	22224-92-6	0.5	µg/L	<0.5	5 µg/L	97.2	64.1	116
EP068: Prothiofos	34643-46-4	0.5	µg/L	<0.5	5 µg/L	100	67.8	114
EP068: Ethion	563-12-2	0.5	µg/L	<0.5	5 µg/L	74.4	74.0	120
EP068: Carbophenothion	786-19-6	0.5	µg/L	<0.5	5 µg/L	91.7	66.2	114
EP068: Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	5 µg/L	91.3	51.6	128
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons (QCLot: 2705844)								
EP075(SIM): Naphthalene	91-20-3	1	µg/L	<1.0	5 µg/L	66.5	50.0	94.0
EP075(SIM): Acenaphthylene	208-96-8	1	µg/L	<1.0	5 µg/L	70.4	63.6	114
EP075(SIM): Acenaphthene	83-32-9	1	µg/L	<1.0	5 µg/L	71.7	62.2	113
EP075(SIM): Fluorene	86-73-7	1	µg/L	<1.0	5 µg/L	73.5	63.9	115
EP075(SIM): Phenanthrene	85-01-8	1	µg/L	<1.0	5 µg/L	79.1	62.6	116
EP075(SIM): Anthracene	120-12-7	1	µg/L	<1.0	5 µg/L	90.3	64.3	116
EP075(SIM): Fluoranthene	206-44-0	1	µg/L	<1.0	5 µg/L	87.3	63.6	118
EP075(SIM): Pyrene	129-00-0	1	µg/L	<1.0	5 µg/L	98.4	63.1	118
EP075(SIM): Benz(a)anthracene	56-55-3	1	µg/L	<1.0	5 µg/L	66.2	64.1	117
EP075(SIM): Chrysene	218-01-9	1	µg/L	<1.0	5 µg/L	84.6	62.5	116
EP075(SIM): Benzo(b+j)fluoranthene	205-99-2 205-82-3	1	µg/L	<1.0	5 µg/L	69.1	61.7	119
EP075(SIM): Benzo(k)fluoranthene	207-08-9	1	µg/L	<1.0	5 µg/L	69.3	63.0	115
EP075(SIM): Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	5 µg/L	82.3	63.3	117
EP075(SIM): Indeno(1.2.3.cd)pyrene	193-39-5	1	µg/L	<1.0	5 µg/L	69.5	59.9	118
EP075(SIM): Dibenz(a.h)anthracene	53-70-3	1	µg/L	<1.0	5 µg/L	69.5	61.2	117
EP075(SIM): Benzo(g.h.i)perylene	191-24-2	1	µg/L	<1.0	5 µg/L	82.4	59.1	118
EP080/071: Total Petroleum Hydrocarbons (QCLot: 2705845)								
EP071: C10 - C14 Fraction	----	50	µg/L	<50	2000 µg/L	64.4	55.8	112
EP071: C15 - C28 Fraction	----	100	µg/L	<100	3000 µg/L	77.2	71.6	113
EP071: C29 - C36 Fraction	----	50	µg/L	<50	2000 µg/L	76.1	56.0	121
EP080/071: Total Petroleum Hydrocarbons (QCLot: 2708918)								
EP080: C6 - C9 Fraction	----	20	µg/L	<20	260 µg/L	89.9	75.0	127
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 2705845)								
EP071: >C10 - C16 Fraction	----	100	µg/L	<100	2500 µg/L	68.7	57.9	119
EP071: >C16 - C34 Fraction	----	100	µg/L	<100	3500 µg/L	76.4	62.5	110
EP071: >C34 - C40 Fraction	----	100	µg/L	<100	1500 µg/L	74.7	61.5	121
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 2708918)								

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 2708918) - continued								
EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	310 µg/L	87.2	75.0	127
EP080: BTEXN (QCLot: 2708918)								
EP080: Benzene	71-43-2	1	µg/L	<1	10 µg/L	92.5	70.0	122
EP080: Toluene	108-88-3	2	µg/L	<2	10 µg/L	92.5	69.0	123
EP080: Ethylbenzene	100-41-4	2	µg/L	<2	10 µg/L	91.9	70.0	120
EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	10 µg/L	93.2	69.0	121
EP080: ortho-Xylene	95-47-6	2	µg/L	<2	10 µg/L	92.3	72.0	122
EP080: Naphthalene	91-20-3	5	µg/L	<5	10 µg/L	99.5	70.0	120
EP090: Organotin Compounds (Soluble) (QCLot: 2707059)								
EP090S: Tributyltin	56573-85-4	2	ngSn/L	<2	147 ngSn/L	81.1	30.7	134
EP203A: Explosives (QCLot: 2707326)								
EP203-SL: HMX	2691-41-0	20	µg/L	<20	200 µg/L	97.3	53.0	147
EP203-SL: RDX	----	20	µg/L	<20	----	----	----	----
EP203-SL: 1.3.5-Trinitrobenzene	99-35-4	20	µg/L	<20	----	----	----	----
EP203-SL: 1.3-Dinitrobenzene	99-65-0	20	µg/L	<20	----	----	----	----
EP203-SL: Tetryl	479-45-8	20	µg/L	<20	----	----	----	----
EP203-SL: 2.4.6-TNT	118-96-7	20	µg/L	<20	200 µg/L	107	63.0	145
EP203-SL: 4-Amino.2.6-DNT	19406-51-0	20	µg/L	<20	200 µg/L	96.0	59.0	135
EP203-SL: 2-Amino-4.6-DNT	35572-78-2	20	µg/L	<20	----	----	----	----
EP203-SL: 2.4-Dinitrotoluene	121-14-2	20	µg/L	<20	200 µg/L	96.0	59.0	131
EP203-SL: 2.6-Dinitrotoluene	606-20-2	20	µg/L	<20	----	----	----	----
EP203-SL: Nitrobenzene	98-95-3	20	µg/L	<20	200 µg/L	79.4	52.0	140
EP203-SL: 2-Nitrotoluene	88-72-2	20	µg/L	<20	----	----	----	----
EP203-SL: 3-Nitrotoluene	99-08-1	20	µg/L	<20	----	----	----	----
EP203-SL: 4-Nitrotoluene	99-99-0	20	µg/L	<20	----	----	----	----
EP203-SL: Nitroglycerine	55-63-0	200	µg/L	<200	----	----	----	----
EP203-SL: PETN	78-11-5	200	µg/L	<200	200 µg/L	93.9	75.0	143
EP231A: Perfluoroalkyl Sulfonic Acids (QCLot: 2710050)								
EP231X-SUT: Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0005	µg/L	<0.0005	0.0025 µg/L	75.8	50.0	130
EP231X-SUT: Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0005	µg/L	<0.0005	0.0025 µg/L	87.0	50.0	130
EP231X-SUT: Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0005	µg/L	<0.0005	0.0025 µg/L	86.2	50.0	130
EP231X-SUT: Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0005	µg/L	<0.0005	0.0025 µg/L	96.6	50.0	130
EP231X-SUT: Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	µg/L	<0.0002	0.0025 µg/L	80.0	50.0	130
EP231X-SUT: Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0005	µg/L	<0.0005	0.0025 µg/L	51.8	50.0	130
EP231A: Perfluoroalkyl Sulfonic Acids (QCLot: 2735784)								
EP231X-SUT: Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0005	µg/L	<0.0005	0.0025 µg/L	61.6	50.0	130
EP231X-SUT: Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0005	µg/L	<0.0005	0.0025 µg/L	62.0	50.0	130

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
EP231A: Perfluoroalkyl Sulfonic Acids (QCLot: 2735784) - continued								
EP231X-SUT: Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0005	µg/L	<0.0005	0.0025 µg/L	57.0	50.0	130
EP231X-SUT: Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0005	µg/L	<0.0005	0.0025 µg/L	64.8	50.0	130
EP231X-SUT: Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	µg/L	<0.0002	0.0025 µg/L	75.8	50.0	130
EP231X-SUT: Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0005	µg/L	<0.0005	0.0025 µg/L	50.2	50.0	130
EP231B: Perfluoroalkyl Carboxylic Acids (QCLot: 2710050)								
EP231X-SUT: Perfluorobutanoic acid (PFBA)	375-22-4	0.002	µg/L	<0.0020	0.0125 µg/L	60.3	30.0	130
EP231X-SUT: Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0005	µg/L	<0.0005	0.0025 µg/L	83.2	50.0	130
EP231X-SUT: Perfluorohexanoic acid (PFHxA)	307-24-4	0.0005	µg/L	<0.0005	0.0025 µg/L	83.4	50.0	130
EP231X-SUT: Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0005	µg/L	<0.0005	0.0025 µg/L	86.0	50.0	130
EP231X-SUT: Perfluorooctanoic acid (PFOA)	335-67-1	0.0005	µg/L	<0.0005	0.0025 µg/L	91.6	50.0	130
EP231X-SUT: Perfluorononanoic acid (PFNA)	375-95-1	0.0005	µg/L	<0.0005	0.0025 µg/L	86.0	50.0	130
EP231X-SUT: Perfluorodecanoic acid (PFDA)	335-76-2	0.0005	µg/L	<0.0005	0.0025 µg/L	74.2	50.0	130
EP231X-SUT: Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0005	µg/L	<0.0005	0.0025 µg/L	61.2	40.0	130
EP231X-SUT: Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0005	µg/L	<0.0005	0.0025 µg/L	62.0	40.0	130
EP231X-SUT: Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0005	µg/L	<0.0005	0.0025 µg/L	41.8	40.0	130
EP231X-SUT: Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	µg/L	<0.0005	0.00625 µg/L	67.3	40.0	130
EP231B: Perfluoroalkyl Carboxylic Acids (QCLot: 2735784)								
EP231X-SUT: Perfluorobutanoic acid (PFBA)	375-22-4	0.002	µg/L	<0.0020	0.0125 µg/L	51.5	30.0	130
EP231X-SUT: Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0005	µg/L	<0.0005	0.0025 µg/L	76.6	50.0	130
EP231X-SUT: Perfluorohexanoic acid (PFHxA)	307-24-4	0.0005	µg/L	<0.0005	0.0025 µg/L	72.4	50.0	130
EP231X-SUT: Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0005	µg/L	<0.0005	0.0025 µg/L	81.8	50.0	130
EP231X-SUT: Perfluorooctanoic acid (PFOA)	335-67-1	0.0005	µg/L	<0.0005	0.0025 µg/L	82.4	50.0	130
EP231X-SUT: Perfluorononanoic acid (PFNA)	375-95-1	0.0005	µg/L	<0.0005	0.0025 µg/L	83.2	50.0	130
EP231X-SUT: Perfluorodecanoic acid (PFDA)	335-76-2	0.0005	µg/L	<0.0005	0.0025 µg/L	93.8	50.0	130
EP231X-SUT: Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0005	µg/L	<0.0005	0.0025 µg/L	60.2	40.0	130
EP231X-SUT: Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0005	µg/L	<0.0005	0.0025 µg/L	44.4	40.0	130
EP231X-SUT: Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0005	µg/L	<0.0005	0.0025 µg/L	41.6	40.0	130
EP231X-SUT: Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	µg/L	<0.0005	0.00625 µg/L	50.1	40.0	130
EP231C: Perfluoroalkyl Sulfonamides (QCLot: 2710050)								
EP231X-SUT: Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0005	µg/L	<0.0005	0.0025 µg/L	73.2	40.0	130
EP231X-SUT: N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.001	µg/L	<0.001	0.00625 µg/L	51.4	40.0	130
EP231X-SUT: N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.001	µg/L	<0.001	0.00625 µg/L	68.1	40.0	130
EP231X-SUT: N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.001	µg/L	<0.001	0.00625 µg/L	56.6	40.0	130
EP231X-SUT: N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.001	µg/L	<0.001	0.00625 µg/L	52.7	40.0	130

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
EP231C: Perfluoroalkyl Sulfonamides (QCLot: 2710050) - continued								
EP231X-SUT: N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0005	µg/L	<0.0005	0.0025 µg/L	43.6	40.0	130
EP231X-SUT: N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0005	µg/L	<0.0005	0.0025 µg/L	55.6	40.0	130
EP231C: Perfluoroalkyl Sulfonamides (QCLot: 2735784)								
EP231X-SUT: Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0005	µg/L	<0.0005	0.0025 µg/L	62.8	40.0	130
EP231X-SUT: N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.001	µg/L	<0.001	0.00625 µg/L	56.9	40.0	130
EP231X-SUT: N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.001	µg/L	<0.001	0.00625 µg/L	54.1	40.0	130
EP231X-SUT: N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.001	µg/L	<0.001	0.00625 µg/L	57.9	40.0	130
EP231X-SUT: N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.001	µg/L	<0.001	0.00625 µg/L	56.2	40.0	130
EP231X-SUT: N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0005	µg/L	<0.0005	0.0025 µg/L	50.2	40.0	130
EP231X-SUT: N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0005	µg/L	<0.0005	0.0025 µg/L	45.2	40.0	130
EP231D: (n:2) Fluorotelomer Sulfonic Acids (QCLot: 2710050)								
EP231X-SUT: 4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.001	µg/L	<0.001	0.0025 µg/L	88.8	50.0	130
EP231X-SUT: 6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.001	µg/L	<0.001	0.0025 µg/L	89.4	50.0	130
EP231X-SUT: 8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.001	µg/L	<0.001	0.0025 µg/L	92.4	50.0	130
EP231X-SUT: 10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.001	µg/L	<0.001	0.0025 µg/L	87.8	50.0	130
EP231D: (n:2) Fluorotelomer Sulfonic Acids (QCLot: 2735784)								
EP231X-SUT: 4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.001	µg/L	<0.001	0.0025 µg/L	78.6	50.0	130
EP231X-SUT: 6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.001	µg/L	<0.001	0.0025 µg/L	78.6	50.0	130
EP231X-SUT: 8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.001	µg/L	<0.001	0.0025 µg/L	72.6	50.0	130
EP231X-SUT: 10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.001	µg/L	<0.001	0.0025 µg/L	53.6	50.0	130
EP231P: PFAS Sums (QCLot: 2710050)								
EP231X-SUT: Sum of PFHxS and PFOS	355-46-4/17 63-23-1	0.0002	µg/L	<0.0002	----	----	----	----
EP231X-SUT: Sum of PFAS (WA DER List)	----	0.0002	µg/L	<0.0002	----	----	----	----
EP231X-SUT: Sum of PFAS	----	0.0002	µg/L	<0.0002	----	----	----	----
EP231P: PFAS Sums (QCLot: 2735784)								
EP231X-SUT: Sum of PFHxS and PFOS	355-46-4/17 63-23-1	0.0002	µg/L	<0.0002	----	----	----	----
EP231X-SUT: Sum of PFAS (WA DER List)	----	0.0002	µg/L	<0.0002	----	----	----	----
EP231X-SUT: Sum of PFAS	----	0.0002	µg/L	<0.0002	----	----	----	----

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **SOIL**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG035T: Total Recoverable Mercury by FIMS (Low Level) (QCLot: 2707197)							
EP1911899-003	C01S03	EG035T-LL: Mercury	7439-97-6	10 mg/kg	97.1	70.0	130
EG020-SD: Total Metals in Sediments by ICPMS (QCLot: 2707198)							
EP1911899-003	C01S03	EG020-SD: Arsenic	7440-38-2	50 mg/kg	109	70.0	130
		EG020-SD: Cadmium	7440-43-9	50 mg/kg	102	70.0	130
		EG020-SD: Chromium	7440-47-3	50 mg/kg	108	70.0	130
		EG020-SD: Copper	7440-50-8	50 mg/kg	99.3	70.0	130
		EG020-SD: Lead	7439-92-1	50 mg/kg	94.2	70.0	130
		EG020-SD: Nickel	7440-02-0	50 mg/kg	104	70.0	130
		EG020-SD: Selenium	7782-49-2	10 mg/kg	99.3	70.0	130
		EG020-SD: Zinc	7440-66-6	50 mg/kg	103	70.0	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2707179)							
EP1911899-003	C01S03	EK057G: Nitrite as N (Sol.)	14797-65-0	2.5 mg/kg	103	70.0	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2707177)							
EP1911899-003	C01S03	EK059G: Nitrite + Nitrate as N (Sol.)	----	2.5 mg/kg	98.6	70.0	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2742269)							
EP1911899-003	C01S03	EK061G: Total Kjeldahl Nitrogen as N	----	500 mg/kg	88.4	70.0	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2742268)							
EP1911899-003	C01S03	EK067G: Total Phosphorus as P	----	100 mg/kg	109	70.0	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 2707178)							
EP1911899-003	C01S03	EK071G: Reactive Phosphorus as P	14265-44-2	2.5 mg/kg	99.7	70.0	130
EK255A SD: Ammonia in Sediment (QCLot: 2729942)							
EP1911584-010	Anonymous	EK255A: Ammonia as N	7664-41-7	0.5 mg/kg	118	70.0	130
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (QCLot: 2701281)							
EP1911899-003	C01S03	EP080-SD: C6 - C9 Fraction	----	32 mg/kg	82.4	70.0	130
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (QCLot: 2701282)							
EP1911899-003	C01S03	EP071-SD: C10 - C14 Fraction	----	252 mg/kg	93.5	70.0	130
		EP071-SD: C15 - C28 Fraction	----	634 mg/kg	83.4	70.0	130
		EP071-SD: C29 - C36 Fraction	----	99 mg/kg	72.8	70.0	130
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons (QCLot: 2701281)							
EP1911899-003	C01S03	EP080-SD: C6 - C10 Fraction	C6_C10	37 mg/kg	75.2	70.0	130
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons (QCLot: 2701282)							

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%) MS	Recovery Limits (%) Low	High
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons (QCLot: 2701282) - continued							
EP1911899-003	C01S03	EP071-SD: >C10 - C16 Fraction	----	404 mg/kg	92.1	70.0	130
		EP071-SD: >C16 - C34 Fraction	----	567 mg/kg	76.2	70.0	130
		EP071-SD: >C34 - C40 Fraction	----	33 mg/kg	73.7	70.0	130
EP080-SD: BTEXN (QCLot: 2701281)							
EP1911899-003	C01S03	EP080-SD: Benzene	71-43-2	2 mg/kg	115	70.0	130
		EP080-SD: Toluene	108-88-3	2 mg/kg	107	70.0	130
EP090: Organotin Compounds (QCLot: 2707442)							
EP1911899-003	C01S03	EP090: Tributyltin	56573-85-4	1.25 µgSn/kg	100	20.0	130
EP130A: Organophosphorus Pesticides (Ultra-trace) (QCLot: 2707412)							
EP1911899-001	C01S01	EP130: Bromophos-ethyl	4824-78-6	50 µg/kg	53.4	36.0	144
		EP130: Carbophenothion	786-19-6	50 µg/kg	52.2	38.0	120
		EP130: Chlorfenvinphos (E)	18708-86-6	5 µg/kg	53.4	49.0	157
		EP130: Chlorfenvinphos (Z)	18708-87-7	50 µg/kg	58.8	53.0	145
		EP130: Chlorpyrifos	2921-88-2	50 µg/kg	60.3	60.0	140
		EP130: Chlorpyrifos-methyl	5598-13-0	50 µg/kg	62.2	56.0	126
		EP130: Demeton-S-methyl	919-86-8	50 µg/kg	54.9	9.70	148
		EP130: Diazinon	333-41-5	50 µg/kg	69.5	60.0	122
		EP130: Dichlorvos	62-73-7	50 µg/kg	54.8	33.0	123
		EP130: Dimethoate	60-51-5	50 µg/kg	61.9	36.0	142
		EP130: Ethion	563-12-2	50 µg/kg	52.8	48.0	136
		EP130: Fenamiphos	22224-92-6	50 µg/kg	55.8	42.0	136
		EP130: Fenthion	55-38-9	50 µg/kg	55.9	35.0	131
		EP130: Malathion	121-75-5	50 µg/kg	56.8	55.0	141
		EP130: Azinphos Methyl	86-50-0	50 µg/kg	60.4	23.5	132
		EP130: Monocrotophos	6923-22-4	50 µg/kg	55.1	35.0	153
		EP130: Parathion	56-38-2	50 µg/kg	57.8	57.0	147
		EP130: Parathion-methyl	298-00-0	50 µg/kg	55.0	48.0	140
		EP130: Pirimphos-ethyl	23505-41-1	50 µg/kg	54.0	45.0	137
		EP130: Prothiofos	34643-46-4	50 µg/kg	52.2	51.0	137
EP131A: Organochlorine Pesticides (QCLot: 2707411)							
EP1911899-001	C01S01	EP131A: Aldrin	309-00-2	5 µg/kg	36.0	23.4	153
		EP131A: alpha-BHC	319-84-6	5 µg/kg	38.1	17.6	156
		EP131A: beta-BHC	319-85-7	5 µg/kg	42.5	24.9	153
		EP131A: delta-BHC	319-86-8	5 µg/kg	32.3	25.2	147
		EP131A: 4.4`-DDD	72-54-8	5 µg/kg	41.7	25.9	150
		EP131A: 4.4`-DDE	72-55-9	5 µg/kg	44.7	31.2	125
		EP131A: 4.4`-DDT	50-29-3	5 µg/kg	60.2	23.4	163
		EP131A: Dieldrin	60-57-1	5 µg/kg	42.4	30.2	140

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%) MS	Recovery Limits (%) Low	High
EP131A: Organochlorine Pesticides (QCLot: 2707411) - continued							
EP1911899-001	C01S01	EP131A: alpha-Endosulfan	959-98-8	5 µg/kg	51.1	28.8	135
		EP131A: beta-Endosulfan	33213-65-9	5 µg/kg	56.1	22.6	141
		EP131A: Endosulfan sulfate	1031-07-8	5 µg/kg	56.4	16.1	156
		EP131A: Endrin	72-20-8	5 µg/kg	75.5	17.7	162
		EP131A: Endrin aldehyde	7421-93-4	5 µg/kg	56.4	20.1	116
		EP131A: Endrin ketone	53494-70-5	5 µg/kg	51.9	13.4	151
		EP131A: Heptachlor	76-44-8	5 µg/kg	37.0	23.8	170
		EP131A: Heptachlor epoxide	1024-57-3	5 µg/kg	34.6	28.3	140
		EP131A: Hexachlorobenzene (HCB)	118-74-1	5 µg/kg	41.9	17.7	144
		EP131A: gamma-BHC	58-89-9	5 µg/kg	25.1	21.8	158
		EP131A: Methoxychlor	72-43-5	5 µg/kg	62.8	24.4	158
		EP131A: cis-Chlordane	5103-71-9	5 µg/kg	44.9	27.3	139
		EP131A: trans-Chlordane	5103-74-2	5 µg/kg	41.7	29.5	138
EP132B: Polynuclear Aromatic Hydrocarbons (QCLot: 2701283)							
EP1911899-003	C01S03	EP132B-SD: Naphthalene	91-20-3	25 µg/kg	90.0	70.0	130
		EP132B-SD: Acenaphthylene	208-96-8	25 µg/kg	98.3	70.0	130
		EP132B-SD: Acenaphthene	83-32-9	25 µg/kg	96.2	70.0	130
		EP132B-SD: Fluorene	86-73-7	25 µg/kg	97.9	70.0	130
		EP132B-SD: Phenanthrene	85-01-8	25 µg/kg	93.7	70.0	130
		EP132B-SD: Anthracene	120-12-7	25 µg/kg	89.3	70.0	130
		EP132B-SD: Fluoranthene	206-44-0	25 µg/kg	94.1	70.0	130
		EP132B-SD: Pyrene	129-00-0	25 µg/kg	94.4	70.0	130
		EP132B-SD: Benz(a)anthracene	56-55-3	25 µg/kg	91.4	70.0	130
		EP132B-SD: Chrysene	218-01-9	25 µg/kg	81.3	70.0	130
		EP132B-SD: Benzo(b+j)fluoranthene	205-99-2 205-82-3	25 µg/kg	104	70.0	130
		EP132B-SD: Benzo(k)fluoranthene	207-08-9	25 µg/kg	102	70.0	130
		EP132B-SD: Benzo(a)pyrene	50-32-8	25 µg/kg	87.6	70.0	130
		EP132B-SD: Benzo(g.h.i)perylene	191-24-2	25 µg/kg	101	70.0	130
		EP132B-SD: Dibenz(a.h)anthracene	53-70-3	25 µg/kg	89.8	70.0	130
		EP132B-SD: Indeno(1.2.3.cd)pyrene	193-39-5	25 µg/kg	102	70.0	130
EP203A: Explosives (QCLot: 2707316)							
EM1919349-001	Anonymous	EP203: HMX	2691-41-0	1 mg/kg	110	58.0	141
		EP203: 2.4.6-TNT	118-96-7	1 mg/kg	114	58.0	139
		EP203: 4-Amino.2.6-DNT	19406-51-0	1 mg/kg	81.0	56.0	140
		EP203: 2.4-Dinitrotoluene	121-14-2	1 mg/kg	92.4	59.0	139
		EP203: Nitrobenzene	98-95-3	1 mg/kg	80.1	60.0	132
		EP203: PETN	78-11-5	1 mg/kg	108	59.0	136

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%) MS	Recovery Limits (%) Low	High
EP231A: Perfluoroalkyl Sulfonic Acids (QCLot: 2706601)							
EM1919294-001	Anonymous	EP231X: Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.00125 mg/kg	74.0	50.0	130
		EP231X: Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.00125 mg/kg	81.6	50.0	130
		EP231X: Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.00125 mg/kg	75.2	50.0	130
		EP231X: Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.00125 mg/kg	71.6	50.0	130
		EP231X: Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.00125 mg/kg	62.8	50.0	130
		EP231X: Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.00125 mg/kg	70.4	50.0	130
EP231B: Perfluoroalkyl Carboxylic Acids (QCLot: 2706601)							
EM1919294-001	Anonymous	EP231X: Perfluorobutanoic acid (PFBA)	375-22-4	0.00625 mg/kg	63.4	30.0	130
		EP231X: Perfluoropentanoic acid (PFPeA)	2706-90-3	0.00125 mg/kg	75.2	50.0	130
		EP231X: Perfluorohexanoic acid (PFHxA)	307-24-4	0.00125 mg/kg	86.8	50.0	130
		EP231X: Perfluoroheptanoic acid (PFHpA)	375-85-9	0.00125 mg/kg	85.6	50.0	130
		EP231X: Perfluorooctanoic acid (PFOA)	335-67-1	0.00125 mg/kg	80.0	50.0	130
		EP231X: Perfluorononanoic acid (PFNA)	375-95-1	0.00125 mg/kg	85.6	50.0	130
		EP231X: Perfluorodecanoic acid (PFDA)	335-76-2	0.00125 mg/kg	76.8	50.0	130
		EP231X: Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.00125 mg/kg	74.4	50.0	130
		EP231X: Perfluorododecanoic acid (PFDoDA)	307-55-1	0.00125 mg/kg	72.0	50.0	130
		EP231X: Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.00125 mg/kg	79.2	30.0	130
		EP231X: Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.00312 mg/kg	70.0	30.0	130
EP231C: Perfluoroalkyl Sulfonamides (QCLot: 2706601)							
EM1919294-001	Anonymous	EP231X: Perfluorooctane sulfonamide (FOSA)	754-91-6	0.00125 mg/kg	90.8	50.0	130
		EP231X: N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.00312 mg/kg	62.7	30.0	130
		EP231X: N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.00312 mg/kg	60.9	30.0	130
		EP231X: N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.00312 mg/kg	55.4	30.0	130
		EP231X: N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.00312 mg/kg	65.4	30.0	130
		EP231X: N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.00125 mg/kg	85.2	30.0	130
		EP231X: N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.00125 mg/kg	80.4	30.0	130
EP231D: (n:2) Fluorotelomer Sulfonic Acids (QCLot: 2706601)							
EM1919294-001	Anonymous	EP231X: 4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.00125 mg/kg	70.4	50.0	130
		EP231X: 6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.00125 mg/kg	84.0	50.0	130
		EP231X: 8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.00125 mg/kg	92.8	50.0	130
		EP231X: 10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.00125 mg/kg	109	50.0	130

Sub-Matrix: **WATER**

Matrix Spike (MS) Report: Spike	SpikeRecovery(%)	Recovery Limits (%)

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%) MS	Recovery Limits (%) Low	High
EG020T: Total Metals by ICP-MS (QCLot: 2704610)							
EP1911804-007	Anonymous	EG020A-T: Arsenic	7440-38-2	1.3 mg/L	# Not Determined	70.0	130
		EG020A-T: Cadmium	7440-43-9	0.325 mg/L	96.8	70.0	130
		EG020A-T: Chromium	7440-47-3	1.3 mg/L	98.3	70.0	130
		EG020A-T: Cobalt	7440-48-4	1.3 mg/L	91.2	70.0	130
		EG020A-T: Copper	7440-50-8	1.3 mg/L	# Not Determined	70.0	130
		EG020A-T: Lead	7439-92-1	1.3 mg/L	96.2	70.0	130
		EG020A-T: Manganese	7439-96-5	1.3 mg/L	94.4	70.0	130
		EG020A-T: Nickel	7440-02-0	1.3 mg/L	72.3	70.0	130
		EG020A-T: Vanadium	7440-62-2	1.3 mg/L	94.7	70.0	130
		EG020A-T: Zinc	7440-66-6	1.3 mg/L	102	70.0	130
EG035T: Total Mercury by FIMS (QCLot: 2718842)							
EP1911899-009	C03S03	EG035T-LL: Mercury	7439-97-6	0.0001 mg/L	113	70.0	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2704652)							
EP1911699-011	Anonymous	EG035T: Mercury	7439-97-6	0.01 mg/L	102	70.0	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 2704653)							
EP1911899-027	WB2	EG035T: Mercury	7439-97-6	0.01 mg/L	96.5	70.0	130
EG093T: Total Metals in Saline Water by ORC-ICPMS (QCLot: 2720861)							
EM1919085-001	Anonymous	EG093A-T: Arsenic	7440-38-2	50 µg/L	105	70.0	130
		EG093A-T: Cadmium	7440-43-9	12.5 µg/L	104	70.0	130
		EG093A-T: Chromium	7440-47-3	50 µg/L	103	70.0	130
		EG093A-T: Cobalt	7440-48-4	50 µg/L	102	70.0	130
		EG093A-T: Copper	7440-50-8	50 µg/L	95.1	70.0	130
		EG093A-T: Lead	7439-92-1	50 µg/L	94.8	70.0	130
		EG093A-T: Manganese	7439-96-5	50 µg/L	104	70.0	130
		EG093A-T: Nickel	7440-02-0	50 µg/L	96.4	70.0	130
		EG093A-T: Vanadium	7440-62-2	50 µg/L	106	70.0	130
		EG093A-T: Zinc	7440-66-6	50 µg/L	95.5	70.0	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2700453)							
EP1911894-001	Anonymous	EK055G: Ammonia as N	7664-41-7	1 mg/L	75.3	70.0	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2700456)							
EP1911885-001	Anonymous	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	103	70.0	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2700454)							
EP1911894-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	95.2	70.0	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2710684)							

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2710684) - continued							
EP1911883-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	86.4	70.0	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2710683)							
EP1911883-001	Anonymous	EK067G: Total Phosphorus as P	----	0.842 mg/L	80.9	70.0	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 2700459)							
EP1911885-001	Anonymous	EK071G: Reactive Phosphorus as P	14265-44-2	0.5 mg/L	100	70.0	130
EK255A: Ammonia (QCLot: 2720021)							
EP1911899-001	C01S01	EK255A-SW: Ammonia as N	7664-41-7	0.1 mg/L	# Not Determined	70.0	130
EK257A: Nitrite (QCLot: 2720020)							
EP1911899-001	C01S01	EK257A-SW: Nitrite as N	14797-65-0	0.1 mg/L	94.3	70.0	130
EK259A: Nitrite and Nitrate (NOx) (QCLot: 2720023)							
EP1911899-001	C01S01	EK259A-SW: Nitrite + Nitrate as N	----	0.1 mg/L	104	70.0	130
EK262A: Total Nitrogen (QCLot: 2719099)							
EP1911899-001	C01S01	EK262PA-SW: Total Nitrogen as N	----	0.5 mg/L	74.4	70.0	130
EK267A: Total Phosphorus (Persulfate Digestion) (QCLot: 2719098)							
EP1911899-001	C01S01	EK267PA-SW: Total Phosphorus as P	----	0.5 mg/L	74.6	70.0	130
EK271A: Reactive Phosphorus (QCLot: 2720022)							
EP1911899-001	C01S01	EK271A-SW: Reactive Phosphorus as P	14265-44-2	0.1 mg/L	94.6	70.0	130
EP068A: Organochlorine Pesticides (OC) (QCLot: 2705846)							
EP1911899-025	WR2	EP068: gamma-BHC	58-89-9	5 µg/L	95.1	70.0	130
		EP068: Heptachlor	76-44-8	5 µg/L	99.0	70.0	130
		EP068: Aldrin	309-00-2	5 µg/L	103	70.0	130
		EP068: Dieldrin	60-57-1	5 µg/L	77.8	70.0	130
		EP068: Endrin	72-20-8	20 µg/L	86.6	70.0	130
		EP068: 4.4`-DDT	50-29-3	20 µg/L	84.9	70.0	130
EP068B: Organophosphorus Pesticides (OP) (QCLot: 2705846)							
EP1911899-025	WR2	EP068: Diazinon	333-41-5	5 µg/L	107	70.0	130
		EP068: Chlorpyrifos-methyl	5598-13-0	5 µg/L	94.7	70.0	130
		EP068: Pirimphos-ethyl	23505-41-1	5 µg/L	90.3	70.0	130
		EP068: Bromophos-ethyl	4824-78-6	5 µg/L	91.4	70.0	130
		EP068: Prothiofos	34643-46-4	5 µg/L	74.0	70.0	130
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons (QCLot: 2705844)							
EP1911899-025	WR2	EP075(SIM): Acenaphthene	83-32-9	20 µg/L	75.3	70.0	130
		EP075(SIM): Pyrene	129-00-0	20 µg/L	89.7	70.0	130
EP080/071: Total Petroleum Hydrocarbons (QCLot: 2705845)							

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%) MS	Recovery Limits (%) Low	High
EP080/071: Total Petroleum Hydrocarbons (QCLot: 2705845) - continued							
EP1911899-025	WR2	EP071: C10 - C14 Fraction	----	200 µg/L	94.3	70.0	130
		EP071: C15 - C28 Fraction	----	250 µg/L	114	71.0	130
		EP071: C29 - C36 Fraction	----	200 µg/L	92.4	67.0	130
EP080/071: Total Petroleum Hydrocarbons (QCLot: 2708918)							
EP1911885-001	Anonymous	EP080: C6 - C9 Fraction	----	325 µg/L	123	70.0	130
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 2705845)							
EP1911899-025	WR2	EP071: >C10 - C16 Fraction	----	250 µg/L	89.8	70.0	130
		EP071: >C16 - C34 Fraction	----	350 µg/L	98.7	75.0	130
		EP071: >C34 - C40 Fraction	----	150 µg/L	82.7	67.0	130
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 2708918)							
EP1911885-001	Anonymous	EP080: C6 - C10 Fraction	C6_C10	375 µg/L	122	70.0	130
EP080: BTEXN (QCLot: 2708918)							
EP1911885-001	Anonymous	EP080: Benzene	71-43-2	25 µg/L	119	70.0	130
		EP080: Toluene	108-88-3	25 µg/L	102	70.0	130
		EP080: Ethylbenzene	100-41-4	25 µg/L	104	70.0	130
		EP080: meta- & para-Xylene	108-38-3 106-42-3	25 µg/L	103	70.0	130
		EP080: ortho-Xylene	95-47-6	25 µg/L	104	70.0	130
		EP080: Naphthalene	91-20-3	25 µg/L	101	70.0	130
EP203A: Explosives (QCLot: 2707326)							
EP1911899-024	WR1	EP203-SL: HMX	2691-41-0	200 µg/L	96.5	57.0	143
		EP203-SL: 2.4.6-TNT	118-96-7	200 µg/L	103	66.0	138
		EP203-SL: 4-Amino.2.6-DNT	19406-51-0	200 µg/L	95.1	63.0	131
		EP203-SL: 2.4-Dinitrotoluene	121-14-2	200 µg/L	92.6	69.0	133
		EP203-SL: Nitrobenzene	98-95-3	200 µg/L	79.7	57.0	127
		EP203-SL: PETN	78-11-5	200 µg/L	99.8	51.0	145

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EP1911899**	Page	: 1 of 29
Client	: **RPS Australia West Pty Ltd**	Laboratory	: Environmental Division Perth
Contact	: SHAE MILLER-WHITE	Telephone	: 08 9406 1306
Project	: EEC19032.011	Date Samples Received	: 13-Nov-2019
Site	: Rottnest Army Jetty	Issue Date	: 06-Dec-2019
Sampler	: ----	No. of samples received	: 30
Order number	: ----	No. of samples analysed	: 25

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **Surrogate recovery outliers exist for all regular sample matrices - please see following pages for full details.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
EG020T: Total Metals by ICP-MS	EP1911804--007	Anonymous	**Arsenic**	7440-38-2	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EG020T: Total Metals by ICP-MS	EP1911804--007	Anonymous	**Copper**	7440-50-8	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EK255A: Ammonia	EP1911899--001	C01S01	**Ammonia as N**	7664-41-7	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Regular Sample Surrogates

Sub-Matrix: **SEDIMENT**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Samples Submitted							
EP090S: Organotin Surrogate	EP1911899-016	C06S01	**Tripropyltin**	----	172 %	35.0-130 %	**Recovery greater than upper data quality objective**

Sub-Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Samples Submitted							
EP090S: Organotin Surrogate	EP1911899-024	WR1	**Tripropyltin**	----	133 %	24.0-116 %	**Recovery greater than upper data quality objective**
EP090S: Organotin Surrogate	EP1911899-027	WB2	**Tripropyltin**	----	126 %	24.0-116 %	**Recovery greater than upper data quality objective**

Outliers : Frequency of Quality Control Samples

Matrix: **SOIL**

Quality Control Sample Type	Count		Rate (%)		Quality Control Specification
Method	QC	Regular	Actual	Expected	
Matrix Spikes (MS)					
TPH - Speciation	0	7	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Quality Control Sample Type	Count		Rate (%)		Quality Control Specification
Method	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
Organotin Compounds (Soluble)	0	9	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	0	16	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
Organotin Compounds (Soluble)	0	9	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	0	16	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA029-A: pH Measurements								
Snap Lock Bag - frozen on receipt at ALS (EA029-TPA)								
C01S01,	C01S03,	**12-Nov-2019**	**25-Nov-2019**	11-Nov-2020	✓	**02-Dec-2019**	23-Feb-2020	✓
C02S01,	C03S01,							
C06S01,	C06S03,							
C07S01,	SZ1							
Snap Lock Bag - frozen on receipt at ALS (EA029-TPA)								
C04S01,	C05S01	**13-Nov-2019**	**25-Nov-2019**	12-Nov-2020	✓	**02-Dec-2019**	23-Feb-2020	✓
EA029-B: Acidity Trail								
Snap Lock Bag - frozen on receipt at ALS (EA029-TPA)								
C01S01,	C01S03,	**12-Nov-2019**	**25-Nov-2019**	11-Nov-2020	✓	**02-Dec-2019**	23-Feb-2020	✓
C02S01,	C03S01,							
C06S01,	C06S03,							
C07S01,	SZ1							
Snap Lock Bag - frozen on receipt at ALS (EA029-TPA)								
C04S01,	C05S01	**13-Nov-2019**	**25-Nov-2019**	12-Nov-2020	✓	**02-Dec-2019**	23-Feb-2020	✓
EA033-A: Actual Acidity								
Snap Lock Bag - frozen on receipt at ALS (EA033)								
C01S01,	C01S03,	**12-Nov-2019**	**25-Nov-2019**	11-Nov-2020	✓	**05-Dec-2019**	23-Feb-2020	✓
C02S01,	C03S01,							
C06S01,	C06S03,							
C07S01,	SZ1							
Snap Lock Bag - frozen on receipt at ALS (EA033)								
C04S01,	C05S01	**13-Nov-2019**	**25-Nov-2019**	12-Nov-2020	✓	**05-Dec-2019**	23-Feb-2020	✓
EA033-B: Potential Acidity								
Snap Lock Bag - frozen on receipt at ALS (EA033)								
C01S01,	C01S03,	**12-Nov-2019**	**25-Nov-2019**	11-Nov-2020	✓	**05-Dec-2019**	23-Feb-2020	✓
C02S01,	C03S01,							
C06S01,	C06S03,							
C07S01,	SZ1							
Snap Lock Bag - frozen on receipt at ALS (EA033)								
C04S01,	C05S01	**13-Nov-2019**	**25-Nov-2019**	12-Nov-2020	✓	**05-Dec-2019**	23-Feb-2020	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA033-C: Acid Neutralising Capacity								
Snap Lock Bag - frozen on receipt at ALS (EA033)								
C01S01, C02S01, C06S01, C07S01,	C01S03, C03S01, C06S03, SZ1	**12-Nov-2019**	**25-Nov-2019**	11-Nov-2020	✓	**05-Dec-2019**	23-Feb-2020	✓
Snap Lock Bag - frozen on receipt at ALS (EA033)								
C04S01,	C05S01	**13-Nov-2019**	**25-Nov-2019**	12-Nov-2020	✓	**05-Dec-2019**	23-Feb-2020	✓
EA033-D: Retained Acidity								
Snap Lock Bag - frozen on receipt at ALS (EA033)								
C01S01, C02S01, C06S01, C07S01,	C01S03, C03S01, C06S03, SZ1	**12-Nov-2019**	**25-Nov-2019**	11-Nov-2020	✓	**05-Dec-2019**	23-Feb-2020	✓
Snap Lock Bag - frozen on receipt at ALS (EA033)								
C04S01,	C05S01	**13-Nov-2019**	**25-Nov-2019**	12-Nov-2020	✓	**05-Dec-2019**	23-Feb-2020	✓
EA033-E: Acid Base Accounting								
Snap Lock Bag - frozen on receipt at ALS (EA033)								
C01S01, C02S01, C06S01, C07S01,	C01S03, C03S01, C06S03, SZ1	**12-Nov-2019**	**25-Nov-2019**	11-Nov-2020	✓	**05-Dec-2019**	23-Feb-2020	✓
Snap Lock Bag - frozen on receipt at ALS (EA033)								
C04S01,	C05S01	**13-Nov-2019**	**25-Nov-2019**	12-Nov-2020	✓	**05-Dec-2019**	23-Feb-2020	✓
EA055: Moisture Content (Dried @ 105-110°C)								
HDPE Soil Jar (EA055)								
SZ2		**12-Nov-2019**	**----**	----	----	**18-Nov-2019**	26-Nov-2019	✓
Soil Glass Jar - Unpreserved (EA055)								
C01S01, C02S01, C03S01, C06S01, C06S03, C07S02, SZ1	C01S03, C02S02, C03S03, C06S02, C07S01, C07S03,	**12-Nov-2019**	**----**	----	----	**18-Nov-2019**	26-Nov-2019	✓
Soil Glass Jar - Unpreserved (EA055)								
C04S01, C05S01, C05S03	C04S02, C05S02,	**13-Nov-2019**	**----**	----	----	**18-Nov-2019**	27-Nov-2019	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA150: Particle Sizing								
Snap Lock Bag - Friable Asbestos/PSD Bag (EA150H)								
C01S01, C03S01, C07S02	C02S01, C06S03,	12-Nov-2019	----	----	----	27-Nov-2019	10-May-2020	✓
Snap Lock Bag - Friable Asbestos/PSD Bag (EA150H)								
C04S01,	C05S02	13-Nov-2019	----	----	----	27-Nov-2019	11-May-2020	✓
EA150: Soil Classification based on Particle Size								
Snap Lock Bag - Friable Asbestos/PSD Bag (EA150H)								
C01S01, C03S01, C07S02	C02S01, C06S03,	12-Nov-2019	----	----	----	27-Nov-2019	10-May-2020	✓
Snap Lock Bag - Friable Asbestos/PSD Bag (EA150H)								
C04S01,	C05S02	13-Nov-2019	----	----	----	27-Nov-2019	11-May-2020	✓
EA152: Soil Particle Density								
Snap Lock Bag - Friable Asbestos/PSD Bag (EA152)								
C01S01, C03S01, C07S02	C02S01, C06S03,	12-Nov-2019	----	----	----	27-Nov-2019	10-May-2020	✓
Snap Lock Bag - Friable Asbestos/PSD Bag (EA152)								
C04S01,	C05S02	13-Nov-2019	----	----	----	27-Nov-2019	11-May-2020	✓
EA200: AS 4964 - 2004 Identification of Asbestos in Soils								
Snap Lock Bag - Friable Asbestos/PSD Bag (EA200)								
C01S01, C02S01, C06S01,	C01S03, C03S01, C07S01	12-Nov-2019	----	----	----	18-Nov-2019	10-May-2020	✓
Snap Lock Bag - Friable Asbestos/PSD Bag (EA200)								
C04S01,	C05S01	13-Nov-2019	----	----	----	18-Nov-2019	11-May-2020	✓
EA200N: Asbestos Quantification (non-NATA)								
Snap Lock Bag - Friable Asbestos/PSD Bag (EA200N)								
C01S01, C02S01, C06S01,	C01S03, C03S01, C07S01	12-Nov-2019	----	----	----	18-Nov-2019	10-May-2020	✓
Snap Lock Bag - Friable Asbestos/PSD Bag (EA200N)								
C04S01,	C05S01	13-Nov-2019	----	----	----	18-Nov-2019	11-May-2020	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG020-SD: Total Metals in Sediments by ICPMS							
Soil Glass Jar - Unpreserved (EG020-SD) C01S01, C01S03, C02S01, C02S02, C03S01, C03S03, C06S01, C06S02, C07S01, C07S03, SZ1	**12-Nov-2019**	**18-Nov-2019**	10-May-2020	✓	**19-Nov-2019**	10-May-2020	✓
Soil Glass Jar - Unpreserved (EG020-SD) C04S01, C04S02, C05S01, C05S03	**13-Nov-2019**	**18-Nov-2019**	11-May-2020	✓	**19-Nov-2019**	11-May-2020	✓
EG035T: Total Recoverable Mercury by FIMS							
Soil Glass Jar - Unpreserved (EG035T-LL) C01S01, C01S03, C02S01, C02S02, C03S01, C03S03, C06S01, C06S02, C07S01, C07S03, SZ1	**12-Nov-2019**	**18-Nov-2019**	10-Dec-2019	✓	**19-Nov-2019**	10-Dec-2019	✓
Soil Glass Jar - Unpreserved (EG035T-LL) C04S01, C04S02, C05S01, C05S03	**13-Nov-2019**	**18-Nov-2019**	11-Dec-2019	✓	**19-Nov-2019**	11-Dec-2019	✓
EK057G: Nitrite as N by Discrete Analyser							
Soil Glass Jar - Unpreserved (EK057G) C01S01, C01S03, C02S01, C03S01, C06S01, C07S01, SZ1	**12-Nov-2019**	**19-Nov-2019**	10-May-2020	✓	**19-Nov-2019**	10-May-2020	✓
Soil Glass Jar - Unpreserved (EK057G) C04S01, C05S01	**13-Nov-2019**	**19-Nov-2019**	11-May-2020	✓	**19-Nov-2019**	11-May-2020	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Soil Glass Jar - Unpreserved (EK059G) C01S01, C01S03, C02S01, C03S01, C06S01, C07S01, SZ1	**12-Nov-2019**	**19-Nov-2019**	10-May-2020	✓	**19-Nov-2019**	10-May-2020	✓
Soil Glass Jar - Unpreserved (EK059G) C04S01, C05S01	**13-Nov-2019**	**19-Nov-2019**	11-May-2020	✓	**19-Nov-2019**	11-May-2020	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Soil Glass Jar - Unpreserved (EK061G) C01S01, C01S03, C02S01, C03S01, C06S01, C07S01, SZ1	**12-Nov-2019**	**04-Dec-2019**	10-May-2020	✓	**06-Dec-2019**	10-May-2020	✓
Soil Glass Jar - Unpreserved (EK061G) C04S01, C05S01	**13-Nov-2019**	**04-Dec-2019**	11-May-2020	✓	**06-Dec-2019**	11-May-2020	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Soil Glass Jar - Unpreserved (EK067G) C01S01, C01S03, C02S01, C03S01, C06S01, C07S01, SZ1	**12-Nov-2019**	**04-Dec-2019**	10-May-2020	✓	**06-Dec-2019**	10-May-2020	✓
Soil Glass Jar - Unpreserved (EK067G) C04S01, C05S01	**13-Nov-2019**	**04-Dec-2019**	11-May-2020	✓	**06-Dec-2019**	11-May-2020	✓
EK071G: Reactive Phosphorus as P by discrete analyser							
Soil Glass Jar - Unpreserved (EK071G) C01S01, C01S03, C02S01, C03S01, C06S01, C07S01, SZ1	**12-Nov-2019**	**19-Nov-2019**	10-May-2020	✓	**19-Nov-2019**	10-May-2020	✓
Soil Glass Jar - Unpreserved (EK071G) C04S01, C05S01	**13-Nov-2019**	**19-Nov-2019**	11-May-2020	✓	**19-Nov-2019**	11-May-2020	✓
EK255A SD: Ammonia in Sediment							
Soil Glass Jar - Unpreserved (EK255A SD) C01S01, C01S03, C02S01, C03S01, C06S01, C07S01, SZ1	**12-Nov-2019**	**----**	----	----	**27-Nov-2019**	10-May-2020	✓
Soil Glass Jar - Unpreserved (EK255A SD) C04S01, C05S01	**13-Nov-2019**	**----**	----	----	**27-Nov-2019**	11-May-2020	✓
EN68: Seawater Elutriate Testing Procedure							
Non-Volatile Leach: 28 day HT(e.g. Hg, CrVI) (EN68a) C01S01, C02S01, C03S03, C06S02, C07S01	**12-Nov-2019**	**21-Nov-2019**	10-Dec-2019	✓	**----**	----	----
Non-Volatile Leach: 28 day HT(e.g. Hg, CrVI) (EN68a) C04S02, C05S03, EW	**13-Nov-2019**	**21-Nov-2019**	11-Dec-2019	✓	**----**	----	----

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP003: Total Organic Carbon (TOC) in Soil							
Soil Glass Jar - Unpreserved (EP003) C01S01, C01S03, C02S01, C03S01, C06S01, C07S01, SZ1	**12-Nov-2019**	**03-Dec-2019**	10-Dec-2019	✓	**03-Dec-2019**	10-Dec-2019	✓
Soil Glass Jar - Unpreserved (EP003) C04S01, C05S01	**13-Nov-2019**	**03-Dec-2019**	11-Dec-2019	✓	**03-Dec-2019**	11-Dec-2019	✓
EP070: Total Petroleum Hydrocarbons - Speciation							
Soil Glass Jar - Unpreserved (EP070) C01S01, C02S01, C03S01, C06S03, C07S02	**12-Nov-2019**	**18-Nov-2019**	26-Nov-2019	✓	**21-Nov-2019**	28-Dec-2019	✓
Soil Glass Jar - Unpreserved (EP070) C04S01, C05S02	**13-Nov-2019**	**18-Nov-2019**	27-Nov-2019	✓	**21-Nov-2019**	28-Dec-2019	✓
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions							
Soil Glass Jar - Unpreserved (EP071-SD) C01S01, C01S03, C02S01, C02S02, C03S01, C03S03, C06S01, C06S02, C07S01, C07S03, SZ1	**12-Nov-2019**	**18-Nov-2019**	26-Nov-2019	✓	**26-Nov-2019**	28-Dec-2019	✓
Soil Glass Jar - Unpreserved (EP071-SD) C04S01, C04S02, C05S01, C05S03	**13-Nov-2019**	**18-Nov-2019**	27-Nov-2019	✓	**26-Nov-2019**	28-Dec-2019	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons								
Soil Glass Jar - Unpreserved (EP071-SD)								
C01S01, C02S01, C03S01, C06S01, C07S01, SZ1	C01S03, C02S02, C03S03, C06S02, C07S03,	**12-Nov-2019**	**18-Nov-2019**	26-Nov-2019	✓	**26-Nov-2019**	28-Dec-2019	✓
Soil Glass Jar - Unpreserved (EP080-SD)								
C01S01, C02S01, C03S01, C06S01, C07S01, SZ1	C01S03, C02S02, C03S03, C06S02, C07S03,	**12-Nov-2019**	**26-Nov-2019**	26-Nov-2019	✓	**26-Nov-2019**	26-Nov-2019	✓
Soil Glass Jar - Unpreserved (EP071-SD)								
C04S01, C05S01,	C04S02, C05S03	**13-Nov-2019**	**18-Nov-2019**	27-Nov-2019	✓	**26-Nov-2019**	28-Dec-2019	✓
Soil Glass Jar - Unpreserved (EP080-SD)								
C04S01, C05S01,	C04S02, C05S03	**13-Nov-2019**	**26-Nov-2019**	27-Nov-2019	✓	**26-Nov-2019**	27-Nov-2019	✓
EP080-SD / EP071-SD: Total Recoverable Hydrocarbons								
Soil Glass Jar - Unpreserved (EP080-SD)								
C01S01, C02S01, C03S01, C06S01, C07S01, SZ1	C01S03, C02S02, C03S03, C06S02, C07S03,	**12-Nov-2019**	**26-Nov-2019**	26-Nov-2019	✓	**26-Nov-2019**	26-Nov-2019	✓
Soil Glass Jar - Unpreserved (EP080-SD)								
C04S01, C05S01,	C04S02, C05S03	**13-Nov-2019**	**26-Nov-2019**	27-Nov-2019	✓	**26-Nov-2019**	27-Nov-2019	✓
EP080-SD: BTEXN								
Soil Glass Jar - Unpreserved (EP080-SD)								
C01S01, C02S01, C03S01, C06S01, C07S01, SZ1	C01S03, C02S02, C03S03, C06S02, C07S03,	**12-Nov-2019**	**26-Nov-2019**	26-Nov-2019	✓	**26-Nov-2019**	26-Nov-2019	✓
Soil Glass Jar - Unpreserved (EP080-SD)								
C04S01, C05S01,	C04S02, C05S03	**13-Nov-2019**	**26-Nov-2019**	27-Nov-2019	✓	**26-Nov-2019**	27-Nov-2019	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP090: Organotin Compounds							
Soil Glass Jar - Unpreserved (EP090) C01S01, C01S03, C02S01, C03S01, C06S01, C07S01, SZ1	**12-Nov-2019**	**18-Nov-2019**	26-Nov-2019	✓	**19-Nov-2019**	28-Dec-2019	✓
Soil Glass Jar - Unpreserved (EP090) C04S01, C05S01	**13-Nov-2019**	**18-Nov-2019**	27-Nov-2019	✓	**19-Nov-2019**	28-Dec-2019	✓
EP130A: Organophosphorus Pesticides (Ultra-trace)							
Soil Glass Jar - Unpreserved (EP130) C01S01, C01S03, C02S01, C02S02, C03S01, C03S03, C06S01, C06S02, C07S01, C07S03, SZ1	**12-Nov-2019**	**18-Nov-2019**	26-Nov-2019	✓	**20-Nov-2019**	28-Dec-2019	✓
Soil Glass Jar - Unpreserved (EP130) C04S01, C04S02, C05S01, C05S03	**13-Nov-2019**	**18-Nov-2019**	27-Nov-2019	✓	**20-Nov-2019**	28-Dec-2019	✓
EP131A: Organochlorine Pesticides							
Soil Glass Jar - Unpreserved (EP131A) C01S01, C01S03, C02S01, C02S02, C03S01, C03S03, C06S01, C06S02, C07S01, C07S03, SZ1	**12-Nov-2019**	**18-Nov-2019**	26-Nov-2019	✓	**20-Nov-2019**	28-Dec-2019	✓
Soil Glass Jar - Unpreserved (EP131A) C04S01, C04S02, C05S01, C05S03	**13-Nov-2019**	**18-Nov-2019**	27-Nov-2019	✓	**20-Nov-2019**	28-Dec-2019	✓
EP132B: Polynuclear Aromatic Hydrocarbons							
Soil Glass Jar - Unpreserved (EP132B-SD) C01S01, C01S03, C02S01, C02S02, C03S01, C03S03, C06S01, C06S02, C07S01, C07S03, SZ1	**12-Nov-2019**	**18-Nov-2019**	26-Nov-2019	✓	**29-Nov-2019**	28-Dec-2019	✓
Soil Glass Jar - Unpreserved (EP132B-SD) C04S01, C04S02, C05S01, C05S03	**13-Nov-2019**	**18-Nov-2019**	27-Nov-2019	✓	**29-Nov-2019**	28-Dec-2019	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP203A: Explosives								
Soil Glass Jar - Unpreserved (EP203)								
C01S01, C02S01, C06S01, SZ1	C01S03, C03S01, C07S01,	**12-Nov-2019**	**19-Nov-2019**	26-Nov-2019	✓	**19-Nov-2019**	29-Dec-2019	✓
Soil Glass Jar - Unpreserved (EP203)								
C04S01,	C05S01	**13-Nov-2019**	**19-Nov-2019**	27-Nov-2019	✓	**19-Nov-2019**	29-Dec-2019	✓
EP231A: Perfluoroalkyl Sulfonic Acids								
HDPE Soil Jar (EP231X)								
C01S01, C02S01, C03S01, C06S01, C07S01, SZ1,	C01S03, C02S02, C03S03, C06S02, C07S03, SZ2	**12-Nov-2019**	**17-Nov-2019**	10-May-2020	✓	**20-Nov-2019**	27-Dec-2019	✓
HDPE Soil Jar (EP231X)								
C04S01, C05S01,	C04S02, C05S03	**13-Nov-2019**	**17-Nov-2019**	11-May-2020	✓	**20-Nov-2019**	27-Dec-2019	✓
EP231B: Perfluoroalkyl Carboxylic Acids								
HDPE Soil Jar (EP231X)								
C01S01, C02S01, C03S01, C06S01, C07S01, SZ1,	C01S03, C02S02, C03S03, C06S02, C07S03, SZ2	**12-Nov-2019**	**17-Nov-2019**	10-May-2020	✓	**20-Nov-2019**	27-Dec-2019	✓
HDPE Soil Jar (EP231X)								
C04S01, C05S01,	C04S02, C05S03	**13-Nov-2019**	**17-Nov-2019**	11-May-2020	✓	**20-Nov-2019**	27-Dec-2019	✓
EP231C: Perfluoroalkyl Sulfonamides								
HDPE Soil Jar (EP231X)								
C01S01, C02S01, C03S01, C06S01, C07S01, SZ1,	C01S03, C02S02, C03S03, C06S02, C07S03, SZ2	**12-Nov-2019**	**17-Nov-2019**	10-May-2020	✓	**20-Nov-2019**	27-Dec-2019	✓
HDPE Soil Jar (EP231X)								
C04S01, C05S01,	C04S02, C05S03	**13-Nov-2019**	**17-Nov-2019**	11-May-2020	✓	**20-Nov-2019**	27-Dec-2019	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP231D: (n:2) Fluorotelomer Sulfonic Acids								
HDPE Soil Jar (EP231X)								
C01S01,	C01S03,	**12-Nov-2019**	**17-Nov-2019**	10-May-2020	✓	**20-Nov-2019**	27-Dec-2019	✓
C02S01,	C02S02,							
C03S01,	C03S03,							
C06S01,	C06S02,							
C07S01,	C07S03,							
SZ1,	SZ2							
HDPE Soil Jar (EP231X)								
C04S01,	C04S02,	**13-Nov-2019**	**17-Nov-2019**	11-May-2020	✓	**20-Nov-2019**	27-Dec-2019	✓
C05S01,	C05S03							
EP231P: PFAS Sums								
HDPE Soil Jar (EP231X)								
C01S01,	C01S03,	**12-Nov-2019**	**17-Nov-2019**	10-May-2020	✓	**20-Nov-2019**	27-Dec-2019	✓
C02S01,	C02S02,							
C03S01,	C03S03,							
C06S01,	C06S02,							
C07S01,	C07S03,							
SZ1,	SZ2							
HDPE Soil Jar (EP231X)								
C04S01,	C04S02,	**13-Nov-2019**	**17-Nov-2019**	11-May-2020	✓	**20-Nov-2019**	27-Dec-2019	✓
C05S01,	C05S03							

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG020T: Total Metals by ICP-MS								
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG020B-T)								
WR1,	WB1	**12-Nov-2019**	**15-Nov-2019**	10-May-2020	✓	**15-Nov-2019**	10-May-2020	✓
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG020B-T)								
WR2,	WB2	**13-Nov-2019**	**15-Nov-2019**	11-May-2020	✓	**15-Nov-2019**	11-May-2020	✓
EG035T: Total Mercury by FIMS								
Clear HDPE (U-T ORC) - Unfiltered; Lab-acidified (EG035T-LL)								
C01S01,	C02S01,	**21-Nov-2019**	**----**	----	----	**26-Nov-2019**	19-Dec-2019	✓
C03S03,	C04S02,							
C05S03,	C06S02,							
C07S01,	EW							
EG035T: Total Recoverable Mercury by FIMS								
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG035T)								
WR1,	WB1	**12-Nov-2019**	**----**	----	----	**15-Nov-2019**	10-Dec-2019	✓
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG035T)								
WR2,	WB2	**13-Nov-2019**	**----**	----	----	**15-Nov-2019**	11-Dec-2019	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG093T: Total Metals in Saline Water by ORC-ICPMS							
Clear HDPE (U-T ORC) - Unfiltered; Lab-acidified (EG093A-T) C01S01, C02S01, C03S03, C04S02, C05S03, C06S02, C07S01, EW	**21-Nov-2019**	**23-Nov-2019**	19-May-2020	✓	**23-Nov-2019**	19-May-2020	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G) WR1, WB1	**12-Nov-2019**	**----**	----	----	**13-Nov-2019**	10-Dec-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G) WR2, WB2	**13-Nov-2019**	**----**	----	----	**13-Nov-2019**	11-Dec-2019	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G) WR1, WB1	**12-Nov-2019**	**----**	----	----	**13-Nov-2019**	14-Nov-2019	✓
Clear Plastic Bottle - Natural (EK057G) WR2, WB2	**13-Nov-2019**	**----**	----	----	**13-Nov-2019**	15-Nov-2019	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G) WR1, WB1	**12-Nov-2019**	**----**	----	----	**13-Nov-2019**	10-Dec-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G) WR2, WB2	**13-Nov-2019**	**----**	----	----	**13-Nov-2019**	11-Dec-2019	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G) WR1, WB1	**12-Nov-2019**	**20-Nov-2019**	10-Dec-2019	✓	**21-Nov-2019**	10-Dec-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G) WR2, WB2	**13-Nov-2019**	**20-Nov-2019**	11-Dec-2019	✓	**21-Nov-2019**	11-Dec-2019	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G) WR1, WB1	**12-Nov-2019**	**20-Nov-2019**	10-Dec-2019	✓	**21-Nov-2019**	10-Dec-2019	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G) WR2, WB2	**13-Nov-2019**	**20-Nov-2019**	11-Dec-2019	✓	**21-Nov-2019**	11-Dec-2019	✓
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G) WR1, WB1	**12-Nov-2019**	**----**	----	----	**13-Nov-2019**	14-Nov-2019	✓
Clear Plastic Bottle - Natural (EK071G) WR2, WB2	**13-Nov-2019**	**----**	----	----	**13-Nov-2019**	15-Nov-2019	✓
EK255A: Ammonia							
Clear Plastic - Filtered & Frozen (AS/ISO) - UT Nu (EK255A-SW) C01S01, C02S01, C03S03, C04S02, C05S03, C06S02, C07S01, EW	**21-Nov-2019**	**----**	----	----	**22-Nov-2019**	19-Dec-2019	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK257A: Nitrite							
Clear Plastic - Filtered & Frozen (AS/ISO) - UT Nu (EK257A-SW)							
C01S01, C02S01, C03S03, C04S02, C05S03, C06S02, C07S01, EW	**21-Nov-2019**	**----**	----	----	**22-Nov-2019**	25-Nov-2019	✓
EK259A: Nitrite and Nitrate (NOx)							
Clear Plastic - Filtered & Frozen (AS/ISO) - UT Nu (EK259A-SW)							
C01S01, C02S01, C03S03, C04S02, C05S03, C06S02, C07S01, EW	**21-Nov-2019**	**----**	----	----	**22-Nov-2019**	19-Dec-2019	✓
EK262A: Total Nitrogen							
Clear Plastic Bottle - Frozen (AS) (EK262PA-SW)							
C01S01, C02S01, C03S03, C04S02, C05S03, C06S02, C07S01, EW	**21-Nov-2019**	**22-Nov-2019**	19-Dec-2019	✓	**22-Nov-2019**	19-Dec-2019	✓
EK267A: Total Phosphorus (Persulfate Digestion)							
Clear Plastic Bottle - Frozen (AS) (EK267PA-SW)							
C01S01, C02S01, C03S03, C04S02, C05S03, C06S02, C07S01, EW	**21-Nov-2019**	**22-Nov-2019**	19-Dec-2019	✓	**22-Nov-2019**	19-Dec-2019	✓
EK271A: Reactive Phosphorus							
Clear Plastic - Filtered & Frozen (AS/ISO) - UT Nu (EK271A-SW)							
C01S01, C02S01, C03S03, C04S02, C05S03, C06S02, C07S01, EW	**21-Nov-2019**	**----**	----	----	**22-Nov-2019**	19-Dec-2019	✓
EP068A: Organochlorine Pesticides (OC)							
Amber Glass Bottle - Unpreserved (EP068)							
WR1, WB1	**12-Nov-2019**	**16-Nov-2019**	19-Nov-2019	✓	**19-Nov-2019**	26-Dec-2019	✓
Amber Glass Bottle - Unpreserved (EP068)							
WR2, WB2	**13-Nov-2019**	**16-Nov-2019**	20-Nov-2019	✓	**19-Nov-2019**	26-Dec-2019	✓
EP068B: Organophosphorus Pesticides (OP)							
Amber Glass Bottle - Unpreserved (EP068)							
WR1, WB1	**12-Nov-2019**	**16-Nov-2019**	19-Nov-2019	✓	**19-Nov-2019**	26-Dec-2019	✓
Amber Glass Bottle - Unpreserved (EP068)							
WR2, WB2	**13-Nov-2019**	**16-Nov-2019**	20-Nov-2019	✓	**19-Nov-2019**	26-Dec-2019	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Amber Glass Bottle - Unpreserved (EP075(SIM)) WR1,	WB1	**12-Nov-2019**	**16-Nov-2019**	19-Nov-2019	✓	**19-Nov-2019**	26-Dec-2019	✓
Amber Glass Bottle - Unpreserved (EP075(SIM)) WR2,	WB2	**13-Nov-2019**	**16-Nov-2019**	20-Nov-2019	✓	**19-Nov-2019**	26-Dec-2019	✓
EP080/071: Total Petroleum Hydrocarbons								
Amber Glass Bottle - Unpreserved (EP071) WR1,	WB1	**12-Nov-2019**	**16-Nov-2019**	19-Nov-2019	✓	**19-Nov-2019**	26-Dec-2019	✓
Amber Glass Bottle - Unpreserved (EP071) WR2,	WB2	**13-Nov-2019**	**16-Nov-2019**	20-Nov-2019	✓	**19-Nov-2019**	26-Dec-2019	✓
Amber VOC Vial - Sulfuric Acid (EP080) WR1, WTB1	WB1,	**12-Nov-2019**	**21-Nov-2019**	26-Nov-2019	✓	**21-Nov-2019**	26-Nov-2019	✓
Amber VOC Vial - Sulfuric Acid (EP080) WR2,	WB2	**13-Nov-2019**	**21-Nov-2019**	27-Nov-2019	✓	**21-Nov-2019**	27-Nov-2019	✓
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
Amber Glass Bottle - Unpreserved (EP071) WR1,	WB1	**12-Nov-2019**	**16-Nov-2019**	19-Nov-2019	✓	**19-Nov-2019**	26-Dec-2019	✓
Amber Glass Bottle - Unpreserved (EP071) WR2,	WB2	**13-Nov-2019**	**16-Nov-2019**	20-Nov-2019	✓	**19-Nov-2019**	26-Dec-2019	✓
Amber VOC Vial - Sulfuric Acid (EP080) WR1, WTB1	WB1,	**12-Nov-2019**	**21-Nov-2019**	26-Nov-2019	✓	**21-Nov-2019**	26-Nov-2019	✓
Amber VOC Vial - Sulfuric Acid (EP080) WR2,	WB2	**13-Nov-2019**	**21-Nov-2019**	27-Nov-2019	✓	**21-Nov-2019**	27-Nov-2019	✓
EP080: BTEXN								
Amber VOC Vial - Sulfuric Acid (EP080) WR1, WTB1	WB1,	**12-Nov-2019**	**21-Nov-2019**	26-Nov-2019	✓	**21-Nov-2019**	26-Nov-2019	✓
Amber VOC Vial - Sulfuric Acid (EP080) WR2,	WB2	**13-Nov-2019**	**21-Nov-2019**	27-Nov-2019	✓	**21-Nov-2019**	27-Nov-2019	✓
EP090: Organotin Compounds (Soluble)								
Amber Glass Bottle - Unpreserved (EP090S) WR1,	WB1	**12-Nov-2019**	**18-Nov-2019**	19-Nov-2019	✓	**19-Nov-2019**	28-Dec-2019	✓
Amber Glass Bottle - Unpreserved (EP090S) WR2,	WB2	**13-Nov-2019**	**18-Nov-2019**	20-Nov-2019	✓	**19-Nov-2019**	28-Dec-2019	✓
EP203A: Explosives								
Amber Glass Bottle - Unpreserved (EP203-SL) WR1,	WB1	**12-Nov-2019**	**----**	----	----	**18-Nov-2019**	19-Nov-2019	✓
Amber Glass Bottle - Unpreserved (EP203-SL) WR2,	WB2	**13-Nov-2019**	**----**	----	----	**18-Nov-2019**	20-Nov-2019	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP231A: Perfluoroalkyl Sulfonic Acids								
HDPE (no PTFE) (EP231X-SUT)								
WR1, WTB1	WB1,	**12-Nov-2019**	**19-Nov-2019**	10-May-2020	✓	**22-Nov-2019**	10-May-2020	✓
HDPE (no PTFE) (EP231X-SUT)								
WR2,	WB2	**13-Nov-2019**	**19-Nov-2019**	11-May-2020	✓	**22-Nov-2019**	11-May-2020	✓
HDPE (no PTFE) (EP231X-SUT)								
C01S01, C03S03, C05S03, C07S01,	C02S01, C04S02, C06S02, EW	**21-Nov-2019**	**30-Nov-2019**	19-May-2020	✓	**02-Dec-2019**	19-May-2020	✓
EP231B: Perfluoroalkyl Carboxylic Acids								
HDPE (no PTFE) (EP231X-SUT)								
WR1, WTB1	WB1,	**12-Nov-2019**	**19-Nov-2019**	10-May-2020	✓	**22-Nov-2019**	10-May-2020	✓
HDPE (no PTFE) (EP231X-SUT)								
WR2,	WB2	**13-Nov-2019**	**19-Nov-2019**	11-May-2020	✓	**22-Nov-2019**	11-May-2020	✓
HDPE (no PTFE) (EP231X-SUT)								
C01S01, C03S03, C05S03, C07S01,	C02S01, C04S02, C06S02, EW	**21-Nov-2019**	**30-Nov-2019**	19-May-2020	✓	**02-Dec-2019**	19-May-2020	✓
EP231C: Perfluoroalkyl Sulfonamides								
HDPE (no PTFE) (EP231X-SUT)								
WR1, WTB1	WB1,	**12-Nov-2019**	**19-Nov-2019**	10-May-2020	✓	**22-Nov-2019**	10-May-2020	✓
HDPE (no PTFE) (EP231X-SUT)								
WR2,	WB2	**13-Nov-2019**	**19-Nov-2019**	11-May-2020	✓	**22-Nov-2019**	11-May-2020	✓
HDPE (no PTFE) (EP231X-SUT)								
C01S01, C03S03, C05S03, C07S01,	C02S01, C04S02, C06S02, EW	**21-Nov-2019**	**30-Nov-2019**	19-May-2020	✓	**02-Dec-2019**	19-May-2020	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP231D: (n:2) Fluorotelomer Sulfonic Acids							
HDPE (no PTFE) (EP231X-SUT) WR1, WB1, WTB1	**12-Nov-2019**	**19-Nov-2019**	10-May-2020	✓	**22-Nov-2019**	10-May-2020	✓
HDPE (no PTFE) (EP231X-SUT) WR2, WB2	**13-Nov-2019**	**19-Nov-2019**	11-May-2020	✓	**22-Nov-2019**	11-May-2020	✓
HDPE (no PTFE) (EP231X-SUT) C01S01, C02S01, C03S03, C04S02, C05S03, C06S02, C07S01, EW	**21-Nov-2019**	**30-Nov-2019**	19-May-2020	✓	**02-Dec-2019**	19-May-2020	✓
EP231P: PFAS Sums							
HDPE (no PTFE) (EP231X-SUT) WR1, WB1, WTB1	**12-Nov-2019**	**19-Nov-2019**	10-May-2020	✓	**22-Nov-2019**	10-May-2020	✓
HDPE (no PTFE) (EP231X-SUT) WR2, WB2	**13-Nov-2019**	**19-Nov-2019**	11-May-2020	✓	**22-Nov-2019**	11-May-2020	✓
HDPE (no PTFE) (EP231X-SUT) C01S01, C02S01, C03S03, C04S02, C05S03, C06S02, C07S01, EW	**21-Nov-2019**	**30-Nov-2019**	19-May-2020	✓	**02-Dec-2019**	19-May-2020	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	Method	QC	Regular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
Ammonia in Sediments	EK255A SD	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Chromium Suite for Acid Sulphate Soils	EA033	1	10	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Explosives	EP203	2	17	11.76	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Moisture Content	EA055	4	34	11.76	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	1	9	11.11	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N - Soluble by Discrete Analyser	EK057G	1	9	11.11	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Organochlorine Pesticides (Ultra-trace)	EP131A	2	15	13.33	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Organophosphorus Pesticides (Ultra-trace)	EP130	2	15	13.33	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Organotin Analysis	EP090	1	9	11.11	10.00	✓	NEPM 2013 B3 & ALS QC Standard
PAHs in Sediments by GCMS(SIM)	EP132B-SD	2	15	13.33	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-Soluble By Discrete Analyser	EK071G	1	9	11.11	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029-TPA	1	10	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
TKN as N By Discrete Analyser	EK061G	2	13	15.38	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS (Low Level)	EG035T-LL	2	15	13.33	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Sediments by ICPMS	EG020-SD	2	15	13.33	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP003	2	18	11.11	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosporus By Discrete Analyser	EK067G	2	13	15.38	10.00	✓	NEPM 2013 B3 & ALS QC Standard
TPH - Semivolatile Fraction	EP071-SD	2	15	13.33	10.00	✓	NEPM 2013 B3 & ALS QC Standard
TPH - Speciation	EP070	1	7	14.29	10.00	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX in Sediments	EP080-SD	2	15	13.33	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Ammonia in Sediments	EK255A SD	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Chromium Suite for Acid Sulphate Soils	EA033	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Explosives	EP203	1	17	5.88	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	1	9	11.11	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N - Soluble by Discrete Analyser	EK057G	1	9	11.11	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Organochlorine Pesticides (Ultra-trace)	EP131A	1	15	6.67	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Organophosphorus Pesticides (Ultra-trace)	EP130	1	15	6.67	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Organotin Analysis	EP090	1	9	11.11	5.00	✓	NEPM 2013 B3 & ALS QC Standard
PAHs in Sediments by GCMS(SIM)	EP132B-SD	1	15	6.67	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-Soluble By Discrete Analyser	EK071G	1	9	11.11	5.00	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Control Samples (LCS) - Continued							
TKN as N By Discrete Analyser	EK061G	2	13	**15.38**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS (Low Level)	EG035T-LL	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Sediments by ICPMS	EG020-SD	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP003	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosporus By Discrete Analyser	EK067G	2	13	**15.38**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TPH - Semivolatile Fraction	EP071-SD	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TPH - Speciation	EP070	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX in Sediments	EP080-SD	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia in Sediments	EK255A SD	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chromium Suite for Acid Sulphate Soils	EA033	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Explosives	EP203	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N - Soluble by Discrete Analyser	EK057G	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Organochlorine Pesticides (Ultra-trace)	EP131A	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Organophosphorus Pesticides (Ultra-trace)	EP130	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Organotin Analysis	EP090	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAHs in Sediments by GCMS(SIM)	EP132B-SD	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-Soluble By Discrete Analyser	EK071G	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029-TPA	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TKN as N By Discrete Analyser	EK061G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS (Low Level)	EG035T-LL	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Sediments by ICPMS	EG020-SD	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP003	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosporus By Discrete Analyser	EK067G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TPH - Semivolatile Fraction	EP071-SD	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TPH - Speciation	EP070	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX in Sediments	EP080-SD	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia in Sediments	EK255A SD	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Explosives	EP203	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N - Soluble by Discrete Analyser	EK057G	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Organochlorine Pesticides (Ultra-trace)	EP131A	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Organophosphorus Pesticides (Ultra-trace)	EP130	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Organotin Analysis	EP090	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Matrix Spikes (MS) - Continued							
PAHs in Sediments by GCMS(SIM)	EP132B-SD	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-Soluble By Discrete Analyser	EK071G	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TKN as N By Discrete Analyser	EK061G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS (Low Level)	EG035T-LL	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Sediments by ICPMS	EG020-SD	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosporus By Discrete Analyser	EK067G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TPH - Semivolatile Fraction	EP071-SD	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TPH - Speciation	EP070	0	7	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX in Sediments	EP080-SD	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Ammonia as N - Ultra-Trace in Saline Waters	EK255A-SW	1	8	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	6	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Explosives (Standard Level)	EP203-SL	2	10	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N - Ultra-Trace in Saline Waters	EK259A-SW	1	8	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	6	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N - Ultra-Trace in Saline Waters	EK257A-SW	1	8	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	11	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Organotin Compounds (Soluble)	EP090S	0	9	**0.00**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	4	**25.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X-SUT	0	16	**0.00**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	1	4	**25.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P - Ultra-Trace in Saline Water	EK271A-SW	1	8	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	10	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	3	22	**13.64**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS - Low Level	EG035T-LL	1	8	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	4	**25.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Saline Water Suite A by ORC-ICPMS	EG093A-T	2	21	**9.52**	**9.52**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Saline Water -Suite B by ORC-ICPMS	EG093B-T	1	8	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Nitrogen/Persulfate Digestion/Ultra-Trace/Saline	EK262PA-SW	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus/Persulfate Digestion/ Ultra Trace /Saline	EK267PA-SW	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	8	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Control Samples (LCS)							
Ammonia as N - Ultra-Trace in Saline Waters	EK255A-SW	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	6	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Explosives (Standard Level)	EP203-SL	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N - Ultra-Trace in Saline Waters	EK259A-SW	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	6	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N - Ultra-Trace in Saline Waters	EK257A-SW	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Organotin Compounds (Soluble)	EP090S	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X-SUT	2	16	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P - Ultra-Trace in Saline Water	EK271A-SW	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	22	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS - Low Level	EG035T-LL	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Saline Water Suite A by ORC-ICPMS	EG093A-T	1	21	**4.76**	**4.76**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Saline Water -Suite B by ORC-ICPMS	EG093B-T	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Nitrogen/Persulfate Digestion/Ultra-Trace/Saline	EK262PA-SW	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus/Persulfate Digestion/ Ultra Trace /Saline	EK267PA-SW	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N - Ultra-Trace in Saline Waters	EK255A-SW	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	6	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Explosives (Standard Level)	EP203-SL	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N - Ultra-Trace in Saline Waters	EK259A-SW	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	6	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N - Ultra-Trace in Saline Waters	EK257A-SW	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Organotin Compounds (Soluble)	EP090S	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X-SUT	2	16	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P - Ultra-Trace in Saline Water	EK271A-SW	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Total Mercury by FIMS	EG035T	2	22	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS - Low Level	EG035T-LL	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Saline Water Suite A by ORC-ICPMS	EG093A-T	1	21	**4.76**	**4.76**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Saline Water -Suite B by ORC-ICPMS	EG093B-T	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Nitrogen/Persulfate Digestion/Ultra-Trace/Saline	EK262PA-SW	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus/Persulfate Digestion/ Ultra Trace /Saline	EK267PA-SW	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N - Ultra-Trace in Saline Waters	EK255A-SW	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	6	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Explosives (Standard Level)	EP203-SL	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N - Ultra-Trace in Saline Waters	EK259A-SW	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	6	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N - Ultra-Trace in Saline Waters	EK257A-SW	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Organotin Compounds (Soluble)	EP090S	0	9	**0.00**	**5.00**	✗	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X-SUT	0	16	**0.00**	**5.00**	✗	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P - Ultra-Trace in Saline Water	EK271A-SW	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	22	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS - Low Level	EG035T-LL	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Saline Water Suite A by ORC-ICPMS	EG093A-T	1	21	**4.76**	**4.76**	✓	NEPM 2013 B3 & ALS QC Standard
Total Nitrogen/Persulfate Digestion/Ultra-Trace/Saline	EK262PA-SW	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus/Persulfate Digestion/ Ultra Trace /Saline	EK267PA-SW	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029-TPA	SOIL	In house: Referenced to Ahern et al 2004 - a suspension peroxide oxidation method following the 'sulfur trail' by determining the level of 1M KCL extractable sulfur and the sulfur level after oxidation of soil sulphides. The 'acidity trail' is followed by measurement of TAA, TPA and TSA. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.
Chromium Suite for Acid Sulphate Soils	EA033	SOIL	In house: Referenced to Ahern et al 2004. This method covers the determination of Chromium Reducible Sulfur (SCR); pHKCl; titratable actual acidity (TAA); acid neutralising capacity by back titration (ANC); and net acid soluble sulfur (SNAS) which incorporates peroxide sulfur. It applies to soils and sediments (including sands) derived from coastal regions. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.
Moisture Content	EA055	SOIL	In house: A gravimetric procedure based on weight loss over a 12 hour drying period at 105-110 degrees C. This method is compliant with NEPM (2013) Schedule B(3) Section 6.1 and Table 1 (14 day holding time).
Particle Size Analysis by Hydrometer	EA150H	SOIL	Particle Size Analysis by Hydrometer according to AS1289.3.6.3 - 2003
Soil Particle Density	EA152	SOIL	Soil Particle Density by AS 1289.3.5.1-2006 : Methods of testing soils for engineering purposes - Soil classification tests - Determination of the soil particle density of a soil - Standard method
Asbestos Identification in Soils	EA200	SOIL	AS 4964 - 2004 Method for the qualitative identification of asbestos in bulk samples Analysis by Polarised Light Microscopy including dispersion staining
Asbestos Classification and Quantitation per NEPM 2013	* EA200N	SOIL	Asbestos Classification and Quantitation per NEPM 2013 with Confirmation of Identification by AS 4964 - 2004 Gravimetric determination of Asbestos Containing Material, Fibrous Asbestos, Asbestos Fines and sample weight and calculation of percentage concentrations per NEPM protocols. Asbestos (Fines and Fibrous FA+AF) is reported as the equivalent weight in the sample received after accounting for sub-sampling (where applicable for the <7mm and/or <2mm fractions).
Total Metals in Sediments by ICPMS	EG020-SD	SOIL	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector. Analyte list and LORs per NODG.
Total Mercury by FIMS (Low Level)	EG035T-LL	SOIL	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion. Ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Total Metals in Saline Water Suite A by ORC-ICPMS	EG093A-T	SOIL	In house: Referenced to APHA 3125; USEPA SW846 - 6020. The ORC-ICPMS technique removes interfering species through a series of chemical reactions prior to ion detection. Ions are passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to measurement by a discrete dynode ion detector. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Total Metals in Saline Water -Suite B by ORC-ICPMS	EG093B-T	SOIL	In house: Referenced to APHA 3125; USEPA SW846 - 6020. The ORC-ICPMS technique removes interfering species through a series of chemical reactions prior to ion detection. Ions are passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to measurement by a discrete dynode ion detector. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N - Soluble by Discrete Analyser	EK057G	SOIL	In house: Referenced to APHA 4500-NO3- B. Nitrite in a water extract is determined by direct colourimetry by Discrete Analyser.
Nitrate as N - Soluble by Discrete Analyser	EK058G	SOIL	In house: Referenced to APHA 4500-NO3- F. Nitrate in the 1:5 soil:water extract is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results.
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	SOIL	In house: Thermo Scientific Method D08727 and NEMI (National Environmental Method Index) Method ID: 9171. This method covers the determination of total oxidised nitrogen (NOx-N) and nitrate (NO3-N) by calculation, Combined oxidised Nitrogen (NO2+NO3) in a water extract is determined by direct colourimetry by Discrete Analyser.
TKN as N By Discrete Analyser	EK061G	SOIL	In house: Referenced to APHA 4500-Norg-D Soil samples are digested using Kjeldahl digestion followed by determination by Discrete Analyser.
Total Nitrogen as N (TKN + NOx) By Discrete Analyser	EK062G	SOIL	In house: Referenced to APHA 4500 Norg/NO3- Total Nitrogen is determined as the sum of TKN and Oxidised Nitrrogen, each determined seperately as N.
Total Phosporus By Discrete Analyser	EK067G	SOIL	In house: Referenced to APHA 4500 P-B&F This procedure involves sulfuric acid digestion and quantification using Discrete Analyser.
Reactive Phosphorus as P-Soluble By Discrete Analyser	EK071G	SOIL	In house: Referenced to APHA 4500 P-F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3) (
Ammonia in Sediments	EK255A SD	SOIL	In house: Referenced to Rayment and Higginson (1992) Method 7C1 and 7C2. This method measures exchangeable ammonium which is defined by the amount of ammonium released by shaking sediment with an un-buffered 2M potassium chloride solution.
Ammonia as N - Ultra-Trace in Saline Waters	EK255A-SW	SOIL	In house: Referenced to APHA 4500-NH3 H. Ammonia is determined by direct colorimetry by FIA. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N - Ultra-Trace in Saline Waters	EK257A-SW	SOIL	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by FIA.
Nitrate as N - Ultra-Trace in Saline Waters	EK258A-SW	SOIL	In house: Referenced to APHA 4500-NO3- I. Nitrate is reduced to nitrite by way of a cadmium reduction column followed by quantification by FIA. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results.
Nitrite and Nitrate as N - Ultra-Trace in Saline Waters	EK259A-SW	SOIL	In house: Referenced to APHA 4500-NO3- I. Combined oxidised Nitrogen (NO2+NO3) is determined by Cadmium Reduction and direct colourimetry by FIA.
TKN (Total N - NOx-N). (FIA - UT) in Saline Waters	EK261PA-SW	SOIL	In house: Referenced to APHA 4500-P J. & 4500-NO3- I. Calculated by difference from total Nitrogen and NOx. Contributing method parameters are determined by FIA. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Total Nitrogen/Persulfate Digestion/Ultra-Trace/Saline	EK262PA-SW	SOIL	In house: Referenced to APHA 4500-P J. Persulfate Method for Simultaneous Determination of Total Nitrogen and Total Phosphorus. As sample is digested with persulfate under alkaline conditions yielding orthophosphate and nitrate. Following digestion, analytes are determined by flow injection analysis. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus/Persulfate Digestion/ Ultra Trace /Saline	EK267PA-SW	SOIL	In house: Referenced to APHA 4500-P J. Persulfate Method for Simultaneous Determination of Total Nitrogen and Total Phosphorus. As sample is digested with persulfate under alkaline conditions yielding orthophosphate and nitrate. Following digestion, analytes are determined by flow injection analysis. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P - Ultra-Trace in Saline Water	EK271A-SW	SOIL	In house: Referenced to APHA 4500-P E Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by FIA. This method is compliant with NEPM (2013) Schedule B(3)
Total Organic Carbon	EP003	SOIL	In house C-IR17. Dried and pulverised sample is reacted with acid to remove inorganic Carbonates, then combusted in a furnace in the presence of strong oxidants / catalysts. The evolved (Organic) Carbon (as CO2) is automatically measured by infra-red detector.
TPH - Speciation	EP070	SOIL	In house: Referenced to USEPA SW 846 - 8015A Sample extracts are analysed by Capillary GC/FID and quantified against alkane standards over the range C10 - C36. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3) (Method 506.1)
TPH - Semivolatile Fraction	EP071-SD	SOIL	In house: Referenced to USEPA SW 846 - 8270D. Extracts are analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3) (Method 504)
TRH Volatiles/BTEX in Sediments	EP080-SD	SOIL	In house: Referenced to USEPA SW 846 - 8260B Extracts are analysed by Purge and Trap, Capillary GC/MS. Quantification is by comparison against an established 5 point calibration curve.
Organotin Analysis	EP090	SOIL	In house: Referenced to USEPA SW 846 - 8270D Prepared sample extracts are analysed by GC/MS coupled with high volume injection, and quanitified against an established calibration curve.
Organophosphorus Pesticides (Ultra-trace)	EP130	SOIL	In house: Referenced to USEPA Method 3640 (GPC cleanup), 8141 (GC/FPD - Capillary Column) This technique is compliant with NEPM (2013) Schedule B(3).
Organochlorine Pesticides (Ultra-trace)	EP131A	SOIL	In house: Referenced to USEPA Method 3640 (GPC cleanup),3620 (Florisil), 8081/8082 (GC/µECD/µECD) This technique is compliant with NEPM (2013) Schedule B(3)
PAHs in Sediments by GCMS(SIM)	EP132B-SD	SOIL	In house: Referenced to USEPA 8270D GCMS Capillary column, SIM mode using large volume programmed temperature vaporisation injection.
Explosives	EP203	SOIL	In house: Referenced to USEPA 8330 UV-DAD, LCMS (APCI in negative mode). Residues of explosives are extracted from air-dried soil samples with acetonitrile. An aliquot of the organic phase is taken and diluted with water for LC/MS determination.
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X	SOIL	In-house: Analysis of soils by solvent extraction followed by LC-Electrospray-MS-MS, Negative Mode using MRM using internal standard quantitation. Isotopically labelled analogues of target analytes used as internal standards and surrogates are added to a portion of soil which is then extracted with MTBE and an ion pairing reagent. A portion of extract is exchanged into the analytical solvent mixture, combined with an equal volume reagent water and filtered for analysis. Method procedures and data quality objectives conform to US DoD QSM 5.3, table B-15 requirements.

Analytical Methods	Method	Matrix	Method Descriptions
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X-SUT	SOIL	In-house: Analysis of fresh and saline waters by Solid Phase Extraction (SPE) followed by LC-Electrospray-MS-MS, Negative Mode using MRM and internal standard quantitation. Isotopically labelled analogues of target analytes used as internal standards and surrogates are added to the sample container. The entire contents are transferred to a solid phase extraction (SPE) cartridge. The sample container is successively rinsed with aliquots of the elution solvent. The eluted extract is concentrated, combined with an equal volume of reagent water and filtered for analysis. Method procedures and data quality objectives conform to US DoD QSM 5.3, table B-15 requirements.
Total Metals by ICP-MS - Suite A	EG020A-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite B	EG020B-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Mercury by FIMS	EG035T	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Pesticides by GCMS	EP068	WATER	In house: Referenced to USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
TRH - Semivolatile Fraction	EP071	WATER	In house: Referenced to USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	WATER	In house: Referenced to USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS in SIM Mode and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
TRH Volatiles/BTEX	EP080	WATER	In house: Referenced to USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. Alternatively, a sample is equilibrated in a headspace vial and a portion of the headspace determined by GCMS analysis. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
Organotin Compounds (Soluble)	EP090S	WATER	In house: Referenced to USEPA SW 846 - 8270D Sample extracts are analysed by GC/MS coupled with high volume injection and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Explosives (Standard Level)	EP203-SL	WATER	In house: Referenced to USEPA 8330, Modified In-House, UV-DAD, LCMS (APCI in negative mode). Samples are diluted with acetonitrile and subjected to LC/MS for quantification.
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X-SUT	WATER	In-house: Analysis of fresh and saline waters by Solid Phase Extraction (SPE) followed by LC-Electrospray-MS-MS, Negative Mode using MRM and internal standard quantitation. Isotopically labelled analogues of target analytes used as internal standards and surrogates are added to the sample container. The entire contents are transferred to a solid phase extraction (SPE) cartridge. The sample container is successively rinsed with aliquots of the elution solvent. The eluted extract is concentrated, combined with an equal volume of reagent water and filtered for analysis. Method procedures and data quality objectives conform to US DoD QSM 5.3, table B-15 requirements.

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	SOIL	In house: Referenced to APHA 4500 Norg- D; APHA 4500 P - H. Macro Kjeldahl digestion.
Persulfate Digestion for UT Dissolved TN and TP for FIA fin	EK262/267PA-SW Prep	SOIL	In house: Referenced to APHA 4500 P - J. This method is compliant with NEPM (2013) Schedule B(3)
Drying at 85 degrees, bagging and labelling (ASS)	EN020PR	SOIL	In house
Digestion for Total Recoverable Metals - ORC	EN25-ORC	SOIL	In house: Referenced to USEPA SW846-3005. This is an Ultrapure Nitric acid digestion procedure used to prepare surface and ground water samples for analysis by ORC- ICPMS. This method is compliant with NEPM (2013) Schedule B(3)
1:5 solid / water leach for soluble analytes	EN34	SOIL	10 g of soil is mixed with 50 mL of reagent grade water and tumbled end over end for 1 hour. Water soluble salts are leached from the soil by the continuous suspension. Samples are settled and the water filtered off for analysis.

Preparation Methods	Method	Matrix	Method Descriptions
Seawater Elutriate Testing Procedure	EN68a	SOIL	USEPA Evaluation of Dredged Material Proposed for Ocean Disposal - Testing Guide, 1991, EPA-503/8-91/001, USEPA and US Army Corps of Engineers. ANZECC Interim Ocean Disposal Guidelines, December, 1998 This Procedure outlines the preparation of leachate designed to simulate release of contaminants from sediment during the disposal of dredged material. Release can occur by physical processes or a variety of chemical changes such as oxidation of metal sulphides and release of contaminants adsorbed to particles or organic matter.
Hot Block Digest for metals in soils sediments and sludges	EN69	SOIL	In house: Referenced to USEPA 200.2. Hot Block Acid Digestion 1.0g of sample is heated with Nitric and Hydrochloric acids, then cooled. Peroxide is added and samples heated and cooled again before being filtered and bulked to volume for analysis. Digest is appropriate for determination of selected metals in sludge, sediments, and soils. This method is compliant with NEPM (2013) Schedule B(3) (Method 202)
Tumbler Extraction for Explosives.	EP203-PR	SOIL	In house: Referenced to USEPA8330. Sample extractions are performed using end over end tumbling in place of sonic bath extraction.
Dry and Pulverise (up to 100g)	GEO30	SOIL	#
Methanolic Extraction of Soils for Purge and Trap	ORG16	SOIL	In house: Referenced to USEPA SW 846 - 5030A. 5g of solid is shaken with surrogate and 10mL methanol prior to analysis by Purge and Trap - GC/MS.
Tumbler Extraction of Solids/ Sample Cleanup	ORG17A-UTP	SOIL	In house: Mechanical agitation (tumbler). 20g of sample, Na2SO4 and surrogate are extracted with 150mL 1:1 DCM/Acetone by end over end tumble. Samples are extracted, concentrated (by KD) and exchanged into an appropriate solvent for GPC and florisil cleanup as required.
Tumbler Extraction of Solids for LVI (Non-concentrating)	ORG17D	SOIL	In house: 10g of sample, Na2SO4 and surrogate are extracted with 50mL 1:1 DCM/Acetone by end over end tumbling. An aliquot is concentrated by nitrogen blowdown to a reduced volume for analysis if required.
Tumbler Extraction of Solids (Option B - Non-concentrating)	ORG17-SP	SOIL	In house: Mechanical agitation (tumbler). 10g of sample, Na2SO4 and surrogate are extracted with 20mL 1:1 DCM/Acetone by end over end tumble. The solvent is transferred directly to a GC vial for analysis.
Organotin Sample Preparation	ORG35	SOIL	In house: 20g sample is spiked with surrogate and leached in a methanol:acetic acid:UHP water mix and vacuum filtered. Reagents and solvents are added to the sample and the mixture tumbled. The butyltin compounds are simultaneously derivatised and extracted. The extract is further extracted with petroleum ether. The resultant extracts are combined and concentrated for analysis.
SPE preparation for PFAS	ORG72	SOIL	In house
Sample Extraction for PFAS	ORG73	SOIL	In house
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)
Digestion for Total Recoverable Metals	EN25	WATER	In house: Referenced to USEPA SW846-3005. Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (2013) Schedule B(3)
Separatory Funnel Extraction of Liquids	ORG14	WATER	In house: Referenced to USEPA SW 846 - 3510B 100 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (2013) Schedule B(3) . ALS default excludes sediment which may be resident in the container.
Volatiles Water Preparation	ORG16-W	WATER	A 5 mL aliquot or 5 mL of a diluted sample is added to a 40 mL VOC vial for sparging.

Preparation Methods	Method	Matrix	Method Descriptions
Organotin Sample Preparation	ORG34	WATER	In house. A specified volume of sample is spiked with surrogate, acidified and vacuum filtered. Reagents and solvent are added and the mixture tumbled. The butyltin compounds is derivitisated, extracted and the subtitution reaction completed. The extract is transferred to a separatory funnel and further extracted two times with petroleum ether. The resultant extracts are combined and concentrated for analysis.
SPE preparation for PFAS	ORG72	WATER	In house

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **EP1911899**

Client	: **RPS Australia West Pty Ltd**	Laboratory	: Environmental Division Perth
Contact	: SHAE MILLER-WHITE	Contact	: Rhiannon Steere
Address	: PO BOX 170 WEST PERTH WA 6872	Address	: 26 Rigali Way Wangara WA Australia 6065
E-mail	: miller-whites@rpsgroup.com.au	E-mail	: rhiannon.steere@alsglobal.com
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Project	: EEC19032.011	Page	: 1 of 6
Order number	: ----	Quote number	: EP2019AQUTER0003 (EP/705/19)
C-O-C number	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	: Rottnest Army Jetty		
Sampler	:		

Dates

Date Samples Received	: 13-Nov-2019 14:45	Issue Date	: 13-Nov-2019
Client Requested Due Date	: 06-Dec-2019	Scheduled Reporting Date	: **06-Dec-2019**

Delivery Details

Mode of Delivery	: Client Drop Off	Security Seal	: Not Available
No. of coolers/boxes	: 8	Temperature	: 27.8 - Ice present
Receipt Detail	:	No. of samples received / analysed	: 30 / 26

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- TOC and TBT conducted by ALS Brisbane, NATA Site No. 818.
- Asbestos conducted by ALS Melbourne, NATA accreditation no. 825, site no 13778
- PSD conducted by ALS Newcastle, NATA accreditation no. 825, site no 1656.
- Elutriate, UT Organics and UT nutrients conducted by ALS Sydney, NATA accreditation no. 825, site no 10911.
- Please see scanned COC for sample discrepencies: extra samples , samples not received etc.
- Please direct any queries related to sample condition / numbering / breakages to Sample Receipt (Samples.Perth@alsglobal.com)
- Analytical work for this work order will be conducted at ALS Environmental Perth.
- **PSD analysis will be conducted by ALS Environmental, Newcastle, NATA accreditation no. 825, Site No. 1656.**
- Please direct any turnaround / technical queries to the laboratory contact designated above.
- Sample Disposal - Aqueous (3 weeks), Solid (2 months) from receipt of samples.
- **TOC and TBT analysis will be conducted by ALS Environmental, Brisbane, NATA accreditation no. 825, Site No. 818.**
- **Asbestos analysis will be conducted by ALS Environmental, Melbourne, NATA accreditation No. 825, Site No. 13778.**
- **Elutriate, UT Organics and UT nutrients analysis will be conducted by ALS Environmental, Sydney, NATA accreditation no. 825, Site No. 10911.**
- **pH analysis should be conducted within 6 hours of sampling.**
- Please be aware that APHA/NEPM recommends water and soil samples be chilled to less than or equal to 6°C for chemical analysis, and less than or equal to 10°C but unfrozen for Microbiological analysis. Where samples are received above this temperature, it should be taken into consideration when interpreting results. Refer to ALS EnviroMail 85 for ALS recommendations of the best practice for chilling samples after sampling and for maintaining a cool temperature during transit.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exists.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component

Matrix: **SOIL**

Laboratory sample ID	Client sampling date / time	Client sample ID	SOIL - EP070 (solids) TRH Speciation - Aliphatic & Aromatic	SOIL - EP090 (solids) Organotins	SOIL - EP203 (solids) Explosives	SOIL - NT-11S Total N + Total P	SOIL - NT-3S Minor Anions (NO2, NO3, Reactive P)	SOIL - TPH-SD Low Level TRH/BTEXN for Sediments	SOIL - UTO-1S Ultratrace OP / OC Pesticides
EP1911899-001	12-Nov-2019 00:00	C01S01	✓	✓	✓	✓	✓	✓	✓
EP1911899-003	12-Nov-2019 00:00	C01S03		✓	✓	✓	✓	✓	✓
EP1911899-004	12-Nov-2019 00:00	C02S01	✓	✓	✓	✓	✓	✓	✓
EP1911899-005	12-Nov-2019 00:00	C02S02						✓	✓
EP1911899-007	12-Nov-2019 00:00	C03S01	✓	✓	✓	✓	✓	✓	✓
EP1911899-009	12-Nov-2019 00:00	C03S03						✓	✓
EP1911899-010	13-Nov-2019 00:00	C04S01	✓	✓	✓	✓	✓	✓	✓
EP1911899-011	13-Nov-2019 00:00	C04S02						✓	✓
EP1911899-013	13-Nov-2019 00:00	C05S01		✓	✓	✓	✓	✓	✓
EP1911899-014	13-Nov-2019 00:00	C05S02	✓						
EP1911899-015	13-Nov-2019 00:00	C05S03						✓	✓
EP1911899-016	12-Nov-2019 00:00	C06S01		✓	✓	✓	✓	✓	✓
EP1911899-017	12-Nov-2019 00:00	C06S02						✓	✓
EP1911899-018	12-Nov-2019 00:00	C06S03	✓						
EP1911899-019	12-Nov-2019 00:00	C07S01		✓	✓	✓	✓	✓	✓
EP1911899-020	12-Nov-2019 00:00	C07S02	✓						
EP1911899-021	12-Nov-2019 00:00	C07S03						✓	✓
EP1911899-022	12-Nov-2019 00:00	SZ1		✓	✓	✓	✓	✓	✓

Matrix: **SOIL**

Laboratory sample ID	Client sampling date / time	Client sample ID	SOIL - EA029b TPA TPA	SOIL - EA033-WA WA - Chromium Suite for Acid Sulphate Soils	SOIL - EA055-103 Moisture Content	SOIL - EA200F Asbestos Quantitation (FA+AF) in Soil by	SOIL - EG020-SD Total Metals in Sediments by ICPMS (NODG)	SOIL - EG035-SD Mercury in Sediments by FIMS (NODG-required	SOIL - EP132B-SD Ultra-trace PAHs in Sediments
EP1911899-001	12-Nov-2019 00:00	C01S01	✓	✓	✓	✓	✓	✓	✓
EP1911899-003	12-Nov-2019 00:00	C01S03	✓	✓	✓	✓	✓	✓	✓
EP1911899-004	12-Nov-2019 00:00	C02S01	✓	✓	✓	✓	✓	✓	✓
EP1911899-005	12-Nov-2019 00:00	C02S02			✓		✓	✓	✓
EP1911899-007	12-Nov-2019 00:00	C03S01	✓	✓	✓	✓	✓	✓	✓
EP1911899-009	12-Nov-2019 00:00	C03S03			✓		✓	✓	✓

			SOIL - EA029b TPA TPA	SOIL - EA033-WA WA - Chromium Suite for Acid Sulphate Soils	SOIL - EA055-103 Moisture Content	SOIL - EA200F Asbestos Quantitation (FA+AF) in Soil by	SOIL - EG020-SD Total Metals in Sediments by ICPMS (NODG)	SOIL - EG035-SD Mercury in Sediments by FIMS (NODG-required	SOIL - EP132B-SD Ultra-trace PAHs in Sediments
EP1911899-010	13-Nov-2019 00:00	C04S01	✓	✓	✓	✓	✓	✓	✓
EP1911899-011	13-Nov-2019 00:00	C04S02			✓		✓	✓	✓
EP1911899-013	13-Nov-2019 00:00	C05S01	✓	✓	✓	✓	✓	✓	✓
EP1911899-014	13-Nov-2019 00:00	C05S02			✓				
EP1911899-015	13-Nov-2019 00:00	C05S03			✓		✓	✓	✓
EP1911899-016	12-Nov-2019 00:00	C06S01	✓	✓	✓	✓	✓	✓	✓
EP1911899-017	12-Nov-2019 00:00	C06S02			✓		✓	✓	✓
EP1911899-018	12-Nov-2019 00:00	C06S03	✓	✓	✓				
EP1911899-019	12-Nov-2019 00:00	C07S01	✓	✓	✓	✓	✓	✓	✓
EP1911899-020	12-Nov-2019 00:00	C07S02			✓				
EP1911899-021	12-Nov-2019 00:00	C07S03			✓		✓	✓	✓
EP1911899-022	12-Nov-2019 00:00	SZ1	✓	✓	✓		✓	✓	✓
EP1911899-023	12-Nov-2019 00:00	SZ2			✓				

Matrix: **SOIL**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	SOIL - EA150H/EA152 Particle Sizing with Hydrometer + Soil Particle	SOIL - EG035T-LL Total Mercury - Low Level	SOIL - EK255A SD Ammonia in Sediment by FIA	SOIL - EN68-2/3 Preparation of Elutriates for 2-3 analysis	SOIL - EP003 Total Organic Carbon (TOC) in Soil	SOIL - EP231X (solids) PFAS - Full Suite (28 analytes)	SOIL - UTN-4 SW Ultratrace NO2, NO3, NH3, Nitrogen,
EP1911899-001	12-Nov-2019 00:00	C01S01	✓	✓	✓	✓	✓	✓	✓
EP1911899-003	12-Nov-2019 00:00	C01S03			✓		✓	✓	
EP1911899-004	12-Nov-2019 00:00	C02S01	✓	✓	✓	✓	✓	✓	✓
EP1911899-005	12-Nov-2019 00:00	C02S02						✓	
EP1911899-007	12-Nov-2019 00:00	C03S01	✓		✓		✓	✓	
EP1911899-009	12-Nov-2019 00:00	C03S03		✓		✓		✓	✓
EP1911899-010	13-Nov-2019 00:00	C04S01	✓		✓		✓	✓	
EP1911899-011	13-Nov-2019 00:00	C04S02		✓		✓		✓	✓
EP1911899-013	13-Nov-2019 00:00	C05S01			✓		✓	✓	
EP1911899-014	13-Nov-2019 00:00	C05S02	✓						
EP1911899-015	13-Nov-2019 00:00	C05S03		✓		✓		✓	✓
EP1911899-016	12-Nov-2019 00:00	C06S01			✓		✓	✓	
EP1911899-017	12-Nov-2019 00:00	C06S02		✓		✓		✓	✓
EP1911899-018	12-Nov-2019 00:00	C06S03	✓						
EP1911899-019	12-Nov-2019 00:00	C07S01		✓	✓	✓	✓	✓	✓
EP1911899-020	12-Nov-2019 00:00	C07S02	✓						
EP1911899-021	12-Nov-2019 00:00	C07S03						✓	

			SOIL - EA150H/EA152 Particle Sizing with Hydrometer + Soil Particle	SOIL - EG035T-LL Total Mercury - Low Level	SOIL - EK255A SD Ammonia in Sediment by FIA	SOIL - EN68-2/3 Preparation of Elutriates for 2-3 analysis	SOIL - EP003 Total Organic Carbon (TOC) in Soil	SOIL - EP231X (solids) PFAS - Full Suite (28 analytes)	SOIL - UTN-4 SW Ultratrace NO2, NO3, NH3, Nitrogen,
EP1911899-022	12-Nov-2019 00:00	SZ1			✓		✓	✓	
EP1911899-023	12-Nov-2019 00:00	SZ2						✓	
EP1911899-030	13-Nov-2019 00:00	EW		✓		✓			✓

Matrix: **SOIL**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	(On Hold) SOIL No analysis requested	SOIL - EG093-T Total Metals by ORC - Ultra Trace in Saline	SOIL - EP231X-SUT PFAS - Super Ultra Trace Waters Long Suite (28
EP1911899-001	12-Nov-2019 00:00	C01S01		✓	✓
EP1911899-002	12-Nov-2019 00:00	C01S02	✓		
EP1911899-004	12-Nov-2019 00:00	C02S01		✓	✓
EP1911899-006	12-Nov-2019 00:00	C02S03	✓		
EP1911899-008	12-Nov-2019 00:00	C03S02	✓		
EP1911899-009	12-Nov-2019 00:00	C03S03		✓	✓
EP1911899-011	13-Nov-2019 00:00	C04S02		✓	✓
EP1911899-012	13-Nov-2019 00:00	C04S03	✓		
EP1911899-015	13-Nov-2019 00:00	C05S03		✓	✓
EP1911899-017	12-Nov-2019 00:00	C06S02		✓	✓
EP1911899-019	12-Nov-2019 00:00	C07S01		✓	✓
EP1911899-030	13-Nov-2019 00:00	EW		✓	✓

Matrix: **WATER**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	WATER - EG035T Total Mercury	WATER - EP203SL Explosives - Standard Level	WATER - W-07 TRH/BTEXN/PAH	WATER - W-12 OC/OP Pesticides
EP1911899-024	12-Nov-2019 00:00	WR1	✓	✓	✓	✓
EP1911899-025	13-Nov-2019 00:00	WR2	✓	✓	✓	✓
EP1911899-026	12-Nov-2019 00:00	WB1	✓	✓	✓	✓
EP1911899-027	13-Nov-2019 00:00	WB2	✓	✓	✓	✓
EP1911899-029	13-Nov-2019 00:00	ES-01	✓	✓	✓	✓

Matrix: **WATER**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	WATER - EG020F Dissolved Metals by ICP/MS	WATER - EG020T Total Metals by ICP/MS (including digestion)	WATER - EG035F Dissolved Mercury	WATER - EP090S Organotins (TBT) Brisbane	WATER - EP231X-SUT PFAS - Super Ultra Trace Waters Long Suite (28	WATER - NT-08A Total Nitrogen + NO2 + NO3 + NH3 + Total P +	WATER - W-18 TRH(C6 - C9)/BTEXN
EP1911899-024	12-Nov-2019 00:00	WR1		✓		✓	✓	✓	
EP1911899-025	13-Nov-2019 00:00	WR2		✓		✓	✓	✓	
EP1911899-026	12-Nov-2019 00:00	WB1		✓		✓	✓	✓	
EP1911899-027	13-Nov-2019 00:00	WB2		✓		✓	✓	✓	
EP1911899-028	12-Nov-2019 00:00	WTB1					✓		✓
EP1911899-029	13-Nov-2019 00:00	ES-01	✓		✓	✓	✓	✓	

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

ACCOUNTS PAYABLE

- A4 - AU Tax Invoice (INV)	Email	West.AccountsPayable@rpsgroup.com.au

ALAN FOLEY

- *AU Certificate of Analysis - NATA (COA)	Email	Alan.Foley@rpsgroup.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	Alan.Foley@rpsgroup.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	Alan.Foley@rpsgroup.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	Alan.Foley@rpsgroup.com.au
- Attachment - Report (SUBCO)	Email	Alan.Foley@rpsgroup.com.au
- Chain of Custody (CoC) (COC)	Email	Alan.Foley@rpsgroup.com.au
- EDI Format - ENMRG (ENMRG)	Email	Alan.Foley@rpsgroup.com.au
- EDI Format - ESDAT (ESDAT)	Email	Alan.Foley@rpsgroup.com.au
- EDI Format - XTab (XTAB)	Email	Alan.Foley@rpsgroup.com.au

SHAE MILLER-WHITE

- *AU Certificate of Analysis - NATA (COA)	Email	miller-whites@rpsgroup.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	miller-whites@rpsgroup.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	miller-whites@rpsgroup.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	miller-whites@rpsgroup.com.au
- Attachment - Report (SUBCO)	Email	miller-whites@rpsgroup.com.au
- Chain of Custody (CoC) (COC)	Email	miller-whites@rpsgroup.com.au
- EDI Format - ENMRG (ENMRG)	Email	miller-whites@rpsgroup.com.au
- EDI Format - ESDAT (ESDAT)	Email	miller-whites@rpsgroup.com.au
- EDI Format - XTab (XTAB)	Email	miller-whites@rpsgroup.com.au

CHAIN OF CUSTODY

Asbestos quantation.

rps MAKING COMPLEX EASY

Site:	Rottnest Army Jetty
Project reference:	EEC19032.011
Scientist(s)	SMW
Sample type(s):	Sediment and Water
Report to:	Alan Foley / Shae Miller-White
Invoice to:	west.accountspayable@rpsgroup.com

Level 2, 27-31 Troode Street
West Perth WA 6005
Tel: (618) 9211 1111
Fax: (618) 9211 1122

Page number: 1 of 2.

Turnaround time: Standard

Quote number: EP/705/19

Analytical suites

Sample I.D.		Date collected	Number of jars / bottles / bags	Sediment Suite (1)	Sediment Suite (2)	Sediment Suite (3)	ASLP Suite (1)	Elutriate Suite (1)	Water Suite (1)	PFAS - Full Suite (28 Compounds)	Storage	CES Suite + TRA	Remarks
C01S01	1	12.11.19	Refer to quote	X	X	X		X					
C01S02	2		Refer to quote										
C01S03	3		Refer to quote	X	X								
C02S01	4		Refer to quote	X	X	X		X					
C02S02	5		Refer to quote	X									
C02S03	6		Refer to quote										
C03S01	7		Refer to quote	X	X	X							
C03S02	8		Refer to quote										
C03S03	9		Refer to quote	X				X					
C04S01	10	13.11.19	Refer to quote	X	X	X							
C04S02	11	"	Refer to quote	X				X					
C04S03	12	"	Refer to quote										
C05S01	13	"	Refer to quote	X	X								
C05S02	14	"	Refer to quote			X							
C05S03	15	"	Refer to quote	X				X					
C06S01	16	12.11.19	Refer to quote	X	X								
C06S02	17		Refer to quote	X				X					
C06S03	18		Refer to quote			X						X	
C07S01	19		Refer to quote	X	X			X					
C07S02	20		Refer to quote			X							
C07S03	21		Refer to quote	X									
Total number of bottles/bags/jars													

Environmental Division
Perth
Work Order Reference
EP1911899

Telephone : + 61-8-9406 1301

Primary destination:	ALS	Received by:	NO	Secondary destination:	Received by:
Relinquished by:	Shae Miller-White	Organisation:	ALS	Relinquished by:	Organisation:
Organisation:	RPS	Date:	13.11.19	Organisation:	Date:
Date:	13.11.19	Time:	14:25	Date:	Time:
Time:				Time:	

P.T.O.

CHAIN OF CUSTODY

Level 2, 27-31 Troode Street
West Perth WA 6005
Tel: (618) 9211 1111
Fax: (618) 9211 1122

Site:	Rottnest Army Jetty
Project reference:	EEC19032.011
Scientist(s)	SMW
Sample type(s):	Sediment and Water
Report to:	Alan Foley / Shae Miller-White
Invoice to:	west.accountspayable@rpsgroup.com

Page number:	2 of 2.
Turnaround time:	Standard
Quote number:	EP/705/19

Analytical suites

Sample I.D.		Date collected	Number of jars / bottles / bags	Sediment Suite (1)	Sediment Suite (2) (No Asbestos.)	Sediment Suite (3)	ASLP Suite (1)	Elutriate Suite (1)	Water Suite (1)	PFAS - Full Suite (28 Compounds) (As per quote.)	Storage		BTEX													Remarks
SAZ1	22	12.11.19		X	X																					
SAZ2	23	↓								X																
WR1	24	↓							X																	
WR2	25	13.11.19							X																	
WB1	26	12.11.19							X																	
WB2	27	13.11.19							X																	
WTB1	28	12.11.19								X			X													
ES-01	29	13.11.19.						X																		* Please lab filter dissolved metals bottle *
EW	30																									
	(SP)																									

Total number of bottles/bags/jars

Primary destination:	ALS	Received by:	ND	Secondary destination:	Received by:
Relinquished by:	Shae Miller-White	Organisation:	ALS	Relinquished by:	Organisation:
Organisation:	RPS	Date:	13.11.19	Organisation:	Date:
Date:		Time:		Date:	Time:
Time:				Time:	

Certificate of Analysis

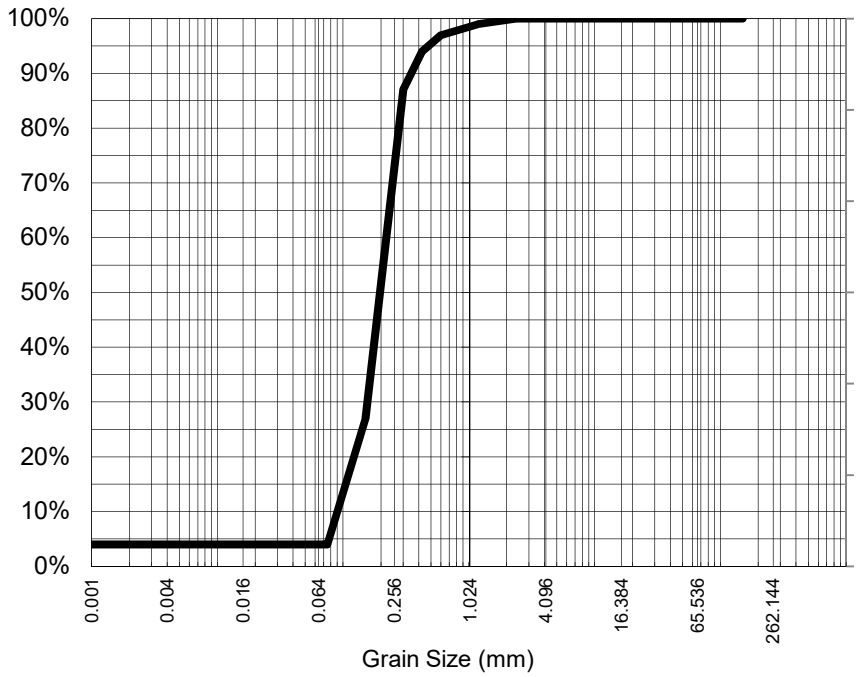
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	SHAE MILLER-WHITE	**DATE REPORTED:**	27-Nov-2019
COMPANY:	RPS Australia West Pty Ltd	**DATE RECEIVED:**	13-Nov-2019
ADDRESS:	PO Box 170 West Perth WA	**REPORT NO:**	EP1911899-001 / PSD
PROJECT:	EEC19032.011	**SAMPLE ID:**	C01S01

Particle Size Distribution



Particle Size (mm)	% Passing
2.36	100%
1.18	99%
0.600	97%
0.425	94%
0.300	87%
0.150	27%
0.075	4%
Particle Size (microns)	
55	4%
39	4%
28	4%
20	4%
14	4%
10	4%
7	4%
5	4%
1	4%

Median Particle Size (mm)*	0.208

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Analysis Notes

Samples analysed as received.

Sample Comments:	AS1289.3.6.3 states that hydrometer analysis is not applicable for samples containing <10% fines (<75um). Results should be assessed accordingly	**Analysed:**	22-Nov-19
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	SAND,VEG	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3		
Soil Particle Density (<2.36mm)	2.7		

NATA Accreditation: 825 Site: Newcastle
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NATA
WORLD RECOGNISED ACCREDITATION

Dianne Blane
Laboratory Coordinator
Authorised Signatory

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pH 02 4014 2500
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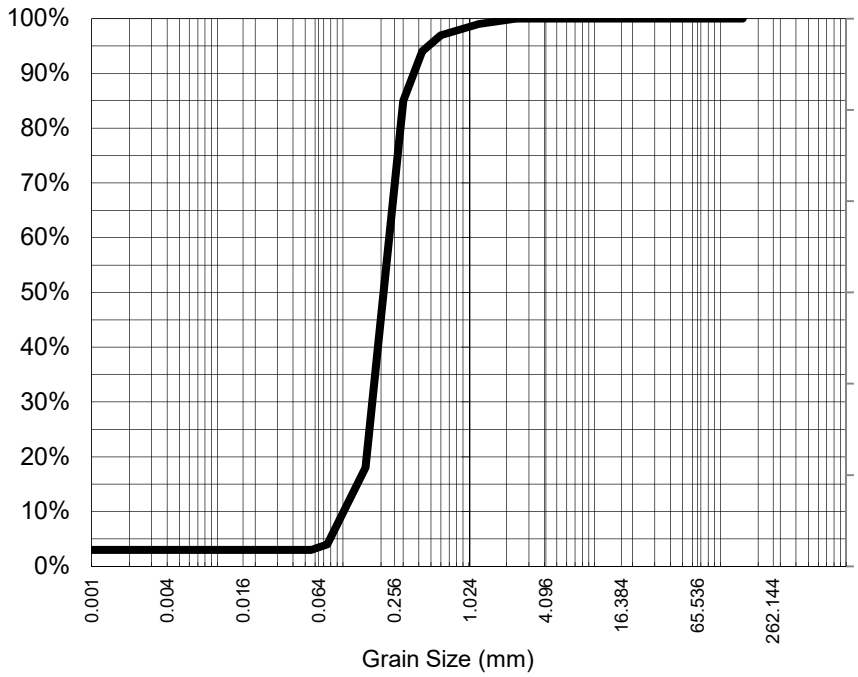
ALS Environmental

Newcastle, NSW

CLIENT:	SHAE MILLER-WHITE	**DATE REPORTED:**	27-Nov-2019
COMPANY:	RPS Australia West Pty Ltd	**DATE RECEIVED:**	13-Nov-2019
ADDRESS:	PO Box 170 West Perth WA	**REPORT NO:**	EP1911899-004 / PSD
PROJECT:	EEC19032.011	**SAMPLE ID:**	C02S01

Particle Size Distribution



Particle Size (mm)	% Passing
2.36	100%
1.18	99%
0.600	97%
0.425	94%
0.300	85%
0.150	18%
0.075	4%
Particle Size (microns)	
56	3%
40	3%
28	3%
20	3%
14	3%
10	3%
7	3%
5	3%
1	3%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	0.222

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:	AS1289.3.6.3 states that hydrometer analysis is not applicable for samples containing <10% fines (<75um). Results should be assessed accordingly	**Analysed:**	22-Nov-19
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	SAND,VEG	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3		
Soil Particle Density (<2.36mm)	2.68		

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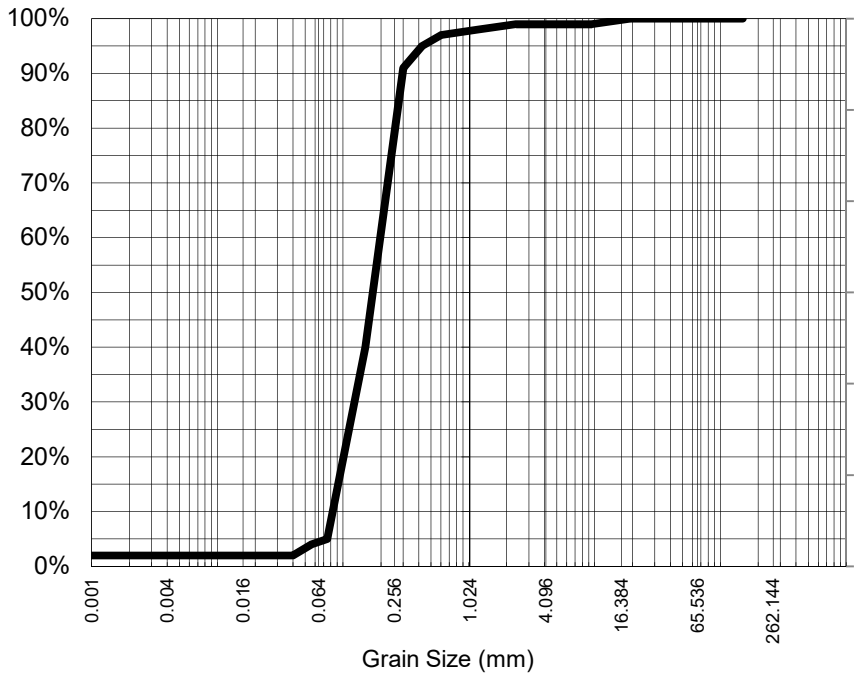
ALS Environmental

Newcastle, NSW

CLIENT:	SHAE MILLER-WHITE	**DATE REPORTED:**	27-Nov-2019
COMPANY:	RPS Australia West Pty Ltd	**DATE RECEIVED:**	13-Nov-2019
ADDRESS:	PO Box 170 West Perth WA	**REPORT NO:**	EP1911899-007 / PSD
PROJECT:	EEC19032.011	**SAMPLE ID:**	C03S01

Particle Size Distribution



Particle Size (mm)	% Passing
19.0	100%
9.50	99%
4.75	99%
2.36	99%
1.18	98%
0.600	97%
0.425	95%
0.300	91%
0.150	40%
0.075	5%
Particle Size (microns)	
56	4%
40	2%
28	2%
20	2%
14	2%
10	2%
7	2%
5	2%
1	2%

Median Particle Size (mm)*	0.179

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Analysis Notes

Samples analysed as received.

Sample Comments:	AS1289.3.6.3 states that hydrometer analysis is not applicable for samples containing <10% fines (<75um). Results should be assessed accordingly	**Analysed:**	22-Nov-19
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	SAND,VEG	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3		
Soil Particle Density (<2.36mm)	2.69		

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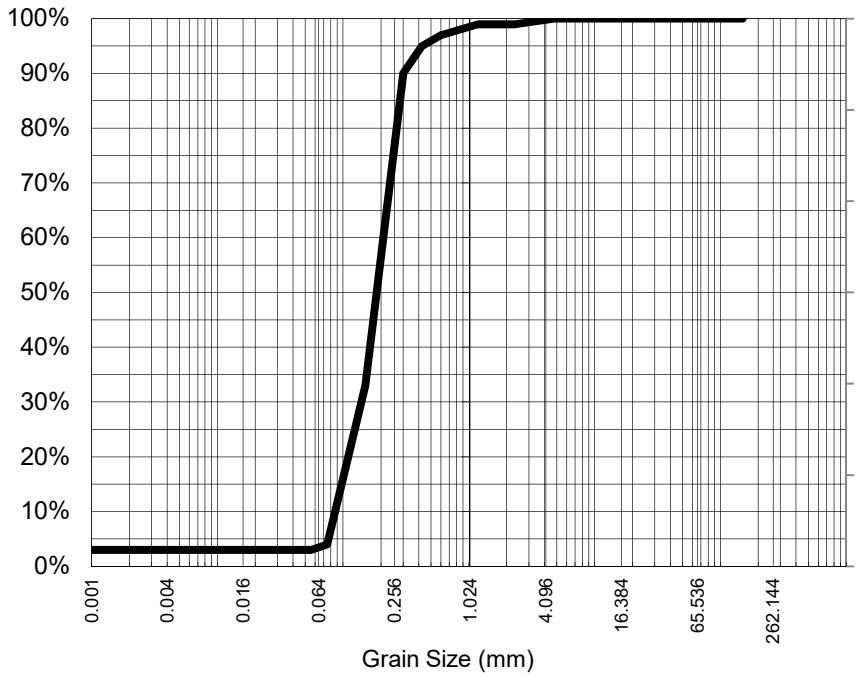
ALS Environmental

Newcastle, NSW

CLIENT:	SHAE MILLER-WHITE	**DATE REPORTED:**	27-Nov-2019
COMPANY:	RPS Australia West Pty Ltd	**DATE RECEIVED:**	13-Nov-2019
ADDRESS:	PO Box 170 West Perth WA	**REPORT NO:**	EP1911899-010 / PSD
PROJECT:	EEC19032.011	**SAMPLE ID:**	C04S01

Particle Size Distribution



Particle Size (mm)	% Passing
4.75	100%
2.36	99%
1.18	99%
0.600	97%
0.425	95%
0.300	90%
0.150	33%
0.075	4%
Particle Size (microns)	
56	3%
40	3%
28	3%
20	3%
14	3%
10	3%
7	3%
5	3%
1	3%

Median Particle Size (mm)*	0.195

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Analysis Notes

Samples analysed as received.

Sample Comments:	AS1289.3.6.3 states that hydrometer analysis is not applicable for samples containing <10% fines (<75um). Results should be assessed accordingly	**Analysed:**	22-Nov-19
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	SAND,VEG	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3		
Soil Particle Density (<2.36mm)	2.68		

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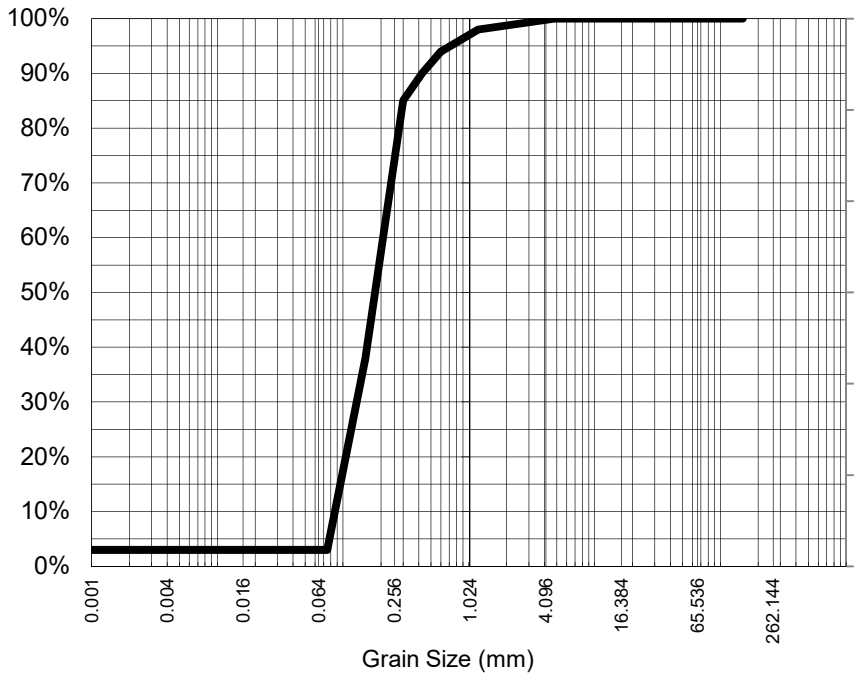
ALS Environmental

Newcastle, NSW

CLIENT:	SHAE MILLER-WHITE	**DATE REPORTED:**	27-Nov-2019
COMPANY:	RPS Australia West Pty Ltd	**DATE RECEIVED:**	13-Nov-2019
ADDRESS:	PO Box 170 West Perth WA	**REPORT NO:**	EP1911899-014 / PSD
PROJECT:	EEC19032.011	**SAMPLE ID:**	C05S02

Particle Size Distribution



Particle Size (mm)	% Passing
4.75	100%
2.36	99%
1.18	98%
0.600	94%
0.425	90%
0.300	85%
0.150	38%
0.075	3%
Particle Size (microns)	
56	3%
40	3%
28	3%
20	3%
14	3%
10	3%
7	3%
5	3%
1	3%

Median Particle Size (mm)*	0.188

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Analysis Notes

Samples analysed as received.

Sample Comments:	AS1289.3.6.3 states that hydrometer analysis is not applicable for samples containing <10% fines (<75um). Results should be assessed accordingly	**Analysed:**	22-Nov-19
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	SAND,VEG	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3		
Soil Particle Density (<2.36mm)	2.67		

NATA Accreditation: 825 Site: Newcastle
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

NATA
WORLD RECOGNISED ACCREDITATION

Dianne Blane
Laboratory Coordinator
Authorised Signatory

Certificate of Analysis

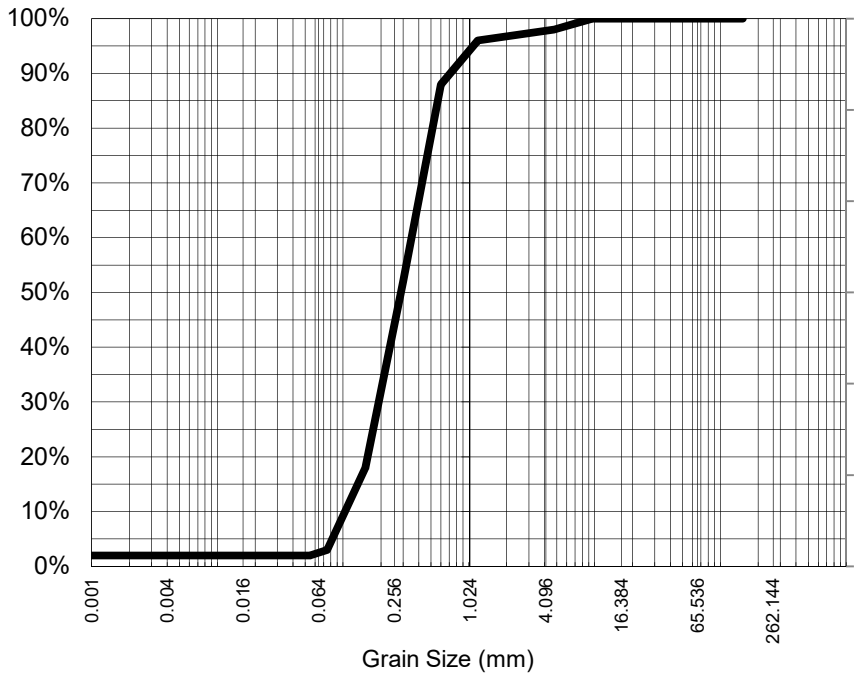
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	SHAE MILLER-WHITE	**DATE REPORTED:**	27-Nov-2019
COMPANY:	RPS Australia West Pty Ltd	**DATE RECEIVED:**	13-Nov-2019
ADDRESS:	PO Box 170 West Perth WA	**REPORT NO:**	EP1911899-018 / PSD
PROJECT:	EEC19032.011	**SAMPLE ID:**	C06S03

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	98%
2.36	97%
1.18	96%
0.600	88%
0.425	70%
0.300	52%
0.150	18%
0.075	3%
Particle Size (microns)	
55	2%
39	2%
28	2%
20	2%
14	2%
10	2%
7	2%
5	2%
1	2%

Median Particle Size (mm)*	0.291

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Analysis Notes

Samples analysed as received.

Sample Comments:	AS1289.3.6.3 states that hydrometer analysis is not applicable for samples containing <10% fines (<75um). Results should be assessed accordingly	**Analysed:**	22-Nov-19
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	SAND,VEG	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3		
Soil Particle Density (<2.36mm)	2.7		

NATA Accreditation: 825 Site: Newcastle
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NATA
WORLD RECOGNISED ACCREDITATION

Dianne Blane
Laboratory Coordinator
Authorised Signatory

Certificate of Analysis

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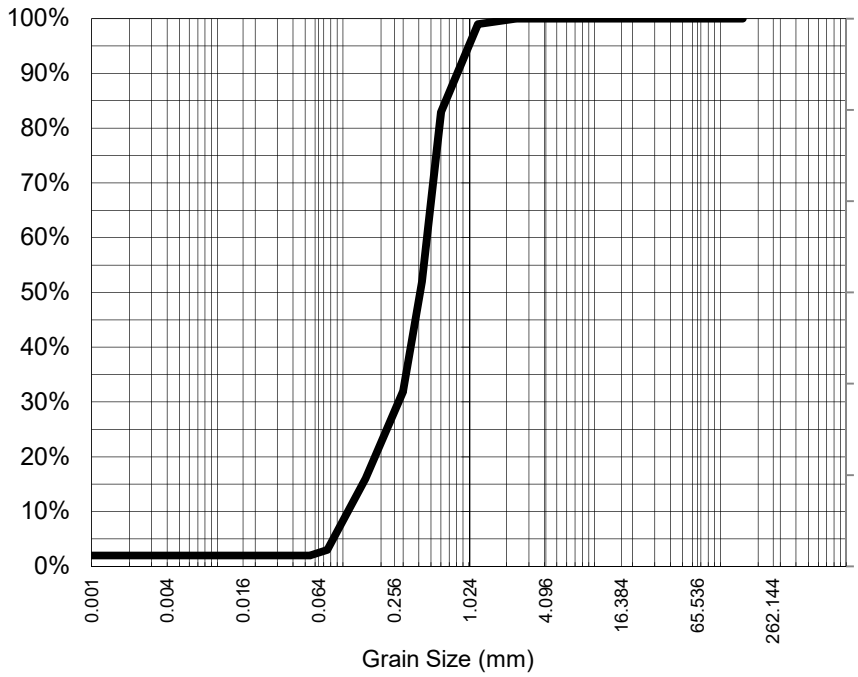
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	SHAE MILLER-WHITE	**DATE REPORTED:**	27-Nov-2019
COMPANY:	RPS Australia West Pty Ltd	**DATE RECEIVED:**	13-Nov-2019
ADDRESS:	PO Box 170 West Perth WA	**REPORT NO:**	EP1911899-020 / PSD
PROJECT:	EEC19032.011	**SAMPLE ID:**	C07S02

Particle Size Distribution



Particle Size (mm)	% Passing
2.36	100%
1.18	99%
0.600	83%
0.425	52%
0.300	32%
0.150	16%
0.075	3%
Particle Size (microns)	
55	2%
39	2%
28	2%
20	2%
14	2%
10	2%
7	2%
5	2%
1	2%

Median Particle Size (mm)*	0.413

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Analysis Notes

Samples analysed as received.

Sample Comments:	AS1289.3.6.3 states that hydrometer analysis is not applicable for samples containing <10% fines (<75um). Results should be assessed accordingly	**Analysed:**	22-Nov-19
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	SAND,VEG	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3		
Soil Particle Density (<2.36mm)	2.7		

NATA Accreditation: 825 Site: Newcastle
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NATA
WORLD RECOGNISED ACCREDITATION

Dianne Blane
Laboratory Coordinator
Authorised Signatory

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EP1913217**	Page	: 1 of 6
Client	: **RPS Australia West Pty Ltd**	Laboratory	: Environmental Division Perth
Contact	: SHAE MILLER-WHITE	Contact	: Rhiannon Steere
Address	: PO BOX 170 WEST PERTH WA 6872	Address	: 26 Rigali Way Wangara WA Australia 6065
Telephone	: 9211 1111	Telephone	: 08 9406 1306
Project	: EEC19032.011	Date Samples Received	: 13-Nov-2019 14:25
Order number	: ----	Date Analysis Commenced	: 16-Dec-2019
C-O-C number	: ----	Issue Date	: 20-Dec-2019 15:25
Sampler	: SHAE MILLER-WHITE		
Site	: Rottnest Army Jetty		
Quote number	: EP/705/19		
No. of samples received	: 3		
No. of samples analysed	: 3		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Daniel Fisher	Inorganics Analyst	Perth ASS, Wangara, WA
Gaston Allende	R&D Chemist	Sydney Organics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- PFAS conducted by ALS Sydney, NATA accreditation no. 825, site no 10911.
- ALS is not NATA accredited for the analysis of EA033 (ANC) on an unpulverised sample.
- EP231: Stable isotope enriched internal standards are added to samples prior to extraction. Target compounds have a direct analogous internal standard with the exception of PFPeS, PFHpA, PFDS, PFTrDA and 10:2 FTS. These compounds use an internal standard that is chemically related and has a retention time close to that of the target compound. The DQO for internal standard response is 50-150% of that established at initial calibration. PFOS is quantified using a certified, traceable standard consisting of linear and branched PFOS isomers. These practices are in line with recommendations in the National Environmental Management Plan for PFAS (Australian HEPA) and also conform to QSM 5.3 (US DoD) requirements.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	C01S01 EP1911899-001	C06S03 EP1911899-018	----	----	----
			Client sampling date / time	12-Dec-2019 00:00	12-Dec-2019 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EP1913217-002	EP1913217-003	--------	--------	--------
				Result	Result	----	----	----
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	**80.9**	**77.8**	**----**	**----**	**----**
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	**16200**	**15600**	**----**	**----**	**----**
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	**25.9**	**24.9**	**----**	**----**	**----**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	ES-01	----	----	----	----
			Client sampling date / time	13-Nov-2019 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EP1913217-001	--------	--------	--------	--------
				Result	----	----	----	----
EP231A: Perfluoroalkyl Sulfonic Acids								
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0005	µg/L	<0.0005	----	----	----	----
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0005	µg/L	<0.0005	----	----	----	----
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0005	µg/L	<0.0005	----	----	----	----
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0005	µg/L	<0.0005	----	----	----	----
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	µg/L	<0.0002	----	----	----	----
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0005	µg/L	<0.0005	----	----	----	----
EP231B: Perfluoroalkyl Carboxylic Acids								
Perfluorobutanoic acid (PFBA)	375-22-4	0.0020	µg/L	<0.0020	----	----	----	----
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0005	µg/L	<0.0005	----	----	----	----
Perfluorohexanoic acid (PFHxA)	307-24-4	0.0005	µg/L	<0.0005	----	----	----	----
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0005	µg/L	<0.0005	----	----	----	----
Perfluorooctanoic acid (PFOA)	335-67-1	0.0005	µg/L	<0.0005	----	----	----	----
Perfluorononanoic acid (PFNA)	375-95-1	0.0005	µg/L	<0.0005	----	----	----	----
Perfluorodecanoic acid (PFDA)	335-76-2	0.0005	µg/L	<0.0005	----	----	----	----
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0005	µg/L	<0.0005	----	----	----	----
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0005	µg/L	<0.0005	----	----	----	----
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0005	µg/L	<0.0005	----	----	----	----
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	µg/L	<0.0005	----	----	----	----
EP231C: Perfluoroalkyl Sulfonamides								
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0005	µg/L	<0.0005	----	----	----	----
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.001	µg/L	<0.001	----	----	----	----
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.001	µg/L	<0.001	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	ES-01	----	----	----	----
			Client sampling date / time	13-Nov-2019 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EP1913217-001	--------	--------	--------	--------
				Result	----	----	----	----
EP231C: Perfluoroalkyl Sulfonamides - Continued								
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.001	µg/L	<0.001	----	----	----	----
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.001	µg/L	<0.001	----	----	----	----
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0005	µg/L	<0.0005	----	----	----	----
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0005	µg/L	<0.0005	----	----	----	----
EP231D: (n:2) Fluorotelomer Sulfonic Acids								
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.001	µg/L	<0.001	----	----	----	----
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.001	µg/L	<0.001	----	----	----	----
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.001	µg/L	<0.001	----	----	----	----
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.001	µg/L	<0.001	----	----	----	----
EP231P: PFAS Sums								
^ Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	µg/L	<0.0002	----	----	----	----
^ Sum of PFAS (WA DER List)	----	0.0002	µg/L	<0.0002	----	----	----	----
^ Sum of PFAS	----	0.0002	µg/L	<0.0002	----	----	----	----
EP231S: PFAS Surrogate								
13C4-PFOS	----	0.0005	%	**86.3**	----	----	----	----
13C8-PFOA	----	0.0005	%	**106**	----	----	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP231S: PFAS Surrogate			
13C4-PFOS	----	60	120
13C8-PFOA	----	60	120

QUALITY CONTROL REPORT

Work Order	: **EP1913217**	Page	: 1 of 5
Client	: **RPS Australia West Pty Ltd**	Laboratory	: Environmental Division Perth
Contact	: SHAE MILLER-WHITE	Contact	: Rhiannon Steere
Address	: PO BOX 170 WEST PERTH WA 6872	Address	: 26 Rigali Way Wangara WA Australia 6065
Telephone	: 9211 1111	Telephone	: 08 9406 1306
Project	: EEC19032.011	Date Samples Received	: 13-Nov-2019
Order number	: ----	Date Analysis Commenced	: 16-Dec-2019
C-O-C number	: ----	Issue Date	: 20-Dec-2019
Sampler	: SHAE MILLER-WHITE		
Site	: Rottnest Army Jetty		
Quote number	: EP/705/19		
No. of samples received	: 3		
No. of samples analysed	: 3		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Daniel Fisher	Inorganics Analyst	Perth ASS, Wangara, WA
Gaston Allende	R&D Chemist	Sydney Organics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA033-C: Acid Neutralising Capacity (QC Lot: 2767224)									
EP1913217-002	C01S01 EP1911899-001	EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	80.9	80.8	0.223	0% - 20%
		EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	25.9	25.9	0.193	0% - 20%
		EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	16200	16100	0.219	0% - 20%

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP231A: Perfluoroalkyl Sulfonic Acids (QC Lot: 2772182)									
EM1921331-001	Anonymous	EP231X-SUT: Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	µg/L	0.335	0.400	17.7	0% - 20%
		EP231X-SUT: Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0005	µg/L	0.0118	0.0131	10.2	No Limit
		EP231X-SUT: Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0005	µg/L	0.0131	0.0162	20.8	0% - 50%
		EP231X-SUT: Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0005	µg/L	0.160	0.183	13.5	0% - 20%
		EP231X-SUT: Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0005	µg/L	0.0067	0.0107	45.9	No Limit
		EP231X-SUT: Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0005	µg/L	<0.0016	<0.0016	0.00	No Limit
EP231B: Perfluoroalkyl Carboxylic Acids (QC Lot: 2772182)									
EM1921331-001	Anonymous	EP231X-SUT: Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0005	µg/L	0.0808	0.0949	16.0	0% - 20%
		EP231X-SUT: Perfluorohexanoic acid (PFHxA)	307-24-4	0.0005	µg/L	0.0872	0.100	14.2	0% - 20%
		EP231X-SUT: Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0005	µg/L	0.0608	0.0706	14.8	0% - 20%
		EP231X-SUT: Perfluorooctanoic acid (PFOA)	335-67-1	0.0005	µg/L	0.0456	0.0538	16.4	0% - 20%

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP231B: Perfluoroalkyl Carboxylic Acids (QC Lot: 2772182) - continued									
EM1921331-001	Anonymous	EP231X-SUT: Perfluorononanoic acid (PFNA)	375-95-1	0.0005	µg/L	0.0128	0.0141	9.52	No Limit
		EP231X-SUT: Perfluorodecanoic acid (PFDA)	335-76-2	0.0005	µg/L	0.0018	0.0024	30.8	No Limit
		EP231X-SUT: Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0005	µg/L	<0.0016	<0.0016	0.00	No Limit
		EP231X-SUT: Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0005	µg/L	<0.0016	<0.0016	0.00	No Limit
		EP231X-SUT: Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0005	µg/L	<0.0016	<0.0016	0.00	No Limit
		EP231X-SUT: Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	µg/L	<0.0040	<0.0040	0.00	No Limit
		EP231X-SUT: Perfluorobutanoic acid (PFBA)	375-22-4	0.002	µg/L	<0.0020	<0.0020	0.00	No Limit
EP231C: Perfluoroalkyl Sulfonamides (QC Lot: 2772182)									
EM1921331-001	Anonymous	EP231X-SUT: Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0005	µg/L	<0.0016	<0.0016	0.00	No Limit
		EP231X-SUT: N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0005	µg/L	<0.0016	<0.0016	0.00	No Limit
		EP231X-SUT: N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0005	µg/L	<0.0016	<0.0016	0.00	No Limit
		EP231X-SUT: N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.001	µg/L	<0.004	<0.004	0.00	No Limit
		EP231X-SUT: N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.001	µg/L	<0.004	<0.004	0.00	No Limit
		EP231X-SUT: N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.001	µg/L	<0.004	<0.004	0.00	No Limit
		EP231X-SUT: N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.001	µg/L	<0.004	<0.004	0.00	No Limit
EP231D: (n:2) Fluorotelomer Sulfonic Acids (QC Lot: 2772182)									
EM1921331-001	Anonymous	EP231X-SUT: 4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.001	µg/L	<0.002	<0.002	0.00	No Limit
		EP231X-SUT: 6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.001	µg/L	0.051	0.062	18.8	0% - 20%
		EP231X-SUT: 8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.001	µg/L	0.004	0.005	0.00	No Limit
		EP231X-SUT: 10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.001	µg/L	<0.002	<0.002	0.00	No Limit
EP231P: PFAS Sums (QC Lot: 2772182)									
EM1921331-001	Anonymous	EP231X-SUT: Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	µg/L	0.495	0.583	16.3	0% - 20%
		EP231X-SUT: Sum of PFAS (WA DER List)	----	0.0002	µg/L	0.836	0.982	16.1	0% - 20%
		EP231X-SUT: Sum of PFAS	----	0.0002	µg/L	0.871	1.02	16.4	0% - 20%

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA033-C: Acid Neutralising Capacity (QCLot: 2767224)								
EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	<0.01	4.9 % CaCO3	104	98.1	108
EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	<10	----	----	----	----
EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	<0.01	----	----	----	----

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EP231A: Perfluoroalkyl Sulfonic Acids (QCLot: 2772182)								
EP231X-SUT: Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0005	µg/L	<0.0005	0.004 µg/L	102	50.0	130
EP231X-SUT: Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0005	µg/L	<0.0005	0.004 µg/L	101	50.0	130
EP231X-SUT: Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0005	µg/L	<0.0005	0.004 µg/L	112	50.0	130
EP231X-SUT: Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0005	µg/L	<0.0005	0.004 µg/L	112	50.0	130
EP231X-SUT: Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	µg/L	<0.0002	0.004 µg/L	76.8	50.0	130
EP231X-SUT: Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0005	µg/L	<0.0005	0.004 µg/L	84.0	50.0	130
EP231B: Perfluoroalkyl Carboxylic Acids (QCLot: 2772182)								
EP231X-SUT: Perfluorobutanoic acid (PFBA)	375-22-4	0.002	µg/L	<0.0020	0.02 µg/L	98.8	30.0	130
EP231X-SUT: Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0005	µg/L	<0.0005	0.004 µg/L	102	50.0	130
EP231X-SUT: Perfluorohexanoic acid (PFHxA)	307-24-4	0.0005	µg/L	<0.0005	0.004 µg/L	115	50.0	130
EP231X-SUT: Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0005	µg/L	<0.0005	0.004 µg/L	92.4	50.0	130
EP231X-SUT: Perfluorooctanoic acid (PFOA)	335-67-1	0.0005	µg/L	<0.0005	0.004 µg/L	102	50.0	130
EP231X-SUT: Perfluorononanoic acid (PFNA)	375-95-1	0.0005	µg/L	<0.0005	0.004 µg/L	98.4	50.0	130
EP231X-SUT: Perfluorodecanoic acid (PFDA)	335-76-2	0.0005	µg/L	<0.0005	0.004 µg/L	94.8	50.0	130
EP231X-SUT: Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0005	µg/L	<0.0005	0.004 µg/L	95.6	40.0	130
EP231X-SUT: Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0005	µg/L	<0.0005	0.004 µg/L	115	40.0	130
EP231X-SUT: Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0005	µg/L	<0.0005	0.004 µg/L	86.4	40.0	130
EP231X-SUT: Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	µg/L	<0.0005	0.01 µg/L	89.9	40.0	130
EP231C: Perfluoroalkyl Sulfonamides (QCLot: 2772182)								
EP231X-SUT: Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0005	µg/L	<0.0005	0.004 µg/L	89.6	40.0	130
EP231X-SUT: N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.001	µg/L	<0.001	0.01 µg/L	101	40.0	130
EP231X-SUT: N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.001	µg/L	<0.001	0.01 µg/L	97.9	40.0	130
EP231X-SUT: N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.001	µg/L	<0.001	0.01 µg/L	101	40.0	130

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
EP231C: Perfluoroalkyl Sulfonamides (QCLot: 2772182) - continued								
EP231X-SUT: N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.001	µg/L	<0.001	0.01 µg/L	86.7	40.0	130
EP231X-SUT: N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0005	µg/L	<0.0005	0.004 µg/L	90.8	40.0	130
EP231X-SUT: N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0005	µg/L	<0.0005	0.004 µg/L	82.8	40.0	130
EP231D: (n:2) Fluorotelomer Sulfonic Acids (QCLot: 2772182)								
EP231X-SUT: 4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.001	µg/L	<0.001	0.004 µg/L	91.6	50.0	130
EP231X-SUT: 6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.001	µg/L	<0.001	0.004 µg/L	112	50.0	130
EP231X-SUT: 8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.001	µg/L	<0.001	0.004 µg/L	99.6	50.0	130
EP231X-SUT: 10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.001	µg/L	<0.001	0.004 µg/L	121	50.0	130
EP231P: PFAS Sums (QCLot: 2772182)								
EP231X-SUT: Sum of PFHxS and PFOS	355-46-4/17 63-23-1	0.0002	µg/L	<0.0002	----	----	----	----
EP231X-SUT: Sum of PFAS (WA DER List)	----	0.0002	µg/L	<0.0002	----	----	----	----
EP231X-SUT: Sum of PFAS	----	0.0002	µg/L	<0.0002	----	----	----	----

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

- **No Matrix Spike (MS) or Matrix Spike Duplicate (MSD) Results are required to be reported.**

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EP1913217**	Page	: 1 of 4
Client	: **RPS Australia West Pty Ltd**	Laboratory	: Environmental Division Perth
Contact	: SHAE MILLER-WHITE	Telephone	: 08 9406 1306
Project	: EEC19032.011	Date Samples Received	: 13-Nov-2019
Site	: Rottnest Army Jetty	Issue Date	: 20-Dec-2019
Sampler	: SHAE MILLER-WHITE	No. of samples received	: 3
Order number	: ----	No. of samples analysed	: 3

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type	Count		Rate (%)		Quality Control Specification
Method	QC	Regular	Actual	Expected	
Matrix Spikes (MS)					
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	0	7	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / *Container / Client Sample ID(s)*	*Sample Date*	*Extraction / Preparation*			*Analysis*		
		Date extracted	*Due for extraction*	*Evaluation*	*Date analysed*	*Due for analysis*	*Evaluation*
EA033-C: Acid Neutralising Capacity							
Snap Lock Bag - frozen (EA033)							
C01S01 - EP1911899-001, C06S03 - EP1911899-018	**12-Dec-2019**	**16-Dec-2019**	11-Dec-2020	✓	**20-Dec-2019**	15-Mar-2020	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / *Container / Client Sample ID(s)*	*Sample Date*	*Extraction / Preparation*			*Analysis*		
		Date extracted	*Due for extraction*	*Evaluation*	*Date analysed*	*Due for analysis*	*Evaluation*
EP231A: Perfluoroalkyl Sulfonic Acids							
HDPE (no PTFE) (EP231X-SUT)							
ES-01	**13-Nov-2019**	**19-Dec-2019**	11-May-2020	✓	**19-Dec-2019**	11-May-2020	✓
EP231B: Perfluoroalkyl Carboxylic Acids							
HDPE (no PTFE) (EP231X-SUT)							
ES-01	**13-Nov-2019**	**19-Dec-2019**	11-May-2020	✓	**19-Dec-2019**	11-May-2020	✓
EP231C: Perfluoroalkyl Sulfonamides							
HDPE (no PTFE) (EP231X-SUT)							
ES-01	**13-Nov-2019**	**19-Dec-2019**	11-May-2020	✓	**19-Dec-2019**	11-May-2020	✓
EP231D: (n:2) Fluorotelomer Sulfonic Acids							
HDPE (no PTFE) (EP231X-SUT)							
ES-01	**13-Nov-2019**	**19-Dec-2019**	11-May-2020	✓	**19-Dec-2019**	11-May-2020	✓
EP231P: PFAS Sums							
HDPE (no PTFE) (EP231X-SUT)							
ES-01	**13-Nov-2019**	**19-Dec-2019**	11-May-2020	✓	**19-Dec-2019**	11-May-2020	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Chromium Suite for Acid Sulphate Soils	EA033	1	2	**50.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Chromium Suite for Acid Sulphate Soils	EA033	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chromium Suite for Acid Sulphate Soils	EA033	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X-SUT	1	7	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X-SUT	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X-SUT	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X-SUT	0	7	**0.00**	**5.00**	✗	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Chromium Suite for Acid Sulphate Soils	EA033	SOIL	In house: Referenced to Ahern et al 2004. This method covers the determination of Chromium Reducible Sulfur (SCR); pHKCl; titratable actual acidity (TAA); acid neutralising capacity by back titration (ANC); and net acid soluble sulfur (SNAS) which incorporates peroxide sulfur. It applies to soils and sediments (including sands) derived from coastal regions. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X-SUT	WATER	In-house: Analysis of fresh and saline waters by Solid Phase Extraction (SPE) followed by LC-Electrospray-MS-MS, Negative Mode using MRM and internal standard quantitation. Isotopically labelled analogues of target analytes used as internal standards and surrogates are added to the sample container. The entire contents are transferred to a solid phase extraction (SPE) cartridge. The sample container is successively rinsed with aliquots of the elution solvent. The eluted extract is concentrated, combined with an equal volume of reagent water and filtered for analysis. Method procedures and data quality objectives conform to US DoD QSM 5.3, table B-15 requirements.

Preparation Methods	Method	Matrix	Method Descriptions
Drying at 85 degrees, bagging and labelling (ASS)	EN020PR	SOIL	In house
Solid Phase Extraction (SPE) for PFAS in water	ORG72	WATER	In-house: Isotopically labelled analogues of target analytes used as internal standards and surrogates are added to the sample container. The entire contents are transferred to a solid phase extraction (SPE) cartridge. The sample container is successively rinsed with aliquots of the elution solvent. The eluted extract is combined with an equal volume of reagent water and a portion is filtered for analysis. Method procedures conform to US DoD QSM 5.3, table B-15 requirements.

ALS Environmental

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **EP1913217**

Client	: **RPS Australia West Pty Ltd**	Laboratory	: Environmental Division Perth
Contact	: SHAE MILLER-WHITE	Contact	: Rhiannon Steere
Address	: PO BOX 170 WEST PERTH WA 6872	Address	: 26 Rigali Way Wangara WA Australia 6065
E-mail	: miller-whites@rpsgroup.com.au	E-mail	: rhiannon.steere@alsglobal.com
Telephone	: 9211 1111	Telephone	: 08 9406 1306
Facsimile	: 9211 1122	Facsimile	: +61-8-9406 1399
Project	: EEC19032.011	Page	: 1 of 3
Order number	: ----	Quote number	: EP2019AQUTER0003 (EP/705/19)
C-O-C number	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	: Rottnest Army Jetty		
Sampler	: SHAE MILLER-WHITE		

Dates

Date Samples Received	: 13-Nov-2019 14:25	Issue Date	: 12-Dec-2019
Client Requested Due Date	: 20-Dec-2019	Scheduled Reporting Date	: **20-Dec-2019**

Delivery Details

Mode of Delivery	: Samples On Hand	Security Seal	: Not Available
No. of coolers/boxes	: ----	Temperature	: ----
Receipt Detail	:	No. of samples received / analysed	: 3 / 3

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- PFAS conducted by ALS Sydney, NATA accreditation no. 825, site no 10911.
- Please see scanned COC for sample discrepencies: extra samples , samples not received etc.
- ALS is not NATA accredited for the analysis of EA033 (ANC) on an unpulverised sample.
- Please direct any queries related to sample condition / numbering / breakages to Sample Receipt (Samples.Perth@alsglobal.com)
- Analytical work for this work order will be conducted at ALS Environmental Perth.
- Please direct any turnaround / technical queries to the laboratory contact designated above.
- Sample Disposal - Aqueous (3 weeks), Solid (2 months) from receipt of samples.
- **PFAS analysis will be conducted by ALS Environmental, Sydney, NATA accreditation no. 825, Site No. 10911.**
- **pH analysis should be conducted within 6 hours of sampling.**
- Please be aware that APHA/NEPM recommends water and soil samples be chilled to less than or equal to 6°C for chemical analysis, and less than or equal to 10°C but unfrozen for Microbiological analysis. Where samples are received above this temperature, it should be taken into consideration when interpreting results. Refer to ALS EnviroMail 85 for ALS recommendations of the best practice for chilling samples after sampling and for maintaining a cool temperature during transit.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exists.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component

Matrix: **SOIL**

Laboratory sample ID	Client sampling date / time	Client sample ID	SOIL - EA033-C ANC ANC only from Chromium Suite Method
EP1913217-002	12-Dec-2019 00:00	C01S01	✓
EP1913217-003	12-Dec-2019 00:00	C06S03	✓

Matrix: **WATER**

Laboratory sample ID	Client sampling date / time	Client sample ID	WATER - EP231X-SUT PFAS - Super Ultra Trace Waters Long Suite (28
EP1913217-001	13-Nov-2019 00:00	ES-01	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

ACCOUNTS PAYABLE

- A4 - AU Tax Invoice (INV)	Email	West.AccountsPayable@rpsgroup.com.au

ALAN FOLEY

- *AU Certificate of Analysis - NATA (COA)	Email	Alan.Foley@rpsgroup.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	Alan.Foley@rpsgroup.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	Alan.Foley@rpsgroup.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	Alan.Foley@rpsgroup.com.au
- Chain of Custody (CoC) (COC)	Email	Alan.Foley@rpsgroup.com.au
- EDI Format - ENMRG (ENMRG)	Email	Alan.Foley@rpsgroup.com.au
- EDI Format - ESDAT (ESDAT)	Email	Alan.Foley@rpsgroup.com.au
- EDI Format - XTab (XTAB)	Email	Alan.Foley@rpsgroup.com.au

SHAE MILLER-WHITE

- *AU Certificate of Analysis - NATA (COA)	Email	miller-whites@rpsgroup.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	miller-whites@rpsgroup.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	miller-whites@rpsgroup.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	miller-whites@rpsgroup.com.au
- A4 - AU Tax Invoice (INV)	Email	miller-whites@rpsgroup.com.au
- Chain of Custody (CoC) (COC)	Email	miller-whites@rpsgroup.com.au
- EDI Format - ENMRG (ENMRG)	Email	miller-whites@rpsgroup.com.au
- EDI Format - ESDAT (ESDAT)	Email	miller-whites@rpsgroup.com.au
- EDI Format - XTab (XTAB)	Email	miller-whites@rpsgroup.com.au

Natalie Duncan

From: Alan Foley <Alan.Foley@rpsgroup.com.au>
Sent: Wednesday, 11 December 2019 6:02 AM
To: Samples Perth
Cc: Brandon Ovens
Subject: [EXTERNAL] - RE: RESULTS & EDD for ALS Workorder : EP1911899 | Your Reference: EEC19032.011

Follow Up Flag: Follow up
Flag Status: Flagged

Categories: Natalie

CAUTION: This email originated from outside of ALS. Do not click links or open attachments unless you recognize the sender and are sure content is relevant to you.

Good morning

There was a sample ES-01 submitted with this batch; could I please get it run for PFAS – super ultra-trace (EP231X-SUT) per quote EP-705-19

Regards

Alan

Alan Foley
Principal Scientist - Contamination and Acid Sulfate Soils
RPS | Australia Asia Pacific
M +61 457 554 432
E alan.foley@rpsgroup.com.au

From: angel-no-reply@alsglobal.com <angel-no-reply@alsglobal.com>
Sent: Friday, 6 December 2019 5:10 PM
To: Alan Foley <Alan.Foley@rpsgroup.com.au>
Subject: RESULTS & EDD for ALS Workorder : EP1911899 | Your Reference: EEC19032.011

CAUTION: This email originated from outside of RPS.

ALS

Environmental Division
Perth
Work Order Reference
EP1913217

Deliverables for ALS Workorder EP1911899

Project: EEC19032.011

Telephone : +61-8-9406 1301

Dear ALAN FOLEY,

Natalie Duncan

From:	Alan Foley <Alan.Foley@rpsgroup.com.au>
Sent:	Thursday, 12 December 2019 8:32 AM
To:	Samples Perth
Cc:	Brandon Ovens
Subject:	[EXTERNAL] - RE: RESULTS & EDD for ALS Workorder : EP1911899 | Your Reference: EEC19032.011
Follow Up Flag:	Follow up
Flag Status:	Flagged
Categories:	Natalie

CAUTION: This email originated from outside of ALS. Do not click links or open attachments unless you recognize the sender and are sure content is relevant to you.

Good morning

Can you please see if there is any dried uncrushed/pulverised sample remaining of the following samples:

C01S01
C06S03

If so can I please get the ANC (EA033) only run on a dried uncrushed/unpulverised sample, sieved to 0.6 mm

Regards

Alan

Alan Foley
Principal Scientist - Contamination and Acid Sulfate Soils
RPS | Australia Asia Pacific
M +61 457 554 432
E alan.foley@rpsgroup.com.au

From: angel-no-reply@alsglobal.com <angel-no-reply@alsglobal.com>
Sent: Friday, 6 December 2019 5:10 PM
To: Alan Foley <Alan.Foley@rpsgroup.com.au>
Subject: RESULTS & EDD for ALS Workorder : EP1911899 | Your Reference: EEC19032.011

CAUTION: This email originated from outside of RPS.

Deliverables for ALS Workorder EP1911899

Please find enclosed the following deliverables for **EP1911899**:

- EP1911899_0_COA.pdf
- EP1911899_0_ENMRG.CSV
- EEC19032 011.ESDAT_EP1911899_0.Chemistry2e.CSV
- EEC19032 011.ESDAT_EP1911899_0.Header.XML
- EEC19032 011.ESDAT_EP1911899_0.Sample2e.CSV
- EP1911899_0_XTAB.XLS
- EP1911899_0_QC.pdf
- EP1911899_0_QCI.pdf
- EP1911899_PSD.pdf
- EP1911899_COC.pdf

Report Recipients

- SHAE MILLER-WHITE
  - EP1911899_0_COA.pdf (Email)
  - EP1911899_0_ENMRG.CSV (Email)
  - EEC19032 011.ESDAT_EP1911899_0.Chemistry2e.CSV (Email)
  - EEC19032 011.ESDAT_EP1911899_0.Header.XML (Email)
  - EEC19032 011.ESDAT_EP1911899_0.Sample2e.CSV (Email)
  - EP1911899_0_XTAB.XLS (Email)
  - EP1911899_0_QC.pdf (Email)
  - EP1911899_0_QCI.pdf (Email)
  - EP1911899_PSD.pdf (Email)
  - EP1911899_COC.pdf (Email)
- ACCOUNTS PAYABLE
  - EP1911899_COC.pdf (Email)
- ALAN FOLEY
  - EP1911899_0_COA.pdf (Email)
  - EP1911899_0_ENMRG.CSV (Email)
  - EEC19032 011.ESDAT_EP1911899_0.Chemistry2e.CSV (Email)
  - EEC19032 011.ESDAT_EP1911899_0.Header.XML (Email)
  - EEC19032 011.ESDAT_EP1911899_0.Sample2e.CSV (Email)
  - EP1911899_0_XTAB.XLS (Email)
  - EP1911899_0_QC.pdf (Email)
  - EP1911899_0_QCI.pdf (Email)
  - EP1911899_PSD.pdf (Email)
  - EP1911899_COC.pdf (Email)

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CHAIN OF CUSTODY

Asbestos quantation.

Level 2, 27-31 Troode Street
West Perth WA 6005
Tel: (618) 9211 1111
Fax: (618) 9211 1122

Site:	Rottnest Army Jetty
Project reference:	EEC19032.011
Scientist(s)	SMW
Sample type(s):	Sediment and Water
Report to:	Alan Foley / Shae Miller-White
Invoice to:	west.accountspayable@rpsgroup.com

Page number:	1 of 2.
Turnaround time:	Standard
Quote number:	EP/785/19

Sample ID		Date collected	Number of bottles/bags	Analytical suites: Sediment Suite 1	Sediment Suite 2	Sediment Suite 3	Sediment Suite 4	Sediment Suite 5	Water Suite 1	Water Suite 2	Water Suite 3	Water Suite 4	Water Suite 5	Water Suite 6	Water Suite 7	Water Suite 8	Water Suite 9	Water Suite 10	Water Suite 11	Water Suite 12	Water Suite 13	Water Suite 14	Water Suite 15	Water Suite 16	Water Suite 17	Water Suite 18	Water Suite 19	Water Suite 20	Water Suite 21	Water Suite 22	Water Suite 23	Water Suite 24	Water Suite 25	Water Suite 26	Water Suite 27	Water Suite 28	Water Suite 29	Water Suite 30	Remarks
C01S01	1	12.11.19	Refer to quote	X	X	X		X																															
C01S02	2		Refer to quote																																				
C01S03	3		Refer to quote	X	X																																		
C02S01	4		Refer to quote	X	X	X		X																															
C02S02	5		Refer to quote	X																																			
C02S03	6		Refer to quote																																				
C03S01	7		Refer to quote	X	X	X																																	
C03S02	8		Refer to quote																																				
C03S03	9		Refer to quote	X				X																															
C04S01	10	13.11.19	Refer to quote	X	X	X																																	
C04S02	11	"	Refer to quote	X				X																															
C04S03	12	"	Refer to quote																																				
C05S01	13	"	Refer to quote	X	X																																		
C05S02	14	"	Refer to quote			X																																	
C05S03	15	"	Refer to quote	X				X																															
C06S01	16	12.11.19	Refer to quote	X	X																																		
C06S02	17		Refer to quote	X				X																															
C06S03	18		Refer to quote			X							X																										
C07S01	19		Refer to quote	X	X			X																															
C07S02	20		Refer to quote			X																																	
C07S03	21		Refer to quote	X																																			
Total number of bottles/bags/jars																																							

Environmental Division
Perth
Work Order Reference
EP1911899

Primary destination:	ALS	Received by:	NO	Secondary destination:	Received by:
Relinquished by:	Shae Miller-White	Organisation:	ALS	Relinquished by:	Organisation
Organisation:	RPS	Date:	13.11.19	Organisation:	Date:
Date:	13.11.19	Time:	14:25	Date:	Time:
Time:				Time:	

P.T.O.

CHAIN OF CUSTODY

rps MAKING COMPLEX EASY
Level 2, 27-31 Troode Street
West Perth WA 6005
Tel: (618) 9211 1111
Fax: (618) 9211 1122

Site:	Rottnest Army Jetty
Project reference:	EEC19032.011
Scientist(s)	SMW
Sample type(s):	Sediment and Water
Report to:	Alan Foley / Shae Miller-White
Invoice to:	west.accountspayable@rpsgroup.com

Page number: 2 of 2.
Turnaround time: Standard
Quote number: EP/705/19
Remarks:

No Asbestos.

As per quote.

| Sample ID | | Date collected | Number of jars / bottles / bags | Sediment Suite | Metals Suite | Organics Suite | PAH Suite | Metals Suite (1) | Water Suite | Phosphorus Fractions | SSC/TSS | | |

CERTIFICATE OF ANALYSIS

Work Order	: **EP2003111**	Page	: 1 of 21
Client	: **RPS Australia West Pty Ltd**	Laboratory	: Environmental Division Perth
Contact	: ALAN FOLEY	Contact	: Lauren Biagioni
Address	: PO BOX 170 WEST PERTH WA 6872	Address	: 26 Rigali Way Wangara WA Australia 6065
Telephone	: ----	Telephone	: 08 9406 1307
Project	: EEC19032.012	Date Samples Received	: 24-Mar-2020 11:40
Order number	: ----	Date Analysis Commenced	: 27-Mar-2020
C-O-C number	: ----	Issue Date	: 17-Apr-2020 11:14
Sampler	: SMW		
Site	: Rottnest Army Jetty		
Quote number	: EP/705/19		
No. of samples received	: 36		
No. of samples analysed	: 28		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Franco Lentini	LCMS Coordinator	Sydney Inorganics, Smithfield, NSW
Franco Lentini	LCMS Coordinator	Sydney Organics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- PFAS conducted by ALS Sydney, NATA accreditation no. 825, site no 10911.
- EP231X: PFAS results for sample #35 confirmed by re-extraction and re-analysis.
- EN68: This analysis in accordance with National Ocean Disposal Guidelines, Commonwealth of Australia, 2002 - (modified). Results reported are those determined on a 1:4 sediment/seawater elutriate without blank correction.
- EP231: Stable isotope enriched internal standards are added to samples prior to extraction. Target compounds have a direct analogous internal standard with the exception of PFPeS, PFHpA, PFDS, PFTrDA and 10:2 FTS. These compounds use an internal standard that is chemically related and has a retention time close to that of the target compound. The DQO for internal standard response is 50-150% of that established at initial calibration. PFOS is quantified using a certified, traceable standard consisting of linear and branched PFOS isomers. These practices are in line with recommendations in the National Environmental Management Plan for PFAS (Australian HEPA) and also conform to QSM 5.3 (US DoD) requirements.

