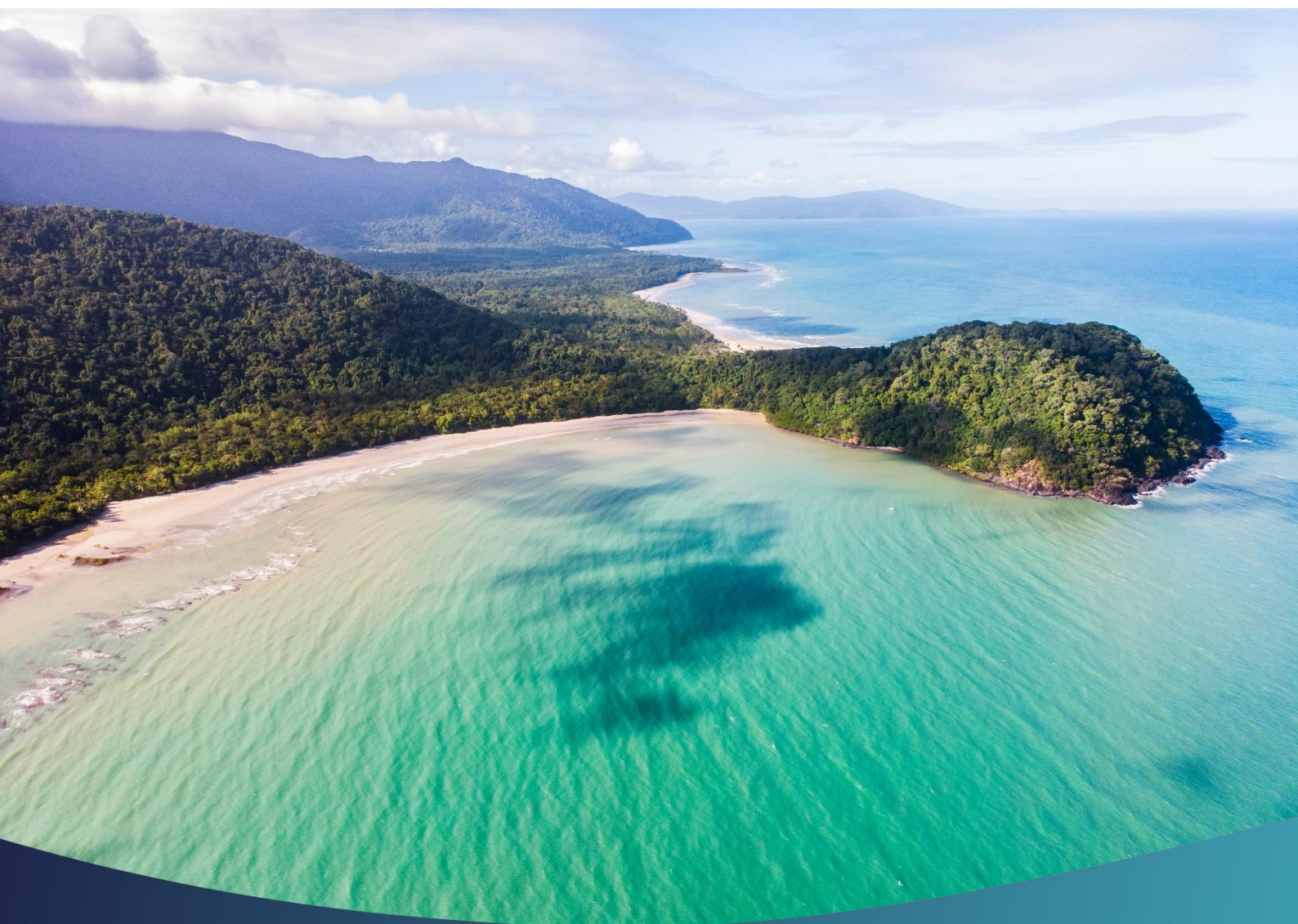


Optimised Mardie Project

Benthic Communities and Habitat Monitoring and Management Plan



CLIENT: BCI Minerals Limited

STATUS: Rev C

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Acknowledgement Of Country

In the spirit of reconciliation BCI Minerals Limited, Preston Consulting Pty Ltd and O2 Marine Pty Ltd acknowledge that this project is proposed on the lands of the Yaburara Mardudhunera 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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Acronyms and Abbreviations

Term	Full term
DBCA	Department of Biodiversity, Conservation and Attractions.
BCH	Benthic Communities and Habitat
BCHMMP	Benthic Communities and Habitat Monitoring and Management Plan
CC	Closed Canopy
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DMP	Dredge Management Plan
DPIRD	Department of Primary Industries and Development
DWER	Department of Water and Environmental Regulation
EP Act	<i>Environmental Protection Act 1986 (WA)</i>
EPA	Environmental Protection Authority
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999 (Cth)</i>
EQG	Environmental Quality Guidelines
EQS	Environmental Quality Standards
ERD	Environmental Review Document
GMMP	Groundwater Monitoring and Management Plan
ha	hectares
L	Licence
LAT	Lowest astronomical tide
LAU	Local Assessment Unit
Mardie Minerals	Mardie Minerals Pty Ltd
MCP	Mine Closure Plan
MEQMMP	Marine Environmental Quality Monitoring and Management Plan
Mining Act	<i>Mining Act 1978 (WA)</i>
MS	Ministerial Statement
N/A	Not Applicable
Optimised Proposal	Optimised Mardie Project
OSRP	Oil Spill Response Plan
PPA	Pilbara Ports Authority
Proposal	Mardie Project



QA/QC	Quality Assurance/Quality Control
RWL	Radar water level
RRDMMA	Robe River Delta Mangrove Management Area
SC	Scattered
SoP	Sulphate of potash
WA	Western Australia

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1. Context, scope and rationale

1.1. The Optimised Mardie Project

Mardie Minerals Pty Ltd (Mardie Minerals) has been granted approval for the Mardie Project (the Original Proposal), a greenfields high quality salt and sulphate of potash (SoP) project and an associated export facility at Mardie, approximately 80 km south west of Karratha, in the Pilbara region of Western Australia (WA) (Figure 1).

The Original Proposal was assessed by the WA Environmental Protection Authority (EPA) under Part IV of the *Environmental Protection Act 1986* (WA) (EP Act) and approved by the WA Minister for Environment via Ministerial Statement (MS) 1175 on 24 November 2021. Environmental approval was also granted by the Department of Climate Change, Energy, the Environment and Water (DCCEEW) under the *Environmental Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) on 12 January 2020 via EPBC 2018/8236. Mardie Minerals has since revised the project design, referred to as the Optimised Mardie Project (Optimised Proposal).

The Optimised Proposal is an evaporative solar salt project that utilises seawater to produce raw salts as a feedstock for processing high purity salt, fertiliser grade sulphate of potash, and other commercial by-products. To meet this production, the Optimised Proposal will include seawater intakes and a series of evaporation and crystallisation ponds. Waste bitterns will be discharged through diffusers offshore. In their assessment of the Original Proposal (EPA Report 1704), the EPA identified impacts on intertidal Benthic Communities and Habitat (BCH) from direct disturbance, changes to surface water, groundwater quality groundwater regimes, and marine environmental quality. The DCCEEW also identified the need to minimise impacts to migratory shorebirds and marine fauna due to loss of BCH as a result of dredging operations, poor water quality, changes in groundwater, and surface water from the installation of surface water diversions.

The Development Envelope, layout and indicative infrastructure of the Optimised Proposal are shown in Figure 2.