Analytical Results

Sub-Matrix: ELUTRIATE (Matrix: WATER)			Client sample ID	C01S01	C02S01	C03S03	C04S02	C05S03
			Client sampling date / time	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00
Compound	CAS Number	LOR	Unit	EP2003111-001	EP2003111-004	EP2003111-009	EP2003111-011	EP2003111-015
				Result	Result	Result	Result	Result
EP231A: Perfluoroalkyl Sulfonic Acids								
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	µg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EP231B: Perfluoroalkyl Carboxylic Acids								
Perfluorobutanoic acid (PFBA)	375-22-4	0.0020	µg/L	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorohexanoic acid (PFHxA)	307-24-4	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorooctanoic acid (PFOA)	335-67-1	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorononanoic acid (PFNA)	375-95-1	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorodecanoic acid (PFDA)	335-76-2	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EP231C: Perfluoroalkyl Sulfonamides								
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: ELUTRIATE (Matrix: WATER)			Client sample ID	C01S01	C02S01	C03S03	C04S02	C05S03
			Client sampling date / time	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00
Compound	CAS Number	LOR	Unit	EP2003111-001	EP2003111-004	EP2003111-009	EP2003111-011	EP2003111-015
				Result	Result	Result	Result	Result
EP231C: Perfluoroalkyl Sulfonamides - Continued								
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EP231D: (n:2) Fluorotelomer Sulfonic Acids								
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
EP231P: PFAS Sums								
^ Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	µg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
^ Sum of PFAS (WA DER List)	----	0.0002	µg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
^ Sum of PFAS	----	0.0002	µg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
EP231S: PFAS Surrogate								
13C4-PFOS	----	0.0005	%	**74.5**	**76.1**	**73.5**	**76.2**	**77.0**
13C8-PFOA	----	0.0005	%	**102**	**97.6**	**98.6**	**99.7**	**99.4**

Analytical Results

Sub-Matrix: ELUTRIATE (Matrix: WATER)			Client sample ID	C06S02	C07S01	EW	----	----
			Client sampling date / time	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00	----	----
Compound	CAS Number	LOR	Unit	EP2003111-017	EP2003111-019	EP2003111-035	--------	--------
				Result	Result	Result	----	----
EP231A: Perfluoroalkyl Sulfonic Acids								
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	µg/L	<0.0002	<0.0002	<0.0002	----	----
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
EP231B: Perfluoroalkyl Carboxylic Acids								
Perfluorobutanoic acid (PFBA)	375-22-4	0.0020	µg/L	<0.0020	<0.0020	<0.0020	----	----
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
Perfluorohexanoic acid (PFHxA)	307-24-4	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
Perfluorooctanoic acid (PFOA)	335-67-1	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
Perfluorononanoic acid (PFNA)	375-95-1	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
Perfluorodecanoic acid (PFDA)	335-76-2	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
EP231C: Perfluoroalkyl Sulfonamides								
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.001	µg/L	<0.001	<0.001	<0.001	----	----
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.001	µg/L	<0.001	<0.001	<0.001	----	----

Analytical Results

Sub-Matrix: ELUTRIATE (Matrix: WATER)			Client sample ID	C06S02	C07S01	EW	----	----
			Client sampling date / time	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00	----	----
Compound	CAS Number	LOR	Unit	EP2003111-017	EP2003111-019	EP2003111-035	--------	--------
				Result	Result	Result	----	----
EP231C: Perfluoroalkyl Sulfonamides - Continued								
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.001	µg/L	<0.001	<0.001	<0.001	----	----
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.001	µg/L	<0.001	<0.001	<0.001	----	----
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0005	µg/L	<0.0005	<0.0005	<0.0005	----	----
EP231D: (n:2) Fluorotelomer Sulfonic Acids								
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.001	µg/L	<0.001	<0.001	<0.001	----	----
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.001	µg/L	<0.001	<0.001	<0.001	----	----
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.001	µg/L	<0.001	<0.001	<0.001	----	----
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.001	µg/L	<0.001	<0.001	<0.001	----	----
EP231P: PFAS Sums								
^ Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	µg/L	<0.0002	<0.0002	<0.0002	----	----
^ Sum of PFAS (WA DER List)	----	0.0002	µg/L	<0.0002	<0.0002	<0.0002	----	----
^ Sum of PFAS	----	0.0002	µg/L	<0.0002	<0.0002	<0.0002	----	----
EP231S: PFAS Surrogate								
13C4-PFOS	----	0.0005	%	**74.8**	**73.3**	**71.2**	----	----
13C8-PFOA	----	0.0005	%	**98.9**	**103**	**103**	----	----

Analytical Results

Sub-Matrix: SEAWATER (Matrix: WATER)			Client sample ID	Matrix Blank	----	----	----	----
			Client sampling date / time	23-Mar-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EP2003111-036	--------	--------	--------	--------
				Result	----	----	----	----
EP231A: Perfluoroalkyl Sulfonic Acids								
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0005	µg/L	<0.0005	----	----	----	----
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0005	µg/L	<0.0005	----	----	----	----
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0005	µg/L	<0.0005	----	----	----	----
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0005	µg/L	<0.0005	----	----	----	----
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	µg/L	<0.0002	----	----	----	----
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0005	µg/L	<0.0005	----	----	----	----
EP231B: Perfluoroalkyl Carboxylic Acids								
Perfluorobutanoic acid (PFBA)	375-22-4	0.0020	µg/L	<0.0020	----	----	----	----
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0005	µg/L	<0.0005	----	----	----	----
Perfluorohexanoic acid (PFHxA)	307-24-4	0.0005	µg/L	<0.0005	----	----	----	----
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0005	µg/L	<0.0005	----	----	----	----
Perfluorooctanoic acid (PFOA)	335-67-1	0.0005	µg/L	<0.0005	----	----	----	----
Perfluorononanoic acid (PFNA)	375-95-1	0.0005	µg/L	<0.0005	----	----	----	----
Perfluorodecanoic acid (PFDA)	335-76-2	0.0005	µg/L	<0.0005	----	----	----	----
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0005	µg/L	<0.0005	----	----	----	----
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0005	µg/L	<0.0005	----	----	----	----
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0005	µg/L	<0.0005	----	----	----	----
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	µg/L	<0.0005	----	----	----	----
EP231C: Perfluoroalkyl Sulfonamides								
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0005	µg/L	<0.0005	----	----	----	----
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.001	µg/L	<0.001	----	----	----	----
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.001	µg/L	<0.001	----	----	----	----

Analytical Results

Sub-Matrix: SEAWATER (Matrix: WATER)			Client sample ID	Matrix Blank	----	----	----	----
			Client sampling date / time	23-Mar-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EP2003111-036	--------	--------	--------	--------
				Result	----	----	----	----
EP231C: Perfluoroalkyl Sulfonamides - Continued								
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.001	µg/L	<0.001	----	----	----	----
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.001	µg/L	<0.001	----	----	----	----
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0005	µg/L	<0.0005	----	----	----	----
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0005	µg/L	<0.0005	----	----	----	----
EP231D: (n:2) Fluorotelomer Sulfonic Acids								
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.001	µg/L	<0.001	----	----	----	----
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.001	µg/L	<0.001	----	----	----	----
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.001	µg/L	<0.001	----	----	----	----
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.001	µg/L	<0.001	----	----	----	----
EP231P: PFAS Sums								
^ Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	µg/L	<0.0002	----	----	----	----
^ Sum of PFAS (WA DER List)	----	0.0002	µg/L	<0.0002	----	----	----	----
^ Sum of PFAS	----	0.0002	µg/L	<0.0002	----	----	----	----
EP231S: PFAS Surrogate								
13C4-PFOS	----	0.0005	%	**75.6**	----	----	----	----
13C8-PFOA	----	0.0005	%	**108**	----	----	----	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C01S01	C01S03	C02S01	C02S02	C03S01
			Client sampling date / time	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00
Compound	CAS Number	LOR	Unit	EP2003111-001	EP2003111-003	EP2003111-004	EP2003111-005	EP2003111-007
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	33.3	33.6	45.7	32.6	25.8
EN68: Seawater Elutriate Testing Procedure								
Seawater Sampling Date	----	-	-	28/03/2020	----	28/03/2020	----	----
EP231A: Perfluoroalkyl Sulfonic Acids								
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
EP231B: Perfluoroalkyl Carboxylic Acids								
Perfluorobutanoic acid (PFBA)	375-22-4	0.001	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorohexanoic acid (PFHxA)	307-24-4	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorooctanoic acid (PFOA)	335-67-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorononanoic acid (PFNA)	375-95-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorodecanoic acid (PFDA)	335-76-2	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EP231C: Perfluoroalkyl Sulfonamides								
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C01S01	C01S03	C02S01	C02S02	C03S01
			Client sampling date / time	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00
Compound	CAS Number	LOR	Unit	EP2003111-001	EP2003111-003	EP2003111-004	EP2003111-005	EP2003111-007
				Result	Result	Result	Result	Result
EP231C: Perfluoroalkyl Sulfonamides - Continued								
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
EP231D: (n:2) Fluorotelomer Sulfonic Acids								
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EP231P: PFAS Sums								
Sum of PFAS	----	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Sum of PFAS (WA DER List)	----	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
EP231S: PFAS Surrogate								
13C4-PFOS	----	0.0002	%	**91.5**	**108**	**102**	**108**	**112**
13C8-PFOA	----	0.0002	%	**96.5**	**104**	**99.0**	**94.0**	**100**

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C03S03	C04S01	C04S02	C05S01	C05S03
			Client sampling date / time	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00
Compound	CAS Number	LOR	Unit	EP2003111-009	EP2003111-010	EP2003111-011	EP2003111-013	EP2003111-015
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	36.3	36.4	34.7	24.5	27.4
EN68: Seawater Elutriate Testing Procedure								
Seawater Sampling Date	----	-	-	28/03/2020	----	28/03/2020	----	28/03/2020
EP231A: Perfluoroalkyl Sulfonic Acids								
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
EP231B: Perfluoroalkyl Carboxylic Acids								
Perfluorobutanoic acid (PFBA)	375-22-4	0.001	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorohexanoic acid (PFHxA)	307-24-4	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorooctanoic acid (PFOA)	335-67-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorononanoic acid (PFNA)	375-95-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorodecanoic acid (PFDA)	335-76-2	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EP231C: Perfluoroalkyl Sulfonamides								
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C03S03	C04S01	C04S02	C05S01	C05S03
			Client sampling date / time	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00
Compound	CAS Number	LOR	Unit	EP2003111-009	EP2003111-010	EP2003111-011	EP2003111-013	EP2003111-015
				Result	Result	Result	Result	Result
EP231C: Perfluoroalkyl Sulfonamides - Continued								
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
EP231D: (n:2) Fluorotelomer Sulfonic Acids								
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EP231P: PFAS Sums								
Sum of PFAS	----	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Sum of PFAS (WA DER List)	----	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
EP231S: PFAS Surrogate								
13C4-PFOS	----	0.0002	%	**102**	**108**	**98.5**	**98.5**	**114**
13C8-PFOA	----	0.0002	%	**98.5**	**100**	**97.0**	**95.0**	**100**

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C06S01	C06S02	C07S01	C07S03	SZ1
			Client sampling date / time	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00
Compound	CAS Number	LOR	Unit	EP2003111-016	EP2003111-017	EP2003111-019	EP2003111-021	EP2003111-022
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	29.5	28.2	16.9	20.4	31.7
EN68: Seawater Elutriate Testing Procedure								
Seawater Sampling Date	----	-	-	----	28/03/2020	28/03/2020	----	----
EP231A: Perfluoroalkyl Sulfonic Acids								
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
EP231B: Perfluoroalkyl Carboxylic Acids								
Perfluorobutanoic acid (PFBA)	375-22-4	0.001	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorohexanoic acid (PFHxA)	307-24-4	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorooctanoic acid (PFOA)	335-67-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorononanoic acid (PFNA)	375-95-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorodecanoic acid (PFDA)	335-76-2	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EP231C: Perfluoroalkyl Sulfonamides								
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	C06S01	C06S02	C07S01	C07S03	SZ1
			Client sampling date / time	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00
Compound	CAS Number	LOR	Unit	EP2003111-016	EP2003111-017	EP2003111-019	EP2003111-021	EP2003111-022
				Result	Result	Result	Result	Result
EP231C: Perfluoroalkyl Sulfonamides - Continued								
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
EP231D: (n:2) Fluorotelomer Sulfonic Acids								
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EP231P: PFAS Sums								
Sum of PFAS	----	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Sum of PFAS (WA DER List)	----	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
EP231S: PFAS Surrogate								
13C4-PFOS	----	0.0002	%	**111**	**102**	**98.0**	**108**	**93.5**
13C8-PFOA	----	0.0002	%	**99.0**	**99.5**	**102**	**108**	**94.5**

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	SZ2	EW	----	----	----
			Client sampling date / time	23-Mar-2020 00:00	23-Mar-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EP2003111-023	EP2003111-035	--------	--------	--------
				Result	Result	----	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**31.0**	----	----	----	----
EN68: Seawater Elutriate Testing Procedure								
Seawater Sampling Date	----	-	-	----	**28/03/2020**	----	----	----
EP231A: Perfluoroalkyl Sulfonic Acids								
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0002	mg/kg	<0.0002	----	----	----	----
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0002	mg/kg	<0.0002	----	----	----	----
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0002	mg/kg	<0.0002	----	----	----	----
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0002	mg/kg	<0.0002	----	----	----	----
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	mg/kg	<0.0002	----	----	----	----
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0002	mg/kg	<0.0002	----	----	----	----
EP231B: Perfluoroalkyl Carboxylic Acids								
Perfluorobutanoic acid (PFBA)	375-22-4	0.001	mg/kg	<0.001	----	----	----	----
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0002	mg/kg	<0.0002	----	----	----	----
Perfluorohexanoic acid (PFHxA)	307-24-4	0.0002	mg/kg	<0.0002	----	----	----	----
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0002	mg/kg	<0.0002	----	----	----	----
Perfluorooctanoic acid (PFOA)	335-67-1	0.0002	mg/kg	<0.0002	----	----	----	----
Perfluorononanoic acid (PFNA)	375-95-1	0.0002	mg/kg	<0.0002	----	----	----	----
Perfluorodecanoic acid (PFDA)	335-76-2	0.0002	mg/kg	<0.0002	----	----	----	----
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0002	mg/kg	<0.0002	----	----	----	----
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0002	mg/kg	<0.0002	----	----	----	----
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0002	mg/kg	<0.0002	----	----	----	----
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	mg/kg	<0.0005	----	----	----	----
EP231C: Perfluoroalkyl Sulfonamides								
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0002	mg/kg	<0.0002	----	----	----	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	SZ2	EW	----	----	----
			Client sampling date / time	23-Mar-2020 00:00	23-Mar-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EP2003111-023	EP2003111-035	--------	--------	--------
				Result	Result	----	----	----
EP231C: Perfluoroalkyl Sulfonamides - Continued								
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.0005	mg/kg	<0.0005	----	----	----	----
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.0005	mg/kg	<0.0005	----	----	----	----
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.0005	mg/kg	<0.0005	----	----	----	----
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.0005	mg/kg	<0.0005	----	----	----	----
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0002	mg/kg	<0.0002	----	----	----	----
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0002	mg/kg	<0.0002	----	----	----	----
EP231D: (n:2) Fluorotelomer Sulfonic Acids								
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.0005	mg/kg	<0.0005	----	----	----	----
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.0005	mg/kg	<0.0005	----	----	----	----
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.0005	mg/kg	<0.0005	----	----	----	----
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.0005	mg/kg	<0.0005	----	----	----	----
EP231P: PFAS Sums								
Sum of PFAS	----	0.0002	mg/kg	<0.0002	----	----	----	----
Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	mg/kg	<0.0002	----	----	----	----
Sum of PFAS (WA DER List)	----	0.0002	mg/kg	<0.0002	----	----	----	----
EP231S: PFAS Surrogate								
13C4-PFOS	----	0.0002	%	**94.0**	----	----	----	----
13C8-PFOA	----	0.0002	%	**96.0**	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	WZ1	WZ2	WR1	WR2	WB1
			Client sampling date / time	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00
Compound	CAS Number	LOR	Unit	EP2003111-024	EP2003111-025	EP2003111-026	EP2003111-027	EP2003111-028
				Result	Result	Result	Result	Result
EP231A: Perfluoroalkyl Sulfonic Acids								
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	µg/L	**0.0006**	**0.0003**	<0.0002	**0.0003**	<0.0002
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EP231B: Perfluoroalkyl Carboxylic Acids								
Perfluorobutanoic acid (PFBA)	375-22-4	0.0020	µg/L	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorohexanoic acid (PFHxA)	307-24-4	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorooctanoic acid (PFOA)	335-67-1	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorononanoic acid (PFNA)	375-95-1	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorodecanoic acid (PFDA)	335-76-2	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EP231C: Perfluoroalkyl Sulfonamides								
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	WZ1	WZ2	WR1	WR2	WB1
			Client sampling date / time	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00
Compound	CAS Number	LOR	Unit	EP2003111-024	EP2003111-025	EP2003111-026	EP2003111-027	EP2003111-028
				Result	Result	Result	Result	Result
EP231C: Perfluoroalkyl Sulfonamides - Continued								
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EP231D: (n:2) Fluorotelomer Sulfonic Acids								
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
EP231P: PFAS Sums								
^ Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	µg/L	**0.0006**	**0.0003**	<0.0002	**0.0003**	<0.0002
^ Sum of PFAS (WA DER List)	----	0.0002	µg/L	**0.0006**	**0.0003**	<0.0002	**0.0003**	<0.0002
^ Sum of PFAS	----	0.0002	µg/L	**0.0006**	**0.0003**	<0.0002	**0.0003**	<0.0002
EP231S: PFAS Surrogate								
13C4-PFOS	----	0.0005	%	**95.8**	**110**	**96.5**	**96.3**	**96.2**
13C8-PFOA	----	0.0005	%	**86.1**	**82.7**	**86.3**	**82.5**	**86.2**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	TBW 197	TBW 168	C01-SW	C04-SW	C06-SW
			Client sampling date / time	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00
Compound	CAS Number	LOR	Unit	EP2003111-029	EP2003111-030	EP2003111-032	EP2003111-033	EP2003111-034
				Result	Result	Result	Result	Result
EP231A: Perfluoroalkyl Sulfonic Acids								
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	µg/L	<0.0002	<0.0002	<0.0002	<0.0002	**0.0002**
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EP231B: Perfluoroalkyl Carboxylic Acids								
Perfluorobutanoic acid (PFBA)	375-22-4	0.0020	µg/L	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorohexanoic acid (PFHxA)	307-24-4	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorooctanoic acid (PFOA)	335-67-1	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorononanoic acid (PFNA)	375-95-1	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorodecanoic acid (PFDA)	335-76-2	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EP231C: Perfluoroalkyl Sulfonamides								
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	TBW 197	TBW 168	C01-SW	C04-SW	C06-SW
			Client sampling date / time	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00	23-Mar-2020 00:00
Compound	CAS Number	LOR	Unit	EP2003111-029	EP2003111-030	EP2003111-032	EP2003111-033	EP2003111-034
				Result	Result	Result	Result	Result
EP231C: Perfluoroalkyl Sulfonamides - Continued								
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0005	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EP231D: (n:2) Fluorotelomer Sulfonic Acids								
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.001	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001
EP231P: PFAS Sums								
^ Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	µg/L	<0.0002	<0.0002	<0.0002	<0.0002	**0.0002**
^ Sum of PFAS (WA DER List)	----	0.0002	µg/L	<0.0002	<0.0002	<0.0002	<0.0002	**0.0002**
^ Sum of PFAS	----	0.0002	µg/L	<0.0002	<0.0002	<0.0002	<0.0002	**0.0002**
EP231S: PFAS Surrogate								
13C4-PFOS	----	0.0005	%	**93.0**	**91.8**	**99.6**	**91.9**	**82.7**
13C8-PFOA	----	0.0005	%	**86.6**	**84.5**	**89.1**	**81.3**	**77.6**

Surrogate Control Limits

Sub-Matrix: **ELUTRIATE**

Compound	CAS Number	Recovery Limits (%) Low	High
EP231S: PFAS Surrogate			
13C4-PFOS	----	60	120
13C8-PFOA	----	60	120

Sub-Matrix: **SEAWATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP231S: PFAS Surrogate			
13C4-PFOS	----	60	120
13C8-PFOA	----	60	120

Sub-Matrix: **SEDIMENT**

Compound	CAS Number	Recovery Limits (%) Low	High
EP231S: PFAS Surrogate			
13C4-PFOS	----	60	120
13C8-PFOA	----	60	120

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP231S: PFAS Surrogate			
13C4-PFOS	----	60	120
13C8-PFOA	----	60	120

QUALITY CONTROL REPORT

Work Order	: **EP2003111**	Page	: 1 of 9
Client	: **RPS Australia West Pty Ltd**	Laboratory	: Environmental Division Perth
Contact	: ALAN FOLEY	Contact	: Lauren Biagioni
Address	: PO BOX 170 WEST PERTH WA 6872	Address	: 26 Rigali Way Wangara WA Australia 6065
Telephone	: ----	Telephone	: 08 9406 1307
Project	: EEC19032.012	Date Samples Received	: 24-Mar-2020
Order number	: ----	Date Analysis Commenced	: 27-Mar-2020
C-O-C number	: ----	Issue Date	: 17-Apr-2020
Sampler	: SMW		
Site	: Rottnest Army Jetty		
Quote number	: EP/705/19		
No. of samples received	: 36		
No. of samples analysed	: 28		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Franco Lentini	LCMS Coordinator	Sydney Inorganics, Smithfield, NSW
Franco Lentini	LCMS Coordinator	Sydney Organics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA055: Moisture Content (Dried @ 105-110°C) (QC Lot: 2942102)									
EP2003067-003	Anonymous	EA055: Moisture Content	----	0.1	%	3.3	3.5	7.91	0% - 20%
EP2003111-013	C05S01	EA055: Moisture Content	----	0.1	%	24.5	25.2	2.98	0% - 20%
EA055: Moisture Content (Dried @ 105-110°C) (QC Lot: 2942103)									
EP2003126-002	Anonymous	EA055: Moisture Content	----	0.1	%	10.6	11.7	9.68	0% - 20%
EP2003126-014	Anonymous	EA055: Moisture Content	----	0.1	%	9.8	9.8	0.00	0% - 20%
EP231A: Perfluoroalkyl Sulfonic Acids (QC Lot: 2951026)									
EP2003111-001	C01S01	EP231X: Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
EP2003111-017	C06S02	EP231X: Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
EP231B: Perfluoroalkyl Carboxylic Acids (QC Lot: 2951026)									
EP2003111-001	C01S01	EP231X: Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorohexanoic acid (PFHxA)	307-24-4	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorooctanoic acid (PFOA)	335-67-1	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorononanoic acid (PFNA)	375-95-1	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP231B: Perfluoroalkyl Carboxylic Acids (QC Lot: 2951026) - continued									
EP2003111-001	C01S01	EP231X: Perfluorodecanoic acid (PFDA)	335-76-2	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
		EP231X: Perfluorobutanoic acid (PFBA)	375-22-4	0.001	mg/kg	<0.001	<0.001	0.00	No Limit
EP2003111-017	C06S02	EP231X: Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorohexanoic acid (PFHxA)	307-24-4	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorooctanoic acid (PFOA)	335-67-1	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorononanoic acid (PFNA)	375-95-1	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorodecanoic acid (PFDA)	335-76-2	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
		EP231X: Perfluorobutanoic acid (PFBA)	375-22-4	0.001	mg/kg	<0.001	<0.001	0.00	No Limit
EP231C: Perfluoroalkyl Sulfonamides (QC Lot: 2951026)									
EP2003111-001	C01S01	EP231X: Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
		EP231X: N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
		EP231X: N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
		EP231X: N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
EP2003111-017	C06S02	EP231X: Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0002	mg/kg	<0.0002	<0.0002	0.00	No Limit
		EP231X: N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
		EP231X: N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP231C: Perfluoroalkyl Sulfonamides (QC Lot: 2951026) - continued									
EP2003111-017	C06S02	EP231X: N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
		EP231X: N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
EP231D: (n:2) Fluorotelomer Sulfonic Acids (QC Lot: 2951026)									
EP2003111-001	C01S01	EP231X: 4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
		EP231X: 6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
		EP231X: 8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
		EP231X: 10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
EP2003111-017	C06S02	EP231X: 4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
		EP231X: 6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
		EP231X: 8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit
		EP231X: 10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.0005	mg/kg	<0.0005	<0.0005	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EP231A: Perfluoroalkyl Sulfonic Acids (QCLot: 2951026)								
EP231X: Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0002	mg/kg	<0.0002	0.00125 mg/kg	110	70.0	130
EP231X: Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0002	mg/kg	<0.0002	0.00125 mg/kg	125	70.0	130
EP231X: Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0002	mg/kg	<0.0002	0.00125 mg/kg	111	70.0	130
EP231X: Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0002	mg/kg	<0.0002	0.00125 mg/kg	122	70.0	130
EP231X: Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	mg/kg	<0.0002	0.00125 mg/kg	103	70.0	130
EP231X: Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0002	mg/kg	<0.0002	0.00125 mg/kg	114	70.0	130
EP231B: Perfluoroalkyl Carboxylic Acids (QCLot: 2951026)								
EP231X: Perfluorobutanoic acid (PFBA)	375-22-4	0.001	mg/kg	<0.001	0.00625 mg/kg	108	70.0	130
EP231X: Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0002	mg/kg	<0.0002	0.00125 mg/kg	122	70.0	130
EP231X: Perfluorohexanoic acid (PFHxA)	307-24-4	0.0002	mg/kg	<0.0002	0.00125 mg/kg	109	70.0	130
EP231X: Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0002	mg/kg	<0.0002	0.00125 mg/kg	106	70.0	130
EP231X: Perfluorooctanoic acid (PFOA)	335-67-1	0.0002	mg/kg	<0.0002	0.00125 mg/kg	112	70.0	130
EP231X: Perfluorononanoic acid (PFNA)	375-95-1	0.0002	mg/kg	<0.0002	0.00125 mg/kg	123	70.0	130
EP231X: Perfluorodecanoic acid (PFDA)	335-76-2	0.0002	mg/kg	<0.0002	0.00125 mg/kg	107	70.0	130
EP231X: Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0002	mg/kg	<0.0002	0.00125 mg/kg	111	70.0	130
EP231X: Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0002	mg/kg	<0.0002	0.00125 mg/kg	97.2	70.0	130
EP231X: Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0002	mg/kg	<0.0002	0.00125 mg/kg	81.6	70.0	130
EP231X: Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	mg/kg	<0.0005	0.00312 mg/kg	118	70.0	130
EP231C: Perfluoroalkyl Sulfonamides (QCLot: 2951026)								
EP231X: Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0002	mg/kg	<0.0002	0.00125 mg/kg	112	70.0	130
EP231X: N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.0005	mg/kg	<0.0005	0.00312 mg/kg	103	70.0	130
EP231X: N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.0005	mg/kg	<0.0005	0.00312 mg/kg	115	70.0	130
EP231X: N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.0005	mg/kg	<0.0005	0.00312 mg/kg	96.0	70.0	130
EP231X: N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.0005	mg/kg	<0.0005	0.00312 mg/kg	127	70.0	130
EP231X: N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0002	mg/kg	<0.0002	0.00125 mg/kg	126	70.0	130
EP231X: N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0002	mg/kg	<0.0002	0.00125 mg/kg	111	70.0	130
EP231D: (n:2) Fluorotelomer Sulfonic Acids (QCLot: 2951026)								
EP231X: 4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.0005	mg/kg	<0.0005	0.00125 mg/kg	103	70.0	130
EP231X: 6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.0005	mg/kg	<0.0005	0.00125 mg/kg	104	70.0	130
EP231X: 8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.0005	mg/kg	<0.0005	0.00125 mg/kg	110	70.0	130

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%) Low	Recovery Limits (%) High
EP231D: (n:2) Fluorotelomer Sulfonic Acids (QCLot: 2951026) - continued								
EP231X: 10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.0005	mg/kg	<0.0005	0.00125 mg/kg	126	70.0	130

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%) Low	Recovery Limits (%) High
EP231A: Perfluoroalkyl Sulfonic Acids (QCLot: 2944249)								
EP231X-SUT: Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0005	µg/L	<0.0005	0.004 µg/L	86.8	50.0	130
EP231X-SUT: Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0005	µg/L	<0.0005	0.004 µg/L	93.6	50.0	130
EP231X-SUT: Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0005	µg/L	<0.0005	0.004 µg/L	86.0	50.0	130
EP231X-SUT: Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0005	µg/L	<0.0005	0.004 µg/L	111	50.0	130
EP231X-SUT: Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	µg/L	<0.0002	0.004 µg/L	92.8	50.0	130
EP231X-SUT: Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0005	µg/L	<0.0005	0.004 µg/L	82.0	50.0	130
EP231A: Perfluoroalkyl Sulfonic Acids (QCLot: 2945083)								
EP231X-SUT: Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0005	µg/L	<0.0005	0.004 µg/L	76.0	50.0	130
EP231X-SUT: Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0005	µg/L	<0.0005	0.004 µg/L	75.2	50.0	130
EP231X-SUT: Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0005	µg/L	<0.0005	0.004 µg/L	90.0	50.0	130
EP231X-SUT: Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0005	µg/L	<0.0005	0.004 µg/L	86.4	50.0	130
EP231X-SUT: Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	µg/L	<0.0002	0.004 µg/L	63.2	50.0	130
EP231X-SUT: Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0005	µg/L	<0.0005	0.004 µg/L	70.4	50.0	130
EP231B: Perfluoroalkyl Carboxylic Acids (QCLot: 2944249)								
EP231X-SUT: Perfluorobutanoic acid (PFBA)	375-22-4	0.002	µg/L	<0.0020	0.02 µg/L	94.6	30.0	130
EP231X-SUT: Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0005	µg/L	<0.0005	0.004 µg/L	97.2	50.0	130
EP231X-SUT: Perfluorohexanoic acid (PFHxA)	307-24-4	0.0005	µg/L	<0.0005	0.004 µg/L	94.0	50.0	130
EP231X-SUT: Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0005	µg/L	<0.0005	0.004 µg/L	102	50.0	130
EP231X-SUT: Perfluorooctanoic acid (PFOA)	335-67-1	0.0005	µg/L	<0.0005	0.004 µg/L	87.6	50.0	130
EP231X-SUT: Perfluorononanoic acid (PFNA)	375-95-1	0.0005	µg/L	<0.0005	0.004 µg/L	91.2	50.0	130
EP231X-SUT: Perfluorodecanoic acid (PFDA)	335-76-2	0.0005	µg/L	<0.0005	0.004 µg/L	92.4	50.0	130
EP231X-SUT: Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0005	µg/L	<0.0005	0.004 µg/L	79.2	40.0	130
EP231X-SUT: Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0005	µg/L	<0.0005	0.004 µg/L	118	40.0	130
EP231X-SUT: Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0005	µg/L	<0.0005	0.004 µg/L	75.2	40.0	130
EP231X-SUT: Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	µg/L	<0.0005	0.01 µg/L	101	40.0	130
EP231B: Perfluoroalkyl Carboxylic Acids (QCLot: 2945083)								
EP231X-SUT: Perfluorobutanoic acid (PFBA)	375-22-4	0.002	µg/L	<0.0020	0.02 µg/L	100	30.0	130
EP231X-SUT: Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0005	µg/L	<0.0005	0.004 µg/L	96.0	50.0	130
EP231X-SUT: Perfluorohexanoic acid (PFHxA)	307-24-4	0.0005	µg/L	<0.0005	0.004 µg/L	98.0	50.0	130
EP231X-SUT: Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0005	µg/L	<0.0005	0.004 µg/L	88.4	50.0	130
EP231X-SUT: Perfluorooctanoic acid (PFOA)	335-67-1	0.0005	µg/L	<0.0005	0.004 µg/L	90.4	50.0	130
EP231X-SUT: Perfluorononanoic acid (PFNA)	375-95-1	0.0005	µg/L	<0.0005	0.004 µg/L	96.0	50.0	130
EP231X-SUT: Perfluorodecanoic acid (PFDA)	335-76-2	0.0005	µg/L	<0.0005	0.004 µg/L	78.8	50.0	130

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EP231B: Perfluoroalkyl Carboxylic Acids (QCLot: 2945083) - continued								
EP231X-SUT: Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0005	µg/L	<0.0005	0.004 µg/L	88.0	40.0	130
EP231X-SUT: Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0005	µg/L	<0.0005	0.004 µg/L	114	40.0	130
EP231X-SUT: Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0005	µg/L	<0.0005	0.004 µg/L	73.2	40.0	130
EP231X-SUT: Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	µg/L	<0.0005	0.01 µg/L	94.1	40.0	130
EP231C: Perfluoroalkyl Sulfonamides (QCLot: 2944249)								
EP231X-SUT: Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0005	µg/L	<0.0005	0.004 µg/L	89.2	40.0	130
EP231X-SUT: N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.001	µg/L	<0.001	0.01 µg/L	73.8	40.0	130
EP231X-SUT: N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.001	µg/L	<0.001	0.01 µg/L	72.2	40.0	130
EP231X-SUT: N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.001	µg/L	<0.001	0.01 µg/L	104	40.0	130
EP231X-SUT: N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.001	µg/L	<0.001	0.01 µg/L	106	40.0	130
EP231X-SUT: N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0005	µg/L	<0.0005	0.004 µg/L	112	40.0	130
EP231X-SUT: N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0005	µg/L	<0.0005	0.004 µg/L	80.8	40.0	130
EP231C: Perfluoroalkyl Sulfonamides (QCLot: 2945083)								
EP231X-SUT: Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0005	µg/L	<0.0005	0.004 µg/L	90.0	40.0	130
EP231X-SUT: N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.001	µg/L	<0.001	0.01 µg/L	99.7	40.0	130
EP231X-SUT: N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.001	µg/L	<0.001	0.01 µg/L	87.2	40.0	130
EP231X-SUT: N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.001	µg/L	<0.001	0.01 µg/L	93.6	40.0	130
EP231X-SUT: N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.001	µg/L	<0.001	0.01 µg/L	96.0	40.0	130
EP231X-SUT: N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0005	µg/L	<0.0005	0.004 µg/L	89.2	40.0	130
EP231X-SUT: N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0005	µg/L	<0.0005	0.004 µg/L	79.2	40.0	130
EP231D: (n:2) Fluorotelomer Sulfonic Acids (QCLot: 2944249)								
EP231X-SUT: 4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.001	µg/L	<0.001	0.004 µg/L	76.4	50.0	130
EP231X-SUT: 6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.001	µg/L	<0.001	0.004 µg/L	86.0	50.0	130
EP231X-SUT: 8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.001	µg/L	<0.001	0.004 µg/L	98.8	50.0	130
EP231X-SUT: 10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.001	µg/L	<0.001	0.004 µg/L	114	50.0	130
EP231D: (n:2) Fluorotelomer Sulfonic Acids (QCLot: 2945083)								
EP231X-SUT: 4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.001	µg/L	<0.001	0.004 µg/L	74.8	50.0	130

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
EP231D: (n:2) Fluorotelomer Sulfonic Acids (QCLot: 2945083) - continued								
EP231X-SUT: 6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.001	µg/L	<0.001	0.004 µg/L	82.8	50.0	130
EP231X-SUT: 8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.001	µg/L	<0.001	0.004 µg/L	86.8	50.0	130
EP231X-SUT: 10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.001	µg/L	<0.001	0.004 µg/L	68.8	50.0	130
EP231P: PFAS Sums (QCLot: 2944249)								
EP231X-SUT: Sum of PFHxS and PFOS	355-46-4/17 63-23-1	0.0002	µg/L	<0.0002	----	----	----	----
EP231X-SUT: Sum of PFAS (WA DER List)	----	0.0002	µg/L	<0.0002	----	----	----	----
EP231X-SUT: Sum of PFAS	----	0.0002	µg/L	<0.0002	----	----	----	----
EP231P: PFAS Sums (QCLot: 2945083)								
EP231X-SUT: Sum of PFHxS and PFOS	355-46-4/17 63-23-1	0.0002	µg/L	<0.0002	----	----	----	----
EP231X-SUT: Sum of PFAS (WA DER List)	----	0.0002	µg/L	<0.0002	----	----	----	----
EP231X-SUT: Sum of PFAS	----	0.0002	µg/L	<0.0002	----	----	----	----

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%): MS	Recovery Limits (%): Low	Recovery Limits (%): High
EP231A: Perfluoroalkyl Sulfonic Acids (QCLot: 2951026)							
EP2003111-001	C01S01	EP231X: Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.00125 mg/kg	100	50.0	130
		EP231X: Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.00125 mg/kg	122	50.0	130
		EP231X: Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.00125 mg/kg	110	50.0	130
		EP231X: Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.00125 mg/kg	111	50.0	130
		EP231X: Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.00125 mg/kg	106	50.0	130
		EP231X: Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.00125 mg/kg	123	50.0	130
EP231B: Perfluoroalkyl Carboxylic Acids (QCLot: 2951026)							
EP2003111-001	C01S01	EP231X: Perfluorobutanoic acid (PFBA)	375-22-4	0.00625 mg/kg	110	30.0	130
		EP231X: Perfluoropentanoic acid (PFPeA)	2706-90-3	0.00125 mg/kg	123	50.0	130
		EP231X: Perfluorohexanoic acid (PFHxA)	307-24-4	0.00125 mg/kg	117	50.0	130
		EP231X: Perfluoroheptanoic acid (PFHpA)	375-85-9	0.00125 mg/kg	116	50.0	130
		EP231X: Perfluorooctanoic acid (PFOA)	335-67-1	0.00125 mg/kg	111	50.0	130
		EP231X: Perfluorononanoic acid (PFNA)	375-95-1	0.00125 mg/kg	116	50.0	130
		EP231X: Perfluorodecanoic acid (PFDA)	335-76-2	0.00125 mg/kg	107	50.0	130
		EP231X: Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.00125 mg/kg	112	50.0	130
		EP231X: Perfluorododecanoic acid (PFDoDA)	307-55-1	0.00125 mg/kg	123	50.0	130

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%) MS	Recovery Limits (%) Low	High
EP231B: Perfluoroalkyl Carboxylic Acids (QCLot: 2951026) - continued							
EP2003111-001	C01S01	EP231X: Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.00125 mg/kg	99.2	30.0	130
		EP231X: Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.00312 mg/kg	123	30.0	130
EP231C: Perfluoroalkyl Sulfonamides (QCLot: 2951026)							
EP2003111-001	C01S01	EP231X: Perfluorooctane sulfonamide (FOSA)	754-91-6	0.00125 mg/kg	110	50.0	130
		EP231X: N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.00312 mg/kg	99.7	30.0	130
		EP231X: N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.00312 mg/kg	111	30.0	130
		EP231X: N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.00312 mg/kg	103	30.0	130
		EP231X: N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.00312 mg/kg	123	30.0	130
		EP231X: N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.00125 mg/kg	121	30.0	130
		EP231X: N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.00125 mg/kg	107	30.0	130
EP231D: (n:2) Fluorotelomer Sulfonic Acids (QCLot: 2951026)							
EP2003111-001	C01S01	EP231X: 4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.00125 mg/kg	103	50.0	130
		EP231X: 6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.00125 mg/kg	96.0	50.0	130
		EP231X: 8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.00125 mg/kg	93.2	50.0	130
		EP231X: 10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.00125 mg/kg	123	50.0	130

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EP2003111**	Page	: 1 of 8
Client	: **RPS Australia West Pty Ltd**	Laboratory	: Environmental Division Perth
Contact	: ALAN FOLEY	Telephone	: 08 9406 1307
Project	: EEC19032.012	Date Samples Received	: 24-Mar-2020
Site	: Rottnest Army Jetty	Issue Date	: 17-Apr-2020
Sampler	: SMW	No. of samples received	: 36
Order number	: ----	No. of samples analysed	: 28

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type / Method	Count QC	Count Regular	Rate (%) Actual	Rate (%) Expected	Quality Control Specification
Laboratory Duplicates (DUP)					
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	0	19	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	0	19	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / *Container / Client Sample ID(s)*	*Sample Date*	*Extraction / Preparation* Date extracted	Due for extraction	Evaluation	*Analysis* Date analysed	Due for analysis	Evaluation
EA055: Moisture Content (Dried @ 105-110°C)							
HDPE Soil Jar (EA055)							
C01S01, C01S03, C02S01, C02S02, C03S01, C03S03, C04S01, C04S02, C05S01, C05S03, C06S01, C06S02, C07S01, C07S03, SZ1, SZ2	**23-Mar-2020**	**----**	----	----	**27-Mar-2020**	06-Apr-2020	✓
EN68: Seawater Elutriate Testing Procedure							
Non-Volatile Leach: 180 day HT (e.g. PFAS, metals ex.Hg) (EN68a)							
C01S01, C02S01, C03S03, C04S02, C05S03, C06S02, C07S01, EW	**23-Mar-2020**	**28-Mar-2020**	19-Sep-2020	✓	**----**	----	----

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP231A: Perfluoroalkyl Sulfonic Acids								
HDPE Soil Jar (EP231X)								
C01S01,	C01S03,	**23-Mar-2020**	**03-Apr-2020**	19-Sep-2020	✓	**06-Apr-2020**	13-May-2020	✓
C02S01,	C02S02,							
C03S01,	C03S03,							
C04S01,	C04S02,							
C05S01,	C05S03,							
C06S01,	C06S02,							
C07S01,	C07S03,							
SZ1,	SZ2							
EP231B: Perfluoroalkyl Carboxylic Acids								
HDPE Soil Jar (EP231X)								
C01S01,	C01S03,	**23-Mar-2020**	**03-Apr-2020**	19-Sep-2020	✓	**06-Apr-2020**	13-May-2020	✓
C02S01,	C02S02,							
C03S01,	C03S03,							
C04S01,	C04S02,							
C05S01,	C05S03,							
C06S01,	C06S02,							
C07S01,	C07S03,							
SZ1,	SZ2							
EP231C: Perfluoroalkyl Sulfonamides								
HDPE Soil Jar (EP231X)								
C01S01,	C01S03,	**23-Mar-2020**	**03-Apr-2020**	19-Sep-2020	✓	**06-Apr-2020**	13-May-2020	✓
C02S01,	C02S02,							
C03S01,	C03S03,							
C04S01,	C04S02,							
C05S01,	C05S03,							
C06S01,	C06S02,							
C07S01,	C07S03,							
SZ1,	SZ2							
EP231D: (n:2) Fluorotelomer Sulfonic Acids								
HDPE Soil Jar (EP231X)								
C01S01,	C01S03,	**23-Mar-2020**	**03-Apr-2020**	19-Sep-2020	✓	**06-Apr-2020**	13-May-2020	✓
C02S01,	C02S02,							
C03S01,	C03S03,							
C04S01,	C04S02,							
C05S01,	C05S03,							
C06S01,	C06S02,							
C07S01,	C07S03,							
SZ1,	SZ2							

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP231P: PFAS Sums								
HDPE Soil Jar (EP231X)								
C01S01,	C01S03,	**23-Mar-2020**	**03-Apr-2020**	19-Sep-2020	✓	**06-Apr-2020**	13-May-2020	✓
C02S01,	C02S02,							
C03S01,	C03S03,							
C04S01,	C04S02,							
C05S01,	C05S03,							
C06S01,	C06S02,							
C07S01,	C07S03,							
SZ1,	SZ2							

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP231A: Perfluoroalkyl Sulfonic Acids								
Clear Plastic Bottle - Natural (EP231X-SUT)								
Matrix Blank		**23-Mar-2020**	**03-Apr-2020**	19-Sep-2020	✓	**06-Apr-2020**	19-Sep-2020	✓
HDPE (no PTFE) (EP231X-SUT)								
WZ1,	WZ2,	**23-Mar-2020**	**03-Apr-2020**	19-Sep-2020	✓	**06-Apr-2020**	19-Sep-2020	✓
WR1,	WR2,							
WB1,	TBW 197,							
TBW 168,	C01-SW,							
C04-SW,	C06-SW							
HDPE (no PTFE) (EP231X-SUT)								
C01S01,	C02S01,	**28-Mar-2020**	**03-Apr-2020**	24-Sep-2020	✓	**06-Apr-2020**	24-Sep-2020	✓
C03S03,	C04S02,							
C05S03,	C06S02,							
C07S01,	EW							
EP231B: Perfluoroalkyl Carboxylic Acids								
Clear Plastic Bottle - Natural (EP231X-SUT)								
Matrix Blank		**23-Mar-2020**	**03-Apr-2020**	19-Sep-2020	✓	**06-Apr-2020**	19-Sep-2020	✓
HDPE (no PTFE) (EP231X-SUT)								
WZ1,	WZ2,	**23-Mar-2020**	**03-Apr-2020**	19-Sep-2020	✓	**06-Apr-2020**	19-Sep-2020	✓
WR1,	WR2,							
WB1,	TBW 197,							
TBW 168,	C01-SW,							
C04-SW,	C06-SW							
HDPE (no PTFE) (EP231X-SUT)								
C01S01,	C02S01,	**28-Mar-2020**	**03-Apr-2020**	24-Sep-2020	✓	**06-Apr-2020**	24-Sep-2020	✓
C03S03,	C04S02,							
C05S03,	C06S02,							
C07S01,	EW							

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP231C: Perfluoroalkyl Sulfonamides							
Clear Plastic Bottle - Natural (EP231X-SUT) Matrix Blank	**23-Mar-2020**	**03-Apr-2020**	19-Sep-2020	✓	**06-Apr-2020**	19-Sep-2020	✓
HDPE (no PTFE) (EP231X-SUT) WZ1, WZ2, WR1, WR2, WB1, TBW 197, TBW 168, C01-SW, C04-SW, C06-SW	**23-Mar-2020**	**03-Apr-2020**	19-Sep-2020	✓	**06-Apr-2020**	19-Sep-2020	✓
HDPE (no PTFE) (EP231X-SUT) C01S01, C02S01, C03S03, C04S02, C05S03, C06S02, C07S01, EW	**28-Mar-2020**	**03-Apr-2020**	24-Sep-2020	✓	**06-Apr-2020**	24-Sep-2020	✓
EP231D: (n:2) Fluorotelomer Sulfonic Acids							
Clear Plastic Bottle - Natural (EP231X-SUT) Matrix Blank	**23-Mar-2020**	**03-Apr-2020**	19-Sep-2020	✓	**06-Apr-2020**	19-Sep-2020	✓
HDPE (no PTFE) (EP231X-SUT) WZ1, WZ2, WR1, WR2, WB1, TBW 197, TBW 168, C01-SW, C04-SW, C06-SW	**23-Mar-2020**	**03-Apr-2020**	19-Sep-2020	✓	**06-Apr-2020**	19-Sep-2020	✓
HDPE (no PTFE) (EP231X-SUT) C01S01, C02S01, C03S03, C04S02, C05S03, C06S02, C07S01, EW	**28-Mar-2020**	**03-Apr-2020**	24-Sep-2020	✓	**06-Apr-2020**	24-Sep-2020	✓
EP231P: PFAS Sums							
Clear Plastic Bottle - Natural (EP231X-SUT) Matrix Blank	**23-Mar-2020**	**03-Apr-2020**	19-Sep-2020	✓	**06-Apr-2020**	19-Sep-2020	✓
HDPE (no PTFE) (EP231X-SUT) WZ1, WZ2, WR1, WR2, WB1, TBW 197, TBW 168, C01-SW, C04-SW, C06-SW	**23-Mar-2020**	**03-Apr-2020**	19-Sep-2020	✓	**06-Apr-2020**	19-Sep-2020	✓
HDPE (no PTFE) (EP231X-SUT) C01S01, C02S01, C03S03, C04S02, C05S03, C06S02, C07S01, EW	**28-Mar-2020**	**03-Apr-2020**	24-Sep-2020	✓	**06-Apr-2020**	24-Sep-2020	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Moisture Content	EA055	4	32	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X-SUT	0	19	**0.00**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X-SUT	2	19	**10.53**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X-SUT	2	19	**10.53**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X-SUT	0	19	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Moisture Content	EA055	SOIL	In house: A gravimetric procedure based on weight loss over a 12 hour drying period at 105-110 degrees C. This method is compliant with NEPM (2013) Schedule B(3) Section 6.1 and Table 1 (14 day holding time).
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X	SOIL	In-house: Analysis of soils by solvent extraction followed by LC-Electrospray-MS-MS, Negative Mode using MRM using internal standard quantitation. Isotopically labelled analogues of target analytes used as internal standards and surrogates are added to a portion of soil which is then extracted with MTBE and an ion pairing reagent. A portion of extract is exchanged into the analytical solvent mixture, combined with an equal volume reagent water and filtered for analysis. Method procedures and data quality objectives conform to US DoD QSM 5.3, table B-15 requirements.
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X-SUT	SOIL	In-house: Analysis of fresh and saline waters by Solid Phase Extraction (SPE) followed by LC-Electrospray-MS-MS, Negative Mode using MRM and internal standard quantitation. Isotopically labelled analogues of target analytes used as internal standards and surrogates are added to the sample container. The entire contents are transferred to a solid phase extraction (SPE) cartridge. The sample container is successively rinsed with aliquots of the elution solvent. The eluted extract is concentrated, combined with an equal volume of reagent water and filtered for analysis. Method procedures and data quality objectives conform to US DoD QSM 5.3, table B-15 requirements.
Per- and Polyfluoroalkyl Substances (PFAS) by LCMSMS	EP231X-SUT	WATER	In-house: Analysis of fresh and saline waters by Solid Phase Extraction (SPE) followed by LC-Electrospray-MS-MS, Negative Mode using MRM and internal standard quantitation. Isotopically labelled analogues of target analytes used as internal standards and surrogates are added to the sample container. The entire contents are transferred to a solid phase extraction (SPE) cartridge. The sample container is successively rinsed with aliquots of the elution solvent. The eluted extract is concentrated, combined with an equal volume of reagent water and filtered for analysis. Method procedures and data quality objectives conform to US DoD QSM 5.3, table B-15 requirements.

Preparation Methods	Method	Matrix	Method Descriptions
Seawater Elutriate Testing Procedure	EN68a	SOIL	USEPA Evaluation of Dredged Material Proposed for Ocean Disposal - Testing Guide, 1991, EPA-503/8-91/001, USEPA and US Army Corps of Engineers. ANZECC Interim Ocean Disposal Guidelines, December, 1998 This Procedure outlines the preparation of leachate designed to simulate release of contaminants from sediment during the disposal of dredged material. Release can occur by physical processes or a variety of chemical changes such as oxidation of metal sulphides and release of contaminants adsorbed to particles or organic matter.
Solid Phase Extraction (SPE) for PFAS in water	ORG72	SOIL	In-house: Isotopically labelled analogues of target analytes used as internal standards and surrogates are added to the sample container. The entire contents are transferred to a solid phase extraction (SPE) cartridge. The sample container is successively rinsed with aliquots of the elution solvent. The eluted extract is combined with an equal volume of reagent water and a portion is filtered for analysis. Method procedures conform to US DoD QSM 5.3, table B-15 requirements.

Preparation Methods	Method	Matrix	Method Descriptions
Sample Extraction for PFAS in solid matrices	ORG73	SOIL	In-house: Isotopically labelled analogues of target analytes used as internal standards and surrogates are added to a portion of soil which is then extracted with MTBE and an ion pairing reagent. A portion of extract is exchanged into the analytical solvent mixture, combined with an equal volume reagent water and filtered for analysis. Method procedures conform to US DoD QSM 5.3, table B-15 requirements.
Solid Phase Extraction (SPE) for PFAS in water	ORG72	WATER	In-house: Isotopically labelled analogues of target analytes used as internal standards and surrogates are added to the sample container. The entire contents are transferred to a solid phase extraction (SPE) cartridge. The sample container is successively rinsed with aliquots of the elution solvent. The eluted extract is combined with an equal volume of reagent water and a portion is filtered for analysis. Method procedures conform to US DoD QSM 5.3, table B-15 requirements.

ALS Environmental

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **EP2003111**

Client	: **RPS Australia West Pty Ltd**	Laboratory	: Environmental Division Perth
Contact	: ALAN FOLEY	Contact	: Lauren Biagioni
Address	: PO BOX 170 WEST PERTH WA 6872	Address	: 26 Rigali Way Wangara WA Australia 6065
E-mail	: Alan.Foley@rpsgroup.com.au	E-mail	: Lauren.biagioni@alsglobal.com
Telephone	: ----	Telephone	: 08 9406 1307
Facsimile	: ----	Facsimile	: +61-8-9406 1399
Project	: EEC19032.012	Page	: 1 of 3
Order number	: ----	Quote number	: EP2019AQUTER0003 (EP/705/19)
C-O-C number	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	: Rottnest Army Jetty		
Sampler	: SMW		

Dates

Date Samples Received	: 24-Mar-2020 11:40	Issue Date	: 25-Mar-2020
Client Requested Due Date	: 09-Apr-2020	Scheduled Reporting Date	: **09-Apr-2020**

Delivery Details

Mode of Delivery	: Carrier	Security Seal	: Not Available
No. of coolers/boxes	: 5	Temperature	: 15.9/25.0 - Ice present
Receipt Detail	:	No. of samples received / analysed	: 36 / 28

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- PFAS conducted by ALS Sydney, NATA accreditation no. 825, site no 10911.
- Please see scanned COC for sample discrepencies: extra samples , samples not received etc.
- **PFAS analysis will be conducted by ALS Environmental, Sydney, NATA accreditation no. 825, Site No. 10911.**
- Please direct any queries related to sample condition / numbering / breakages to Sample Receipt (Samples.Perth@alsglobal.com)
- Please direct any turnaround / technical queries to the laboratory contact designated above.
- Sample Disposal - Aqueous (3 weeks), Solid (2 months) from receipt of samples.
- **pH analysis should be conducted within 6 hours of sampling.**
- Please be aware that APHA/NEPM recommends water and soil samples be chilled to less than or equal to 6°C for chemical analysis, and less than or equal to 10°C but unfrozen for Microbiological analysis. Where samples are received above this temperature, it should be taken into consideration when interpreting results. Refer to ALS EnviroMail 85 for ALS recommendations of the best practice for chilling samples after sampling and for maintaining a cool temperature during transit.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exists.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component

Matrix: **SOIL**

Laboratory sample ID	Client sampling date / time	Client sample ID	(On Hold) SOIL No analysis requested	SOIL - EA055-103 Moisture Content	SOIL - EN68-1 Preparation of Elutriates for a single analysis	SOIL - EP231X (solids) PFAS - Full Suite (28 analytes)	SOIL - EP231X-SUT PFAS - Super Ultra Trace Waters Long Suite (28
EP2003111-001	23-Mar-2020 00:00	C01S01		✓	✓	✓	✓
EP2003111-002	23-Mar-2020 00:00	C01S02	✓				
EP2003111-003	23-Mar-2020 00:00	C01S03		✓		✓	
EP2003111-004	23-Mar-2020 00:00	C02S01		✓	✓	✓	✓
EP2003111-005	23-Mar-2020 00:00	C02S02		✓		✓	
EP2003111-006	23-Mar-2020 00:00	C02S03	✓				
EP2003111-007	23-Mar-2020 00:00	C03S01		✓		✓	
EP2003111-008	23-Mar-2020 00:00	C03S02	✓				
EP2003111-009	23-Mar-2020 00:00	C03S03		✓	✓	✓	✓
EP2003111-010	23-Mar-2020 00:00	C04S01		✓		✓	
EP2003111-011	23-Mar-2020 00:00	C04S02		✓	✓	✓	✓
EP2003111-012	23-Mar-2020 00:00	C04S03	✓				
EP2003111-013	23-Mar-2020 00:00	C05S01		✓		✓	
EP2003111-014	23-Mar-2020 00:00	C05S02	✓				
EP2003111-015	23-Mar-2020 00:00	C05S03		✓	✓	✓	✓
EP2003111-016	23-Mar-2020 00:00	C06S01		✓		✓	
EP2003111-017	23-Mar-2020 00:00	C06S02		✓	✓	✓	✓
EP2003111-018	23-Mar-2020 00:00	C06S03	✓				
EP2003111-019	23-Mar-2020 00:00	C07S01		✓	✓	✓	✓
EP2003111-020	23-Mar-2020 00:00	C07S02	✓				
EP2003111-021	23-Mar-2020 00:00	C07S03		✓		✓	
EP2003111-022	23-Mar-2020 00:00	SZ1		✓		✓	
EP2003111-023	23-Mar-2020 00:00	SZ2		✓		✓	
EP2003111-031	23-Mar-2020 00:00	C07S04	✓				
EP2003111-035	23-Mar-2020 00:00	EW			✓		✓

Matrix: **WATER**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	WATER - EP231X-SUT PFAS - Super Ultra Trace Waters Long Suite (28
EP2003111-024	23-Mar-2020 00:00	WZ1	✓
EP2003111-025	23-Mar-2020 00:00	WZ2	✓
EP2003111-026	23-Mar-2020 00:00	WR1	✓
EP2003111-027	23-Mar-2020 00:00	WR2	✓
EP2003111-028	23-Mar-2020 00:00	WB1	✓
EP2003111-029	23-Mar-2020 00:00	TBW 197	✓
EP2003111-030	23-Mar-2020 00:00	TBW 168	✓
EP2003111-032	23-Mar-2020 00:00	C01-SW	✓
EP2003111-033	23-Mar-2020 00:00	C04-SW	✓
EP2003111-034	23-Mar-2020 00:00	C06-SW	✓
EP2003111-036	23-Mar-2020 00:00	Matrix Blank	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

ACCOUNTS PAYABLE

- A4 - AU Tax Invoice (INV)	Email	West.AccountsPayable@rpsgroup.com.au

ALAN FOLEY

- *AU Certificate of Analysis - NATA (COA)	Email	Alan.Foley@rpsgroup.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	Alan.Foley@rpsgroup.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	Alan.Foley@rpsgroup.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	Alan.Foley@rpsgroup.com.au
- A4 - AU Tax Invoice (INV)	Email	Alan.Foley@rpsgroup.com.au
- Chain of Custody (CoC) (COC)	Email	Alan.Foley@rpsgroup.com.au
- EDI Format - ENMRG (ENMRG)	Email	Alan.Foley@rpsgroup.com.au
- EDI Format - ESDAT (ESDAT)	Email	Alan.Foley@rpsgroup.com.au
- EDI Format - XTab (XTAB)	Email	Alan.Foley@rpsgroup.com.au

SHAE MILLER-WHITE

- *AU Certificate of Analysis - NATA (COA)	Email	miller-whites@rpsgroup.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	miller-whites@rpsgroup.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	miller-whites@rpsgroup.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	miller-whites@rpsgroup.com.au
- Chain of Custody (CoC) (COC)	Email	miller-whites@rpsgroup.com.au
- EDI Format - ENMRG (ENMRG)	Email	miller-whites@rpsgroup.com.au
- EDI Format - ESDAT (ESDAT)	Email	miller-whites@rpsgroup.com.au
- EDI Format - XTab (XTAB)	Email	miller-whites@rpsgroup.com.au

CHAIN OF CUSTODY

rps MAKING COMPLEX EASY

Site:	Rottnest Army Jetty
Project reference:	EEC19032.012
Scientist(s)	SMW
Sample type(s):	Sediment and Water
Report to:	Alan Foley / Shae Miller-White
Invoice to:	west.accountspayable@rpsgroup.com

Level 2, 27-31 Troode Street
West Perth WA 6005
Tel: (618) 9211 1111
Fax: (618) 9211 1122

Page number:

Turnaround time: Standard

Quote number: EP1705/19.

Remarks

Analytical suites

Sample I.D.		Date collected	Number of jars / bottles / bags	PFAS (Standard) - Sediment	PFAS (Trace levels) - Elutriate	PFAS (Trace levels) - Water	Storage
C01S01	1	23.3.20	Refer to quote	x	x		
C01S02	2		Refer to quote				x
C01S03	3		Refer to quote	x			
C02S01	4		Refer to quote	x	x		
C02S02	5		Refer to quote	x			
C02S03	6		Refer to quote				x
C03S01	7		Refer to quote	x			
C03S02	8		Refer to quote				x
C03S03	9		Refer to quote	x	x		
C04S01	10		Refer to quote	x			
C04S02	11		Refer to quote	x	x		
C04S03	12		Refer to quote				x
C05S01	13		Refer to quote	x			
C05S02	14		Refer to quote				x
C05S03	15		Refer to quote	x	x		
C06S01	16		Refer to quote	x			
C06S02	17		Refer to quote	x	x		
C06S03	18		Refer to quote				x
C07S01	19		Refer to quote	x	x		
C07S02	20		Refer to quote				x
C07S03	21		Refer to quote	x			
Total number of bottles/bags/jars							

Environmental Division
Perth
Work Order Reference
EP2003111

Telephone : + 61-8-9406 1301

Primary destination:	ALS	**Received by:**	NO	**Secondary destination:**	**Received by:**
Relinquished by:	Shae Miller-White	**Organisation:**	als	**Relinquished by:**	**Organisation:**
Organisation:	RPS	**Date:**	24/3/2020	**Organisation:**	**Date:**
Date:	24.3.20	**Time:**	1140	**Date:**	**Time:**
Time:	9am			**Time:**	

CHAIN OF CUSTODY

rps MAKING COMPLEX EASY

Site:	Rottnest Army Jetty
Project reference:	EEC19032.012
Scientist(s)	SMW
Sample type(s):	Sediment and Water
Report to:	Alan Foley / Shae Miller-White
Invoice to:	west.accountspayable@rpsgroup.com

Level 2, 27-31 Troode Street
West Perth WA 6005
Tel: (618) 9211 1111
Fax: (618) 9211 1122

Page number:

Turnaround time: Standard

Quote number: EP/705/19

Remarks

Analytical suites

Sample I.D.		Date collected	Number of jars / bottles / bags	PFAS (Standard) - Sediment	PFAS (Trace levels) - Elutriate	PFAS (Trace levels) - Water	Storage
SZ1	22	23.3.20.	Refer to quote	X			
SZ2	23			X			
WZ1	24					X	
WZ2	25					X	
WR1	26					X	
WR2	27					X	
WB1	28					X	
TBW	29/30	19.3.20.				X	
C07S04	31	23.3.20.					X
C01-SW	32					X	
C04-SW	33					X	
C06-SW	34					X	

Total number of bottles/bags/jars

Primary destination:	ALS	Received by:	NM	Secondary destination:	Received by:
Relinquished by:	Shae Miller-White	Organisation:	als	Relinquished by:	Organisation:
Organisation:	RPS	Date:	24/3/2020	Organisation:	Date:
Date:	24.3.20	Time:	1140	Date:	Time:
Time:	9am			Time:	

Envirolab Services (WA) Pty Ltd trading as MPL Laboratories
ABN 53 140 099 207
16-18 Hayden Court Myaree WA 6154
ph 08 9317 2505 fax 08 9317 4163
lab@mpl.com.au
www.mpl.com.au

CERTIFICATE OF ANALYSIS 236228

Client Details

Client	RPS Australia West Pty Ltd
Attention	Alan Foley
Address	Level 2, 27-31 Troode St, WEST PERTH, WA, 6005

Sample Details

Your Reference	**EEC19032.011 - Rottnest Army Jetty**
Number of Samples	2 soils
Date samples received	13/11/2019
Date completed instructions received	13/11/2019

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	28/11/2019
Date of Issue	28/11/2019

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Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Heram Halim, Operations Manager
Michael Kubiak, Laboratory Manager
Stacey Hawkins, Acid Soils Supervisor

Authorised By

Michael Kubiak, Laboratory Manager

External Testing		
Our Reference		236228-1
Your Reference	UNITS	SZZ1
Date Sampled		12/11/2019
Type of sample		Soil
Total Organic Carbon by Combustion	mg/kg	1,500

Nutrients in Soil		
Our Reference		236228-1
Your Reference	UNITS	SZZ1
Date Sampled		12/11/2019
Type of sample		Soil
Date prepared	-	19/11/2019
Date analysed	-	19/11/2019
Total Nitrogen	mg/kg	140
Nitrate-N	mg/kg	<0.1
Nitrite-N	mg/kg	<0.1
Ammonia as N (1:5 KCl extract)	mg/kg	2.9
Total Phosphorus	mg/kg	280
Phosphate as P	mg/kg	<0.5

Metals - soil		
Our Reference		236228-1
Your Reference	UNITS	SZZ1
Date Sampled		12/11/2019
Type of sample		Soil
Date digested	-	18/11/2019
Date analysed	-	19/11/2019
Silver	mg/kg	<0.1
Arsenic	mg/kg	0.7
Cadmium	mg/kg	0.1
Cobalt	mg/kg	<0.5
Copper	mg/kg	<0.5
Mercury	mg/kg	<0.01
Manganese	mg/kg	6
Nickel	mg/kg	0.7
Lead	mg/kg	<0.5
Antimony	mg/kg	<0.5
Selenium	mg/kg	0.2
Vanadium	mg/kg	6.8
Zinc	mg/kg	0.5

TRH in Sediment (C6-C9) + BTEX		
Our Reference		236228-1
Your Reference	UNITS	SZZ1
Date Sampled		12/11/2019
Type of sample		Soil
Date extracted	-	18/11/2019
Date analysed	-	18/11/2019
TRH C_6 - C_9	mg/kg	<25
TRH C_6 - C_{10}	mg/kg	<25
Benzene	mg/kg	<0.2
Toluene	mg/kg	<0.2
Ethylbenzene	mg/kg	<0.2
m+p-xylene	mg/kg	<0.4
o-xylene	mg/kg	<0.2
Surrogate aaa-Trifluorotoluene	%	93

sTRH in Sediment (C10-C36)		
Our Reference		236228-1
Your Reference	UNITS	SZZ1
Date Sampled		12/11/2019
Type of sample		Soil
Date extracted	-	18/11/2019
Date analysed	-	18/11/2019
TRH C_{10} - C_{14}	mg/kg	<25
TRH C_{15} - C_{28}	mg/kg	<25
TRH C_{29} - C_{36}	mg/kg	<25
TRH >C_{10} - C_{16}	mg/kg	<25
TRH >C_{16} - C_{34}	mg/kg	<25
TRH >C_{34} - C_{40}	mg/kg	<25

PAHs in Sediment (NAGD)		
Our Reference		236228-1
Your Reference	UNITS	SZZ1
Date Sampled		12/11/2019
Type of sample		Soil
Date extracted	-	18/11/2019
Date analysed	-	26/11/2019
Naphthalene	µg/kg	<5
2-Methylnaphthalene	µg/kg	<5
Acenaphthylene	µg/kg	<5
Acenaphthene	µg/kg	<5
Fluorene	µg/kg	<5
Phenanthrene	µg/kg	<5
Anthracene	µg/kg	<5
Fluoranthene	µg/kg	<5
Pyrene	µg/kg	<5
Benzo(a)anthracene	µg/kg	<5
Chrysene	µg/kg	<5
Benzo(b,j+k)fluoranthene	µg/kg	<10
Benzo(e)pyrene	µg/kg	<5
Benzo(a)pyrene	µg/kg	<5
Perylene	µg/kg	<5
Indeno(1,2,3-c,d)pyrene	µg/kg	<5
Dibenzo(a,h)anthracene	µg/kg	<5
Benzo(g,h,i)perylene	µg/kg	<5
Coronene	µg/kg	<5
Surrogate p-Terphenyl-D_{14}	%	116

OCP in Sediment (ANZECC)		
Our Reference		236228-1
Your Reference	UNITS	SZZ1
Date Sampled		12/11/2019
Type of sample		Soil
Date extracted	-	18/11/2019
Date analysed	-	26/11/2019
Hexachlorobenzene (HCB)	µg/kg	<1
a-BHC	µg/kg	<1
b-BHC	µg/kg	<1
Lindane (g-BHC)	µg/kg	<0.3
d-BHC	µg/kg	<1
Heptachlor	µg/kg	<1
Aldrin	µg/kg	<1
Heptachlor Epoxide	µg/kg	<1
a-chlordane	µg/kg	<0.5
g-Chlordane	µg/kg	<0.5
a-endosulphan	µg/kg	<1
p,p'-DDE	µg/kg	<1
Dieldrin	µg/kg	<0.2
Endrin	µg/kg	<0.2
p,p'-DDD	µg/kg	<1
b-endosulphan	µg/kg	<1
Endosulfan Sulphate	µg/kg	<1
p,p'-DDT	µg/kg	<1
Methoxychlor	µg/kg	<1
Oxychlordane	µg/kg	<1

Low Level OPP in soil		
Our Reference		236228-1
Your Reference	UNITS	SZZ1
Date Sampled		12/11/2019
Type of sample		Soil
Date extracted	-	18/11/2019
Date analysed	-	26/11/2019
Dichlorovos	mg/kg	<0.05
Diazinon	mg/kg	<0.05
Chlorpyrifos methyl	mg/kg	<0.05
Ronnel	mg/kg	<0.05
Fenitrothion	mg/kg	<0.05
Malathion	mg/kg	<0.05
Chlorpyrifos	mg/kg	<0.05
Parathion-ethyl	mg/kg	<0.05
Ethion	mg/kg	<0.05
Bromophos ethyl	mg/kg	<0.05
Dimethoate	mg/kg	<0.05
Azinphos methyl (Guthion)	mg/kg	<0.05
Surrogate p-Terphenyl-D_{14}	%	116

PFAS in Soil Extended			
Our Reference		236228-1	236228-2
Your Reference	UNITS	SZZ1	SZZ2
Date Sampled		12/11/2019	12/11/2019
Type of sample		Soil	Soil
Date prepared	-	19/11/2019	19/11/2019
Date analysed	-	19/11/2019	19/11/2019
Perfluorobutanesulfonic acid	µg/kg	<0.1	<0.1
Perfluoropentanesulfonic acid	µg/kg	<0.1	<0.1
Perfluorohexanesulfonic acid	µg/kg	<0.1	<0.1
Perfluoroheptanesulfonic acid	µg/kg	<0.2	<0.2
Perfluorooctanesulfonic acid PFOS	µg/kg	<0.1	<0.1
Perfluorodecanesulfonic acid	µg/kg	<0.2	<0.2
Perfluorobutanoic acid	µg/kg	<0.2	<0.2
Perfluoropentanoic acid	µg/kg	<0.2	<0.2
Perfluorohexanoic acid	µg/kg	<0.1	<0.1
Perfluoroheptanoic acid	µg/kg	<0.1	<0.1
Perfluorooctanoic acid PFOA	µg/kg	<0.1	<0.1
Perfluorononanoic acid	µg/kg	<0.1	<0.1
Perfluorodecanoic acid	µg/kg	<0.5	<0.5
Perfluoroundecanoic acid	µg/kg	<0.5	<0.5
Perfluorododecanoic acid	µg/kg	<0.5	<0.5
Perfluorotridecanoic acid	µg/kg	<0.5	<0.5
Perfluorotetradecanoic acid	µg/kg	<5	<5
4:2 FTS	µg/kg	<0.1	<0.1
6:2 FTS	µg/kg	<0.1	<0.1
8:2 FTS	µg/kg	<0.1	<0.1
10:2 FTS	µg/kg	<0.1	<0.1
Perfluorooctane sulfonamide	µg/kg	<1	<1
N-Methyl perfluorooctane sulfonamide	µg/kg	<1	<1
N-Ethyl perfluorooctanesulfon -amide	µg/kg	<1	<1
N-Me perfluorooctanesulfonamid -oethanol	µg/kg	<1	<1
N-Et perfluorooctanesulfonamid -oethanol	µg/kg	<5	<5
MePerfluorooctanesulf- amid oacetic acid	µg/kg	<0.2	<0.2
EtPerfluorooctanesulf- amid oacetic acid	µg/kg	<0.2	<0.2
Surrogate $^{13}C_8$ PFOS	%	86	92
Surrogate $^{13}C_2$ PFOA	%	83	82
Extracted ISTD $^{13}C_3$ *PFBS*	%	76	73
Extracted ISTD $^{18}O_2$ *PFHxS*	%	67	68
Extracted ISTD $^{13}C_4$ *PFOS*	%	77	71
Extracted ISTD 13C4 PFBA	%	64	62

PFAS in Soil Extended			
Our Reference		236228-1	236228-2
Your Reference	UNITS	SZZ1	SZZ2
Date Sampled		12/11/2019	12/11/2019
Type of sample		Soil	Soil
Extracted ISTD $^{13}C_3$ *PFPeA*	%	74	73
Extracted ISTD $^{13}C_2$ *PFHxA*	%	73	73
Extracted ISTD $^{13}C_4$ *PFHpA*	%	78	76
Extracted ISTD $^{13}C_4$ *PFOA*	%	78	78
Extracted ISTD $^{13}C_5$ *PFNA*	%	74	74
Extracted ISTD $^{13}C_2$ *PFDA*	%	72	75
Extracted ISTD $^{13}C_2$ *PFUnDA*	%	76	76
Extracted ISTD $^{13}C_2$ *PFDoDA*	%	72	69
Extracted ISTD $^{13}C_2$ *PFTeDA*	%	61	57
Extracted ISTD $^{13}C_2$ *4:2FTS*	%	82	80
Extracted ISTD $^{13}C_2$ *6:2FTS*	%	72	77
Extracted ISTD $^{13}C_2$ *8:2FTS*	%	77	72
Extracted ISTD $^{13}C_8$ *FOSA*	%	73	75
Extracted ISTD d_3 *N MeFOSA*	%	65	68
Extracted ISTD d_5 *N EtFOSA*	%	70	67
Extracted ISTD d_7 *N MeFOSE*	%	70	70
Extracted ISTD d_9 *N EtFOSE*	%	73	68
Extracted ISTD d_3 *N MeFOSAA*	%	85	81
Extracted ISTD d_5 *N EtFOSAA*	%	78	74
Total Positive PFHxS & PFOS	µg/kg	<0.1	<0.1
Total Positive PFOS & PFOA	µg/kg	<0.1	<0.1
Total Positive PFAS	µg/kg	<0.1	<0.1

Organotin Compounds in Soil		
Our Reference		236228-1
Your Reference	UNITS	SZZ1
Date Sampled		12/11/2019
Type of sample		Soil
Date extracted	-	19/11/2019
Date analysed	-	19/11/2019
Tributyltin as Sn	µg Sn/kg	<0.5
Surrogate Triphenyltin	%	97

Explosives in Soil		
Our Reference		236228-1
Your Reference	UNITS	SZZ1
Date Sampled		12/11/2019
Type of sample		Soil
Date prepared	-	19/11/2019
Date analysed	-	27/11/2019
2,4,6-TNT	mg/kg	<0.1
1,3-Dinitrobenzene	mg/kg	<0.1
2,4-dinitrotoluene	mg/kg	<0.1
2,6-dinitrotoluene	mg/kg	<0.1
2-Amino.4.6-DNT	mg/kg	<0.1
4-Amino.2.6-DNT	mg/kg	<0.1
HMX	mg/kg	<0.1
2-nitrotoluene	mg/kg	<0.1
3-nitrotoluene	mg/kg	<0.1
4-nitrotoluene	mg/kg	<0.1
Nitrobenzene	mg/kg	<0.1
Nitroglycerine	mg/kg	<0.1
PETN	mg/kg	<0.1
RDX	mg/kg	<0.1
Tetryl	mg/kg	<0.1
1,3,5-Trinitrobenzene	mg/kg	<0.1

Aromatic & Aliphatic TPH		
Our Reference		236228-1
Your Reference	UNITS	SZZ1
Date Sampled		12/11/2019
Type of sample		Soil
Date extracted	-	18/11/2019
Date analysed	-	18/11/2019
>C10-C16 Aliphatic	mg/kg	<100
>C16-C35 Aliphatic	mg/kg	<100
>C35 Aliphatic	mg/kg	<100
>C10-C16 Aromatic	mg/kg	<50
>C16-C35 Aromatic	mg/kg	<50
Surrogate 1-chlorooctadecane	%	93

Moisture			
Our Reference		236228-1	236228-2
Your Reference	UNITS	SZZ1	SZZ2
Date Sampled		12/11/2019	12/11/2019
Type of sample		Soil	Soil
Date prepared	-	18/11/2019	18/11/2019
Date analysed	-	19/11/2019	19/11/2019
Moisture	%	30	12

Chromium Suite		
Our Reference		236228-1
Your Reference	UNITS	SZZ1
Date Sampled		12/11/2019
Type of sample		Soil
Date analysed	-	19/11/2019
pH $_{kcl}$	pH units	10.0
TAA	moles H^+ /t	<5
S_{KCl}	%w/w S	NT
Chromium Reducible Sulfur	%w/w	<0.005
ANC_{BT}	% $CaCO_3$	90
S_{HCl}	%w/w S	NT
s-TAA	%w/w S	<0.01
a-Chromium Reducible Sulfur	moles H^+ /t	<5
a-ANC_{BT}	moles H^+ /t	18,000
s-ANC_{BT}	%w/w S	29
Fineness Factor		1.50
S_{NAS}	%w/w S	NT
a-S_{NAS}	moles H^+ /t	NT
s-SNAS	%w/w S	NT
s-Net Acidity	%w/w S	<0.005
a-Net Acidity	moles H^+ /t	<5
Liming rate	kg $CaCO_3$ /t	<0.75
s-Net Acidity without ANCE	% w/w S	<0.005
a-Net Acidity without ANCE	moles H^+ /t	<5
Liming rate without ANCE	kg $CaCO_3$ /t	<0.75

sPOCAS		
Our Reference		236228-1
Your Reference	UNITS	SZZ1
Date Sampled		12/11/2019
Type of sample		Soil
Date prepared	-	13/11/2019
Date analysed	-	19/11/2019
pH $_{Ox}$	pH units	8.1
TPA	moles H^+ /t	<5

Method ID	Methodology Summary
Ext-011	Subcontracted to ALS.
Ext-054	Analysed by Envirolab Services Sydney, accreditation number 2901
INORG-008	Moisture content determined by heating at 105 deg C for a minimum of 12 hours.
INORG-055	Nitrite - determined colourimetrically. Soils are analysed from a water extract.
INORG-055	Nitrate - determined colourimetrically. Soils are analysed from a water extract.
INORG-057	Ammonia by colourimetric analysis based on APHA latest edition 4500-NH3 F.
INORG-060	Phosphate- determined colourimetrically. Soils are analysed from a water extract.
INORG-062	TKN - determined colourimetrically based on APHA latest edition Norg C.
INORG-064	Suspension Peroxide Oxidation Combined Acidity and Sulphate (SPOCAS) using ASSMAC guidelines.
INORG-068	Chromium Reducible Sulfur - Hydrogen Sulfide is quantified by iodometric titration after distillation to determine potential acidity. Based on Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004.
METALS-020	Determination of various metals by ICP-AES.
METALS-021	Determination of Mercury by Cold Vapour AAS. For urine samples total Mercury is determined, however, mercury in urine is almost entirely in the inorganic form (CDC).
METALS-022	Determination of various metals by ICP-MS.
ORG-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis.
ORG-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. Fractionation with hexane through a silica gel column for aliphatics and DCM for aromatics.
ORG-008/015	Organophosphorus Pesticides in soil by DCM:Acetone extraction and water by DCM extraction with determination by GC-ECD/GC-MS.
ORG-012	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS.
ORG-012	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS. Benzo(a)pyrene TEQ as per NEPM draft B1 Guideline on Investigation Levels for Soil and Groundwater.
ORG-014	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS.
ORG-015	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS or GC-MS/MS.
ORG-016	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater.

Method ID	Methodology Summary
ORG-018	Based on SFS-EN ISO 17353, ISO/DIS 23161 and NIOSH 5504. Air samples are extracted with acetonitrile containing 0.1% acetic acid using sonication. Extracts are then derivatised and extracted. Soils are extracted with a mix of water and methanolic KOH solution, neutralised and then derivatised and extracted. Water samples are pH adjusted, salt added and then derivatised, extracted into hexane and concentrated to a small volume. The extracts are analysed by GC/MSMS.
Org-035	Soil samples are extracted with basified Methanol. Waters and soil extracts are directly injected and/or concentrated after SPE. Analysis is undertaken with LC-MS/MS. PFAS results include the sum of branched and linear isomers where applicable. Please note that PFAS results are corrected for Extracted Internal Standards (QSM 5.3 Table B-15 terminology), which are mass labelled analytes added prior to sample preparation to assess matrix effects and verify processing of the sample. PFAS analytes without a commercially available mass labelled analogue are corrected vs a closely eluting mass labelled PFAS compound. Surrogates are also reported, in this context they are mass labelled PFAS compounds added prior to extraction but are used as monitoring compounds only (not used for result correction). Envicarb (or similar) is used discretionally to remove interfering matrix components. Please contact the laboratory if estimates of Measurement Uncertainty are required as per WA DER.

QUALITY CONTROL: External Testing						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Total Organic Carbon by Combustion	mg/kg	100	Ext-054	<100	[NT]	[NT]	[NT]	[NT]	91	[NT]

QUALITY CONTROL: Nutrients in Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			19/11/2019	1	19/11/2019	19/11/2019		19/11/2019	[NT]
Date analysed	-			19/11/2019	1	19/11/2019	19/11/2019		19/11/2019	[NT]
Total Nitrogen	mg/kg	10	INORG-062	<10	1	140	[NT]		104	[NT]
Nitrate-N	mg/kg	0.1	INORG-055	<0.1	1	<0.1	[NT]		101	[NT]
Nitrite-N	mg/kg	0.1	INORG-055	<0.1	1	<0.1	[NT]		106	[NT]
Ammonia as N (1:5 KCl extract)	mg/kg	0.5	INORG-057	<0.5	1	2.9	2.9	0	101	[NT]
Total Phosphorus	mg/kg	10	METALS-020	<10	1	280	[NT]		112	[NT]

QUALITY CONTROL: Metals - soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date digested	-			18/11/2019	[NT]	[NT]	[NT]	[NT]	18/11/2019	[NT]
Date analysed	-			19/11/2019	[NT]	[NT]	[NT]	[NT]	19/11/2019	[NT]
Silver	mg/kg	0.1	METALS-022	<0.1	[NT]	[NT]	[NT]	[NT]	98	[NT]
Arsenic	mg/kg	0.5	METALS-022	<0.5	[NT]	[NT]	[NT]	[NT]	102	[NT]
Cadmium	mg/kg	0.1	METALS-022	<0.1	[NT]	[NT]	[NT]	[NT]	100	[NT]
Cobalt	mg/kg	0.5	METALS-022	<0.5	[NT]	[NT]	[NT]	[NT]	98	[NT]
Copper	mg/kg	0.5	METALS-022	<0.5	[NT]	[NT]	[NT]	[NT]	98	[NT]
Mercury	mg/kg	0.01	METALS-021	<0.01	[NT]	[NT]	[NT]	[NT]	106	[NT]
Manganese	mg/kg	1	METALS-022	<1	[NT]	[NT]	[NT]	[NT]	101	[NT]
Nickel	mg/kg	0.5	METALS-022	<0.5	[NT]	[NT]	[NT]	[NT]	99	[NT]
Lead	mg/kg	0.5	METALS-022	<0.5	[NT]	[NT]	[NT]	[NT]	96	[NT]
Antimony	mg/kg	0.5	METALS-022	<0.5	[NT]	[NT]	[NT]	[NT]	115	[NT]
Selenium	mg/kg	0.1	METALS-022	<0.1	[NT]	[NT]	[NT]	[NT]	107	[NT]
Vanadium	mg/kg	0.5	METALS-022	<0.5	[NT]	[NT]	[NT]	[NT]	102	[NT]
Zinc	mg/kg	0.5	METALS-022	<0.5	[NT]	[NT]	[NT]	[NT]	103	[NT]

QUALITY CONTROL: TRH in Sediment (C6-C9) + BTEX					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date extracted	-			18/11/2019	[NT]	[NT]	[NT]	[NT]	18/11/2019	[NT]
Date analysed	-			18/11/2019	[NT]	[NT]	[NT]	[NT]	18/11/2019	[NT]
TRH C_6 - C_9	mg/kg	25	ORG-016	<25	[NT]	[NT]	[NT]	[NT]	89	[NT]
TRH C_6 - C_{10}	mg/kg	25	ORG-016	<25	[NT]	[NT]	[NT]	[NT]	89	[NT]
Benzene	mg/kg	0.2	ORG-016	<0.2	[NT]	[NT]	[NT]	[NT]	102	[NT]
Toluene	mg/kg	0.2	ORG-016	<0.2	[NT]	[NT]	[NT]	[NT]	86	[NT]
Ethylbenzene	mg/kg	0.2	ORG-016	<0.2	[NT]	[NT]	[NT]	[NT]	89	[NT]
m+p-xylene	mg/kg	0.4	ORG-016	<0.4	[NT]	[NT]	[NT]	[NT]	85	[NT]
o-xylene	mg/kg	0.2	ORG-016	<0.2	[NT]	[NT]	[NT]	[NT]	85	[NT]
Surrogate aaa-Trifluorotoluene	%		ORG-014	102	[NT]	[NT]	[NT]	[NT]	105	[NT]

QUALITY CONTROL: sTRH in Sediment (C10-C36)						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date extracted	-			18/11/2019	[NT]	[NT]	[NT]	[NT]	18/11/2019	[NT]
Date analysed	-			18/11/2019	[NT]	[NT]	[NT]	[NT]	18/11/2019	[NT]
TRH C_{10} - C_{14}	mg/kg	25	ORG-003	<25	[NT]	[NT]	[NT]	[NT]	112	[NT]
TRH C_{15} - C_{28}	mg/kg	25	ORG-003	<25	[NT]	[NT]	[NT]	[NT]	101	[NT]
TRH C_{29} - C_{36}	mg/kg	25	ORG-003	<25	[NT]	[NT]	[NT]	[NT]	97	[NT]
TRH >C_{10} - C_{16}	mg/kg	25	ORG-003	<25	[NT]	[NT]	[NT]	[NT]	112	[NT]
TRH >C_{16} - C_{34}	mg/kg	25	ORG-003	<25	[NT]	[NT]	[NT]	[NT]	99	[NT]
TRH >C_{34} - C_{40}	mg/kg	25	ORG-003	<25	[NT]	[NT]	[NT]	[NT]	100	[NT]

QUALITY CONTROL: PAHs in Sediment (NAGD)						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date extracted	-			18/11/2019	1	18/11/2019	18/11/2019		18/11/2019	[NT]
Date analysed	-			26/11/2019	1	26/11/2019	26/11/2019		26/11/2019	[NT]
Naphthalene	µg/kg	5	ORG-012	<5	1	<5	<5	0	117	[NT]
2-Methylnaphthalene	µg/kg	5	ORG-012	<5	1	<5	<5	0	[NT]	[NT]
Acenaphthylene	µg/kg	5	ORG-012	<5	1	<5	<5	0	[NT]	[NT]
Acenaphthene	µg/kg	5	ORG-012	<5	1	<5	<5	0	[NT]	[NT]
Fluorene	µg/kg	5	ORG-012	<5	1	<5	<5	0	116	[NT]
Phenanthrene	µg/kg	5	ORG-012	<5	1	<5	<5	0	115	[NT]
Anthracene	µg/kg	5	ORG-012	<5	1	<5	<5	0	[NT]	[NT]
Fluoranthene	µg/kg	5	ORG-012	<5	1	<5	<5	0	118	[NT]
Pyrene	µg/kg	5	ORG-012	<5	1	<5	<5	0	119	[NT]
Benzo(a)anthracene	µg/kg	5	ORG-012	<5	1	<5	<5	0	[NT]	[NT]
Chrysene	µg/kg	5	ORG-012	<5	1	<5	<5	0	122	[NT]
Benzo(b,j+k)fluoranthene	µg/kg	10	ORG-012	<10	1	<10	<10	0	[NT]	[NT]
Benzo(e)pyrene	µg/kg	5	ORG-012	<5	1	<5	<5	0	[NT]	[NT]
Benzo(a)pyrene	µg/kg	5	ORG-012	<5	1	<5	<5	0	124	[NT]
Perylene	µg/kg	5	ORG-012	<5	1	<5	<5	0	[NT]	[NT]
Indeno(1,2,3-c,d)pyrene	µg/kg	5	ORG-012	<5	1	<5	<5	0	[NT]	[NT]
Dibenzo(a,h)anthracene	µg/kg	5	ORG-012	<5	1	<5	<5	0	[NT]	[NT]
Benzo(g,h,i)perylene	µg/kg	5	ORG-012	<5	1	<5	<5	0	[NT]	[NT]
Coronene	µg/kg	5	ORG-012	<5	1	<5	<5	0	[NT]	[NT]
Surrogate p-Terphenyl-D_{14}	%		ORG-012	90	1	116	109	6	115	[NT]

QUALITY CONTROL: OCP in Sediment (ANZECC)						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date extracted	-			18/11/2019	1	18/11/2019	18/11/2019		18/11/2019	[NT]
Date analysed	-			26/11/2019	1	26/11/2019	26/11/2019		26/11/2019	[NT]
Hexachlorobenzene (HCB)	µg/kg	1	ORG-012	<1	1	<1	<1	0	[NT]	[NT]
a-BHC	µg/kg	1	ORG-012	<1	1	<1	<1	0	121	[NT]
b-BHC	µg/kg	1	ORG-012	<1	1	<1	<1	0	119	[NT]
Lindane (g-BHC)	µg/kg	0.3	ORG-012	<0.3	1	<0.3	<0.3	0	[NT]	[NT]
d-BHC	µg/kg	1	ORG-012	<1	1	<1	<1	0	[NT]	[NT]
Heptachlor	µg/kg	1	ORG-012	<1	1	<1	<1	0	112	[NT]
Aldrin	µg/kg	1	ORG-012	<1	1	<1	<1	0	114	[NT]
Heptachlor Epoxide	µg/kg	1	ORG-012	<1	1	<1	<1	0	115	[NT]
a-chlordane	µg/kg	0.5	ORG-012	<0.5	1	<0.5	<0.5	0	[NT]	[NT]
g-Chlordane	µg/kg	0.5	ORG-012	<0.5	1	<0.5	<0.5	0	[NT]	[NT]
a-endosulphan	µg/kg	1	ORG-012	<1	1	<1	<1	0	[NT]	[NT]
p,p'-DDE	µg/kg	1	ORG-012	<1	1	<1	<1	0	129	[NT]
Dieldrin	µg/kg	0.2	ORG-012	<0.2	1	<0.2	<0.2	0	116	[NT]
Endrin	µg/kg	0.2	ORG-012	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
p,p'-DDD	µg/kg	1	ORG-012	<1	1	<1	<1	0	128	[NT]
b-endosulphan	µg/kg	1	ORG-012	<1	1	<1	<1	0	[NT]	[NT]
Endosulfan Sulphate	µg/kg	1	ORG-012	<1	1	<1	<1	0	120	[NT]
p,p'-DDT	µg/kg	1	ORG-012	<1	1	<1	<1	0	[NT]	[NT]
Methoxychlor	µg/kg	1	ORG-012	<1	1	<1	<1	0	[NT]	[NT]
Oxychlordane	µg/kg	1	ORG-012	<1	1	<1	<1	0	[NT]	[NT]

QUALITY CONTROL: Low Level OPP in soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date extracted	-			18/11/2019	1	18/11/2019	18/11/2019		18/11/2019	[NT]
Date analysed	-			26/11/2019	1	26/11/2019	26/11/2019		26/11/2019	[NT]
Dichlorovos	mg/kg	0.05	ORG-015	<0.05	1	<0.05	<0.05	0	[NT]	[NT]
Diazinon	mg/kg	0.05	ORG-015	<0.05	1	<0.05	<0.05	0	[NT]	[NT]
Chlorpyrifos methyl	mg/kg	0.05	ORG-015	<0.05	1	<0.05	<0.05	0	117	[NT]
Ronnel	mg/kg	0.05	ORG-015	<0.05	1	<0.05	<0.05	0	[NT]	[NT]
Fenitrothion	mg/kg	0.05	ORG-015	<0.05	1	<0.05	<0.05	0	130	[NT]
Malathion	mg/kg	0.05	ORG-015	<0.05	1	<0.05	<0.05	0	[NT]	[NT]
Chlorpyrifos	mg/kg	0.05	ORG-015	<0.05	1	<0.05	<0.05	0	121	[NT]
Parathion-ethyl	mg/kg	0.05	ORG-008/015	<0.05	1	<0.05	<0.05	0	[NT]	[NT]
Ethion	mg/kg	0.05	ORG-015	<0.05	1	<0.05	<0.05	0	115	[NT]
Bromophos ethyl	mg/kg	0.05	ORG-015	<0.05	1	<0.05	<0.05	0	[NT]	[NT]
Dimethoate	mg/kg	0.05	ORG-015	<0.05	1	<0.05	<0.05	0	[NT]	[NT]
Azinphos methyl (Guthion)	mg/kg	0.05	ORG-015	<0.05	1	<0.05	<0.05	0	[NT]	[NT]
Surrogate p-Terphenyl-D_{14}	%		ORG-008/015	90	1	116	109	6	115	[NT]

QUALITY CONTROL: PFAS in Soil Extended						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			19/11/2019	[NT]	[NT]	[NT]	[NT]	19/11/2019	[NT]
Date analysed	-			19/11/2019	[NT]	[NT]	[NT]	[NT]	19/11/2019	[NT]
Perfluorobutanesulfonic acid	µg/kg	0.1	Org-035	<0.1	[NT]	[NT]	[NT]	[NT]	105	[NT]
Perfluoropentanesulfonic acid	µg/kg	0.1	Org-035	<0.1	[NT]	[NT]	[NT]	[NT]	105	[NT]
Perfluorohexanesulfonic acid	µg/kg	0.1	Org-035	<0.1	[NT]	[NT]	[NT]	[NT]	107	[NT]
Perfluoroheptanesulfonic acid	µg/kg	0.2	Org-035	<0.2	[NT]	[NT]	[NT]	[NT]	112	[NT]
Perfluorooctanesulfonic acid PFOS	µg/kg	0.1	Org-035	<0.1	[NT]	[NT]	[NT]	[NT]	108	[NT]
Perfluorodecanesulfonic acid	µg/kg	0.2	Org-035	<0.2	[NT]	[NT]	[NT]	[NT]	107	[NT]
Perfluorobutanoic acid	µg/kg	0.2	Org-035	<0.2	[NT]	[NT]	[NT]	[NT]	107	[NT]
Perfluoropentanoic acid	µg/kg	0.2	Org-035	<0.2	[NT]	[NT]	[NT]	[NT]	105	[NT]
Perfluorohexanoic acid	µg/kg	0.1	Org-035	<0.1	[NT]	[NT]	[NT]	[NT]	111	[NT]
Perfluoroheptanoic acid	µg/kg	0.1	Org-035	<0.1	[NT]	[NT]	[NT]	[NT]	103	[NT]
Perfluorooctanoic acid PFOA	µg/kg	0.1	Org-035	<0.1	[NT]	[NT]	[NT]	[NT]	111	[NT]
Perfluorononanoic acid	µg/kg	0.1	Org-035	<0.1	[NT]	[NT]	[NT]	[NT]	109	[NT]
Perfluorodecanoic acid	µg/kg	0.5	Org-035	<0.5	[NT]	[NT]	[NT]	[NT]	114	[NT]
Perfluoroundecanoic acid	µg/kg	0.5	Org-035	<0.5	[NT]	[NT]	[NT]	[NT]	115	[NT]
Perfluorododecanoic acid	µg/kg	0.5	Org-035	<0.5	[NT]	[NT]	[NT]	[NT]	107	[NT]
Perfluorotridecanoic acid	µg/kg	0.5	Org-035	<0.5	[NT]	[NT]	[NT]	[NT]	100	[NT]
Perfluorotetradecanoic acid	µg/kg	5	Org-035	<5	[NT]	[NT]	[NT]	[NT]	108	[NT]
4:2 FTS	µg/kg	0.1	Org-035	<0.1	[NT]	[NT]	[NT]	[NT]	102	[NT]
6:2 FTS	µg/kg	0.1	Org-035	<0.1	[NT]	[NT]	[NT]	[NT]	106	[NT]
8:2 FTS	µg/kg	0.1	Org-035	<0.1	[NT]	[NT]	[NT]	[NT]	106	[NT]
10:2 FTS	µg/kg	0.1	Org-035	<0.1	[NT]	[NT]	[NT]	[NT]	114	[NT]
Perfluorooctane sulfonamide	µg/kg	1	Org-035	<1	[NT]	[NT]	[NT]	[NT]	111	[NT]
N-Methyl perfluorooctane sulfonamide	µg/kg	1	Org-035	<1	[NT]	[NT]	[NT]	[NT]	111	[NT]
N-Ethyl perfluorooctanesulfon -amide	µg/kg	1	Org-035	<1	[NT]	[NT]	[NT]	[NT]	108	[NT]
N-Me perfluorooctanesulfonamid -oethanol	µg/kg	1	Org-035	<1	[NT]	[NT]	[NT]	[NT]	117	[NT]
N-Et perfluorooctanesulfonamid -oethanol	µg/kg	5	Org-035	<5	[NT]	[NT]	[NT]	[NT]	115	[NT]
MePerfluorooctanesulf- amid oacetic acid	µg/kg	0.2	Org-035	<0.2	[NT]	[NT]	[NT]	[NT]	106	[NT]
EtPerfluorooctanesulf- amid oacetic acid	µg/kg	0.2	Org-035	<0.2	[NT]	[NT]	[NT]	[NT]	99	[NT]
Surrogate $^{13}C_8$ PFOS	%		Org-035	91	[NT]	[NT]	[NT]	[NT]	90	[NT]
Surrogate $^{13}C_2$ PFOA	%		Org-035	87	[NT]	[NT]	[NT]	[NT]	84	[NT]
Extracted ISTD $^{13}C_3$ *PFBS*	%		Org-035	88	[NT]	[NT]	[NT]	[NT]	90	[NT]

QUALITY CONTROL: PFAS in Soil Extended						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Extracted ISTD $^{18}O_2$ *PFHxS*	%		Org-035	83	[NT]	[NT]	[NT]	[NT]	85	[NT]
Extracted ISTD $^{13}C_4$ *PFOS*	%		Org-035	86	[NT]	[NT]	[NT]	[NT]	90	[NT]
Extracted ISTD 13C4 PFBA	%		Org-035	91	[NT]	[NT]	[NT]	[NT]	89	[NT]
Extracted ISTD $^{13}C_3$ *PFPeA*	%		Org-035	94	[NT]	[NT]	[NT]	[NT]	90	[NT]
Extracted ISTD $^{13}C_2$ *PFHxA*	%		Org-035	93	[NT]	[NT]	[NT]	[NT]	91	[NT]
Extracted ISTD $^{13}C_4$ *PFHpA*	%		Org-035	93	[NT]	[NT]	[NT]	[NT]	95	[NT]
Extracted ISTD $^{13}C_4$ *PFOA*	%		Org-035	94	[NT]	[NT]	[NT]	[NT]	91	[NT]
Extracted ISTD $^{13}C_5$ *PFNA*	%		Org-035	89	[NT]	[NT]	[NT]	[NT]	89	[NT]
Extracted ISTD $^{13}C_2$ *PFDA*	%		Org-035	91	[NT]	[NT]	[NT]	[NT]	92	[NT]
Extracted ISTD $^{13}C_2$ *PFUnDA*	%		Org-035	94	[NT]	[NT]	[NT]	[NT]	99	[NT]
Extracted ISTD $^{13}C_2$ *PFDoDA*	%		Org-035	94	[NT]	[NT]	[NT]	[NT]	92	[NT]
Extracted ISTD $^{13}C_2$ *PFTeDA*	%		Org-035	80	[NT]	[NT]	[NT]	[NT]	85	[NT]
Extracted ISTD $^{13}C_2$ *4:2FTS*	%		Org-035	105	[NT]	[NT]	[NT]	[NT]	101	[NT]
Extracted ISTD $^{13}C_2$ *6:2FTS*	%		Org-035	102	[NT]	[NT]	[NT]	[NT]	96	[NT]
Extracted ISTD $^{13}C_2$ *8:2FTS*	%		Org-035	105	[NT]	[NT]	[NT]	[NT]	110	[NT]
Extracted ISTD $^{13}C_8$ *FOSA*	%		Org-035	89	[NT]	[NT]	[NT]	[NT]	90	[NT]
Extracted ISTD d_3 *N MeFOSA*	%		Org-035	87	[NT]	[NT]	[NT]	[NT]	82	[NT]
Extracted ISTD d_5 *N EtFOSA*	%		Org-035	87	[NT]	[NT]	[NT]	[NT]	87	[NT]
Extracted ISTD d_7 *N MeFOSE*	%		Org-035	90	[NT]	[NT]	[NT]	[NT]	83	[NT]
Extracted ISTD d_9 *N EtFOSE*	%		Org-035	91	[NT]	[NT]	[NT]	[NT]	91	[NT]
Extracted ISTD d_3 *N MeFOSAA*	%		Org-035	93	[NT]	[NT]	[NT]	[NT]	98	[NT]

QUALITY CONTROL: PFAS in Soil Extended						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Extracted ISTD d_5 *N EtFOSAA*	%		Org-035	82	[NT]	[NT]	[NT]	[NT]	82	[NT]

QUALITY CONTROL: Organotin Compounds in Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date extracted	-			19/11/2019	[NT]	[NT]	[NT]	[NT]	19/11/2019	[NT]
Date analysed	-			19/11/2019	[NT]	[NT]	[NT]	[NT]	19/11/2019	[NT]
Tributyltin as Sn	µg Sn/kg	0.5	ORG-018	<0.5	[NT]	[NT]	[NT]	[NT]	90	[NT]
Surrogate Triphenyltin	%		ORG-018	100	[NT]	[NT]	[NT]	[NT]	102	[NT]

QUALITY CONTROL: Explosives in Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			19/11/2019	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Date analysed	-			27/11/2019	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
2,4,6-TNT	mg/kg	0.1	Ext-011	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,3-Dinitrobenzene	mg/kg	0.1	Ext-011	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
2,4-dinitrotoluene	mg/kg	0.1	Ext-011	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
2,6-dinitrotoluene	mg/kg	0.1	Ext-011	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
2-Amino.4.6-DNT	mg/kg	0.1	Ext-011	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
4-Amino.2.6-DNT	mg/kg	0.1	Ext-011	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
HMX	mg/kg	0.1	Ext-011	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
2-nitrotoluene	mg/kg	0.1	Ext-011	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
3-nitrotoluene	mg/kg	0.1	Ext-011	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
4-nitrotoluene	mg/kg	0.1	Ext-011	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Nitrobenzene	mg/kg	0.1	Ext-011	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Nitroglycerine	mg/kg	0.1	Ext-011	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
PETN	mg/kg	0.1	Ext-011	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
RDX	mg/kg	0.1	Ext-011	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Tetryl	mg/kg	0.1	Ext-011	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,3,5-Trinitrobenzene	mg/kg	0.1	Ext-011	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]

QUALITY CONTROL: Aromatic & Aliphatic TPH						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date extracted	-			18/11/2019	[NT]	[NT]	[NT]	[NT]	18/11/2019	[NT]
Date analysed	-			18/11/2019	[NT]	[NT]	[NT]	[NT]	18/11/2019	[NT]
>C10-C16 Aliphatic	mg/kg	100	ORG-003	<100	[NT]	[NT]	[NT]	[NT]	112	[NT]
>C16-C35 Aliphatic	mg/kg	100	ORG-003	<100	[NT]	[NT]	[NT]	[NT]	101	[NT]
>C35 Aliphatic	mg/kg	100	ORG-003	<100	[NT]	[NT]	[NT]	[NT]	97	[NT]
>C10-C16 Aromatic	mg/kg	50	ORG-003	<50	[NT]	[NT]	[NT]	[NT]	112	[NT]
>C16-C35 Aromatic	mg/kg	50	ORG-003	<50	[NT]	[NT]	[NT]	[NT]	99	[NT]
Surrogate 1-chlorooctadecane	%		ORG-003	104	[NT]	[NT]	[NT]	[NT]	102	[NT]

QUALITY CONTROL: Moisture						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			18/11/2019	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Date analysed	-			19/11/2019	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Moisture	%	0.1	INORG-008	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]

QUALITY CONTROL: Chromium Suite						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date analysed	-			19/11/2019	1	19/11/2019	19/11/2019		19/11/2019	[NT]
pH $_{kcl}$	pH units		INORG-064	[NT]	1	10.0	10.0	0	99	[NT]
TAA	moles H^+/t	5	INORG-064	[NT]	1	<5	<5	0	102	[NT]
S_{KCl}	%w/w S	0.005	INORG-064	[NT]	1	NT	NT		[NT]	[NT]
Chromium Reducible Sulfur	%w/w	0.005	INORG-068	[NT]	1	<0.005	<0.005	0	101	[NT]
ANC_{BT}	% $CaCO_3$	0.01	INORG-068	[NT]	1	90	90	0	101	[NT]
S_{HCl}	%w/w S	0.005	INORG-068	[NT]	1	NT	NT		[NT]	[NT]
s-TAA	%w/w S	0.01	INORG-068	[NT]	1	<0.01	<0.01	0	[NT]	[NT]
a-Chromium Reducible Sulfur	moles H^+/t	5	INORG-068	[NT]	1	<5	<5	0	[NT]	[NT]
a-ANC_{BT}	moles H^+/t	5	INORG-068	[NT]	1	18000	18000	0	[NT]	[NT]
s-ANC_{BT}	%w/w S	0.01	INORG-068	[NT]	1	29	29	0	[NT]	[NT]
Fineness Factor			INORG-064	[NT]	1	1.50	1.50	0	[NT]	[NT]
S_{NAS}	%w/w S	0.005	INORG-068	[NT]	1	NT	NT		[NT]	[NT]
a-S_{NAS}	moles H^+/t	5	INORG-064	[NT]	1	NT	NT		[NT]	[NT]
s-SNAS	%w/w S	0.01	INORG-064	[NT]	1	NT	NT		[NT]	[NT]
s-Net Acidity	%w/w S	0.005	INORG-064	[NT]	1	<0.005	<0.005	0	[NT]	[NT]
a-Net Acidity	moles H^+/t	5	INORG-064	[NT]	1	<5	<5	0	[NT]	[NT]
Liming rate	kg $CaCO_3$/t	0.75	INORG-068	[NT]	1	<0.75	<0.75	0	[NT]	[NT]
s-Net Acidity without ANCE	% w/w S	0.005	INORG-064	[NT]	1	<0.005	<0.005	0	[NT]	[NT]
a-Net Acidity without ANCE	moles H^+/t	5	INORG-064	[NT]	1	<5	<5	0	[NT]	[NT]
Liming rate without ANCE	kg $CaCO_3$/t	0.75	INORG-064	[NT]	1	<0.75	<0.75	0	[NT]	[NT]

QUALITY CONTROL: sPOCAS						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			13/11/2019	1	13/11/2019	13/11/2019		13/11/2019	[NT]
Date analysed	-			19/11/2019	1	19/11/2019	19/11/2019		19/11/2019	[NT]
pH $_{Ox}$	pH units		INORG-064	[NT]	1	8.1	8.1	0	101	[NT]
TPA	moles H^+ /t	5	INORG-064	[NT]	1	<5	<5	0	[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available).

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

TOC and PFAS analysis in soil conducted by Envirolab Services. Report 230884.

Explosives analysis conducted by ALS. Report 794039.

CHAIN OF CUSTODY

rps MAKING COMPLEX EASY

Level 2, 27-31 Troode Street
West Perth WA 6005
Tel: (618) 9211 1111
Fax: (618) 9211 1122

Site:	Rottnest Army Jetty
Project reference:	EEC19032.011
Scientist(s)	SMW
Sample type(s):	Sediment ~~and Water~~
Report to:	Alan Foley / Shae Miller-White
Invoice to:	west.accountspayable@rpsgroup.com

Page number:	
Turnaround time:	Standard
Quote number:	~~EBI705/19~~ 19P387
Remarks	

Analytical suites

Sample I.D.	Date collected	Number of jars / bottles / bags	Sediment Suite (1)	Sediment Suite (2)	Sediment Suite (3)	ASLP Suite (1)	Elutriate Suite (1)	Water Suite (1)	PFAS - Full Suite (28 Compounds)	Storage	Sediment Suite (Extended Suite)	No Asbestos (No Particle size Quote: 19P387)
S~~B~~-ZZ1 1	12/11/19										x	
S~~B~~-ZZ2 2	12/11/19								x			

Total number of bottles/bags/jars

mpl Laboratories ENVIROLAB GROUP
Job No.- 2362208
Date Rec - 13-11-19
Time Rec - 1645
Rec By - mc
TAT Req - SAME 1 / 2 / 3 STD
Temp - cool / ambient
Cooling - Ice / Ice pack / None
Security Seal - Yes / No

Primary destination:	MPL	Received by:	mc	Secondary destination:	Received by:
Relinquished by:	Shae Miller-White	Organisation:	MPL	Relinquished by:	Organisation:
Organisation:	RPS	Date:	13-11-19	Organisation:	Date:
Date:	13/11/19	Time:	1645	Date:	Time:
Time:	1645			Time:	

Envirolab Services (WA) Pty Ltd trading as MPL Laboratories
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16-18 Hayden Court Myaree WA 6154
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DATA QUALITY ASSESSMENT SUMMARY

Report Details

Envirolab Report Reference	**236228**
Client ID	RPS Australia West Pty Ltd
Project Reference	EEC19032.011 - Rottnest Army Jetty
Date Issued	28/11/2019

QC DATA

All laboratory QC data was within the Envirolab Group's specifications.

HOLDING TIME COMPLIANCE EVALUATION

All preservation / holding times (based on AS/ASPHA/ISO/NEPM/USEPA reference documents and standards) are compliant except:

Holding Time Exceedances

Analysis	Sample No	Date Sampled	Date Extracted	Date Analysed	Accepted
External Testing					
	236228-1	12/11/2019			**##**

Holding Table Comments

No Extract or Analysed Dates were provided. Holding Times cannot be calculated.

Certain analyses have had their recommended technical holding times elongated by filtering and/or freezing on receipt at the laboratory (e.g. BOD, chlorophyll/Pheophytin, nutrients and acid sulphate soil tests).

COMPLIANCE TO QC FREQUENCY (NEPM)

Internal laboratory QC rate complies with NEPM requirements (LCS/MB/MS 1 in 20, Duplicates 1 in 10 samples). Note, samples are batched together with other sample consignments in order to assign QC sample frequency.

QC Evaluation

Duplicate(s) was performed as per NEPM frequency	✓
Laboratory Control Sample(s) were analysed with the samples received	✓
A Method Blank was performed with the samples received	✓
Matrix spike(s) was performed as per NEPM frequency	✓

Refer to Certificate of Analysis for all Quality Control data.

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SAMPLE RECEIPT ADVICE

Client Details

Client	RPS Australia West Pty Ltd
Attention	Alan Foley

Sample Login Details

Your reference	EEC19032.011 - Rottnest Army Jetty
MPL Reference	236228
Date Sample Received	13/11/2019
Date Instructions Received	13/11/2019
Date Results Expected to be Reported	28/11/2019

Sample Condition

Samples received in appropriate condition for analysis	Yes
No. of Samples Provided	2 soils
Turnaround Time Requested	Standard
Temperature on Receipt (°C)	Cool
Cooling Method	Ice
Sampling Date Provided	Yes

Comments

Nil

Please direct any queries to:

Heram Halim	Meredith Conroy
Phone: 08 9317 2505	**Phone: 08 9317 2505**
Fax: 08 9317 4163	**Fax: 08 9317 4163**
Email: hhalim@mpl.com.au	**Email: mconroy@mpl.com.au**

Analysis Underway, details on the following page:

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Sample ID	External Testing	Nutrients in Soil	Metals - soil	TRH in Sediment (C6-C9) + BTEX	sTRH in Sediment (C10-C36)	PAHs in Sediment (NAGD)	OCP in Sediment (ANZECC)	Low Level OPP in soil	PFAS in Soil Extended	Organotin Compounds in Soil	Explosives in Soil	Aromatic & Aliphatic TPH	Chromium Suite	sPOCAS
SZZ1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SZZ2									✓					

The '✓' indicates the testing you have requested. **THIS IS NOT A REPORT OF THE RESULTS.**

Additional Info

Sample storage - Waters are routinely disposed of approximately 1 month and soils approximately 2 months from receipt.
Requests for longer term sample storage must be received in writing.

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CERTIFICATE OF ANALYSIS 242245

Client Details

Client	RPS Australia West Pty Ltd
Attention	Alan Foley
Address	Level 2, 27-31 Troode St, WEST PERTH, WA, 6005

Sample Details

Your Reference	**EEC19032.012 Rottnest Army Jetty**
Number of Samples	2 Soil, 5 Water
Date samples received	24/03/2020
Date completed instructions received	24/03/2020

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	02/04/2020
Date of Issue	02/04/2020

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Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Heram Halim, Operations Manager

Authorised By

Michael Kubiak, Laboratory Manager

PFAS in Soil Extended				
Our Reference			242245-1	242245-2
Your Reference	UNITS	PQL	SZZ1	SZZ2
Date Sampled			23/03/2020	23/03/2020
Type of sample			Soil	Soil
Date prepared	-		26/03/2020	26/03/2020
Date analysed	-		01/04/2020	01/04/2020
Perfluorobutanesulfonic acid	µg/kg	0.1	<0.1	<0.1
Perfluoropentanesulfonic acid	µg/kg	0.1	<0.1	<0.1
Perfluorohexanesulfonic acid	µg/kg	0.1	<0.1	<0.1
Perfluoroheptanesulfonic acid	µg/kg	0.2	<0.2	<0.2
Perfluorooctanesulfonic acid PFOS	µg/kg	0.1	<0.1	0.5
Perfluorodecanesulfonic acid	µg/kg	0.2	<0.2	<0.2
Perfluorobutanoic acid	µg/kg	0.2	<0.2	<0.2
Perfluoropentanoic acid	µg/kg	0.2	<0.2	<0.2
Perfluorohexanoic acid	µg/kg	0.1	<0.1	<0.1
Perfluoroheptanoic acid	µg/kg	0.1	<0.1	<0.1
Perfluorooctanoic acid PFOA	µg/kg	0.1	<0.1	<0.1
Perfluorononanoic acid	µg/kg	0.1	<0.1	<0.1
Perfluorodecanoic acid	µg/kg	0.5	<0.5	<0.5
Perfluoroundecanoic acid	µg/kg	0.5	<0.5	<0.5
Perfluorododecanoic acid	µg/kg	0.5	<0.5	<0.5
Perfluorotridecanoic acid	µg/kg	0.5	<0.5	<0.5
Perfluorotetradecanoic acid	µg/kg	5	<5	<5
4:2 FTS	µg/kg	0.1	<0.1	<0.1
6:2 FTS	µg/kg	0.1	<0.1	<0.1
8:2 FTS	µg/kg	0.1	<0.1	<0.1
10:2 FTS	µg/kg	0.1	<0.1	<0.1
Perfluorooctane sulfonamide	µg/kg	1	<1	<1
N-Methyl perfluorooctane sulfonamide	µg/kg	1	<1	<1
N-Ethyl perfluorooctanesulfon -amide	µg/kg	1	<1	<1
N-Me perfluorooctanesulfonamid -oethanol	µg/kg	1	<1	<1
N-Et perfluorooctanesulfonamid -oethanol	µg/kg	5	<5	<5
MePerfluorooctanesulf- amid oacetic acid	µg/kg	0.2	<0.2	<0.2
EtPerfluorooctanesulf- amid oacetic acid	µg/kg	0.2	<0.2	<0.2
Surrogate $^{13}C_8$ PFOS	%		103	98
Surrogate $^{13}C_2$ PFOA	%		83	99
Extracted ISTD $^{13}C_3$ *PFBS*	%		96	84
Extracted ISTD $^{18}O_2$ *PFHxS*	%		108	81
Extracted ISTD $^{13}C_4$ *PFOS*	%		110	85
Extracted ISTD 13C4 PFBA	%		55	43

PFAS in Soil Extended				
Our Reference			242245-1	242245-2
Your Reference	UNITS	PQL	SZZ1	SZZ2
Date Sampled			23/03/2020	23/03/2020
Type of sample			Soil	Soil
Extracted ISTD $^{13}C_3$ *PFPeA*	%		80	69
Extracted ISTD $^{13}C_2$ *PFHxA*	%		93	68
Extracted ISTD $^{13}C_4$ *PFHpA*	%		104	73
Extracted ISTD $^{13}C_4$ *PFOA*	%		114	75
Extracted ISTD $^{13}C_5$ *PFNA*	%		106	81
Extracted ISTD $^{13}C_2$ *PFDA*	%		108	79
Extracted ISTD $^{13}C_2$ *PFUnDA*	%		97	90
Extracted ISTD $^{13}C_2$ *PFDoDA*	%		128	80
Extracted ISTD $^{13}C_2$ *PFTeDA*	%		87	66
Extracted ISTD $^{13}C_2$ *4:2FTS*	%		91	84
Extracted ISTD $^{13}C_2$ *6:2FTS*	%		98	94
Extracted ISTD $^{13}C_2$ *8:2FTS*	%		116	93
Extracted ISTD $^{13}C_8$ *FOSA*	%		109	81
Extracted ISTD d_3 *N MeFOSA*	%		86	75
Extracted ISTD d_5 *N EtFOSA*	%		93	76
Extracted ISTD d_7 *N MeFOSE*	%		133	87
Extracted ISTD d_9 *N EtFOSE*	%		126	84
Extracted ISTD d_3 *N MeFOSAA*	%		104	71
Extracted ISTD d_5 *N EtFOSAA*	%		103	81
Total Positive PFHxS & PFOS	µg/kg	0.1	<0.1	0.5
Total Positive PFOS & PFOA	µg/kg	0.1	<0.1	0.5
Total Positive PFAS	µg/kg	0.1	<0.1	0.5

Moisture				
Our Reference			242245-1	242245-2
Your Reference	UNITS	PQL	SZZ1	SZZ2
Date Sampled			23/03/2020	23/03/2020
Type of sample			Soil	Soil
Date prepared	-		26/03/2020	26/03/2020
Date analysed	-		27/03/2020	27/03/2020
Moisture	%	0.1	32	37

PFAS in water TRACE Extended							
Our Reference			242245-3	242245-4	242245-5	242245-6	242245-7
Your Reference	UNITS	PQL	WZZ1	WZZ2	WRR1	WRR2	WBB1
Date Sampled			23/03/2020	23/03/2020	23/03/2020	23/03/2020	23/03/2020
Type of sample			Water	Water	Water	Water	Water
Date prepared	-		27/03/2020	27/03/2020	27/03/2020	27/03/2020	27/03/2020
Date analysed	-		27/03/2020	27/03/2020	27/03/2020	27/03/2020	27/03/2020
Perfluorobutanesulfonic acid	µg/L	0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
Perfluoropentanesulfonic acid	µg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Perfluorohexanesulfonic acid	µg/L	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluoroheptanesulfonic acid	µg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Perfluorooctanesulfonate PFOS	µg/L	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorodecanesulfonic acid	µg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Perfluorobutanoic acid	µg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Perfluoropentanoic acid	µg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Perfluorohexanoic acid	µg/L	0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
Perfluoroheptanoic acid	µg/L	0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
Perfluorooctanoic acid PFOA	µg/L	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Perfluorononanoic acid	µg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Perfluorodecanoic acid	µg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Perfluoroundecanoic acid	µg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Perfluorododecanoic acid	µg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Perfluorotridecanoic acid	µg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Perfluorotetradecanoic acid	µg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05
4:2 FTS	µg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
6:2 FTS	µg/L	0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
8:2 FTS	µg/L	0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
10:2 FTS	µg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Perfluorooctane sulfonamide	µg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
N-Methyl perfluorooctane sulfonamide	µg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005
N-Ethyl perfluorooctanesulfon -amide	µg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
N-Me perfluorooctanesulfonamid -oethanol	µg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005
N-Et perfluorooctanesulfonamid -oethanol	µg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05
MePerfluorooctanesulf- amid oacetic acid	µg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002
EtPerfluorooctanesulf- amid oacetic acid	µg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Surrogate $^{13}C_8$ PFOS	%		96	95	98	96	100
Surrogate $^{13}C_2$ PFOA	%		107	100	98	96	98
Extracted ISTD $^{13}C_3$ *PFBS*	%		100	105	99	115	110
Extracted ISTD $^{18}O_2$ *PFHxS*	%		85	91	92	100	97
Extracted ISTD $^{13}C_4$ *PFOS*	%		61	68	82	87	87
Extracted ISTD $^{13}C_4$ *PFBA*	%		56	59	93	100	103

PFAS in water TRACE Extended							
Our Reference			242245-3	242245-4	242245-5	242245-6	242245-7
Your Reference	UNITS	PQL	WZZ1	WZZ2	WRR1	WRR2	WBB1
Date Sampled			23/03/2020	23/03/2020	23/03/2020	23/03/2020	23/03/2020
Type of sample			Water	Water	Water	Water	Water
Extracted ISTD $^{13}C_3$ PFPeA	%		96	104	107	118	113
Extracted ISTD $^{13}C_2$ PFHxA	%		87	92	93	101	100
Extracted ISTD $^{13}C_4$ PFHpA	%		93	98	101	104	102
Extracted ISTD $^{13}C_4$ PFOA	%		100	110	111	120	115
Extracted ISTD $^{13}C_5$ PFNA	%		86	103	105	111	106
Extracted ISTD $^{13}C_2$ PFDA	%		60	72	89	100	90
Extracted ISTD $^{13}C_2$ PFUnDA	%		50	65	81	93	88
Extracted ISTD $^{13}C_2$ PFDoDA	%		67	64	100	58	56
Extracted ISTD $^{13}C_2$ PFTeDA	%		57	65	100	59	57
Extracted ISTD $^{13}C_2$ 4:2FTS	%		160	173	#	#	162
Extracted ISTD $^{13}C_2$ 6:2FTS	%		170	174	#	#	#
Extracted ISTD $^{13}C_2$ 8:2FTS	%		92	109	165	158	146
Extracted ISTD $^{13}C_8$ FOSA	%		52	60	64	75	72
Extracted ISTD d_3 N MeFOSA	%		43	61	55	70	73
Extracted ISTD d_5 N EtFOSA	%		51	70	64	79	85
Extracted ISTD d_7 N MeFOSE	%		50	59	56	60	65
Extracted ISTD d_9 N EtFOSE	%		56	63	59	67	74
Extracted ISTD d_3 N MeFOSAA	%		59	66	85	81	83
Extracted ISTD d_5 N EtFOSAA	%		62	72	93	93	82
Total Positive PFHxS & PFOS	µg/L	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Total Positive PFOS & PFOA	µg/L	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Total Positive PFAS	µg/L	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002

Method ID	Methodology Summary
INORG-008	Moisture content determined by heating at 105 deg C for a minimum of 12 hours.
Org-035	Soil samples are extracted with basified Methanol. Waters and soil extracts are directly injected and/or concentrated after SPE. Analysis is undertaken with LC-MS/MS. PFAS results include the sum of branched and linear isomers where applicable. Please note that PFAS results are corrected for Extracted Internal Standards (QSM 5.3 Table B-15 terminology), which are mass labelled analytes added prior to sample preparation to assess matrix effects and verify processing of the sample. PFAS analytes without a commercially available mass labelled analogue are corrected vs a closely eluting mass labelled PFAS compound. Surrogates are also reported, in this context they are mass labelled PFAS compounds added prior to extraction but are used as monitoring compounds only (not used for result correction). Envicarb (or similar) is used discretionally to remove interfering matrix components. Please contact the laboratory if estimates of Measurement Uncertainty are required as per WA DER.

QUALITY CONTROL: PFAS in Soil Extended						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			26/03/2020	1	26/03/2020	26/03/2020		26/03/2020	[NT]
Date analysed	-			01/04/2020	1	01/04/2020	01/04/2020		01/04/2020	[NT]
Perfluorobutanesulfonic acid	µg/kg	0.1	Org-035	<0.1	1	<0.1	<0.1	0	115	[NT]
Perfluoropentanesulfonic acid	µg/kg	0.1	Org-035	<0.1	1	<0.1	<0.1	0	107	[NT]
Perfluorohexanesulfonic acid	µg/kg	0.1	Org-035	<0.1	1	<0.1	<0.1	0	105	[NT]
Perfluoroheptanesulfonic acid	µg/kg	0.2	Org-035	<0.2	1	<0.2	<0.2	0	105	[NT]
Perfluorooctanesulfonic acid PFOS	µg/kg	0.1	Org-035	<0.1	1	<0.1	0.2	67	115	[NT]
Perfluorodecanesulfonic acid	µg/kg	0.2	Org-035	<0.2	1	<0.2	<0.2	0	93	[NT]
Perfluorobutanoic acid	µg/kg	0.2	Org-035	<0.2	1	<0.2	<0.2	0	100	[NT]
Perfluoropentanoic acid	µg/kg	0.2	Org-035	<0.2	1	<0.2	<0.2	0	115	[NT]
Perfluorohexanoic acid	µg/kg	0.1	Org-035	<0.1	1	<0.1	<0.1	0	108	[NT]
Perfluoroheptanoic acid	µg/kg	0.1	Org-035	<0.1	1	<0.1	<0.1	0	112	[NT]
Perfluorooctanoic acid PFOA	µg/kg	0.1	Org-035	<0.1	1	<0.1	<0.1	0	105	[NT]
Perfluorononanoic acid	µg/kg	0.1	Org-035	<0.1	1	<0.1	<0.1	0	108	[NT]
Perfluorodecanoic acid	µg/kg	0.5	Org-035	<0.5	1	<0.5	<0.5	0	103	[NT]
Perfluoroundecanoic acid	µg/kg	0.5	Org-035	<0.5	1	<0.5	<0.5	0	92	[NT]
Perfluorododecanoic acid	µg/kg	0.5	Org-035	<0.5	1	<0.5	<0.5	0	120	[NT]
Perfluorotridecanoic acid	µg/kg	0.5	Org-035	<0.5	1	<0.5	<0.5	0	100	[NT]
Perfluorotetradecanoic acid	µg/kg	5	Org-035	<5	1	<5	<5	0	106	[NT]
4:2 FTS	µg/kg	0.1	Org-035	<0.1	1	<0.1	<0.1	0	98	[NT]
6:2 FTS	µg/kg	0.1	Org-035	<0.1	1	<0.1	<0.1	0	106	[NT]
8:2 FTS	µg/kg	0.1	Org-035	<0.1	1	<0.1	<0.1	0	105	[NT]
10:2 FTS	µg/kg	0.1	Org-035	<0.1	1	<0.1	<0.1	0	110	[NT]
Perfluorooctane sulfonamide	µg/kg	1	Org-035	<1	1	<1	<1	0	108	[NT]
N-Methyl perfluorooctane sulfonamide	µg/kg	1	Org-035	<1	1	<1	<1	0	116	[NT]
N-Ethyl perfluorooctanesulfon -amide	µg/kg	1	Org-035	<1	1	<1	<1	0	110	[NT]
N-Me perfluorooctanesulfonamid -oethanol	µg/kg	1	Org-035	<1	1	<1	<1	0	103	[NT]
N-Et perfluorooctanesulfonamid -oethanol	µg/kg	5	Org-035	<5	1	<5	<5	0	97	[NT]
MePerfluorooctanesulf- amid oacetic acid	µg/kg	0.2	Org-035	<0.2	1	<0.2	<0.2	0	107	[NT]
EtPerfluorooctanesulf- amid oacetic acid	µg/kg	0.2	Org-035	<0.2	1	<0.2	<0.2	0	132	[NT]
Surrogate $^{13}C_8$ PFOS	%		Org-035	100	1	103	103	0	97	[NT]
Surrogate $^{13}C_2$ PFOA	%		Org-035	90	1	83	86	4	97	[NT]
Extracted ISTD $^{13}C_3$ *PFBS*	%		Org-035	108	1	96	91	5	89	[NT]

QUALITY CONTROL: PFAS in Soil Extended						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Extracted ISTD $^{18}O_2$ *PFHxS*	%		Org-035	113	1	108	101	7	92	[NT]
Extracted ISTD $^{13}C_4$ *PFOS*	%		Org-035	115	1	110	107	3	95	[NT]
Extracted ISTD 13C4 PFBA	%		Org-035	89	1	55	52	6	83	[NT]
Extracted ISTD $^{13}C_3$ *PFPeA*	%		Org-035	108	1	80	78	3	85	[NT]
Extracted ISTD $^{13}C_2$ *PFHxA*	%		Org-035	114	1	93	86	8	88	[NT]
Extracted ISTD $^{13}C_4$ *PFHpA*	%		Org-035	124	1	104	103	1	92	[NT]
Extracted ISTD $^{13}C_4$ *PFOA*	%		Org-035	126	1	114	107	6	93	[NT]
Extracted ISTD $^{13}C_5$ *PFNA*	%		Org-035	134	1	106	113	6	94	[NT]
Extracted ISTD $^{13}C_2$ *PFDA*	%		Org-035	139	1	108	101	7	97	[NT]
Extracted ISTD $^{13}C_2$ *PFUnDA*	%		Org-035	117	1	97	88	10	129	[NT]
Extracted ISTD $^{13}C_2$ *PFDoDA*	%		Org-035	117	1	128	115	11	109	[NT]
Extracted ISTD $^{13}C_2$ *PFTeDA*	%		Org-035	101	1	87	94	8	59	[NT]
Extracted ISTD $^{13}C_2$ *4:2FTS*	%		Org-035	97	1	91	85	7	98	[NT]
Extracted ISTD $^{13}C_2$ *6:2FTS*	%		Org-035	98	1	98	102	4	96	[NT]
Extracted ISTD $^{13}C_2$ *8:2FTS*	%		Org-035	96	1	116	100	15	96	[NT]
Extracted ISTD $^{13}C_8$ *FOSA*	%		Org-035	115	1	109	108	1	90	[NT]
Extracted ISTD d_3 *N MeFOSA*	%		Org-035	97	1	86	92	7	74	[NT]
Extracted ISTD d_5 *N EtFOSA*	%		Org-035	109	1	93	103	10	77	[NT]
Extracted ISTD d_7 *N MeFOSE*	%		Org-035	127	1	133	121	9	91	[NT]
Extracted ISTD d_9 *N EtFOSE*	%		Org-035	124	1	126	121	4	88	[NT]
Extracted ISTD d_3 *N MeFOSAA*	%		Org-035	118	1	104	101	3	97	[NT]

QUALITY CONTROL: PFAS in Soil Extended						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Extracted ISTD d_5 *N EtFOSAA*	%		Org-035	109	1	103	109	6	110	[NT]

QUALITY CONTROL: Moisture						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	
Date prepared	-			26/03/2020	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Date analysed	-			27/03/2020	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Moisture	%	0.1	INORG-008	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]

QUALITY CONTROL: PFAS in water TRACE Extended						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	242245-4
Date prepared	-			27/03/2020	3	27/03/2020	27/03/2020		27/03/2020	27/03/2020
Date analysed	-			27/03/2020	3	27/03/2020	27/03/2020		27/03/2020	27/03/2020
Perfluorobutanesulfonic acid	µg/L	0.0004	Org-035	<0.0004	3	<0.0004	<0.0004	0	102	100
Perfluoropentanesulfonic acid	µg/L	0.001	Org-035	<0.001	3	<0.001	<0.001	0	100	102
Perfluorohexanesulfonic acid	µg/L	0.0002	Org-035	<0.0002	3	<0.0002	<0.0002	0	107	102
Perfluoroheptanesulfonic acid	µg/L	0.001	Org-035	<0.001	3	<0.001	<0.001	0	97	91
Perfluorooctanesulfonate PFOS	µg/L	0.0002	Org-035	<0.0002	3	<0.0002	<0.0002	0	108	110
Perfluorodecanesulfonic acid	µg/L	0.002	Org-035	<0.002	3	<0.002	<0.002	0	69	70
Perfluorobutanoic acid	µg/L	0.002	Org-035	<0.002	3	<0.002	<0.002	0	102	104
Perfluoropentanoic acid	µg/L	0.002	Org-035	<0.002	3	<0.002	<0.002	0	105	105
Perfluorohexanoic acid	µg/L	0.0004	Org-035	<0.0004	3	<0.0004	<0.0004	0	104	103
Perfluoroheptanoic acid	µg/L	0.0004	Org-035	<0.0004	3	<0.0004	<0.0004	0	107	129
Perfluorooctanoic acid PFOA	µg/L	0.0002	Org-035	<0.0002	3	<0.0002	<0.0002	0	106	107
Perfluorononanoic acid	µg/L	0.001	Org-035	<0.001	3	<0.001	<0.001	0	103	100
Perfluorodecanoic acid	µg/L	0.002	Org-035	<0.002	3	<0.002	<0.002	0	110	105
Perfluoroundecanoic acid	µg/L	0.002	Org-035	<0.002	3	<0.002	<0.002	0	91	91
Perfluorododecanoic acid	µg/L	0.005	Org-035	<0.005	3	<0.005	<0.005	0	84	82
Perfluorotridecanoic acid	µg/L	0.01	Org-035	<0.01	3	<0.01	<0.01	0	80	75
Perfluorotetradecanoic acid	µg/L	0.05	Org-035	<0.05	3	<0.05	<0.05	0	64	83
4:2 FTS	µg/L	0.001	Org-035	<0.001	3	<0.001	<0.001	0	99	97
6:2 FTS	µg/L	0.0004	Org-035	<0.0004	3	<0.0004	<0.0004	0	98	96
8:2 FTS	µg/L	0.0004	Org-035	<0.0004	3	<0.0004	<0.0004	0	90	93
10:2 FTS	µg/L	0.001	Org-035	<0.001	3	<0.001	<0.001	0	68	62
Perfluorooctane sulfonamide	µg/L	0.01	Org-035	<0.01	3	<0.01	<0.01	0	89	85
N-Methyl perfluorooctane sulfonamide	µg/L	0.005	Org-035	<0.005	3	<0.005	<0.005	0	84	95
N-Ethyl perfluorooctanesulfon -amide	µg/L	0.01	Org-035	<0.01	3	<0.01	<0.01	0	85	104
N-Me perfluorooctanesulfonamid -oethanol	µg/L	0.005	Org-035	<0.005	3	<0.005	<0.005	0	84	98
N-Et perfluorooctanesulfonamid -oethanol	µg/L	0.05	Org-035	<0.05	3	<0.05	<0.05	0	83	92
MePerfluorooctanesulf- amid oacetic acid	µg/L	0.002	Org-035	<0.002	3	<0.002	<0.002	0	88	123
EtPerfluorooctanesulf- amid oacetic acid	µg/L	0.002	Org-035	<0.002	3	<0.002	<0.002	0	81	103
Surrogate $^{13}C_8$ PFOS	%		Org-035	104	3	96	100	4	97	102
Surrogate $^{13}C_2$ PFOA	%		Org-035	103	3	107	98	9	100	100
Extracted ISTD $^{13}C_3$ *PFBS*	%		Org-035	100	3	100	109	9	100	97

QUALITY CONTROL: PFAS in water TRACE Extended						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	242245-4
Extracted ISTD $^{18}O_2$ *PFHxS*	%		Org-035	92	3	85	93	9	90	85
Extracted ISTD $^{13}C_4$ *PFOS*	%		Org-035	73	3	61	59	3	78	62
Extracted ISTD $^{13}C_4$ *PFBA*	%		Org-035	78	3	56	60	7	88	63
Extracted ISTD $^{13}C_3$ *PFPeA*	%		Org-035	103	3	96	101	5	104	97
Extracted ISTD $^{13}C_2$ *PFHxA*	%		Org-035	97	3	87	91	4	100	89
Extracted ISTD $^{13}C_4$ *PFHpA*	%		Org-035	99	3	93	97	4	97	91
Extracted ISTD $^{13}C_4$ *PFOA*	%		Org-035	104	3	100	106	6	102	102
Extracted ISTD $^{13}C_5$ *PFNA*	%		Org-035	90	3	86	86	0	92	96
Extracted ISTD $^{13}C_2$ *PFDA*	%		Org-035	77	3	60	56	7	74	67
Extracted ISTD $^{13}C_2$ *PFUnDA*	%		Org-035	71	3	50	54	8	66	62
Extracted ISTD $^{13}C_2$ *PFDoDA*	%		Org-035	67	3	67	64	5	64	62
Extracted ISTD $^{13}C_2$ *PFTeDA*	%		Org-035	57	3	57	65	13	65	71
Extracted ISTD $^{13}C_2$ *4:2FTS*	%		Org-035	131	3	160	173	8	131	157
Extracted ISTD $^{13}C_2$ *6:2FTS*	%		Org-035	132	3	170	168	1	117	155
Extracted ISTD $^{13}C_2$ *8:2FTS*	%		Org-035	103	3	92	90	2	98	99
Extracted ISTD $^{13}C_8$ *FOSA*	%		Org-035	67	3	52	54	4	63	58
Extracted ISTD d_3 *N MeFOSA*	%		Org-035	63	3	43	41	5	64	50
Extracted ISTD d_5 *N EtFOSA*	%		Org-035	66	3	51	45	12	70	53
Extracted ISTD d_7 *N MeFOSE*	%		Org-035	60	3	50	53	6	64	53
Extracted ISTD d_9 *N EtFOSE*	%		Org-035	71	3	56	54	4	62	53

QUALITY CONTROL: PFAS in water TRACE Extended						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	242245-4
Extracted ISTD d_3 *N MeFOSAA*	%		Org-035	66	3	59	56	5	62	53
Extracted ISTD d_5 *N EtFOSAA*	%		Org-035	66	3	62	55	12	64	60

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
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Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

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Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

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Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

PFAS analysis conducted by Envirolab Services. Report 239635.

For PFAS Extracted Internal Standards denoted with # or outside the 50-150% acceptance range, the respective target analyte results may be unaffected, in other circumstances the PQL has been raised to accommodate the outlier(s).

PFAS_Elutriate: MeFOSA and EtFOSA Extracted Internal Standards are outside of global acceptance criteria (50-150%) for LCS but within analyte specific acceptance criteria.

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CERTIFICATE OF ANALYSIS 242245-A

Client Details

Client	RPS Australia West Pty Ltd
Attention	Alan Foley
Address	Level 2, 27-31 Troode St, WEST PERTH, WA, 6005

Sample Details

Your Reference	**EEC19032.012 Rottnest Army Jetty**
Number of Samples	2 Elutriate
Date samples received	24/03/2020
Date completed instructions received	24/03/2020

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	11/04/2020
Date of Issue	02/04/2020

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Results Approved By
Heram Halim, Operations Manager

Authorised By

Michael Kubiak, Laboratory Manager

PFAS in elutriate TRACE Extended				
Our Reference			242245-A-1	242245-A-2
Your Reference	UNITS	PQL	SZZ1	SZZ2
Date Sampled			23/03/2020	23/03/2020
Type of sample			Elutriate	Elutriate
Date prepared	-		01/04/2020	01/04/2020
Date analysed	-		01/04/2020	01/04/2020
pH of Elutriate	pH Units		8.0	8.0
Perfluorobutanesulfonic acid	µg/L	0.0004	<0.0004	<0.0004
Perfluoropentanesulfonic acid	µg/L	0.001	<0.001	<0.001
Perfluorohexanesulfonic acid	µg/L	0.0002	<0.0002	<0.0002
Perfluoroheptanesulfonic acid	µg/L	0.001	<0.001	<0.001
Perfluorooctanesulfonate PFOS	µg/L	0.0002	<0.0002	0.0005
Perfluorodecanesulfonic acid	µg/L	0.002	<0.002	<0.002
Perfluorobutanoic acid	µg/L	0.002	<0.002	<0.002
Perfluoropentanoic acid	µg/L	0.002	<0.002	<0.002
Perfluorohexanoic acid	µg/L	0.0004	<0.0004	<0.0004
Perfluoroheptanoic acid	µg/L	0.0004	<0.0004	<0.0004
Perfluorooctanoic acid PFOA	µg/L	0.0002	<0.0002	<0.0002
Perfluorononanoic acid	µg/L	0.001	<0.001	<0.001
Perfluorodecanoic acid	µg/L	0.002	<0.002	<0.002
Perfluoroundecanoic acid	µg/L	0.002	<0.002	<0.002
Perfluorododecanoic acid	µg/L	0.005	<0.005	<0.005
Perfluorotridecanoic acid	µg/L	0.01	<0.01	<0.01
Perfluorotetradecanoic acid	µg/L	0.05	<0.05	<0.05
4:2 FTS	µg/L	0.001	<0.001	<0.001
6:2 FTS	µg/L	0.0004	<0.0004	<0.0004
8:2 FTS	µg/L	0.0004	<0.0004	<0.0004
10:2 FTS	µg/L	0.001	<0.001	<0.001
Perfluorooctane sulfonamide	µg/L	0.01	<0.01	<0.01
N-Methyl perfluorooctane sulfonamide	µg/L	0.005	<0.005	<0.005
N-Ethyl perfluorooctanesulfon -amide	µg/L	0.01	<0.01	<0.01
N-Me perfluorooctanesulfonamid -oethanol	µg/L	0.005	<0.005	<0.005
N-Et perfluorooctanesulfonamid -oethanol	µg/L	0.05	<0.05	<0.05
MePerfluorooctanesulf- amid oacetic acid	µg/L	0.002	<0.002	<0.002
EtPerfluorooctanesulf- amid oacetic acid	µg/L	0.002	<0.002	<0.002
Surrogate $^{13}C_8$ PFOS	%		102	98
Surrogate $^{13}C_2$ PFOA	%		91	97
Extracted ISTD $^{13}C_3$ *PFBS*	%		118	110
Extracted ISTD $^{18}O_2$ *PFHxS*	%		95	93
Extracted ISTD $^{13}C_4$ *PFOS*	%		99	85

PFAS in elutriate TRACE Extended				
Our Reference			242245-A-1	242245-A-2
Your Reference	UNITS	PQL	SZZ1	SZZ2
Date Sampled			23/03/2020	23/03/2020
Type of sample			Elutriate	Elutriate
Extracted ISTD $^{13}C_4$ *PFBA*	%		85	78
Extracted ISTD $^{13}C_3$ *PFPeA*	%		108	107
Extracted ISTD $^{13}C_2$ *PFHxA*	%		110	109
Extracted ISTD $^{13}C_4$ *PFHpA*	%		125	120
Extracted ISTD $^{13}C_4$ *PFOA*	%		149	130
Extracted ISTD $^{13}C_5$ *PFNA*	%		158	124
Extracted ISTD $^{13}C_2$ *PFDA*	%		125	86
Extracted ISTD $^{13}C_2$ *PFUnDA*	%		90	86
Extracted ISTD $^{13}C_2$ *PFDoDA*	%		84	66
Extracted ISTD $^{13}C_2$ *PFTeDA*	%		70	49
Extracted ISTD $^{13}C_2$ *4:2FTS*	%		#	181
Extracted ISTD $^{13}C_2$ *6:2FTS*	%		#	#
Extracted ISTD $^{13}C_2$ *8:2FTS*	%		#	177
Extracted ISTD $^{13}C_8$ *FOSA*	%		84	67
Extracted ISTD d_3 *N MeFOSA*	%		39	34
Extracted ISTD d_5 *N EtFOSA*	%		42	28
Extracted ISTD d_7 *N MeFOSE*	%		59	48
Extracted ISTD d_9 *N EtFOSE*	%		71	49
Extracted ISTD d_3 *N MeFOSAA*	%		151	83
Extracted ISTD d_5 *N EtFOSAA*	%		137	78
Total Positive PFHxS & PFOS	µg/L	0.0002	<0.0002	0.0005
Total Positive PFOS & PFOA	µg/L	0.0002	<0.0002	0.0005
Total Positive PFAS	µg/L	0.0002	<0.0002	0.0005

Method ID	Methodology Summary
INORG-001	pH - Measured using pH meter and electrode base on APHA latest edition, Method 4500-H+. Please note that the results for water analyses may be indicative only, as analysis can be completed outside of the APHA recommended holding times. Soils are reported from a 1:5 water extract unless otherwise specified.
Org-035	Soil samples are extracted with basified Methanol. Waters and soil extracts are directly injected and/or concentrated after SPE. Analysis is undertaken with LC-MS/MS. PFAS results include the sum of branched and linear isomers where applicable. Please note that PFAS results are corrected for Extracted Internal Standards (QSM 5.3 Table B-15 terminology), which are mass labelled analytes added prior to sample preparation to assess matrix effects and verify processing of the sample. PFAS analytes without a commercially available mass labelled analogue are corrected vs a closely eluting mass labelled PFAS compound. Surrogates are also reported, in this context they are mass labelled PFAS compounds added prior to extraction but are used as monitoring compounds only (not used for result correction). Envicarb (or similar) is used discretionally to remove interfering matrix components. Please contact the laboratory if estimates of Measurement Uncertainty are required as per WA DER.

QUALITY CONTROL: PFAS in elutriate TRACE Extended						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	242245-A-2
Date prepared	-			01/04/2020	1	01/04/2020	01/04/2020		01/04/2020	01/04/2020
Date analysed	-			01/04/2020	1	01/04/2020	01/04/2020		01/04/2020	01/04/2020
Perfluorobutanesulfonic acid	µg/L	0.0004	Org-035	<0.0004	1	<0.0004	<0.0004	0	102	107
Perfluoropentanesulfonic acid	µg/L	0.001	Org-035	<0.001	1	<0.001	<0.001	0	108	112
Perfluorohexanesulfonic acid	µg/L	0.0002	Org-035	<0.0002	1	<0.0002	<0.0002	0	102	107
Perfluoroheptanesulfonic acid	µg/L	0.001	Org-035	<0.001	1	<0.001	<0.001	0	103	115
Perfluorooctanesulfonate PFOS	µg/L	0.0002	Org-035	<0.0002	1	<0.0002	<0.0002	0	106	105
Perfluorodecanesulfonic acid	µg/L	0.002	Org-035	<0.002	1	<0.002	<0.002	0	81	81
Perfluorobutanoic acid	µg/L	0.002	Org-035	<0.002	1	<0.002	<0.002	0	98	103
Perfluoropentanoic acid	µg/L	0.002	Org-035	<0.002	1	<0.002	<0.002	0	101	102
Perfluorohexanoic acid	µg/L	0.0004	Org-035	<0.0004	1	<0.0004	<0.0004	0	105	109
Perfluoroheptanoic acid	µg/L	0.0004	Org-035	<0.0004	1	<0.0004	<0.0004	0	102	114
Perfluorooctanoic acid PFOA	µg/L	0.0002	Org-035	<0.0002	1	<0.0002	<0.0002	0	104	110
Perfluorononanoic acid	µg/L	0.001	Org-035	<0.001	1	<0.001	<0.001	0	105	109
Perfluorodecanoic acid	µg/L	0.002	Org-035	<0.002	1	<0.002	<0.002	0	122	115
Perfluoroundecanoic acid	µg/L	0.002	Org-035	<0.002	1	<0.002	<0.002	0	94	102
Perfluorododecanoic acid	µg/L	0.005	Org-035	<0.005	1	<0.005	<0.005	0	110	124
Perfluorotridecanoic acid	µg/L	0.01	Org-035	<0.01	1	<0.01	<0.01	0	81	95
Perfluorotetradecanoic acid	µg/L	0.05	Org-035	<0.05	1	<0.05	<0.05	0	109	104
4:2 FTS	µg/L	0.001	Org-035	<0.001	1	<0.001	<0.001	0	101	111
6:2 FTS	µg/L	0.0004	Org-035	<0.0004	1	<0.0004	<0.0004	0	110	102
8:2 FTS	µg/L	0.0004	Org-035	<0.0004	1	<0.0004	<0.0004	0	103	95
10:2 FTS	µg/L	0.001	Org-035	<0.001	1	<0.001	<0.001	0	77	128
Perfluorooctane sulfonamide	µg/L	0.01	Org-035	<0.01	1	<0.01	<0.01	0	108	104
N-Methyl perfluorooctane sulfonamide	µg/L	0.005	Org-035	<0.005	1	<0.005	<0.005	0	111	96
N-Ethyl perfluorooctanesulfon -amide	µg/L	0.01	Org-035	<0.01	1	<0.01	<0.01	0	113	97
N-Me perfluorooctanesulfonamid -oethanol	µg/L	0.005	Org-035	<0.005	1	<0.005	<0.005	0	111	102
N-Et perfluorooctanesulfonamid -oethanol	µg/L	0.05	Org-035	<0.05	1	<0.05	<0.05	0	98	99
MePerfluorooctanesulf- amid oacetic acid	µg/L	0.002	Org-035	<0.002	1	<0.002	<0.002	0	100	90
EtPerfluorooctanesulf- amid oacetic acid	µg/L	0.002	Org-035	<0.002	1	<0.002	<0.002	0	87	93
Surrogate $^{13}C_8$ PFOS	%		Org-035	97	1	102	98	4	100	94
Surrogate $^{13}C_2$ PFOA	%		Org-035	94	1	91	94	3	102	95
Extracted ISTD $^{13}C_3$ *PFBS*	%		Org-035	117	1	118	114	3	95	97

QUALITY CONTROL: PFAS in elutriate TRACE Extended						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	242245-A-2
Extracted ISTD $^{18}O_2$ *PFHxS*	%		Org-035	95	1	95	87	9	81	82
Extracted ISTD $^{13}C_4$ *PFOS*	%		Org-035	94	1	99	86	14	80	84
Extracted ISTD $^{13}C_4$ *PFBA*	%		Org-035	119	1	85	83	2	106	76
Extracted ISTD $^{13}C_3$ *PFPeA*	%		Org-035	125	1	108	110	2	101	103
Extracted ISTD $^{13}C_2$ *PFHxA*	%		Org-035	126	1	110	104	6	108	103
Extracted ISTD $^{13}C_4$ *PFHpA*	%		Org-035	125	1	125	114	9	99	113
Extracted ISTD $^{13}C_4$ *PFOA*	%		Org-035	122	1	149	138	8	96	115
Extracted ISTD $^{13}C_5$ *PFNA*	%		Org-035	107	1	158	136	15	99	117
Extracted ISTD $^{13}C_2$ *PFDA*	%		Org-035	85	1	125	109	14	69	88
Extracted ISTD $^{13}C_2$ *PFUnDA*	%		Org-035	94	1	90	85	6	77	74
Extracted ISTD $^{13}C_2$ *PFDoDA*	%		Org-035	75	1	84	85	1	61	55
Extracted ISTD $^{13}C_2$ *PFTeDA*	%		Org-035	81	1	70	74	6	53	50
Extracted ISTD $^{13}C_2$ *4:2FTS*	%		Org-035	117	1	#	#		83	156
Extracted ISTD $^{13}C_2$ *6:2FTS*	%		Org-035	127	1	#	#		84	186
Extracted ISTD $^{13}C_2$ *8:2FTS*	%		Org-035	130	1	#	#		106	#
Extracted ISTD $^{13}C_8$ *FOSA*	%		Org-035	84	1	84	71	17	66	57
Extracted ISTD d_3 *N MeFOSA*	%		Org-035	53	1	39	35	11	42	31
Extracted ISTD d_5 *N EtFOSA*	%		Org-035	51	1	42	41	2	36	31
Extracted ISTD d_7 *N MeFOSE*	%		Org-035	79	1	59	64	8	59	47
Extracted ISTD d_9 *N EtFOSE*	%		Org-035	74	1	71	68	4	60	46

QUALITY CONTROL: PFAS in elutriate TRACE Extended						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	242245-A-2
Extracted ISTD d_3 *N MeFOSAA*	%		Org-035	96	1	151	127	17	71	75
Extracted ISTD d_5 *N EtFOSAA*	%		Org-035	86	1	137	120	13	64	64

Result Definitions

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For VOCs in water samples, three vials are required for duplicate or spike analysis.

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Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

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Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

PFAS analysis conducted by Envirolab Services. Report 239635.

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lab@mpl.com.au
www.mpl.com.au

DATA QUALITY ASSESSMENT SUMMARY

Report Details

Envirolab Report Reference	**242245-A**
Client ID	RPS Australia West Pty Ltd
Project Reference	EEC19032.012 Rottnest Army Jetty
Date Issued	02/04/2020

QC DATA

All laboratory QC data was within the Envirolab Group's specifications except:

QC Specification Exceptions

QC Type	Reference	Analysis	Comments
Spike Recovery %	242245-A-2	*Extracted ISTD* $^{13}C_2$ *8:2FTS*	Fails internal acceptance criteria

See Report 242245-A-[R00] for QA/QC details

HOLDING TIME COMPLIANCE EVALUATION

All preservation / holding times (based on AS/ASPHA/ISO/NEPM/USEPA reference documents and standards) are compliant except:

Holding Time Exceedances

Analysis	Sample No	Date Sampled	Date Extracted	Date Analysed	Accepted
PFAS in elutriate TRACE Extended					
	242245-A-1	23/03/2020	01/04/2020	01/04/2020	✗
	242245-A-2	23/03/2020	01/04/2020	01/04/2020	✗

Certain analyses have had their recommended technical holding times elongated by filtering and/or freezing on receipt at the laboratory (e.g. BOD, chlorophyll/Pheophytin, nutrients and acid sulphate soil tests).

COMPLIANCE TO QC FREQUENCY (NEPM)

Internal laboratory QC rate complies with NEPM requirements (LCS/MB/MS 1 in 20, Duplicates 1 in 10 samples). Note, samples are batched together with other sample consignments in order to assign QC sample frequency.

QC Evaluation

Duplicate(s) was performed as per NEPM frequency	✓
Laboratory Control Sample(s) were analysed with the samples received	✓
A Method Blank was performed with the samples received	✓
Matrix spike(s) was performed as per NEPM frequency (Not Applicable for Air samples)	✓

Refer to Certificate of Analysis for all Quality Control data.

CHAIN OF CUSTODY

rps MAKING COMPLEX EASY

Site:	Rottnest Army Jetty
Project reference:	EEC19032.012
Scientist(s)	SMW
Sample type(s):	Sediment and Water
Report to:	Alan Foley / Shae Miller-White
Invoice to:	west.accountspayable@rpsgroup.com

Level 2, 27-31 Troode Street
West Perth WA 6005
Tel: (618) 9211 1111
Fax: (618) 9211 1122

Page number:
Turnaround time: Standard
Quote number:

Analytical suites

Extended suites No 2413

Sample I.D.		Date collected	Number of jars / bottles / bags	PFAS (Standard) - Sediment	PFAS (Trace levels) - Elutriate	PFAS (Trace levels) - Water	Storage	Remarks
SWZZ1	1	23.3.20	2x PFAS.	x	x			
SWZZ2	2	↓	↓	x	x			
WZZ1	3	↓	↓			x		
WZZ2	4	↓	↓			x		
WRR1	5	↓	↓			x		
WRR2	6	↓	↓			x		
WBB1	7	↓	↓			x		

Total number of bottles/bags/jars

Envirolab Laboratories
Job No.- 242245
Date Rec- 24/3
Time Rec- 945
Rec By- [illegible]
TAT Req- SAME 1 / 2 / 3 / STD
Temp ice / ambient
Cooling Ice / Ice pack / None
Security Seal Yes / No

Primary destination:	MPL	Received by:	C. Jackson	Secondary destination:	Received by:
Relinquished by:	Shae Miller-White	Organisation:	MPL	Relinquished by:	Organisation:
Organisation:	RPS	Date:	24/3/20	Organisation:	Date:
Date:	24.3.20	Time:	945	Date:	Time:
Time:	9am.			Time:	

Envirolab Services (WA) Pty Ltd trading as MPL Laboratories
ABN 53 140 099 207
16-18 Hayden Court Myaree WA 6154
ph 08 9317 2505 fax 08 9317 4163
lab@mpl.com.au
www.mpl.com.au

DATA QUALITY ASSESSMENT SUMMARY

Report Details

Envirolab Report Reference	**242245**
Client ID	RPS Australia West Pty Ltd
Project Reference	EEC19032.012 Rottnest Army Jetty
Date Issued	02/04/2020

QC DATA

All laboratory QC data was within the Envirolab Group's specifications.

HOLDING TIME COMPLIANCE EVALUATION

All preservation / holding times (based on AS/ASPHA/ISO/NEPM/USEPA reference documents and standards) are compliant.

Certain analyses have had their recommended technical holding times elongated by filtering and/or freezing on receipt at the laboratory (e.g. BOD, chlorophyll/Pheophytin, nutrients and acid sulphate soil tests).

COMPLIANCE TO QC FREQUENCY (NEPM)

Internal laboratory QC rate complies with NEPM requirements (LCS/MB/MS 1 in 20, Duplicates 1 in 10 samples). Note, samples are batched together with other sample consignments in order to assign QC sample frequency.

QC Evaluation

Duplicate(s) was performed as per NEPM frequency	✓
Laboratory Control Sample(s) were analysed with the samples received	✓
A Method Blank was performed with the samples received	✓
Matrix spike(s) was performed as per NEPM frequency (Not Applicable for Air samples)	✓

Refer to Certificate of Analysis for all Quality Control data.

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SAMPLE RECEIPT ADVICE

Client Details

Client	RPS Australia West Pty Ltd
Attention	Alan Foley

Sample Login Details

Your reference	EEC19032.012 Rottnest Army Jetty
MPL Reference	242245
Date Sample Received	24/03/2020
Date Instructions Received	24/03/2020
Date Results Expected to be Reported	02/04/2020

Sample Condition

Samples received in appropriate condition for analysis	Yes
No. of Samples Provided	2 Soil, 5 Water
Turnaround Time Requested	Standard
Temperature on Receipt (°C)	7
Cooling Method	Ice
Sampling Date Provided	Yes

Comments

Nil

Please direct any queries to:

Heram Halim	Meredith Conroy
Phone: 08 9317 2505	**Phone: 08 9317 2505**
Fax: 08 9317 4163	**Fax: 08 9317 4163**
Email: hhalim@mpl.com.au	**Email: mconroy@mpl.com.au**

Analysis Underway, details on the following page:

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Sample ID	PFAS in Soil Extended	PFAS in water TRACE Extended
SZZ1	✓	✓
SZZ2	✓	✓
WZZ1		✓
WZZ2		✓
WRR1		✓
WRR2		✓
WBB1		✓

The '✓' indicates the testing you have requested. **THIS IS NOT A REPORT OF THE RESULTS.**

Additional Info

Sample storage - Waters are routinely disposed of approximately 1 month and soils approximately 2 months from receipt.

Requests for longer term sample storage must be received in writing.

Appendix C
Quality Control and Assurance Evaluation

APPENDIX C: QUALITY CONTROL AND ASSURANCE EVALUATION

1.1 Overview

Sampling and analysis was undertaken in general accordance with the following guidance documentation:

- Commonwealth of Australia, 2009. *National Assessment Guidelines for Dredging (NAGD)*
- Simpson et al. 2005. *Handbook for Sediment Quality Assessment*. CSIRO
- DWER. 2014. *Assessment and Management of Contaminated Sites*
- Department of Water and Environment Regulation. June 2015a. *Identification and Investigation of Acid Sulfate Soils and Acid Landscapes*
- NEPM 2013. *National Environment Protection (Assessment of Site Contamination) Measure*. National Environmental Protection Council,
- HEPA. 2018. *PFAS National Environmental Management Plan*.
- Standards Australia. 2005. AS 4482.1. *Guide to the Sampling and Investigation of Potentially Contaminated Soil, Part 1: Non-volatile and Semi-volatile Compounds*.
- Standards Australia. 1999. AS 4482.2. *Guide to the Sampling and Investigation of Potentially Contaminated Soil, Part 2: Volatile Compound*s.
- Standards Australia. 1998. Water Quality—Sampling. Part 9: *Guidance on sampling from marine waters* (AS/NZS 5667.9:1998).

Strict hygiene procedures were applied throughout to assure sample integrity and quality, including the decontamination of all sampling equipment between sampling locations to prevent possible cross-contamination.

Consistent with aforementioned guidance documentation, quality control procedures included the collection and analysis of a duplicate sample for every 20 samples (minimum) collected (per matrix) submitted for analysis. The primary laboratory used during this exercise was ALS Environmental (ALS).

1.2 Quality Control Criteria

RPS requires that laboratories have a QAQC program that is endorsed by National Association of Testing Authorities (NATA) and meets the following criteria:

- All recovery rates to be between 70% and 130%.
- Relative percentage differences (RPDs) between original and duplicate samples to range between +/-30%. If the RPD is greater than +/-30%, the higher value is used for evaluation purposes.

Calculation of the RPD value is provided in the following equation:

$$RPD = \frac{(Co - Cs)}{\left(\frac{Co + Cs}{2}\right)} x100$$

where: Co = concentration of the original sample

Cs = concentration of the duplicate sample

The RPD calculation was used to normalise each pair of results to allow for better QAQC data interpretation. For those RPD values which exceed a generally acceptable 30–50% (Standards Australia 2005) data correlation is considered poor, however, consideration needs to be given to sample homogeneity and the concentrations detected.

1.3 Field QAQC Evaluation

1.3.1 Sediment Field Duplicates

Tables C-A to C-G presents the sediment field duplicate RPD assessment calculations.

- A total of 214 of the 216 analyte tests (~99%) performed on the field duplicate samples had a RPD within 30% of the original samples indicating the sampling and analysis procedures applied by RPS and the laboratory were generally reproducible. A review of the observed exceedances concludes the following:
  - Both failures are considered insignificant as concentrations of both the primary and duplicate samples are <5x LOR. These results merely reflect that analytical test precision decreases as analyte concentrations approach the limit of detection.

These failures are not considered to have affected the overall assessment, as all concentrations were below relevant assessment criteria and the highest concentration has been used in the assessment.

1.3.2 Sediment Field Triplicates

Tables C-A to C-G presents the sediment field triplicate RPD assessment calculations.

A total of 197 of the 215 analyte tests (~92%) performed on the field triplicate samples had a RPD within 30% of the original samples indicating the sampling and analysis procedures applied by RPS and the laboratory were generally reproducible. A review of the observed exceedances concludes the following:

- The majority of exceedances occurred on metals and nutrients where various in concentrations can be observed due to heterogeneity.
- Several of the metals and the PFAS result exceedances are considered insignificant as concentrations of both the primary and triplicate samples are <5x LOR. These results merely reflect that analytical test precision decreases as analyte concentrations approach the limit of detection.
- For all the above cases implementing a conservative approach, the higher sample values have been adopted to characterise the sediment quality of the site, and as such no re-analysis was considered necessary.

These failures are not considered to have affected the overall assessment, as all concentrations were below relevant assessment criteria and the highest concentration has been used in the assessment.

1.3.3 Surface Water Field Duplicates

Table C-E-2 presents the surface water field duplicate RPD assessment calculations.

- A total of 54 of the 60 analyte tests (~90%) performed on the field duplicate samples had a RPD within 30% of the original samples indicating the sampling and analysis procedures applied by RPS and the laboratory were generally reproducible. A review of the observed exceedances concludes the following:
  - All failures are considered insignificant as concentrations of both the primary and duplicate samples are <5x LOR. These results merely reflect that analytical test precision decreases as analyte concentrations approach the limit of detection.

These failures are not considered to have affected the overall assessment, as the highest concentration has been used in the assessment.

1.3.4 Surface Water Field Triplicates

Table C-E-2 presents the surface water field triplicate RPD assessment calculations.

- All of the 60 analyte tests (~100%) performed on the field triplicate samples had a RPD within 30% of the original samples indicating the sampling and analysis procedures applied by RPS and the laboratory were generally reproducible.

1.3.5 Elutriate Field Triplicates

Table C-E-3 presents the elutriate water field triplicate RPD assessment calculations.

A total of 57 of the 60 analyte tests (~95%) performed on the field duplicate samples had a RPD within 30% of the original samples indicating the sampling and analysis procedures applied by RPS and the laboratory were generally reproducible. A review of the observed exceedances concludes the following:

- All failures are considered insignificant as concentrations of both the primary and triplicate samples are <5x LOR. These results merely reflect that analytical test precision decreases as analyte concentrations approach the limit of detection.

These failures are not considered to have affected the overall assessment, as the highest concentration has been used in the assessment.

1.3.6 Rinsates, Blanks and Trip Blanks

Tables C-H to C-M presents the investigation rinsate, blank and trip blank results.

Concentrations of analytes for the field rinsates, field blanks and trip blanks were generally below the respective LORs (>99%), with the exceptions limited to copper, zinc and PFOS as discussed below:

- Concentrations of copper zinc were present in the rinsate and blank samples from the 13 November 2019 that marginally exceeded the respective LORs, and concentrations were <5x LOR. The presence of trace metals and nutrients in all of the water QAQC samples demonstrates that the presence of minor contamination of the supplied deionised water. As such, the exceedances are not considered a consequence of contamination occurring during sampling and are not considered to have affected the overall assessment.

- A minor detection of PFOS was observed in a rinsate from the 23 March 2020 that marginally exceeded the respective LORs, and concentrations were <5x LOR. Given the marginal exceedance and no other PFAS identified in the sample and or any other rinsate, blank and or trip blank, the exceedance is not considered a consequence of contamination occurring during sampling and is not considered to have affected the overall assessment.

1.3.7 Overall

Although QAQC failures were identified, they are not considered to have affected the integrity of the data collected or the resultant overall site assessment, and the data collected is considered suitable to use to characterise the site.

1.4 Internal Laboratory QAQC Evaluation

1.4.1 Laboratory Summary

In accordance with ISO/IEC 17025:2005, the NATA accredited laboratories are required to perform various internal QAQC procedures to ensure integrity of analytical results.

Standard laboratory methods were used throughout the program by the National Association of Testing Authorities (NATA) accredited laboratory with a summary of QAQC procedures implemented and details any outliers by the laboratory for each area presented in Table C.1 below.

Table C.1: Laboratory QA/QC Summary

Laboratory QAQC Undertaken/ Outliers		Matrix	
		Sediment	Water
Method Blank	Undertaken	Y	Y
	Outlier/Failures	N	N
Control Standard	Undertaken	Y	Y
	Outlier/Failures	Y	Y
Duplicate	Undertaken	Y	Y
	Outlier/Failures	N	N
Spike	Undertaken	Y	Y
	Outlier/Failures	Y	N
Surrogates	Undertaken	Y	Y
	Outlier/Failures	Y	N
Quality Control Frequency	Undertaken	Y	Y
	Outlier/Failures	N	Y
Holding Time	Undertaken	Y	Y
	Outlier/Failures	Y	N

Notes: Y – Yes, N – No

1.4.2 Laboratory Method Blanks

No laboratory method blank results were above their respective analyte LORs, indicating no contamination occurred during the sample preparation or subsequent analysis.

1.4.3 Laboratory Control Standards

All laboratory control standards (LCS) were reported within acceptable criteria.

1.4.4 Laboratory Duplicates

All laboratory duplicates were within acceptable criteria.

1.4.5 Surrogates

The majority of surrogate recoveries were within the acceptance criteria, indicating minimal sample matrix interferences were observed. Exceptions to this was identified in the sediment and water surrogate recovery for organotin which had a low recovery due to matrix interferences.

1.4.6 Matrix Spikes

Most matrix spike recoveries were within the acceptance criteria; however a failure for ammonia was reported due to the concentrations in the sample being significantly greater than the spike concentration. This is a reflection of the matrix of the samples are not the method.

1.4.7 Quality Control Frequency

All laboratory quality control frequencies were within the acceptance criteria, with the exception of some water analysis due to insufficient samples.

1.4.8 Sample Holding Time Evaluation

All samples were transported to the laboratory within the recommended holding time for each analyte and as such the several holding time failures are a result of the laboratory and not the sampling process.

1.4.9 Overall

Although QAQC failures were identified overall they are not considered to affect the overall assessment.

1.5 Documentation Completeness

Chain of Custody (CoC) documentation was submitted to the laboratory together with the samples. These were signed by the personnel accepting the samples and included the following information:

- sampling location and job reference number
- sample ID
- date
- name of sampler
- name of Project Manager
- requested suite of analysis
- type of sample preservation (if any)
- date and time and signature verifying release to the laboratory
- date and time and signature verifying acceptance from the laboratory.

For each QAQC sample the identifier and sample type were noted. The sampler, sampling conditions, date, and place at which the samples were taken are recorded on the log sheet. All QAQC samples are recorded on CoCs.

All QAQC samples submitted to a NATA accredited laboratory for analysis have a signed laboratory report detailing the results of the analysis.

1.6 Data Completeness

All samples designated for chemical analysis were determined based on the historic and current site use and previous findings. All sampling and analysis was undertaken in accordance with Water Quality Australia and DWER requirements.

1.7 Data Comparability

There are a number of factors that contribute to, or detract from, data comparability. These can be grouped into two general categories, factors related to sample collection and handling, and factors related to the analytical methods used. Sample collection issues include sample support (i.e. exactly what was sampled) and acquisition techniques, environmental conditions at the time of sampling, and sample handling/preservation methods. Analytical issues related to data comparability include sample preparation, clean up, and determinative methods used. Analytical surety in this monitoring investigation was addressed by employing NATA accredited laboratories.

Sample collection issues were addressed by utilising laboratory issued, standard collection bottles appropriate for the analytes of interest, the use of rigorous decontamination procedures, using appropriate preservation and storage techniques and by keeping storage times to a minimum. These measures generally

maintain, as much as is practically possible, the comparability of data between chronologically separate sampling events.

1.8 Data Representativeness

The sample set detailed above was determined to be sufficiently representative of the site for the purpose of the program. The duplicate sample results were subjected to analytical data validation and it was concluded that the results could be used to confirm the conclusions about the quality of soil and groundwater at the site.

1.9 Data Comparability Checks

The samples were collected by trained field scientists throughout the sampling program. The field scientists followed the RPS field manual and employed identical sampling methodology and techniques.