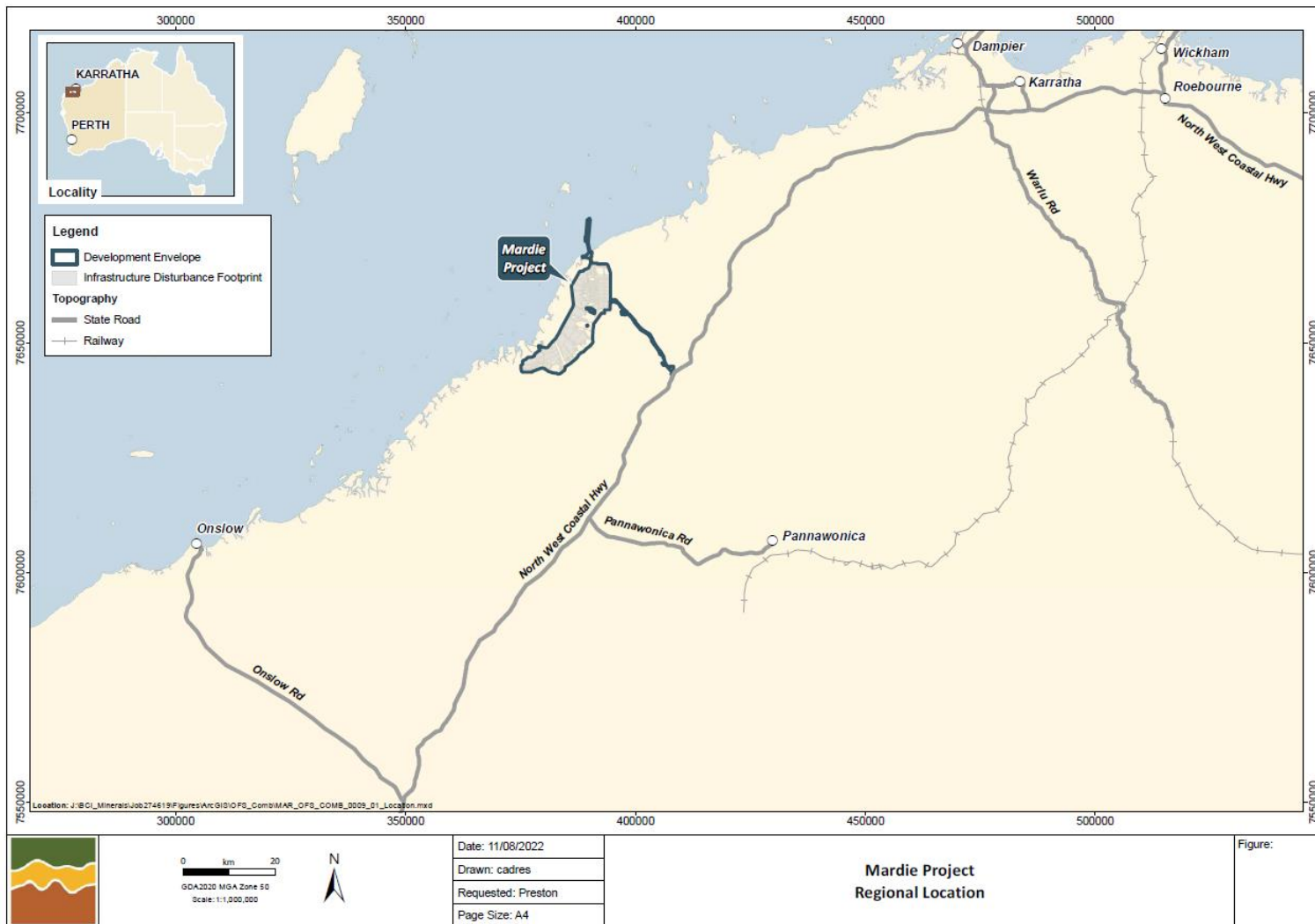


Figure 1: Regional location of the Optimised Proposal

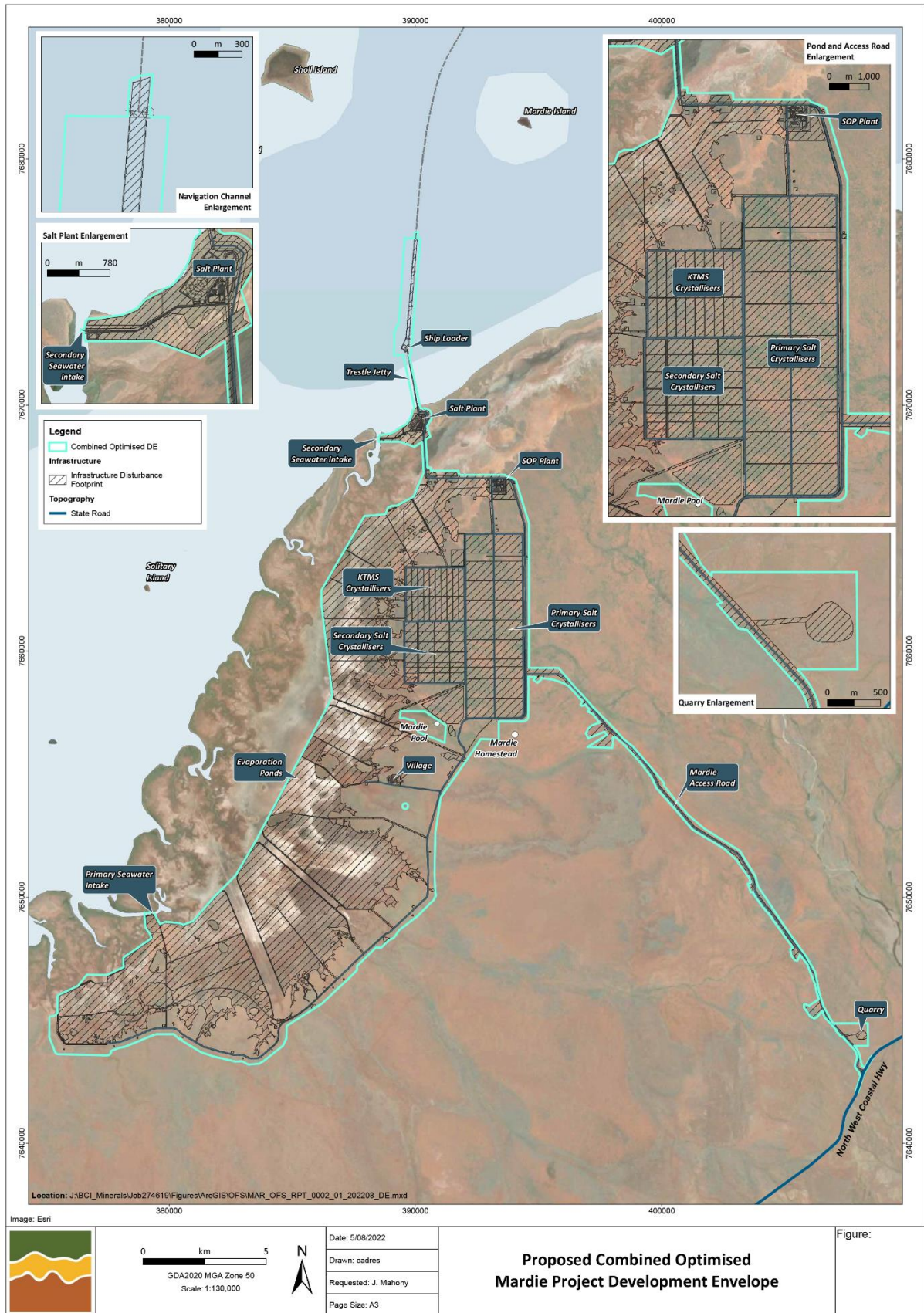


Figure 2: Indicative location of ponds and infrastructure

1.2. Purpose of this Management Plan

This BCH Monitoring and Management Plan (BCHMMP) provides monitoring and management measures to be implemented by Mardie Minerals to protect the health, abundance and diversity of BCH. The BCHMMP has been prepared to satisfy relevant conditions defined in MS 1175 and EPBC 2018/8236, and to demonstrate Mardie Minerals' commitment to achieving EPA's objectives for BCH and minimising impacts to protected matters.

A summary of the key outcomes and objectives for the Optimised Proposal BCHMMP are provided in Table 1.

Table 1: Summary key outcomes and objectives for the Optimised Proposal BCHMMP

Key outcomes	<p>No development that would have an adverse impact on the ecological function of the Robe River Delta Mangrove Management Area (RRDMMA) or the maintenance of ecological processes which sustain mangrove habitats within the RRDMMA</p> <p>No changes to the health, extent of diversity of more than five (5) hectares (ha) of intertidal BCH, including mangrove, samphire and algal mat as a result of changes to groundwater regimes or groundwater quality associated with the proposal</p> <p>Direct impacts to coastal samphire (as defined in the Mardie Project – Response to Submissions March 2021) of no more than 7.2% of the extent within the study area identified in Figure 3 (of MS 1175)</p> <p>Direct and Proposal attributable indirect disturbance to algal mat of no more than 25% of the extent within the study area identified in Figure 3 (of MS 1175)</p> <p>Proposal-attributable direct and indirect impacts of no more than 8% of the extent of algal mat on the west Pilbara coast</p> <p>No long-term (greater than five (5) years) Proposal-attributable net detectable loss of algal mat outside the Proposal footprint</p>
Key Objectives	<p>1) Changes to the health, diversity, and extent of intertidal BCH as a result of changes to surface water, groundwater quality, groundwater regimes, and marine environmental quality associated with the proposal are detected as early as possible</p> <p>Loss of intertidal BCH as a result of the proposal, including loss of health, abundance or diversity as a result of Proposal attributable indirect impacts, are accurately recorded and reported to meet the requirements of condition 14-1(4)</p> <p>Proposal attributable adverse impacts to intertidal BCH are addressed using best-practice available management mitigation and contingency measures.</p>

1.3. Expertise

This BCHMMP was developed by O2 Marine in consultation with leading ecologists and marine scientists from Phoenix Environmental Sciences, Preston Consulting, Actis Environmental Services and the WAMSI Mardie Projects Intertidal Research Offsets Program team. In addition, leading ecologists have been engaged by Mardie Minerals to advise on intertidal ecology and have contributed to the content and methods presented in this BCHMMP. Significant revisions have been made to the BCHMMP with this version based on additional recent field studies and information.

1.4. Key environmental factors

The EPA's key environmental factor relevant to this BCHMMP is BCH. The activities that may affect this factor are described in **Error! Reference source not found.**. The EPA's objective for BCH is *"to protect benthic communities and habitats so that biological diversity and ecological integrity are maintained"*.

The EPBC Act is managed by the DCCEEW and covers nine protected matters, including nationally significant animals, plants, habitats and places. Relevant to this BCHMMP, listed Threatened species, ecological communities, migratory species and marine species of significance are considered in the development of the Proposal. In particular, EPBC 2018/8236 recognises the importance of protecting BCH to minimise impacts to migratory shorebirds and marine fauna.

1.5. Scope and association with other management plans

This BCHMMP has been prepared to align with other Optimised Proposal management plans and avoid repetition. A summary flowchart of the relevant monitoring and management plans is presented in Figure 3.

This BCHMMP provides monitoring and management actions for BCH impacts, with the exception of monitoring and management actions associated with:

- Dredging and spoil disposal activities, which are covered in the Dredge Management Plan (DMP)
- Bitterns disposal, which is covered in the Marine Environmental Quality Monitoring and Management Plan (MEQMMP)
- Mine closure, which is covered in the Mine Closure Plan (MCP).

The Groundwater Monitoring and Management Plan (GMMP) provides monitoring and management actions related to groundwater seepage and mounding, which provide early warning trigger criteria that will trigger implementation of BCH monitoring actions presented in this BCHMMP.

The actions in this BCHMMP may trigger additional monitoring measures in the Long-term Migratory Shorebird Survey Program and the Turtle Monitoring Program.

The management of marine pests will be in accordance with Department of Primary Industries and Development (DPIRD) requirements and therefore has not been included in this BCHMMP.

The management of leaks or spills of hydrocarbons, chemicals or hypersaline brine are defined within the Oil Spill Response Plan (OSRP), established in consultation with the Pilbara Ports Authority (PPA). This plan will be managed under PPA requirements, the Mining Act 1978 (Mining Act) and Part V of the EP Act and therefore has not been included in this BCHMMP.

The OSRP is to be submitted as part of Mardie Mineral's port construction application package to the PPA and prepared in accordance with the PPA's (2017) Port Development Guidelines, Australian Maritime Safety Authority's Technical Guidelines for Preparing Contingency Plans for Marine and Coastal Facilities and International Tanker Owners Pollution Federation Limited Technical Information Paper 17 Response to Marine Chemical Incidents. The OSRP will detail:

- Response arrangements, priorities, divisions of responsibility and terminology
- Reporting and call-out arrangements, incident assessment and reporting procedures
- Incident management responsibilities

- An incident control system
- Response strategies, resource activation and deployment, termination procedures, training etc.

Management of leaks or spills of hydrocarbons, chemicals or hypersaline brine under the Mining Act, will be conducted in accordance with environmental outcomes, performance criteria and monitoring and reporting commitments detailed in the Optimised Proposal's Mining Proposal.