Table C-A: Sediment Analytical Results - Metals, Metalloids, Organotins and Nutrients - QAQC

Definitions:

LOR (Limits of Reporting),
--- denotes not tested

Notes:

All values in mg/kg except Tributyl in µg Sn/kg. Table uses colour coding for data interpretation.

deontes <LOR
denotes exceeds the RPD

Sample ID	Date Sampled	Trigger	Total Metals															Nutrients					
			Antimony	Arsenic	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Vanadium	Zinc	Tributyl Tin	Total Phosphorus	Phosphorous Reactive	Total Nitrogen	Nitrogen Kjeldahl Total	Ammonia (as N)	NOX
		LOR	0.5	1	0.1	1	0.5	1	1	10	0.01	1	0.1	0.1	2	1	2	0.1	20	20	20	0.1	0.1
Duplicate																							
C01S03	12/11/2019		0.5	1	0.2	10	1	1	1	10	0.01	1	0.1	0.1	11	1.1	0.5	232	0.1	310	310	0.2	0.1
SZ01			0.6	1.09	0	9.8	1	1	1	10	0.01	1	0.2	0.1	11	1.2	0.5	305	0.1	310	310	0.5	0.1
RPD%			18	9	0	1	0	0	0	0	0	0	**67**	0	1	9	0	27	0	0	0	**86**	0
Triplicate																							
C01S03	12/11/2019		0.5	1	0.2	10	1	1	1	10	0.01	1	0.1	0.1	11	1.1	0.5	232	0.1	310	310	0.2	0.1
SZZ01			1	0.7	0.1	---	0.5	0.5	0.5	6	0.01	0.7	0.2	0.1	6.8	0.5	0.5	280	0.5	140	140	---	0.1
RPD%			0	0	**67**	#	0	0	0	0	0	**0**	**67**	0	**50**	**75**	0	19	0	**76**	**76**	0	0

MAKING COMPLEX EASY

Table C-B: Sediment Analytical Results - PAHs - QAQC

Definitions:

LOR (Limits of Reporting), PAH - Polycyclic Aromatic Hydrocarbons

--- denotes not tested

Notes:

All values in mg/kg unless indicated. Table uses colour coding for data interpretation.

deontes <LOR

denotes exceeds the RPD

Sample ID	Date Sampled	Trigger	PAHs																					
			2-methyl-naphthalene	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benz(a)pyrene	Benz(b)fluoranthene	Benz(e)pyrene	Benz(ghi)perylene	Benz(k)fluoranthene	Chrysene	Coronene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Perylene	Phenanthrene	Pyrene	TEQ BaP	Total PAH
		LOR	0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004
Duplicate																								
C01S03	12/11/2019		0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004
SZ01			0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004
RPD%			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triplicate																								
C01S03	12/11/2019		0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.004	0.004
SZZ01			0.005	0.005	0.005	0.005	0.005	0.005	0.010	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
RPD%			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

MAKING COMPLEX EASY

Table C-C: Sediment Analytical Results - TRH and BTEX - QAQC

Definitions:

LOR (Limits of Reporting),
--- denotes not tested

Notes:

All values in mg/kg unless indicated. Table uses colour coding for data interpretation.
deontes <LOR
denotes exceeds the RPD

Sample ID	Date Sampled	Trigger	BTEX							TPH					TRH						
			Benzene	Ethyl Benzene	Toluene	ortho-Xylene	meta,para-Xylene	Xylene	Sum of BTEX	C6 - C9	C10 - C14	C15 - C28	C29 - C36	C10 - C36 (sum)	C6 - C10	C6 - C10 minus BTEX (F1)	>C10 - C16	>C10 - C16 minus Naphthalene (F2)	>C16 - C34	>C34 - C40	>C10 - C40 (sum)
		LOR	0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
Duplicate																					
C01S03	12/11/2019		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
SZ01			0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
RPD%			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triplicate																					
C01S03	12/11/2019		0.2	0.2	0.2	0.2	0.2	0.5	0.2	3	3	3	5	3	3	3	3	3	3	5	3
SZZ01			0.2	0.2	0.2	0.2	0.4	0.4	0.2	25	25	25	25	25	25	25	25	2	25	25	25
RPD%			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

MAKING COMPLEX EASY

Table C-D: Sediment Analytical Results - OC/OP Pesticides - QAQC

Definitions:

LOR (Limits of Reporting),
--- denotes not tested

Notes:

All values in mg/kg unless indicated. Table uses colour coding for data interpretation.
deontes <LOR
denotes exceeds the RPD

Sample ID	Date Sampled	Trigger	OCs																								
			Aldrin	Aldrin+Dieldrin	Alpha-BHC	Beta-BHC	Chlordane	cis-Chlordane	DDD	DDE	DDT	Delta-BHC	Dieldrin	Endosulfan (sum)	Endosulphan I	Endosulphan II	Endosulphan Sulfate	Endrin	Endrin Aldehyde	Endrin Ketone	gamma-BHC (Lindane)	HCB	Heptachlor	Heptachlor Epoxide	Methoxychlor	Oxychlordane	trans-Chlordane
		LOR	0.0005	0.0005	0.0005	0.0005	0.00025	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005
Duplicate																											
C01S03	12/11/2019		0.0005	0.0005	0.00050	0.00050	0.00025	0.00025	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00025	0.00050	0.00050	0.00050	0.00050	0.00025	0.00050
SZ01			0.0005	0.0005	0.00050	0.00050	0.00025	0.00025	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00025	0.00050	0.00050	0.00050	0.00050	0.00025	0.00050
RPD%			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triplicate																											
C01S03	12/11/2019		0.0005	0.0005	0.00050	0.00050	0.00025	0.00025	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00025	0.00050	0.00050	0.00050	0.00050	0.00025	0.00050
SZZ01			0.0010	0.0010	0.0010	0.0010	0.0005	0.0005	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0002	---	---	0.0010	0.0000	0.0010	0.0010	0.0010	0.0010	0.0010
RPD%			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	#	#	0	0	0	0	0	0	0

Sample ID	Date Sampled	Trigger	OPs																			
			Bromophos-ethyl	Carbophenothion	Chlorfenvinphos (E)	Chlorfenvinphos (Z)	Chlorpyrifos	Chlorpyrifos-methyl	Demeton-S-methyl	Diazinon	Dichlorvos	Dimethoate	Ethion	Fenamiphos	Fenthion	Malathion	Azinphos Methyl	Monocrotophos	Parathion	Parathion-methyl	Pirimphos-ethyl	Prothiofos
		LOR	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Duplicate																						
C01S03	12/11/2019		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
SZ01			0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
RPD%			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triplicate																						
C01S03	12/11/2019		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
SZZ01			0.05	---	---	---	0.05	0.05	---	0.05	---	---	0.05	---	0.05	0.05	---	---	0.05	0.05	0.05	---
RPD%			0	#	#	#	0	0	#	0	#	#	0	#	0	0	#	#	0	0	0	#

Table C-E-1: Sediment Analytical Results - PFAS - QAQC

Definitions:

LOR (Limits of Reporting),
--- denotes not tested

Notes:

All values in mg/kg unless indicated. Table uses colour coding for data interpretation.
deontes <LOR
denotes exceeds the RPD

Sample ID	Date Sampled	Trigger	PFAS																												
			Perfluorobutane sulfonic acid (PFBS)	Perfluoropentane sulfonic acid (PFPeS)	Perfluorohexane sulfonic acid (PFHxS)	Perfluoroheptane sulfonic acid (PFHpS)	Perfluorooctane sulfonic acid (PFOS)	Sum of PFHxS and PFOS	Perfluorodecane sulfonic acid (PFDS)	Perfluorobutanoic acid (PFBA)	Perfluoropentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnDA)	Perfluorododecanoic acid (PFDoDA)	Perfluorotridecanoic acid (PFTrDA)	Perfluorotetradecanoic acid (PFTeDA)	Perfluorooctane sulfonamide (FOSA)	N-methyl perfluorooctane sulfonamide (MeFOSA)	N-ethyl perfluorooctane sulfonamide (EtFOSA)	N-methyl perfluorooctane sulfonamidoethanol (MeFOSE)	N-ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	N-methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	N-ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	4:2 Fluorotelomer sulfonic acid (4:2 FTS)	6:2 Fluorotelomer sulfonic acid (6:2 FTS)	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	10:2 Fluorotelomer sulfonic acid (10:2 FTS)	Total PFAS
		LOR	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
Duplicate																															
C01S03	12/11/2019		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
SZ01			0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
RPD%			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C01S01	23/03/2020		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
SZ1			0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
RPD%			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C02S01	23/03/2020		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
SZ2			0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
RPD%			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triplicate																															
C01S03	12/11/2019		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
SZZ01			0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.0050	0.0010	0.0010	0.0050	0.0010	0.0010	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001
RPD%			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C01S01	23/03/2020		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
SZZ1			0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.0050	0.0010	0.0010	0.0050	0.0010	0.0010	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001
RPD%			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C02S01	23/03/2020		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0002
SZZ2			0.0001	0.0001	0.0001	0.0002	0.0005	0.0005	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.0050	0.0010	0.0010	0.0050	0.0010	0.0010	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0005
RPD%			0	0	0	0	86	86	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	86

Table C-E-2: Surface Water Analytical Results - PFAS - QAQC

Definitions:

LOR (Limits of Reporting),
--- denotes not tested

Notes:

All values in µg/L unless indicated. Table uses colour coding for data interpretation.
deontes <LOR
denotes exceeds the RPD

Sample ID	Date Sampled	Trigger	PFAS																												
			Perfluorobutane sulfonic acid (PFBS)	Perfluoropentane sulfonic acid (PFPeS)	Perfluorohexane sulfonic acid (PFHxS)	Perfluoroheptane sulfonic acid (PFHpS)	Perfluorooctane sulfonic acid (PFOS)	Sum of PFHxS and PFOS	Perfluorodecane sulfonic acid (PFDS)	Perfluorobutanoic acid (PFBA)	Perfluoropentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnDA)	Perfluorododecanoic acid (PFDoDA)	Perfluorotridecanoic acid (PFTrDA)	Perfluorotetradecanoic acid (PFTeDA)	Perfluorooctane sulfonamide (FOSA)	N-methyl perfluorooctane sulfonamide (MeFOSA)	N-ethyl perfluorooctane sulfonamide (EtFOSA)	N-methyl perfluorooctane sulfonamidoethanol (MeFOSE)	N-ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	N-methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	N-ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	4:2 Fluorotelomer sulfonic acid (4:2 FTS)	6:2 Fluorotelomer sulfonic acid (6:2 FTS)	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	10:2 Fluorotelomer sulfonic acid (10:2 FTS)	Total PFAS
		LOR	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.002	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0002
Duplicate																															
C06-SW	23/03/2020		0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.002	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0002
WZ1			0.0005	0.0005	0.0005	0.0005	0.0006	0.0006	0.0005	0.0020	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0010	0.0010	0.0010	0.0010	0.0005	0.0005	0.0010	0.0010	0.0010	0.0010	0.0006
RPD%			0	0	0	0	100	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
C04-SW	23/03/2020		0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.002	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0002
WZ2			0.0005	0.0005	0.0005	0.0005	0.0003	0.0003	0.0005	0.0020	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0010	0.0010	0.0010	0.0010	0.0005	0.0005	0.0010	0.0010	0.0010	0.0010	0.0003
RPD%			0	0	0	0	40	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40
Triplicate																															
C06-SW	23/03/2020		0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.002	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0002
WZZ1			0.0004	0.0010	0.0002	0.0010	0.0002	0.0002	0.0020	0.0020	0.0020	0.0004	0.0004	0.0002	0.0010	0.0020	0.0020	0.0050	0.0100	0.0500	0.0100	0.0050	0.0100	0.0050	0.0500	0.0020	0.0020	0.0010	0.0004	0.0004	0.0010	0.0002
RPD%			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C04-SW	23/03/2020		0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.002	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0002
WZZ2			0.0004	0.0010	0.0002	0.0010	0.0002	0.0002	0.0020	0.0020	0.0020	0.0004	0.0004	0.0002	0.0010	0.0020	0.0020	0.0050	0.0100	0.0500	0.0100	0.0050	0.0100	0.0050	0.0500	0.0020	0.0020	0.0010	0.0004	0.0004	0.0010	0.0002
RPD%			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table C-E-3: Elutriate Analytical Results - PFAS - QAQC

Definitions:

LOR (Limits of Reporting),
--- denotes not tested

Notes:

All values in µg/L unless indicated. Table uses colour coding for data interpretation.
deontes <LOR
denotes exceeds the RPD

MAKING COMPLEX EASY

Sample ID	Date Sampled	Trigger	PFAS																													
			Perfluorobutane sulfonic acid (PFBS)	Perfluoropentane sulfonic acid (PFPeS)	Perfluorohexane sulfonic acid (PFHxS)	Perfluoroheptane sulfonic acid (PFHpS)	Perfluorooctane sulfonic acid (PFOS)	Sum of PFHxS and PFOS	Perfluorodecane sulfonic acid (PFDS)	Perfluorobutanoic acid (PFBA)	Perfluoropentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnDA)	Perfluorododecanoic acid (PFDoDA)	Perfluorotridecanoic acid (PFTrDA)	Perfluorotetradecanoic acid (PFTeDA)	Perfluorooctane sulfonamide (FOSA)	N-methyl perfluorooctane sulfonamide (MeFOSA)	N-ethyl perfluorooctane sulfonamide (EtFOSA)	N-methyl perfluorooctane sulfonamidoethanol (MeFOSE)	N-ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	N-methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	N-ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	4:2 Fluorotelomer sulfonic acid (4:2 FTS)	6:2 Fluorotelomer sulfonic acid (6:2 FTS)	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	10:2 Fluorotelomer sulfonic acid (10:2 FTS)	Total PFAS
		LOR	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.002	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0002
Triplicate																																
C01S01	23/03/2020		0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.002	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0002
SZZ1			0.0004	0.0010	0.0002	0.0010	0.0002	0.0002	0.0020	0.0020	0.0020	0.0004	0.0004	0.0002	0.0010	0.0020	0.0020	0.0050	0.0100	0.0500	0.0100	0.0050	0.0100	0.0050	0.0500	0.0020	0.0020	0.0010	0.0004	0.0004	0.0010	0.0002
RPD%			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C02S01	23/03/2020		0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.002	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0002
SZZ2			0.0004	0.0010	0.0002	0.0010	0.0005	0.0005	0.0020	0.0020	0.0020	0.0004	0.0004	0.0002	0.0010	0.0020	0.0020	0.0050	0.0100	0.0500	0.0100	0.0050	0.0100	0.0050	0.0500	0.0020	0.0020	0.0010	0.0004	0.0004	0.0010	0.0005
RPD%			0	0	0	0	**86**	**86**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**86**

MAKING COMPLEX EASY

Table C-F: Sediment Analytical Results - Explosives - QAQC

Definitions:

LOR (Limits of Reporting),
--- denotes not tested

Notes:

All values in mg/kg unless indicated. Table uses colour coding for data interpretation.

deontes <LOR
denotes exceeds the RPD

Sample ID	Date Sampled	Trigger	Explosives																	
			HMX	RDX	1.3.5-Trinitrobenzene	1.3-Dinitrobenzene	Tetryl	2.4.6-TNT	4-Amino.2.6-DNT	2-Amino-4.6-DNT	4- & 2-Am-DNT(Isomeric Mixture)	2.4-Dinitrotoluene	2.6-Dinitrotoluene	2.4- & 2.6-DNT(Isomeric Mixture)	Nitrobenzene	2-Nitrotoluene	3-Nitrotoluene	4-Nitrotoluene	Nitroglycerine	PETN
		LOR	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1
Duplicate																				
C01S03	12/11/2019		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1
SZ01			0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1
RPD%			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triplicate																				
C01S03	12/11/2019		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1
SZZ01			0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1
RPD%			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

MAKING COMPLEX EASY

Table C-G: Sediment Analytical Results - Acid Sulfate Soils - QAQC

Definitions:

LOR (Limits of Reporting),
--- denotes not tested

Notes:

Units as ndicated. Table uses colour coding for data interpretation.
deontes <LOR
denotes exceeds the RPD

Sample ID	Date Sampled	Test	Acidity Trail					CRS		Net Acidity excluding ANC		ANC	
		Analyte	pH_{KCl}	pH_{OX}	TAA	S_{TAA}	TPA	aS_{CR}	S_{CR}	$S_{CR} + S_{TAA}$		ANC	ANC
		Units	pH	pH	mol (H+/tonne)	%S	mol (H+/tonne)	mol (H+/tonne)	%S	mol (H+/tonne)	%S	mol (H+/tonne)	%S
		LOR	0.1	0.1	2	0.01	2	5	0.005	5	0.005	10	0.02
Duplicate													
C01S03	12/11/2019		10.0	7.9	<2	<0.02	<2	<10	0.007	<10	<0.02	17,500	28
SZ01			10.0	7.8	<2	<0.02	<2	<10	0.007	<10	<0.02	17,000	27.2
RPD%			0	0	0	0	0	0	0	0	0	3	3
Triplicate													
C01S03	12/11/2019		10.0	7.9	<2	<0.02	<2	<10	0.007	<10	<0.02	17,500	28
SZZ01			10.0	8.1	<5	<0.01	<5	<5	<0.005	<5	<0.005	18,000	29
RPD%			0	2	0	0	0	0	0	0	0	3	4

MAKING COMPLEX EASY

Table C-H: Rinsate, Blanks and Trip Blank Results - Metals, Metalloids and Nutrients

Definitions:

LOR (Limits of Reporting),

Notes:

All values in mg/L . Table uses colour coding for data interpretation.

deontes <LOR

Sample ID	Date Sampled	Sample Type	Trigger	Total Metals														Nutrients					
				Antimony	Arsenic	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Vanadium	Zinc	Total Phosphorus	Phosphorous Reactive	Total Nitrogen	Nitrogen Kjeldahl Total	Ammonia (as N)	NOX
			LOR	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.0001	0.001	0.001	0.01	0.001	0.01	0.005	0.01	0.01	0.1	0.1	0.01	0.01
Blank																							
WB1	12/11/2019	Blank		<0.001	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.01	<0.005	0.01	0.01	0.1	0.1	0.01	0.01
WB2	13/11/2019	Blank		<0.001	<0.001	<0.0001	<0.001	<0.001	0.014	<0.001	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.01	0.012	0.01	0.01	0.1	0.1	0.01	0.01

MAKING COMPLEX EASY

Table C-I: Rinsate, Blanks and Trip Blank Results - PAHs

Definitions:

LOR (Limits of Reporting),

Notes:

All values in mg/L . Table uses colour coding for data interpretation.

deontes <LOR

Sample ID	Date Sampled	Sample Type	Trigger	PAHs															
				Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b+j)fluoranthene	Benzo(g.h.i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a.h)anthracene	Fluoranthene	Fluorene	Indeno(1.2.3.cd)pyrene	Naphthalene	Phenanthrene	Pyrene
			LOR	0.001	0.001	0.001	0.001	0.0005	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Blank																			
WB1	12/11/2019	Blank		0.001	0.001	0.001	0.001	0.0005	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
WB2	13/11/2019	Blank		0.001	0.001	0.001	0.001	0.0005	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Rinsate																			
WR1	12/11/2019	Rinsate		0.001	0.001	0.001	0.001	0.0005	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
WR2	13/11/2019	Rinsate		0.001	0.001	0.001	0.001	0.0005	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

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Table C-J: Rinsate, Blanks and Trip Blank Results - TRH and BTEX

Definitions:

LOR (Limits of Reporting), --- not tested

Notes:

All values in mg/L unless indicated. Table uses colour coding for data interpretation.

deontes <LOR

Sample ID	Date Sampled	Sample Type	Trigger	BTEX							TPH					TRH						
				Benzene	Ethyl Benzene	Toluene	ortho-Xylene	meta,para-Xylene	Xylene	Sum of BTEX	C6 - C9	C10 - C14	C15 - C28	C29 - C36	C10 - C36 (sum)	C6 - C10	C6 - C10 minus BTEX (F1)	>C10 - C16	>C10 - C16 minus Naphthalene (F2)	>C16 - C34	>C34 - C40	>C10 - C40 (sum)
			LOR	0.001	0.002	0.002	0.002	0.002	0.002	0.001	0.02	0.05	0.1	0.05	0.05	0.02	0.02	0.1	0.1	0.1	0.1	0.1
Blank																						
WB1	12/11/2019	Blank		0.001	0.002	0.002	0.002	0.002	0.002	0.001	0.02	0.05	0.1	0.05	0.05	0.02	0.02	0.1	0.1	0.1	0.1	0.1
WB2	13/11/2019	Blank		0.001	0.002	0.002	0.002	0.002	0.002	0.001	0.02	0.05	0.1	0.05	0.05	0.02	0.02	0.1	0.1	0.1	0.1	0.1
Rinsate																						
WR1	12/11/2019	Rinsate		0.001	0.002	0.002	0.002	0.002	0.002	0.001	0.02	0.05	0.1	0.05	0.05	0.02	0.02	0.1	0.1	0.1	0.1	0.1
WR2	13/11/2019	Rinsate		0.001	0.002	0.002	0.002	0.002	0.002	0.001	0.02	0.05	0.1	0.05	0.05	0.02	0.02	0.1	0.1	0.1	0.1	0.1
Trip Blank																						
WTB1	12/11/2020	Trip Blank		0.001	0.002	0.002	0.002	0.002	0.002	0.001	0.02	0.05	---	---	---	0.02	0.02	---	---	---	---	---

MAKING COMPLEX EASY

Table C-K: Rinsate, Blanks and Trip Blank Results - OC/OP Pesticides

Definitions:

LOR (Limits of Reporting),

Notes:

All values in µg/L unless indicated. Table uses colour coding for data interpretation.

deontes <LOR

Sample ID	Date Sampled	Sample Type	Trigger	OCs																							
				4,4'-DDD	4,4'-DDE	4,4'-DDT	Aldrin	alpha-BHC	alpha-Endosulfan	beta-BHC	beta-Endosulfan	cis-Chlordane	delta-BHC	Dieldrin	Endosulfan sulfate	Endrin	Endrin aldehyde	Endrin ketone	gamma-BHC	Heptachlor	Heptachlor epoxide	Hexachlorobenzene (HCB)	Methoxychlor	Sum of Aldrin + Dieldrin	Sum of DDD + DDE + DDT	Total Chlordane (sum)	trans-Chlordane
			LOR	0.5	0.5	2	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	2	0.5	0.5	0.5	0.5
Blank																											
WB1	12/11/2019	Blank		0.5	0.5	2	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	2	0.5	0.5	0.5	0.5
WB2	13/11/2019	Blank		0.5	0.5	2	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	2	0.5	0.5	0.5	0.5
Rinsate																											
WR1	12/11/2019	Rinsate		0.5	0.5	2	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	2	0.5	0.5	0.5	0.5
WR2	13/11/2019	Rinsate		0.5	0.5	2	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	2	0.5	0.5	0.5	0.5

Sample ID	Date Sampled	Sample Type	Trigger	OPs																			
				Azinphos-methyl	Bromophos-ethyl	Carbofenothion	Chlorfenvinphos	Chlorpyrifos	Chlorpyrifos-methyl	Demeton-S-methyl	Diazinon	Dichlorvos	Dimethoate	Disulfoton	Ethion	Fenamiphos	Fenthion	Malathion	Monocrotophos	Parathion	Parathion-methyl	Pirimiphos-ethyl	Prothiofos
			LOR	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	2	2	2	0.5	0.5	0.1
Blank																							
WB1	12/11/2019	Blank		0.50	0.5	0.50	0.50	0.50	0.5	0.50	0.50	0.5	0.50	0.50	0.50	0.50	0.50	2	2	2	0.5	0.50	0.1
WB2	13/11/2019	Blank		0.50	0.5	0.50	0.50	0.50	0.5	0.50	0.50	0.5	0.50	0.50	0.50	0.50	0.50	2	2	2	0.5	0.50	0.1
Rinsate																							
WR1	12/11/2019	Rinsate		0.50	0.5	0.50	0.50	0.50	0.5	0.50	0.50	0.5	0.50	0.50	0.50	0.50	0.50	2	2	2	0.5	0.50	0.1
WR2	13/11/2019	Rinsate		0.50	0.5	0.50	0.50	0.50	0.5	0.50	0.50	0.5	0.50	0.50	0.50	0.50	0.50	2	2	2	0.5	0.50	0.1

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Table C-L: Rinsate, Blanks and Trip Blank Results - PFAS - QAQC

Definitions:

LOR (Limits of Reporting),

Notes:

All values in µg/L unless indicated. Table uses colour coding for data interpretation.

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Sample ID	Date Sampled	Sample Type	Trigger	PFAS																												
				Perfluorobutane sulfonic acid (PFBS)	Perfluoropentane sulfonic acid (PFPeS)	Perfluorohexane sulfonic acid (PFHxS)	Perfluoroheptane sulfonic acid (PFHpS)	Perfluorooctane sulfonic acid (PFOS)	Sum of PFHxS and PFOS	Perfluorodecane sulfonic acid (PFDS)	Perfluorobutanoic acid (PFBA)	Perfluoropentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnDA)	Perfluorododecanoic acid (PFDoDA)	Perfluorotridecanoic acid (PFTrDA)	Perfluorotetradecanoic acid (PFTeDA)	Perfluorooctane sulfonamide (FOSA)	N-Methyl perfluorooctane sulfonamide (MeFOSA)	N-Ethyl perfluorooctane sulfonamide (EtFOSA)	N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	4:2 Fluorotelomer sulfonic acid (4:2 FTS)	6:2 Fluorotelomer sulfonic acid (6:2 FTS)	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	10:2 Fluorotelomer sulfonic acid (10:2 FTS)	Total PFAS
			LOR	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.002	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0002
Blank																																	
WB1	12/11/2019	Blank		0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0020	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0002
WB2	13/11/2019	Blank		0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0020	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0002
WB1	23/03/2020	Blank		0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0020	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0002
WBB1	23/03/2020	Trip Blank		0.0004	0.0010	0.0002	0.0010	0.0002	0.0002	0.0020	0.0020	0.0004	0.0004	0.0002	0.0010	0.0020	0.0020	0.0050	0.0100	0.0500	0.0100	0.0050	0.010	0.005	0.050	0.002	0.0020	0.0010	0.000	0.000	0.001	0.001	0.0002
Rinsate																																	
WR1	12/11/2019	Rinsate		0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0020	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0002
WR2	13/11/2019	Rinsate		0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0020	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0002
WR1	23/03/2020	Rinsate		0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0020	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0002
WR2	23/03/2020	Rinsate		0.0005	0.0005	0.0005	0.0005	0.0003	0.0003	0.0005	0.0020	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0003
WRR1	23/03/2020	Trip Rinsate		0.0004	0.0010	0.0002	0.0010	0.0002	0.0002	0.0020	0.0020	0.0004	0.0004	0.0002	0.0010	0.0020	0.0020	0.0050	0.0100	0.0500	0.0100	0.0050	0.010	0.005	0.050	0.002	0.0020	0.0010	0.000	0.000	0.001	0.001	0.0002
WRR2	23/03/2020	Trip Rinsate		0.0004	0.0010	0.0002	0.0010	0.0002	0.0002	0.0020	0.0020	0.0004	0.0004	0.0002	0.0010	0.0020	0.0020	0.0050	0.0100	0.0500	0.0100	0.0050	0.010	0.005	0.050	0.002	0.0020	0.0010	0.000	0.000	0.001	0.001	0.0002
Trip Blank																																	
WTB1	12/11/2020	Trip Blank		0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0020	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0002
TBW 197	23/03/2020	Trip Blank		0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0020	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0002
TBW 168	23/03/2020	Trip Blank		0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.0005	0.0020	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0005	0.0005	0.001	0.001	0.001	0.001	0.0002

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Table C-M: Rinsate, Blanks and Trip Blank Results - Explosives - QAQC

Definitions:

LOR (Limits of Reporting),

Notes:

All values in µg/L unless indicated. Table uses colour coding for data interpretation.

deontes <LOR

Sample ID	Date Sampled		Trigger	Explosives																	
				HMX	RDX	1.3.5-Trinitrobenzene	1.3-Dinitrobenzene	Tetryl	2.4.6-TNT	4-Amino.2.6-DNT	2-Amino-4.6-DNT	4- & 2-Am-DNT(Isomeric Mixture)	2.4-Dinitrotoluene	2.6-Dinitrotoluene	2.4- & 2.6-DNT(Isomeric Mixture)	Nitrobenzene	2-Nitrotoluene	3-Nitrotoluene	4-Nitrotoluene	Nitroglycerine	PETN
			LOR	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	200	200
Blank																					
WB1	12/11/2019	Blank		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	200	200
WB2	13/11/2019	Blank		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	200	200
Rinsate																					
WR1	12/11/2019	Rinsate		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	200	200
WR2	13/11/2019	Rinsate		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	200	200

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REPORT

Appendix I
Flora and vegetation survey; South Thompson and Kingstown, Rottnest Island (Wadjemup) (FVC 2023)

FLORA AND VEGETATION SURVEY

SOUTH THOMSON AND KINGSTOWN, ROTTNEST ISLAND (WADJEMUP)

THE ROTTNEST ISLAND AUTHORITY

JUNE 2023

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TABLE OF CONTENTS

Executive Summary

1 Introduction 6

1.1 BACKGROUND 6
1.2 LOCATION 6
1.3 SCOPE OF WORK 6

2 Legislative Context 8

2.1 THREATENED AND PRIORITY FLORA 8
2.2 THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES 11
2.3 VEGETATION OF SIGNIFICANCE 11
2.3.1 Nationally Significant Vegetation 11
2.3.2 State Significant Vegetation 11
2.3.3 Regionally Significant Vegetation 12
2.3.4 Locally Significant Vegetation 12
2.4 VEGETATION CLEARING, EXTENT AND STATUS 12
2.5 ENVIRONMENTALLY SENSITIVE AREAS 12
2.6 INTRODUCED FLORA 13
2.6.1 Weeds of National Significance 13
2.6.2 Declared Pest Plants 13
2.6.3 Environmental Weeds 13

3 Existing Environment 14

3.1 CLIMATE 14
3.2 IBRA REGION 15
3.3 SOILS 15
3.4 VEGETATION 17

4 Methodology 20

4.1 DESKTOP REVIEW 20
4.2 FIELD ASSESSMENT 20
4.3 SURVEY LIMITATIONS 24

5 Results and Discussion 25

5.1 DESKTOP ASSESSMENT 25
5.1.1 Threatened and Priority Flora 25
5.1.2 Threatened and Priority Ecological Communities 28
5.2 FIELD ASSESSMENT 30
5.2.1 Flora 30
5.2.2 Vegetation 30
5.2.3 Threatened and Priority Ecological Communities 35
5.3 VEGETATION OF SIGNIFICANCE 37
5.3.1 Nationally Significant Vegetation 37
5.3.2 State Significant Vegetation 37
5.3.3 Regionally Significant Vegetation 37
5.3.4 Locally Significant Vegetation 38
5.3.5 Summary of Vegetation Significance 39

6 Conclusions **41**
7 List of Participants **42**
8 References **43**
APPENDIX A - DBCA NATURE MAP SEARCH REPORT **A1**
APPENDIX B - EPBC PROTECTED MATTERS SEARCH REPORT **B1**
APPENDIX C – FLORA SPECIES BY VEGETATION UNIT **C1**
APPENDIX D – QUADRAT AND RELEVÉ SITE DATA **D1**
APPENDIX E – BATCH AND SSI DENDROGRAMS **E1**

FIGURES

FIGURE 1 - SURVEY AREA 7
FIGURE 2 - CLIMATE DATA FOR ROTTNEST ISLAND WEATHER STATION (009193) (BOM 2022) 14
FIGURE 3 – SOILS 16
FIGURE 4 – PRE-EUROPEAN VEGETATION 19
FIGURE 5 – QUADRAT AND RELEVÉ LOCATIONS 22
FIGURE 6 – SEARCH TRAVERSES 23
FIGURE 7 – DBCA THREATENED AND PRIORITY FLORA 27
FIGURE 8 – THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES 29
FIGURE 9 – VEGETATION UNITS 32
FIGURE 10 – VEGETATION CONDITION 34
FIGURE 11 – QUADRAT PATN ANALYSIS DENDROGRAM 35

TABLES

TABLE 1 - DEFINITIONS OF THREATENED AND PRIORITY FLORA SPECIES (DBCA 2019) 9
TABLE 2 - CATEGORIES OF EPBC ACT THREATENED FLORA SPECIES 10
TABLE 3 - SUMMARY OF SOIL SYSTEMS WITHIN THE SURVEY AREA (SCHOKNECHT *ET AL.* 2004) 15
TABLE 4 - PRE-EUROPEAN VEGETATION OF THE SURVEY AREA (BEARD 1990, DBCA 2018) 17
TABLE 5 – VEGETATION COMPLEXES WITHIN THE SURVEY AREA (HEDDLE *ET AL.* 1980) 18
TABLE 6 – POTENTIAL SURVEY LIMITATIONS AND CONSTRAINTS 24
TABLE 7 - THREATENED AND PRIORITY FLORA WITH THE POTENTIAL TO OCCUR WITHIN THE SURVEY AREA 26
TABLE 8 – THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES OCCURRING WITHIN THE SURVEY AREA 28
TABLE 9 - SUMMARY OF RECORDED VEGETATION UNITS IN THE SURVEY AREA 31
TABLE 10 - SUMMARY VEGETATION CONDITION WITHIN THE SURVEY AREA 33
TABLE 11 – SUMMARY OF FLORISTIC ANALYSIS RESULTS 36
TABLE 12 – SUMMARY OF THE SIGNIFICANCE OF THE RECORDED VEGETATION UNITS 39
TABLE 13 – SUMMARY OF LEVEL OF POTENTIAL SIGNIFICANCE FOR THE RECORDED VEGETATION UNITS 40
TABLE 14 – PROJECT TEAM 42

EXECUTIVE SUMMARY

Focused Vision Consulting Pty Ltd (FVC) was commissioned by the Rottnest Island Authority (RIA) to undertake a flora and vegetation survey with particular emphasis on potential Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs), and Threatened or Priority flora of Rottnest Island (Wadjemup) within the South Thompson and Kingstown areas.

The scope of work included a single-phase, reconnaissance flora and vegetation survey during autumn, which assessed three areas, with associated reporting and data delivery. After this initial survey, it was decided that an addition single-phase, reconnaissance flora and vegetation survey was also required, which assessed an additional three areas during late-winter, with associated reporting and data-delivery.

These two single-phase, reconnaissance flora and vegetation field assessments were carried out in the survey area by experienced botanists on 2 May and 30 August 2022.

The key findings and conclusions arising from the flora and vegetation assessments within the survey area were as follows:

- No Threatened flora listed under the *Biodiversity Conservation Act 2016* (BC Act) or the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) were recorded.
- No Priority species listed by the Department of Biodiversity, Conservation and Attractions (DBCA) were recorded.
- No weeds listed as Weeds of National Significance (WoNS) or Declared Pest (DP) plants under the *Biosecurity and Agriculture Management Act 2007* (BAM Act) were recorded.
- The condition of the vegetation was found to range from 'Excellent' to 'Completely Degraded' with the greatest proportion in 'Good' and 'Degraded' condition.
- Nine vegetation units and four other classifications (Beach, Planted, Open Water and Cleared areas) were defined and mapped within the survey area.
- Two of the recorded vegetation units were determined to be characteristic of the State-listed *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands, Swan Coastal Plain Threatened Ecological Community (TEC) (*Callitris preissii - Melaleuca lanceolata* forests and woodlands TEC).
- The remaining extent of the one vegetation association (vegetation association 125) supported by the survey area falls below the 10% retention target in the context of the Swan Coastal Plain, and two vegetation associations relevant to the survey area represented by less than 30% of pre-European extent across the Swan Coastal Plain and Perth IBRA sub-region.
- Vegetation units MlAp and CpMl are considered to be representative of the State-listed *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands TEC (FCT 30a), and therefore, these units are considered to be of State significance.
- Rottnest Island (Wadjemup) is an A Class Reserve and an ESA, therefore all vegetation it supports is considered to be of State and regional significance.
- Vegetation units MlAp, CpMl, TiSS, LpAl and SlG are representative of pre-European vegetation associations and/or complexes that have less than 30% of their original extent remaining and are therefore considered regionally significant.
- Vegetation units CpMl occurs as a small, isolated community also being limited in its local extent and/or distribution, and is therefore considered locally significant.
- *Lepidium puberulum* (P4) has previously been recorded from one location within the survey area (DBCA 2022a). This species was not recorded to occur within the survey area despite extensive searching in the vicinity of the known recorded location. Further targeted surveys may be appropriate.

1 INTRODUCTION

The Rottnest Island Authority respects the Whadjuk people as the traditional custodians of Wadjemup (Rottnest Island).

1.1 BACKGROUND

Rottnest Island (Wadjemup) is governed by the *Rottnest Island Authority Act 1987* (RIA Act), which establishes the Rottnest Island Authority (RIA) as a statutory body to control and manage the island.

Focused Vision Consulting Pty Ltd (FVC) was commissioned by RIA for a targeted and reconnaissance flora and vegetation assessment, with particular emphasis on potential Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs), and Threatened or Priority flora within the South Thomson and Kingstown areas. The survey results may be utilised for future Environmental Impact Assessments (EIA) and therefore were required to be conducted as per the *Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016a).

1.2 LOCATION

The survey area is located within the South Thomson and Kingstown areas of Rottnest Island, an offshore island, approximately 18 kilometres (km) west of Fremantle. Rottnest Island (Wadjemup) is part of the City of Cockburn. The survey area, as shown in **Figure 1**, comprises of six individual areas, herein referred to as the survey area.

1.3 SCOPE OF WORK

The scope of work required to be fulfilled for the survey area was as follows:

- Flora and vegetation desktop assessment, in accordance with the *Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment* (Western Australian Environmental Protection Authority (EPA) 2016a)
- Undertake a field assessment survey, incorporating:
    - a reconnaissance assessment in accordance with EPA (2016a) across the full area extent/s of the initial survey area (autumn) and secondary survey area (late-winter) to identify, describe and map general flora species, vegetation communities and vegetation condition
    - opportunistic targeted survey for Threatened and Priority flora
    - determination of the presence of potential Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs) and mapping of their extent, with a particular focus on Floristic Community Type (FCT) 30a
- Prepare a report that presents the desktop and field assessment findings, prepared in accordance with EPA (2016a)
- Preparation of an Index of Biodiversity Surveys for Assessment (IBSA)-compliant package of spatial data.

0 250 500 750 m

GDA 94 / MGA Zone 50

Legend

Survey Area

Figure 1 - Survey Area

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RIA22001 14th September 2002

2 LEGISLATIVE CONTEXT

The flora and vegetation assessments were conducted in accordance with the following legislation:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- Western Australian *Environmental Protection Act 1986* (EP Act)
- Western Australian *Biodiversity Conservation Act 2016* (BC Act).

The assessments complied with the requirements for environmental survey and reporting in Western Australia, as outlined in:

- EPA (2008) *Guidance Statement No. 33: Environmental Guidance for Planning and Development*
- EPA (2016a) *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment*
- EPA (2016b) *Environmental Factor Guideline – Flora and Vegetation*.

Survey methodology guidance for targeted flora searches was also taken from:

- Commonwealth of Australia (2013) *Survey Guidelines for Australia's Threatened Orchids*.

2.1 THREATENED AND PRIORITY FLORA

The Department of Biodiversity, Conservation and Attractions (DBCA) assigns conservation status to endemic plant species that are geographically restricted to few known populations or threatened by local processes. Allocating conservation status to plant species assists in protecting populations and conserving species from potential threats (DBCA 2019).

The BC Act provides a statutory basis for the listing of threatened ecological communities (TECs), threatened and specially protected species, critical habitat and key threatening processes. Whilst not awarded any statutory protection, the DBCA maintains the Priority flora list, for species of conservation concern. Therefore, both Threatened and Priority flora are important focuses of flora and vegetation surveys and their definitions are presented in **Table 1**.

Table 1 - Definitions of Threatened and Priority Flora Species (DBCA 2019)

Conservation Code	Category
T	**Threatened Species** Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the BC Act. Threatened flora is that subset of 'Rare Flora' listed under schedules 1 to 3 of the Wildlife Conservation (Rare Flora) Notice for Threatened Flora.
P1	**Priority 1 – Poorly Known Species** Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
P2	**Priority 2 – Poorly Known Species** Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.
P3	**Priority 3 – Poorly Known Species** Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.
P4	**Priority 4 – Rare, Near Threatened and other species in need of monitoring** (a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for Vulnerable but are not listed as Conservation Dependent. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Under the EPBC Act, actions that have, or are likely to have, a significant impact on a matter of national environmental significance (MNES) require approval from the Federal Minister for the Environment. Species at risk of extinction are recognised as Threatened at a Commonwealth level and are categorised according to the EPBC Act as summarised in **Table 2**.

Table 2 - Categories of EPBC Act Threatened Flora Species

Conservation Code	Category
EX	**Extinct** Species where "there is no reasonable doubt that the last member of the species has died", and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).
EW	**Extinct in the Wild** Species that "is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form", and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act). Currently there are no threatened fauna or threatened flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.
CR	**Critically Endangered** Threatened species considered to be "facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for critically endangered fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for critically endangered flora.
EN	**Endangered** Threatened species considered to be "facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for endangered fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for endangered flora.
VU	**Vulnerable** Threatened species considered to be "facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for vulnerable fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for vulnerable flora.

Any species listed in State and Commonwealth legislation as being of conservation significance is broadly considered to be a significant species. This incorporates species that are endangered, vulnerable and rare or covered by international conventions. Significance is not limited to species covered by State and Commonwealth legislation that also includes species of local significance and species showing significant range extensions or at the edge of their known range.

2.2 THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES

TECs are naturally occurring biological assemblages that occur in a particular type of habitat, which are subject to processes that threaten to destroy or significantly modify the assemblage across its range (DEC 2007).

The Minister may list an ecological community as a TEC in one of the following categories: Presumed Totally Destroyed (PD), Critically Endangered (CR), Endangered (EN) or Vulnerable (VU). A publicly available database listing TECs within Western Australia (WA) is maintained by DBCA.

TECs in WA are protected under the State BC Act and some are also protected under the Commonwealth EPBC Act. The TECs on the Commonwealth register are also listed on the Department of Climate Change, Energy, the Environment and Water (DCCEEW) website, and in the Protected Matters Database (DCCEEW 2022a, 2022b).

Additional to TECs, ecological communities that are considered to be potentially of conservation significance (and potentially TECs) that do not currently meet survey criteria or that are not adequately defined, are rare but not threatened, have been recently removed from the TEC list or require regular monitoring, are considered to be Priority Ecological Communities (PECs) (DEC 2013) and are also required to be taken into consideration during environmental impact assessments (EPA 2016b).

2.3 VEGETATION OF SIGNIFICANCE

Alongside and in addition to significance according to statutory listings, vegetation may be considered significant at a National, State, regional or local level. Whilst not applicable to statutory protection, vegetation significance is an important consideration in the environmental impact assessment process.

2.3.1 Nationally Significant Vegetation

Vegetation communities may be considered to be of National significance where they support the following Commonwealth listed Matters of National Environmental Significance (MNES):

- Populations of Threatened (EPBC listed) species
- TECs listed as nationally (EPBC) significant
- RAMSAR Wetlands of International Importance (DCCEEW 2022a).

2.3.2 State Significant Vegetation

Vegetation communities may be considered to be of State significance where they:

- Support State listed Threatened flora, fauna and TECs afforded protection under the BC Act (EPA 2008, WALGA 2004)
- Occur within the State-managed conservation estate (areas protected under the *Conservation and Land Management Act 1984* (CALM Act)) or areas that have been formally recommended by DBCA for inclusion in the State conservation estate (EPA 2008).

2.3.3 Regionally Significant Vegetation

Vegetation communities may be considered to be of regional significance where they:

- Support populations of Priority Flora or ecological communities (EPA 2016b, Government of Western Australia 2000a)
- Are formally protected or recognised as Environmentally Sensitive Areas (ESAs), or under planning schemes for conservation, such as Bush Forever (EPA 2008, WALGA 2004)
- Support conservation category wetlands including associated vegetation (Government of Western Australia 2000a)
- Maintain important ecological processes (EPA 2016b)
- Contain flora species exhibiting range extensions and undescribed species (EPA 2016b)
- Have a restricted regional distribution (EPA 2016b)
- Are represented by less than 30% of their pre-European extent (Commonwealth of Australia 2001).

2.3.4 Locally Significant Vegetation

Vegetation communities may be considered to be locally significant where they:

- Occur as small, isolated communities (Government of Western Australia 2000b, WALGA 2004)
- Have a restricted local extent (proportion) (EPA 2016b) and/or are locally restricted to only one or a few locations (WALGA 2004).

2.4 VEGETATION CLEARING, EXTENT AND STATUS

Clearing of native vegetation is regulated in WA under the EP Act and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*. Any clearing of native vegetation is an offence, unless carried out under a clearing permit or if the clearing is for an exempt purpose (Department of Water and Environmental Regulation (DWER 2022). A clearing permit may be required under Part V of the EP Act, whereby permit applications to clear native vegetation must be assessed against the '10 Clearing Principles' as outlined in the regulations (DER 2019).

Where clearing of native vegetation is proposed to occur, there are several key criteria applied to the assessment of clearing permit applications, in the interests of biodiversity conservation (DER 2019).

The objective of the EPA in relation to flora and vegetation is 'to protect flora and vegetation so that biological diversity and ecological integrity are maintained' (EPA 2016a). This objective is documented in the EPA Factor Guideline - Flora and Vegetation (EPA 2016a). The EPA considers it is important that ecological communities are maintained above the threshold level of 30% of the original pre-clearing extent of the community in unconstrained areas and 10% within 'constrained' areas (EPA 2008).

2.5 ENVIRONMENTALLY SENSITIVE AREAS

Environmentally Sensitive Areas (ESAs) are areas that require special protection due to aspects such as landscape, fauna or historical value and are generally considered to be areas of high conservation value. ESAs are declared in the *Environmental Protection (Environmentally Sensitive Areas) Notice 2005*, which was gazetted on 8 April 2005 (Minister for the Environment 2005).

There are several types of ESAs relating to flora and vegetation, declared under Part V of the EP Act, which include:

- a defined wetland and the area within 50 m of that wetland
- the area covered by vegetation within 50 m of rare (Threatened) flora, to the extent where the vegetation is continuous with the vegetation in which the rare (Threatened) flora is located
- the area covered by a TEC
- Bush Forever sites.

2.6 INTRODUCED FLORA

Over 1,200 introduced (weed) species have been recognised to occur within Western Australia (EPA 2007). Weeds are plants that are not indigenous to an area and have been introduced either directly or indirectly through human activity. They establish in natural ecosystems and adversely modify natural processes, have the potential to dominate and simplify the ecosystems and thus decrease habitat value provided for native fauna. Weeds pose a threat to many native flora species due to their ability to rapidly grow and out-compete for available water, space, sunlight, and nutrients (EPA 2007).

2.6.1 Weeds of National Significance

Under the Australian Weed Strategy 2017-2027, there are currently 32 weed species listed as Weeds of National Significance (WoNS) (Commonwealth of Australia 2017). Each weed listed was considered for inclusion based on the following criteria:

- invasive tendencies
- impacts
- potential for spread
- socioeconomic and environmental values.

2.6.2 Declared Pest Plants

The Western Australian Organism List (WAOL) details organisms listed as Declared Pests, including pest plants, under the *Biosecurity and Agriculture Management Act 2007* (BAM Act) (Department of Primary Industries and Regional Development (DPIRD 2022)). Under the BAM Act, Declared Pests are listed under one of the following categories:

- **C1 (exclusion)**, that applies to pests not established in Western Australia; control measures are to be taken to prevent their entry and establishment
- **C2 (eradication)**, that applies to pests that are present in Western Australia but in low numbers or in limited areas where eradication is still a possibility
- **C3 (management)**, that applies to plants that should have some form of management applied that will alleviate the harmful impacts of the plant, reduce the numbers or distribution of the plant, or prevent or contain the spread of the plant (DPIRD 2017).

2.6.3 Environmental Weeds

Introduced species have also been ranked by a number of attributes, including invasiveness, distribution and environmental impacts in the various regions in the *Environmental Weed Strategy* (Department of Conservation and Land Management (CALM) 1999). To advance the above categorisation, the Invasive Plant Prioritisation Process for DBCA was developed in 2008 (DPAW 2013).

3 EXISTING ENVIRONMENT

3.1 CLIMATE

Rottnest Island (Wadjemup) has a temperate Mediterranean climate which is characterised by mild dry, warm summers and moderate seasonality. Rottnest Island (Site Number 009193) is one of the Bureau of Meteorology (BoM) meteorological recording stations, located approximately 4.5 km from the survey area and which has been recording since 1983. The site has recorded an average annual rainfall of 567.7 mm and annual mean maximum temperatures ranging from 17.8°C in winter to 27.3°C in summer (BoM 2022) (**Figure 2**). The summer months preceding the May field survey (January to March 2022), were recorded to be hotter and drier than the long-term average; however, the month prior to field survey (April) experienced average temperatures and 23.6 mm more rain than the monthly average (**Figure 2**). The three months preceding the August field survey (May to July 2022), recorded maximum temperatures similar to that of the long-term average while the months of May and June were wetter than average, receiving 58.1 mm more rainfall than the monthly average (**Figure 2**).

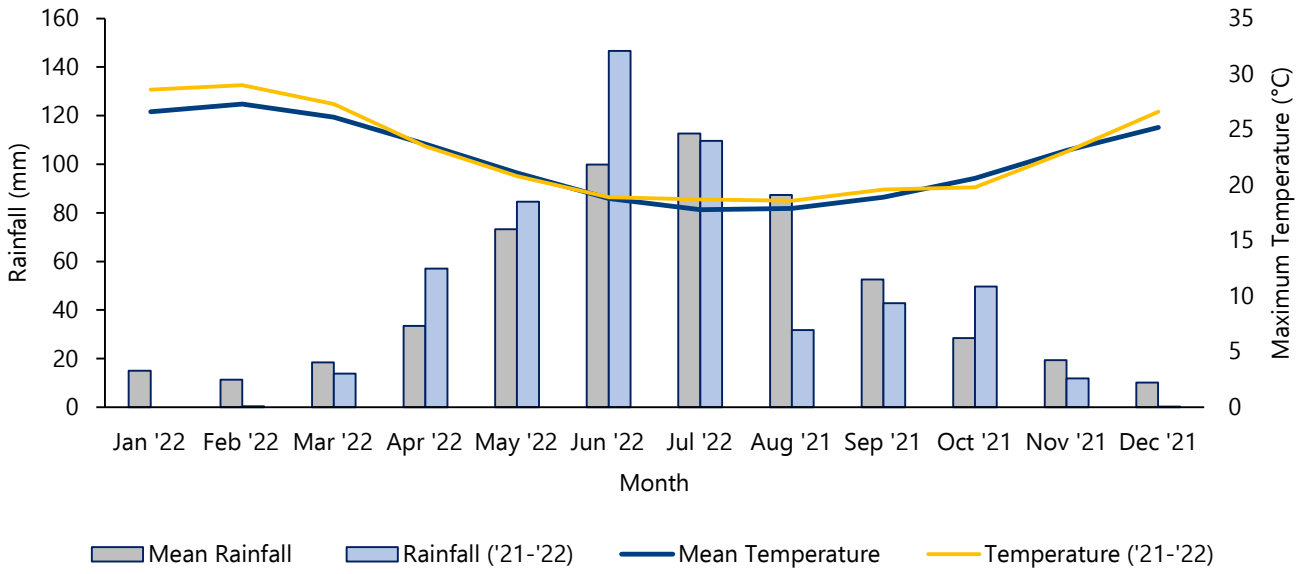

Figure 2 - Climate Data for Rottnest Island Weather Station (009193) (BoM 2022)

3.2 IBRA REGION

There are 89 recognised Interim Biogeographic Regionalisation for Australia (IBRA) regions across Australia that have been defined based on climate, geology, landforms and characteristic vegetation and fauna (DCCEEW 2022c). The survey area lies within the Swan Coastal Plain (SWA) IBRA region and, at a finer scale, within the Perth subregion (SWA2) (Mitchell *et al.* 2002).

The Swan Coastal Plain bioregion is a low lying coastal plain, mainly covered with Banksia and Tuart (*Eucalyptus gomphocephala*) woodlands on sandy soils. The Perth subregion is composed of colluvial and aeolian sands, alluvial river flats, coastal limestone, as well as heath and/or Tuart woodlands on limestone, Banksia and Jarrah (*Eucalyptus marginata*) - Banksia woodlands on Quaternary marine dunes of various ages, Marri (*Corymbia calophylla*) on colluvial and alluvials (Mitchell *et al.* 2002).

3.3 SOILS

The Swan Coastal Plain supports five major geomorphological systems (landforms) that lie parallel to the coast. From west to east these five systems include; the Quindalup Dunes, Spearwood Dunes, Bassendean Dunes, Pinjarra Plain and Ridge Hill Shelf (Churchward and McArthur 1980; Gibson *et al.* 1994). The survey area is situated on the Quindalup South System (211Qu) and developed from Tamala Limestone (Playford 1988) (**Table 3**). The spatial extent of this system is presented in **Figure 3**.

Table 3 - Summary of Soil Systems within the Survey Area (Schoknecht *et al.* 2004)

System	Soil Unit	Description
Quindalup South System	211Qu	Coastal dunes, of the Swan Coastal Plain, with calcareous deep sands and yellow sands. Vegetation consists of coastal scrub.

0 1 2 3 km

GDA 94 / MGA Zone 50

Legend

Survey Area

Quindalup South System

Figure 3 - Soils

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3.4 VEGETATION

The survey area is located on the Swan Coastal Plain and has been broadly characterised by Beard (1990). The three Beard vegetation associations (15, 125 and 1007) supported by the survey area and the remaining extent across a range of contexts are presented in **Table 4** and spatially in **Figure 4**.

Table 4 - Pre-European Vegetation of the Survey Area (Beard 1990, DBCA 2018)

Extent Context	Vegetation System Association	Broad Vegetation Description	Pre-European Extent (Ha)	Current Extent (ha)	Pre-European Extent Remaining (%)	Current Extent in DBCA Managed Lands (%)
Western Australia	15	Low forest; cypress pine	2,374.16	1,576.52	66.40	37.34
	125	Bare areas; salt lakes	3,485,785.49	3,146,487.22	90.27	7.62
	1007	Mosaic Shrublands: *Acacia lasiocarpa* and *Melaleuca acerosa* Heath / *Acacia rostellifera* and *Acacia cyclops* thicket	30,407.75	20,691.11	68.05	10.04
Swan Coastal Plain IBRA Region	15	Low forest; cypress pine	17,364.58	3,150.77	18.14	2.11
	125	Bare areas; salt lakes	136,188.20	9,017.32	6.62	1.43
	1007	Mosaic Shrublands: *Acacia lasiocarpa* and *Melaleuca acerosa* Heath / *Acacia rostellifera* and *Acacia cyclops* thicket	30,109.89	20,679.62	68.68	10.13
Perth IBRA Subregion	15	Low forest; cypress pine	1,977.93	1,564.26	79.09	44.66
	125	Bare areas; salt lakes	9,401.12	1,948.17	20.72	11.70
	1007	Mosaic Shrublands: *Acacia lasiocarpa* and *Melaleuca acerosa* Heath / *Acacia rostellifera* and *Acacia cyclops* thicket	30,109.89	20,679.62	68.68	10.13
City of Cockburn	15	Low forest; cypress pine	1,353.14	886.49	65.51	65.51
	125	Bare areas; salt lakes	166.17	53.27	32.06	29.66
	1007	Mosaic Shrublands: *Acacia lasiocarpa* and *Melaleuca acerosa* Heath / *Acacia rostellifera* and *Acacia cyclops* thicket	337.86	271.35	80.32	80.32

Cells highlighted grey indicate vegetation associations with less than 30% extent remaining
Cell highlighted yellow indicates vegetation association with less than 10% extent remaining

Vegetation complexes within the survey area have also been defined by Heddle *et al.* (1980) and are based on vegetation in association with landforms and underlying geology. Only the Quindalup Complex occurs within the survey area and this complex is described as coastal dune consisting of two alliances; the strand and fore-dune alliance and the mobile and stable dune alliance. Local variations include the low, closed forest of *Melaleuca lanceolata* (Rottnest Teatree) - *Callitris preissii* (Rottnest Island Pine), the closed scrub of *Acacia rostellifera* (Summer-scented Wattle) and the low, closed *Agonis flexuosa* (Peppermint) forest of Geographe Bay. The pre-European extent and current known extent of this complex is listed in **Table 5**.

Table 5 – Vegetation Complexes Within the Survey Area (Heddle *et al.* 1980)

Extent Context	Vegetation Complex	Pre-European Extent (Ha)	Current Extent (ha)	Pre-European Extent Remaining (%)	Current Extent in DBCA Managed Lands (%)
Swan Coastal Plain	Quindalup Complex	54,573.87	33,011.64	60.49	10.98
City of Cockburn	Quindalup Complex	1,021.62	728.23	71.28	1.87

The objective of the EPA in relation to flora and vegetation is: *To protect flora and vegetation so that biological diversity and ecological integrity are maintained* (EPA 2016a). The EPA considers it is important that vegetation associations are maintained above a threshold level of 30% for unconstrained areas and 10% for constrained areas (which includes the Perth metropolitan area), of the original pre-clearing extent of each association (EPA 2008). A level of 30% pre-clearing extent is considered to be the level below which species loss appears to accelerate exponentially at the ecosystem level (EPA 2008).

The following key criteria are applied to vegetation clearing from a biodiversity perspective, which justifies the retention targets (EPA 2000):

- The 'threshold level' below which species loss appears to accelerate exponentially within an ecosystem level, is regarded as being at a level of 30% (of the pre-European, i.e. pre-1750 extent of the vegetation type)
- A level of 10% of the original extent of a vegetation community is regarded as being a level representing Endangered
- Clearing which would increase the threat level to a vegetation community should be avoided.

The remaining extent of all three Beard (1990) vegetation associations exceed the 30% threshold within Western Australia (**Table 4**). Within the Swan Coastal Plain IBRA region; vegetation associations 15 (Low forest; cypress pine) and 125 (Bare area; salt lakes) have remaining extents of 18.14% and 6.62%, respectively. This indicates that both associations fall below the 30% threshold and vegetation association 125 also falling below the 10% threshold. Within the Perth IBRA subregion, vegetation association 125 exhibits a remaining extent of 20.72%, not meeting the 30% threshold.

The remaining extent for the Heddle *et al.* (1980) Quindalup complex exceeds 30% threshold for the Swan Coastal Plain IBRA region and City of Cockburn extents (**Table 5**).

0 1 2 3 km

GDA 94 / MGA Zone 50

Legend

- Survey Area
- 1007
- 125
- 15

Figure 4 - Pre-European Vegetation

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4 METHODOLOGY

4.1 DESKTOP REVIEW

The desktop assessment consisted of database searches for significant flora and ecological communities based on a central point within the survey area (115°32'49.9" E, 32°00'18.9" S) with a 5 km buffer, hereafter referred to as the desktop assessment area. Database searches included the DBCA Threatened and Priority flora records (DBCA 2022a), NatureMap (DBCA 2022b) (**Appendix A**), the Commonwealth DCCEEW Protected Matters Search Tool (PMST) (DCCEEW 2022b) for Matters of National Environmental Significance (MNES) (**Appendix B**) and the DBCA Threatened and Priority Ecological Communities records (DBCA 2022c).

The database search results were compiled into a table that concluded the likelihood of occurrence of each of the significant species and communities based on habitat preferences of known recorded locations for each species. The likelihood of all significant flora occurring within the survey area was assessed based on known records and their age (currency) and proximity to the survey area, and the presence of suitable habitat within the survey area. Based on this assessment, each species was given a likelihood of occurrence category of 'likely' to occur, 'may occur' or 'unlikely' to occur. Where recent records and suitable species habitat occurs within or near the survey area, these species were given a category of 'likely to occur', whilst species occurring a greater distance from the survey area with limited suitable habitat, or for very old records, a category of 'unlikely to occur' or 'may occur' was applied, depending on record relevance.

4.2 FIELD ASSESSMENT

A reconnaissance flora and vegetation field assessment was carried out within the survey area on 2 May 2022 by, Kellie Bauer-Simpson (Principal Ecologist) and Lisa Chappell (Senior Botanist) with a secondary reconnaissance field assessment carried out on 30 August 2022 by Kellie Bauer-Simpson (Principal Ecologist), Lisa Chappell (Senior Botanist) and Sarah Beckwith (Undergraduate Ecologist), in accordance with EPA guidelines (2016a).

Within areas that were considered to potentially be representative of TECs or PECs, targeted surveys were carried out via the sampling of quadrats where condition was 'Good' to 'Excellent'. During sampling, a temporary peg was installed to mark the north-west corner while marking out quadrats within measuring tapes, and when sampling was complete, the peg was removed. Quadrat dimensions were 10 m x 10 m in accordance with the Technical Guidance (EPA 2016a). Detailed data collection points (relevés) were recorded where vegetation was not considered to be a TEC or PEC and to inform vegetation mapping. During the survey, vegetation data from five quadrats and 13 relevés were recorded, with their locations visually represented in **Figure 5**.

The following information was collected at each quadrat and relevé:

- observer
- date
- GPS location (MGA94)
- representative photograph
- soil type and colour
- topography
- vegetation condition/degradation/disturbances (e.g. grazing, weed invasion, fire)
- flora species observed, including average height and projected foliage cover of dominant species within each stratum
- vegetation community, described in accordance with Level 5 of the National Vegetation Information System (NVIS) (DEH 2003)
- vegetation condition, assessed against the currently accepted scale; an adaptation of the Keighery (1994) condition scale.

Selective targeted searching for Threatened and Priority flora, TECs and PECs was carried out while traversing the survey areas, and track logs of all personnel were captured using GPS-enabled devices to demonstrate survey effort. These combined track logs for the survey area are presented in **Figure 6**.

The flora and vegetation data collected during the field assessments, from the combination of quadrats, relevés and continuous opportunistic observations, contributed to the flora inventory for the survey area. The vegetation units of the survey area have also been defined by data collected within quadrats and relevés and opportunistically between, and how they relate to other environmental features such as soil type and landform. A map of the vegetation units was then developed using GIS and is presented in **Section 5.2.2**.

Vegetation condition was assessed using the current bushland condition scale, which is an adaptation of Keighery (1994) scale, as described in EPA (2016a).

All field data was recorded using electronic tablets equipped with the mobile mapping software, Mappt™ and customised data collection forms, tailored to the electronic collection of quadrat data and targeted flora surveys. Draft vegetation unit and condition mapping were also prepared in shapefiles directly into Mappt™ whilst in the field, and this formed the basis of the mapping presented in this report and provided in spatial data.

Quadrat and relevé data was then subject to floristic analysis to detect similar vegetation within the survey area and also in comparison to relevant reference data (Gibson *et al.* 1994 and Keighery *et al.* 2012), in order to infer FCTs. The floristic analysis was first carried out for all quadrats sampled (batch analysis) and then for each quadrat individually (single site insertion (SSI)).

0 100 200 300 400 m

GDA 94 / MGA Zone 50

Legend

- Survey Area
- Quadrat
- Relevé

Figure 5 - Quadrat and Relevé Locations

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RIA22001 12 October 2022

0 100 200 300 400 m

GDA 94 / MGA Zone 50

Legend

Survey Area

May 2022

August 2022

Figure 6 - Search Traverses

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RIA22001 12 October 2022

4.3 SURVEY LIMITATIONS

The current assessments were assessed against limitations imposed by many variables as outlined in the *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016a) (**Table 6**).

Table 6 – Potential Survey Limitations and Constraints

Aspect	Constraint?	Commentary
Availability of regional data, previously available information	No	A wealth of data, literature and other information is available for sites within the Perth metropolitan area, such as the survey area. DBCA database search results are evidence of the high volume of records that exist for the survey area and surrounds.
Scope (detail)	No	Out of season reconnaissance flora and vegetation assessments were carried out in accordance with EPA (2016a) during May and August 2022. The EPA Guidelines state that a minimum of three quadrats should be sampled in each vegetation unit considered to be of 'Good' or better condition. Five quadrats were sampled within vegetation in 'Good' or better condition and 13 relevés were sampled in areas of 'Degraded' or poorer condition vegetation. This level of survey detail was considered more than adequate for the assessment of floristic values.
Competency/Experience of personnel	No	All of the personnel leading the field assessments, and undertaking flora identifications, data analysis, vegetation mapping and reporting are experienced botanists, with specialist skills in their respective fields. All botanists have a minimum of 18 years' experience with a significant proportion of which have been on the Swan Coastal Plain.
Survey effort/detail/intensity	No	The field flora and vegetation field assessments were not conducted during the optimal spring survey season although the reconnaissance assessments were considered adequate to determine the floristic values within the survey area. Five quadrats were sampled within vegetation in 'Good' or better condition and 13 relevés were sampled in an area of 'Degraded' or poorer condition vegetation. Five quadrats and seven relevés were sampled in 8 May 2022, with six relevés sampled on 30 August 2022.
Seasonal timing and climatic conditions	Yes	The flora and vegetation field assessments were not conducted during the optimal spring season for biological surveys on the Swan Coastal Plain. It is considered that the number of species recorded, particularly annual species, would be higher if the survey was conducted during spring. Some annual species are less likely to be present outside their optimal survey period. In the months preceding the May field assessment, February (particularly) and March experienced drier and hotter seasonal conditions than average; however, April experienced 4 mm more rainfall than the average. The months preceding the August field survey, June (particularly) experienced 46.7 mm more rainfall than the average. These conditions, although variable from long-term averages, are generally representative of the Perth Metropolitan summer / autumn climatic conditions.
Access	No	The entire survey area was mostly easily accessible on foot (except where extremely dense) and was traversed in relatively good detail during May and August 2022.
Mapping reliability	No	The mapping has been prepared at a scale based on ground-truthed areas, with limited extrapolation given the good accessibility of the survey area. Therefore, mapping reliability is considered high.
Disturbances	No	Numerous tracks bisect the survey area, which have high foot and bicycle traffic, plus some vehicular access on suitable tracks. The disturbances are considered to be a minor constraint for the survey.
Survey completeness	No	Most areas were easily accessible and data and other information for the region is abundant. The field surveys for the current survey were all able to be completed for the entire survey area and in thorough detail.

5 RESULTS AND DISCUSSION

5.1 DESKTOP ASSESSMENT

5.1.1 Threatened and Priority Flora

The DBCA database search (incorporating Western Australian Herbarium (WAH) records), NatureMap Species Report and the DCCEEW PMST conducted for the survey area determined five species of Threatened and Priority flora that have the potential to occur on Rottnest Island (**Table 7**). The list of conservation significant species comprised one Commonwealth and State-listed Vulnerable (Threatened) flora, two Priority (P) 1 and two Priority 4 species, and all are annual or short-lived perennial species, emerging and flowering in spring.

Of these five species, four have been previously recorded on Rottnest Island, and have previous known locations within the survey area or within 3 km of the survey area (**Figure 7**). One species, *Lepidium puberulum* (P4) has been previously recorded within the survey area and is therefore 'likely' to occur. The remaining three species that have been previously recorded on the island were determined to 'possibly' occur, and the fifth species, not known to occur on the island, was determined to be 'unlikely' to occur.

Table 7 - Threatened and Priority Flora with the Potential to occur within the Survey Area

Species	EPBC Act Conservation Status	BC Act/DBCA Conservation Status	Description	Preferred Habitat	Likelihood of Occurrence	Source of Record
Diuris micrantha	Vulnerable	Vulnerable	Tuberous, perennial orchid growing to 0.3-0.6 m high with a basal tuft of narrow, linear leaves. Produces up to 7 yellow flowers with red-brown markings from August to October.	Brown/black sandy clay-loam and clayey soils. Winter-wet depressions and swamps, in shallow water.	**Unlikely**. Four previous records approx. 38 km SE of the survey area, on the mainland.	PMST
Lachnagrostis nesomytica subsp. *nesomytica*		Priority 1	Loosely tufted, annual or short-lived perennial grass growing to 0.2 m high. Produces purple-green flowers known from November (likely longer period).	Peat and loam soils. Edges of salt lakes, marshes and drainage areas.	**Possible**. Two previous records in possibly similar habitat within 2.8 km, W of the survey area.	DBCA, NatureMap
Lachnagrostis nesomytica subsp. *pseudofiliformis*		Priority 1	Loosely tufted, annual or short-lived perennial grass growing to 0.3-0.5 m high. Produces purple-green flowers, flowering period unknown.	Grey-brown sand, peaty soils. Coastal areas, edges of saline lakes on Garden Island.	**Possible**. Three previous records in likely similar habitat 700 m to 1.7 km W of the survey area.	DBCA, NatureMap
Lepidium puberulum		Priority 4	Erect annual herb growing to 0.4 m high. Produces greenish white flowers from July to November.	Sandy soil. Coastal areas, islands, often associated with limestone.	**Likely**. One previous record within the survey area.	DBCA, NatureMap
Myosotis australis		Priority 4	Erect to procumbent annual herb growing to 0.3 m high. Produces blue-white flowers from August to November.	Sandy soil. Coastal dunes and swales often associated with limestone.	**Possible**. Two previous records within 1.7 km SW from the survey area is possibly similar habitat.	DBCA/WAH, NatureMap

0 0.5 1 1.5 km

GDA 94 / MGA Zone 50

Legend

- Survey Area
- Lachnagrostis nesomytica subsp. nesomytica
- Lachnagrostis nesomytica subsp. pseudofiliformis
- Lepidium puberulum
- Myosotis australis

Figure 7 - DBCA Threatened and Priority Flora

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5.1.2 Threatened and Priority Ecological Communities

A review of DBCA's Threatened and Priority Ecological Communities (TEC and PEC) database and the EPBC Protected Matters Search Tool identified that one TEC and six PECs occur within a 5 km buffer of the survey area (DBCA 2022c, DCCEEW 2022b) (**Table 8**). Of these, five are Microbial (Microbialites and microbial mat) communities and are not of conservation-significance due to flora and vegetation values; therefore, these communities are not discussed further in this report. The known extent of the two floristic communities of relevance to flora and vegetation values, SCP 30a and SCP 29a, are presented in **Figure 8**, and discussed further below in Section 5.1.2.1.

Table 8 – Threatened and Priority Ecological Communities Occurring within the Survey Area

Abbreviated Identifier	Community Name	Commonwealth Category	State Category
Floristic Communities			
SCP 30a	*Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands, Swan Coastal Plain (FCT 30a (Gibson *et al.* 1994))	-	Vulnerable
SCP29a	Coastal shrublands on shallow sands	-	Priority 3
Microbial Communities			
Rottnest Island Microbial - Garden	Microbialites and microbial mats of coastal hypersaline lakes (Rottnest Island). Community 5 - Garden Lake	-	Priority 1
Rottnest Island Microbial - Serpentine	Rottnest Island Microbial Lake community 1 - Serpentine Lake	-	Priority 1
Rottnest Island Microbial - Herschel	Microbialites and microbial mats of coastal hypersaline lakes (Rottnest Island). Community 6 - Herschel Lake	-	Priority 1
Rottnest Island Microbial - Baghdad	Microbialites and microbial mats of coastal hypersaline lakes (Rottnest Island); Lake Baghdad	-	Priority 1
Government House Lake Microbial	Hypersaline microbial community 1 (Government House Lake, Rottnest)	-	Priority 2

5.1.2.1 *SCP 30a – Callitris preissii (or Melaleuca lanceolata) Forests and Woodlands*

The Rottnest Island Pine (*Callitris preissii*) and Tea Tree (*Melaleuca lanceolata*) TEC (Rottnest Island Pine and Tea Tree TEC) is listed as 'Vulnerable' under State legislation and is described as a woodland and forest community dominated by *Callitris preissii*, *Melaleuca lanceolata*, *Spyridium globulosum*, *Acanthocarpus preissii*, *Rhagodia baccata*, *Austrostipa flavescens* and *Trachymene pilosa* (Gibson *et al.* 1994). The critical habitat for the Rottnest Island Pine and Tea Tree TEC includes the dunes and swale habitat on which they occur, the fresh superficial groundwater that is likely to provide water to the trees in the community, and the catchment for this groundwater (DPaW 2014).

5.1.2.2 *SCP 29a – Coastal Shrublands on Shallow Sands*

SCP 29a (Coastal Shrublands on Shallow Sands) supports shrublands on shallow sands over limestone, in close proximity to the coast, on the southern Swan Coastal Plain. Landforms are dunes from Supergroup 4; uplands centred on Spearwood and Quindalup Dunes (Gibson *et al.* 1994). Key species include *Spyridium globulosum, Rhagodia baccata* and *Olearia axillaris* (DBCA 2022c).

0 0.5 1 1.5 km

GDA 94 / MGA Zone 50

Legend

- Survey Area
- Callitris preissii (or Melaleuca lanceolata) forests and woodlands, Swan Coastal Plain
- Coastal shrublands on shallow sands

Figure 8 - Threatened and Priority Ecological Communities

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5.2 FIELD ASSESSMENT

5.2.1 Flora

A total of 32 flora taxa, from 29 genera and 18 families was recorded during the field survey. The dominant families were found to be Poaceae (five taxa), Cyperaceae (four taxa), Chenopodiaceae (three taxa) and Myrtaceae (three taxa). The total includes 27 (84.38%) native species and five (15.63%) introduced (weed) species. The average species richness within quadrats was 5.6 species. Two species were recorded in 50% or more of the sample sites (quadrats and relevés), indicating a greater dominance and distribution compared to other species. These species were:

- *Acanthocarpus preissii* (recorded in 61.1% of sample sites)
- **Trachyandra divaricata* (recorded in 72.2% of sample sites).

The full list of vascular flora species recorded within each vegetation unit and at each sample site is presented in **Appendix C** and individual quadrat and relevé data is presented in **Appendix D**.

No species listed as Threatened or Priority flora under the BC Act or under the EPBC Act were recorded in the field assessment. All five of the potentially occurring Threatened and Priority flora resulting from the desktop assessment are annual or short-lived perennial species, emerging and flowering in spring, and would have been unlikely to be present/visible, flowering or presenting identifiable material at the time of the May field survey.

Lepidium puberulum (P4) has previously been recorded from one location within the survey area (DBCA 2022a). This species was not recorded to occur within the survey area for this assessment, despite extensive searching in the vicinity of the known recorded location. This annual herb species would only be observable during late winter and spring. Therefore, where clearing impacts may be proposed within areas of suitable habitat (sandy soils associated with limestone), further targeted surveys during late winter and spring may be appropriate.

None of the recorded flora are exhibiting an extension beyond their currently documented range, in accordance with records of the Western Australian Herbarium (WAH 1998-).

No taxa listed as Declared Pest [s22(2)] plants under the BAM Act (DPIRD 2022) were recorded. In addition, none of the weed species recorded are listed as WoNS (Commonwealth of Australia 2017).

5.2.2 Vegetation

5.2.2.1 *Vegetation Units*

Nine vegetation units and four other classifications (Beach, Planted, Open Water and Cleared areas) were defined and mapped within the survey area as described in **Table 9**. A large portion of the survey area (44%) consists of vegetation unit MlAp (*Melaleuca/Acanthocarpus* Woodland), and vegetation unit MlGl (*Melaleuca/Guichenotia* Shrubland) accounts for 22.79% of the survey area.

The remaining seven vegetation units account a total of 24.81% of the survey area. The three classifications (Beach, Planted and Cleared areas) occupy the remaining 8.4% of the survey area. The spatial extent of the varying vegetation units is presented in **Figure 9**.

Table 9 - Summary of Recorded Vegetation Units in the Survey Area

Broad Type	Vegetation Unit	Vegetation Description	Site Number	Area (ha)	% of Survey Area
Woodland	**MlAp** *Melaleuca/Acanthocarpus* Woodland	*Melaleuca lanceolata* Tall Shrubland over *Acanthocarpus preissii* Low Open Shrubland	Q03, Q06, Q08, Q11, R16	44.39	44.00
Shrubland	**ArAp** *Acacia/Acanthocarpus* Shrubland	*Acacia rostellifera* Tall Open Shrubland over *Acanthocarpus preissii* Low Shrubland over *Trachyandra divaricata* Low Sparse Forbland	R01	5.20	5.15
	CpMl *Callitris/Melaleuca* Shrubland	*Callitris preissii* and *Melaleuca lanceolata* Tall Shrubland	Q12	0.60	0.60
	MlGl *Melaleuca/Guichenotia* Shrubland	*Melaleuca lanceolata* and *Callitris preissii* Tall Sparse Shrubland over *Guichenotia ledifolia, Acanthocarpus preissii* and *Rhagodia baccata* Shrubland over *Trachyandra divaricata* Low Sparse Forbland	R02, R15	23.00	22.79
	OaAp *Olearia/Acanthocarpus* Shrubland	*Olearia axillaris* Tall Sparse Shrubland over *Acanthocarpus preissii* Low Open Shrubland	R05, R17	4.03	4.00
	TiSS *Tecticornia* Samphire Shrubland	*Tecticornia indica* subsp. *bidens* Low Samphire Shrubland	R09, R14	5.70	5.65
Sedgelands	**GtS** *Gahnia* Sedgeland	*Gahnia trifida* and *Ficinia nodosa* Tall Sedgeland	R04, R18	3.88	3.85
	LpAp *Lepidosperma/Acanthocarpus* Sedgeland	*Acanthocarpus preissii, Rhagodia baccata* and *Conostylis candicans* Low Open Shrubland over *Lepidosperma gladiatum* Open Sedgeland over *Trachyandra divaricata* Low Sparse Forbland	R07, R13	3.05	3.02
Grassland	**SlG** Spinifex Grassland	*Scaevola crassifolia* Low Open Shrubland over *Spinifex longifolius* Grassland	R10	2.56	2.54
Planted		Planted non-endemic species	NA	0.33	0.33
Beach			NA	0.83	0.83
Open Water			NA	0.62	0.61
Cleared			NA	6.69	6.63
			TOTAL	**100.88**	**100**

0 100 200 300 400 m

GDA 94 / MGA Zone 50

Legend

- Survey Area
- ArAp
- Beach
- Cleared
- CpMl
- GtS
- LpAp
- MlAp
- MlGl
- OaAp
- Planted
- SIG
- TiSS
- Water

Figure 9 - Vegetation Units

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5.2.2.2 *Vegetation Condition*

The condition of the vegetation within the survey area was found to range from 'Excellent' to 'Completely Degraded' with three other classifications (Beach, Open Water and Cleared) (**Table 10**). The greatest proportion of the vegetation (49.16%) was observed to be in either 'Good' condition (24.58%) or 'Degraded' condition (24.58%). The spatial extent of the varying vegetation condition is presented in **Figure 10**.

Table 10 - Summary Vegetation Condition within the Survey Area

Vegetation Condition Rating	Area (ha)	% of Survey Area
Excellent	1.02	1.01
Very Good - Excellent	0.06	0.06
Very Good	14.16	14.03
Good - Very Good	13.63	13.51
Good	24.79	24.58
Degraded - Good	6.52	6.46
Degraded	24.79	24.58
Completely Degraded - Degraded	5.84	5.79
Completely Degraded	1.92	1.91
Beach	0.84	0.83
Open Water	0.62	0.61
Cleared	6.69	6.63
Total	**100.88**	**100**

Legend

- Survey Area
- Excellent
- Very Good-Excellent
- Very Good
- Good-Very Good
- Good
- Degraded-Good
- Degraded
- Degraded-Completely Degraded
- Completely Degraded
- Beach
- Cleared
- Water

Figure 10 - Vegetation Condition

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5.2.2.3 *Assessment of Floristic Community Types*

All vegetation units within the survey area were sampled and defined from a single relevé, unless they were suspected to be representative of the TEC, FCT 30a. Five quadrats were sampled in vegetation considered to be representative of FCT 30a, and in order to analyse the similarity between these quadrats, floristic analysis was carried out in PATN (Belbin 2013). This floristic analysis grouped four of the quadrats, with the fifth (Q12) determined to be floristically dissimilar, as shown in **Figure 11**.

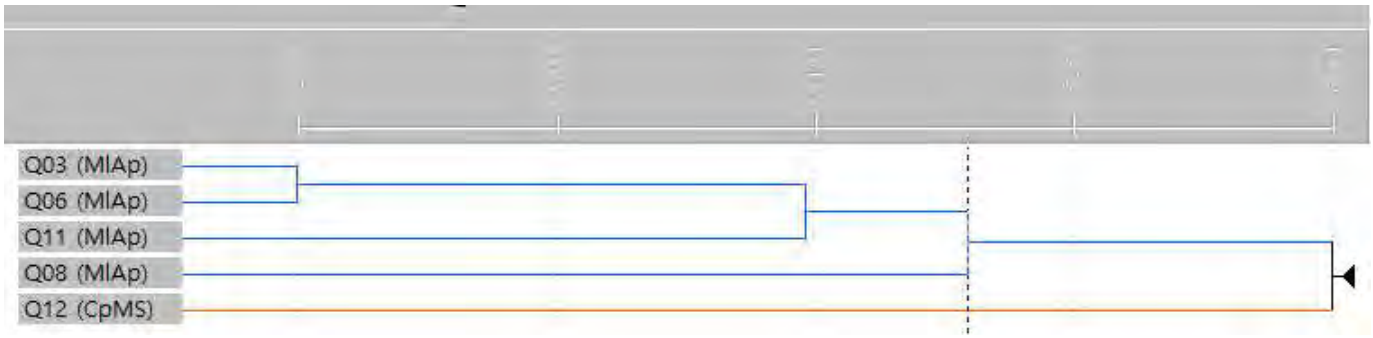

Figure 11 – Quadrat PATN Analysis Dendrogram

In order to then infer the FCT/s most likely represented by the sampled quadrats, floristic analysis was carried out, incorporating reference data from the Gibson *et al.* 1994 and Keighery *et al.* 2012 studies. The analysis was first conducted on the full suite of quadrats (batch analysis) and then via single site insertion (SSI,) utilising multivariate cluster analysis of species presence/absence in PATN. The dendrograms resulting from the analyses are presented in **Appendix E**, with these results and the results of dissimilarity analyses presented in **Table 11**.

The floristic analysis determined that all sampled quadrats, representative of vegetation units CpMl (one quadrat, *Callitris/Melaleuca* Shrubland) and MlAp (four quadrats) are likely representations of FCT 30a.

5.2.3 Threatened and Priority Ecological Communities

The TEC, *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands TEC (FCT 30a), has been previously reported to occur within the survey area (DBCA 2022c). The community, also known as the 'Rottnest Island Pine (*Callitris preissii*) and Rottnest Island Tea Tree (*Melaleuca lanceolata*) Woodland' is listed as a 'Vulnerable' TEC under State legislation (RIA 2014). This community is described as a woodland and forest dominated by *Callitris preissii, Melaleuca lanceolata, Spyridium globulosum, Acanthocarpus preissii, Rhagodia baccata*, *Austrostipa flavescens* and *Trachymene pilosa* (Gibson *et al.* 1994). Critical habitat for this community is the sandy soils on which the community occurs and the fresh superficial groundwater that helps to sustain key dominant trees (DPaW 2014).

The field survey and analyses carried out for all quadrats identified that vegetation units MlAp (*Melaleuca/Acanthocarpus* Woodland) and CpMl (*Callitris/Melaleuca* Shrubland) have the greatest similarity to FCT 30a (**Table 11**). A large proportion of the survey area (40.6% of the survey area was mapped as vegetation units MlAp and CpMl) (**Figure 9**) is therefore considered to be representative of the Vulnerable TEC, FCT 30a, *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands TEC.

Table 11 – Summary of Floristic Analysis Results

Vegetation Unit	Quadrat	Vegetation Condition	SSI Dendrogram Result*	Ref. Quadrat	FCT	Dissimilarity Value	Ref. Quadrat	FCT	Dissimilarity Value	Ref. Quadrat	FCT	Dissimilarity Value	Inferred FCT	Reasoning
CpMI *Callitris/ Melaleuca* SL	Q12	Very Good	30a, 30a2, S12	rott01	S11	0.6842	WOODP-1	30a	0.6842	WOODP-1	30a	0.6842	30a	Gibson *et al.* (1994) and Keighery *et al.* (2012) quadrats analysed present the same dissimilarity value in comparison to Q12. FCT S11 did not record a dominant species of Q12, *Callitris preissii* and is dominated by *Melaleuca acerosa,* which was absent from Q12. S12 is a sub-type of FCT 30a (DPaW 2014). Key/dominant species of Q12 and FCT 30a align. Greatest similarity to **FCT 30a**.
MIAp *Melaleuca/ Acanthocarpus* Woodland	Q03	Good - Very Good	S12, 29a, S11, 30a	rott01	S11	0.6471	GARD04	30a	0.7273	GARDEN -4	30a2	0.7273	30a	S11 is 'Northern *Acacia rostellifera – Melaleuca acerosa* shrublands', whilst FCT 30a is '*Callitris preissii* (or *Melaleuca lanceolata*) forest and woodlands'. Q03 does not contain *Acacia rostellifera* or *Melaleuca acerosa* and is therefore not considered representative of FCT S11. Based on the height and cover of canopy species, the vegetation is considered to be a Woodland or forest. FCT 29a is a shrubland, lacking the woodland canopy layer present in Q03. S12 is a sub-type of FCT 30a (DPaW 2014). Key/dominant species of Q03 and FCT 30a align. Greatest similarity to **FCT 30a**.
	Q06	Very Good	S12, S11, 29a, 30a	rott01	S11	0.5789	rott03	S12	0.6800	GARD01	30a1	0.6923	30a	S11 is 'Northern *Acacia rostellifera – Melaleuca acerosa* shrublands' and both species are absent from Q06. Based on the height and cover of canopy species, the vegetation is considered to be a woodland or forest. FCT 29a is a shrubland, lacking the woodland canopy layer present in Q06. S12 is a sub-type of FCT 30a (DPaW 2014). Key/dominant species of Q06 and FCT 30a align. Greatest similarity to **FCT 30a**.
	Q08	Good - Very Good	S19, 18, 7	rott01	S11	0.7778	rott06	S12	0.7778	cool 04	17	0.8182	30a	S11 is 'Northern *Acacia rostellifera – Melaleuca acerosa* shrublands' and Q08 did not record either species. *Melaleuca lanceolata,* dominant in Q08 does not occur within FCT 17. S12 is a sub-type of FCT 30a (DPaW 2014). Key/dominant species of Q08 do not align with S19 or FCTs 7 or 18 but do align with FCT 30a. Greatest similarity to **FCT 30a**.
	Q11	Very Good	S11, S12, 30a	rott01	S11	0.5556	MI11	13	0.7273	GARD04	30a2	0.7391	30a	S11 is 'Northern *Acacia rostellifera – Melaleuca acerosa* shrublands' and both species are absent from Q13. FCT 13 is a wetland with key dominant species that do not align with Q13. S12 is a sub-type of FCT 30a (DPaW 2014). Key/dominant species of Q13 and FCT 30a align. Greatest similarity to **FCT 30a**.

5.3 VEGETATION OF SIGNIFICANCE

5.3.1 Nationally Significant Vegetation

The National significance of the vegetation units was assessed based on presence of:

- populations of Threatened (EPBC listed) species
- TECs listed as nationally (EPBC) significant
- Ramsar Wetlands of International Importance (DAWE 2022).

5.3.1.1 *Threatened Flora*

No EPBC-listed Threatened flora were recorded within the survey area and therefore, none of the recorded vegetation units are of significance due to this factor.

5.3.1.2 *Threatened Ecological Communities*

No EPBC-listed TECs are considered to occur within the survey area. Therefore, none of the defined vegetation units are considered to be of National Significance due to this factor.

5.3.1.3 *Ramsar Wetlands*

No Ramsar wetlands occur within the survey area and therefore, none of the recorded vegetation units are of significance due to this factor.

5.3.2 State Significant Vegetation

The State significance of the vegetation units was assessed based on presence of:

- State-listed Threatened flora
- State-listed TECs
- land within (or areas recommended by DBCA for inclusion) the State-managed conservation estate.

5.3.2.1 *Threatened Flora*

No State-listed Threatened flora were recorded within the survey area and therefore, none of the recorded vegetation units are of significance due to this factor.

5.3.2.2 *TECs*

Two of the defined unit, MlAp and CpMl, were considered to be representative of or form part of a State-listed TEC (*Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands TEC). Therefore, these vegetation units are considered to be State significance due to this factor.

5.3.2.3 *Conservation Estate*

Rottnest Island (Wadjemup) is an A Class Reserve. Therefore, all recorded vegetation units which occupy the reserve are considered to be of State significance due to this factor.

5.3.3 Regionally Significant Vegetation

The regional significance of the vegetation units was assessed based on:

- the presence of populations of Priority flora or ecological communities
- the presence of ESAs or areas relevant to a conservation scheme
- the presence of conservation category wetlands
- the presence of high diversity of flora, fauna, communities, or community structure
- the presence of flora species exhibiting range extensions or undescribed species
- having a restricted regional distribution
- being represented by less than 30% of the pre-European extent.

5.3.3.1 *Priority Flora*

No State-listed Priority flora were recorded within the survey area and therefore, none of the recorded vegetation units are of significance due to this factor.

5.3.3.2 *Priority Ecological Communities*

No DBCA listed PECs are considered to occur within the survey area. Therefore, none of the defined units are considered significant to be of regional significance due to this factor.

5.3.3.3 *ESAs or Conservation Areas*

Rottnest Island (Wadjemup) is an A Class Reserve, which is therefore an ESA. Therefore, all recorded vegetation units which occupy the reserve are considered to be of regional significance due to this factor.

5.3.3.4 *Conservation Category Wetlands*

No conservation category wetlands occur within the survey area. Therefore, none of the defined vegetation units are considered to be of regional significance due to this factor.

5.3.3.5 *High Diversity*

The mean species richness across all quadrats within vegetation units with an affinity for FCT 30a (MlAp and CpMl) was 5.6 species. In comparison to the mean species richness that was recorded by Gibson *et al.* (1994) for FCT SCP 30a, 21.1 species, the recorded species richness values for this assessment are considered low in comparison.

Of the total 32 species recorded, 15.63% are weeds. The diversity of native taxa recorded within quadrats is not considered high; however, surveying outside of the optimal spring season is likely to have resulted in fewer species (e.g. annuals) being present. None of the recorded vegetation units are considered to exhibit high diversity and are therefore not considered to be of regional significance due to this factor.

5.3.3.6 *Range Extending/Undescribed Flora*

No undescribed or range extending flora species were recorded within the survey area. Therefore, none of the defined units are considered significant to be of regional significance due to this factor.

5.3.3.7 *Restricted Regional Representation and Distribution*

Beard (1990) vegetation association 125 is represented by 9,017.32 ha across the Swan Coastal Plain and 1,948.17 ha across the Perth IBRA sub-region, which is considered to be restricted in its representation. However, no areas of vegetation association 125 intersect the survey area, and therefore, the none of the recorded vegetation units, are considered to be of regional significance due to this factor.

5.3.3.8 *Extent Remaining*

The Beard (1990) vegetation associations 125 and 15 represented within the survey area fall below the unconstrained (30%) threshold, with association 125 also falling below the constrained (10%) threshold for retention in comparison to their pre-European extent. Therefore, vegetation units MlAp and CpMl, representative of the 'Low forest cypress pine', association 15 and vegetation units LpAp, TiSS and GtS, representative of the 'Bare areas; salt lakes', association 125 are considered to be of regional significance due to this factor.

5.3.4 Locally Significant Vegetation

The local significance of the vegetation units was assessed based on:

- representing small, isolated communities
- their local extent (proportion) and distribution.

5.3.4.1 *Small, Isolated Communities*

Vegetation units CpMl occur as a small, isolated community within the survey area and is considered locally significant due to this factor.

5.3.4.2 *Locally Limited Extent and Distribution*

The vegetation unit CpMl (*Callitris/ Melaleuca* Shrubland) occupies a small portion (≤1%) of the survey area covering an extent of 0.6% (0.6 ha). This vegetation unit is considered limited in its local extent and distribution and is considered locally significant due to this factor.

5.3.5 Summary of Vegetation Significance

The significance of the vegetation units within the survey area, along with the aspects determining their significance, are summarised in **Table 12**. The level of significance for each vegetation unit is broadly summarised in **Table 13**.

Table 12 – Summary of the Significance of the Recorded Vegetation Units

Scale	Significance Aspect	Vegetation Units
National Significance	Populations of Threatened (EPBC listed) species	-
	Presence of EPBC listed TECs	-
	Presence of Ramsar wetlands	-
State Significance	Presence of State-listed Threatened flora	-
	Presence of State-listed TECs	MlAp, CpMl
	Land within the Conservation Estate	MlAp, ArAp, CpMl, MlGl, OaAp, TiSS, GtS, LpAp, SlG
Regional Significance	Presence of Priority flora	-
	Presence of PECs	-
	Presence of ESAs or areas relevant to a conservation scheme	MlAp, ArAp, CpMl, MlGl, OaAp, TiSS, GtS, LpAp, SlG
	Presence of conservation category wetlands	-
	High diversity of flora, fauna, communities, or community structure	-
	Presence of flora species exhibiting a range extension	-
	Presence of undescribed flora	-
	Having a restricted regional representation and distribution	-
	Represented by less than 30% of the pre-European extent	MlAp, CpMl, TiSS, GtS, LpAp,
Local Significance	Small, isolated communities	CpMl
	Having a limited local extent and/or distribution	CpMl

Table 13 – Summary of Level of Potential Significance for the Recorded Vegetation Units

Vegetation Unit	Overall Significance – Factor of Significance	Area (ha)	% of Survey Area
MlAp *Melaleuca/ Acanthocarpus* Woodland	State significance – Presence of State-listed TEC State significance – Land within the Conservation Estate Regional significance – within an ESA Regional significance – Represented by <30% of pre-European extent	44.39	44.00
ArAp *Acacia/Acanthocarpus* Shrubland	State significance – Land within the Conservation Estate Regional significance – within an ESA	5.20	5.15
CpMl *Callitris/Melaleuca* Shrubland	State significance – Presence of State-listed TEC State significance – Land within the Conservation Estate Regional significance – within an ESA Regional significance – Represented by <30% of pre-European extent Local significance – occurring as a small, isolated community Local significance – limited local extent and/or distribution	0.60	0.60
MlGl *Melaleuca/ Guichenotia* Shrubland	State significance – Land within the Conservation Estate Regional significance – within an ESA	23.00	22.79
OaAp *Olearia/ Acanthocarpus* Shrubland	State significance – Land within the Conservation Estate Regional significance – within an ESA	4.03	4.00
TiSS *Tecticornia* Samphire Shrubland	State significance – Land within the Conservation Estate Regional significance – within an ESA Regional significance – Represented by <30% of pre-European extent	5.70	5.65
GtS *Gahnia* Sedgeland	State significance – Land within the Conservation Estate Regional significance – within an ESA	3.88	3.85
LpAp *Lepidosperma/ Acanthocarpus* Sedgeland	State significance – Land within the Conservation Estate Regional significance – within an ESA Regional significance – Represented by <30% of pre-European extent	3.05	3.02
SlG Spinifex Grassland	State significance – Land within the Conservation Estate Regional significance – within an ESA Regional significance – Represented by <30% of pre-European extent	2.56	2.54
Planted		0.33	0.33
Beach		0.83	0.83
Open Water		0.62	0.61
Cleared		6.69	6.63
	TOTAL	**100.88**	**100**

6 CONCLUSIONS

The key findings and conclusions arising from the flora and vegetation assessment within the survey area:

- No Threatened flora listed under the BC Act or the EPBC Act were recorded.
- No Priority species as listed by DBCA were recorded.
- No weeds listed as WoNS or DP plants under the BAM Act were recorded.
- The condition of the vegetation was found to range from 'Excellent' to 'Completely Degraded - Degraded' with the greatest proportion in 'Good' or 'Degraded' condition.
- Nine vegetation units and four other classifications (Beach, Planted, Open Water and Cleared areas) were defined and mapped within the survey area.
- Two of the recorded vegetation units were determined to be characteristic of the State-listed *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands TEC (FCT 30a).
- The remaining extent of the one vegetation association (vegetation association 125) supported by the survey area falls below the 10% retention target in the context of the Swan Coastal Plain, and two vegetation associations relevant to the survey area represented by less than 30% of pre-European extent across the Swan Coastal Plain and Perth IBRA sub-region.
- Vegetation units MlAp and CpMl are considered to be representative of the State-listed *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands TEC (FCT 30a), and therefore, these units are considered to be of State significance.
- Rottnest Island (Wadjemup) is an A Class Reserve and an ESA, therefore all vegetation it supports is considered to be of State and regional significance.
- Vegetation units MlAp, CpMl, TiSS, LpAl and SlG are representative of pre-European vegetation associations and/or complexes that have less than 30% of their original extent remaining and are therefore considered regionally significant.
- Vegetation units CpMl occurs as a small, isolated community also being limited in its local extent and/or distribution, and is therefore considered locally significant.
- *Lepidium puberulum* (P4) has previously been recorded from one location within the survey area (DBCA 2022a). This species was not recorded to occur within the survey area despite extensive searching in the vicinity of the known recorded location. Further targeted surveys may be appropriate.

7 LIST OF PARTICIPANTS

The personnel who contributed to the project are summarised in **Table 14**.

Table 14 – Project Team

Name	Qualification	Years of Relevant Experience	Role
Kellie Bauer–Simpson Principal Ecologist	BSc. (Biological Science)	23	Project manager, field assessment, flora identification, technical and authorisation review
Lisa Chappell Senior Botanist/Environmental Scientist	BEnvSc. (Hons) (Environmental Science)	19	Field assessment, data management, floristic analysis, GIS mapping, report preparation
Olga Nazarova Botanist/Taxonomist	BSc. (Botany and Genetics)	4	Flora identifications support, technical support, report preparation
Megan Gray Ecologist	BSc. (Environmental Biology)	3	Report preparation
Kelly Hopkinson Graduate Ecologist	BSc. (Biological Science and Conservation Biology)	1	Report preparation
Kristen Bleby Senior Ecologist	BSc. (Natural Resource Management) (Hons), PhD (Wildlife Ecology)	8	Report review
Sarah Beckwith Undergraduate Ecologist		0.5	Field survey, data entry
Will Bauer–Simpson Technician	Cert IV (Health and Safety)	10	Field safety and logistics planning, GIS mapping, spatial analysis, spatial data management
Megan Rabadan Administration		5	Data entry, editorial support

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APPENDIX A - DBCA NATURE MAP SEARCH REPORT

Life Form	Taxon	WA Cons Code
DICOT	*Acacia aptaneura*	
DICOT	*Acacia cyclops*	
DICOT	*Acacia lasiocarpa* var. *lasiocarpa* cockleshell gully variant (E.A. Griffin 2039)	
DICOT	*Acacia littorea*	
DICOT	*Acacia rostellifera*	
DICOT	*Acacia truncata*	
DICOT	*Acrotriche cordata*	
DICOT	*Agonis flexuosa* var. *flexuosa*	
DICOT	*Alyxia buxifolia*	
DICOT	*Angianthus cunninghamii*	
DICOT	*Angianthus preissianus*	
DICOT	*Apium annuum*	
DICOT	*Arctotheca calendula*	
DICOT	*Arctotheca populifolia*	
DICOT	*Arenaria leptoclados*	
DICOT	*Argyranthemum frutescens*	
DICOT	*Atriplex cinerea*	
DICOT	*Atriplex isatidea*	
DICOT	*Atriplex rhagodioides*	
DICOT	*Atriplex sp.*	
DICOT	*Beyeria viscosa*	
DICOT	*Boronia alata*	
DICOT	*Caesalpinia gilliesii*	
DICOT	*Cakile maritima*	
DICOT	*Cakile maritima* Scop. subsp. *maritima*	
DICOT	*Calandrinia brevipedata*	
DICOT	*Calandrinia tholiformis*	
DICOT	*Callitriche stagnalis*	
DICOT	*Canarium mutabile*	
DICOT	*Cardamine hirsuta*	
DICOT	*Carduus pycnocephalus*	
DICOT	*Carpobrotus virescens*	
DICOT	*Cassytha glabella*	
DICOT	*Casuarina equisetifolia*	
DICOT	*Casuarina glauca*	
DICOT	*Casuarina obesa*	
DICOT	*Centaurea melitensis*	
DICOT	*Centaurium erythraea*	
DICOT	*Centaurium pulchellum*	
DICOT	*Centaurium tenuiflorum*	
DICOT	*Cerastium balearicum*	
DICOT	*Cerastium glomeratum*	
DICOT	*Chenopodium murale*	
DICOT	*Cirsium vulgare*	
DICOT	*Clematis linearifolia*	
DICOT	*Clematis microphylla*	
DICOT	*Comesperma confertum*	

Life Form	Taxon	WA Cons Code
DICOT	*Comesperma integerrimum*	
DICOT	*Conyza bonariensis*	
DICOT	*Conyza parva*	
DICOT	*Conyza sumatrensis*	
DICOT	*Cotula australis*	
DICOT	*Cotula bipinnata*	
DICOT	*Cotula coronopifolia*	
DICOT	*Crassula colorata*	
DICOT	*Crassula colorata* var. *colorata*	
DICOT	*Crassula decumbens*	
DICOT	*Crassula decumbens* var. *decumbens*	
DICOT	*Crassula glomerata*	
DICOT	*Crassula natans* var. *minus*	
DICOT	*Crassula thunbergiana* subsp. *thunbergiana*	
DICOT	*Cymbalaria muralis*	
DICOT	*Daucus glochidiatus*	
DICOT	*Dichondra repens*	
DICOT	*Diplolaena dampieri*	
DICOT	*Diplotaxis muralis*	
DICOT	*Dischisma arenarium*	
DICOT	*Dittrichia graveolens*	
DICOT	*Dodonaea aptera*	
DICOT	*Drosera ramellosa*	
DICOT	*Drosera stolonifera* subsp. *stolonifera*	
DICOT	*Enchylaena tomentosa* var. *tomentosa*	
DICOT	*Eremophila glabra*	
DICOT	*Eremophila glabra* subsp. *albicans*	
DICOT	*Erodium cicutarium*	
DICOT	*Erythrostemon gilliesii*	
DICOT	*Eucalyptus camaldulensis*	
DICOT	*Eucalyptus camaldulensis* subsp. *obtusa*	
DICOT	*Eucalyptus decipiens*	
DICOT	*Eucalyptus erythrocorys*	
DICOT	*Eucalyptus gomphocephala*	
DICOT	*Eucalyptus spathulata*	
DICOT	*Eucalyptus utilis*	
DICOT	*Euphorbia paralias*	
DICOT	*Euphorbia peplus*	
DICOT	*Ficus carica*	
DICOT	*Ficus elastica*	
DICOT	*Ficus macrophylla*	
DICOT	*Ficus microcarpa* subsp. *hillii*	
DICOT	*Ficus rubiginosa*	
DICOT	*Frankenia pauciflora*	
DICOT	*Galium murale*	
DICOT	*Gamochaeta calviceps*	
DICOT	*Geranium molle*	
DICOT	*Gnaphalium indutum*	
DICOT	*Gnaphalium indutum* subsp. *indutum*	

Life Form	Taxon	WA Cons Code
DICOT	*Gomphocarpus fruticosus*	
DICOT	*Gonocarpus pithyoides*	
DICOT	*Guichenotia ledifolia*	
DICOT	*Halosarcia halocnemoides* subsp. *halocnemoides*	
DICOT	*Halosarcia indica* subsp. *bidens*	
DICOT	*Hardenbergia comptoniana*	
DICOT	*Hedypnois rhagadioloides*	
DICOT	*Hedypnois rhagadioloides* subsp. *cretica*	
DICOT	*Heliophila pusilla*	
DICOT	*Heliotropium curassavicum*	
DICOT	*Hemichroa pentandra*	
DICOT	*Hibbertia racemosa*	
DICOT	*Hornungia procumbens*	
DICOT	*Hydrocotyle blepharocarpa*	
DICOT	*Hydrocotyle diantha*	
DICOT	*Hydrocotyle hispidula*	
DICOT	*Hydrocotyle* sp. Hamelinensis (G.J. Keighery s.n. PERTH 02391325)	
DICOT	*Hydrocotyle tetragonocarpa*	
DICOT	*Hypochaeris glabra*	
DICOT	*Lagunaria patersonia*	
DICOT	*Leontodon rhagadioloides*	
DICOT	*Lepidium didymum*	
DICOT	*Lepidium foliosum*	
DICOT	*Lepidium puberulum*	P4
DICOT	*Leptorhynchos scaber*	
DICOT	*Leucophyta brownii*	
DICOT	*Leucopogon insularis*	
DICOT	*Leucopogon parviflorus*	
DICOT	*Lobelia anceps*	
DICOT	*Lycium ferocissimum*	
DICOT	*Lycopersicon esculentum*	
DICOT	*Lysiana casuarinae*	
DICOT	*Lysimachia arvensis*	
DICOT	*Malva arborea*	
DICOT	*Malva parviflora*	
DICOT	*Malva preissiana*	
DICOT	*Medicago polymorpha*	
DICOT	*Medicago sativa*	
DICOT	*Melaleuca armillaris*	
DICOT	*Melaleuca huegelii*	
DICOT	*Melaleuca lanceolata*	
DICOT	*Melaleuca nesophila*	
DICOT	*Melia azedarach*	
DICOT	*Melianthus major*	
DICOT	*Melilotus indicus*	
DICOT	*Mesembryanthemum crystallinum*	
DICOT	*Millotia myosotidifolia*	
DICOT	*Minuartia mediterranea*	
DICOT	*Myoporum caprarioides*	

Life Form	Taxon	WA Cons Code
DICOT	*Myoporum insulare*	
DICOT	*Myosotis australis*	P4
DICOT	*Nerium oleander*	
DICOT	*Nicotiana glauca*	
DICOT	*Nitraria billardierei*	
DICOT	*Olea europaea*	
DICOT	*Olearia axillaris*	
DICOT	*Orobanche minor*	
DICOT	*Oxalis corniculata*	
DICOT	*Oxalis exilis*	
DICOT	*Oxalis pes-caprae*	
DICOT	*Parentucellia latifolia*	
DICOT	*Parietaria cardiostegia*	
DICOT	*Parietaria debilis*	
DICOT	*Pelargonium capitatum*	
DICOT	*Pelargonium littorale*	
DICOT	*Phyllangium divergens*	
DICOT	*Phyllanthus calycinus*	
DICOT	*Pithocarpa cordata*	
DICOT	*Pittosporum ligustrifolium*	
DICOT	*Plantago debilis*	
DICOT	*Plantago exilis*	
DICOT	*Plantago lanceolata*	
DICOT	*Podotheca angustifolia*	
DICOT	*Polycarpon tetraphyllum*	
DICOT	*Poranthera drummondii*	
DICOT	*Portulaca oleracea*	
DICOT	*Ranunculus pumilio*	
DICOT	*Ranunculus pumilio* var. *politus*	
DICOT	*Raphanus raphanistrum*	
DICOT	*Reseda alba*	
DICOT	*Reseda luteola*	
DICOT	*Rhagodia baccata*	
DICOT	*Rhagodia baccata* subsp. *baccata*	
DICOT	*Rhagodia baccata* subsp. *dioica*	
DICOT	*Rhamnus alaternus*	
DICOT	*Rhodanthe citrina*	
DICOT	*Ricinus communis*	
DICOT	*Roepera billardierei*	
DICOT	*Roepera similis*	
DICOT	*Sagina apetala*	
DICOT	*Sagina maritima*	
DICOT	*Salicornia blackiana*	
DICOT	*Salicornia quinqueflora*	
DICOT	*Salicornia* sp.	
DICOT	*Salsola australis*	
DICOT	*Samolus repens*	
DICOT	*Samolus repens* (J.R.Forst. & G.Forst.) Pers. var. *repens*	
DICOT	*Sarcocornia quinqueflora*	

Life Form	Taxon	WA Cons Code
DICOT	*Sarcocornia quinqueflora* (Bunge ex Ung.-Sternb.) A.J.Scott subsp. *quinqueflora*	
DICOT	*Scaevola crassifolia*	
DICOT	*Schenkia australis*	
DICOT	*Schinus terebinthifolius*	
DICOT	*Scholtzia involucrata*	
DICOT	*Senecio lautus* subsp. *maritimus*	
DICOT	*Senecio pinnatifolius* var. *latilobus*	
DICOT	*Senecio pinnatifolius* var. *maritimus*	
DICOT	*Silene nocturna*	
DICOT	*Sisymbrium orientale*	
DICOT	*Solanum lycopersicum*	
DICOT	*Solanum nigrum*	
DICOT	*Solanum symonii*	
DICOT	*Sonchus asper*	
DICOT	*Sonchus oleraceus*	
DICOT	*Spergularia brevifolia*	
DICOT	*Spyridium globulosum*	
DICOT	*Stackhousia pubescens*	
DICOT	*Stellaria media*	
DICOT	*Stellaria pallida*	
DICOT	*Stylidium androsaceum*	
DICOT	*Suaeda australis*	
DICOT	*Tamarix aphylla*	
DICOT	*Tamarix* sp.	
DICOT	*Tecoma stans*	
DICOT	*Tecticornia halocnemoides*	
DICOT	*Tecticornia indica* subsp. *bidens*	
DICOT	*Templetonia retusa*	
DICOT	*Tetragonia amplexicoma*	
DICOT	*Tetragonia decumbens*	
DICOT	*Tetragonia implexicoma*	
DICOT	*Thomasia cognata*	
DICOT	*Threlkeldia diffusa*	
DICOT	*Trachymene coerulea*	
DICOT	*Trachymene coerulea* subsp. *coerulea*	
DICOT	*Trachymene pilosa*	
DICOT	*Trifolium suffocatum*	
DICOT	*Trifolium tomentosum*	
DICOT	*Trifolium tomentosum* var. *tomentosum*	
DICOT	*Urtica urens*	
DICOT	*Verbascum* sp. *scsp*	
DICOT	*Waitzia nitida*	
DICOT	*Westringia dampieri*	
DICOT	*Wilsonia backhousei*	
DICOT	*Wilsonia humilis*	
DICOT	*Zygophyllum ammophilum*	
DICOT	*Zygophyllum fruticulosum*	
GYMNO	*Callitris preissii*	
GYMNO	*Pinus halepensis*	

Life Form	Taxon	WA Cons Code
GYMNO	*Pinus radiata*	
LIVERWORT	*Petalophyllum preissii*	
MONOCOT	*Acanthocarpus preissii*	
MONOCOT	*Agave americana*	
MONOCOT	*Agave attenuata*	
MONOCOT	*Agave sisalana*	
MONOCOT	*Aira cupaniana*	
MONOCOT	*Allium ampeloprasum*	
MONOCOT	*Althenia preissii*	
MONOCOT	*Amaryllis dianae*	
MONOCOT	*Amaryllis quokka*	
MONOCOT	*Amphibolis antarctica*	
MONOCOT	*Amphibolis griffithii*	
MONOCOT	*Asphodelus fistulosus*	
MONOCOT	*Austrostipa elegantissima*	
MONOCOT	*Austrostipa flavescens*	
MONOCOT	*Austrostipa* sp.	
MONOCOT	*Avellinia michelii*	
MONOCOT	*Avena barbata*	
MONOCOT	*Baumea juncea*	
MONOCOT	*Brachypodium distachyon*	
MONOCOT	*Briza minor*	
MONOCOT	*Bromus arenarius*	
MONOCOT	*Bromus diandrus*	
MONOCOT	*Bromus hordeaceus*	
MONOCOT	*Bromus madritensis*	
MONOCOT	*Bromus rubens*	
MONOCOT	*Bulbine semibarbata*	
MONOCOT	*Caladenia latifolia*	
MONOCOT	*Carex preissii*	
MONOCOT	*Carex thecata*	
MONOCOT	*Catapodium rigidum*	
MONOCOT	*Cenchrus clandestinus*	
MONOCOT	*Centrolepis polygyna*	
MONOCOT	*Conostylis candicans*	
MONOCOT	*Conostylis candicans* subsp. *calcicola*	
MONOCOT	*Conostylis candicans* subsp. *candicans*	
MONOCOT	*Cortaderia selloana*	
MONOCOT	*Cynodon dactylon*	
MONOCOT	*Cyrtostylis huegelii*	
MONOCOT	*Desmocladus flexuosus*	
MONOCOT	*Ehrharta brevifolia*	
MONOCOT	*Ehrharta brevifolia* var. *cuspidata*	
MONOCOT	*Ehrharta longiflora*	
MONOCOT	*Eragrostis curvula*	
MONOCOT	*Ferraria crispa*	
MONOCOT	*Ferraria crispa* subsp. *crispa*	
MONOCOT	*Ficinia nodosa*	
MONOCOT	*Gahnia trifida*	

Life Form	Taxon	WA Cons Code
MONOCOT	*Halophila australis*	
MONOCOT	*Halophila ovalis*	
MONOCOT	*Heterozostera tasmanica*	
MONOCOT	*Hordeum leporinum*	
MONOCOT	*Hordeum* sp.	
MONOCOT	*Hydrilla verticillata*	
MONOCOT	*Hypoxis glabella* var. *glabella*	
MONOCOT	*Iris germanica*	
MONOCOT	*Isolepis cernua*	
MONOCOT	*Isolepis cernua* var. *setiformis*	
MONOCOT	*Isolepis marginata*	
MONOCOT	*Johnsonia pubescens*	
MONOCOT	*Johnsonia pubescens* subsp. *pubescens*	
MONOCOT	*Juncus bufonius*	
MONOCOT	*Juncus kraussii* subsp. *australiensis*	
MONOCOT	*Lachnagrostis nesomytica*	
MONOCOT	*Lachnagrostis nesomytica* subsp. *nesomytica*	P1
MONOCOT	*Lachnagrostis nesomytica* subsp. *pseudofiliformis*	P1
MONOCOT	*Lachnagrostis* sp.	
MONOCOT	*Lagurus ovatus*	
MONOCOT	*Lepidosperma calcicola*	
MONOCOT	*Lepidosperma gladiatum*	
MONOCOT	*Lepidosperma pubisquameum*	
MONOCOT	*Lepidosperma squamatum*	
MONOCOT	*Leucojum aestivum*	
MONOCOT	*Lolium rigidum*	
MONOCOT	*Microlaena stipoides*	
MONOCOT	*Moraea flaccida*	
MONOCOT	*Moraea miniata*	
MONOCOT	*Narcissus papyraceus*	
MONOCOT	*Narcissus tazetta*	
MONOCOT	*Narcissus tazetta* subsp. *italicus*	
MONOCOT	*Ornithogalum arabicum*	
MONOCOT	*Parapholis incurva*	
MONOCOT	*Pauridia glabella*	
MONOCOT	*Phoenix canariensis*	
MONOCOT	*Phoenix dactylifera*	
MONOCOT	*Phormium tenax*	
MONOCOT	*Poa annua*	
MONOCOT	*Poa poiformis*	
MONOCOT	*Polypogon maritimus*	
MONOCOT	*Polypogon maritimus* var. *subspatheaceus*	
MONOCOT	*Polypogon monspeliensis*	
MONOCOT	*Polypogon tenellus*	
MONOCOT	*Posidonia australis*	
MONOCOT	*Posidonia coriacea*	
MONOCOT	*Posidonia sinuosa*	
MONOCOT	*Prasophyllum giganteum*	
MONOCOT	*Romulea rosea* var. *australis*	

Life Form	Taxon	WA Cons Code
MONOCOT	*Rostraria cristata*	
MONOCOT	*Ruppia polycarpa*	
MONOCOT	*Ruppia tuberosa*	
MONOCOT	*Rytidosperma occidentale*	
MONOCOT	*Schoenus humilis*	
MONOCOT	*Schoenus nitens*	
MONOCOT	*Sorghum bicolor*	
MONOCOT	*Spinifex hirsutus*	
MONOCOT	*Spinifex longifolius*	
MONOCOT	*Sporobolus indicus* var. *capensis*	
MONOCOT	*Sporobolus virginicus*	
MONOCOT	*Stenotaphrum secundatum*	
MONOCOT	*Syringodium isoetifolium*	
MONOCOT	*Thalassodendron pachyrhizum*	
MONOCOT	*Thysanotus patersonii*	
MONOCOT	*Trachyandra divaricata*	
MONOCOT	*Triglochin minutissima*	
MONOCOT	*Triglochin mucronata*	
MONOCOT	*Triglochin muelleri* subsp. *recurvum*	
MONOCOT	*Triglochin striata*	
MONOCOT	*Triglochin trichophora*	
MONOCOT	*Typha orientalis*	
MONOCOT	*Vulpia fasciculata*	
MONOCOT	*Vulpia muralis*	
MONOCOT	*Vulpia myuros*	
MONOCOT	*Vulpia myuros* forma *megalura*	
MONOCOT	*Washingtonia filifera*	
MONOCOT	*Washingtonia robusta*	
MONOCOT	*Wurmbea dioica* subsp. *alba*	
MONOCOT	*Wurmbea monantha*	
MONOCOT	*Zantedeschia aethiopica*	
MOSS	*Bryum pachytheca*	
MOSS	*Pseudocrossidium hornschuchianum*	
MOSS	*Racopilum cuspidigerum* var. *convolutaceum*	
MOSS	*Syntrichia pagorum*	
MOSS	*Thuidiopsis sparsa*	
MOSS	*Weissia controversa*	

APPENDIX B - EPBC PROTECTED MATTERS SEARCH REPORT

Australian Government
Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 08-Jun-2022

- Summary
- Details
  - Matters of NES
  - Other Matters Protected by the EPBC Act
  - Extra Information
- Caveat
- Acknowledgements

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	1
Listed Threatened Species:	39
Listed Migratory Species:	65

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	93
Whales and Other Cetaceans:	12
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	1
Regional Forest Agreements:	None
Nationally Important Wetlands:	1
EPBC Act Referrals:	3
Key Ecological Features (Marine):	None
Biologically Important Areas:	13
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community may occur within area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat may occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432]	Critically Endangered	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat likely to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche carteri		
Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta		
Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida		
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris		
Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi		
White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area
Zanda latirostris listed as Calyptorhynchus latirostris		
Carnaby's Black Cockatoo, Short-billed Black-cockatoo [87737]	Endangered	Species or species habitat may occur within area
FISH		
Thunnus maccoyii		
Southern Bluefin Tuna [69402]	Conservation Dependent	Species or species habitat likely to occur within area
INSECT		
Hesperocolletes douglasi		
Douglas' Broad-headed Bee, Rottnest Bee [66734]	Critically Endangered	Species or species habitat may occur within area
MAMMAL		
Balaenoptera musculus		
Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Eubalaena australis		
Southern Right Whale [40]	Endangered	Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Neophoca cinerea		
Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat likely to occur within area
Setonix brachyurus		
Quokka [229]	Vulnerable	Species or species habitat known to occur within area
PLANT		
Diuris micrantha		
Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat may occur within area
REPTILE		
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
SHARK		
Carcharias taurus (west coast population)		
Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Pristis pristis		
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sphyrna lewini Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat likely to occur within area

Listed Migratory Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna pacifica Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat may occur within area
Hydroprogne caspia Caspian Tern [808]		Breeding known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Macronectes halli		
Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Onychoprion anaethetus		
Bridled Tern [82845]		Breeding known to occur within area
Phaethon rubricauda		
Red-tailed Tropicbird [994]		Breeding known to occur within area
Sterna dougallii		
Roseate Tern [817]		Breeding known to occur within area
Thalassarche carteri		
Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta		
Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida		
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris		
Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi		
White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area
Migratory Marine Species		
Balaenoptera edeni		
Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eubalaena australis as Balaena glacialis australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area
Mobula alfredi as Manta alfredi Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat known to occur within area
Mobula birostris as Manta birostris Giant Manta Ray [90034]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Roosting known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Thalasseus bergii Greater Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Tringa totanus Common Redshank, Redshank [835]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Ardenna carneipes as Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna pacifica as Puffinus pacificus Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area overfly marine area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Calidris tenuirostris		
Great Knot [862]	Critically Endangered	Roosting known to occur within area overfly marine area
Charadrius bicinctus		
Double-banded Plover [895]		Roosting known to occur within area overfly marine area
Charadrius leschenaultii		
Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus		
Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus		
Red-capped Plover [881]		Roosting known to occur within area overfly marine area
Chroicocephalus novaehollandiae as Larus novaehollandiae		
Silver Gull [82326]		Breeding known to occur within area
Diomedea amsterdamensis		
Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea epomophora		
Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area
Diomedea exulans		
Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi		
Northern Royal Albatross [64456]	Endangered	Species or species habitat may occur within area
Gallinago megala		
Swinhoe's Snipe [864]		Roosting likely to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area overfly marine area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat may occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area overfly marine area
Hydroprogne caspia as Sterna caspia Caspian Tern [808]		Breeding known to occur within area
Larus pacificus Pacific Gull [811]		Foraging, feeding or related behaviour may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area overfly marine area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area overfly marine area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area overfly marine area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Onychoprion anaethetus as Sterna anaethetus Bridled Tern [82845]		Breeding known to occur within area
Onychoprion fuscatus as Sterna fuscata Sooty Tern [90682]		Breeding known to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat likely to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Roosting known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area overfly marine area
Puffinus assimilis Little Shearwater [59363]		Breeding known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Roosting known to occur within area overfly marine area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sternula nereis as Sterna nereis Fairy Tern [82949]		Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area
Thalasseus bergii as Sterna bergii Greater Crested Tern [83000]		Breeding known to occur within area
Thinornis cucullatus as Thinornis rubricollis Hooded Plover, Hooded Dotterel [87735]		Species or species habitat known to occur within area overfly marine area
Tringa brevipes as Heteroscelus brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area overfly marine area
Tringa totanus Common Redshank, Redshank [835]		Roosting known to occur within area overfly marine area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area overfly marine area
Fish		
Acentronura australe Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area
Campichthys galei Gale's Pipefish [66191]		Species or species habitat may occur within area
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Hippocampus subelongatus West Australian Seahorse [66722]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Lissocampus fatiloquus Prophet's Pipefish [66250]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys meraculus Western Crested Pipefish [66259]		Species or species habitat may occur within area
Nannocampus subosseus Bonyhead Pipefish, Bony-headed Pipefish [66264]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Urocampus carinirostris		
Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer		
Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi		
Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus		
Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammal		
Arctocephalus forsteri		
Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Neophoca cinerea		
Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat likely to occur within area
Reptile		
Aipysurus pooleorum		
Shark Bay Seasnake [66061]		Species or species habitat may occur within area
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and Other Cetaceans		[Resource Information]
Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves [Resource Information]

Protected Area Name	Reserve Type	State
Rottnest Island	State Reserve	WA

Nationally Important Wetlands [Resource Information]

Wetland Name	State
Rottnest Island Lakes	WA

EPBC Act Referrals [Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
INDIGO Central Submarine Telecommunications Cable	2017/8127	Not Controlled Action	Completed
Rottnest Lodge Redevelopment	2019/8565	Not Controlled Action	Completed
Seismic Survey, Bremer Basin, Mentelle Basin and Zeewyck Sub-basin	2004/1700	Not Controlled Action	Completed

Biologically Important Areas

Scientific Name	Behaviour	Presence

Scientific Name	Behaviour	Presence
Seabirds		
Ardenna carneipes Flesh-footed Shearwater [82404]	Aggregation	Known to occur
Ardenna pacifica Wedge-tailed Shearwater [84292]	Foraging (in high numbers)	Known to occur
Eudyptula minor Little Penguin [1085]	Foraging (provisioning young)	Known to occur
Hydroprogne caspia Caspian Tern [808]	Foraging (provisioning young)	Known to occur
Larus pacificus Pacific Gull [811]	Foraging (in high numbers)	Former Range
Onychoprion anaethetus Bridled Tern [82845]	Foraging (in high numbers)	Known to occur
Puffinus assimilis tunneyi Little Shearwater [59363]	Foraging (in high numbers)	Known to occur
Sterna dougallii Roseate Tern [817]	Foraging	Known to occur
Sternula nereis Fairy Tern [82949]	Foraging (in high numbers)	Known to occur
Seals		
Neophoca cinerea Australian Sea Lion [22]	Foraging (male)	Likely to occur
Whales		
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Distribution	Known to occur
Eubalaena australis Southern Right Whale [40]	Calving buffer	Known to occur

Scientific Name	Behaviour	Presence
Megaptera novaeangliae		
Humpback Whale [38]	Migration (north and south)	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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APPENDIX C – FLORA SPECIES BY VEGETATION UNIT

*denotes introduced (weed) species

Family	Taxon	MIAp					CpMI	ArAp	MIGI		GtS		OaAp		LpAp		TiSS		SIG
		Q03	Q06	Q08	Q11	R16	Q12	R01	R02	R15	R04	R18	R05	R17	R07	R13	R09	R14	R10
Araliaceae	*Trachymene coerulea*							+											
Asparagaceae	*Acanthocarpus preissii*	1	+	+	+			+	+	+			+	+	+				+
Asphodelaceae	**Asphodelus fistulosus*					+							+	+			+	+	+
Asphodelaceae	**Trachyandra divaricata*	+	+		+	+	+	+	+	+		+			+	+		+	+
Asteraceae	**Dittrichia graveolens*								+				+				+		+
Asteraceae	*Olearia axillaris*												+	+	+				
Casuarinaceae	*Allocasuarina huegeliana*				+														
Chenopodiaceae	*Rhagodia baccata*								+	+					+	+			
Chenopodiaceae	*Tecticornia indica*																	+	
Chenopodiaceae	*Tecticornia indica* subsp. *bidens*																+		
Crassulaceae	*Cotyledon* sp.	+																	
Cupressaceae	*Callitris preissii*		+				+		+										
Cyperaceae	*Ficinia nodosa*											+				+			
Cyperaceae	*Gahnia trifida*			+							+	+					+	+	
Cyperaceae	*Lepidosperma gladiatum*														+	+			
Cyperaceae	*Lepidosperma pubisquameum*												+						
Euphorbiaceae	**Euphorbia peplus*									+								+	
Fabaceae	*Acacia preissiana*					+						+				+			
Fabaceae	*Acacia rostellifera*				+		+	+	+						+				
Goodeniaceae	*Scaevola crassifolia*							+											+
Haemodoraceae	*Conostylis candicans*									+				+	+	+			
Malvaceae	*Guichenotia ledifolia*		+			+		+	+	+		+							
Myrtaceae	*Agonis flexuosa*						+												
Myrtaceae	*Eucalyptus platypus*						+												
Myrtaceae	*Melaleuca lanceolata*	+	+	+	+	+	+		+										
Pittosporaceae	*Pittosporum ligustrifolium*									+									
Poaceae	*Austrostipa flavescens*								+							+		+	

Family	Taxon	MlAp					CpMl	ArAp	MlGl		GtS		OaAp		LpAp		TiSS		SIG
		Q03	Q06	Q08	Q11	R16	Q12	R01	R02	R15	R04	R18	R05	R17	R07	R13	R09	R14	R10
Poaceae	**Pentameris airoides*			+															
Poaceae	*Poa poiformis*	+	+	+					+				+		+		+		
Poaceae	*Spinifex longifolius*																		+
Poaceae	*Sporobolus virginicus*																+		
Zygophyllaceae	*Roepera* sp.			+															

APPENDIX D – QUADRAT AND RELEVÉ SITE DATA

APPENDIX A – QUADRAT AND RELEVÉ SITE DATA

Site Q03

Date	2 May 2022
Botanist	Kellie Bauer-Simpson and Lisa Chappell
Quadrat Size	10 x 10 m
NW Corner Coordinates	362326mE 6457483mN
Vegetation Unit	Melaleuca/ Acanthocarpus Woodland
Slope	Flat
Landform	Valley
Soil Colour	Brown
Soil Type	Sand
Litter	70%
Bare Ground	5%
Fire Age	>10 Years
Vegetation Condition	Good to Very Good
Disturbances/Impacts	Loss of structure, no mid or understorey

Species	Height (m)	% Cover
Melaleuca lanceolata	10	70
Poa poiformis	0.2	1
Acanthocarpus preissii	0.15	<1
**Trachyandra divaricata*	0.1	<1
Cotyledon sp.	0.01	1

Site Q06

Date	2 May 2022
Botanist	Kellie Bauer-Simpson and Lisa Chappell
Quadrat Size	10 x 10 m
NW Corner Coordinates	362619mE 6457770mN
Vegetation Unit	Melaleuca/ Acanthocarpus Woodland
Slope	Steep
Landform	Hilltop
Soil Colour	Pale brown
Soil Type	Sand
Litter	25%
Bare Ground	15%
Fire Age	>10 Years
Vegetation Condition	Very Good
Disturbances/Impacts	Some weeds, some loss of mid-storey

Species	Height (m)	% Cover
Melaleuca lanceolata	9	20
Acanthocarpus preissii	1	15
Poa poiformis	0.7	4
Guichenotia ledifolia	0.6	7
**Trachyandra divaricata*		+
Callitris preissii		Associated

Site Q08

Date	2 May 2022
Botanist	Kellie Bauer-Simpson and Lisa Chappell
Quadrat Size	10 x 10 m
NW Corner Coordinates	362948mE 6457893mN
Vegetation Unit	Melaleuca/ Acanthocarpus Woodland
Slope	Flat
Landform	Swamp edge
Soil Colour	Brown
Soil Type	Sandy clay
Litter	90%
Bare Ground	2%
Fire Age	>10 Years
Vegetation Condition	Good to Very Good
Disturbances/Impacts	Fallen wood, dry conditions

Species	Height (m)	% Cover
Melaleuca lanceolata	11	70
Gahnia trifida	0.6	1
Poa poiformis	0.3	1
Acanthocarpus preissii		+
Pentameris airoides		+
Zygophyllum sp.		+

Site Q11

Date	2 May 2022
Botanist	Kellie Bauer-Simpson and Lisa Chappell
Quadrat Size	10 x 10 m
NW Corner Coordinates	362690mE 6458323mN
Vegetation Unit	Melaleuca/ Acanthocarpus Woodland
Slope	Moderate
Landform	Hillside
Soil Colour	Pale brown
Soil Type	Sand
Litter	20%
Bare Ground	5%
Fire Age	>10 Years
Vegetation Condition	Very Good
Disturbances/Impacts	Fallen wood, weeds

Species	Height (m)	% Cover
Melaleuca lanceolata	8	25
Allocasuarina huegeliana	5	1
Acanthocarpus preissii	0.8	30
Acacia rostellifera		+
Trachyandra divaricata		+

Site Q12

Date	2 May 2022
Botanist	Kellie Bauer-Simpson and Lisa Chappell
Quadrat Size	10 x 10 m
NW Corner Coordinates	362392mE 6458498mN
Vegetation Unit	Callitris/ Melaleuca Shrubland
Slope	Flat
Landform	Flat
Soil Colour	Pale brown
Soil Type	Sand
Litter	50%
Bare Ground	5%
Fire Age	5-10 Years
Vegetation Condition	Very Good
Disturbances/Impacts	No structure (rehab?)

Species	Height (m)	% Cover
Callitris preissii	4	15
Agonis flexuosa	3	5
Melaleuca lanceolata	3	5
Acacia rostellifera	3	12
Eucalyptus platypus		Associated
Trachyandra divaricata		Associated

Site R01

Date	2 May 2022
Botanist	Kellie Bauer-Simpson and Lisa Chappell
Quadrat Size	10 x 10 m
NW Corner Coordinates	362253mE 6457299mN
Vegetation Unit	Acacia/ Acanthocarpus Shrubland
Slope	Moderate
Landform	Valley
Soil Colour	Brown
Soil Type	Sand
Litter	80%
Bare Ground	0%
Fire Age	5-10 Years
Vegetation Condition	Excellent
Disturbances/Impacts	Negligible

Species	Height (m)	% Cover
Acacia rostellifera	5	20
Acanthocarpus preissii	1	40
Trachyandra divaricata	0.2	1
Guichenotia ledifolia		+
Scaevola crassifolia		+
Trachymene coerulea		+

Site R02

Date	2 May 2022
Botanist	Kellie Bauer-Simpson and Lisa Chappell
Quadrat Size	10 x 10 m
NW Corner Coordinates	362262mE 6457381mN
Vegetation Unit	Melaleuca/ Guichenotia Shrubland
Slope	Moderate
Landform	Hillside
Soil Colour	Pale brown
Soil Type	Sand
Litter	15%
Bare Ground	15%
Fire Age	5-10 Years
Vegetation Condition	Good
Disturbances/Impacts	Weeds, loss of structure

Species	Height (m)	% Cover
Melaleuca lanceolata	2.5	2
Callitris preissii	2	2
Guichenotia ledifolia	1	30
Acanthocarpus preissii	0.8	15
Rhagodia baccata	0.6	5
Trachyandra divaricata	0.3	1
Acacia rostellifera		+
Austrostipa flavescens		+
Dittrichia graveolens		+
Poa poiformis		+

Site R04

Date	2 May 2022
Botanist	Kellie Bauer-Simpson and Lisa Chappell
Quadrat Size	10 x 10 m
NW Corner Coordinates	362490mE 6457633mN
Vegetation Unit	Gahnia Sedgeland
Slope	Flat
Landform	Swamp
Soil Colour	Brown
Soil Type	Clay
Litter	5%
Bare Ground	20%
Fire Age	>10 Years
Vegetation Condition	Very Good to Excellent
Disturbances/Impacts	No diversity

Species	Height (m)	% Cover
Gahnia trifida	1.3	30

Site R05

Date	2 May 2022
Botanist	Kellie Bauer-Simpson and Lisa Chappell
Quadrat Size	10 x 10 m
NW Corner Coordinates	362486mE 6457775mN
Vegetation Unit	Olearia/ Acanthocarpus Shrubland
Slope	Moderate
Landform	Hillside
Soil Colour	Pale brown
Soil Type	Sand
Litter	15%
Bare Ground	25%
Fire Age	5-10 Years
Vegetation Condition	Very Good
Disturbances/Impacts	Weeds

Species	Height (m)	% Cover
Olearia axillaris	2	10
Acanthocarpus preissii	0.6	20
Asphodelus fistulosus	0.5	5
Poa poiformis	0.4	4
Dittrichia graveolens		+
Lepidosperma pubisquameum		+
Lepidosperma gladiatum	0.7	15
Rhagodia baccata	0.5	4

Site R07

Date	2 May 2022
Botanist	Kellie Bauer-Simpson and Lisa Chappell
Quadrat Size	10 x 10 m
NW Corner Coordinates	362738mE 6457638mN
Vegetation Unit	Lepidosperma/ Acanthocarpus Sedgeland
Slope	Steep
Landform	Hillside
Soil Colour	Very pale brown
Soil Type	Sand
Litter	10%
Bare Ground	15%
Fire Age	5-10 Years
Vegetation Condition	Good
Disturbances/Impacts	Some weeds

Species	Height (m)	% Cover
Acanthocarpus preissii	0.5	25
Conostylis candicans	0.3	8
Trachyandra divaricata	0.1	3
Acacia rostellifera		+
Olearia axillaris		+
Poa poiformis		+

Site R09

Date	2 May 2022
Botanist	Kellie Bauer-Simpson and Lisa Chappell
Quadrat Size	10 x 10 m
NW Corner Coordinates	362987mE 6458043mN
Vegetation Unit	Tecticornia Samphire Shrubland
Slope	Flat
Landform	Swamp
Soil Colour	Pale brown
Soil Type	Clay
Litter	10%
Bare Ground	15%
Fire Age	>10 Years
Vegetation Condition	Very Good
Disturbances/Impacts	Nil

Species	Height (m)	% Cover
Spinifex longifolius	0.8	50
Scaevola crassifolia	0.3	15
Acanthocarpus preissii		+
Asphodelus fistulosus		+
Dittrichia graveolens		+
Trachyandra divaricata		+

Site R10

Date	2 May 2022
Botanist	Kellie Bauer-Simpson and Lisa Chappell
Quadrat Size	10 x 10 m
NW Corner Coordinates	363577mE 6458299mN
Vegetation Unit	Spinifex Grassland
Slope	Steep
Landform	Foredune
Soil Colour	White
Soil Type	Sand
Litter	5%
Bare Ground	15%
Fire Age	>10 Years
Vegetation Condition	Degraded to Good

Species	Height (m)	% Cover
Spinifex longifolius	0.8	50
Scaevola crassifolia	0.3	15
Acanthocarpus preissii		+
Asphodelus fistulosus		+
Dittrichia graveolens		+
Trachyandra divaricata		+

Site R13

Date	30 August 2022
Botanist	Kellie Bauer-Simpson and Sarah Beckwith
Quadrat Size	10 x 10 m
NW Corner Coordinates	361714mE 6457868mN
Vegetation Unit	*Lepidosperma/Acanthocarpus* Sedgeland
Slope	Gentle
Landform	Lower slope
Soil Colour	Pale brown
Soil Type	Sand
Litter	10%
Bare Ground	15%
Fire Age	>10 Years
Vegetation Condition	Good
Disturbances/Impacts	Weeds

Species	Height (m)	% Cover
Lepidosperma gladiatum	1.5	8
Ficinia nodosa	1.2	6
Rhagodia baccata	0.6	10
Acacia preissiana	0.5	5
Austrostipa flavescens	0.5	4
**Trachyandra divaricata*	0.5	15
Conostylis candicans	0.2	2

Site R14

Date	30 August 2022
Botanist	Kellie Bauer-Simpson and Sarah Beckwith
Quadrat Size	10 x 10 m
NW Corner Coordinates	362080mE 6457850mN
Vegetation Unit	*Tecticornia* Samphire Shrubland
Slope	Flat
Landform	Wetland
Soil Colour	Brown
Soil Type	Sandy clay
Litter	2%
Bare Ground	5%
Fire Age	>10 Years
Vegetation Condition	Good to Very Good
Disturbances/Impacts	Weeds

Species	Height (m)	% Cover
Gahnia trifida	1.5	30
Tecticornia indica	1	15
**Trachyandra divaricata*	0.6	10
**Asphodelus fistulosus*	0.5	10
Austrostipa flavescens	0.3	8
**Euphorbia peplus*		+

Site R15

Date	30 August 2022
Botanist	Kellie Bauer-Simpson and Sarah Beckwith
Quadrat Size	10 x 10 m
NW Corner Coordinates	361870mE 6457735mN
Vegetation Unit	*Melaleuca/Guichenotia* Shrubland
Slope	Moderate
Landform	Mid-slope
Soil Colour	Pale brown
Soil Type	Sand
Litter	3%
Bare Ground	10%
Fire Age	>10 Years
Vegetation Condition	Good
Disturbances/Impacts	Weeds

Species	Height (m)	% Cover
Acanthocarpus preissii	0.8	15
Rhagodia baccata	0.7	5
Guichenotia ledifolia	0.6	40
**Trachyandra divaricata*	0.3	20
**Euphorbia peplus*	0.1	10
Conostylis candicans		Associated
Pittosporum ligustrifolium		+

Site R16

Date	30 August 2022
Botanist	Kellie Bauer-Simpson and Sarah Beckwith
Quadrat Size	10 x 10 m
NW Corner Coordinates	361857mE 6457782mN
Vegetation Unit	*Melaleuca/Acanthocarpus* Woodland
Slope	Gentle
Landform	Mid-slope
Soil Colour	Brown
Soil Type	Clay loam
Litter	80%
Bare Ground	0%
Fire Age	>10 Years
Vegetation Condition	Very Good
Disturbances/Impacts	Loss of understorey

Species	Height (m)	% Cover
Melaleuca lanceolata	9	80
Acacia preissiana		Associated
**Asphodelus fistulosus*		Associated
Guichenotia ledifolia		Associated
**Trachyandra divaricata*		Associated

Site R17

Date	30 August 2022
Botanist	Kellie Bauer-Simpson and Sarah Beckwith
Quadrat Size	10 x 10 m
NW Corner Coordinates	362359mE 6457778mN
Vegetation Unit	*Olearia/Acanthocarpus* Shrubland
Slope	Moderate
Landform	Hill
Soil Colour	Pale brown
Soil Type	Sand
Litter	1%
Bare Ground	35%
Fire Age	>10 Years
Vegetation Condition	Very Good
Disturbances/Impacts	Rubbish

Species	Height (m)	% Cover
Olearia axillaris	1	8
Acanthocarpus preissii	0.5	6
Conostylis candicans	0.2	7
**Asphodelus fistulosus*		+

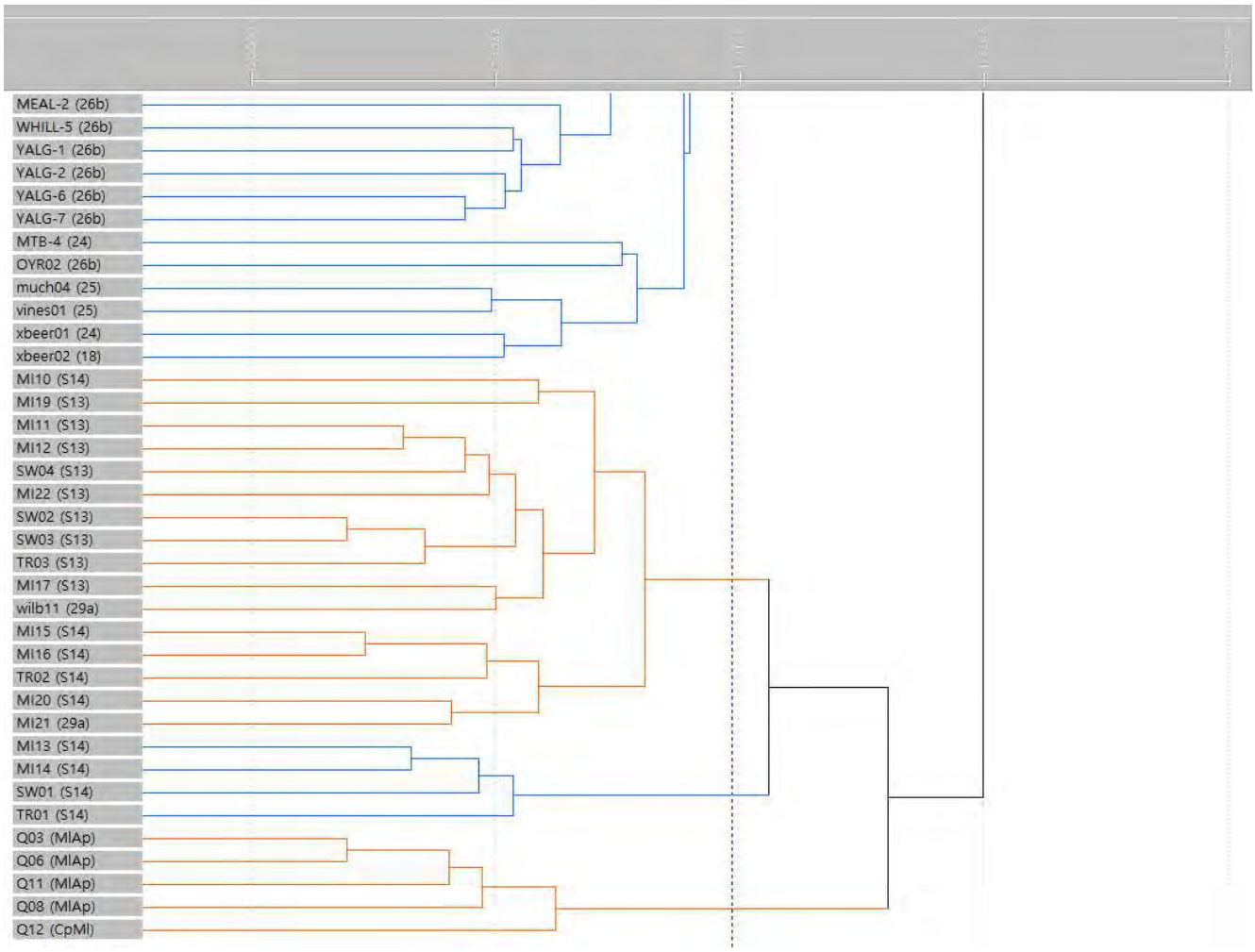
Site R18

Date	30 August 2022
Botanist	Kellie Bauer-Simpson and Sarah Beckwith
Quadrat Size	10 x 10 m
NW Corner Coordinates	362326mE 6457483mN
Vegetation Unit	*Gahnia* Sedgeland
Slope	Flat
Landform	Swamp
Soil Colour	Brown
Soil Type	Loamy sandy clay
Litter	5%
Bare Ground	5%
Fire Age	>10 Years
Vegetation Condition	Good
Disturbances/Impacts	Weeds

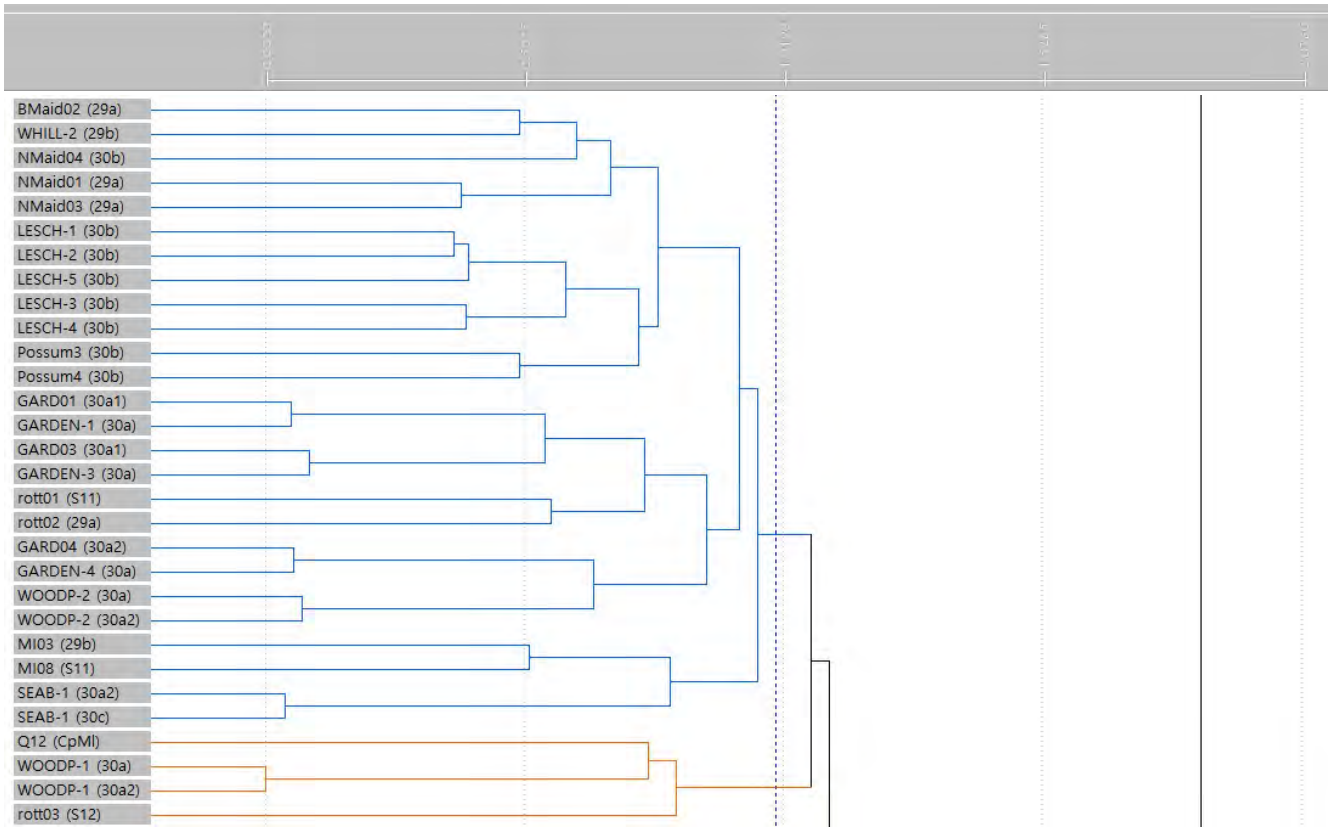
Species	Height (m)	% Cover
Gahnia trifida	1.3	25
Acacia preissiana	1.1	5
Ficinia nodosa	1.1	25
Guichenotia ledifolia	0.6	5
**Trachyandra divaricata*	0.6	10

APPENDIX E – BATCH AND SSI DENDROGRAMS

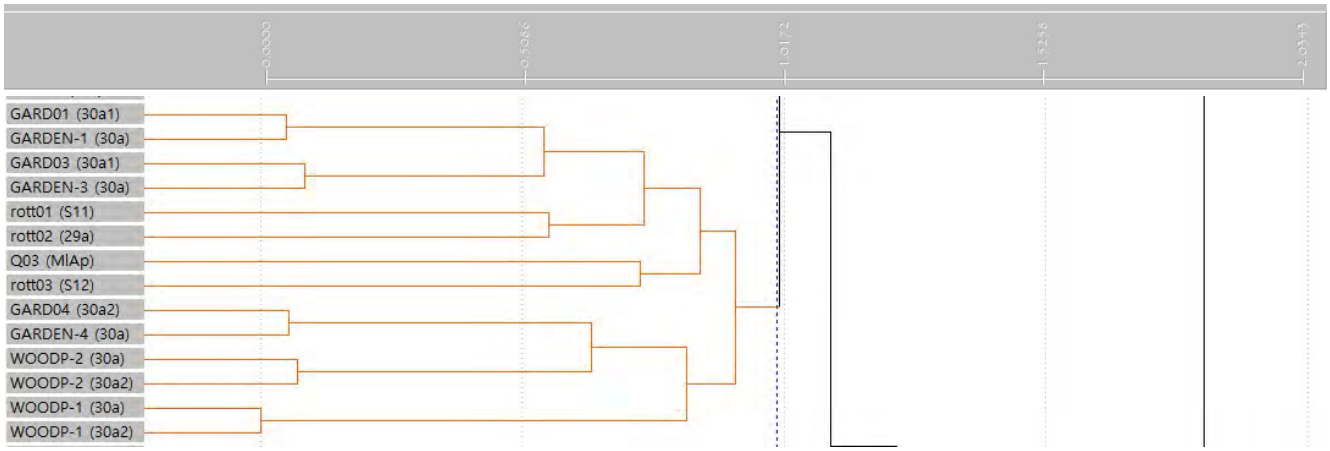
Dendrogram 1 – Excerpt Batch Analysis RIA Quadrats



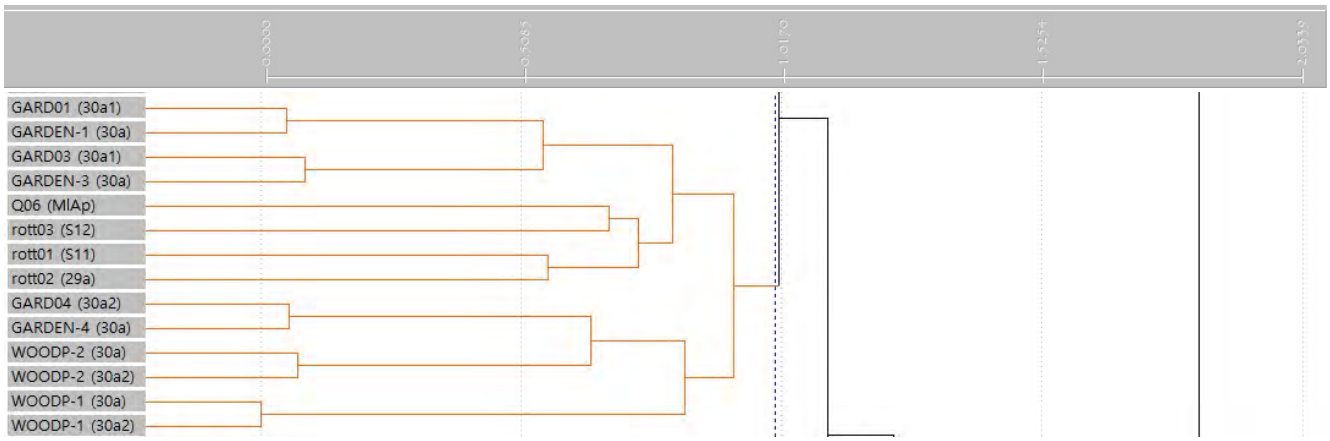
Dendrogram 2– CpMl SSI Q02



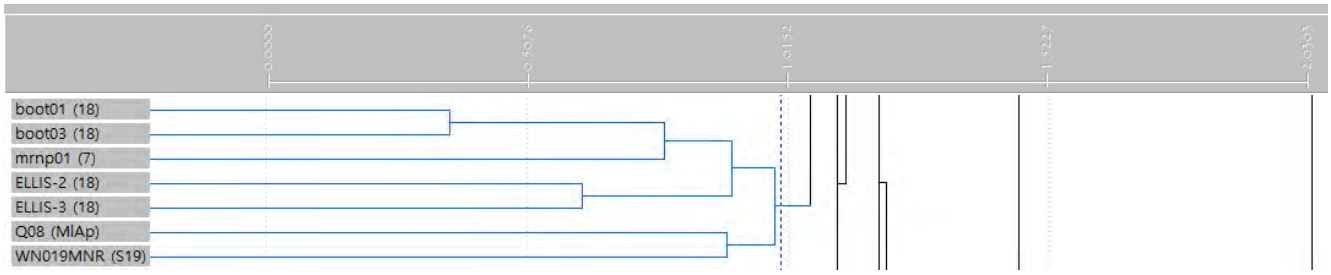
Dendrogram 3 – MlAp SSI Q03



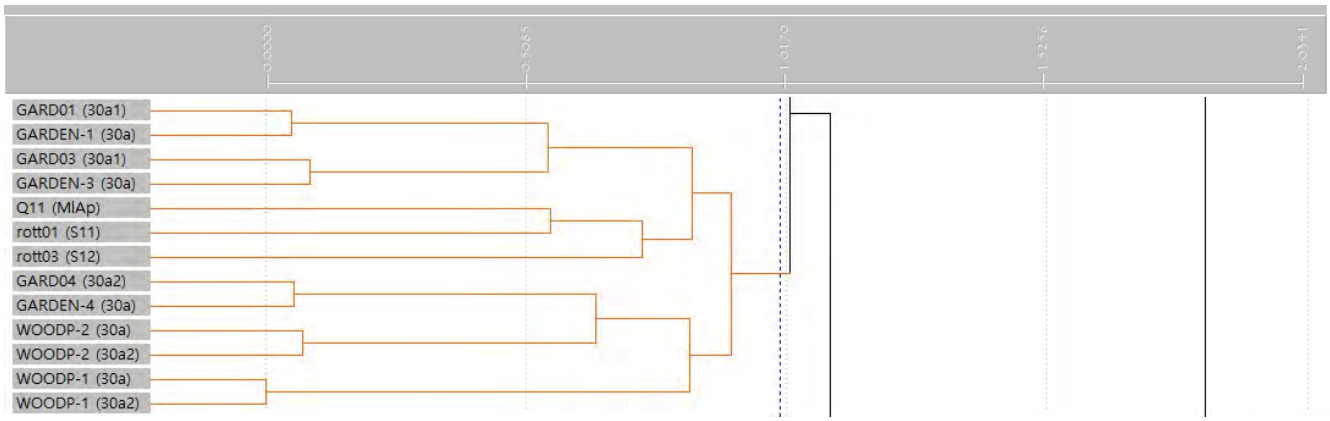
Dendrogram 4 – MlAp SSI Q06



Dendrogram 5 – MlAp SSI Q08



Dendrogram 6– MlAp SSI Q12



REPORT

Appendix J
South Thomson Barge redevelopment flora and vegetation survey (RPS 2024d)

Level 3, 500 Hay Street
Subiaco, WA 6008
T +61 8 9211 1111

Our ref: AU213012799.001

Date: 5th February 2024

David Pond
Rottnest Island Authority
Environment Compliance and Approvals Coordinator
1 Mews Road, Fremantle WA 6160

Dear David,

South Thomson Barge Redevelopment Flora and Vegetation Survey

Introduction

In 2019, the Rottnest Island Authority (RIA) commenced investigations for the South Thomson Barge Landing development approvals process. During this time, a flora survey and a benthic habitat assessment were undertaken to facilitate the approvals process, however, at the end of 2019, a decision was made to pause the project and no further works were undertaken.

In 2023, RIA recommenced the project and consequently require a review of the benthic habitat assessment and in addition, require a flora and vegetation survey, a terrestrial fauna survey, and a marine fauna survey and habitat mapping to be completed.

This report details the flora and vegetation survey conducted as part of this project. Figure 1 shows the project location.

Scope of Work

The objectives of the flora and vegetation survey were to:

- Conduct a spring flora survey of the South Thomson Barge Landing Area in line with the Environmental Protection Authority's *Technical Guidance. Flora and vegetation surveys for environmental impact assessment* (EPA, 2016).
- Conduct a targeted search of the South Thomson Barge Landing Area for the conservation significant taxon *Lepidium puberulum* (a Priority 4 species (P4))*
- Conduct a spring flora survey of two Environmentally Sensitive Area (ESA) lakes located to the south west of the South Thomson Barge Landing Area in accordance with EPA (2016), including condition reporting.
- Conduct targeted searches for the conservation significant taxa *Lachnagrostis nesomytica* subsp. *nesomytica* (P1) and *L. nesomytica* subsp. *pseudofiliformis* (Priority 1) within the boundaries of the ESA lakes.
- Undertake a targeted flora survey of the area proposed for a Light Industrial Area (LIA) to search for conservation significant taxa, in particular *Lepidium puberulum* (P4).

*Priority taxa are listed because there is insufficient knowledge regarding their conservation status and do not enjoy legislative protection, but are considered as part of project planning.

These areas are shown in Figure 2.

Figure 1 Rottnest Island location

Figure 2 Survey locations

South Thomson Barge Landing Onshore Area

This site is located immediately adjacent to the proposed barge landing development and is approximately 4.1 ha in size (Figure 1). A spring flora survey was requested for this site, and RPS completed a spring reconnaissance survey.

A reconnaissance survey is used to provide context and gather broad information about a site. The Environmental Protection Authority's *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016) states that (s4.1)

"Generally, a reconnaissance survey is required where flora and vegetation values are well defined, the area is not likely to support significant flora or vegetation and the scale and nature of the potential impacts are not likely to be significant."

RPS considered these criteria to be met and furthermore that the small size of the site precluded the implementation of a detailed survey using quadrats.

Environmentally Sensitive Area (ESA) Lakes

The portion of Government House Lake located on the southern boundary of the Rottnest Airport, is approximately 4.6 ha in area. The second lake, known as Unnamed Lake, is in the north-eastern part of the airport land and is approximately 2.2 ha in area. These lakes were botanically mapped by Focused Vision Consulting (FVC 2023). As with the South Thomson Barge Landing Onshore survey area, the size of the individual areas mitigates against the use of quadrats and a reconnaissance survey, to confirm previous work in the area, is considered adequate.

The RIA also requested targeted searches of the lakes for the conservation significant taxa *Lachnagrostis nesomytica* subsp. *nesomytica* (P1) and *Lachnogrostis nesomytica* subsp. *pseudofiliformis* (P1). These two taxa have only been recorded on Rottnest Island (Western Australian Herbarium, 1998-).

Light Industrial Area (LIA)

The proposed LIA comprises approximately 55 ha, largely surrounding the Rottnest Airport, and encompassing the solar farm (Figure 1). RIA requested that this area be surveyed for the conservation significant taxon *Lepidium puberulum* (P4). RPS considers that the taxon *Myosotis australis* subsp. *australis* (P4) is also of interest as it has been recorded in similar habitat to the south of the LIA search area.

Methods

Desktop Assessment

RPS reviewed the Focused Vision Consulting (FVC, 2023) report *Flora and Vegetation Survey South Thomson and Kingstown, Rottnest Island (Wadjemup)* as a desktop reference, as this report covers an area that includes mapping of the current site, and is relatively recent. It also covers the other areas listed above. This report was supplied by the RIA for this purpose.

Background data regarding Rottnest Island was also provided in this report, and the report is included with the current report as Attachment A for reference.

Field Assessment

Field assessment of the Rottnest Island survey areas was conducted on the 23rd, 24th and 27th November 2023.

South Thomson Barge Landing Onshore Area

Following review of FVC 2023, RPS conducted a field visit to the site. Four relevés (unbounded sample sites, see Figure 3) were described, with the following data collected:

- GPS waypoint and unique identifier
- Description of landform and soil
- List of taxa present, with foliar cover estimate and average height
- Assessment of vegetation condition (using scale of Keighery, 1994 as required for the south-west of Western Australia by EPA 2016)
- Digital photograph.

Any taxa not known to the surveying botanist were collected, pressed and dried, and identified using the resources of the Western Australian Herbarium and relevant published keys. The vegetation was described and mapped from the information collected.

A targeted survey was conducted for conservation significant taxa. Of particular interest is *Lepidium puberulum* (P4).

Figure 3 Location of relevés, South Thomson Barge Landing Onshore Area

Government House Lake & Unnamed Lake

Each lake was visited and the vegetation type mapping by FVC (2023) confirmed and revised as necessary.

The targeted survey was conducted by walking transects across accessible parts the lakes. Originally a spacing of 10-15 metres was intended, however the density of the existing vegetation precluded such a systematic search model.

Using knowledge of the habitat preferences of the target taxa, Government House Lake searches were restricted to the edge of the waterbody and the *Tecticornia* community adjacent. Unnamed Lake did not

contain this community or an extant waterbody and was not examined in the same detail for the target taxa, beyond confirming and revising FVC (2023) vegetation mapping.

Density of vegetation in and surrounding both ESA lakes (*Gahnia trifida* sedgeland) mitigated against the potential discovery of the targeted conservation significant taxa over the majority of the proposed search area. However, the habitat that was unable to be examined is not known to be a preference for these taxa.

When the target taxa were observed, a waypoint was taken (GDA2020 datum) and samples collected to confirm identification, and the number of individuals counted.

Light Industrial Area

RPS undertook a targeted search of the proposed LIA envelope using transects spaced 10-15 m apart. Distance varied due to landform and vegetation density. Denser vegetation, often although not always composed of *Guichenotia ledifolia,* was avoided as the density makes searching more difficult and it is not known if the target taxa grow in such habitat. In addition, survey of these areas posed a potential health and safety risk for the surveyor (snake bite). Sections of *Melaleuca lanceolata* woodlands were also considered too dense to penetrate, and the density often prevents growth underneath in any case. Parts of the LIA were dominated by limestone outcrop and these were not searched as the habitat was unsuitable for the subject taxa.

If the *Lepidium* was observed, a waypoint was taken as well as samples and/or photos to confirm identification and the number of individuals counted. For larger populations a boundary was walked and mapped with waypoints and an estimate made of the number of individuals present.

Results

Desktop Assessment

The review of FCV (2023) indicated that a total of 32 taxa from 29 genera and 18 families was recorded during the field survey, with the dominant families Poaceae (grasses-5), Cyperaceae (sedges-4), Chenopodiaceae (chenopods-3) and Myrtaceae (myrtles-3).

Nine vegetation units were mapped by FVC (2023). The units of relevance to the current survey of the South Thomson Barge Landing Onshore Area, Government House Lake and Unnamed Lake are presented in Table 1:

Table 1 FVC (2023) vegetation mapping units

Code	Description	Notes
MlGl *Melaleuca/Guichenotia* shrubland	*Melaleuca lanceolata* and *Callitris preissii* tall sparse shrubland over *Guichenotia ledifolia, Acanthocarpus preissii* and *Rhagodia baccata* shrubland over **Trachyandra divaricata* low sparse forbs	Analogous to *Callitris preissii/Melaleuca lanceolata* woodland TEC
SIG *Spinifex* grassland	*Scaevola crassifolia* low open shrubland over *Spinifex longifolius* grassland	Coastal strip
MlAp *Melaleuca/Acanthocarpus* woodland	*Melaleuca lanceolata* tall shrubland over *Acanthocarpus preissii low open shrubland*	Analogous to *Melaleuca lanceolata/Callitris preissii* woodland TEC
TiSS *Tecticornia* samphire shrubland	*Tecticornia indica* subsp. *bidens* low samphire shrubland	Government House Lake
GtS *Gahnia* sedgeland	*Gahnia trifida* and *Ficinia nodosa* tall sedgeland	Government House Lake Unnamed Lake

Conservation significant vegetation and Environmentally Sensitive Areas

Examination of the dataset contained in DWER-046 (DWER 2023) indicates that a number of Environmentally Sensitive Areas (ESA) and/or their buffer zones coincide with the survey area (Figure 4).

Government House Lake and Unnamed Lake are both classified as ESA, as is Bickley Swamp which is part of the LIA survey area.

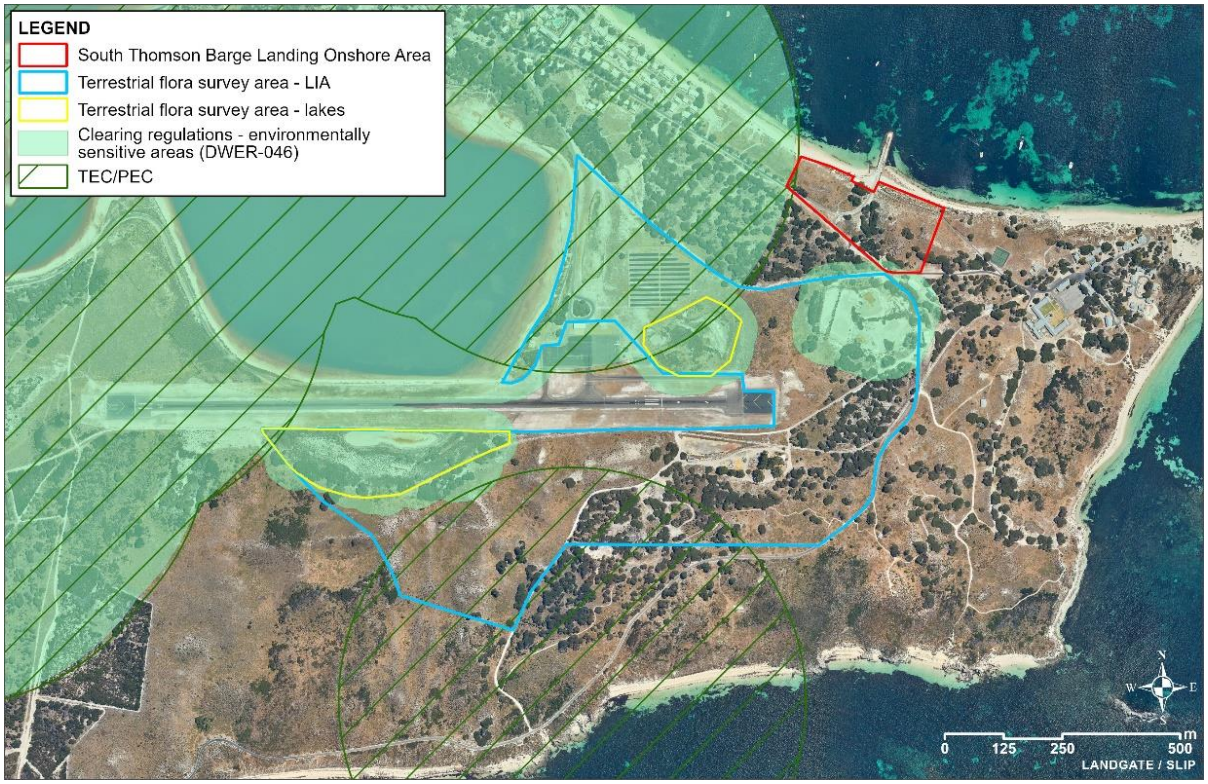


Figure 4 Rottnest Island Environmentally Sensitive Areas

The green shaded crosshatched ESA(s) are Threatened Ecological Communities (TEC). Both are examples of '*Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands of the Swan Coastal Plain (floristic community type 30c as originally described by Gibson *et. al.* 1994) (Government of Western Australia, 2023).

FVC (2023) also mapped 'Coastal shrublands on shallow sands, southern Swan Coastal Plain (floristic community type 29a)' to the south of and overlapping the boundary of the current survey area. This vegetation type is a Priority Ecological Community (PEC) (DBCA 2023) and its extent is shown by the crosshatched unshaded area.

Field Assessment

South Thomson Barge Landing Onshore Area

Vegetation

Three vegetation units were described to cover the South Thomson Barge Landing Onshore Area (Figure 5).

ApAf*Td

Acanthocarpus preissii, Scaevola crassifolia low-mid shrubland/open shrubland over *Austrostipa flavescens* mid grassland/open grassland over **Trachyandra divaricata, Conostylis candicans* subsp. *calcicola* low forbland/open forbland.

Plate 1 ApAf*Td

Plate 2 ApAf*Td

This unit covered the greater majority of the survey area over secondary dunes and slopes.

MlAp*Td

Melaleuca lanceolata (*Callitris preissii*) open woodland over *Acanthocarpus preissii, Rhagodia baccata* shrubland/low shrubland over **Trachyandra divaricata, Conostylis candicans* subsp. *calcicola* low very open forbland.

It was observed that a number of the *Melaleuca lanceolata* and *Callitris preissii* individuals present in this unit had been planted.

Plate 3 MlAp*Td

This unit occurs largely in the eastern part of the survey area over the crest of the secondary dune.

Sc*TdSl

Scaevola crassifolia low open shrubland over **Trachyandra divaricata* low forbland over *Spinifex longifolius, Austrostipa flavescens* low-mid open grassland.

Plate 4 Sc*TdSl

This vegetation type occupies the small strip of foredune, between the strand and **ApAf*Td** vegetation type.

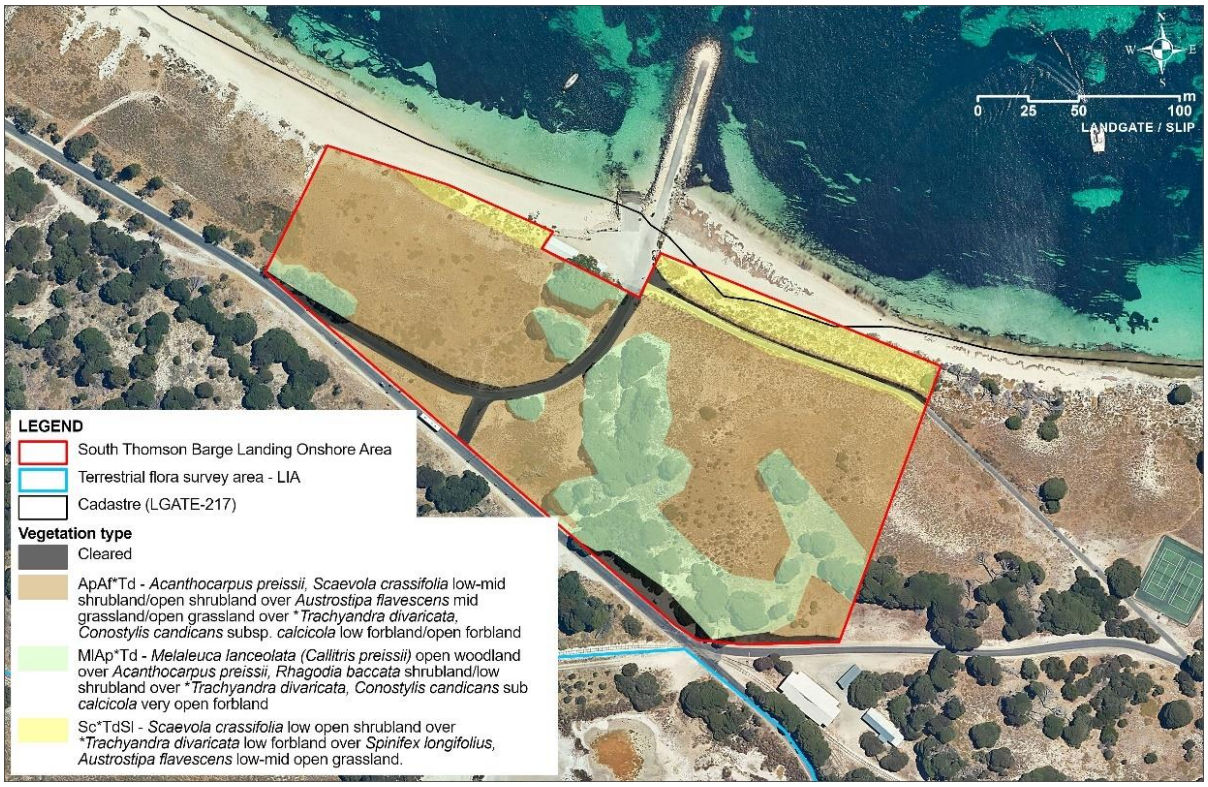


Figure 5 South Thomsons Barge Landing Onshore Area vegetation units

Vegetation condition was assessed by the scale of Keighery (1996) as largely Good, mixed with patches of Degraded vegetation. In areas around taller shrubs and trees condition was assessed as Degraded with patches of Good condition. Figure 6 maps these areas.

Figure 6 Vegetation condition mapping, South Thomson Barge Landing Onshore Area

Flora

Seventeen taxa were recorded in the survey area, four of which were introduced (2).

Table 2 Introduced taxa in the survey area

Family	Introduced taxon	Common name
Poaceae	*Avena barbata*	Bearded Oat
Poaceae	*Bromus diandrus*	Great Brome
Poaceae	*Lagurus ovatus*	Hare's Tail Grass
Asphodelaceae	*Trachyandra divaricata*	Onion Weed

None of these introduced taxa are Declared Organisms (DPIRD, 2023) or Weeds of National Significance (Weeds Australia, 2023).

The remaining thirteen taxa belong to ten different families and thirteen different genera (Table 3).

Table 3 Endemic taxa in the survey area

Family	Taxon
Asparagaceae	*Acanthocarpus preissii*
Asteraceae	*Olearia axillaris*
Chenopodiaceae	*Rhagodia baccata*
Cupressaceae	*Callitris preissii*
Cyperaceae	*Ficinia nodosa*
Cyperaceae	*Gahnia trifida*
Goodeniaceae	*Scaevola crassifolia*
Haemodoraceae	*Conostylis candicans* subsp. *candicans*
Malvaceae	*Guichenotia ledifolia*

Family	Taxon
Myrtaceae	*Melaleuca lanceolata*
Poaceae	*Austrostipa flavescens*
Poaceae	*Spinifex longifolius*
Poaceae	*Sporobolus virginicus*

All these taxa are relatively common in similar habitats. No conservation significant taxa were recorded, either as Matters of National Environmental Significance (MNES) under the federal *EPBC Act 1999* or Threatened or Priority taxa recognised by the EPA.

Targeted survey tracks for the South Thomson Barge Landing Onshore Area were lost from the GPS unit for an unknown reason.

Government House Lake and Unnamed Lake

Vegetation

Government House Lake, on the Rottnest Airport southern boundary , was mapped as vegetation unit **TiSS,** *Tecticornia indica* subsp. *bidens* low samphire shrubland by FVC (2023). Following the RPS visit, the following mapping is suggested incorporating the FVC (2023) vegetation units (Figure 7). RPS considers that two vegetation units occur within the boundary of the ESA, with a samphire shrubland surrounded by sedgeland (Table 4).

Table 4 Government House Lake vegetation/mapping units

Code	Description
TiSS *Tecticornia* samphire shrubland	*Tecticornia indica* subsp. *bidens* low samphire shrubland
GtS *Gahnia* sedgeland	*Gahnia trifida* and *Ficinia nodosa* tall sedgeland
MlAp*Td	*Melaleuca lanceolata* (*Callitris preissii*) open woodland over *Acanthocarpus preissii, Rhagodia baccata shrubland/low shrubland* over **Trachyandra divaricata, Conostylis candicans* subsp. *calcicola* very open forbland
Lake floor	Bare lake floor
Cleared	Cleared on airstrip

Unnamed Lake, on the northern side of the Rottnest Airport, was assessed by RPS to be generally accurately described by FVC (2023), however, the following revision is suggested. Three vegetation units were described for Unnamed Lake, incorporating and revising the mapping provided by FVC (2023). These units are described in Table 5.

Table 5 Unnamed Lake vegetation/mapping units

Code	Description
GtS *Gahnia* sedgeland	*Gahnia trifida* and *Ficinia nodosa* tall sedgeland
AfAt*Td	*Acanthocarpus preissii, Scaevola crassifolia* low-mid shrubland/open shrubland over *Austrostipa flavescens* mid grassland/open grassland over **Trachyandra divaricata, Conostylis candicans* subsp. *calcicola* low forbland/open forbland.
Sv	*Sporobolus virginicus* grassland

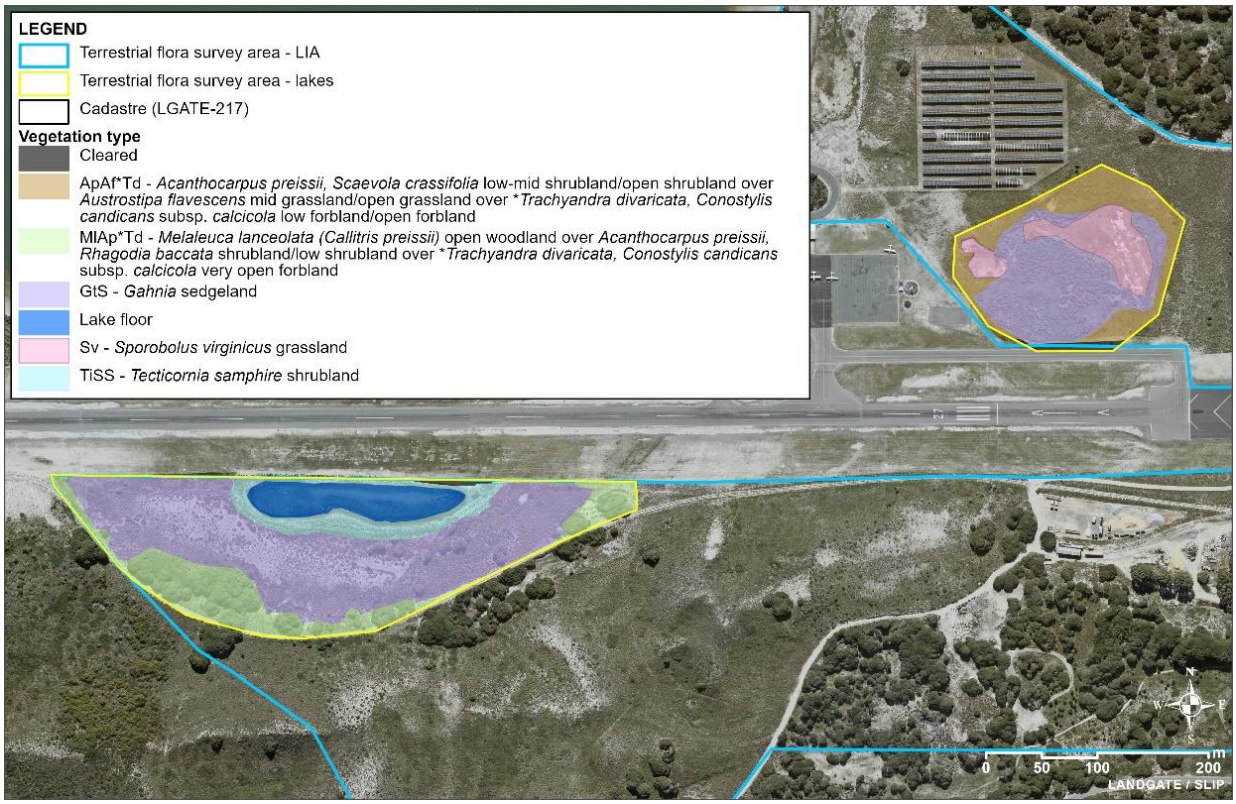


Figure 7 Revised vegetation mapping, Government House Lake and Unnamed Lake

Conservation significant flora

The conservation significant taxon *Lachnagrostis nesomytica* subsp. *nesomytica* (P1) was recorded in the **TiSS** vegetation unit at Government House Lake. At each location a count was made of the number of individuals visible. If an estimate was necessary, a count was made as far as reasonably possible and the '+' sign added (Table 6).

A Rare and Priority Flora report Form will be submitted to the DBCA with details of these records. The completed form is included as Attachment A.

Table 6 Locations and numbers of *Lachnagrostis nesomytica* subsp. *nesomytica* (P1), Government House Lake

Waypoint (GDA2020)	Number	Location
50H 361891.09 m E, 6457839.26 m S	10+	Government House Lake
50H 361923.65 m E, 6457841.92 m S	11	Government House Lake
50H 361929.95 m E, 6457837.35 m S	5	Government House Lake
50H 361988.90 m E, 6457830.61 m S	20	Government House Lake

Figure 8 shows these locations.

Figure 8 *Lachnagrostis nesomytica* subsp. *nesomytica* (P1) locations

LIA Targeted Searches

The LIA comprises approximately 54 hectares and was systematically searched for the conservation significant taxa listed in Table 2. The taxon *Lachnagrostis nesomytica* subsp. *nesomytica* was recorded in Bickley Swamp, locations are recorded in Table 7, and included in Attachment B.

Table 7 Conservation significant taxa potentially in the proposed LIA

Taxon	Habitat/Notes	Growth/Flowering times
Lachnagrostis nesomytica subsp. *nesomytica* (P1)	Previously recorded near Lake Baghdad (Western Australian Herbarium 1998-) and Government House Lake (this survey). Not requested in SoW but RPS considered it potentially present based on habitat preference of edges of saline lakes.	November
Lepidium puberulum (P4)	Previously recorded SW of Research Station in *Melaleuca* woodland, however, habitat preference is for sandy soils and not restricted to woodland.	July - November
Myosotis australis subsp. *australis* (P4)	Previously collected near Porpoise Bay and Green Island in the **ApAf*Td** mapping unit, habitat grey sand over limestone. Not requested in SoW but RPS considered it potentially present based on habitat preference.	August - October

Table 8 *Lachnagrostis nesomytica* subsp. *nesomytica* (P1) locations in Bickley Swamp, LIA

Waypoint (GDA2020)	Numbers	Location
50H 363017.94 m E, 6458057.46 m S	2	Bickley Swamp
50H 363021.72 m E, 6458050.75 m S	10+	Bickley Swamp
50H 363021.64 m E, 6458041.99 m S	20+	Bickley Swamp

Figure 9 shows the targeted survey tracks for the LIA, Government House Lake and Unnamed Lake.

Figure 9 Survey tracks for the LIA, Government House Lake and Unnamed Lake.

Discussion

No taxa listed as MNES were recorded during the surveys and no introduced taxa recorded are listed as Declared Organisms or Weeds of National Significance.

Surveys were undertaken in the spring season as required by EPA (2016). However, as timing was late in spring, it is possible that annual taxa may have senesced to the point where they were not recognisable or visible.

The discovery of the P1 taxon *Lachnagrostis nesomytica* subsp. *nesomytica* at two locations indicates that this taxon may be further widespread in the specific habitat in which it was recorded (lake edges). Priority taxa are listed as such by the DBCA because there is insufficient information regarding them and the threats they may face. In the context of this taxon the ranking may rely on the fact that it has only ever been recorded on Rottnest Island before and may therefore be of restricted range. As both of the recorded locations are within ESAs the taxon has a level of protection, however it may be of interest for the RIA to search lake edge habitats at an appropriate time of year to increase the store of scientific knowledge regarding this and the closely related *Lachnagrostis nesomytica* subsp. *pseudofiliformis* (P1) which inhabits similar habitat.

Barge Landing Area

No conservation significant taxa were recorded in the barge landing area.

Four mapping units were described for the Barge Landing Area, including one for cleared areas such as roads. One of these units, **MlAp*Td** is analogous to the Threated Ecological Community (TEC) *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands of the Swan Coastal Plain (Floristic Community Type 30c as originally described by Gibson *et. al.* 1994). This mapping unit is also recorded within the Government House Lake boundary (Figure 7).

The conservation significant taxon *Lepidium puberulum* (P4) was not recorded during searches of the survey area.

ESA Lakes

The conservation significant taxon *Lachnagrostis nesomytica* subsp. *nesomytica* (P1) was recorded at Government House Lake. Over 46 individuals were recorded from four locations on the edge of the lake. Unnamed Lake comprises different habitat and does not offer the same opportunities for this taxon to occur due to the lack of *Tecticornia* sp. around the boundary. It also presents difficulty in searching due to the density of the *Gahnia* sedgeland vegetation type.

Vegetation mapping was updated from FVC (2023) mapping to account for new data recorded.

Light Industrial Area

The LIA was searched systematically for conservation significant taxa, primarily *Lepidium puberulum* (P4), which was not recorded. *Lachnagrostis nesomytica* subsp. *nesomytica* (P1) was recorded in Bickley Swamp within the LIA. Over thirty-two individuals were recorded at the two locations. Rottnest Island is the only location this taxon has been recorded.

No other conservation significant taxa were recorded.

Yours sincerely,
for RPS AAP Consulting Pty Ltd

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Attachment A

Flora and Vegetation Survey South Thomson and Kingstown, Rottnest Island (Wadjemup)

FLORA AND VEGETATION SURVEY

SOUTH THOMSON AND KINGSTOWN, ROTTNEST ISLAND (WADJEMUP)

THE ROTTNEST ISLAND AUTHORITY

JUNE 2023

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TABLE OF CONTENTS

Executive Summary

1 Introduction 6

1.1 BACKGROUND 6
1.2 LOCATION 6
1.3 SCOPE OF WORK 6

2 Legislative Context 8

2.1 THREATENED AND PRIORITY FLORA 8
2.2 THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES 11
2.3 VEGETATION OF SIGNIFICANCE 11
2.3.1 Nationally Significant Vegetation 11
2.3.2 State Significant Vegetation 11
2.3.3 Regionally Significant Vegetation 12
2.3.4 Locally Significant Vegetation 12
2.4 VEGETATION CLEARING, EXTENT AND STATUS 12
2.5 ENVIRONMENTALLY SENSITIVE AREAS 12
2.6 INTRODUCED FLORA 13
2.6.1 Weeds of National Significance 13
2.6.2 Declared Pest Plants 13
2.6.3 Environmental Weeds 13

3 Existing Environment 14

3.1 CLIMATE 14
3.2 IBRA REGION 15
3.3 SOILS 15
3.4 VEGETATION 17

4 Methodology 20

4.1 DESKTOP REVIEW 20
4.2 FIELD ASSESSMENT 20
4.3 SURVEY LIMITATIONS 24

5 Results and Discussion 25

5.1 DESKTOP ASSESSMENT 25
5.1.1 Threatened and Priority Flora 25
5.1.2 Threatened and Priority Ecological Communities 28
5.2 FIELD ASSESSMENT 30
5.2.1 Flora 30
5.2.2 Vegetation 30
5.2.3 Threatened and Priority Ecological Communities 35
5.3 VEGETATION OF SIGNIFICANCE 37
5.3.1 Nationally Significant Vegetation 37
5.3.2 State Significant Vegetation 37
5.3.3 Regionally Significant Vegetation 37
5.3.4 Locally Significant Vegetation 38
5.3.5 Summary of Vegetation Significance 39

6 Conclusions **41**
7 List of Participants **42**
8 References **43**
APPENDIX A - DBCA NATURE MAP SEARCH REPORT **A1**
APPENDIX B - EPBC PROTECTED MATTERS SEARCH REPORT **B1**
APPENDIX C – FLORA SPECIES BY VEGETATION UNIT **C1**
APPENDIX D – QUADRAT AND RELEVÉ SITE DATA **D1**
APPENDIX E – BATCH AND SSI DENDROGRAMS **E1**

FIGURES

FIGURE 1 - SURVEY AREA 7
FIGURE 2 - CLIMATE DATA FOR ROTTNEST ISLAND WEATHER STATION (009193) (BOM 2022) 14
FIGURE 3 – SOILS 16
FIGURE 4 – PRE-EUROPEAN VEGETATION 19
FIGURE 5 – QUADRAT AND RELEVÉ LOCATIONS 22
FIGURE 6 – SEARCH TRAVERSES 23
FIGURE 7 – DBCA THREATENED AND PRIORITY FLORA 27
FIGURE 8 – THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES 29
FIGURE 9 – VEGETATION UNITS 32
FIGURE 10 – VEGETATION CONDITION 34
FIGURE 11 – QUADRAT PATN ANALYSIS DENDROGRAM 35

TABLES

TABLE 1 - DEFINITIONS OF THREATENED AND PRIORITY FLORA SPECIES (DBCA 2019) 9
TABLE 2 - CATEGORIES OF EPBC ACT THREATENED FLORA SPECIES 10
TABLE 3 - SUMMARY OF SOIL SYSTEMS WITHIN THE SURVEY AREA (SCHOKNECHT *ET AL.* 2004) 15
TABLE 4 - PRE-EUROPEAN VEGETATION OF THE SURVEY AREA (BEARD 1990, DBCA 2018) 17
TABLE 5 – VEGETATION COMPLEXES WITHIN THE SURVEY AREA (HEDDLE *ET AL.* 1980) 18
TABLE 6 – POTENTIAL SURVEY LIMITATIONS AND CONSTRAINTS 24
TABLE 7 - THREATENED AND PRIORITY FLORA WITH THE POTENTIAL TO OCCUR WITHIN THE SURVEY AREA 26
TABLE 8 – THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES OCCURRING WITHIN THE SURVEY AREA 28
TABLE 9 - SUMMARY OF RECORDED VEGETATION UNITS IN THE SURVEY AREA 31
TABLE 10 - SUMMARY VEGETATION CONDITION WITHIN THE SURVEY AREA 33
TABLE 11 – SUMMARY OF FLORISTIC ANALYSIS RESULTS 36
TABLE 12 – SUMMARY OF THE SIGNIFICANCE OF THE RECORDED VEGETATION UNITS 39
TABLE 13 – SUMMARY OF LEVEL OF POTENTIAL SIGNIFICANCE FOR THE RECORDED VEGETATION UNITS 40
TABLE 14 – PROJECT TEAM 42

EXECUTIVE SUMMARY

Focused Vision Consulting Pty Ltd (FVC) was commissioned by the Rottnest Island Authority (RIA) to undertake a flora and vegetation survey with particular emphasis on potential Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs), and Threatened or Priority flora of Rottnest Island (Wadjemup) within the South Thompson and Kingstown areas.

The scope of work included a single-phase, reconnaissance flora and vegetation survey during autumn, which assessed three areas, with associated reporting and data delivery. After this initial survey, it was decided that an addition single-phase, reconnaissance flora and vegetation survey was also required, which assessed an additional three areas during late-winter, with associated reporting and data-delivery.

These two single-phase, reconnaissance flora and vegetation field assessments were carried out in the survey area by experienced botanists on 2 May and 30 August 2022.

The key findings and conclusions arising from the flora and vegetation assessments within the survey area were as follows:

- No Threatened flora listed under the *Biodiversity Conservation Act 2016* (BC Act) or the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) were recorded.
- No Priority species listed by the Department of Biodiversity, Conservation and Attractions (DBCA) were recorded.
- No weeds listed as Weeds of National Significance (WoNS) or Declared Pest (DP) plants under the *Biosecurity and Agriculture Management Act 2007* (BAM Act) were recorded.
- The condition of the vegetation was found to range from 'Excellent' to 'Completely Degraded' with the greatest proportion in 'Good' and 'Degraded' condition.
- Nine vegetation units and four other classifications (Beach, Planted, Open Water and Cleared areas) were defined and mapped within the survey area.
- Two of the recorded vegetation units were determined to be characteristic of the State-listed *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands, Swan Coastal Plain Threatened Ecological Community (TEC) (*Callitris preissii - Melaleuca lanceolata* forests and woodlands TEC).
- The remaining extent of the one vegetation association (vegetation association 125) supported by the survey area falls below the 10% retention target in the context of the Swan Coastal Plain, and two vegetation associations relevant to the survey area represented by less than 30% of pre-European extent across the Swan Coastal Plain and Perth IBRA sub-region.
- Vegetation units MlAp and CpMl are considered to be representative of the State-listed *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands TEC (FCT 30a), and therefore, these units are considered to be of State significance.
- Rottnest Island (Wadjemup) is an A Class Reserve and an ESA, therefore all vegetation it supports is considered to be of State and regional significance.
- Vegetation units MlAp, CpMl, TiSS, LpAl and SlG are representative of pre-European vegetation associations and/or complexes that have less than 30% of their original extent remaining and are therefore considered regionally significant.
- Vegetation units CpMl occurs as a small, isolated community also being limited in its local extent and/or distribution, and is therefore considered locally significant.
- *Lepidium puberulum* (P4) has previously been recorded from one location within the survey area (DBCA 2022a). This species was not recorded to occur within the survey area despite extensive searching in the vicinity of the known recorded location. Further targeted surveys may be appropriate.

1 INTRODUCTION

The Rottnest Island Authority respects the Whadjuk people as the traditional custodians of Wadjemup (Rottnest Island).

1.1 BACKGROUND

Rottnest Island (Wadjemup) is governed by the *Rottnest Island Authority Act 1987* (RIA Act), which establishes the Rottnest Island Authority (RIA) as a statutory body to control and manage the island.

Focused Vision Consulting Pty Ltd (FVC) was commissioned by RIA for a targeted and reconnaissance flora and vegetation assessment, with particular emphasis on potential Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs), and Threatened or Priority flora within the South Thomson and Kingstown areas. The survey results may be utilised for future Environmental Impact Assessments (EIA) and therefore were required to be conducted as per the *Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016a).

1.2 LOCATION

The survey area is located within the South Thomson and Kingstown areas of Rottnest Island, an offshore island, approximately 18 kilometres (km) west of Fremantle. Rottnest Island (Wadjemup) is part of the City of Cockburn. The survey area, as shown in **Figure 1**, comprises of six individual areas, herein referred to as the survey area.

1.3 SCOPE OF WORK

The scope of work required to be fulfilled for the survey area was as follows:

- Flora and vegetation desktop assessment, in accordance with the *Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment* (Western Australian Environmental Protection Authority (EPA) 2016a)
- Undertake a field assessment survey, incorporating:
    - a reconnaissance assessment in accordance with EPA (2016a) across the full area extent/s of the initial survey area (autumn) and secondary survey area (late-winter) to identify, describe and map general flora species, vegetation communities and vegetation condition
    - opportunistic targeted survey for Threatened and Priority flora
    - determination of the presence of potential Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs) and mapping of their extent, with a particular focus on Floristic Community Type (FCT) 30a
- Prepare a report that presents the desktop and field assessment findings, prepared in accordance with EPA (2016a)
- Preparation of an Index of Biodiversity Surveys for Assessment (IBSA)-compliant package of spatial data.

0 250 500 750 m

GDA 94 / MGA Zone 50

Legend

Survey Area

Figure 1 - Survey Area

FOCUSED VISION consulting

RIA22001 14th September 2002

2 LEGISLATIVE CONTEXT

The flora and vegetation assessments were conducted in accordance with the following legislation:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- Western Australian *Environmental Protection Act 1986* (EP Act)
- Western Australian *Biodiversity Conservation Act 2016* (BC Act).

The assessments complied with the requirements for environmental survey and reporting in Western Australia, as outlined in:

- EPA (2008) *Guidance Statement No. 33: Environmental Guidance for Planning and Development*
- EPA (2016a) *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment*
- EPA (2016b) *Environmental Factor Guideline – Flora and Vegetation*.

Survey methodology guidance for targeted flora searches was also taken from:

- Commonwealth of Australia (2013) *Survey Guidelines for Australia's Threatened Orchids*.

2.1 THREATENED AND PRIORITY FLORA

The Department of Biodiversity, Conservation and Attractions (DBCA) assigns conservation status to endemic plant species that are geographically restricted to few known populations or threatened by local processes. Allocating conservation status to plant species assists in protecting populations and conserving species from potential threats (DBCA 2019).

The BC Act provides a statutory basis for the listing of threatened ecological communities (TECs), threatened and specially protected species, critical habitat and key threatening processes. Whilst not awarded any statutory protection, the DBCA maintains the Priority flora list, for species of conservation concern. Therefore, both Threatened and Priority flora are important focuses of flora and vegetation surveys and their definitions are presented in **Table 1**.

Table 1 - Definitions of Threatened and Priority Flora Species (DBCA 2019)

Conservation Code	Category
T	**Threatened Species** Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the BC Act. Threatened flora is that subset of 'Rare Flora' listed under schedules 1 to 3 of the Wildlife Conservation (Rare Flora) Notice for Threatened Flora.
P1	**Priority 1 – Poorly Known Species** Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
P2	**Priority 2 – Poorly Known Species** Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.
P3	**Priority 3 – Poorly Known Species** Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.
P4	**Priority 4 – Rare, Near Threatened and other species in need of monitoring** (a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for Vulnerable but are not listed as Conservation Dependent. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Under the EPBC Act, actions that have, or are likely to have, a significant impact on a matter of national environmental significance (MNES) require approval from the Federal Minister for the Environment. Species at risk of extinction are recognised as Threatened at a Commonwealth level and are categorised according to the EPBC Act as summarised in **Table 2**.

Table 2 - Categories of EPBC Act Threatened Flora Species

Conservation Code	Category
EX	**Extinct** Species where "there is no reasonable doubt that the last member of the species has died", and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).
EW	**Extinct in the Wild** Species that "is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form", and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act). Currently there are no threatened fauna or threatened flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.
CR	**Critically Endangered** Threatened species considered to be "facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for critically endangered fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for critically endangered flora.
EN	**Endangered** Threatened species considered to be "facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for endangered fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for endangered flora.
VU	**Vulnerable** Threatened species considered to be "facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for vulnerable fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for vulnerable flora.

Any species listed in State and Commonwealth legislation as being of conservation significance is broadly considered to be a significant species. This incorporates species that are endangered, vulnerable and rare or covered by international conventions. Significance is not limited to species covered by State and Commonwealth legislation that also includes species of local significance and species showing significant range extensions or at the edge of their known range.

2.2 THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES

TECs are naturally occurring biological assemblages that occur in a particular type of habitat, which are subject to processes that threaten to destroy or significantly modify the assemblage across its range (DEC 2007).

The Minister may list an ecological community as a TEC in one of the following categories: Presumed Totally Destroyed (PD), Critically Endangered (CR), Endangered (EN) or Vulnerable (VU). A publicly available database listing TECs within Western Australia (WA) is maintained by DBCA.

TECs in WA are protected under the State BC Act and some are also protected under the Commonwealth EPBC Act. The TECs on the Commonwealth register are also listed on the Department of Climate Change, Energy, the Environment and Water (DCCEEW) website, and in the Protected Matters Database (DCCEEW 2022a, 2022b).

Additional to TECs, ecological communities that are considered to be potentially of conservation significance (and potentially TECs) that do not currently meet survey criteria or that are not adequately defined, are rare but not threatened, have been recently removed from the TEC list or require regular monitoring, are considered to be Priority Ecological Communities (PECs) (DEC 2013) and are also required to be taken into consideration during environmental impact assessments (EPA 2016b).

2.3 VEGETATION OF SIGNIFICANCE

Alongside and in addition to significance according to statutory listings, vegetation may be considered significant at a National, State, regional or local level. Whilst not applicable to statutory protection, vegetation significance is an important consideration in the environmental impact assessment process.

2.3.1 Nationally Significant Vegetation

Vegetation communities may be considered to be of National significance where they support the following Commonwealth listed Matters of National Environmental Significance (MNES):

- Populations of Threatened (EPBC listed) species
- TECs listed as nationally (EPBC) significant
- RAMSAR Wetlands of International Importance (DCCEEW 2022a).

2.3.2 State Significant Vegetation

Vegetation communities may be considered to be of State significance where they:

- Support State listed Threatened flora, fauna and TECs afforded protection under the BC Act (EPA 2008, WALGA 2004)
- Occur within the State-managed conservation estate (areas protected under the *Conservation and Land Management Act 1984* (CALM Act)) or areas that have been formally recommended by DBCA for inclusion in the State conservation estate (EPA 2008).

2.3.3 Regionally Significant Vegetation

Vegetation communities may be considered to be of regional significance where they:

- Support populations of Priority Flora or ecological communities (EPA 2016b, Government of Western Australia 2000a)
- Are formally protected or recognised as Environmentally Sensitive Areas (ESAs), or under planning schemes for conservation, such as Bush Forever (EPA 2008, WALGA 2004)
- Support conservation category wetlands including associated vegetation (Government of Western Australia 2000a)
- Maintain important ecological processes (EPA 2016b)
- Contain flora species exhibiting range extensions and undescribed species (EPA 2016b)
- Have a restricted regional distribution (EPA 2016b)
- Are represented by less than 30% of their pre-European extent (Commonwealth of Australia 2001).

2.3.4 Locally Significant Vegetation

Vegetation communities may be considered to be locally significant where they:

- Occur as small, isolated communities (Government of Western Australia 2000b, WALGA 2004)
- Have a restricted local extent (proportion) (EPA 2016b) and/or are locally restricted to only one or a few locations (WALGA 2004).

2.4 VEGETATION CLEARING, EXTENT AND STATUS

Clearing of native vegetation is regulated in WA under the EP Act and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*. Any clearing of native vegetation is an offence, unless carried out under a clearing permit or if the clearing is for an exempt purpose (Department of Water and Environmental Regulation (DWER 2022). A clearing permit may be required under Part V of the EP Act, whereby permit applications to clear native vegetation must be assessed against the '10 Clearing Principles' as outlined in the regulations (DER 2019).

Where clearing of native vegetation is proposed to occur, there are several key criteria applied to the assessment of clearing permit applications, in the interests of biodiversity conservation (DER 2019).

The objective of the EPA in relation to flora and vegetation is 'to protect flora and vegetation so that biological diversity and ecological integrity are maintained' (EPA 2016a). This objective is documented in the EPA Factor Guideline - Flora and Vegetation (EPA 2016a). The EPA considers it is important that ecological communities are maintained above the threshold level of 30% of the original pre-clearing extent of the community in unconstrained areas and 10% within 'constrained' areas (EPA 2008).

2.5 ENVIRONMENTALLY SENSITIVE AREAS

Environmentally Sensitive Areas (ESAs) are areas that require special protection due to aspects such as landscape, fauna or historical value and are generally considered to be areas of high conservation value. ESAs are declared in the *Environmental Protection (Environmentally Sensitive Areas) Notice 2005*, which was gazetted on 8 April 2005 (Minister for the Environment 2005).

There are several types of ESAs relating to flora and vegetation, declared under Part V of the EP Act, which include:

- a defined wetland and the area within 50 m of that wetland
- the area covered by vegetation within 50 m of rare (Threatened) flora, to the extent where the vegetation is continuous with the vegetation in which the rare (Threatened) flora is located
- the area covered by a TEC
- Bush Forever sites.

2.6 INTRODUCED FLORA

Over 1,200 introduced (weed) species have been recognised to occur within Western Australia (EPA 2007). Weeds are plants that are not indigenous to an area and have been introduced either directly or indirectly through human activity. They establish in natural ecosystems and adversely modify natural processes, have the potential to dominate and simplify the ecosystems and thus decrease habitat value provided for native fauna. Weeds pose a threat to many native flora species due to their ability to rapidly grow and out-compete for available water, space, sunlight, and nutrients (EPA 2007).

2.6.1 Weeds of National Significance

Under the Australian Weed Strategy 2017-2027, there are currently 32 weed species listed as Weeds of National Significance (WoNS) (Commonwealth of Australia 2017). Each weed listed was considered for inclusion based on the following criteria:

- invasive tendencies
- impacts
- potential for spread
- socioeconomic and environmental values.

2.6.2 Declared Pest Plants

The Western Australian Organism List (WAOL) details organisms listed as Declared Pests, including pest plants, under the *Biosecurity and Agriculture Management Act 2007* (BAM Act) (Department of Primary Industries and Regional Development (DPIRD 2022)). Under the BAM Act, Declared Pests are listed under one of the following categories:

- **C1 (exclusion)**, that applies to pests not established in Western Australia; control measures are to be taken to prevent their entry and establishment
- **C2 (eradication)**, that applies to pests that are present in Western Australia but in low numbers or in limited areas where eradication is still a possibility
- **C3 (management)**, that applies to plants that should have some form of management applied that will alleviate the harmful impacts of the plant, reduce the numbers or distribution of the plant, or prevent or contain the spread of the plant (DPIRD 2017).

2.6.3 Environmental Weeds

Introduced species have also been ranked by a number of attributes, including invasiveness, distribution and environmental impacts in the various regions in the *Environmental Weed Strategy* (Department of Conservation and Land Management (CALM) 1999). To advance the above categorisation, the Invasive Plant Prioritisation Process for DBCA was developed in 2008 (DPAW 2013).

3 EXISTING ENVIRONMENT

3.1 CLIMATE

Rottnest Island (Wadjemup) has a temperate Mediterranean climate which is characterised by mild dry, warm summers and moderate seasonality. Rottnest Island (Site Number 009193) is one of the Bureau of Meteorology (BoM) meteorological recording stations, located approximately 4.5 km from the survey area and which has been recording since 1983. The site has recorded an average annual rainfall of 567.7 mm and annual mean maximum temperatures ranging from 17.8°C in winter to 27.3°C in summer (BoM 2022) (**Figure 2**). The summer months preceding the May field survey (January to March 2022), were recorded to be hotter and drier than the long-term average; however, the month prior to field survey (April) experienced average temperatures and 23.6 mm more rain than the monthly average (**Figure 2**). The three months preceding the August field survey (May to July 2022), recorded maximum temperatures similar to that of the long-term average while the months of May and June were wetter than average, receiving 58.1 mm more rainfall than the monthly average (**Figure 2**).

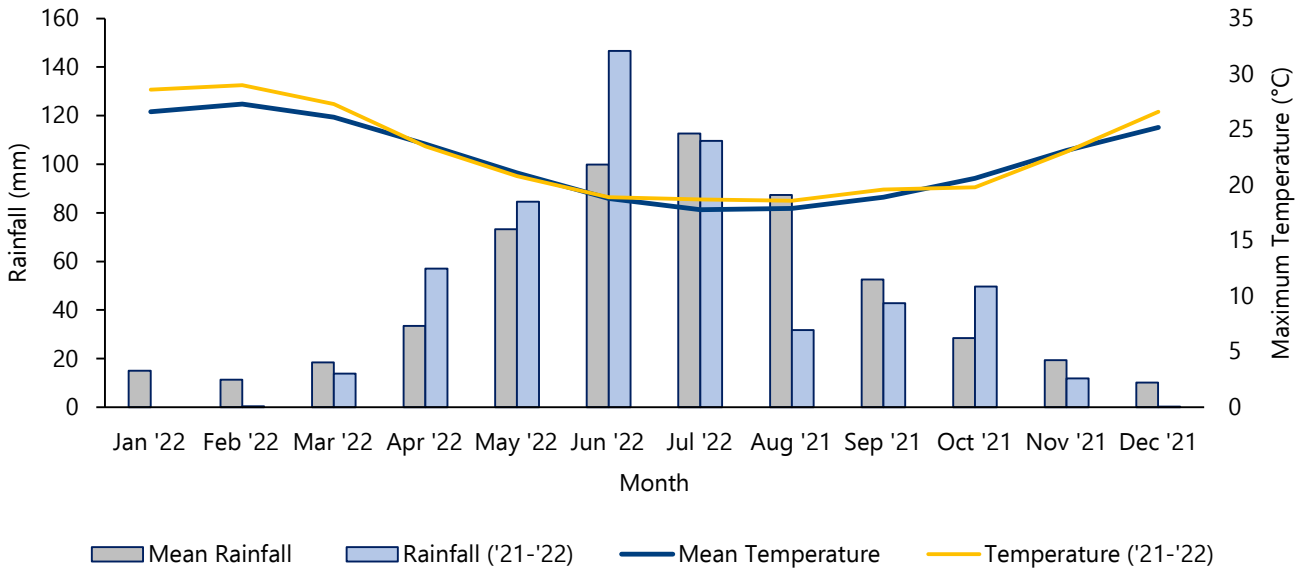

Figure 2 - Climate Data for Rottnest Island Weather Station (009193) (BoM 2022)

3.2 IBRA REGION

There are 89 recognised Interim Biogeographic Regionalisation for Australia (IBRA) regions across Australia that have been defined based on climate, geology, landforms and characteristic vegetation and fauna (DCCEEW 2022c). The survey area lies within the Swan Coastal Plain (SWA) IBRA region and, at a finer scale, within the Perth subregion (SWA2) (Mitchell *et al.* 2002).

The Swan Coastal Plain bioregion is a low lying coastal plain, mainly covered with Banksia and Tuart (*Eucalyptus gomphocephala*) woodlands on sandy soils. The Perth subregion is composed of colluvial and aeolian sands, alluvial river flats, coastal limestone, as well as heath and/or Tuart woodlands on limestone, Banksia and Jarrah (*Eucalyptus marginata*) - Banksia woodlands on Quaternary marine dunes of various ages, Marri (*Corymbia calophylla*) on colluvial and alluvials (Mitchell *et al.* 2002).

3.3 SOILS

The Swan Coastal Plain supports five major geomorphological systems (landforms) that lie parallel to the coast. From west to east these five systems include; the Quindalup Dunes, Spearwood Dunes, Bassendean Dunes, Pinjarra Plain and Ridge Hill Shelf (Churchward and McArthur 1980; Gibson *et al.* 1994). The survey area is situated on the Quindalup South System (211Qu) and developed from Tamala Limestone (Playford 1988) (**Table 3**). The spatial extent of this system is presented in **Figure 3**.

Table 3 - Summary of Soil Systems within the Survey Area (Schoknecht *et al.* 2004)

System	Soil Unit	Description
Quindalup South System	211Qu	Coastal dunes, of the Swan Coastal Plain, with calcareous deep sands and yellow sands. Vegetation consists of coastal scrub.

0 1 2 3 km

GDA 94 / MGA Zone 50

Legend

Survey Area

Quindalup South System

Figure 3 - Soils

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RIA22001 12 October 2022

3.4 VEGETATION

The survey area is located on the Swan Coastal Plain and has been broadly characterised by Beard (1990). The three Beard vegetation associations (15, 125 and 1007) supported by the survey area and the remaining extent across a range of contexts are presented in **Table 4** and spatially in **Figure 4**.

Table 4 - Pre-European Vegetation of the Survey Area (Beard 1990, DBCA 2018)

Extent Context	Vegetation System Association	Broad Vegetation Description	Pre-European Extent (Ha)	Current Extent (ha)	Pre-European Extent Remaining (%)	Current Extent in DBCA Managed Lands (%)
Western Australia	15	Low forest; cypress pine	2,374.16	1,576.52	66.40	37.34
	125	Bare areas; salt lakes	3,485,785.49	3,146,487.22	90.27	7.62
	1007	Mosaic Shrublands: *Acacia lasiocarpa* and *Melaleuca acerosa* Heath / *Acacia rostellifera* and *Acacia cyclops* thicket	30,407.75	20,691.11	68.05	10.04
Swan Coastal Plain IBRA Region	15	Low forest; cypress pine	17,364.58	3,150.77	18.14	2.11
	125	Bare areas; salt lakes	136,188.20	9,017.32	6.62	1.43
	1007	Mosaic Shrublands: *Acacia lasiocarpa* and *Melaleuca acerosa* Heath / *Acacia rostellifera* and *Acacia cyclops* thicket	30,109.89	20,679.62	68.68	10.13
Perth IBRA Subregion	15	Low forest; cypress pine	1,977.93	1,564.26	79.09	44.66
	125	Bare areas; salt lakes	9,401.12	1,948.17	20.72	11.70
	1007	Mosaic Shrublands: *Acacia lasiocarpa* and *Melaleuca acerosa* Heath / *Acacia rostellifera* and *Acacia cyclops* thicket	30,109.89	20,679.62	68.68	10.13
City of Cockburn	15	Low forest; cypress pine	1,353.14	886.49	65.51	65.51
	125	Bare areas; salt lakes	166.17	53.27	32.06	29.66
	1007	Mosaic Shrublands: *Acacia lasiocarpa* and *Melaleuca acerosa* Heath / *Acacia rostellifera* and *Acacia cyclops* thicket	337.86	271.35	80.32	80.32

Cells highlighted grey indicate vegetation associations with less than 30% extent remaining
Cell highlighted yellow indicates vegetation association with less than 10% extent remaining

Vegetation complexes within the survey area have also been defined by Heddle *et al.* (1980) and are based on vegetation in association with landforms and underlying geology. Only the Quindalup Complex occurs within the survey area and this complex is described as coastal dune consisting of two alliances; the strand and fore-dune alliance and the mobile and stable dune alliance. Local variations include the low, closed forest of *Melaleuca lanceolata* (Rottnest Teatree) - *Callitris preissii* (Rottnest Island Pine), the closed scrub of *Acacia rostellifera* (Summer-scented Wattle) and the low, closed *Agonis flexuosa* (Peppermint) forest of Geographe Bay. The pre-European extent and current known extent of this complex is listed in **Table 5**.

Table 5 – Vegetation Complexes Within the Survey Area (Heddle *et al.* 1980)

Extent Context	Vegetation Complex	Pre-European Extent (Ha)	Current Extent (ha)	Pre-European Extent Remaining (%)	Current Extent in DBCA Managed Lands (%)
Swan Coastal Plain	Quindalup Complex	54,573.87	33,011.64	60.49	10.98
City of Cockburn	Quindalup Complex	1,021.62	728.23	71.28	1.87

The objective of the EPA in relation to flora and vegetation is: *To protect flora and vegetation so that biological diversity and ecological integrity are maintained* (EPA 2016a). The EPA considers it is important that vegetation associations are maintained above a threshold level of 30% for unconstrained areas and 10% for constrained areas (which includes the Perth metropolitan area), of the original pre-clearing extent of each association (EPA 2008). A level of 30% pre-clearing extent is considered to be the level below which species loss appears to accelerate exponentially at the ecosystem level (EPA 2008).

The following key criteria are applied to vegetation clearing from a biodiversity perspective, which justifies the retention targets (EPA 2000):

- The 'threshold level' below which species loss appears to accelerate exponentially within an ecosystem level, is regarded as being at a level of 30% (of the pre-European, i.e. pre-1750 extent of the vegetation type)
- A level of 10% of the original extent of a vegetation community is regarded as being a level representing Endangered
- Clearing which would increase the threat level to a vegetation community should be avoided.

The remaining extent of all three Beard (1990) vegetation associations exceed the 30% threshold within Western Australia (**Table 4**). Within the Swan Coastal Plain IBRA region; vegetation associations 15 (Low forest; cypress pine) and 125 (Bare area; salt lakes) have remaining extents of 18.14% and 6.62%, respectively. This indicates that both associations fall below the 30% threshold and vegetation association 125 also falling below the 10% threshold. Within the Perth IBRA subregion, vegetation association 125 exhibits a remaining extent of 20.72%, not meeting the 30% threshold.

The remaining extent for the Heddle *et al.* (1980) Quindalup complex exceeds 30% threshold for the Swan Coastal Plain IBRA region and City of Cockburn extents (**Table 5**).

0 1 2 3 km

GDA 94 / MGA Zone 50

Legend

- Survey Area
- 1007
- 125
- 15

Figure 4 - Pre-European Vegetation

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RIA22001 12 October 2022

4 METHODOLOGY

4.1 DESKTOP REVIEW

The desktop assessment consisted of database searches for significant flora and ecological communities based on a central point within the survey area (115°32'49.9" E, 32°00'18.9" S) with a 5 km buffer, hereafter referred to as the desktop assessment area. Database searches included the DBCA Threatened and Priority flora records (DBCA 2022a), NatureMap (DBCA 2022b) (**Appendix A**), the Commonwealth DCCEEW Protected Matters Search Tool (PMST) (DCCEEW 2022b) for Matters of National Environmental Significance (MNES) (**Appendix B**) and the DBCA Threatened and Priority Ecological Communities records (DBCA 2022c).

The database search results were compiled into a table that concluded the likelihood of occurrence of each of the significant species and communities based on habitat preferences of known recorded locations for each species. The likelihood of all significant flora occurring within the survey area was assessed based on known records and their age (currency) and proximity to the survey area, and the presence of suitable habitat within the survey area. Based on this assessment, each species was given a likelihood of occurrence category of 'likely' to occur, 'may occur' or 'unlikely' to occur. Where recent records and suitable species habitat occurs within or near the survey area, these species were given a category of 'likely to occur', whilst species occurring a greater distance from the survey area with limited suitable habitat, or for very old records, a category of 'unlikely to occur' or 'may occur' was applied, depending on record relevance.

4.2 FIELD ASSESSMENT

A reconnaissance flora and vegetation field assessment was carried out within the survey area on 2 May 2022 by, Kellie Bauer-Simpson (Principal Ecologist) and Lisa Chappell (Senior Botanist) with a secondary reconnaissance field assessment carried out on 30 August 2022 by Kellie Bauer-Simpson (Principal Ecologist), Lisa Chappell (Senior Botanist) and Sarah Beckwith (Undergraduate Ecologist), in accordance with EPA guidelines (2016a).

Within areas that were considered to potentially be representative of TECs or PECs, targeted surveys were carried out via the sampling of quadrats where condition was 'Good' to 'Excellent'. During sampling, a temporary peg was installed to mark the north-west corner while marking out quadrats within measuring tapes, and when sampling was complete, the peg was removed. Quadrat dimensions were 10 m x 10 m in accordance with the Technical Guidance (EPA 2016a). Detailed data collection points (relevés) were recorded where vegetation was not considered to be a TEC or PEC and to inform vegetation mapping. During the survey, vegetation data from five quadrats and 13 relevés were recorded, with their locations visually represented in **Figure 5**.

The following information was collected at each quadrat and relevé:

- observer
- date
- GPS location (MGA94)
- representative photograph
- soil type and colour
- topography
- vegetation condition/degradation/disturbances (e.g. grazing, weed invasion, fire)
- flora species observed, including average height and projected foliage cover of dominant species within each stratum
- vegetation community, described in accordance with Level 5 of the National Vegetation Information System (NVIS) (DEH 2003)
- vegetation condition, assessed against the currently accepted scale; an adaptation of the Keighery (1994) condition scale.

Selective targeted searching for Threatened and Priority flora, TECs and PECs was carried out while traversing the survey areas, and track logs of all personnel were captured using GPS-enabled devices to demonstrate survey effort. These combined track logs for the survey area are presented in **Figure 6**.

The flora and vegetation data collected during the field assessments, from the combination of quadrats, relevés and continuous opportunistic observations, contributed to the flora inventory for the survey area. The vegetation units of the survey area have also been defined by data collected within quadrats and relevés and opportunistically between, and how they relate to other environmental features such as soil type and landform. A map of the vegetation units was then developed using GIS and is presented in **Section 5.2.2**.

Vegetation condition was assessed using the current bushland condition scale, which is an adaptation of Keighery (1994) scale, as described in EPA (2016a).

All field data was recorded using electronic tablets equipped with the mobile mapping software, Mappt™ and customised data collection forms, tailored to the electronic collection of quadrat data and targeted flora surveys. Draft vegetation unit and condition mapping were also prepared in shapefiles directly into Mappt™ whilst in the field, and this formed the basis of the mapping presented in this report and provided in spatial data.

Quadrat and relevé data was then subject to floristic analysis to detect similar vegetation within the survey area and also in comparison to relevant reference data (Gibson *et al.* 1994 and Keighery *et al.* 2012), in order to infer FCTs. The floristic analysis was first carried out for all quadrats sampled (batch analysis) and then for each quadrat individually (single site insertion (SSI)).

0 100 200 300 400 m

GDA 94 / MGA Zone 50

Legend

- Survey Area
- Quadrat
- Relevé

Figure 5 - Quadrat and Relevé Locations

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0 100 200 300 400 m

GDA 94 / MGA Zone 50

Legend

Survey Area

May 2022

August 2022

Figure 6 - Search Traverses

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RIA22001 12 October 2022

4.3 SURVEY LIMITATIONS

The current assessments were assessed against limitations imposed by many variables as outlined in the *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016a) (**Table 6**).

Table 6 – Potential Survey Limitations and Constraints

Aspect	Constraint?	Commentary
Availability of regional data, previously available information	No	A wealth of data, literature and other information is available for sites within the Perth metropolitan area, such as the survey area. DBCA database search results are evidence of the high volume of records that exist for the survey area and surrounds.
Scope (detail)	No	Out of season reconnaissance flora and vegetation assessments were carried out in accordance with EPA (2016a) during May and August 2022. The EPA Guidelines state that a minimum of three quadrats should be sampled in each vegetation unit considered to be of 'Good' or better condition. Five quadrats were sampled within vegetation in 'Good' or better condition and 13 relevés were sampled in areas of 'Degraded' or poorer condition vegetation. This level of survey detail was considered more than adequate for the assessment of floristic values.
Competency/Experience of personnel	No	All of the personnel leading the field assessments, and undertaking flora identifications, data analysis, vegetation mapping and reporting are experienced botanists, with specialist skills in their respective fields. All botanists have a minimum of 18 years' experience with a significant proportion of which have been on the Swan Coastal Plain.
Survey effort/detail/intensity	No	The field flora and vegetation field assessments were not conducted during the optimal spring survey season although the reconnaissance assessments were considered adequate to determine the floristic values within the survey area. Five quadrats were sampled within vegetation in 'Good' or better condition and 13 relevés were sampled in an area of 'Degraded' or poorer condition vegetation. Five quadrats and seven relevés were sampled in 8 May 2022, with six relevés sampled on 30 August 2022.
Seasonal timing and climatic conditions	Yes	The flora and vegetation field assessments were not conducted during the optimal spring season for biological surveys on the Swan Coastal Plain. It is considered that the number of species recorded, particularly annual species, would be higher if the survey was conducted during spring. Some annual species are less likely to be present outside their optimal survey period. In the months preceding the May field assessment, February (particularly) and March experienced drier and hotter seasonal conditions than average; however, April experienced 4 mm more rainfall than the average. The months preceding the August field survey, June (particularly) experienced 46.7 mm more rainfall than the average. These conditions, although variable from long-term averages, are generally representative of the Perth Metropolitan summer / autumn climatic conditions.
Access	No	The entire survey area was mostly easily accessible on foot (except where extremely dense) and was traversed in relatively good detail during May and August 2022.
Mapping reliability	No	The mapping has been prepared at a scale based on ground-truthed areas, with limited extrapolation given the good accessibility of the survey area. Therefore, mapping reliability is considered high.
Disturbances	No	Numerous tracks bisect the survey area, which have high foot and bicycle traffic, plus some vehicular access on suitable tracks. The disturbances are considered to be a minor constraint for the survey.
Survey completeness	No	Most areas were easily accessible and data and other information for the region is abundant. The field surveys for the current survey were all able to be completed for the entire survey area and in thorough detail.

5 RESULTS AND DISCUSSION

5.1 DESKTOP ASSESSMENT

5.1.1 Threatened and Priority Flora

The DBCA database search (incorporating Western Australian Herbarium (WAH) records), NatureMap Species Report and the DCCEEW PMST conducted for the survey area determined five species of Threatened and Priority flora that have the potential to occur on Rottnest Island (**Table 7**). The list of conservation significant species comprised one Commonwealth and State-listed Vulnerable (Threatened) flora, two Priority (P) 1 and two Priority 4 species, and all are annual or short-lived perennial species, emerging and flowering in spring.

Of these five species, four have been previously recorded on Rottnest Island, and have previous known locations within the survey area or within 3 km of the survey area (**Figure 7**). One species, *Lepidium puberulum* (P4) has been previously recorded within the survey area and is therefore 'likely' to occur. The remaining three species that have been previously recorded on the island were determined to 'possibly' occur, and the fifth species, not known to occur on the island, was determined to be 'unlikely' to occur.

Table 7 - Threatened and Priority Flora with the Potential to occur within the Survey Area

Species	EPBC Act Conservation Status	BC Act/DBCA Conservation Status	Description	Preferred Habitat	Likelihood of Occurrence	Source of Record
Diuris micrantha	Vulnerable	Vulnerable	Tuberous, perennial orchid growing to 0.3-0.6 m high with a basal tuft of narrow, linear leaves. Produces up to 7 yellow flowers with red-brown markings from August to October.	Brown/black sandy clay-loam and clayey soils. Winter-wet depressions and swamps, in shallow water.	**Unlikely**. Four previous records approx. 38 km SE of the survey area, on the mainland.	PMST
Lachnagrostis nesomytica subsp. *nesomytica*		Priority 1	Loosely tufted, annual or short-lived perennial grass growing to 0.2 m high. Produces purple-green flowers known from November (likely longer period).	Peat and loam soils. Edges of salt lakes, marshes and drainage areas.	**Possible**. Two previous records in possibly similar habitat within 2.8 km, W of the survey area.	DBCA, NatureMap
Lachnagrostis nesomytica subsp. *pseudofiliformis*		Priority 1	Loosely tufted, annual or short-lived perennial grass growing to 0.3-0.5 m high. Produces purple-green flowers, flowering period unknown.	Grey-brown sand, peaty soils. Coastal areas, edges of saline lakes on Garden Island.	**Possible**. Three previous records in likely similar habitat 700 m to 1.7 km W of the survey area.	DBCA, NatureMap
Lepidium puberulum		Priority 4	Erect annual herb growing to 0.4 m high. Produces greenish white flowers from July to November.	Sandy soil. Coastal areas, islands, often associated with limestone.	**Likely**. One previous record within the survey area.	DBCA, NatureMap
Myosotis australis		Priority 4	Erect to procumbent annual herb growing to 0.3 m high. Produces blue-white flowers from August to November.	Sandy soil. Coastal dunes and swales often associated with limestone.	**Possible**. Two previous records within 1.7 km SW from the survey area is possibly similar habitat.	DBCA/WAH, NatureMap

0 0.5 1 1.5 km

GDA 94 / MGA Zone 50

Legend

- Survey Area
- Lachnagrostis nesomytica subsp. nesomytica
- Lachnagrostis nesomytica subsp. pseudofiliformis
- Lepidium puberulum
- Myosotis australis

Figure 7 - DBCA Threatened and Priority Flora

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RIA22001 12 October 2022

5.1.2 Threatened and Priority Ecological Communities

A review of DBCA's Threatened and Priority Ecological Communities (TEC and PEC) database and the EPBC Protected Matters Search Tool identified that one TEC and six PECs occur within a 5 km buffer of the survey area (DBCA 2022c, DCCEEW 2022b) (**Table 8**). Of these, five are Microbial (Microbialites and microbial mat) communities and are not of conservation-significance due to flora and vegetation values; therefore, these communities are not discussed further in this report. The known extent of the two floristic communities of relevance to flora and vegetation values, SCP 30a and SCP 29a, are presented in **Figure 8**, and discussed further below in Section 5.1.2.1.

Table 8 – Threatened and Priority Ecological Communities Occurring within the Survey Area

Abbreviated Identifier	Community Name	Commonwealth Category	State Category
Floristic Communities			
SCP 30a	*Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands, Swan Coastal Plain (FCT 30a (Gibson *et al.* 1994))	-	Vulnerable
SCP29a	Coastal shrublands on shallow sands	-	Priority 3
Microbial Communities			
Rottnest Island Microbial - Garden	Microbialites and microbial mats of coastal hypersaline lakes (Rottnest Island). Community 5 - Garden Lake	-	Priority 1
Rottnest Island Microbial - Serpentine	Rottnest Island Microbial Lake community 1 - Serpentine Lake	-	Priority 1
Rottnest Island Microbial - Herschel	Microbialites and microbial mats of coastal hypersaline lakes (Rottnest Island). Community 6 - Herschel Lake	-	Priority 1
Rottnest Island Microbial - Baghdad	Microbialites and microbial mats of coastal hypersaline lakes (Rottnest Island); Lake Baghdad	-	Priority 1
Government House Lake Microbial	Hypersaline microbial community 1 (Government House Lake, Rottnest)	-	Priority 2

5.1.2.1 *SCP 30a – Callitris preissii (or Melaleuca lanceolata) Forests and Woodlands*

The Rottnest Island Pine (*Callitris preissii*) and Tea Tree (*Melaleuca lanceolata*) TEC (Rottnest Island Pine and Tea Tree TEC) is listed as 'Vulnerable' under State legislation and is described as a woodland and forest community dominated by *Callitris preissii*, *Melaleuca lanceolata*, *Spyridium globulosum*, *Acanthocarpus preissii*, *Rhagodia baccata*, *Austrostipa flavescens* and *Trachymene pilosa* (Gibson *et al.* 1994). The critical habitat for the Rottnest Island Pine and Tea Tree TEC includes the dunes and swale habitat on which they occur, the fresh superficial groundwater that is likely to provide water to the trees in the community, and the catchment for this groundwater (DPaW 2014).

5.1.2.2 *SCP 29a – Coastal Shrublands on Shallow Sands*

SCP 29a (Coastal Shrublands on Shallow Sands) supports shrublands on shallow sands over limestone, in close proximity to the coast, on the southern Swan Coastal Plain. Landforms are dunes from Supergroup 4; uplands centred on Spearwood and Quindalup Dunes (Gibson *et al.* 1994). Key species include *Spyridium globulosum, Rhagodia baccata* and *Olearia axillaris* (DBCA 2022c).

0 0.5 1 1.5 km

GDA 94 / MGA Zone 50

Legend

- Survey Area
- Callitris preissii (or Melaleuca lanceolata) forests and woodlands, Swan Coastal Plain
- Coastal shrublands on shallow sands

Figure 8 - Threatened and Priority Ecological Communities

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RIA22001 12 October 2022

5.2 FIELD ASSESSMENT

5.2.1 Flora

A total of 32 flora taxa, from 29 genera and 18 families was recorded during the field survey. The dominant families were found to be Poaceae (five taxa), Cyperaceae (four taxa), Chenopodiaceae (three taxa) and Myrtaceae (three taxa). The total includes 27 (84.38%) native species and five (15.63%) introduced (weed) species. The average species richness within quadrats was 5.6 species. Two species were recorded in 50% or more of the sample sites (quadrats and relevés), indicating a greater dominance and distribution compared to other species. These species were:

- *Acanthocarpus preissii* (recorded in 61.1% of sample sites)
- **Trachyandra divaricata* (recorded in 72.2% of sample sites).

The full list of vascular flora species recorded within each vegetation unit and at each sample site is presented in **Appendix C** and individual quadrat and relevé data is presented in **Appendix D**.

No species listed as Threatened or Priority flora under the BC Act or under the EPBC Act were recorded in the field assessment. All five of the potentially occurring Threatened and Priority flora resulting from the desktop assessment are annual or short-lived perennial species, emerging and flowering in spring, and would have been unlikely to be present/visible, flowering or presenting identifiable material at the time of the May field survey.

Lepidium puberulum (P4) has previously been recorded from one location within the survey area (DBCA 2022a). This species was not recorded to occur within the survey area for this assessment, despite extensive searching in the vicinity of the known recorded location. This annual herb species would only be observable during late winter and spring. Therefore, where clearing impacts may be proposed within areas of suitable habitat (sandy soils associated with limestone), further targeted surveys during late winter and spring may be appropriate.

None of the recorded flora are exhibiting an extension beyond their currently documented range, in accordance with records of the Western Australian Herbarium (WAH 1998-).

No taxa listed as Declared Pest [s22(2)] plants under the BAM Act (DPIRD 2022) were recorded. In addition, none of the weed species recorded are listed as WoNS (Commonwealth of Australia 2017).

5.2.2 Vegetation

5.2.2.1 *Vegetation Units*

Nine vegetation units and four other classifications (Beach, Planted, Open Water and Cleared areas) were defined and mapped within the survey area as described in **Table 9**. A large portion of the survey area (44%) consists of vegetation unit MlAp (*Melaleuca/Acanthocarpus* Woodland), and vegetation unit MlGl (*Melaleuca/Guichenotia* Shrubland) accounts for 22.79% of the survey area.

The remaining seven vegetation units account a total of 24.81% of the survey area. The three classifications (Beach, Planted and Cleared areas) occupy the remaining 8.4% of the survey area. The spatial extent of the varying vegetation units is presented in **Figure 9**.

Table 9 - Summary of Recorded Vegetation Units in the Survey Area

Broad Type	Vegetation Unit	Vegetation Description	Site Number	Area (ha)	% of Survey Area
Woodland	**MlAp** *Melaleuca/Acanthocarpus* Woodland	*Melaleuca lanceolata* Tall Shrubland over *Acanthocarpus preissii* Low Open Shrubland	Q03, Q06, Q08, Q11, R16	44.39	44.00
Shrubland	**ArAp** *Acacia/Acanthocarpus* Shrubland	*Acacia rostellifera* Tall Open Shrubland over *Acanthocarpus preissii* Low Shrubland over *Trachyandra divaricata* Low Sparse Forbland	R01	5.20	5.15
	CpMl *Callitris/Melaleuca* Shrubland	*Callitris preissii* and *Melaleuca lanceolata* Tall Shrubland	Q12	0.60	0.60
	MlGl *Melaleuca/Guichenotia* Shrubland	*Melaleuca lanceolata* and *Callitris preissii* Tall Sparse Shrubland over *Guichenotia ledifolia, Acanthocarpus preissii* and *Rhagodia baccata* Shrubland over *Trachyandra divaricata* Low Sparse Forbland	R02, R15	23.00	22.79
	OaAp *Olearia/Acanthocarpus* Shrubland	*Olearia axillaris* Tall Sparse Shrubland over *Acanthocarpus preissii* Low Open Shrubland	R05, R17	4.03	4.00
	TiSS *Tecticornia* Samphire Shrubland	*Tecticornia indica* subsp. *bidens* Low Samphire Shrubland	R09, R14	5.70	5.65
Sedgelands	**GtS** *Gahnia* Sedgeland	*Gahnia trifida* and *Ficinia nodosa* Tall Sedgeland	R04, R18	3.88	3.85
	LpAp *Lepidosperma/Acanthocarpus* Sedgeland	*Acanthocarpus preissii, Rhagodia baccata* and *Conostylis candicans* Low Open Shrubland over *Lepidosperma gladiatum* Open Sedgeland over *Trachyandra divaricata* Low Sparse Forbland	R07, R13	3.05	3.02
Grassland	**SlG** Spinifex Grassland	*Scaevola crassifolia* Low Open Shrubland over *Spinifex longifolius* Grassland	R10	2.56	2.54
Planted		Planted non-endemic species	NA	0.33	0.33
Beach			NA	0.83	0.83
Open Water			NA	0.62	0.61
Cleared			NA	6.69	6.63
			TOTAL	**100.88**	**100**

Figure 9 - Vegetation Units

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RIA22001 12 October 2022

5.2.2.2 *Vegetation Condition*

The condition of the vegetation within the survey area was found to range from 'Excellent' to 'Completely Degraded' with three other classifications (Beach, Open Water and Cleared) (**Table 10**). The greatest proportion of the vegetation (49.16%) was observed to be in either 'Good' condition (24.58%) or 'Degraded' condition (24.58%). The spatial extent of the varying vegetation condition is presented in **Figure 10**.

Table 10 - Summary Vegetation Condition within the Survey Area

Vegetation Condition Rating	Area (ha)	% of Survey Area
Excellent	1.02	1.01
Very Good - Excellent	0.06	0.06
Very Good	14.16	14.03
Good - Very Good	13.63	13.51
Good	24.79	24.58
Degraded - Good	6.52	6.46
Degraded	24.79	24.58
Completely Degraded - Degraded	5.84	5.79
Completely Degraded	1.92	1.91
Beach	0.84	0.83
Open Water	0.62	0.61
Cleared	6.69	6.63
Total	**100.88**	**100**

0 100 200 300 400 m

GDA 94 / MGA Zone 50

Legend

- Survey Area
- Excellent
- Very Good-Excellent
- Very Good
- Good-Very Good
- Good
- Degraded-Good
- Degraded
- Degraded-Completely Degraded
- Completely Degraded
- Beach
- Cleared
- Water

Figure 10 - Vegetation Condition

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RIA22001 12 October 2022

5.2.2.3 *Assessment of Floristic Community Types*

All vegetation units within the survey area were sampled and defined from a single relevé, unless they were suspected to be representative of the TEC, FCT 30a. Five quadrats were sampled in vegetation considered to be representative of FCT 30a, and in order to analyse the similarity between these quadrats, floristic analysis was carried out in PATN (Belbin 2013). This floristic analysis grouped four of the quadrats, with the fifth (Q12) determined to be floristically dissimilar, as shown in **Figure 11**.

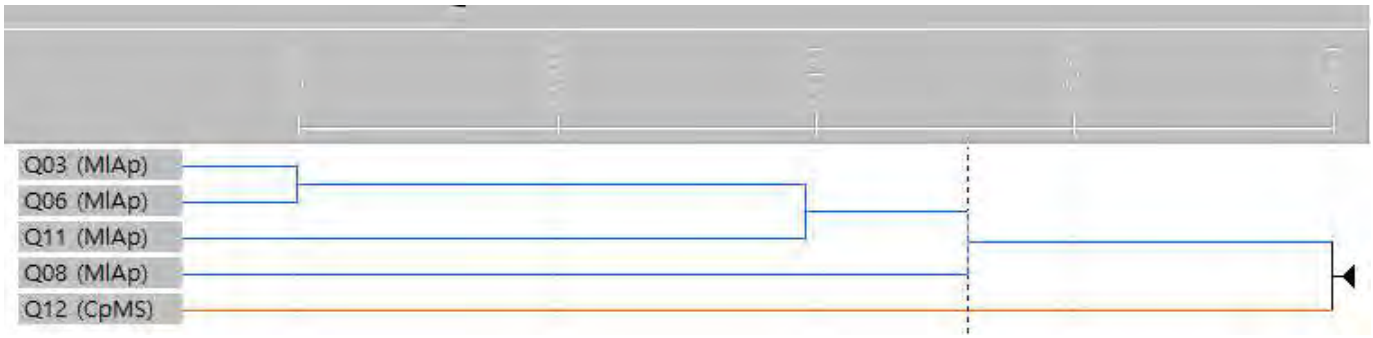

Figure 11 – Quadrat PATN Analysis Dendrogram

In order to then infer the FCT/s most likely represented by the sampled quadrats, floristic analysis was carried out, incorporating reference data from the Gibson *et al.* 1994 and Keighery *et al.* 2012 studies. The analysis was first conducted on the full suite of quadrats (batch analysis) and then via single site insertion (SSI,) utilising multivariate cluster analysis of species presence/absence in PATN. The dendrograms resulting from the analyses are presented in **Appendix E**, with these results and the results of dissimilarity analyses presented in **Table 11**.

The floristic analysis determined that all sampled quadrats, representative of vegetation units CpMl (one quadrat, *Callitris/Melaleuca* Shrubland) and MlAp (four quadrats) are likely representations of FCT 30a.

5.2.3 Threatened and Priority Ecological Communities

The TEC, *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands TEC (FCT 30a), has been previously reported to occur within the survey area (DBCA 2022c). The community, also known as the 'Rottnest Island Pine (*Callitris preissii*) and Rottnest Island Tea Tree (*Melaleuca lanceolata*) Woodland' is listed as a 'Vulnerable' TEC under State legislation (RIA 2014). This community is described as a woodland and forest dominated by *Callitris preissii, Melaleuca lanceolata, Spyridium globulosum, Acanthocarpus preissii, Rhagodia baccata*, *Austrostipa flavescens* and *Trachymene pilosa* (Gibson *et al.* 1994). Critical habitat for this community is the sandy soils on which the community occurs and the fresh superficial groundwater that helps to sustain key dominant trees (DPaW 2014).

The field survey and analyses carried out for all quadrats identified that vegetation units MlAp (*Melaleuca/Acanthocarpus* Woodland) and CpMl (*Callitris/Melaleuca* Shrubland) have the greatest similarity to FCT 30a (**Table 11**). A large proportion of the survey area (40.6% of the survey area was mapped as vegetation units MlAp and CpMl) (**Figure 9**) is therefore considered to be representative of the Vulnerable TEC, FCT 30a, *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands TEC.

Table 11 – Summary of Floristic Analysis Results

Vegetation Unit	Quadrat	Vegetation Condition	SSI Dendrogram Result*	Ref. Quadrat	FCT	Dissimilarity Value	Ref. Quadrat	FCT	Dissimilarity Value	Ref. Quadrat	FCT	Dissimilarity Value	Inferred FCT	Reasoning
CpMI *Callitris/ Melaleuca* SL	Q12	Very Good	30a, 30a2, S12	rott01	S11	0.6842	WOODP-1	30a	0.6842	WOODP-1	30a	0.6842	30a	Gibson *et al.* (1994) and Keighery *et al.* (2012) quadrats analysed present the same dissimilarity value in comparison to Q12. FCT S11 did not record a dominant species of Q12, *Callitris preissii* and is dominated by *Melaleuca acerosa,* which was absent from Q12. S12 is a sub-type of FCT 30a (DPaW 2014). Key/dominant species of Q12 and FCT 30a align. Greatest similarity to **FCT 30a**.
MIAp *Melaleuca/ Acanthocarpus* Woodland	Q03	Good - Very Good	S12, 29a, S11, 30a	rott01	S11	0.6471	GARD04	30a	0.7273	GARDEN -4	30a2	0.7273	30a	S11 is 'Northern *Acacia rostellifera – Melaleuca acerosa* shrublands', whilst FCT 30a is '*Callitris preissii* (or *Melaleuca lanceolata*) forest and woodlands'. Q03 does not contain *Acacia rostellifera* or *Melaleuca acerosa* and is therefore not considered representative of FCT S11. Based on the height and cover of canopy species, the vegetation is considered to be a Woodland or forest. FCT 29a is a shrubland, lacking the woodland canopy layer present in Q03. S12 is a sub-type of FCT 30a (DPaW 2014). Key/dominant species of Q03 and FCT 30a align. Greatest similarity to **FCT 30a**.
	Q06	Very Good	S12, S11, 29a, 30a	rott01	S11	0.5789	rott03	S12	0.6800	GARD01	30a1	0.6923	30a	S11 is 'Northern *Acacia rostellifera – Melaleuca acerosa* shrublands' and both species are absent from Q06. Based on the height and cover of canopy species, the vegetation is considered to be a woodland or forest. FCT 29a is a shrubland, lacking the woodland canopy layer present in Q06. S12 is a sub-type of FCT 30a (DPaW 2014). Key/dominant species of Q06 and FCT 30a align. Greatest similarity to **FCT 30a**.
	Q08	Good - Very Good	S19, 18, 7	rott01	S11	0.7778	rott06	S12	0.7778	cool 04	17	0.8182	30a	S11 is 'Northern *Acacia rostellifera – Melaleuca acerosa* shrublands' and Q08 did not record either species. *Melaleuca lanceolata,* dominant in Q08 does not occur within FCT 17. S12 is a sub-type of FCT 30a (DPaW 2014). Key/dominant species of Q08 do not align with S19 or FCTs 7 or 18 but do align with FCT 30a. Greatest similarity to **FCT 30a**.
	Q11	Very Good	S11, S12, 30a	rott01	S11	0.5556	MI11	13	0.7273	GARD04	30a2	0.7391	30a	S11 is 'Northern *Acacia rostellifera – Melaleuca acerosa* shrublands' and both species are absent from Q13. FCT 13 is a wetland with key dominant species that do not align with Q13. S12 is a sub-type of FCT 30a (DPaW 2014). Key/dominant species of Q13 and FCT 30a align. Greatest similarity to **FCT 30a**.

5.3 VEGETATION OF SIGNIFICANCE

5.3.1 Nationally Significant Vegetation

The National significance of the vegetation units was assessed based on presence of:

- populations of Threatened (EPBC listed) species
- TECs listed as nationally (EPBC) significant
- Ramsar Wetlands of International Importance (DAWE 2022).

5.3.1.1 *Threatened Flora*

No EPBC-listed Threatened flora were recorded within the survey area and therefore, none of the recorded vegetation units are of significance due to this factor.

5.3.1.2 *Threatened Ecological Communities*

No EPBC-listed TECs are considered to occur within the survey area. Therefore, none of the defined vegetation units are considered to be of National Significance due to this factor.

5.3.1.3 *Ramsar Wetlands*

No Ramsar wetlands occur within the survey area and therefore, none of the recorded vegetation units are of significance due to this factor.

5.3.2 State Significant Vegetation

The State significance of the vegetation units was assessed based on presence of:

- State-listed Threatened flora
- State-listed TECs
- land within (or areas recommended by DBCA for inclusion) the State-managed conservation estate.

5.3.2.1 *Threatened Flora*

No State-listed Threatened flora were recorded within the survey area and therefore, none of the recorded vegetation units are of significance due to this factor.

5.3.2.2 *TECs*

Two of the defined unit, MlAp and CpMl, were considered to be representative of or form part of a State-listed TEC (*Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands TEC). Therefore, these vegetation units are considered to be State significance due to this factor.

5.3.2.3 *Conservation Estate*

Rottnest Island (Wadjemup) is an A Class Reserve. Therefore, all recorded vegetation units which occupy the reserve are considered to be of State significance due to this factor.

5.3.3 Regionally Significant Vegetation

The regional significance of the vegetation units was assessed based on:

- the presence of populations of Priority flora or ecological communities
- the presence of ESAs or areas relevant to a conservation scheme
- the presence of conservation category wetlands
- the presence of high diversity of flora, fauna, communities, or community structure
- the presence of flora species exhibiting range extensions or undescribed species
- having a restricted regional distribution
- being represented by less than 30% of the pre-European extent.

5.3.3.1 *Priority Flora*

No State-listed Priority flora were recorded within the survey area and therefore, none of the recorded vegetation units are of significance due to this factor.

5.3.3.2 *Priority Ecological Communities*

No DBCA listed PECs are considered to occur within the survey area. Therefore, none of the defined units are considered significant to be of regional significance due to this factor.

5.3.3.3 *ESAs or Conservation Areas*

Rottnest Island (Wadjemup) is an A Class Reserve, which is therefore an ESA. Therefore, all recorded vegetation units which occupy the reserve are considered to be of regional significance due to this factor.

5.3.3.4 *Conservation Category Wetlands*

No conservation category wetlands occur within the survey area. Therefore, none of the defined vegetation units are considered to be of regional significance due to this factor.

5.3.3.5 *High Diversity*

The mean species richness across all quadrats within vegetation units with an affinity for FCT 30a (MlAp and CpMl) was 5.6 species. In comparison to the mean species richness that was recorded by Gibson *et al.* (1994) for FCT SCP 30a, 21.1 species, the recorded species richness values for this assessment are considered low in comparison.

Of the total 32 species recorded, 15.63% are weeds. The diversity of native taxa recorded within quadrats is not considered high; however, surveying outside of the optimal spring season is likely to have resulted in fewer species (e.g. annuals) being present. None of the recorded vegetation units are considered to exhibit high diversity and are therefore not considered to be of regional significance due to this factor.

5.3.3.6 *Range Extending/Undescribed Flora*

No undescribed or range extending flora species were recorded within the survey area. Therefore, none of the defined units are considered significant to be of regional significance due to this factor.

5.3.3.7 *Restricted Regional Representation and Distribution*

Beard (1990) vegetation association 125 is represented by 9,017.32 ha across the Swan Coastal Plain and 1,948.17 ha across the Perth IBRA sub-region, which is considered to be restricted in its representation. However, no areas of vegetation association 125 intersect the survey area, and therefore, the none of the recorded vegetation units, are considered to be of regional significance due to this factor.

5.3.3.8 *Extent Remaining*

The Beard (1990) vegetation associations 125 and 15 represented within the survey area fall below the unconstrained (30%) threshold, with association 125 also falling below the constrained (10%) threshold for retention in comparison to their pre-European extent. Therefore, vegetation units MlAp and CpMl, representative of the 'Low forest cypress pine', association 15 and vegetation units LpAp, TiSS and GtS, representative of the 'Bare areas; salt lakes', association 125 are considered to be of regional significance due to this factor.

5.3.4 Locally Significant Vegetation

The local significance of the vegetation units was assessed based on:

- representing small, isolated communities
- their local extent (proportion) and distribution.

5.3.4.1 *Small, Isolated Communities*

Vegetation units CpMl occur as a small, isolated community within the survey area and is considered locally significant due to this factor.

5.3.4.2 *Locally Limited Extent and Distribution*

The vegetation unit CpMl (*Callitris/ Melaleuca* Shrubland) occupies a small portion (≤1%) of the survey area covering an extent of 0.6% (0.6 ha). This vegetation unit is considered limited in its local extent and distribution and is considered locally significant due to this factor.

5.3.5 Summary of Vegetation Significance

The significance of the vegetation units within the survey area, along with the aspects determining their significance, are summarised in **Table 12**. The level of significance for each vegetation unit is broadly summarised in **Table 13**.

Table 12 – Summary of the Significance of the Recorded Vegetation Units

Scale	Significance Aspect	Vegetation Units
National Significance	Populations of Threatened (EPBC listed) species	-
	Presence of EPBC listed TECs	-
	Presence of Ramsar wetlands	-
State Significance	Presence of State-listed Threatened flora	-
	Presence of State-listed TECs	MlAp, CpMl
	Land within the Conservation Estate	MlAp, ArAp, CpMl, MlGl, OaAp, TiSS, GtS, LpAp, SlG
Regional Significance	Presence of Priority flora	-
	Presence of PECs	-
	Presence of ESAs or areas relevant to a conservation scheme	MlAp, ArAp, CpMl, MlGl, OaAp, TiSS, GtS, LpAp, SlG
	Presence of conservation category wetlands	-
	High diversity of flora, fauna, communities, or community structure	-
	Presence of flora species exhibiting a range extension	-
	Presence of undescribed flora	-
	Having a restricted regional representation and distribution	-
	Represented by less than 30% of the pre-European extent	MlAp, CpMl, TiSS, GtS, LpAp,
Local Significance	Small, isolated communities	CpMl
	Having a limited local extent and/or distribution	CpMl

Table 13 – Summary of Level of Potential Significance for the Recorded Vegetation Units

Vegetation Unit	Overall Significance – Factor of Significance	Area (ha)	% of Survey Area
MlAp *Melaleuca/ Acanthocarpus* Woodland	State significance – Presence of State-listed TEC State significance – Land within the Conservation Estate Regional significance – within an ESA Regional significance – Represented by <30% of pre-European extent	44.39	44.00
ArAp *Acacia/Acanthocarpus* Shrubland	State significance – Land within the Conservation Estate Regional significance – within an ESA	5.20	5.15
CpMl *Callitris/Melaleuca* Shrubland	State significance – Presence of State-listed TEC State significance – Land within the Conservation Estate Regional significance – within an ESA Regional significance – Represented by <30% of pre-European extent Local significance – occurring as a small, isolated community Local significance – limited local extent and/or distribution	0.60	0.60
MlGl *Melaleuca/ Guichenotia* Shrubland	State significance – Land within the Conservation Estate Regional significance – within an ESA	23.00	22.79
OaAp *Olearia/ Acanthocarpus* Shrubland	State significance – Land within the Conservation Estate Regional significance – within an ESA	4.03	4.00
TiSS *Tecticornia* Samphire Shrubland	State significance – Land within the Conservation Estate Regional significance – within an ESA Regional significance – Represented by <30% of pre-European extent	5.70	5.65
GtS *Gahnia* Sedgeland	State significance – Land within the Conservation Estate Regional significance – within an ESA	3.88	3.85
LpAp *Lepidosperma/ Acanthocarpus* Sedgeland	State significance – Land within the Conservation Estate Regional significance – within an ESA Regional significance – Represented by <30% of pre-European extent	3.05	3.02
SlG Spinifex Grassland	State significance – Land within the Conservation Estate Regional significance – within an ESA Regional significance – Represented by <30% of pre-European extent	2.56	2.54
Planted		0.33	0.33
Beach		0.83	0.83
Open Water		0.62	0.61
Cleared		6.69	6.63
	TOTAL	**100.88**	**100**

6 CONCLUSIONS

The key findings and conclusions arising from the flora and vegetation assessment within the survey area:

- No Threatened flora listed under the BC Act or the EPBC Act were recorded.
- No Priority species as listed by DBCA were recorded.
- No weeds listed as WoNS or DP plants under the BAM Act were recorded.
- The condition of the vegetation was found to range from 'Excellent' to 'Completely Degraded - Degraded' with the greatest proportion in 'Good' or 'Degraded' condition.
- Nine vegetation units and four other classifications (Beach, Planted, Open Water and Cleared areas) were defined and mapped within the survey area.
- Two of the recorded vegetation units were determined to be characteristic of the State-listed *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands TEC (FCT 30a).
- The remaining extent of the one vegetation association (vegetation association 125) supported by the survey area falls below the 10% retention target in the context of the Swan Coastal Plain, and two vegetation associations relevant to the survey area represented by less than 30% of pre-European extent across the Swan Coastal Plain and Perth IBRA sub-region.
- Vegetation units MlAp and CpMl are considered to be representative of the State-listed *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands TEC (FCT 30a), and therefore, these units are considered to be of State significance.
- Rottnest Island (Wadjemup) is an A Class Reserve and an ESA, therefore all vegetation it supports is considered to be of State and regional significance.
- Vegetation units MlAp, CpMl, TiSS, LpAl and SlG are representative of pre-European vegetation associations and/or complexes that have less than 30% of their original extent remaining and are therefore considered regionally significant.
- Vegetation units CpMl occurs as a small, isolated community also being limited in its local extent and/or distribution, and is therefore considered locally significant.
- *Lepidium puberulum* (P4) has previously been recorded from one location within the survey area (DBCA 2022a). This species was not recorded to occur within the survey area despite extensive searching in the vicinity of the known recorded location. Further targeted surveys may be appropriate.

7 LIST OF PARTICIPANTS

The personnel who contributed to the project are summarised in **Table 14**.

Table 14 – Project Team

Name	Qualification	Years of Relevant Experience	Role
Kellie Bauer–Simpson Principal Ecologist	BSc. (Biological Science)	23	Project manager, field assessment, flora identification, technical and authorisation review
Lisa Chappell Senior Botanist/Environmental Scientist	BEnvSc. (Hons) (Environmental Science)	19	Field assessment, data management, floristic analysis, GIS mapping, report preparation
Olga Nazarova Botanist/Taxonomist	BSc. (Botany and Genetics)	4	Flora identifications support, technical support, report preparation
Megan Gray Ecologist	BSc. (Environmental Biology)	3	Report preparation
Kelly Hopkinson Graduate Ecologist	BSc. (Biological Science and Conservation Biology)	1	Report preparation
Kristen Bleby Senior Ecologist	BSc. (Natural Resource Management) (Hons), PhD (Wildlife Ecology)	8	Report review
Sarah Beckwith Undergraduate Ecologist		0.5	Field survey, data entry
Will Bauer–Simpson Technician	Cert IV (Health and Safety)	10	Field safety and logistics planning, GIS mapping, spatial analysis, spatial data management
Megan Rabadan Administration		5	Data entry, editorial support

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APPENDIX A - DBCA NATURE MAP SEARCH REPORT

Life Form	Taxon	WA Cons Code
DICOT	*Acacia aptaneura*	
DICOT	*Acacia cyclops*	
DICOT	*Acacia lasiocarpa* var. *lasiocarpa* cockleshell gully variant (E.A. Griffin 2039)	
DICOT	*Acacia littorea*	
DICOT	*Acacia rostellifera*	
DICOT	*Acacia truncata*	
DICOT	*Acrotriche cordata*	
DICOT	*Agonis flexuosa* var. *flexuosa*	
DICOT	*Alyxia buxifolia*	
DICOT	*Angianthus cunninghamii*	
DICOT	*Angianthus preissianus*	
DICOT	*Apium annuum*	
DICOT	*Arctotheca calendula*	
DICOT	*Arctotheca populifolia*	
DICOT	*Arenaria leptoclados*	
DICOT	*Argyranthemum frutescens*	
DICOT	*Atriplex cinerea*	
DICOT	*Atriplex isatidea*	
DICOT	*Atriplex rhagodioides*	
DICOT	*Atriplex sp.*	
DICOT	*Beyeria viscosa*	
DICOT	*Boronia alata*	
DICOT	*Caesalpinia gilliesii*	
DICOT	*Cakile maritima*	
DICOT	*Cakile maritima* Scop. subsp. *maritima*	
DICOT	*Calandrinia brevipedata*	
DICOT	*Calandrinia tholiformis*	
DICOT	*Callitriche stagnalis*	
DICOT	*Canarium mutabile*	
DICOT	*Cardamine hirsuta*	
DICOT	*Carduus pycnocephalus*	
DICOT	*Carpobrotus virescens*	
DICOT	*Cassytha glabella*	
DICOT	*Casuarina equisetifolia*	
DICOT	*Casuarina glauca*	
DICOT	*Casuarina obesa*	
DICOT	*Centaurea melitensis*	
DICOT	*Centaurium erythraea*	
DICOT	*Centaurium pulchellum*	
DICOT	*Centaurium tenuiflorum*	
DICOT	*Cerastium balearicum*	
DICOT	*Cerastium glomeratum*	
DICOT	*Chenopodium murale*	
DICOT	*Cirsium vulgare*	
DICOT	*Clematis linearifolia*	
DICOT	*Clematis microphylla*	
DICOT	*Comesperma confertum*	

Life Form	Taxon	WA Cons Code
DICOT	*Comesperma integerrimum*	
DICOT	*Conyza bonariensis*	
DICOT	*Conyza parva*	
DICOT	*Conyza sumatrensis*	
DICOT	*Cotula australis*	
DICOT	*Cotula bipinnata*	
DICOT	*Cotula coronopifolia*	
DICOT	*Crassula colorata*	
DICOT	*Crassula colorata* var. *colorata*	
DICOT	*Crassula decumbens*	
DICOT	*Crassula decumbens* var. *decumbens*	
DICOT	*Crassula glomerata*	
DICOT	*Crassula natans* var. *minus*	
DICOT	*Crassula thunbergiana* subsp. *thunbergiana*	
DICOT	*Cymbalaria muralis*	
DICOT	*Daucus glochidiatus*	
DICOT	*Dichondra repens*	
DICOT	*Diplolaena dampieri*	
DICOT	*Diplotaxis muralis*	
DICOT	*Dischisma arenarium*	
DICOT	*Dittrichia graveolens*	
DICOT	*Dodonaea aptera*	
DICOT	*Drosera ramellosa*	
DICOT	*Drosera stolonifera* subsp. *stolonifera*	
DICOT	*Enchylaena tomentosa* var. *tomentosa*	
DICOT	*Eremophila glabra*	
DICOT	*Eremophila glabra* subsp. *albicans*	
DICOT	*Erodium cicutarium*	
DICOT	*Erythrostemon gilliesii*	
DICOT	*Eucalyptus camaldulensis*	
DICOT	*Eucalyptus camaldulensis* subsp. *obtusa*	
DICOT	*Eucalyptus decipiens*	
DICOT	*Eucalyptus erythrocorys*	
DICOT	*Eucalyptus gomphocephala*	
DICOT	*Eucalyptus spathulata*	
DICOT	*Eucalyptus utilis*	
DICOT	*Euphorbia paralias*	
DICOT	*Euphorbia peplus*	
DICOT	*Ficus carica*	
DICOT	*Ficus elastica*	
DICOT	*Ficus macrophylla*	
DICOT	*Ficus microcarpa* subsp. *hillii*	
DICOT	*Ficus rubiginosa*	
DICOT	*Frankenia pauciflora*	
DICOT	*Galium murale*	
DICOT	*Gamochaeta calviceps*	
DICOT	*Geranium molle*	
DICOT	*Gnaphalium indutum*	
DICOT	*Gnaphalium indutum* subsp. *indutum*	

Life Form	Taxon	WA Cons Code
DICOT	*Gomphocarpus fruticosus*	
DICOT	*Gonocarpus pithyoides*	
DICOT	*Guichenotia ledifolia*	
DICOT	*Halosarcia halocnemoides* subsp. *halocnemoides*	
DICOT	*Halosarcia indica* subsp. *bidens*	
DICOT	*Hardenbergia comptoniana*	
DICOT	*Hedypnois rhagadioloides*	
DICOT	*Hedypnois rhagadioloides* subsp. *cretica*	
DICOT	*Heliophila pusilla*	
DICOT	*Heliotropium curassavicum*	
DICOT	*Hemichroa pentandra*	
DICOT	*Hibbertia racemosa*	
DICOT	*Hornungia procumbens*	
DICOT	*Hydrocotyle blepharocarpa*	
DICOT	*Hydrocotyle diantha*	
DICOT	*Hydrocotyle hispidula*	
DICOT	*Hydrocotyle* sp. Hamelinensis (G.J. Keighery s.n. PERTH 02391325)	
DICOT	*Hydrocotyle tetragonocarpa*	
DICOT	*Hypochaeris glabra*	
DICOT	*Lagunaria patersonia*	
DICOT	*Leontodon rhagadioloides*	
DICOT	*Lepidium didymum*	
DICOT	*Lepidium foliosum*	
DICOT	*Lepidium puberulum*	P4
DICOT	*Leptorhynchos scaber*	
DICOT	*Leucophyta brownii*	
DICOT	*Leucopogon insularis*	
DICOT	*Leucopogon parviflorus*	
DICOT	*Lobelia anceps*	
DICOT	*Lycium ferocissimum*	
DICOT	*Lycopersicon esculentum*	
DICOT	*Lysiana casuarinae*	
DICOT	*Lysimachia arvensis*	
DICOT	*Malva arborea*	
DICOT	*Malva parviflora*	
DICOT	*Malva preissiana*	
DICOT	*Medicago polymorpha*	
DICOT	*Medicago sativa*	
DICOT	*Melaleuca armillaris*	
DICOT	*Melaleuca huegelii*	
DICOT	*Melaleuca lanceolata*	
DICOT	*Melaleuca nesophila*	
DICOT	*Melia azedarach*	
DICOT	*Melianthus major*	
DICOT	*Melilotus indicus*	
DICOT	*Mesembryanthemum crystallinum*	
DICOT	*Millotia myosotidifolia*	
DICOT	*Minuartia mediterranea*	
DICOT	*Myoporum caprarioides*	

Life Form	Taxon	WA Cons Code
DICOT	*Myoporum insulare*	
DICOT	*Myosotis australis*	P4
DICOT	*Nerium oleander*	
DICOT	*Nicotiana glauca*	
DICOT	*Nitraria billardierei*	
DICOT	*Olea europaea*	
DICOT	*Olearia axillaris*	
DICOT	*Orobanche minor*	
DICOT	*Oxalis corniculata*	
DICOT	*Oxalis exilis*	
DICOT	*Oxalis pes-caprae*	
DICOT	*Parentucellia latifolia*	
DICOT	*Parietaria cardiostegia*	
DICOT	*Parietaria debilis*	
DICOT	*Pelargonium capitatum*	
DICOT	*Pelargonium littorale*	
DICOT	*Phyllangium divergens*	
DICOT	*Phyllanthus calycinus*	
DICOT	*Pithocarpa cordata*	
DICOT	*Pittosporum ligustrifolium*	
DICOT	*Plantago debilis*	
DICOT	*Plantago exilis*	
DICOT	*Plantago lanceolata*	
DICOT	*Podotheca angustifolia*	
DICOT	*Polycarpon tetraphyllum*	
DICOT	*Poranthera drummondii*	
DICOT	*Portulaca oleracea*	
DICOT	*Ranunculus pumilio*	
DICOT	*Ranunculus pumilio* var. *politus*	
DICOT	*Raphanus raphanistrum*	
DICOT	*Reseda alba*	
DICOT	*Reseda luteola*	
DICOT	*Rhagodia baccata*	
DICOT	*Rhagodia baccata* subsp. *baccata*	
DICOT	*Rhagodia baccata* subsp. *dioica*	
DICOT	*Rhamnus alaternus*	
DICOT	*Rhodanthe citrina*	
DICOT	*Ricinus communis*	
DICOT	*Roepera billardierei*	
DICOT	*Roepera similis*	
DICOT	*Sagina apetala*	
DICOT	*Sagina maritima*	
DICOT	*Salicornia blackiana*	
DICOT	*Salicornia quinqueflora*	
DICOT	*Salicornia* sp.	
DICOT	*Salsola australis*	
DICOT	*Samolus repens*	
DICOT	*Samolus repens* (J.R.Forst. & G.Forst.) Pers. var. *repens*	
DICOT	*Sarcocornia quinqueflora*	

Life Form	Taxon	WA Cons Code
DICOT	*Sarcocornia quinqueflora* (Bunge ex Ung.-Sternb.) A.J.Scott subsp. *quinqueflora*	
DICOT	*Scaevola crassifolia*	
DICOT	*Schenkia australis*	
DICOT	*Schinus terebinthifolius*	
DICOT	*Scholtzia involucrata*	
DICOT	*Senecio lautus* subsp. *maritimus*	
DICOT	*Senecio pinnatifolius* var. *latilobus*	
DICOT	*Senecio pinnatifolius* var. *maritimus*	
DICOT	*Silene nocturna*	
DICOT	*Sisymbrium orientale*	
DICOT	*Solanum lycopersicum*	
DICOT	*Solanum nigrum*	
DICOT	*Solanum symonii*	
DICOT	*Sonchus asper*	
DICOT	*Sonchus oleraceus*	
DICOT	*Spergularia brevifolia*	
DICOT	*Spyridium globulosum*	
DICOT	*Stackhousia pubescens*	
DICOT	*Stellaria media*	
DICOT	*Stellaria pallida*	
DICOT	*Stylidium androsaceum*	
DICOT	*Suaeda australis*	
DICOT	*Tamarix aphylla*	
DICOT	*Tamarix* sp.	
DICOT	*Tecoma stans*	
DICOT	*Tecticornia halocnemoides*	
DICOT	*Tecticornia indica* subsp. *bidens*	
DICOT	*Templetonia retusa*	
DICOT	*Tetragonia amplexicoma*	
DICOT	*Tetragonia decumbens*	
DICOT	*Tetragonia implexicoma*	
DICOT	*Thomasia cognata*	
DICOT	*Threlkeldia diffusa*	
DICOT	*Trachymene coerulea*	
DICOT	*Trachymene coerulea* subsp. *coerulea*	
DICOT	*Trachymene pilosa*	
DICOT	*Trifolium suffocatum*	
DICOT	*Trifolium tomentosum*	
DICOT	*Trifolium tomentosum* var. *tomentosum*	
DICOT	*Urtica urens*	
DICOT	*Verbascum* sp. *scsp*	
DICOT	*Waitzia nitida*	
DICOT	*Westringia dampieri*	
DICOT	*Wilsonia backhousei*	
DICOT	*Wilsonia humilis*	
DICOT	*Zygophyllum ammophilum*	
DICOT	*Zygophyllum fruticulosum*	
GYMNO	*Callitris preissii*	
GYMNO	*Pinus halepensis*	

Life Form	Taxon	WA Cons Code
GYMNO	*Pinus radiata*	
LIVERWORT	*Petalophyllum preissii*	
MONOCOT	*Acanthocarpus preissii*	
MONOCOT	*Agave americana*	
MONOCOT	*Agave attenuata*	
MONOCOT	*Agave sisalana*	
MONOCOT	*Aira cupaniana*	
MONOCOT	*Allium ampeloprasum*	
MONOCOT	*Althenia preissii*	
MONOCOT	*Amaryllis dianae*	
MONOCOT	*Amaryllis quokka*	
MONOCOT	*Amphibolis antarctica*	
MONOCOT	*Amphibolis griffithii*	
MONOCOT	*Asphodelus fistulosus*	
MONOCOT	*Austrostipa elegantissima*	
MONOCOT	*Austrostipa flavescens*	
MONOCOT	*Austrostipa* sp.	
MONOCOT	*Avellinia michelii*	
MONOCOT	*Avena barbata*	
MONOCOT	*Baumea juncea*	
MONOCOT	*Brachypodium distachyon*	
MONOCOT	*Briza minor*	
MONOCOT	*Bromus arenarius*	
MONOCOT	*Bromus diandrus*	
MONOCOT	*Bromus hordeaceus*	
MONOCOT	*Bromus madritensis*	
MONOCOT	*Bromus rubens*	
MONOCOT	*Bulbine semibarbata*	
MONOCOT	*Caladenia latifolia*	
MONOCOT	*Carex preissii*	
MONOCOT	*Carex thecata*	
MONOCOT	*Catapodium rigidum*	
MONOCOT	*Cenchrus clandestinus*	
MONOCOT	*Centrolepis polygyna*	
MONOCOT	*Conostylis candicans*	
MONOCOT	*Conostylis candicans* subsp. *calcicola*	
MONOCOT	*Conostylis candicans* subsp. *candicans*	
MONOCOT	*Cortaderia selloana*	
MONOCOT	*Cynodon dactylon*	
MONOCOT	*Cyrtostylis huegelii*	
MONOCOT	*Desmocladus flexuosus*	
MONOCOT	*Ehrharta brevifolia*	
MONOCOT	*Ehrharta brevifolia* var. *cuspidata*	
MONOCOT	*Ehrharta longiflora*	
MONOCOT	*Eragrostis curvula*	
MONOCOT	*Ferraria crispa*	
MONOCOT	*Ferraria crispa* subsp. *crispa*	
MONOCOT	*Ficinia nodosa*	
MONOCOT	*Gahnia trifida*	

Life Form	Taxon	WA Cons Code
MONOCOT	*Halophila australis*	
MONOCOT	*Halophila ovalis*	
MONOCOT	*Heterozostera tasmanica*	
MONOCOT	*Hordeum leporinum*	
MONOCOT	*Hordeum* sp.	
MONOCOT	*Hydrilla verticillata*	
MONOCOT	*Hypoxis glabella* var. *glabella*	
MONOCOT	*Iris germanica*	
MONOCOT	*Isolepis cernua*	
MONOCOT	*Isolepis cernua* var. *setiformis*	
MONOCOT	*Isolepis marginata*	
MONOCOT	*Johnsonia pubescens*	
MONOCOT	*Johnsonia pubescens* subsp. *pubescens*	
MONOCOT	*Juncus bufonius*	
MONOCOT	*Juncus kraussii* subsp. *australiensis*	
MONOCOT	*Lachnagrostis nesomytica*	
MONOCOT	*Lachnagrostis nesomytica* subsp. *nesomytica*	P1
MONOCOT	*Lachnagrostis nesomytica* subsp. *pseudofiliformis*	P1
MONOCOT	*Lachnagrostis* sp.	
MONOCOT	*Lagurus ovatus*	
MONOCOT	*Lepidosperma calcicola*	
MONOCOT	*Lepidosperma gladiatum*	
MONOCOT	*Lepidosperma pubisquameum*	
MONOCOT	*Lepidosperma squamatum*	
MONOCOT	*Leucojum aestivum*	
MONOCOT	*Lolium rigidum*	
MONOCOT	*Microlaena stipoides*	
MONOCOT	*Moraea flaccida*	
MONOCOT	*Moraea miniata*	
MONOCOT	*Narcissus papyraceus*	
MONOCOT	*Narcissus tazetta*	
MONOCOT	*Narcissus tazetta* subsp. *italicus*	
MONOCOT	*Ornithogalum arabicum*	
MONOCOT	*Parapholis incurva*	
MONOCOT	*Pauridia glabella*	
MONOCOT	*Phoenix canariensis*	
MONOCOT	*Phoenix dactylifera*	
MONOCOT	*Phormium tenax*	
MONOCOT	*Poa annua*	
MONOCOT	*Poa poiformis*	
MONOCOT	*Polypogon maritimus*	
MONOCOT	*Polypogon maritimus* var. *subspatheaceus*	
MONOCOT	*Polypogon monspeliensis*	
MONOCOT	*Polypogon tenellus*	
MONOCOT	*Posidonia australis*	
MONOCOT	*Posidonia coriacea*	
MONOCOT	*Posidonia sinuosa*	
MONOCOT	*Prasophyllum giganteum*	
MONOCOT	*Romulea rosea* var. *australis*	

Life Form	Taxon	WA Cons Code
MONOCOT	*Rostraria cristata*	
MONOCOT	*Ruppia polycarpa*	
MONOCOT	*Ruppia tuberosa*	
MONOCOT	*Rytidosperma occidentale*	
MONOCOT	*Schoenus humilis*	
MONOCOT	*Schoenus nitens*	
MONOCOT	*Sorghum bicolor*	
MONOCOT	*Spinifex hirsutus*	
MONOCOT	*Spinifex longifolius*	
MONOCOT	*Sporobolus indicus* var. *capensis*	
MONOCOT	*Sporobolus virginicus*	
MONOCOT	*Stenotaphrum secundatum*	
MONOCOT	*Syringodium isoetifolium*	
MONOCOT	*Thalassodendron pachyrhizum*	
MONOCOT	*Thysanotus patersonii*	
MONOCOT	*Trachyandra divaricata*	
MONOCOT	*Triglochin minutissima*	
MONOCOT	*Triglochin mucronata*	
MONOCOT	*Triglochin muelleri* subsp. *recurvum*	
MONOCOT	*Triglochin striata*	
MONOCOT	*Triglochin trichophora*	
MONOCOT	*Typha orientalis*	
MONOCOT	*Vulpia fasciculata*	
MONOCOT	*Vulpia muralis*	
MONOCOT	*Vulpia myuros*	
MONOCOT	*Vulpia myuros* forma *megalura*	
MONOCOT	*Washingtonia filifera*	
MONOCOT	*Washingtonia robusta*	
MONOCOT	*Wurmbea dioica* subsp. *alba*	
MONOCOT	*Wurmbea monantha*	
MONOCOT	*Zantedeschia aethiopica*	
MOSS	*Bryum pachytheca*	
MOSS	*Pseudocrossidium hornschuchianum*	
MOSS	*Racopilum cuspidigerum* var. *convolutaceum*	
MOSS	*Syntrichia pagorum*	
MOSS	*Thuidiopsis sparsa*	
MOSS	*Weissia controversa*	

APPENDIX B - EPBC PROTECTED MATTERS SEARCH REPORT

Australian Government
Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 08-Jun-2022

- Summary
- Details
  - Matters of NES
  - Other Matters Protected by the EPBC Act
  - Extra Information
- Caveat
- Acknowledgements

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	1
Listed Threatened Species:	39
Listed Migratory Species:	65

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	93
Whales and Other Cetaceans:	12
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	1
Regional Forest Agreements:	None
Nationally Important Wetlands:	1
EPBC Act Referrals:	3
Key Ecological Features (Marine):	None
Biologically Important Areas:	13
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community may occur within area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat may occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432]	Critically Endangered	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat likely to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche carteri		
Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta		
Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida		
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris		
Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi		
White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area
Zanda latirostris listed as Calyptorhynchus latirostris		
Carnaby's Black Cockatoo, Short-billed Black-cockatoo [87737]	Endangered	Species or species habitat may occur within area
FISH		
Thunnus maccoyii		
Southern Bluefin Tuna [69402]	Conservation Dependent	Species or species habitat likely to occur within area
INSECT		
Hesperocolletes douglasi		
Douglas' Broad-headed Bee, Rottnest Bee [66734]	Critically Endangered	Species or species habitat may occur within area
MAMMAL		
Balaenoptera musculus		
Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Eubalaena australis		
Southern Right Whale [40]	Endangered	Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Neophoca cinerea		
Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat likely to occur within area
Setonix brachyurus		
Quokka [229]	Vulnerable	Species or species habitat known to occur within area
PLANT		
Diuris micrantha		
Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat may occur within area
REPTILE		
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
SHARK		
Carcharias taurus (west coast population)		
Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Pristis pristis		
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sphyrna lewini Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat likely to occur within area

Listed Migratory Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna pacifica Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat may occur within area
Hydroprogne caspia Caspian Tern [808]		Breeding known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Macronectes halli		
Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Onychoprion anaethetus		
Bridled Tern [82845]		Breeding known to occur within area
Phaethon rubricauda		
Red-tailed Tropicbird [994]		Breeding known to occur within area
Sterna dougallii		
Roseate Tern [817]		Breeding known to occur within area
Thalassarche carteri		
Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta		
Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida		
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris		
Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi		
White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area
Migratory Marine Species		
Balaenoptera edeni		
Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eubalaena australis as Balaena glacialis australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area
Mobula alfredi as Manta alfredi Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat known to occur within area
Mobula birostris as Manta birostris Giant Manta Ray [90034]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Roosting known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Thalasseus bergii Greater Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Tringa totanus Common Redshank, Redshank [835]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Ardenna carneipes as Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna pacifica as Puffinus pacificus Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area overfly marine area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Calidris tenuirostris		
Great Knot [862]	Critically Endangered	Roosting known to occur within area overfly marine area
Charadrius bicinctus		
Double-banded Plover [895]		Roosting known to occur within area overfly marine area
Charadrius leschenaultii		
Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus		
Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus		
Red-capped Plover [881]		Roosting known to occur within area overfly marine area
Chroicocephalus novaehollandiae as Larus novaehollandiae		
Silver Gull [82326]		Breeding known to occur within area
Diomedea amsterdamensis		
Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea epomophora		
Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area
Diomedea exulans		
Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi		
Northern Royal Albatross [64456]	Endangered	Species or species habitat may occur within area
Gallinago megala		
Swinhoe's Snipe [864]		Roosting likely to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area overfly marine area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat may occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area overfly marine area
Hydroprogne caspia as Sterna caspia Caspian Tern [808]		Breeding known to occur within area
Larus pacificus Pacific Gull [811]		Foraging, feeding or related behaviour may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area overfly marine area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area overfly marine area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area overfly marine area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Onychoprion anaethetus as Sterna anaethetus Bridled Tern [82845]		Breeding known to occur within area
Onychoprion fuscatus as Sterna fuscata Sooty Tern [90682]		Breeding known to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat likely to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Roosting known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area overfly marine area
Puffinus assimilis Little Shearwater [59363]		Breeding known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Roosting known to occur within area overfly marine area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sternula nereis as Sterna nereis Fairy Tern [82949]		Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area
Thalasseus bergii as Sterna bergii Greater Crested Tern [83000]		Breeding known to occur within area
Thinornis cucullatus as Thinornis rubricollis Hooded Plover, Hooded Dotterel [87735]		Species or species habitat known to occur within area overfly marine area
Tringa brevipes as Heteroscelus brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area overfly marine area
Tringa totanus Common Redshank, Redshank [835]		Roosting known to occur within area overfly marine area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area overfly marine area
Fish		
Acentronura australe Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area
Campichthys galei Gale's Pipefish [66191]		Species or species habitat may occur within area
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Hippocampus subelongatus West Australian Seahorse [66722]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Lissocampus fatiloquus Prophet's Pipefish [66250]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys meraculus Western Crested Pipefish [66259]		Species or species habitat may occur within area
Nannocampus subosseus Bonyhead Pipefish, Bony-headed Pipefish [66264]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Urocampus carinirostris		
Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer		
Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi		
Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus		
Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammal		
Arctocephalus forsteri		
Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Neophoca cinerea		
Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat likely to occur within area
Reptile		
Aipysurus pooleorum		
Shark Bay Seasnake [66061]		Species or species habitat may occur within area
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and Other Cetaceans		[Resource Information]
Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves [Resource Information]

Protected Area Name	Reserve Type	State
Rottnest Island	State Reserve	WA

Nationally Important Wetlands [Resource Information]

Wetland Name	State
Rottnest Island Lakes	WA

EPBC Act Referrals [Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
INDIGO Central Submarine Telecommunications Cable	2017/8127	Not Controlled Action	Completed
Rottnest Lodge Redevelopment	2019/8565	Not Controlled Action	Completed
Seismic Survey, Bremer Basin, Mentelle Basin and Zeewyck Sub-basin	2004/1700	Not Controlled Action	Completed

Biologically Important Areas

Scientific Name	Behaviour	Presence

Scientific Name	Behaviour	Presence
Seabirds		
Ardenna carneipes Flesh-footed Shearwater [82404]	Aggregation	Known to occur
Ardenna pacifica Wedge-tailed Shearwater [84292]	Foraging (in high numbers)	Known to occur
Eudyptula minor Little Penguin [1085]	Foraging (provisioning young)	Known to occur
Hydroprogne caspia Caspian Tern [808]	Foraging (provisioning young)	Known to occur
Larus pacificus Pacific Gull [811]	Foraging (in high numbers)	Former Range
Onychoprion anaethetus Bridled Tern [82845]	Foraging (in high numbers)	Known to occur
Puffinus assimilis tunneyi Little Shearwater [59363]	Foraging (in high numbers)	Known to occur
Sterna dougallii Roseate Tern [817]	Foraging	Known to occur
Sternula nereis Fairy Tern [82949]	Foraging (in high numbers)	Known to occur
Seals		
Neophoca cinerea Australian Sea Lion [22]	Foraging (male)	Likely to occur
Whales		
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Distribution	Known to occur
Eubalaena australis Southern Right Whale [40]	Calving buffer	Known to occur

Scientific Name	Behaviour	Presence
Megaptera novaeangliae		
Humpback Whale [38]	Migration (north and south)	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

APPENDIX C – FLORA SPECIES BY VEGETATION UNIT

*denotes introduced (weed) species

Family	Taxon	MIAp					CpMI	ArAp	MIGI		GtS		OaAp		LpAp		TiSS		SIG
		Q03	Q06	Q08	Q11	R16	Q12	R01	R02	R15	R04	R18	R05	R17	R07	R13	R09	R14	R10
Araliaceae	*Trachymene coerulea*							+											
Asparagaceae	*Acanthocarpus preissii*	1	+	+	+			+	+	+			+	+	+				+
Asphodelaceae	**Asphodelus fistulosus*					+							+	+			+	+	+
Asphodelaceae	**Trachyandra divaricata*	+	+		+	+	+	+	+	+		+			+	+		+	+
Asteraceae	**Dittrichia graveolens*								+				+				+		+
Asteraceae	*Olearia axillaris*												+	+	+				
Casuarinaceae	*Allocasuarina huegeliana*				+														
Chenopodiaceae	*Rhagodia baccata*								+	+					+	+			
Chenopodiaceae	*Tecticornia indica*																	+	
Chenopodiaceae	*Tecticornia indica* subsp. *bidens*																+		
Crassulaceae	*Cotyledon* sp.	+																	
Cupressaceae	*Callitris preissii*		+				+		+										
Cyperaceae	*Ficinia nodosa*											+				+			
Cyperaceae	*Gahnia trifida*			+							+	+					+	+	
Cyperaceae	*Lepidosperma gladiatum*														+	+			
Cyperaceae	*Lepidosperma pubisquameum*												+						
Euphorbiaceae	**Euphorbia peplus*									+								+	
Fabaceae	*Acacia preissiana*					+						+				+			
Fabaceae	*Acacia rostellifera*				+		+	+	+						+				
Goodeniaceae	*Scaevola crassifolia*							+											+
Haemodoraceae	*Conostylis candicans*									+				+	+	+			
Malvaceae	*Guichenotia ledifolia*		+			+		+	+	+		+							
Myrtaceae	*Agonis flexuosa*						+												
Myrtaceae	*Eucalyptus platypus*						+												
Myrtaceae	*Melaleuca lanceolata*	+	+	+	+	+	+		+										
Pittosporaceae	*Pittosporum ligustrifolium*									+									
Poaceae	*Austrostipa flavescens*								+							+		+	

Family	Taxon	MlAp					CpMl	ArAp	MlGl		GtS		OaAp		LpAp		TiSS		SlG
		Q03	Q06	Q08	Q11	R16	Q12	R01	R02	R15	R04	R18	R05	R17	R07	R13	R09	R14	R10
Poaceae	**Pentameris airoides*			+															
Poaceae	*Poa poiformis*	+	+	+					+				+		+		+		
Poaceae	*Spinifex longifolius*																		+
Poaceae	*Sporobolus virginicus*																+		
Zygophyllaceae	*Roepera* sp.			+															

APPENDIX D – QUADRAT AND RELEVÉ SITE DATA

APPENDIX A – QUADRAT AND RELEVÉ SITE DATA

Site Q03

Date	2 May 2022
Botanist	Kellie Bauer-Simpson and Lisa Chappell
Quadrat Size	10 x 10 m
NW Corner Coordinates	362326mE 6457483mN
Vegetation Unit	Melaleuca/ Acanthocarpus Woodland
Slope	Flat
Landform	Valley
Soil Colour	Brown
Soil Type	Sand
Litter	70%
Bare Ground	5%
Fire Age	>10 Years
Vegetation Condition	Good to Very Good
Disturbances/Impacts	Loss of structure, no mid or understorey

Species	Height (m)	% Cover
Melaleuca lanceolata	10	70
Poa poiformis	0.2	1
Acanthocarpus preissii	0.15	<1
**Trachyandra divaricata*	0.1	<1
Cotyledon sp.	0.01	1

Site Q06

Date	2 May 2022
Botanist	Kellie Bauer-Simpson and Lisa Chappell
Quadrat Size	10 x 10 m
NW Corner Coordinates	362619mE 6457770mN
Vegetation Unit	Melaleuca/ Acanthocarpus Woodland
Slope	Steep
Landform	Hilltop
Soil Colour	Pale brown
Soil Type	Sand
Litter	25%
Bare Ground	15%
Fire Age	>10 Years
Vegetation Condition	Very Good
Disturbances/Impacts	Some weeds, some loss of mid-storey

Species	Height (m)	% Cover
Melaleuca lanceolata	9	20
Acanthocarpus preissii	1	15
Poa poiformis	0.7	4
Guichenotia ledifolia	0.6	7
**Trachyandra divaricata*		+
Callitris preissii		Associated

Site Q08

Date	2 May 2022
Botanist	Kellie Bauer-Simpson and Lisa Chappell
Quadrat Size	10 x 10 m
NW Corner Coordinates	362948mE 6457893mN
Vegetation Unit	Melaleuca/ Acanthocarpus Woodland
Slope	Flat
Landform	Swamp edge
Soil Colour	Brown
Soil Type	Sandy clay
Litter	90%
Bare Ground	2%
Fire Age	>10 Years
Vegetation Condition	Good to Very Good
Disturbances/Impacts	Fallen wood, dry conditions

Species	Height (m)	% Cover
Melaleuca lanceolata	11	70
Gahnia trifida	0.6	1
Poa poiformis	0.3	1
Acanthocarpus preissii		+
Pentameris airoides		+
Zygophyllum sp.		+

Site Q11

Date	2 May 2022
Botanist	Kellie Bauer-Simpson and Lisa Chappell
Quadrat Size	10 x 10 m
NW Corner Coordinates	362690mE 6458323mN
Vegetation Unit	Melaleuca/ Acanthocarpus Woodland
Slope	Moderate
Landform	Hillside
Soil Colour	Pale brown
Soil Type	Sand
Litter	20%
Bare Ground	5%
Fire Age	>10 Years
Vegetation Condition	Very Good
Disturbances/Impacts	Fallen wood, weeds

Species	Height (m)	% Cover
Melaleuca lanceolata	8	25
Allocasuarina huegeliana	5	1
Acanthocarpus preissii	0.8	30
Acacia rostellifera		+
Trachyandra divaricata		+

Site Q12

Date	2 May 2022
Botanist	Kellie Bauer-Simpson and Lisa Chappell
Quadrat Size	10 x 10 m
NW Corner Coordinates	362392mE 6458498mN
Vegetation Unit	Callitris/ Melaleuca Shrubland
Slope	Flat
Landform	Flat
Soil Colour	Pale brown
Soil Type	Sand
Litter	50%
Bare Ground	5%
Fire Age	5-10 Years
Vegetation Condition	Very Good
Disturbances/Impacts	No structure (rehab?)

Species	Height (m)	% Cover
Callitris preissii	4	15
Agonis flexuosa	3	5
Melaleuca lanceolata	3	5
Acacia rostellifera	3	12
Eucalyptus platypus		Associated
Trachyandra divaricata		Associated

Site R01

Date	2 May 2022
Botanist	Kellie Bauer-Simpson and Lisa Chappell
Quadrat Size	10 x 10 m
NW Corner Coordinates	362253mE 6457299mN
Vegetation Unit	Acacia/ Acanthocarpus Shrubland
Slope	Moderate
Landform	Valley
Soil Colour	Brown
Soil Type	Sand
Litter	80%
Bare Ground	0%
Fire Age	5-10 Years
Vegetation Condition	Excellent
Disturbances/Impacts	Negligible

Species	Height (m)	% Cover
Acacia rostellifera	5	20
Acanthocarpus preissii	1	40
Trachyandra divaricata	0.2	1
Guichenotia ledifolia		+
Scaevola crassifolia		+
Trachymene coerulea		+

Site R02

Date	2 May 2022
Botanist	Kellie Bauer-Simpson and Lisa Chappell
Quadrat Size	10 x 10 m
NW Corner Coordinates	362262mE 6457381mN
Vegetation Unit	Melaleuca/ Guichenotia Shrubland
Slope	Moderate
Landform	Hillside
Soil Colour	Pale brown
Soil Type	Sand
Litter	15%
Bare Ground	15%
Fire Age	5-10 Years
Vegetation Condition	Good
Disturbances/Impacts	Weeds, loss of structure

Species	Height (m)	% Cover
Melaleuca lanceolata	2.5	2
Callitris preissii	2	2
Guichenotia ledifolia	1	30
Acanthocarpus preissii	0.8	15
Rhagodia baccata	0.6	5
Trachyandra divaricata	0.3	1
Acacia rostellifera		+
Austrostipa flavescens		+
Dittrichia graveolens		+
Poa poiformis		+

Site R04

Date	2 May 2022
Botanist	Kellie Bauer-Simpson and Lisa Chappell
Quadrat Size	10 x 10 m
NW Corner Coordinates	362490mE 6457633mN
Vegetation Unit	Gahnia Sedgeland
Slope	Flat
Landform	Swamp
Soil Colour	Brown
Soil Type	Clay
Litter	5%
Bare Ground	20%
Fire Age	>10 Years
Vegetation Condition	Very Good to Excellent
Disturbances/Impacts	No diversity

Species	Height (m)	% Cover
Gahnia trifida	1.3	30

Site R05

Date	2 May 2022
Botanist	Kellie Bauer-Simpson and Lisa Chappell
Quadrat Size	10 x 10 m
NW Corner Coordinates	362486mE 6457775mN
Vegetation Unit	Olearia/ Acanthocarpus Shrubland
Slope	Moderate
Landform	Hillside
Soil Colour	Pale brown
Soil Type	Sand
Litter	15%
Bare Ground	25%
Fire Age	5-10 Years
Vegetation Condition	Very Good
Disturbances/Impacts	Weeds

Species	Height (m)	% Cover
Olearia axillaris	2	10
Acanthocarpus preissii	0.6	20
Asphodelus fistulosus	0.5	5
Poa poiformis	0.4	4
Dittrichia graveolens		+
Lepidosperma pubisquameum		+
Lepidosperma gladiatum	0.7	15
Rhagodia baccata	0.5	4

Site R07

Date	2 May 2022
Botanist	Kellie Bauer-Simpson and Lisa Chappell
Quadrat Size	10 x 10 m
NW Corner Coordinates	362738mE 6457638mN
Vegetation Unit	Lepidosperma/ Acanthocarpus Sedgeland
Slope	Steep
Landform	Hillside
Soil Colour	Very pale brown
Soil Type	Sand
Litter	10%
Bare Ground	15%
Fire Age	5-10 Years
Vegetation Condition	Good
Disturbances/Impacts	Some weeds

Species	Height (m)	% Cover
Acanthocarpus preissii	0.5	25
Conostylis candicans	0.3	8
Trachyandra divaricata	0.1	3
Acacia rostellifera		+
Olearia axillaris		+
Poa poiformis		+

Site R09

Date	2 May 2022
Botanist	Kellie Bauer-Simpson and Lisa Chappell
Quadrat Size	10 x 10 m
NW Corner Coordinates	362987mE 6458043mN
Vegetation Unit	Tecticornia Samphire Shrubland
Slope	Flat
Landform	Swamp
Soil Colour	Pale brown
Soil Type	Clay
Litter	10%
Bare Ground	15%
Fire Age	>10 Years
Vegetation Condition	Very Good
Disturbances/Impacts	Nil

Species	Height (m)	% Cover
Spinifex longifolius	0.8	50
Scaevola crassifolia	0.3	15
Acanthocarpus preissii		+
Asphodelus fistulosus		+
Dittrichia graveolens		+
Trachyandra divaricata		+

Site R10

Date	2 May 2022
Botanist	Kellie Bauer-Simpson and Lisa Chappell
Quadrat Size	10 x 10 m
NW Corner Coordinates	363577mE 6458299mN
Vegetation Unit	Spinifex Grassland
Slope	Steep
Landform	Foredune
Soil Colour	White
Soil Type	Sand
Litter	5%
Bare Ground	15%
Fire Age	>10 Years
Vegetation Condition	Degraded to Good

Species	Height (m)	% Cover
Spinifex longifolius	0.8	50
Scaevola crassifolia	0.3	15
Acanthocarpus preissii		+
Asphodelus fistulosus		+
Dittrichia graveolens		+
Trachyandra divaricata		+

Site R13

Date	30 August 2022
Botanist	Kellie Bauer-Simpson and Sarah Beckwith
Quadrat Size	10 x 10 m
NW Corner Coordinates	361714mE 6457868mN
Vegetation Unit	*Lepidosperma/Acanthocarpus* Sedgeland
Slope	Gentle
Landform	Lower slope
Soil Colour	Pale brown
Soil Type	Sand
Litter	10%
Bare Ground	15%
Fire Age	>10 Years
Vegetation Condition	Good
Disturbances/Impacts	Weeds

Species	Height (m)	% Cover
Lepidosperma gladiatum	1.5	8
Ficinia nodosa	1.2	6
Rhagodia baccata	0.6	10
Acacia preissiana	0.5	5
Austrostipa flavescens	0.5	4
**Trachyandra divaricata*	0.5	15
Conostylis candicans	0.2	2

Site R14

Date	30 August 2022
Botanist	Kellie Bauer-Simpson and Sarah Beckwith
Quadrat Size	10 x 10 m
NW Corner Coordinates	362080mE 6457850mN
Vegetation Unit	*Tecticornia* Samphire Shrubland
Slope	Flat
Landform	Wetland
Soil Colour	Brown
Soil Type	Sandy clay
Litter	2%
Bare Ground	5%
Fire Age	>10 Years
Vegetation Condition	Good to Very Good
Disturbances/Impacts	Weeds

Species	Height (m)	% Cover
Gahnia trifida	1.5	30
Tecticornia indica	1	15
**Trachyandra divaricata*	0.6	10
**Asphodelus fistulosus*	0.5	10
Austrostipa flavescens	0.3	8
**Euphorbia peplus*		+

Site R15

Date	30 August 2022
Botanist	Kellie Bauer-Simpson and Sarah Beckwith
Quadrat Size	10 x 10 m
NW Corner Coordinates	361870mE 6457735mN
Vegetation Unit	*Melaleuca/Guichenotia* Shrubland
Slope	Moderate
Landform	Mid-slope
Soil Colour	Pale brown
Soil Type	Sand
Litter	3%
Bare Ground	10%
Fire Age	>10 Years
Vegetation Condition	Good
Disturbances/Impacts	Weeds

Species	Height (m)	% Cover
Acanthocarpus preissii	0.8	15
Rhagodia baccata	0.7	5
Guichenotia ledifolia	0.6	40
**Trachyandra divaricata*	0.3	20
**Euphorbia peplus*	0.1	10
Conostylis candicans		Associated
Pittosporum ligustrifolium		+

Site R16

Date	30 August 2022
Botanist	Kellie Bauer-Simpson and Sarah Beckwith
Quadrat Size	10 x 10 m
NW Corner Coordinates	361857mE 6457782mN
Vegetation Unit	*Melaleuca/Acanthocarpus* Woodland
Slope	Gentle
Landform	Mid-slope
Soil Colour	Brown
Soil Type	Clay loam
Litter	80%
Bare Ground	0%
Fire Age	>10 Years
Vegetation Condition	Very Good
Disturbances/Impacts	Loss of understorey

Species	Height (m)	% Cover
Melaleuca lanceolata	9	80
Acacia preissiana		Associated
**Asphodelus fistulosus*		Associated
Guichenotia ledifolia		Associated
**Trachyandra divaricata*		Associated

Site R17

Date	30 August 2022
Botanist	Kellie Bauer-Simpson and Sarah Beckwith
Quadrat Size	10 x 10 m
NW Corner Coordinates	362359mE 6457778mN
Vegetation Unit	*Olearia/Acanthocarpus* Shrubland
Slope	Moderate
Landform	Hill
Soil Colour	Pale brown
Soil Type	Sand
Litter	1%
Bare Ground	35%
Fire Age	>10 Years
Vegetation Condition	Very Good
Disturbances/Impacts	Rubbish

Species	Height (m)	% Cover
Olearia axillaris	1	8
Acanthocarpus preissii	0.5	6
Conostylis candicans	0.2	7
**Asphodelus fistulosus*		+

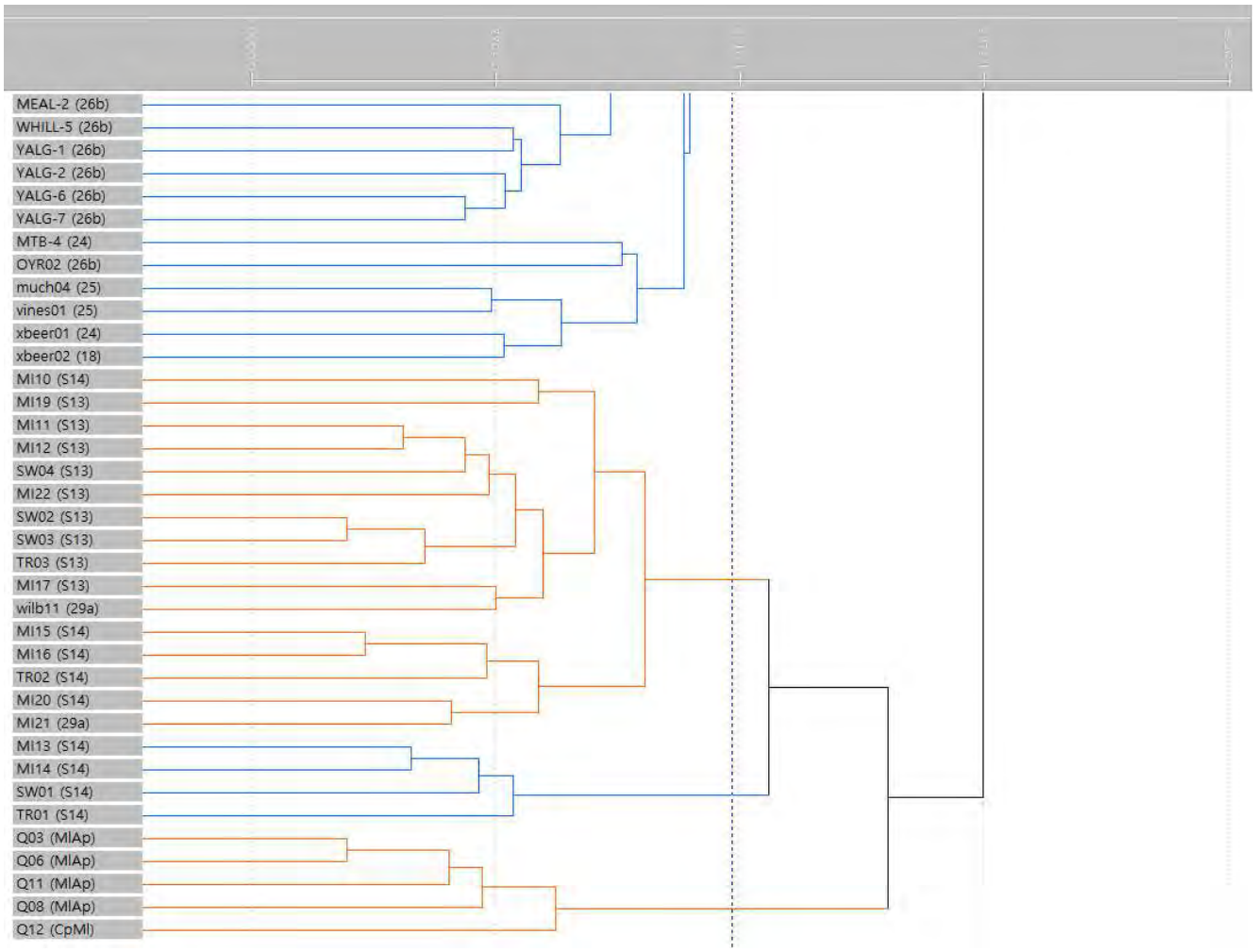
Site R18

Date	30 August 2022
Botanist	Kellie Bauer-Simpson and Sarah Beckwith
Quadrat Size	10 x 10 m
NW Corner Coordinates	362326mE 6457483mN
Vegetation Unit	*Gahnia* Sedgeland
Slope	Flat
Landform	Swamp
Soil Colour	Brown
Soil Type	Loamy sandy clay
Litter	5%
Bare Ground	5%
Fire Age	>10 Years
Vegetation Condition	Good
Disturbances/Impacts	Weeds

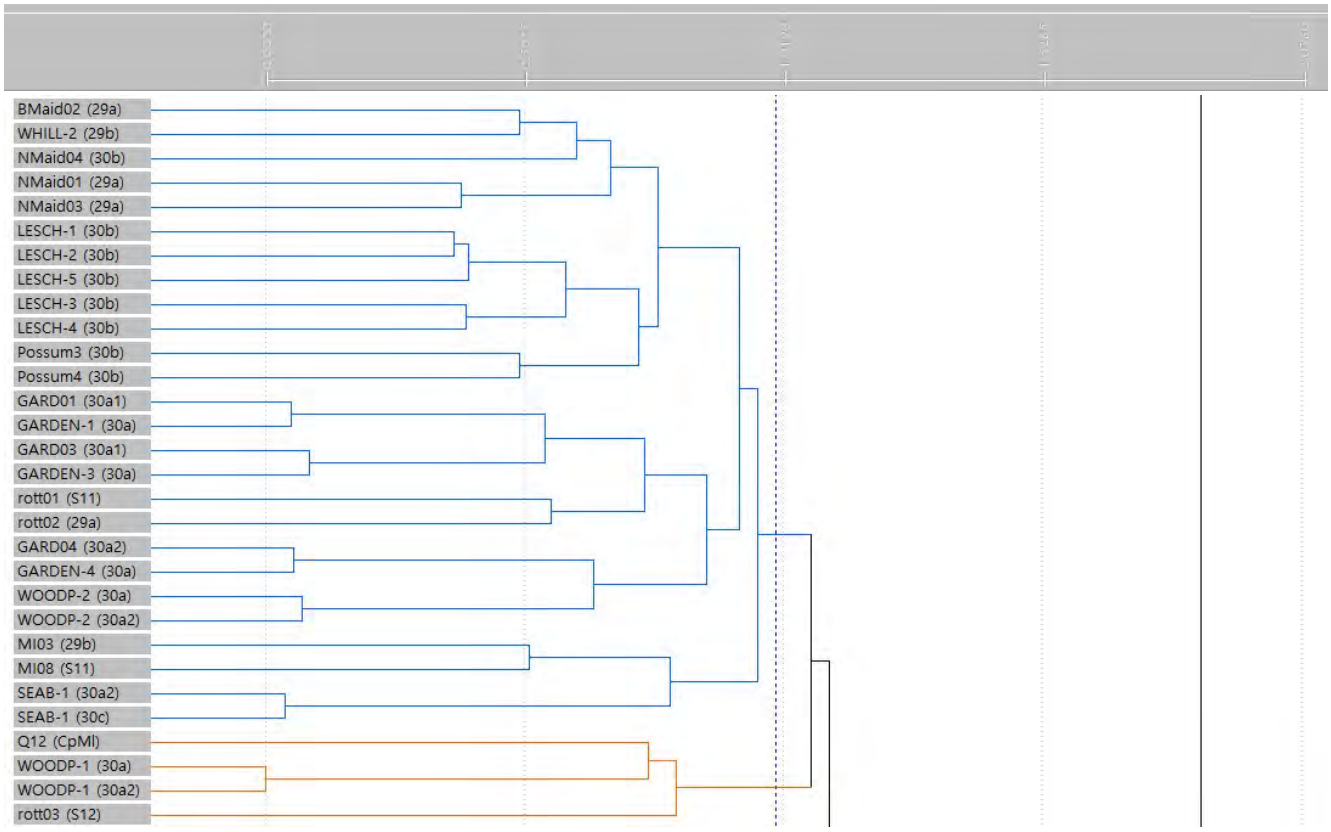
Species	Height (m)	% Cover
Gahnia trifida	1.3	25
Acacia preissiana	1.1	5
Ficinia nodosa	1.1	25
Guichenotia ledifolia	0.6	5
**Trachyandra divaricata*	0.6	10

APPENDIX E – BATCH AND SSI DENDROGRAMS

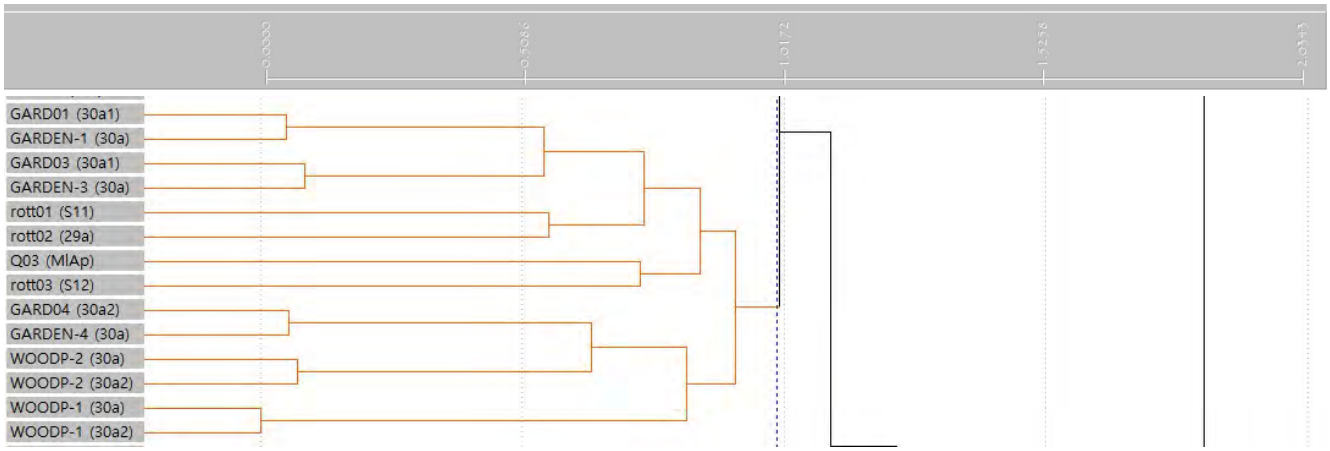
Dendrogram 1 – Excerpt Batch Analysis RIA Quadrats



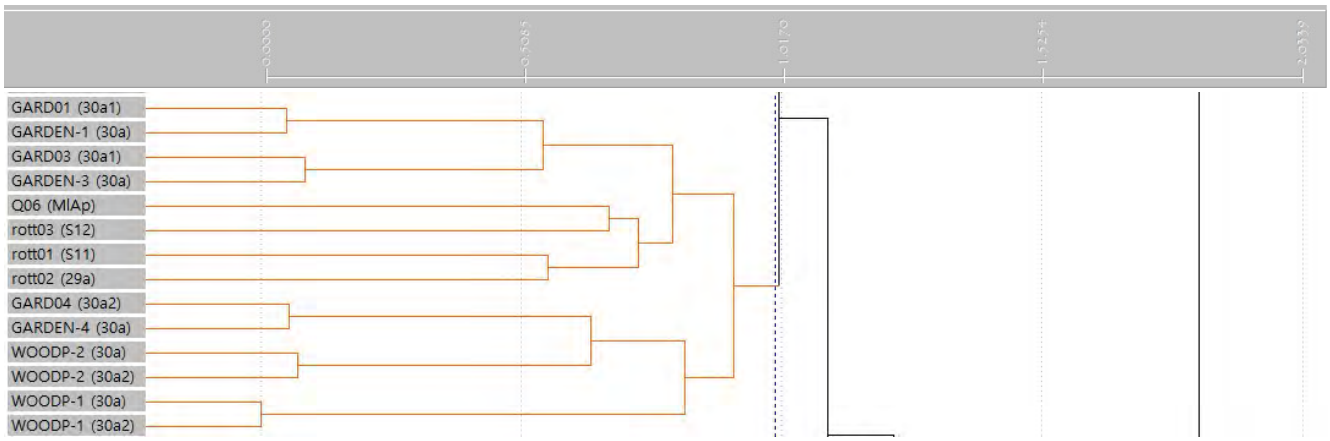
Dendrogram 2– CpMl SSI Q02



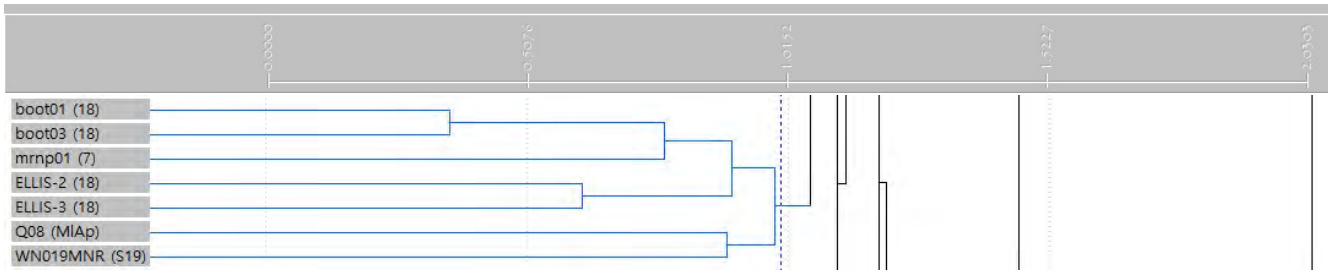
Dendrogram 3 – MlAp SSI Q03



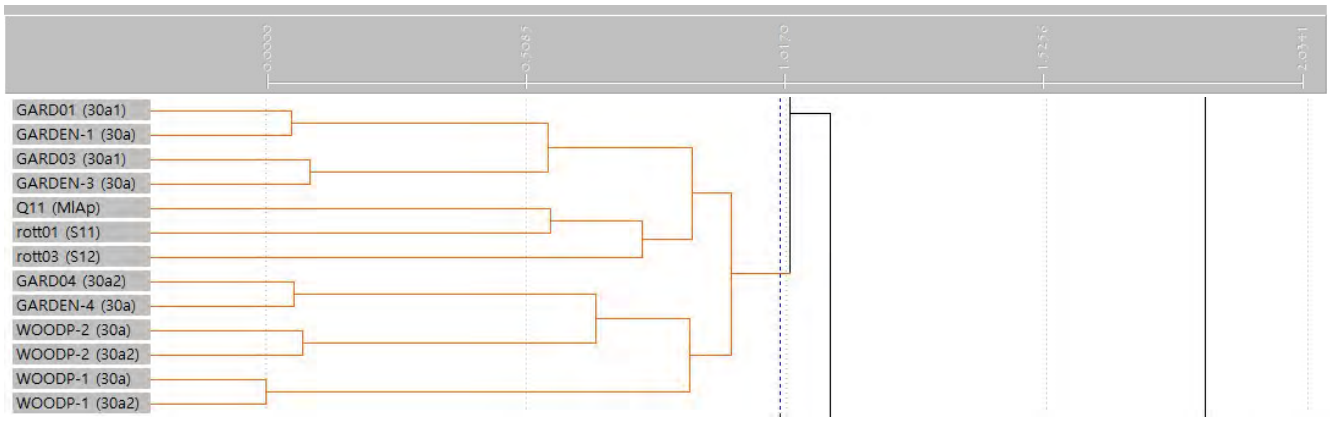
Dendrogram 4 – MlAp SSI Q06



Dendrogram 5 – MlAp SSI Q08



Dendrogram 6– MlAp SSI Q12



Attachment B

Threatened and Priority Flora Report Form

Department of **Biodiversity, Conservation and Attractions**

GOVERNMENT OF WESTERN AUSTRALIA

Threatened and Priority Flora Report Form

Version 1.4 March 2021

Please complete as much of the form as possible, with emphasis on those sections bordered in black. For information on how to complete the form please refer to the Threatened & Priority Flora Report Form (TPRF) manual on the DBCA website at www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-plants

TAXON: *Lachnagrostis nesomytica* subsp. *nesomytica* **TPFL Pop. No:**

OBSERVATION DATE: 23-24/11/2023 **CONSERVATION STATUS:** P1 **New population** X

OBSERVER/S: Martin Henson **PHONE** 0427 437 795

ROLE: Lead Botanist **ORGANISATION:** RPS AAP Consulting

EMAIL: Martin.henson@rpsgroup.com.au

DESCRIPTION OF LOCATION (Provide at least nearest town/named locality, and the distance and direction to that place)**:**

Rottnest Island – Bickley Swamp and Government House Lake

Reserve No:

DBCA DISTRICT: Swan **LGA:** City of Cockburn Land manager present: ☐

DATUM:

GDA94 / MGA94 X

AGD84 / AMG84 ☐

WGS84 ☐

Unknown ☐

COORDINATES: (If UTM coords provided, **Zone** is also required)

DecDegrees ☐ DegMinSec ☐ UTMs X

Lat / Northing: See spreadsheet

Long / Easting:

ZONE:

METHOD USED:

GPS X Differential GPS ☐ Map ☐

No. satellites: ____ Map used: _____

Boundary polygon captured: ☐ Map scale: _____

LAND TENURE:

Nature reserve ☐ Timber reserve ☐ Private property ☐ Rail reserve ☐ Shire road reserve ☐

National park ☐ State forest ☐ Pastoral lease ☐ MRWA road reserve ☐ Other Crown reserve ☐

Conservation park ☐ Water reserve ☐ UCL X SLK/Pole _____ to _____ Specify other: _____

AREA ASSESSMENT: Edge survey ☐ Partial survey ☐ Full survey X Area observed (m²): _____

EFFORT: Time spent surveying (minutes): 660 No. of minutes spent / 100 m²: _____

POP'N COUNT ACCURACY: Actual X Extrapolation ☐ Estimate X Count method: Actual count

(Refer to field manual for list)

WHAT COUNTED: Plants X Clumps ☐ Clonal stems ☐

TOTAL POP'N STRUCTURE:

	Mature:	Juveniles:	Seedlings:	Totals:
Alive				
Dead				

Area of pop (m²): _____

Note: Pls record count as numbers (not percentages) for database.

QUADRATS PRESENT: No. ____ Size _____ Data attached ☐ Total area of quadrats (m²): _____

Summary Quad. Totals: Alive				

REPRODUCTIVE STATE: Clonal ☐ Vegetative ☐ Flowerbud ☐ Flower ☐

Immature fruit ☐ Fruit ☐ Dehisced fruit ☐ Percentage in flower: _____%

CONDITION OF PLANTS: Healthy ☐ Moderate ☐ Poor ☐ Senescent X

COMMENT:

THREATS - type, agent and supporting information: Eg clearing, too frequent fire, weed, disease. Refer to field manual for list of threats & agents. **Specify agent** where relevant. Rate current and potential threat impact: N=Nil, L=Low, M=Medium, H=High, E=Extreme Estimate time to potential impact: S=Short (<12mths), M=Medium (<5yrs), L=Long (5yrs+)	**Current impact (N-E)**	**Potential Impact (L-E)**	**Potential Threat Onset (S-L)**
•			
•			
•			

Please return completed form to **Species And Communities Program** DBCA,

Locked Bag 104, BENTLEY DELIVERY CENTRE WA 6983 **OR** email to: flora.data@dbca.wa.gov.au

RECORDS: Please forward to **Flora Administrative Officer,** Species and Communities Program.

Record entered by:_____ **Sheet No.:**_____ **Record Entered in Database** ❑

Department of **Biodiversity, Conservation and Attractions**

GOVERNMENT OF WESTERN AUSTRALIA

Threatened and Priority Flora Report Form

Version 1.4 March 2021

HABITAT INFORMATION:

LANDFORM:	**ROCK TYPE:**	**LOOSE ROCK:**	**SOIL TYPE:**	**SOIL COLOUR:**	**DRAINAGE:**
Crest ☐	Granite ☐	(on soil surface; eg gravel, quartz fields)	Sand X	Red ☐	Well drained X
Hill ☐	Dolerite ☐		Sandy loam X	Brown ☐	Seasonally inundated ☐
Ridge ☐	Laterite ☐	0-10% X	Loam ☐	Yellow ☐	Permanently inundated ☐
Outcrop ☐	Ironstone ☐	10-30% ☐	Clay loam ☐	White ☐	Tidal ☐
Slope ☐	Limestone X	30-50% ☐	Light clay ☐	Grey ☐	
Flat ☐	Quartz ☐	50-100% ☐	Peat ☐	Black ☐	
Open depression ☐	Specify other:		Specify other:	Specify other:	
Drainage line ☐	_____		_____	Yellow-orange_____	
Closed depression ☐					
Wetland X					

Specific **Landform** Element: Tecticornia shrubland at lake edge
(Refer to field manual for additional values)

CONDITION OF SOIL: Dry ☐ Moist ☐ Waterlogged ☐ Inundated ☐

VEGETATION CLASSIFICATION*:
Eg: **1**. Banksia woodland (B. attenuata, B. ilicifolia); **2**. Open shrubland (Hibbertia sp., Acacia spp.) ; **3**. Isolated clumps of sedges (M.tetragona)

1. Tecticornia shrubland
2.
3.
4.

ASSOCIATED SPECIES:
Other (non-dominant) spp

* Please record up to four of the most representative vegetation layers (with up to three dominant species in each layer). Structural Formations should follow 2009 *Australian Soil and Land Survey Field Handbook* guidelines – refer to field manual for further information and structural formation table.

CONDITION OF HABITAT: Pristine ☐ Excellent X Very good ☐ Good ☐ Degraded ☐ Completely degraded ☐

COMMENT:

FIRE HISTORY: **Last Fire:** Season/Month: _____ Year: _____ **Fire Intensity:** High ☐ Medium ☐ Low ☐ No signs of fire X

FENCING: Not required X Present ☐ Replace / repair ☐ Required ☐ Length req'd: _____

ROADSIDE MARKERS: Not required X Present ☐ Replace / reposition ☐ Required ☐ Quantity req'd: _____

OTHER COMMENTS: (Please include recommended management actions and/or implemented actions - include date. Also include details of additional data available, and how to locate it.)

FLORA AUTHORISATION / LICENCE No: _____Note if only observing plants (i.e. no specimens or plant matieral is taken) then no authorisation/licence is required. For further information on authorisation and licening requirements see the Threatened Flora and Wildlife Licensing pages on DBCA's website. Any actions carried out under authorisations/licences should be recorded above in the OTHER COMMENTS section.

SPECIMEN: Collectors No: _____ WA Herb. ☐ Regional Herb. ☐ District Herb. ☐ Other: _____

LODGEMENT: WA Herb Lodgement No: _____

ATTACHED: Map ☐ Mudmap ☐ Photo ☐ GIS data ☐ Field notes ☐ Other: _____

COPY SENT TO: Regional Office ☐ District Office ☐ Other: _____

Submitter of Record: _____ Role: _____ Signed: _____ Date: / /

Please return completed form to **Species And Communities Program** DBCA,
Locked Bag 104, BENTLEY DELIVERY CENTRE WA 6983 **OR** email to: flora.data@dbca.wa.gov.au

RECORDS: Please forward to **Flora Administrative Officer,** Species and Communities Program.

Record entered by:_____ **Sheet No.:**_____ **Record Entered in Database** ❑

Appendix K
Rottnest Island Basic Fauna Survey (Eco Logical 2024)

Rottnest Island Basic Fauna Survey

RPS

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DOCUMENT TRACKING

Project Name	Rottnest Island Basic Fauna Survey
Project Number	23PER6686
Project Manager	Jeni Morris
Prepared by	Jeni Morris
Reviewed by	Jeff Cargill
Approved by	Jeff Cargill
Status	**Final**
Version Number	**V3**
Last saved on	**5 February 2024**

This report should be cited as 'Eco Logical Australia Click here to enter a year. *Rottnest Island Basic Fauna Survey*. Prepared for RPS**.**

ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd.

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Template 2.8.1

1. Introduction

In 2019, the Rottnest Island Authority (RIA) commenced investigations for the South Thomson Barge Landing development approvals process. During this time, a flora survey and a benthic habitat assessment were undertaken to facilitate the approvals process, however at the end of 2019, a decision was made to pause the project and no further works were undertaken.

In 2023, RIA commenced the project and, as such, the RIA require a review of the benthic habitat assessment and in addition, require a flora survey, a terrestrial fauna and marine fauna survey to be completed in accordance with guidelines for impact assessment under Section 38 of the State Environmental Protection Act 1986 (EP Act).

1.1. Scope of works

Eco Logical Australia (ELA) were engaged by RPS as a sub-consultant to complete a Basic terrestrial fauna survey of the survey area, an area of 4.16 hectares (ha) located on Army Jetty Road, Wadjemup / Rottnest Island (**Figure 1**). The following tasks were completed as part of this assessment:

- Desktop assessment to determine environmental values and conservation significant fauna relating to the survey areas;
- Undertaking a Basic fauna survey to assess values pertaining fauna habitat and terrestrial fauna;
- Preparation of a letter-style terrestrial fauna survey report for the survey area; and
- Providing all spatial/mapping data collected during the survey.

Figure 1: Project location

Survey area
Distributor Road
Access Road

N

0 100 200 400
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

23PER6686-JP Date: 8/11/2023

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2. Methodology

2.1. Desktop assessment

2.1.1. Database searches and literature review

An initial desktop assessment was undertaken prior to the field survey to determine environmental values and conservation significant fauna relating to the survey area. The following Commonwealth and State databases were searched for information relating to conservation significant fauna to inform the field survey:

- *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool (PMST) for Matters of National Environmental Significance (MNES), including any Threatened species and communities listed under the EPBC Act (Department of Climate Change, Energy, the Environment and Water [DCCEEW] 2023a; **Appendix A**); and
- The Department of Biodiversity, Conservation and Attractions (DBCA) Threatened and Priority fauna database searches for Scheduled fauna listed under the EPBC Act or latest WA Biodiversity Conservation (listing of native species) (fauna) order and Priority Fauna.

In addition, the following report/s relevant to the survey area were reviewed. Aerial photography for the survey area was reviewed to identify land use patterns, the extent of vegetation, relevant landscape/catchment matters and any other relevant issues where possible.

- *Flora and vegetation survey: South Thompson and Kingstown, Rottnest Island (Wadjemup*; 360 Environmental 2022a);
- *Native Vegetation Clearing Permit: Supporting Documentation* (360 Environmental 2022b); and
- *Flora and vegetation survey: South Thompson and Kingstown, Rottnest Island (Wadjemup*; Focused Vision 2022).

2.1.2. Likelihood of occurrence assessment

An assessment of the likelihood of potential conservation significant fauna species (Threatened and Priority) being present within the survey area (where relevant) was carried out. The assessment is based on specific likelihood of occurrence criteria. The criteria include factors such as location of previous records in relation to the survey area, suitable landforms, soils, and habitat that appear to be present based on the desktop review and aerial imagery. Conservation codes, categories and criteria for fauna protected under the EPBC Act and the State *Biodiversity Conservation Act 2016* (BC Act) are provided in **Appendix B**. Criteria used for this assessment are presented in **Appendix C**.

Marine specific fauna (e.g., sharks, fish and marine mammals) have been excluded from this assessment as the survey area does not contain habitat to support these species. The RIA are conducting a separate marine fauna assessment for relevant areas.

2.2. Field survey

2.2.1. Survey team and timing

A Basic terrestrial fauna survey was conducted by Jeni Morris (Ecologist) on 31 October 2023 (**Table 1**). No scientific licences were required to undertake the field survey.

The survey timing was consistent with the Environmental Protection Authority (EPA) *Technical Guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment* recommendations for undertaking vertebrate fauna assemblage surveys in the Southern climatic region (i.e., reptiles in October-December, birds and mammals in September-December; EPA 2020).

Table 1: Field personnel

Staff	Project role	Experience
Jeni Morris (BSc Cons. Wildlife and Biology)	Ecologist, field survey, project manager	Jeni has over seven years conducting Baseline (Detailed), Targeted and Basic fauna surveys on the Swan Coastal Plain.

2.2.2. Basic fauna survey

The Basic fauna survey involved personnel walking traverses through the survey area, delineating and mapping fauna habitats and recording opportunistic sightings of fauna (**Figure 2**). A total of 10 fauna habitat points were taken to aid in delineation and mapping of fauna habitat (**Figure 2**; **Appendix D**). Fauna habitats were assessed for their ability to support and sustain populations of fauna, along with an assessment of the likelihood of occurrence of conservation significant fauna species.

The habitat characteristics and fauna database records used in assessing likelihood of occurrence for fauna included:

- Vegetation community, structure, and condition;
- Soil and landform type;
- Extent and connectivity of bushland;
- Fauna species habitat preferences;
- Proximity of conservation significant fauna records; and
- Signs of species presence.

Opportunistic recordings of fauna species were made at all times during the field survey. These included visual sightings of active fauna such as reptiles and birds; records of bird calls; and signs of species presence such as tracks, diggings, burrows, scats, and any other signs of fauna activity. Nomenclature used for the vertebrate fauna species within this report follows the Western Australian Museum (WAM) Checklist of the Vertebrates of Western Australia (WAM 2023).

Figure 2: Survey effort

Survey area

Traverses

Fauna habitat points

N

0 15 30 60

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

23PER6686-JP Date: 8/11/2023

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3. Results

3.1. Desktop assessment

3.1.1. Conservation significant fauna

Conservation significant fauna species previously recorded within, and in proximity to the survey area (DBCA 2023, DCCEEW 2023a) are presented in **Figure 3**. The pre-survey fauna likelihood of occurrence assessment is provided in **Appendix E**.

A total of 76 conservation significant fauna species were identified from the desktop assessment. A pre-survey likelihood of occurrence assessment determined that of these, two species have been previously recorded within the survey area, namely the Rottnest Island dugite (*Pseudonaja affinis exilis*, listed as P4 by DBCA) and the Rottnest Island bobtail (*Tiliqua rugosa konowi*, listed as VU under the BC Act; RIA; pers comms 5 January 2024). Of the remaining 74 conservation significant fauna species identified from the desktop assessment, a total of 26 were identified as having the Potential to occur within the survey area, comprising 20 birds (18 of which are migratory), three reptiles, two insects and one mammal. The remaining 48 fauna species were assessed as unlikely to occur in the survey area.

3.2. Fauna survey

Weather conditions at the time of the field survey were moderately warm and clear with a maximum temperature of 23.8°C, with no rainfall recorded (Bureau of Meteorology 2023).

3.2.1. Fauna species

A total of 14 native vertebrate fauna species were recorded within the survey area during the field survey, comprising 11 birds, two reptiles and one mammal. A complete fauna species list is provided in **Appendix F**.

3.2.2. Conservation significant fauna

One conservation significant fauna species was recorded within the survey area, the Quokka (Kwoka; *Setonix brachyurus*), listed as Vulnerable (VU) under the EPBC Act and BC Act (**Plate 1**). This species was recorded from three locations within the survey area, with individuals observed at two locations and scats observed at a third location (**Figure 4**; **Appendix G**).

No additional Threatened or Priority fauna species listed under the EPBC Act, BC Act or by DBCA were recorded within the survey area. No introduced (feral) fauna species were recorded within the survey area.

Following the field survey, a post-field likelihood of occurrence assessment determined that of the remaining 75 species identified from the desktop assessment as possibly occurring within the survey area, four are considered as having the Potential to occur within the survey area due to the availability of potentially suitable habitat and location of nearby recent records:

- *Pandion haliaetus* (Osprey; listed as MI under the EPBC Act and BC Act);
- *Tiliqua rugosa konowi* (Rottnest Island bobtail; listed as VU under the BC Act);
- *Lerista lineata* (Perth slider; listed as Priority [P] 3 by DBCA); and
- *Pseudonaja affinis exilis* (Rottnest Island dugite; listed as P4 by DBCA).

The remaining 71 species are considered as being unlikely to occur due to lack of suitable habitat recorded and location/age of records in vicinity of the survey area. The post-survey fauna likelihood of occurrence assessment is provided in **Appendix E**.

Plate 1: Quokka (Kwoka; *Setonix brachyurus*) individuals and scats recorded within the survey area © ELA 2023

3.2.3. Fauna habitat

Two fauna habitat types were recorded within the survey area, namely 'Fauna habitat 1: Trees and tall shrubs over low shrubs, grasses and herbs on sand dunes' (0.87 ha; 20.9% of the survey area) and 'Fauna habitat 2: Low shrubs over grasses and herbs on sand dunes' (3.00 ha; 72.3% of the survey area). The remaining 0.28 ha (6.8% of the survey area) was mapped as tracks/cleared areas (**Table 2**; **Figure 5**).

Table 2: Fauna habitats recorded within the survey area

Fauna habitat	Associated flora species	Conservation significant fauna species potentially utilising the habitat	Extent (ha)	Proportion (%)	Photo
Fauna habitat 1: Trees and tall shrubs over low shrubs, grasses and herbs on sand dunes.	*Melaleuca lanceolata*, *Callitris preissii*, *Eucalyptus gomphocephala*, *Agonis flexuosa*, *Acacia rostellifera*, *Acanthocarpus preissii*, *Lepidosperma gladiatum*, **Trachyandra divaricata*, *Conostylis candicans* subsp. *calcicola*, *Austrostipa* sp.	*Lerista lineata* (Perth slider) *Pandion haliaetus* (Osprey) *Pseudonaja affinis exilis* (Rottnest Island dugite) *Tiliqua rugosa konowi* (Rottnest Island bobtail)	0.87	20.9	
Fauna habitat 2: Low shrubs over grasses and herbs on sand dunes.	*Acanthocarpus preissii*, *Scaevola crassifolia*, *Guichenotia ledifolia*, *Lepidosperma gladiatum*, **Trachyandra divaricata*, *Conostylis candicans* subsp. *calcicola*, *Spinifex longifolius*, *Austrostipa* sp.	*Lerista lineata* (Perth slider) *Pandion haliaetus* (Osprey) *Pseudonaja affinis exilis* (Rottnest Island dugite) *Tiliqua rugosa konowi* (Rottnest Island bobtail)	3.00	72.3	
Tracks/cleared areas			0.28	6.8	
Total			**4.16**	**100**	

Figure 3: Conservation significant fauna (terrestrial) previously recorded in the vicinity of the survey area (DBCA 2023

Survey area

Conservation significant fauna

- Threatened
- Threatened and Priority 4
- Priority 3
- Priority 4

0 0.5 1 2
Kilometres

Datum/Projection:
GDA 1994 MGA Zone 50

23PER6686-JP Date: 5/02/2024

N

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Figure 4: Locations of conservation significant species recorded within the survey area

Survey area

Conservation significant fauna species

Setonix brachyurus (Quokka, Kwoka; VU under EPBC Act and BC Act)

N

0 15 30 60
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

23PER6686-JP Date: 8/11/2023

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Figure 5: Fauna habitats of the survey area

Survey area

Tracks/cleared areas

Fauna habitat type

Fauna habitat 1: Trees and tall shrubs over low shrubs, grasses and herbs on sand dunes.

Fauna habitat 2: Low shrubs over grasses and herbs on sand dunes.

0 15 30 60

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

23PER6686-JP Date: 8/11/2023

N

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4. Discussion

4.1. Desktop assessment

A total of 76 conservation significant fauna species were identified from the desktop assessment as possibly occurring within the survey area. Of these species, two have been previously recorded within the survey area, namely the Rottnest Island dugite (*Pseudonaja affinis exilis*, listed as P4 by DBCA) and the Rottnest Island bobtail (*Tiliqua rugosa konowi*, listed as VU under the BC Act; RIA; pers comms 5 January 2024).

Tiliqua rugosa konowi (Rottnest Island bobtail; listed as VU under the BC Act) is a robust skink with a broad triangular head, short blunt tail and extremely large rugose scales, smaller with narrower head and darker, less variable colour than the mainland *T. rugosa* (Wilson and Swan 2010). Bobtails, also known as Shinglebacks, are common around limestone rocks and prefer limestone heath, woodland and coastal habitats (360 Environmental 2022a). A large number of historical and recent records of this species occur from the central to western extent of Rottnest Island (DBCA 2023), and sightings of this species have been made by RIA within the survey area (RIA; pers comms 5 January 2024). Their diet is known to include plant material (especially fruit), snails, insects and carrion (360 Environmental 2022a). The Rottnest Island bobtail is likely to utilise both fauna habitats within the survey area to forage and shelter.

Pseudonaja affinis exilis (Rottnest Island dugite; listed as P4 by DBCA) is a snake with midbody scales in 19 rows, much smaller than *P. affinis* (to 1.1 m compared with to 2 m on the mainland) and uniformly dark, including ventral surfaces (Wilson and Swan 2010). The subspecies occurs on Rottnest Island and is known from 68 records across the island, with the nearest record occurring approximately 100 m to the south of the survey area (DBCA 2023). This species has been observed by RIA within the survey area, with multiple records of this species being removed from the area (RIA; pers comms 5 January 2024). Dugites occupy a wide variety of habitats including coastal dunes, heathlands, shrublands, woodlands and forests, and occupy the Settlement areas of Rottnest Island (Wilson and Swan 2010; 360 Environmental 2022a). Rottnest Island dugite is likely to utilise both habitats within the survey area.

4.2. Field survey

A Basic fauna survey was conducted on Tuesday 31 October 2023 by Jeni Morris (Ecologist). The survey timing was consistent with the Environmental Protection Authority (EPA) *Technical Guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment* recommendations for undertaking vertebrate fauna assemblage surveys in the Southern climatic region (i.e., reptiles in October-December, birds and mammals in September-December; EPA 2020).

Two fauna habitats were identified and mapped within the survey area, Fauna habitat 1 comprising stands of trees and tall shrubs (primarily *Melaleuca lanceolata*) over low shrubs, grasses and herbs on sand dunes, and Fauna habitat 2 comprising low shrubs over grasses and herbs on sand dunes. Fauna habitat 2 was the most commonly occurring, covering 72.3% (3.00 ha) of the survey area. Fauna habitats align with vegetation communities mapped across the area by Focused Vision in 2022 with the presence of *Melaleuca lanceolata* shrubland over *Acanthocarpus preissii* and **Trachyandra divaricata* (Focused Vision 2022).

A total of 14 native vertebrate fauna species were recorded within the survey area during the field survey, comprising 11 birds, two reptiles and one mammal. No introduced (feral) fauna species were recorded within the survey area.

One conservation significant fauna species was recorded within the survey area during the field survey, the Quokka (Kwoka; *Setonix brachyurus*), listed as Vulnerable (VU) under the EPBC Act and BC Act. This species was recorded from three locations within the survey area, with individuals observed at two locations and scats observed at a third location.

The Quokka, or Kwoka in Noongar, is a small wallaby with thick, coarse, grey-brown fur with lighter underparts, and a head and body length of 400-540 mm long (Department of Environment and Conservation [DEC] 2013). The Quokka occurs on two offshore islands (Rottnest Island/Wadjemup and Bald Island) and several mainland sites in south-west WA, ranging from just south of Perth to the Hunter River (DEC 2013; DCCEEW 2023b). The Rottnest Island quokka population is considered to be relatively stable. Previous records of this species are located across the island from the eastern to western points (DBCA 2023). The species is a habitat specialist, preferring dense understory to meet dietary and refuge requirements. These covered/shady microhabitats may also be important during the hotter months, particularly on Rottnest Island, where animals converge in dense thickets of *Gahnia* spp. and *Acanthocarpus* spp. (DCCEEW 2023b). Within the survey area, this species was recorded within Fauna habitat 1, foraging and evidence observed under *Melaleuca lanceolata* and adjacent to *Acanthocarpus preissii*, though is considered as likely occurring within Fauna habitat 2 due to the dense understory coverage provided by *Acanthocarpus preissii* in this habitat.

Following the field survey, a post-field likelihood of occurrence assessment determined that of the remaining 73 species identified from the desktop assessment as possibly occurring within the survey area, two are considered as having the potential to occur within the survey area, namely *Pandion haliaetus* (Osprey) and *Lerista lineata* (Perth slider).

Pandion haliaetus (Osprey; listed as MI under the EPBC Act and BC Act) is a medium-sized raptor to 65 centimetres (cm), dark brown to blackish brown above and white below with a white head and neck (DCCEEW 2023c). The species is widespread, with a total range (breeding plus non-breeding) extending north from Esperance in Western Australia to New South Wales, where records become scarcer towards the south, and into Victoria and Tasmania, where the species is a rare vagrant (DCCEEW 2023c). This species is also known to breed on Rottnest Island (DCCEEW 2023c). The Osprey occurs in littoral and coastal habitats and require extensive areas of open fresh, brackish or saline water for foraging and are known to frequent a variety of wetland habitats including inshore waters, reefs, bays, coastal cliffs and beaches (DCCEEW 2023c). Typically, the Osprey exhibits a preference for coastal cliffs and elevated islands in some parts of their range but have also been known to occur over atypical habitats such as heath, woodland or forest when travelling to and from foraging sites (DCCEEW 2023c). The Osprey is considered as having the potential to occur within the survey area as a vagrant visitor, due to the availability of adjacent foraging habitat (saline water, beaches).

Lerista lineata (Perth slider; listed as Priority [P] 3 by DBCA) is a small, slender *Lerista* to 11 cm long with 2 fingers, 3 toes and an immovable eyelid (Storr *et al*. 1999). The species is distributed along the lower west coast of WA from Perth to Mandurah, including Busselton, Rottnest Island and Garden Island (Storr *et al*. 1999; Wilson and Swan 2010). This species is known from 12 records on Rottnest Island, majority recent (2017), with the closest occurring approximately 330 m east of the survey area (DBCA 2023). *L. lineata* occurs on sandy, coastal heath and shrubland (Wilson and Swan 2010). Perth slider is considered

as having the potential to occur within the survey area based on availability of suitable habitat (sandy, coastal heath and shrubland) within Fauna habitat 1 and Fauna habitat 2.

The remaining 71 conservation significant fauna species identified from the desktop assessment are considered as being unlikely to occur, based on a lack of suitable habitat available for these species within the survey area and lack of recent records in the vicinity of the survey area.

Rottnest Island has been classified as a Key Biodiversity Area (KBA) by BirdLife Australia, providing critical breeding habitat for many shorebirds, including the Banded Stilt (*Cladorhynchus leucocephalus*) and the Fairy Tern (*Sternula nereis*; Birdlife Australia 2023).

A number of waterbirds and waders were identified as possibly occurring within the site based on the desktop assessment. However, a post-field survey likelihood of occurrence assessment determined that the survey area does not contain suitable breeding or foraging habitat for these species, whose habitat preferences align with habitat adjacent to, and in the vicinity of the survey area, including shore, rocky areas, intertidal habitats and wetlands. As these habitats do not occur within the survey area itself, it is considered that these species would be unlikely to occur.

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Appendix A PMST database search results

Australian Government

Department of Climate Change, Energy, the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 25-Oct-2023

- Summary
- Details
  - Matters of NES
  - Other Matters Protected by the EPBC Act
  - Extra Information
- Caveat
- Acknowledgements

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	1
Listed Threatened Species:	39
Listed Migratory Species:	66

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	94
Whales and Other Cetaceans:	12
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	1
Regional Forest Agreements:	None
Nationally Important Wetlands:	1
EPBC Act Referrals:	2
Key Ecological Features (Marine):	None
Biologically Important Areas:	12
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community may occur within area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Foraging, feeding or related behaviour known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Foraging, feeding or related behaviour known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat may occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432]	Critically Endangered	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat likely to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Sternula nereis nereis		
Australian Fairy Tern [82950]	Vulnerable	Species or species habitat known to occur within area
Thalassarche carteri		
Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta		
Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida		
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris		
Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi		
White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area
Zanda latirostris listed as Calyptorhynchus latirostris		
Carnaby's Black Cockatoo, Short-billed Black-cockatoo [87737]	Endangered	Species or species habitat may occur within area
FISH		
Thunnus maccoyii		
Southern Bluefin Tuna [69402]	Conservation Dependent	Species or species habitat likely to occur within area
INSECT		
Hesperocolletes douglasi		
Douglas' Broad-headed Bee, Rottnest Bee [66734]	Critically Endangered	Species or species habitat may occur within area
MAMMAL		
Balaenoptera musculus		
Blue Whale [36]	Endangered	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Eubalaena australis		
Southern Right Whale [40]	Endangered	Breeding known to occur within area
Neophoca cinerea		
Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat likely to occur within area
Setonix brachyurus		
Quokka [229]	Vulnerable	Species or species habitat known to occur within area
PLANT		
Diuris micrantha		
Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat may occur within area
REPTILE		
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
SHARK		
Carcharias taurus (west coast population)		
Grey Nurse Shark (west coast population) [68752]	Vulnerable	Congregation or aggregation known to occur within area
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sphyrna lewini Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat likely to occur within area

Listed Migratory Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat may occur within area
Ardenna pacifica Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat may occur within area
Hydroprogne caspia Caspian Tern [808]		Breeding known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Onychoprion anaethetus Bridled Tern [82845]		Breeding known to occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area
Migratory Marine Species		
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eubalaena australis as Balaena glacialis australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Megaptera novaeangliae		
Humpback Whale [38]		Species or species habitat known to occur within area
Mobula alfredi as Manta alfredi		
Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat known to occur within area
Mobula birostris as Manta birostris		
Giant Manta Ray [90034]		Species or species habitat may occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Orcinus orca		
Killer Whale, Orca [46]		Species or species habitat may occur within area
Pristis pristis		
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Migratory Terrestrial Species		
Motacilla cinerea		
Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres		
Ruddy Turnstone [872]		Foraging, feeding or related behaviour known to occur within area

Scientific Name	Threatened Category	Presence Text
Calidris acuminata Sharp-tailed Sandpiper [874]		Foraging, feeding or related behaviour known to occur within area
Calidris alba Sanderling [875]		Foraging, feeding or related behaviour known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Foraging, feeding or related behaviour known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Foraging, feeding or related behaviour known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Foraging, feeding or related behaviour known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Foraging, feeding or related behaviour known to occur within area

Scientific Name	Threatened Category	Presence Text
Gallinago megala Swinhoe's Snipe [864]		Foraging, feeding or related behaviour likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Foraging, feeding or related behaviour likely to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Foraging, feeding or related behaviour known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Foraging, feeding or related behaviour likely to occur within area
Numenius phaeopus Whimbrel [849]		Foraging, feeding or related behaviour known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Foraging, feeding or related behaviour known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Foraging, feeding or related behaviour known to occur within area

Scientific Name	Threatened Category	Presence Text
Pluvialis squatarola Grey Plover [865]		Foraging, feeding or related behaviour known to occur within area
Thalasseus bergii Greater Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Foraging, feeding or related behaviour known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Foraging, feeding or related behaviour known to occur within area
Tringa totanus Common Redshank, Redshank [835]		Foraging, feeding or related behaviour known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Foraging, feeding or related behaviour known to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Ardenna carneipes as Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna grisea as Puffinus griseus Sooty Shearwater [82651]		Species or species habitat may occur within area
Ardenna pacifica as Puffinus pacificus Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Foraging, feeding or related behaviour known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Foraging, feeding or related behaviour known to occur within area
Calidris alba Sanderling [875]		Foraging, feeding or related behaviour known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Calidris ruficollis Red-necked Stint [860]		Foraging, feeding or related behaviour known to occur within area overfly marine area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Foraging, feeding or related behaviour known to occur within area overfly marine area
Charadrius bicinctus Double-banded Plover [895]		Foraging, feeding or related behaviour known to occur within area overfly marine area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Foraging, feeding or related behaviour known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Foraging, feeding or related behaviour known to occur within area overfly marine area
Chroicocephalus novaehollandiae as Larus novaehollandiae Silver Gull [82326]		Breeding known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat may occur within area
Gallinago megala Swinhoe's Snipe [864]		Foraging, feeding or related behaviour likely to occur within area overfly marine area
Gallinago stenura Pin-tailed Snipe [841]		Foraging, feeding or related behaviour likely to occur within area overfly marine area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat may occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Foraging, feeding or related behaviour known to occur within area overfly marine area
Hydroprogne caspia as Sterna caspia Caspian Tern [808]		Breeding known to occur within area
Larus pacificus Pacific Gull [811]		Foraging, feeding or related behaviour may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Limosa limosa Black-tailed Godwit [845]		Foraging, feeding or related behaviour known to occur within area overfly marine area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area overfly marine area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Foraging, feeding or related behaviour likely to occur within area overfly marine area
Numenius phaeopus Whimbrel [849]		Foraging, feeding or related behaviour known to occur within area
Onychoprion anaethetus as Sterna anaethetus Bridled Tern [82845]		Breeding known to occur within area
Onychoprion fuscatus as Sterna fuscata Sooty Tern [90682]		Breeding known to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Foraging, feeding or related behaviour known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Foraging, feeding or related behaviour known to occur within area
Pluvialis squatarola Grey Plover [865]		Foraging, feeding or related behaviour known to occur within area overfly marine area
Puffinus assimilis Little Shearwater [59363]		Breeding known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Foraging, feeding or related behaviour known to occur within area overfly marine area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area overfly marine area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sternula nereis as Sterna nereis Fairy Tern [82949]		Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area
Thalasseus bergii as Sterna bergii Greater Crested Tern [83000]		Breeding known to occur within area
Thinornis cucullatus as Thinornis rubricollis Hooded Plover, Hooded Dotterel [87735]		Species or species habitat likely to occur within area overfly marine area
Tringa brevipes as Heteroscelus brevipes Grey-tailed Tattler [851]		Foraging, feeding or related behaviour known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area overfly marine area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Foraging, feeding or related behaviour known to occur within area overfly marine area
Tringa totanus Common Redshank, Redshank [835]		Foraging, feeding or related behaviour known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Xenus cinereus Terek Sandpiper [59300]		Foraging, feeding or related behaviour known to occur within area overfly marine area
Fish		
Acentronura australe Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area
Campichthys galei Gale's Pipefish [66191]		Species or species habitat may occur within area
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Hippocampus subelongatus West Australian Seahorse [66722]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus fatiloquus Prophet's Pipefish [66250]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys meraculus Western Crested Pipefish [66259]		Species or species habitat may occur within area
Nannocampus subosseus Bonyhead Pipefish, Bony-headed Pipefish [66264]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Vanacampus phillipi		
Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus		
Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammal		
Arctocephalus forsteri		
Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Neophoca cinerea		
Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat likely to occur within area
Reptile		
Aipysurus pooleorum		
Shark Bay Seasnake [66061]		Species or species habitat may occur within area
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Disteira kingii		
Spectacled Seasnake [1123]		Species or species habitat may occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Scientific Name	Threatened Category	Presence Text
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and Other Cetaceans

[Resource Information]

Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves [Resource Information]

Protected Area Name	Reserve Type	State
Rottnest Island	State Reserve	WA

Nationally Important Wetlands [Resource Information]

Wetland Name	State
Rottnest Island Lakes	WA

EPBC Act Referrals [Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
INDIGO Central Submarine Telecommunications Cable	2017/8127	Not Controlled Action	Completed
Seismic Survey, Bremer Basin, Mentelle Basin and Zeewyck Sub-basin	2004/1700	Not Controlled Action	Completed

Biologically Important Areas

Scientific Name	Behaviour	Presence
Seabirds		
Ardenna carneipes Flesh-footed Shearwater [82404]	Aggregation	Known to occur
Ardenna pacifica Wedge-tailed Shearwater [84292]	Foraging (in high numbers)	Known to occur
Eudyptula minor Little Penguin [1085]	Foraging (provisioning young)	Known to occur
Hydroprogne caspia Caspian Tern [808]	Foraging (provisioning	Known to occur

Scientific Name	Behaviour	Presence
	young)	
Larus pacificus Pacific Gull [811]	Foraging (in high numbers)	Former Range
Onychoprion anaethetus Bridled Tern [82845]	Foraging (in high numbers)	Known to occur
Puffinus assimilis tunneyi Little Shearwater [59363]	Foraging (in high numbers)	Known to occur
Sterna dougallii Roseate Tern [817]	Foraging	Known to occur
Sternula nereis Fairy Tern [82949]	Foraging (in high numbers)	Known to occur
Seals		
Neophoca cinerea Australian Sea Lion [22]	Foraging (male)	Likely to occur
Whales		
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Distribution	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Migration (north and south)	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

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Appendix B Framework for conservation significant flora and fauna ranking

CATEGORIES OF THREATENED SPECIES UNDER THE ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999 (EPBC ACT)

Threatened fauna and flora may be listed in any one of the following categories as defined in Section 179 of the EPBC Act. Species listed as 'conservation dependent' and 'extinct' are not Matters of National Environmental Significance and therefore do not trigger the EPBC Act.

Category	Definition
Extinct (EX)	There is no reasonable doubt that the last member of the species has died.
Extinct in the Wild (EW)	Taxa known to survive only in captivity or as a naturalised population well outside its past range; or taxa has not been recorded in its known and/or expected habitat at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically Endangered (CE)	Taxa considered to be facing an extremely high risk of extinction in the wild.
Endangered (EN)	Taxa considered to be facing a very high risk of extinction in the wild.
Vulnerable (VU)	Taxa considered to be facing a high risk of extinction in the wild.
Near Threatened (NT)	Taxa has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.
Least Concern (LC)	Taxa has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.
Data Deficient (DD)	There is inadequate information to make a direct, or indirect, assessment of taxa's risk extinction based on its distribution and/or population status.
Not Evaluated (NE)	Taxa has not yet been evaluated against the criteria.
Migratory (MI)	Not an IUCN category. Species are defined as migratory if they are listed in an international agreement approved by the Commonwealth Environment Minister, including: • the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animal) for which Australia is a range state; • the agreement between the Government of Australian and the Government of the People's Republic of China for the Protection of Migratory Birds and their environment (CAMBA); • the agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (JAMBA); or • the agreement between Australia and the Republic of Korea to develop a bilateral migratory bird agreement similar to the JAMBA and CAMBA in respect to migratory bird conservation and provides a basis for collaboration on the protection of migratory shorebirds and their habitat (ROKAMBA).

CONSERVATION CODES FOR WESTERN AUSTRALIA FLORA AND FAUNA

The Wildlife Conservation (Specially Protected Fauna) Notice 2018 and the Wildlife Conservation (Rare Flora) Notice 2018 have been transitioned under regulations 170, 171 and 172 of the Biodiversity Conservation Regulations 2018 to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the *Biodiversity Conservation Act 2016*.

Specially protected fauna or flora are species which have been adequately searched for and are deemed to be, in the wild, threatened, extinct or in need of special protection, and have been gazetted as such.

Threatened species (T)

Threatened fauna is that subset of 'Specially Protected Fauna' listed under Schedule 2 of the Biodiversity Conservation (Listing of Native Species) (Fauna) Order 2022 made by the Minister under sections 13(1), 19(1) and 23(1) of the Act and regulation 174(1) of the *Biodiversity Conservation Regulations 2018*.

Threatened flora is that subset of 'Rare Flora' listed under Schedule 1 of the Biodiversity Conservation (Listing of Native Species) (Rare Flora) Notice 2022 made by the Minister under sections 19(1) and 23(1) of the BC Act and regulation 174(1) of the *Biodiversity Conservation Regulations 2018*.

The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.

Category	Code	Description
Critically Endangered species	CR	Threatened species considered to be "facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under Schedule 2-Division 1 of the Biodiversity Conservation (Listing of Native Species) (Fauna) Order 2022 for critically endangered fauna or Schedule 1-Division 1 of the Biodiversity Conservation (Rare Flora) Notice 2022 for critically endangered flora.
Endangered species	EN	Threatened species considered to be "facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under Schedule 2-Division 2 of the Biodiversity Conservation (Listing of Native Species) (Fauna) Order 2022 for endangered fauna or Schedule 1-Division 2 of the Biodiversity Conservation (Rare Flora) Notice 2022 for critically endangered flora.
Vulnerable species	VU	Threatened species considered to be "facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under Schedule 2-Division 3 of the Biodiversity Conservation (Listing of Native Species) (Fauna) Order 2022 for endangered fauna or Schedule 1-Division 3 of the Biodiversity Conservation (Rare Flora) Notice 2022 for critically endangered flora.

Extinct species

Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild, as follows:

Category	Code	Description
Extinct species	EX	Species which have been adequately searched for and there is no reasonable doubt that the last individual has died. Published as Extinct Species under Schedule 3 of the Biodiversity Conservation (Listing of Native Species) (Fauna) Order 2022 for endangered fauna or Schedule 2 of the Biodiversity Conservation (Rare Flora) Notice 2022 for critically endangered flora.
Extinct in the wild species	EW	Species that "is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form", and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act). Currently there are no threatened fauna or threatened flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.

Specially protected species

Listed by order of the Minister as specially protected under section 13(1) of the BC Act. These species meet one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection.

Species that are listed as threatened species (critically endangered, endangered or vulnerable) or extinct species under the BC Act cannot also be listed as Specially Protected species.

Categories are detailed below.

Category	Code	Description
Migratory species	MI	Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act). Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species. Published as migratory birds protected under an international agreement under Schedule 1-Division 2 of the 5 of the Biodiversity Conservation (Listing of Native Species) (Fauna) Order 2022.
Species of special conservation interest (conservation dependent fauna)	CD	Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14 of the BC Act). Published as conservation dependent fauna under Schedule 1-Division 1 of the Biodiversity Conservation (Listing of Native Species) (Fauna) Order 2022.
Other specially protected species	OS	Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act). Published as other specially protected fauna under Schedule 1-Division 3 of the Biodiversity Conservation (Listing of Native Species) (Fauna) Order 2022.

Priority species (P)

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened fauna or flora.

Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

Category	Code	Definition
Priority 1	P1	Poorly-known species Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g., agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
Priority 2	P2	Poorly-known species Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g., national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.
Priority 3	P3	Poorly-known species Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.
Priority 4	P4	Rare, Near Threatened and other species in need of monitoring (a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Appendix C Likelihood of occurrence assessment criteria

Likelihood rating	Criteria
Recorded	The species has previously been recorded within the survey area from DBCA database search results and/or from previous surveys of the survey area, and/or the species has been confirmed through a current vouchered specimen at WA Herbarium.
Likely	The species has not previously been recorded from within the survey area. However, (to qualify requires one or more criteria to be met): the species has been recorded in close proximity to the survey area, and occurs in similar habitat to that which occurs within the survey area; core habitat and suitable landforms for the species occurs within the survey area either year-round or seasonally. In relation to fauna species, this could be that a host plant is seasonally present on site, or habitat features such as caves are present that may be used during particular times during its life cycle e.g., for breeding. In relation to both flora and fauna species, it may be there are seasonal wetlands present; and there is a medium to high probability that a species uses the survey area.
Potential	The species has not previously been recorded from within the survey area. However, (one or more criteria requires to be met): targeted surveys may locate the species based on records occurring in proximity to the survey area and suitable habitat occurring in the survey area; the survey area has been assessed as having potentially suitable habitat through habitat modelling; the species is known to be cryptic and may not have been detected despite extensive surveys; the species is highly mobile and has an extensive foraging range so may not have been detected during previous surveys; The species has been recorded in the survey area by a previous consultant survey or there is historic evidence of species occurrence within the survey area. However, (one or more criteria requires to be met): doubt remains over taxonomic identification, or the majority of habitat does not appear suitable (although presence cannot be ruled out due to factors such as species ecology or distribution); and coordinates are doubtful.
Unlikely	The species has been recorded locally through DBCA database searches. However, it has not been recorded within the survey area and it is unlikely to occur due to the site lacking critical habitat, having at best marginally suitable habitat, and/or being severely degraded. it is unlikely to occur due to few historic record/s and no other current collections in the local area. The species has been recorded within the bioregion based on literature review but has not been recorded locally or within the survey area through DBCA database searches. The species has not been recorded in the survey area despite adequate survey efforts, such as a standardised methodology or targeted searching within potentially suitable habitat.
Does not occur (one or more criteria requires to be met).	The species is not known to occur within the IBRA bioregion based on current literature and distribution. The conspicuous species has not been recorded in the survey area despite adequate survey efforts at an appropriate time of year to detect the species within potentially suitable habitat. The survey area lacks important habitat for a species that has highly selective habitat requirements. The species has been historically recorded within survey area or locally; however, it is considered locally extinct due to significant habitat changes such as land clearing and/or introduced predators.