Conditions set by the Proposal's Licence (L9253/2020/1), issued under Part V of the EP Act, regulate emissions caused by the Proposal (including leaks or spills of hydrocarbons, chemicals or hypersaline brine), as well as define monitoring, audit and compliance reporting requirements.

Mardie Minerals proposes to use management commitments, outcomes and reporting requirements detailed in these documents, in addition to management plans required under state and federal approval conditions, to both mitigate and manage against potential leakages or spills into the environment. An adaptive management approach will ensure Mardie Minerals achieves constant improvement in environmental results and management practices throughout the implementation of the Proposal (Section 5).

Overview of BCH Monitoring and Management Plans – Optimised Mardie Project

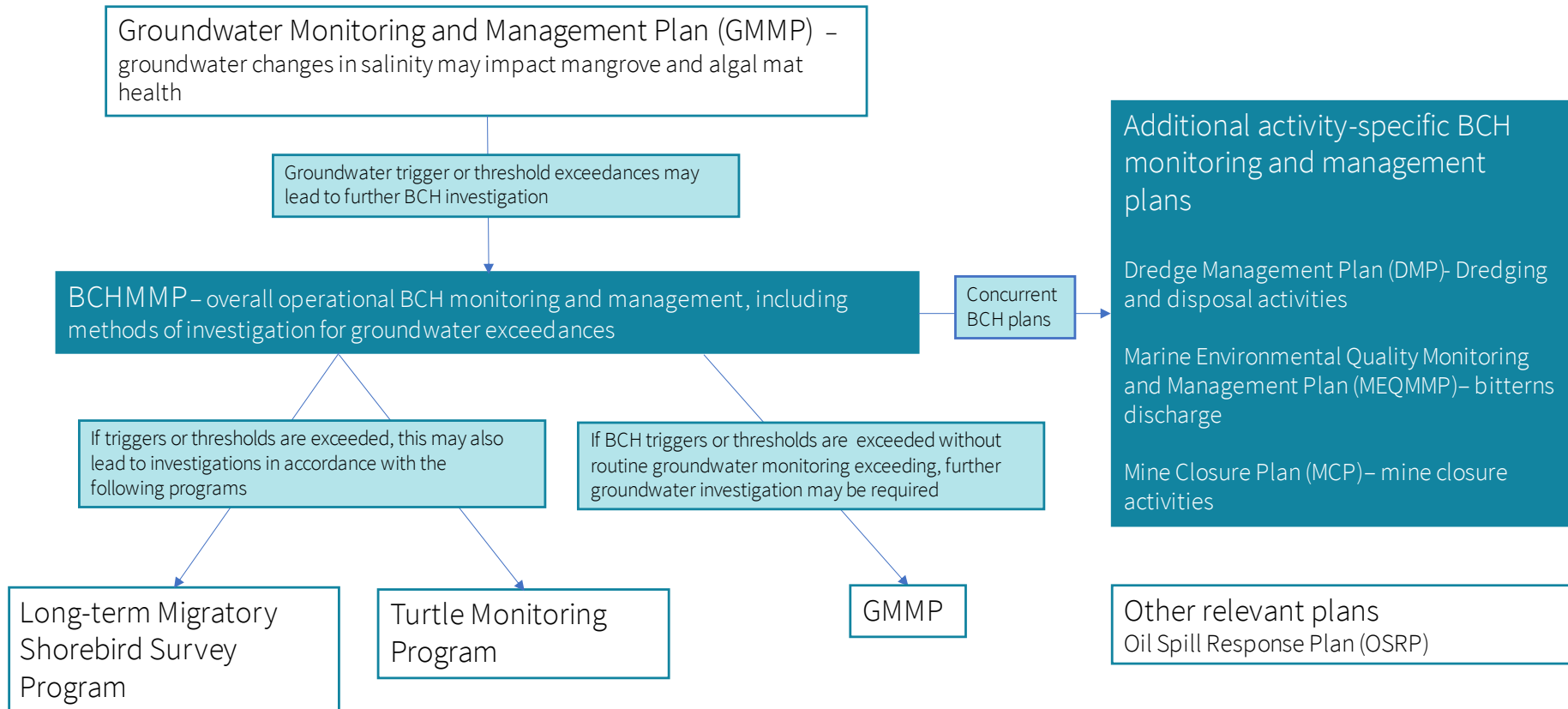


Figure 3: Summary flowchart of relevant monitoring and management plans

1.6. Condition requirements

Table 2 lists the state approval conditions under MS 1175 and Commonwealth approval conditions under EPBC 2018/8236 that are relevant to the BCHMMP and how they will be addressed in this BCHMMP.

Table 2: relevant approval conditions

Condition	Requirement	Reference in Plan
Ministerial Statement 1175		
2	Robe River Delta Mangrove Management Area	
2-1	The proponent shall ensure that the implementation of the proposal achieves the following outcome in the RRDMMMA as shown in Figure 3: (1) no development that would have an adverse impact on the ecological function of the RRDMMMA or the maintenance of ecological processes which sustain mangrove habitats within the RRDMMMA.	Section 3
3	Inland Waters	
3-1	The proponent shall ensure that the following outcomes are achieved: (3) no changes to the extent of surface water flooding extent during a one (1)-year ARI or changes to tidal inundation as a result of the construction of the intertidal causeway that are greater than predicted in Mardie Project – Environmental Review Document (June 2020); (4) no changes to the health, extent of diversity of more than five (5) hectares (ha) of intertidal benthic communities and habitat, including mangrove, samphire and algal mat as a result of changes to groundwater regimes or groundwater quality associated with the proposal; (5) decreased freshwater inundation attributable to the project of no more than fifty-two (52) ha of coastal samphire; (6) decreased freshwater inundation attributable to the project of no more than thirteen (13) ha mangroves outside the RRDMMMA; and (7) decreased freshwater inundation attributable to the project of no more than 130 ha mangroves within the RRDMMMA, subject to the requirements of condition 2-3.	Section 3
4	Marine Environmental Quality	
4-2	The proponent shall manage all aspects of the proposal, including bitterns discharge, to meet the following outcome: 1. the levels of ecological protection to be achieved inside of the: a. Low Ecological Protection Area shown in Figure 2 and described in the spatial data in schedule 1;	Section 3

	<p>b. Moderate Ecological Protection Area shown in Figure 2 and described in the spatial data in schedule 1;</p> <p>c. High Ecological Protection Area shown in Figure 2 and described in the spatial data in schedule 1; and</p> <p>d. Maximum Ecological Protection Area shown in Figure 2 and described in the spatial data in schedule 1,</p> <p>are consistent with the method for deriving Environmental Quality Guidelines (EQG) and Environmental Quality Standards (EQS) for the corresponding level of ecological protection described in Appendix 1, Table 1 of the EPA’s Technical Guidance for protecting the quality of Western Australia’s marine environment.</p>	
6	Benthic Communities and Habitat and Monitoring and Management Plan	
6-1	<p>The proponent shall ensure the implementation of the proposal achieves the following outcomes:</p> <ol style="list-style-type: none"> 1. direct impacts to coastal samphire (as defined in the Mardie Project – Response to Submissions March 2021) of no more than 7.2% of the extent within the study area identified in Figure 3; 2. direct and project attributable indirect disturbance to algal mat of no more than 25% of the extent within the study area identified in Figure 3; 3. project attributable direct and indirect impacts of no more than 8% of the extent of algal mat on the west Pilbara coast; 4. no long-term (greater than five (5) years) project attributable net detectable loss of algal mat outside the proposal footprint; and 5. no project attributable loss of subtidal benthic communities and habitat (including subtidal macroalgae) within the area specified in condition 4-2(1)(d) and outside the Zones of impact authorised in condition 7. 	All Sections & addressed in DMP
6-2	<p>The proponent shall ensure the proposal is constructed and operated to meet the following objectives:</p> <ol style="list-style-type: none"> 1. changes to the health, diversity, and extent of benthic communities and habitat (including subtidal macroalgae) as a result of changes to surface water, groundwater quality groundwater regimes, and marine environmental quality associated with the proposal are detected as early as possible; 2. loss of benthic communities and habitat (including subtidal macroalgae) as a result of the proposal, including loss of health, abundance or diversity as a result of project attributable indirect impacts, are accurately recorded and reported to meet the requirements of condition 14-1(4); and 3. project attributable adverse impacts to benthic communities and habitat (including subtidal macroalgae) are addressed using best-practice available management mitigation and contingency measures. 	Section 3 Subtidal BCH & addressed in DMP



6-3	Prior to the construction of any pond walls, intertidal causeway, or other structure that could potentially impact on intertidal benthic communities and habitat, including mangrove habitat, algal mat and samphire habitat, unless otherwise approved by the CEO in writing, the proponent shall prepare and submit to the CEO a Benthic Communities and Habitat Monitoring and Management Plan.	All Sections
6-4	<p>The Benthic Communities and Habitat Monitoring and Management Plan shall:</p> <ol style="list-style-type: none"> 1. when implemented, substantiate and ensure that the outcomes of conditions 2-1 and 6-1 will be met, and the objectives of condition 6-2 will be achieved; 2. substantiate whether the outcomes of conditions 3-1(4) and 4-2 are being met. 3. take account of all available data to determine whether the outcome of condition 6-1(3) will be met; 4. include the details of mitigation actions to be implemented if the outcomes of condition 6-1 are not being met; 5. include the methodology of a monitoring program for mangroves in the RRDMMMA shown in Figure 1, to ensure no indirect impacts occur within this area as a result of the proposal subject to the requirements of condition 2-3, and to demonstrate that the outcome of condition 2-1 is met; 6. specify early warning Trigger Criteria that will trigger the implementation of management and/or contingency actions to prevent non-compliance with the outcomes of conditions 2-1 and 6-1 or non-achievement of the objectives in condition 3-1 (4) and 6-2; 7. specify Threshold Criteria to demonstrate compliance with conditions 2-1 3-1 (4) and 6-1 and that the objectives in condition 6-2 are being achieved; 8. specify the details of a monitoring program to determine if Trigger Criteria required by condition 6-4(6) and Threshold Criteria required by condition 6-4(7) have been met; 9. specify management and/or contingency actions to be implemented if the Trigger Criteria required by condition 6-4(6) and/or the Threshold Criteria required by condition 6-4(7) have not been met; and 10. provide the format and timing for the reporting of monitoring results against Trigger Criteria and Threshold Criteria to demonstrate that the outcomes in condition 6-1 have been met and the objectives in condition 6-2 have been achieved over the reporting period in the Compliance Assessment Report required by condition 18-6. 	Sections 3 and 4
6-5	The proponent must not commence operations until the CEO has confirmed in writing that the Benthic Communities and Habitat Monitoring and Management Plan submitted under condition 6-3 addresses the requirements of condition 6-4, the outcomes of conditions 2-1, 3-1(4), and 6-1, and the objectives of condition 6-2.	N/A