Appendix D Fauna habitat points

Fauna habitat point	Fauna habitat type	Associated flora species	Landform	Easting	Northing	Photo
SITE 1	Fauna habitat 1: Trees and tall shrubs over low shrubs, grasses and herbs on sand dunes.	*Agonis flexuosa, Acanthocarpus preissii, *Trachyandra divaricata, Conostylis candicans subsp. calcicola, Austrostipa* sp.	Sand dunes	362853	6458416	
SITE 2	Fauna habitat 2: Low shrubs over grasses and herbs on sand dunes.	*Acanthocarpus preissii, Scaevola crassifolia, Conostylis candicans* subsp. *calcicola, Austrostipa* sp., **Trachyandra divaricata*	Sand dunes	362865	6458432	
SITE 3	Fauna habitat 1: Trees and tall shrubs over low shrubs, grasses and herbs on sand dunes.	*Melaleuca lanceolata, Acanthocarpus preissii, Austrostipa* sp., **Trachyandra divaricata*	Sand dunes	362934	6458370	

Fauna habitat point	Fauna habitat type	Associated flora species	Landform	Easting	Northing	Photo
SITE 4	Fauna habitat 1: Trees and tall shrubs over low shrubs, grasses and herbs on sand dunes.	*Eucalyptus gomphocephala, Melaleuca lanceolata, Acanthocarpus preissii, Scaevola crassifolia, *Trachyandra divaricata*	Sand dunes	362982	6458394	
SITE 5	Fauna habitat 2: Low shrubs over grasses and herbs on sand dunes.	*Acanthocarpus preissii, Lepidosperma gladiatum, Austrostipa sp., *Trachyandra divaricata*	Sand dunes	362933	6458306	
SITE 6	Fauna habitat 1: Trees and tall shrubs over low shrubs, grasses and herbs on sand dunes.	*Melaleuca lanceolata, Callitris preissii, Acanthocarpus preissii, *Trachyandra divaricata*	Sand dunes and flats	362959	6458306	

Fauna habitat point	Fauna habitat type	Associated flora species	Landform	Easting	Northing	Photo
SITE 7	Fauna habitat 1: Trees and tall shrubs over low shrubs, grasses and herbs on sand dunes.	*Melaleuca lanceolata, Callitris preissii, Acacia rostellifera, Acanthocarpus preissii, *Trachyandra divaricata*	Sand dunes and flats	362989	6458252	
SITE 8	Fauna habitat 2: Low shrubs over grasses and herbs on sand dunes.	*Melaleuca lanceolata, Acanthocarpus preissii, Scaevola crassifolia, Guichenotia ledifolia, Conostylis candicans* subsp. *calcicola,*	Sand dunes	363030	6458276	
SITE 9	Fauna habitat 1: Trees and tall shrubs over low shrubs, grasses and herbs on sand dunes.	*Melaleuca lanceolata, Acanthocarpus preissii, Austrostipa* sp., **Trachyandra divaricata*	Sand dunes	363091	6458277	

Fauna habitat point	Fauna habitat type	Associated flora species	Landform	Easting	Northing	Photo
SITE 10	Fauna habitat 2: Low shrubs over grasses and herbs on sand dunes.	*Acanthocarpus preissii, Scaevola crassifolia, Conostylis candicans* subsp*. calcicola, Austrostipa* sp., **Trachyandra divaricata, Austrostipa* sp.	Sand dunes	363115	6458319	

Appendix E Fauna likelihood of occurrence assessment

Species	Common name	Type	EPBC Act	BC Act /DBCA	Source	Habitat description	Pre-survey likelihood	Justification	Post-survey likelihood	Justification
Calidris ferruginea	Curlew Sandpiper	Bird	CR, MI	CR	DCCEEW 2023a, DBCA 2023	Curlew sandpipers forage on mudflats and nearby shallow water. In non-tidal wetlands, they usually wade, mostly in water 15–30 mm, but up to 60 mm deep. They forage at the edges of shallow pools and drains of intertidal mudflats and sandy shores. At high tide, they sometimes forage among low sparse emergent vegetation, such as saltmarsh, and sometimes forage in flooded paddocks or inundated saltflats. Curlew sandpipers roost in open situations with damp substrate, especially on bare shingle, shell or sand beaches, sandspits and islets in or around coastal or near-coastal lagoons and other wetlands, occasionally roosting in dunes during very high tides and sometimes in saltmarsh.	Potential	Suitable habitat may be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Calidris tenuirostris	Great Knot	Bird	CR, MI	CR	DCCEEW 2023a, DBCA 2023	In Australasia, the species typically prefers sheltered coastal habitats, with large intertidal mudflats or sandflats. This includes inlets, bays, harbours, estuaries and lagoons. They are occasionally found on exposed reefs or rock platforms, shorelines with mangrove vegetation, ponds in saltworks, at swamps near the coast, saltlakes and non-tidal lagoons.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Numenius madagascariensis	Eastern Curlew, Far Eastern Curlew	Bird	CR, MI	CR	DCCEEW 2023a	The Eastern Curlew does not breed in Australia. The eastern curlew mainly forages during the non-breeding season on soft sheltered intertidal sandflats or mudflats, open and without vegetation or covered with seagrass, often near mangroves, on saltflats and in saltmarsh, rockpools and among rubble on coral reefs, and on ocean beaches near the tideline. The birds are rarely seen on near-coastal lakes or in grassy areas. The eastern curlew roosts during high tide periods on sandy spits, sandbars and islets, especially on beach sand near the high-water mark, and among coastal vegetation including low saltmarsh or mangroves.	Potential	Suitable habitat may be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.

Species	Common name	Type	EPBC Act	BC Act /DBCA	Source	Habitat description	Pre-survey likelihood	Justification	Post-survey likelihood	Justification
Hesperocolletes douglasi	Douglas' Broad-headed Bee, Rottnest Bee	Insect	CR	CR	DCCEEW 2023a, 360 Environmental 2022b, DBCA 2023	The species was previously listed as 'presumed extinct' based on a specimen found in 1938 on Rottnest Island, the dramatic changes to the island vegetation since European settlement and despite extensive searched in the Perth Region (including Rottnest and Garden Islands). In 2015, a single specimen was collected within the *Banksia* woodland in Muchea and on that basis has been reassessed and listed as Critically Endangered. Very little is known about the species including its floral preferences.	Potential	Habitat requirements of this species are unknown. Species may utilise the survey area.	Unlikely	Habitat requirements of this species are unknown, however the species is only known from two specimens, one from East of Muchea on the Swan Coastal Plain and one from Rottnest Island from 1938.
Limosa lapponica menzbieri	Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit	Bird	CR	CR	DCCEEW 2023a	The Bar-tailed Godwit is found mainly in coastal habitats such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays. It is found often around beds of seagrass and, sometimes, in nearby saltmarsh. It has been sighted in coastal sewage farms and saltworks, saltlakes and brackish wetlands near coasts, sandy ocean beaches, rock platforms, and coral reef-flats. It is rarely found on inland wetlands or in areas of short grass, such as farmland, paddocks and airstrips, although it is commonly recorded in paddocks at some locations overseas.	Potential	Suitable habitat may be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Diomedea amsterdamensis	Amsterdam Albatross	Bird	EN, MI	CR	DCCEEW 2023a	The Amsterdam Albatross is a marine, pelagic seabird. It nests in open patchy vegetation (among tussocks, ferns or shrubs) near exposed ridges or hillocks. It sleeps and rests on ocean waters when not breeding.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Diomedea dabbenena	Tristan Albatross	Bird	EN, MI	CR	DCCEEW 2023a	The Tristan albatross is a marine, pelagic seabird. It forages in open water in the Atlantic Ocean near the Cape of Good Hope, South Africa. It sleeps and rests on ocean waters when not breeding.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.

Species	Common name	Type	EPBC Act	BC Act /DBCA	Source	Habitat description	Pre-survey likelihood	Justification	Post-survey likelihood	Justification
Calidris canutus	Red Knot, Knot	Bird	EN, MI	EN	DCCEEW 2023a, DBCA 2023	In Australasia the Red Knot mainly inhabit intertidal mudflats, sandflats and sandy beaches of sheltered coasts, in estuaries, bays, inlets, lagoons and harbours; sometimes on sandy ocean beaches or shallow pools on exposed wave-cut rock platforms or coral reefs. They are occasionally seen on terrestrial saline wetlands near the coast, such as lakes, lagoons, pools and pans, and recorded on sewage ponds and saltworks, but rarely use freshwater swamps. They rarely use inland lakes or swamps.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Caretta caretta	Loggerhead Turtle	Reptile	EN, MI	EN	DCCEEW 2023a	It spends most of its life in open ocean, shallow coastal waters and estuarine habitats, with females briefly coming ashore (to sandy beach) to lay eggs. The loggerhead sea turtle is omnivorous, feeding mainly on bottom-dwelling invertebrates. Hatchling loggerhead turtles live in floating mats of Sargassum algae.	Unlikely	Although species may utilise adjacent beach, they are unlikely to utlise areas (vegetated) within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Charadrius mongolus	Lesser Sand Plover, Mongolian Plover	Bird	EN, MI	EN	DCCEEW 2023a, DBCA 2023	In non-breeding grounds in Australia, this species usually occurs in coastal littoral and estuarine environments. It inhabits large intertidal sandflats or mudflats in sheltered bays, harbours and estuaries, and occasionally sandy ocean beaches, coral reefs, wave-cut rock platforms and rocky outcrops. It also sometime occurs in short saltmarsh or among mangroves. The species also inhabits saltworks and near-coastal saltpans, brackish swamps and sandy or silt islands in river beds.	Potential	Suitable habitat may be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Diomedea sanfordi	Northern Royal Albatross	Bird	EN, MI	EN	DCCEEW 2023a	The Northern Royal Albatross is marine, pelagic and aerial. Its habitat includes subantarctic, subtropical, and occasionally Antarctic waters. The Northern Royal Albatross nests on flat or gently sloping ground, on slopes, ridges, gullies and plateaux of large islands, and on the summits of islets.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.

Species	Common name	Type	EPBC Act	BC Act /DBCA	Source	Habitat description	Pre-survey likelihood	Justification	Post-survey likelihood	Justification
Botaurus poiciloptilus	Australasian Bittern	Bird	EN	EN	DCCEEW 2023a	The Australasian Bittern occurs mainly in freshwater wetlands and, rarely, in estuaries or tidal wetlands.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Neophoca cinerea	Australian Sea-lion, Australian Sea Lion	Mammal	EN	EN	DCCEEW 2023a, DBCA 2023	Australian Sea-lions use a wide variety of habitats for breeding sites (called rookeries) and, during the non-breeding season, for haul-out sites (rest stops, which are also useful for predator avoidance, thermal regulation and social activity). Onshore habitats used include exposed islands and reefs, rocky terrain, sandy beaches and vegetated fore dunes and swales. They also use caves and deep cliff overhangs as haul-out sites or breeding habitat.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Rostratula australis	Australian Painted Snipe	Bird	EN	EN	DCCEEW 2023a	The Australian painted snipe occurs in shallow freshwater (occasionally brackish) wetlands, both ephemeral and permanent, such as lakes, swamps, claypans, inundated or waterlogged grassland/saltmarsh, dams, rice crops, sewage farms and bore drains, generally with a good cover of grasses, rushes and reeds, low scrub, *Muehlenbeckia* spp. (lignum), open timber or samphire.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.

Species	Common name	Type	EPBC Act	BC Act /DBCA	Source	Habitat description	Pre-survey likelihood	Justification	Post-survey likelihood	Justification
Zanda latirostris	Carnaby's Black Cockatoo, Short-billed Black-cockatoo	Bird	EN	EN	DCCEEW 2023a, DBCA 2023	Carnaby's Cockatoo occurs in uncleared or remnant native eucalypt woodlands, especially those that contain salmon gum and wandoo, and in shrubland or kwongan heathland dominated by hakea, dryandra, banksia and grevillea species.	Potential	Suitable habitat may be present within the survey area.	Unlikely	Very marginal suitable habitat for this species was recorded within the survey area; namely Tuart (*Eucalyptus gomphocephala*) trees for roosting. Species is unlikely to use this habitat given the proximity to infrastruture, degraded nature of vegetation and availability of further resources on the island.
Dermochelys coriacea	Leatherback Turtle, Leathery Turtle, Luth	Reptile	EN, MI	VU	DCCEEW 2023a, DBCA 2023	The Leatherback Turtle breeds in tropical locations, but when non-breeding it often migrates to middle latitudes such as the coastal waters of southern Australia. It feeds at the surface, moving slowly to consume jellyfish. Leatherback sea turtles can be found primarily in the open ocean. Leatherbacks follow their jellyfish prey throughout the day, resulting in turtles "preferring" deeper water in the daytime, and shallower water at night. Their favored breeding beaches are mainland sites facing the deep water with soft sand. The typical nesting environment includes a dark forested area adjacent to the beach.	Unlikely	Although species may utilise adjacent beach, they are unlikely to utlise areas (vegetated) within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.

Species	Common name	Type	EPBC Act	BC Act /DBCA	Source	Habitat description	Pre-survey likelihood	Justification	Post-survey likelihood	Justification
Thalassarche cauta	Shy Albatross	Bird	EN, MI	VU	DCCEEW 2023a	Breeds on islands off New Zealand and Tasmania, dispersing across the southern Indian Ocean to southern African waters, where it is especially common off the southern and western coast of South Africa and Namibia. It generally prefers water on the continental shelf, while more scarce further out in the ocean. It does both hunting and scavenging, mainly feeding on pelagic schooling fish and offal and bycatch from fishing vessels, supplemented with crustaceans and squid.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Macronectes giganteus	Southern Giant-Petrel, Southern Giant Petrel	Bird	EN, MI	MI	DCCEEW 2023a	The Southern Giant-Petrel breeds on six subantarctic and Antarctic islands in Australian territory; Macquarie Island, Heard Island and McDonald Island in the Southern Ocean, and Giganteus Island, Hawker Island, and Frazier Island in the Australian Antarctic Territories.	Unlikely	Outside of species distribution.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Phoebetria fusca	Sooty Albatross	Bird	VU, MI	EN	DCCEEW 2023a	The Sooty Albatross is marine and pelagic. During both the breeding and non-breeding seasons, the species occurs widely over pelagic waters, exploiting dispersed sources of food. The species breeds on subtropical and subantarctic islands in the Indian and Atlantic Oceans, on vegetated cliffs and steep slopes that are sheltered from prevailing winds, often amongst tussock grass.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Thalassarche carteri	Indian Yellow-nosed Albatross	Bird	VU, MI	EN	DCCEEW 2023a	The Indian Yellow-nosed Albatross is a marine bird, located in subtropical and warmer subantarctic waters. The species nests on tussock-covered coastal cliffs and slopes, often in rocky situations.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.

Species	Common name	Type	EPBC Act	BC Act /DBCA	Source	Habitat description	Pre-survey likelihood	Justification	Post-survey likelihood	Justification
Thalassarche melanophris	Black-browed Albatross	Bird	VU, MI	EN	DCCEEW 2023a	The Black-browed Albatross is a marine species that inhabits Antarctic, subantarctic and temperate waters and occasionally enters the tropics. It forages around the breaks of continental and island shelves and across nearby underwater banks. The Black-browed Albatross breeds on subantarctic and peri-antarctic islands. The species is rarely sighted over land away from its breeding islands.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Anous tenuirostris melanops	Australian Lesser Noddy	Bird	VU	EN	DCCEEW 2023a	The Australian Lesser Noddy is endemic to Australia and nests on the Houtman Abrolhos Islands and, possibly, Ashmore Reef. Birds remain near breeding islands throughout the year, however, gales may displace birds many hundreds of kilometres. The subspecies *A. t.* subsp. *tenuirostris* nests on tropical and sub-tropical islands in the Indian Ocean.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area. Survey area is not within this species usual distribution.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Macronectes halli	Northern Giant Petrel	Bird	VU, MI	MI	DCCEEW 2023a	In summer, it occurs predominantly in sub-Antarctic to Antarctic waters, usually between 40 and 64° south in open oceans.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Charadrius leschenaultii	Greater Sand Plover, Large Sand Plover	Bird	VU, MI	VU	DCCEEW 2023a, DBCA 2023	The Greater Sand Plover does not breed in Australia. The species is almost entirely coastal, inhabiting littoral and estuarine habitats. They mainly occur on sheltered sandy, shelly or muddy beaches with large intertidal mudflats or sandbanks, as well as sandy estuarine lagoons. Greater sand plovers usually feed from the surface of wet sand or mud on open intertidal flats of sheltered embayments, lagoons or estuaries. Greater sand plovers usually roost on sand-spits and banks on beaches or in tidal lagoons, and occasionally on rocky points or in adjacent areas of saltmarsh or claypans.	Potential	Suitable habitat may be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.

Species	Common name	Type	EPBC Act	BC Act /DBCA	Source	Habitat description	Pre-survey likelihood	Justification	Post-survey likelihood	Justification
Chelonia mydas	Green Turtle	Reptile	VU, MI	VU	DCCEEW 2023a	Green sea turtles move across three habitat types, depending on their life stage. They lay eggs on beaches. Mature turtles spend most of their time in shallow, coastal waters with lush seagrass beds. Adults frequent inshore bays, lagoons, and shoals with lush seagrass meadows. Entire generations often migrate between one pair of feeding and nesting areas. Within their geographical range, the green sea turtles generally stay near continental and island coastlines. Near the coastlines, the green sea turtles live within shallow bays and protected shores. In these protected shores and bays, the green sea turtle habitats include coral reefs, salt marshes, and nearshore seagrass beds. Juveniles are carnivorous, but as they mature they become omnivorous. Young sea turtles eat fish eggs, molluscs, jellyfish, small invertebrates, worms, sponges, algae, and crustaceans. Most adult sea turtles are strictly herbivorous, feeding on algae and sea grass.	Unlikely	Although species may utilise adjacent beach, they are unlikely to utlise areas (vegetated) within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Diomedea epomophora	Southern Royal Albatross	Bird	VU, MI	VU	DCCEEW 2023a	Nearly 80 percent of a royal albatross' life is spent directly exposed to the cold, treacherous, open oceans of the Southern Hemisphere. Remote tropical islands are sought out for nesting. They typically nest on slopes with tussock grass providing some shelter, though exposed sites are also common as they ease the often difficult tasks of take-off and landing.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Diomedea exulans	Wandering Albatross	Bird	VU, MI	VU	DCCEEW 2023a, DBCA 2023	The Wandering Albatross is marine, pelagic and aerial. On breeding islands, the Wandering Albatross nests on coastal or inland ridges, slopes, plateaux and plains, often on marshy ground.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Natator depressus	Flatback Turtle	Reptile	VU, MI	VU	DCCEEW 2023a	Adults inhabit soft bottom habitat over the continental shelf of northern Australia. Flatback Turtles feed in turbid, shallow inshore waters. Nesting habitat includes sandy beaches in the tropics and subtropics with sand temperatures between 25 °C and 33 °C at nest depth.	Unlikely	Although species may utilise adjacent beach, they are unlikely to utlise areas (vegetated) within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.

Species	Common name	Type	EPBC Act	BC Act /DBCA	Source	Habitat description	Pre-survey likelihood	Justification	Post-survey likelihood	Justification
Thalassarche impavida	Campbell Albatross, Campbell Black-browed Albatross	Bird	VU, MI	VU	DCCEEW 2023a	The Campbell Albatross is a marine sea bird inhabiting sub-Antarctic and subtropical waters from pelagic to shelf-break water habitats. In breeding and non-breeding seasons, the Campbell Albatross are specialised shelf feeders, concentrating around breeding islands or over adjacent submarine banks. They make their nests on tussock-covered ledges and terraces of cliffs, slopes and hills, overlooking the sea or valleys, and on the summits of rocky islets.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Thalassarche steadi	White-capped Albatross	Bird	VU, MI	VU	DCCEEW 2023a	The White-capped Albatross is a marine species and occurs in subantarctic and subtropical waters. Birds nest on slopes vegetated with tussock and succulents on Auckland Island.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Setonix brachyurus	Quokka, Kwoka	Mammal	VU	VU	DCCEEW 2023a, 360 Environmental 2022b, DBCA 2023	The Quokka is a habitat specialist. In the north of its range it prefers dense understorey, less than 10 years since fire, adjacent vegetation age that is greater than 25 years and the absence of feral predators. The understorey structure of the habitats currently inhabited by the Quokka consist of dense, low vegetation that provides refuge from predation by owls, the Fox (*Vulpes vulpes*) and the Cat (*Felis catus*). These covered/shady microhabitats may also be important during the hotter months, particularly on Rottnest Island, where animals converge in dense thickets of *Gahnia* spp. and *Acanthocarpus* spp. The main habitat for mainland populations of the Quokka is dense riparian vegetation,but the species also uses a range of other habitat, including: heath and shrubland on the mainland coast and offshore islands, swampy shrublands, swordgrass-dominated understorey, Paperbark (*Melaleuca* spp.) swamp.	Potential	Species is mobile across the island and may utilise the survey area.	Recorded	Species was recorded within the survey area.
Sternula nereis nereis	Australian Fairy Tern	Bird	VU	VU	DCCEEW 2023a, DBCA 2023	The Fairy Tern (Australian) nests on sheltered sandy beaches, spits and banks above the high tide line and below vegetation.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.

Species	Common name	Type	EPBC Act	BC Act /DBCA	Source	Habitat description	Pre-survey likelihood	Justification	Post-survey likelihood	Justification
Halobaena caerulea	Blue Petrel	Bird	VU		DCCEEW 2023a	The blue petrel previously bred on Macquarie Island itself, but breeding is now restricted to offshore stacks near Macquarie Island. Blue petrels nest in colonies, laying a single egg in rock crevices or burrows dug among rocks or tussock grasses. The blue petrel forages in Antarctic and subantarctic waters for pelagic crustaceans, fish, cephalopods and insects.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Pachyptila turtur subantarctica	Fairy Prion (southern)	Bird	VU		DCCEEW 2023a	In Australia, breeding is recorded on two rock stacks off Macquarie Island and on the nearby Bishop and Clerk Island. The population may have been larger prior to the arrival of black rats on Macquarie Island. The subspecies digs burrows among rocks or low vegetation in which to nest. Burrows may be dug below mat forming herbs. Feeds by plucking food from the ocean surface. Some individuals may migrate towards New Zealand and southern Australia in winter.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Pterodroma mollis	Soft-plumaged Petrel	Bird	VU		DCCEEW 2023a	The Soft-plumaged Petrel is a marine, oceanic species. Birds breeding at Iles Crozet forage mainly to the north of the islands, over subtropical waters. The birds burrow among tussock grass and ferns on slopes and valleys.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Ardenna carneipes	Flesh-footed Shearwater, Fleshy-footed Shearwater	Bird	MI	VU	DCCEEW 2023a	The Flesh-footed Shearwater mainly occurs in the subtropics over continental shelves and slopes and occasionally inshore waters. Individuals also pass through the tropics and over deeper waters when on migration. Pairs breed on islands in burrows on sloping ground in coastal forest, scrubland, shrubland or grassland.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Phaethon rubricauda	Red-tailed Tropicbird	Bird	MI	MI, P4	DCCEEW 2023a, DBCA 2023	It nests in loose colonies, on offshore islands and stacks, rocky cliffs, coral atolls and cays. It rarely nests on large bodies of land, though has done so in southern Western Australia.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.

Species	Common name	Type	EPBC Act	BC Act /DBCA	Source	Habitat description	Pre-survey likelihood	Justification	Post-survey likelihood	Justification
Tringa brevipes	Grey-tailed Tattler	Bird	MI	MI, P4	DCCEEW 2023a	The Grey-tailed Tattler is often found on sheltered coasts with reefs and rock platforms or with intertidal mudflats. It can also be found at intertidal rocky, coral or stony reefs as well as platforms and islets that are exposed at low tide.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Actitis hypoleucos	Common Sandpiper	Bird	MI	MI	DCCEEW 2023a	The Common Sandpiper does not breed in Australia. The species utilises a wide range of coastal wetlands and some inland wetlands, with varying levels of salinity, and is mostly found around muddy margins or rocky shores and rarely on mudflats. Generally the species forages in shallow water and on bare soft mud at the edges of wetlands; often where obstacles project from substrate, e.g. rocks or mangrove roots. Roost sites are typically on rocks or in roots or branches of vegetation, especially mangroves.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Anous stolidus	Common Noddy	Bird	MI	MI	DCCEEW 2023a, DBCA 2023	During the breeding season, the Common Noddy usually occurs on or near islands, on rocky islets and stacks with precipitous cliffs, or on shoals or cays of coral or sand. When not at the nest, individuals will remain close to the nest, foraging in the surrounding waters. Birds may nest in bushes, saltbush, or other low vegetation. They may also nest on the ground in Pigface (Carpobrotus spp.) or grass, on bare rock, on top of rocks protruding above vegetation, on shingle beaches, among coral rubble or in sand close to grassy areas.	Potential	Suitable habitat may be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.

Species	Common name	Type	EPBC Act	BC Act /DBCA	Source	Habitat description	Pre-survey likelihood	Justification	Post-survey likelihood	Justification
Apus pacificus	Fork-tailed Swift	Bird	MI	MI	DCCEEW 2023a, DBCA 2023	The Fork-tailed Swift is almost exclusively aerial, flying from less then 1 m to at least 300 m above ground and probably much higher. In Australia, they mostly occur over inland plains but sometimes above foothills or in coastal areas. They often occur over cliffs and beaches and also over islands and sometimes well out to sea. They also occur over settled areas, including towns, urban areas and cities. They mostly occur over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh.	Potential	Suitable habitat may be present within the survey area.	Unlikely	Marginal habitat for this species (scrub, coastal areas, beaches) occurs within the survey area. However, species is almost exclusively aerial. Two records of this species from Rottnest Island are both >20 years old.
Ardenna grisea	Sooty Shearwater	Bird	MI	MI	DCCEEW 2023a	The Sooty Shearwater forages in pelagic (open ocean) sub-tropical, sub-Antarctic and Antarctic waters. The Sooty Shearwater breeds mainly on subtropical and sub-Antarctic islands, as well as on the mainland of New Zealand. Birds nest in burrows or rock crevices on coastal slopes, ridges and cliff tops, in herbfields, tussock grassland or forest. Areas with waterlogged or shallow soils and/or dense vegetation are avoided.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Ardenna pacifica	Wedge-tailed Shearwater	Bird	MI	MI	DCCEEW 2023a, DBCA 2023	The Wedge-tailed Shearwater is a pelagic, marine bird known from tropical and subtropical waters. The species tolerates a range of surface-temperatures and salinities, but is most abundant where temperatures are greater than 21 °C and salinity is greater than 34.6 %. In tropical zones the species may feed over cool nutrient-rich waters. The species has been recorded in offshore waters of eastern Victoria and southern NSW, mostly over continental slope with sea-surface temperatures of 13.9–24.4 °C and usually off the continental shelf in north-west Australia.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.

Species	Common name	Type	EPBC Act	BC Act /DBCA	Source	Habitat description	Pre-survey likelihood	Justification	Post-survey likelihood	Justification
Arenaria interpres	Ruddy Turnstone	Bird	MI	MI	DCCEEW 2023a, DBCA 2023	In Australasia, the Ruddy Turnstone is mainly found on coastal regions with exposed rock coast lines or coral reefs. It also lives near platforms and shelves, often with shallow tidal pools and rocky, shingle or gravel beaches. It can, however, be found on sand, coral or shell beaches, shoals, cays and dry ridges of sand or coral. It has occasionally been sighted in estuaries, harbours, bays and coastal lagoons, among low saltmarsh or on exposed beds of seagrass, around sewage ponds and on mudflats. In north Australia it is known to occur in a wide variety of habitats, and may prefer wide mudflats.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Calidris acuminata	Sharp-tailed Sandpiper	Bird	MI	MI	DCCEEW 2023a, DBCA 2023	The Sharp-tailed Sandpiper does not breed in Australia. In Australia, the species prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. They forage at the edge of the water of wetlands or intertidal mudflats, either on bare wet mud or sand, or in shallow water. Roosting occurs at the edges of wetlands, on wet open mud or sand, in shallow water, or in short sparse vegetation, such as grass or saltmarsh.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Calidris alba	Sanderling	Bird	MI	MI	DCCEEW 2023a, DBCA 2023	In Australia, the species is almost always found on the coast, mostly on open sandy beaches exposed to open sea-swell, and also on exposed sandbars and spits, and shingle banks, where they forage in the wave-wash zone and amongst rotting seaweed. Sanderlings also occur on beaches that may contain wave-washed rocky outcrops. Less often the species occurs on more sheltered sandy shorelines of estuaries, inlets and harbours. Rarely, they are recorded in near-coastal wetlands, such as lagoons, hypersaline lakes, saltponds and samphire flats.	Potential	Suitable habitat may be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.

Species	Common name	Type	EPBC Act	BC Act /DBCA	Source	Habitat description	Pre-survey likelihood	Justification	Post-survey likelihood	Justification
Calidris melanotos	Pectoral Sandpiper	Bird	MI	MI	DCCEEW 2023a, DBCA 2023	In Australasia, the Pectoral Sandpiper prefers shallow fresh to saline wetlands. The species is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Calidris ruficollis	Red-necked Stint	Bird	MI	MI	DCCEEW 2023a, DBCA 2023	In Australasia, the Red-necked Stint is mostly found in coastal areas, including in sheltered inlets, bays, lagoons and estuaries with intertidal mudflats, often near spits, islets and banks and, sometimes, on protected sandy or coralline shores. Occasionally they have been recorded on exposed or ocean beaches, and sometimes on stony or rocky shores, reefs or shoals. They also occur in saltworks and sewage farms; saltmarsh; ephemeral or permanent shallow wetlands near the coast or inland, including lagoons, lakes, swamps, riverbanks, waterholes, bore drains, dams, soaks and pools in saltflats. They sometimes use flooded paddocks or damp grasslands. They have occasionally been recorded on dry gibber plains, with little or no perennial vegetation.	Potential	Suitable habitat may be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Charadrius bicinctus	Double-banded Plover	Bird	MI	MI	DCCEEW 2023a	The Double-banded Plover is found on littoral, estuarine and fresh or saline terrestrial wetlands and also saltmarsh, grasslands and pasture. It occurs on muddy, sandy, shingled or sometimes rocky beaches, bays and inlets, harbours and margins of fresh or saline terrestrial wetlands such as lakes, lagoons and swamps, shallow estuaries and rivers. The species is sometimes associated with coastal lagoons, inland saltlakes and saltworks. It is also found on seagrass beds, especially Zostera, which, when exposed at low tide, remain heavily saturated or have numerous water-filled depressions. This species sometimes utilises kelp beds.	Potential	Suitable habitat may be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.

Species	Common name	Type	EPBC Act	BC Act /DBCA	Source	Habitat description	Pre-survey likelihood	Justification	Post-survey likelihood	Justification
Charadrius dubius	Little ringed plover	BIRD	MI	MI	DBCA 2023	Their breeding habitat is open gravel areas near freshwater, including gravel pits, islands and river edges across the Palearctic including northwestern Africa. It less commonly inhabits coastal areas such as saltpans, estuaries, creeks or rainwater pools on dry salt-flats bordering mangroves.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Gallinago megala	Swinhoe's Snipe	Bird	MI	MI	DCCEEW 2023a	During the non-breeding season Swinhoe's Snipe occurs at the edges of wetlands, such as wet paddy fields, swamps and freshwater streams. The species is also known to occur in grasslands, drier cultivated areas. Habitat specific to Australia includes the dense clumps of grass and rushes round the edges of fresh and brackish wetlands. This includes swamps, billabongs, river pools, small streams and sewage ponds. They are also found in drying claypans and inundated plains pitted with crab holes.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Gallinago stenura	Pin-tailed Snipe	Bird	MI	MI	DCCEEW 2023a	During non-breeding period the Pin-tailed Snipe occurs most often in or at the edges of shallow freshwater swamps, ponds and lakes with emergent, sparse to dense cover of grass/sedge or other vegetation. The species is also found in drier, more open wetlands such as claypans in more arid parts of species' range. It is also commonly seen at sewage ponds; not normally in saline or inter-tidal wetlands.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Hydroprogne caspia	Caspian Tern	Bird	MI	MI	DCCEEW 2023a, DBCA 2023	This species is mostly found in sheltered coastal embayments (harbours, lagoons, inlets, bays, estuaries and river deltas) and those with sandy or muddy margins are preferred. They also occur on near-coastal or inland terrestrial wetlands that are either fresh or saline, especially lakes (including ephemeral lakes), waterholes, reservoirs, rivers and creeks.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.

Species	Common name	Type	EPBC Act	BC Act /DBCA	Source	Habitat description	Pre-survey likelihood	Justification	Post-survey likelihood	Justification
Limosa lapponica	Bar-tailed Godwit	Bird	MI	MI	DCCEEW 2023a, DBCA 2023	Mainly in coastal habitats such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays. It is found often around beds of seagrass and, sometimes, in nearby saltmarsh. It has been sighted in coastal sewage farms and saltworks, saltlakes and brackish wetlands near coasts, sandy ocean beaches, rock platforms, and coral reef-flats. It is rarely found on inland wetlands or in areas of short grass, such as farmland, paddocks and airstrips, although it is commonly recorded in paddocks at some locations overseas.	Potential	Suitable habitat may be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Limosa limosa	Black-tailed Godwit	Bird	MI	MI	DCCEEW 2023a	In Australia the Black-tailed Godwit has a primarily coastal habitat environment. The species is commonly found in sheltered bays, estuaries and lagoons with large intertidal mudflats or sandflats, or spits and banks of mud, sand or shell-grit; occasionally recorded on rocky coasts or coral islets. The use of habitat often depends on the stage of the tide. It is also found in shallow and sparsely vegetated, near-coastal, wetlands; such as saltmarsh, saltflats, river pools, swamps, lagoons and floodplains. There are a few inland records, around shallow, freshwater and saline lakes, swamps, dams and bore-overflows.	Potential	Suitable habitat may be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Motacilla cinerea	Grey Wagtail	Bird	MI	MI	DCCEEW 2023a	Often near flowing water with nearby rocks or surrogate rocky habitat, from mountain streams to weirs in suburban parklands. Outside the breeding season, they may also be seen around lakes, coasts and other watery habitats.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.

Species	Common name	Type	EPBC Act	BC Act /DBCA	Source	Habitat description	Pre-survey likelihood	Justification	Post-survey likelihood	Justification
Numenius minutus	Little Curlew, Little Whimbrel	Bird	MI	MI	DCCEEW 2023a	The Little Curlew is most often found feeding in short, dry grassland and sedgeland, including dry floodplains and blacksoil plains, which have scattered, shallow freshwater pools or areas seasonally inundated. Open woodlands with a grassy or burnt understorey, dry saltmarshes, coastal swamps, mudflats or sandflats of estuaries or beaches on sheltered coasts, mown lawns, gardens, recreational areas, ovals, racecourses and verges of roads and airstrips are also used. When resting during the heat of day, the Little Curlew congregates around pools, river beds and water-filled tidal channels, and shallow water at edges of billabongs.	Potential	Suitable habitat may be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Numenius phaeopus	Whimbrel	Bird	MI	MI	DCCEEW 2023a, DBCA 2023	The Whimbrel is often found on the intertidal mudflats of sheltered coasts. It is also found in harbours, lagoons, estuaries and river deltas, often those with mangroves, but also open, unvegetated mudflats. The Whimbrel generally forages on intertidal mudflats, along the muddy banks of estuaries and in coastal lagoons, either in open unvegetated areas or among mangroves.	Potential	Suitable habitat may be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.

Species	Common name	Type	EPBC Act	BC Act /DBCA	Source	Habitat description	Pre-survey likelihood	Justification	Post-survey likelihood	Justification
Onychoprion anaethetus	Bridled Tern	Bird	MI	MI	DCCEEW 2023a	Bridled Terns occupy tropical and subtropical seas, breeding on islands, including vegetated coral cays, rocky continental islands and rock stacks. Bridled Terns are only rarely found in inshore continental waters and along mainland coastlines, though the species is reported to breed on the mainland of far southern Western Australia. The Bridled Tern roosts ashore when breeding. Frequency of use of different sites varies with time of breeding cycle following return from non-breeding areas, and with time of day. At breeding colonies, birds roost or loaf on branches of shrubs or low trees (such as Pisonia, Argusia), on rocks, less often on the ground among vegetation or rubble or on the shoreline. However, at the start of the breeding season and when the chicks are older (about 40 days old), birds roost or loaf in groups during the day on sandbanks or beaches and the like, distant from final breeding sites.	Potential	Suitable habitat may be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Pandion haliaetus	Osprey	Bird	MI	MI	DCCEEW 2023a	Eastern Ospreys occur in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia and offshore islands. They are mostly found in coastal areas but occasionally travel inland along major rivers, particularly in northern Australia. They require extensive areas of open fresh, brackish or saline water for foraging.	Potential	Suitable habitat may be present within the survey area.	Potential	Marginal habitat for this species (coastal areas, trees for perching, adjacent ocean for foraging) occurs within the survey area. Species is highly mobile and may utilise the survey area as a transient visitor.
Phalaropus lobatus	Red-necked Phalarope	Bird	MI	MI	DCCEEW 2023a, DBCA 2023	During non-breeding period the Red-necked Phalarope occurs mainly at sea. In Australia it is recorded at both inland and coastal lakes/swamps, including highly saline waters and artificial wetlands notably saltfields.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.

Species	Common name	Type	EPBC Act	BC Act /DBCA	Source	Habitat description	Pre-survey likelihood	Justification	Post-survey likelihood	Justification
Pluvialis fulva	Pacific Golden Plover	Bird	MI	MI	DCCEEW 2023a, DBCA 2023	In non-breeding grounds in Australia this species usually inhabits coastal habitats, though it occasionally occurs around inland wetlands. Pacific Golden Plovers usually occur on beaches, mudflats and sandflats (sometimes in vegetation such as mangroves, low saltmarsh such as *Sarcocornia*, or beds of seagrass) in sheltered areas including harbours, estuaries and lagoons, and also in evaporation ponds in saltworks. The species is also sometimes recorded on islands, sand and coral cays and exposed reefs and rocks.	Potential	Suitable habitat may be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Pluvialis squatarola	Grey Plover	Bird	MI	MI	DCCEEW 2023a, DBCA 2023	In non-breeding grounds in Australia, Grey Plovers occur almost entirely in coastal areas, where they usually inhabit sheltered embayments, estuaries and lagoons with mudflats and sandflats, and occasionally on rocky coasts with wave-cut platforms or reef-flats, or on reefs within muddy lagoons. They also occur around terrestrial wetlands such as near-coastal lakes and swamps, or salt-lakes.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Sterna dougallii	Roseate Tern	Bird	MI	MI	DCCEEW 2023a, DBCA 2023	The Roseate Tern occurs in coastal and marine areas in subtropical and tropical seas. The species inhabits rocky and sandy beaches, coral reefs, sand cays and offshore islands. Birds rarely occur in inshore waters or near the mainland, usually venturing into these areas only accidentally, when nesting islands are nearby. They are rarely recorded foraging in shallow sheltered inshore waters. The Roseate Tern usually roosts or loafs in the intertidal zone on islands, including on the upper sections of beaches, above the high-water mark (but still in the wash-zone) on banks, spits and bars, usually of coral or sand. Birds can roost in the open, but this is often at the edge of, or among, sparse, prostrate vegetation, including grasses, succulents and herbs, usually comprising less than 25% ground-cover.	Potential	Suitable habitat may be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.

Species	Common name	Type	EPBC Act	BC Act /DBCA	Source	Habitat description	Pre-survey likelihood	Justification	Post-survey likelihood	Justification
Thalasseus bergii	Greater Crested Tern	Bird	MI	MI	DCCEEW 2023a, DBCA 2023	Greater Crested Terns are widespread around the coasts of the Indian Ocean, Southern Ocean and west-central Pacific Ocean. They may rest on the surface of the sea in calm weather but during storms they shelter behind dunes, rocks and vegetation.	Potential	Suitable habitat may be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area. Vegetation is open, not sheltered.
Tringa nebularia	Common Greenshank, Greenshank	Bird	MI	MI	DCCEEW 2023a, DBCA 2023	The Common Greenshank does not breed in Australia. The species is found in a wide variety of inland wetlands and sheltered coastal habitats of varying salinity. It occurs in sheltered coastal habitats, typically with large mudflats and saltmarsh, mangroves or seagrass. The species is known to forage at edges of wetlands, in soft mud on mudflats, in channels, or in shallows around the edges of water. The Common Greenshank roosts and loafs round wetlands, in shallow pools and puddles, or slightly elevated on rocks, sandbanks or small muddy islets.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Tringa stagnatilis	Marsh Sandpiper, Little Greenshank	Bird	MI	MI	DCCEEW 2023a, DBCA 2023	Permanent or ephemeral wetlands of varying salinity, including swamps, lagoons, billabongs, saltpans, saltmarshes, estuaries, pools on inundated floodplains, and intertidal mudflats and also regularly at sewage farms and saltworks. The Marsh Sandpiper usually forages in shallow water at the edge of wetlands. They probe wet mud of mudflats or feed among marshy vegetation. The Marsh Sandpiper has been recorded roosting or loafing on tidal mudflats, near low saltmarsh, and around inland swamps.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.

Species	Common name	Type	EPBC Act	BC Act /DBCA	Source	Habitat description	Pre-survey likelihood	Justification	Post-survey likelihood	Justification
Tringa totanus	Common Redshank, Redshank	Bird	MI	MI	DCCEEW 2023a	In Australia, the Common Redshank has been recorded at scattered locations. In Western Australia (WA), the species is vargrant to the south-west with records at Peel Inlet, Coodanup, the Gascoyne region, Coral Bay and Carnarvon. The Common Redshank is found at sheltered coastal wetlands such as bays, river estuaries, lagoons, inlets and saltmarsh (with bare open flats and banks of mud or sand). They are also found around saltlakes, freshwater lagoons, artificial wetlands and saltworks and sewage farms.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Xenus cinereus	Terek Sandpiper	Bird	MI	MI	DCCEEW 2023a	The Terek Sandpiper mostly forages in the open, on soft wet intertidal mudflats or in sheltered estuaries, embayments, harbours or lagoons.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Tiliqua rugosa konowi	Rottnest Island bobtail	Reptile	-	VU	360 Environmental 2022b, DBCA 2023	Rottnest Island Bobtails, also known as Shinglebacks, are common around limestone rocks and prefer limestone heath, woodland, and coastal habitats, but also be found around the Settlement Area.	Potential	Suitable habitat may be present within the survey area.	Recorded	Previously recorded by RIA (RIA; pers comms 5 January 2024)
Falco peregrinus	Peregrine Falcon	Bird	-	OS	360 Environmental 2022b, DBCA 2023	The Peregrine Falcon is found in most habitats, from rainforests to the arid zone, and at most altitudes, from the coast to alpine areas. It requires abundant prey and secure nest sites, and prefers coastal and inland cliffs or open woodlands near water, and may even be found nesting on high city buildings. It occurs along rivers and ranges, as well as wooded watercourses and lakes.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.

Species	Common name	Type	EPBC Act	BC Act /DBCA	Source	Habitat description	Pre-survey likelihood	Justification	Post-survey likelihood	Justification
Idiosoma sigillatum	Swan Coastal Plain shieldbacked trapdoor spider	Insect	-	P3	360 Environmental 2022b, DBCA 2023	This species is the dominant idiopid trapdoor spider on the Swan Coastal Plan, where it occurs from Dalyellup north to at least Ledge Point (including Rottnest Island and Garden Island) with the eastern limit of its range along the sandy foothills of the Darling Escarpment, from Boyanup north to at least Gingin (WAM 2018b, Rix et al. 2018). Many of these records are historical in nature and occur within the Perth metropolitan area. It is highly likely that much of the habitat for this species within the Perth metropolitan area has been cleared for urban development and the species is unlikely to occur through much of its historical distribution in urban areas except in remnant habitats (e.g., Kings Park, Bold Park, and Shenton Park bushland). Burrows of this species usually occur in Banksia woodland and heathland on sandy soils and are adorned with a typical 'moustache-like' arrangement of twig-lines.	Potential	Suitable habitat may be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area. One historical record (>60 years) is located within 2km of the survey area.
Lerista lineata	Perth slider, lined skink	Reptile	-	P3	DCCEEW 2023a, DBCA 2023	The species was found in summer-scented wattle (*Acacia rostellifera*) scrub on Rottnest Island in 2016. Occurs in white sand.	Potential	Suitable habitat may be present within the survey area.	Potential	Suitable habitat for this species occurs within the survey area. Records are located within 2km of the survey area.
Ixobrychus dubius	Australian little bittern	BIRD	-	P4	DBCA 2023	The Australian Little Bittern occurs in diverse freshwater habitats, mainly where tall rushes, reeds, *Typha* (*cumbungi*), shrub thickets or other dense cover is inundated by at least 30cm of water. It can be found in vast swamps, but unlike the Australasian Bittern, it often inhabits small patches of dense wetland vegetation such as *Typha* along drains or in small urban lakes.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area. Only one historical record from >80 years.	Unlikely	Suitable habitat for this species was not recorded within the survey area.
Pseudonaja affinis exilis	Rottnest Island dugite	Reptile	-	P4	360 Environmental 2022b, DBCA 2023	Dugites live in abandoned burrows or hollow logs and prefer coastal habitat, limestone heath, woodland, and the Settlement areas of the island.	Potential	Suitable habitat may be present within the survey area.	Recorded	Previously recorded by RIA (RIA; pers comms 5 January 2024)

Species	Common name	Type	EPBC Act	BC Act /DBCA	Source	Habitat description	Pre-survey likelihood	Justification	Post-survey likelihood	Justification
Thinornis cucullatus	Hooded plover, hooded dotterel	BIRD	-	P4	DBCA 2023	The hooded plover (eastern) is a small Australian beach nesting bird. It mainly occurs on wide beaches backed by dunes with large amounts of seaweed and jetsam, creek mouths and inlet entrances. Nests are found above the high water mark on flat beaches, on stony terraces, or on sparsely vegetated dunes.	Unlikely	Suitable habitat for this species is unlikely to be present within the survey area.	Unlikely	Suitable habitat for this species was not recorded within the survey area.

Appendix F Fauna species list

Type	Species	Common name	Listing	Observation type
Bird	*Chroicocephalus novaehollandiae*	Silver gull (Djeninkara)	-	Directly observed
Bird	*Corvus coronoides*	Australian Raven	-	Directly observed
Bird	*Gerygone fusca*	Western Gerygone	-	Heard
Bird	*Hirundo neoxena*	Welcome Swallow	-	Directly observed
Bird	*Lichenostomus virescens*	Singing Honeyeater	-	Directly observed
Bird	*Merops ornatus*	Rainbow bee-eater (Birin-birin)	-	Heard
Bird	*Pachycephala pectoralis*	Golden Whistler	-	Heard
Bird	*Petroica goodenovii*	Red-capped robin	-	Directly observed
Bird	*Spilopelia chinensis*	Spotted Dove	-	Directly observed
Bird	*Todiramphus sanctus*	Sacred Kingfisher	-	Directly observed
Bird	*Zosterops lateralis*	Silvereye	-	Directly observed
Mammal	*Setonix brachyurus*	Quokka (Kwoka)	VU	Directly observed
Reptile	*Ctenotus fallens*	West-coast laterite ctenotus	-	Directly observed
Reptile	*Egernia kingii*	King's skink (Woondi)	-	Directly observed

Appendix G Locations of conservation significant fauna recorded within the survey area

Species	Listing	Easting	Northing	Observation type
Setonix brachyurus (Quokka, Kwoka)	VU under EPBC Act and BC Act	362969	6458348	Scats
Setonix brachyurus (Quokka, Kwoka)	VU under EPBC Act and BC Act	362964	6458395	Directly observed
Setonix brachyurus (Quokka, Kwoka)	VU under EPBC Act and BC Act	362998	6458276	Directly observed

REPORT

Appendix L
Greenhouse Gas Emission Assessment, South Thomson Barge Development Landing (Kewan Bond 2024)

GREENHOUSE GAS EMISSIONS ASSESSMENT

SOUTH THOMSON BARGE DEVELOPMENT LANDING

PREPARED FOR:
ROTTNEST ISLAND AUTHORITY

10 MAY 2024

KEWAN BOND PTY LTD

ENVIRONMENTAL ACCOUNTING
AND CONSULTING SERVICES

Table of Contents

1 Introduction 3
2 Project Description 3
3 Emission Sources 3
4 Emission Calculation Methods 5
5 Raw Data and Emission Calculations 6
5.1 Diesel & LPG Consumption 6
5.2 Seagrass Dredging 7
5.3 Scope 3 Emissions 7
6 Results 8
6.1 Scope 1 Emissions 8
6.2 Scope 3 Emissions 9
7 References 11

1 Introduction

Kewan Bond Pty Ltd (KBPL) was commissioned by the Rottnest Island Authority (RIA) to calculate the estimated greenhouse gas (GHG) emissions associated with the proposed South Thomson Barge Development Landing (the Project).

Emission estimates were calculated based on the available project information and through the application of the latest industry-accepted emission estimation techniques and emission factors. Estimated emissions include consideration of Scope 1, Scope 2 and Scope 3 emissions.

The full emissions inventory for the project is presented in **Attachment 1**.

2 Project Description

The Rottnest Island Authority (RIA) proposes to construct a marine facility in South Thomson Bay at the existing Army Groyne site. The proposed facility will be used primarily for daily supply barge operations which will be relocated from the existing Main Jetty ferry terminal in Thomson Bay, with the intention of separating barge operations from public passenger transfer activities and easing congestion at the ferry terminal.

The marine facility concept also includes the following supporting infrastructure:

- Ferry berth to provide overflow/emergency capacity for passenger transfer during peak seasons.
- Laydown area to support cargo transfer to/from the island.
- Small craft refuelling berth.

Design details have been sourced from consulting engineering firm PAEMAC, who have prepared the design and cost reports associated with the Project.

3 Emission Sources

The calculation and assessment of GHG emissions associated with the Project includes Scope 1, 2 and 3 emissions. This assessment considers estimated emissions associated with the construction phase of the Project, and the first fifty (50) years of operations.

The operational phase involves the relocation of current activities from the existing Main Jetty to the proposed larger barge facility, such that only minimal change to the operational GHG emissions is anticipated to result from the Project. This minor increase is due to the additional distance of the proposed barge landing from the main island settlement. In addition, there is an expected future increase in barge activities, which will involve an increase in fuel consumption and GHG emissions. However, these activities would similarly increase at the existing barge facilities and so are not resulting from the Project itself (the increased activity and emissions would occur even if the Project does not occur).

Scope 1 emissions are the emissions released to the atmosphere as a direct result of an activity, or series of activities at a facility level. Scope 1 emissions are sometimes referred to as direct emissions. Scope 1 emissions associated with the Project will primarily be generated from the consumption of diesel by construction equipment (e.g. barges, earthmoving equipment, dredging equipment).

Emissions resulting from the destruction of sea grass beds have also been assessed and are reported as Scope 1 emissions.

Scope 2 emissions are the emissions released to the atmosphere from the indirect consumption of an energy commodity, such as grid electricity that is generated at another facility. Scope 2 emissions will result from the Project if electricity is sourced from the SWIS (grid supply), but not if electricity is generated on site. Electricity at Rottnest Island is generated on site, so no Scope 2 emissions are expected from the Project.

Scope 3 emissions are indirect GHG emissions other than scope 2 emissions that are generated upstream and downstream of the Project's value chain. They occur as a consequence of the activities of a facility, but from sources not owned or controlled by that facility's business. Examples of scope 3 emissions associated with the Project include:

- Emissions associated with extracting, refining and transporting fuels that are eventually used at the project site
- Emissions associated with the production of key construction materials, including steel and concrete.

4 Emission Calculation Methods

The methods adopted by KBPL for calculating the GHG emissions are aligned primarily with the Australian Government's National Greenhouse and Energy Reporting Scheme (NGERS), which is administered by the Clean Energy Regulator. The greenhouse gases that are reported under the NGER Scheme include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6) and specified kinds of hydro fluorocarbons and perfluorocarbons. The main gases expected to be released from activities associated with the Project are CO_2, CH_4 and N_2O. These are expressed in units of tonnes carbon dioxide equivalent (CO_2-e), which takes into account the 'global warming potential' (GWP) of each gas. Carbon dioxide has a GWP of 1. Methane has a GWP of 28, such that 1 tonne of methane is expressed as 28 tonnes CO_2-e. Nitrous oxide has a GWP of 265.

Energy and emission factors for each of the identified Scope 1 emissions sources are sourced from the latest NGERS Measurement Determination (Compilation 16) (Australian Office of Parliamentary Counsel, 2023).

Some emission sources are not required to be reported by Australian companies under the NGERS. These include Scope 3 emissions and emissions from vegetation clearing. However, these emission sources have been estimated for inclusion within the Project's GHG emission assessment.

Emissions from the decomposition of carbon contained in disturbed seagrass beds have been calculated using emission factors available from recent research papers. The research specifically assessed the emissions associated with seagrass losses in Cockburn Sound, located only 26km to the south east of Rottnest Island. The findings from this research are therefore considered to be closely aligned with the expected results from seagrass losses associated with the Project.

Scope 3 emissions have been calculated based on factors from various sources including:

- Australian National Greenhouse Accounts Factors (2023) – for emission factors for the extraction, refining and delivery of fuels consumed on site.
- NGERS Measurement Determination for emission factors associated with the production of cement used for the Project.
- International Energy Agency for emissions intensity associated with the production of steel used for the Project.

5 Raw Data and Emission Calculations

The following key data, assumptions and emission factors have been applied to the calculation and modelling of GHG emissions for the Project.

5.1 Diesel & LPG Consumption

Estimated volumes of diesel to be consumed during the construction of the Project was provided by PAEMAC. Operational consumption of diesel and LPG was provided by the RIA and is based on current consumption rates by existing operators (Pelagic barge operations and PFM logistics operations), with estimates of anticipated future increased activity. This data is presented in Table 1.

Over the fifty-year operational period modelled, it has been assumed that emissions from diesel and LPG consumption will remain consistent with current operational activities. Although there may be potential for activities to increase over this time, it is assumed that any increase is likely to be more than offset by improvements in energy efficiency and emissions intensity of the activities.

Table 1 Estimated Diesel Consumption

Estimated Fuel Consumption (Litres)				
Construction	**Stage 1**	**Stage 2**	**Annual Operations**	**TOTAL (50 years)**
Diesel - Transport of construction materials and construction personnel to the island	60,108	36,060	-	96,168
Diesel - All construction equipment (including dredging)	512,112	104,938	-	617,050
Operations				
Diesel - Barges	-	-	98,800	4,940,000
Diesel - Trucks & Tow Motors	-	-	15,860	793,000
LPG - Forklifts	-	-	34,515	1,725,750
TOTAL DIESEL	**572,220**	**140,998**	**114,660**	**6,446,218**
TOTAL LPG	**-**	**-**	**34,515**	**1,725,750**

Energy and emission factors for diesel and LPG consumption are sourced from the latest NGERS Measurement Determination (Compilation 16) (Australian Office of Parliamentary Counsel, 2023). These factors include emission estimates for CO_2, CH_4 and N_2O – which are reported in units of CO_2^{-e} and consider the GWP of each gas.

5.2 Seagrass Dredging

The Project will require dredging of the sea floor near the proposed jetty. The dredging will involve the destruction of approximately 2.39 ha of existing seagrass beds. The disturbance of organic carbon (C_{org}) stocks within seagrass meadows can result in the decomposition, remineralization and release of these carbon stocks as CO_2. Research of seagrass meadows in Cockburn Sound estimated that shallow seagrass meadows had C_{org} stocks in 50 cm thick soils of 4.5 ± 0.7 kg C_{org}/m^2. (Salinas, et al., 2020). This carbon content has been assumed for the seagrass beds impacted in Thomsons Bay by the Project.

It is difficult to determine what proportion of organic carbon disturbed during the Project's construction will be remineralized and released as CO_2. For the purposes of the GHG assessment, a worst-case scenario has been assumed, whereby 100% of estimated soil carbon stocks is released as CO_2. This approach is consistent with the approach taken in a recent research project (Dahl, et al., 2023).

Soil organic carbon stocks are converted to CO_2^{-e} emissions by multiplying by 3.67 (the molecular ratio of CO_2 to C).

5.3 Scope 3 Emissions

A process of identifying the likely Project Scope 3 emissions was conducted, with consideration of:

- the relative significance of the emissions
- RIA's level of influence on emission reductions.

Of the various materials and inputs to be consumed for the Project, steel and cement were considered to have significant emission profiles for their upstream production/manufacturing.

Diesel consumption is the main Scope 1 emission source for the Project. Scope 3 emission factors exist for estimating emissions from the upstream extraction, refining and transport of diesel.

The following assumptions were made in relation to the Scope 3 emission calculations:

a) Steel during construction – volumes provided by PAEMAC. Emission factor (1.39 tonnes CO2-e/t) is the direct CO_2 intensity of crude steel production (International Energy Agency https://www.iea.org/reports/iron-and-steel)

b) Cement during construction – volumes of pre-mixed concrete provide by PAEMAC. Assume 420kg cement per m^3 of concrete. Emission factor (0.544 t CO_2^{-e}/t cement) sourced from NGERS Measurement Determination.

c) Diesel refining and transport – volumes are the kL of diesel expected to be consumed for the Project. Emission factor (3.6 kg CO_2^{-e}/GJ) sourced from the National Greenhouse Accounts Factors (Table 8) (Australian Government, Department of Climate Change, Energy, the Environment and Water, 2023).

6 Results

6.1 Scope 1 Emissions

Project construction across Stages 1 and 2 are estimated have scope 1 GHG emissions of 2,328 tonnes CO_2^{-e}. Scope 1 emissions of CO_2, CH_4 and N_2O are presented in Table 2 and Figure 1. Annual scope 1 emissions over the construction and operational phases are presented in Figure 2.

There are no Scope 2 emissions associated with the project because there is no consumption of electricity from the WA State grid supply.

Table 2 Project Emission Estimates by Gas

Scope 1 CO_2 Emissions (CO_2^{-e})	Units	Construction		Operations		TOTAL
		Stage 1	Stage 2	Annual	Over 50 Yrs	
Diesel (Construction)	Tonne	1,382	283	-	-	1,665
Diesel (Transport)	Tonne	162	97	309	15,468	15,728
LPG	Tonne	-	-	80	4,010	4,010
Seagrass disturbance	Tonne	394.7	0	-	-	394.7
Total Scope 1 CO_2 Emissions	**Tonne**	**1,939**	**380**	**390**	**19,479**	**21,798**

Scope 1 CH_4 Emissions (CO_2^{-e})	Units	Construction		Operations		TOTAL
		Stage 1	Stage 2	Annual	Over 50 Yrs	
Diesel (Construction)	Tonne	1.98	0.41	-	-	2.38
Diesel (Transport)	Tonne	0.02	0.01	0.04	2.21	2.25
LPG	Tonne	-	-	0.27	13.32	13.32
Total Scope 1 CH_4 Emissions	**Tonne**	**2.00**	**0.42**	**0.31**	**15.54**	**17.95**

Scope 1 N_2O Emissions (CO_2^{-e})	Units	Construction		Operations		TOTAL
		Stage 1	Stage 2	Annual	Over 50 Yrs	
Diesel (Construction)	Tonne	3.95	0.81	-	-	4.76
Diesel (Transport)	Tonne	1.16	0.70	2.21	110.65	112.50
LPG	Tonne	-	-	0.27	13.32	13.32
Total Scope 1 N_2O Emissions	**Tonne**	**5.11**	**1.51**	**2.48**	**123.97**	**130.59**

Total Scope 1 Emissions (CO_2^{-e})	Units	Construction		Operations		TOTAL
		Stage 1	Stage 2	Annual	Over 50 Yrs	
Diesel (Construction)	Tonne	1,388	284	-	-	1,672
Diesel (Transport)	Tonne	163	98	312	15,581	15,843
Seagrass disturbance	Tonne	395	0	-	-	395
LPG	Tonne	-	-	81	4,037	4,037
Total Scope 1 CO_2^{-e} Emissions	**Tonne**	**1,946**	**382**	**392**	**19,618**	**21,946**

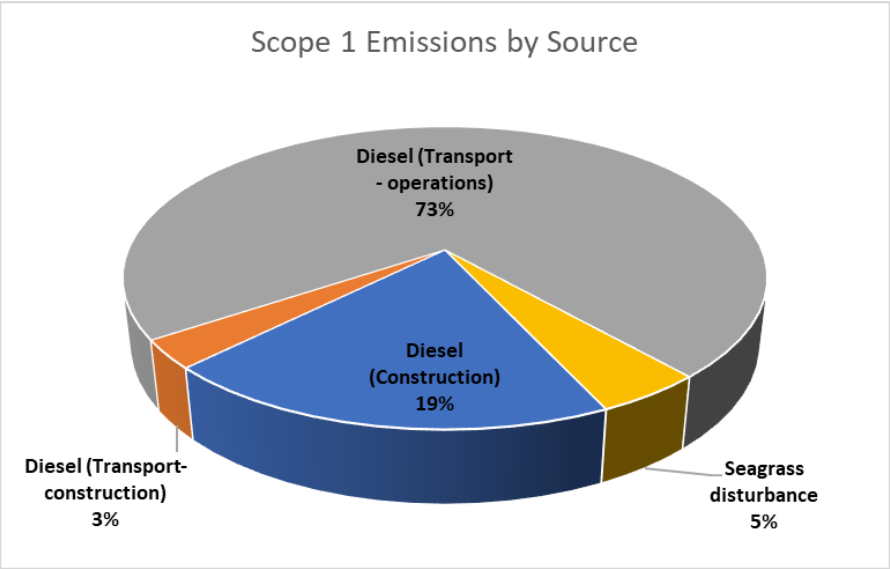

Figure 1 Scope 1 GHG Emissions by Emission Source

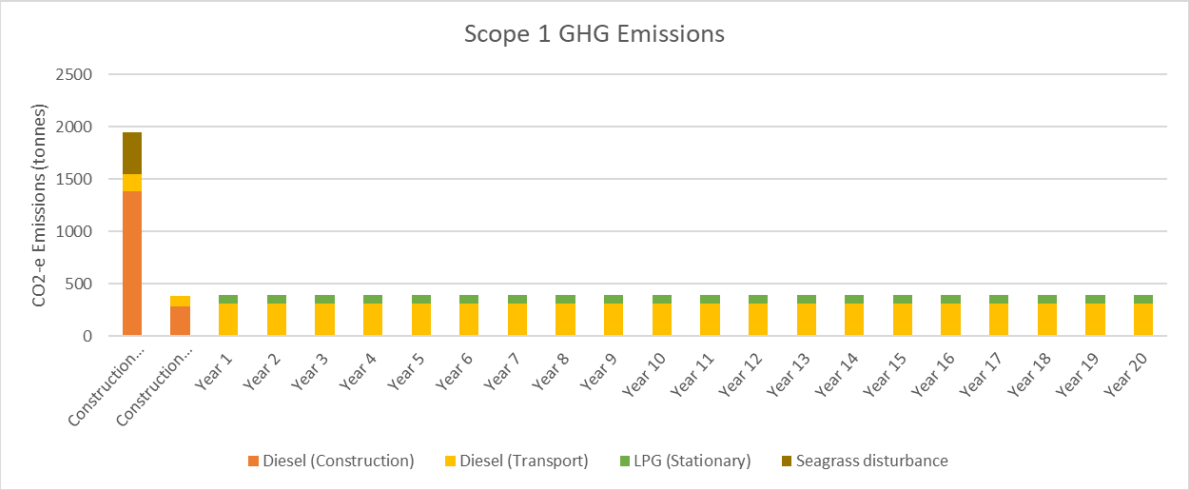

Figure 2 Scope 1 GHG Emissions by Emission Year

6.2 Scope 3 Emissions

Estimated Scope 3 emissions associated with the Project's construction and operations are presented in Table 3. Scope 3 emissions represent 23% of the total Scope 1 and Scope 3 emissions, as shown in Figure 3.

The identification and calculation of Scope 3 emissions was conducted in alignment with the GHG Protocol's 'Corporate Value Chain (Scope 3) Accounting and Reporting Standard', published by the World Resources Institute. The selection of Scope 3 emission sources involved identifying the most significant likely sources of emissions upstream and downstream of the Project's value chain.

The production and manufacturing of cement and steel have a relatively high emissions intensity and are key construction materials for the Project.

Table 3 Project Scope 3 Emission Estimates by Source

Total Scope 3 Emissions (CO_2^{-e})	Units	Construction		Operations		TOTAL
		Stage 1	Stage 2	Annual	Over 50 Yrs	
Diesel	Tonne	382	94	77	3,828	4,305
Cement	Tonne	39	34	-	-	73
Steel	Tonne	39	125	-	-	164
Total Emissions	**Tonne**	**460**	**253**	**77**	**3,828**	**4,542**

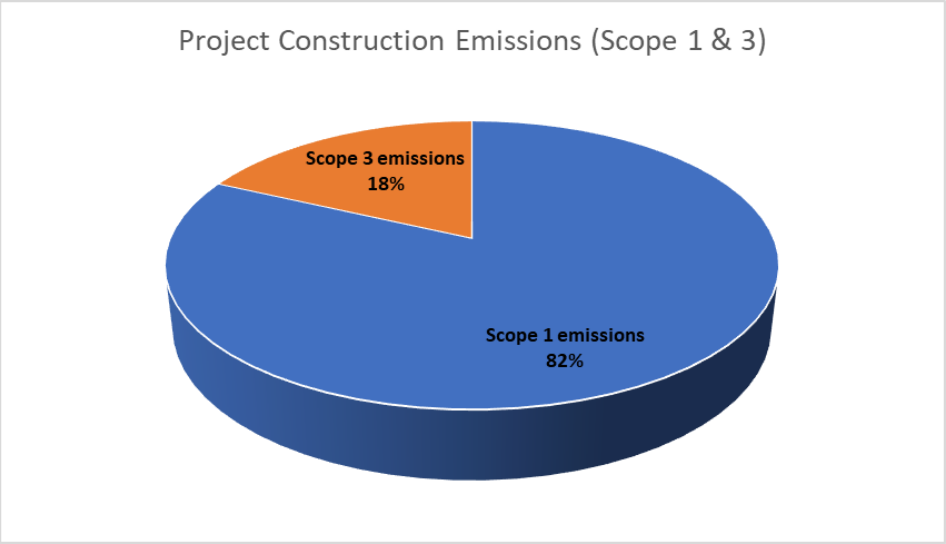

Figure 3 Total Scope 1 and Scope 3 GHG Emissions

7 References

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ATTACHMENT 1 – GHG EMISSIONS INVENTORY

Raw Data	Units	Construction Stage 1	Construction Stage 2	Total Operations (over 50 Years)	PROJECT TOTAL
Diesel (Non-Transport)	kL	512	105		617
Diesel (Transport)	kL	60	36	5,733	5,829
LPG (Non-transport)	kL			1,726	1,726
Area of seagrass disturbance	m2	23,900	0.00	0.00	23,900
Organic carbon factor in seagrass beds	kg C_{org}/m^2)	4.50			
Total organic carbon disturbed	t	107.55			
Pre-mix concrete	m3	170.00	150.00	0.00	320
Cement component	t	71.40	63.00	0.00	134
Construction Steel	t	28.00	89.80	0.00	118

Energy Use in GJ	Units	Construction Stage 1	Construction Stage 2	Total Operations (over 50 Years)	PROJECT TOTAL
Diesel (Non-Transport)	GJ	19,768	4,051		23,818
Diesel (Transport)	GJ	2,320	1,392	221,294	225,006
LPG (Stationary)	GJ	0	0	66,614	66,614
Total Energy	**GJ**	**22,088**	**5,443**	**287,908**	**315,438**

Scope 1 CO_2 Emission Factors	Units	Construction Stage 1	Construction Stage 2	Total Operations (over 50 Years)	PROJECT TOTAL
Diesel (Stationary)	Tonne CO2e/GJ	0.0699	0.0699	0.0699	0.0699
Diesel (Mobile)	Tonne CO2e/GJ	0.0699	0.0699	0.0699	0.0699
LPG (Stationary)	Tonne CO2e/GJ	0.0602	0.0602	0.0602	0.0602
Seagrass disturbance	T CO_2^e/t org C	3.67			

Scope 1 CH_4 Emission Factors	Units	Construction Stage 1	Construction Stage 2	Total Operations (over 50 Years)	PROJECT TOTAL
Diesel (Stationary)	Tonne CO2e/GJ	0.0001	0.0001	0.0001	0.0001
Diesel (Mobile)	Tonne CO2e/GJ	0.00001	0.00001	0.00001	0.00001
LPG (Stationary)	Tonne CO2e/GJ	0.0002	0.0002	0.0002	0.0002

Scope 1 N_2O Emission Factors	Units	Construction Stage 1	Construction Stage 2	Total Operations (over 50 Years)	PROJECT TOTAL
Diesel (Stationary)	Tonne CO2e/GJ	0.0002	0.0002	0.0002	0.0002
Diesel (Mobile)	Tonne CO2e/GJ	0.0005	0.0005	0.0005	0.0005
LPG (Stationary)	Tonne CO2e/GJ	0.0002	0.0002	0.0002	0.0002

Scope 2 CO_2-e Emission Factors	Units	Construction Stage 1	Construction Stage 2	Total Operations (over 50 Years)	PROJECT TOTAL
Electricity	Tonne CO2e/MWh	0.51	0.51	0.51	0.51

Scope 1 CO_2 Emissions (CO2-e)	Units	Construction Stage 1	Construction Stage 2	Total Operations (over 50 Years)	PROJECT TOTAL
Diesel (Other Stationary)	Tonne	1,382	283	0	1,665
Diesel (Transport)	Tonne	162	97	15,468	15,728
LPG (Stationary)	Tonne	0	0	4,010	4,010
Seagrass disturbance	Tonne	394.7		0.0	394.7
Total Scope 1 CO2 Emissions	**Tonne**	**1,939**	**380**	**19,479**	**21,798**

Scope 1 CH4 Emissions (CO2-e)	Units	Construction Stage 1	Construction Stage 2	Total Operations (over 50 Years)	PROJECT TOTAL
Diesel (Other Stationary)	Tonne	1.98	0.41	0.00	2.38
Diesel (Transport)	Tonne	0.02	0.01	2.21	2.25
LPG (Stationary)	Tonne	0.00	0.00	13.32	13.32
Total Scope 1 CH4 Emissions	**Tonne (CO2-e)**	**2.00**	**0.42**	**15.54**	**17.95**

Scope 1 N2O Emissions (CO2-e)	Units	Construction Stage 1	Construction Stage 2	Total Operations (over 50 Years)	PROJECT TOTAL
Diesel (Other Stationary)	Tonne	3.95	0.81	0.00	4.76
Diesel (Transport)	Tonne	1.16	0.70	110.65	112.50
LPG (Stationary)	Tonne	0.00	0.00	13.32	13.32
Total Scope 1 N2O Emissions	**Tonne (CO2-e)**	**5.11**	**1.51**	**123.97**	**130.59**

Total Scope 1 Emissions (CO2-e)	Units	Construction Stage 1	Construction Stage 2	Total Operations (over 50 Years)	PROJECT TOTAL
Diesel (Construction)	Tonne	1,388	284	0	1,672
Diesel (Transport- construction)				0	261
Diesel (Transport)	Tonne	163	98	15,581	15,581
LPG (Stationary)	Tonne	0	0	4,037	4,037
Seagrass disturbance	Tonne	395		0	395
Total Scope 1 CO2 Emissions	**Tonne**	**1,946**	**382**	**19,618**	**21,946**

Scope 2 CO_2-e Emissions	Units	Construction Stage 1	Construction Stage 2	Total Operations (over 50 Years)	PROJECT TOTAL
Electricity	Tonne	0	0	0	0

Scope 3 CO_2-e Emission Factors	Units	Construction Stage 1	Construction Stage 2	Total Operations (over 50 Years)	PROJECT TOTAL
Diesel	Tonne CO2e/GJ	0.0173	0.0173	0.0173	0.0173
Cement	Tonne CO2-e/t	0.544	0.5440	0.5440	0.5440
Steel	Tonne CO2-e/t	1.390	1.3900	1.3900	1.3900

Total Scope 3 Emissions (CO2-e)	Units	Construction Stage 1	Construction Stage 2	Total Operations (over 50 Years)	PROJECT TOTAL
Diesel	Tonne	382	94	3,828	4,305
Cement	Tonne	39	34	0	73
Steel	Tonne	39	125	0	164
Total Emissions	**Tonne**	**460**	**253**	**3,828**	**4,542**

TOTAL EMISSIONS (Scope 1&3)	Units	Construction Stage 1	Construction Stage 2	Total Operations (over 50 Years)	PROJECT TOTAL
Scope 1 emissions	Tonne	1,946	382	19,618	21,946
Scope 3 emissions	Tonne	460	253	3,828	4,542
Total Emissions	**Tonne**	**2,406**	**636**	**23,446**	**26,488**

REPORT

Appendix M
Aboriginal cultural heritage documents

South West Aboriginal Land and Sea Council Aboriginal Corporation
Level 2, 100 Royal St | East Perth | WA | 6004
PO Box 6383 | East Perth | WA | 6892
T 08 9358 7400
F 08 9358 7499
W noongar.org.au
ICN 3832
ABN 42 485 265 673

Your ref: 24/67
Our ref: HER.1517

25 March 2024

Richenda Prall
Cultural Heritage Manager
Rottnest Island Authority
1 Mews Road
Fremantle WA 6160

By email: richenda.prall@dbca.wa.gov.au

Dear Richenda,

Whadjuk – Noongar Standard Heritage Agreement (NSHA) Activity Notice – South Thompson Barge Development Landing

We refer to the above-mentioned Activity Notice, issued to the South West Aboriginal Land and Sea Council (**SWALSC**) on 1 March 2024.

Activity Notice Response (ANR) under Clause 8.3 of the NSHA.

	Clause	Key Statements	SWALSC Assessment
1.	8.3(a), 9.2	Requirement for Survey	As per AN Key Statement (b) – Survey **is not** required

Reasons to support the assessment are:

- The Activity Program does not consist of Low Ground Disturbance Activities under the terms of the Noongar Standard Heritage Agreement.
- However, a previous heritage survey has been conducted over the Activity Area in Feburary 2019.
- The recommendation from this heritage survey was that Whadjuk Archaeological Monitors are present during ground disturbing works.

Should you wish to discuss or request further information in relation to any aspect of the matter, please do not hesitate to contact me on 9358 7400 or at heritage@noongar.org.au.

Yours sincerely,

Tricia Ranger
Manager Heritage, Land & Community

REPORT OF AN ETHNOGRAPHIC ABORIGINAL HERITAGE SURVEY OF THE ARMY JETTY, ROTTNEST ISLAND, WESTERN AUSTRALIA

A report prepared for the Rottnest Island Authority

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- Mr Ezra Jacobs – Rottnest Island Authority (Aboriginal Heritage Officer)
- Mr Clinton Hull – Rottnest Island Authority (Project Manager)
- Mr Tristan Clark – Department of Planning, Lands & Heritage (Heritage Support)
- Ms Louise Huxtable – Brad Goode & Associates Pty Ltd (Consulting Anthropologist)
- Mrs Leah Mackie – Brad Goode & Associates Pty Ltd (Research & Mapping Assistant)

Whadjuk People WC2011/009 Native Title Claim group representatives

- Mr Gary Bennell
- Mr Brendan Moore
- Mr Trevor McMahon
- Mr Elisha Jacobs
- Mr Greg Ugle
- Mr Peter Garlett
- Mr Tony Hill

DISCLAIMER

All of the information contained in this report is believed to be correct and accurate at the time it was recorded. The author does not take responsibility or accept any liability for errors or omissions contained in the report based upon information supplied by others.

Warning: This document may contain names, images or material that relates to deceased Aboriginal persons. Permission was sought and granted by the consulted informants to cite this information.

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MAPPING

Datum Used: GDA 1994 MGA Zone 50. Handheld GPS Unit Garmin 64ST (+/- 10m)

GLOSSARY OF TERMS

The Proponent – Rottnest Island Authority
The Consultant – Brad Goode & Associates Pty Ltd
ACMC – Aboriginal Cultural Material Committee
AHA – Western Australian Aboriginal Heritage Act (1972)
AHIS – Aboriginal Heritage Inquiry System
BGA – Brad Goode & Associates Pty Ltd
CHMP – Cultural Heritage Management Plan
DPLH – Department of Planning, Lands and Heritage
HIS – Heritage Information Submission
NSHA – Noongar Standard Heritage Agreement
RIA – Rottnest Island Authority
SWALSC – South West Aboriginal Land and Sea Council

EXECUTIVE SUMMARY

The Rottnest Island Authority ('RIA') is proposing a new barge landing and cargo handling facility to the existing Army Jetty site which is located in Thomson Bay on the eastern shoreline of Rottnest Island, Western Australia.

To inform design, Geotechnical investigations on the sea bed are required followed by construction and dredging to provide safe vessel access to the new facility. All construction will be confined within the 'Works Area'. The works area is to the east of the existing Army Jetty site and covers an area of sea bed and shore line which measures 190m x 150m, an area of 2.6 hectares (see Figure 1).

As a part of the approvals process the proponent has commissioned Brad Goode and Associates Pty Ltd (BGA) to conduct a Site Identification Ethnographic Aboriginal Heritage Survey of the Works Area, to determine potential impacts to any sites or places of Aboriginal heritage significance as defined by section 5 of the Western Australian Aboriginal Heritage Act (1972) – AHA.

Specifically the works proposed include:

- Construction of an extension to the existing Army Jetty groyne including ferry berthing facility, increasing the total length of the jetty to approximately 180m. A new 60m groyne will be constructed to the east of the facility;
- Dredging area to the east of the existing jetty to include the navigation channel (a circular area approximately 100m in diameter)
- Conduct geotechnical investigations on the sea bed to the east and north of the existing jetty (a rectangular area approximately 190m x 150m)
- Road access and foreshore improvements to facilitate vehicle and pedestrian access.

A search of the DPLH Aboriginal Heritage Inquiry System (AHIS) conducted on 22nd January 2019 determined that there are **no** previously recorded Registered Aboriginal Sites located within the Army Jetty Works Area. The search did identify that there are **three** Other Heritage Places that have DPLH extents overlaying the 'Works Area' (see Table 1 and Appendix 1).

Place ID 3443 Rottnest Cemetery North, Place ID 3776 Indian Ocean and Place ID 20862 Rottnest Island (Wadjemup) have been assessed by the ACMC as not meeting the terms of section 5 of the AHA and are classified as Stored Data. Rottnest Island Authority has no legal obligations under the AHA in relation to these heritage places.

In relation to Place ID 20862 Rottnest Island (Wadjemup), a review of previous Aboriginal Heritage Surveys has revealed the high cultural and historical significance attributed to the whole of Rottnest Island as a sacred site. It is believed to not only be a place for spirits of the dead, it is also seen as a "land of the living where the ancestral spirits, the spirits of historic heroes and the spirit of living generations rest before their journey back through the cycle of life" (Muir 2012: 179).

Archival research identifies a creation story about the formation of Rottnest. 'The Legend of the Crocodile and the Waugal' is a traditional mythological narrative that depicts a battle where Rottnest Island alongside Garden Island are formed as the broken pieces of the Crocodile tail left behind after an epic battle between the Crocodile and the Shark, which resulted in the two islands being formed (Muir 2012: 25, 192-193).

Despite these narratives the ACMC has not determined that these values meet the criteria of section (5b) of the AHA, nor has the ACMC recognised the special place (5c) that Rottnest has in the history of the State.

Despite this determination the whole of the island has immense heritage and cultural significance to the Whadjuk people and as such this should be respected by the RIA in any activities that they conduct anywhere on the island (see Green & Aguiar 2018).

As a result of the consultations held with seven representatives of the Whadjuk NTC group on the 5th February 2019 **no new** ethnographic sites, as defined by section 5 of the AHA were identified within the Army Jetty Works Area.

During the consultations, the Whadjuk NTC group representatives were concerned that there could be artefacts in the subsurface and potential burials could be located in the dunes close to the Works Area as traditionally Nyungars were buried facing east behind sand dunes (see Bates 1985: 222-224). As a result it was requested that Archaeological monitors be present during all ground disturbing works and archaeological techniques, such as test pitting and sieving be employed if artefacts are found.

During the consultations the Whadjuk NTC group representatives confirmed the previously recorded creation mythology for Rottnest (Wadjemup) Island and its significance and objected to the determination by the ACMC that the island does not constitute an Aboriginal site within the meaning of the AHA.

In relation to spiritual significance of the project area, the Whadjuk NTC group confirmed that Nyungar people traditionally believed that when they died their spirit would cross the Western Sea and go to Koorannup (at Wadjemup) to a place of rest (see Bates 1985: 222-224). The group further advised that historically when Aboriginal people were imprisoned on Rottnest Island, many Nyungar people believed that those imprisoned were literally coming to Rottnest to die and in fact many did. Therefore it is the view that burials could be anywhere as opposed to the known cemetery.

As a result of the spiritual sentiment associated with the project area, the Whadjuk NTC group representatives requested that a proprietary ritual be performed prior to the works occurring at the Army Jetty. This ceremony would be determined by the Whadjuk who are engaged to conduct it, but it would need to be prior to any work occurring.

In relation to the Aboriginal history of Rottnest Island, the Whadjuk NTC group representatives also requested that interpretative signage be installed at the Army Jetty to provide people visiting the island more information about Aboriginal history of the project area.

As a result of the survey the following recommendations are made in relation to the Western Australian Aboriginal Heritage Act (1972):

As no ethnographic sites of significance as defined by section 5 of the AHA were identified to be located in the Army Jetty Project Area **it is recommended** that Rottnest Island Authority can proceed with the project as currently planned without undue risk of breaching the AHA in relation to ethnographic sites and places.

It is further recommended that Rottnest Island Authority gives due consideration to the requests made during the ethnographic survey by the Whadjuk WC2011/009 that:

- Archaeological monitors be present during all ground disturbing works and archaeological techniques, such as test pitting and sieving be employed if artefacts are found;
- A proprietary ritual (to be determined by the Whadjuk NTC group) be performed prior to the works occurring; and
- An interpretative sign be installed at the Army Jetty which explains the Aboriginal history of the area.

CONTENTS

ACKNOWLEDGEMENTS **1**

MAPPING **1**

GLOSSARY OF TERMS **1**

EXECUTIVE SUMMARY **2**

CONTENTS **4**

ISSUE **6**

REPORT OBJECTIVES **6**

BACKGROUND **6**

LOCATION **8**

ETHNOGRAPHIC & HISTORICAL BACKGROUND **9**

TRADITIONAL CULTURE 9
BRIEF ABORIGINAL HISTORY OF ROTTNEST ISLAND 11

ARCHIVAL RESEARCH **14**

SITES AND PLACES REGISTER SEARCH 14
REVIEW OF RELEVANT SITE FILES 15
REVIEW OF RELEVANT HERITAGE PLACE FILES 15
REVIEW OF RELEVANT ETHNOGRAPHIC REPORTS 17
OUTCOMES OF ARCHIVAL RESEARCH 19

IDENTIFICATION OF SPOKESPEOPLE **20**

THE RIGHT TO SPEAK ON HERITAGE ISSUES 20
NATIVE TITLE CLAIMS OVER THE SURVEY AREA 21
SELECTION OF SPOKESPEOPLE FOR THIS SURVEY 21

COMMUNITY CONSULTATION **23**

AIMS 23
METHOD 23
COMMUNITY CONSULTATION PROCESS 23
COMMUNITY CONSULTATION OUTCOMES 31

RECOMMENDATIONS **32**

BIBLIOGRAPHY **33**

APPENDIX 1: DPLH SITES AND PLACES REGISTER SEARCH **35**

APPENDIX 2: LETTER OF ADVICE **36**

APPENDIX 3: MAP OF THE PROJECT AREA IN RELATION TO ABORIGINAL HERITAGE SITES **37**

APPENDIX 4: DESIGN PLANS **38**

LIST OF FIGURES

FIGURE 1: ROTTNEST ISLAND ARMY JETTY DESIGN PLAN - STAGE 2B..... 7
FIGURE 2: ROTTNEST ISLAND ARMY JETTY DESIGN PLAN – STAGE 2B 7
FIGURE 3: LOCATION OF THE ARMY JETTY SURVEY AREA..... 8
FIGURE 4: VISITORS ARRIVING AT EXCURSIONIST JETTY IN 1910 BEING TAKEN BY CAR AND HORSE-DRAWN TRAM FROM TO THE SETTLEMENT OF THOMSON BAY (PHOTO RIA 2019)..... 13
FIGURE 5: GEORGIE AT THE EXCURSIONIST JETTY (PHOTO RIA 2019). 13
FIGURE 6: SURVEY TEAM MEETING AT A GAZEBO LOCATED AT THE ARMY JETTY..... 23
FIGURE 7: MR HULL EXPLAINING THE DESIGN PLANS FOR THE PROPOSED WINGWALL EXTENSION, NEW WINGWALL AND DREDGING. 24
FIGURE 8: MR HULL POINTING OUT THE AREAS WHERE THE NEW WINGWALLS AND DREDGING ARE PROPOSED; VIEW N/NW..... 25
FIGURE 9: SURVEY TEAM VIEWING THE SEAWEED ACCUMULATED ON THE EASTERN SIDE OF ARMY JETTY; VIEW TO THE NORTH..... 26
FIGURE 10: (FROM LEFT) MS LOUISE HUXTABLE, MR GARY BENNELL, MR GREG UGLE, MR ELISHA JACOBS, MR BRENDAN MOORE, MR TREVOR MCMAHON, MR BRAD GOODE, MR CLINTON HULL, MR PETER GARLETT, MR TONY HILL AND MR EZRA JACOBS. 31

LIST OF TABLES

TABLE 1: SUMMARY OF ABORIGINAL HERITAGE SITES AND PLACES WITHIN THE PROJECT AREA 14

REPORT

Report of an Ethnographic Aboriginal Heritage Survey of Army Jetty, Rottnest Island, Western Australia

ISSUE

The Rottnest Island Authority ('RIA') is proposing a new barge landing and cargo handling facility and 60m groyne to the existing Army Jetty site which is located in Thomson Bay on the eastern shoreline of Rottnest Island, Western Australia.

To inform design, Geotechnical investigations on the sea bed are required followed by construction and dredging to safe vessel access to the new facility. All construction will be confined within the 'Works Area'. The works area is to the east of the existing Army Jetty and covers an area of sea bed and shore line which measures 190m x 150m, an area of 2.6 hectares (see Figure 1).

The proponent wishes to determine if there are any sites or places of Aboriginal heritage significance as defined by Section 5 of the Western Australian Aboriginal Heritage Act (1972) (AHA) that will be affected by this proposed work thereby fulfilling their obligations under the AHA.

REPORT OBJECTIVES

To report on archival research in order to determine if any previously recorded Aboriginal Heritage sites or places will be affected by the above project proposal.

To report on consultations held with representatives of the Whadjuk People WC2011/009 Native Title Claim (NTC) group in order to determine if any new Aboriginal Heritage sites or places will be affected by the above project proposal.

To report upon management recommendations should any sites or places of significance as defined by Section 5 of the AHA be identified to be located within the project area.

To report upon any recommendations and/or the significance of the sites or places should the proponent be required to make application under Section 18 of the AHA for consent to use the land that may contain an Aboriginal site.

BACKGROUND

On 11th January 2019, Mr Ezra Jacobs (Aboriginal Heritage Officer) from Rottnest Island Authority commissioned Brad Goode and Associates Pty Ltd (BGA) to conduct a Site Identification Ethnographic Aboriginal Heritage Survey of the Army Jetty on Rottnest Island, Western Australia.

Specifically the works proposed include:

- Construction of an extension to the existing Army Jetty groyne including ferry berthing facility, increasing the total length of the jetty to approximately 180m. A new 60m groyne will be constructed to the east of the facility;
- Dredging area to the east of the existing jetty to include the navigational channel (a circular area approximately 100m in diameter);
- Conduct geotechnical investigations on the sea bed to the east and north of the existing jetty (a rectangular area approximately 190m x 150m); and
- Road access and foreshore improvements to facility vehicle and pedestrian access.

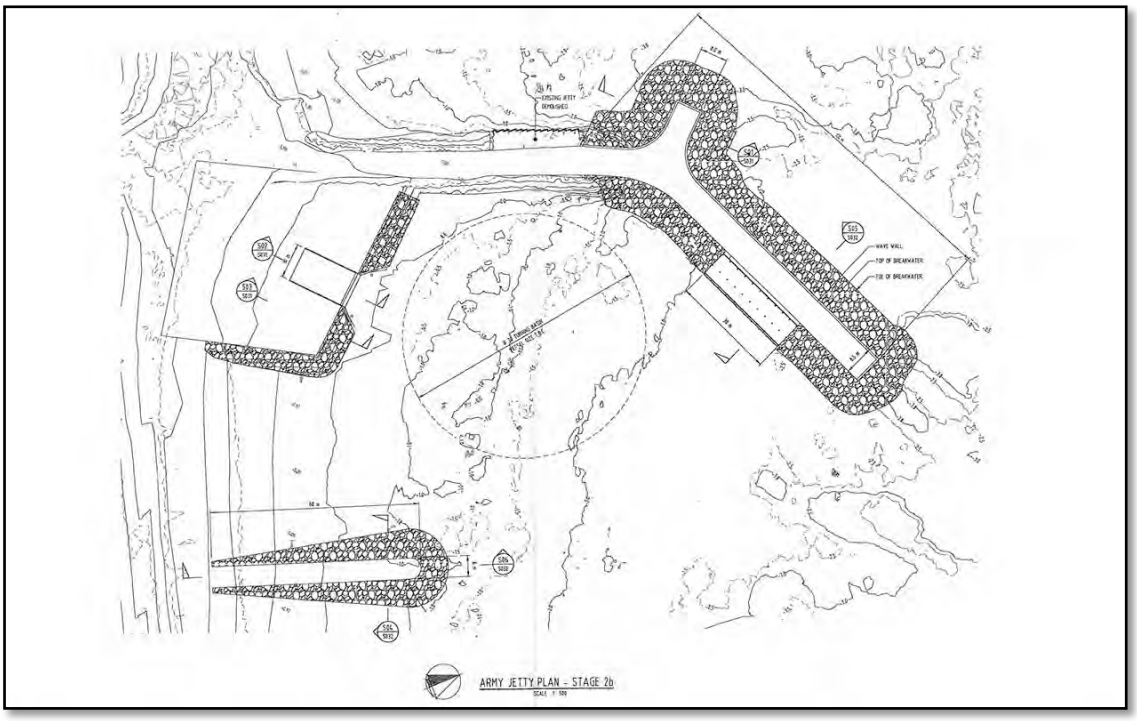

Figure 1: Rottnest Island Army Groyne – Proposed barge ramp and cargo handling facility Design Plan.

Figure 2: Rottnest Island Army Groyne – Proposed barge ramp and cargo handling facility Design Plan

LOCATION

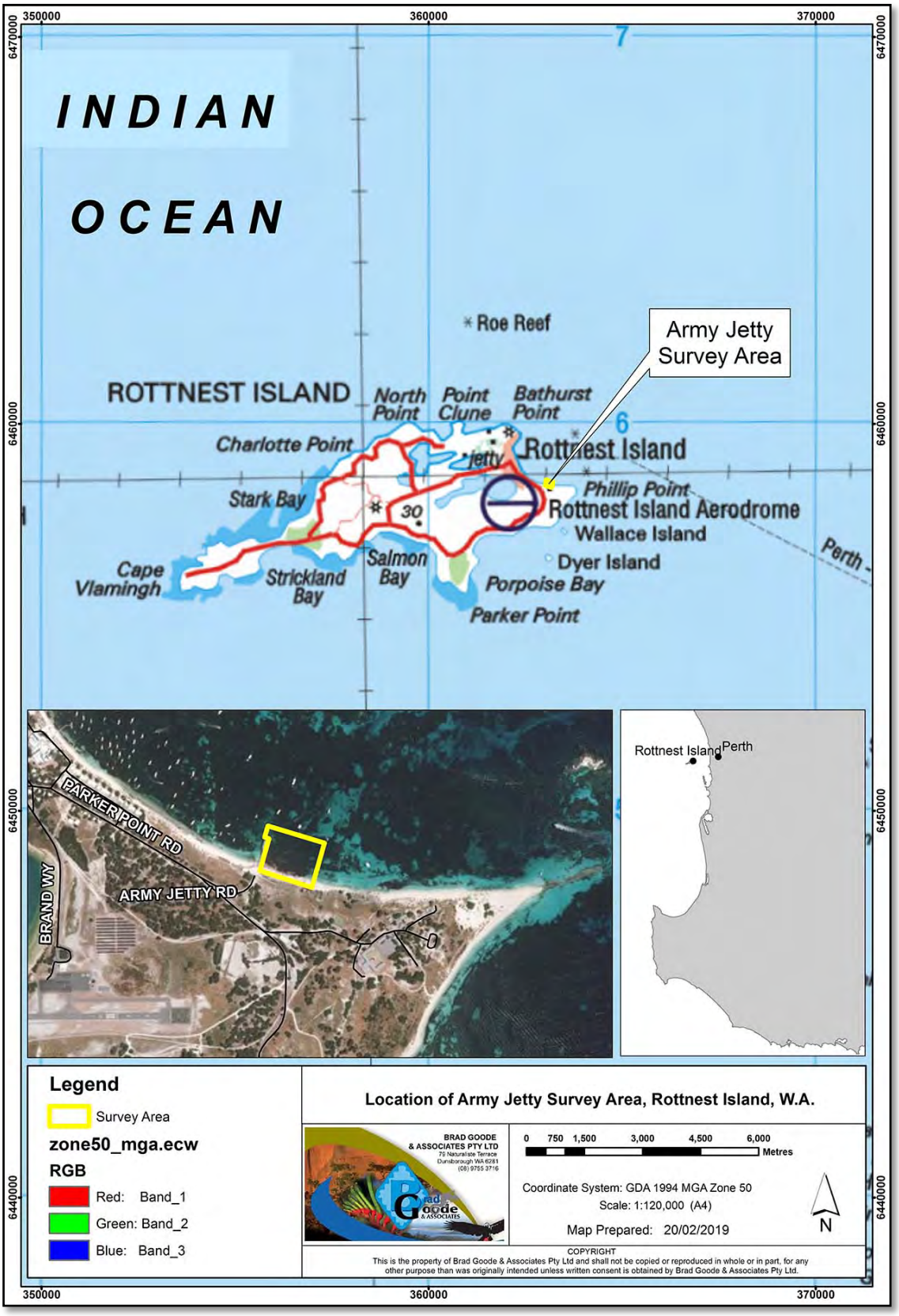

Figure 3: Location of the Army Jetty Survey Area.

ETHNOGRAPHIC & HISTORICAL BACKGROUND

TRADITIONAL CULTURE

The Army Jetty survey area is located in Thomson Bay on the east coast of Rottnest Island, approximately 29km west/south-west of Perth and 19km from Fremantle. The survey area is within the Whadjuk WC2011/009 Indigenous Land Use Agreement Area (ILUA).

Prior to European settlement of the south west of Western Australia this region was occupied by a distinct cultural bloc that was defined by the distribution of 'Nyungar' language groups. The word 'Nyungar' is the generic term used today to define those people of Aboriginal descent whose ancestors occupied the whole of the south-western corner of Western Australia (Bates 1985: 47, Collard 1994: 23).

Before the word 'Nyungar' was used as a group or linguistic term the southwest Aboriginal people recognized themselves, their language and culture, as 'Bibbulmun.' According to Bates (1985) Bibbulmun land took in everything to the west of a line drawn from Jurien Bay on the west coast to east of Esperance on the south coast, with the inland boundary following that of the circumcised tribes (Bates 1966: 59).

Bates identified the sub-group of Bibbulmun in the Perth Fremantle region as the Yabbaru Bibbulmun (Bates 1985: 54). Their country comprised of Perth, Fremantle and Rockingham and was "bounded on the south by the Serpentine River, the hills forming their eastern boundary" (ibid: 49). The Nyungar or Bibbulmun people were a distinct group in that their initiation practices varied markedly from their desert and semi-desert dwelling neighbours. Bates records that the Bibbulmun did not practice circumcision or sub-incision, but rather practiced a ritual of nasal septum piercing and cicatrisation of the upper body (ibid: 151-162).

Tindale (1974) noted that the coastal area in the vicinity of Cockburn Sound was inhabited by the 'Whadjuk' to the north and the 'Pindjarup' to the south. The Whadjuk group inhabited the lands of the north and eastern tributary inland to Mt Helena at Kalamunda/Armadale to the Victoria Plains south of Toodyay, west to York and south along the coast to Pinjarra (Tindale 1974:260). The Pindjarup group inhabited the lands from Bunbury in the south, south-east to Boyanup, north-east to Collie, north to Mt Cooke and west to Rockingham (Tindale 1974: 256)

Traditional initiation practices varied from those of their inland neighbours. The Bibbulmun Nyungars practiced nasal septum piercing and cicatrisation (scarring) of the upper body rather than circumcision as an initiation rite (Bates 1985, Tindale 1974).

Nyungar people traditionally obeyed a recognized system of rights and obligations, transmitted through birth and marriage, which gave individuals rights to the use of and economic benefits of the land over which they also acted as custodians. These areas were significant because they were associated with mythic figures relating to the Aboriginal concept of Dreaming (Silberbauer 1994: 124; Stanner 1965: 13). The Dreaming refers to a period of creation when mythical figures transformed the landscape creating hills, lakes, rivers and animals (Machin 1996: 10).

The Waugal is one example of a Dream-time figure which has transformed the landscape as well as infusing it with a living spirit. The Waugal is a creative spirit associated with water and which takes the physical shape of a snake. Bates (1985: 221) reported that the Waugal made "all the big rivers of the Southwest and that wherever it travelled it made a river." Bates also noted that everywhere the Waugal went or camped was sacred (Bates 1985: 219). It was at these places that it left traces of its journeys, that it metamorphosed and left parts of itself which were transformed into topographic features and other natural features, including hills, rocks, trees, caves, sand dunes, ridges etc. The Waugal is associated with many of the major rivers in the Darling Range as well as many of the smaller springs, swamps, pools and lakes located on the Swan Coastal Plain (O'Connor, et al 1989: 46).

Each socio-linguistic group, sometimes referred to as the 'tribe', consisted of a number of smaller groups. These subgroups could be described as a family, a band or a horde (Green 1984: 9). An individual or a group's land was called their *Kalla*, or 'fireplace' (Moore 1884: 39). This referred to an area of land which was used by the group and over which the members of the group exercised the greatest rights to its resources.

Other groups would also have some rights of access to land and use gained through marriage (Le Souef 1993: 30-43).

> Ownership rights to land were held by groups of people linked through common descent; there was definite ownership of land in both social and personal ways. As well as belonging to a local descent group by birth, each individual simultaneously belonged to an economic or food gathering group (Le Souef 1993: 30).

According to Makin (1970) and Brown (1983) early writers such as Symmons (1840), Lyon (1833) and Armstrong (1836) recorded that the Swan River Aboriginals had a system of land ownership that divided up the country around the river between local clan groups.

Lyons described districts within Perth in terms of an area name and a single leader. The *Mooro* tribe occupied the district of *Yellowgonga*, *Beeloo* was the district of *Munday* and *Beeliar* was the district of *Midgegooroo* (see Lyon's 1833 map of Aboriginal Tribal Districts surrounding Perth cited in Brown 1983: 6). Armstrong also recognized that land appeared to be assigned to specific families, rather than being held in common by the wider 'tribe' (Brown 1983: 5).

Makin (1970) recorded that from Fremantle (*Wol-yal-lu*) up the river to Butlers Bay (*Bi-ri-gap*) and to Mt Eliza (*Ga-ra-katta*) was the 'Land of *Yal-gong-ga*', his sons, wives and children (Makin 1970: 72-74). From Mt Eliza past the flats (*Min-da-rop*) near the Narrows Bridge to the Peninsula (*Wu-rut*) north of the farm belonging to Colonial Secretary Mr Brown at Bassendean was the land of 'Monday' (or Munday) (ibid). From the Bassendean ferry jetty to the head of the Swan River was the land of *Ngu-nyt*. The Canning tribes occupied the left (south) bank of the Swan River and the adjacent Canning River. The land from Fremantle to Preston Point and Point Walter around to Butlers Bay, the entrance to the Canning River, was *Djar*, *Gar-bal*, *Yurjil* and *Nin-g-ara* (ibid). From the entrance of the Canning River past Mill Point to near Guildford was *Bi-nan*, *Yur-gan*. From Guildford to the Swan River head were *Mol-li-dobbin*, *Mol-li-mig-rat* and *Wiban* and other branches of the family (ibid).

For the Rockingham area, specifically from a line drawn due east from Mangles Bay, extending northwards to the foreshores of the Swan and Canning Rivers was the 'territory' of the Beeliar Aboriginal group. This group included the Aboriginal influential *Midgegooroo* and his son, *Yagan*. The wetlands in this region were most intensively occupied, given the availability of fresh water and food resources (waterfowl, turtles, kangaroos). Wells were dug close to swamps in order to filter water and some swamp vegetation was consumed. Spears were made from 'spear wood' and comprised an important trade item. Pads connected the wetlands and rivers and extended through this territory from the present day Perth area south to Rockingham, Mandurah and the Murray River (Ralph, Locke and Smith 1990: 8).

With regards to the Rockingham area various researches such as Machin (1989) and McDonald (2002, 2004) have recorded myths that relate to the creation of Cockburn Sound and the offshore islands Rottnest Island (traditionally known as 'Wadjemup'), Garden Island, Carnac Island and the area of the coast around Mangles Bay, what is now Rotary Park and the adjacent wetlands. These myths were recorded by the above researchers as told by Mr K. Colbung, the primary informant of this creation story.

These stories had also formerly been recorded in the early 19th century by Moore (1884) and Armstrong (1836) who reported different versions of the same myth. Moore (1884, cited in Brown 1983: 16) records that a great fire was responsible for the creation of the offshore islands:

> The natives have a tradition that Rottnest, Carnac and Garden Island once formed part of the mainland, and that the intervening ground was thickly covered with trees; which took fire in some unaccountable way, and burned with such intensity that the ground split asunder with great noise, and the sea rushed in between cutting off the islands from the mainland (Moore 1884: 6-8 cited in Brown 1983: 16).

Armstrong (1836: 790) version of the story was recorded as:

> They state, as a fact handed down to them from their ancestors, that Garden Island was formerly united to the main, and that the separation was caused, in some preternatural manner, by the Waugal (Armstrong 1836: 790).

These versions of the story substantially differ from that reported by Mr K. Colbung whose central figure was a Crocodile. The 'Legend of the Crocodile and the Waugal' tells of a time during the *Nyitting*, or Ice Age, when a number of ancestral figures had gathered at Two Rocks and they watched an altercation between 'Shark' and 'Crocodile':

> They watched as Shark tore strips off Crocodile, which formed the reefs around Two Rocks. It is said that the waves which flap over the reefs when the sea is high come from the skin of Crocodile. In the end Shark was so enraged that he just tore Crocodile's tail right off in two chunks and now those two big chunks are Rottnest Island and Garden Island.
>
> Now that he had lost his tail, Crocodile could not swim. He had no power to push himself forward and no means of steering himself through the water, so he started walking down the coastline. When Crocodile got to the Fremantle entrance to the Swan River, which the Aborigines called Derbal-Yarragan, he started to go in there to rest up. But Waugal, the Rainbow Serpent, said he could not go in and told him to get going back up the coast. Waugal was frightened that Crocodile would eat all the animals and flatten the land (extract from Heritage Council of WA 1998: 15-17 cited in Muir 2012: 192).

McDonald (2002) has suggested that the inconsistency of the above narratives can be considered anthropologically as a natural part of all myth systems and as noted by Miranda (1972:8 cited in McDonald 2002) myths often consist of a reorganising of the traditional components in the face of new circumstances and times. McDonald (2002) argues that this is what is happening with the above myth as told by Mr Colbung. McDonald (2002) argues that this is a legitimate part of contemporary Aboriginal people reinterpreting traditional mythological stories by incorporating contemporary and modern beliefs into the versions now being told (McDonald 2002: 8).

BRIEF ABORIGINAL HISTORY OF ROTTNEST ISLAND

In 1696 Dutch explorer Willem de Vlamingh named Rottnest Island during an expedition along the west coast of Western Australia. Vlamingh named it *'Eylandt 't Rottenest'* or 'Rats Nest Island' after he sighted many Quokkas on the island and mistook them for 'bush rats' (Green & Aguiar 2018: 11; Woods 2007: 3; Playford 1996: 25-26).

In 1838 plans to establish a prison on Rottnest Island commenced which was seen at the time "as progressive and humanitarian to hold Aboriginal people away from the close confinement of

European style gaols" (Rottnest Island Guide 2012: 10). During 1838-1849 prisoners came from places south of Geraldton and west of York (Green & Aguiar 2018: 8). Over a period of almost 100 years at least 3,670 Aboriginal men were sent to Rottnest, some were as young as 8 years old and others were more than 70 years old. The first recorded death on Rottnest Island was in 1839 (Green & Aguiar 2018: vii).

The first six prisoners taken to Rottnest Island, as noted by Dr Neville Green in his book *Far From Home Aboriginal Prisoners of Rottnest Island 1838 - 1931*, were Buoyeen, Mollydobbin, Tyoocan, Helia, Cogat and Goordap – for offences ranging from robbery, assault and murder. When they arrived at Rottnest Island there was no provision made for their accommodation and "at night the soldiers slept under canvas while the prisoners sheltered in a large coastal cave near Point Bathurst" (Green & Aguiar 2018: 13-14).

In the early years chained prisoners were transported from Fremantle to Rottnest Island in open boats. Later, after 1855, they were taken by a pilot boat to Thomson Bay where they were ferried to shore in a whale boat (Green & Aguiar 2018: 44). A historical photograph captures this and is reproduced in Green & Aguiar (2018) – see figure on page 46, courtesy of Battye W.A. State Library Board 5959P.

While the first period (1838-1849) of Rottnest Prison's history was intended to be a humanitarian endeavour, with the objective to not just punish but to also rehabilitate prisoners into colonial society, the next period (1855-1902) of the prison's history was a "grim period when more than 3,000 prisoners arrived on the island" during that time period (Green & Aguiar 2018: 13). Greater numbers of prisoners contributed to deteriorating conditions for the prisoners during influenza and measles epidemics that occurred in 1883 (ibid 2018: 23).

By 1902 plans were made to make the island a tourist accommodation and the prison was then officially closed. Aboriginal prisoners were then either sent to other prisons or liberated, with some sent to work within the Police and Telegraph Departments (ibid 2018: 32). However, after closing the prison, the government then decided for it to become an annex of Fremantle Prison from 1902-1931. A number of European prisoners then arrived on Rottnest Island and during these years, "as many as forty prisoners at a time worked on Rottnest, about one in ten of whom were Aboriginal" (ibid 2018: 34).

The Army Jetty was originally built in 1906 and was known as the 'Excursionist Jetty' as it allowed horse-drawn trams to meet passengers at the start of the jetty for transport into the Thomson Bay Settlement (Bigourden & McAllister 2012: 5). Aboriginal prisoners were employed as porters and animal handlers to manage the horse-drawn 'charabanc' (bus) during the transfer of visitors from the jetty (see figures 4 and 5 – photos supplied by Mr Ezra Jacobs, Rottnest Island Authority, 8th February 2019).

During 1914-1915 the jetty was used solely for military purposes during the first World War as Rottnest Island was used for internment and as a Prisoner of War camp (Bigourden & McAllister 2012: 5; Green & Aguiar 2018: 34-39, 69). Extensions and reinforcing upgrades to the jetty were conducted during 1936-37 and again in 1942 and from this time on it became known as the 'Army Jetty'.

After the second World War the jetty became open to the public again and served as the primary jetty for tourists until 1961, until a larger timber jetty was built closer to the settlement (Bigourden & McAllister 2012: 7). The majority of the original Excursionist Jetty and Army Jetty have since been demolished and removed during redevelopment that was conducted in 1972 (Bigourden & McAllister 2012: 13).

Figure 4: Visitors arriving at Excursionist Jetty in 1910 being taken by car and horse-drawn tram from to the settlement of Thomson Bay (photo RIA 2019).

Figure 5: Georgie at the Excursionist Jetty (photo RIA 2019).

ARCHIVAL RESEARCH

Archival research involved an examination of the Department of Planning, Lands and Heritage (DPLH) Aboriginal Sites and Places Register, a review of any relevant site and place files, and a review of any unpublished ethnographic reports that relate to the survey area on Rottnest Island, Western Australia.

SITES AND PLACES REGISTER SEARCH

The DPLH Aboriginal Sites and Places Register categorises places reported to be of importance and significance to Indigenous people into two separate categories.

The first category contains sites classified as **'Registered.'** Registered sites have been assessed by the Aboriginal Cultural Materials Committee (ACMC) as meeting the definition of Section 5 of the AHA and are fully protected under the law. Disturbance to land that contains such sites requires a Section 18 application for ministerial consent should proponents wish to use the land that contain these sites.

'Other Heritage Places' is the second category of places contained upon the Aboriginal Sites and Places Register. These types of places include reported places **'Lodged'** and awaiting ACMC assessment, and places where the information has been assessed but there is **'Insufficient information'** to make a final determination under Section 5 of the AHA but there is enough information to warrant these places temporary protection in law. Disturbance to land that contains such places requires a Section 18 application for ministerial consent should proponents wish to use the land that contain these places.

Within the category of 'Other Heritage Places' the final category is '**Stored Data.'** Such places have been assessed by the ACMC but fail to meet the definition of section 5 of the AHA. Places in this category are not sites under the AHA and are not protected in law. Proponents have no further legal requirements for such places should they wish to use the land unless further information is reported which would lead to such a place being reassessed as a site in terms of the definition of section 5 of the AHA.

A search of the DPLH Aboriginal Heritage Inquiry System (AHIS) conducted on 22nd January 2019 determined that there are no previously recorded Registered Aboriginal Sites located within the Army Jetty survey area (see Table 1 and Appendix 1).

The search also determined that there are 3 previously recorded Other Heritage Places that have DPLH extents overlaying the survey area. One of these places, Place ID 3443 Rottnest Cemetery North has restrictions placed on the DPLH file and was unable to be sourced from DPLH.

Place ID 3776 Indian Ocean and 20862 Rottnest Island (Wadjemup) have been assessed as not meeting the terms of section 5 of the AHA and are listed as Stored Data. Rottnest Island Authority has no legal obligations under the AHA in relation to these heritage places.

Table 1: Summary of Aboriginal heritage sites and places within the project area

ID	Name	Status	Access	Restriction	Location (GDA94 Z50)* mE	mN	Type
Other Heritage Places							
3443	Rottnest: Cemetery North	S	C	Yes	Not available	Not available	Modified Tree, Skeletal Material / Burial
3776	Indian Ocean	S	O	No	372624	6445362	Myth

ID	Name	Status	Access	Restriction	Location (GDA94 Z50)* mE	mN	Type
20862	Rottnest Island (Wadjemup)	S	O	No	359511	6457858	Artefacts/ Scatter, Historical, Man-made structure, Midden / Scatter, Myth, Quarry, Rockshelter, Skeletal Material / Burial, Arch deposit, Camp, Hunting Place, Massacre, Meeting Place, Natural Feature, Shell, Water Source

***** Please note: Coordinates are indicative locations that represent the centre of sites as shown on maps produced by the DPLH – they may not necessarily represent the true centre of all sites.

LEGEND

R – Registered Site, **I** - Insufficient Information, **S** - Stored Data/Not a Site, **L** - Lodged awaiting assessment, **O** – Access Open, **C** - Closed Access, **N** – File Not Restricted.

REVIEW OF RELEVANT SITE FILES

There are no previously recorded Registered Sites located within the Army Jetty survey area.

REVIEW OF RELEVANT HERITAGE PLACE FILES

Place ID 3443 Rottnest: Cemetery North

This heritage place is a restricted DPLH file and access to view the file was not obtained by the consultants. Place ID 3443 is recorded as a modified tree, skeletal material and burial place.

DPLH have mapped the extent of this heritage place as 2km x 2km positioned over the north-eastern corner of Rottnest Island.

The status of this heritage place is 'Stored Data' and as such Rottnest Island Authority has no further obligations under the AHA to use the land that falls within the DPLH Extent of this heritage place.

Place ID 3776 Indian Ocean

This mythological heritage place was recorded on the DPLH Sites and Places Register as a result of an Aboriginal heritage survey report conducted by S.H. Brown in 1983. During this survey of proposed highway and road developments in the Perth Metropolitan region, Brown (1983) conducted ethnographic investigations of a number of Aboriginal sites in the region.

Place ID 3776 Indian Ocean was described as the "sea between mainland and offshore islands" (Brown 1983: 16) and Brown cited two Aboriginal myths that explain the separation of some of the offshore islands from the mainland.

> They state, as a fact handed down to them from their ancestors, that Garden Island was formerly united to the main, and that the separation was caused, in some preternatural manner, by the Waugal (Armstrong 1836: 790).
>
> The natives have a tradition that Rottnest, Carnac, and Garden Island, once formed part of the mainland, and that the intervening ground was thickly covered with trees; which took fire in some unaccountable way, and burned with such intensity that the

> ground split asunder with a great noise, and the sea rushed in between cutting off those islands from the mainland (Moore 1884: 6-8).

Further research has been added to the Heritage File which includes early historical information compiled in 'Landscope WA's Conservation, Parks and Wildlife Magazine'. In this article the Dreaming story as told by local Nyungar Mr Trevor Walley was published:

> Gumbar Yondock Ancestral Crocodile travelled down from the north and pushed himself onto the land, where his tail cut a deep channel in Cockburn Sound (now known as Gage Roads) and pushed up Rottnest (Wadjemup). The sound of rushing water woke the rainbow sea serpent (Waugal). Waugal smelled the salt and went out to investigate. A battle between the two pushed up Carnac (Ngooloormayp) Island. At Woodman Point, the Waugal manoeuvred and carved out Jervois Bay with his tail. Waugal bit the tail of crocodile, who then gave up, Waugal heard the sea water come rushing into the Swan River (stirred up because of all the fighting) and anchored the severed tail across the entrance, using the hair from his chin and armpit and the crocodile's toenails to anchor the tail down. This formed a reef across the Swan River mouth, and it was jagged like the tail of a crocodile (this reef once blocked the mouth of the Swan River at Fremantle, before it was removed to create Fremantle Harbour). Waugal then made crocodile walk back up north whilst his spirit remained as Garden Island. Hence, Garden Island is known as Meeandip Yondock (Yondock with tail missing). (Landscope Magazine 2003 cited in DPLH file for Place ID 3776).

This heritage place was spatially recorded by DPLH to capture the sea between the east coast of Rottnest Island to the mainland at Cottesloe and then extends south to take in Cockburn Sound and the east coast of Garden Island. The most southern point of this heritage place is the southern tip of Garden Island and then heads east to the mainland at Kwinana Beach.

In 1998 the ACMC assessed this heritage place as a site under Section 5(b) and (c) and Section 39.2 (a)(b) and (c) of the AHA (ACMC Meeting Date 7th April 1998 Resolution ID 2788 Number 98012). However in 2004 further assessment took place which resulted in the 'Indian Ocean' not meeting the terms of a site under the AHA and it was classified as 'Stored Data/Not a Site' (ACMC Meeting Date 2nd June 2004 Resolution ID 5072 Number 04082).

In relation to the Army Jetty survey area, Place ID 3776 Indian Ocean overlays the entire survey area, however as this heritage place is not a site under the AHA, Rottnest Island Authority has no further obligations under the AHA in relation to this heritage place.

Place ID 20862 Rottnest Island (Wadjemup)

This heritage place was recorded in 2003 by Mr Ron Parker following an ethnographic consultation in South Fremantle with representatives from the Corunna, Wilkes, Bropho, Hayward-Jackson and Garlett families. The group requested that Rottnest Island be recorded as a "men's place" and that the island be reported in total (Parker 2003: 14). On an Aboriginal Site Recording Form, Parker recorded:

> "Rottnest Island (Wadjemup) is the manifestation of one of the Two Men of Western Desert Dreamtime chronicles concerning the creation of the Darling Scarp" (Place ID 20862 Aboriginal Site Recording Form).

In 2004 DPLH mapped the boundary of this heritage place to include the whole island. The extent is 10km SW/NE x 5km SE/NW and follows the perimeter of Rottnest Island.

In 2006 further information was reported to DPLH regarding this heritage place by site informants Mr R. Bropho and Mr I. Hayward-Jackson. A limestone formation and cluster of

stones were reported to be culturally significant at 356146mE 6456917mN, along Digby Drive at Strickland Bay.

A number of archaeological journal articles regarding artefacts previously recorded on Rottnest Island are also included within the DPLH file for Place ID 20862 (see Dortch & Hesp 1994; Hesp et al. 1999).

Place ID 20862 is recorded as a mythological, skeletal material, burial, man-made structure, quarry, artefacts/scatter, midden/scatter, historical, archaeological deposit, massacre, meeting place, camp, shell, hunting place, rockshelter, natural feature and water source.

Place ID 20862 was assessed by the ACMC in 2004 and it was classified as Stored Data / Not a Site under the AHA.

Rottnest Island Authority has no further obligations under the AHA in relation to Place ID 20862 Rottnest Island (Wadjemup).

REVIEW OF RELEVANT ETHNOGRAPHIC REPORTS

Randolph, P. 2014, *Charlie Dortch, Rottnest Island and the Department of Aboriginal Sites: Reminiscence and Comment*, unpublished report [DPLH Report ID 200141].

This reminiscence report was conducted by Mr Peter Randolph in 2014 in regards to Dr Charlie Dortch who "had a keen interest in the potential for prehistoric Aboriginal occupation of offshore islands along the south and west coast of WA" (Randolph 2014: 2).

Artefacts located by Dortch embedded in limestone near the Bathurst Point Lighthouse (Place ID 20592 and 23867) were noted to be a major find that was key "evidence to prove that Rottnest had been occupied by Aboriginal people in prehistoric time" (Randolph 2014: 8).

Muir, K. 2012, *Aboriginal Heritage Investigation and Survey of Rottnest Island, report on Rottnest Island Aboriginal Heritage Survey for Rottnest Island Authority*, draft report prepared by Aboriginal Heritage Consultants Pty Ltd for Rottnest Island Authority, June 2012.

This Aboriginal Heritage Survey Report was authored by Mr Kado Muir in 2012 which consisted of a comprehensive desktop and literature review of relevant Aboriginal heritage survey reports and historical records of Aboriginal involvement and interaction on Rottnest Island. Dr Neville Green assisted with the historical research which was conducted 2008-2009.

Regarding the anthropological context for the project area Muir notes that 'The Legend of the Crocodile and the Waugal' is one mythological narrative that identifies Rottnest Island alongside Garden Island as the broken pieces of the Crocodile tail, left behind after an epic battle between the Crocodile and the Shark, which resulted in the two islands being formed (Muir 2012: 25, 192-193).

Consultations were also conducted with Aboriginal people and Aboriginal Representative Bodies in 2009-2010 to provide management recommendations and strategies for the management of Aboriginal heritage on Rottnest Island.

A search of the Register of Aboriginal Sites and Places conducted in 2012 revealed that there were 23 previously recorded Aboriginal heritage sites and places located on Rottnest Island (Muir 2012: 29).

During the survey 10 new Aboriginal sites were recorded which comprised of 6 man-made structures and 4 artefact scatters, one of which included a rockshelter (Muir 2012: 101). In relation to previously recorded sites and places, Muir recorded further information for 6 DPLH site/place files (Muir 2012: 136).

During the course of fieldwork many elders consulted "indicated that it was their main desire to focus on the historical significance of places and not on the spiritual and other ethnographic values of the places and/or events" (Muir 2012: 154).

In relation to Place ID 20862 Rottnest Island (Wadjemup), desktop research revealed that the ACMC had previously assessed this place in 2004 as not a site under the AHA, as the ACMC did not accept the view that Rottnest Island is one of the Two Men from the Western Desert Dreamtime chronicles connected with the formation of the Darling Scarp. Muir notes, "the fact that Rottnest is not considered a site is something many Aboriginal people [feel] strongly about" (Muir 2012: 173).

During the fieldwork, the consulted Aboriginal representatives reported that Place ID 20862 Rottnest Island (Wadjemup) continues to be a place of "extreme spiritual and cultural significance" and that the whole of Rottnest Island is a sacred site. In addition to Rottnest Island believed to be a place for spirits of the dead, it is also seen as a "land of the living where the ancestral spirits, the spirits of historic heroes and the spirit of living generations rest before their journey back through the cycle of life" (Muir 2012: 179).

Muir concluded by stating that the Aboriginal sites on Rottnest Island represent the living history of Western Australia Aboriginal people and that together they form a complex across the Island, connecting many communities and families, and that Rottnest Island is "perhaps one of, if not the single most significant site in Western Australia" (Muir 2012: 182).

Harris, J. 1990, *A report on archaeological monitoring of ground disturbance at Rottnest Island*, report prepared for Dallhold Investments Pty Ltd and Rottnest Island Authority.

This archaeological monitoring of ground disturbance was conducted by Mrs Jacqueline Harris (Archaeologist) in 1990 for the development of a unit complex on Dallhold Investments Pty Ltd lease on Rottnest Island.

During the course of archaeological monitoring of ground disturbance, no human remains or any Aboriginal artefacts were discovered. No sites of significance as defined by Section 5 of the AHA were located in the survey area.

Harris noted that extinct pipes related to past services criss-crossed the development area within layers of original sediment and that the likelihood of undisturbed deposits remaining with archaeological significance is remote (Harris 1990: 19). There was minimum ground disturbance conducted in the lodge and surrounds, and the courtyards and gardens were areas where previous disturbance from service installation and landscaping had already taken place. In relation to the desalination plant, Harris noted that ground disturbance was conducted in an area that was entirely fill and that the archaeological potential was unknown (Harris 1990: 19).

In relation to the current survey area for the Army Jetty, Harris (1990) report project area was located approximately 750m to the west/north-west.

Bradshaw, E. 1988, *Rottnest Island Report on Meeting of 10 March 1988* [DPLH Report ID 103686].

This consultation meeting was conducted in 1988 by Ms Pam Beggs (Minister for Tourism) on Rottnest Island and 200 representatives of families of the Aboriginal prisoners that died on

Rottnest Island during it's time as a penal institution. Ms Elizabeth Bradshaw (Site Documentation Officer) Department of Aboriginal Sites was in attendance and reported on the meeting.

The purpose of the meeting was to discuss the recognition of these deaths and to discuss appropriate management strategies for Site ID 3781 'Wadjemup Aboriginal Prisoners Cemetery' (S02118).

The primary spokespeople for the Nyungar community was Mr Corrie Bodney, Mr E. Kickett, Mr R. Bropho, Mr Ted Wilkes, Mr Ben Taylor, Mrs Bropho and Mrs Marshall.

As a result of the consultation a number of requests of the Nyungar community were presented which included (but not limited to) detouring of roads, removal of some cottages and camping areas moved back from Site ID 3781. It was also requested that Aboriginal people be employed to research the Aboriginal history of Rottnest Island and that the extent of the burials be investigated by anthropologists and archaeologists (Bradshaw 1988: 1-2).

OUTCOMES OF ARCHIVAL RESEARCH

A search of the DPLH Aboriginal Heritage Inquiry System (AHIS) conducted on 22nd January 2019 determined that there are no previously recorded Registered Aboriginal Sites located within the Army Jetty survey area (see Table 1 and Appendix 1).

The search also determined that there are 3 previously recorded Other Heritage Places that have DPLH extents overlaying the survey area. Place ID 3443 Rottnest Cemetery North, Place ID 3776 Indian Ocean and Place ID 20862 Rottnest Island (Wadjemup) have been assessed by the ACMC as not meeting the terms of section 5 of the AHA and are listed as Stored Data.

Rottnest Island Authority has no legal obligations under the AHA in relation to these heritage places.

In relation to Place ID 20862 Rottnest Island (Wadjemup), a review of previous Aboriginal Heritage Surveys has revealed the high cultural and historical significance attributed to the whole of Rottnest Island as a sacred site. It is believed to not only be a place for spirits of the dead, it is also seen as a "land of the living where the ancestral spirits, the spirits of historic heroes and the spirit of living generations rest before their journey back through the cycle of life" (Muir 2012: 179).

Archival research reveals that 'The Legend of the Crocodile and the Waugal' is one mythological narrative that identifies Rottnest Island alongside Garden Island as the broken pieces of the Crocodile tail, left behind after an epic battle between the Crocodile and the Shark, which resulted in the two islands being formed (Muir 2012: 25, 192-193).

Despite these narratives the ACMC has not determined that these values meet the criteria of section 5 of the AHA, nor has the ACMC recognised the place that Rottnest has in the history of settlement and the special place that the island has in the history of the State. Despite this determination the whole of the island has immense heritage and cultural significance to the Whadjuk people and as such this should be respected by the RIA in any activities that they conduct anywhere on the island (see Green & Aguiar 2018).

IDENTIFICATION OF SPOKESPEOPLE

THE RIGHT TO SPEAK ON HERITAGE ISSUES

Various authors have discussed the contemporary problem of who in the Indigenous community has the authority to speak on heritage issues within an area. O'Connor et al (1989: 51) suggests that when this question is posed to people in Indigenous Australia, answers are usually framed by such terms as 'the Traditional Owners', i.e., those people who are defined by place of birth, or descent. Myers (1986) presents a broader and more contemporary view of 'ownership' based upon descent and association,

> An estate, commonly a sacred site, has a number of individuals who may identify with and control it. They constitute a group solely in relationship to this estate… Identification refers to a whole set of relationships a person can claim or assert between him/herself and a place. Because of this multiplicity of claims, land holding groups take essentially the form of bilateral, descending kindred. Membership as a recognised owner is widely extended and therefore groups are not a given (Myers 1986: 128).

Myers (1986) further clarifies the current perception of 'ownership' when he states,

> ....such rights exist only when they are accepted by others. The movement of the political process follows a graduated series of links or claims of increasing substantiality, from mere identification and residual interest in a place to actual control of its sacred association. The possession of such rights as recognised by others, called 'holding' (*kanyininpa*) a country, is the product of negotiation (Myers 1986: 128-129).

While the notion of descent is clearly an important criterion within Myers analysis, it must be seen in terms of the contemporary Nyungar situation. Nyungar tradition in the South West has been seriously eroded since colonisation as lines of descent have been broken and previously forbidden and mixed marriages have interconnected many Nyungar groups who would not have traditionally had a close association (Machin 1993: 20). Consequently, in contemporary times the criteria of historical 'association' may in some cases also be regarded as a 'right to speak' on heritage issues within an area. Machin (1995) elaborates,

> Traditional subsistence no longer sufficed to support Aboriginals so they combined this with menial work on farms and over time new relationships to land developed. As a consequence, the more recent history associated with their involvement with European agriculture and labour patterns is often more relevant than the pre-contact mode of attachment to an old way of life and the roots of the identity as original owners of the land. Biographical associations are often tied to post-settlement labour patterns and identification. These can predominate. This is part of a dynamic process of ethnicity, identity and tradition (Machin 1995: 11).

O'Connor et al. (1989) identified several criteria for determining contemporary community spokespeople. A spokesperson must have a long-term association with an area, usually as a young person, and had extensive contact with a member or members of the 'pivotal generation of the culture transmitters'; those people whom, as children themselves, had contact with people who could pass on their traditional knowledge. A spokesperson must also demonstrate knowledge of the region's natural resources, its hunting, fishing and camping grounds, local water sources and flora and fauna. This is important because a person without this knowledge is unlikely to be seen by their fellow Nyungar people as truly being from that country, despite having been born or lived in that area. In some cases, people from outside a specific region have established themselves by political activism. They are accepted by their fellow Nyungars because they may have participated in mainstream pursuits, such as advanced education or legal and political careers, which have empowered them within the broader community. As such, these people are a valuable resource to the local Indigenous community. The people consulted in this survey fulfil at least one of these criteria.

NATIVE TITLE CLAIMS OVER THE SURVEY AREA

Currently lodged with the Register of Native Title Claims and the Schedule of Applications, held by the Commonwealth Native Title Tribunal, there is one registered Native Title application that is located to the east of Rottnest Island. The Schedule of Applications includes registered applications, unregistered applications and applications still undergoing the registration test.

- **Whadjuk People WC2011/009 WAD242/11 (Registered)**

  Applicants: Mr C. Davis, Mr N. Morich, Mr N. Wilkes, Mr T. Nettle, Ms D. Wynne.

SELECTION OF SPOKESPEOPLE FOR THIS SURVEY

As the representative body under the *Native Title Act 1993* for the registered Whadjuk People WC2011/009 Native Title Claim group, SWALSC were required to select representatives to be consulted with in regards to the project. In line with the terms of the Noongar Standard Heritage Agreement (NSHA), an Activity Notice for the project was submitted by Rottnest Island Authority to SWALSC. SWALSC then provided the proponent with the following list (SWALSC HER.0232) of nominated representatives from the Whadjuk NTC group to be consulted with:

- Mr Gary Bennell
- Mr Tony Hill
- Mr Brendan Moore
- Mr Elisha Jacobs
- Mr Greg Ugle
- Mr Peter Garlett
- Mr Trevor McMahon
- Mr Reg Yarran (did not attend)

As a result of this pre-consultation process the following 7 representatives attended the ethnographic survey on the 5th February 2019:

Mr Gary Bennell was born in Pingelly to his parents Mr Andy Bennell of Quairading and Mrs Alice Bennell from Cuballing. Mr Bennell's paternal grandfather was Mr Ned Bennell from Brookton and his maternal grandparents were Mr Charlie Hill from Bridgetown and Ms Rachael Abraham from Narrogin. His apical ancestors are Cleetland and Jenny and Bill Humphries. Mr Bennell completed schooling at Pingelly High School. Mr Bennell was nominated by SWALSC to participate in this ethnographic survey.

Mr Tony Hill was born in Pingelly to parents Mr Andy Bennell of Quairading and Mrs Alice Bennell from Cuballing. Mr Hill shares the same familial connections as Mr Gary Bennell noted above. Mr Hill completed his schooling in Pingelly and has been employed in the agricultural industry in Pingelly and Bunbury and has worked as a truck driver in Collie. Mr Hill was nominated by SWALSC to participate in this ethnographic survey.

Mr Greg Ugle was born at the Mogumber Mission to parents Mr John Felix Jackamarra from New Norcia and Ms Lizie Ugle from Beverley. Mr Ugle's paternal grandparents are Mr Felix Jackamarra from New Norcia and Ms Susan Wandering from the Mogumber Mission. Mr Ugle's maternal grandfather is Mr Beale Ugle from Beverley. Mr Ugle went to school in Kalgoorlie prior to working as a spray painter and a truck driver. Mr Ugle claims traditional descent from apical ancestor *Toolbuk* who was born on the Heirisson Island mud flats. Mr Ugle is a Whadjuk working party member and was nominated by SWALSC to attend this survey.

Mr Peter Garlett did not provide any biographic information on the day of the ethnographic survey. Mr Garlett was selected by SWALSC to participate in this heritage survey.

Mr Brendan Moore was born in Moora to parents Mr Colin Moore from Dandaragan and Ms Pamela Billett from Melbourne. Mr Moore's paternal grandparents are Mr Granville Moore from Burney (England) and Ms Edith Madeline Warrell from Dandaragan. Mr Moore shares a cultural association with the project area through traditional blood ties to apical ancestors Mr William Warrell (*Madeegro*) and Ms Sarah Minyulo. Mr Moore's family has a long history working in the farming/agricultural industry in Dandaragan. Mr David Moore and Mrs Debra Moore, relatives of Mr Brendan Moore, still reside in Dandaragan and his brother, Mr Peter Moore owns a farm in Dandaragan that has been in the family since 1973. Mr Moore conducted his schooling in Dandaragan and Moora and attained a Post graduate Masters degree in Applied Sciences and International Studies prior to working with the Department of Agriculture for 10 years. Mr Moore was employed with SWALSC for 4.5 years and is currently employed by the City of Fremantle as an Aboriginal Engagement Officer. Mr Moore was selected by SWALSC to participate in this heritage survey.

Mr Trevor McMahon was born in Carnarvon to parents Mr Kenny McMahon, from Derby, and Ms Corel Gillespie, from Busselton. Mr McMahon's maternal grandparents are Mr James Gillespie, from the Success Hill and Eden Hill area, and Mrs Evelyn May Gillespie, from Bridgetown. Mr McMahon undertook schooling at Eden Hill Primary School and Lockridge Senior High School before undertaking work as a carpenter. Mr McMahon is a Working Party Member of the Whadjuk Native Title Claim group and was selected by SWALSC to participate in this heritage survey.

Mr Elisha Jacobs did not provide any biographic information on the day of the ethnographic survey. Mr Jacobs was selected by SWALSC to participate in this heritage survey.

COMMUNITY CONSULTATION

AIMS

- To establish contact with Indigenous people who retain traditional or current knowledge pertaining to the region.
- To determine if there are any sites or places of significance, as defined by Section 5 of the AHA, within the project area.
- To record any ethnographic information provided about identified sites or places.
- To generate consensual recommendations from the Indigenous community representatives in regards to any Section 18 requests and to record management strategies for identified ethnographic and archaeological sites.

METHOD

To arrange the survey the selected informants were contacted by phone and mail with an onsite meeting arranged. At the commencement of the meeting the informants were briefed as to the details of the project with the aid of the project plans and previously recorded Aboriginal heritage sites and places overlaid upon a large scale air photo map.

Ethnographic information was recorded in a notebook and photographs of the survey process were taken. GPS coordinates of any cultural features were recorded in the field and transferred to mapping software ArcView V10 where final maps were produced.

COMMUNITY CONSULTATION PROCESS

On the 6th February 2019 BGA consultants, Mr Brad Goode (Director) and Ms Louise Huxtable (Consultant Anthropologist), met seven representatives from the Whadjuk People NTC group, Mr Gary Bennell, Mr Greg Ugle, Mr Tony Hill, Mr Peter Garlett, Mr Brendan Moore, Mr Trevor McMahon and Ms Elisha Jacobs, at 10am at the Rottnest Island Airport. From there the group drove to the survey area on Army Jetty Road where they were met by Mr Ezra Jacobs (Aboriginal Heritage Officer) and Mr Clinton Hull (Project Manager) from the Rottnest Island Authority.

Figure 6: Survey Team meeting at a gazebo located at the Army Jetty.

Mr Goode began the survey by introducing the survey team and thanking them for their participation. He explained the history of Rottnest Island and its significance to the Whadjuk people. Mr Goode advised the group on the Rottnest Island Authority's obligations to the Traditional Owners under the NSHA. Mr Goode also advised the group that there are three previously recorded DPLH places which have DPLH extents which intersected with the survey area, both with archaeological and ethnographic components. The purpose of the ethnographic survey, Mr Goode advised, was for the Whadjuk NTC group representatives to provide statements regarding the importance and significance of the Aboriginal heritage values of the area. With the aid of an aerial photographic map of the survey area Mr Goode explained the survey area.

Mr Jacobs then introduced himself to the group and gave a brief explanation of the proposed works. He advised that although the jetty upgrade works do not impact upon the previously recorded DPLH places, the Rottnest Island Authority still wishes to hold consultations with the Whadjuk NTC group representatives in regards to the potential impact the works could have upon the previously recorded, or new, Aboriginal heritage sites. To enable the jetty to be utilised for commercial purpose and take congestion away from the main jetty, the Army Jetty is proposed to be upgraded. Mr Jacobs advised that recently a portion of the concrete decking on the jetty collapsed in late 2018 with the structure removed and groyne rectified.

Mr Hull then elaborated on the proposed works, advising that it is intended to increase the capacity of the jetty to accommodate commercial transport from the mainland, as well as provide an alternative facility for contingency ferry berthing and small vessel refuelling. Mr Hull then showed the group conceptual designs for the proposed barge ramp and laydown area, groyne extension and short 60m groyne, including the proposed dredging area. He advised that it is proposed to extend the existing groyne at a 30º angle to approximately the similar length of which it currently exists (90m). This will create an area of sheltered water for berthing and increase the capacity of the barge and cargo area. The total overall length of the groyne will be approximately 180m in length and up to 25m in width at the sea bed.

Figure 7: Mr Hull explaining the concept plans for the proposed groyne extension, new protection groyne and dredging area.

Mr McMahon enquired into whether the new jetty would require regular dredging to which Mr Hull responded that the area would be dredged to allow 3m depth for the works with maintenance dredging possibly required every 10 or so years. Mr Goode enquired into what would be done with the spoil from the dredging to which Mr Hull responded that the spoil from the works would be used as fill for the project, whilst any spoil removed during future maintenance dredging will be dissipated or removed from site dependant on volume.

The group then walked closer to inspect the existing jetty, stopping at GPS coordinates 363005mE 6458433mN. Here Mr Hull pointed out the areas where the new short 60m groyne and dredging were proposed.

Figure 8: Mr Hull pointing out the areas where the new groyne and dredging are proposed; view N/NW.

Mr McMahon enquired into whether the seaweed which was built up alongside the existing jetty would be removed as part of the works and expressed his concerns that the new extended groyne would also encourage seaweed build up. Mr Hull responded that the shape of the new facility would help minimise and manage seaweed build up.

Mr Goode enquired into whether the dredging will only be removing sand or rock to which Mr Hull responded that it was predominately sand, however geotechnical investigations would reveal the stratigraphy or bedrock of the seabed and whether excavations were necessary. Mr Hull advised that aerial photographs from the past decade of the survey area had been examined which has provided data about how it has changed over the years.

Mr Goode enquired into whether the works would impact upon the marine environment, including any endangered species to which Mr Hull responded that the design proposes to minimise impact upon the marine environment, particularly as the existing navigation channel is nearby so the depth to the seabed is intended to minimise damage on the seagrass. Mr Hull added that there are no known endangered fish species in this particular bay and that the works are not intended to greatly impact upon the sea life.

Figure 9: Survey team viewing the seaweed accumulated on the eastern side of Army Jetty; view to the north.

Mr Goode enquired into whether the existing Army Jetty Road would be extended to the jetty to which Mr Hull responded that it was likely the single lane road could be extended down to the jetty with the possible realignment feeding into the existing path.

Mr Bennell enquired into when the works were planned to be carried out to which Mr Hull responded that they were yet to be scheduled, however would likely occur within the next few years. Mr Goode added that this would be subject to approvals and explained to the group the planning and approvals process, particularly in relation to Aboriginal heritage approvals. Mr Hull added that the project would also likely involve referrals to the Environmental Protection Authority and an opportunity for public comment.

On the issue of public consultation Mr Moore enquired into the background of the consultation process and advised the Rottnest Island Authority that the Whadjuk Traditional Owners were there being consulted as representatives of the Whadjuk NTC group as opposed to an organisation set up for consultation in regards to Aboriginal heritage on Rottnest Island as a whole. Mr Ezra Jacobs agreed and advised that the consultation was the only planned engagement with the Whadjuk NTC group about the project. He further advised that the Rottnest Island Authority do engage with the Wadjemup Aboriginal Reference Group, in particular with the ongoing works at the old Aboriginal prison, however advised that the Wadjemup Aboriginal Reference Group would not be consulted with in regards to the jetty project, unless instructed to by SWALSC.

Mr Ezra Jacobs advised that if additional works are required, such as upgrade works to the Army Jetty Road, then representatives from the Whadjuk NTC group would be consulted with separately as instructed by SWALSC.

Mr Goode then enquired into whether the Whadjuk NTC group representatives had any knowledge about the Army Jetty survey area which had not been previously recorded. Mr Moore responded by clarifying when the groyne was built. Mr Hull responded that a rock groyne with timber jetty was the original structure built in 1906 and was used as the first boat access to the island before the existing main ferry jetty was built in the 1960s. Mr Hull

elaborated that the jetty was utilised by the Army leading up to and during WWII and the timber structure was replaced, upon which heavy machinery was bought over from the mainland to quarry rock to build the extended rock groyne in the 1970s. Mr McMahon then stated that due to the amount of earthworks there could be artefacts within or underneath the existing Groyne. Mr Elisha Jacobs agreed and stated, "In the older days there was no consideration for artefacts when moving earth around". Mr Hull responded that archaeological assessments of the area carried out by the WA Museum in 2012 were looked at by the Rottnest Island Authority during the preliminary concept design of the new facility, however could not recall if archaeological material was recorded. Mr Goode and Mr Ezra Jacobs advised the group that they would look into the 2012 report.

Mr Ezra Jacobs advised that Aboriginal prisoners were incarcerated at Rottnest Island from 1838 to 1931, advising that they were still housed there from 1904-1931 when the island began to be transformed into a tourist destination and were used to carry tourists bags and other menial jobs. He explained that whilst the Aboriginal prisoners arrived on another side of an island, they could have still been at the current survey area and possibly have left artefacts.

Mr Ezra Jacobs advised that whilst he recognises that monitoring is a limited form of engagement, the Rottnest Island Authority could employ archaeological monitors to be present during ground disturbing works to observe any artefacts which may be uncovered as a result of the works. Mr Goode suggested that methods, such as sieving, could be employed to salvage artefacts, however advised that techniques such as this were expensive and likely needed justification to occur. Mr Ezra Jacobs agreed that whilst the survey area was not located within a DPLH registered site or place where archaeological material had been recorded it could be recommended as part of the project.

Mr Ezra Jacobs advised that 7,000 years ago Rottnest Island, or Wadjemup, was connected to the mainland and was low lying coastal plain where archaeological material dating between 20,000 to 30,000 years ago has been recorded, showing that Whadjuk ancestors did live there. Mr Goode agreed and added that in the South West skeletal remains from traditional burials have been found on the eastern sides of coastal dunes. Mr Goode recalled traditional stories about the red-tailed black cockatoo who ferried the souls of the departed from the mainland to a place called *Koorannup* (sp. Bates 1985: 222) across the western sea and concluded that there was potential for the dunes to have burials present. Mr Ezra Jacobs added that the Rottnest Island Authority had recorded a mythology from Whadjuk elder Barry McGuire about *Koorinup* (sp. McGuire) in which has been published in a guide on the Aboriginal History on Wadjemup (see Rottnest Island 2012: 8).

Mr Goode then enquired into whether the Whadjuk NTC group representatives were aware of any mythological or other culturally significant places within or nearby the survey area to which Mr Elisha Jacobs responded that his elders had always emphasised old stories and mythologies about whales, seals and sea lions on Rottnest Island.

Here Mr Ezra Jacobs pointed out that Rottnest Island holds cultural significance to different Whadjuk families who may have different stories. He advised that Whadjuk elder Barry McGuire had also provided a mythology on the formation of Wadjemup which had also been published and that the Rottnest Island Authority would also be happy to document other mythologies from the Whadjuk NTC group representatives if they were happy to share them. Mr Moore responded,

> If the separation of Rottnest Island from the mainland occurred 7,000 years ago I doubt that people on the mainland knew about stories from 7,000 years ago, and they were the ones passing down stories. Apart from stories occurring after settlement. 7,000 years ago was a long time ago and there have been many generations between that time, the stories that have been passed down about the mythologies or topography

> of the island have probably been lost. I don't think there is a cultural memory which stretches back that far if people weren't continuing to live on the island.

Mr Goode enquired into whether the Whadjuk NTC group representatives had any knowledge regarding the historical use of the island to which Mr Garlett responded,

> My Great grandmother would tell yarns about the 'big hills' and about the Garlett and Bennell family who used to walk out here. She also told us about a Dreamtime story about Crocodile and Waugal who had a fight at Cockburn Sound and who created the Swan Coast and the islands here.

Mr Goode advised that Dr Machin had recorded a mythology about a Waugal and a Shark having a fight and subsequently creating the coastline in a survey at Rockingham. Following this the group discussed how whilst the characters in mythologies may change, the specific events stay the same and are the focus of the mythologies.

Mr Goode then discussed how the DPLH places on Rottnest Island are all 'stored data' under the AHA (see the archival section of this report) and advised that it is likely that not enough information about the places was recorded in order for them to become registered sites. He advised that the places were recorded by Dr Barrie Machin and reported by Ken Colbung and Corrie Bodney. Mr Moore responded that whilst the Swan River people are the Traditional Owners, Ken Colbung and Corrie Bodney were not the Traditional Owners of the area.

Mr Goode enquired into whether the proposed works are seen to affect the Nyungar cultural heritage values or beliefs associated with the Island to which Mr Garlett responded by asking why the works are only occurring now and not before the jetty accident which occurred in October of 2018. Mr Hull responded that there were previous proposals to upgrade the site between 2012-2017, however these were not progressed. Mr Garlett enquired into whether the upgrade could be delayed again to which Mr Hull responded it would be the RIA's intention to progress, however timing was dependent on approvals and funding.

Mr Garlett stated that there has been a big movement towards acknowledging the Aboriginal burials in the cemetery on Rottnest Island, however there does not appear to be the same recognition as Rottnest Island as a penal colony. Mr Ezra Jacobs responded that is part of the reason for the current consultation and the creation of the Wadjemup Aboriginal Reference Group with the Rottnest Island Authority wanting to incorporate more consultation, interpretation and engagement across the island.

Mr Ugle then stated,

> You ask us questions about the impacts [to sites or values] that we know of. If our ancestors were here, if they practiced traditional culture and ceremonies then they would have done it in quiet or else they would have been punished. They were imprisoned on the island for being Aboriginal, our culture was condemned. The army back then were bullies. There are likely burials all over the place. There wouldn't have been consultations with Aboriginal people when they replaced the timber jetty with rock back then which would have had a significant impact. But they didn't care then. Our ancestors were the guardians of this land and we are still the guardians. We know you'll go ahead with this regardless of what we think but my concern is the extent of the impact.

Mr Ugle then enquired into whether it was possible to move the proposed dredging, groyne extension and groyne construction to the western side of the existing groyne, stating that the western side had already been subject to previous disturbance. Mr Hull responded that this was

unlikely as the eastern side where the works are proposed provides sheltered waters to vessels and advised that the existing groyne alignment is proposed to be built upon.

Mr Bennell enquired into how long the construction period would be to which Mr Hull responded that he was unsure as the design was not finalised, however it would require a reasonable amount of work due to importing of materials and weather.

Mr Elisha Jacobs enquired into whether public access to the Jetty beach would be maintained to which Mr Hull responded yes, adding that when the works are complete this area would not appear to have been altered much with the exception of lighting and fencing of the commercial storage area.

Mr Moore then stated,

> Getting back to the mythological side of this, I think that it is a big concern that the government can always seem to find money to carry out infrastructure and provide services, promote tourism, etc. But the island is a spiritual Mecca to just about every Aboriginal person. There may not be the traditional mythological story about the island but we attribute spiritual and mythological significance to it. There are burials and the whole island is spiritual to us. So before the works there should be a cultural ceremony or practice to make sure the spirits are acknowledged and to placate the spirits from all of those buried here.

Mr Garlett agreed and added,

> We never came here as children because we were told there were so many spirits here. Aboriginal people didn't like to come here as the island belongs to them, the spirits of the people who died here.

Mr Moore suggested that interpretative signage could be installed at the Army Jetty. Mr Elisha Jacobs agreed with this request and stated that interpretative signage could cater to Aboriginal people visiting the island in the future, as well as provide the public with the Aboriginal history of the area. Mr Garlett agreed but stated, "We're only just getting signage at the cemetery, there's not much else elsewhere on the island for us". Mr Moore advised him that there had been funding granted to create a Wadjemup cultural centre.

Mr Goode enquired into whether there was a Whadjuk name for the specific place or bay where the group were standing to which Mr Moore responded "We're 20km from the mainland, like Ezra said, it was connected to the mainland 7,000 years ago. The memory of the name wouldn't have lasted that long". Mr Ezra Jacobs stated that he had not heard of a name however there was a chance that knowledge did exist somewhere. Mr Goode enquired into whether if there was a name would the Whadjuk NTC group representatives be interested in dual naming of Thompson Bay to recognise the Whadjuk history to which Mr Moore responded yes, however reiterated his doubts that the name survived.

Mr McMahon then stated that he knew of Whadjuk people fishing on Garden Island and enquired into whether there was any evidence, such as canoes, of Whadjuk people fishing on Rottnest Island. Mr Goode responded no and discussed how Nyungar people were not seafaring people. Mr Ugle agreed and stated that Nyungar people were land dwelling people, with small rafts made out of paperbark occasionally used to travel along the rivers. Mr Ezra Jacobs added that there was archaeological evidence that proves that the island was occupied prior to its separation from the mainland 7, 000 years ago but there has been no evidence found/recorded to date, archaeological or other, that suggests Noongar people continued to visit the island after separation and prior to settlement.

Mr Goode advised that the Tea Tree branches would be bundled together with Paperbark placed over the top and added that the Aboriginal prisoners would also be told that there were big sharks around the island to stop them from trying to escape and swim back to the mainland.

Mr Ugle then pointed out that it was not just Nyungars imprisoned on Rottnest Island and advised that his grandfather came from the North West and was imprisoned on the island. Mr Moore agreed and stated that numerous Aboriginal men and boys from across the state were imprisoned together, who conducted different cultural practices. Mr Moore added that, as such, Rottnest Island contains a spiritual sense for a lot of Aboriginal people, not just Nyungars.

Mr Goode then summarised the consultation and enquired into whether the Whadjuk NTC group representatives had any knowledge of any specific ethnographic sites or places, as defined by section 5 of the AHA, located within the Army Jetty survey area. Mr Elisha Jacobs responded "You could find out whether it's a site if you uncover artefacts when doing the works. There could be objects under the ground".

Mr Goode enquired into whether the Whadjuk NTC group had any feelings or sentiment about the Army Jetty survey area to which Mr Bennell responded that there could be burials within, or close to the survey area as traditionally Nyungars were buried facing the east where the sun rises behind sand dunes.

Mr Goode then enquired into whether the Whadjuk NTC group representatives had any management recommendations to make in regards to the proposed works to which Mr Moore reiterated his request for a ceremony or ritual to be carried out prior to the works occurring to acknowledge the spiritual significance of the Island. Mr Goode enquired into what form the ritual or ceremony would or whether that would be determined by the Whadjuk Working Party at a later date to which Mr Ugle responded that it would be determined by the Whadjuk people at a later date.

Mr Ugle added "there could be artefacts here, bodies nearby in the dunes. We can't give an educated opinion about how to address these issues without knowing everything".

Mr Moore agreed and added "This is a spiritual level to us. It's abstract".

Mr Ugle stated "It is spiritual to us because of the Aboriginal bodies here".

Mr Garlett stated "Our mob used to believe that when we died we would go to Koorannup across the western sea so when they were taken on boats across the sea here they actually thought they were literally coming here to die".

Mr Ezra Jacobs added "Pop Barry McGuire told of a song about Wadjemup with the Whale. The story is about crossing the sea".

Mr Goode then discussed archaeological monitoring and advised that he would talk to BGA archaeologist Jacqueline Harris about previous archaeological surveys on the island which she had been a part of and would find out whether there was any archaeological material recorded in the Army Jetty survey area.

Mr Goode enquired into whether the Whadjuk NTC group representatives had any questions or comments to make in regards to the proposed works to which they responded no.

The consultants and proponents then thanked the group and concluded the ethnographic consultations.

Figure 10: (from left) Ms Louise Huxtable, Mr Gary Bennell, Mr Greg Ugle, Mr Elisha Jacobs, Mr Brendan Moore, Mr Trevor McMahon, Mr Brad Goode, Mr Clinton Hull, Mr Peter Garlett, Mr Tony Hill and Mr Ezra Jacobs.

COMMUNITY CONSULTATION OUTCOMES

As a result of the consultations held with seven representatives of the Whadjuk NTC group on the 5th February 2019 **no new** ethnographic sites, as defined by section 5 of the AHA were identified within the Army Jetty Works Area.

During the consultations, the Whadjuk NTC group representatives were concerned that there could be artefacts in the subsurface and potential burials could be located in the dunes close to the Works Area as traditionally Nyungars were buried facing east behind sand dunes (see Bates 1985: 222-224). As a result it was requested that Archaeological monitors be present during all ground disturbing works and archaeological techniques, such as test pitting and sieving be employed if artefacts are found.

During the consultations the Whadjuk NTC group representatives confirmed the previously recorded creation mythology for Rottnest (Wadjemup) Island and its significance and objected to the determination by the ACMC that the island does not constitute an Aboriginal site within the meaning of the AHA.

In relation to spiritual significance of the project area, the Whadjuk NTC group confirmed that Nyungar people traditionally believed that when they died their spirit would cross the Western Sea and go to Koorannup (at Wadjemup) to a place of rest (see Bates 1985: 222-224). The group further advised that historically when Aboriginal people were imprisoned on Rottnest Island, many Nyungar people believed that those imprisoned were literally coming to Rottnest to die and in fact many did. Therefore it is the view that burials could be anywhere as opposed to the known cemetery.

As a result of the spiritual sentiment associated with the project area, the Whadjuk NTC group representatives requested that a proprietary ritual be performed prior to the works occurring at the Army Jetty. This ceremony would be determined by the Whadjuk who are engaged to conduct it, but it would need to be prior to any work occurring.

In relation to the Aboriginal history of Rottnest Island, the Whadjuk NTC group representatives also requested that interpretative signage be installed at the Army Jetty to provide people visiting the island more information about Aboriginal history of the project area.

RECOMMENDATIONS

As a result of the survey the following recommendations are made in relation to the Western Australian Aboriginal Heritage Act (1972):

As no ethnographic sites of significance as defined by section 5 of the AHA were identified to be located in the Army Jetty Project Area **it is recommended** that Rottnest Island Authority can proceed with the project as currently planned without undue risk of breaching the AHA in relation to ethnographic sites and places.

It is further recommended that Rottnest Island Authority gives due consideration to the requests made during the ethnographic survey by the Whadjuk WC2011/009 that:

- Archaeological monitors be present during all ground disturbing works and archaeological techniques, such as test pitting and sieving be employed if artefacts are found;
- A proprietary ritual (to be determined by the Whadjuk NTC group) be performed prior to the works occurring; and
- An interpretative sign be installed at the Army Jetty which explains the Aboriginal history of the area.

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Legend

- Registered Aboriginal Site
- Search Area
- Town
- Road
- River
- Local Government Authority

0.10 kilometres

Map Scale 1 : 3,130

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3443	ROTTNEST: CEMETERY NORTH	Yes	Yes	No Gender Restrictions	Stored Data / Not a Site	Modified Tree, Skeletal Material / Burial	*Registered Knowledge Holder names available from DAA	Not available when location is restricted	S02668
3776	INDIAN OCEAN	No	No	No Gender Restrictions	Stored Data / Not a Site	Mythological	*Registered Knowledge Holder names available from DAA	372624mE 6445362mN Zone 50 [Reliable]	S02169
20862	Rottnest Island (Wadjemup)	No	No	No Gender Restrictions	Stored Data / Not a Site	Artefacts / Scatter, Historical, Man-Made Structure, Midden / Scatter, Mythological, Quarry, Rockshelter, Skeletal Material / Burial, Arch Deposit, Camp, Hunting Place, Massacre, Meeting Place, Natural Feature, Shell, Water Source	*Registered Knowledge Holder names available from DAA	359511mE 6457858mN Zone 50 [Reliable]	

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- Town
- Road
- River
- Local Government Authority

0.10 kilometres

Map Scale 1 : 3,130

MGA Zone 50 (GDA94)

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APPENDIX 2: LETTER OF ADVICE

Brad Goode & Associates Pty Ltd
Consulting Anthropologist
Heritage Assessments

79 Naturaliste Terrace
DUNSBOROUGH WA 6281
(08) 9755 3716
bradnlee@westnet.com.au
ACN: 134 732 040
ABN: 41 134 732 040

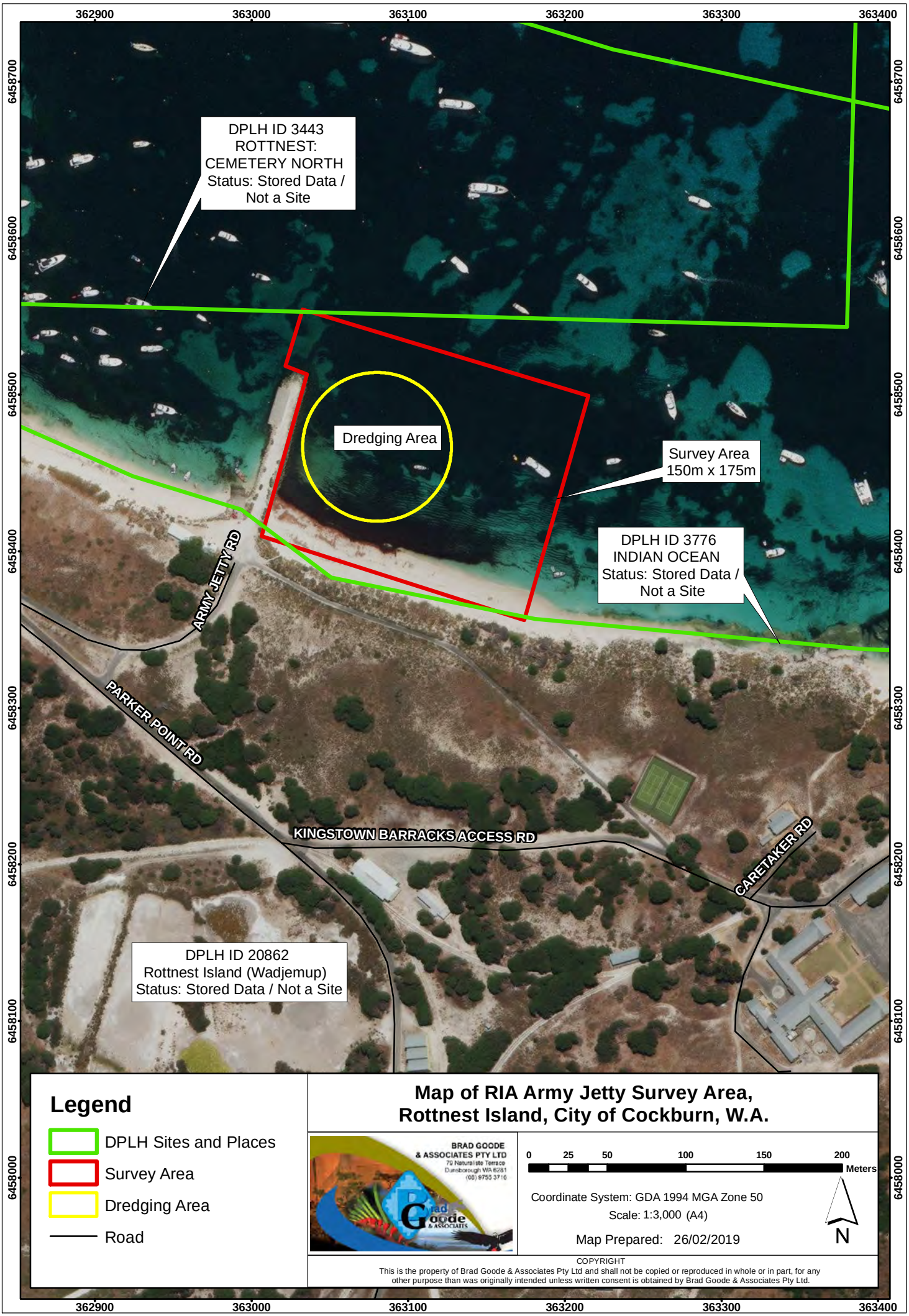
05th February 2019

We the undersigned have been consulted by Brad Goode & Associates Pty Ltd, on behalf of the Rottnest Island Authority, regarding the proposed break wall extension, dredging and geotechnical investigations as part of the Army Jetty upgrade works. We would like to make the following recommendations in relation to the Western Australian Aboriginal Heritage Act 1972:

- There are no new ethnographic sites, as defined by section 5 of the AHA, located within the Army Jetty survey area.
- We request that the Rottnest Island Authority gives due consideration to our requests that:
  - Archaeological monitors be present during all ground disturbing works and archaeological techniques, such as test pitting and sieving be employed;
  - A proprietary ritual (to be determined by the Whadjuk NTA) be performed prior to the works occurring; and
  - An interpretative sign be installed at the ~~gro~~ Jetty which explains the Aboriginal history of the area.

Whadjuk People WC2011/009 Native Title Claim group		
Garry Bennell	05.02.2019	
Greg Ugle	05.02.2019	
Brendon Moore	05.02.2019	B Moore
Peter Garlett	05.02.2019	
Trevor McMahon	05.02.2019	
Tony Bennell Hill	05.02.2019	
Reg Yarran	05.02.2019	
Elisha Jacobs	05.02.2019	

APPENDIX 3: MAP OF THE PROJECT AREA IN RELATION TO ABORIGINAL HERITAGE SITES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DPLH ID 3443
ROTTNEST:
CEMETERY NORTH
Status: Stored Data /
Not a Site
Dredging Area
Survey Area
150m x 175m
DPLH ID 3776
INDIAN OCEAN
Status: Stored Data /
Not a Site
ARMY JETTY RD
PARKER POINT RD
KINGSTOWN BARRACKS ACCESS RD
CARETAKER RD
DPLH ID 20862
Rottnest Island (Wadjemup)
Status: Stored Data / Not a Site
Legend
DPLH Sites and Places
Survey Area
Dredging Area
Road
Map of RIA Army Jetty Survey Area,
Rottnest Island, City of Cockburn, W.A.
BRAD GOODE
& ASSOCIATES PTY LTD
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Dunsborough WA 6281
(08) 9755 3716
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Meters
Coordinate System: GDA 1994 MGA Zone 50
Scale: 1:3,000 (A4)
Map Prepared: 26/02/2019
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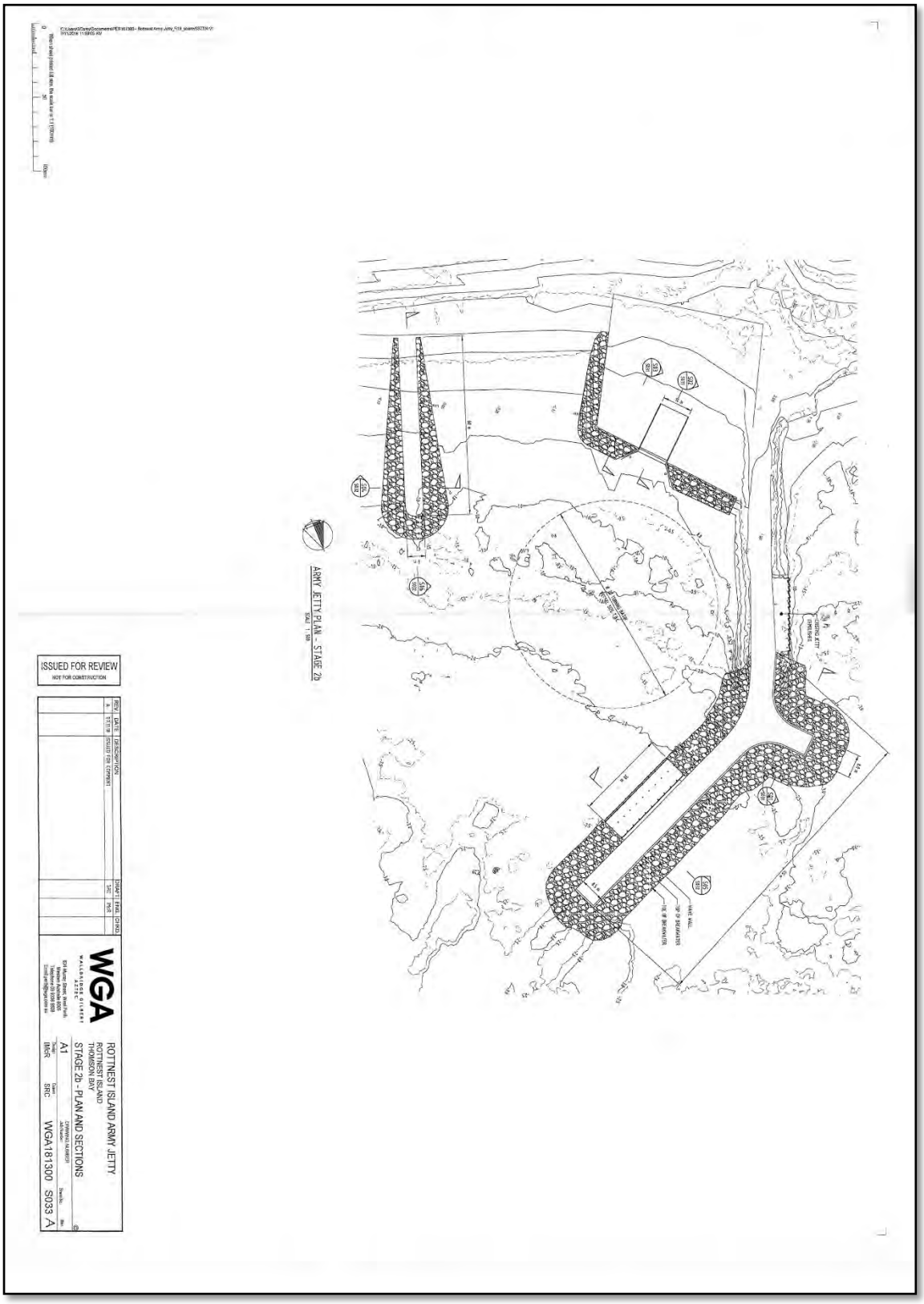

REPORT

Appendix N
Assessment of benthic habitats, South Thomson Bay barge and cargo facility

SOUTH THOMSON BAY BARGE AND CARGO FACILITY

Assessment of Benthic Habitats

EEN19032.002
Thomson Bay Habitat Survey
Revision 1
17 April 2019

rpsgroup.com

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
A	Internal Review	MMA	JFI	JerFit	16/4/19
1	Review by Client	MMA			17/4/19

Approval for issue

Jeremy Fitzpatrick	[Date]

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Contents

1 INTRODUCTION 4

2 METHODS 6
2.1 Field Survey 6
2.2 Data processing 6
2.2.1 Habitat Classification 6
2.2.2 Development of benthic habitat map 7

3 RESULTS AND DISCUSSION 8
3.1 Defining a Local Assessment Unit (LAU) 8
3.2 Benthic habitat map within the FSA 8
3.3 Assess the veracity of existing habitat maps 11
3.4 Estimates of BCH loss as a consequence of the proposed development 12
3.5 Estimates of cumulative BCH loss 13
3.5.1 Historic BCH loss 13
3.5.2 Increase in cumulative BCH loss due to proposed development 14

4 REFERENCES 15

Tables

Table 3.1 Habitat type at each field survey site 9
Table 3.2 Comparison of habitat area estimates between RPS and Harvey habitat maps 11

Figures

Figure 1. Proposed barge ramp and cargo handling facilities at the former Army Jetty in Thomson Bay, Rottnest Island 5
Figure 2. Habitat map of Rottnest Island by Harvey (2009) 8
Figure 3. Benthic habitat map of the survey area within south Thomson Bay, Rottnest Island 10
Figure 4. Footprint of proposed development in Thomson Bay overlaid on benthic habitat map 13

Appendices

Appendix A : Thomson Bay Benthic Survey 16
Appendix B : Field Survey Data 17

1 INTRODUCTION

As anticipated in the *Rottnest Island Management Plan 2014-19* (RIA 2014), the Rottnest Island Authority (RIA) is proceeding with development of the former Army Jetty in south Thomson Bay into a barge ramp and cargo handling facility with contingency ferry berth (Figure 1). The barge landing area, breakwater and groyne components of this development will be constructed from limestone boulders, with seabed spoil from associated dredging operations used as infill.

Rottnest Island is an A-class reserve with significant ecological, cultural and social values (RIA 2014). The marine reserve is characterised by a unique blend of tropical and temperate species, and a diverse range of habitats and communities including coral reef and extensive seagrass meadows. Protection of this unique environment is one of five critical areas of focus for the RIA (RIA 2014), and as such it has undertaken a preliminary assessment of the environmental impacts associated with the proposed development. These are primarily associated with impacts of dredging and development footprints on benthic marine communities and habitats (BCH), in particular the seagrass meadows that dominate Thomson Bay and comprise ~30% of the total seagrass area around Rottnest Island (Harvey 2009).

Based on early-stage design concepts it was estimated that the proposed development would result in the irreversible loss of up to 1.5% of these seagrass meadows in Thomson Bay, which is approximately 0.5% of the total area of seagrass within the Rottnest Island Marine Reserve (RPS 2019). However, RPS (2019) also noted that discrepancies existed in benthic habitats shown in recent (2014 and 2018) aerial images and the benthic habitat maps developed by Harvey (2009). As such, RPS (2019) recommended that an updated habitat map based on ground-truthed aerial imagery be developed for Thomson Bay, to enable more accurate assessment of impacts to benthic habitat due to the proposed development.

Based on recommendations by RPS (2019) and in preparation for referral of the proposed development under Section 38 of the *Environmental Protection Act 1986*, the objectives of this report are to:

- define a Local Assessment Unit (LAU) for assessment of benthic impacts from the proposed development
- assess the veracity of habitat mapping by Harvey (2009) and its suitability for LAU-scale estimates
- develop detailed benthic habitat map of development area
- confirm estimates of BCH (seagrass) loss due to the proposed development.
- estimate cumulative BCH loss.

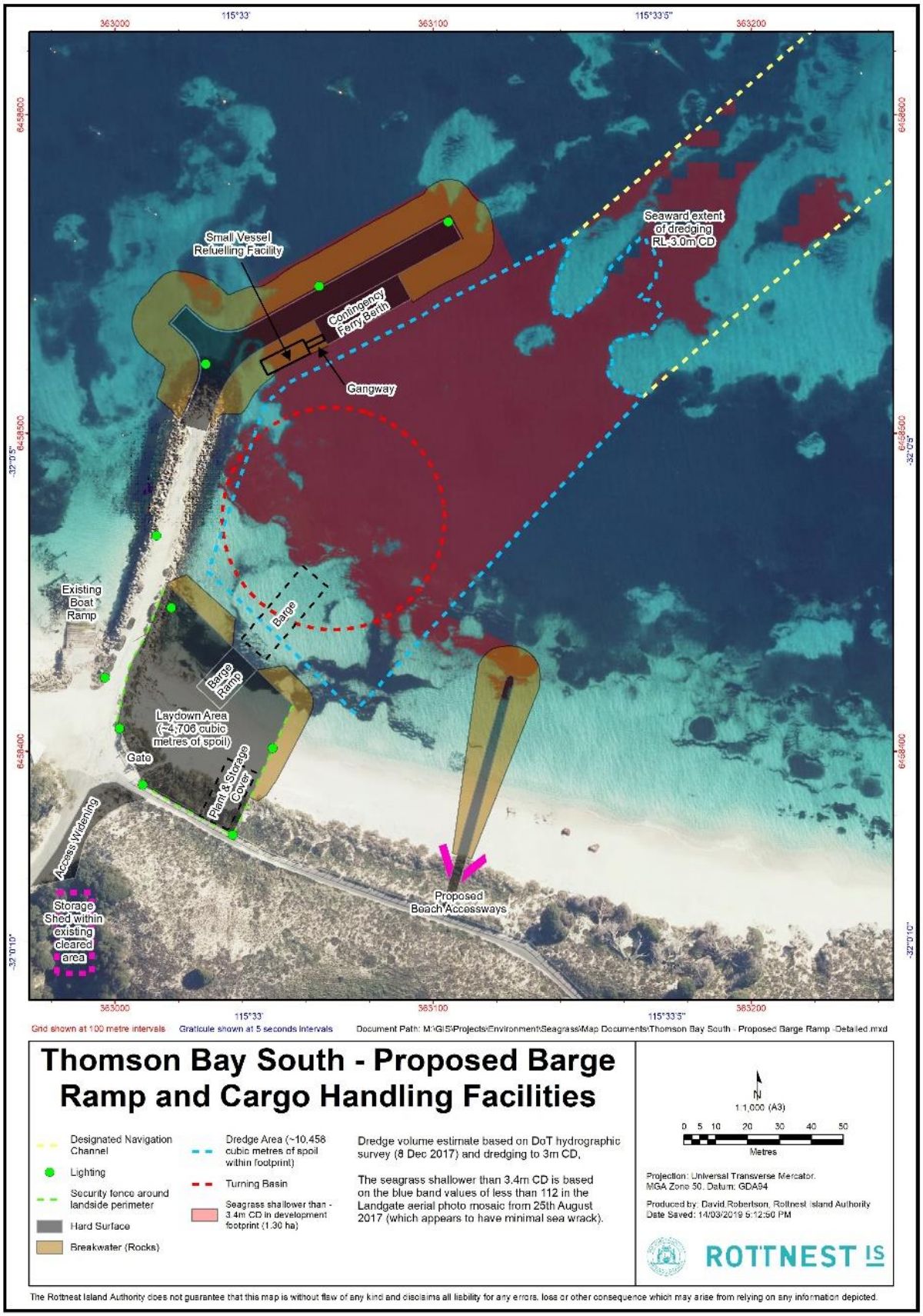


Figure 1. Proposed barge ramp and cargo handling facilities at the former Army Jetty in Thomson Bay, Rottnest Island

2 METHODS

2.1 Field Survey

Objectives of this report required assessment of habitat within an area of south Thomson Bay encompassing the proposed development. This area measured approximately 2.6 x 1.0 km and is referred to as the 'Field Survey Area' (FSA; Appendix A).

The FSA defined the extent of a benthic habitat survey used to ground-truth aerial images for development of the habitat map. The survey was completed between 0830 and 1400 hrs on the 27th March 2018. Weather was fine with light cloud cover and 10 - 15 KN southerly. Water visibility was good, with detailed benthic habitat classification (ie distinguish mixed biota) reliable to approximately five metres and general classification (ie identify dominant habitat) to approximately seven metres. Tides on the day were: low tide (0304 hrs/0.41 m) and high tide (1254 hrs/0.86 m).

The RIA ten metre rigid inflatable vessel *Ranger 1* was used during the survey. This was skippered by an RIA Ranger who navigated along pre-determined transects within the FSA that included the former army jetty and proposed navigation channel within Thomson Bay (Appendix A). These transects were orientated directly north-south and set ~200 m apart. Along each transect, the skipper stopped the vessel at pre-determined locations 100 metres apart. Additional 'off transect' locations to assess habitat of interest (as identified from the aerial image) were also surveyed.

At each location an RPS field scientist lowered a glass bottomed viewing tube into the water and made a point assessment of the habitat type vertically below the viewing location near the rear of the vessel. The assessment area was approximately two metres across. Data recorded was percent cover of seagrass (to genus), macroalgae, bare substrate (sand or limestone reef/platform) and wrack (unattached macroalgal thalli and dead seagrass leaves) (Appendix B). Data was recorded by a second RPS field scientist along with sampling location onto a digitised aerial image of the survey area.

2.2 Data processing

Sampling locations recorded during the field survey were downloaded into GIS and correlated with habitat classes. These classes were derived from percent cover of biota and bare substrate obtained during the field survey, as described in Section 2.2.1. A map of benthic communities and habitat was subsequently developed using methods described in Section 2.2.2.

2.2.1 Habitat Classification

The classification scheme used in the field component of this study was based on that developed for Seamap Australia (Butler et al. 2017). This is a dominance-based scheme, i.e. the classes are defined based on the dominant biota, or a mixture of one or more dominant species (Table 2.1). In this study the criteria for dominance is >50% cover. A mixed class is identified where the percentage cover of the two or more dominant classes are separated by ≤ 30% (relative to the percentage cover of the most dominant class). For example, a sampling location consisting of 25% macroalgae and 60% *Posidonia* spp, would be classed as *Posidonia*-dominated, whereas a location consisting of 40% macroalgae and 60% *Posidonia* spp, would be classed as mixed *Posidonia* / macroalgae habitat. The classification scheme was also designed to be compatible with the hierarchical scheme developed by Harvey (2009) for classifying marine benthic habitats of Rottnest Island, to enable extrapolation to broader spatial scales.