6-6	The exceedance of a Threshold Criteria (regardless of whether Management Actions or Threshold Contingency Actions have been or are being implemented), and/or comply with the requirements of the Benthic Communities and Habitat Monitoring and Management Plan represents non-compliance with these conditions.	Section 4
6-7	The proponent shall implement the most recent version of the Benthic Communities and Habitat Monitoring and Management Plan which the CEO has confirmed by notice in writing, addresses the requirements of conditions 2-1, 3-1(4), 6-1 and 6-2.	Section 4
6-8	<p>In the event that monitoring or investigations at any time indicate an exceedance of Threshold Criteria specified in the Benthic Communities and Habitat Monitoring and Management Plan confirmed under condition 6-5, the proponent shall:</p> <ol style="list-style-type: none"> 1. report the exceedance in writing to the CEO within seven (7) days of the exceedance being identified; 2. implement the contingency actions required by the Benthic Communities and Habitat Monitoring and Management Plan within seven (7) days of the exceedances being reported and continue implementation of those actions until the CEO has confirmed by notice in writing that it has been demonstrated that the Threshold Criteria are being met and implementation of the Threshold Contingency Actions are no longer required; 3. investigate to determine the cause of the Threshold Criteria being exceeded; 4. investigate to provide information for the CEO to determine potential environmental harm or alteration of the environment that occurred due to Threshold Criteria being exceeded; 5. provide a report to the CEO within twenty-one (21) days of the exceedance being reported. The report shall include: <ol style="list-style-type: none"> a. details of contingency actions implemented; b. the effectiveness of the contingency actions implemented against the Threshold Criteria; c. the findings of the investigations required by conditions 6-8(3) and 6-8(4); d. measures to prevent the Threshold Criteria being exceeded in the future; e. measures to prevent, control or abate impacts which may have occurred; and f. justification of the Threshold Criteria remaining, or being adjusted based on better understanding, demonstrating that the objectives in condition 6-1 will be met. 	Section 4
6-9	<p>The proponent:</p> <ol style="list-style-type: none"> 6. may review and submit proposed amendments to the Benthic Communities and Habitat Monitoring and Management Plan; 	Section 4

	<p>7. shall review and submit proposed amendments to the Benthic Communities and Habitat Monitoring and Management Plan as and when directed by the CEO; and</p> <p>8. shall review and submit proposed amendments to the Benthic Communities and Habitat Monitoring and Management Plan every five (5) years.</p>	
6-10	The proponent shall continue to implement the Benthic Communities and Habitat Monitoring and Management Plan or any subsequent revisions as confirmed by the CEO in condition 6-5, until the CEO has confirmed by notice in writing that the proponent has demonstrated that the environmental outcomes detailed in conditions 2-1 and 6-1 and the objectives in condition 6-2 have been met.	Section 4
EPBC 2018/8236		
23.	<p>To minimise impacts to migratory shorebirds and marine fauna due to the loss of Benthic Communities and Habitat as a result of dredging operations, poor water quality, changes in groundwater, and surface water from to the installation of surface water diversions, the approval holder must:</p> <ol style="list-style-type: none"> a) Comply with condition 6 of the WA Approval. b) Submit a Benthic Communities and Habitat Monitoring and Management Plan (BCHMMP) to meet the outcomes of condition 6-1 and the objectives in 6-2 of the WA Approval to the Minister for approval. c) Not commence operations until the BCHMMP has been approved by the Minister in writing. d) The BCHMMP must be consistent with the Department’s Environmental Management Plan Guidelines. e) The BCHMMP must be consistent with the Environmental Management Plan Guidelines and include: <ol style="list-style-type: none"> i. The BCHMMP must be consistent with the Environmental Management Plan Guidelines and include: ii. The details specified in condition 6-4 of the WA Approval. iii. Trigger criteria and threshold criteria for each intertidal and subtidal habitat type. iv. Management actions that will be implemented, if any trigger criterion is reached and/or any threshold criterion exceeded. v. A monitoring program that specifies how monitoring will be undertaken routinely, during and following events such as a toxicant spill, instances of death, disease and/or lesions being detected in protected species, and following disturbance events such as cyclones, heatwaves, and as directed by an exceedance of Environmental Quality Guidelines outlined in the Marine Environmental Quality Monitoring and Management Plan vi. Details of how the predicted coastal inundation or sea level rise will be monitored (as outlined in BCI Mardie Salt Project Coastal Inundation Studies Rev3 29 November 2019). vii. Details for how coastal inundation and/or sea level rise will be addressed. viii. Details of how the implementation of the plan will inform the implementation of monitoring of surface water flows and the intertidal rock causeway required by these conditions and the other plans: <ol style="list-style-type: none"> 1. Mardie Dredge Management Plan 2. Marine Environmental Quality Monitoring and Management Plan 	All Sections

	<ul style="list-style-type: none"> 3. Long-term migratory shorebird monitoring program 4. Groundwater Monitoring and Management Plan (GMMP) ix. describe how the combination of on-ground, underwater and remote monitoring will be undertaken every 5 years or after a trigger event described in condition 231(ii). f) Notify the Department in the event that any threshold criterion specified in the approved BCHMMP is at any time exceeded, within the same information and timeframes as specified in condition 6-8 of the WA Approval, undertake the actions specified in condition 6-8 of the WA Approval and include the following: <ul style="list-style-type: none"> i. within 6 months of any such exceedance have the BCHMMP reviewed by a suitably qualified intertidal and subtidal benthic ecologist to advise if the BCHMMP needs to be revised to prevent any possibility of the exceedance reoccurring and submit the report of the suitably qualified intertidal and subtidal benthic ecologist to the Department. If the review of the BCHMMP by a suitably qualified intertidal and subtidal benthic ecologist recommends that the BCHMMP be revised, the approval holder must submit the revised BCHMMP to the Department for the approval of the Minister within 8 months of any such exceedance. ii. within 6 months of any such exceedance develop a Remediation Plan that will need to be reviewed by suitably qualified intertidal and subtidal benthic ecologist to be submitted to the Department for the Minister’s approval for any impact(s) to protected matters arising from the exceedance as detailed in the report required under condition 23(f). iii. If a Remediation Plan is submitted in accordance with condition 23(f) and that Remediation Plan has not been approved by the Minister in writing within 9 months of the exceedance event, and the Minister notifies the approval holder that the Remediation Plan is not suitable for approval, the Minister may, at least two months after so notifying the approval holder, approve a version of the Remediation Plan revised by the Department. The approval holder must implement the approved Remediation Plan. iv. If the Minister determines that it is not possible to remediate the impact of the exceedance, then the approval holder must, within 10 months of the exceedance of the threshold criterion, submit an Offset Strategy specifying how the impact will be offset in accordance with the Environmental Offsets Policy. If the Offset Strategy has not been approved by the Minister in writing within 11 months of the exceedance event, and the Minister notifies the approval holder that the Offset Strategy is not suitable for approval, the Minister may, at least two months after so notifying the approval holder, approve a version of the Offset Strategy revised by the Department. The approval holder must implement the approved Offset Strategy for the remainder of the life of the project. g) The BCHMMP must be reviewed and adapted according to best practices and data gathered from the plan to be submitted to the Minister for approval every five (5) years in alignment with condition 6-9 (3) of the WA Approval. The data outcomes of the monitoring program will need to be provided with this amended plan every five (5) years. The approval holder may update the plan at any time and the updated plan must approved by the Minister. h) Implement the approved BCHMMP for the life of the project. 	
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1.7. Rationale and approach

Mardie Minerals' management approach used in this BCHMMP is to emphasise managing impacts through planning, organisation and controlling aspects of the Proposal during construction and operation. A hierarchical approach to manage potential impacts from the Optimised Proposal has been used:

- Avoidance: measures used to avoid or prevent impacts from the Optimised Proposal
- Minimisation: measures taken to reduce the duration, intensity and/or the extent of impact.

Results from surveys, study findings, and the EPA's assessment of the Original Proposal (EPA Report 1704: EPA, 2021b) inform this management approach.

1.7.1. Key BCH

The key BCH relevant to this BCHMMP are coastal samphire, algal mat, mangrove and seagrass.

1.7.2. Key assumptions and uncertainties

The indirect BCH impacts of the Optimised Proposal associated with hydrological changes are based on numerous models, all of which use a number of key assumptions to develop the models. These include:

- Soil permeability and seepage rates
- Groundwater flow rates
- Surface water runoff volumes and flow rates during rainfall events
- Tidal inundation flow paths
- Sea level rise estimates.

This BCHMMP and other associated management plans include verification of these model assumptions and adaptive management, if required, based on updated information. No additional assumptions and uncertainties have been identified.

1.7.3. Rationale for choice of provisions

A combination of baseline information (if available) and control sites is proposed to be able to determine if the result is a natural event or as a result of the Proposal. Baseline information was gathered for the assessment phase, including baseline subtidal monitoring at the locations described in this BCHMMP.

The rationale for the choice of provisions is based on implementing the management approach described above to avoid and minimise the potential impacts of the Optimised Proposal on BCH. Management Targets, Management Actions, Trigger Criteria, Threshold Criteria, and Threshold Contingency Actions have been selected to ensure the development and operation of the Proposal aligns with outcomes set by MS 1175 and EPBC 2018/8236 (Table 2). Where relevant, triggers, Threshold Criteria, and Management Actions detailed in the DMP, GMMP, and MEQMMP will be used as early warning indicators in order to identify and prevent corresponding impacts to BCH requiring remediation/non-compliance reporting.

The Management Actions presented in this BCHMMP have been designed according to the following rationale:

1. Model verification monitoring should be conducted as soon as possible to allow more accurate modelling to be conducted using real-time data. The revised model outputs should then be used to determine if there are any expected changes in the spatial extent, intensity, duration or magnitude of any predicted impact
2. Trigger Criteria are used, based on the physical monitoring and management of impacting influences. For example, the monitoring of hydrological changes should trigger early Management Actions rather than rely on the results of BCH monitoring
3. Management Actions allow for expected changes to the environment (such as sea level rise) or possible effects of issues external to the Optimised Proposal
4. Threshold Contingency Actions are chosen that will have an appropriate timeframe to take effect.

The indicators for each BCH type have been chosen in order to align the information as best as possible. Percent cover will be calculated for all intertidal BCH, though different methods will be adopted to allow for the different heights in species and habitat types. This is considered the most reliable and stable indicator of health within all communities. Additional information such as chlorophyll-a concentrations will also be measured within BCH and results will be evaluated and interpreted using a multiple lines of evidence approach. Spatial extent will also be monitored using remote sensing multispectral imagery for mapping the extent of intertidal habitats as an additional line of evidence. The specific methods to be used for each indicator are described in detail in Section 3.

Mardie Minerals have also committed to undertake a pilot study to use satellite remote imagery to undertake an early warning assessment of BCH health on a quarterly basis. If this pilot study is successful and endorsed by the EPA, it will be incorporated into a future revision of the BCHMMP. However, this method is not planned to be used to initiate any management actions within the current version.

2. Existing Environment

2.1. Historical survey effort

A number of surveys and studies have been undertaken for BCH within the Proposal study areas, including:

- A regional intertidal BCH assessment of mangal (mangroves) and algal mat communities undertaken by Stantec (2018) consisting of a desktop (literature) review, preliminary hydrological modelling, and reconnaissance and targeted field surveys
- Intertidal BCH assessments undertaken by O2 Marine (2020a), including a comprehensive desktop review of the intertidal BCH in vicinity to the Proposal and two field surveys (March 2018, December 2018) to collect information to fill any data gaps identified in the desktop review
- A series of five surveys conducted from March 2018 to March 2019 by O2 Marine (2020b) to characterise, map and describe the functional ecological value and regional significance of the subtidal BCH within Local Assessment Unit (LAU) 7
- A detailed flora and vegetation survey by Phoenix Environmental Sciences (Phoenix, 2019), including extensive reconnaissance and detailed field surveys to verify and build on desktop reviews compiled using existing information of the Proposal and its surroundings. Survey effort included two helicopter reconnaissance surveys (August 2017, September 2017), a first phase detailed flora survey (May 2018), a second phase detailed flora survey (August 2018) and an additional survey of extended survey areas (September 2019)
- Actis Environmental Services (2020) conducted a review of the survey effort within samphire communities: 'Survey Adequacy of *Tecticornia* Communities at the Proposed Mardie Salt Field'.

These survey reports are included in the Original Proposal Environmental Review Document (ERD) and Response to Submissions document available on the EPA website. The results of the surveys as relevant to this BCHMMP are summarised in the sections below.

2.2. Local Assessment Units

Seven (7) LAUs were established across the O2 Marine study area (O2 Marine 2020b), to provide a regional context for characterisation, mapping and assessment of impacts to BCH (Figure 4). LAUs were determined through consideration of the following key factors:

- BCH type, condition, extent and distribution
- Management boundaries (i.e. regionally significant mangrove areas)
- Bathymetry
- Coastal geomorphology.

Additional information related to the LAUs is provided in the Original Proposal ERD (Preston Consulting 2020) and the BCH Cumulative Loss Assessment Report (O2 Marine, 2020c), which are available on the EPA's website.

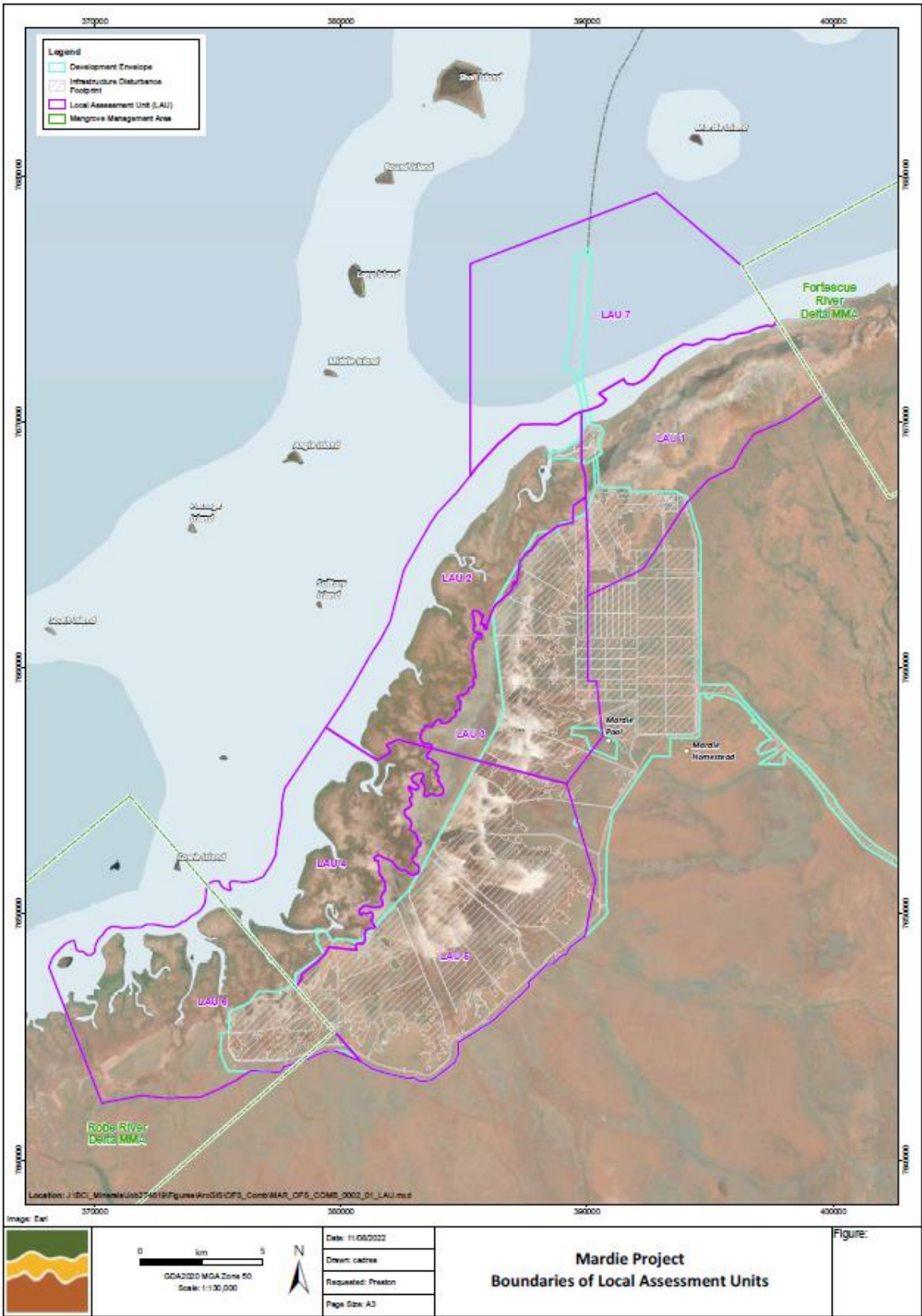
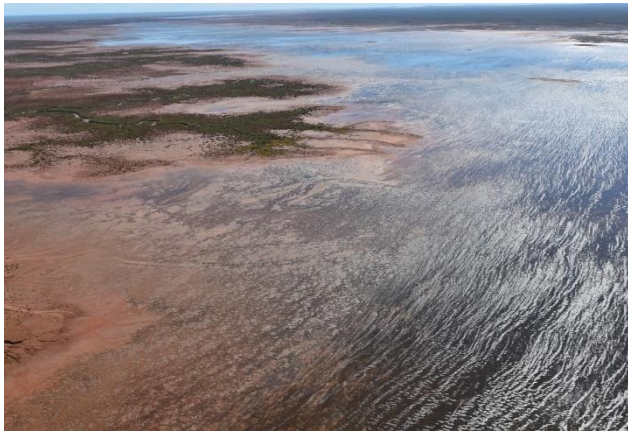






Figure 4: Boundaries of LAUs developed in O2 Marine (2020c)



2.3. Intertidal BCH

Eight (8) broad intertidal BCH classes were identified and mapped within the Study Area, as detailed in Table 3 and shown in Figure 5 and Figure 6.

Table 3: Description of broad intertidal BCH classes mapped within the Study Area

Habitat Class	Example Image
<p>Algal Mat</p> <p>Algal mats are typically green to grey or black, and either contiguous or fragmented. 11 species were identified with filamentous cyanobacteria <i>Microcoleus</i> sp. and <i>Lyngbya</i> sp. the dominant species.</p> <p>Algal mat communities extend over 3,400 ha and comprise 10% of the total mapped intertidal BCH area. They predominantly occur in two major communities within the central and northern sections of the Study Area. They occur within a relatively nominal elevation of 1.1 – 1.3 m AHD which is lower than the adjacent seaward BCH where they form vast shallow lakes at high tides (>1.2m).</p>	
<p>Closed Canopy (CC) Seaward Mangroves</p> <p>CC mangroves comprise the greater structural complexity, typically higher seaward mangrove associations. <i>Avicennia marina</i> dominate the species with <i>Rhizophora stylosa</i> the sub dominant species.</p> <p>CC mangrove communities extend over 1,280 ha and comprise 4% of the total mapped intertidal BCH area. They are very well established within LAU 6, with over 46% of their total area represented. CC mangroves occur as ribbons along the coastline and fringing tidal creeks, with more vast forest occurring within the southern LAU, particularly LAU 6 within the boundary of the RRDMMMA.</p>	
<p>Scattered (SC) landward Mangroves</p> <p>SC mangroves comprise the least structural complexity, typically lower landward mangrove associations. <i>Avicennia marina</i> dominate the species with <i>Ceriops australis</i> also observed.</p> <p>SC mangrove communities occur over 2,300 ha and comprise 7% of the total mapped BCH area. SC mangroves are the most extensive mangrove functional groups representing over 64%. They are typically located on the landward extents extending</p>	