Table 2.1 Classification scheme used in analysis of benthic habitat

Habitat Class	Description
Sand	71 – 100% bare sand
Sand with seagrass	≤ 30% seagrass
Sand with wrack	>30% wrack (note: wrack present with other biota is not classified)
Posidonia dominated	>50% *Posidonia* spp.
Amphibolis dominated	>50% *Amphibolis* spp.
Macroalgae dominated	>50% brown macroalgae
Mixed seagrass	% cover of dominant seagrasses separated by ≤ 30%
Mixed algae/seagrass	% cover of dominant seagrass/algae separated by ≤ 30%
Limestone reef / pavement	Limestone reef or platform with minor (<30%) attached seagrass/macroalgae

2.2.2 Development of benthic habitat map

Habitat mapping was undertaken using Esri's ArcMap to create a digitized image in vector shapefile format. This image was based on Landgate's August 2017 and August 2018 Web Map Service aerial photographs, which were selected for their water clarity and well-defined seabed features. Comparison between the two photographs also enabled mobile areas of wrack to be identified and where relevant removed from areas of seagrass habitat. Further assessment of habitat was undertaken using fine-scale bathymetric data and the Global Mapper GIS application. Areas of habitat on the digitised image were then classified into habitat classes using data from the RPS field surveys, which was pooled where necessary to provide a more reliable description of habitat across the FSA.

3 RESULTS AND DISCUSSION

3.1 Defining a Local Assessment Unit (LAU)

The LAU is a geographical area that establishes the spatial context for the calculation and assessment of recoverable impacts and cumulative losses (EPA 2016a). Local assessment units are location specific and should take into account local physical, ecological, administrative and jurisdictional considerations.

The most appropriate LAU for the proposed development is the area mapped by Harvey (2009). This comprises 2,746 ha of described habitat in which historic habitat loss from anthropogenic impacts have been estimated (Oceanica 2013; as discussed further below). It also represents a complete island ecosystem and is consistent with EPA guidance for the size of an LAU in Western Australia (EPA 2016a).

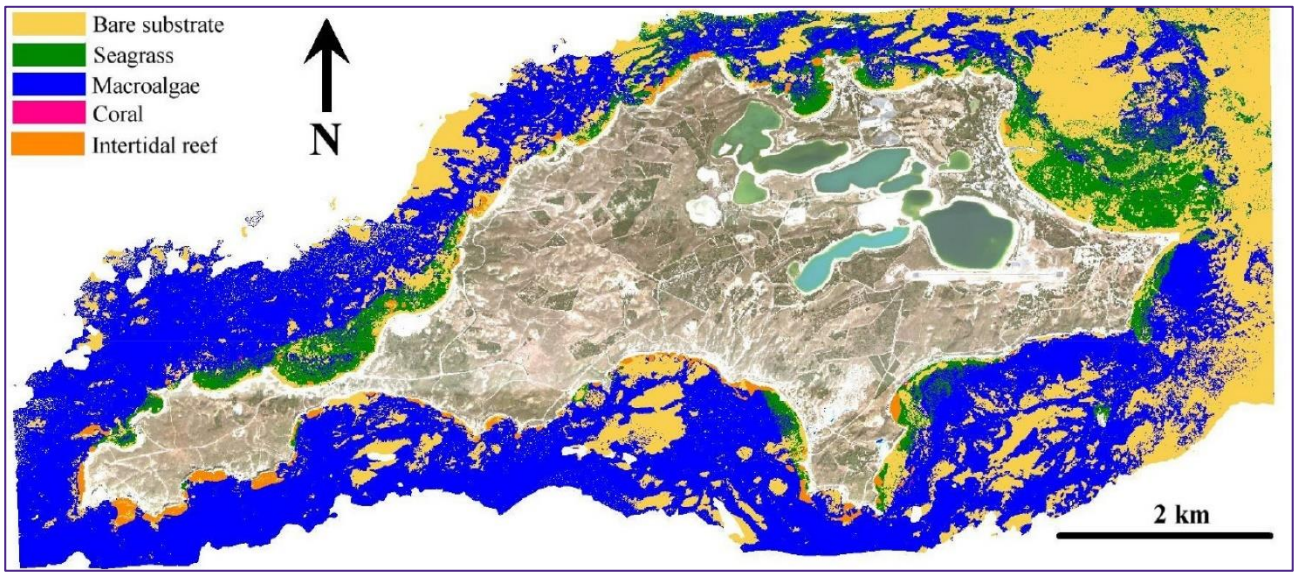


Figure 2. Habitat map of Rottnest Island by Harvey (2009)

3.2 Benthic habitat map within the FSA

A benthic habitat map is necessary for estimating historic habitat loss and predicting additional losses from planned developments (EPA 2016a). The benthic habitats of Rottnest Island were mapped by Harvey (2009) using a combination of *in situ* observation and aerial hyperspectral imagery. Benthic habitats were classified at four levels by Harvey (2009), where Level 2 identified seagrass, macroalgae, coral, intertidal reef, sand and unclassified (typically beach). Approximately 399 ha or 14.5% of the total mapped area (2746 ha) was classified as seagrass meadows, with 119 ha located within Thomson Bay.

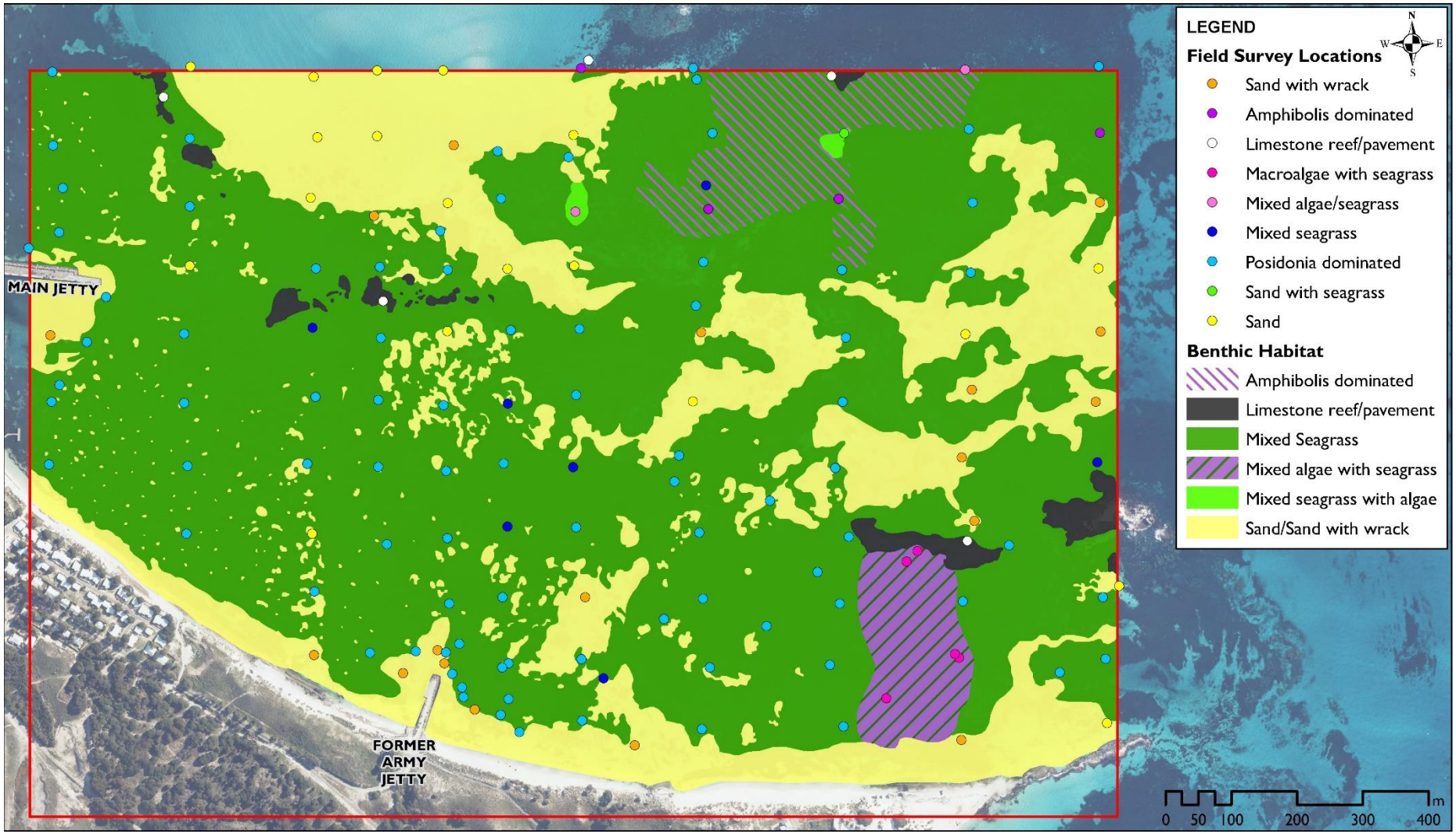
The benthic habitat map developed here for assessment of the south Thomson Bay development (Figure 3) shows the distribution of seagrass in the vicinity of the proposed development and more broadly across southern Thomson Bay. The relative cover of the different habitat types is shown in Table 3.1 and confirms the dominance of seagrass, in particular *Posidonia* spp. 'Bare' sand habitat also occupies a substantial part of the FSA, and the presence of wrack over sand in 14% of the sampling sites confirms observations by RPS (2019) that estimates of seagrass habitat may be affected by its presence. Areas of mobile wrack over sand that might otherwise have been classified as seagrass or other habitat were identified by comparison of the 2017 and 2018 aerial images. These areas can be seen as darker areas of sand in Figure 3 and are common across the FSA, particularly in nearshore waters.

The benthic habitat map shown in Figure 3 also indicates an area dominated by macroalgae in the southeast part of the FSA. This was identified by several of the survey locations however the boundary of this area was difficult to define from the aerial images, even with depth contours overlaid and with use of Global mapper to distinguish between colour values. Similarly, a broad area in the northern part of the FSA appears to comprise a mix of seagrass and algae that could not be clearly defined from the aerial images. This may also be grouped with seagrass habitat to define benthic primary producer habitat.

Table 3.1 Habitat type at each field survey site

Habitat type	# of sites	Percent of total
Amphibolis dominated	4	3%
Limestone reef/pavement	5	4%
Macroalgae dominated	4	3%
Mixed algae/seagrass	2	2%
Mixed seagrass	6	5%
Posidonia dominated	69	54%
Sand	18	14%
Sand with seagrass	2	2%
Sand with wrack	18	14%
Grand Total	**128**	**100%**

Figure 3. Benthic habitat map of the survey area within south Thomson Bay, Rottnest Island



3.3 Assess the veracity of existing habitat maps

The EPA (2016a) notes that technical reviews and assumptions forming the basis of predictions of cumulative loss of BCH within clearly defined LAUs should be clearly described in environmental impact assessments. The habitat maps developed by Harvey (2009) are an important resource for impact assessments within the Rottnest Island Marine Reserve. These maps were developed using hyperspectral imagery obtained in 2004 and based on spectral signatures of the dominant habitat components. At the broadest scale, areas of bio-substrate were separated from bare substrates in the image with an overall accuracy of 95%, whereas at the finest scale, bare substrates and dominant species or genera were separated with an accuracy of 70% (Harvey 2009).

One reason for the decrease in accuracy at the finer scale was the inherent spatial inaccuracy of the geo-location of both the image and the validation data collected in the field (Harvey 2009). Harvey (2009), in comparing the habitat maps he developed with an earlier map by Ong et al. (1998), also noted similarities at the broad scale but less so at the finer scale. Similarly, when comparing the benthic habitat map by Harvey (2009) to aerial images taken in August 2014/2018 and observations from the site visit, RPS (2019) identified mismatches in areas of seagrass and sand habitat, considered most likely to be due to fine-scale misclassification of habitats by Harvey (2009). In particular, RPS (2019) observed that misclassification of mobile wrack as seagrass by Harvey (2009) would result in an overestimate of the amount of seagrass loss within the planned development footprint.

The spatial scale of analysis is therefore a critical element in determining the accuracy of habitat maps, and therefore in assessing the impacts associated with the proposed development. Table 3.2 highlights broad similarities between the habitat map developed in this study for the FSA and the Level 2 habitat map developed by Harvey (2009) for the same area. However, it also indicates that the map by Harvey (2009) underestimates the amount of seagrass in south Thomson Bay and overestimates the amount of algae, particularly in the area identified during the current study as comprising a mix of algae and seagrass (see Section 3.2). The map by Harvey (2009) also indicates more areas of sand than the current study.

Based on the above, and considering the guidance by EPA (2016a) that the understanding of benthic communities and their habitats should be proportional to the scale of the proposed development, it is considered reasonable that the habitat map developed by Harvey (2009) is satisfactory for description of habitat within the LAU defined for the proposed development. It is also a conservative approach because the map by Harvey (2009) is shown to underestimate seagrass habitat within the FSA. For this reason, it is more appropriate to base assessment of seagrass habitat loss due to the proposed development on the habitat map developed during the current study (Section 3.2).

Table 3.2 Comparison of habitat area estimates between RPS and Harvey habitat maps

Harvey (2009) category	RPS category	Harvey hectares	RPS hectares	Difference
macroalgae/intertidal	limestone reef/pavement	16.04	7.09	8.95
	mixed algae with seagrass			
	mixed seagrass with algae			
seagrass	mixed seagrass	91.69	110.28	-18.59
	mixed seagrass (*Amphibolis* dominated)			
	mixed seagrass (*Posidonia* dominated)			
sand	sand/sand with wrack	55.12	46.09	9.03
unclassified	na	0.56		0.56

3.4 Estimates of BCH loss as a consequence of the proposed development

Detail of the proposed development is shown in Figure 1 and overlaid on the benthic habitat map in Figure 4. The calculations by RPS (2019) of BCH loss or permanent alteration were based on the following impacts:

- footprint of all new infrastructure, including the barge landing area, breakwater and beach groyne
- an additional 15 m 'halo' around new infrastructure (excluding dredged areas), consistent with observations around the former Army Jetty and Main Jetty
- area enclosed by the breakwater and beach groyne, incorporating the (dredged) barge turning circle
- outer envelope of potential dredged areas (including batter) within the barge approach corridor to allow for access of various vessel drafts
- 15 m buffer applied to dredged areas as a notional area for localised indirect sedimentation and erosional impacts.

dredging of navigation channel to -3.4 m LWMF or -4.16 m AHD within dredge area.

Based on these parameters the following estimates of seagrass loss as a consequence of the proposed development are made [NOTE: need to check with RIA if they can confirm these calculations due to GIS budget issues]:

- 1.43 ha direct seagrass loss (permanent):
  - Development direct loss: 0.23 ha
  - Dredging direct loss 1.07 ha
  - Dredging 15m halo direct loss 0.13 ha
- 0.47 ha indirect seagrass impact – effectively irreversible of where recovery is unlikely to occur for at least five years.

This total of 1.9 ha represents irreversible loss and does not consider short-term recoverable impacts from dredge-generated sediments. Estimates of recoverable impacts require predictive modelling of hydrodynamic and sediment transportation as well as consideration of sediment characteristics (EPA 2016b). These are not considered here.

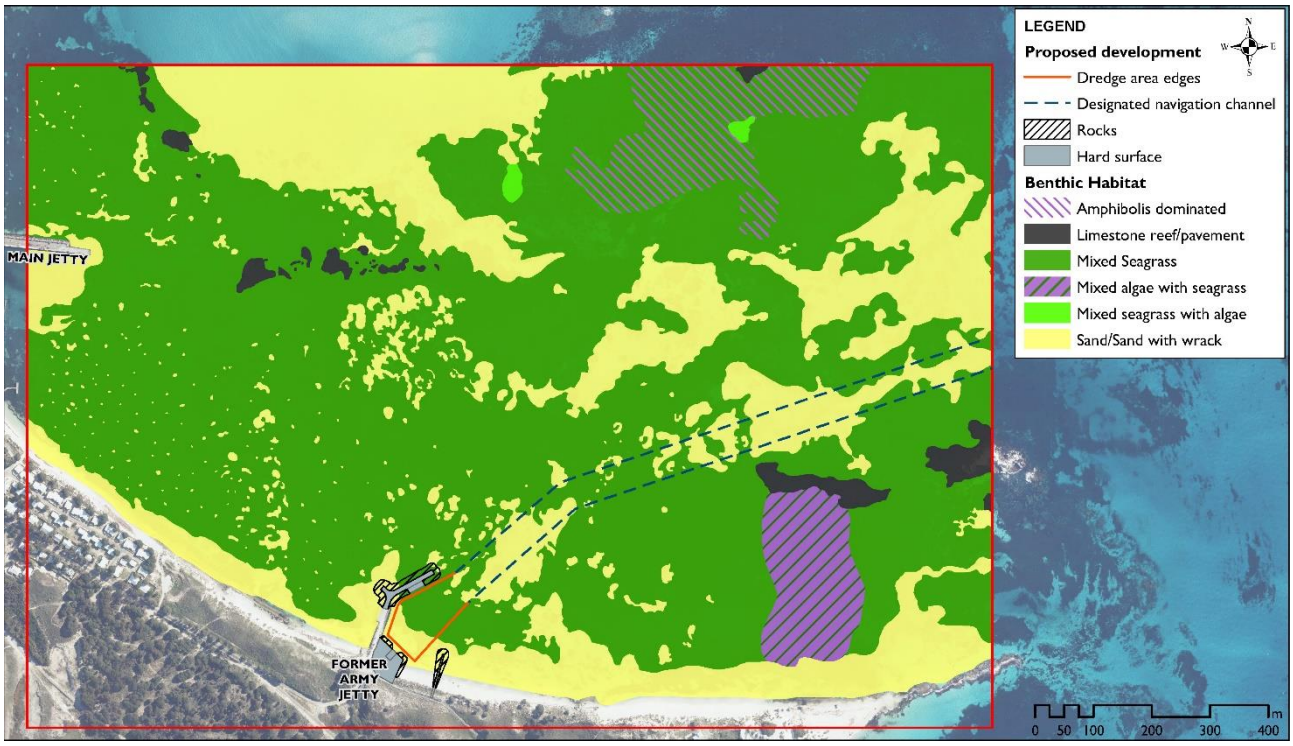


Figure 4. Footprint of proposed development in Thomson Bay overlaid on benthic habitat map

3.5 Estimates of cumulative BCH loss

Calculation of cumulative BCH loss within a defined LAU requires estimates of the extent of BCH (EPA 2016a):

- prior to all human-induced disturbance
- at the time of the proposed development
- remaining after the development is completed

Oceanic (2013) provided estimates for the first two points above through calculations of historic BCH loss within the defined LAU for Rottnest Island. These are reviewed below. Preliminary estimates for the third point above (BCH loss due to the proposed development) are described above in Section 3.4, with a combined calculation of cumulative BCH (seagrass) loss described below.

3.5.1 Historic BCH loss

Oceanica (2013) estimated historic anthropogenic BCH loss associated with vessel moorings (mooring scars) and jetties from a review of aerial imagery taken in March 2008. Their estimates are only for seagrass because there was insufficient data for other habitat types such as coral and macroalgae, and because seagrass meadows typically occur within sheltered, shallow bays where this marine infrastructure is located. This is acceptable for the current study because seagrass is the key impacted habitat. The estimates by Oceanica (2013) did not consider other potential sources of anthropogenic stressors such as eutrophication, propeller scour and sedimentation, and assumed that areas of bare sand around marine infrastructure and moorings were previously 100% seagrass. The latter may result in an over-estimate of seagrass loss as some areas may have historically been bare sand (RPS 2019). Further, there appears to have been some recovery of cleared seagrass due to the change to environmentally friendly mooring designs which has allowed some seagrass regrowth (Oceanica 2013). RPS (2019) found evidence of both degradation and regrowth of seagrass habitat to the east and west of Main Jetty in Thomson Bay, respectively, and noted that regrowth may be associated with a change in the species composition of seagrass. Ultimately, estimations of historic anthropogenic losses are inherently difficult due to a lack of reliable baseline data and lack of understanding

of loss due to natural events such as storms and alongshore sediment transport (RPS 2019). A conservative approach is therefore taken in this report by not accounting for areas of regrowth.

In considering the above, the estimate of seagrass loss around Rottnest Island by Oceanica (2013) is acceptable for LAU-scale calculations. These estimates use the data by Harvey (2009) to estimate the 'current' extent of seagrass habitat as 398.70 ha which, when combined with the amount lost due to human-induced disturbance (7.95 ha) results in an estimated 406.65 ha of seagrass habitat within the LAU prior to impacts due to human activities. This represents a 1.95% loss of historic seagrass habitat within the LAU.

3.5.2 Increase in cumulative BCH loss due to proposed development

Based on calculations described in Section 3.4 the direct and indirect seagrass losses as a consequence of the proposed development represent a 0.35% increase in cumulative loss over the LAU. (from 1.95%)
[NOTE: this figure needs confirming with data in section 3.4]

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Appendix A: Thomson Bay Benthic Survey

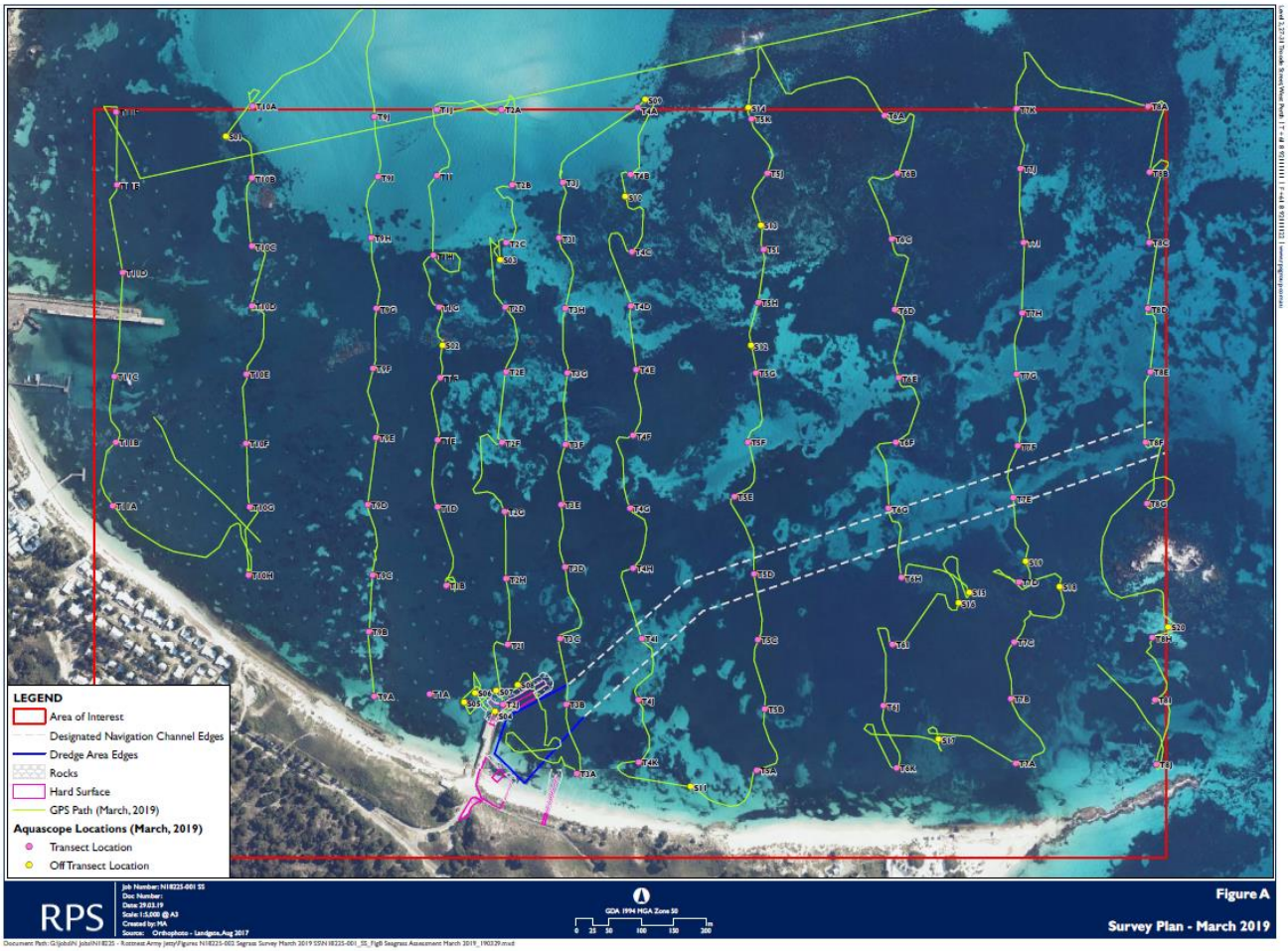

Figure A. The FSA within Thomson Bay (red rectangle), vessel track and sites ground-truthed during the survey. Also shown are the proposed channel and development footprint

Appendix B: Field Survey Data

New_ID	LAT_dd	LONG_Dd	Habitat classification
S01	-31.993218	115.545670	Limestone reef/pavement
S02	-31.996108	115.549166	Limestone reef/pavement
S03	-31.994951	115.550124	*Posidonia* dominated
S04	-32.001122	115.549945	*Posidonia* dominated
S05	-32.000994	115.549437	Sand with wrack
S06	-32.000863	115.549617	*Posidonia* dominated
S07	-32.000850	115.549968	Sand with wrack
S08	-32.000769	115.550319	*Posidonia* dominated
S09	-31.992794	115.552524	Limestone reef/pavement
S10	-31.994117	115.552181	*Posidonia* dominated
S11	-32.002192	115.553123	Sand with wrack
S12	-31.996176	115.554200	*Posidonia* dominated
S13	-31.994531	115.554390	Mixed seagrass
S14	-31.992920	115.554212	*Posidonia* dominated
S15	-31.999586	115.557713	Macroalgae dominated
S16	-31.999723	115.557537	Macroalgae dominated
S17	-32.001593	115.557182	Macroalgae dominated
S18	-31.999525	115.559192	*Posidonia* dominated
S19	-31.999180	115.558643	Sand with wrack
S20	-32.000096	115.560953	Sand
T1A	-32.000876	115.548878	*Posidonia* dominated
T1B	-31.999392	115.549173	*Posidonia* dominated
T1D	-31.998328	115.549048	*Posidonia* dominated
T1E	-31.997413	115.549063	*Posidonia* dominated
T1F	-31.996562	115.549119	*Posidonia* dominated
T1G	-31.995590	115.549120	*Posidonia* dominated
T1H	-31.994888	115.549037	Sand with wrack
T1I	-31.993794	115.549106	Sand
T1J	-31.992892	115.549120	Sand
T2A	-31.992904	115.550179	Sand
T2B	-31.993933	115.550337	Sand with wrack
T2C	-31.994724	115.550225	Sand
T2D	-31.995607	115.550193	*Posidonia* dominated
T2E	-31.996483	115.550193	Sand
T2F	-31.997453	115.550112	*Posidonia* dominated
T2G	-31.998399	115.550143	*Posidonia* dominated
T2H	-31.999320	115.550149	*Posidonia* dominated
T2I	-32.000216	115.550161	*Posidonia* dominated
T2J	-32.001033	115.550075	Sand with wrack
T2K			Sand with wrack
T3A	-32.001987	115.551264	*Posidonia* dominated

T3B	-32.001043	115.551105	*Posidonia* dominated
T3C	-32.000138	115.551022	*Posidonia* dominated
T3D	-31.999171	115.551116	Mixed seagrass
T3E	-31.998309	115.551073	*Posidonia* dominated
T3F	-31.997486	115.551149	Mixed seagrass
T3G	-31.996517	115.551198	*Posidonia* dominated
T3H	-31.995636	115.551172	Sand
T3I	-31.994674	115.551088	*Posidonia* dominated
T3J	-31.993912	115.551162	*Posidonia* dominated
T4A	-31.992902	115.552403	*Amphibolis* dominated
T4B	-31.993815	115.552269	Sand
T4C	-31.994868	115.552278	Mixed algae/seagrass
T4D	-31.995608	115.552250	Sand
T4E	-31.996477	115.552324	*Posidonia* dominated
T4F	-31.997382	115.552254	*Posidonia* dominated
T4G	-31.998373	115.552190	Mixed seagrass
T4H	-31.999194	115.552226	*Posidonia* dominated
T4I	-32.000154	115.552354	Sand with wrack
T4J	-32.001000	115.552282	*Posidonia* dominated
T4K	-32.001840	115.552281	*Posidonia* dominated
T5A	-32.001983	115.554207	*Posidonia* dominated
T5B	-32.001139	115.554347	*Posidonia* dominated
T5C	-32.000195	115.554253	*Posidonia* dominated
T5D	-31.999291	115.554204	*Posidonia* dominated
T5E	-31.998229	115.553897	*Posidonia* dominated
T5F	-31.997490	115.554130	Sand
T5G	-31.996543	115.554278	Sand with wrack
T5H	-31.995583	115.554328	*Posidonia* dominated
T5I	-31.994856	115.554423	*Amphibolis* dominated
T5J	-31.993818	115.554502	*Posidonia* dominated
T5K	-31.993077	115.554261	*Posidonia* dominated
T6A	-31.993053	115.556433	Limestone reef/pavement
T6B	-31.993838	115.556628	Sand with seagrass
T6C	-31.994742	115.556522	*Amphibolis* dominated
T6D	-31.995714	115.556559	*Posidonia* dominated
T6E	-31.996642	115.556606	*Posidonia* dominated
T6F	-31.997525	115.556546	*Posidonia* dominated
T6G	-31.998428	115.556409	*Posidonia* dominated
T6H	-31.999374	115.556611	*Posidonia* dominated
T6I	-32.000285	115.556450	*Posidonia* dominated
T6J	-32.001124	115.556284	*Posidonia* dominated
T6K	-32.001973	115.556486	*Posidonia* dominated
T7A	-32.001931	115.558433	Sand with wrack
T7B	-32.001049	115.558366	Macroalgae dominated
T7C	-32.000276	115.558437	*Posidonia* dominated

T7D	-31.999455	115.558520	Limestone reef/pavement
T7E	-31.998310	115.558450	Sand with wrack
T7F	-31.997597	115.558537	Sand with wrack
T7G	-31.996618	115.558534	Sand
T7H	-31.995774	115.558635	*Posidonia* dominated
T7I	-31.994817	115.558681	*PosidoniaPosidonia* dominated
T7J	-31.993806	115.558636	*PosidoniaPosidonia* dominated
T7K	-31.992990	115.558588	Mixed algae/seagrass
T8A	-31.992970	115.560739	*PosidoniaPosidonia* dominated
T8B	-31.993881	115.560746	*Amphibolis* dominated
T8C	-31.994836	115.560729	Sand with wrack
T8D	-31.995744	115.560692	Sand
T8E	-31.996606	115.560716	Sand with wrack
T8F	-31.997572	115.560620	Sand with wrack
T8G	-31.998400	115.560631	Mixed seagrass
T8H	-32.000246	115.560694	*PosidoniaPosidonia* dominated
T8I	-32.001094	115.560725	*PosidoniaPosidonia* dominated
T8J	-32.001971	115.560733	Sand with seagrass
T9A	-32.000894	115.547975	Sand with wrack
T9B	-32.000014	115.547896	*Posidonia* dominated
T9C	-31.999236	115.547972	Sand
T9D	-31.998274	115.547907	*Posidonia* dominated
T9E	-31.997362	115.548056	*Posidonia* dominated
T9F	-31.996414	115.548022	Mixed seagrass
T9G	-31.995598	115.548091	*Posidonia* dominated
T9H	-31.994630	115.548021	Sand
T9I	-31.993802	115.548143	Sand
T9J	-31.992972	115.548096	Sand
T10A	-31.992810	115.546115	Sand
T10B	-31.993792	115.546086	*Posidonia* dominated
T10C	-31.994727	115.546070	*Posidonia* dominated
T10D	-31.995540	115.546057	Sand
T10E	-31.996469	115.545955	*Posidonia* dominated
T10F	-31.997418	115.545937	*Posidonia* dominated
T10G	-31.998284	115.545981	*Posidonia* dominated
T10H	-31.999211	115.545947	*Posidonia* dominated
T11A	-31.998238	115.543745	*Posidonia* dominated
T11B	-31.997377	115.543805	*Posidonia* dominated
T11C	-31.996468	115.543797	Sand with wrack
T11D	-31.995058	115.543961	*Posidonia* dominated
T11E	-31.993865	115.543880	*Posidonia* dominated
T11F	-31.992855	115.543886	*Posidonia* dominated

REPORT

Appendix O
Dredging Environmental Monitoring and Management Plan (02 Environment 2024)

Dredging Environmental Monitoring and Management Plan

South Thomson Bay Barge Landing Development

ENVIRONMENT
An O2Marine company

CLIENT: Rottnest Island Authority

STATUS: Rev 0

REPORT NUMBER: R240007

ISSUE DATE: 7 August 2024

O2 MARINE

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Acknowledgement Of Country

In the spirit of reconciliation O2 Marine Pty Ltd acknowledge that this project is proposed on the lands of the Whadjuk Noongar People. We pay our respects to Elders past, present and emerging and recognise their continuing connection to land, sea, culture and community.

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Version Register

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Rev C	Draft	N Claydon	G Motherwell	Draft for Client Review	N Claydon 14/6/2024
Rev 0	Final	N Claydon	G Motherwell	Final Issued for Use	N Claydon 7/8/2024
Rev 1	Final	N Claydon	G Motherwell	Final Issued for Use	N Claydon 7/8/2024

Transmission Register

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Acronym Table

Acronyms/Abbreviation	Description
ASS	Acid Sulfate Soil
BCH	Benthic Communities and Habitat
BTEX	benzene, toluene, ethyl-benzene and xylene
CD	Chart Datum
DBCA	Department of Biodiversity Conservation and Attractions
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DO	Dissolved Oxygen
DoT	Department of Transport
DPIRD	Department of Primary Industries and Regional Development
DEMMP	Dredging Environment Management and Monitoring Plan
DWER	Department of Water and Environmental Regulation
EIL	Ecological Investigation levels
EPA	Environmental Protection Authority
EP Act	Environmental Protection Act 1986
EPBC Act	Environmental Protection and Biodiversity Conservation Act
EPO	Environmental Protection Outcomes
ESL	Ecological Screening Levels
HIL-A	Health Investigation Levels for residential soil access
IMP	Introduced marine pests
Km	Kilometre
LAU	Local assessment unit
LCT	Landing Craft Tank
LoR	Limit of Reporting
m	Metre
MEQ	Marine Environmental Quality
MFO	Marine Fauna Observer
MNES	Matters of national environmental significance
MT	Management Targets
MWQMP	Marine water quality monitoring program
NAGD	National Assessment Guidelines for Dredging
NTU	Nephelometric Turbidity Units
The proposal	The South Thomson Barge Landing development

Acronyms/Abbreviation	Description
PAH	polycyclic aromatic hydrocarbons
PAR	Photosynthetically active radiation
PFAS	per- and poly-fluoroalkyl substances
POLREP	Pollution Report Form
RIA	Rottnest Island Authority
SSC	Suspended Sediment Concentration
SWASP	State Wide Array Surveillance Program
TMF	Tiered Management Framework
TRH	total recoverable hydrocarbons
TSS	Total Suspended Solids
WA	Western Australia
ZoHI	Zone of High Impact
ZoI	Zone of Influence
ZoMI	Zone of Moderate Impact

Contents

1. Introduction 1

1.1. Proposal description 1

1.2. Proposed dredging and disposal activity 2

1.3. Purpose of this plan 6

1.4. Objectives 6

1.5. Legislation, regulations and guidelines 6

1.6. Approvals background 7

1.7. Port governance 8

2. Existing Environment 9

2.1. General environment 9

3. Roles and responsibilities 15

4. Environmental factors and objectives 17

5. Monitoring and Management 20

5.1. Marine environmental quality 21

5.2. Benthic Communities and Habitats 23

5.3. Marine Fauna 25

5.4. Hydrocarbon Management 27

5.5. Waste Management 28

5.6. Introduced Marine Pests 30

6. Reporting 31

6.1. Additional Reporting 32

7. Ongoing stakeholder consultation 34

8. Availability of the DEMMP 34

9. Audit and review 34

10. References 36

Appendix A. Plan Amendments 37

Document Change Register 37

Appendix B. Monitoring programs 38

Appendix B.1. Marine water quality monitoring program 38

B.1.1 Rationale 38

B.1.2 Monitoring locations 38

B.1.3 Frequency *41*

B.1.4 Environmental protection outcomes, management targets and trigger levels *41*

B.1.6 Data analysis *45*

B.1.7 Corrective actions *45*

B.1.8 Reporting *45*

Appendix B.2. Benthic communities & habitat monitoring program 46

B.2.2. Rationale *46*

B.2.4. Locations *46*

B.2.5. Frequency *46*

B.2.6. Survey Methods *47*

B.2.7. Data Analysis *47*

B.2.8. Reporting *48*

Appendix B.3. Marine Fauna Observations 49

B.3.1. Protocols and Procedures *49*

B.3.2. Frequency *51*

B.3.3. Location *52*

B.3.4. Records & Reporting *52*

Table of Tables

Table 1: Summary of the proposal 1

Table 2: impact zones, definitions and boundary thresholds (BMT 2021 as presented in Baird 2024) 4

Table 3: calculated zones of impact and influence for the Proposal 4

Table 4: area of habitats within the development footprint (RPS 2024) 13

Table 5: Roles and responsibilities of key personnel 15

Table 6: Potential environmental impacts from dredging and disposal and associated proposal specific Environmental Protection Outcomes and Management Targets 17

Table 7: Management actions to minimise impacts on MEQ 21

Table 8: Management actions to minimise impacts on benthic community habitats 23

Table 9: Management actions to minimise impacts on marine fauna 25

Table 10: Management actions to minimise the risk of hydrocarbon pollution 27

Table 11: Management actions to manage waste 28

Table 12: Management actions to minimise of introduced marine pests 30

Table 13: Compliance reporting requirements 31
Table 14: Additional reporting requirements required to demonstrate compliance..... 32
Table 15: DEMMP Review Schedule..... 34
Table 16: Proposed coordinates of water quality monitoring locations..... 39
Table 17: Proposed triggers and thresholds for the proposal 42

Table of Figures

Figure 1: Proposal development envelope overview (Emerge 2024) 3
Figure 3: Zones of impact (Source: Baird (2024)) 5
Figure 4: Wind direction and speeds measured at 9am over 12019 daily observations (BoM 2024) 10
Figure 5: Wind direction and speeds measured at 3pm over 12004 daily observations (BoM 2024) 10
Figure 6: Broad scale benthic habitat within the Rottnest Island LAU (Harvey 2009) 13
Figure 7: Benthic habitat within and around the proposal development envelope (data source: RPS 2024). 14
Figure 8: Proposed water quality and BCH monitoring locations 40
Figure 9: Tiered management framework for the Marine Water Quality Management Plan (MWQMP) . 44

1. Introduction

The Rottnest Island Authority (RIA) (the proponent) is intending to redevelop an area of South Thomson Bay to provide a barge landing for commercial marine and barge services. The South Thomson Barge Landing development (the proposal) will consist of the construction of a laydown area and breakwater/groyne extension which involves dredging, construction of the laydown using the dredged material and piling for the jetty. A summary of the proposal is given in Table 1.

Table 1: Summary of the proposal

Proposal title	South Thompson Barge Landing Development
Proponent name	Rottnest Island Authority
Short description	The Rottnest Island Authority is proposing to develop the South Thomson Barge Landing Development at the existing Army Groyne in South Thompson Bay. The proposal will be primarily used for barge operations, which will be relocated from the existing ferry terminal at central Thompson Bay to the proposed location at South Thompson Bay. This will separate barge operations from public passenger transfer activities and ease congestion at the ferry terminal.

Wadjemup (Rottnest Island) is located approximately 20 km west of the port of Fremantle in Western Australia (WA). It is an A-class reserve of ecological, cultural and social significance. It is a world-renowned tourist attraction with over 780,000 visitors annually. Most visitors travel by ferry, though many can travel by private vessel or even by small plane. There are limited short stay accommodation, and a very small resident population. The proposal will be located at the existing Army Groyne less than 1 kilometre (km) south of the existing ferry terminal, where the cargo barges are berthed currently. The Rottnest Island Master Plan highlighted the need to improve functionality and efficiency of transporting bulk cargo to and from Wadjemup, reduce noise levels for residents and to improve safety and amenities for visitors. It is proposed that redeveloping the Army Grone will achieve this, by converting it into a barge landing, freight handling and associated storage area.

1.1. Proposal description

In order to redevelop the area, it is anticipated that the proposal will require dredging and piling for the construction of a turning basin and jetty. The marine dredging and construction aspects of the proposal include the following (Baird 2024):

- Extending the existing groyne by approximately 150 metres (m), which includes a 90 m (nominal) breakwater that will run approximately parallel to the shoreline
- A Landing Craft Tank (LCT) Barge Ramp in the lee of the shore perpendicular section of the new breakwater structure, and including a laydown area of approximately 2,300 m^2
- Dredging the approach to and footprint within the new breakwater structure to a declared depth of – 3.0 m Chart Datum (CD) which will include a turning basin with a nominal diameter of 80 m, resulting in a required dredging volume of approximately 16,000 m^3 when considering an overdredge requirement of 0.6 m.

A backhoe dredge is likely to be used for the dredging works and it is anticipated to be undertaken during the winter months.

Following dredging, piling is also likely to be undertaken for the construction of the structure.

The proposal location with dredging and disposal footprint is shown in Figure 1.

1.2. Proposed dredging and disposal activity

1.2.1. Dredging volume

Capital dredging of up to 16,000 m^3 will be required to create the turning basin of approximately 80 m in diameter.

1.2.2. Dredging and disposal methods

It is anticipated that the sand section of the dredging area will be dredged using a backhoe dredge, though another method may be required for the rock sections. The methods are yet to be finalised, based on the dredge contractor specifications. A silt curtain will be used around the dredging to minimise the dredge plume.

Dredged material will be directly placed into a bunded area which will form the laydown area. The bund will be created with existing armour from the eastern side of the Army Groyne and moved periodically to the north to increase the reclamation area to allow for the dredge spoil to remain in place.

A geofabric textile weave will be placed within the bund walls to reduce the amount of fines being released back into the water. Based on studies of the particle size distribution of the material to be dredged, there is a small proportion of fines in the material. Therefore, it is proposed that Texcel 1200R geofabric will be used which is expected to trap both sandy and fine sediments within the bund and still allowing water to return out of the bund.

1.2.3. Dredging schedule

Dredging and piling are likely to be undertaken in the winter months of 2026. Dredge plume modelling by Baird (2024) assumed that dredging may take up to 7.5 weeks to complete.

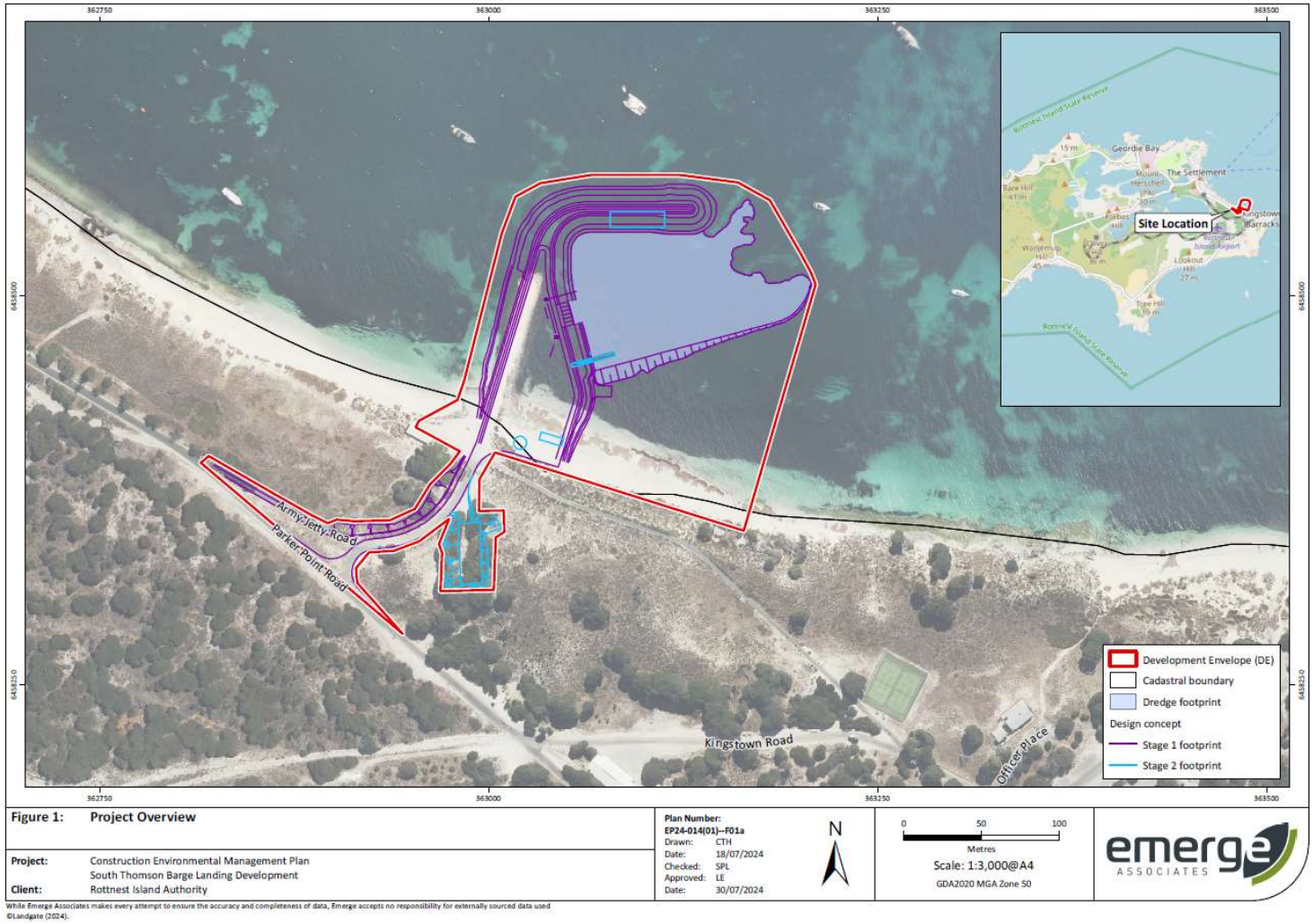

Figure 1: **Project Overview**

Project: Construction Environmental Management Plan
South Thomson Barge Landing Development
Client: Rottnest Island Authority

Plan Number: EP24-014(01)--F01a
Drawn: CTH
Date: 18/07/2024
Checked: SPL
Approved: LE
Date: 30/07/2024

N

0 50 100
Metres
Scale: 1:3,000@A4
GDA2020 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used
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Figure 1: Proposal development envelope overview (Emerge 2024)

1.2.4. Zones of impact and influence

The zones of impact and influence associated with levels of dredging pressures on benthic communities and habitats (BCH) were determined by Baird (2024). The methods used were based on plume modelling undertaken with impact zone definitions and boundary thresholds from a previous Port Beach project by BMT (2021). These definitions were given in Baird (2024) and replicated here in Table 2. As dredging will be occuring in winter, the winter scenario was used for the calculations.

The calculated zones for this proposal are presented in Table 3 and Figure 3.

Table 2: impact zones, definitions and boundary thresholds (BMT 2021 as presented in Baird 2024)

Impact zone	Definition	Boundary Threshold(s)
Zone of High Impact (ZoHI)	The area where impact on BCH are predicted to be irreversible. The term irreversible means 'lacking a capacity to return or recover to a state resembling that prior to being impacted within a timeframe of five years or less'. Areas within and immediately adjacent to proposed dredge and disposal sites are typically within the ZoHI.	• Boundary of the dredging and placement area • Where sedimentation/burial is >10 cm or 10,000 g/m^2
Zone of Moderate Impact (ZoMI)	The area within which predicted impacts on BCH are recoverable within a period of five years following completion of the dredging and placement activities. The ZoMI abuts and lies immediately outside of the ZoHI.	• The 95th percentile of the area where a total suspended solids (TSS) concentration of >10 mg/L was exceeded. • Where sedimentation burial is 5-10 cm or 5,000 – 10,000 g/m^2
Zone of Influence (ZoI)	The are within which changes in environmental quality associated with turbid plumes are predicted and anticipated during dredging and placement activities, but where these changes would not result in a measurable impact on BCH.	• The 100th percentile of the area where a TSS concentration of >2 mg/L above background was exceeded (representing the maximum predicted extent of visible plumes).

Table 3: calculated zones of impact and influence for the Proposal

Impact zone	Resultant area definition	Resultant calculated area (km^2) (Baird 2024)
ZoHI	The ZoHI encompasses all the dredging area and construction area (which is also where disposal will occur) with a minimum distance of 25 m from the dredging footprint to be conservative	0.02
ZoMI	The ZoMI encompasses the area outisde the ZoHI to at least 150 m from the dedging area	0.07
ZoI	The ZoI encompasses the maximum predicted extent of visible plumes (though these would not result in a measurable impact on BCH)	0.17

Figure 2: Zones of impact (Source: Baird (2024))

1.3. Purpose of this plan

The purpose of this dredging environmental monitoring and management plan (DEMMP) is to ensure that potential environmental impacts resulting from dredging and disposal are effectively mitigated and to assign appropriate management targets and management actions.

This DEMMP has been prepared to be included in the environmental referral documents to the Western Australian Environmental Protection Authority (EPA) for the approval of the proposal. This DEMMP outlines the framework for the dredging activities including:

- Legislation and regulations that apply to the dredging program
- Overall management framework
- The areas where dredging is to occur
- Type of materials to be dredged
- Environmental values to be protected, the risks that dredging may pose, and the mechanisms to be implemented to mediate these risks (management strategies)
- Responsible parties
- Monitoring and reporting
- Consultation.

Note this DEMMP may need to be revised to meet conditions of any approvals issued for the proposal.

1.4. Objectives

The specific objectives of this DEMMP are aligned with the environmental objectives presented within the EPA's statement of principles, environmental, factors, objectives and aims of EIA which are summarised below and explained in greater detail in Section 4 (EPA 2021):

- To protect benthic communities and habitat (BCH) so that biological diversity and ecological integrity are maintained
- To maintain the quality of water, sediment and biota so that environmental values are protected
- To protect marine fauna so that biological diversity and ecological integrity are maintained.

1.5. Legislation, regulations and guidelines

The potential environmental impacts of the proposal will be assessed at Commonwealth, State and Local Authority level with each Authority providing guidance on the level of assessment required. This DEMMP was developed with consideration of those approvals and with the following legislation and guidelines.

1.5.1. State

- *Environmental Protection Act 1986 (EP Act)*
- *Biodiversity Conservation Act 2016*
- *Port Authorities Act 1999*
- Navigable Waters Regulations 1958

- Shipping and Pilotage (Port and Harbour) Regulations 1967
- *Western Australian Marine Act 1982*
- *Pollution of Waters by Oil and Noxious Substances Act 1987*
- *Marine and Harbours Act 1981*
- *Environmental Protection Act 1986*
- Environmental Protection Regulations 1987
- *Fisheries Resource Management Act 1994* (relevant to Introduced Marine Pests)
- Western Australia Environmental Protection Authority - Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans (EPA, 2021)
- Western Australia Environmental Protection Authority Technical Guidance - Assessment Guidelines of Marine Dredging Proposals (EPA, 2021)
- Western Australia Environmental Protection Authority Technical Guidance - Protecting the Quality of Western Australia's Marine Environment (EPA, 2016b)
- Western Australia Environmental Protection Authority Technical Guidance – Protection of Benthic Communities and Habitats (EPA, 2016c).

1.5.2. Commonwealth

- *Environmental Protection and Biodiversity Conservation Act (1999) (*EPBC Act*)*
- *Environment Protection (Sea Dumping) Act 1981*
- *Protection of the Seas (Prevention of Pollution from Ships) Act 1983*
- *Biosecurity Act 2015*
- Biosecurity Regulations (2016)
- Australian Ballast Water Management Requirements Version 7 2017
- National Water Quality Management Strategy (Commonwealth of Australia 1992).

Even though offshore disposal of materials will not be occuring for this Proposal, the National Australian Guidelines for Dredging (NAGD) (Commonwealth of Australia 2009) has also been considered when preparing this document to ensure best practice.

1.6. Approvals background

Environmental Protection Act, 1986 Part IV

The environmental factors include:

- Benthic communities and habitat
- Coastal processes
- Marine environmental quality
- Marine fauna
- Flora and vegetation
- Terrestrial fauna
- Social surroundings
- Other factors.

In 2023 the RIA met with the WA EPA to discuss referral of the proposal. Following this meeting the RIA recommenced the proposal, and as such the following studies are currently underway, or have been recently completed to progress environmental approvals:

- Terrestrial flora and fauna survey of the onshore area.
- Benthic habitat assessment of the marine development area and surrounds.
- Marine fauna desktop assessment of the marine development area and surrounds.
- MNES assessment.
- Dredge plume modelling.
- Coastal processes assessment.
- Baseline water quality monitoring.

Environmental Protection Act, 1986 Part V

A works approval and operating licence for the proposal may be required under the EP Act Part V. The following items will be assessed, and management provisions assigned:

- Noise emissions
- Air emissions
- Wastewater disposal
- Solid waste disposal.

Environmental Protection and Biodiversity Conservation Act 1999

RIA may also refer the proposal to the Department of Climate Change, Energy, the Environment and Water (DCCEEW). It would likely be assessed by the DCCEEW and WA EPA under the bilateral agreement as an accredited assessment. The relevant matters of national environmental significance (MNES) for this proposal are:

- Listed threatened species and communities (sections 18 and 218A)
- Listed migratory species (sections 20 and 20A)
- The world heritage values of a declared world heritage property (sections 12 and 15A)
- The heritage values of a national heritage place (sections 15B and 15C)
- Commonwealth land (section 26 and 27A).

1.7. Port governance

Rottnest Island Authority is the responsible authority over the marine jetties around the Island.

2. Existing Environment

2.1. General environment

The existing jetty at the proposal area at Wadjemup or Rottnest Island (the Island) was built from rock fill and compacted limestone base in 1972, which replaced an older jetty at the same location (RPS 2020). It is approximately 120 m long and approximately 1,700 m^2 and in 2018 the platform was removed and it was converted into a rock groyne due to its fragility and partial collapse (RPS 2020). It is within a relatively healthy environment, with little turbidity and abundant seagrasses and macroalgae.

2.1.1. Climate and oceanography

The Island is located within in the temperate region of the Indian Ocean approximately 18 km west of Perth in WA.

There are six seasons within the Wadjemup region in accordance with Noongar culture:

- Birak – December and January
- Bunuru – February and March, the hottest period of the year
- Djeran – April and May
- Makuru – June and July – generally the first rains (and highest rainfall) and the colder months of the year
- Djilba – August and September – known for the second rains and still colder months of the year
- Kambarang – October and November.

Sea water temperature generally ranges between 16.4℃ in September and 26.5℃ in March (Sea Temperature 2024). Air temperature ranges between a mean minimum of 12.4℃ in August and mean maximum of 27.2℃ in February (BoM 2024), coinciding with the six seasons. Mean annual rainfall is 558.4 mm, with a maximum average monthly rainfall of 111.5 mm in July. Annually, the 9am wind direction varies from northeasterly and easterly to southern winds, as shown in Figure 5. By 3pm there is less variation annually, with winds generally south to south-west, as shown in Figure 6.

Dredging is proposed to be undertaken in the winter months, which are between June and August.

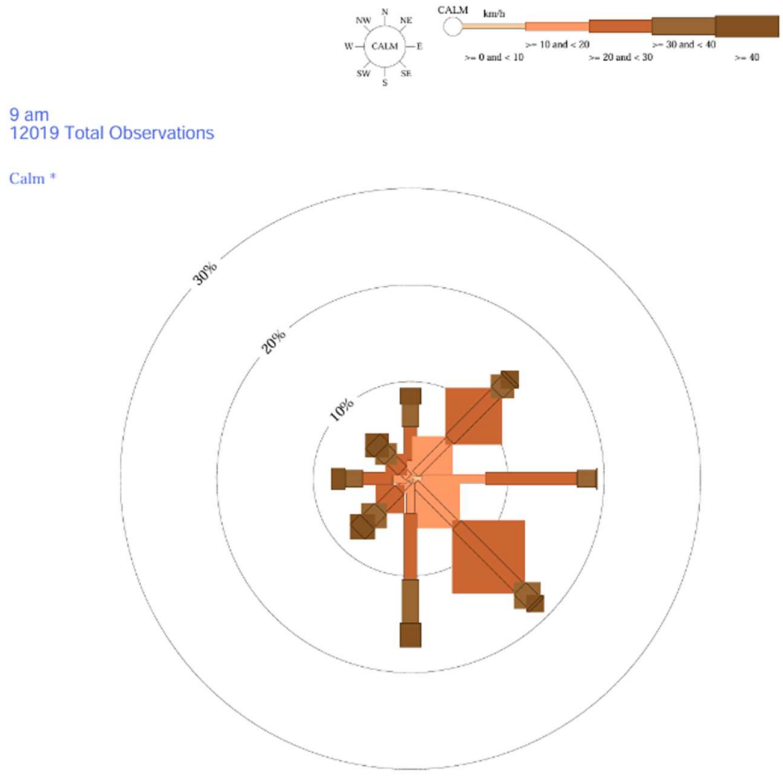

Figure 3: Wind direction and speeds measured at 9am over 12019 daily observations (BoM 2024)

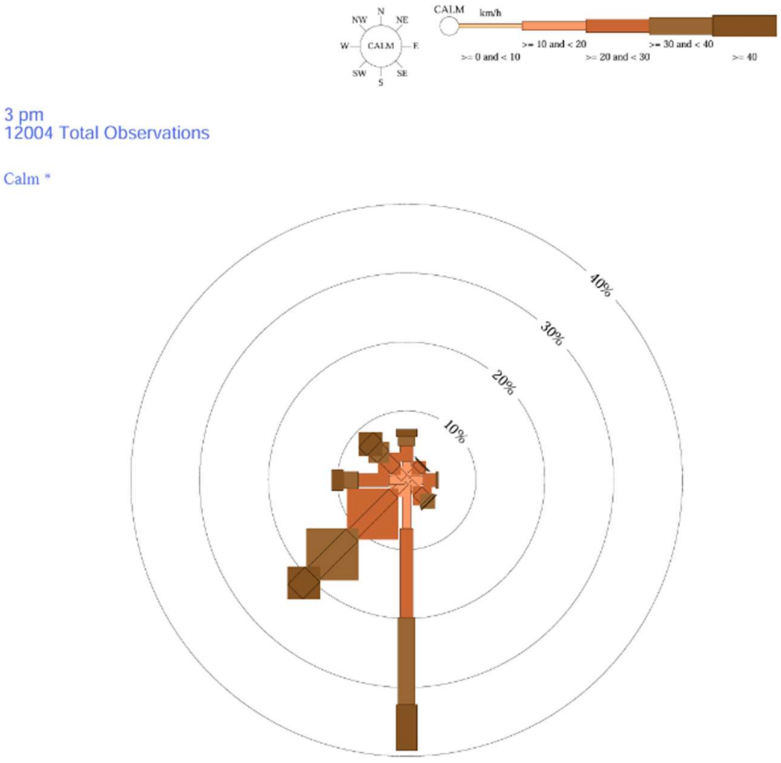

Figure 4: Wind direction and speeds measured at 3pm over 12004 daily observations (BoM 2024)

Currents measured around the proposed proposal site (Baird 2024) found a depth averaged peak current speed of 0.05 ms^{-1} to 0.1 ms^{-1} during neaps and 0.1 ms^{-1} to 0.15 ms^{-1} during spring tides. Current direction was relatively consistent across the tidal cycle at 80° - 100°, changing to come from northerly directions occasionally. Increasing wind speeds also seemed to strongly correlate with increasing current speeds (Baird 2024). Waves around the Island were found to be dominated by diffracted and refracted swell waves ranging from 0.4 m to 0.7 m with peak periods 12 to 18 seconds. Occasionally wind sea resulted in higher waves (0.8-0.9 m at peak wave periods of 5-10 s) arriving from the northwestern sector.

Within the proposal area, the bathymetry is relatively shallow, with up to 1.6 m at the end of the Army Groyne and decreasing to approximately 3.5 m CD depth 100 m offshore (DoT 2022). The rest of the Island is also relatively shallow, though to the west of Rottnest Island there a large drop in depth within 2 km, down to approximately -55 m at mean sea level.

2.1.2. Geology and geomorphology

The Island is the largest and northernmost island of the Garden Island Ridge, a rocky remnant Pleistocene ridge forming a chain of submarine reef platforms and emergent islands of approximately 12 km offshore of the Swan Coastal Plain. The Island sits within the middle shelf region of the narrow Rottnest shelf (Brooke 2010).

The proposal site has been found to consist of white medium-grained sand, well-sorted, sub-angular quartz and shell debris (DMIRS 2020).

2.1.3. Water quality

Water quality sampling was undertaken between November and December 2023 at six locations in and around the proposal site. Samples were analysed for turbidity (Nephelometric Turbidity Units (NTU) and total suspended solids (TSS)) in November, and in December the samples were analysed for NTU, TSS, hydrocarbons and metals. Hydrocarbons and phosphorus were all below the limit of reporting (LoR) in all samples. All metals sampled were also below the ANZG (2018) water quality guidelines except for one sample which had a high zinc concentration, however this would be considered to be an anomaly likely due to contamination from sunscreen or similar.

Turbidity at the site is very low, with profiles taken in December finding zero NTU at several sites within the proposal area. Turbidity of water samples was also measured in the laboratory in November and December 2023, which ranged between 0 and 0.66 NTU. Total suspended solids (TSS) was also found to be low, with <5.0 mg/L in all samples. This is not surprising due to the water clarity in the area during this time of year.

2.1.4. Sediment quality

Sediment sampling was undertaken in November 2019 (with some additional sampling in March 2020) at seven locations within the proposed dredge area (RPS 2020). Sediment samples were analysed for metals and metalloids, acid sulfate soil (ASS) parameters, pesticides, polycyclic aromatic hydrocarbons (PAHs), total recoverable hydrocarbons (TRHs) and benzene, toluene, ethyl-benzene and xylene (BTEX), nutrients and per- and poly-fluoroalkyl substances (PFASs).

Samples were taken from each 0.5 m horizon where possible, up to a depth of 1.2 m at each location. Some locations reached refusal due to hard sediment layers at approximately 1 m depth, and therefore there were a total of 17 samples (with 14 additional samples taken in March 2020 to re-analyse for PFAS due to laboratory contamination).

Particle distribution was found to be predominantly sand between 0.06 and 2 mm, with the mean median particle size being 0.242 mm (242 µm). There was only a small proportion of sediment larger than 2 mm.

The toxicants were all analysed by a NATA accredited laboratory, and the results compared to the following guideline values:

- Ecological Investigation levels (EILs) and Ecological Screening Levels (ESLs) for areas of ecological significance and public open space (NEPM 2013)
- Health Investigation Levels for residential soil access (HIL-A) (NEPM 2013 and CRC CARE 2011)
- National Assessment Guidelines for Dredging (Commonwealth of Australia 2009) screening levels.

All metals, metalloids, pesticides, PAHs, TRHs, BTEX, nutrients and PFAS tested were below their respective guideline values. The site is also not considered to be an ASS risk (RPS 2020). One sample being classified as potential ASS as inorganic acidity was detected. However, there was a significant amount of acid neutralising capacity, so RPS (2020) recommended that no liming would be required if onshore disposal was conducted. Therefore, the material is considered suitable for reuse as fill for the construction of the jetty (or onshore disposal if required).

2.1.5. Benthic communities and habitat

In accordance with EPA (2016) a local assessment unit (LAU) should be established in order to calculate and assess the cumulative impacts of disturbance to BCH from projects. They are location specific, and would typically be approximately 50 km^2, though large or smaller areas would be considered by the EPA if well justified. An LAU around Rottnest Island has been nominated for this proposal based on the assessment area for a previous study of the BCH by Harvey (2009). The BCH within the LAU is given in Figure 5, and Harvey (2009) identified bare substrate, seagrass, macroalgae, coral and intertidal reef within the assessment area.

A benthic communities and habitat (BCH) assessment was undertaken by RPS in 2019, updated in 2023 for the proposal area and then updated again in early 2024 to include additional area where modelling predicted possible impacts (RPS 2024). Within South Thomson Bay, RPS (2023) conducted a finer scale survey within and around the proposal area as shown in Figure 8. Seagrass and macroalgae species were identified and the habitats were classified by species dominance (a species was dominant if it was more than 50% covered by that species). The classification scheme is presented in RPS (2023) and the data was then used to determine BCH loss within the proposal area and the context of the survey area. These loss calculations are shown in Table 1. Within the wider LAU, historical BCH loss was also assessed to determine a cumulative loss. Overall, it was estimated that a 1.95% loss of seagrass had occurred over time due to human activities, and the proposal would lead to an additional 0.36% loss, resulting in a cumulative loss of 2.31% over the LAU (RPS 2023).

Table 4: area of habitats within the development footprint (RPS 2024)

Area	Habitat (Ha)			
	Mixed seagrass	Macroalgae dominated	Sand/Sand with Wrack	Limestone reef/pavement
Field survey area (2019/2023 survey area)	108.10	10.80	42.43	1.79
Survey area (2024 plume extension survey area)	0.92	0	1.27	0.35
Total survey area	109.02	10.80	43.70	2.14
Development envelope	1.65	0	1.44	0
Development envelope and modelled Zone of High Impact (ZoHI)	2.06	0	1.26	0

Figure 5: Broad scale benthic habitat within the Rottnest Island LAU (Harvey 2009)

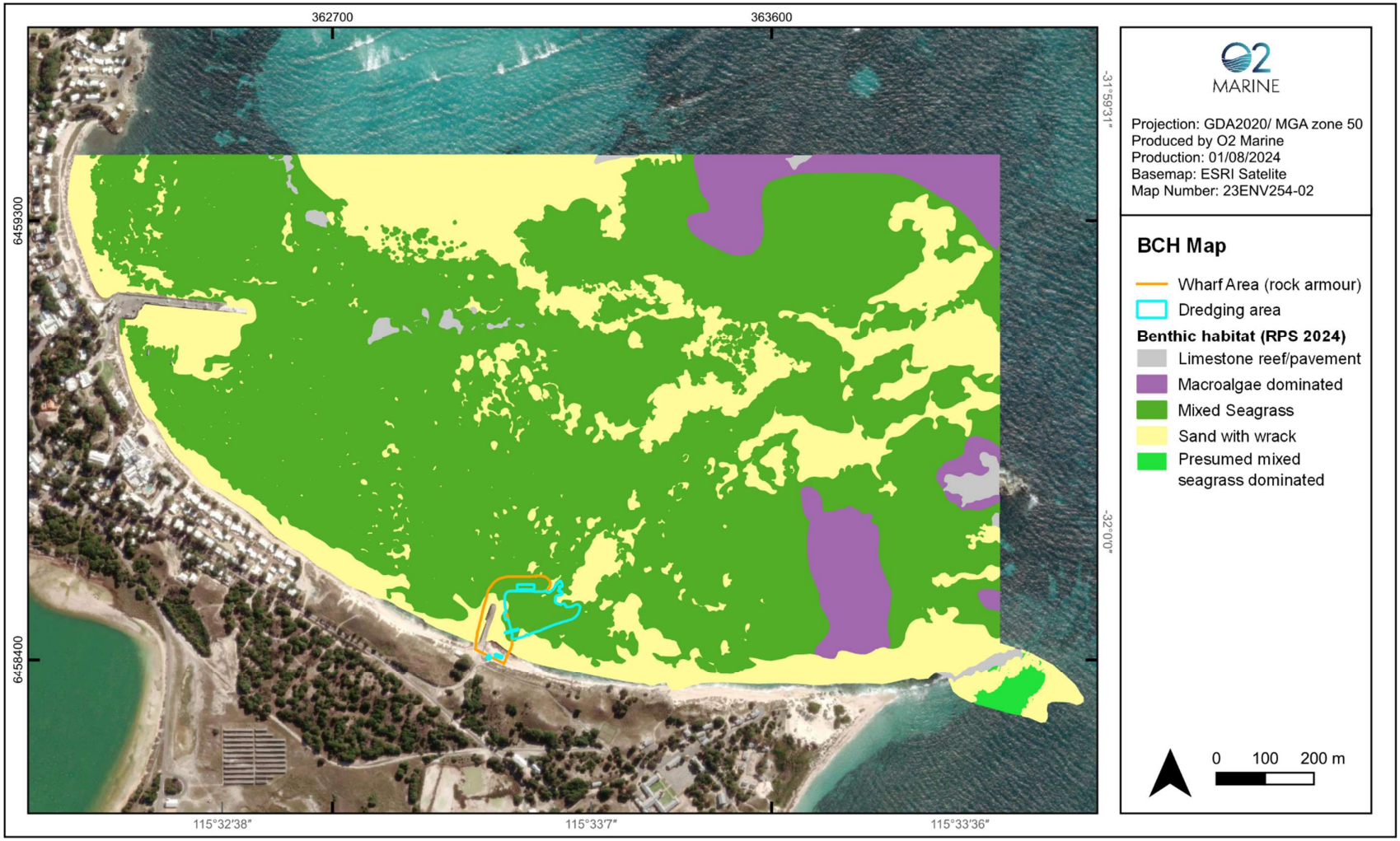

Figure 6: Benthic habitat within and around the proposal development envelope (data source: RPS 2024).

2.1.6. Marine fauna

A marine fauna desktop analysis was undertaken for the proposal by RPS (2023). A list of species that may occur within the proposal area was collated and included 41 threatened marine fauna species and 92 listed marine or migratory marine fauna species that may occur in Thomson Bay. Key species and their ecological windows for monitoring and management were not identified by RPS (2023), though species (that may occur within the proposal area) that can be monitored during dredging activities were identified to include:

- Humpback whale
- Killer whale
- Pygmy blue whale
- Minke whale
- Australian sea lion
- New Zealand fur seal
- Indo-pacific bottlenose dolphin
- Spinner dolphin
- Loggerhead turtle
- Leatherback turtle
- Green turtle

These can often be viewed as umbrella species, so mitigation and management put into place to protect these species will also protect others that may occur within the proposal area.

3. Roles and responsibilities

The roles and responsibilities for the implementation of the DEMMP are summarised in Table 2.

Table 5: Roles and responsibilities of key personnel

Position	Responsibility
Project Manager	• Overall responsibility for implementation of this DEMMP • Overall responsibility for complying with relevant legislation, standards and guidelines • Ensures dredging activities are conducted in an environment safe for both site personnel and the public
Environment Manager	• Complies with the requirements of this DEMMP • Provides advice on dredging and dredge material environmental issues • Oversee implementation of environmental controls, monitoring programs, inspections, audits and management actions in this DEMMP • Completes compliance reporting requirements • Responsible for the implementation of the environmental monitoring program and inspections • Prepares environmental monitoring reports • Provides advice with respect to environmental issues as required

	• Reports on environmental performance for the project to key stakeholders • Responsible for environmental compliance reporting • Responsible for reporting all environmental non-compliance incidents
Dredging contractor	• Complies with the requirements of this DEMMP • Undertakes dredging and excavation works • Prepares and implements an environmental management plan in accordance with the requirements of this DEMMP • Implements the management actions of this DEMMP • Ensures adequate training of all staff within their area of responsibility • Ensures all equipment is adequately maintained and correctly operated • Responsible for reporting all environmental incidents to the Department of Transport (DoT) within 24 hours in accordance with DoT incident reporting procedures • Ensures dredging activities are conducted in an environment safe for both site personnel and the public
All persons involved in the project	• Comply with the requirements of this DEMMP • Comply with all legal requirements under the approval's documents and relevant Acts • Exercise a Duty of Care to the environment at all times • Report all environmental incidents

4. Environmental factors and objectives

The key environmental factors and objectives to be managed under this DEMMP have been derived from the Statement of environmental principles, factors, objectives and aims of EIA (EPA 2021), which outlines objectives aimed at protecting all environments (Themes) including Sea, Land, Water, Air and People. The Key Environmental Factors and EPA Objectives to be managed under this DEMMP are listed below:

- Benthic communities and habitats
- Marine environmental quality
- Marine fauna

The proposal specific Environmental Protection Outcomes (EPOs) and Management Targets (MTs) for each of these key marine environmental factors are outlined in Table 4.

Table 6: Potential environmental impacts from dredging and disposal and associated proposal specific Environmental Protection Outcomes and Management Targets

Environmental Factor	EPA Objective	Potential Environmental Impact Pathway	Environmental Protection Outcome (EPO)	Management Target (MT)	Risk Management Strategy
Benthic Communities and Habitats	To protect BCH so that biological diversity and ecological integrity are maintained.	Direct impacts of BCH due to removal within the dredging and disposal footprint.	Irreversible impacts to benthic communities and habitats from dredging and construction activities is confined to the construction footprint and the Zone of High Impact (ZoHI) (Figure 4).	Dredging operations do not occur outside the defined dredging footprint.	Refer to Table 5.
				Disposal operations do not occur outside the defined areas.	
		Indirect impacts of BCH due to reduction in available light caused by increase in suspended sediments released into the water column during dredging.	No irreversible impacts to benthic communities and habitats from dredging activities within the ZoMI (Figure 4).	Recoverable impact to BCH limited to within the ZoMI (Figure 4).	
			No observable impacts to BCH outside of the ZoMI (Figure 4).	No observable impacts to BCH outside of the ZoHI (Figure 4).	

Environmental Factor	EPA Objective	Potential Environmental Impact Pathway	Environmental Protection Outcome (EPO)	Management Target (MT)	Risk Management Strategy
Marine Environmental Quality (MEQ)	To maintain the quality of water, sediment and biota so that environmental values are protected.	Disturbance of contaminants in sediments during dredging has the potential to deteriorate water quality and contaminate marine organisms.	Maintain the MEQ outside the predicted zones of influence as defined by dredge modelling (ZoHI, ZoMI, and ZoI). MEQ will be temporarily reduced to a Moderate Level of Ecological Protection during construction but will return to a High Level of Ecological Protection two weeks after completion of dredging and construction activities.	MEQ shall be maintained at a Moderate Level of Ecological Protection (Figure 8) during dredging and return to a High Level of Ecological Protection within 2 weeks following completion of dredging. MT allows for the increased turbidity which will occur in the vicinity of the dredging activities.	Refer to Table 4, Table 7 and Table 8.
		Changes to the physico-chemical properties of the water column as a result of dredging.			
		Hydrocarbon release into the marine environment from a vessel spill and or bunkering operations.	No reported hydrocarbon spills or release of waste into the marine environment from dredging and disposal activities.	No hydrocarbon spills to the marine environment. No release of waste into the marine environment.	
Marine Fauna	To protect marine fauna so that biological diversity and ecological integrity are maintained.	Injury or death of marine fauna as a result of dredge operations including hydrocarbon or waste spills or underwater noise impacts.	No irreversible loss of marine fauna habitat outside of the zone of irreversible direct loss (i.e. ZoHI as defined by dredge modelling). No reported impacts to marine fauna as a result of hydrocarbon spill or release of waste associated with dredging and disposal activities	No incidences of marine fauna injury or death as a result of dredge operations.	Refer to Table 9, Table 11 and Table 12 and Table 12.
				No direct impacts to marine fauna from underwater noise from dredge operations.	
		Injury or death of marine fauna due to vessel movement (strike).		No incidences of marine fauna injury or death as a result of vessel strike.	

Environmental Factor	EPA Objective	Potential Environmental Impact Pathway	Environmental Protection Outcome (EPO)	Management Target (MT)	Risk Management Strategy
		Introduced Marine Pests translocation from dredging vessels.	including entanglement or ingestion of waste. No reported introduction or establishment of IMS as a result of dredging and disposal activities associated with the proposal. No reported death or injury to marine fauna from vessel strike associated with dredging or disposal activities. No reported death, injury or behavioural change to marine fauna as a result of underwater noise associated with dredging and disposal activities.	No introduction and/or spread of introduced marine species	
				No disruption to marine fauna from artificial lighting	

5. Monitoring and Management

Identified environmental receptors most susceptible to dredging and disposal activities associated with the proposal include:

- Water quality
- Seagrass and macroalgae health
- Marine fauna.

In addition to the management actions that will be implemented during dredging to avoid adverse impacts on the surrounding environment, environmental monitoring of the marine environment will also be undertaken to verify the predicted impacts and to ensure that impacts do not exceed their predicted magnitude or trigger thresholds. The following monitoring will be undertaken for the proposal:

- Physical water quality monitoring using water quality profilers
- Monitoring of seagrass and macroalgae health
- Marine fauna observations.

The aim of environmental monitoring will be to identify any change in health of seagrass outside the ZoHI for the duration of dredging, disposal and reclamation activities.

The potential environmental impacts identified above in Table 3 have been assigned monitoring and management actions to measure compliance against the EPOs and MTs. Management measures for each environmental factor (EPA, 2018) are detailed below. Management actions have been separated into:

- Tier 1 (which specially address the three identified environmental factors, BCH, Marine environmental quality (MEQ) and marine fauna, including matters of national environmental significance (MNES))
- Tier 2 (which relate to the overall works and can be managed through standard operational procedures (including hydrocarbons, waste and introduced marine pests)).

5.1. Marine environmental quality

The (Tier 1) management actions proposed to minimise potential impacts on the environmental factor 'Marine Environmental Quality' are described in Table 7. For the management targets associated with hydrocarbon spills please refer to Section 5.4, and for waste management please refer to Section 5.5.

Table 7: Management actions to minimise impacts on MEQ

Marine environmental quality					
Activity	Dredging and disposal operations				
Potential Impacts	• Disturbance of contaminants in sediments during dredging has the potential to deteriorate water quality and contaminate marine organisms • Changes to the physico-chemical properties of the water column as a result of dredging • Hydrocarbon release into the marine environment from a vessel spill and or bunkering operations				
Management Targets	Management Actions	Environmental Performance			
	Actions	Responsibility	Reporting/Evidence	Timing	Contingency
MEQ shall be maintained at a moderate level of ecological protection (Figure 8) during dredging and return to a High Level of Ecological Protection within 2 weeks following completion of dredging	Implement the Marine Water Quality Monitoring Program (MWQMP) as defined in Appendix B.1 for suspended sediment	RIA	• Water quality monitoring in accordance with the MWQMP and final report following the cessation of dredging	• As described in Appendix B.1.3	• Implement Tiered Management Framework (TMF) as defined in Appendix B.1
	Inspections of all dredge equipment to check for leaks or damage	Contractor	• Vessel and Site Environment Safety and Health inspection checklist	• Daily throughout dredging	• Cease works if significant spillage or damage observed • Activate spill response actions (control drainage, clean up) as required • Undertake incident investigation and implement recommendations
	Use of silt curtains during dredging to minimise the potential impacts	Contractor	• Maintain silt curtain to minimise leakage and report in pre-	• Silt curtain to be inspected prior to commencement of dredging and daily thereafter	• If silt curtain is found to be damaged or leaking, dredge operations are paused and curtain repaired

	associated with increased turbidity		mobilisation checklist and equipment maintenance schedule /documentation		
	The placement of geofabric (such as Texcel 1200R) textile weave along the bund wall will ensure that the placement of dredge spoil during reclamation works will not impact or increase the dredge plume zones. All vessels will comply with commonwealth biosecurity requirements and complete DPIRDs 'Vessel check'. All vessels will have a ballast water management plan and ballast water exchanges will be in accordance with IMO requirements and the Commonwealth *Biosecurity Act 2015*	Contractor	• Water quality monitoring in accordance with the MWQMP and final report following the cessation of dredging • Maintain geofabric to minimise leakage and report in pre-mobilisation checklist and equipment maintenance schedule /documentation	• WQMP As described in Appendix B.1.3 • Geofabric to be inspected prior to commencement of disposal and daily thereafter	• Implement Tiered Management Framework (TMF) as defined in Appendix B.1 • If geofabric is found to be damaged or leaking, disposal operations are paused until repaired

5.2. Benthic Communities and Habitats

The (Tier 1) management actions to minimise potential impacts on the environmental factor 'Benthic Communities and Habitat' are described in Table 5.

Table 8: Management actions to minimise impacts on benthic community habitats

Benthic Communities and Habitats					
Activity	Dredging and disposal operations				
Potential Impacts	• Direct loss of benthic communities and habitats due to dredging activities • Indirect impacts of benthic communities and habitats due to reduction in available light caused by increase in suspended sediments released into the water column during dredging, increased sedimentation rates or burial				
Management Targets	Management Actions	Environmental Performance			
	Actions	Responsibility	Reporting/Evidence	Timing	Contingency
Dredging operations do not occur outside the defined dredging footprint	Employ high-resolution positioning system to control dredge operations	Contractor	• Validate positioning and vessel monitoring system • Dredge progress reports submitted throughout dredging works period	• Prior to and during dredge operations • Weekly throughout dredging	• Cessation of dredging and relocation of dredge • Service/replacement of positioning system
Disposal operations do not occur outside the defined areas	Employ high-resolution positioning system to control hopper barge during placement at the dredge material placement area (Proposed spoil ground locations)	Contractor	• Active recording of vessel position • Dredge reports submitted throughout works period	• Prior to and during dredge operations • Weekly throughout dredging	• Cessation of dredging and relocation of dredge material dump position; and • Service of positioning system
Recoverable impact to BCH limited to within the ZoMI (Figure 4)	Implement the Marine Water Quality Monitoring Program (MWQMP) as defined in Appendix B.1	RIA	• WQ profiling • Summary report at the completion of monitoring	• Commence at least one month prior to commencement of dredging • Continuous during dredging • Continue for one week after cessation dredging or until water	• Implement Tiered Management Framework (TMF) as defined in Appendix B.1.

No observable impacts to BCH outside of the ZoHI (Figure 4)				quality has returned to pre-dredging baseline.	• Silt curtains to be employed to reduce plume as necessary
	Implement the Benthic Communities & Habitat Monitoring Program (BCHMP) as defined in Appendix B.2.	RIA	• Pre-disturbance Survey Report • Post-dredging Survey Report • Reactive Survey Report (As required) • Monitoring Close-out Report	• Pre-dredging surveys at least one month prior to commencement of dredging • Reactive surveys as required in accordance with MWQMP triggers. Refer to Appendix B.1 • Post-dredging survey within 2 months following completion of dredging	• Implement Reactive BCH Monitoring Event as per Appendix B.2. • Continue post-dredging surveys on an annual basis (Maximum of five years) as required to identify evidence of BCH recovery within the authorised ZoMI as per Appendix B.2.
	Inspect and maintain dredge hopper and to minimise leakage	Contractor	• Pre-mobilisation equipment checklist • Equipment maintenance schedule/documentation	• Prior to commencement of dredging and daily during dredging	• Cease dredge operations and repair leakage

5.3. Marine Fauna

The (Tier 1) management actions proposed to minimise potential impacts on the environmental factor 'Marine Fauna' (including MNES) are described in Table 9. For the management targets associated with introduced marine pests please refer to Section 5.6.

Table 9: Management actions to minimise impacts on marine fauna

Environmental Factor	**Marine fauna**				
Activity	Dredging , disposal and general vessel operations				
Potential Impacts	• Injury, death or behavioural change of marine fauna as a result of dredge operations (loading and dumping, deployment of silt curtains) • Injury or death of marine fauna due to vessel movement (strike) • Direct impacts from underwater noise from dredging operations • Direct impacts from light pollution • Habitat disturbance or loss through reduction temporary localised increase in suspended sediment concentration (SSC).				
Management Targets	Management Actions	Environmental Performance			
	Actions	Responsibility	Reporting/Evidence	Timing	Contingency
No incidences of marine fauna injury or death as a result of dredge operations	Implement marine fauna monitoring and management as outlined in Appendix B.3. Internal training of Marine Fauna Observer(s) (MFO), which provides clear direction on: • The dredging Management Zones (Observations Zones and Exclusion Zones) • Key marine fauna species that are known or likely to be present in the proposal area and how to identify species (i.e. whales, dolphins, seals and sea lions, and turtles)	Contractor	• MFO daily records • Final summary report • Refer to Appendix B.3 • Maintain silt curtain to minimise leakage and report in pre-mobilisation	• Daily • Refer to Appendix B.3 • Silt curtain to be inspected prior to commencement of dredging and daily thereafter	• Where marine fauna are observed within an Exclusion Zone then dredging will cease immediately. • If silt curtain is found to be damaged or leaking, or marine fauna are entangled, dredging operations are paused and silt curtain to be maintained and marine fauna to be released

	• The actions to be undertaken by the MFO in the event of marine fauna being sighted within the Management Zones. • The actions to be undertaken by the MFO in the event of an incident resulting in injury or death of a marine species. Use of silt curtains during dredging to minimise the potential impacts associated with increased turbidity		checklist and equipment maintenance schedule /documentation		
No direct impacts to marine fauna from underwater noise from dredge operations	Implement marine fauna monitoring and management as outlined in Appendix B.3 Ensure all vessel equipment and machinery is in good condition and subject to regular maintenance When in transit, all proposal vessels will be operated in accordance with EPBC Regulations 2000- Part 8 Division 8.1. Minimise the duration of run-time for vessel engines, thrusters and dredging plant by avoiding stand-by or running mode to the degree practical and consistent with safe operations.	Contractor	• Refer to Appendix B.3	• Refer to Appendix B.3	• Where marine fauna are observed within an exclusion zone then dredging will cease immediately.
No incidences of marine fauna injury or death as a result of vessel strike	Implement marine fauna monitoring and management as outlined in Appendix B.3. The maximum vessel speed within all areas of the proposal is 5 knots and all vessels are to adhere to standard set in the National Whale Watching Guidelines (DoEE 2017b).	Contractor	• Refer to Appendix B.3	• Daily • Refer to Appendix B.3	• Where marine fauna are observed within an exclusion zone then dredging will cease immediately.
No disruption to marine fauna from artificial lighting	All dredging and construction works to be undertaken during daylight hours only	Contractor	• Daily logs	• Throughout dredging and construction activities	• Pause dredging and construction if artificial lighting required

5.4. Hydrocarbon Management

The (Tier 2) management actions proposed to minimise potential impacts associated with hydrocarbon spill described in Table 10.

Table 10: Management actions to minimise the risk of hydrocarbon pollution

Activity	General Vessel Operations				
Potential Impacts	• Decrease in MEQ quality due to water and potential sediment contamination • Potential smothering of BCH and marine fauna				
Management Targets	Management Actions	Environmental Performance			
	Actions	Responsibility	Reporting/Evidence	Timing	Contingency
No hydrocarbon spills to the marine environment	Document vessel bunkering management, including appropriately licensed bunkering facilities	Contractor	• Vessel management procedures	• Prior to dredge entering Western Australian Waters from overseas or interstate.	• Dredge operations not to commence prior to development and Proponent approval of vessel bunkering management procedure
	Undertake vessel maintenance and bunkering in accordance with dredging contractors approved vessel management systems	Contractor	• Vessel management procedures	• For the duration of dredging	• Vessel bunkering management systems to be reviewed and refined (if required) in the event of an identified procedural breach or hydrocarbon spill
	Implement industry standard hydrocarbon management practices (chemical handling, storage, segregation and spill response)	Contractor	• Vessel management procedures • The approval holder and RIA is to be notified immediately in the event of a hydrocarbon spill of any volume	• Prior to commencement of dredging	• Dredge operations not to commence prior to development and approval of vessel management procedures • Investigate spill event and review management actions and responses
	Undertake an environmental inspection of all dredging vessels	Contractor	• Vessel management procedures	• Prior to the commencement of dredging	• Dredge operations not to commence prior to development and approval of vessel management procedures

5.5. Waste Management

The (Tier 2) management actions proposed to minimise potential impacts that waste management may have on the environment are listed in Table 7.

Table 11: Management actions to manage waste

Activity	Incorrect or accidental disposal from a vessel				
Potential Impacts	• Impacts on the MEQ (both sediment and water) and marine fauna due to presence of foreign materials				
Management Targets	Management Actions	Environmental Performance			
	Actions	Responsibility	Reporting/Evidence	Timing	Contingency
No release of waste into the marine environment.	Manage waste in compliance with requirements for RIA and in accordance with MARPOL 73/78 Convention Annex IV (sewage) and Annex V (garbage). Dredging contractor to establish and implement a sewage and garbage disposal plan in accordance with RIA requirements and MARPOL 73/78	Contractor	• Plan – one week prior to dredging • Incident - Within 12 hours of a reportable incidence.	• Prior to commencement of dredging • Duration of dredging operations.	• RIA to approve Plan prior to commencement of dredging • Plan and procedures to be revised to prevent recurrence of incident • RIA to audit performance during dredging if/as required.
	Manage the correct onshore disposal and reporting systems Only a licenced Controlled Waste Carrier to be used for any controlled waste discharged ashore	Contractor	• Controlled waste tracking forms to be completed as soon as possible.	• Duration of dredging operations.	• RIA to audit performance during dredging if/as required.
	All forms of waste need to be stored in appropriately labelled drums or tanks and be correctly disposed of and not discharged to the environment	Contractor	• Approval certification and tracking forms to be completed as soon as possible	• Duration of dredging operations.	• Vessel management plan/procedures to be reviewed and endorsed by RIA prior to dredging

			• Vessel waste management plan/procedures.		• RIA to audit performance during dredging if/as required.
	Reporting of any type of spillage within the marine environment directly to the RIA.	Contractor	• As soon as possible, within 24 hours.	• During the duration of dredging operations.	• Revise associated management plans or procedures to ensure no incident recurrence • RIA to audit performance during dredging if/as required

5.6. Introduced Marine Pests

The (Tier 2) management actions proposed to minimise potential impacts that waste management may have on the environment are listed in Table 8.

Table 12: Management actions to minimise of introduced marine pests

Activity	Introduction of marine pests from vessels entering the area				
Potential Impacts	• Impacts on local marine fauna due to presence of introduced marine pests (IMPs)				
Management Targets	Management Actions	Environmental Performance			
	Actions	Responsibility	Reporting/Evidence	Timing	Contingency
No introduction or movement of IMPs	Use the WA Department of Primary Industries and Regional Development (DPIRD) 'Vessel Check' risk assessment (https://vesselcheck.fish.wa.gov.au) and submit to RIA (including supporting documentation) for all dredging and support vessels (i.e., Dredge vessel and Barges) that mobilise from interstate or international waters. Risk assessment must indicate that the vessel poses a low risk of IMP to the proposal area.	Contractor	• 'Vessel Check' risk assessment report (including supporting documentation) • If pest is identified record location, date and time, size, colour, water depth, environment (e.g. beach, sand etc), and take a photo.	• Prior to vessel(s) entering the proposal Area.	• Notify RIA and DPIRD of the introduction of IMPs within 12 hours (1800 815 507).
	All vessels will comply with Commonwealth biosecurity requirements and complete DPIRDs 'Vessel check'. All vessels will have a ballast water management plan and ballast water exchanges will be in accordance with IMO requirements and the Commonwealth *Biosecurity Act 2015*				

6. Reporting

A summary of the reporting requirements for the proposal are provided in Table 13. Reporting may be revised following further advice from DWER.

Table 13: Compliance reporting requirements

Report	Content	Timeframe	Responsibility	Recipient
Environmental Incidents or Environmental Risks Report	Report any environmental incident or environmental risk Detail the incident or risk, the measures taken, the success of those measures in addressing the incident or risk and any additional proposed to be taken Document any incidents involving the dumping activities that result in injury or death to any marine species. The date, time and nature of each incident and the species involved, if known, must be recorded.	Within 12 hours	Dredging Contractor	RIA / DoT – Reportable Oil Spill/ Pollution Report form (POLREP) Department of Biodiversity Conservation and Attractions (DBCA) – Reportable wildlife incident RIA / DPIRD – Reportable IMP detected.
Non-compliance Summary Report	Identify which EPO has not been achieved Detail the monitoring results that identified the EPO was not being achieved Describe the investigation being undertaken into the cause of the EPO not being achieved Identify any corrective or contingency management actions proposed to be implemented or being implemented	Within 7 days of determining that an EPO has not been achieved	RIA	Department of Water and Environmental Regulation (DWER) DCCEEW
Non-compliance Investigation Report	Identify which EPO has not been achieved Detail the findings of the investigations undertaken into the cause of the EPO not being achieved	Within 30 days of determining that any EPO has not been achieved	RIA	DWER DCCEEW
Close-out Report	Report which evaluates the performance of monitoring and management in achieving the EPOs.	Within 12 months following completion of dredging	RIA	DWER DCCEEW

6.1. Additional Reporting

A summary of the additional reports that are expected to inform compliance reporting commitments (Table 13) are listed in Table 14.

Table 14: Additional reporting requirements required to demonstrate compliance

Topic	Content	Timeframe	Responsibility	Recipient
BCH Reporting	• Pre-dredging BCH survey report • Post-dredging BCH survey report • Reactive BCH survey report (as required).	• Pre-dredging survey report issued as soon as practical following the completion of the survey • Post-dredging surveys issued within 6 months following completion of dredging • Reactive survey reports as required to support potential non-compliance investigation.	RIA	DWER DCCEEW
Marine Water Quality Monitoring Program Reporting	• Marine Water Quality Monitoring Program Summary Report.	• Monitoring summary report to be issued with Close-out report.	RIA	DWER DCCEEW
Site and vessel inspection checklists / logs	• Vessel Environment, Safety & Health inspection – (e.g., equipment inspection, navigation equipment systems, speed, MFO personnel, bunkering log). • Dredge operation log – (e.g., operations times, types of operations, Global Positioning System (GPS) location, dredge volumes). • Marine fauna observation Logs – (e.g., dredge operation time, name of observer, fauna species, distance/direction from vessel, management response).	Daily during dredging	Contractor	Approval holder
Pollution Incidents	Reactive pollution incident report as required. Approval Holder to coordinate state reporting requirement to DoT	Within 24 hours of incident	Contractor RIA	Approval holder

Topic	Content	Timeframe	Responsibility	Recipient
	Maritime Environmental Emergency Response (MEER) duty officer and online Pollution Report Form (POLREP)			DoT / RIA
Complaints	Approval Holder to be notified of any complaints received in relation to the dredging activities. Notification should detail the nature of the complaint and how it was resolved.	Within 72 hours of any complaint received	Dredging Contractor	Approval Holder

7. Ongoing stakeholder consultation

Stakeholders are important to any development within Western Australia, and RIA understands the stakeholders are extremely important in this process. Stakeholders will be notified of proposal developments through the proposal website https://www.ria.wa.gov.au/projects-and-developments/significant-projects/south-thomson-barge-landing.

8. Availability of the DEMMP

This DEMMP will be available on the EPA and RIA websites and can be provided to the public or stakeholders upon request.

9. Audit and review

RIA are committed to continual improvement and will conduct regular review of the content and implementation of this DEMMP. This includes undertaking audits of the dredge contractor and their operations as required throughout the proposal, to assess compliance against this DEMMP. The performance of the dredging operations against these requirements will be reported.

This DEMMP is a living document and will be reviewed in accordance with Table 11. Any significant changes must be documented in Appendix A. Changes to the document may also require approval from DWER, depending on the requirements of the Ministerial Statement.

Table 15: DEMMP Review Schedule

Timing	Rationale
Upon receipt of approval conditions	If Regulator (DWER/DCCEEW) approval conditions are provided for the proposal this will necessitate a comprehensive review of this DEMMP to ensure all relevant commitments are covered within this Plan to ensure compliance.
Prior to commencement of action	To ensure that the contractor and approval holder implement all commitments accordingly and that no operational details are non-compliant. To confirm the most suitable monitoring locations, trigger levels and monitoring methods area appropriate.
Any time operational activities significantly alter	Operational changes to the proposal may result in an altered risk profile. Therefore, the DEMMP will require a review to ensure that it remains fit-for-purpose for altered operational conditions. Any significant change in environmental risk may require the DEMMP to be resubmitted to DWER for endorsement (this may not be required if the proposal is Not Assessed or not considered a controlled action.
Following any significant incidents or non-compliance events	To ensure that the management actions and controls in place are adequate to ensure no re-occurrence of incidents or non-compliances.

During review of the DEMMP, consideration will be given, but not limited to:

- Overall effectiveness of the DEMMP
- Changes in schedule
- Changes to monitoring trigger values, where determined to be ineffective or inappropriate
- Any changes in methodology or equipment used.

10. References

Baird (2024) South Thomson Bay Barge Development: Dredge Plume Modelling Assessment. 2 February 2024, Rev 0.

BMT (2021) Port Beach Sand Nourishment via Dredging – Environmental Review Document. Prepared for the City of Fremantle, R-10807-5.

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DoT (Department of Transport) (2022) Nautical chart of Rottnest Island. https://www.transport.wa.gov.au/imarine/coastaldata/nauticalcharts/pdfs/WA412_rottnest_island.pdf

Emerge (2024) Construction Environmental Management Plan. Rottnest Island Authority – South Thomson Barge Landing Development. Prepared for Rottnest Island Authority. June 2024.

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RPS (2020) SAP Implementation Report. Rottnest Island Army Jetty Dredging. Rev 0, 11 May 2020.

RPS (2024) Environmental Supporting Document: South Thomson Barge Landing Development, Wadjemup / Rottnest Island.

Sea Temperature (2024) Water temperature in Rottnest Island. Rottnest Island ocean water temperature today | WA, Australia (seatemperature.info)

WA Museum (Western Australian Museum) (2012) Maritime Archaeological Assessment of the Army Jetty Thompson Bay, Rottnest Island. Prepared for the Rottnest Island Authority by Nicolas Bigourdan and Madeline McAllister. Report – Department of Maritime Archaeology, Western Australian Museum, No. 204.

Appendix A. Plan Amendments

Document Change Register

Organisation	Date	Comment	Response

Appendix B. Monitoring programs

Appendix B.1. Marine water quality monitoring program

The environmental outcomes for MEQ for dredging activities are as follows:

- Maintain the MEQ outside the predicted zones of influence as defined by dredge modelling (ZoHI, ZoMI and ZoI)
- MEQ is returned to a High Level of Ecological Protection two weeks after completion of dredging and construction activities
- No reported hydrocarbon spills or release of waste into the marine environment from dredging and disposal activities.

B.1.1 Rationale

Dredge plume modelling undertaken by Baird (2023) calculated predicted increase in suspended sediment within the environment during dredging activities This was undertaken using suspended sediment concentration (SSC) and assumed the base case was 0 mg/L. Light was not modelled as the relationship between SSC and light (measured as Daily Light Integral) had not been derived, and therefore the interpretation of modelling results based on light impacts to seagrasses was not possible.

This marine water quality monitoring program (MWQMP) will be undertaken to ensure the turbidity at the zone boundaries as defined by Baird (2023) are meeting those management targets. As SSC is unable to be measured in situ, turbidity will be measured as Nephelometric Turbidity Units (NTU) using a turbidity profiler and compared to the SSC using a correlation coefficient calculated prior to the commencement of dredging.

As an additional line of evidence, turbidity (NTU) will also be measured using loggers taking measurements every 30 minutes throughout dredging activities. These will be downloaded at the end of the dredging campaign, or if the profiling measurements indicate that an exceedance of the trigger may be likely.

B.1.2 Monitoring locations

Turbidity (NTU) profiling will be measured at seven impact sites and two reference sites. The impact sites will be located at the boundaries of the ZoHI/ZoMI, and ZoMI/ZoI and will be used to monitor EPOs and MTs associated with no negative change from baseline conditions. Impact sites will be positioned over identified seagrass/macroalgae receptors adjacent to the ZoMI boundary where practicable. No monitoring is proposed within the ZoHI as it assumed this area will have irreversible impacts to BCH. No monitoring is proposed further than the ZoMI/ZoI boundary as it is expected that no changes will be observed in BCH and WQ parameter requirements will be met at the ZoMI/ZoI boundary and extending out into the ZoI.

The proposed monitoring locations are presented in Table 14 and Figure 11, which have been based on the zones of impact and influence derived by Baird from the dredge plume modelling results (Figure 3).

During the establishment survey the benthic communities at each location will be reviewed in the field and the locations may be altered to be closer to seagrass.

Table 16: Proposed coordinates of water quality monitoring locations

	Name	Type	Easting (GDA2020 MGAz50)	Northing (GDA2020 MGAz50)
Impact Sites	STWQ-01	ZoHI to ZoMI	363106	6458564
	STWQ-02	ZoHI to ZoMI	363194	6458555
	STWQ-03	ZoHI to ZoMI	363228	6458491
	STWQ-04	ZoHI to ZoMI	363143	6458440
	STWQ-05	ZoMI to ZoI	363305	6458522
	STWQ-06	ZoMI to ZoI	363288	6458443
	STWQ-07	ZoMI to ZoI	363238	6458394
Reference Sites	Ref-1	Reference	363061	6458838
	Ref-2	Reference	363462	6458590

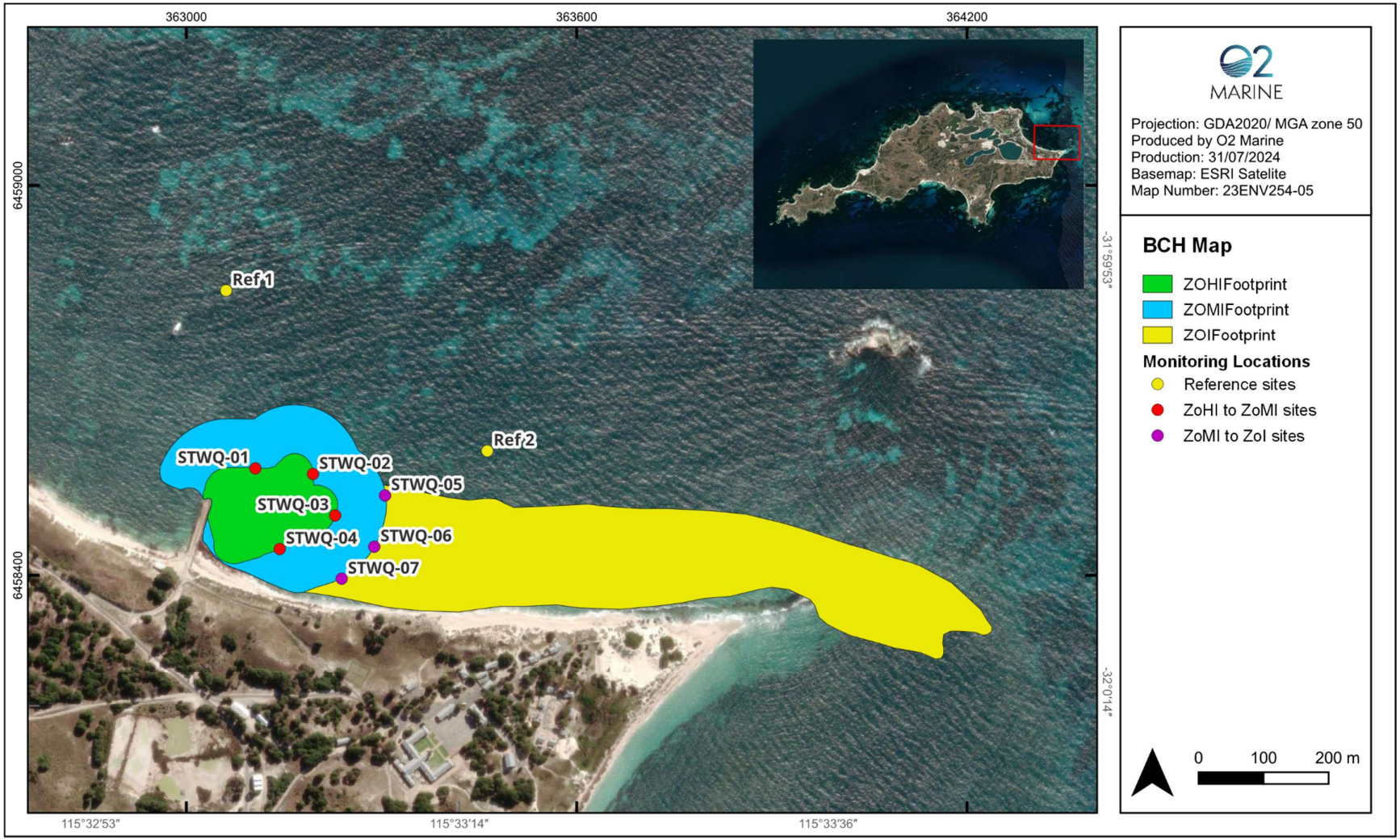

Figure 7: Proposed water quality and BCH monitoring locations

B.1.3 Frequency

Baseline

A TSS:NTU correlation sampling event will be undertaken one month prior to the commencement of dredging to validate the correlation coefficient used to set the trigger levels to be used during the dredging period. This will be undertaken at several sites within Thomson Bay, including around the existing ferry terminal to gain an understanding of a more turbid environment.

Routine monitoring

Water quality profiling will be undertaken every 3 days during dredging activities. The following parameters will be measured:

- Turbidity (measured as NTU)
- Photosynthetic Active Radiation (PAR)
- Conductivity
- Temperature
- Dissolved Oxygen (DO)
- Depth.

This will be undertaken at impact and reference monitoring locations only.

If trigger levels are exceeded and management response actions are required, reactive BCH health monitoring will be implemented (triggers given in Section B.1.4).

Converting SSC to NTU will have some margin of error, and Fisher et al (2019) recommends frequent checking and reconfirming that the conversion factors are relevant throughout dredging activities. Therefore during dredging activities, one further TSS:NTU correlation sampling event will be undertaken to ensure the correlation coefficient remains accurate within the proposal environment. If NTU trigger values are updated then this will be reflected in the compliance monitoring report.

Post dredging

Water quality profiling will continue to be collected and analysed until water quality returns to pre-dredging levels, or at least two weeks following the cessation of dredging (whichever is longer).

B.1.4 Environmental protection outcomes, management targets and trigger levels

Seagrass was identified to be the most sensitive BCH receptor within the proposal area, and therefore EPOs, MTs and trigger levels have been developed for protection of seagrass during dredging and disposal. EPOs and MTs are presented in Table 6 of the DEMMP.

Zones of impact were identified by Baird (2023) based on the methods used by BMT in their analysis of the dredge plume and modelling and their impact on seagrasses using the thresholds defined by Statton et al (2017). This assessment determined nominal values of SSC that would have detrimental impacts on local BCH as follows:

- 2 mg/L, approximating a potentially visible plume

- 5 mg/L, approximating a value that may pose a low risk to seagrasses (ZoI will be expected to be between 2 mg/L and 10 mg/L above background)
- 10 mg/L, approximating a value that may pose a moderate risk to seagrasses (ZoMI will be expected to be between 10 mg/L and 20 mg/L above background)
- 20 mg/L, approximating a value that poses a high risk of impacts to seagrass health (ZoHI will be expected to be 20 mg/L or higher above background).

Given these values, 10 mg/L (95th percentile) was used to delineate the ZoMI, and 2 mg/L (100th percentile) was used to delineate ZoI. Therefore, it is predicted that at the boundary of the ZoHI/ZoMI, the SSC should be less than 20 mg/L, and at the ZoMI/ZoI boundary the SSC should be less than 10 mg/L. In order to ensure a high risk to seagrass health is not reached in the ZoMI and the moderate risk is not reached in the ZoI, the below trigger levels are proposed (Table 17).

Table 17: Proposed triggers and thresholds for the proposal

	Trigger 1	Trigger 2
ZoHI/ZoMI boundary	Turbidity >19 mg/L (to be converted to NTU following the TSS:NTU correlation calculation) above the medians of both reference sites. Duration Turbidity must exceed for any 2 week monitoring period to be considered a trigger exceedance.	Turbidity >20 mg/L (to be converted to NTU following the TSS:NTU correlation calculation) above the medians of both reference sites. Duration Turbidity must exceed for any 2 week monitoring period to be considered a trigger exceedance.
ZoMI/ZoI boundary	Turbidity >9 mg/L (to be converted to NTU following the TSS:NTU correlation calculation) above the medians of both reference sites. Duration Turbidity must exceed for any 2 week monitoring period to be considered a trigger exceedance.	Turbidity >10 mg/L (to be converted to NTU following the TSS:NTU correlation calculation) above the medians of both reference sites. Duration Turbidity must exceed for any 2 week monitoring period to be considered a trigger exceedance.

Management actions to be undertaken given an exceedance of a trigger:

- Trigger 1:
  - investigate if a Trigger 2 has been exceeded for any sites
  - sample again at that monitoring site and associated reference site each day until turbidity has decreased.
- Trigger 2:
  - Investigate cause of exceedance using the following steps:
    - Assess metocean and weather conditions
    - Investigate if dredging/disposal has been occurring and if that's likely to be attributable to the exceedance.

- Conduct further data collection and analysis:
  - Investigate results of the other parameters including PAR to determine if there is likely to be stress on the surrounding seagrass.
  - sample again at that monitoring site and associated reference site each day until turbidity has decreased.

If impacts to seagrasses are predicted due to the increased turbidity, the following actions should be considered and undertaken if relevant and possible:

- Undertake a reactive BCH survey assessment (See Appendix B.2)
- Change the dredging activities e.g. pause dredging for 12 hours and consider changing dredging activities
- Change the disposal activities e.g. pause disposal until turbidity has decreased.

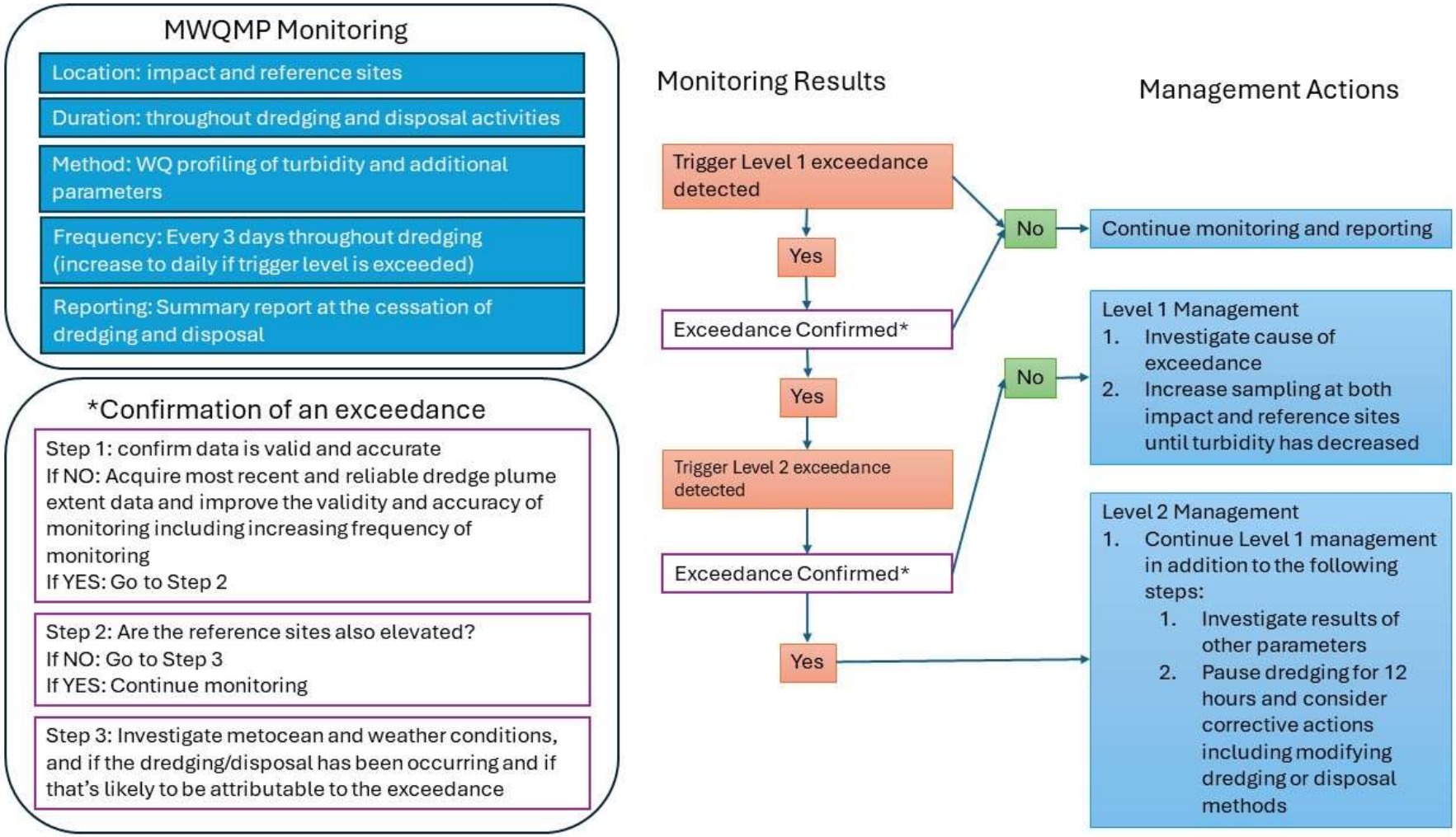

Figure 8: Tiered management framework for the Marine Water Quality Management Plan (MWQMP)

B.1.6 Data analysis

Any potential impact of dredging on water quality decline will be assessed and will include a consideration of the following factors:

- Correct instrument calibration, function, operation and maintenance
- Potential influence of shipping movements through the area
- Locations and status of dredging activities in relation to the site(s) at the time of the exceedance
- Metocean conditions at the time of the exceedance
- Assessment against background conditions (reference site)
- Spatial extent of water quality decline at the time of exceedance based on review of plume extent (i.e. multispectral imagery).

Baseline water quality will be analysed and the TSS:NTU correlation calculated as soon as possible following the completion of baseline monitoring. This will then be used to validate the interim trigger levels and compared to the compliance monitoring data.

This information will then be presented in the final water quality monitoring report.

B.1.7 Corrective actions

Turbidity and light data will be assessed against the established Trigger Levels (Table B1-2). If the Trigger Levels are exceeded (or indicate a progressive increase towards the Trigger Levels) then modifications to the dredging program are to be considered, and may include, but not necessarily be limited to:

- Temporary pause to dredging activities (e.g. if exceedance appears to be due to non-dredging vessel movements, tide and/or weather conditions)
- Relocate the dredge (e.g. to an area of coarser sediment)
- Reduce the dredge cut depth, rate of swing-speed and/or increase the dredge pump flow
- Reduce disposal of material if the plume is coming from the reclamation area.

Modifications to the dredge program are to continue until the trigger levels are no longer exceeded. If Trigger Level 2 is exceeded for two consecutive days ('continued exceedance') dredging will cease and Level 2 management actions shall be instigated. In this instance dredging will only recommence after Trigger Level 1 is no longer exceeded. In addition, detailed investigations on the likely causes of the exceedance and the recommended changes to dredge program is required within 7 days of this Trigger Level 2 exceedance.

B.1.8 Reporting

A compliance report will be prepared following the completion of the dredging and construction works and the associated water quality monitoring. Due to the short duration of the works, baseline information will be included in the compliance report.

Appendix B.2. Benthic communities & habitat monitoring program

B.2.2. Rationale

Seagrass communities are the most vulnerable (of those BCH present in the impact area) to the effects of increased turbidity (measured as NTU, TSS or SSC) and the associated decline in benthic light availability. Therefore, seagrass health will be lead indicator for monitoring of benthic community health. Seagrass and macroalgae will both be monitored with the water quality thresholds for the protection of seagrass.

Diver based transects will be used to collect data from each site, which will be analysed to determine seagrass or macroalgae percent cover (total and for each genera, to cater for shifts in species dominance). Total percent cover of any other benthic flora and fauna within sites will also be recorded. Sampling methodology is based upon Vanderklift et al (2016), whereby at each site, three 50 m transects are surveyed, with a 0.25 x 0.25 m image collected every meter (n=150 per site). Additional qualitative observations will also be recorded such as evidence of dead rhizome mat, or presence of invasive marine species.

B.2.4. Locations

Indicative monitoring locations will be selected in areas of at least moderate BCH cover and include:

- Four (4) locations along the ZoHI/ZoMI boundary to assess recoverable impacts
- Three (3) locations along the ZoMI/ZoI boundary to assess no change from baseline state.

A further two (2) reference monitoring locations are required to be determined as suitable control locations. These locations are proposed to be at the same/similar locations to the water quality sites so that water quality triggers are related to the BCH monitoring sites. No monitoring is proposed within the ZoHI as it assumed this area will have irreversible impacts. No monitoring is proposed further than the ZoMI/ZoI boundary as it is expected that no changes will be from the boundary. The proposed coordinates and locations are given in Table 16 and Figure 7 in Section B.1.2.

As described in Section B.1.2, these monitoring locations will be confirmed following the finalisation of the dredge modelling and zones of impact and influence, and again during the establishment/baseline surveys after a review of the benthic communities.

B.2.5. Frequency

Baseline surveys

BCH surveys to establish baseline conditions should be undertaken within one month prior to commencement of dredging.

Reactive surveys during dredging (as required)

During dredging, BCH surveys are only required in the event that a trigger level 2 exceedance has occurred management actions are required.

Post-Dredging Survey

If a reactive survey was required during the dredging activities, then post-dredging surveys will also be undertaken (i.e. it will not be required if the water quality triggers were not exceeded). One post-dredging survey will be undertaken within 2 months (preferably within the same season as the baseline) following completion of dredging and construction to evaluate status of EPOs within the ZoMI and the ZOI. Where dredging impacts were detected in areas outside of the ZoHI, then post-dredging BCH surveys will continue, on at least an annual basis, for up to 5 years, or until BCH that is impacted as a result of dredging is considered to have recovered to a pre-dredging (baseline) condition as demonstrated through monitoring.

B.2.6. Survey Methods

BCH monitoring for community health will involve implementation of a standard diver-based survey of before / after / control / impact (BACI) design. At least three (3) 50 m transects radiating in different bearings at each monitoring location will be established and a tape measure will be run over each transect. Divers will capture still images within a 25 x 25 cm quadrat at each metre along the transects using an underwater camera. Still camera shots will be taken within <1 m of the substrate. Following the field work, analysis of still images will be undertaken to determine percent cover, and observations will also be taken of presence of other species, dominance of species and presence of dead organisms.

B.2.7. Data Analysis

The percentage of benthic species cover that directly intercept the tape measure length of each 20 m transect using the line-intercept method will be calculated into a proportion of each benthic group (i.e., 20 m equals 100%). The benthic groups used will be calculated manually in excel to determine the relative abundance, mean, standard deviation, standard error and the Shannon-Weaver diversity Index of each benthic cover type at each site.

Multiple lines of evidence

In the event that management criteria are exceeded, a series of investigations and statistical analyses will be initiated in a structured decision-making framework to rigorously assess whether the detected change at an affected reef was due to dredging or simply the result of natural change.

The first step will be an assessment of the magnitude of change (effect size and its confidence interval) in cover between the impact and reference locations, from before dredging to the current survey period.

Multiple lines of evidence, based on causal indicators, are used to assess the impact hypothesis and may apply a variety of univariate or multivariate analysis. With lines of evidence there is a need to seek evidence not only to support the impact prediction, but evidence to rule out plausible alternative predictions, such as that the observed difference was due to natural processes including thermal bleaching from warm water temperatures, natural mortality, pollution, predation, cyclonic events, salinity change and anthropogenic causes for elevated turbidity (e.g. ship propeller disturbance). Potential natural and anthropogenic causes not related to the dredging activities will be monitored and noted during routine surveys as part of the MWQMP, and in some cases during the reactive monitoring

program. A reactive monitoring program will be activated when there is a potential for a decline in BCH occurring.

A number of factors are relevant to the likelihood and level of severity of an impact occurring, including existing stress levels, age, size and health status of organisms, associated biota and adaptations to localised conditions. Differences in the physical characteristics between reference and impact locations and how this could affect the scale of effect observed should also be considered. The data will be compiled to provide a weight of evidence to determine if dredging activities were reasonably considered to cause or contribute to the impact.

Continuation of the post-dredging surveys on an annual basis (Maximum of five years) may be required to identify evidence of BCH recovery within the authorised ZoMI. Where BCH has not shown evidence of recovery within the authorised ZoMI after 3 years, options for translocation, transplantation and/or restoration will be considered. In the event that water quality triggers are exceeded at the outer boundary of the authorised ZoMI, the pre- and post-dredging BCH surveys will consider a variety of health measures of BCH in the areas outside the authorised ZoMI and ZoHI, which can be used to provide evidence that this EPO has or has not been met.

B.2.8. Reporting

Baseline report

A baseline report will be prepared following the completion of the baseline survey ready for comparison to reactive surveys if required. The results of the baseline surveys will be summarised and assessed with the intention to characterise natural background changes in the condition of BCH in the areas likely to be affected by capital dredging and in the reference locations.

The report is proposed to also include a summary of the weather and marine water quality conditions (i.e., benthic light availability), which will be recorded during the pre-dredge period. This information will be used to develop understanding of how the condition of BCH in the areas are likely to be affected by capital dredging and control locations are influenced by natural processes.

Reactive survey reports (as required)

In the event that level 3 management criteria are triggered, a reactive survey investigation may be warranted. The investigation will consider relevant field observations, comparison of reference sites, water quality and sediment deposition data collected, dredge operations and metocean conditions to delineate impacts detected from natural causes or other anthropogenic sources as part of a multiple lines of assessment approach. Each reactive survey report will include:

1. A summary of data collected during the survey
2. Comparison of BCH condition with baseline and against reference locations
3. Multiple lines of evidence assessment
4. Evaluation of whether EPOs have been achieved or not
5. Recommendations for additional investigations / management / monitoring if required.

Reactive survey reports should be reviewed together with any required compliance investigation reports for recommendations of the next steps for dredging operations.

Post-Dredging Report

The post-dredging report will be prepared following completion of each annual post-dredging survey. The Post-dredging report will include:

1. A summary of data collected during the survey
2. Comparison of BCH condition with baseline and against reference locations
3. Multiple lines of evidence assessment
4. Evaluation of whether EPOs were achieved or not
5. Evaluation of the effectiveness of the BHMP and WQMP
6. Recommendations for additional investigations / management / monitoring if required.

Appendix B.3. Marine Fauna Observations

B.3.1. Protocols and Procedures

The monitoring protocols and procedures will be informed by previous regulatory advice and dredging campaigns completed in similar environments. As part of this proposal, piling will also be undertaken, and underwater noise modelling was completed to assess the magnitude of impacts associated with piling. The results are known to be similar for dredging and vibration piling, which both produce a continuous noise, and the zones here are sufficient for mitigating continuous noise, from both activities. Observation and exclusion zones around the dredging and disposal activities to prevent injury, including collision with vessels and reducing entrainment and entrapment, are presented in Table B3-1. Note that the observation and exclusion zones for piling activities will be different and are presented in the Construction Environmental Management Plan (Emerge 2024).

It is vital to ensure the protection of marine fauna for the duration of the proposal. The frequency and location of the observer are paramount to ensure the safety of the marine fauna, with the continuity of the proposal depending on their response to potential interactions with marine fauna.

Table B3-1: Dredging marine fauna management zones

Marine Fauna Group	Observation Zone (m)	Exclusion Zone Disposal (m)	Exclusion Zone Dredging (m)
Whales	500	300	300
Dolphins	300	150	150
Seals and sea lions	500	300	300
Turtles	500	300	300

To mitigate potential impacts of the proposed works on significant marine fauna the Contractor must implement the following management and monitoring protocols during dredging and disposal works:

Pre-start

Dredging activities must not commence until a suitably trained MFO has verified that no target marine fauna; whales, cetaceans, and marine reptiles have been observed within the Exclusion zone during the 30-minute soft-start period completed immediately prior to the commencement of dredging activities. If target marine fauna is observed within the Exclusion Zone, dredging operations shall be delayed until target marine fauna has been observed exiting the zone or has not been seen for 30-minutes.

Soft-start

The 30-minute soft-start procedure for the dredge will involve activating the bucket in a controlled manner, prior to dredging, to passively disturb and deter resident fauna. If target marine fauna is sighted in the observation zone, soft-start may continue and the trained MFO will continue to monitor. If no marine fauna are sighted in the Exclusion zone dredging can commence.

Dredging and disposal

A suitably trained MFO must monitor the observation radius of 500 m (Observation Zone) around the dredging activities continuously during these works to identify if there are any target marine fauna in the management zones. If marine fauna sighted in exclusion zone shut-down procedures apply.

Shut-down procedures

- If a suitably trained MFO observes target marine fauna within the nominated dredging or disposal Exclusion zones, then these activities must be suspended within two minutes of the sighting or as soon as safely possible.
- Dredging or disposal activities that have been suspended must not recommence until the sighted fauna have moved beyond the exclusion zone or not sighted for at least 30 minutes.

Low-visibility and nightworks

During periods of low visibility or at night-time (where a distance out to 500 m cannot be clearly viewed), dredging activities may be undertaken, provided that during the preceding 24-hour period:

  - there have not been 3 or more marine fauna shutdowns
  - a 2-hour period of good visibility has been maintained prior to onset of low visibility, and no marine fauna were sighted
  - if marine fauna is detected in the exclusion zone during poor, visibility, operations must cease until visibility improves to enable full visual monitoring of the management zones.
- Monitor and log the occurrence of present, sick, injured and dead fauna within the development envelope.

Vessel approach distances

A suitably trained MFO (see below) must maintain a watch for cetaceans (i.e., whales and dolphins) and marine turtles during transit of the barge and tug. If any of these organisms are sighted within 300 m the tug and barge maximum vessel speed must be limited to 5 knots (See Section below and Table B-1).

The distances have considered the Australian National Guidelines for Whale and Dolphin Watching (DoEE 2017) and the National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (CoA 2017) (Table 14). During transit for the dredge and barge the trained MFOs will maintain watch to out for marine fauna.

The speed limit within the proposal area is already below 6 knots and therefore consistent with vessel speed restriction for marine fauna of 6 knots. Caution zones cannot be entered into by a vessel if the animal is injured, stranded, entangled, or distressed or if a single calf or pod of calves are present. No more than three vessels are permitted to be in a caution zone at the same time. Should a travelling dolphin enter the no approach zone, including with an attempt to 'bow ride', the vessel shall either maintain its course and speed, or maintain its course and gradually slow down.

Table B- 1: Vessel approach distances (DoEE 2017)

Marine fauna group	Caution zone	No approach zone (metres)	Distress/disturbance
Adult whales	300	100 m to the side of the whale 300 m in front or to rear of the whale	Withdraw from caution zone at speed less than 6 knots
Whale calf* present	-	300 m	Withdraw from No approach zone at speed less than 6 knots
Adult dolphins	150	50 m to the side of the dolphin 150 m in front or to rear of the dolphin with the exception of animals bow-riding	Withdraw from caution zone at speed less than 6 knots
Dolphin calf* present	-	150 m	Withdraw from No approach zone at speed less than 6 knots
**A calf is defined as half the length of the mother/nearest adult*			

Trained Marine Fauna Observer training and qualifications

Trained MFOs are crew members trained in marine fauna species observations and mitigation measures, consistent with the proposal environmental management plans. Trained MFOs will be on duty on proposal vessel during dredging. There will be always at least one Trained MFO on duty during dredging.

All vessel crews engaged for the marine construction and operations of the proposal will attend a minimum of one marine fauna induction to become familiar with the range of conservation significant marine fauna that could be present in the proposal area and the risks the dredging may present to this fauna. All commitments made by the Proponent to manage dredging activity with conservation significant marine fauna will be included in the induction. The content of the induction will be updated as required to ensure it remains current and reflects the marine fauna being observed in the proposal area and any vessel interactions with marine fauna that has occurred. This marine fauna induction can be combined with other crew inductions that may be required. Evidence of personnel and training certificates will be kept on record, which may be used in future audits. Information will include:

- MFO name and contact details
- Details of MFO training.

B.3.2. Frequency

Marine fauna observations shall be undertaken for the duration of dredging and disposal activities.

B.3.3. Location

Appropriate monitoring locations shall be selected by the MFO prior to the commencement of a dredging activities to ensure an unobstructed view of the exclusion zones describe above.

B.3.4. Records & Reporting

Field log

Trained MFOs will use pre-designed datasheets to record observer effort, fauna observations and mitigation measures. They will be based on those developed by the Australian Government to record marine fauna sightings made during seismic surveys. Datasheets will include:

- Location, date and start time of survey
- Name, qualifications and experience of MFOs involved in the survey
- Location, times and reasons when observations were hampered by poor sighting conditions
- Location and time of start-up delays, power downs, or stop work procedures as a result of marine fauna sightings
- Location, time and distance of any fauna sightings including species where possible.

Reportable incidents

All contractor employees shall immediately report all environmental incidents as a non-conformance (i.e. performance indicators are not met or management actions are not followed (See Section 2; Table 5) to the site supervisor who will investigate the incident with both the RIA Project Manager and Contractor Project Manager.

Reportable incidences are injury to wildlife as a result of the proposal activities or general observations of injured wildlife not related to proposal activities to be reported to Subcon PM. The PM is to notify RIA, who will notify the Department of Biodiversity Conservation and Attractions (DBCA).

It is a requirement that all incidents follow a contractor's Incident Management Procedure. The employee is to report the incident immediately to the site supervisor. In every case the site supervisor is to document the incident using RIA's Incident Management System (Appendix C).

Completion report

On completion of the program, a full report will be submitted which will allow compliance auditing. A log detailing marine fauna sightings and activities will also be maintained on all vessels.

All employees of RIA and Contractor shall immediately report all environmental incidents as a non-conformance (i.e., performance indicators are not met or management actions are not followed) to the Contractor site supervisor who will investigate the incident with both the Contractor Project Manager (PM) and RIA Project Manager.

Reportable incidences are injury to wildlife as a result of the proposal activities or general observations of injured wildlife not related to proposal activities to be reported to Contractor PM. The PM is to notify RIA who will notify the Department of Biodiversity Conservation and Attractions (DBCA) within 48 hours.

It is a requirement that all incidents follow the prepared incident Management Procedure by the Contractor. The employee is to report the incident immediately to the site supervisor. In every case the site supervisor is to document the incident using notify RIA Incident Management System.

REPORT

Appendix P
Construction Environmental Management Plan (CEMP) Rottnest Island Authority – South Thomson Barge Landing Development (Emerge Associates 2024)

Construction Environmental Management Plan (CEMP)

Rottnest Island Authority - South Thomson Barge Landing Development

Project No: EP24-014(01)

Prepared for Rottnest Island Authority
August 2024

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	Changes as per client review				

Acknowledgement Of Country

We acknowledge the traditional custodians of country in all of the regions in which we work. We recognise their continuing connection to land, sea, community and culture. We pay our respects to elders past, present and emerging and recognise their continuing connection to land, sea, culture and community.

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Executive Summary

This Construction Environmental Management Plan (CEMP) has been prepared to outline Rottnest Island Authorities (RIA) (the proponent) approach to managing environmental impacts throughout the construction phase of the South Thomson Barge Landing Development in Thomson Bay South, Wadjemup/Rottnest Island ('the proposal') as per **Table 1** below.

Table 1: Summary and purpose of this CEMP

Proponent Name	Rottnest Island Authority (RIA)
Ministerial Statement Number	N/A
Purpose of the CEMP	The purpose of this CEMP is to demonstrate how the potential construction impacts will be avoided, mitigated, monitored and managed, and how environmental outcomes can be achieved. The scope of this CEMP includes the relevant terrestrial, coastal and non-dredging marine related impacts. A separate Dredging Environmental Monitoring and Management Plan (DEMMP) will be developed to focus on the impacts and management related to dredging activities during construction. The CEMP outlines the management actions, management targets, monitoring and contingency actions relating to the construction of the proposal, to comply with the relevant environmental legislation. The objective of this CEMP is to ensure best practice and/or appropriate environmental management practices are applied throughout the proposal. In addition, this CEMP describes how the proponent will minimise the environmental risks and achieve the environmental objectives of the key environmental factors as relevant to the proposal.
Key environmental factor/s, outcome/s and/or objectives	This CEMP has been developed with relevant information and management strategies for key environmental issues relating to the following: • **Benthic Communities and Habitat**: Minimisation of benthic habitat disturbance during construction. • **Marine Environmental Quality**: Minimisation of disturbance and management of impacts to water quality during construction. • **Marine Fauna**: Minimisation of disturbance and management of impacts through avoidance of direct impact on conservation significant species. • **Flora and Vegetation**: Minimisation of disturbance and management of impacts through avoidance of direct impact on conservation significant species. • **Terrestrial Fauna**: Minimisation of disturbance to fauna habitat and management of activities to prevent direct impact on native fauna during construction. • **Social Surroundings**: Limit impact on Aboriginal cultural heritage and social surroundings including noise, dust, visual intrusion, and ensure local amenity is protected and public safety measures are undertaken.
Condition clauses	N/A
Key components in the CEMP	The key provisions in this management plan are detailed in **Section 2**. These include objective based actions to be applied at relevant stages of the proposal.
Proposed construction date	Indicatively construction would take place from 2026 to 2027.
EMP required pre-construction?	Yes

Table of Contents

1 Context, scope and rationale 1

1.1 Proposal 1
1.2 Scope and purpose 4
1.3 Key environmental factors 4
1.4 Condition requirements 7
1.5 Rationale and approach 7
1.5.1 Survey and study findings 7
1.5.2 Key assumptions and uncertainties 11
1.5.3 Management approach 11
1.5.4 Rationale for choice of provisions 11

2 CEMP components 13

2.1 Overview 13
2.2 Benthic communities and habitats 13
2.2.1 EPA objective 13
2.2.2 Key impacts and risks 13
2.2.3 Environmental protection outcomes 13
2.2.4 Proposed provisions 14
2.3 Marine environmental quality 15
2.3.1 EPA objective 15
2.3.2 Key impacts and risks 15
2.3.3 Environmental protection outcomes 15
2.3.4 Proposed provisions 16
2.4 Marine fauna 18
2.4.1 EPA objective 18
2.4.2 Key impacts and risks 18
2.4.3 Environmental protection outcomes 18
2.4.4 Proposed provisions 19
2.5 Flora and vegetation 23
2.5.1 EPA objective 23
2.5.2 Key impact and risks 23
2.5.3 Environmental protection outcomes 23
2.5.4 Proposed provisions 24
2.6 Terrestrial fauna 27
2.6.1 EPA objective 27
2.6.2 Key impacts and risks 27
2.6.3 Environmental protection outcomes 27
2.6.4 Proposed provisions 28
2.7 Social Surroundings 30
2.7.1 EPA Objective 30
2.7.2 Key impacts and risks 30
2.7.3 Environmental protection outcomes 30
2.7.4 Proposed Provisions 31

3 Adaptive management 34

3.1 Overview 34
3.2 Environmental monitoring and corrective actions 34
3.3 Audits 34
3.4 Management plan review 34

4 Stakeholder Consultation 35

4.1 Key Stakeholders 35
4.2 Stakeholder consultation undertaken to date 35
4.3 Ongoing stakeholder consultation 35

5 References 41

5.1 General references 41

List of Tables

Table 1: Summary and purpose of this CEMP ii
Table 2: Key environmental factors and values relevant to the construction phase of the proposal 5
Table 3: Key studies and findings 7
Table 4: Benthic communities and habitats – Provisions 14
Table 5: Marine environmental quality – Provisions 16
Table 6: Marine fauna – Provisions 19
Table 7: Flora and Vegetation – Provisions 24
Table 8: Terrestrial Fauna – Provisions 28
Table 9: Social Surroundings – Provisions 31
Table 10: Key Stakeholders 35
Table 11: Summary of stakeholder engagement outcomes 36

Figures

Figure 1 Overview of the proposal

Appendices

Appendix A

Marine Fauna Provisions (O2 Marine)

Abbreviation Tables

Table A1: Abbreviations – Organisations

Organisations	
DBCA	Department of Biodiversity, Conservation and Attractions
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DWER	Department of Water and Environmental Regulation
DPLH	Department of Planning, Lands and Heritage
RIA	Rottnest Island Authority

Table A2: Abbreviations – General terms

General terms	
ACH	Aboriginal Cultural Heritage
BCH	Benthic Communities and Habitats
CEMP	Construction Environmental Management Plan
DEMMP	Dredging Environmental Monitoring and Management Plan
OEMP	Operational Environmental Management Plan
PMST	Protected Matters Search Tool
PFOS	Perfluorooctane sulfonate

Table A3: Abbreviations – units of measurement

Units of measurement	
EPO	Environmental protection outcome
ha	hectare
km	kilometre
m AHD	metres in relation to the Australian Height Datum
NTU	Nephelometric Turbidity Unit
ZoHI	Zone of High Impact
ZoMI	Zone of Moderate Impact
ZOI	Zone of Influence

Table A4: Abbreviations –Legislation or standards

Legislation	
AH Act	*Aboriginal Heritage Act 1972*
BC Act	*Biodiversity Conservation Act 2016*
EP Act	*Environmental Protection Act 1986*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*

1 Context, scope and rationale

1.1 Proposal

The Rottnest Island Authority (RIA) is proposing to upgrade the former Army Groyne in Thomson Bay South, Wadjemup/Rottnest Island to facilitate the relocation of commercial barging operations away from the main jetty in Wadjemup/Rottnest Island. The main jetty is experiencing significant pressures due to increasing demand for commercial services with current commercial landing and storage facilities located in close proximity of recreational visitors. The RIA identified the need to relocate commercial operations away from the main jetty initially in the 20-year master plan for Rottnest Island (RIA 2019), and more recently in the Rottnest Island Management Plan (RIMP) 2023-28 (RIA 2023). The upgrade of the former Army Groyne known as the South Thomson Barge Landing Development (herein referred to as 'the proposal') will reduce public safety risks and improve the overall visitor arrival experience.

The proposal comprises a barge landing area, breakwater and groyne constructed from limestone boulders, with seabed spoil from associated dredging operations used as infill. The proposal will be delivered in two stages namely, Stage 1 which involves the maritime infrastructure and Stage 2 which involves the onshore infrastructure and ferry berth.

Key activities involved in the Stage 1 works include:

- **Mobilisation and setup:** installation of site sheds and preparation of laydown areas. This includes mechanical clearing of vegetation and cut and fill/ leveling of adjacent dune.
- **Dredging:** An estimated 14,000 m3 of sand and 2,017 m3 of rock will be dredged. A backhoe dredge (BHD) will be utilised to carry out mechanical processes required to loosen and cut in situ materials as per dredging processes.
- **Reclamation**: A laydown area shall incorporate reclaimed dredged fill material. Bunding will be constructed along the eastern and northern sides of the reclamation zone to allow dredge spoil to settle and remain in place. The bunding is to prevent dredge spoil from being washed away into the marine environment by waves or during high tides.
- **Construction**: On completion of the reclamation works, construction and upgrade of Army groyne will take place, in addition to maritime infrastructure works which will include piling (Barge landing ramp), underground services infrastructure (electrical, water, fuel), road works, storage shed, and finally a demobilisation process which will ensure any debris on the seabed has been removed.

Key activities involved in the Stage 2 works include:

- **Ferry berth**: includes the installation of piles, precast concrete deck and surface, and the installation of the wharf with fenders, fender chains, mooring bollards, signage, lighting and other relevant marine infrastructure.
- **Small craft landing works**: includes installation of piles, abutment, floating deck units and navigational aids.
- **Storage building installation:** installation of storage building.

Indicatively construction would take place from 2026 to 2027. It is anticipated that works will be undertaken within daylight hours only.

The Development Envelope (DE) as shown in **Figure 1** comprises the total marine and onshore areas required to implement the proposal including the adjacent foreshore up to the intersection of Army Jetty Road and Parker Point Road.

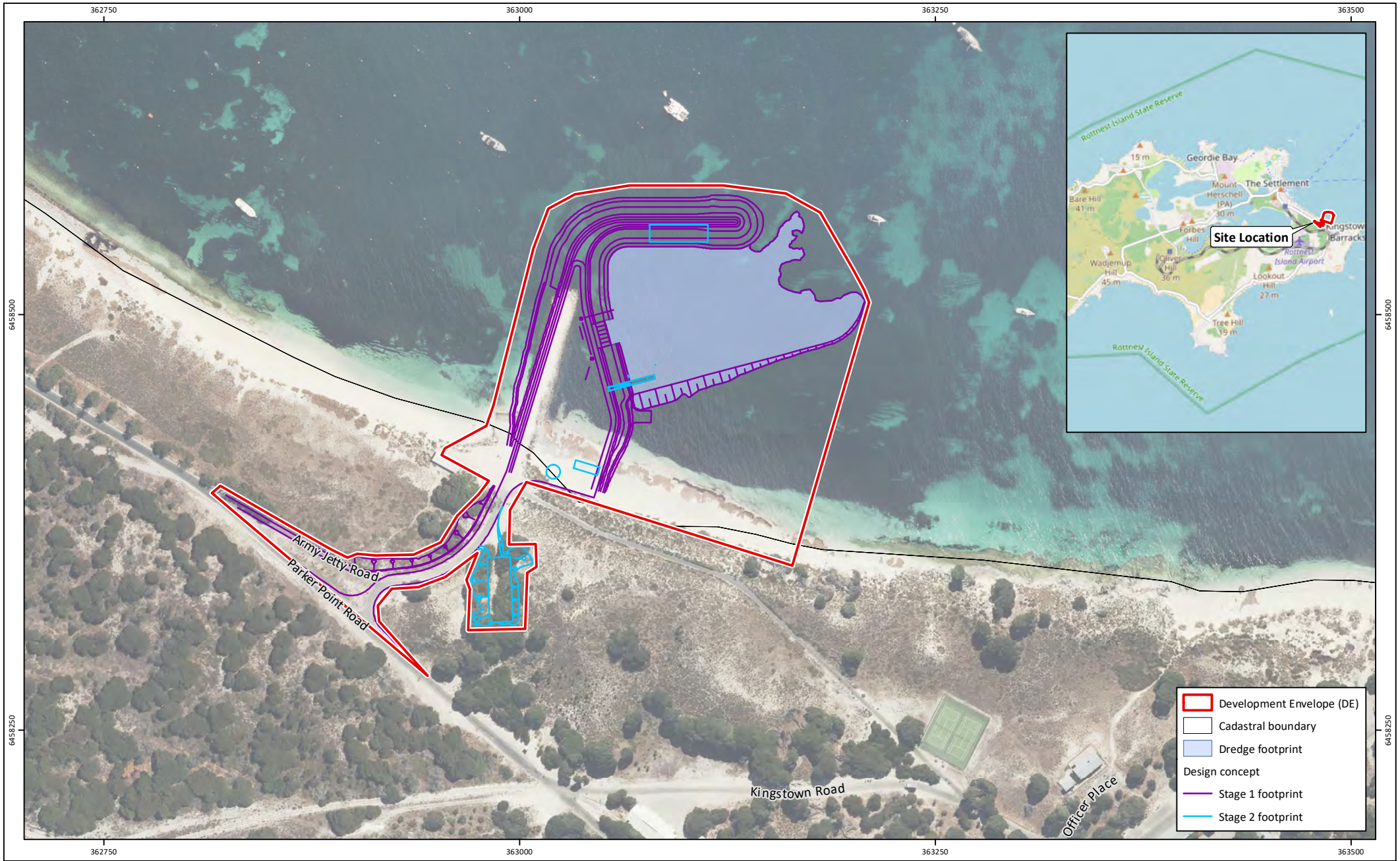

Figure 1: Project Overview

Project: Construction Environmental Management Plan
South Thomson Barge Landing Development

Client: Rottnest Island Authority

Plan Number:
EP24-014(01)--F01a

Drawn:	CTH
Date:	18/07/2024
Checked:	SPL
Approved:	LE
Date:	30/07/2024

N

0 50 100
Metres

Scale: 1:3,000@A4

GDA2020 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used
©Landgate (2024).

1.2 Scope and purpose

This Construction Environmental Management Plan (CEMP) will support environmental referrals to satisfy the Western Australian Environmental Protection Authority (EPA) that the RIA can adequately manage construction related environmental impacts of the proposal so that any residual impacts on the environment are acceptable.

The purpose of this CEMP is to demonstrate how the potential construction impacts will be avoided, mitigated, monitored and managed, and how environmental outcomes can be achieved. The scope of this CEMP includes the relevant terrestrial, coastal and non-dredging marine related impacts. A separate Dredging Environmental Monitoring and Management Plan (DEMMP) will be developed to focus on the impacts and management related to dredging activities during construction.

This CEMP has been prepared in accordance with Western Australian Environmental Protection Authority (EPA) *Instructions – Preparing Environmental Protection Act 1986 PIV Environmental Management Plans* (EPA 2021) and is subject to approval by the EPA for implementation. The Contractor appointed by the RIA will incorporate the approved management framework into the Contractors CEMP prior to construction. The Contractors CEMP will include site specific actions and more detailed instructions on the day-to-day management specific to their individual work package and will align with the intent and proposed management measures outlined in this overarching CEMP.

Associated documents to be read in conjunction with this CEMP include:

- **Dredging Environmental Management and Monitoring Plan (DEMMP)** (O2 Marine 2024) describes how dredging and dredging related activities will be managed for the proposal.
- **Operational Environmental Management Plan (OEMP)** (Emerge & O2 Marine 2024) describes how potential impacts to environmental factors from the proposal operational activities will be managed.

1.3 Key environmental factors

The referral documentation identifies the key EPA environmental factors as relevant to the construction phase of the proposal to include:

- Benthic communities and habitats
- Marine environmental quality
- Marine fauna
- Flora and vegetation
- Terrestrial fauna
- Social surroundings

Table 2 outlines the environmental values for each of the key environmental factors and describes the construction activities that would affect each of these factors.

Table 2: Key environmental factors and values relevant to the construction phase of the proposal

Key environmental factor	Proposal activities	Environmental values
Benthic communities and habitats (BCH)	• Construction of the breakwater and laydown area, including reclamation works.	• There are dense healthy seagrass meadows and macroalgae communities within the proposal DE and surrounding the Island.
Marine environmental quality	• Construction of the breakwater and laydown, including reclamation works and piling works.	• Wadjemup/Rottnest Island waters have been assigned a "High" indicative level of ecological protection, in accordance with Table 3 of the EPA's MEQ Technical Guidance (EPA 2016) which requires all environmental values to be protected which are: o Ecosystem health – protecting the quality of water, sediment and biota within the area. o Fishing and aquaculture – ensuring seafood is safe for eating. o Recreation and aesthetics – the area is valued for its marine recreation and tourism. o Industrial water supply – not applicable to proposal. o Cultural and spiritual values – the area is culturally important to Western Australians, including the local Noongar communities.
Marine fauna	• Construction of the breakwater and laydown, including reclamation works and piling works.	• The Protected Matters Search Tool (PMST) search identified 43 threatened fauna species within a 5 km radius of the proposal area, though Wadjemup is home to a large diversity of fauna including those not threatened. • Recreation and aesthetics – marine fauna species in the area may include commercially and recreationally important species.
Flora and vegetation	• Clearing of native vegetation. • Construction works including excavation, soil disturbance, compaction, movement, and stockpiling. • Construction of permanent infrastructure and alteration of landscape. • Operation and movement of plant, machinery, and vehicles during construction (including generation of dust and noise emissions). • Discharge of water for the purpose of dust suppression where and when required. • Installation of site sheds and preparation of laydown areas A and B. The preparation of laydown area B will require mechanical clearing of vegetation and cut and fill of the adjacent dune to level this area. • Erection of site signage and mobilisation of equipment.	• The condition of the vegetation across the proposal area is largely good, with some mixed patches of degraded vegetation. One vegetation unit (MlAp*Td) is considered to be representative of the State-listed Threated Ecological Community (TEC) *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands of the Swan Coastal Plain and is considered to be of State significance. This vegetation unit is also representative of a pre-European vegetation association and/or complex that has less than 30% of the original extent remaining and is therefore considered regionally significant.

Table 2: Key environmental factors and values relevant to the construction phase of the proposal (continued)

Key environmental factor	Proposal activities	Environmental values
Terrestrial fauna	• Clearing of native vegetation. • Construction works including excavation, soil disturbance, compaction, movement, and stockpiling. • Construction of permanent infrastructure and alteration of landscape. • Operation and movement of plant machinery and vehicles during construction (including generation of dust and noise emissions). • Discharge of water for the purpose of dust suppression where and when required.	• A total of 76 conservation significant fauna species were identified as having a likelihood of occurrence within the site. • One conservation significant fauna species was recorded within the proposal area, the Quokka (*Kwoka; Setonix brachyurus*), listed as Vulnerable (VU) under the EPBC Act and BC Act • Four fauna species are considered as having the Potential to occur within the proposal area including: o *Pandion haliaetus* (Osprey; listed as MI under the EPBC Act and BC Act). o *Tiliqua rugosa konowi* (Rottnest Island bobtail; listed as VU under the BC Act). o *Lerista lineata* (Perth slider; listed as Priority [P] 3 by DBCA); and o *Pseudonaja affinis exilis* (Rottnest Island dugite; listed as P4 by DBCA). • Two fauna habitat types were recorded within the proposal area.
Social surroundings	• Clearing of native vegetation and works including excavation, soil disturbance, compaction, movement, and stockpiling. • Dredging of 14,000 m3 of sand and 2,017 m3 of rock • Operation and movement of plant machinery and vehicles during construction (including generation of dust and noise emissions). • Removal and relocation of vessel moorings.	• Local community, visitors and tourists utilise the area, including recreational boaters who hold existing moorings within the vicinity of the Army Groyne. • The site contains cultural, spiritual and heritage values associated with the broader cultural indigenous significance with Wadjemup/ Rottnest Island, and the historical heritage value of the Army Groyne.

1.4 Condition requirements

The template for the *Environmental Protection Act 1986 Part IV – Environmental Management Plans* requires a table be provided of the Ministerial Statement conditions (including any environmental objectives / outcomes), if applicable, and in which section of the environmental management plan (EMP) they are addressed.

This CEMP will support environmental referrals as described in **Section 1.2** and therefore does not currently have Ministerial Statement conditions however, the Contractor will develop a more detailed and site specific CEMP for the proposal once engaged by the RIA.

1.5 Rationale and approach

This CEMP addresses potential impacts to the key environmental factors determined as being relevant to the construction aspects of the proposal. The results of the baseline environmental assessments and associated assumptions and uncertainties have informed the approach for meeting the management provisions outlined in **Section 2**. The identified targets, actions and proposed monitoring and reporting approach are aligned with the overall management approach, designed to ensure that the environmental objectives for each key environmental factor can be met.

1.5.1 Survey and study findings

Table 3 below summarises the key studies and surveys that have been undertaken for the proposal.

Table 3: Key studies and findings

Study / survey	Key findings
Environmental Advisory Report – Repair and extension of former Army Jetty, Rottnest Island (RPS 2019)	The Environmental Advisory Report was prepared by RPS to assess the proposal scenarios, identify the key environmental values / impacts, provide approvals advice/ strategy, and recommend controls. The key findings of the report include: • The vegetation within the survey area does not comprise a high level of biological diversity. Species richness of the vegetation sampled is relatively low. Survey determined None of the vegetation represents state or Commonwealth Threatened and Priority Ecological Communities (TEC/PEC). • Terrestrial habitat not expected to home conservation significant fauna species, • Aboriginal heritage significance within the area. Marine heritage 'Uribes' site sits within shallow water nearby to the jetty. • Benthic communities - predominately seagrass, support habitat for marine fauna • The proposal poses a range of potential impacts including: o direct loss of seagrass impacting benthic communities and habitats, o creation of dredge plumes affecting marine environmental quality o alteration of coastal processes including changes in wave and current patterns o potential contamination from dredging o loss of terrestrial vegetation o potential impacts on both marine and terrestrial fauna due to habitat disturbance o potential impacts on social surroundings such as vessel movement, moorings, and recreational activities • Given estimated seagrass loses and the high level of public interest around any development on Rottnest Island, the proposal is being referred to the EPA under Section 38 of the EP Act.

Table 3: Key studies and findings (continued)

Study / survey	Key findings
Sampling and Analysis Plan (SAP) Implementation Report – Rottnest Island Army Jetty Dredging (RPS 2020)	• SAP investigations undertaken determined that all results were reported below relevant default guideline values, and the sediments are not considered to pose a significant risk during dredging. • Only one sediment is classified as Potential Acid Sulfate Soils (PASS) based upon DWER guidelines, however the Acid Neutralizing capacity (ANC), is not included, with only inorganic acidity detected. The SAP determined that lime treatment of the material is not required when the sediment is disturbed and used for reclamation activities. The ANC is sufficiently kinetically available to safeguard against acidification over the long term. • Perfluorooctane sulfonate (PFOS) concentrations were observed within a PFOS elutriate analysis and in the surface water at the site, indicating the presence of low level PFOS within the existing environment. Only very low concentrations of PFOS were observed in sediments/ elutriates and given the low concentrations, it is expected that the concentrations would be diluted quickly within the marine environment during the works. As a result, there is not considered to be any risk to receptors from PFAS during dredging and therefore no specific management requirements are considered necessary.
Flora and Vegetation Survey South Thomson and Kingstown Rottnest Island (Wadjemup) (Focused Vision 2023)	Survey within the broader area identified: • No Threatened flora listed under the *Biodiversity Conservation Act 2016* (BC Act) or the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) were recorded. • No Priority species listed by the Department of Biodiversity, Conservation and Attractions (DBCA) were recorded. • No weeds listed as Weeds of National Significance (WoNS) or Declared Pest (DP) plants under the *Biosecurity and Agriculture Management Act 2007* (BAM Act) were recorded. • The condition of the vegetation was found to range from 'Excellent' to 'Completely Degraded' with the greatest proportion in 'Good' and 'Degraded' condition. • Nine vegetation units and four other classifications (Beach, Planted, Open Water and Cleared areas) were defined and mapped within the survey area. • Two of the recorded vegetation units were determined to be characteristic of the State-listed *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands, Swan Coastal Plain Threatened Ecological Community (TEC) (*Callitris preissii - Melaleuca lanceolata forests and woodlands TEC*). • The remaining extent of the one vegetation association (vegetation association 125) supported by the survey area falls below the 10% retention target in the context of the Swan Coastal Plain, and two vegetation associations relevant to the survey area represented by less than 30% of pre-European extent across the Swan Coastal Plain and Perth IBRA sub-region. • Vegetation units MlAp and CpMl are considered to be representative of the State-listed *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands TEC (FCT 30a), and therefore, these units are considered to be of State significance. • Rottnest Island (Wadjemup) is an A Class Reserve and an ESA, therefore all vegetation it supports is considered to be of State and regional significance. • Vegetation is representative of pre-European vegetation associations and/or complexes that have less than 30% of their original extent remaining and are therefore considered regionally significant.
South Thomson Barge Landing Development Marine Fauna and Benthic Habitat Assessment (RPS 2023)	• The BCH assessment identified seagrass and macroalgae species along with bare substrate within the proposal DE. A wider Local Assessment Unit was also assessed where similar habitat were also identified, along with limestone reef/pavement outside the DE. A list of species that may occur within the DE was collated and included 41 threatened marine fauna species and 92 listed marine or migratory marine fauna species that may occur in Thomson Bay. Key species for monitoring and management were not identified.

Table 3: Key studies and findings (continued)

Study / survey	Key findings
Matters of National Environmental Significance Assessment Report – South Thomson Bay Maritime Facilities Redevelopment, Rottnest Island (RPS 2023)	• The PMST search (10km radius) identified the potential for the following MNES to occur within the proposal footprint: o Commonwealth marine area o Listed threatened species (10km radius): Flora- dwarf bee orchid (*Diuris micrantha*), 43 threatened fauna species (primarily bird species). o Listed migratory species (10km radius): 102 migratory species, predominately bird species. • As identified in the report potential impacts on MNES include[1]: o Potential impacts of up to 3.48 ha of terrestrial vegetation comprising habitat for quokka (vulnerable). o Potential impacts of up to 1.68 ha of benthic habitats which may provide habitat for listed threatened marine species. o Introduction of invasive marine species during the operation of the proposal • It should be noted that the disturbance impact area has changed since the initial MNES report investigation. • Activities during construction may have an impact on the behaviour of migratory species in the area. The severity of these impacts would only be significant if piling is proposed. • The MNES assessment did not identify any significant impacts to MNES within the offshore proposal footprint and it is unlikely that an EPBC referral will be required. However, if future site investigations or changes to proposal design result in the following impacts, then an EPBC referral would be required.
South Thomson Barge Redevelopment Flora and Vegetation Survey (RPS 2024)	• Three (3) vegetation units were described to cover the South Thomson Barge Landing Onshore Area, including Vegetation unit MlAp*Td is analogous with the Threated Ecological Community (TEC) *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands of the Swan Coastal Plain. • Vegetation condition assessed as largely Good, mixed with patches of Degraded vegetation. • Seventeen (17) flora species were recorded in the survey area, four of which were introduced. None of these introduced taxa are Declared Organisms (DPIRD, 2023) or Weeds of National Significance (Weeds Australia, 2023). • The proposal proposes impacts to: o 0.17 ha of vegetation type ApAf*Td in Good to Degraded Condition. o 0.23 ha of vegetation type MlAp*Td in Degraded to Good Condition. This vegetation unit is analogous with the Threated Ecological Community (TEC) *Callitris preissii* (or *Melaleuca lanceolata)* forests and woodlands of the Swan Coastal Plain. o 0.06 ha of vegetation type Sc*TdSl in Good to Degraded Condition.
Rottnest Island Basic Fauna Survey (Eco Logical Australia 2024)	• A total of 76 conservation significant fauna species were identified as having a likelihood of occurrence within the site. • One conservation significant fauna species was recorded within the survey area, the Quokka (*Kwoka; Setonix brachyurus*), listed as Vulnerable (VU) under the EPBC Act and BC Act • Four fauna species are considered as having the Potential to occur within the survey area including: o *Pandion haliaetus* (Osprey; listed as MI under the EPBC Act and BC Act). o *Tiliqua rugosa konowi* (Rottnest Island bobtail; listed as VU under the BC Act). o *Lerista lineata* (Perth slider; listed as Priority [P] 3 by DBCA); and

[1] Noting the disturbance areas referenced in the MNES Report have now changed given changes to the DE. Correct values are reported in **Section 2** of this CEMP.

Table 3: Key studies and findings (continued)

Study / survey	Key findings
(continued from above)	o *Pseudonaja affinis exilis* (Rottnest Island dugite; listed as P4 by DBCA). • Two fauna habitat types were recorded within the survey area.
Coastal Processes Assessment (Baird 2024)	• Wave assessment – the dominant wave conditions at the proposal location were identified to be from the north and north-east, which would be reduced by the proposed construction to allow for safe berthing of the barges. • Sediment transport assessment – sediment transport and the shoreline has already adapted to the existing structures, and the additional proposed construction was not considered to have a significant impact to the current conditions. • Wrack accumulation (build of material) – it was considered that the proposal will not have a significant impact on the timing or volume of wrack accumulation across the beaches of Thomson Bay.
South Thomson Barge Landing Development Project - Underwater Acoustic Assessment (Tetra Tech 2024)	An underwater noise assessment was undertaken for the proposed barge facility. Two noise generating methods were implemented - Impact pile driving and Vibratory pile driving, with the findings as below: • Impact pile driving involves a weighted hammer that pile drives foundations into the sea floor. The largest distance was modelled to be 84 meters corresponding to 160 dB for a marine mammal. Distance to threshold values were low. For fish injury/ behavioural onset the largest distance was modelled to be 348 meters corresponding to the 150 dB marine mammal behavioural criterion without mitigation for the impact installation of the 24-inch pile diameter. There were no associated distances for Sea turtle injury and behavioural onset because the thresholds are greater than the source level. • Vibratory pile driving involves rotating eccentric weights on shafts. The largest distance was modelled to be 167 meters corresponding to 120dB for marine mammal injury/ behavioural onset. For fish behavioural onset results, the largest distance of 21 meters occurred for unmitigated distance to the 183 dB acoustic threshold for the vibratory installation of the 24-inch pile diameter. There were no associated distances for Sea turtle injury and behavioural onset because the thresholds are greater than the source level.
Rottnest Barge Facility - Acoustic Assessment (Herring Storer Acoustics 2024)	A land noise assessment was undertaken for the land-based activities of the existing Rottnest barge facility. The findings include: • The main source of noise emissions come from forklift and truck movements as well as noise from settling containers down during the loading and unloading phases. o Forklift movement: 92 dB o Truck movement: 94 dB o Container set down noise: 101 dB • It is considered likely that impulsive characteristics would be present only for container set down noise, therefore a +10 dB adjustment is applicable to these noise levels. • During operation and noise emissions from the facility, vehicle movements will need to comply with the regulation levels. • The results indicate that noise emissions from the existing operations at the Rottnest barge facility comply with the criteria set out by the *Environmental Protection (Noise) Regulation 1997* at all times.

1.5.2 Key assumptions and uncertainties

The proposal has been comprehensively surveyed under commissioning by the RIA to ensure confidence in the predicted and identified occurrences of conservation significance species and the vegetation, fauna, and inland characteristics.

The information provided in this CEMP relies on the accuracy and adequacy from the numerous field surveys and methods provided in the investigations. These surveys have been completed in compliance with EPA and Department of Climate Change, Energy, the Environment and Water (DCCEEW) requirements.

It is assumed that the surveys and assessments have adequately:

- Identified the flora, vegetation, fauna, and marine benthic and fauna conservation values present within the DE.
- Mapped and understood respective the local and regional scale of surroundings to ensure potential direct and indirect impacts are accurately determined for the proposal.
- The surveys undertaken to date have accurately reported the distributions and status of conservation significant species.
- Those conditions experienced during the survey and assessments were ideal for recording species appropriately, unless specified otherwise.
- That applicable surveys and assessments have been completed as per relevant technical guidance methodologies.

Key uncertainties include:

- Cumulative impacts to fauna and fauna habitats resulting from Third-Party operations which may be conservative and may not represent the most accurate levels of disturbance.
- The adaptive management processes adopted by this CEMP (**Section 3**) allows for management actions and monitoring to be revised as new information becomes available.

1.5.3 Management approach

This CEMP adopts management provisions to achieve the environmental objectives and environmental performance outcomes (EPO's) for each key environmental factor identified in **Section 1.3**. The following sections of the CEMP have been developed based on the mitigation hierarchy (avoid, minimise, rehabilitate, offset; EPA 2015) and detailed reviews of the various studies and surveys completed for the proposal. The hierarchical approach focuses on avoiding impacts to the key environmental factors. Where impacts are unavoidable, management aims to minimise the duration, intensity and/or extent of impacts on key environmental factors during construction.

1.5.4 Rationale for choice of provisions

This CEMP adopts objective-based provisions established on industry standard practices for avoidance, minimisation, and rehabilitation of environmental impacts during construction.

Outcomes-based provisions were not considered in the management approach for this CEMP due to the short duration of construction works and the early concept phase of the proposal. The relatively short timeframe to construct the proposal are likely to result in minor and temporary impacts which

can be adequately managed, therefore outcome-based provisions are not considered applicable to this phase. In addition, the purpose of this CEMP as described in **Section 1.2**, is to support the environmental referrals and outline the proposed approach to adequately manage construction related environmental impacts of the proposal so that any residual impacts on the environment are acceptable. It is anticipated that once the design progresses to a detailed stage and a contractor has been appointed by the RIA, a more detailed and site specific CEMP will be developed and will align with the intent and proposed management measures outlined in this overarching CEMP.

An objective-based approach has been followed to ensure the risk of secondary or indirect impacts are minimised, typically to the level of 'as low as reasonably practicable' (ALARP). Management actions (safeguards and controls) and performance targets have been assigned to ensure the associated objectives are achieved (**Section 2**). The provisions reflect the duration of construction activities presented in **Section 1** and the nature of impacts posed by construction activities included in **Table 2**.

The choice of management actions and targets are considered to be appropriate to minimise and mitigate identified environmental impacts and ensure effective and efficient environmental management in order to achieve the environmental objectives stated in **Section 2**.

2 CEMP components

2.1 Overview

As the proposal is subject to further environmental approvals, most activity-specific management actions will be identified and detailed in other documents for assessment and approval by the DWER. This section of the CEMP identifies the measures that the RIA will implement to ensure that the defined environmental objectives for each of the key environmental factors are met during construction. Objective-based provisions are provided for each of the key environmental factors including monitoring and reporting requirements.

2.2 Benthic communities and habitats

2.2.1 EPA objective

To protect benthic communities and habitats so that biological diversity and ecological integrity are maintained.

2.2.2 Key impacts and risks

The key impacts and risks related to benthic communities and habitats during construction of the proposal include:

- Direct impacts:
  - Direct loss of 2.06 ha of mixed seagrass habitat within the Development Envelope (calculation including 5 m buffer and dredge footprint) (RPS 2023).
  - Direct loss of 1.26 ha of sand/ sand with wrack habitat within the Development Envelope (calculation including 5 m buffer and dredge footprint) (RPS 2023).

- Indirect impacts:
  - Reduced environmental quality due to temporary decrease in light availability from increased turbidity; increased sedimentation rates or burial; accidental fuel spills.
  - Loss of benthic habitats including a recoverable loss of 3.71 ha within the Zone of Moderate Impact (ZoMI) including temporary loss of 2.62 ha of mixed seagrass and 1.09 ha of sand with wrack.
  - Introduction of invasive marine species that could alter the natural benthic habitat communities. Environmental protection outcomes

2.2.3 Environmental protection outcomes

As per the Environmental Review Document (ERD) (RPS 2024), the EPO's developed for the proposal in relation to benthic communities and habitats include:

- Direct disturbance of BCH from construction activities is confined to the construction footprint.

The EPO's have informed the management targets and actions presented in **Table 4.**

2.2.4 Proposed provisions

Objective-based provisions for benthic communities and habitats are provided in **Table 4**. Dredging will also be undertaken within the proposal DE, and therefore the construction works will be within the identified zones of impact as described in the Dredge Environmental Monitoring and Management Plan (DEMMP) (O2 Marine 2024).

Table 4: Benthic communities and habitats – Provisions

Management Targets	Management Actions	Monitoring	Frequency/ Timing	Reporting	Responsible Party
No detectable impacts to BCH outside the area of direct impact associated with construction	• Piling will be undertaken using vibro-hammering which generates minimal sediment and therefore no suspended sediment should be released to the water column. • Movement of rock armour will be undertaken using methods which minimise sediment suspension. This will also be done concurrently with dredging. • The placement of geofabric (such as Texcel 1200R) textile weave along the bund wall will ensure that the placement of dredge spoil during reclamation works will not impact or increase the dredge plume zones. • All vessels will comply with commonwealth biosecurity requirements and complete DPIRDs 'Vessel check'. All vessels will have a ballast water management plan and ballast water exchanges will be in accordance with IMO requirements and the Commonwealth *Biosecurity Act 2015*	• Monitoring will already be undertaken for dredging and disposal in accordance with the DEMMP (O2 Marine 2024) and this is considered sufficient for the proposal as construction will be within the same Development Envelope • Piling will only require visual plume monitoring for the protection of BCH and MEQ as sediment is unlikely to be suspended into the water column using the methods described.	• Throughout construction activities • Dredging and disposal monitoring will be undertaken in accordance with Appendix B.2 of the DEMMP (O2 Marine 2024)	• As described in Section 6 and Appendix B.2 of the DEMMP (O2 Marine 2024)	• Construction and piling Contractors • RIA

2.3 Marine environmental quality

2.3.1 EPA objective

To maintain the quality of water, sediment and biota so that environmental values are protected.

2.3.2 Key impacts and risks

The key impacts and risks related to marine environmental quality during construction of the proposal include:

- Release of contaminated sediments during dredging within the proposed dredge footprint
- Temporary, localised turbidity increase from dredging, construction of wharf area (including rock dumping and excavation) and piling.
- Accidental hydrocarbon spills into the marine and intertidal environment from construction vessels.
- Release of toxicants or nutrients to the water column due to spills from land-based construction.

2.3.3 Environmental protection outcomes

As per the ERD (RPS 2024), the EPO's developed for the proposal in relation to marine environmental quality include:

- MEQ will be temporarily reduced to a Moderate Level of Ecological Protection during construction but will return to a High Level of Ecological Protection two weeks after completion of dredging and construction activities.
- No reported hydrocarbon spills or release of waste into the marine environment from construction activities.

The EPO's have informed the management targets and actions presented in **Table 5.**

2.3.4 Proposed provisions

Objective-based provisions for marine environmental quality and habitats are provided in **Table 5.**

Table 5: Marine environmental quality – Provisions

Management Targets	Management Actions	Monitoring	Frequency/ Timing	Reporting	Responsible party
No visible resuspension and spread of contaminated sediments associated with construction activities. To maintain marine environmental quality within the area	• Piling will be undertaken using vibro-hammering which generates minimal sediment and therefore no suspended sediment should be released to the water column. • Construction of wharf area (including rock dumping and excavation) will be undertaken using methods which minimise sediment suspension. This will also be done concurrently with dredging. • If a visible plume is identified during piling, then a silt curtain around the piling may be implemented.	• Monitoring will already be undertaken for dredging and disposal in accordance with the DEMMP (O2 Marine 2024) and this is considered sufficient for the proposal as construction will be within the same Development Envelope • Piling will only require visual plume monitoring for the protection of BCH and MEQ as sediment is unlikely to be suspended into the water column using the methods described. Visual monitoring will be undertaken by the construction and piling contractors.	• Water quality monitoring will be undertaken as described in Appendix B.1 of the DEMMP (O2 Marine 2024) • Visual plume monitoring will be undertaken during piling and other construction activities.	• Water quality monitoring will be as described in Section 6 and Appendix B.1 of the DEMMP (O2 Marine 2024) • Piling daily vessel logs by contractor	• Piling and construction Contractors • RIA
No hydrocarbon or chemical spills to the marine environment	• Utilise piling equipment that has no leaks or damage • Implement refuelling in accordance with relevant legislation and supply own fuel. • Implement industry standard hydrocarbon management practices (chemical handling, storage, segregation and spill response)	• Inspections of all piling and construction equipment to check for leaks or damage • Undertake vessel maintenance and bunkering in accordance with piling and construction contractor's vessel management systems	• Prior to the commencement of piling/construction	• Contractor's maintenance log • Report any significant spillage to RIA and MARPOL	• Contractor
Manage waste in compliance with requirements for MWPA and in accordance with MARPOL 73/78	• Any construction vessels including piling vessels/barges to establish a sewage and garbage disposal plan.	• If there is an incident it should be reported to Department of Transport (DoT) within 12 hours or as described within the contractor's plan	• Contractor's plan to be approved one week prior to commencement of dredging and to be	• RIA to approve Contractor plan which will include	• Contractor

Table 5: Marine environmental quality – Provisions (continued)

Management Targets	Management Actions	Monitoring	Frequency/ Timing	Reporting	Responsible party
Convention Annex IV (sewage) and Annex V (garbage).	*(Continued from above)*	*(Continued from above)*	• used throughout construction	reporting requirements. • Report any waste spill to DoT (Ph: 9480 9924)	*(Continued from above)*
Manage waste in accordance with the RIA's Development Planning Guideline No. 3: Sustainable Development (RIA 2022)	• Only a licenced Controlled Waste Carrier to be used for any controlled waste discharged ashore. • All forms of waste need to be stored in appropriately labelled drums or tanks and be correctly disposed of and not discharged to the environment. • Reporting of any type of spillage within the marine environment directly to RIA. • Green waste is to be collected for use on Rottnest Island as mulch, brushing, wood chipping or any other purpose directed by the RIA • Materials from demolition (including dredging) is to be used in new construction and alteration and additions to existing buildings	• Vessel waste management plan/procedures that align to IMO's Guidelines for the Development of Garbage Management Plans (IMO 2012) • Undertaken visual monitoring throughout activities	• Visual monitoring throughout all construction works	• Reporting of any spillage to RIA be undertaken as soon as possible within 24 hours Report any waste spill to DoT (Ph: 9480 9924)	• Contractor

2.4 Marine fauna

2.4.1 EPA objective

To protect marine fauna so that biological diversity and ecological integrity are maintained.

2.4.2 Key impacts and risks

The key impacts and risks related to marine fauna during construction of the proposal include:

- Direct impacts:
  - Injury, death or behavioural change of marine fauna from underwater noise associated with piling.
  - Injury from vessel strike.
  - Injury, death or behavioural change of marine fauna during construction of wharf area (including entrapment during rock dumping for breakwater construction).
  - Light pollution from construction activities.

- Indirect impacts
  - Loss of marine fauna habitat due to direct removal or disturbance of BCH from construction (e.g. breakwater and laydown area).
  - Temporary, localised turbidity increase from dredging and construction of wharf area (including rock dumping and excavation) resulting in behavioural changes to marine fauna (See **Section 2.2 and 2.3**).
  - Hydrocarbon spills causing marine fauna injury or fatalities and/or impact on critical habitat.
  - Entanglement /plastic ingestion from marine debris.
  - Introduction of marine pests from proposal vessels.

2.4.3 Environmental protection outcomes

As per the ERD (RPS 2024), the EPO's developed for the proposal in relation to marine fauna include:

- No irreversible loss of marine fauna habitat outside of the zone of irreversible direct loss (i.e. ZoHI as defined by dredge modelling).
- No reported introduction or establishment of IMS as a result of construction activities associated with the proposal.
- No reported impacts to marine fauna as a result of hydrocarbon spill or release of waste associated with construction activities including entanglement or ingestion of waste.
- No reported death or injury to marine fauna from vessel strike associated with piling activities.
- No reported death, injury or behavioural change to marine fauna as a result of underwater noise associated with construction activities.
- No reported negative impacts on marine fauna attributable to the construction lighting requirements of the proposal.

The EPO's have informed the management targets and actions presented in **Table 6.**

2.4.4 Proposed provisions

Objective-based provisions for marine fauna are provided in **Table 6**.