Habitat Class	Example Image
<p>over wide intertidal mudflat areas with the largest areas occurring in LAU 2, LAU 4 and LAU 6.</p>	
<p>Samphire/Samphire Mudflat</p> <p>Samphire/Samphire Mudflats are distributed over more than 5,900 ha, comprising approximately 17% of the mapped intertidal BCH. They are typically located on the landward extent of mangroves, whilst through the centre of the Study Area are on the seaward extent of algal mats, with a smaller communities in LAU 1 and LAU 3 seaward of terrestrial vegetation. By area they are the greatest in LAU 2 and lowest in LAU 1.</p>	
<p>Foreshore Mudflat/Tidal Creek</p> <p>A variety of benthic habitat types from flat fine to coarse sands, flat mud, sparse to high macroalgae, and low to moderate seagrasses were identified occurring within Foreshore Mudflats/Tidal Creeks.</p> <p>Foreshore Mudflats/Tidal Creeks occur over 5,000 ha and comprise 14% of the total mapped intertidal BCH area. Tidal creeks are typically well established within the southern LAUs (Robe River Delta) and become sparser in the northern LAUs. Foreshore mudflats extend over a wider area through the central LAUs with subtidal area much closer to the coastline in the northern and southern LAUs.</p>	
<p>Rocky Shoreline</p> <p>Rocky shorelines within the Study Area were typically low relief rock platforms generally with little to low associated flora and fauna. Macroalgae were identified as the dominant communities with minimal juvenile hard corals, oyster stacks and some soft corals also present.</p> <p>Rocky shorelines occur over 59 ha comprising <1% of the total mapped BCH area. They are only located within LAU 2 and LAU 6.</p>	<p>Not available.</p>

Habitat Class	Example Image
<p>Mudflat/Saltflat</p> <p>Mudflat/Saltflats are extremely low in biodiversity and support little to no associated fauna or flora due to their characteristic high salinities.</p> <p>Mudflat/Saltflats are the dominant intertidal BCH extending over 10,500 ha and comprising 29% of the total mapped BCH area. They are most dominant through the supratidal LAUs (3 & 5) representing over 83% of their total distribution. They typically occur on the higher intertidal gradients on the landward extent of Samphire's or Algal Mats.</p>	
<p>Sandy Beach</p> <p>Sandy beaches are typically flat, low energy, low profile beaches backed by gently rising dunes. Sandy beaches are only located within LAU 1 and LAU 2 representing 32 ha in total and comprising <1% of mapped BCH. They are found extending from the northern extent of LAU 1 into the northern LAU 2 they continue along the coast for approximately 2.5 km west of the northernmost creek mouth.</p>	

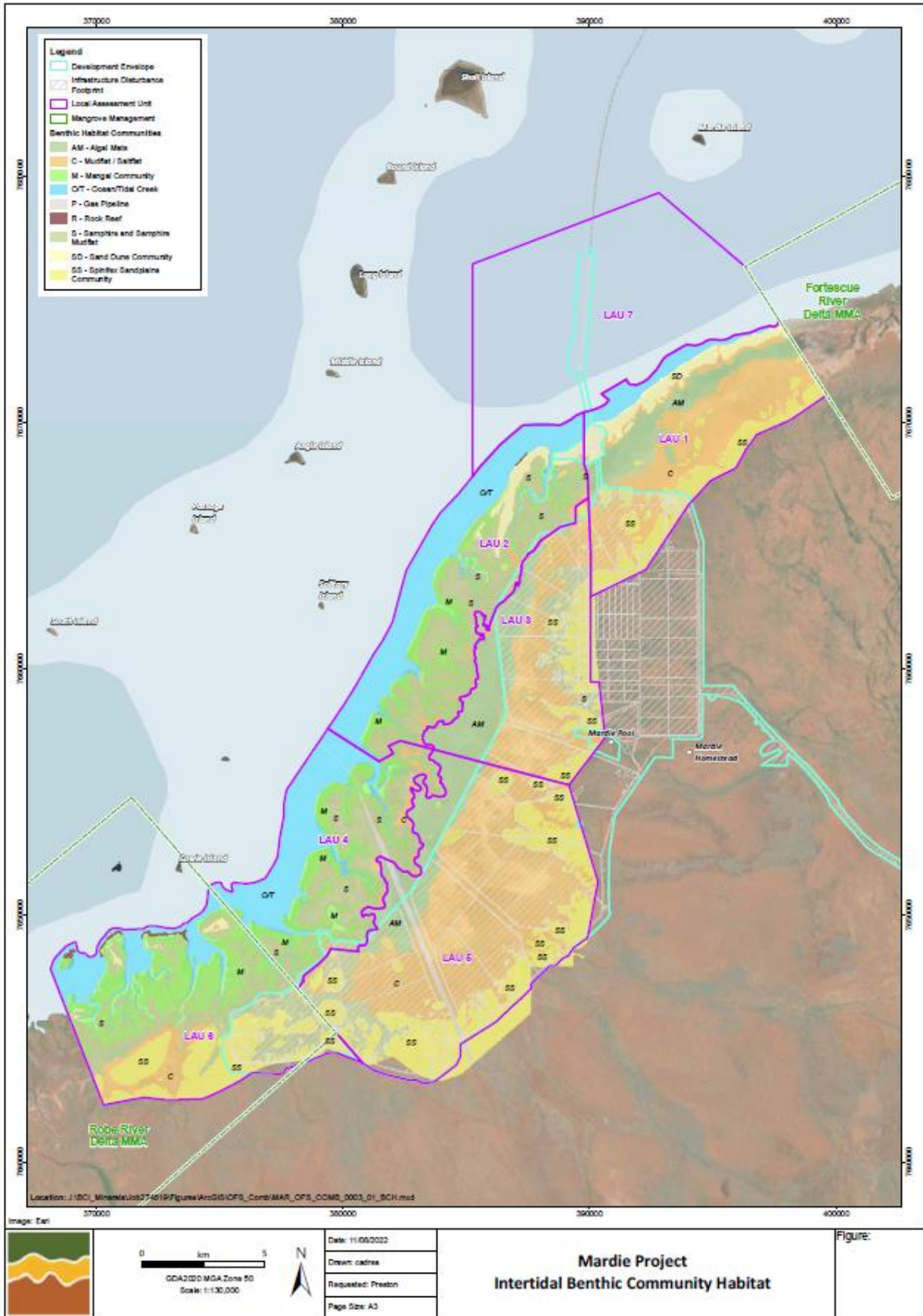


Figure 5: Intertidal BCH within the LAUs 1 to 6

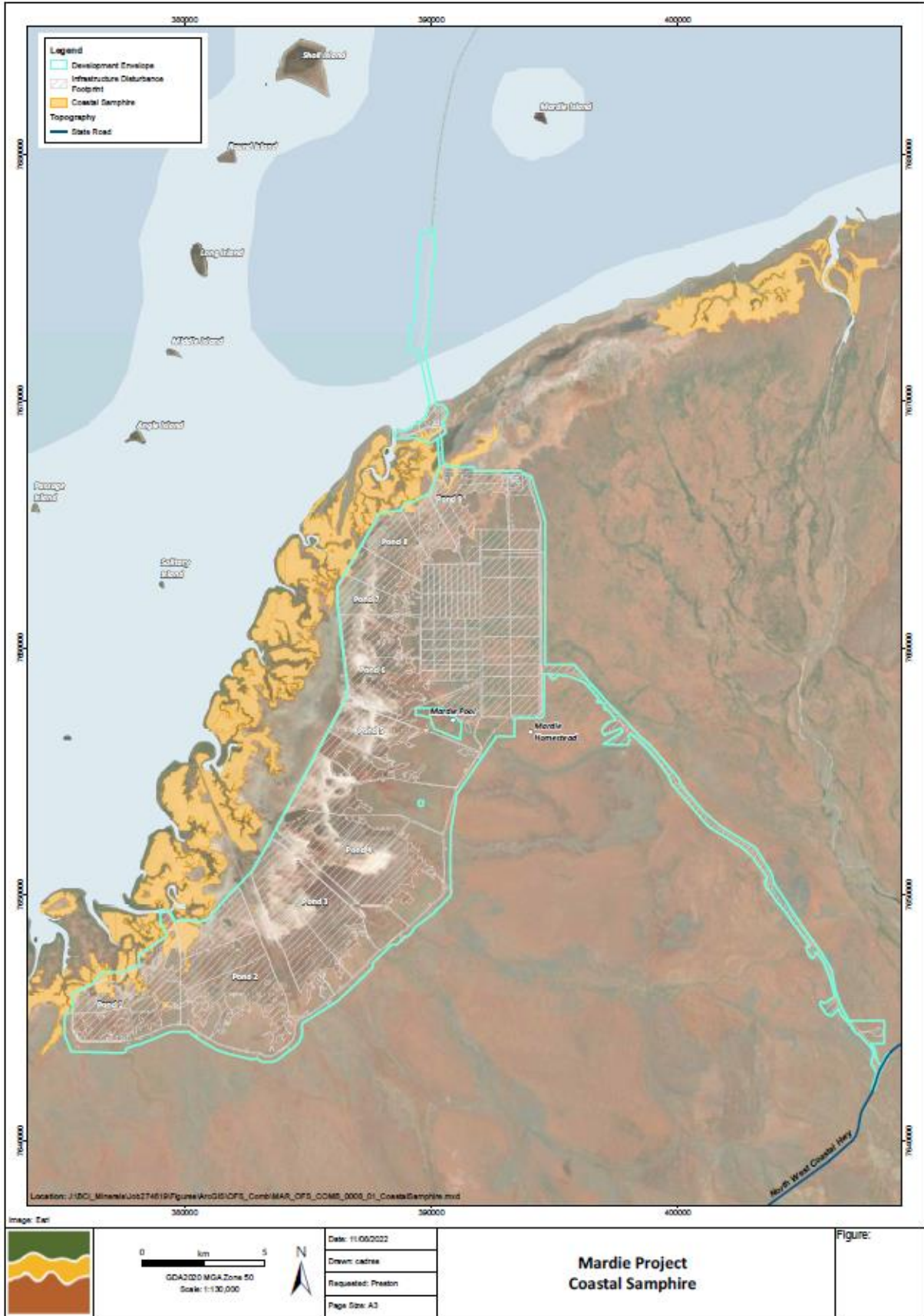



Figure 6: Coastal Samphire BCH



2.4. Subtidal BCH


During the subtidal habitat mapping phase of the investigations, three broad subtidal BCH classes were identified within LAU7 (O2 Marine 2020b). Within those three broad classes (bare sand, filter feeder/macroalgae/seagrasses and coral/macroalgae), eight BCH subclasses were distinguished based on varying levels of benthic cover and dominant taxa. These classes and subclasses are described in Table 4 and mapped in Figure 7. Subsequent to mapping, further pilot studies were undertaken to refine the subtidal BCH health monitoring program and create baseline data. These surveys found ephemeral seagrasses dominate nearshore areas of the foreshore mudflats (i.e. around depths of lowest astronomical tide (LAT)), recording seagrass cover up to nearly 60% at one site. These areas were not mapped initially as the risk to these areas from marine related activities (e.g. dredging and bitterns discharges) was considered low. However, monitoring sites have been established in nearshore seagrass habitat to monitor for potential changes to surface water, groundwater and tidal regimes. These locations are described in more detail in Section 3.4.

Table 4: Description of broad subtidal classes and subclasses mapped within LAU 7

BCH Class	Description	Example image
Bare sand	<p>Bare Silt/Sand</p> <p>Typically comprises of silt or sand with no or occasional very sparse macroalgae. Silt areas often comprised of bioturbation (burrows formed by living organisms). Sand areas often contain traces of shell grit.</p> <p>The habitat comprises 89% of the subtidal BCH within LAU 7 and is also widely dispersed across the region.</p>	

BCH Class	Description	Example image
	<p>Sand/Sparse (<5%) Macroalgae</p> <p>Fine silt/sand and bioturbated bedform with a very patchy distribution of macroalgae and invertebrates. Macroalgae (Phaeophyta) was the dominant cover, but was very sparse, generally comprising <1% of the overall cover. Class was differentiated from the other macroalgal classes due to the very sparse nature of the cover and the much finer grained, and often bioturbated sediments.</p> <p>This habitat comprises 1% of the subtidal BCH within LAU 7. Outside LAU 7, it was also observed on the eastern fringing waters of Round Island, whilst the largest contiguous area was observed closer to the mainland in the shallow waters between Angle Island and the mainland.</p>	
Filter feeder/ macroalgae/ seagrass	<p>Sand/Sparse (<5%) Filter Feeders</p> <p>Sparse filter feeder habitat occurs where the relief is flat and is associated with fine to coarse sands. Although only present in sparse densities (<5% cover), hydroids are most common where there is no bedform, whilst sponges occur where there is some bioturbation.</p> <p>This habitat comprises 2% of the subtidal BCH within LAU 7 and is widely dispersed throughout the region.</p>	
	<p>Low (5-10%) Cover Macroalgae/Filter Feeders</p> <p>Flat to low relief constituting fine to coarse sands, including shell grit on occasions. Macroalgae, hydrozoan and sponge species are equally dispersed throughout this habitat although benthic cover is low (3-10%). Occasional very sparse (<1%) cover of Halophila sp. seagrass was also observed at some locations.</p>	

BCH Class	Description	Example image
	<p>This habitat comprises 6% of the subtidal BCH within LAU 7 and follows a patchy distribution throughout the region.</p> <p>Outside of LAU 7, habitat as described above, was also observed in small patches fringing the shallow waters of Long Island, Mardie Island and close to the mainland</p>	
Coral/ macroalgae	<p>Low (5-10%) Cover Coral</p> <p>Flat to low relief rock and rubble with coarse sand. Low (3 - 10%) cover of soft and hard corals, including Faviidae, Dendrophyllidae, Mussidae and Octocorals. Sparse macroalgae was also present.</p> <p>This habitat comprises 1% of the subtidal BCH within LAU 5. Outside of LAU 7 this habitat was also found fringing Mardie Island and in small isolated patches between Angle Island and the mainland. It was generally recorded in waters between 1-3 m depth.</p>	
	<p>Moderate (10-25%) Cover Coral/Macroalgae/Seagrass</p> <p>Low to moderate relief rock and rubble/coarse sand. Low to moderate cover (3 - 25%) of soft and hard corals with macroalgae. Corals largely consisted of Faviidae, Poritidae, and Octocorals, while Phaeophyceae dominated the macroalgae communities.</p> <p>This habitat class comprises only 1% of the subtidal BCH within LAU 7. However, outside of LAU 7, it was recorded in larger areas in fringing shallow waters south of Mardie Island and adjacent to the mainland coast, while near shore, areas of moderately</p>	

BCH Class	Description	Example image
	sparse ephemeral seagrass meadows (10-25% cover) has been detected.	
Coral/ macroalgae	<p>Dense (>25%) Cover Macroalgae/Coral/Filter Feeders</p> <p>This habitat class occurs on low relief substrate with fine to coarse sands and areas of exposed limestone reef. Dense assemblages (>75%) of macroalgae and hydrozoan species predominately in waters at depths of 2.2 - 4.0 m. This habitat also supported sparse juvenile corals (Faviidae, Dendrophyllidae, Mussidae) with occasional larger coral (Poritidae) bommies (1 – 2 m diameter). This habitat class comprised <1% of the subtidal BCH in LAU 7. It was also identified outside of LAU 7 in the waters fringing the eastern outer edge of Long Island, Round Island and Sholl Island.</p>	
	<p>Dense (>25%) Cover Coral Dominated</p> <p>Low relief limestone reef and rubble substrate which supports high coral cover (25%-75%) of diverse coral species, including Faviidae, Dendrophyllidae, Mussidae, Portitidae, and Octocoral species.</p> <p>This habitat class was only recorded at one location in LAU 7 and, as such, comprises only <1% of the subtidal BCH within LAU 7. However, it was also recorded outside LAU 7, in a much larger area, fringing the northern edge of Mardie Island.</p>	

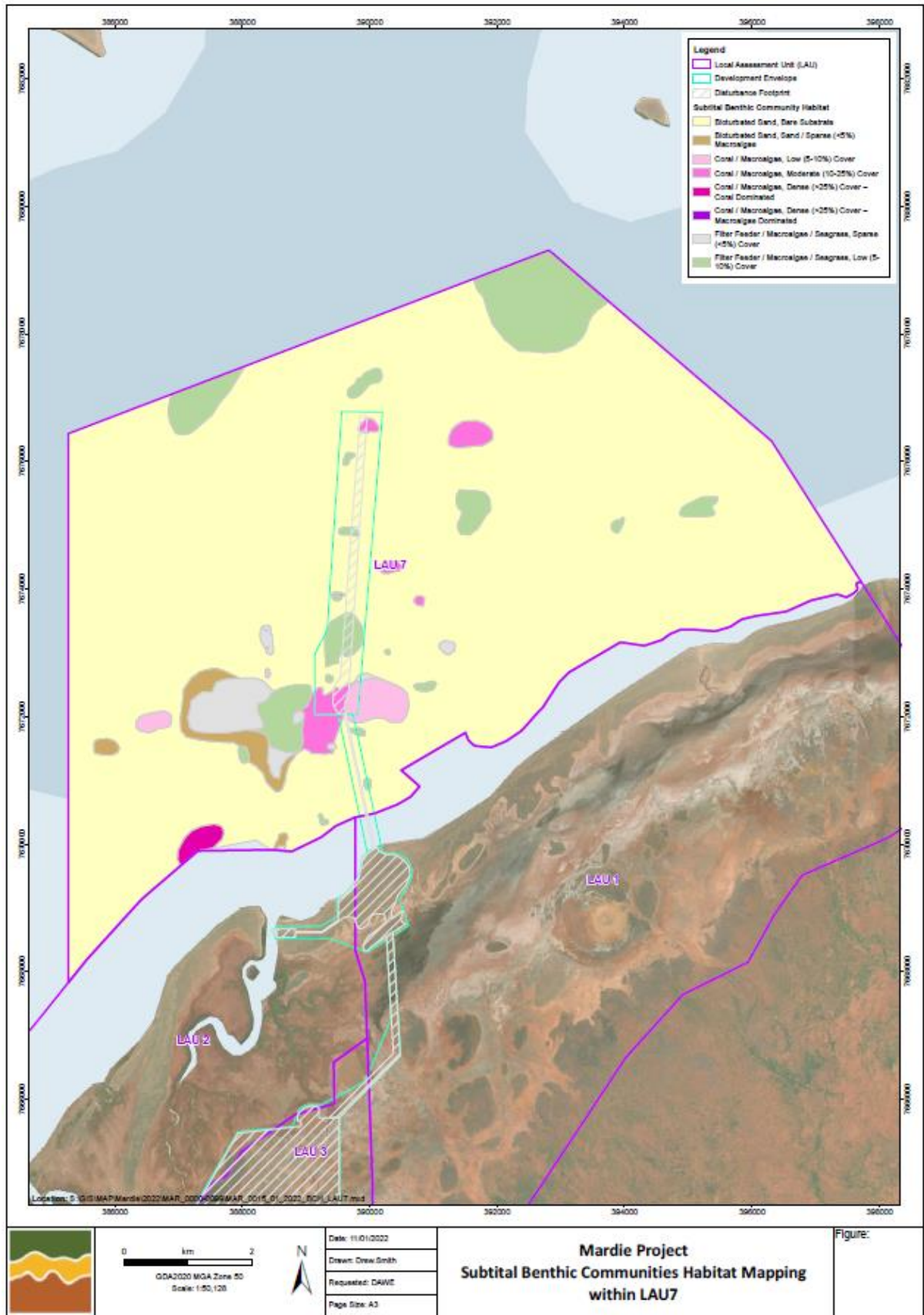


Figure 7: Subtidal BCH within LAU 7

3. Monitoring program components

The BCH monitoring program has been designed to comply with the conditions set out in Table 2 and achieve the objectives of this BCHMMP given in Section 1.2. The monitoring program will consist of health monitoring using field techniques to evaluate changes to condition and abundance of BCH within quadrats or plots at nominated monitoring sites. Tidal inundation and surface water level monitoring will also be undertaken to provide information relevant to the relationship between hydrological changes and BCH health and distribution. A summary of the monitoring programs is provided in Table 5, and each part is detailed in the following sections (Sections 3.1 to 3.5). In addition to these routine events, reactive monitoring and management is proposed in response to a trigger event, which may include, but is not necessarily limited to:

- A bund failure or seepage
- A toxicant spill
- Monitoring data that indicates a significant change, coastal inundation and/or sea level rise has occurred.
- Reports of fauna deaths or impacts
- Exceedance of environmental quality guidelines (managed under the MEQMMP)
- Exceedance of trigger levels from other related management plans (i.e., GMMP)
- After cyclones or heatwaves, if warranted.

The data will be analysed using a Before/After/Control/Impact monitoring strategy. Each subsequent monitoring survey is compared to the initial and previous surveys, and if significant changes are recorded, then the impact site data is also compared to the reference site data to determine if it is natural variation, or possibly attributable to the Optimised Proposal.