Table 6: Marine fauna – Provisions

Management Targets	Management Actions	Monitoring	Frequency/ Timing	Reporting	Responsible party
No loss of marine fauna habitat outside of the construction area	• Construction will be undertaken within the construction footprint only • Silt curtains will be implemented if piling is producing a visible plume	• Undertake monitoring for BCH in accordance with Section 2.2	• Throughout marine construction works	• In accordance with the BCH and marine water quality monitoring requirements in the DEMMP (O2 Marine 2024)	• RIA
No introduction, establishment or movement of marine pests	• WA DPIRD's 'Vessel Check' risk assessment (https://vesselcheck.fish.wa.gov.au) submitted to RIA (including supporting documentation) for all dredging and support vessels (i.e., piling vessel and barges) that mobilise from interstate or international waters. Risk assessment must indicate that the vessel poses a low risk of IMP to the proposal DE. • All vessels will have a ballast water management plan and ballast water exchanges will be in accordance with IMO requirements and the Commonwealth Biosecurity Act 2015.	• 'Vessel Check' risk assessment report (including supporting documentation).	• Prior to vessel(s) entering the Proposal area	• Notify RIA and DPIRD of the introduction of IMPs is suspected in accordance with existing procedures under the collaborative State-Wide Array Surveillance Program (SWASP) (DPIRD 2019) • Notify RIA and DPIRD of the introduction of IMPs within 12 hours (1800 815 507) • If pest is identified record location, date and time, size, colour, water depth, environment (e.g. beach, sand etc), and take a photo)	• Vessel contractors

Table 6: Marine fauna – Provisions (continued)

Management Targets	Management Actions	Monitoring	Frequency/ Timing	Reporting	Responsible party
Manage vessel bunkering, chemical storage spill response, and debris to ensure no adverse impacts to the marine environment.	• Implement industry standard hydrocarbon management practices (chemical handling, storage, segregation, and spill response) • Any construction vessels including piling vessels/barges to establish a sewage and garbage disposal plan • Undertake vessel maintenance and bunkering in accordance with contractors approved vessel management systems. Hydrocarbon spills into the marine environment be immediately reported to Department of Transport's Maritime Environmental Emergency Response (MEER) unit (ph. 9480 9924).	• Approval certification and tracking forms to be completed as soon as possible • Vessel waste management plan/procedures that align to IMO's Guidelines for the Development of Garbage Management Plans (IMO 2012) • Inspections of all dredge equipment to check for leaks or damage • Undertake vessel maintenance and bunkering in accordance with dredging contractor's vessel management systems	• Throughout all construction works Full duration of construction	• Reporting of any spillage to RIA and the following departments be undertaken as soon as possible within 24 hours o Oil spill: POLREP/MEER (Ph: 9480 9924) • Waste spill: DoT (P: 9480 9924)	• Contractor
No death or injury from vessel strike	• Speed limit restricted to 5 knots in Proposal area • At least 1 trained MFO on all Proposal vessels when in transit (Section A.3 of Appendix A) • Apply vessel approach distances (Table 3A of Appendix A) o The No Approach Zone is the area directly in front and behind fauna where boats should not enter (cut in front of fauna or follow fauna) and are a zone of total vessel exclusion o The Caution Zone is the area surrounding fauna in all directions where vessel speeds are limited to no more than 6 knots – noting the Proposal areas speed limit is 5 knots. • Should a travelling dolphin enter the No Approach Zone, including bow riding the vessel shall either maintain its course and speed, or maintain its course and gradually slow down.	• Trained MFO will be on duty (Section A.3 of Appendix A) on Project vessels during construction and may have other vessel duties.	• When vessel is in transit	• Section A.3 of Appendix A	• Vessel Contractor

Table 6: Marine fauna – Provisions (continued)

Management Targets	Management Actions	Monitoring	Frequency/ Timing	Reporting	Responsible party
No injury or death of marine fauna associated with piling. No behavioural change, injury or death of marine fauna from underwater noise	• Piling will be undertaken using vibro-hammering which produces continuous (non-impulsive) noise reducing noise exposure, where possible, if vibro piling meets refusal then impact hammer piling will be used. Marine fauna management zones (Appendix A.2) are based off a conservative approach and will be sufficient for mitigating underwater noise for both vibro-hammering and impact hammer piling. • Implement Appendix A. Marine Fauna Provisions o Pre-start, soft-start, shut-down and low-visibility requirements (Section A.2 of Appendix A) o Piling to be completed during daylight hours only. o Piling to be undertaken outside key ecological windows for key marine fauna species. o Piling operations should be completed using the best available technologies (BATs) for noise reduction and installation. o Implement underwater Management Zones (Observation and Exclusion Zones, see Plate 1 in Appendix A) • Dedicated Marine Fauna Observers (MFOs) (see Section A.1 of Appendix A)	• Marine fauna observations are to be undertaken for the duration of underwater piling (see Section A.2 of Appendix A). Daily MFO logs.	Continuous observations, including 30 mins prior to piling (pre-start procedures see Section A.2 of Appendix A) and for the duration of piling.	• MFO datasheets will be used throughout piling to record effort, sightings and mitigation (see Section A.2 of Appendix A) • A full summary report of operations, sightings and mitigation actions to be provided to DBCA and DCCEEW	• Piling Contractors
No injury or death of marine fauna from rock dumping or excavation or other construction works	• Dedicated MFOs (see Section A.1 of Appendix A) during rock dumping and excavation to implement management measures (see Section A.3 of Appendix A). • Implement rock dumping and excavation Management Zones (Observation and Exclusion Zones) (Section A.3 of Appendix A). • Rock dumping and excavation to occur during daylight hours only.	• Marine fauna observers are to be undertaken for the duration of rock dumping and excavation (See Section A.3 of Appendix A). • Daily MFO logs.	• 30-min continuous observations prior to dumping or excavation • Continuous observations during dumping and excavation.	• MFO datasheets will be used throughout rock excavation and dumping to record effort, sightings and mitigation (see Section A.3 of Appendix A) • • A full summary report of operations, sightings and mitigation actions to be provided to DBCA and DCCEEW.	• Contractors, Third party

Table 6: Marine fauna – Provisions (continued)

Management Targets	Management Actions	Monitoring	Frequency/ Timing	Reporting	Responsible party
No disturbance to marine fauna from artificial light	• Construction activities restricted to daylight hours only	• N/A	• Full duration of construction.	• N/A	• RIA • Contractors

2.5 Flora and vegetation

2.5.1 EPA objective

To protect flora and vegetation so that biological diversity and ecological integrity are maintained.

2.5.2 Key impact and risks

The key impacts and risks related to flora and vegetation during construction of the proposal include:

- Direct impacts:
  - 0.17 ha of vegetation type ApAf*Td in Good to Degraded Condition.
  - 0.23 ha of vegetation type MlAp*Td in Degraded to Good Condition. This vegetation unit is analogous with the Threated Ecological Community (TEC) *Callitris preissii* (or Melaleuca lanceolata) forests and woodlands of the Swan Coastal Plain.
  - 0.06 ha of vegetation type Sc*TdSl in Good to Degraded Condition.

- Indirect impacts
  - Introduction and/or spread of weeds and disease (i.e. dieback) into adjacent vegetation.
  - Potential for localised erosion which may affect adjacent land / vegetation.
  - Potential for accidental clearing/ over clearing.

2.5.3 Environmental protection outcomes

As per the ERD (RPS 2024), the EPO's developed for the proposal in relation to flora and vegetation include:

- Direct impacts to native vegetation resulting from the proposal will not exceed 0.46 ha.
- Direct impacts to native vegetation (MlAp*Td) analogous with the TEC, *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands of the Swan Coastal Plain does not exceed 0.23 ha.
- No introduction of new weed species attributable to the proposal.

The EPO's have informed the management targets and actions presented in **Table 7**.

2.5.4 Proposed provisions

Objective-based provisions for flora and vegetation are provided in **Table 7**.

Table 7: Flora and Vegetation – Provisions

Management Targets	Management Actions	Monitoring	Frequency/ Timing	Reporting	Responsible Party
Clearing of native vegetation within the DE will not exceed more than 0.46 ha. Do not exceed more than 0.23 ha clearing of vegetation type MlAp*Td (TEC representative) No incidents of vegetation clearing outside of the approved disturbance area. No degradation to adjacent land / vegetation from erosion.	• Delineation of the approved clearing area prior to commencement of clearing activities (e.g. via a survey and the installation of temporary fencing) to prevent clearing outside of approved areas. • Clearly delineate all identified populations of MlAp*Td using highly visible flagging or similar around all identified populations. Clearly delineate the vegetation to be cleared and the vegetation not to be cleared. • Establishment of clearly delineated access points to prevent unauthorised disturbance and access. • Ensure site access and laydown areas for vehicles and plant is arranged to utilise designated tracks and existing areas cleared of vegetation to minimise vegetation disturbance. • Ensure all applicable vehicles and plant remains within designated tracks, works areas, and laydown areas. • All construction personnel will be made aware of the clearing area boundaries through the induction / training process. • Installation of temporary fencing, inclusive of sediment controls, along the boundary of the terrestrial construction works area to restrict machinery access to be within the approved disturbance area.	• Daily inspections to visually check / review clearing boundaries and compliance during clearing activities. • Photographic records of the clearing area pre- and post-clearing activities. • Inspection to verify no degradation/disturbance beyond approved clearing boundary from erosion. • Inspection of stockpile heights and areas of placement.	• Photographs prior to construction activities • Daily inspections during clearing activities	• Maintain clearing register that includes date, location of clearing. • Post clearing inspection confirms there are no incidents of disturbance outside approved/disturbance boundary. • Records (written and photographic) will be kept of native vegetation clearing including; date, location and size of the area that was cleared, including location of stockpiles. • Incident reports • Induction and Training register	• Third party, Contractor

Table 7: Flora and Vegetation – Provisions (continued)

Management Targets	Management Actions	Monitoring	Frequency/ Timing	Reporting	Responsible party
(continued from above)	• Controlled placement of stockpiles within existing cleared areas within the DE. Ensure no erosion or damage to surrounding vegetation and use of sediment control structures (if required). • Placement of vegetation and topsoil stockpiles will not preclude access/egress of vehicles via designated access points from the site. • Topsoils stockpiles will be no more than 2m tall and external bunding used for stockpiles where required. • Ensure waste management implementation and rubbish disposal on site during construction.	*(continued from above)*	*(continued from above)*	*(continued from above)*	*(continued from above)*
No introduction of invasive weeds not already present and no introduction of disease within immediate adjacent areas attributable to construction activities.	• Weed management protocols will be implemented prior to commencement of construction, including: o Vehicle inspection on entry and exit to ensure the vehicle is free from obvious soil/organic material prior. o All cleaning of machinery to be cleared of soil and plant material. This will include the spraying of tyres/ tracks using disinfectant. Cleaning will occur at a suitable designated cleaning point with waste removed from the site (as required when detected). o Hygiene practices to ensure no spread of weeds/ diseases within the development envelope, including brush down of boots alongside wash-down. o All personnel will be made aware of weed management practices through the induction / training process.	• Visual inspections for unauthorised access to surrounding native vegetation e.g. damage to fencing and observation of vehicles or machinery. • Visual inspection of earth moving mobile equipment and vehicles prior to leaving site for evidence of weed contamination.	• Weekly visual inspections • Weekly spot checks of mobile equipment and vehicles.	• Regular inspection/audit/incident reports verify no introduction of weeds to site. • Inspection/audit/pre-start logbooks verify implementation of hygiene measures, including hygiene points at key road entry and exit points along the alignment, and food waste management measures. • Inspection/audit/pre-start logbooks verify vehicles, plant and equipment enter site clean, including boots.	• Third party, Contractor

Table 7: Flora and Vegetation – Provisions (continued)

Management Targets	Management Actions	Monitoring	Frequency/ Timing	Reporting	Responsible party
(continued from above)	o Controlled placement of stockpiles within existing cleared areas within the DE. Ensure no erosion or damage to surrounding vegetation and use of sediment control structures (if required). • Contractor to supply weed and seed certificates for all vehicles and machinery prior to first mobilisation on Rottnest Island.	*(continued from above)*	*(continued from above)*	down facility and are regularly maintained. • Induction records • Incident reports	*(continued from above)*

2.6 Terrestrial fauna

2.6.1 EPA objective

To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.

2.6.2 Key impacts and risks

The key impacts and risks related to flora and vegetation during construction of the proposal include:

- Direct impacts:
  - Clearing of 0.46 ha of native vegetation comprising fauna habitat.
  - Injury or mortality of fauna due to infrastructure, machinery, or vehicles.

- Indirect impacts
  - Introduction and/or spread of weeds/ disease impacting fauna habitat (addressed in **Section 2.5** flora and vegetation).
  - Accidental clearing impacting fauna habitat.
  - Alteration of fauna behaviour due to noise, lighting and increased human presence.

2.6.3 Environmental protection outcomes

As per the ERD (RPS 2024), the EPO's developed for the proposal in relation to terrestrial fauna include:

- Direct impacts to potential fauna habitat resulting from the proposal will not exceed 0.46 ha of native vegetation.
- No introduction of new weed species attributable to the proposal.
- No increase in incidents of terrestrial fauna injury or death during construction associated with the proposal works.

The EPO's have informed the management targets and actions presented in **Table 8**.

2.6.4 Proposed provisions

Objective-based provisions for terrestrial fauna are provided in **Table 8**.

Table 8: Terrestrial Fauna – Provisions

Management Targets	Management Actions	Monitoring	Frequency/ timing of monitoring	Reporting	Responsible party
Minimise disturbance to terrestrial fauna habitat during construction. No incidents of terrestrial fauna injury or death during construction associated with the proposal works. Prevent the alteration of fauna behaviour due to noise, lighting and increased human presence.	• The construction boundary will be clearly delineated to prevent encroachment of construction outside of the DE (e.g. via a survey and the installation of temporary fencing) to prevent clearing outside of approved areas. • Installation of temporary fencing, inclusive of sediment controls, along the boundary of the terrestrial construction works area to restrict machinery access to be within the approved disturbance area. • All site personnel to undertake environmental induction, including information on terrestrial fauna and associated management actions. • Targeted pre-clearance surveys for terrestrial fauna (i.e. walkover prior to clearing) • Undertake vegetation clearing commencing from a disturbed edge, where practicable, to encourage remaining mobile fauna to naturally relocate to areas of adjacent vegetation. • Clearing will be conducted progressively to allow any fauna within the site boundaries to naturally migrate to surround habitats off-site. • Established roads used for access and limited to roads essential for operations and travelling where practicable. Speed limits are adhered to prevent injury or death to fauna. Vehicles to be restricted to within the DE only. • Construction works to occur during daylight hours only.	• Weekly Inspection Checklist -weekly inspections to ensure fencing and other controls are maintained. • Pre-mobilisation checklist covers any necessary approvals for clearing including construction boundaries, no-go areas and vehicle access. • Documentation / photographs verifying that pre-clearance surveys were undertaken prior to clearing. • Inspection/audit reports verify no injury or deaths to fauna as a result of speeding, unauthorised night driving/works or access using unapproved routes. • Toolbox talks / site inductions to address site access and vehicle requirements and likely fauna present and procedures should any be hit.	• Weekly inspections - prior to construction activities • Prior to clearing activities (daily) • Reporting of incidents daily / where required during ground disturbance.	• Inspection checklists • Induction register • Clearing documentation / photographs • Incident register	• Third party, Contractor

Table 8: Terrestrial Fauna – Provisions (continued)

Management Targets	Management Actions	Monitoring	Frequency/ timing of monitoring	Reporting	Responsible party
(continued from above)	• A fauna spotter will be present during all clearing activities to ensure fauna are not directly impacted during construction. • If native fauna is encountered during clearing works it should, initially, be allowed to make its own way from the works area. However, if this is not possible or practicable, a qualified wildlife handler will be contacted to relocate it. • Injured animals will be provided with first aid and handled on advice from the Wildcare Helpline (ph. 9474 9055) and RIA Rangers (ph. 9372 9788). • Hygiene practices to ensure no spread of weeds/ diseases within the DE. • All personnel will be made aware of weed management practices through the induction / training process.	*(continued from above)*	*(continued from above)*	*(continued from above)*	*(continued from above)*

2.7 Social Surroundings

2.7.1 EPA Objective

To protect social surroundings from significant harm.

2.7.2 Key impacts and risks

The key impacts and risks related to social surroundings during construction of the proposal include:

- Restricted public access to proposal area during construction phase and temporary relocation of some existing vessel mooring holders.
- Increased waste to Rottnest Island during construction works.
- Impacts to recreational values including impacts to recreational fishers from loss of fish feeding/spawning habitat; potential impact to public safety particularly swimmers; impacts to mooring users from lighting, odour, noise, dust.
- Potential for bushfire.
- Potential disturbance of Unexploded Ordinance (UXO) site.
- Potential impacts to previously unidentified Aboriginal cultural heritage.

2.7.3 Environmental protection outcomes

As per the ERD (RPS 2024), the EPO's developed for the proposal in relation to social surroundings include:

- Noise emissions do not exceed assigned noise levels as prescribed in the *Environmental Protection (Noise) Regulations 1997.*
- Maintain recreational fishing values by ensuring there are no observable impacts to benthic communities and habitats outside the ZoMI.
- Minimise risk of disturbance to UXO.
- No permanent loss or change to the total number of moorings as a result of implementation of the proposal.
- No impacts to registered Aboriginal cultural heritage sites.
- Maintain amenity values during construction and operation.

The EPO's have informed the management targets and actions presented in **Table 9.**

2.7.4 Proposed Provisions

Objective-based provisions for social surroundings are provided in **Table 9**.

Table 9: Social Surroundings – Provisions

Management Targets	Management Actions	Monitoring	Frequency/ timing of monitoring	Reporting	Responsible party
Noise emissions do not exceed assigned noise levels as prescribed in the *Environmental Protection (Noise) Regulations 1997.*	• Construction contractor specifications will require that all construction work will be carried out in accordance with control of noise practices set out in Section 4 of Australian Standard 2436 "Guide to Noise Control on Construction, Maintenance and Demolition Sites. • Vehicle operation will occur during prescribed hours (between 07:00 and 17:00). Noise is not to exceed *Environmental Protection (Noise) Regulations 1997.* • Equipment will be fitted with noise control devices where possible and appropriate. • A community complaints procedure will be implemented for the construction period of the proposal and the community will be notified of how to make a complaint.	• Physical inspections during works with the potential to generate noise impacts, e.g., heavy equipment operation. • Noise monitoring may be undertaken if ongoing complaints are received. • Weekly Inspection Checklist. • Complaints Register. • Equipment Maintenance Register.	• Prior to construction activities • Daily or weekly where required during ground disturbance.	• Complaints register detailing date, time. Location and nature of complaint • Complaints will be investigated, and the complainant contacted within seven days	• Third party, Contractor
No fugitive dust emission outside of the DE.	• Implement dust suppression measures, including use of water carts on cleared areas. • Enforce speed limits in construction areas	• Daily visual monitoring of airborne dust to confirm no offsite dust impacts and efficacy of dust control measures.	• Daily visual monitoring	• Complaints register detailing date, time. Location and nature of complaint	• Third party, Contractor
Reduce waste volume, maximise recycling, reuse and recovery, prevent any construction waste/litter entering the environment.	• Provide labelled waste bins to accommodate the type, volume and service frequency of anticipated waste streams.	• Daily inspection of work site to occur. Review of waste bins (% full, time to next service).	• Daily site inspections • As required when leaving site.	• Incident reports.	• Third party, Contractor

Table 9: Social Surroundings – Provisions (continued)

Management Targets	Management Actions	Monitoring	Frequency/ timing of monitoring	Reporting	Responsible party
(continued from above)	• All loads arriving or leaving the site will be appropriately secured. • Provide information regarding waste management in site specific inductions, including waste separation and importance of securing vehicle loads. • Each construction laydown will have a dedicated storage area for fuels, lubricants, and small quantities of other hazardous materials. • Implementation of an active program of recycling for office paper and cardboard, plastics, glass, batteries and scrap metal. • Implementation of responsible handling and storage procedures for wastes such as waste oil until collected by a licensed waste transporter for removal and recycling.	• Waste volumes leaving site from waste contractors.	• (continued from above)	• Contractor to immediately report any non-conformance to the RIA Representative (without delay).	• (continued from above)
Zero incidences of fire resulting from the proposal	• Emergency Response Protocols will be developed and implemented by Contractor. • Fire extinguishers within all vehicles and plant.	• Record any fire occurrences during construction. • Weekly inspections testing compliance for fire extinguishers.	• As required. • Weekly inspections of fire extinguishers.	• Incident register verifies no accidental fires started from proposal activities. • Contractor weekly inspections checklists to verify compliance of vehicle fire extinguishers.	• Third party, Contractor

Table 9: Social Surroundings – Provisions (continued)

Management Targets	Management Actions	Monitoring	Frequency/ timing of monitoring	Reporting	Responsible party
Minimise risk of disturbance to UXO site	• Undertake UXO survey prior to construction works to assess anomalies identified during the initial UXO survey.	• Monitoring for UXO potential will occur as part of the pre-mobilisation survey and is considered sufficient for the proposal.	• Pre-mobilisation	• UXO survey report / output.	• Third party, Contractor
To minimise potential impacts to any previously unidentified subsurface Aboriginal cultural heritage (ACH)	• The following actions will be implemented as per the recommendations from the representatives of the Whadjuk NTC group: • Archaeological monitors are present during all ground disturbing works and that archaeological techniques, such as test pitting and sieving, are employed if artefacts are found. • Ongoing consultation will be undertaken with traditional owners as required to determine additional Aboriginal heritage information about potential sites.	• Visual inspection / monitoring present during ground disturbance works for presence of artefacts.	• As required during ground disturbance works	• Maintain records of any Aboriginal Heritage finds and communicate promptly with DPLH.	• Third party, Contractor
Relocation of moorings	• RIA to undertake ongoing stakeholder consultation and the minimum number of moorings will be relocated as required to construct the facility.	• As needs basis.	• As needs basis.	• Complaints register	• RIA
Minimise impact of lighting	• Ensure all construction works to be undertaken during daylight hours only.	• Site inductions to communicate works during daylight hours only.	• Initial site induction	• Site induction register	• Third party, Contractor
Ensure adequate public safety measures are implemented to avoid incidents on the public (i.e. swimmers).	• Implement the installation of floating markers and signs to limit access to the construction areas	• Weekly site inspections (walk overs) to ensure appropriate signage is displayed to prevent boat anchorage and public limit access to construction areas	• Weekly site inspection (walk overs).	• Visual site inspections/ photo log of signage.	• Third party, Contractor

3 Adaptive management

3.1 Overview

The RIA will implement an adaptive management approach in response to any issues identified in the implementation of management actions, monitoring and evaluation against the management targets. This approach involves modifying management and mitigation measures to meet the environmental objective more effectively for each of the key environmental factors. The adaptive management approach will be informed by:

- Evaluation of monitoring data.
- Review of assumptions and uncertainties.
- Re-evaluation of proposal-related risks.
- Increased understanding of the ecological regime.
- External changes during the construction phase of the proposal.

3.2 Environmental monitoring and corrective actions

If monitoring reveals any non-conformance with the environmental approvals, an investigation of the incident will be conducted, and the appropriate corrective measures will be implemented. These may involve modifications to equipment, processes, or management measures, as deemed necessary. Any alterations will be documented through the appropriate approval process and communicated to site personnel.

3.3 Audits

To guarantee the appropriate implementation of management measures and adherence to applicable design and environmental standards, routine environmental audits will be conducted by the Contractor as outlined in the specific management plans' established programs.

As previously described, the proposal is subject to further environmental approvals. Most activity specific management actions will be identified and detailed in other supporting documents for assessment and approval by the DWER.

Consequently, auditing of relevant management actions may need to be undertaken in accordance with the relevant regulatory document (if required).

3.4 Management plan review

This CEMP will be reviewed on an as needs basis to determine if any changes are required to the management controls to maintain the EPA’s objective for each of the key environmental factors relevant to the proposal. Changes to legislation may also alter the nominated assessment criteria to be met. A review of the applicability of management objectives, targets and provisions will be conducted regularly during the construction period to update the Contractors CEMP.

4 Stakeholder Consultation

4.1 Key Stakeholders

The following groups of stakeholders as outlined in **Table 10** have been identified as having an interest in the proposal.

Table 10: Key Stakeholders

State government agencies and Regulators	Local governments, authorities, and organisations	Local community groups
• Environmental Protection Authority (EPA) • Department of Planning, Lands and Heritage (DPLH) • Department of Transport (DoT) •	• Rottnest Island Chamber of Commerce (RICC) • The Rottnest Society • Rottnest Foundation • Wadjemup Aboriginal Reference Group (WARG)	• Fishing groups o BoatingWA o Recfishwest • Marine groups: o University of Western Australia (UWA) o West Australian Divers for Diversity Inc (WADDI) o Reef life o Australian Marine Conservation Society (AMCS) o Pew Trust o SaveOurSeas • Quokka coaches • Pinnacle Travel Group • Mooring licensees • General Public

4.2 Stakeholder consultation undertaken to date

The RIA has continually engaged with stakeholders during the proposal's planning phase to facilitate a collaborative approach to the design and management of the proposal. A summary of the engagement undertaken to date with the above key stakeholders in outlined in **Table 11**.

4.3 Ongoing stakeholder consultation

Affected stakeholders will be kept aware of scheduled activities and impacts as the proposal progresses. Ongoing consultation will occur via email/letters, meetings, and circulation of updates to relevant stakeholders.

Table 11: Summary of stakeholder engagement outcomes

Stakeholder	Date	Type of Consultation	Objective	Issues / Topics Raised	Proponent Response / Outcome
EPA Services EPA	October 2019	Face to face meetings / site visit	Introduction to the proposal and site visit	• The RIA provided an overview to the EPA on the plans and potential environmental issues for the proposal. • The RIA outlined the investigations to be undertaken including dredge plume modelling and jet probing.	• EPA were pleased with the update and the planned works investigations and raised no concerns.
	14/2/2020	Meeting and email	Advice sought on PFAS management measures	• The RIA described the elevated PFAS results in elutriate samples and sought advice on management for PFAS during dredging • The RIA and EPA agreed that the PFAS results in elutriate samples were a result of laboratory contamination. • Dredge material deemed to be suitable for reuse onsite and no additional sampling required, subject to: • Monitoring for PFAS to be outlined in a dredge management plan at the following locations: • Within waters surrounding the dredging. • Within dredge return waters. • Contingencies measures to be outlined in the dredge management plan for the management of dredge return water should PFAS be identified.	• The RIA engaged further sediment and surface water sampling works. • Results of further works did not identify PFAS at concentrations that would pose a risk to environment and human health.
	12/6/2023	Meeting	Discussion on recommencement of the proposal	• RIA and EPA discussed the recommencement of the project and outlined the baseline studies and management plans to be undertaken/developed as part of the progression to referral. • EPA noted that a Marine Environmental Quality Monitoring and Management Plan (MEQMMP) would be required in addition to the proposed suite of management plans.	• No further action.
	13/6/2023	Email	Advice sought on Aboriginal Cultural Heritage Act (ACHA) and the relationship with the EP Act.	• EPA provided links to published guidance on Aboriginal Cultural Heritage matters and the impacts that would be dealt with under ACHA and EP Act.	• To be addressed in approval documentation.

Table 11: Summary of stakeholder engagement outcomes (continued)

Stakeholder	Date	Type of Consultation	Objective	Issues / Topics Raised	Proponent Response / Outcome
(continued from above)	19/2/2024	Emails	Advice on MEQMMP and OEMP	• The RIA proposed preparation of an Operational Environmental Management Plan (OMEP) instead of a Marine Environmental Quality Monitoring and Management Plan (MEQMMP) based on the limited ongoing risk to water quality.	• EPA agreed with the proposed change to prepare OEMP.
Rottnest Foundation	1/3/2024	Email	Introduction to the proposal	• The RIA provided a link to project information website page to inform of the proposal and request feedback. • No response received.	• No further action.
Fishing groups: BoatingWA / Recfishwest	1/3/2024	Email	Introduction to the proposal	• The RIA provided a link to project information website page to inform of the proposal and request feedback. • No response received.	• No further action.
Marine groups: UWA / WADDI / Reef life / AMCS / Pew Trust / SaveOurSeas	1/3/2024	Email	Introduction to the proposal	• The RIA provided a link to project information website page to inform of the proposal and request feedback. • No response received.	• No further action.
DPLH	1/3/2024	Email	Introduction to the proposal	• The RIA provided a link to project information website page to inform of the proposal and request feedback. • DPLH requested to be informed of project updates.	• No further action.
General public submission	1/3/2024-29/3/2024	Website advertisement	Introduction to the proposal	• The RIA published information on their website regarding the proposal with an opportunity for feedback to be received. • Overall, the submissions were opposed to the proposal with references to: • The negative terrestrial and marine environmental impacts (seagrass loss, land clearing, impact on quokka population, noise, water, and light pollution). • The negative impact to local boat users, island residents and local visitors • Impact to the built-heritage value of the Army Groyne.	• Project justification to be identified within the EIA referral. • Marine environmental impact (loss of seagrass, water quality issues and light pollution) context and mitigations to be identified within the EIA referral. • Terrestrial environmental impact (impact on quokka population) context and mitigations to be identified within the EIA referral. • Public amenity (noise, lighting, marine traffic and loss of anchoring grounds) context and

Table 11: Summary of stakeholder engagement outcomes (continued)

Stakeholder	Date	Type of Consultation	Objective	Issues / Topics Raised	Proponent Response / Outcome
(continued from above)				o Concern for the loss of suitable anchoring grounds. o Concern for the increase in traffic along Parker Point Rd and associated public safety risk. o Support for refurbishment of the current jetty and barge landing instead of constructing new facility.	mitigations to be identified within the EIA referral. • Public safety risk (i.e. traffic along Parker Point Rd) is addressed by policing and road regulations applicable to Rottnest Island roads. • Built heritage context of the Army Groyne addressed in separate submission to DPLH.
Rottnest Island Chamber of Commerce (RICC)	6/3/2024	Meeting	Introduction to the proposal	• The RIA presented to RICC monthly meeting with all business representatives present. • In general, there was support for the proposal. • Questions and comments were raised in relation to: o The logistics of ferry operations and luggage deliveries. o General questions about the status of baseline environmental studies. o General questions about project cost and timeframes. o Impacts to moorings and anchorage. o Upgrades to the access road.	• Workshop to be held to discuss ferry operations and logistics once funding and detailed designs are known. • RIA provided verbal responses to the other questions based on information known at the time.
Quokka coaches	7/03/2024	Email	Support for the proposal	• Email in support of the proposal stating: o Project will benefit the barge operators who currently work in a confined area. o Project will enhance overall visitor impression on arrival.	• No further action.
Pinnacle Travel Group	20/03/2024	Email	Support for the proposal	• Email in support of the proposal stating: o Project will increase the experience and amenity for tourists and improve the ability of ferry companies to operate. o Significantly reduce traffic around the main jetty and main bus stop, easing congestion.	• No further action.

Table 11: Summary of stakeholder engagement outcomes (continued)

Stakeholder	Date	Type of Consultation	Objective	Issues / Topics Raised	Proponent Response / Outcome
The Rottnest Society	29/03/2024	Meeting	Introduction to the proposal	• The RIA presented to the Rottnest Society to inform of the proposal and request feedback. • Questions and comments were raised in relation to: o Concern for terrestrial and marine environmental impact. o Concern for lack of proposed revegetation and restoration. o Recommends that evaluation of current barge landing is undertaken to effectively reduce conflicts with pedestrians. o Notes that information was difficult to source as a result of the RIA website being upgraded.	• Project justification to be identified within the EIA referral. • Marine environmental impact context and mitigations to be identified within the EIA referral. • Terrestrial environmental impact (impact on quokka population) context and mitigations to be identified within the EIA referral.
Wadjemup Aboriginal Reference Group (WARG)	4/04/2024	Meeting	Introduction to the proposal	• The RIA presented to the WARG to inform of the proposal and seek feedback. • Questions and comments were raised in relation to: o In general, there was support for the proposal. o Concern for marine species impacted by the noise from piling, in particular whales. o Enquiry about heritage values in the project area o Works should stop should Aboriginal cultural material is disturbed. o Enquiry about incorporation of renewable energy in the design.	• RIA to notify WARG if any approvals are referred to for further investigation. • Cultural heritage (disturbance of Aboriginal heritage) context to be identified within the EIA referral. • Cultural heritage mitigations to be identified within Activity Notice documentation. • Design to consider sources of energy.
Mooring licensees	9/4/2024-24/4/2024	Letters, phone calls	Introduction to the proposal	• The RIA contacted mooring licensees to inform them of the proposal and the permanent/temporary relation of mooring (where applicable). • Overall, the responses were opposed to the proposal with general references to: o The negative impact to current vessel mooring licensee's, local boat users, island residents and local visitors.	• Project justification to be identified within the EIA referral. • Marine environmental impact (loss of seagrass, water quality issues and light pollution) context and mitigations to be identified within the EIA referral. • Terrestrial environmental impact (impact on quokka population) context and mitigations to be identified within the EIA referral.

Table 11: Summary of stakeholder engagement outcomes (continued)

Stakeholder	Date	Type of Consultation	Objective	Issues / Topics Raised	Proponent Response / Outcome
(continued from above)				o Impact to the built-heritage value of the Army Groyne o Concerns about the increased risk/safety to swimmers as a result of increasing marine traffic and boat wash. o Requests for relocation and clarification on the relocation process. o Concern for the loss of suitable anchoring grounds. o The negative terrestrial and marine environmental impacts (seagrass loss, land clearing, impact on quokka population, noise, water, odour and light pollution).	• Public amenity (noise, lighting, marine traffic and loss of anchoring grounds) context and mitigations to be identified within the EIA referral. • Public safety risk (i.e. traffic along Parker Point Rd) is addressed by policing and road regulations applicable to Rottnest Island roads. • Built heritage context of the Army Groyne addressed in separate submission to DPLH.
DoT	1/5/2024	Email	Introduction to the proposal	• The RIA provided a link to project information website page to inform of the proposal and request feedback. • DoT stated that a navigational safety channel is not required and that no additional lead lights are required.	• No changes to the marine safety infrastructure required. • No further action.

5 References

5.1 General references

The references listed below have been considered as part of preparing this document.

Baird (2024). South Thomson Bay Barge Development Coastal Processes Assessment. **13029.101.R1.Rev0**.

DPIRD (2019). National award for WA marine biosecurity. Accessed: https://www.fish.wa.gov.au/About-Us/Media-releases/Pages/_archive/National-award-for-WA-marine-biosecurity.aspx. Accessed on: 18.07.2024

Eco Logical Australia (2024). Rottnest Island Basic Fauna Survey. **23PER6686**.

EPA (2016). Environmental Factor Guideline – Marine Environmental Quality. Environmental Protection Authority. Perth.

EPA (2021). Environmental Impact Assessment (Part IV Division 1 and 2) Administrative Procedures 2021. Environmental Protection Authority. Western Australia

Focused Vision (2023). Flora and Vegetation Survey South Thomson and Kingstown Rottnest Island (Wadjemup)

IMO (2012). Guidelines for the Development of Garbage Management Plans. Resolution MEPC.220(63). Addressed: https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/2014%20revision/RESOLUTION%20MEPC.220(63)%20Guidelines%20for%20the%20Development%20of%20Garbage%20Management%20Plans.pdf. Accessed on 18.07.2024

Herring Storer Acoustics (2024). Rottnest Barge Facility - Acoustic Assessment.

RIA (2019). A 20 year vision - Rottnest Island Masterplan.

RIA (2023). Rottnest Island Management Plan 2023–28.

RPS (2019). Environmental advisory report - Repair and extension of former Army Jetty, Rottnest Island. **EEN18225.001**.

RIA (2021). Development Planning Guideline No.3: Sustainable Development.

RPS (2020). SAP Implementation Report - Rottnest Island Army Jetty Dredging. **EEC19032.011**.

RPS (2023). Matters of National Environmental Significance Assessment Report - South Thomson Bay Maritime Facilities Redevelopment, Rottnest Island. **AU213012591.001**.

RPS (2023). South Thomson Barge Landing Development Marine Fauna and Benthic Habitat Assessment. **AU213012799**.

RPS (2024). Environmental Supporting Document - South Thomson Barge Landing Development, Wadjemup / Rottnest Island **AU213014226.001**.

RPS (2024). South Thomson Barge Redevelopment Flora and Vegetation Survey. **AU213012799.001**.

Tetra Tech (2024). South Thomson Barge Landing Development Project - Draft Underwater Acoustic Assessment.

Appendix A

Marine Fauna Provisions (O2 Marine)

Appendix A. Marine Fauna Provisions

A.1 Dedicated Marine Fauna Observer

A.1.1 Training and qualifications

Two Dedicated Marine Fauna Observer (MFOs) will be used prior to and throughout piling works and rock dumping and excavation activities. The dedicated MFOs will be suitably trained and qualified, adhering to the requirement of the Wildlife Conservation (Closed Season Marine Mammals) Notice 1998. MFOs must demonstrate a knowledge of marine wildlife species in the South-west marine bio region, including Threatened and Migratory Species listed under the EPBC Act and BC Act and priority listing, including morphological and behavioural characteristics. The dedicated MFOs will have demonstrated knowledge and experience in marine fauna species observation, distance estimation and reporting. They will not have other duties while engaging in visual observations.

Evidence of personnel suitability will be kept on record through staff curriculum vitae, training certificates and in-field record keeping, which may be used in future audits. Information will include:

- MFO names and contact details.
- Details of MFOs training (including provider and course dates)
- Previous experience as MFOs on underwater piling surveys and/or rock dumping and excavation works.
- Other MFO experience.

A.1.2 Shifts

Dedicated MFO shifts will be set prior to field mobilisation to prevent observer fatigue, which can reduce the quality of observation and data recording. From a health and safety perspective, having coordinated shifts will ensure that observers have amenity breaks and reduced weather exposure.

A.1.3 Platform

The dedicated MFOs will be on a suitably elevated platform elevated point, for example this could include from a roaming vessel, piling barge, or existing infrastructure, that provides appropriate unimpeded vantage of the Management Zones and with 360-degree views around the noise source (piling or rock dumping and excavation). This point may need to shift pending the location of the noise source on any given day (i.e. site construction activities).

A.1.4 Recording and Reporting

A.1.4.1 Field log

The dedicated MFOs will use a pre-designed datasheet to record observer effort, fauna observation and mitigation measures. All records will be sent to DBCA and DCCEEW. Field logs will include:

- Location, date and start time of observations

- Name of the two Dedicated MFOs on shift
- Start/finish time of piling or rock dumping and excavation activities
- Other marine fauna observations within 500 m of piling operations
- Fauna behaviours, in particular any behaviours that could be attributed to piling or rock dumping and excavation activities
- Location, times and reason when observations were hampered by poor sighting conditions
- Location and time of pre-start, soft-start, and shut-down procedures for piling, and pre-start and shut-down procedures for rock dumping and excavation
- Location, time and distance of any fauna sighting and mitigation applied
- Observed cetacean in a format consistent with the National Cetacean Sighting and Stranding's Database.
- Adherence to management responses in relation to dead or injured wildlife

A.1.5 Reportable incidents

All employees and contractors shall immediately report all environmental incidents as a non-conformance, whether these are reportable non-reportable incidents (i.e., performance indicators are not met, or management actions are not followed to the Contractor site supervisor who will investigate the incident). It is a requirement that all incidents follow RIA Incident Management Procedure. The employee is to report the incident immediately to the site supervisor. In every case the site supervisor is to document the incident using RIA's Incident Management System.

Reportable incidences are injury to conservation significant fauna or listed species as a result of the Proposal activities or general observations of injured wildlife not related to proposal activities to be reported to Contractor PM. The PM is to notify RIA who will notify the Department of Biodiversity Conservation and Attractions (DBCA) and Department of Water and Environmental Regulation (DWER). All environmental incidents will be reported by RIA within 48 hours of RIA being made aware.

A.1.6 Completion Report

On completion of the program the construction program piling and rock dumping and excavation, a full report will be submitted which will allow for compliance auditing. The report will include a full summary report of operations, sightings and mitigation actions impletion for the duration of the campaign. RIA on completion of the program, RIA will provide a full report to DBCA and DCCEEW.

A.2 Piling Provisions

A.2.1 Management Zones

Two Management Zones, that will be monitored by 2 Dedicated MFOs during piling works, have been set for target marine fauna groups, namely:

- Observation Zones
- Exclusion Zones.

These Management Zones have been informed by results of the underwater noise modelling results (Tetra Tech 2024) (Table 1A; Palte 1).The proposed piling method is to use a vibro-hammer, which

produces a continuous (non-impulsive) noise reducing noise exposure. However, it is possible that the vibro-hammer may meet refusal, and in these instances, impact hammer piling will be required. Therefore, the underwater noise modelling (Tetra Tech 2024) modelled both vibro-hammer and impact hammer piling methods, and the same management zones will be implemented for both methods, using a precautionary approach. For each group, Observation Zones have been informed by the modelled Temporary Threshold Shift (TTS) onset distance and the Exclusion Zones are based on the Permanent Threshold Shift (PTS) onset distance from the underwater noise modelling. These distances adopt a precautionary approach to the management zone distances, by using management zone distances from the 'high tide' impact hammer piling approach modelled scenario where noise propagates the farthest and had the greatest potential zones. The adopted zones are broader than the model outputs, based on the inherent variability between underwater noise modelling and empirical values. Therefore, the zones need to be larger than the modelled, based on PTS and TTS distances. The observable distances are easily achievable.

Table 1A: Marine Fauna - Observation and Exclusion Zones (Based on Tetra Tech 2024, impact hammer piling scenario – worst-case scenario for PTS and TTS, Vibratory Piling for Behavioural distance)

Marine Fauna Group	TTS Distance Limit (m)	PTS Distance Limit (m)	Behavioural Distance Limit (m)*	Observation Zone (m)	Exclusion Zone (m)
Whales (Low-frequency cetaceans)	404	73	167	600	150
Toothed whales (Mid-frequency cetacean)	36	No exceedance	167	300	150
Dolphins (High-frequency cetaceans)	500	73	167	600	150
Australian sea lions and New Zealand fur seals (Otariids pinnipeds)	25	No exceedance	167	300	150
Turtles	3	30	37**	200	100

^Distances from Tetra Tech 2024 impact piling driving results

*Distances from Tetra Tech 2024 vibratory hammer pile results

**Behavioural response distance was greater for impact hammer piling for turtles, there value presented in the table is impact hammer piling behavioural distance limit.

Fish species were presented in the noise modelling; however, they are not surface breathers, therefore they do not bask at the surface which makes observations an ineffective mitigation measure. Piling will be undertaken using vibro-hammering which produces continuous (non-impulsive) noise reducing noise exposure to fish species, which noise modelling results demonstrated

that for small and large fish all distances to threshold values were low (<50 m), which is lower than the impact hammer piling threshold values (Tetra Tech 2024).

The methods below will be implemented for both vibro-hammering and impact hammer piling.

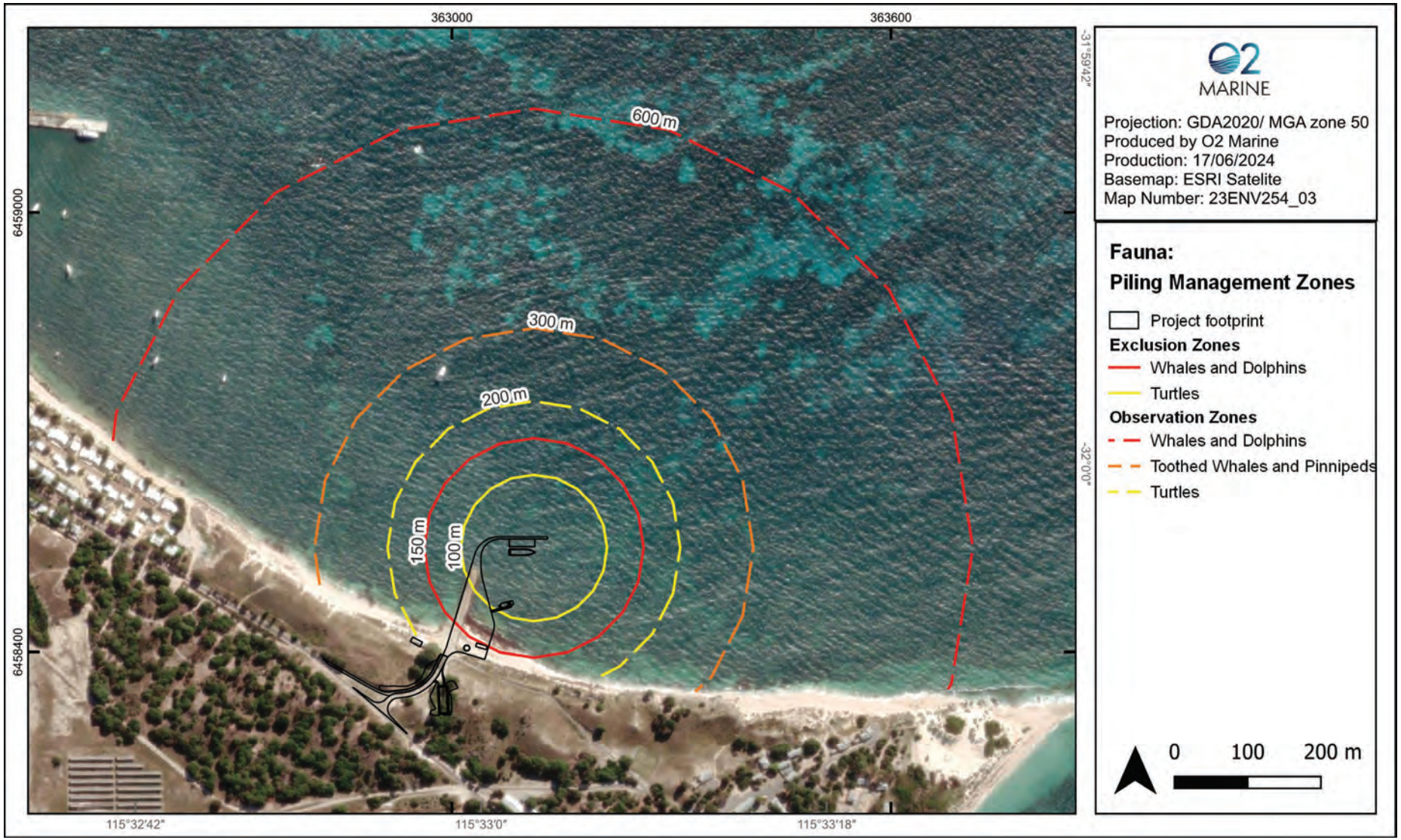

Plate 1 Fauna Piling Management Zones

A.2.2 Pre-start

Prior to piling works each day and for each pile the dedicated MFOs will commence continuous visual observation within the management zones for 30-minutes. MFOs must have sight lines of the piling Observation Zone, enabling them to effectively manage the disturbance distance and species management zones. MFOs in conjunction with underwater piling contractors and PM will carry out the following duties and comply with the following protocols in regard to pre-start procedures:

- If target marine fauna is observed within the management zone, piling operations shall be delayed until target marine fauns have been observed exiting the Observation Zone or have not been seen for 30-minutes
- If target marine fauna is not observed within either the Exclusion or Observation Zones within 30-minutes, underwater piling can commence with soft-start procedures.

A.2.3 Soft-Start piling

Soft-start procedures is required for all pile installation and involves the commencement of piling at low vibro-hammer energy, gradually increasing to full impact energy over a 30-minute period. This procedure may alert marine fauna to the presence of the piling activity and enable them to move away to distances where injury is unlikely. The dedicated MFOs will continuously monitor the management zones during soft-start procedures. Full energy may only be used after the 30-minute soft-start period, if no marine fauna are sighted within the Exclusion Zone.

- If target marine fauna are observed in the Observation Zone, soft-start procedures will continue and the MFO will continue to monitor the marine fauna
- If target marine fauna are observed in the Exclusion zone, soft-start procedures will cease until the observed target marine fauna leaves the Exclusion Zone target or have not been seen for 30 minutes, on competition of the 30 minutes duration and no animal has been observed in the exclusion zone soft-start procedures will recommence
- If it is evident that the marine fauna are in distress then piling operations shall cease until marine fauna have exited the management zones or have not been seen for 30 minutes. Once target marine fauna have exited the management zone, soft start piling may recommence.

A.2.4 Normal Piling

Where target marine fauna are not observed in Management Zones during soft-start procedures then normal piling can commence. Normal piling involves commencement of full energy piling. The dedicated MFOs will continually monitor the management zones during normal piling. If marine fauna is sighted then the shut-down procedures will be implemented.

A.2.5 Shut-down Procedures

The dedicated MFOs will maintain continuous observations during underwater piling. They will notify the Project Manager/Piling contractor if target marine fauna is sighted within the corresponding Observation or Exclusion Zone. Where marine fauna is observed within the Observation Zone (but outside the Exclusion Zone) during piling activities (including Soft-start procedures), then the following action shall be taken:

- If target marine fauna is sighted and is in distress then piling activities shall be suspended within two minutes of the sighting, or as soon as safely possible
- If target marine fauna is not showing signs of distress and remains within the Observation Zones (but outside the Exclusion Zones), piling activities will continue and the MFO will continue to monitor the target marine fauna
- Underwater piling works will cease if target marine fauna enters the Exclusion Zone.
- Where target marine fauna is observed within the Exclusion Zone during piling activities (including Soft-start procedures), then the following actions will be taken:
- Piling works will cease when target marine fauna is identified within, or about to enter, the Exclusion Zone
- Piling activities that have been suspended must not recommence until the target marine fauna has exited the corresponding Exclusion Zone and Observation Zone of its own accord or has not been seen by the MFO within these zones for a period of 30-minutes
- Once able to resume, piling will recommence following soft-start procedures.

A.2.6 Low-visibility conditions

During periods of low visibility (i.e. where a distance of 500 m cannot be clearly viewed), then piling operations may commence with soft-start procedures provided that during the preceding 24-hour period:

- There have not been three or more circumstances where marine fauna have been observed which resulted in ceasing of piling operations
- There have not been three or more whale instigated shut-down situations
- A 2-hour period of continual observations was undertaken in good visibility within the 24-hour period prior to proposed piling and no marine fauna sighted
- Piling will be restricted to daylight hours only, these hours will vary depending on the time of year piling is undertaken (unless in the case of a safety/emergency)
- If marine fauna are sighted, the shut-down procedures will apply.

A.3 Rocking dumping and excavation

A.3.1 Management Zones

Two Management Zones; Observation Zone and Exclusion Zones will be monitored by two Dedicated MFOs (see Appendix A.1) during rock dumping and excavation works, have been set for target marine fauna groups. These Management Zones are presented in Table 2A.

Table 2A: Marine Fauna - rock dumping and excavation zones

Marine Fauna Group	Observation Zone (m)	Exclusion Zone (m)
Whales	500	300
Dolphins	300	150
Sea lions and seals	500	300
Turtles	500	300

To mitigate the potential impacts of rock dumping and excavation on conservation significant marine fauna two dedicated MFOs must implement the following management and monitoring protocols.

A.3.2 Pre-start

Prior to rock dumping and excavation works the dedicated MFOs will commence continuous visual observation within the Management Zones (Table 2A) for 30-minutes. MFOs must have sight lines of the rock dumping and excavation Observation Zone, enabling them to effectively manage the disturbance distance and species management zones. MFOs in conjunction with contractors and PM will carry out the following duties and comply with the following protocols in regard to pre-start procedures:

- If target marine fauna is observed within the management zone, rock dumping and excavation shall be delayed until target marine fauns have been observed exiting the Observation Zone or have not been seen for 30-minutes
- If target marine fauna is not observed within either the Exclusion or Observation Zones within 30-minutes, rock dumping and excavation can commence

A.3.3 Rock dumping and excavation

Rock dumping and excavation work may commence following the 30-minutes, if the requirements above are met, and the dedicated MFOs must maintain continuous observation around the rock dumping and excavation work, if the dedicated MFOs observe a target marine fauna species within the Exclusion Zones then shut-down procedures will be implemented.

A.3.4 Shut-down procedures

Where target marine fauna is observed within the Exclusion Zone during rock dumping and excavation activities, then the following actions will be taken:

- Rock dumping and excavation activities will cease with 2-minutes or as soon as safely possible when target marine fauna of when target marine fauna is identified within, or about to enter, the Exclusion Zone
- Rock dumping and excavation activities that have been suspended must not recommence until the target marine fauna has exited the corresponding Exclusion Zone and Observation Zone of its own accord or has not been seen by the MFO within these zones for a period of 30-minutes rock dumping and excavation activities can recommence
- Where marine fauna is observed within the Observation Zone (but outside the Exclusion Zone) during rock dumping and excavation activities (including Soft-start procedures), then the following action shall be taken:
- If target marine fauna is sighted and is in distress then rock dumping and excavation activities shall be suspended within two minutes of the sighting, or as soon as safely possible
- If target marine fauna is not showing signs of distress and remains within the Observation Zones (but outside the Exclusion Zones), rock dumping and excavation activities will continue and the MFO will continue to monitor the target marine fauna
- Rock dumping and excavation works will cease if target marine fauna enters the Exclusion Zone.

A.3.5 Low-visibility conditions

During periods of low visibility (i.e. where a distance of 500 m cannot be clearly viewed), then rock dumping and excavation activities may commence with soft-start procedures provided that during the preceding 24-hour period:

- There have not been three or more circumstances where marine fauna have been observed which resulted in ceasing of rock dumping and excavation activities operations
- There have not been three or more whale instigated shut-down situations
- A 2-hour period of continual observations was undertaken in good visibility within the 24-hour period prior to rock dumping and excavation activities and no marine fauna sighted
- Rock dumping and excavation activities will be restricted to daylight hours only, these hours will vary depending on the time of year the work is undertaken (unless in the case of a safety/emergency)
- If marine fauna are sighted, the shut-down procedures will apply.

A.4 Vessel strike provisions

A.4.1 Vessel approach distances

The distances have considered the Australian National Guidelines for Whale and Dolphin Watching (DoEE 2017) and the National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (CoA 2017) (Table 3A).

The speed limit with the proposal's Development Envelope (DE) are already below 6 knots and therefore are consistent with vessel speed restriction for marine fauna of 6 knots. Caution zones cannot be entered into by a vessel if the animal is injured, stranded, entangled, or distressed or if a single calf or pod of calves are present. No more than three vessels are permitted to be in a caution zone at the same time. Should a travelling dolphin enter the no approach zone, including with an attempt to 'bow ride', the vessel shall either maintain its course and speed, or maintain its course and gradually slow down.

Table 3A: Marine fauna - vessel approach distances (DoEE 2017)

Marine fauna group	Caution zone	No approach zone (metres)	Distress/disturbance
Adult whales	300	100 m to the side of the whale 300 m in front or to rear of the whale	Withdraw from caution zone at speed less than 6 knots
Whale calf* present	-	300 m	Withdraw from No approach zone at speed less than 6 knots
Adult dolphins	150	50 m to the side of the dolphin 150 m in front or to rear of the dolphin with the exception of animals bow-riding	Withdraw from caution zone at speed less than 6 knots
Dolphin calf* present	-	150 m	Withdraw from No approach zone at speed less than 6 knots

**A calf is defined as half the length of the mother/nearest adult*

A.4.2 Trained MFO

Trained MFOs are crew members trained in marine fauna species observations and mitigation measures, consistent with the Proposals environmental management plans. Trained MFOs will be on duty on Proposal vessel during construction. There will be always at least one Trained MFO on duty during vessel transits within the proposal area.

All vessel crews engaged for the marine construction phase of the Proposal will attend a minimum of one marine fauna induction to become familiar with the range of conservation significant marine fauna that could be present in the Proposal area and the risks the dredging may present to this fauna. This marine fauna induction can be combined with other crew inductions that may be required. All commitments made by RIA to manage construction activities with conservation significant marine fauna will be included in the induction. The content of the induction will be updated as required to ensure it remains current and reflects the marine fauna being observed in the Proposal area and any vessel interactions with marine fauna that has occurred.

Evidence of personnel and training certificates will be kept on record which may be used in future audits. Information will include:

- MFO name and contact details
- Details of MFO training.

A.4.3 Platform

Trained MFO observations will be undertaken from a suitably elevated point that provides appropriate vantage of cautions zones during vessel transit and provides unimpeded views.

A.4.3.1 Recording and reporting

Trained MFOs onboard vessels are to maintain detailed daily records of all sightings of target marine fauna and other notable observations. Trained MFOs will use a pre-designed datasheet to record observer effort, fauna observations and mitigation measures, tailored to vessel operations. All records will be sent to DBCA and DCCEEW (Ports and Marine Section). Field logs will include:

- Location, date and start time of observations
- Name of MFO involved in the observations
- Finish time of MFO shift on transiting vessel
- Location, times and distance of any fauna sightings including species where possible
- Location, times and reason of when observation were hampered by poor sighting conditions
- Management responses including any vessel response to avoid marine fauna, and dead and injured wildlife
- Observed cetacean in a format consistent with the National Cetacean Sighting and Stranding's Database.

Reportable incidences are injury to conservation significant fauna or listed due to the Proposal activities or general observations of injured wildlife not related to the Proposal activities are to be reported to the Contractor PM. The Contractor PM is to notify RIA PM who will notify DBCA and

DCCEEW. All environmental incidents will be reported by RIA to DCCEEW within 48 hours of RIA being made aware.

REPORT

Appendix Q
Operational Environmental Management Plan (OEMP) Emerge Associates 2024

Operational Environmental Management Plan (OEMP)

Rottnest Island Authority - South Thomson Barge Landing Development

Project No: EP24-014(03)

Prepared for Rottnest Island Authority
August 2024

Document Control

Doc name:	Operational Environmental Management Plan (OEMP) Rottnest Island Authority - South Thomson Barge Landing Development				
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	Issued to RIA for review				
A	August 2024	Samuel Luckas	SPL	Lauren Elvidge	LLE
	Changes as per client review				

Acknowledgement Of Country

In the spirit of reconciliation Emerge Associates and O2 Marine acknowledge that this project is proposed on the lands of the Whadjuk Noongar People. We pay our respects to Elders past, present and emerging and recognise their continuing connection to land, sea, culture and community.

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Executive Summary

This Operational Environmental Management Plan (OEMP) has been prepared to outline the Rottnest Island Authority's (the proponent) approach to managing environmental impacts throughout operation of the South Thomson Barge Landing Development ('the proposal') as per **Table 1** below.

Table 1: Summary and purpose of this OEMP

Proponent Name	Rottnest Island Authority (RIA)
Ministerial Statement Number	N/A
Purpose of the OEMP	The purpose of this OEMP is to demonstrate how operational-related impacts of the proposal on key environmental factors will be managed. The OEMP will demonstrate and communicate how the potential impacts on the environment will be avoided, mitigated, monitored and managed and will consider all operational related impacts including marine and terrestrial operations. The OEMP outlines the management actions, management targets, monitoring and contingency actions relating to operation of the proposal, to comply with environmental approvals and any relevant environmental legislation. The objective of this OEMP is to ensure best practice and/or appropriate environmental management practices are applied throughout the proposal. In addition, this OEMP describes how the proponent will minimise the environmental risks and achieve the EPA environmental objectives for the environmental factors as related to the proposal by providing a structured approach to ensure appropriate environmental controls are implemented.
Key environmental factor/s, outcome/s and/or objectives	This OEMP has been developed with relevant information and management strategies for the key environmental issues relating to the following: • **Marine Environmental Quality**: Minimisation of disturbance and management of impacts of water quality during operations. • **Benthic Communities and Habitat**: Minimisation of benthic habitat disturbance during operations. • **Marine Fauna**: Minimisation of disturbance and management of impacts through avoidance of direct impact on conservation significant species. • **Coastal Processes**: Minimisation of disturbance and management of activities to prevent the disturbance and alteration of coastal processes during operations. • **Flora and Vegetation**: Minimisation of disturbance and management of impacts through avoidance of direct impact on conservation significant species. • **Terrestrial Fauna**: Minimisation of disturbance to fauna habitat and management of activities to prevent direct impact on native fauna during operations. • **Social Surroundings**: Limit impact on Aboriginal cultural heritage and social surroundings including noise, dust, visual intrusion, and ensure local amenity is protected and public safety measures are undertaken.
Condition clauses	N/A
Key components in the OEMP	The key provisions in this management plan are detailed in **Section 2**. These include objective based actions which will be applied at relevant stages of the proposal.
Proposed date of operations	Indicatively the proposal will become operation in 2027.

Table of Contents

1 Context, scope and rationale 6

1.1 Background 6
1.2 Proposal 6
1.3 Scope and purpose of this OEMP 8
1.4 Key environmental factors 8
1.5 Condition requirements 11
1.6 Rationale and approach 11
1.6.1 Survey and study findings 11
1.6.2 Key assumptions and uncertainties 15
1.6.3 Management approach 15
1.6.4 Rationale for choice of provisions 15

2 OEMP Components 17

2.1 Overview 17
2.2 Marine environmental quality 18
2.2.1 EPA Objective 18
2.2.2 Key impacts and risks 18
2.2.3 Environmental protection outcomes 18
2.2.4 Environmental management strategies 19
2.3 Benthic communities and habitats 21
2.3.1 EPA Objective 21
2.3.2 Key impacts and risks 21
2.3.3 Environmental protection outcomes 21
2.3.4 Environmental management strategies 22
2.4 Marine fauna 24
2.4.1 EPA Objective 24
2.4.2 Key impacts and risks 24
2.4.3 Environmental protection outcomes 24
2.4.4 Environmental management strategies 25
2.5 Coastal Processes 28
2.5.1 EPA Objective 28
2.5.2 Key impacts and risks 28
2.5.3 Environmental protection outcomes 28
2.5.4 Environmental management strategies 29
2.6 Flora and Vegetation 30
2.6.1 EPA objective 30
2.6.2 Key impacts and risks 30
2.6.3 Environmental protection outcomes 30
2.6.4 Environmental management strategies 31
2.7 Terrestrial fauna 33
2.7.1 EPA Objective 33
2.7.2 Key impacts and risks 33
2.7.3 Environmental protection outcomes 33
2.7.4 Environmental management strategies 34
2.8 Social surroundings 35
2.8.1 EPA Objective 35
2.8.2 Key impacts and risks 35
2.8.3 Environmental protection outcomes 35
2.8.4 Environmental management strategies 36

3 Adaptive management approach 38

3.1 Overview 38
3.2 Environmental monitoring and corrective actions 38
3.3 Audits 38
3.4 Management plan review 38

4 Stakeholder Consultation 39

4.1 Key stakeholders 39
4.2 Stakeholder consultation undertaken to date 39
4.3 Ongoing stakeholder consultation 39

5 References 45

5.1 General references 45

List of Tables

Table 1: Summary and purpose of this OEMP ii
Table 2: Key environmental factors and values relevant to the operational phase of the proposal 9
Table 3: Key studies and findings 11
Table 4: Marine environmental quality - Key impacts and risks 18
Table 5: Marine environmental quality – environmental management 19
Table 6: Benthic communities and habitats - Key impacts and risks 21
Table 7: Benthic communities and habitats – environmental management 22
Table 8: Marine fauna - Key impacts and risks 24
Table 9: Marine fauna – environmental management 25
Table 10: Coastal Processes – Key impacts and risks 28
Table 11: Coastal processes – environmental management 29
Table 12: Flora and Vegetation – Key impacts and risks 30
Table 13: Flora and Vegetation – environmental management 31
Table 14: Terrestrial fauna – Key impacts and risks 33
Table 15: Terrestrial fauna – environmental management 34
Table 16: Social Surroundings – Key impacts and risks 35
Table 17: Social surroundings – environmental management 36
Table 18: Key Stakeholders 39
Table 19: Summary of consultation with stakeholders: state government agencies and regulators, local government and the local community 40

Appendices

Appendix A

Marine Fauna Vessel Approach Distances

Abbreviation Tables

Table A1: Abbreviations – Organisations

Organisations	
DBCA	Department of Biodiversity, Conservation and Attractions
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DWER	Department of Water and Environmental Regulation
DPLH	Department of Planning, Lands and Heritage
RIA	Rottnest Island Authority

Table A2: Abbreviations – General terms

General terms	
ACH	Aboriginal Cultural Heritage
BCH	Benthic Communities and Habitats
DEMMP	Dredging Environmental Monitoring and Management Plan
OEMP	Operational Environmental Management Plan
PMST	Protected Matters Search Tool
PFOS	Perfluorooctane sulfonate

Table A3: Abbreviations – units of measurement

Units of measurement	
EPO	Environmental protection outcome
ha	hectare
km	kilometre
m^2	square metre
TSS	Total Suspended Solids
NTU	Nephelometric Turbidity Unit
ZoHI	Zone of High Impact
ZoMI	Zone of Moderate Impact
ZOI	Zone of Influence

Table A4: Abbreviations –Legislation or standards

Legislation	
AH Act	*Aboriginal Heritage Act 1972*
BC Act	*Biodiversity Conservation Act 2016*
EP Act	*Environmental Protection Act 1986*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*

1 Context, scope and rationale

1.1 Background

Emerge Associates were commissioned by the Rottnest Island Authority (RIA) to prepare an Operational Environmental Management Plan (OEMP) to support the environmental approvals for the South Thomson Barge Landing Development at Rottnest Island. The South Thomson Barge Landing Development is situated at South Thomson Bay, Rottnest Island (herein referred to as 'the proposal'). The site for the proposal is approximately 4.6 ha in size and includes the Army Groyne and adjacent foreshore up to the intersection of Army Jetty Road and Parker Point Road.

1.2 Proposal

The Rottnest Island Authority (RIA) is proposing to upgrade the former Army Groyne in Thomson Bay South, Wadjemup/Rottnest Island to facilitate the relocation of commercial barging operations away from the Main Jetty in Wadjemup/Rottnest Island. The Main Jetty is experiencing significant pressures due to increasing demand for commercial services with current commercial landing and storage facilities located in close proximity of recreational visitors. The RIA identified the need to relocate commercial operations away from the Main Jetty initially in the 20-year master plan for Rottnest Island (RIA 2019), and more recently in the Rottnest Island Management Plan (RIMP) 2023-28 (RIA 2023). The upgrade of the former Army Groyne ('the proposal') will reduce public safety risks and improve the overall visitor arrival experience.

Once operational, all commercial supplies will be brought on to Rottnest Island via the new landing facility at Thomson Bay, South, typically via motorised barge, and transported to the final destinations on the Island as soon as possible. Road access is via Army Jetty Road only and vehicle activity predominantly comprises light vehicles

The proposal and the proposal's Development Envelope (DE) as shown in **Figure 1**, comprises:

- A breakwater / groyne;
- Ferry berth;
- Landing Craft Tank (LCT) barge ramp;
- Small craft fuel jetty;
- Navigation aids (guide dolphins);
- Dredge pocket / turning basin;
- A laydown area, including covered storage and underground for storage for vessel refuelling;
- Installation of erosion and scour protection (rock armour revetment); and
- Onshore storage shed.

A minimum of two barges per day (excluding weekends) are anticipated to dock at the landing facility. However, this may increase as extra services are required to support island logistic needs.

Operations are anticipated to be undertaken during daylight hours, except under exceptional circumstances where night delivery is required.

The proposal is anticipated to have an operating life of minimum 50 years.

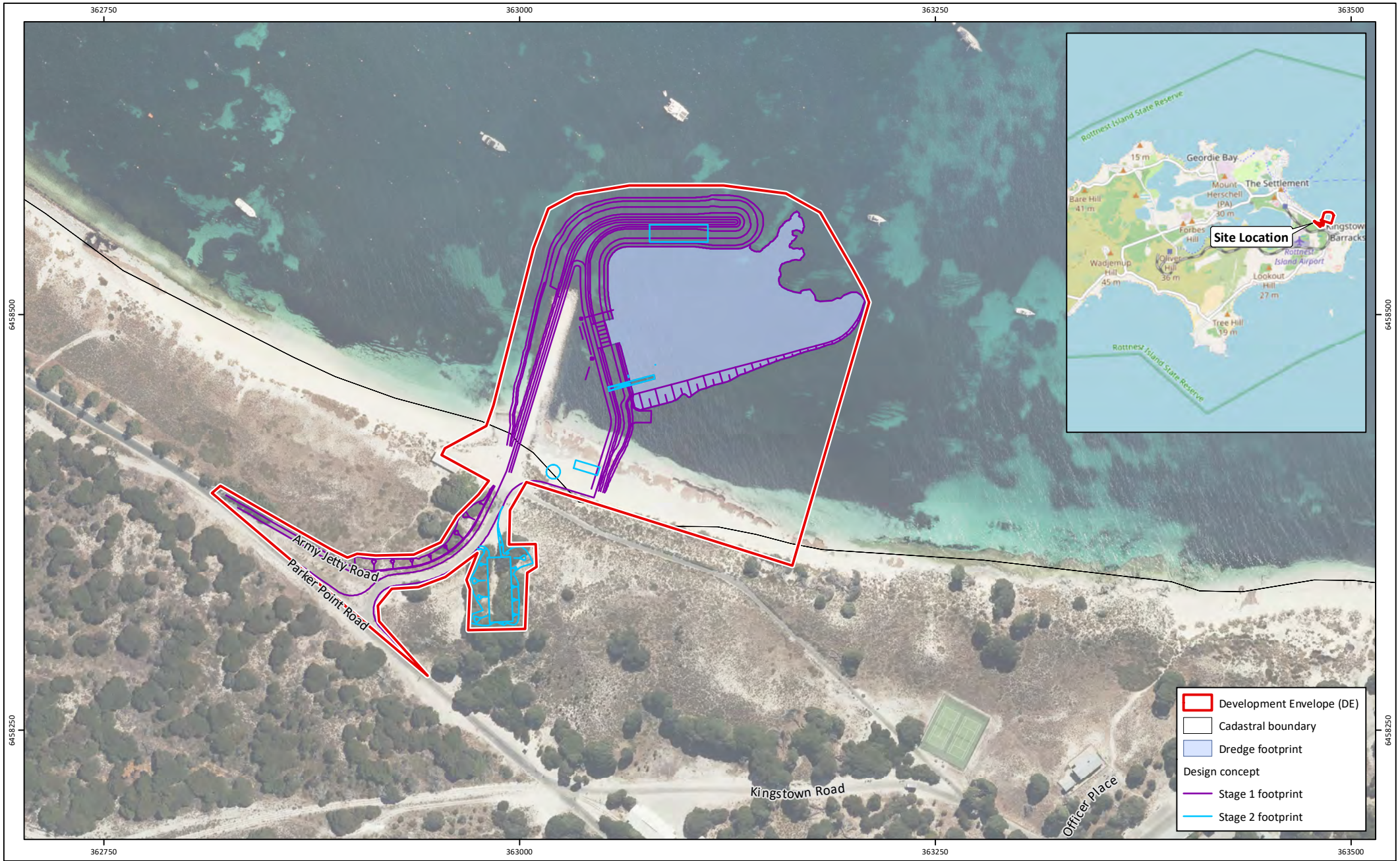

Figure 1: Project Overview

Project: Operational Environmental Management Plan
South Thomson Barge Landing Development

Client: Rottnest Island Authority

Plan Number:
EP24-014(01)--F01a

Drawn:	CTH
Date:	18/07/2024
Checked:	SPL
Approved:	LE
Date:	30/07/2024

N

0 50 100
Metres

Scale: 1:3,000@A4

GDA2020 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used
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1.3 Scope and purpose of this OEMP

This OEMP will support the environmental referrals to satisfy the Western Australian Environmental Protection Authority (EPA) that the RIA can adequately manage all operational related environmental impacts of the proposal so that any residual impacts on the environment are acceptable. This OEMP provides the background information and strategic and broad environmental management considerations for the proposal and includes procedures and processes for environmental management during operations.

This OEMP will also set out the reactive monitoring approach for water quality and benthic communities and habitat (BCH) should there be an incident (e.g. fuel spill) to compare with baseline conditions.

This OEMP has also been prepared in compliance with and as a supporting document to the 'Rottnest Island Management Plan 2023-2028' (RIA 2023).

1.4 Key environmental factors

This OEMP considers seven key environmental factors that relate to the environmental management of the proposal's operation. The factors include:

- Marine environmental quality
- Benthic communities and habitats
- Marine fauna
- Coastal processes
- Flora and vegetation
- Terrestrial fauna
- Social surroundings

Table 2 outlines the environmental values for each of the key environmental factors and describes the proposal activities that would likely affect each of these factors.

Table 2: Key environmental factors and values relevant to the operational phase of the proposal

Key environmental factor	Proposal activities	Environmental values
Marine environmental quality	Freight operation activities involving: • Increased barge traffic and activities • Vessel maintenance activities - breakdown of anodes, substances leaching out of marine debris, degradation of antifoul coatings, and hydrocarbons from vessels or a potential spill incident • Increased human presence – rubbish/ debris/ waste. • Land vehicle movement and activities – potential spill incident	• Wadjemup/Rottnest Island waters have been assigned a "High" indicative level of ecological protection, in accordance with Table 3 of the EPA's MEQ Technical Guidance (EPA 2016) which requires all environmental values to be protected which are: o Ecosystem health – protecting the quality of water, sediment and biota within the area o Fishing and aquaculture – ensuring seafood is safe for eating o Recreation and aesthetics – the area is valued for its marine recreation and tourism o Industrial water supply – not applicable to proposal. o Cultural and spiritual values – the area is culturally important to Western Australians, including the local Noongar communities.
Benthic communities and habitats (BCH)	Freight operation activities involving: • Increased barge traffic and activities in proximity to the benthos • Vessels containing hydrocarbons can enter the marine system through vessels or a potential spill incident	• There are dense healthy seagrass meadows and macroalgae communities within the proposal DE and surrounding the Island.
Marine fauna	Freight operation activities involving: • Increased barge traffic and activities - Increased underwater noise, potential collision. • Increased human presence – rubbish/ debris/ waste. • Increased artificial lighting for barge facility	• The Protected Matters Search Tool (PMST) search identified 43 threatened fauna species within a 5 km radius of the proposal area, though Wadjemup is home to a large diversity of fauna including those not threatened. • Recreation and aesthetics – marine fauna species in the area may include commercially and recreationally important species.
Coastal processes	Freight operation activities involving: • Extension of the breakwater/groyne • Increased barge traffic and activities - wave action, sediment disturbance, and habitat alteration	• Thomson Bay shoreline consists mainly of sandy beaches interspersed with rocky outcrops and limestone reefs. • Wadjemup/Rottnest Island is surrounded by large quantities of coral reefs and rock formations. • Benign wave climate within Thomson Bay.
Flora and vegetation	Freight operation activities involving: • Increased vehicle movement and activities • Increased human presence – rubbish/ debris/ waste.	• The condition of the vegetation across the proposal area is largely good, with some mixed patches of degraded vegetation. One vegetation unit (MlAp*Td) is considered to be representative of the State-listed Threated Ecological Community (TEC) *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands of the Swan Coastal Plain and is considered to be of State significance. This vegetation unit is also representative of a pre-European vegetation association and/or complex that has less than 30% of the original extent remaining and is therefore considered regionally significant.

Table 2: Key environmental factors and values relevant to the operational phase of the proposal (continued)

Key environmental factor	Proposal activities	Environmental values
Terrestrial fauna	Freight operation activities involving: • Increased vehicle movement and activities • Increased noise and dust • Increased human presence – rubbish/ debris/ waste.	• A total of 76 conservation significant fauna species were identified as having a likelihood of occurrence within the site. • One conservation significant fauna species was recorded within the proposal area, the Quokka (*Kwoka; Setonix brachyurus*), listed as Vulnerable (VU) under the EPBC Act and BC Act • Four fauna species are considered as having the Potential to occur within the proposal area including: o *Pandion haliaetus* (Osprey; listed as MI under the EPBC Act and BC Act); o *Tiliqua rugosa konowi* (Rottnest Island bobtail; listed as VU under the BC Act); o *Lerista lineata* (Perth slider; listed as Priority [P] 3 by DBCA); and o *Pseudonaja affinis exilis* (Rottnest Island dugite; listed as P4 by DBCA). • Two fauna habitat types were recorded within the proposal area
Social surroundings	Freight operation activities involving: • Freight operations • Increased traffic (vehicles / vessels) – disturbance to recreational users of the area (increased noise, odour and lighting).	• Local community, visitors and tourists utilise the area, including recreational boaters who hold existing moorings within the vicinity of the Army Groyne. • The site contains cultural, spiritual and heritage values associated with the broader cultural indigenous significance with Wadjemup/ Rottnest Island, and the historical heritage value of the Army Groyne.

1.5 Condition requirements

The template for the *Environmental Protection Act 1986 Part IV – Environmental Management Plans* requires a table be provided of the Ministerial Statement conditions (including any environmental objectives / outcomes), if applicable, and in which section of the environmental management plan (EMP) they are addressed.

This OEMP will support environmental referrals as described in **Section 1.3** and therefore does not have Ministerial Statement conditions.

1.6 Rationale and approach

This OEMP addresses potential impacts to the key environmental factors determined as being relevant to the operational aspects of the proposal. The results of the baseline environmental assessments and associated assumptions and uncertainties have informed the approach for meeting the management provisions outlined in **Section 2**. The identified targets, actions, and proposed review and revision of targets / actions are aligned with the overall management approach and are designed to ensure that the environmental objectives for each key environmental factor can be met.

1.6.1 Survey and study findings

Table 3 below summarises the key studies and surveys that have been undertaken for the proposal as relevant to the scope of this OEMP.

Table 3: Key studies and findings

Study / survey	Key findings
Environmental Advisory Report – Repair and extension of former Army Jetty, Rottnest Island (RPS 2019)	The Environmental Advisory Report was prepared by RPS to assess the proposal scenarios, identify the key environmental values / impacts, provide approvals advice/ strategy, and recommend controls. The key findings of the report include: • The vegetation within the survey area does not comprise a high level of biological diversity. Species richness of the vegetation sampled is relatively low. Survey determined None of the vegetation represents state or Commonwealth Threatened and Priority Ecological Communities (TEC/PEC). • Terrestrial habitat not expected to home conservation significant fauna species, • Aboriginal heritage significance within the area. Marine heritage 'Uribes' site sits within shallow water nearby to the jetty. • Benthic communities - predominately seagrass, support habitat for marine fauna • The proposal poses a range of potential impacts including: o direct loss of seagrass impacting benthic communities and habitats, o creation of dredge plumes affecting marine environmental quality o alteration of coastal processes including changes in wave and current patterns o potential contamination from dredging o loss of terrestrial vegetation o potential impacts on both marine and terrestrial fauna due to habitat disturbance o potential impacts on social surroundings such as vessel movement, moorings, and recreational activities • Given estimated seagrass loses and the high level of public interest around any development on Rottnest Island, the proposal is being referred to the EPA under Section 38 of the EP Act.

Table 3: Key studies and findings (continued)

Study / survey	Key findings
Sampling and Analysis Plan (SAP) Implementation Report – Rottnest Island Army Jetty Dredging (RPS 2020)	• SAP investigations undertaken determined that all results were reported below relevant default guideline values, and the sediments are not considered to pose a significant risk during dredging. • Only one sediment is classified as Potential Acid Sulfate Soils (PASS) based upon DWER guidelines, however the Acid Neutralizing capacity (ANC), is not included, with only inorganic acidity detected. The SAP determined that lime treatment of the material is not required when the sediment is disturbed and used for reclamation activities. The ANC is sufficiently kinetically available to safeguard against acidification over the long term. • Perfluorooctane sulfonate (PFOS) concentrations were observed within a PFOS elutriate analysis and in the surface water at the site, indicating the presence of low level PFOS within the existing environment. Only very low concentrations of PFOS were observed in sediments/ elutriates and given the low concentrations, it is expected that the concentrations would be diluted quickly within the marine environment during the works. As a result, there is not considered to be any risk to receptors from PFAS during dredging and therefore no specific management requirements are considered necessary.
Flora and Vegetation Survey South Thomson and Kingstown Rottnest Island (Wadjemup) (Focused Vision 2023)	Survey within the broader area identified: • No Threatened flora listed under the Biodiversity Conservation Act 2016 (BC Act) or the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) were recorded. • No Priority species listed by the Department of Biodiversity, Conservation and Attractions (DBCA) were recorded. • No weeds listed as Weeds of National Significance (WoNS) or Declared Pest (DP) plants under the Biosecurity and Agriculture Management Act 2007 (BAM Act) were recorded. • The condition of the vegetation was found to range from 'Excellent' to 'Completely Degraded' with the greatest proportion in 'Good' and 'Degraded' condition. • Nine vegetation units and four other classifications (Beach, Planted, Open Water and Cleared areas) were defined and mapped within the survey area. • Two of the recorded vegetation units were determined to be characteristic of the State-listed *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands, Swan Coastal Plain Threatened Ecological Community (TEC) (*Callitris preissii - Melaleuca lanceolata forests and woodlands TEC*). • The remaining extent of the one vegetation association (vegetation association 125) supported by the survey area falls below the 10% retention target in the context of the Swan Coastal Plain, and two vegetation associations relevant to the survey area represented by less than 30% of pre-European extent across the Swan Coastal Plain and Perth IBRA sub-region. • Vegetation units MlAp and CpMl are considered to be representative of the State-listed *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands TEC (FCT 30a), and therefore, these units are considered to be of State significance. • Rottnest Island (Wadjemup) is an A Class Reserve and an ESA, therefore all vegetation it supports is considered to be of State and regional significance. • Vegetation is representative of pre-European vegetation associations and/or complexes that have less than 30% of their original extent remaining and are therefore considered regionally significant.
South Thomson Barge Landing Development Marine Fauna and Benthic Habitat Assessment (RPS 2023b)	• The BCH assessment identified seagrass and macroalgae species along with bare substrate within the proposal DE. A wider Local Assessment Unit was also assessed where similar habitat were also identified, along with limestone reef/pavement outside the DE. • A list of species that may occur within the DE was collated and included 41 threatened marine fauna species and 92 listed marine or migratory marine fauna species that may occur in Thomson Bay. Key species for monitoring and management were not identified.

Table 3: Key studies and findings (continued)

Study / survey	Key findings
Matters of National Environmental Significance Assessment Report – South Thomson Bay Maritime Facilities Redevelopment, Rottnest Island (RPS 2023a)	• The PMST search (10km radius) identified the potential for the following MNES to occur within the proposal footprint: o Commonwealth marine area o Listed threatened species (10km radius): Flora- dwarf bee orchid (*Diuris micrantha*), 43 threatened fauna species (primarily bird species). o Listed migratory species (10km radius): 102 migratory species, predominately bird species. • As identified in the report potential impacts on MNES include[1]: o Potential impacts of up to 3.48 ha of terrestrial vegetation comprising habitat for quokka (vulnerable). o Potential impacts of up to 1.68 ha of benthic habitats which may provide habitat for listed threatened marine species. o Introduction of invasive marine species during the operation of the proposal • It should be noted that the disturbance impact area has changed since the initial MNES report investigation. • Activities during construction may have an impact on the behaviour of migratory species in the area. The severity of these impacts would only be significant if piling is proposed. • The MNES assessment did not identify any significant impacts to MNES within the offshore proposal footprint and it is unlikely that an EPBC referral will be required. However, if future site investigations or changes to proposal design result in the following impacts, then an EPBC referral would be required.
South Thomson Barge Redevelopment Flora and Vegetation Survey (RPS 2024b)	• Three (3) vegetation units were described to cover the South Thomson Barge Landing Onshore Area, including Vegetation unit MlAp*Td is analogous with the Threated Ecological Community (TEC) *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands of the Swan Coastal Plain. • Vegetation condition assessed as largely Good, mixed with patches of Degraded vegetation. • Seventeen (17) flora species were recorded in the survey area, four of which were introduced. None of these introduced taxa are Declared Organisms (DPIRD, 2023) or Weeds of National Significance (Weeds Australia, 2023). • The proposal proposes impacts to: o 0.17 ha of vegetation type ApAf*Td in Good to Degraded Condition. o 0.23 ha of vegetation type MlAp*Td in Degraded to Good Condition. This vegetation unit is analogous with the Threated Ecological Community (TEC) Callitris preissii (or Melaleuca lanceolata) forests and woodlands of the Swan Coastal Plain. o 0.06 ha of vegetation type Sc*TdSl in Good to Degraded Condition.
Rottnest Island Basic Fauna Survey (Eco Logical Australia 2024)	• A total of 76 conservation significant fauna species were identified as having a likelihood of occurrence within the site. • One conservation significant fauna species was recorded within the survey area, the Quokka (*Kwoka; Setonix brachyurus*), listed as Vulnerable (VU) under the EPBC Act and BC Act • Four fauna species are considered as having the Potential to occur within the survey area including: o *Pandion haliaetus* (Osprey; listed as MI under the EPBC Act and BC Act).; o *Tiliqua rugosa konowi* (Rottnest Island bobtail; listed as VU under the BC Act). o *Lerista lineata* (Perth slider; listed as Priority [P] 3 by DBCA); and

Table 3: Key studies and findings (continued)

[1] Noting the disturbance areas referenced in the MNES Report have now changed given changes to the DE. Correct values are reported in **Section 2** of this OEMP.

Study / survey	Key findings
(continued from above)	o *Pseudonaja affinis exilis* (Rottnest Island dugite; listed as P4 by DBCA). • Two fauna habitat types were recorded within the survey area.
Coastal Processes Assessment (Baird 2024)	• Wave assessment – the dominant wave conditions at the proposal location were identified to be from the north and north-east, which would be reduced by the proposed construction to allow for safe berthing of the barges. • Sediment transport assessment – sediment transport and the shoreline has already adapted to the existing structures, and the additional proposed construction was not considered to have a significant impact to the current conditions. • Wrack accumulation (build of material) – it was considered that the proposal will not have a significant impact on the timing or volume of wrack accumulation across the beaches of Thomson Bay.
South Thomson Barge Landing Development Project - Underwater Acoustic Assessment (Tetra Tech 2024)	An underwater noise assessment was undertaken for the proposed barge facility. Two noise generating methods were implemented - Impact pile driving and Vibratory pile driving, with the findings as below: • Impact pile driving involves a weighted hammer that pile drives foundations into the sea floor. The largest distance was modelled to be 84 meters corresponding to 160 dB for a marine mammal. Distance to threshold values were low. For fish injury/ behavioural onset the largest distance was modelled to be 348 meters corresponding to the 150 dB marine mammal behavioural criterion without mitigation for the impact installation of the 24-inch pile diameter. There were no associated distances for Sea turtle injury and behavioural onset because the thresholds are greater than the source level. • Vibratory pile driving involves rotating eccentric weights on shafts. The largest distance was modelled to be 167 meters corresponding to 120dB for marine mammal injury/ behavioural onset. For fish behavioural onset results, the largest distance of 21 meters occurred for unmitigated distance to the 183 dB acoustic threshold for the vibratory installation of the 24-inch pile diameter. There were no associated distances for Sea turtle injury and behavioural onset because the thresholds are greater than the source level.
Rottnest Barge Facility - Acoustic Assessment (Herring Storer Acoustics 2024)	A land noise assessment was undertaken for the land-based activities of the existing Rottnest barge facility. The findings include: • The main source of noise emissions come from forklift and truck movements as well as noise from settling containers down during the loading and unloading phases. o Forklift movement: 92 dB o Truck movement: 94 dB o Container set down noise: 101 dB • It is considered likely that impulsive characteristics would be present only for container set down noise, therefore a +10 dB adjustment is applicable to these noise levels. • During operation and noise emissions from the facility, vehicle movements will need to comply with the regulation levels. • The results indicate that noise emissions from the existing operations at the Rottnest barge facility comply with the criteria set out by the *Environmental Protection (Noise) Regulation 1997* at all times.

1.6.2 Key assumptions and uncertainties

The proposal has been comprehensively surveyed under commissioning by the RIA to ensure confidence in the predicted and identified occurrences of conservation significance species and the vegetation, fauna, and landscape characteristics.

The information provided in this OEMP relies on the accuracy and adequacy from the numerous field surveys and methods provided in the investigations. These surveys have been completed in compliance with EPA and Department of Climate Change, Energy, the Environment and Water (DCCEEW) requirements.

It is assumed that the surveys and assessments have adequately:

- Identified the flora, vegetation, fauna, and marine benthic and fauna conservation values present within the DE.
- Mapped and understood respective the local and regional scale of surroundings to ensure potential direct and indirect impacts are accurately determined for the proposal.
- The surveys undertaken to date have accurately reported the distributions and status of conservation significant species.
- Those conditions experienced during the survey and assessments were ideal for recording species appropriately, unless specified otherwise.
- That applicable surveys and assessments have been completed as per relevant technical guidance methodologies.

Key uncertainties include:

- Cumulative impacts to fauna and fauna habitats resulting from Third-Party operations which may be conservative and may not represent the most accurate levels of disturbance.
- The adaptive management processes adopted by this OEMP (Section 3) allows for management actions and monitoring to be revised as new information becomes available.

1.6.3 Management approach

This OEMP adopts management provisions to achieve the environmental objectives and environmental performance outcomes (EPO's)for each key environmental factor identified in **Section 1.4**. The following sections of the OEMP have been developed based on the mitigation hierarchy (avoid, minimise, rehabilitate, offset; EPA 2015) and detailed reviews of the various studies and surveys completed for the proposal. The hierarchical approach focuses on avoiding impacts to the key environmental factors. Where impacts are unavoidable, management aims to minimise the duration, intensity and/or extent of impacts on key environmental factors during operations.

1.6.4 Rationale for choice of provisions

This OEMP adopts objective-based provisions established on industry standard practices for avoidance, minimisation, and rehabilitation of environmental impacts during operations.

Outcomes-based provisions were not considered in the management approach for this OEMP due to the early concept phase of the proposal. In addition, the purpose of this OEMP as described in **Section 1.3**, is to support the environmental referrals and outline the proposed approach to

adequately manage operational related environmental impacts of the proposal so that any residual impacts on the environment are acceptable.

An objective-based approach has been followed to ensure the risk of secondary or indirect impacts are minimised, typically to the level of 'as low as reasonably practicable' (ALARP). Management actions (safeguards and controls) and performance targets have been assigned to ensure the associated objectives are achieved (**Section 2**). The provisions reflect the activities presented in **Section 1** and the nature of impacts posed by operational activities included in **Table 2**.

The choice of management actions and targets are considered to be appropriate to minimise and mitigate identified environmental impacts and ensure effective and efficient environmental management in order to achieve the environmental objectives stated in **Section 2**.

2 OEMP Components

2.1 Overview

This OEMP will support environmental referrals as described in **Section 1**, and therefore has not been developed to meet any Ministerial Statement requirements. The following sections of this OEMP outline the key impacts and risks associated with each of the environmental factors relevant to the operations, and the proposed management targets and actions that relate to these in order to achieve the overall management approach as described in **Section 1.6.3**.

As the operator of the facility, the RIA will be responsible for carrying out all management actions and monitoring requirements proposed in this OEMP unless stated otherwise.

2.2 Marine environmental quality

2.2.1 EPA Objective

To maintain the quality of water, sediment and biota so that environmental values are protected.

2.2.2 Key impacts and risks

The key impacts and risks to marine environmental quality identified for the operational activities of the proposal are summarised in **Table 4**.

Table 4: Marine environmental quality - Key impacts and risks

Operational activity	Key potential impacts/risks
Barge traffic	• Toxicants, such as heavy metals and metalloids, can enter the marine system through vessel maintenance activities, breakdown of anodes, substances leaching out of marine debris, degradation of antifoul coatings, and hydrocarbons from vessels or a potential spill incident. • Disturbance from sediments from vessel operations in shallow waters can cause temporary increase in turbidity (measured as total suspended solids (TSS)). • Hydrocarbons can enter the marine system through vessels or a potential spill incident (i.e during vessel refuelling) • Changes to load, bioavailability and/or concentration of nutrients • Increased human made rubbish/debris, including solid wastes, hazardous wastes, and grey water/liquid wastes
Landside activities	• Hydrocarbons can enter the marine system through landside vehicles or a potential spill incident on land can discharge into the marine environment • Changes to load, bioavailability and/or concentration of nutrients due to stormwater runoff • Increased human made rubbish/debris, including solid wastes, hazardous wastes, and grey water/liquid wastes

2.2.3 Environmental protection outcomes

As per the Environmental Review Document (ERD) (RPS 2024a), the EPO's developed for the proposal in relation to marine environmental quality include:

- MEQ is maintained at a High Level of Ecological Protection within and adjacent to the proposal footprint.
- No reported hydrocarbon spills or release of waste into the marine environment from operational activities associated with the proposal.

The EPO's have informed the management targets and actions presented in **Table 5**.

2.2.4 Environmental management strategies

The proposed provisions for the operation of the proposal as relevant to marine environmental quality communities are summarised in **Table 5**.

Table 5: Marine environmental quality – environmental management

Management targets	Management actions	Monitoring/Reporting	Frequency/ timing of monitoring	Reporting	Responsible party
No significant changes to available nutrients associated with vessels No hydrocarbon/toxicant spills from vessels No increase to human-made rubbish/debris entering the marine environment from vessels	• Implement Department of Transport's Maritime Environmental Emergency Response (MEER) oil spill response protocols. • Implement standard waste minimisation and reduction strategies, including providing facilities for waste disposal. • Implement routine removal and off-site disposal of wastes in accordance with State and local policies and procedures. • No liquid waste to be discharged anywhere in Rottnest Island waters, including waste from marine sanitation devices. • Vessels to comply with RIA and DoT boating guidelines for operations in shallow coastal area to reduce sediment disturbance from propellers.	• Visual monitoring to be undertaken by vessel crew and reactive management to be conducted as required. • Hydrocarbon spills into the marine environment be immediately reported to MEER (ph. 9480 9924). • Reporting of any incidents, e.g. possible impacts to water quality with relation to barge traffic operations due to waste or chemical spill. • Requirement for MEQ reactive monitoring after a hydrocarbon-chemical spill incident to be considered on a case by case basis.	• Visual monitoring throughout operations, reactive management following an incident.	• Following an incident • All spills to be reported to RIA who will notify DoT (Oil pollution reporting 9480 9924).	• RIA • Vessel master
No significant changes to available nutrients entering the marine environment from land activities No hydrocarbon/toxicant spills entering the marine environment from land activities No increase to human-made rubbish/debris entering the	• Hydrocarbon spills to be contained as soon as possible and bunded to prevent leakage into the marine environment • Implement standard waste minimisation and reduction strategies, including providing facilities for waste disposal. • Implement routine removal and off-site disposal of wastes in accordance with State and local policies and	• Visual monitoring to be undertaken by landside crew and reactive management to be conducted as required • Reporting of any incidents to RIA for landside spills • Hydrocarbon spills into the marine environment be immediately reported to MEER (ph. 9480 9924).	• Visual monitoring throughout operations, reactive management following an incident.	• Following an incident .	• RIA

Table 5: Marine environmental quality – environmental management (continued)

Management targets	Management actions	Monitoring/Reporting	Frequency/ timing of monitoring	Reporting	Responsible party
marine environment from land activities	procedures, including implementation of safety and leak detection equipment installed in accordance with AS1940 • Implement Department of Transport's Maritime Environmental Emergency Response (MEER) oil spill response protocols if hydrocarbons are entering the marine environment.	• Requirement for MEQ reactive monitoring after a hydrocarbon-chemical spill incident to be considered on a case by case basis.	*(continued from above)*	*(continued from above)*	*(continued from above)*

2.3 Benthic communities and habitats

2.3.1 EPA Objective

To protect benthic communities and habitats so that biological diversity and ecological integrity are maintained.

2.3.2 Key impacts and risks

The key impacts and risks to benthic communities and habitats identified for the operational activities of the proposal are summarised in **Table 6**.

Table 6: Benthic communities and habitats - Key impacts and risks

Operational activity	Key potential impacts/risks
Barge traffic	• The increased barge traffic and activities in proximity to the benthos can contribute to a reduction in seagrass through changes to local sediment transport, increased localised turbidity, uprooting/disturbance of seagrasses or introduction of invasive marine species. • Hydrocarbons can enter the marine system through vessels or a potential spill incident resulting in impacts to the health of seagrass meadows.

2.3.3 Environmental protection outcomes

As per the ERD (RPS 2024a), the EPO's developed for the proposal in relation to benthic communities and habitats include:

- Maintain the health and cover of BCH outside the proposal footprint during operations associated with the proposal (excludes other RIA activities associated with other approval conditions i.e. mooring relocations).

The EPO's have informed the management targets and actions presented in **Table 7**.

2.3.4 Environmental management strategies

The proposed provisions for the operation of the proposal as relevant to benthic habitats and communities are summarised in **Table 7**.

Table 7: Benthic communities and habitats – environmental management

Management targets	Management actions	Monitoring	Frequency/ timing of monitoring	Reporting	Responsible party
Minimise seagrass and macroalgae loss No hydrocarbon/toxicant/liquid waste spills	• Hydrocarbon spills into the marine environment to be managed in accordance with MEQ management actions in **Table 6**. • Implement speed and wake restrictions (as per DoT and Rottnest Island boating guidelines) for barges operating in sensitive coastal areas to minimize shoreline erosion and disturbance to intertidal and shallow BCH.	• Reporting of any incidents, e.g. water quality and BCH with relation to barge traffic operations • Requirement for BCH reactive monitoring after a hydrocarbon-chemical spill incident to be considered on a case by case basis.	• Throughout operations, following an incident	• As required	• RIA
No introduced marine species recorded	• Use the WA Department of Primary Industries and Regional Development (DPIRD) 'Vessel Check' risk assessment (https://vesselcheck.fish.wa.gov.au) and submit to RIA (including supporting documentation) for all dredging and support vessels (i.e., Dredge vessel and Barges) that mobilise from interstate or international waters. Risk assessment must indicate that the	• Vessel inspections • Inspection of jetty infrastructure in accordance with Rottnest Island Management Plan 2023-28: Maintain Maritime Infrastructure requirements	• Prior to vessel(s) entering the Proposal area. • As required for maritime infrastructure maintenance	• Notify RIA and DPIRD of the introduction of IMPs within 12 hours. • If pest is identified record location, date and time, size, colour, water depth, environment	• RIA • Vessel master

Table 7: Benthic communities and habitats – environmental management (continued)

Management targets	Management actions	Monitoring	Frequency/ timing of monitoring	Reporting	Responsible party
No introduced marine species recorded	vessel poses a low risk of IMP to the Proposal area. • All vessels will have a ballast water management plan and ballast water exchanges will be in accordance with IMO requirements and the Commonwealth Biosecurity Act 2015.	*(continued from above)*	*(continued from above)*	(e.g. beach, sand etc), and take a photo	*(continued from above)*

2.4 Marine fauna

2.4.1 EPA Objective

To protect marine fauna so that biological diversity and ecological integrity are maintained.

2.4.2 Key impacts and risks

The key impacts and risks to marine fauna identified for the operational activities of the proposal are summarised in **Table 8**.

Table 8: Marine fauna - Key impacts and risks

Operational activity	Key potential impacts/risks
Barge traffic	• Hydrocarbons can enter the marine system through vessels or a potential spill incident resulting in direct or indirect impacts to marine fauna. • Increased human made rubbish/debris, including solid wastes, hazardous wastes, and grey water resulting in direct or indirect impacts to marine fauna. • Removal, loss, or disturbance of individual organisms of a specific species. • Increased noise for vessel traffic potentially leading to behavioural response, injury or fatality. • Collision with marine fauna leading to injury or fatality • Introduction of marine pests/other marine species due to vessel movements from other locations.
Light pollution	• Artificial lighting from the barge facility can disrupt natural light cycles for coastal organisms, including marine fauna and migratory birds, potentially affecting behaviour, reproduction, and habitat use.

2.4.3 Environmental protection outcomes

As per the ERD (RPS 2024a), the EPO's developed for the proposal in relation to marine fauna include:

- No reported loss of marine fauna habitat outside of the approved footprint attributable to the operations of the proposal.
- No reported introduction or establishment of IMS as a result of operational activities associated with the proposal.
- No reported impacts to marine fauna as a result of hydrocarbon spill or release of waste associated with operational activities including entanglement or ingestion of waste.
- No reported death or injury to marine fauna from vessel strike associated with operational activities.
- No reported negative impacts on marine fauna attributable to the lighting requirements of the proposal associated with operations.

The EPO's have informed the management targets and actions presented in **Table 9**.

2.4.4 Environmental management strategies

The proposed provisions for the operation of the proposal as relevant to marine fauna are summarised in **Table 9**.

Table 9: Marine fauna – environmental management

Management targets	Management actions	Monitoring	Frequency/ timing of monitoring	Reporting	Responsible party
No impacts to marine fauna habitat (BCH) outside the development envelope associated with operations	• In accordance with BCH management given in Table 7	• In accordance with BCH management given in Table 7	• In accordance with BCH management given in Table 7	• In accordance with BCH management given in Table 7	• RIA
No introduced marine species recorded	• Use the WA DPIRD 'Vessel Check' risk assessment (https://vesselcheck.fish.wa.gov.au) and submit to RIA (including supporting documentation) for all dredging and support vessels (i.e., Dredge vessel and Barges) that mobilise from interstate or international waters. Risk assessment must indicate that the vessel poses a low risk of IMP to the Proposal area. • All vessels will have a ballast water management plan and ballast water exchanges will be in accordance with IMO requirements and the Commonwealth Biosecurity Act 2015.	• Vessel inspections • Inspection of jetty infrastructure in accordance with Rottnest Island Management Plan 2023-28: Maintain Maritime Infrastructure requirements	• Prior to vessel(s) entering the Proposal area • As required for maritime infrastructure maintenance	• Notify RIA and DPIRD of the introduction of IMPs within 12 hours (1800 815 507) • If pest is identified record location, date and time, size, colour, water depth, environment (e.g. beach, sand etc), and take a photo	• Vessel master • RIA
No hydrocarbon/toxicant	• Refer to Table 5	• Reporting of any incidents, e.g. hydrocarbon/chemical	• Refer to Table 5	• Refer to Table 5	• RIA • Vessel master

Table 9: Marine fauna – environmental management (continued)

Management targets	Management actions	Monitoring	Frequency/ timing of monitoring	Reporting	Responsible party
spills entering the marine environment No increase to human made rubbish/debris entering the marine environment	*(continued from above)*	spills in accordance with Table 5	*(continued from above)*	*(continued from above)*	*(continued from above)*
No vessel strike with marine fauna No death or injury to marine fauna	• Comply with the RIA and DoT operational requirements including 5 knot speed restrictions for barges and other vessels operating within the Rottnest Island 5 knots speed limit restriction area to minimise disturbance to marine fauna habitats and vessel will abide by the vessel approach distances (See **Appendix A**)	• Reporting of any incidents, e.g. vessel strikes • Throughout operations • Vessel master and/or trained crew to monitor for marine fauna during transit	• Throughout operations, following an incident	• As required • Marine fauna interactions that result in serious injury or facility/vessel strikes to be reported to DBCA (within 24hours (08) 9474 9055)	• RIA • Vessel master
No disturbance to marine fauna from light pollution	• Utilize low impact lighting fixtures and shielding techniques to reduce unnecessary nighttime lighting and minimize disruption to natural light cycles for coastal organisms. If unshielded fittings are used, lighting • Operational lighting to follow best practice measures as per the National Light Pollution Guidelines for Wildlife (DCCEEW 2023) including: o Only add light for specific purposes (e.g. navigation and safety)	• Inspection/audit post-construction to confirm lighting, including a visual inspection of the facility lighting from the shoreline and the Project infrastructure • Implement changes to lighting practices if needed, to mitigate light pollution and protect sensitive marine fauna habitats.	• As required following - installation of lighting or the modification or upgrading of the lighting • Throughout operations	• As required • Can be included with weekly site inspection checklist as required.	• RIA

Table 9: Marine fauna – environmental management (continued)

Management targets	Management actions	Monitoring	Frequency/ timing of monitoring	Reporting	Responsible party
(continued from above)	o Use adaptive light controls to manage light timing, intensity, and colour o Light only the object or area intended – keep lights close to the ground, directs and shielded to avoid light spill o Use the lowest intensity lighting appropriate for the task o Use non-reflective, dark-colours surfaces o Use lights with reduced or filtered blue, violet, and ultra-violet wavelengths. • Lighting on the barge facility should be kept to a minimum that is required for safe operation for vessels and infrastructure.	*(continued from above)*	*(continued from above)*	*(continued from above)*	*(continued from above)*

2.5 Coastal Processes

2.5.1 EPA Objective

To maintain the geophysical processes that shape coastal morphology so that the environmental values of the coast are protected.

2.5.2 Key impacts and risks

The key impacts and risks to Coastal Processes identified for the operational activities of the proposal are summarised in **Table 10**.

Table 10: Coastal Processes – Key impacts and risks

Operational activity	Key potential impacts/risks
Physical infrastructure	• Changes in sediment transport patterns due to the additional structures of the jetty can alter coastal erosion, sediment deposition, and shoreline morphology, affecting coastal ecosystems and sediment-dependent species. • Interruption to longshore sediment transport resulting in the potential for sediment bypassing the structure from east to west to be trapped at the proposed barge development within the breakwater basin area. • Interruption to seagrass wrack transport trajectories and deposition sites resulting in the accumulation of seagrass to occur on the eastern side of the proposed breakwater. • A reduction in wave height (when compared to the existing conditions) within the harbour basin area and to a lesser extent along the shoreline on the western side of the breakwater. • Reflection of waves off structures resulting in increased wave energy in the structures vicinity.

2.5.3 Environmental protection outcomes

As per the ERD (RPS 2024a), the EPO's developed for the proposal in relation to coastal processes include:

- Changes to coastal processes resulting from the proposal will be limited to the accumulation of sediment and seagrass against the wharf structure.

The EPO has informed the management targets and actions presented in **Table 11**.

2.5.4 Environmental management strategies

The proposed provisions for the operation of the proposal as relevant to coastal processes are summarised in **Table 11.**

Table 11: Coastal processes – environmental management

Management targets	Management actions	Monitoring	Frequency/ timing of monitoring	Reporting	Responsible party
Maintain the natural cycles of sand deposition and erosion and avoid build-up of wrack at the barge landing facility.	• Monitor shoreline accretion and seagrass accumulation on east side of facility. • Implement coastal monitoring program as required in the Coastal Hazard Risk Management & Adaptation Planning (CHRMAP).	• Site inspections by coastal technical advisor and photo monitoring	• Annually	• At least once between Autumn and Spring each year	• RIA

2.6 Flora and Vegetation

2.6.1 EPA objective

To protect flora and vegetation so that biological diversity and ecological integrity are maintained.

2.6.2 Key impacts and risks

The key impacts and risks related to flora and vegetation during operation of the proposal are summarised in **Table 12**.

Table 12: Flora and Vegetation – Key impacts and risks

Operational activity	Key potential impacts / risks
Vehicle / personnel movement	• Impact on vegetation from vehicle movement. • Spread of weeds and disease within the area (i.e. vehicles and personnel movements). • Spread of rubbish in vegetated areas.

2.6.3 Environmental protection outcomes

As per the ERD (RPS 2024a), the EPO's developed for the proposal in relation to flora and vegetation include:

- Direct impacts to native vegetation resulting from the proposal will not exceed 0.46 ha.
- Direct impacts to native vegetation (MlAp*Td) analogous with the TEC, *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands of the Swan Coastal Plain does not exceed 0.23 ha.
- No introduction of new weed species attributable to the proposal.

The EPO's have informed the management targets and actions presented in **Table 13**.

2.6.4 Environmental management strategies

The proposed provisions for the operation of the proposal as relevant to flora and vegetation are summarised in **Table 13.**

Table 13: Flora and Vegetation – environmental management

Management Targets	Management Actions	Monitoring	Timing / Frequency	Reporting	Responsible party
Control land vehicle movement to designated roadways	• Ensure access clearly marked, via paved road and laydown area.	• Detailed records of vehicle movements, including frequency, duration, and routes taken • Reporting of any observations/ incidents of vehicle-related impacts on flora and vegetation	• Weekly	• Inspection/ audit reports of vehicle movements	• RIA
Zero introduction of weed species to the site as a result of operations	• Ensure site access and laydown areas for vehicles and plant is arranged to utilise designated tracks and existing areas cleared of vegetation to minimise vegetation disturbance. • Ensure all applicable vehicles and plant remains within designated tracks, works areas, and laydown areas. • All operational personnel will be made aware of the clearing area boundaries through the induction / training process. • Vehicle inspection on site entry and exit to ensure the vehicle is free from obvious soil/organic material prior. • All machinery to be cleared of soil and plant material. Cleaning will occur at a suitable designated cleaning point with waste removed from the site (as required when detected). • All personnel will be made aware of weed management practices through the induction / training process.	• Visual inspection of earth moving mobile equipment and vehicles prior to leaving site for evidence of weed contamination.	• Weekly spot checks of mobile equipment and vehicles.	• Inspection/audit verify weekly spot checks of vehicles, plant and equipment enter site clean, including boots, and are regularly maintained • Induction records	• RIA

Table 13: Flora and Vegetation – environmental management (continued)

Management Targets	Management Actions	Monitoring	Timing / Frequency	Reporting	Responsible party
(continued from above)	• Weed and seed certificates to be provided for all vehicles and machinery prior to first mobilisation on Rottnest Island.	*(continued from above)*	*(continued from above)*	*(continued from above)*	*(continued from above)*
Ensure waste disposal measures and prevent rubbish and litter	• Waste disposal measures undertaken, e.g. bins/ cleanups, to prevent an increase in litter impact on surrounding vegetation	• Visual inspections for rubbish, pollutants and litter	• Weekly	• Inspections/ audits verify rubbish / litter is disposed of appropriately.	• RIA

2.7 Terrestrial fauna

2.7.1 EPA Objective

To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.

2.7.2 Key impacts and risks

The key impacts and risks to terrestrial fauna identified for the operational activities of the proposal are summarised in **Table 14**.

Table 14: Terrestrial fauna – Key impacts and risks

Operational Activity	Key potential impacts/risks
Vehicle movement / freight operations	• Vehicle movement could result in injury to native fauna. • Introduction and/or spread of weeds/ disease impacting fauna habitat (addressed in **Section 2.6** flora and vegetation). • Increased human presence in the vicinity has the potential to result in rubbish/debris/litter having an impact on surrounding terrestrial fauna.

2.7.3 Environmental protection outcomes

As per the ERD (RPS 2024a) the EPO's developed for the proposal in relation to terrestrial fauna include:

- Direct impacts to potential fauna habitat resulting from the proposal will not exceed 0.46 ha of native vegetation.
- No introduction of new weed species attributable to the proposal.
- No increase in incidents of terrestrial fauna injury or death during construction associated with the proposal works.

The EPO's have informed the management targets and actions presented in **Table 15**.

2.7.4 Environmental management strategies

The proposed provisions for the operation of the proposal as relevant to terrestrial fauna are summarised in **Table 15**.

Table 15: Terrestrial fauna – environmental management

Management Targets	Management Actions	Monitoring	Frequency/ timing of monitoring	Reporting	Responsible party
No incidents of terrestrial fauna injury or death during operations.	• Clearly demarcate vehicle access zones and roadways, ensuring no deviation that may have an impact on local terrestrial fauna populations. • Site speed limits are enforced to avoid or minimise vehicle strike incidents. • Vehicles are restricted to driving on designated road (i.e. Army Jetty Road). • Injured animals will be provided with first aid and handled on advice from the Wildcare Helpline (ph. 9474 9055) and RIA Rangers (ph. 9372 9788).	• Report any wildlife-vehicle collisions or other incidents involving fauna Wildcare Helpline (ph. 9474 9055) and RIA Rangers (ph. 9372 9788). • Weekly site inspections (walk overs) to ensure vehicle access areas are clearly demarcated.	• Fauna incident reporting as required. • Weekly site inspections (walk overs).	• Weekly site inspection checklist.	• RIA
Minimise risk of fauna habitat disturbance outside of the DE.	• Site inductions include information regarding fauna and ecological values adjacent to the proposal, key operations that may impact on fauna and fauna management requirements.	• Conduct regular site inspections (walk over) to ensure compliance with management actions outlined in the OEMP.	• Weekly inductions • Weekly site inspections (walk over)	• Induction records • Weekly site inspection checklist.	• RIA
Ensure waste disposal measures and prevent rubbish and litter	• Waste disposal measures undertaken, e.g. bins/ cleanups, to prevent an increase in litter impact on surrounding vegetation	• Visual inspections for rubbish, pollutants and litter	• Weekly	• Inspections/ audits	• RIA

2.8 Social surroundings

2.8.1 EPA Objective

To protect social surroundings from significant harm.

2.8.2 Key impacts and risks

The key impacts and risks to Social Surroundings identified for the operational activities of the proposal are summarised in **Table 16**.

Table 16: Social Surroundings – Key impacts and risks

Operational Activity	Key potential impacts/risks
Vehicle and vessel movements	• Disturbance to existing mooring licensees from increase in noise, lighting, odour and dust due to operation of Barge, and additional traffic. • Removal and relocation of vessel moorings. • Potential disturbance to swimmers from increased marine traffic.
Freight operations	• Freight operations can generate noise, odour and visual intrusions (lighting), potentially affecting the amenity of recreational users (i.e. boat users) of the area. The highest noise emissions from the current facility were associated with container set down noise and vehicle movement.

2.8.3 Environmental protection outcomes

As per the ERD (RPS 2024a), the EPO's developed for the proposal in relation to social surroundings include:

- Noise emissions do not exceed assigned noise levels as prescribed in the Environmental Protection (Noise) Regulations 1997.
- Maintain recreational fishing values by ensuring there are no observable impacts to benthic communities and habitats outside the ZoMI.
- Minimise risk of disturbance to UXO.
- No permanent loss or change to the total number of moorings as a result of implementation of the proposal.
- No impacts to registered Aboriginal cultural heritage sites.
- Maintain amenity values during construction and operation.

The EPO's have informed the management targets and actions presented in **Table 17.**

2.8.4 Environmental management strategies

The proposed provisions for the operation of the proposal as relevant to terrestrial fauna are summarised in **Table 17**.

Table 17: Social surroundings – environmental management

Management Targets	Management actions	Monitoring	Frequency/ timing of reporting	Reporting	Responsible party
Limit the impact on social surroundings, including noise, dust and visual intrusion (lighting) through controlled vehicle movement procedures, to avoid public and community issues	• Vehicle movements will be restricted to the designated access roads to minimise dust impacts and avoidance of Marine heritage. • Vehicle speeds will be restricted to minimise the generation of dust. • Lighting must meet all safety requirements whilst minimising the impact on adjacent boat users. Lighting to be directed to the barge area and away from the marine environment. • A community complaints procedure will be implemented for the life of the proposal and the community will be notified of how to make a complaint.	• Weekly site inspections (walk overs) to ensure vehicle access areas are clearly demarcated / appropriate signage is displayed. Inspections also to ensure lighting is adequately being directed to the barge area away from the marine environment.	• Weekly site inspections (walk overs).	• Weekly site inspections/ checklists. • Complaints register.	• RIA
Limit issues related to freight operations that may cause potential negative impacts on social surroundings	• Vehicle operation will occur during prescribed hours (between 07:00 and 17:00). Noise is not to exceed *Environmental Protection (Noise) Regulations 1997*. • Freight equipment / machinery to be regularly maintained (as appropriate per specifications) to avoid noise exceedances. • A community complaints procedure will be implemented for the life of the proposal and the community will be notified of how to make a complaint.	• Yearly monitoring of freight equipment / machinery to ensure regular maintenance is being undertaken as per specifications. • Noise monitoring may be undertaken if ongoing complaints are received to ensure levels are consistent with the *Environmental Protection (Noise) Regulations 1997*.	• Yearly maintenance reports for freight equipment / machinery. • Complaints register reporting as required.	• Equipment Maintenance Register. • Complaints register.	• RIA

Table 17: Social surroundings – environmental management (continued)

Management Targets	Management actions	Monitoring	Frequency/ timing of reporting	Reporting	Responsible party
Ensure waste disposal measures and prevent rubbish and litter impact on visual amenity	• Avoid and minimise waste impacts to the surrounding area from the proposal's operations. • Ensure all waste is either recycled or moved off site to the Island disposal facility.	• Weekly site inspections (walk overs) to ensure no waste / litter impacts to the surrounding area.	• Weekly site inspections (walk overs).	• Weekly site inspections/ checklists. • Complaints register.	• RIA
Ensure local amenity is protected and public safety measures are undertaken	• RIA to install floating markers/signs at the entrance to the barge landing (within development footprint) to prevent boat anchorage and swimming in peak season. • A community complaints procedure will be implemented for the life of the proposal and the community will be notified of how to make a complaint.	• Weekly site inspections (walk overs) to ensure appropriate signage is displayed to prevent boat anchorage and swimming during peak season.	• Weekly site inspection (walk overs) during peak season	• Visual site inspections/ photo log. • Complaints register.	• RIA
Minimise impacts to mooring holders	• If required and in consultation with mooring holders, the RIA may look to further relocate moorings if impacts attributable to the proposal are experienced.	• As needs basis.	• As needs basis.	• Complaints register	• RIA
No impact to social surroundings from odour	• Odour generated from waste compactors to be managed through short transfer intervals (removed on Tuesdays and Thursdays between 11am and 3pm).	• Monitoring / review of Contractors waste removal records for the facility.	• Weekly	• Contractors waste removal records	• RIA

3 Adaptive management approach

3.1 Overview

The RIA will implement an adaptive management approach in response to any issues identified in the implementation of management actions, monitoring and evaluation against the management targets. This approach involves modifying management and mitigation measures to meet the environmental objective more effectively for each of the key environmental factors. The adaptive management approach will be informed by:

- Evaluation of monitoring data.
- Review of assumptions and uncertainties.
- Re-evaluation of proposal-related risks.
- Increased understanding of the ecological regime.
- External changes during the life of the proposal.
- Changes in industry best practice.
- Changes in methodology or equipment used.

3.2 Environmental monitoring and corrective actions

If monitoring reveals any non-conformance with the environmental approvals, an investigation of the incident will be conducted, and the appropriate corrective measures will be implemented. These may involve modifications to equipment, processes, or management measures, as deemed necessary. Any alterations will be documented through the appropriate approval process and communicated to site personnel.

3.3 Audits

To guarantee the appropriate implementation of management measures and adherence to applicable design and environmental standards, routine environmental audits will be conducted by the RIA.

As previously described, the proposal is subject to further environmental approvals. Most activity specific management actions will be identified and detailed in other supporting documents for assessment and approval by DWER.

Consequently, auditing of relevant management actions may need to be undertaken in accordance with the relevant regulatory document (if required).

3.4 Management plan review

This OEMP will be reviewed on an as needs basis to determine if any changes are required to the management controls to maintain the EPA’s objective for each of the key environmental factors relevant to the proposal. Changes to legislation may also alter the nominated assessment criteria to be met. A review of the applicability of management objectives, targets and provisions will be conducted regularly during the proposal to update the OEMP.

4 Stakeholder Consultation

4.1 Key stakeholders

The following groups of stakeholders as outlined in **Table 18** have been identified as having an interest in the proposal.

Table 18: Key Stakeholders

State government agencies and Regulators	Local governments, authorities, and organisations	Local community groups

• Environmental Protection Authority (EPA)
• Department of Planning, Lands and Heritage (DPLH)
• Department of Transport (DoT)
	• Rottnest Island Chamber of Commerce (RICC)
	• The Rottnest Society
	• Rottnest Foundation
	• Wadjemup Aboriginal Reference Group (WARG)
		• Fishing groups
		  o BoatingWA
		  o Recfishwest
		• Marine groups:
		  o University of Western Australia (UWA)
		  o West Australian Divers for Diversity Inc (WADDI)
		  o Reef life
		  o Australian Marine Conservation Society (AMCS)
		  o Pew Trust
		  o SaveOurSeas
		• Quokka coaches
		• Pinnacle Travel Group
		• Mooring licensees
		• General Public

4.2 Stakeholder consultation undertaken to date

The RIA has continually engaged with stakeholders during the proposal's planning phase to facilitate a collaborative approach to the design and management of the proposal. A summary of the engagement undertaken to date with the above key stakeholders in outlined in **Table 19**.

4.3 Ongoing stakeholder consultation

Affected stakeholders will be kept aware of scheduled activities and impacts as the proposal progresses. The RIA will provide proposal updates via the RIA website and liaise directly with affected mooring holders as required.

Table 19: Summary of consultation with stakeholders: state government agencies and regulators, local government and the local community

Stakeholder	Date	Type of Consultation	Objective	Issues / Topics Raised	Proponent Response / Outcome
EPA Services EPA	October 2019	Face to face meetings / site visit	Introduction to the proposal and site visit	• The RIA provided an overview to the EPA on the plans and potential environmental issues for the proposal. • The RIA outlined the investigations to be undertaken including dredge plume modelling and jet probing.	• EPA were pleased with the update and the planned works investigations and raised no concerns.
	14/2/2020	Meeting and email	Advice sought on PFAS management measures	• The RIA described the elevated PFAS results in elutriate samples and sought advice on management for PFAS during dredging • The RIA and EPA agreed that the PFAS results in elutriate samples were a result of laboratory contamination. • Dredge material deemed to be suitable for reuse onsite and no additional sampling required, subject to: o Monitoring for PFAS to be outlined in a dredge management plan at the following locations: o Within waters surrounding the dredging. o Within dredge return waters. o Contingencies measures to be outlined in the dredge management plan for the management of dredge return water should PFAS be identified.	• The RIA engaged further sediment and surface water sampling works. • Results of further works did not identify PFAS at concentrations that would pose a risk to environment and human health.
	12/6/2023	Meeting	Discussion on recommencement of the proposal	• RIA and EPA discussed the recommencement of the project and outlined the baseline studies and management plans to be undertaken/developed as part of the progression to referral. • EPA noted that a Marine Environmental Quality Monitoring and Management Plan (MEQMMP) would be required in addition to the proposed suite of management plans.	• No further action.
	13/6/2023	Email	Advice sought on Aboriginal Cultural Heritage Act (ACHA) and the relationship with the EP Act.	• EPA provided links to published guidance on Aboriginal Cultural Heritage matters and the impacts that would be dealt with under ACHA and EP Act.	• To be addressed in approval documentation.
	19/2/2024	Emails	Advice on MEQMMP and OEMP	• The RIA proposed preparation of an Operational Environmental Management Plan (OEMP) instead of a Marine Environmental	• EPA agreed with the proposed change to prepare OEMP.

Table 19: Summary of consultation with stakeholders: state government agencies and regulators, local government and the local community (continued)

Stakeholder	Date	Type of Consultation	Objective	Issues / Topics Raised	Proponent Response / Outcome
(continued from above)				Quality Monitoring and Management Plan (MEQMMP) based on the limited ongoing risk to water quality.	
Rottnest Foundation	1/3/2024	Email	Introduction to the proposal	• The RIA provided a link to project information website page to inform of the proposal and request feedback. • No response received.	No further action.
Fishing groups: BoatingWA / Recfishwest	1/3/2024	Email	Introduction to the proposal	• The RIA provided a link to project information website page to inform of the proposal and request feedback. • No response received.	No further action.
Marine groups: UWA / WADDI / Reef life / AMCS / Pew Trust / SaveOurSeas	1/3/2024	Email	Introduction to the proposal	• The RIA provided a link to project information website page to inform of the proposal and request feedback. • No response received.	No further action.
DPLH	1/3/2024	Email	Introduction to the proposal	• The RIA provided a link to project information website page to inform of the proposal and request feedback. • DPLH requested to be informed of project updates.	No further action.
General public submission	1/3/2024-29/3/2024	Website advertisement	Introduction to the proposal	• The RIA published information on their website regarding the proposal with an opportunity for feedback to be received. • Overall, the submissions were opposed to the proposal with references to: o The negative terrestrial and marine environmental impacts (seagrass loss, land clearing, impact on quokka population, noise, water, and light pollution). o The negative impact to local boat users, island residents and local visitors	• Project justification to be identified within the EIA referral. • Marine environmental impact (loss of seagrass, water quality issues and light pollution) context and mitigations to be identified within the EIA referral. • Terrestrial environmental impact (impact on quokka population) context and mitigations to be identified within the EIA referral.

Table 19: Summary of consultation with stakeholders: state government agencies and regulators, local government and the local community (continued)

Stakeholder	Date	Type of Consultation	Objective	Issues / Topics Raised	Proponent Response / Outcome
(continued from above)				o Impact to the built-heritage value of the Army Groyne. o Concern for the loss of suitable anchoring grounds. o Concern for the increase in traffic along Parker Point Rd and associated public safety risk. o Support for refurbishment of the current jetty and barge landing instead of constructing new facility.	• Public amenity (noise, lighting, marine traffic and loss of anchoring grounds) context and mitigations to be identified within the EIA referral. • Public safety risk (i.e. traffic along Parker Point Rd) is addressed by policing and road regulations applicable to Rottnest Island roads. • Built heritage context of the Army Groyne addressed in separate submission to DPLH.
Rottnest Island Chamber of Commerce (RICC)	6/3/2024	Meeting	Introduction to the proposal	• The RIA presented to RICC monthly meeting with all business representatives present. • In general, there was support for the proposal. • Questions and comments were raised in relation to: o The logistics of ferry operations and luggage deliveries. o General questions about the status of baseline environmental studies. o General questions about project cost and timeframes. o Impacts to moorings and anchorage. o Upgrades to the access road.	• Workshop to be held to discuss ferry operations and logistics once funding and detailed designs are known. • RIA provided verbal responses to the other questions based on information known at the time.
Quokka coaches	7/03/2024	Email	Support for the proposal	• Email in support of the proposal stating: o Project will benefit the barge operators who currently work in a confined area. o Project will enhance overall visitor impression on arrival.	• No further action.
Pinnacle Travel Group	20/03/2024	Email	Support for the proposal	• Email in support of the proposal stating: o Project will increase the experience and amenity for tourists and improve the ability of ferry companies to operate. o Significantly reduce traffic around the jetty and main bus stop, easing congestion.	• No further action.

Table 19: Summary of consultation with stakeholders: state government agencies and regulators, local government and the local community (continued)

Stakeholder	Date	Type of Consultation	Objective	Issues / Topics Raised	Proponent Response / Outcome
The Rottnest Society	29/03/2024	Meeting	Introduction to the proposal	• The RIA presented to the Rottnest Society to inform of the proposal and request feedback. • Questions and comments were raised in relation to: o Concern for terrestrial and marine environmental impact. o Concern for lack of proposed revegetation and restoration. o Recommends that evaluation of current barge landing is undertaken to effectively reduce conflicts with pedestrians. o Notes that information was difficult to source as a result of the RIA website being upgraded.	• Project justification to be identified within the EIA referral. • Marine environmental impact context and mitigations to be identified within the EIA referral. • Terrestrial environmental impact (impact on quokka population) context and mitigations to be identified within the EIA referral.
Wadjemup Aboriginal Reference Group (WARG)	4/04/2024	Meeting	Introduction to the proposal	• The RIA presented to the WARG to inform of the proposal and seek feedback. • Questions and comments were raised in relation to: o In general, there was support for the proposal. o Concern for marine species impacted by the noise from piling, in particular whales. o Enquiry about heritage values in the project area o Works should stop should Aboriginal cultural material is disturbed. o Enquiry about incorporation of renewable energy in the design.	• RIA to notify WARG if any approvals are referred to for further investigation. • Cultural heritage (disturbance of Aboriginal heritage) context to be identified within the EIA referral. • Cultural heritage mitigations to be identified within Activity Notice documentation. • Design to consider sources of energy.
Mooring licensees	9/4/2024-24/4/2024	Letters, phone calls	Introduction to the proposal	• The RIA contacted mooring licensees to inform them of the proposal and the permanent/temporary relation of mooring (where applicable). • Overall, the responses were opposed to the proposal with general references to: o The negative impact to current vessel mooring licensee's, local boat users, island residents and local visitors. o Impact to the built-heritage value of the Army Groyne	• Project justification to be identified within the EIA referral. • Marine environmental impact (loss of seagrass, water quality issues and light pollution) context and mitigations to be identified within the EIA referral. • Terrestrial environmental impact (impact on quokka population) context and mitigations to be identified within the EIA referral.

Table 19: Summary of consultation with stakeholders: state government agencies and regulators, local government and the local community (continued)

Stakeholder	Date	Type of Consultation	Objective	Issues / Topics Raised	Proponent Response / Outcome
(continued from above)				o Concerns about the increased risk/safety to swimmers as a result of increasing marine traffic and boat wash. o Requests for relocation and clarification on the relocation process. o Concern for the loss of suitable anchoring grounds. o The negative terrestrial and marine environmental impacts (seagrass loss, land clearing, impact on quokka population, noise, water, odour and light pollution).	• Public amenity (noise, lighting, marine traffic and loss of anchoring grounds) context and mitigations to be identified within the EIA referral. • Public safety risk (i.e. traffic along Parker Point Rd) is addressed by policing and road regulations applicable to Rottnest Island roads. • Built heritage context of the Army Groyne addressed in separate submission to DPLH.
DoT	1/5/2024	Email	Introduction to the proposal	• The RIA provided a link to project information website page to inform of the proposal and request feedback. • DoT stated that a navigational safety channel is not required and that no additional lead lights are required.	• No changes to the marine safety infrastructure required. • No further action.

5 References

5.1 General references

The references listed below have been considered as part of preparing this document.

Baird 2024, *South Thomson Bay Barge Development Coastal Processes Assessment*, 13029.101.R1.Rev0, 0.

Commonwealth of Australia 2017, *Australian National Guidelines for Whale and Dolphin Watching 2017*, < https://www.dcceew.gov.au/sites/default/files/documents/aust-national-guidelines-whale-dolphin-watching-2017.pdf>. Accessed: 07.06.2024

DCCEEW (Department of Climate Change, Energy, the Environment and Water) (2023) National Light Pollution Guidelines for Wildlife, Department of of Climate Change, Energy, the Environment and Water, Canberrra, May. CC BY 4.0.

Eco Logical Australia 2024, *Rottnest Island Basic Fauna Survey*, 23PER6686, 3.

Environmental Protection Authority (EPA) 2016, *Environmental Factor Guideline – Marine Environmental Quality*, Perth.

Focused Vision 2023, *Flora and Vegetation Survey South Thomson and Kingstown Rottnest Island (Wadjemup)* 0.

Herring Storer Acoustics 2024, *Rottnest Barge Facility - Acoustic Assessment*, 1.

RIA 2019, *A 20 year vision - Rottnest Island Masterplan*, 1.

RIA 2023, *Rottnest Island Management Plan 2023–28*, 1.

RPS 2019, *Environmental advisory report - Repair and extension of former Army Jetty, Rottnest Island*, EEN18225.001, 0.

RPS 2020, *SAP Implementation Report - Rottnest Island Army Jetty Dredging*, EEC19032.011, 0.

RPS 2023a, *Matters of National Environmental Significance Assessment Report - South Thomson Bay Maritime Facilities Redevelopment, Rottnest Island*, AU213012591.001, 0.

RPS 2023b, *South Thomson Barge Landing Development Marine Fauna and Benthic Habitat Assessment*, AU213012799, B.

RPS 2024a, *Environmental Supporting Document - South Thomson Barge Landing Development, Wadjemup / Rottnest Island* AU213014226.001, C.

RPS 2024b, *South Thomson Barge Redevelopment Flora and Vegetation Survey*, AU213012799.001, 1.

Tetra Tech 2024, *South Thomson Barge Landing Development Project - Draft Underwater Acoustic Assessment*, 1.

Appendix A

Marine Fauna Vessel Approach Distances

Appendix A

To mitigate vessel traffic negatively impacting marine fauna by vessel strike will be minimised by vessels in the area adhering to the vessel speed restrictions in the area (5 knots). Vessels will adhere to vessel approach distance following EPBC Regulations 2000 – Part 8 Division 8.1: National Guidelines for Whale and Dolphin Watching (Commonwealth of Australia 2017) and the WA BC Act. No approach zones are zones of total vessel exclusion. Caution zones cannot be entered by a vessel if there is an animal that is injured, stranded, entangled or distressed, or if a single calf or pod of calves are present. Should a travelling dolphin enter the no approach zone, including with an attempt to 'bow ride', the vessel shall either maintain its course and speed, or maintain its course and gradually slow down.

Table A: Marine fauna - vessel approach distances (DoEE 2017)

Marine fauna group	Caution zone	No approach zone (metres)	Distress/disturbance
Adult whales	300	• 100 m to the side of the whale • 300 m in front or to rear of the whale	Withdraw from caution zone at speed less than 6 knots
Whale calf* present	-	300 m	Withdraw from No approach zone at speed less than 6 knots
Adult dolphins	150	• 50 m to the side of the dolphin • 150 m in front or to rear of the dolphin with the exception of animals bow-riding	Withdraw from caution zone at speed less than 6 knots
Dolphin calf* present	-	150 m	Withdraw from No approach zone at speed less than 6 knots

*A calf is defined as half the length of the mother/nearest adult

REPORT

Appendix R
Database searches

HERITAGE COUNCIL OF WESTERN AUSTRALIA

REGISTER OF HERITAGE PLACES

Permanent Entry

1. DATA BASE No. 00525

2. NAME *Kingstown Barracks* (1937)

3. LOCATION Rottnest Island (Phillip Point & Bickley Point)

4. DESCRIPTION OF PLACE INCLUDED IN THIS ENTRY

That part of Swan Location 10976, being part Crown Reserve 16713 and being part of the land comprised in Crown Land Record Volume 3096 Folio 976 as is defined in Heritage Council of Western Australia survey drawing No. 0525. prepared by Whelans Survey and Mapping Group Pty Ltd.

5. LOCAL GOVERNMENT AREA Rottnest

6. OWNER The Rottnest Island Authority

7. HERITAGE LISTINGS

• Register of Heritage Places:	Interim Entry	16/10/1992
	Permanent entry	01/10/2002
• National Trust Classification:	Classified	04/04/1969
• Town Planning Scheme:		----------
• Municipal Inventory:		----------
• Register of the National Estate:	Permanent	22/06/1993

8. CONSERVATION ORDER

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9. HERITAGE AGREEMENT

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10. STATEMENT OF SIGNIFICANCE

Kingstown Barracks, forming a component of a defence complex in the Inter-War Art Deco style and containing army institutional buildings with a tower as the focal feature, hospital and the cottages, a jetty, a battalion camp site and a gun battery with supporting communication and observation structures, has cultural heritage significance for the following reasons:

the place was a substantial component of the 1930s national coastal defence fortification, being one of two remaining establishments in Australia from the 1930s. It thus represents the fear of a foreign invasion and the international defence strategies of the time;

as part of World War II fortifications, it represents a system of defensive war activity and demonstrates the function of using ground

based mid-twentieth century weapons and supporting surveillance for protection of a key place;

the place is one of two remaining defence establishments in Australia conceived in the 1930s and inherently reflecting international defence strategies of the time;

the site contributes to an understanding of the military history of Western Australia by providing interpreted extant remains of the coastal defence fortifications, the 1930s type of army accommodation with the hierarchical segregation of personnel by rank, and the design style of an army institution in the years immediately prior to World War II;

the buildings are representative of 1930s army institution in the Art Deco style with semi-enclosed spaces and a tower as the focal feature; and,

the site is valued by the community for educational importance having the ability to demonstrate a tangible link with a major international event.

Protected Matters Search Tool

Report Generated - 10:49AM - 14 September 2023

Matters of National Environment Significance	Count
World Heritage Properties	0
National Heritage Places	0
Wetlands of International Importance (Ramsar Wetlands)	0
Great Barrier Reef Marine Park	0
Commonwealth Marine Area	0
Listed Threatened Ecological Communities	1
Listed Threatened Species	39
Listed Migratory Species	66

Other Matters Protected by the EPBC Act	Count
Commonwealth Lands	0
Commonwealth Heritage Places	0
Listed Marine Species	94
Whales and Other Cetaceans	12
Critical Habitats	0
Commonwealth Reserves Terrestrial	0
Australian Marine Parks	0
Habitat Critical to the Survival of Marine Turtles	0

Extra Information	Count
State and Territory Reserves	1
Regional Forest Agreements	0
Nationally Important Wetlands	1
EPBC Act Referrals	2
Key Ecological Features	0
Biologically Important Areas	12
Bioregional Assessments	0
Geological and Bioregional Assessments	0

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected and is accurate at the time of generation.
Please see the caveat for interpretation of information provided here. Consider carefully the age of information for decision making.

Report Metadata	Caveat

Back to Summary

Listed Threatened Species [Resource Information]

Species ID	Scientific Name	Common Name	Class	Simple Presence	Presence Text	Threatened Category	Migratory Status	Migratory Category	Marine Status	Cetacean Status	Website
86432	*Limosa lapponica*	Northern Siberian	Bird	Known	Species or species	Critically					Species Profile and
862	*Calidris tenuirostris*	Great Knot	Bird	Known	Foraging, feeding or	Critically	Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
847	*Numenius*	Eastern Curlew, Far	Bird	Likely	Species or species	Critically	Migratory	Migratory Wetlands	Listed		Species Profile and
856	*Calidris ferruginea*	Curlew Sandpiper	Bird	Known	Species or species	Critically	Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
77037	*Rostratula australis*	Australian Painted	Bird	May	Species or species	Endangered			Listed - overfly		Species Profile and
1060	*Macronectes giganteus*	Southern Giant-	Bird	May	Species or species	Endangered	Migratory	Migratory Marine	Listed		Species Profile and
879	*Charadrius mongolus*	Lesser Sand Plover,	Bird	Known	Foraging, feeding or	Endangered	Migratory	Migratory Wetlands	Listed		Species Profile and
64405	*Diomedea*	Amsterdam	Bird	May	Species or species	Endangered	Migratory	Migratory Marine	Listed		Species Profile and
89224	*Thalassarche cauta*	Shy Albatross	Bird	Likely	Foraging, feeding or	Endangered	Migratory	Migratory Marine	Listed		Species Profile and
855	*Calidris canutus*	Red Knot, Knot	Bird	Known	Species or species	Endangered	Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
64456	*Diomedea sanfordi*	Northern Royal	Bird	May	Species or species	Endangered	Migratory	Migratory Marine	Listed		Species Profile and
87737	*Zanda latirostris*	Carnaby's Black	Bird	May	Species or species	Endangered (listed					Species Profile and
64445	*Pachyptila turtur*	Fairy Prion	Bird	Likely	Species or species	Vulnerable					Species Profile and
26000	*Anous tenuirostris*	Australian Lesser	Bird	May	Species or species	Vulnerable			Listed		Species Profile and
66472	*Thalassarche*	Black-browed	Bird	Likely	Foraging, feeding or	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
1061	*Macronectes halli*	Northern Giant	Bird	Likely	Foraging, feeding or	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
89221	*Diomedea epomophora*	Southern Royal	Bird	May	Species or species	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
877	*Charadrius leschenaultii*	Greater Sand Plover,	Bird	Likely	Species or species	Vulnerable	Migratory	Migratory Wetlands	Listed		Species Profile and
89223	*Diomedea exulans*	Wandering Albatross	Bird	Likely	Foraging, feeding or	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
64462	*Thalassarche steadi*	White-capped	Bird	May	Species or species	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
64464	*Thalassarche carteri*	Indian Yellow-nosed	Bird	Likely	Species or species	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
64459	*Thalassarche impavida*	Campbell Albatross,	Bird	May	Species or species	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
82950	*Sternula nereis nereis*	Australian Fairy Tern	Bird	Known	Foraging, feeding or	Vulnerable					Species Profile and
69402	*Thunnus maccoyii*	Southern Bluefin	Fish	Likely	Species or species	Conservation					Species Profile and
66734	*Hesperocolletes*	Douglas' Broad-	Insect	May	Species or species	Critically					Species Profile and
22	*Neophoca cinerea*	Australian Sea-lion,	Mammal	Likely	Species or species	Endangered			Listed		Species Profile and
40	*Eubalaena australis*	Southern Right	Mammal	Known	Breeding known to	Endangered	Migratory (as	Migratory Marine		Cetacean	Species Profile and
36	*Balaenoptera musculus*	Blue Whale	Mammal	Likely	Species or species	Endangered	Migratory	Migratory Marine		Cetacean	Species Profile and
229	*Setonix brachyurus*	Quokka	Mammal	Known	Species or species	Vulnerable					Species Profile and
55082	*Diuris micrantha*	Dwarf Bee-orchid	Plant	May	Species or species	Vulnerable					Species Profile and
1768	*Dermochelys coriacea*	Leatherback Turtle,	Reptile	Known	Species or species	Endangered	Migratory	Migratory Marine	Listed		Species Profile and
1763	*Caretta caretta*	Loggerhead Turtle	Reptile	Known	Foraging, feeding or	Endangered	Migratory	Migratory Marine	Listed		Species Profile and
59257	*Natator depressus*	Flatback Turtle	Reptile	Known	Foraging, feeding or	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
1765	*Chelonia mydas*	Green Turtle	Reptile	Known	Foraging, feeding or	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
85267	*Sphyrna lewini*	Scalloped	Shark	Likely	Species or species	Conservation					Species Profile and
64470	*Carcharodon*	White Shark, Great	Shark	Known	Species or species	Vulnerable	Migratory	Migratory Marine			Species Profile and
60756	*Pristis pristis*	Freshwater Sawfish,	Shark	May	Species or species	Vulnerable	Migratory	Migratory Marine			Species Profile and
66680	*Rhincodon typus*	Whale Shark	Shark	May	Species or species	Vulnerable	Migratory	Migratory Marine			Species Profile and
68752	*Carcharias taurus (west*	Grey Nurse Shark	Shark	Known	Species or species	Vulnerable					Species Profile and

Back to Summary

Listed Migratory Species [Resource Information]

Species ID	Scientific Name	Common Name	Class	Presence Rank	Presence Text	Threatened Category	Migratory Status	Migratory Category	Marine Status	Cetacean Status	Website
84292	*Ardenna pacifica*	Wedge-tailed	Bird	Known	Breeding known to		Migratory	Migratory Marine	Listed (as Puffinus		Species Profile and
825	*Anous stolidus*	Common Noddy	Bird	Likely	Species or species		Migratory	Migratory Marine	Listed		Species Profile and
66472	*Thalassarche*	Black-browed	Bird	Likely	Foraging, feeding	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
82845	*Onychoprion*	Bridled Tern	Bird	Known	Breeding known to		Migratory	Migratory Marine	Listed (as Sterna		Species Profile and
1060	*Macronectes giganteus*	Southern Giant-	Bird	May	Species or species	Endangered	Migratory	Migratory Marine	Listed		Species Profile and
1061	*Macronectes halli*	Northern Giant	Bird	Likely	Foraging, feeding	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
817	*Sterna dougallii*	Roseate Tern	Bird	Known	Breeding known to		Migratory	Migratory Marine	Listed		Species Profile and
89221	*Diomedea epomophora*	Southern Royal	Bird	May	Species or species	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
994	*Phaethon rubricauda*	Red-tailed	Bird	Known	Breeding known to		Migratory	Migratory Marine	Listed		Species Profile and
82651	*Ardenna grisea*	Sooty Shearwater	Bird	May	Species or species		Migratory	Migratory Marine	Listed (as Puffinus		Species Profile and
89223	*Diomedea exulans*	Wandering	Bird	Likely	Foraging, feeding	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
64405	*Diomedea*	Amsterdam	Bird	May	Species or species	Endangered	Migratory	Migratory Marine	Listed		Species Profile and
64462	*Thalassarche steadi*	White-capped	Bird	May	Species or species	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
64464	*Thalassarche carteri*	Indian Yellow-nosed	Bird	Likely	Species or species	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
808	*Hydroprogne caspia*	Caspian Tern	Bird	Known	Breeding known to		Migratory	Migratory Marine	Listed (as Sterna		Species Profile and
89224	*Thalassarche cauta*	Shy Albatross	Bird	Likely	Foraging, feeding	Endangered	Migratory	Migratory Marine	Listed		Species Profile and
82404	*Ardenna carneipes*	Flesh-footed	Bird	Likely	Species or species		Migratory	Migratory Marine	Listed (as Puffinus		Species Profile and
64459	*Thalassarche impavida*	Campbell Albatross,	Bird	May	Species or species	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
64456	*Diomedea sanfordi*	Northern Royal	Bird	May	Species or species	Endangered	Migratory	Migratory Marine	Listed		Species Profile and
46	*Orcinus orca*	Killer Whale, Orca	Mammal	May	Species or species		Migratory	Migratory Marine		Cetacean	Species Profile and
35	*Balaenoptera edeni*	Bryde's Whale	Mammal	May	Species or species		Migratory	Migratory Marine		Cetacean	Species Profile and
40	*Eubalaena australis*	Southern Right	Mammal	Known	Breeding known to	Endangered	Migratory (as	Migratory Marine		Cetacean	Species Profile and
38	*Megaptera*	Humpback Whale	Mammal	Known	Species or species		Migratory	Migratory Marine		Cetacean	Species Profile and
39	*Caperea marginata*	Pygmy Right Whale	Mammal	May	Species or species		Migratory	Migratory Marine		Cetacean	Species Profile and
36	*Balaenoptera musculus*	Blue Whale	Mammal	Likely	Species or species	Endangered	Migratory	Migratory Marine		Cetacean	Species Profile and
59257	*Natator depressus*	Flatback Turtle	Reptile	Known	Foraging, feeding	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
1768	*Dermochelys coriacea*	Leatherback Turtle,	Reptile	Known	Species or species	Endangered	Migratory	Migratory Marine	Listed		Species Profile and
1765	*Chelonia mydas*	Green Turtle	Reptile	Known	Foraging, feeding	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
1763	*Caretta caretta*	Loggerhead Turtle	Reptile	Known	Foraging, feeding	Endangered	Migratory	Migratory Marine	Listed		Species Profile and
64470	*Carcharodon*	White Shark, Great	Shark	Known	Species or species	Vulnerable	Migratory	Migratory Marine			Species Profile and
60756	*Pristis pristis*	Freshwater Sawfish,	Shark	May	Species or species	Vulnerable	Migratory	Migratory Marine			Species Profile and
90033	*Mobula alfredi*	Reef Manta Ray,	Shark	Known	Species or species		Migratory (as Manta	Migratory Marine			Species Profile and
90034	*Mobula birostris*	Giant Manta Ray	Shark	May	Species or species		Migratory (as Manta	Migratory Marine			Species Profile and
83288	*Lamna nasus*	Porbeagle, Mackerel	Shark	May	Species or species		Migratory	Migratory Marine			Species Profile and
66680	*Rhincodon typus*	Whale Shark	Shark	May	Species or species	Vulnerable	Migratory	Migratory Marine			Species Profile and
84108	*Carcharhinus*	Oceanic Whitetip	Shark	May	Species or species		Migratory	Migratory Marine			Species Profile and
642	*Motacilla cinerea*	Grey Wagtail	Bird	May	Species or species		Migratory	Migratory	Listed - overfly		Species Profile and
838	*Phalaropus lobatus*	Red-necked	Bird	Known	Foraging, feeding		Migratory	Migratory Wetlands	Listed		Species Profile and
835	*Tringa totanus*	Common Redshank,	Bird	Known	Foraging, feeding		Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
59300	*Xenus cinereus*	Terek Sandpiper	Bird	Known	Foraging, feeding		Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
83000	*Thalasseus bergii*	Greater Crested	Bird	Known	Breeding known to		Migratory	Migratory Wetlands	Listed (as Sterna		Species Profile and
875	*Calidris alba*	Sanderling	Bird	Known	Foraging, feeding		Migratory	Migratory Wetlands	Listed		Species Profile and
832	*Tringa nebularia*	Common	Bird	Known	Species or species		Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
59309	*Actitis hypoleucos*	Common Sandpiper	Bird	Known	Species or species		Migratory	Migratory Wetlands	Listed		Species Profile and
833	*Tringa stagnatilis*	Marsh Sandpiper,	Bird	Known	Foraging, feeding		Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
895	*Charadrius bicinctus*	Double-banded	Bird	Known	Foraging, feeding		Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
872	*Arenaria interpres*	Ruddy Turnstone	Bird	Known	Foraging, feeding		Migratory	Migratory Wetlands	Listed		Species Profile and
952	*Pandion haliaetus*	Osprey	Bird	Known	Breeding known to		Migratory	Migratory Wetlands	Listed		Species Profile and
874	*Calidris acuminata*	Sharp-tailed	Bird	Known	Foraging, feeding		Migratory	Migratory Wetlands	Listed		Species Profile and
877	*Charadrius*	Greater Sand Plover,	Bird	Likely	Species or species	Vulnerable	Migratory	Migratory Wetlands	Listed		Species Profile and
879	*Charadrius mongolus*	Lesser Sand Plover,	Bird	Known	Foraging, feeding	Endangered	Migratory	Migratory Wetlands	Listed		Species Profile and
864	*Gallinago megala*	Swinhoe's Snipe	Bird	Likely	Foraging, feeding		Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
865	*Pluvialis squatarola*	Grey Plover	Bird	Known	Foraging, feeding		Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
862	*Calidris tenuirostris*	Great Knot	Bird	Known	Foraging, feeding	Critically	Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
860	*Calidris ruficollis*	Red-necked Stint	Bird	Known	Foraging, feeding		Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
847	*Numenius*	Eastern Curlew, Far	Bird	Likely	Species or species	Critically	Migratory	Migratory Wetlands	Listed		Species Profile and
844	*Limosa lapponica*	Bar-tailed Godwit	Bird	Known	Species or species		Migratory	Migratory Wetlands	Listed		Species Profile and
845	*Limosa limosa*	Black-tailed Godwit	Bird	Known	Foraging, feeding		Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
25545	*Pluvialis fulva*	Pacific Golden	Bird	Known	Foraging, feeding		Migratory	Migratory Wetlands	Listed		Species Profile and
855	*Calidris canutus*	Red Knot, Knot	Bird	Known	Species or species	Endangered	Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
856	*Calidris ferruginea*	Curlew Sandpiper	Bird	Known	Species or species	Critically	Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
851	*Tringa brevipes*	Grey-tailed Tattler	Bird	Known	Foraging, feeding		Migratory	Migratory Wetlands	Listed (as		Species Profile and
858	*Calidris melanotos*	Pectoral Sandpiper	Bird	Known	Species or species		Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
841	*Gallinago stenura*	Pin-tailed Snipe	Bird	Likely	Foraging, feeding		Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
849	*Numenius phaeopus*	Whimbrel	Bird	Known	Foraging, feeding		Migratory	Migratory Wetlands	Listed		Species Profile and
848	*Numenius minutus*	Little Curlew, Little	Bird	Likely	Foraging, feeding		Migratory	Migratory Wetlands	Listed - overfly		Species Profile and

Back to Summary

Listed Marine Species [Resource Information]

				Presence							
Species ID	Scientific Name	Common Name	Class	Rank	Text	Threatened Category	Migratory Status	Migratory Category	Marine Status	Cetacean Status	Website
66251	*Lissocampus runa*	Javelin Pipefish	Fish	May	Species or species				Listed		Species Profile and
838	*Phalaropus lobatus*	Red-necked	Bird	Known	Foraging, feeding or		Migratory	Migratory Wetlands	Listed		Species Profile and
835	*Tringa totanus*	Common Redshank,	Bird	Known	Foraging, feeding or		Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
66250	*Lissocampus fatiloquus*	Prophet's Pipefish	Fish	May	Species or species				Listed		Species Profile and
66252	*Maroubra perserrata*	Sawtooth Pipefish	Fish	May	Species or species				Listed		Species Profile and
59300	*Xenus cinereus*	Terek Sandpiper	Bird	Known	Foraging, feeding or		Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
84292	*Ardenna pacifica*	Wedge-tailed	Bird	Known	Breeding known to		Migratory	Migratory Marine	Listed (as Puffinus		Species Profile and
77037	*Rostratula australis*	Australian Painted	Bird	May	Species or species	Endangered			Listed - overfly		Species Profile and
83000	*Thalasseus bergii*	Greater Crested Tern	Bird	Known	Breeding known to		Migratory	Migratory Wetlands	Listed (as Sterna		Species Profile and
59257	*Natator depressus*	Flatback Turtle	Reptile	Known	Foraging, feeding or	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
1066	*Pachyptila turtur*	Fairy Prion	Bird	Likely	Species or species				Listed		Species Profile and
26000	*Anous tenuirostris*	Australian Lesser	Bird	May	Species or species	Vulnerable			Listed		Species Profile and
825	*Anous stolidus*	Common Noddy	Bird	Likely	Species or species		Migratory	Migratory Marine	Listed		Species Profile and
66472	*Thalassarche*	Black-browed	Bird	Likely	Foraging, feeding or	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
1123	*Disteira kingii*	Spectacled Seasnake	Reptile	May	Species or species				Listed		Species Profile and
66191	*Campichthys galei*	Gale's Pipefish	Fish	May	Species or species				Listed		Species Profile and
90682	*Onychoprion fuscatus*	Sooty Tern	Bird	Known	Breeding known to				Listed (as Sterna		Species Profile and
875	*Calidris alba*	Sanderling	Bird	Known	Foraging, feeding or		Migratory	Migratory Wetlands	Listed		Species Profile and
832	*Tringa nebularia*	Common	Bird	Known	Species or species		Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
66277	*Stigmatopora nigra*	Widebody Pipefish,	Fish	May	Species or species				Listed		Species Profile and
66276	*Stigmatopora argus*	Spotted Pipefish,	Fish	May	Species or species				Listed		Species Profile and
59309	*Actitis hypoleucos*	Common Sandpiper	Bird	Known	Species or species		Migratory	Migratory Wetlands	Listed		Species Profile and
66273	*Solegnathus lettiensis*	Gunther's Pipehorse,	Fish	May	Species or species				Listed		Species Profile and
833	*Tringa stagnatilis*	Marsh Sandpiper,	Bird	Known	Foraging, feeding or		Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
82845	*Onychoprion*	Bridled Tern	Bird	Known	Breeding known to		Migratory	Migratory Marine	Listed (as Sterna		Species Profile and
22	*Neophoca cinerea*	Australian Sea-lion,	Mammal	Likely	Species or species	Endangered			Listed		Species Profile and
1060	*Macronectes giganteus*	Southern Giant-	Bird	May	Species or species	Endangered	Migratory	Migratory Marine	Listed		Species Profile and
66249	*Lissocampus caudalis*	Australian Smooth	Fish	May	Species or species				Listed		Species Profile and
1061	*Macronectes halli*	Northern Giant	Bird	Likely	Foraging, feeding or	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
1091	*Pelamis platurus*	Yellow-bellied	Reptile	May	Species or species				Listed		Species Profile and
817	*Sterna dougallii*	Roseate Tern	Bird	Known	Breeding known to		Migratory	Migratory Marine	Listed		Species Profile and
66243	*Histiogamphelus*	Rhino Pipefish,	Fish	May	Species or species				Listed		Species Profile and
89221	*Diomedea epomophora*	Southern Royal	Bird	May	Species or species	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
66259	*Mitotichthys meraculus*	Western Crested	Fish	May	Species or species				Listed		Species Profile and
895	*Charadrius bicinctus*	Double-banded	Bird	Known	Foraging, feeding or		Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
871	*Recurvirostra*	Red-necked Avocet	Bird	Known	Foraging, feeding or				Listed - overfly		Species Profile and
870	*Himantopus*	Pied Stilt, Black-	Bird	Known	Foraging, feeding or				Listed - overfly		Species Profile and
872	*Arenaria interpres*	Ruddy Turnstone	Bird	Known	Foraging, feeding or		Migratory	Migratory Wetlands	Listed		Species Profile and
952	*Pandion haliaetus*	Osprey	Bird	Known	Breeding known to		Migratory	Migratory Wetlands	Listed		Species Profile and
874	*Calidris acuminata*	Sharp-tailed	Bird	Known	Foraging, feeding or		Migratory	Migratory Wetlands	Listed		Species Profile and
877	*Charadrius leschenaultii*	Greater Sand Plover,	Bird	Likely	Species or species	Vulnerable	Migratory	Migratory Wetlands	Listed		Species Profile and
879	*Charadrius mongolus*	Lesser Sand Plover,	Bird	Known	Foraging, feeding or	Endangered	Migratory	Migratory Wetlands	Listed		Species Profile and
66185	*Acentronura australe*	Southern Pygmy	Fish	May	Species or species				Listed		Species Profile and
994	*Phaethon rubricauda*	Red-tailed	Bird	Known	Breeding known to		Migratory	Migratory Marine	Listed		Species Profile and
881	*Charadrius ruficapillus*	Red-capped Plover	Bird	Known	Foraging, feeding or				Listed - overfly		Species Profile and
864	*Gallinago megala*	Swinhoe's Snipe	Bird	Likely	Foraging, feeding or		Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
865	*Pluvialis squatarola*	Grey Plover	Bird	Known	Foraging, feeding or		Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
862	*Calidris tenuirostris*	Great Knot	Bird	Known	Foraging, feeding or	Critically	Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
860	*Calidris ruficollis*	Red-necked Stint	Bird	Known	Foraging, feeding or		Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
811	*Larus pacificus*	Pacific Gull	Bird	May	Foraging, feeding or				Listed		Species Profile and
82651	*Ardenna grisea*	Sooty Shearwater	Bird	May	Species or species		Migratory	Migratory Marine	Listed (as Puffinus		Species Profile and
89223	*Diomedea exulans*	Wandering Albatross	Bird	Likely	Foraging, feeding or	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
66268	*Phyllopteryx taeniolatus*	Common Seadragon,	Fish	May	Species or species				Listed		Species Profile and
943	*Haliaeetus leucogaster*	White-bellied Sea-	Bird	May	Species or species				Listed		Species Profile and
64405	*Diomedea*	Amsterdam	Bird	May	Species or species	Endangered	Migratory	Migratory Marine	Listed		Species Profile and
66267	*Phycodurus eques*	Leafy Seadragon	Fish	May	Species or species				Listed		Species Profile and

Species ID	Scientific Name	Common Name	Class	Rank	Text	Threatened Category	Migratory Status	Migratory Category	Marine Status	Cetacean Status	Website
847	*Numenius*	Eastern Curlew, Far	Bird	Likely	Species or species	Critically	Migratory	Migratory Wetlands	Listed		Species Profile and
66269	*Pugnaso curtirostris*	Pugnose Pipefish,	Fish	May	Species or species				Listed		Species Profile and
66235	*Hippocampus breviceps*	Short-head	Fish	May	Species or species				Listed		Species Profile and
66264	*Nannocampus*	Bonyhead Pipefish,	Fish	May	Species or species				Listed		Species Profile and
64462	*Thalassarche steadi*	White-capped	Bird	May	Species or species	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
64464	*Thalassarche carteri*	Indian Yellow-nosed	Bird	Likely	Species or species	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
1768	*Dermochelys coriacea*	Leatherback Turtle,	Reptile	Known	Species or species	Endangered	Migratory	Migratory Marine	Listed		Species Profile and
808	*Hydroprogne caspia*	Caspian Tern	Bird	Known	Breeding known to		Migratory	Migratory Marine	Listed (as Sterna		Species Profile and
82949	*Sternula nereis*	Fairy Tern	Bird	Known	Breeding known to				Listed (as Sterna		Species Profile and
844	*Limosa lapponica*	Bar-tailed Godwit	Bird	Known	Species or species		Migratory	Migratory Wetlands	Listed		Species Profile and
845	*Limosa limosa*	Black-tailed Godwit	Bird	Known	Foraging, feeding or		Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
89224	*Thalassarche cauta*	Shy Albatross	Bird	Likely	Foraging, feeding or	Endangered	Migratory	Migratory Marine	Listed		Species Profile and
25545	*Pluvialis fulva*	Pacific Golden	Bird	Known	Foraging, feeding or		Migratory	Migratory Wetlands	Listed		Species Profile and
87735	*Thinornis cucullatus*	Hooded Plover,	Bird	Likely	Species or species				Listed - overfly		Species Profile and
1765	*Chelonia mydas*	Green Turtle	Reptile	Known	Foraging, feeding or	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
855	*Calidris canutus*	Red Knot, Knot	Bird	Known	Species or species	Endangered	Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
1763	*Caretta caretta*	Loggerhead Turtle	Reptile	Known	Foraging, feeding or	Endangered	Migratory	Migratory Marine	Listed		Species Profile and
856	*Calidris ferruginea*	Curlew Sandpiper	Bird	Known	Species or species	Critically	Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
851	*Tringa brevipes*	Grey-tailed Tattler	Bird	Known	Foraging, feeding or		Migratory	Migratory Wetlands	Listed (as		Species Profile and
59363	*Puffinus assimilis*	Little Shearwater	Bird	Known	Breeding known to				Listed		Species Profile and
82404	*Ardenna carneipes*	Flesh-footed	Bird	Likely	Species or species		Migratory	Migratory Marine	Listed (as Puffinus		Species Profile and
858	*Calidris melanotos*	Pectoral Sandpiper	Bird	Known	Species or species		Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
66234	*Hippocampus angustus*	Western Spiny	Fish	May	Species or species				Listed		Species Profile and
66283	*Vanacampus*	Mother-of-pearl	Fish	May	Species or species				Listed		Species Profile and
82326	*Chroicocephalus*	Silver Gull	Bird	Known	Breeding known to				Listed (as Larus		Species Profile and
66227	*Heraldia nocturna*	Upside-down	Fish	May	Species or species				Listed		Species Profile and
64459	*Thalassarche impavida*	Campbell Albatross,	Bird	May	Species or species	Vulnerable	Migratory	Migratory Marine	Listed		Species Profile and
66061	*Aipysurus pooleorum*	Shark Bay Seasnake	Reptile	May	Species or species				Listed		Species Profile and
66722	*Hippocampus*	West Australian	Fish	May	Species or species				Listed		Species Profile and
66285	*Vanacampus*	Longsnout Pipefish,	Fish	May	Species or species				Listed		Species Profile and
66284	*Vanacampus phillipi*	Port Phillip Pipefish	Fish	May	Species or species				Listed		Species Profile and
66282	*Urocampus carinirostris*	Hairy Pipefish	Fish	May	Species or species				Listed		Species Profile and
841	*Gallinago stenura*	Pin-tailed Snipe	Bird	Likely	Foraging, feeding or		Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
20	*Arctocephalus forsteri*	Long-nosed Fur-seal,	Mammal	May	Species or species				Listed		Species Profile and
849	*Numenius phaeopus*	Whimbrel	Bird	Known	Foraging, feeding or		Migratory	Migratory Wetlands	Listed		Species Profile and
848	*Numenius minutus*	Little Curlew, Little	Bird	Likely	Foraging, feeding or		Migratory	Migratory Wetlands	Listed - overfly		Species Profile and
642	*Motacilla cinerea*	Grey Wagtail	Bird	May	Species or species		Migratory	Migratory Terrestrial	Listed - overfly		Species Profile and
64456	*Diomedea sanfordi*	Northern Royal	Bird	May	Species or species	Endangered	Migratory	Migratory Marine	Listed		Species Profile and

Back to Summary

Whales and Other Cetaceans [Resource Information]

				Presence							
Species ID	**Scientific Name**	**Common Name**	**Class**	**Rank**	**Text**	**Threatened Category**	**Migratory Status**	**Migratory Category**	**Marine Status**	**Cetacean Status**	**Website**
51	*Stenella attenuata*	Spotted Dolphin,	Mammal	May	Species or species					Cetacean	Species Profile and
60	*Delphinus delphis*	Common Dolphin,	Mammal	May	Species or species					Cetacean	Species Profile and
68417	*Tursiops truncatus s.*	Bottlenose Dolphin	Mammal	May	Species or species					Cetacean	Species Profile and
46	*Orcinus orca*	Killer Whale, Orca	Mammal	May	Species or species		Migratory	Migratory Marine		Cetacean	Species Profile and
35	*Balaenoptera edeni*	Bryde's Whale	Mammal	May	Species or species		Migratory	Migratory Marine		Cetacean	Species Profile and
40	*Eubalaena australis*	Southern Right	Mammal	Known	Breeding known to	Endangered	Migratory (as	Migratory Marine		Cetacean	Species Profile and
64	*Grampus griseus*	Risso's Dolphin,	Mammal	May	Species or species					Cetacean	Species Profile and
33	*Balaenoptera*	Minke Whale	Mammal	May	Species or species					Cetacean	Species Profile and
68418	*Tursiops aduncus*	Indian Ocean	Mammal	Likely	Species or species					Cetacean	Species Profile and
38	*Megaptera*	Humpback Whale	Mammal	Known	Species or species		Migratory	Migratory Marine		Cetacean	Species Profile and
39	*Caperea marginata*	Pygmy Right Whale	Mammal	May	Species or species		Migratory	Migratory Marine		Cetacean	Species Profile and
36	*Balaenoptera musculus*	Blue Whale	Mammal	Likely	Species or species	Endangered	Migratory	Migratory Marine		Cetacean	Species Profile and

Back to Summary

State and Territory Reserves

[Resource Information]

Protected Area ID	Protected Area Name	Reserve Type	State	Jurisdiction	Environment
WA_16713	Rottnest Island	State Reserve	WA	State	Terrestrial

Back to Summary

Nationally Important Wetlands

[Resource Information]

Reference Code	Wetland Name	State	Website
WA089	Rottnest Island Lakes	WA	Australian Wetlands

Back to Summary

EPBC Act Referrals [Resource Information]

Reference Number	Title of referral	Jurisdiction	Industry Type	Stage	Stage Description	Referral Outcome	Website
2004/1700	Seismic Survey,	WA	Exploration	Completed	Referral Decision	Not Controlled	EPBC Referral List
2017/8127	INDIGO Central	NSW	Telecommunications	Completed	Referral Decision	Not Controlled	EPBC Referral List

Back to Summary

Biologically Important Areas

Species ID	Scientific Name	Common Name	Species Group	Behaviour	Presence	Website
82404	Ardenna carneipes	Flesh-footed	Seabirds	Aggregation	Known to occur	Species Profile and
84292	Ardenna pacifica	Wedge-tailed	Seabirds	Foraging (in high	Known to occur	Species Profile and
1085	Eudyptula minor	Little Penguin	Seabirds	Foraging	Known to occur	Species Profile and
808	Hydroprogne caspia	Caspian Tern	Seabirds	Foraging	Known to occur	Species Profile and
811	Larus pacificus	Pacific Gull	Seabirds	Foraging (in high	Former Range	Species Profile and
82845	Onychoprion	Bridled Tern	Seabirds	Foraging (in high	Known to occur	Species Profile and
59363	Puffinus assimilis	Little Shearwater	Seabirds	Foraging (in high	Known to occur	Species Profile and
817	Sterna dougallii	Roseate Tern	Seabirds	Foraging	Known to occur	Species Profile and
82949	Sternula nereis	Fairy Tern	Seabirds	Foraging (in high	Known to occur	Species Profile and
22	Neophoca cinerea	Australian Sea Lion	Seals	Foraging (male)	Likely to occur	Species Profile and
81317	Balaenoptera	Pygmy Blue Whale	Whales	Distribution	Known to occur	Species Profile and
38	Megaptera	Humpback Whale	Whales	Migration (north and	Known to occur	Species Profile and

REPORT

Appendix S
Underwater Acoustic Assessment, South Thomson Barge Landing Development (Tetra Tech 2024)

Underwater Acoustic Assessment

South Thomson Barge Landing Development

July 29, 2024

Prepared for

ROTTNEST ISLAND AUTHORITY
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Table of Contents

1.0 INTRODUCTION 1

1.1 Overview of the South Thomson Barge Landing Project 1

1.2 Scope 1

2.0 ACOUSTIC METRICS AND TERMINOLOGY 1

3.0 SOUND PROPAGATION IN SHALLOW WATERS 3

3.1 Seawater Absorption 3

3.2 Scattering and Reflection 4

3.3 Seabed Absorption 4

3.4 Cut-off Frequency 5

4.0 MARINE FAUNA ASSESSMENT CRITERIA 6

5.0 UNDERWATER NOISE MODELING METHODOLOGY 10

5.1 Sound Propagation Model 10

5.2 Modeling Environment 11

5.3 Bathymetry 11

5.4 Sediment Characteristics 11

5.5 Seasonal Sound Speed Profiles 11

5.6 Threshold Range Calculations 12

6.0 ACOUSTIC MODELING SCENARIOS 12

6.1 Underwater Noise Generated by Impact Pile Driving 15

6.2 Underwater Noise Generated by Vibratory Pile Driving 16

7.0 MODEL RESULTS 17

7.1 Impact Pile Driving Results 18

7.1.1 Marine Mammal Injury and Behavioral Onset Results 18

7.1.2 Fish Injury and Behavioral Onset Results 18

7.1.3 Sea Turtle Injury and Behavioral Onset Results 19

7.2 Vibratory Hammer Pile Installation Results 20

7.2.1 Marine Mammal Injury and Behavioral Onset Results 20

7.2.2 Fish Injury and Behavioral Onset Results 20

7.2.3 Sea Turtle Injury and Behavioral Onset Results 21

8.0 REFERENCES 24

List of Tables

Table 1. Summary of Acoustic Terminology 2
Table 2. Acoustic Threshold Levels for Marine Mammals 9
Table 3. Acoustic Threshold Levels for Fish, Injury and Behavior 9
Table 4. Acoustic Threshold Levels for Fish, Impulsive and Non-Impulsive 10
Table 5. Geoacoustic Properties of Sub-bottom Sediments as a Function of Depth 11
Table 6. Piling Coordinates 14
Table 7. Underwater Acoustic Modeling Scenarios 14
Table 8. Impact Pile-Driving Progression Summary 15
Table 9. Marine Mammal Injury and Behavioral Onset Criteria Threshold Distances (meters) for Impact Pile-Driving 18
Table 10. Fish Injury and Behavioral Onset Criteria Threshold Distances (meters) for Impact Pile Driving 19
Table 11. Sea Turtle Injury and Behavioral Onset Criteria Threshold Distances (meters) for Impact Pile Driving 19
Table 12. Marine Mammal Injury and Behavioral Onset Criteria Threshold Distances (meters) for Vibratory Hammer Pile Installation 20
Table 13. Fish Injury and Behavioral Onset Criteria Threshold Distances (meters) for Vibratory Hammer Pile Installation 21
Table 14. Sea Turtle Injury and Behavioral Onset Criteria Threshold Distances (meters) for Vibratory Hammer Pile Installation 21

List of Figures

Figure 1. Cut-off Frequencies for Different Bottom Materials (Au and Hastings 2008) 6
Figure 2. Auditory Weighting Functions for Cetaceans (Low-frequency, Mid-frequency, and High-frequency Species), Pinnipeds in Water from NMFS (2018) 8
Figure 3. Project Area 13
Figure 4. Impact Pile Driving Spectral Source Level 16
Figure 5. Vibratory Hammer Spectral Source Level 17
Figure 6. Underwater Received Sound Levels (SPL): Unmitigated Impact Pile Driving 24-inch Pile Installation 22
Figure 7. Underwater Received Sound Levels (SPL): Unmitigated Vibratory 24-inch Pile Installation 23

List of Appendices

Appendix A. Summary of Acoustical Distances
Appendix B. Underwater Sound Propagation Modeling Inputs

Acronyms and Abbreviations

°C	degree Celsius
°F	degree Fahrenheit
dB	decibel
dB re 1 µPa	decibels referenced at one micropascal
dBSea	Software for the prediction of underwater noise in a variety of environments
dB/km	decibels per kilometer
HF	high frequency
Hz	hertz
ISO	International Organization for Standardization
kHz	kilohertz
km	kilometers
LF	low frequency
L_E	sound exposure level
$L_{E,24hr}$	24-hour cumulative sound exposure level
$L_{p,rms}$	root-mean-squared sound pressure level
$L_{p,pk}$	peak sound pressure
m/s	meters per second
MF	mid-frequency
MMPA	Marine Mammal Protection Act
NMFS	National Marine Fisheries Service
ppt	parts per thousand
Project	Thomson Bay South Development Project
PK	peak sound pressure level
PTS	permanent threshold shift
RIA	Rottnest Island Authority
RPS	RPS Group
rms	root-mean-square
SEL	sound exposure level
SELcum	cumulative sound exposure level
SPL	sound pressure level
Tetra Tech	Tetra Tech, Inc.

TTS	temporary threshold shift
µPa	micropascal

1.0 INTRODUCTION

1.1 Overview of the South Thomson Barge Landing Development

The Rottnest Island Authority (RIA) proposes the South Thomson Barge Landing Development (Project), situated around the former Army Groyne on Rottnest Island (the site), approximately 30 kilometers (km) west of Perth, Western Australia. The development project is to:

- Facilitate increasing demand for commercial marine services arising from planned infrastructure works;
- Manage barge and logistical movement away from the settlement areas; and
- Improve visitor experience and reduce safety risk.

As part of the Project, the RIA will be constructing a rock armor (breakwater) over the existing army groyne and a 100-meter extension, with a 40-meter concrete deck on steel piles (contingency ferry jetty).

1.2 Scope

Tetra Tech Inc. (Tetra Tech) was contracted to model and assess the sources of underwater noise generated during the construction and installation of the Project. The objective of this modeling assessment was to predict the ranges to acoustic thresholds of marine mammals, sea turtles, and fish, and the potential injury and behavioral acoustic exposures of marine mammals and sea turtles during construction of the Project including impact and vibratory pile driving activities. This report includes information relevant to the assessment of specific noise-producing construction-related activities and their potential to impact protected marine animals that may occur in the Project Study Area, which includes a modeling area extending 5 km away from the piling locations.

2.0 ACOUSTIC METRICS AND TERMINOLOGY

This section outlines some of the relevant concepts in acoustics to help the non-specialist reader best understand the modeling assessment and results presented in this report. Sound is the result of mechanical vibrations traveling through a fluid medium such as air or water. These vibrations constitute waves that generate a time-varying pressure disturbance oscillating above and below the ambient pressure.

It is important to note that underwater sound levels are not equivalent to in-air sound levels, with which most readers would be more familiar. An underwater sound pressure level (SPL or L_p) of 150 decibels (dB) referenced to 1 micropascal (re 1 µPa) is not equivalent to an in-air sound pressure level of 150 dB re 20 µPa due to the differences in density and speed of sound between water and air, and the different reference pressures that are used to calculate the dB levels, i.e., 1 µPa for water and 20 µPa for air. Underwater sound levels can be presented either as overall broadband levels or as frequency-dependent levels showing the frequency content of a source. Broadband values present the total sound pressure level of a given sound source within a specified frequency bandwidth. Sometimes it is preferable to use frequency-dependent sound levels to characterize spectral content

of a sound source and/or identify narrowband sources such as one-third octave band levels, which are one-third of an octave wide, wherein octave refers to a factor 2 increase in sound frequency.

The sound level estimates presented in this modeling study are expressed in terms of several metrics and apply the use of exposure durations to allow for interpretation relative to potential biological impacts on marine life. The National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) issued a Technical Guidance that provides acoustical thresholds and defines the threshold metrics (NMFS 2018). The International Organization for Standardization (ISO) 18405 Underwater Acoustics – Terminology (ISO 2017) provided a dictionary of underwater bioacoustics for standardized terminology. Table 1 provides a summary of the relevant metrics from both NMFS (2018) and ISO (2017) that are used within this report.

Table 1. Summary of Acoustic Terminology

Metric	NMFS (2018)	ISO (2017)		Reference Value
		Main Text	Equations and Tables	
Sound Pressure Level	SPL	SPL	L_p	dB re 1 µPa
Peak Sound Pressure Level	PK	L_{pk}	$L_{p,pk}$	dB re 1 µPa
Cumulative Sound Exposure Level	SEL_{cum} 1/	SEL	L_E	dB re 1 µPa^2·s

Note:
1/ NMFS (2018) describes the cumulative sound exposure level (SEL_{cum}) metric over an accumulation period of 24 hours. Following the ISO standard, this will be identified as SEL in the text and $L_{E,24h}$ will be used in tables and equations of this report with the accumulation period identified.

This report follows the ISO (2017) standard terminology and symbols for the sound metrics unless stated otherwise. Below are descriptions of the relevant metrics and concepts that should help frame the discussion of acoustics in this document. The majority of the information in the following sections provides further insight into how data and modeling results have been presented in accordance with regulatory reporting requirements and established criteria.

Peak sound pressure (PK or L_{pk} or $L_{p,pk}$; dB re 1 µPa) is the maximum instantaneous noise level over a given event and is calculated using the level of the squared sound pressure from zero-to-peak within the wave. The peak sound pressure level is commonly used as a descriptor for impulsive sound sources. At high intensities, the L_{pk} can be a valid criterion for assessing whether a sound is potentially injurious; however, since it does not take into account the pulse duration or bandwidth of a signal, it is not a good indicator of loudness or potential for masking effects. The L_{pk} can be calculated using the formula in Equation 1. Impulses are characterized by a relatively rapid rise from ambient pressure to a maximal pressure value followed by a decay period that may include a period of diminishing, oscillating maximal and minimal pressures.

$$L_{p,pk} = 10\, log_{10} \left[\frac{max(|p^2(t)|)}{p_0^2} \right] \; dB \tag{1}$$

Sound pressure level (SPL_{rms} or $L_{p,rms}$; dB re 1 µPa) is the root-mean-square (rms) sound pressure level in a stated frequency band over a specified time window. It is important to note that SPL herewith refers to a rms pressure level and therefore not instantaneous pressure. The SPL is calculated by taking the square root of the average of the square of the pressure waveform over the duration of the

time period. The SPL is also known as the quadratic mean and is a statistical measure of the magnitude of a varying quantity. Given a measurement of the time-varying sound pressure from a given sound source, the SPL is computed according to the formula in Equation 2 where p^2 is the mean squared sound pressure and p_0^2 is the reference value of mean-square sound pressure, which is 1 μPa^2.

$$L_p = 10\, log_{10}\left(\frac{1}{T}\int_T p^2(t)dt/p_0^2\right)\ dB \tag{2}$$

Sound exposure level (SEL or L_E; dB re 1 $\mu Pa^2 \cdot s$) is similar to the SPL but further specifies the sound pressure over a specified time interval or event, for a specified frequency range. The SEL for a single event is calculated by taking the time integral of the squared sound pressure, E_p, over the full event duration as shown in Equation 3:

$$L_E = 10\, log_{10}\left(\int_{T_{100}} p^2(t)dt/T_0 p_0^2\right)\ dB \tag{3}$$

The SEL represents the total acoustic energy received at a given location. Unless otherwise stated, SELs for impulsive noise sources presented in this report, i.e., impact hammer pile-driving, refer to a single pulse. In addition, SEL can be calculated as a cumulative metric over periods with multiple acoustic events. In the case of impulsive sources like impact piling, SEL describes the summation of energy for the entire impulse normalized to 1 second and can be expanded to represent the summation of energy from multiple pulses. The latter is written SEL_{cum} denoting that it represents the cumulative sound exposure level. Sound exposure level is often used in the assessment of marine mammal and fish injury/physiological impacts over a 24-hour time period. The SEL_{cum} (dB re 1 $\mu Pa^2 \cdot s$) can be computed by summing (in linear units) the SEL of N individual events as shown in Equation 4:

$$L_{E,N} = 10\, log_{10}\left(\sum_{i=1}^{N} 10^{\frac{SEL_i}{10}}\right)\ dB \tag{4}$$

3.0 SOUND PROPAGATION IN SHALLOW WATERS

3.1 Seawater Absorption

Absorption in the underwater environment involves conversion of acoustic energy into heat and thereby represents a true loss of acoustic energy to the water. The primary causes of absorption have been attributed to several processes including viscosity, thermal conductivity, and chemical reactions involving ions in the seawater. The absorption of sound energy by water linearly reduces the sound level with range and is given by an absorption coefficient in units of decibels per kilometer (dB/km). The attenuation coefficient is calculated from empirical equations and increases with the square of frequency. For example, for typical open-ocean values (temperature of 50 degrees Fahrenheit (°F) [10 degrees Celsius (°C)], pH of 8.0, and a salinity of 35 practical salinity units, the equations presented by Francois and Garrison (1982a and 1982b) yield the following values for attenuation due to seawater absorption: 0.001 dB/km at 100 hertz (H”), 0.06 dB/km at 1 kilohertz (kHz), 0.96 dB/km at 10 kHz, and 33.6 dB/km at 100 kHz. Thus, low frequencies are favored for long-range propagation. Seawater absorption was accounted for in the acoustic modeling according to the Fisher and Simmons (1977) calculation methodology. Site-specific sound speed profile information was used, resulting in a site-specific sound attenuation rate.

3.2 Scattering and Reflection

Scattering of sound from the surface and bottom boundaries, and from other objects, is difficult to quantify as it is site specific. However, it is valuable in characterizing and understanding the received sound field. Reflection, refraction, and diffraction from gas bubbles and other inhomogeneities in the propagating medium serve to scatter sound and will affect propagation loss, even in relatively calm waters. If boundaries are present, whether “real” like the surface of the sea or “internal” like changes in the physical characteristics of the water, sound propagation is affected. The received acoustic intensity depends on the losses due to the path length as well as the amount of energy reflected from each interface. Multiple reflections may occur as the sound reflects alternately from the sea floor and the sea surface, resulting in constructive and/or destructive interference patterns. Reflections occurring between the sea floor and sea surface are accounted for in the Project acoustic modeling analysis.

Changes in direction of the sound due to variation in sound speed are known as refraction. The speed of sound is not constant with depth and range but depends on the temperature, pressure, and salinity. Of the three factors, the greatest impact on sound velocity is temperature. The change in the direction of the sound wave due to changes in sound speed can produce many complex sound paths. When there is a negative temperature gradient, sound speed decreases with depth, and sound rays bend sharply downward. At some horizontal distance from the sound source, there are regions of low sound intensity where sound rays do not reach, which are known as shadow zones. Variability in sound speed can also produce surface ducts and sound channels that can trap acoustic energy and enable long-distance propagation with minimal losses; for example, the Sound Fixing and Ranging channel, also known as the deep sound channel, acts as an acoustic waveguide and has been used for ocean surveillance and attributed toward increased communication ranges for marine mammals such as fin whales.

Since the inhomogeneities in water are very small compared to the wavelength of the sound signals, this attenuation effect will mostly contribute when the signals encounter changes in bathymetries and propagate through the sea floor and the subsurface. For variable bathymetries, the calculation complexity increases as individual portions of the signal are scattered differently. However, if the acoustic wavelength is much greater than the scale of the seabed non-uniformities, as is most often the case for low-frequency sounds, then the effect of scattering on propagation loss becomes somewhat less important than other factors. Also, scattering loss occurring at the surface due to wave action increases at higher sea states. For reflection from the sea surface, it is assumed that the surface is smooth. While a rough sea surface would increase scattering and transmission loss at higher frequencies, the scale of surface roughness is insufficient to have a significant effect on sound propagation in the near field relative to the source.

3.3 Seabed Absorption

Seabed sediment characteristics influence propagation loss in shallow water due to the repeated reflections and scattering at the water/sea floor interface. For underwater acoustic analysis, shallow water is typically defined as water depths less than 656 feet (200 meters). Depending on the sediment properties, sound may be absorbed or reflected. For example, fine-grained silt and clay absorb sound

efficiently, while sand, gravel, and bedrock are more reflective. To model these effects, the most important parameters to consider are the sediment density, sound speed, and acoustic attenuation.

The acoustic properties of different sediment types display a much greater range of variation than the acoustic properties of seawater. A good understanding of these properties and their spatial variation is useful for accurate modeling. Oftentimes it is challenging to obtain site-specific data characterizing the sea floor; however, based on the provided Project data and regional geological mapping, the Project area consists of sand and shell debris (Department of Mines, Industry Regulation and Safety, 2020). Based on geotechnical site investigation, the planned dredging depth for the Project shows a surficial carbonate sand layer overlying a carbonate rock, which is thought to be Tamala limestone (in2Dredging 2024). Therefore, sand and gravel were used as sediment inputs for the underwater acoustic model. Further details pertaining to sediment characteristics are provided in Section 5.4, and in Appendix B, Underwater Sound Propagation Modeling Methodology.

3.4 Cut-off Frequency

Sound propagation in shallow water is essentially a normal mode where a sound wave moves sinusoidally and has its own frequency and the sound channel is an acoustic waveguide. Each mode is a standing wave in the vertical direction that propagates in the horizontal direction at a frequency-dependent speed. Each mode has a cut-off frequency, below which no sound propagation is possible. The cut-off frequency is determined based on the type of bottom material and water column depth. This limiting frequency can also be calculated if the speed of sound in the sediment ($C_{sediment}$) is known (Au and Hastings 2008) and seasonal temperature variation of the speed of sound of the seawater (C_{water}) is known using the following Equation 5:

$$f_c = \frac{C_{water}}{4h} / \sqrt{1 - (C_{water})^2 / (C_{sediment})^2} \quad (5)$$

Where: f_c = critical frequency
C_{water} = speed of sound of water
$C_{sediment}$ = speed of sound in sediment
h = water depth in the direction of sound propagation

The speed of sound in sediment is higher than in water. In water, it is approximated at 1,500 meters/second (m/s). Values for speed of sound in sediment in the Project Study Area range from 1,526 m/s to 1,530 m/s. Sound traveling in shallower regions of the Project Study Area will be subject to a higher cut-off frequency and a greater attenuation rate than sound propagating in deeper regions.

Figure 1 graphically presents the cut-off frequency for different bottom material types (represented as separate lines on the figure) plotted as a function of water depth (x-axis) and cut-off frequency (y-axis). As shown, at an approximate water depth of 13 feet (4 meters) and a sea bottom consisting of predominantly rock, which represents the Project Study Area, the cut-off frequency would be expected to occur at approximately 0.08 kHz. For the Project acoustic modeling analysis, the concept of cut-off frequency is incorporated into the modeling calculations through the characterization of sediment properties within the seabed.

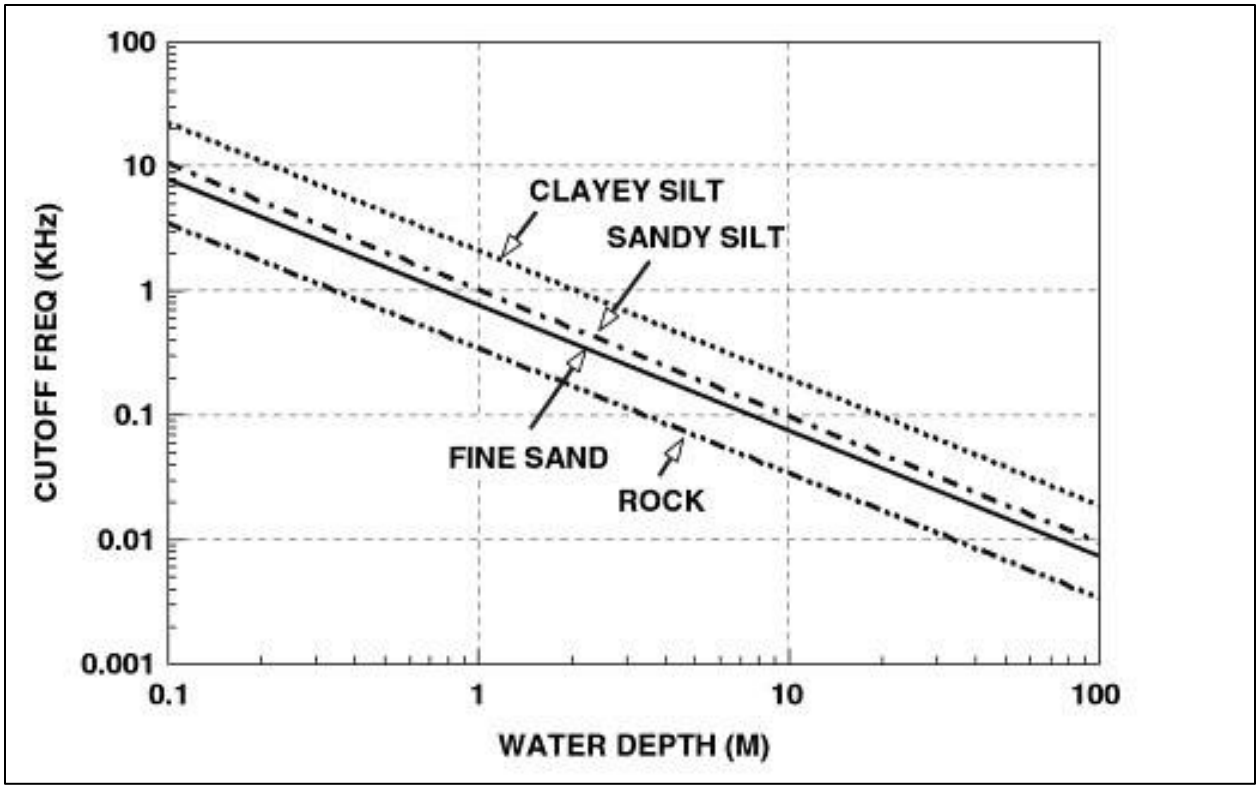

Figure 1. Cut-off Frequencies for Different Bottom Materials (Au and Hastings 2008)

4.0 MARINE FAUNA ASSESSMENT CRITERIA

National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) provided guidance for assessing the impacts of anthropogenic sound on marine mammals under their regulatory jurisdiction, which includes whales, dolphins, porpoises, seals, and sea lions, and updated this guidance in 2018 (NMFS 2018). The guidance specifically defines marine mammal hearing groups; develops auditory weighting functions; and identifies the received levels, or acoustic threshold levels, above which individual marine mammals are predicted to experience changes in their hearing sensitivity (permanent threshold shift [PTS] or temporary threshold shift [TTS]) for acute, incidental exposure to underwater sound. Under this guidance, any occurrence of PTS constitutes a Level A, or injury, take. The sound emitted by man-made sources may induce TTS or PTS in an animal in two ways: (1) peak sound pressure levels ($L_{p,pk}$) may cause damage to the inner ear, and (2) the accumulated sound energy the animal is exposed to (SEL) over the entire duration of a discrete or repeated noise exposure has the potential to induce auditory damage if it exceeds the relevant threshold levels.

Research showed that the frequency content of the sound would play a role in causing damage. Sound outside the hearing range of the animal would be unlikely to affect its hearing, while the sound energy within the hearing range could be harmful. Under the NMFS (2018) guidance, recognizing that marine mammal species do not have equal hearing capabilities, five hearing groups of marine mammals are defined as follows:

- *Low-frequency (LF) Cetaceans*—this group consists of the baleen whales (mysticetes) with a collective generalized hearing range of 7 Hz to 35 kHz.
- *Mid-frequency (MF) Cetaceans*—includes most of the dolphins, all toothed whales except for *Kogia* spp., and all the beaked and bottlenose whales with a generalized hearing range of approximately 150 Hz to 160 kHz (renamed high-frequency cetaceans by Southall et al. [2019] because their best hearing sensitivity occurs at frequencies of several tens of kHz or higher).
- *High-frequency (HF) Cetaceans*—incorporates all the true porpoises, the river dolphins, plus *Kogia* spp., *Cephalorhynchid* spp. (genus in the dolphin family Delphinidae), and two species of *Lagenorhynchus* (Peale's and hourglass dolphins) with a generalized hearing range estimated from 275 Hz to 160 kHz (renamed very high-frequency cetaceans by Southall et al. (2019) since some species have best sensitivity at frequencies exceeding 100 kHz).
- *Phocids Underwater*—consists of true seals with a generalized underwater hearing range from 50 Hz to 86 kHz (renamed Phocids carnivores in water by Southall et al. [2019]).
- *Otariids Underwater*—includes sea lions and fur seals with a generalized underwater hearing range from 60 Hz to 39 kHz (termed Other marine carnivores in water by Southall et al. [2019] and includes otariids, as well as walrus [Family Odobenide], polar bear [*Ursus maritimus*], and sea and marine otters [Family Mustelidae]).

Within these generalized hearing ranges, the ability to hear sounds varies with frequency, as demonstrated by examining audiograms of hearing sensitivity (NMFS 2018; Southall et al. 2019). To reflect higher noise sensitivities at specific frequencies, auditory weighting functions were developed for each functional hearing group that reflected the best available data on hearing ability (composite audiograms), susceptibility to noise-induced hearing loss, impacts of noise on hearing, and data on equal latency (NMFS 2018). These weighting functions are applied to individual sound received levels to reflect the susceptibility of each hearing group to noise-induced threshold shifts, which is not the same as the range of best hearing (Figure 2).

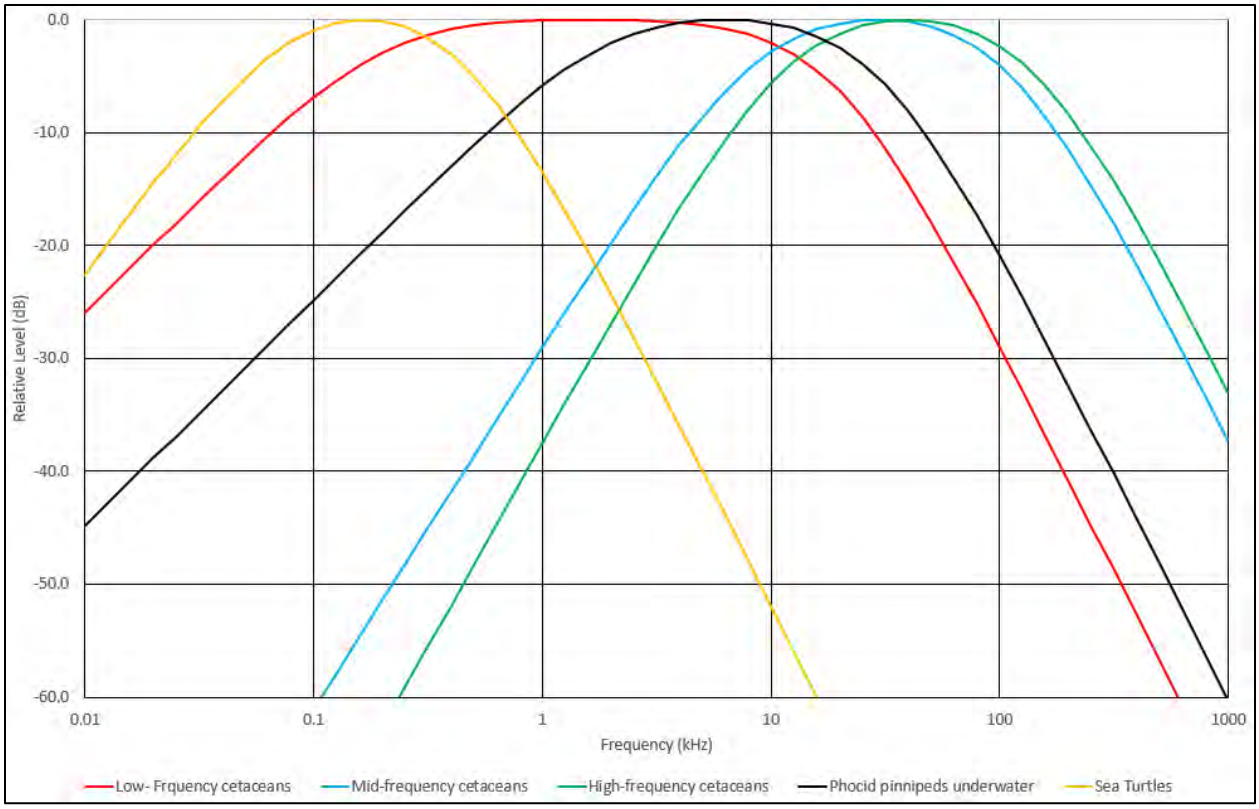

Figure 2. Auditory Weighting Functions for Cetaceans (Low-frequency, Mid-frequency, and High-frequency Species), Pinnipeds in Water from NMFS (2018)

NMFS (2018) defined acoustic threshold levels at which PTS and TTS are predicted to occur for each hearing group for impulsive and non-impulsive signals, which are presented in terms of dual metrics: SEL and $L_{p,pk}$. The Level B harassment thresholds are also provided in Table 2 and were revised by NMFS as interim criteria in 2023.

NMFS anticipates behavioral response for sea turtles from impulsive sources such as impact pile-driving to occur at SPL_{rms} 175 dB, which has elicited avoidance behavior of sea turtles (Table 3; NMFS 2023b; Finneran et al. 2017). There is limited information available on the effects of noise on sea turtles, and the hearing capabilities of sea turtles are still poorly understood. In addition, the U.S. Navy introduced a weighting filter appropriate for sea turtle impact evaluation in their 2017 document titled "Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)." That weighting has been applied to impulsive criterion for PTS (204 dB SEL), impulsive criterion for TTS (189 dB SEL), and non-impulsive criteria for TTS (200 dB SEL and 226 dB $L_{p,pk}$) and PTS (220 dB SEL and 232 dB $L_{p,pk}$). The weighting for sea turtles is presented in Figure 2.

In a cooperative effort between federal and state agencies, interim criteria were developed to assess the potential for injury to fishes exposed to pile-driving sounds. These noise injury thresholds have been established by the Fisheries Hydroacoustic Working Group, which was assembled and subsequently by NMFS as presented in Table 3.

Table 2. Acoustic Threshold Levels for Marine Mammals

Hearing Groups	Impulsive Sounds			Non-Impulsive Sounds		
	PTS Onset	TTS Onset	Behavior	PTS Onset	TTS Onset	Behavior
Low-frequency cetaceans	219 dB ($L_{p,pk}$) 183 ($L_{E,LF,24h}$)	213 dB ($L_{p,pk}$) 168 dB ($L_{E,LF,24h}$)	160 dB (L_p)	199 dB ($L_{E,LF,24h}$)	179 dB ($L_{E,LF,24h}$)	120 dB ($L_{p,rms}$)
Mid-frequency cetaceans	230 dB ($L_{p,pk}$) 185 dB ($L_{E,MF,24h}$)	224 dB ($L_{p,pk}$) 170 dB ($L_{E,MF,24h}$)		198 dB ($L_{E,MF,24h}$)	178 dB ($L_{E,MF,24h}$)	
High-frequency cetaceans	202 dB ($L_{p,pk}$) 155 dB ($L_{E,HF,24h}$)	196 dB ($L_{p,pk}$) 140 dB ($L_{E,HF,24h}$)		173 dB ($L_{E,HF,24h}$)	153 dB ($L_{E,HF,24h}$)	
Phocid pinnipeds underwater	218 dB ($L_{p,pk}$) 185 dB ($L_{E,PW,24h}$)	212 dB ($L_{p,pk}$) 170 dB ($L_{E,PW,24h}$)		201 dB ($L_{E,PW,24h}$)	181 dB ($L_{E,PW,24h}$)	
Otariid pinnipeds underwater	232 dB ($L_{p,pk}$) 203 dB ($L_{E,OW,24h}$)	226 dB ($L_{p,pk}$) 188 dB ($L_{E,OW,24h}$)		219 dB ($L_{E,OW,24h}$)	199 dB ($L_{E,OW,24h}$)	

Sources: Southall et al. (2019); NMFS (2018, 2023a)

$L_{E,24h}$ = cumulative sound exposure level over a 24-hour period (dB re 1 μPa²·s);
$L_{p,pk}$ = peak sound pressure level (dB re 1 μPa);
L_p = root mean square sound pressure level (dB re 1 μPa)

Table 3. Acoustic Threshold Levels for Fishes and Sea Turtles

Hearing Group	Impulsive Signals		Non-impulsive Signals		Behavior (Impulsive and Non-impulsive)
	Injury	TTS Onset	Injury	TTS Onset	
Fishes	206 dB ($L_{p,pk}$) 187 dB ($L_{E,24h}$)	–	–	–	150 dB ($L_{p,rms}$)
Sea Turtles	232 dB ($L_{p,pk}$) 204 dB ($L_{E,TUW,24h}$)	226 dB ($L_{p,pk}$) 189 dB ($L_{E,TUW,24h}$)	220 dB ($L_{E,TUW,24h}$)	200 dB ($L_{E,TUW,24h}$)	175 dB ($L_{p,rms}$)

Sources: Stadler and Woodbury (2009); NMFS (2018, 2023b); Finneran et al. (2017)

$L_{E,24h}$ = cumulative sound exposure level over a 24-hour period (dB re 1 μPa²·s);
$L_{p,pk}$ = peak sound pressure level (dB re 1 μPa);
L_p = root mean square sound pressure level (dB re 1 μPa)

A Working Group organized under the American National Standards Institute-Accredited Standards Committee S3, Subcommittee 1, Animal Bioacoustics, also developed sound exposure guidelines for fish and sea turtles (Table 4; Popper et al. 2014). They identified three types of fishes depending on how they might be affected by underwater sound. The categories include fishes with no swim bladder or other gas chamber (e.g., flounders, dab, and other flatfishes); fishes with swim bladders in which hearing does not involve the swim bladder or other gas volume (e.g., salmonids); and fishes with a swim bladder that is involved in hearing (e.g., channel catfish).

Table 4. Acoustic Threshold Levels for Fish, Impulsive and Non-Impulsive

Hearing Groups	Impulsive Sounds			Non-Impulsive Sounds	
	Mortality and Potential Mortal Injury	Recoverable Injury	TTS	Recoverable Injury	TTS
Fishes without swim bladders	> 213 dB ($L_{p,pk}$) > 219 dB ($L_{E,24h}$)	> 213 dB ($L_{p,pk}$) > 216 dB ($L_{E,24h}$)	> 186 dB ($L_{E,24h}$)	–	–
Fishes with swim bladder not involved in hearing	207 dB ($L_{p,pk}$) 210 dB ($L_{E,24h}$)	207 dB ($L_{p,pk}$) 203 dB ($L_{E,24h}$)	>186 dB ($L_{E,24h}$)	–	–
Fishes with swim bladder involved in hearing	207 dB ($L_{p,pk}$) 207 dB ($L_{E,24h}$)	207 dB ($L_{p,pk}$) 203 dB ($L_{E,24h}$)	186 dB ($L_{E,24h}$)	170 dB ($L_{p,rms}$)	158 dB ($L_{p,rms}$)
Eggs and larvae	207 dB ($L_{p,pk}$) 210 dB ($L_{E,24h}$)	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	–	–

Sources: Popper et al. (2014), NMFS 2023b, Finneran et al. (2017)

$L_{E,24h}$ = cumulative sound exposure over a 24-hour period (dB re 1 μPa^2·s);
$L_{p,pk}$ = peak sound pressure (dB re 1 μPa);
L_p = root mean square sound pressure (dB re 1 μPa)
PTS = permanent threshold shift;
N = near (10s of meters);
I = intermediate (100s of meters);
F = far (1000s of meters);
– = not applicable

5.0 UNDERWATER NOISE MODELING METHODOLOGY

Underwater acoustic model simulations were conducted for primary noise-generating activities occurring during Project construction and operation. The following subsections describe the modeling calculations approach, modeled scenarios, and model input values. Please refer to Appendix B for additional details on the modeling principles and assumptions.

5.1 Sound Propagation Model

Underwater sound propagation modeling was completed using dBSea, a software developed by Marshall Day Acoustics for the prediction of underwater noise in a variety of environments. The model is built by importing bathymetry data and placing noise sources in the environment. Each source can consist of equipment chosen from either the standard or user-defined databases. Noise mitigation methods may also be included. The user has control over the seabed and water properties including sound speed profile, temperature, salinity, and current. Noise levels are calculated to the extent of the bathymetry area. To examine results in more detail, levels may be plotted in cross sections, or a detailed spectrum may be extracted at any point in the calculation area. Levels are calculated in third octave bands from 12.5 Hz to 20 kHz. Please refer to Appendix B for additional details on the modeling principles and assumptions.

5.2 Modeling Environment

The accuracy of underwater noise modeling results is largely dependent on the sound source characteristics and the accuracy of the intrinsically dynamic data inputs and assumptions used to describe the medium between the path and receiver, including sea surface conditions, water column, and sea bottom. Depending on the sound source under review, it was approximated as a point source or a line source, composed of multiple points, extending downward into the water column. Furthermore, determining sound emissions for the various sources are based on a combination of factors, including known properties (e.g., hammer energy) as well as consulting empirical data. The exact information required can never be obtained for all possible modeling situations, particularly for long-range acoustic modeling of temporally varying sound sources where uncertainties in model inputs increase at greater propagation distances from the source. Model input variables incorporated into the calculations are further described in the following subsections.

5.3 Bathymetry

For geometrically shallow water (i.e., less than 200 meters), sound propagation is dominated by boundary effects. Bathymetry data represent the three-dimensional nature of the subaqueous land surface and was provided by the client (DoT 2020). The bathymetry is imported into the model and sets the extents for displaying modeled received sound levels; therefore, prior to selecting the bathymetry, coverage test model runs are conducted to determine the anticipated distance to the lowest relevant underwater acoustic threshold values.

5.4 Sediment Characteristics

Sediment type (e.g., hard rock, sand, mud, clay) directly impacts the speed of sound since it is a part of the medium in which the sound propagates. The sea floor composition in the Project area is expected to be predominantly sand and shell substrate (RPS 2019). The geoacoustic properties with information on the compositional data of the surficial sediments were informed by estimated geophysical and geotechnical data. The sediment layers and the geoacoustic properties used in the modeling analysis of the impact piling are defined in Table 5.

Table 5. Geoacoustic Properties of Sub-bottom Sediments as a Function of Depth

Seabed Layer (m)	Material	Geoacoustic Properties
0 to 2	Sand	Cp = 1650 m/s αs (dB/λ) = 0.8 dB/ λ ρ = 1900 kg/m3
2 to 10	Gravel	Cp = 1800 m/s αs (dB/λ) = 0.6 dB/ λ ρ = 2000 kg/m3

5.5 Seasonal Sound Speed Profiles

The speed of sound in sea water depends on the temperature T (°C), salinity S (parts per thousand [ppt]), and depth D (meters), and can be described using sound speed profiles. Often, a homogeneous or mixed layer of constant velocity is present in the first few meters. It corresponds to the mixing of

superficial water through surface agitation. There can also be other features such as a surface channel, which corresponds to sound velocity increasing from the surface down. This channel is often due to a shallow isothermal layer appearing in winter conditions but can also be caused by water that is very cold at the surface. In a negative sound gradient, the sound speed decreases with depth, which results in sound refracting downward, which may result in increased bottom losses with distance from the source. In a positive sound gradient as predominantly present in the winter season, sound speed increases with depth and the sound is refracted upward, which can aid in long-distance sound propagation. Pile-driving will take place in the daytime. For the construction modeling scenarios, the average of the February and June sound speed profiles was used. The speed of sound profile information was obtained using the NOAA Sound Speed Manager software incorporating the World Ocean Atlas 2018 extension algorithms (Garcia et al. 2019). Additional details pertaining to the sound speed profile sensitivity analysis conducted for the Project can be found in Appendix B.

5.6 Threshold Range Calculations

To determine the ranges to the defined threshold isopleths, a maximum received level-over-depth approach was used. This approach uses the maximum received level that occurs within the water column at each horizontal sampling point. Both the R_{max} and the $R_{95\%}$ ranges were calculated for each of the regulatory thresholds. The R_{max} is the maximum range in the model at which the sound level calculated. The $R_{95\%}$ is the maximum range at which a sound level was calculated excluding 5% of the R_{max}. The $R_{95\%}$ excludes major outliers or protruding areas associated with the underwater acoustic modeling environment. Regardless of shape of the calculated isopleths the predicted range encompasses at least 95 percent of the horizontal area that would be exposed to sound at or above the specified level. All ranges to injury thresholds presented in his report are presented in terms of the $R_{95\%}$ range.

6.0 ACOUSTIC MODELING SCENARIOS

The Project is in a conceptual phase and as such the engineering details of the piling are not confirmed. Using the current design information, the P1 location was selected for modeling pile-driving acoustical impacts as it is farthest offshore compared to the other piling locations and represents expected worst-case conditions, for example, where propagation would occur through gaps in existing barriers (such as the breakwaters) and for the deepest water conditions. Table 6 and Figure 3 shows the piling locations.

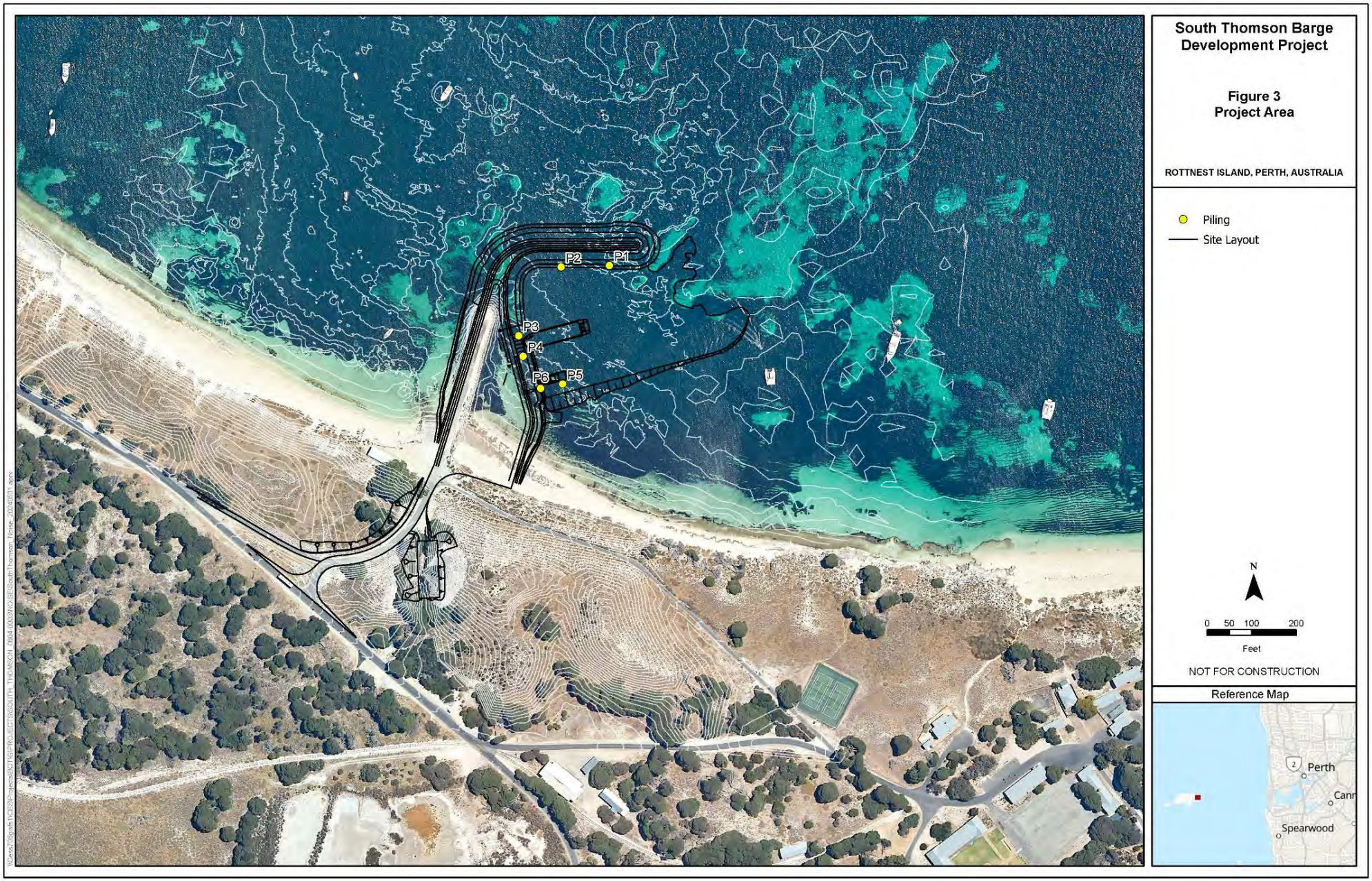

Figure 3. Project Area

Table 6. Piling Coordinates

Piling Locations	Coordinates (UTM Zone 50H)
P1	363112.00 m E, 6458542.00 m S
P2	363079.00 m E, 6458541.00 m S
P3	363050.00 m E, 6458494.00 m S
P4	363053.00 m E, 6458480.00 m S
P5	363080.00 m E, 6458461.00 m S
P6	363065.00 m E, 6458458.00 m S

The representative acoustic modeling scenarios were derived from descriptions of the expected construction activities. The modeled scenarios were chosen to reflect where potential underwater noise impacts of marine species were anticipated and include impact hammer and vibratory hammer associated with pile installation. As discussed above, all modeling scenarios occur at a representative location, which was selected so that the effects of sound propagation at the range of water column depths occurring within the project area could be best observed.

A summary of construction scenarios included in the underwater acoustic modeling analysis is provided in Table 7. The pile diameters selected for the impact pile driving modeling scenarios were based on maximum Project design considerations provided by the RIA. The subsections that follow provide more detailed information about the parameters used to model the noise sources associated with each scenario.

Table 7. Underwater Acoustic Modeling Scenarios

Scenario	Description	Location (UTM Coordinates)	Maximum Hammer Energy (kilojoule)	Total Hammer Blows / Duration[1/]	Source Level
1	Impact pile driving installation, diameter: 24 inches	363112 m, 6458542 m	70	2,838	211 $L_{p,pk}$ 183 $L_{E,ss}$ 193 L_p
2	Vibratory hammer pile installation, diameter: 24 inches	363112 m, 6458542 m	N/A	120 minutes	159 $L_{E,1sec}$

Note:
1/ The total number of blows and duration represents the installation of two piles per day.

Propagation modeling was conducted using the maximum projected blow energy to calculate L_{pk} and SPL; however, a soft start and pile progression were also incorporated into the model to calculate SEL for each pile scenario as shown in Table 8.

Table 8. Impact Pile-Driving Progression Summary

Pile Diameter	Hammer Energy (kilojoule)	Duration (minutes)1/	Blows per Minute2/	Total Number of Blows1/
24 inches	10	18	52	936
	30	10	48	484
	50	10	54	536
	70	18	49	882

Notes:
1/ The total number of blows and duration represents the installation of two piles per day.
2/ Value rounded to the nearest whole number.

6.1 Underwater Noise Generated by Impact Pile Driving

Impact pile driving involves weighted hammers that pile drive foundations into the sea floor. Different methods for lifting the weight associated with the pile driver include hydraulic, steam, or diesel. The acoustic energy is created upon impact; the energy travels into the water along different paths: (1) from the top of the pile where the hammer hits, through the air, into the water; (2) from the top of the pile, down the pile, radiating into the air while traveling down the pile, from air into water; (3) from the top of the pile, down the pile, radiating directly into the water from the length of pile below the waterline; and (4) down the pile radiating into the ground, traveling through the ground and radiating back into the water. Near the pile, acoustic energy arrives from different paths with different associated stage and time lags, which creates a pattern of destructive and constructive interference. Further away from the pile, the water- and seafloor-born energy are the dominant pathways. The underwater noise generated by a pile-driving strike depends primarily on the following factors:

- The impact energy and type of pile-driving hammer;
- The size and type of the pile;
- Water depth; and
- Subsurface hardness in which the pile is being driven.

The acoustic energy radiated into the aquatic environment by a struck pile is directly correlated to the kinetic energy that the impact hammer imparts to it. Engineering considerations about pile penetration and load-bearing capacity dictate that the impact hammer energy must be matched to the pile and to the resistance of the underlying substrate (Parola 1970). Greater hammer impact energy is required for larger diameter piles to achieve the desired load bearing capacity. The water depth also has a strong influence on the acoustic energy propagation in the water column. As water depth increases, the farther the sound will propagate. The site P1, presented in Table 6, has a depth of 4 meters which is representative of the project area where pile driving is expected to occur.

The 24-inch pile driving scenario was modeled using a vertical array of sources spaced at a 0.5-meter array, distributing the sound emissions from pile driving throughout the water column. The vertical array was assigned third-octave band sound characteristics adjusted for site-specific parameters discussed above including expected hammer energy and number of blows. Third octave band center frequencies from 12.5 Hz up to 20 kHz were used in the modeling. The spectra used in the modeling is

shown below in Figure 4. This spectrum is based data for similar pile diameters and is scaled to the broadband source levels presented in Table 7, which is based on empirical and measurement data.

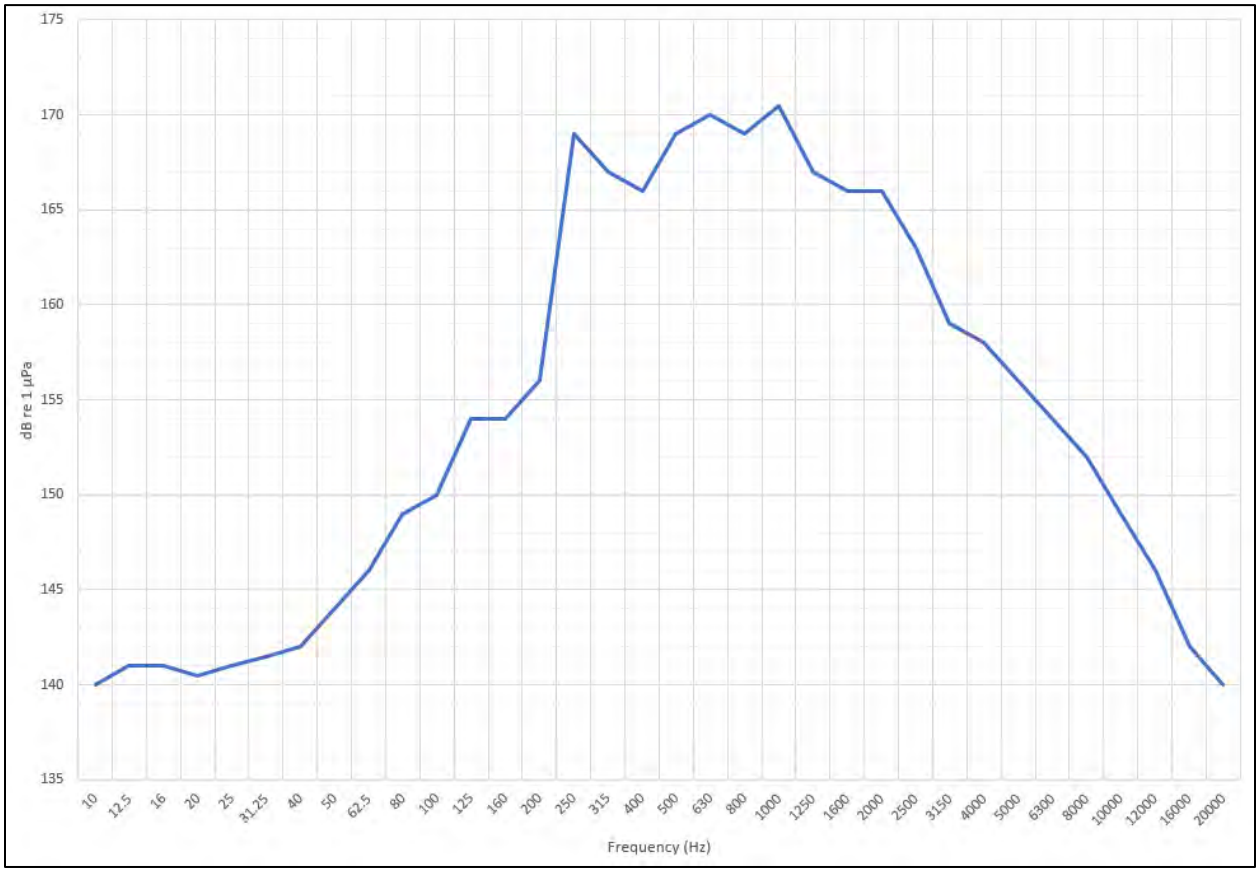

Figure 4. Impact Pile Driving Spectral Source Level

6.2 Underwater Noise Generated by Vibratory Pile Driving

A vibratory hammer will be used for the installation of new piles. Vibratory hammers install piling into the ground by applying a rapidly alternating force to the pile. This is generally accomplished by rotating eccentric weights about shafts. Each rotating eccentric produces a force acting in a single plane and directed toward the centerline of the shaft. The weights are set off-center of the axis of rotation by the eccentric arm. If only one eccentric arm is used, in one revolution, force will be exerted in all directions giving the system significant lateral whip. To avoid this problem, the eccentric arms are paired so the lateral forces cancel each other, leaving only axial force for the pile.

In general, vibratory pile-driving is less noisy than impact pile-driving. Modeling was accomplished using one-third-octave band vibratory hammer source levels from measurements of a similar pile diameter and adjusted to the broadband source levels presented in Table 7. The frequency distribution of the vibratory hammer for pile installation is displayed in Figure 5.

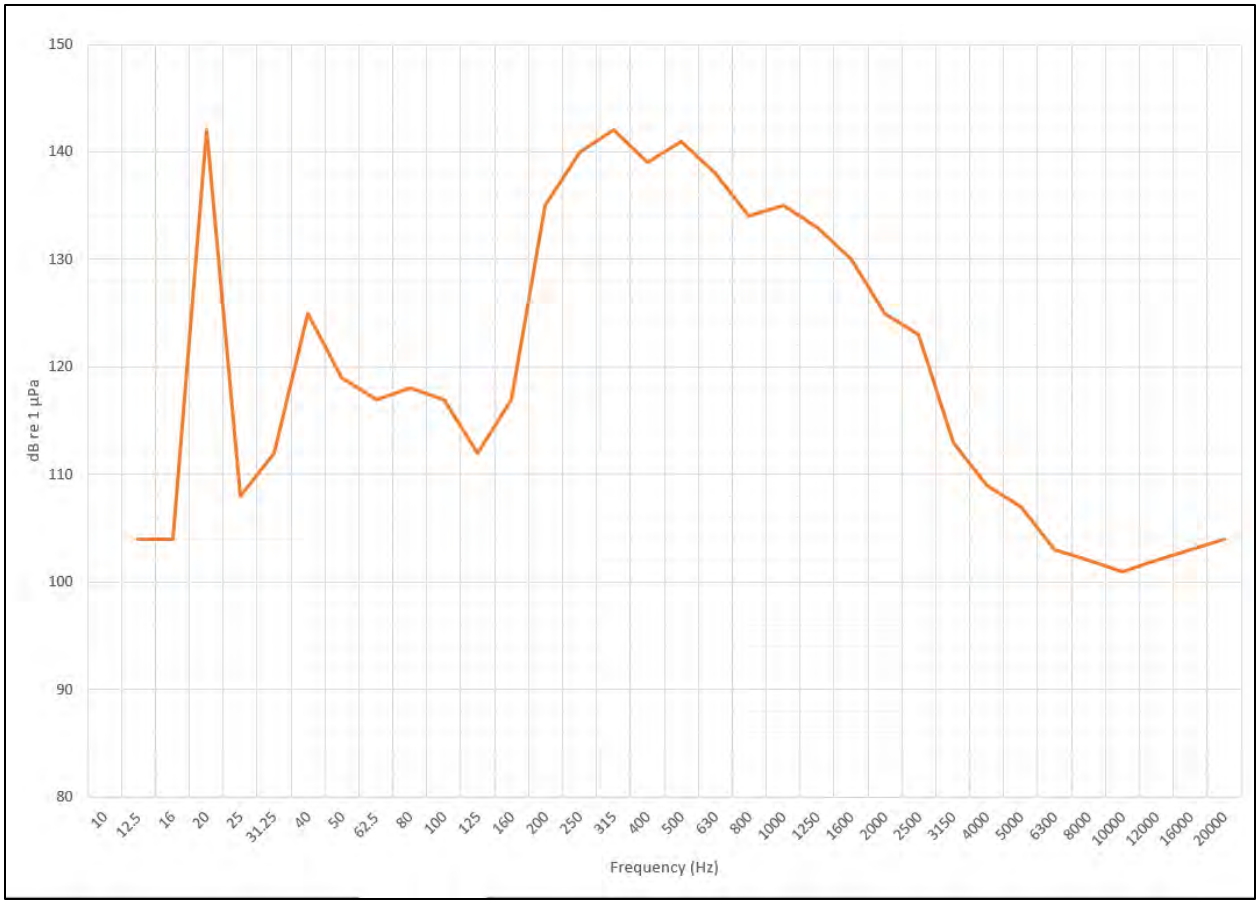

Figure 5. Vibratory Hammer Spectral Source Level

7.0 MODEL RESULTS

As indicated earlier, applying site-specific parameters related to the marine environment and Project sound source characteristics, acoustic modeling was completed using dBSea to assess distances to the various acoustic threshold levels identified in Section 4.0. The analyzed modeling scenarios as described in Table 9 include the following:

- Scenario 1: Impact pile-driving installation for a 24-inch-diameter pile
- Scenario 2: Vibratory hammer installation for a 24-inch-diameter pile

These activities were modeled at a representative location within the Project Study Area. The underwater acoustic modeling results of each of the scenarios are provided in the sections below. Results are presented without mitigation.

Appendix A summarizes the R_{95} distances for the L_{pk} ($L_{p,pk}$), SPL ($L_{p,rms}$), and SEL ($L_{E,24hr}$) metrics. The results of the analysis will be used to inform development of the Project and mitigation measures that will be applied during construction of the Project, in consultation with appropriate regulatory agencies. The Project will obtain the necessary permits to address potential impacts to marine mammals, sea turtles, and other fisheries resources and will establish appropriate and practicable mitigation and monitoring measures through discussions with regulatory agencies. Figure 6 and

Figure 7 show the unweighted and unmitigated underwater received sound pressure levels for each scenario. Underwater sound pressure level ranges are displayed in 5 dB increments and sound propagation characteristics are shown, as applicable, throughout the Project Study Area and beyond.

7.1 Impact Pile Driving Results

7.1.1 Marine Mammal Injury and Behavioral Onset Results

The results for marine mammal injury and behavioral onset for the impact pile driving scenarios are shown in Table 9. The results display trends that are expected, such as increasingly reduced distances as greater levels of noise mitigation are applied. In addition, the smallest distances to thresholds were observed for the L_{pk} acoustic thresholds while the largest distances were observed for the 160 dB SPL_{rms} for the marine mammal behavioral criteria. The largest distance was modeled to be 84 meters corresponding to the 160 dB SPL_{rms} marine mammal behavioral criterion without mitigation for the impact installation of the 24-inch-diameter pile.

Table 9. Marine Mammal Injury and Behavioral Onset Criteria Threshold Distances (meters) for Impact Pile-Driving

Impact Hammer Energy: 70 kJ, Pile Diameter: 24 inches					
Hearing Group	Metric	PTS		TTS	
		Threshold (dB)	Distance (meters)	Threshold (dB)	Distance (meters)
Low-frequency cetaceans	$L_{E,24hr}$ 1/,3/,4/	183	73	168	404
	$L_{p,pk}$ 1/,3/,4/	219	-6/	213	-6/
Mid-frequency cetaceans	$L_{E,24hr}$ 1/,3/,4/	185	-6/	170	36
	$L_{p,pk}$ 1/,3/,4/	230	-6/	224	-6/
High-frequency cetaceans	$L_{E,24hr}$ 1/,3/,4/	155	73	140	500
	$L_{p,pk}$ 1/,3/,4/	202	8	196	18
Phocid pinnipeds	$L_{E,24hr}$ 1/,3/,4/	185	38	170	139
	$L_{p,pk}$ 1/,3/,4/	218	-6/	212	-6/
Otariid pinnipeds	$L_{E,24hr}$ 1/,3/,4/	203	-6/	188	25
	$L_{p,pk}$ 1/,3/,4/	232	-6/	226	-6/
All Marine Mammals	$L_{p,rms}$ 2/,5/	160	84	-	-

Notes:
1/ NMFS 2018
2/ NMFS 2023a
3/ Permanent Threshold Shift (PTS) Onset
4/ Temporary Threshold Shift (TTS) Onset
5/ Behavioral Disturbance
6/ The threshold level is greater than the source level; therefore, distances are not generated.

7.1.2 Fish Injury and Behavioral Onset Results

The results for fish injury and behavioral onset results for fish with no swim bladder, fish with a swim bladder not involved in hearing, fish with swim bladder involved in hearing, eggs and larvae, small fish, and large fish are shown in Table 10. All distance to threshold values were low (i.e., less than 100 meters) except for the distance to the 150 dB SPL_{rms} behavioral threshold criteria. The largest distance

was modeled to be 348 meters corresponding to the 150 dB SPL_{rms} fish behavioral criterion without mitigation for the impact installation of the 24-inch-diameter pile.

Table 10. Fish Injury and Behavioral Onset Criteria Threshold Distances (meters) for Impact Pile Driving

Impact Hammer, Energy: 70 kJ, Pile Diameter: 24 inches			
Hearing Group	Metric	Threshold (dB)	Distance (meters)
Fish: no swim bladder	$L_{E,24hr}$ [1,2]	219	-[6]
	$L_{p,pk}$ [1,2]	213	-[6]
Fish: swim bladder is not involved in hearing	$L_{E,24hr}$ [1,2]	210	-[6]
	$L_{p,pk}$ [1,2]	207	-[6]
Fish: swim bladder involved in hearing	$L_{E,24hr}$ [1,2]	207	4
	$L_{p,pk}$ [1,2]	207	-[6]
Eggs and larvae	$L_{E,24hr}$ [1,2]	210	-[6]
	$L_{p,pk}$ [1,2]	207	-[6]
Small fish	$L_{E,24hr}$ [3,4]	183	76
	$L_{p,pk}$ [3,4]	206	2
	L_p [5]	150	348
Large fish	$L_{E,24hr}$ [3,4]	187	52
	$L_{p,pk}$ [3,4]	206	2
	$L_{p,rms}$ [5]	150	348

Notes:
[1] Popper et al. 2014
[2] Mortality and Potential Mortal Injury
[3] Stadler and Woodbury 2009
[4] Small fish are fish less than 2 grams in weight. Large fish are 2 grams or larger.

[6] The threshold level is greater than the source level; therefore, distances are not generated.

7.1.3 Sea Turtle Injury and Behavioral Onset Results

The results for sea turtle injury and behavioral onset results are shown in Table 11. All distance to threshold values were low (i.e., less than 50 meters). The largest distance was modeled to be 37 meters corresponding to the 175 dB SPL_{rms} marine mammal behavioral criterion without mitigation for the impact installation of the 24-inch-diameter pile.

Table 11. Sea Turtle Injury and Behavioral Onset Criteria Threshold Distances (meters) for Impact Pile Driving

Impact Hammer, Energy: 70 kJ, Pile Diameter: 24 inches			
Hearing Group	Metric	Threshold (dB)	Distance (meters)
Sea Turtle Temporary Threshold Shift	$L_{E,24hr}$ [1,3]	189	30
	$L_{p,pk}$ [1,3]	226	-[4]
Sea Turtle Permanent Threshold Shift	$L_{E,24hr}$ [1,3]	204	3
	$L_{p,pk}$ [1,3]	232	-[4]
Sea Turtle Behavioral	$L_{p,rms}$ [2,3]	175	37

Impact Hammer, Energy: 70 kJ, Pile Diameter: 24 inches			
Hearing Group	Metric	Threshold (dB)	Distance (meters)

Notes:
1/ NMFS 2018
2/ NMFS 2023b
3/ Finneran et al. 2017
4/ The threshold level is greater than the source level; therefore, distances are not generated.
kJ = kilojoule

7.2 Vibratory Hammer Pile Installation Results

7.2.1 Marine Mammal Injury and Behavioral Onset Results

The results for marine mammal injury and behavioral onset for the vibratory hammer pile installation scenarios are shown in Table 12. The smallest distances to thresholds were observed for the SEL acoustic thresholds while the largest distances were observed for the 120 dB SPL_{rms} marine mammal criteria. The largest distance was modeled to be 167 meters corresponding to the 120 dB SPL_{rms} criterion without mitigation for the vibratory installation of the 24-inch pile diameter.

Table 12. Marine Mammal Injury and Behavioral Onset Criteria Threshold Distances (meters) for Vibratory Hammer Pile Installation

Vibratory Hammer, Pile Diameter: 24 inches					
		PTS		TTS	
Hearing Group	Metric	Threshold (dB)	Distance (meters)	Threshold (dB)	Distance (meters)
Low-frequency cetaceans	$L_{E,24hr}$ 1/,3/,4/	199	-6/	179	19
Mid-frequency cetaceans	$L_{E,24hr}$ 1/,3/,4/	198	-6/	178	-6/
High-frequency cetaceans	$L_{E,24hr}$ 1/,3/,4/	173	-6/	153	-6/
Phocid pinnipeds	$L_{E,24hr}$ 1/,3/,4/	201	-6/	181	-6/
Otariid pinnipeds underwater	$L_{E,24hr}$ 1/,3/,4/	219	-6/	199	-6/
All Marine Mammals	$L_{p,rms}$ 2/,5/	120	167	-	-

Notes:
1/ NMFS 2018
2/ NMFS 2023a
3/ Permanent Threshold Shift (PTS) Onset
4/ Temporary Threshold Shift (TTS) Onset
5/ Behavioral Disturbance
6/ The threshold level is greater than the source level; therefore, distances are not generated.

7.2.2 Fish Injury and Behavioral Onset Results

The results for fish injury and behavioral onset results for small fish and large fish are shown in Table 13. All distance to threshold values were low (i.e., less than 50 meters). The largest distance of 21 meters occurred for unmitigated distance to the 183 dB SEL acoustic threshold for the vibratory installation of the 24-inch pile diameter.

Table 13. Fish Injury and Behavioral Onset Criteria Threshold Distances (meters) for Vibratory Hammer Pile Installation

Vibratory Hammer, Pile Diameter: 24 inches			
Hearing Group	Metric	Threshold (dB)	Distance (meters)
Small fish	$L_{E,24hr}$ 3/,4/	183	16
	L_p 5/	150	6
Large fish	$L_{E,24hr}$ 3/,4/	187	21
	$L_{p,rms}$ 5/	150	6

Notes:
1/ Popper et al. 2014
2/ Mortality and Potential Mortal Injury
3/ Stadler and Woodbury 2009
4/ Small fish are fish less than 2 grams in weight. Large fish are 2 grams or larger.

7.2.3 Sea Turtle Injury and Behavioral Onset Results

The results for sea turtle injury and behavioral onset results are shown in Table 14. There were not associated distances because the thresholds are greater than the source level.

Table 14. Sea Turtle Injury and Behavioral Onset Criteria Threshold Distances (meters) for Vibratory Hammer Pile Installation

Vibratory Hammer, Pile Diameter: 24 inches			
Hearing Group	Metric	Threshold (dB)	Distance (meters)
Sea Turtle Temporary Threshold Shift	$L_{E,24hr}$ 1/,3/	200	-4/
Sea Turtle Permanent Threshold Shift	$L_{E,24hr}$ 1/,3/	220	-4/
All Sea Turtles	$L_{p,rms}$ 2/,3/	175	-4/

Notes:
1/ NMFS 2018
2/ NMFS 2023b
3/ Finneran et al. 2017
4/ The threshold level is greater than the source level; therefore, distances are not generated.

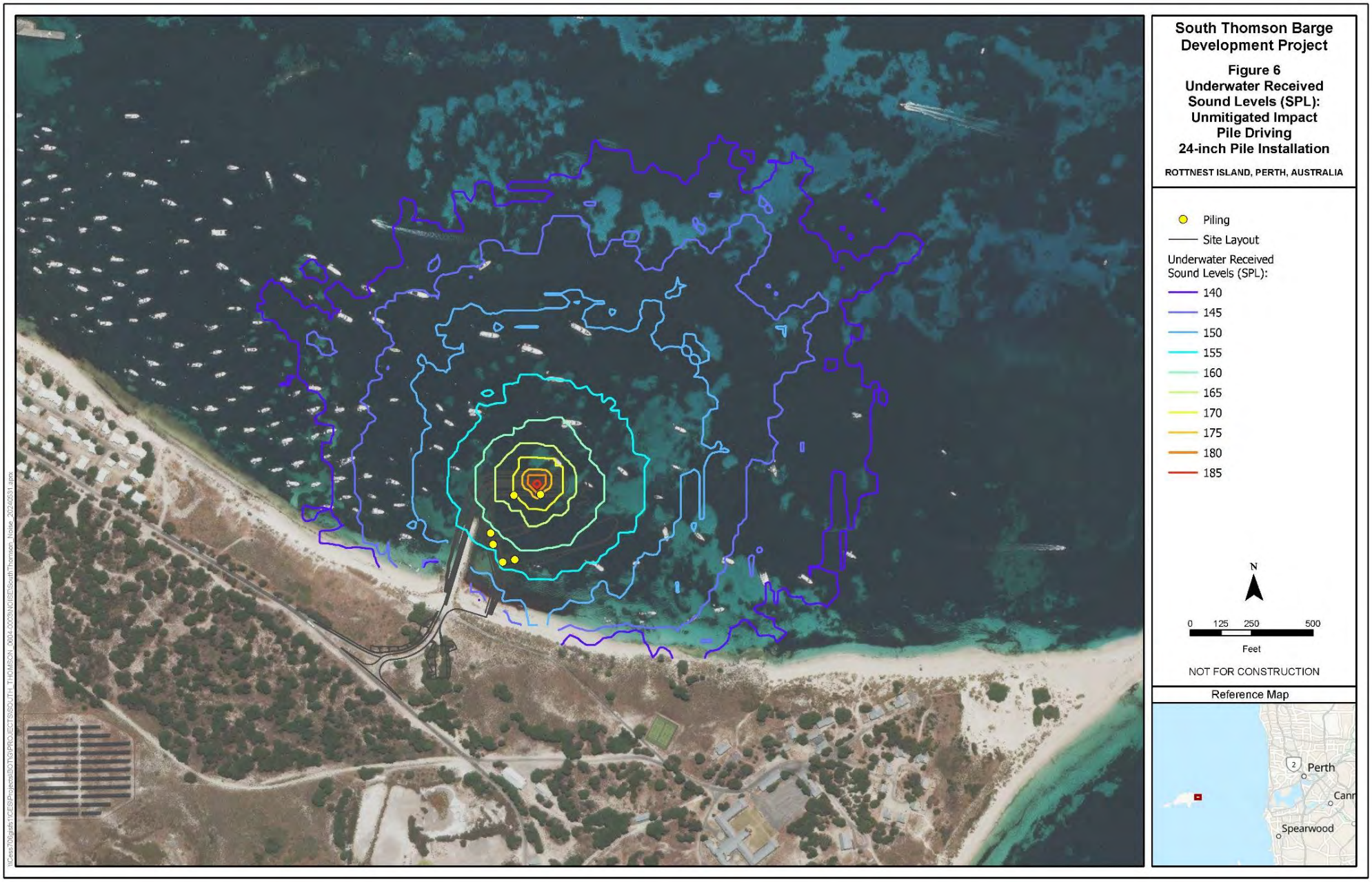

Figure 6. Underwater Received Sound Levels (SPL): Unmitigated Impact Pile Driving 24-inch Pile Installation

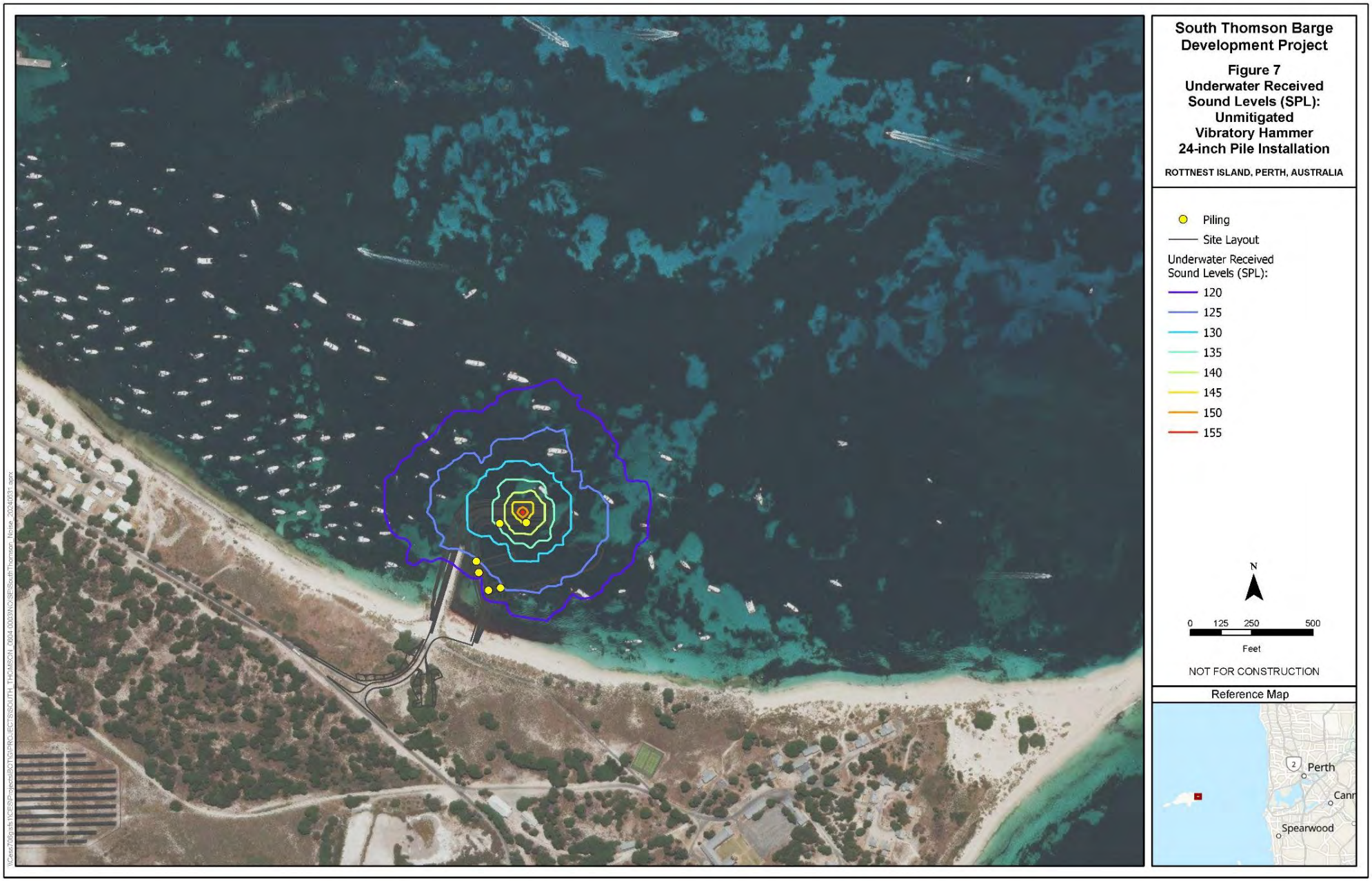

Figure 7. Underwater Received Sound Levels (SPL): Unmitigated Vibratory 24-inch Pile Installation

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APPENDIX A. SUMMARY OF ACOUSTICAL DISTANCES

IMPACT PILE DRIVING SUMMARY TABLES

Peak Sound Pressure Thresholds

Table A-1. Summary of R95% Ranges (in meters) to Lpk due to Impact Pile Driving of 24-inch Pile

Attenuation (dB)	$L_{p,pk}$ dB re 1 µPa											
	232	230	226	220	219	218	213	210	207	206	202	200
0	0	0	0	0	0	0	0	0	0	2	8	14

SPL_{rms} Thresholds

Table A-2 Summary of $R_{95\%}$ Ranges (in meters) to SPL_{rms} due to Impact Pile Driving of 24-inch Pile

Attenuation (dB)	L_p dB re 1 µPa								
	210	200	190	180	175	170	160	150	140
0	0	0	0	14	20	37	84	348	537

SEL Thresholds (Unweighted)

Table A-3 Summary of $R_{95\%}$ Ranges (in meters) to Unweighted Cumulative SEL due to Impact Pile Driving of 24-inch Pile

Attenuation (dB)	$L_{E,24hr}$ dB re 1 µPa^2·s							
	220	219	210	207	200	187	183	180
0	0	0	0	4	16	52	76	106

SEL Thresholds (Weighted)

Table A-4 Summary of $R_{95\%}$ Ranges (in meters) to Cumulative SEL for Marine Mammals and Turtles Functional Hearing Groups due to Impact Pile Driving of 24-inch Pile

Attenuation (dB)	$L_{E,24hr}$ dB re 1 µPa^2·s						
	LF 183	MF 185	HF 155	PP 185	OW 203	TU 204	TU 189
0	73	0	68	36	0	3	30

VIBRATORY HAMMER SUMMARY TABLES

SPL_{rms} Thresholds

Table A-5 Summary of $R_{95\%}$ Ranges (in meters) to SPL_{rms} due to Vibratory Hammer Installation of 24-inch Pile

Attenuation (dB)	L_p dB re 1 µPa									
	210	200	190	180	175	170	160	150	140	120
	0	0	0	0	0	0	0	6	29	176

SEL Thresholds (Unweighted)

Table A-6 Summary of $R_{95\%}$ Ranges (in meters) to Unweighted Cumulative SEL due to Vibratory Hammer Installation of 24-inch Pile

Attenuation (dB)	$L_{E,24hr}$ dB re 1 µPa²·s						
	220	219	210	200	187	183	180
0	0	0	0	0	7	16	22

SEL Thresholds (Weighted)

Table A-7 Summary of $R_{95\%}$ Ranges (in meters) to Cumulative SEL for Marine Mammal Functional Hearing Groups due to Vibratory Hammer Installation of 24-inch Pile

Attenuation (dB)	$L_{E,24hr}$ dB re 1 µPa²·s						
	LF 199	MF 198	HF 173	PP 201	OW 219	TU 220	TU 200
0	0	0	0	0	0	0	0

APPENDIX B. UNDERWATER SOUND PROPAGATION MODELING INPUTS

Underwater Sound Propagation Modeling Methodology

Tetra Tech has developed a reliable and effective approach to evaluating underwater acoustic impacts from pile driving as well as other in-water activities. The underwater noise modeling methodology used to evaluate the Project pile driving activities is described below.

Underwater Sound Propagation Modeling

Tetra Tech uses dBSea for underwater sound propagation modeling. dBSea is a software program developed by Marshall Day Acoustics and Irwin Carr Consulting for the prediction of underwater noise. The three-dimensional model is built by importing bathymetry data and placing noise sources in the environment. Each source can consist of equipment chosen from either the standard or user-defined databases. Noise mitigation methods may also be included. The user has control over the seabed and water properties including sound speed profile ("SSP"), temperature, salinity, and current.

Noise levels are calculated throughout the entire Project Area and displayed in three dimensions. Levels are calculated in third octave bands. For the Project, two different solvers are used for the low- and high-frequency ranges:

- dBSeaModes (Normal Modes Method): The normal models are calculated for each water depth, based on sediment properties and water SSP. The sound field is calculated based on coupling between the calculated modes across the interfaces between different depths. The calculation is of the adiabatic, single forward scattering type. The overlying space is modelled as a vacuum. dBeaModes is suitable where the frequency is low and/or the water depth is shallow. The sediment layer is extended down well below the depth of the water column, with the attenuation rapidly increasing at the lowest depths. In this way, there are no modes where energy is reflected from the very bottom of the sediment layer (the space underneath the bottom of the sediment is also a vacuum).
- dBSeaRay (Ray Tracing Method): The dBSeaRay solver forms a solution by tracing rays from the source to the receiver. Many rays leave the source covering a range of angles, and the sound level at each point in the receiving field is calculated by coherently summing the components from each ray. This is currently the only computationally efficient method at high frequencies.

The specific parameters used in the modeling analysis are described below.

Calculation Grid and Source Solution Setup

The calculation grid and source solution setup are based on the resolution and extents of the bathymetry data. The calculations within dBSea are made along each radial for each range point and depth point. Radials are generated from the source location out to the extent of the bathymetry area. The range points are generated along each radial and are evenly spaced out (range step). However, this spacing does not change if the source is moved. The number of "Radial slices" and "Range points" are entered, which represents the number of radial solution slices for each source and the evaluation range points along those slices (Figure B-1). The range points are determined based on the width and length of the modeled area as well as the required range step resolution (Equation B-1).

$$Range\ Points = \frac{\sqrt{Width^2 + length^2}}{\text{Range Step}} \quad (6)$$

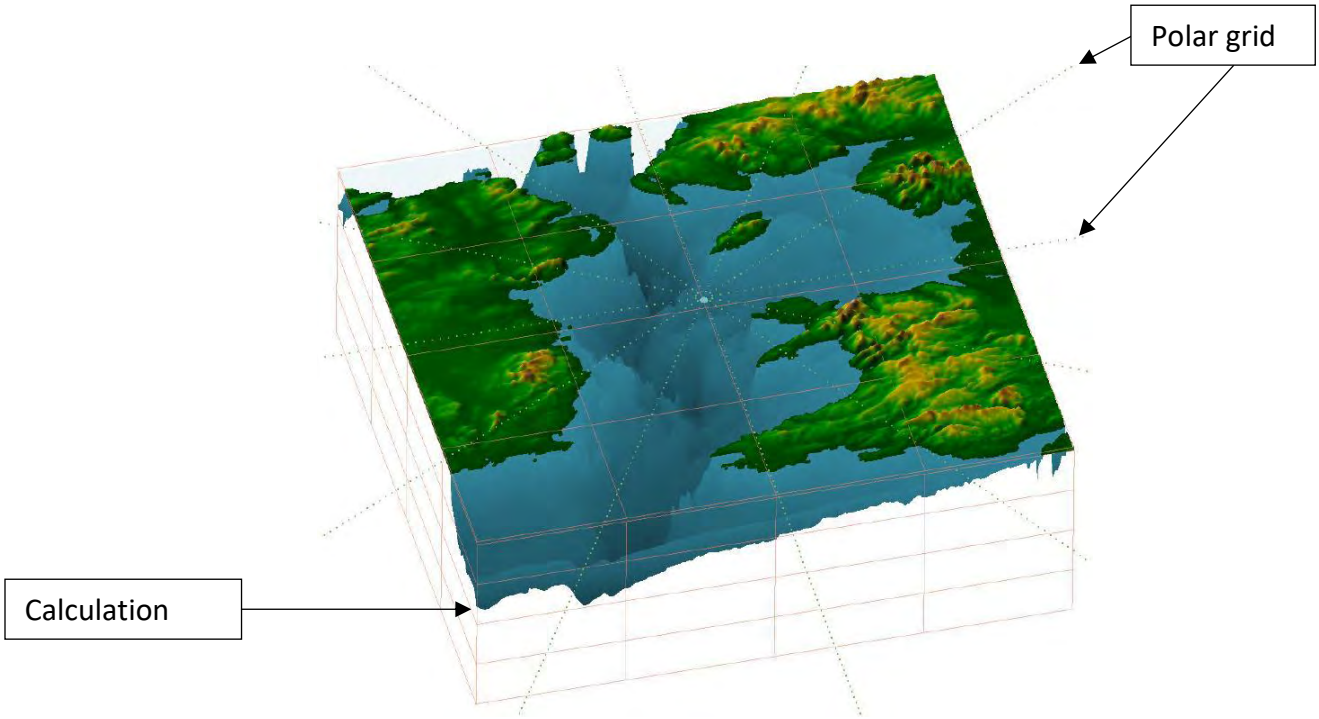

Figure B-1. Example Radial Solution Points

dBSea source solution calculations are completed along the radials (polar grid) based on the defined range and depth points. The calculation grid (cartesian) is filled from the polar grid using the nearest neighbor sampling, i.e., a point in the calculation results grid takes the value of the closest point in the polar grid. The calculation steps in dBSea are summarized below:

- Calculations are done in the polar grid (radials) at multiple depths, which are the same depths as the (cartesian) calculation grid.
- The calculation of the polar grid is smoothed with a triangular kernel, the width of which is selected by the user.
- The results of the cartesian grid is filled by the nearest neighbor sampling from the calculated polar grid using an inverse distance.

The more radials and range points used, the less interpolation needed for the cartesian grid. Because the calculation happens in the polar grid, while the results grid is cartesian, every point in the cartesian grid is “filled” depending on what point of the polar grid it is closest to (Figure B-2).

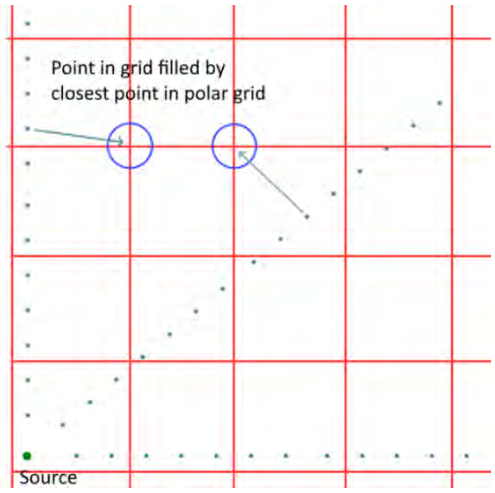

Figure B-2. Example Cartesian Grid Calculation

The underwater acoustic modeling analysis for the Project used a split-solver, with dBSeaModes evaluating the 12.5 Hz to 1 kHz range and dBSeaRay addressing the 1.2 kHz to 20 kHz range. The radial resolution was 10-degree intervals to the extent of the bathymetry. The specific parameters used in the modeling analysis are described below.

Bathymetry

Bathymetry data for Rottnest Island and shoreline surrounding the Army Groyne was provided by the Project. This data included bathymetric multibeam and LiDAR survey data and was obtained from the Government of Australia Department of Transport (DoT 2020). Bathymetric extents for the model were chosen to be 5 km x 5 km and the water depth within that extent ranges from 0 to 37 meters.

Sediment Characteristics

The geoacoustic properties of the surficial sediments by site-specific geophysical and geotechnical data provided by the Project. Based on a regional geological mapping at the site, it consists of sand, quartz, and shell debris (Department of Mines, Industry Regulation and Safety, 2020). The sediment profile is presented in Table B-1 and directly input into dBSea for each defined sediment layer. The parameters entered for each sediment layer is bulleted below:

- Sediment layer depth (provided by the client)
- Material name (provide by the client)
- Speed of sound (meters/second)
- Density (kilograms per cubic meter)
- Attenuation (dB/wavelength)

The acoustic parameters (speed of sound, density, and attenuation) are typically taken from Jensen et al. (2011), Hamilton (1976, 1982), and Hamilton and Bachman (1982).

Table B-1. Geoacoustic Properties of Sub-bottom Sediments as a Function of Depth

Depth	Speed of Sound	Geoacoustic Properties
0 to 2	Sand	Cp = 1650 m/s αs (dB/λ) = 0.8 dB/ λ ρ = 1900 kg/m^3
2 to 10	Gravel	Cp = 1800 m/s αs (dB/λ) = 0.6 dB/ λ ρ = 2000 kg/m^3

Sources: Shannon & Wilson (2018) and Jensen (2011)

Speed of Sound Profile

Sound speed profile information for the year was obtained per month for the construction period. The speed of sound profile was obtained using the NOAA Sound Speed Manager software incorporating the World Ocean Atlas 2018 extension algorithms (Garcia et al. 2019). Pile-driving will take place from February to June, and only taking place in the daytime. For the construction modeling scenarios, the average sound speed profile for the construction period was used in the model. The average sound speed profile was directly input into the dBSea model, and the input is shown in Figure B-3.

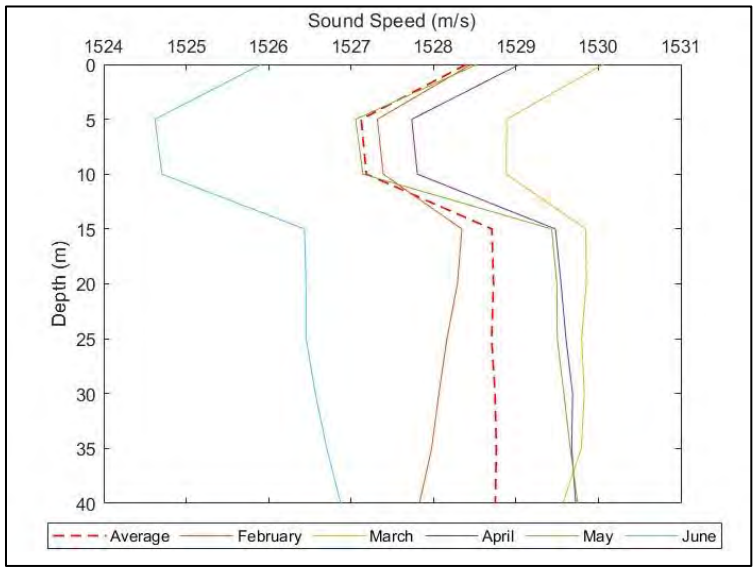

Figure B-3. Sound Speed Profile

Pile Driving Sound Source Characterization

The pile-driving sound source level was represented using three different metrics: peak sound level (L_{pk} [$L_{p,pk}$]), sound exposure level (SEL [$L_{E,24h}$]), and sound pressure level (SPL [$L_{p,rms}$]). The sound source spectrum is entered for each one-third octave band from 12.5 Hz to 20kHz.

For the L_{pk} underwater acoustic modeling scenario, the pile-driving sound source was represented as a point source at mid-water depth. The L_{pk} scenario evaluates a single pile-driving strike.

For the SEL underwater acoustic modeling scenario, the pile-driving sound source was represented by a moving source, which accounts for the speed of sound of steel for the pile itself. The pile-driving scenarios were modeled using a vertical array of point sources spaced at 0.5-meter intervals. Using the SEL level calculated by the empirical model, the SEL sound source is calculated using the following equation to distribute the sound emissions across the vertical array:

$$L_{E,N} = L_{E,\,1\,strike} + 10*Log(N) \qquad \text{(B-1)}$$

Where:

N is the number strikes

$L_{E,\ 1\ strike}$ is the sound exposure level for a single strike

The SPL underwater acoustic modeling scenario is set up identical to the SEL underwater acoustic modeling scenario. The difference regarding the SPL underwater acoustic modeling scenario is that the total number of anticipated pile-driving blows in the 24-hour assessment period is not incorporated into the calculation. For the SPL underwater acoustic modeling scenario, only a single pile-driving strike is evaluated.

Vibratory Hammer Sound Source Characterization

The vibratory hammer source was modeled as a point source at mid-water depth. The source spectrums were entered for each one-third octave band from 12.5 Hz to 20 kHz. The sound source level was empirically obtained from published data as well as the Pile Driving Noise Measurements for Chevron Long Wharf Maintenance and Efficiency Project report (Illingworth & Rodkin 2020).

Time Domain Considerations

Tetra Tech also recognizes the effect time has on pile driving sound. As Bellman (2020) reports, the noise of a single strike is thus temporally stretched with increasing distance. Additionally, the amplitude decreases steadily with the distance to the source, so that the signal-to-noise-ratio continuously decreases. Figure B-4 from Bellman (2020) illustrates the change in signal over time.

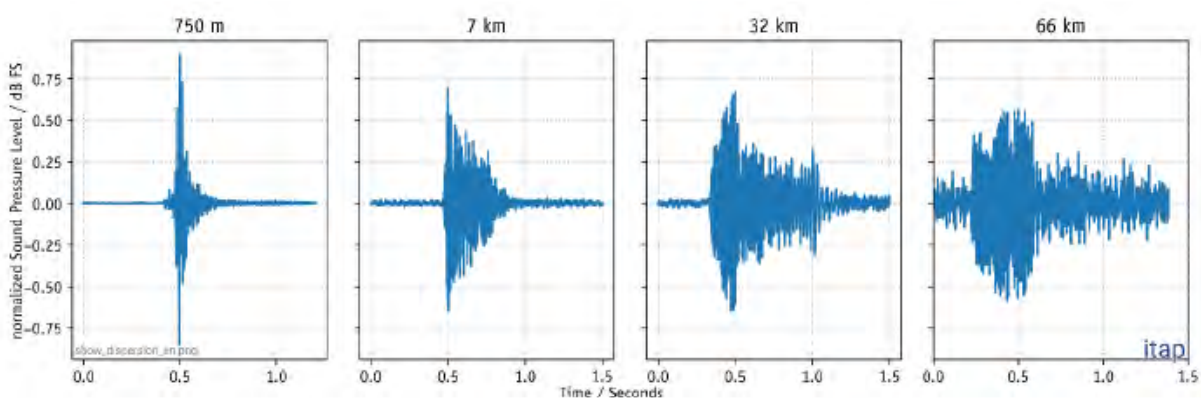

Figure B-4. Time Signal of a Single Strike, Measured in Different Distances to the Pile-Driving Activity (Bellman 2020)

The L_{pk} levels tend to decrease faster than the SEL sound levels as the propagation occurs. There are mixed views on whether the impulsivity of signals decrease over time, suggesting that non-impulsive limits should be applied to assess underwater acoustic impacts. While impulsivity may decrease, it is still observed that the rise times associated with impulsive signals are maintained (Martin et al. 2020). This is especially true when considering the narrow temporal windows (high temporal resolution) of many cetaceans and after application of weightings, excluding lower frequencies.

dBSea can account for the effects of the time domain using two different mechanisms. If time series information is available for use in the modelling analysis, it can be directly loaded into dBSea and used as sound source. The gaussian beam raytracer (dBSeaRay) will calculate the paths and arrival times from the source to all receiver points in the scenario for all the rays emitted from the source. At every receiver point, the transmission loss, phase inversion from the surface, loss to the sediment, and time of arrival is stored. This information is used to convolve all ray-arrivals into a single signal at that point. This means that each receptor point will receive a signal from many perceived origins and at various arrival times (depending on the length of the path travelled). This tends to "smooth" out and stretch the received signal at greater ranges or with more reflections.

Alternatively, if time series data are not known or available, dBSea can include a crest factor, which is a way to incorporate impulsiveness information into the source. The crest factor indicates the dB level above the rms level of the highest peak in the signal. It is applied when assessing peak levels and is applied to all frequency bands. Application of the crest factor is generally expected to yield more conservative results relative to using a time series for characterizing pile-driving sound source levels. Since time series data for the Project's pile-driving activities were not available at the time of the modelling analysis, Tetra Tech used the conservative crest application methodology.

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Appendix T
Marine Magnetic survey at proposed barge landing site, South Thomson (Surrich 2019)

Document Description		**GEOPHYSICAL SURVEY REPORT**
		Marine Magnetic survey at proposed barge landing site, South Thomson Bay
Document ID		SH20191111_November_2019_RIA_South_Thomson_Bay_Magnetic_Survey
Document Author		Justin Anning
		Principal Geophysicist
Project Name		
Contract Number		
Client		Rottnest Island Board

REVISION HISTORY

REV	DATE	REVISION DESCRIPTION	BY	APPROVED
Rev2	15/2/2019	Final.	JMA	
Rev2a	25/2/2019	Updated with defence.gov.au/uxo classification		

DISTRIBUTION LIST

Rottnest Island Authority	ROTTNEST IS

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Contents

1 INTRODUCTION 5
2 DISCLAIMER 6
3 LIMITATIONS 8
3.1 SURVEY COVERAGE 8
3.2 MARINE MAGNETICS 8
4 FIELD LOGISTICS 9
4.1 SAFETY 9
4.2 PROJECT TIMELINE 9
4.3 PROJECT PERSONNEL 9
5 ACQUISITION 10
5.1 SURVEY VESSEL - BASE OF OPERATIONS 10
5.2 SURVEY VESSEL - TENDER TO INTREPID 11
5.3 POSITIONING AND NAVIGATION EQUIPMENT 12
5.4 MARINE MAGNETOMETER 12
6 COORDINATE SYSTEM 13
6.1 HORIZONTAL COORDINATES 13
6.2 VERTICAL COORDINATES 13
7 POSITIONING CHECKS 13
8 PROCESSING 14
8.1 MARINE MAGNETICS 14
9 RESULTS AND DISCUSSION 15
9.1 MAGNETOMETER NOISE LEVELS 15
9.2 POSITIONING ERRORS 15
9.3 BACKGROUND REMOVAL 15
9.4 TARGET PICKING 16
9.5 TARGET DISCUSSION 16
9.6 TARGET REVISIONS SINCE PRELIMINARY DATA SUPPLIED 16
9.7 MASKED AREAS 17
9.8 DIVER INVESTIGATION OF TARGETS 17
9.9 DIVER FOLLOW-UP RECOMMENDATIONS 17
10 CONCLUSIONS 18
11 REFERENCES 18
12 DIGITAL PRODUCTS 19

FIGURES

Figure 1. Army Jetty, South Thompson Bay. Marine Magnetic survey to cover the proposed dredge areas (red boundary). 5

Figure 2. Survey Vessel "Intrepid" 10

Figure 3. Survey tender with low magnetic properties towing the magnetometer. 11

Figure 4. Example magnetic profiles comparing various processing steps. 14

Figure 5. Raw magnetic data example from field prior to low pass filtering and down sampling. 15

TABLES

Table 1. Abbreviations 4

Table 2. Project Timeline 9

Table 3. Project Personnel 9

Table 4. RTK rover SSM results 13

APPENDICES

Appendix A - Scope Document (Chart)

Appendix B - Residual Magnetic Anomaly (Chart)

Appendix C - Analytic Signal – Low Amplitude Colour Scale (Chart)

Appendix D - Analytic Signal – High Amplitude Colour Scale (Chart)

Appendix E - Magnetic Targets (Table)

ABBREVIATIONS

The following abbreviations may be used in this document

AUSPOS	Online GPS base post-processing facility by Geoscience Australia
AHD	Australian Height Datum
CD	Chart Datum
GDA94	Geocentric Datum of Australia 1994
HP	High Pass
Mag	Magnetics
MM	Marine Magnetics
MGA	Map Grid Australia
nT	nanoTesla
UXO	Unexploded Ordnance

Table 1. Abbreviations

1 INTRODUCTION

In November 2019, Surrich Hydrographics was contracted by RIA to conduct a 'UXO survey over proposed dredge area'. Surrich proposed a magnetic survey as a component towards accessing the UXO risk and clearance of the site.

The survey extents were subsequently increased during acquisition to include coverage over the proposed works areas where accessible to the marine magnetic survey.

Surrich provided support to the TAMS dive team performing sediment jet-probing and follow-up investigation of the magnetic targets in the form of preliminary magnetic results, supply of positioning equipment and on-line support of the digital charts used for precise navigation and location of targets.

Figure 1. Army Jetty, South Thompson Bay. Marine Magnetic survey to cover the proposed dredge areas (red boundary).

2 UNEXPLODED ORDANANCE (UXO) RISK

It is outside the experience and capability of Surrich Hydrographics to assess the risk of UXO. The following assessment of risk is not comprehensive and is from public data published on the following web site: https://www.defence.gov.au/uxo/.

By utilizing the mapping application and this information, the user accepts the following disclaimer provided on the web site:

Disclaimer: *The data supplied is based on Defence's assessment of information obtained from a variety of sources. It does not reflect any UXO remediation conducted on behalf of any person or organisation other than Defence. While Defence makes all reasonable efforts to ensure that the information provided is accurate, complete and up-to-date, there may be limitations to the sources available to Defence and the information may be subject to change. The information relating to a specific parcel of land should not be relied upon without additional checks and/or verification from the relevant state, territory or local government.*

Source: https://www.defence.gov.au/UXO/Where/Default.asp

The screen capture presented in Figure 2, shows Rottnest Island has been categorized with a residual Unexploded Ordinance (UXO) potential as "slight". Although the Survey area falls outside the immediate classification boundary, for the purposes of this assessment, we shall interpret the survey area as being subjected to the same classification as the adjacent land area.

The "slight" classification is defined as follows:

Slight

Areas categorised as slight will have a confirmed history of military activities that have resulted in residual UXO but which Defence considers it inappropriate to assess as substantial.

Warning: Allied Defence Forces used many areas throughout Australia, during and after World War II, for encampments, field training, live firing of weapons and other military activities. This property is on such a site. A possibility exists that dangerous items of Unexploded Ordnance (UXO) may still be found on this site. If you should find a suspicious item, that may be a UXO, do not touch or disturb it. It has been there for many years, it will not hurt you if you do not disturb it. There are no known instances, in Australia where UXO have caused injuries except when they were deliberately and intentionally disturbed. Contact police they will arrange for military experts to attend and dispose of it.

Advice: All land usage and development, within these areas, may continue without further UXO investigation or remediation.

Source: https://www.defence.gov.au/UXO/What/Categories.asp

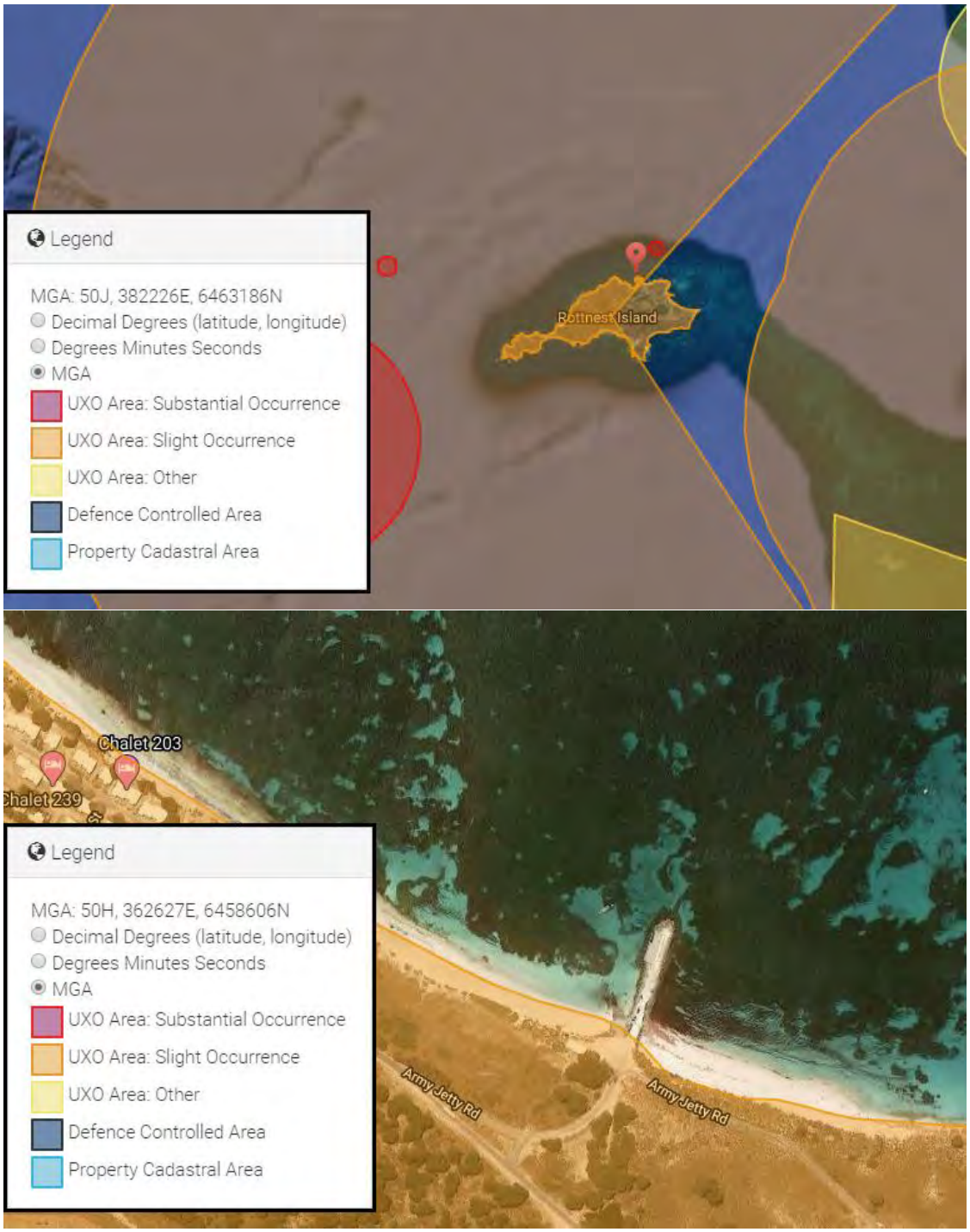


Figure 2. Screen capture from the UXO mapping application.

(Source: https://www.defence.gov.au/uxo/)

3 DISCLAIMER

The interpretations contained in this report are based on the training and experience of the author and information passed on during the investigation. As with all geophysical data, multiple interpretations are possible. 100% imaging of the seabed at consistent accuracy and resolution is unachievable. There are limitations to every geophysical technique. The client is advised to consider information from all available sources prior to deciding on how to proceed.

4 LIMITATIONS

4.1 SURVEY COVERAGE

Survey coverage was achieved across the dredge area and wharf extension footprint.

Due to the thick seagrass accumulation along the beach, it was difficult to achieve consistent coverage immediately parallel to the beach.

4.2 MARINE MAGNETICS

The marine magnetic method responds to man-made ferrous objects above and below the seabed, as well as magnetic minerals in the geology.

The magnetic method does not have the ability to locate all ferrous objects in a survey area. The probability of detection decreases as iron content becomes less and distance from the sensor increases. Operating in high gradient areas, for example, around wharves and steel vessels, reduces the ability of the technique to detect objects on the seabed.

Quantitative interpretation relies on an accurately sampled field, however in practice, even small errors in sensor positioning during marine survey reduce the reliability of the interpretation.

5 FIELD LOGISTICS

5.1 SAFETY

No safety incidents.

5.2 PROJECT TIMELINE

Activity	Dates
Survey acquisition	6/11/2019 - 7/11/2019

Table 2. Project Timeline

5.3 PROJECT PERSONNEL

Name	Role	Qualifications
A. Richardson	Maintain the RTK base station and positioning QC.	Bachelor of Surveying, CPHS 1
J. Anning	Geophysicist, Project Manager, coxswain. On-line support of TAMS divers positioning systems.	Bachelor of Geophysics
G. Edwards	Geophysical and hydrographic survey acquisition, coxswain.	

Table 3. Project Personnel

6 ACQUISITION

6.1 SURVEY VESSEL - BASE OF OPERATIONS

Name	Intrepid
Description	7m Aluminium catamaran. Twin 150hp outboard engines.
Survey Certificate	2C (non passenger vessel, offshore to 30nm)
Navigation Equipment	Plotter/sounder
Communications	VHF
Safety Equipment	All safety equipment as required by AMSA regulations for this class of vessel.
Safe Management System	The vessel operates under a Safety Management System (SMS) developed and maintained to AMSA standards.

Figure 3. Survey Vessel "Intrepid"

6.2 SURVEY VESSEL - TENDER TO INTREPID

Acquisition was conducted from a low magnetic vessel operated as a tender to the survey vessel "Intrepid" which remained onsite during the survey.

Figure 4. Survey tender with low magnetic properties towing the magnetometer.

6.3 Positioning and Navigation Equipment

Positioning System	Septentrio Altus RTK
GNSS correction source	RTK base station located at Surrich office in Mount Claremont.
Navigation System	Hypack 2019
Notes	The positioning system has centimetric accuracy. Sensor positioning is based on a layback calculation.

6.4 Marine Magnetometer

Magnetometer	Geometrics MFAM sensor.
Acquisition System	Hypack 2019
Tow point offset	Directly below RTK Rover antenna.
Sample interval	~ 5cm
Nominal vessel speed	< 2 knots
Line spacing	4m
Base station mag	None utilized.
Acquisition Notes	The magnetometer sensor is towed 9m behind the RTK antenna. The sensor was operated a fixed depth below the water surface of approximately 0.5m. Magnetometer positioning based on the Hypack layback calculation, with final parallax adjustment during processing.

7 COORDINATE SYSTEM

7.1 HORIZONTAL COORDINATES

MGA Zone 50

7.2 VERTICAL COORDINATES

NA.

8 POSITIONING CHECKS

The magnetic data acquired in this report utilized the rover RTK antenna which was also used to perform the QC checks for a MBES bathymetric survey conducted at the Main Jetty, Thomson Bay during the same visit.

For detailed information on establishing the base station and verification of the horizontal and vertical datums, refer to the Surrich bathymetric survey report:

- SH20190909_Nov_2019_RIA_Rottnest_Main_Jetty_Survey_Report_Rev0.pdf

The RTK base station established by Surrich Hydrographics, is a permanent installation located using the Geoscience Australia AUSPOS positioning service. The base station is located in the suburb of Mt Claremont, 22km from the work area. Table 4 contains the results of checks against SSM sites located on the mainland and on Rottnest.

SSM Check Sites

SSM ID	Claremont 61	A854
Datum	GDA94	GDA94
Actual Easting	384521.232	362124.949
Actual Northing	6462418.201	6459810.603
Actual Height	-14.095	-18.744
N Value	-32.869	-33.547

Observation Results

SSM ID	Claremont 61	A854
Rover Model	Septentrio Altus NR3	Septentrio Altus NR3
Antennae Model	Septentrio Altus NR3	Septentrio Altus NR3
Datum	GDA94	GDA94
Measured Easting	384521.258	362124.993
Measured Northing	6462418.215	6459810.614
Measured Height	-14.087	-18.678
No. Of Measurements	120	
Baseline Length	0.329 km	22.760 km
Delta Easting	0.026	0.044
Delta Northing	0.014	0.011
Delta Height	0.008	0.066
Easting StDev	0.005	0.002
Northing StDev	0.003	0.003
Elevation StDev	0.006	0.006

Table 4. RTK rover SSM results

.

9 PROCESSING

9.1 MARINE MAGNETICS

1. Merge positioning, magnetic sensor data and altimeter data.
2. Import data into Geosoft UXO-Marine software.
3. Apply high-pass non-linear filter to level the raw magnetic field, and isolate anomalies
    - This filter also removes the following:
        - The Earths primary magnetic field
        - Long wavelength components from distant magnetic sources.
        - Magnetic "Heading Errors" associated with the sensor and acquisition setup.
    - The final result of this levelling and background removal process is referred to as the "Residual Magnetic Field"
4. Calculate the "Analytic Signal" from the gridded data.
5. Inspect results and manually pick potential UXO targets.
6. Chart data and targets.

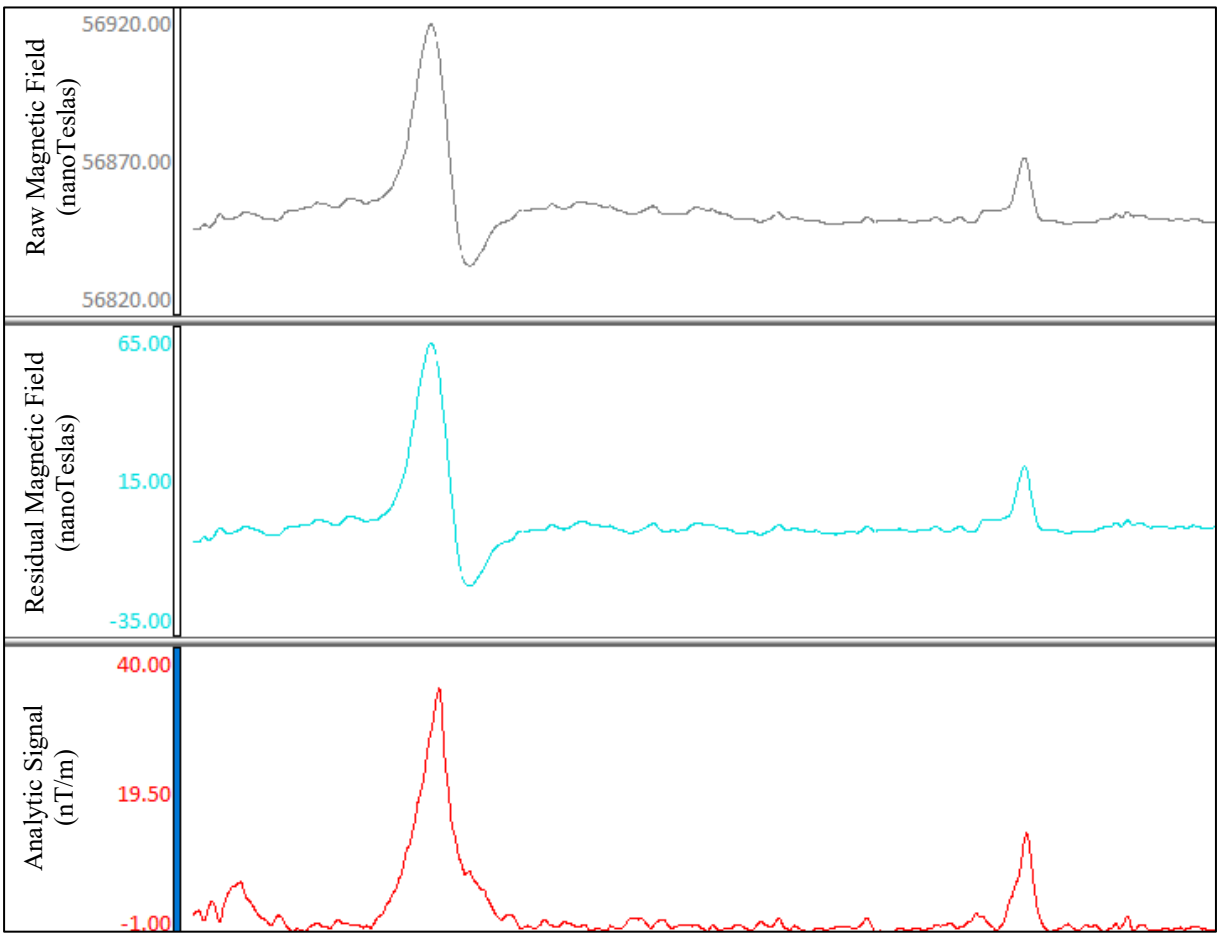


Figure 5. Example magnetic profiles comparing various processing steps.

10 RESULTS AND DISCUSSION

10.1 MAGNETOMETER NOISE LEVELS

The profile in figure 5 is a section of data acquired in the project area. Viewing a relatively flat section of profile in Figure 6, the data from the magnetic sensor has a random noise level of +/- 0.1 nT when measured from reading to reading.

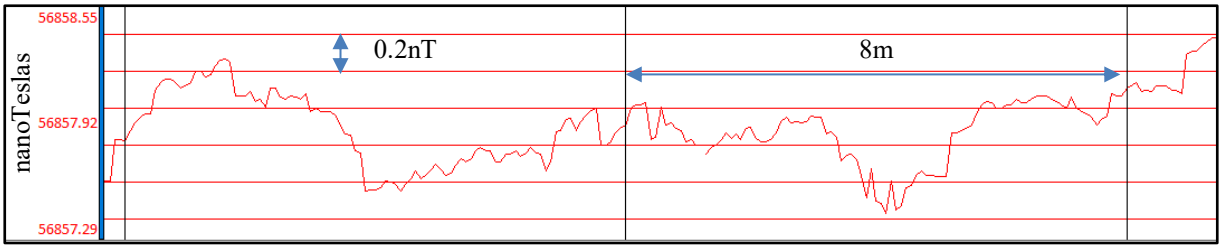


Figure 6. Raw magnetic data example from field prior to low pass filtering and down sampling.

10.2 POSITIONING ERRORS

Data logging was only conducted when a good RTK positioning solution was available. A shallow tow was utilized with a short (9m) umbilical and constant layback distance to the sensor. This contributes to sub-meter horizontal positional errors, however for purposes of uncertainty calculations we shall specify a Root Mean Square Error (RMSE), of 1m.

Horizontal positional uncertainty in the interpreted target location caused by line spacing combined with the need to interpret the location of the object from its magnetic signature, is estimated to have an RMSE of 2m.

Therefor when locating targets it is reasonable to expect an RMSE of 2.2m, calculated by taking the square root of the sum of the squares of the previous estimated uncertainties.

10.3 BACKGROUND REMOVAL

The aim of the background removal filter was to remove diurnal magnetic variations, as well as anomalies from nearby infrastructure while preserving the shorter wavelength anomalies from the ferrous debris targets. The background removal process is typically not perfect and can introduce artefacts into the data, however it can be relied on to preserves the shape of the target anomalies. Introduced artefacts are ignored by examining the raw magnetic data in addition to the processed data when evaluating targets.

10.4 TARGET PICKING

There is very little magnetic response from within the shallow sediments and all magnetic anomalies in this dataset are assumed to be caused by ferrous objects. Potential ferrous objects include the following:

- Anchors
- Anchor chain
- Mooring infrastructure (shackles, clump weights)
- Mooring chain
- Railway track
- Steel pylons
- Debris dropped in the water from general wharf operations including discarded equipment.
- UXO accidently lost during transfer operations

Targets have been selected from the gridded and profile data with the following characteristics:

- Localized anomaly distinct from the background.
- Linear anomalies spanning several lines are ignored.
- Target anomaly may positive, negative or dipolar (positive and negative spikes) in the raw and residual magnetic field data.
- Targets are not picked in complex magnetic areas likely to be associated with existing or historical infrastructure unless the anomaly is suspected to be discrete and a possible ferrous debris object in the seabed.

There are areas where complex and strong magnetic fields associated with existing or historical infrastructure may mask smaller UXO type anomalies. These areas are identified and discussed in the following section.

10.5 TARGET DISCUSSION

The water depth ranges from 0 to 3m (LAT datum). Predicted tide values were 0.59 to 0.75m in Fremantle during the survey days. The sensor was estimated to 0.5m below the water surface. Expected sensor altitude off the seabed varies from 0 m to 3.25m.

The targets are tabulated in Appendix B.

The column “Mag Analytic Signal Amplitude” is a calculation relating to the gradient of the gridded magnetic field, which highlights the presence of near surface ferrous objects. The peak in the Analytic Signal also provides an estimation of the location of the target. The amplitude of the analytic signal relates to a combination of the size of the target object as well as its proximity to the magnetic sensor.

Target properties (size and weight) have not been calculated from the magnetic field data as these are typically erroneous and misleading in single sensor, marine magnetic surveys. All targets identified are ferrous objects.

The targets in Appendix B have been classified with a “high”, “medium” or “low priority” for the benefit of prioritizing the follow-up diver investigation. The “priority” classification is not related to likelihood that the target represents a UXO.

High Priority = Targets located within the dredge boundary.

Medium Priority = Targets located just outside the dredge boundary, which may be impacted by the dredging operations.

Low Priority = Targets outside the dredge boundary.

10.6 TARGET REVISIONS SINCE PRELIMINARY DATA SUPPLIED

The initial target spreadsheet provided for the November 2019 diver investigation was named “rev1”. The latest revision is named “rev2” (revision 2). This report is the first report supplied, however is also named “rev2” to correspond to the latest target spreadsheet revision.

Rev 2 changes are as follows:

Target 31 has been relocated 5m to the SW. This was previously investigated by divers and nothing located in the preliminary location. Re-investigation of the profile data showed a weak anomaly in the preliminary position, and a stronger and more definitive anomaly in the new location on adjacent lines.

Target 47 has been deleted. This weak anomaly was originally prioritized as 'high' as it was within the dredge area, however the anomaly is now considered to be background variation and has been deleted.

10.7 Masked Areas

The end user should be aware there is potential for small anomalies to be masked by larger anomalies. This is typical in magnetic surveys, and has the following implications:

1. Complex magnetic areas around wharf infrastructure or from multiple ferrous objects spaced in close proximity such that their magnetic anomalies overlap, strongly decrease the probability than a discrete uxo-style anomaly may be detected in this area.
2. Any magnetic anomaly caused by a ferrous object, may mask the presence of another ferrous object in the same location with a weaker magnetic field.

The potential of missed anomalies shall be taken into account by the end-user when evaluating the UXO risk. For example if the UXO risk is 'low', it may be considered pragmatic to perform a single magnetic survey and follow up sampling/removal program to confirm the risk assessment, however if the UXO risk is 'high', then several cycles of survey and target removal might be considered.

There are 2 areas exhibiting a strong magnetic response from historical steel infrastructure, either in-situ (e.g., pylons), or dumped objects (e.g., gantry cranes or railway tracks). One is associated with the existing jetty structure. The other area is to the South West of the survey area which maps a considerable, previously unknown structure buried below the present beach surface.

10.8 Diver Investigation of Targets

On the 11th and 14th of November, TAMS investigated a selection of targets using metal detector equipped divers.

Surrich facilitated the divers with an RTK rover antenna and appropriate data layers to allow them to utilize a moving map display to accurately locate targets for investigation while in the field.

The results from the dive investigation are detailed in TAMS report "REC_A01_C13_FOR_C14_0016-02.pdf".

10.9 Diver Follow-Up Recommendations

It is recommended that diver follow-up of targets trial both flux-gate style metal detector in addition to electromagnetic metal detectors.

Flux-gate type metal detectors sensors are the preference, measuring the same physical property as measured in this marine magnetic survey.

11 CONCLUSIONS

- This survey identified 42 ferrous debris targets. 17 of these have been prioritized as 'high' to help direct/prioritize the diver investigation based on them being within or on the dredge boundary. 'Medium' and 'low' priority targets are outside the dredge area, however the end-user should consider the overall works being performed and re-prioritize any targets as appropriate.

- The potential for missed or masked targets shall be taken into account by the end-user when evaluating the UXO risk. For example if the UXO risk is 'low' from a desktop evaluation, it may be considered pragmatic to perform a single magnetic survey and target removal cycle to confirm the risk assessment, however if the UXO risk is 'high', then several cycles of survey and target removal might be considered.

- Diver follow-up should utilize metal detection equipment. Fluxgate sensors are the preference when following up marine magnetic targets.

12 REFERENCES

Keating, P., Pinet, P., 2011, Use of non-linear filtering for the regional-residual separation of potential field data. Journal of Applied Geophysics 73, 315-322.

Blakely, R. J. and Simpson, R. W., 1986, Approximating edges of source bodies from magnetic or gravity anomalies: Geophysics, v.51, p. 1494-1498.

Pennella J. (1982) Magnetometer Techniques in the Detection of Projectiles. NAVEODTECHCEN Technical Report TR-239, Navel Explosive Ordnance Disposal Technology Center, Indian Head Maryland.

Pawlowski J., Lewis R., Dobush T., Valleau N. (1995) An Integrated Approach for Measuring and Processing Geophysical Data for the Detection of Unexploded Ordnance, Proceedings of SAGEEP 1995, Orlando Florida.

13 DIGITAL PRODUCTS

\---rev2

20200215_Targets_Rev2.pdf

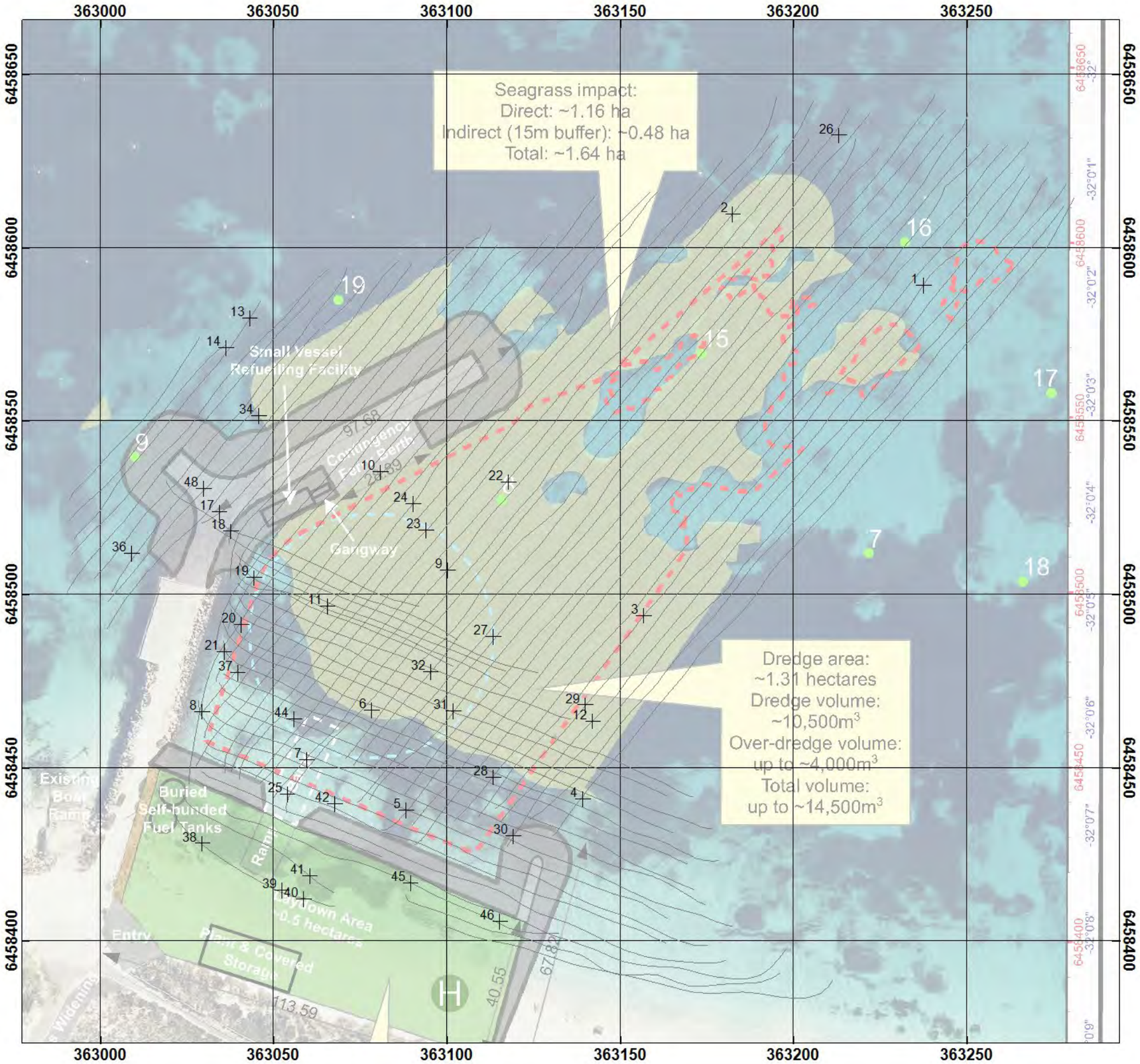
20200215_Targets_Rev2.xlsx

Appendix_B_Residual_Magnetic_Intensity.tif

Appendix_C_Analytic_Signal_Low.tif

Appendix_D_Analytic_Signal_High.tif

SH20191111_November_2019_RIA_Army_Jetty_Magnetic_Survey_rev2.pdf



surrich
HYDROGRAPHICS

Scale 1:1300

25 0 25
metres

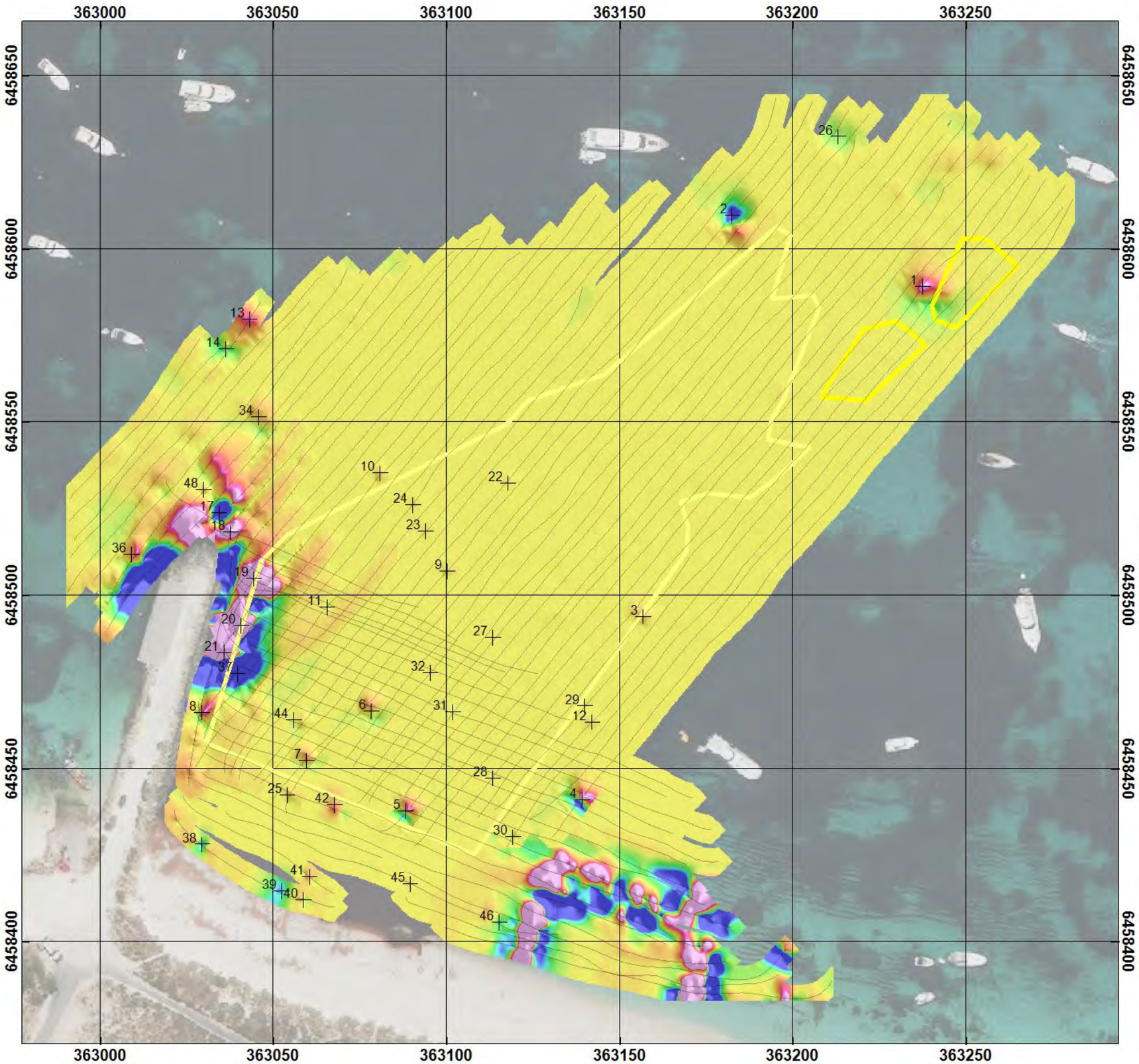
+ Magnetic Target

ROTTNEST ISLAND AUTHORITY

South Thomsons Bay
Magnetic Survey for UXO

Appendix A - Scope Document

Contractor: Surrich Hydrographics
Chart Date: 9/11/2019
Survey Date: 6 to 7/11/2019



surrich
HYDROGRAPHICS

Scale 1:1300

25 0 25

metres

179
149
118
87
56
26
-5
-36
-67
-97
-128
-159
-190

Residual Magnetic Intensity
Uncorrected for Altitude above seabed
Altitude ranges from 0.5 to 4m

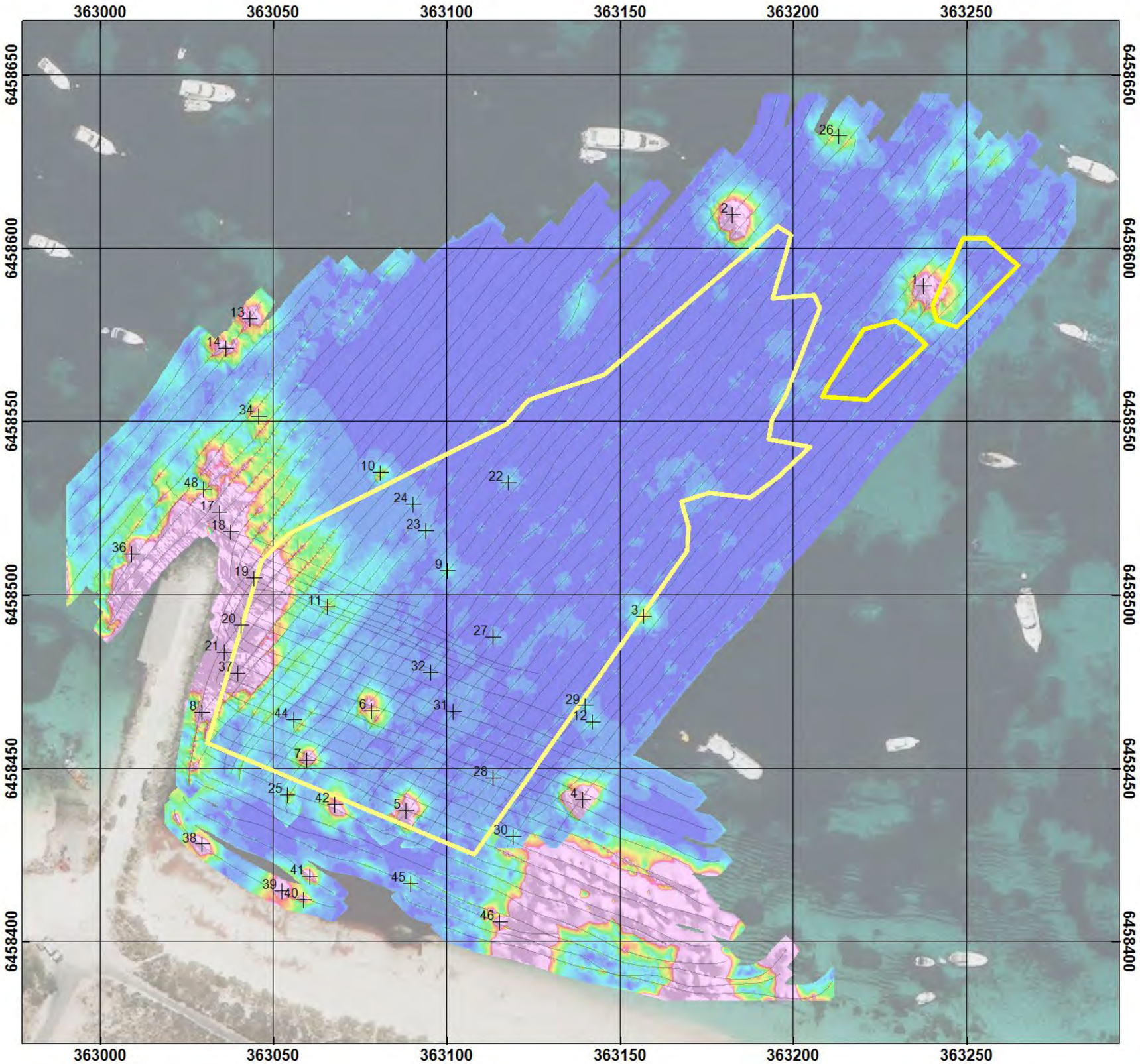
+ Magnetic Target

ROTTNEST ISLAND AUTHORITY

South Thomson Bay
Magnetic Survey for UXO

Appendix B
Residual Magnetic Intensity

Contractor: Surrich Hydrographics
Chart Date: 09/11/2019
Survey Date: 6 to 7/11/2019



surrich
HYDROGRAPHICS

Scale 1:1300
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metres

47
45
42
40
37
35
32
29
27
24
22
19
17
14
12
9
6
4
1

Analytic Signal (nT/m)
Uncorrected for Altitude above seabed
Altitude ranges from 0.5 to 4m

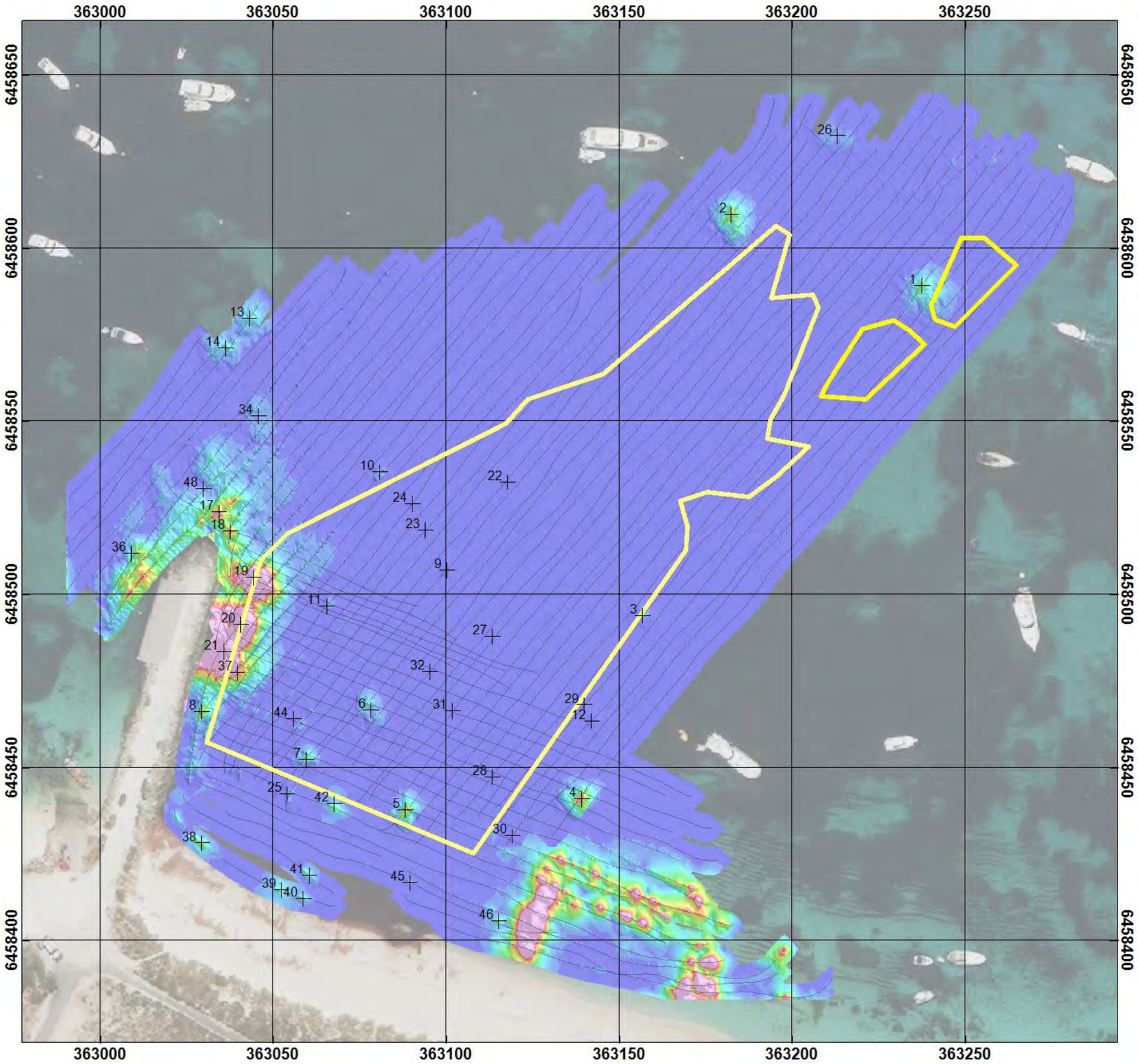
+ Magnetic Target

ROTTNEST ISLAND AUTHORITY

South Thomsons Bay
Magnetic Survey for UXO

Appendix C - Analytic Signal
Low Amplitude Colour Scale

Contractor: Surrich Hydrographics
Chart Date: 9/112019
Survey Date: 6 to 7/11/2019



surrich
HYDROGRAPHICS

Scale 1:1300
25 0 25
metres

474
436
397
359
321
282
244
205
167
128
90
51
13

Analytic Signal (nT/m)
Uncorrected for Altitude above seabed
Altitude ranges from 0.5 to 4m

+ Magnetic Target

ROTTNEST ISLAND AUTHORITY

South Thomsons Bay
Magnetic Survey for UXO

Appendix D - Analytic Signal
High Amplitude Colour Scale

Contractor: Surrich Hydrographics
Chart Date: 9/11/2019
Survey Date: 6 to 7/11/2019

Appendix E. Magnetic Targets (Ferrous Objects)

MGA_E	MGA_N	Target ID	Analytic Signal Amplitude (nT/m)	Priority	Comments	Dive Investigation Results (From TAMS Report "REC_A01_C13_FOR_C14_0016-02.pdf")
363237.5	6458589	1	226	medium	Just outside dredge area. It is probable that identifying this may also indicate the nature of target 2, which is similar.	14/11/2019 RIA mooring chain.
363182.5	6458610	2	334	low	Outside dredge area.	
363156.8	6458494	3	54	high	Moderate to strong anomaly.	11/11/2019 Nothing found requires revisit.
363139.2	6458441	4	999	low	Outside dredge area.	
363088.2	6458438	5	275	high	Strong anomaly.	11/11/2019 Nothing found requires revisit.
363078.2	6458467	6	25	high	Strong anomaly.	11/11/2019. Large metal object. Appears to be structural.
363059.6	6458452	7	247	high	Strong anomaly.	11/11/2019 Nothing found requires revisit.
363029.3	6458466	8	605	medium	Strong anomaly just outside dredge area.	
363100.1	6458507	9	19	high	Moderate anomaly	14/11/2019 Engine block recovered 300mm from target location on seabed, half buried.
363080.8	6458535	10	32	medium	Small object, outside but close to dredge boundary.	
363065.5	6458497	11	30	high	Anomaly seen in both the NS and EW lines.	14/11/2019 Nothing found requires revisit.
363142.1	6458463	12	19	medium	May be related to target 29 on the dredge boundary.	
363043.1	6458580	13	118	low	Outside dredge area.	
363036.3	6458571	14	147	low	Outside dredge area.	
363034.3	6458524	17	884	low	Outside dredge area.	
363037.6	6458518	18	574	low	Outside dredge area.	
363044.4	6458505	19	3474	medium	Likely this is a large object such as and old wharf pylon. On dredge area boundary.	
363040.7	6458491	20	11754	medium	Likely this is a large object such as and old wharf pylon. On dredge area boundary.	

MGA_E	MGA_N	Target ID	Analytic Signal Amplitude (nT/m)	Priority	Comments	Dive Investigation Results (From TAMS Report "REC_A01_C13_FOR_C14_0016-02.pdf")
363035.7	6458483	21	18173	medium	Likely this is a large object such as and old wharf pylon. On dredge area boundary.	
363117.8	6458532	22	9	high	Moderately strong anomaly.	14/11/2019. Small anchor recovered. 500mm from marked location, 400mm deep.
363094	6458518	23	10	high	Moderately strong anomaly.	14/11/2019. Two large links of chain recovered.
363090.3	6458526	24	13	high	Moderately strong anomaly.	14/11/2019. Nothing found requires revisit.
363053.9	6458442	25	29	high	Moderately strong anomaly.	14/11/2019. Small anchor recovered.
363213	6458632	26	17	low	Probable mooring infrastructure.	
363113.3	6458488	27	6	high	Weak dipole anomaly. May be background variations. I.e not real. Search anyway.	14/11/2019. Nothing found requires revisit.
363113.3	6458447	28	5	high	Weak anomaly.	14/11/2019. Nothing found requires revisit. Waist deep weed.
363139.9	6458468	29	11	high	Weak anomaly.	
363119.1	6458430	30	11	low	Outside dredge area.	
363101.8	6458466	31	6	high	This anomaly has been re-evaluated and moved 5m to the South-West based on close assessment of the profile data. This re-alignment has been performed after the initial diver investigation. The anomaly is week however difenitive in	14/11/2019. Nothing found requires revisit.
363095.3	6458478	32	6	high	Weak anomaly however it is a definitive dipole in the NS lines. Reasonable probability a ferrous object exists here. No anomaly in the EW lines	
363045.7	6458551	34	19	low	Outside dredge area.	
363009	6458512	36	75	low	Outside dredge area.	

MGA_E	MGA_N	Target ID	Analytic Signal Amplitude (nT/m)	Priority	Comments	Dive Investigation Results (From TAMS Report "REC_A01_C13_FOR_C14_0016-02.pdf")
363039.7	6458477	37	650	medium	Strong anomaly withn dredge boundary, however this is thought to be the edge of the same anomaly designated target 21 to the west which is outside the dredge boundary. Downgraded to medium priority.	
363029.4	6458428	38	367	low	Outside dredge area.	
363052.3	6458415	39	133	low	Outside dredge area.	
363058.7	6458412	40	132	low	Outside dredge area.	
363060.4	6458419	41	166	low	Outside dredge area.	
363067.6	6458440	42	261	high	Strong anomaly on edge of derge area.	14/11/2019. Nothing found requires revisit. Waist deep weed.
363055.9	6458464	44	148	high	Weak anomaly however anomaly exists in EW and NS lines so high probablilit a ferrous object exists here.	14/11/2019. Nothing found requires revisit.
363089.5	6458417	45	45	low	Outside dredge area.	
363115.3	6458406	46	253	low	Outside dredge area.	
363029.8	6458530	48	17	low	New target outside dredge area whaich was not included in the preliminary data supplied to the drvers for the November 2019 investigation.	

Details			
Project/Client	Rottnest Island Authority - Geological Investigation - Thomson Bay South and UXO investigation/anomaly recovery	**Date**	06-Dec-2019
Subcontract	PO: PER107047	**Job No.**	3032-2
Document No.	REC_A01_C13_FOR_C14_0016	**Revision**	02
Location	Rottnest Island		
Project Manager	Maarten Terwal	**Project Supervisor**	Brendan O' Leary
Personnel	Tony Henson and Matt Webb		

Introduction and Scope of Work

TAMS was engaged by Rottnest Island Authority to supply a vessel and dive team to complete geotechnical investigation at Thompsons Bay South.

The works completed were carried out over 5 days from 15 November to 19 November 2019

- UXO investigation – Number of locations: Total 47 with 14 location inspections completed
- Push tube Sample collection with scientist rep from RPS on board – Number of locations: 7 with a total of 46 Sample tubes collected as per table 1
- Geo sampling with Geologist rep from Douglas Partners on board – Number of locations: 6 with a total of 18 samples collected as per table 2
- Water Jet Probing – Number of locations: 37 with 37 completed as per table 3

Figure 1. Location of area sampled South Thomson Bay

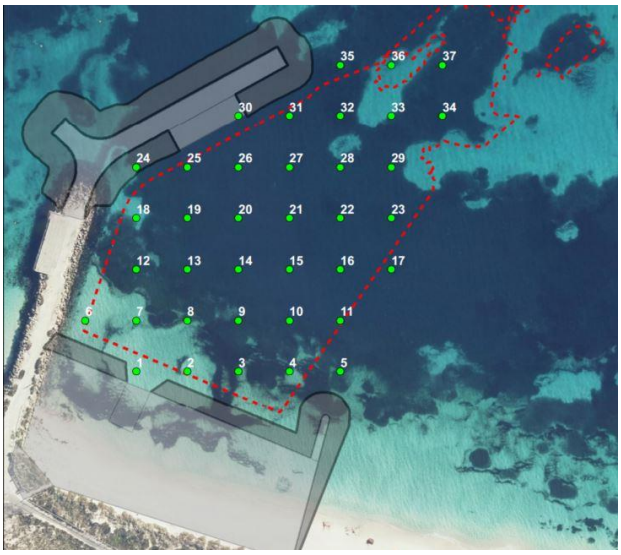


Figure 2. Jet Probe locations (1 to 37)

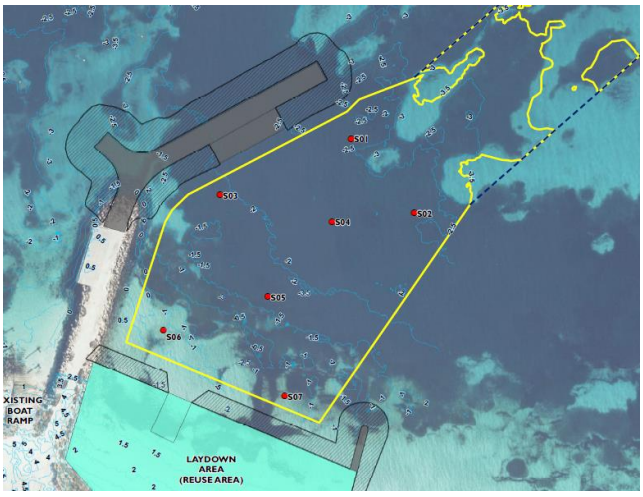


Figure 3. Sediment Sampling Locations (S01 to S07)

Figure 4. Diver searching for UXO with underwater metal detector

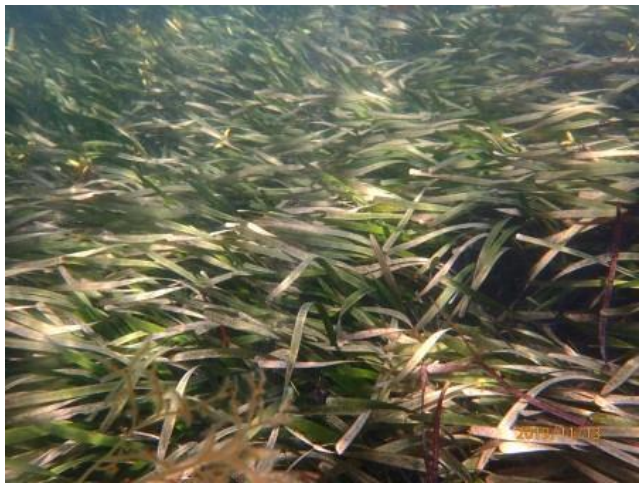


Figure 5. Heavy seagrass cover over 80% of the area

Figure 6. Diver extracting push tube samples

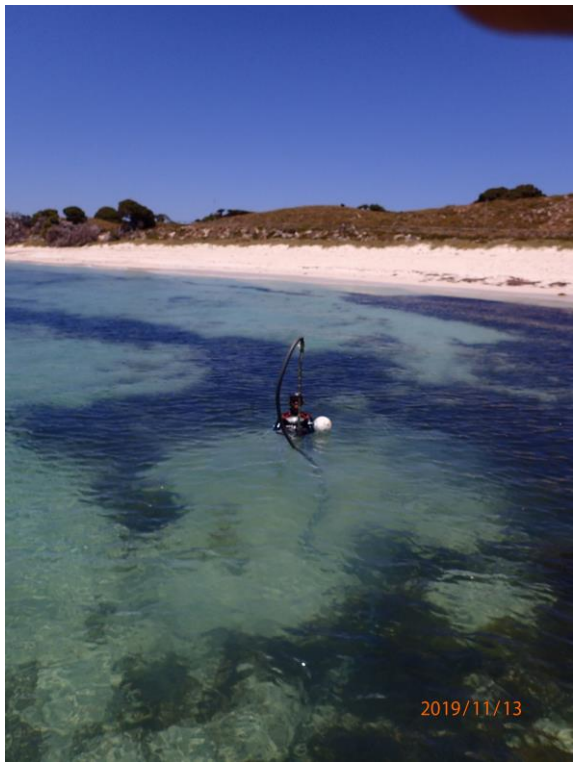


Figure 7. Shallow water jet probing

Figure 8. Diver working in on one of the shallow sample locations

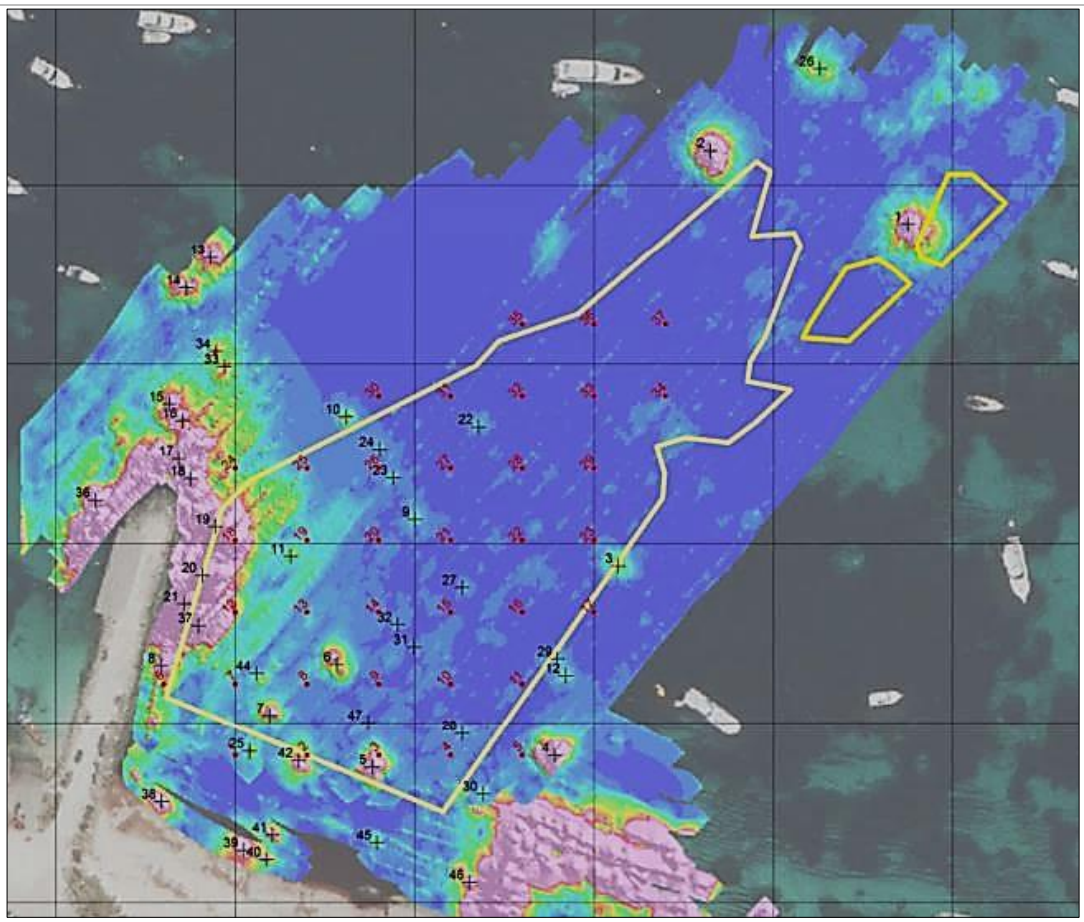


Figure 9. UXO Anomalies

Table 1. **Scientific Push Tube Soil Sample Summary – ID numbers all refer to Figure 3**

Bore Hole ID	DIVER	DATE	TIME	NO. SAMPLES TAKEN	DEPTH - 1.2M OR REFUSAL	ADDITIONAL SAMPLES
S01	TH	12.11.19	8:56 AM - 10:09 AM	1	1.2M	
				2	1.2M	
				3	1.2M	
				4	1.2M	
				5	1.2M	
				6	1.2M	
				EXTRA SAMPLE 7	0.3M	REVISIT - 16:35 TO 16:50
				EXTRA SAMPLE 8	0.3M	REVISIT - 16:35 TO 16:50
S02	TH	12.11.19	11:00AM - 11:40AM	1	1.1M	
				2	1M	
				3	1M	
				4	1M	
				5	0.6M (As Required)	
				EXTRA SAMPLE 6	0.3M	REVISIT - 16:15 TO 16:25
				EXTRA SAMPLE 7	0.3M	REVISIT - 16:15 TO 16:25
S06	TH	12.11.19	12:10AM - 13:02PM	1	1.2M	
				2	1.2M	
				3	1.2M	
				4	0.6M (As Required)	
				5	0.6M (As Required)	
				EXTRA SAMPLE 6		REVISIT - 15:45 TO 15:50
S07	TH	12.11.19	13:19PM - 14:10PM	1	1.2M	
				2	1.2M	
				3	1.2M	

				4	0.6M (As Required)	
				5	0.6M (As Required)	
				EXTRA SAMPLE 6	0.3M	REVISIT - 15:55 TO 16:10
				EXTRA SAMPLE 7	0.3M	REVISIT - 15:55 TO 16:10
MOVE LOCATION						
S03	TH	12.11.19	14:25PM - 15:29PM	1	1.2M	
				2	0.9M	
				3	1.2M	
				4	1.2M	
				5	0.6M (As Required)	
				6	0.6M (As Required)	
S04	MW	13.11.19	08:00AM -09:10AM	1	0.95M	
				2	0.9M	
				3	0.85M	
				4	0.95M	
				5	1M	
				6	0.6M	
MOVE LOCATION						
S05	MW	13.11.19	09:20AM - 10:45AM	1	1.2M	
				2	1.2M	
				3	1.1M	
				4	1.2M	
				5	1.2M	
				6	1.2M	

Table 2. **Geo Core Sample Summary - ID numbers all refer to Figure 2**

BORE HOLE ID	TIME	DATE	MAX DEPTH OF CORE SAMPLES	DEPTH OF WATER	TOTAL	TIDE M	CORE SAMPLE BELOW CHART DATUM
2	13:00	14.11.2019	1.1m x 3 samples	1800mm	2900mm	0.4m	2500mm
4	13:30	14.11.2019	1.1m x 3 samples	2200mm	3300mm	0.4m	2900mm
13	12:17	14.11.2019	0.95m x 3 Samples	2800mm	3750mm	0.4m	3350mm
16	11:30	14.11.2019	1m X 3 Samples	3300mm	4300mm	0.4m	3900mm
25	10:50	14.11.2019	1m X 3 Samples	3100mm	4100mm	0.4m	3700mm
27	10:08	14.11.2019	1m X 3 Samples	3200mm	4200mm	0.3m	3900mm

Table 3. **Jet Probe Locations and depths attained - ID numbers all refer to Figure 2**

ID	Easting (MGA50)	Northing (MGA50)	DATE	TIME	DEPTH OF PENETRATION TO REFUSAL	DEPTH OF WATER	TOTAL	TIDE M	PROBE DEPTH BELOW CHART DATUM
1	363050	6458441	13/11/2019	12:19	1500mm	1300mm	2800mm	0.4	2400mm
2	363070	6458441	13/11/2019	12:42	1350mm	1620mm	2970mm	0.4	2570mm
3	363090	6458441	13/11/2019	13:08	1120mm	1870mm	2990mm	0.4	2590mm
4	363110	6458441	13/11/2019	13:02	1270mm	2040mm	3310mm	0.4	2910mm
5	363130	6458441	13/11/2019	13:20	1030mm	2270mm	3300mm	0.4	2900mm
6	363030	6458461	13/11/2019	13:26	1750mm	1450mm	3200mm	0.4	2800mm
7	363050	6458461	13/11/2019	13:35	1500mm	1830mm	3330mm	0.4	2930mm
8	363070	6458461	13/11/2019	13:50	1570mm	2070mm	3640mm	0.4	3240mm
9	363090	6458461	13/11/2019	14:01	1100mm	2430mm	3530mm	0.4	3130mm
10	363110	6458461	13/11/2019	14:31	1050mm	2580mm	3630mm	0.4	3230mm

11	363130	6458461	13/11/2019	14:36	940mm	2870mm	3810mm	0.4	3410mm
12	363050	6458481	13/11/2019	14:45	1000mm	2200mm	3200mm	0.4	2800mm
13	363070	6458481	13/11/2019	14:57	1230mm	2600mm	3830mm	0.4	3430mm
14	363090	6458481	13/11/2019	15:12	1040mm	2860mm	3900mm	0.4	3500mm
15	363110	6458481	13/11/2019	15:22	1000mm	3200mm	4200mm	0.4	3800mm
16	363130	6458481	13/11/2019	15:27	1340mm	3200mm	4540mm	0.4	4140mm
17	363150	6458481	13/11/2019	15:15	1060mm	3300mm	4360mm	0.4	3960mm
18	363050	6458501	13/11/2019	15:57	1640mm	2700mm	4340mm	0.5	3840mm
19	363070	6458501	13/11/2019	16:00	2810mm	2650mm	5460mm	0.5	4960mm
20	363090	6458501	13/11/2019	16:06	1000mm	3200mm	4200mm	0.5	3700mm
21	363110	6458501	13/11/2019	16:14	1300mm	3200mm	4500mm	0.5	4000mm
22	363130	6458501	13/11/2019	16:20	1100mm	3400mm	4500mm	0.5	4000mm
23	363150	6458501	13/11/2019	16:28	1250mm	3500mm	4750mm	0.5	4250mm
24	363050	6458521	13/11/2019	16:36	2000mm	3200mm	5200mm	0.5	4700mm
25	363070	6458521	13/11/2019	16:47	1750mm	3200mm	4950mm	0.5	4450mm
26	363090	6458521	13/11/2019	16:55	1320mm	3400mm	4720mm	0.5	4220mm
27	363110	6458521	13/11/2019	17:00	1450mm	3300mm	4750mm	0.5	4250mm
28	363130	6458521	14/11/2019	7:40	1180mm	3400mm	4580mm	0.2	4380mm
29	363150	6458521	14/11/2019	7:47	1400mm	3370mm	4770mm	0.2	4570mm
30	363090	6458541	14/11/2019	8:00	1770mm	3200mm	4970mm	0.2	4770mm
31	363110	6458541	14/11/2019	8:05	1560mm	3300mm	4860mm	0.2	4660mm
32	363130	6458541	14/11/2019	8:15	1350mm	3350mm	4700mm	0.2	4500mm
33	363150	6458541	14/11/2019	8:24	1240mm	3350mm	4590mm	0.2	4390mm
34	363170	6458541	14/11/2019	8:34	1150mm	3700mm	4850mm	0.3	4550mm
35	363130	6458561	14/11/2019	8:49	2050mm	3500mm	5550mm	0.3	5250mm
36	363150	6458561	14/11/2019	8:59	1080mm	4300mm	5380mm	0.3	5080mm
37	363170	6458561	14/11/2019	9:05	1420mm	3900mm	5320mm	0.3	5020mm

Table 4. **UXO Findings - ID numbers all refer to Figure 4**

HIGH PRIORITY	SEAGRASS	DRIFT SEAWEED	SAND	DATE AND TIME	RESULT	PHOTO
3	X			11.11.19 - 15:30	Nothing found - requires revisit	
5	X	X		11.11.19 - 14:30 14.11.19 - 08:45	Nothing found (beer can) - revisit - Nothing found second check - requires revisit	
6	X			11.11.19 - 11:45	Large metal object *appears* to be structural and not UXO	YES
7			X	14.11.19 - 15:35 15.11.19 - 07:45	Nothing found - requires revisit	
9	X			14.11.19 - 09:30	Engine block recovered 300mm from location on seabed/half buried	YES
11	X			14.11.19 - 10:30	Nothing found - requires revisit	
22	X			11.11.19 - 13:59	Small anchor recovered - 1000mm from marked location / 300mm deep	YES
23	X			14.11.19 - 11:37	Piece of large link chain recovered - 150mm deep and 1m from mark	YES
24	X			14.11.19 - 13:36	Nothing found - requires revisit (toothpaste tube only)	
25			X	14.11.19 - 07:10	Small anchor recovered - 500mm from marked location / 400mm deep	YES
27	X			11.11.19 - 13:00	Nothing found - requires revisit	
28	X	X		14.11.19 - 02:17	Nothing found - requires revisit (waist deep weed, and drift weed)	
29	X					
31	X			14.11.19 - 15:00	Nothing found - requires revisit	

32	X					
42		X	X	14.11.19 - 12:57	Nothing found - requires revisit (waist deep weed)	
44			X	14.11.19 08:55	Nothing found - airlifting 0.5m then no feedback - requires revisit	
47		X	X			
HIGH PRIORITY	**SEAGRASS**	**DRIFT SEAWEED**	**SAND**	**DATE AND TIME**	**RESULT**	
1			X	14.11.19	RIA Mooring anchor chain	
8		X	X			
10	X					
12	X					
19			X			
20	X					
21	X	X	X			
37	X					

Methodology and Results

Mobilisation of personnel and equipment to Rottnest Island on board the AMS3 on Monday 11 November. Setup of survey was conducted on site with vertical and horizontal accuracy of the sample and water jet location positions undertaken using the CMW DGPS unit during dive operations. On site work was completed by COB on Friday 15th November.

After consultation with the client the decision was made to commence operations in the following order.

- UXO investigation close to sample locations
- Scientific Sample collections
- Water Jet Probing
- Geo. Core Sample collection
- Continue UXO investigation

UXO investigation - With the RTK aerial mounted on the starboard bow gunwale the vessel moved onto location and utilising the RTK positioning system with Global Mapper software, a drop weight was deployed. AMS3 was anchored in location and the diver entered the water. Once the diver was in the water the metal drop weight was recovered and replaced by a PVC tube as a marker. Using the Excalibur 2 underwater metal detector, an area of at least 3 meters around the marker was searched. It was noted that the presence of seagrass over approximately 80% of the area searched resulted in difficulty reading the signal from the metal detector.

In areas the grass was up to 400mm in length and the metal detector had to be pushed down into the grass to obtain the required distance from seabed, in these cases the seagrass touching the sensor resulted readings which were difficult to decipher. Ideally the skid plate should be swept across the seabed approximately 50mm from the ground surface.

In cases where the diver suspected there may be a metal object, the air lift was requested and deployed, and the diver would airlift in the location, digging below the seabed to locate a target object. On completion, the area was once again scanned with the metal detector to check there were no further items. The works completed and results are listed below.

Monday 11.11.2019: Investigate UXO anomalies that were close to sample locations

- UXO Searching 6 - Diver to airlift - object found by diver seemed large and was marked - small stream of bubbles coming from object
- UXO Searching 27 - Nothing found – requires revisit
- UXO Searching 22 - Old buried anchor found and recovered
- UXO Searching 5 - Located old beer can – requires revisit

Thursday 14.11.2019: Complete water jet probing, complete collection of Geo core samples and continue UXO investigation

- UXO Searching location 7 – Nothing found
- UXO Searching location 1 – found anchor chain from (RIA) Rottnest mooring
- UXO Searching location 25, object located 0.5m below seabed buy airlifting – requires revisit, attach subsea marker

Friday 15 November 2019: Continue UXO investigation

- Revisit UXO Searching location 25 – Small anchor recovered
- Revisit UXO Searching location 7 – Nothing found – requires revisit
- UXO Searching location 5 – Nothing found – requires revisit

- UXO Searching location 9 – Old engine Block UXO found and recovered
- UXO Searching location 11 – Nothing found – requires revisit
- UXO Searching location23 – 2 x large links of chain found and recovered
- UXO Searching location 42 – Nothing found – requires revisit
- UXO Searching location 24 – Toothpaste tube found – requires revisit
- UXO Searching location 28 – Nothing found – requires revisit
- UXO Searching location 31 – Nothing found – requires revisit

Note: Items recovered were transported back to Rouse Head and disposed of in the appropriate scrap metal skip bins.

Scientific Sample collections – Table 1

With the RTK aerial mounted on the starboard bow gunwale the vessel moved onto location and using the RTK positioning system a drop weight was deployed. AMS3 was anchored in location and the diver entered the water. Once in the water and under the guidance of the Scientist on board the diver used PVC piping to penetrate the seabed to required depth or refusal, the pipe was capped and sealed resulting in a vacuum and then drawn from the seabed. The other end was capped and the pipe with sample recovered to the AMS 3 for sorting and storage by the onboard scientist. Once adequate sample material was recovered the diver was to exit the water and AMS 3 move to next location with the process being repeated.

Tuesday 12.11.2019: Scientific sample collections

- Sample collection S01 - 6 samples as per XL
- Sample collection S02 - 5 samples as per XL
- Sample collection S06 - 5 samples as per XL
- Sample collection S07 - 5 samples as per XL
- Sample collection S03 - 6 samples as per XL
- Additional sample collection S06 - 1 samples as per XL
- Additional sample collection S07 - 2 samples as per XL
- Additional sample collection S02 - 2 samples as per XL
- Additional sample collection S01 - 2 samples as per XL

Wednesday 13.11.2019: Complete Scientific sample collection

- Sample collection S04 - 6 samples as per XL
- Sample collection S05 - 6 samples as per XL

Water Jet Probing – Table 3 - From seabed to the highest of rock surface or -3.3 m CD at locations defined in document Thomson Bay South Jet Probing Plan Figure 2 and including the correlation of seabed levels to chart datum levels (Thomson Bay) Results as shown on Table 3.

With the RTK aerial mounted on the starboard bow gunwale the vessel moved onto location and using the RTK positioning system a drop weight was deployed. The diver was to enter the water and with a 4m water jet probe and completed a probe to a minimum of 3.3m depth. The RTK was monitored for positioning with no less than 50mm vertical and 35mm horizontal accuracy. In addition, the water jet probe had a horizontal and vertical spirit level attached helping the diver with monitoring these levels during the probing operation.

Wednesday 13.11.2019: Commence water jet probing locations 1 to 27 completed

Thursday 14.11.2019: Complete water jet probing, complete collection of Geo core samples, survey and highlight locations with heavy weed cover and continue UXO investigation

- Water Jet Probing: Locations 28 through to 37 water jet probes completed

Geo. Sample collections – Table 2

With the RTK aerial mounted on the starboard bow gunwale the vessel moved onto location and using the RTK positioning system a drop weight was deployed. AMS3 was anchored in location and the diver entered the water. Once in the water and under the guidance of the Geologist on board the diver drove PVC piping into the seabed penetrating to required depth or refusal, the pipe was capped and sealed resulting in a vacuum and then drawn from the seabed. The other end was capped and the pipe with sample recovered to the AMS 3 for sorting and storage by the onboard scientist. Once adequate sample material was recovered the diver was to exit the water and AMS 3 move to next location with the process being repeated. No drilling was undertaken on this occasion.

Thursday 14.11.2019: Complete water jet probing, complete collection of Geo core samples and continue UXO investigation

- Geo. Core sampling: Locations 27,25, 16, 13, 4 and 2. Three samples taken from each site as per Table 2

Figure 10. HP. Small steel sample broken off item at UXO location 6

Figure 11. HP. Engine block recovered location at UXO location 9

Figure 12. HP. Small anchor recovered UXO location 22

Photo card water damaged, photo lost

Figure 13. HP. Large link chain recovered UXO location 23

Figure 14. HP. Small anchor recovered UXO location 25

Photo card water damaged, photo lost

Figure 15. MP. Ground leg chain from RIA active mooring UXO location 1

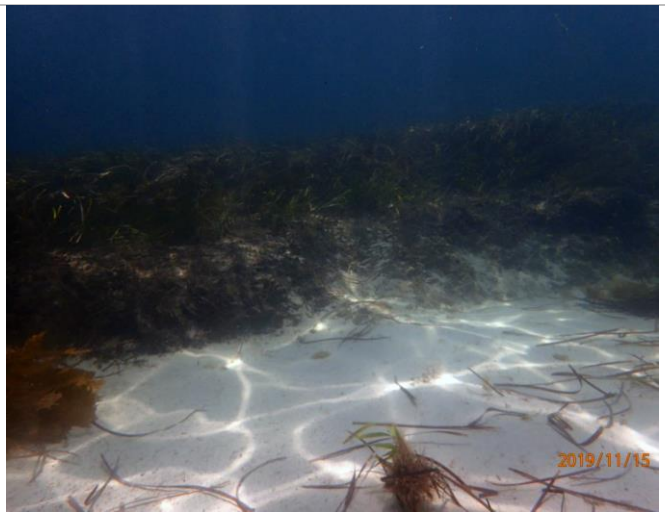


Figure 16. Example of heavy seagrass cover with thick root penetration

Figure 17. Diver working in Seagrass to access seabed

Comments and Discussion

- UXO anomalies require further investigation as time frame was to short to cover a full inspection at each site. The unexpected presence of heavy Sea grass cover and drift seaweed also resulted in slowing progress, it is suggested a more powerful magnetometer which can be used above the weed and with penetration depth of at least 1m be sourced for further investigation of these areas.
- All scientific samples were collected to the satisfaction of the onsite scientist.
- All Geo. samples were recovered down to refusal depth, there are a few remaining sample locations in the shallows which require core drilling to penetrate the rock and reach the required depth.
- All Water Jet Probing locations were successfully completed to the required depth or refusal.

NOTE: TABLES IN THIS REPORT CONATIN RAW FIELD DATA AND SHOUD BE READ IN CONJUNCTION WITH THE FINAL SURVEYORS REPORT AND TABLE - (Jet_Probe_Results_Final_Rev1)

Approvals

TAMS Dive Supervisor Name	**Signature**	**Date**
Brendan O'Leary		06-Dec-2019
Client Representative	**Signature**	**Date**

REPORT

Appendix U
Rottnest Barge Facility, Rottnest Island, Acoustic Assessment (Herring Storer Acoustics 2024)

ROTTNEST BARGE FACILITY
ROTTNEST ISLAND

ACOUSTIC ASSESSMENT

MAY 2024

OUR REF: 32790-1-24194

Rochdale Holdings Pty Ltd A.B.N. 85 009 049 067 trading as:
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DOCUMENT CONTROL PAGE

ACOUSTIC ASSESSMENT

ROTTNEST BARGE FACILITY
ROTTNEST ISLAND

Job No: 24194

Document Reference: 32790-1-24194

FOR

ROTTNEST ISLAND AUTHORITY

DOCUMENT INFORMATION			
Author:	Ashwin Sharma	**Checked By:**	George Watts
Date of Issue :	28 May 2024		

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CONTENTS

1. INTRODUCTION 1

2. EXISTING DEVELOPMENT 1

3. CRITERIA 1

4. NOISE CALCULATIONS 3

5. RESULTS 5

6. ASSESSMENT 5
   6.1 L_{A10} Noise Emissions – vehicle movements 5
   6.2 L_{Amax} Noise Emissions – container set down noise 6

EXECUTIVE SUMMARY

Herring Storer Acoustics have been commissioned to carry out an acoustical assessment of noise emissions associated with the existing Rottnest Barge Facility.

The purpose of this assessment is to undertake noise modelling to ascertain the noise impact that operations at the facility have on surrounding commercial and residential premises.

It is understood that the facility employs forklifts and trucks to load and unload containers and packages onto boats which arrive at the dock.

The criteria considered in this assessment are the *Environmental Protection (Noise) Regulations 1997* requirements. It has been found that noise emissions from the current operation comply with the criteria for all applicable time periods.

1. INTRODUCTION

Herring Storer Acoustics have been commissioned to carry out an acoustical assessment of noise emissions associated with the existing development, Rottnest Barge Facility, located at Thomsons Bay, Rottnest Island.

The objectives of the study were to:

- Perform measurements and noise modelling to predict noise levels at the nearest noise sensitive premises.
- Compare the predicted noise levels received at the closest noise sensitive premises, with relevant acoustic criteria.

2. EXISTING DEVELOPMENT

The existing development of Rottnest Barge Facility is located at Thomsons Bay, Rottnest Island.

It is understood that the venue currently operates from 8am to 2pm, however, compliance with night-time criteria at residential receivers was sought, to be conservative.

3. CRITERIA

The criteria that has been considered in our assessment is the *Environmental Protection (Noise) Regulations 1997*.

The criteria are detailed below:

Environmental Protection (Noise) Regulations 1997

The acoustic criteria are as required in the *Environmental Protection (Noise) Regulations 1997*. These regulations stipulate maximum allowable external noise levels at various types of premises. The allowable assigned noise level at a residential premise is determined by the calculation of an influencing factor, which is then added to the base levels shown in Table 3.1. The influencing factor is calculated for the usage of land within the two circles, having radii of 100m and 450m from the premises of concern. For commercial and industrial premises, the assigned noise levels are fixed. Table 3.1 lists the baseline outdoor noise levels for noise sensitive premises and the allowable noise level for commercial premises.

TABLE 3.1 - BASELINE ASSIGNED OUTDOOR NOISE LEVEL

Premises Receiving Noise	Time of Day	Assigned Level (dB)		
		L_{A10}	L_{A1}	L_{Amax}
Noise sensitive premises	0700 - 1900 hours Monday to Saturday (Day)	45 + IF	55 + IF	65 + IF
	0900 - 1900 hours Sunday and Public Holidays (Sunday / Public Holiday Day)	40 + IF	50 + IF	65 + IF
	1900 - 2200 hours all days (Evening)	40 + IF	50 + IF	55 + IF
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and Public Holidays (Night)	35 + IF	45 + IF	55 + IF
Commercial Premises	All Hours	60	75	80

Note: L_{A10} is the noise level exceeded for 10% of the time.
L_{A1} is the noise level exceeded for 1% of the time.
L_{Amax} is the maximum noise level.
IF is the influencing factor.

It is a requirement that received noise be free of annoying characteristics (tonality, modulation and impulsiveness), defined below as per Regulation 9.

"impulsiveness" means a variation in the emission of a noise where the difference between L_{Apeak} and $L_{Amax\ Slow}$ is more than 15 dB when determined for a single representative event;

"modulation" means a variation in the emission of noise that –

(a) is more than 3dB $L_{A\ Fast}$ or is more than 3 dB $L_{A\ Fast}$ in any one-third octave band;
(b) is present for more at least 10% of the representative assessment period; and
(c) is regular, cyclic and audible;

"tonality" means the presence in the noise emission of tonal characteristics where the difference between –

(a) the A-weighted sound pressure level in any one-third octave band; and

(b) the arithmetic average of the A-weighted sound pressure levels in the 2 adjacent one-third octave bands,

is greater than 3dB when the sound pressure levels are determined as $L_{Aeq,T}$ levels where the time period T is greater than 10% of the representative assessment period, or greater than 8 dB at any time when the sound pressure levels are determined as $L_{A\ Slow}$ levels.

Where the noise emission is not music, if the above characteristics exist and cannot be practicably removed, then any measured level is adjusted according to Table 3.2 below.

TABLE 3.2 - ADJUSTMENTS TO MEASURED LEVELS

Where **tonality** is present	Where **modulation** is present	Where **impulsiveness** is present
+5 dB(A)	+5 dB(A)	+10 dB(A)

Note: These adjustments are cumulative to a maximum of 15 dB.

Where the noise emission is music, then any measured level is adjusted to Table 3.3 below.

TABLE 3.3 - ADJUSTMENTS TO MEASURED MUSIC NOISE LEVELS

Where **impulsiveness** is not present	Where **impulsiveness** is present
+10 dB(A)	+15 dB(A)

The area considered in our assessment is shown in Figure 3.1 below.

FIGURE 3.1 – EXISTING DEVELOPMENT AND SURROUNDING AREA

The influencing factor at the residential receivers R1 and R2 has been taken as **+0 dB** in order to be conservative.

Thus, the assumed Assigned Noise Level for the surrounding area is as listed in Table 3.4.

TABLE 3.4 - ASSIGNED OUTDOOR NOISE LEVEL

Premises Receiving Noise	Time of Day	Assigned Level (dB)		
		$L_{A\ 10}$	$L_{A\ 1}$	$L_{A\ max}$
Neighbouring Residences R1 and R2	Day	45	55	65
	Sunday / Public Holiday Day Period	40	50	65
	Evening	40	50	65
	Night	35	45	55
Commercial Premise C1	All Hours	60	75	80

Note: L_{A10} is the noise level exceeded for 10% of the time.
L_{A1} is the noise level exceeded for 1% of the time.
L_{Amax} is the maximum noise level.

4. NOISE CALCULATIONS

The barge facility was attended by Herring Storer Acoustics and acoustic measurements of operations at the facility were taken. The main sources of noise were emissions resulting from forklift and truck movements, as well as noise from setting containers down during the loading and unloading phases.

Noise modelling was then performed to predict the noise impact to the surroundings from the existing development. Resultant noise levels were then compared to criteria to determine compliance.

Modelling of the noise propagation from the proposed development was carried out using an environmental noise modelling computer program, "SoundPlan" using the CONCAWE algorithm. Calculations were carried out using the EPA weather conditions as stated in the Environmental Protection Authority's *"Draft Guidance for Assessment of Environmental Factors No.8 - Environmental Noise"*.

Ground absorption was considered in the model and uses values of 0.65 for grassed areas, and 0.1 for paved areas such as roads and carparks. A factor of 0 was assumed for water areas.

Google Earth ground contours were utilised to account for the topography of the area.

Noise emissions from the development, include:

- Forklift movements;
- Truck movements;
- Container set-down noise.

The calculations were based in the sound power levels listed in Table 4.1.

TABLE 4.1 – MECH EQUIPMENT SOUND POWER LEVELS

Plant Item	Sound Power Level dB(A)
Forklift Movement	92
Truck Movement	94
Container Set Down Noise	101

It was ascertained that during operations, it is likely that there will be forklifts and trucks moving in the area simultaneously.

Therefore, the modelling was conducted to simulate the maximum noise received at a noise sensitive premise from these sources operating simultaneously.

These levels were assessed against the L_{A10} criteria.

Container set down noise was assessed separately against the L_{AMax} criteria.

The above noise sources need to comply with the following assigned noise levels:

L_{A10} - Vehicle Movements

L_{AMax} - Container set down noise

Environmental Protection (Noise) Regulations 1997

The nearest noise-sensitive premises to the existing development are located to the west of the existing development. Compliance at these premises implies compliance at all other premises in the area.

5. RESULTS

Environmental Protection (Noise) Regulations 1997

Given the calculated noise levels, it is considered likely that impulsive characteristics would be present only for container set down noise, therefore a + 10 dB adjustment is applicable to these noise levels.

Calculations were undertaken to all the premises noted on Figure 3.1.

Table 5.1 and 5.2 below show the calculated noise levels at all the receivers.

TABLE 5.1 – CALCULATED NOISE LEVELS
NOISE SOURCES REQUIRING COMPLIANCE – VEHICLES AND CONTAINER SET DOWN NOISE

Item	Calculated Noise Levels (dB(A))		
	C1	R1	R2
Vehicles	55	31	31
Container Set Down Noise	58	35	37

6. ASSESSMENT

The following provided the acoustic assessment for the noise sources requiring compliance, as listed in Table 5.1.

6.1 L_{A10} NOISE EMISSIONS – VEHICLE MOVEMENTS

During operation, noise emissions from the facility from vehicle movements may occur for more than 10% of the time. Thus, noise received at the neighbouring residences needs to comply with the assigned L_{A10} noise levels.

Based on the information above, the resultant and assessable noise levels are shown in Table 6.1 below.

TABLE 6.1 – APPLICABLE ADJUSTMENTS AND ASSESSABLE L_{A10} NOISE LEVELS, dB(A)
VEHICLE MOVEMENTS – ASSESSABLE LEVELS

Location	Calculated Noise Level, dB(A)	Applicable Adjustments to Measured Noise Levels, dB(A) Where Noise Emission is NOT music			Assessable Noise Level, dB(A)
		Tonality	Modulation	Impulsiveness	
C1	55	-	-	-	55
R1	31	-	-	-	31
R2	31	-	-	-	31

Table 6.2 below shows the assessable noise levels compared to the applicable levels for each receiver.

TABLE 6.2 – ASSESSMENT OF L_{A10} NOISE LEVEL EMISSIONS
VEHICLE MOVEMENTS (NIGHT PERIOD)

Location	Assessable Noise Level, dB(A)	Applicable Times of Day	Applicable Assigned L_{A10} Noise Level (dB)	Exceedance to Assigned Noise Level (dB)
C1	55	Day Period	60	Complies
R1	31	Day Period	35	Complies
R2	31	Day Period	35	Complies

6.2 L_{AMAX} NOISE EMISSIONS – CONTAINER SET DOWN NOISE

During operation, noise emissions from set down noise would occur for less than 1% of the time and are thus assessed to the assigned L_{AMAX} noise criteria.

The noise has the potential to contain impulsive characteristics, so has been assessed the penalty for impulsiveness.

Based on the information above, the resultant noise levels are shown in Table 6.3 below.

TABLE 6.3 – APPLICABLE ADJUSTMENTS AND ASSESSABLE L_{AMAX} NOISE LEVELS, dB(A) CONTAINER SET DOWN NOISE – ASSESSABLE LEVELS

Location	Calculated Noise Level, dB(A)	Applicable Adjustments to Measured Noise Levels, dB(A)			Assessable Noise Level, dB(A)
		Where Noise Emission is NOT music			
		Tonality	Modulation	Impulsiveness	
C1	58	-	-	+10	68
R1	35	-	-	+10	45
R2	37	-	-	+10	47

The assessable noise levels are compared to the relevant criteria in Table 6.4 below.

TABLE 6.4 – ASSESSMENT OF L_{AMAX} NOISE LEVEL EMISSIONS CONTAINER SET DOWN NOISE (NIGHT PERIOD)

Location	Assessable Noise Level, dB(A)	Applicable Times of Day	Applicable Assigned L_{AMax} Noise Level (dB)	Exceedance to Assigned Noise Level (dB)
C1	68	All Hours	80	Complies
R1	45	All Hours	55	Complies
R2	47	All Hours	55	Complies

It is noted that compliance with the night period implies compliance with all other periods.

Hence, noise emissions from the existing operations at the Rottnest Barge Facility comply with the criteria set out by the *Environmental Protection (Noise) Regulations 1997* at all times.