Spatial extent using multi-spectral remote sensing will also be used as an additional line of evidence to understand broad-scale changes over the Project site. Triggers and thresholds will not currently be using this data.

Table 5: A summary of BCHMMP monitoring program and different methods applied

BCH type/ monitoring program components	Monitoring indicators	Sites	Monitoring method	Frequency
Algal mats	Health including percent cover, dormancy, chlorophyll-a, colour, texture	8 impact, 4 reference	Three replicate belt transects comprising 16 quadrats (1 x 1 m) along at nominated monitoring sites	Quarterly routine monitoring for the first 5 years Reactive monitoring as required
Mangrove	Health including canopy cover, leaf area index, species tree	21 impact, 6 reference	Field studies within three replicate 8 x 8 m plots at nominated monitoring	Quarterly routine monitoring of SC mangrove sites and

BCH type/ monitoring program components	Monitoring indicators	Sites	Monitoring method	Frequency
	density & height, chlorophyll a, flowering, diameter breast height measurements for above ground biomass, insect damage, leaf health, counts of seeds, saplings, invertebrate burrows and invertebrate observations.		sites, with 1 x 1 m quadrats for fine scale detail. Closed canopy plots will be 4 x 4 m.	within the potential zone of impact for the first 5 years Annual monitoring of other mangrove assemblages, including closed canopy mangrove monitoring locations for the first 5 years Reactive monitoring as required
Samphire	Health including percent cover, density, height & size frequency, colour, flowering, growth forms, dormancy, number of dead/sick, tip die off.	9 impact, 4 reference	Field studies within three 8 x 8 m plots at nominated monitoring sites with 1 x 1 m plots within the quadrat for fine scale details	Quarterly routine monitoring for the first 5 years Reactive monitoring as required
Subtidal seagrass	Health including percent cover, assemblage composition/diversity, height, epiphytes, other benthic fauna & flora (including macroalgae) Sediment porewater salinity	5 impact 3 reference	Three replicate 50 m transects will be surveyed, using a 0.25 x 0.25 m quadrat collected every meter	Quarterly routine monitoring for the first 5 years Reactive monitoring as required
Tidal flood height/ surface water monitoring	Stations established to measure water level at designated surface water runoff diversion locations & areas of predicted reduction in tidal inundation near monitoring sites. Provides a line of evidence for changing conditions. Validation	4 surface water height 8 tidal flood height	Telemetered radar water level stations to measure continuous water height above the substrate.	Instruments will collect data in 30-minute intervals

BCH monitoring program components	type/	Monitoring indicators	Sites	Monitoring method	Frequency
		against predicted models.			

Intertidal monitoring locations have been determined based on the risk of impacts and to represent the different habitat assemblages seaward of the development envelope and reference areas north and south. These have been placed along transect lines across the intertidal zone. Where possible, monitoring locations of one or more of each habitat assemblage will be established along the transects. The start and end points of each transect is summarised in Table 6, with reasoning for each transect location. Transects and monitoring locations are presented in Figure 8.

Subtidal monitoring locations have also been determined based on these risks and the ability to collect enough data to be statistically robust. The monitoring sites are also presented in Figure 9.

As outlined in Section 1.5, this monitoring plan is also being undertaken concurrently with other management plans, which will be used to inform the analysis of results from the BCHMMP or trigger reactive monitoring or management actions. A summary flowchart for this process is given in Figure 9.

Table 6: Coordinates of intertidal monitoring transect start and finish points (GDA 2020z50)

Transect number	Start		Finish		Purpose
	Easting	Northing	Easting	Northing	
T1	369088	7642990	366957	7646037	Mangrove, algal mat and samphire reference monitoring sites on the south side of the Project to be compared to the impact sites.
T2	371147	7643818	368950	7646504	Mangrove, algal mat and samphire reference monitoring sites to be compared to the impact sites.
T3	373643	7644973	371459	7647755	Corresponds with groundwater monitoring site RRDMMA2 and includes mangrove monitoring locations.
T4	376094	7646319	374511	7648090	Corresponds with groundwater monitoring site RRDMMA1, and includes mangrove and seaward mangrove monitoring locations, and samphire reference site. It is also close to surface water monitoring sites.
T5	379811	7649040	378440	7650792	Mangrove and seaward mangrove monitoring site in between groundwater monitoring sites. It is also close to a tide gauge site.
T6	383316	7651962	380276	7655979	Corresponds with three groundwater monitoring sites originally designed to be an indicator for mangroves. This transect includes algal mat,



Transect number	Start		Finish		Purpose
	Easting	Northing	Easting	Northing	
					samphire, mangrove and seaward mangrove monitoring sites.
T7	384889	7655003	381509	7656090	Corresponds with groundwater monitoring site Playa Site 2-1, a site originally designed as an indicator for algal mats. Algal mat, samphire, mangrove and seaward mangrove monitoring sites have been placed along this transect.
T8	386483	7658929	381903	7659002	Corresponds with groundwater monitoring site Playa Site 3-1, a site originally designed as an indicator for algal mats. Algal mat, samphire, mangrove and seaward mangrove monitoring sites have been placed along this transect.
T9	386285	7660608	382828	7661336	Mangrove and seaward mangrove monitoring site in between groundwater monitoring sites. It is also close to a tide gauge monitoring site.
T10	386292	7662673	383778	7664127	Corresponds with three groundwater monitoring sites originally designed to be an indicator for mangroves. This transect includes 2 samphire, 2 mangrove and seaward mangrove monitoring sites.
T11	388059	7665545	386946	7666349	Corresponds with three groundwater monitoring sites originally designed to be an indicator for mangroves. This transect includes 1 samphire and 2 mangrove monitoring sites.
T12	390305	7667523	388480	7668339	Corresponds with a tide gauge monitoring site, and near to the causeway. This transect includes algal mat, samphire and mangrove monitoring locations.
T13	390617	7667491	390572	7668674	This transect is located on the east side of the causeway and includes a samphire and mangrove monitoring site.
T14	392706	7668638	391547	7669709	Algal mat monitoring site north of the development envelope (no mangroves or samphire present).
T15	398728	7671045	396967	7673347	Algal mat reference site north of the development envelope (no mangroves or samphire present). It is also close to a tide gauge monitoring site.
T16	399247	7671939	398039	7673852	Algal mat reference site north of the development envelope (no mangroves or samphire present).
T17	401540	7675516	402242	7673446	Samphire and mangrove reference sites north of the development envelope.



Transect number	Start		Finish		Purpose
	Easting	Northing	Easting	Northing	
T18	403172	7675919	404426	7673442	Samphire and mangrove reference sites north of the development envelope.

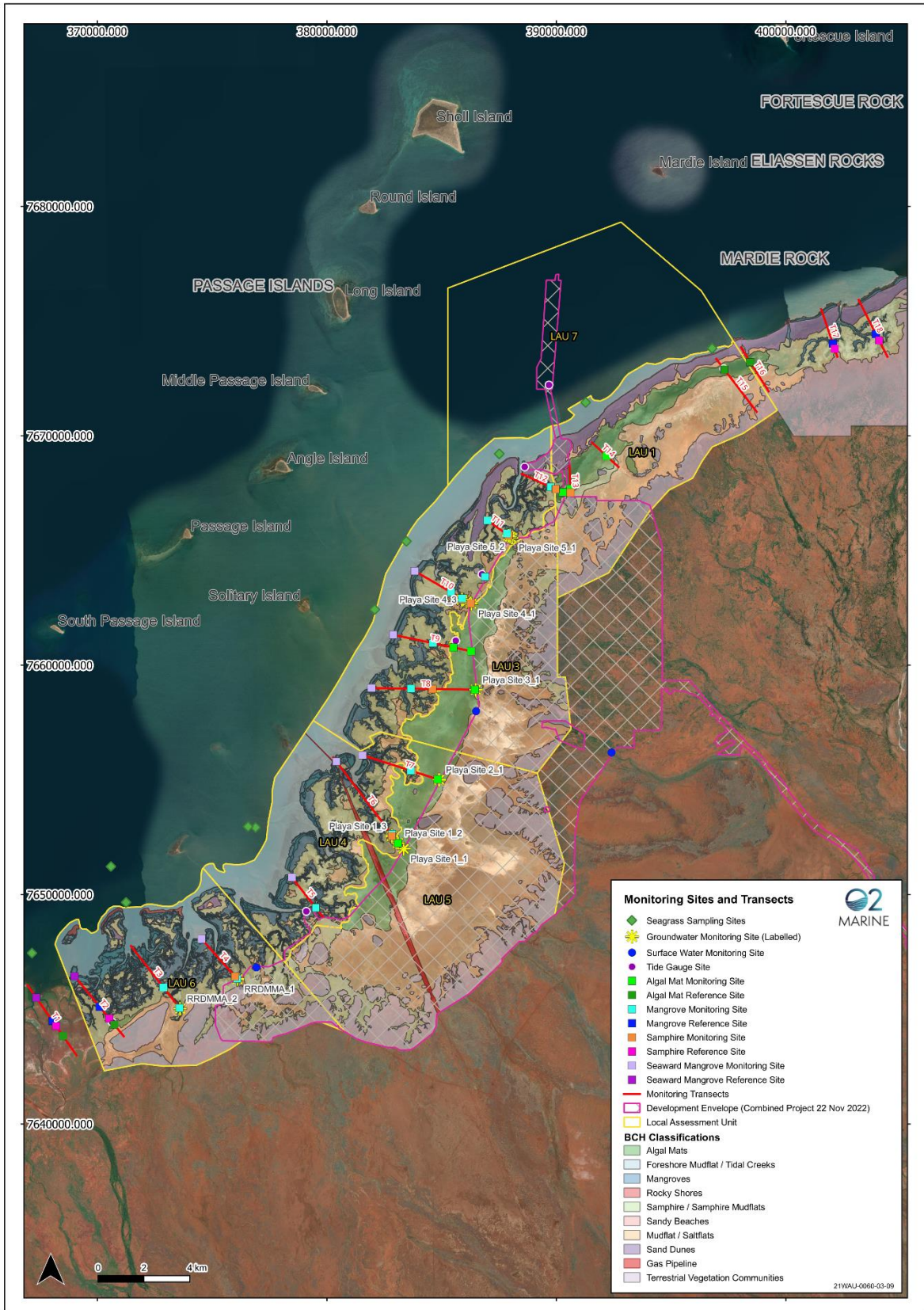


Figure 8: BCH monitoring program monitoring locations

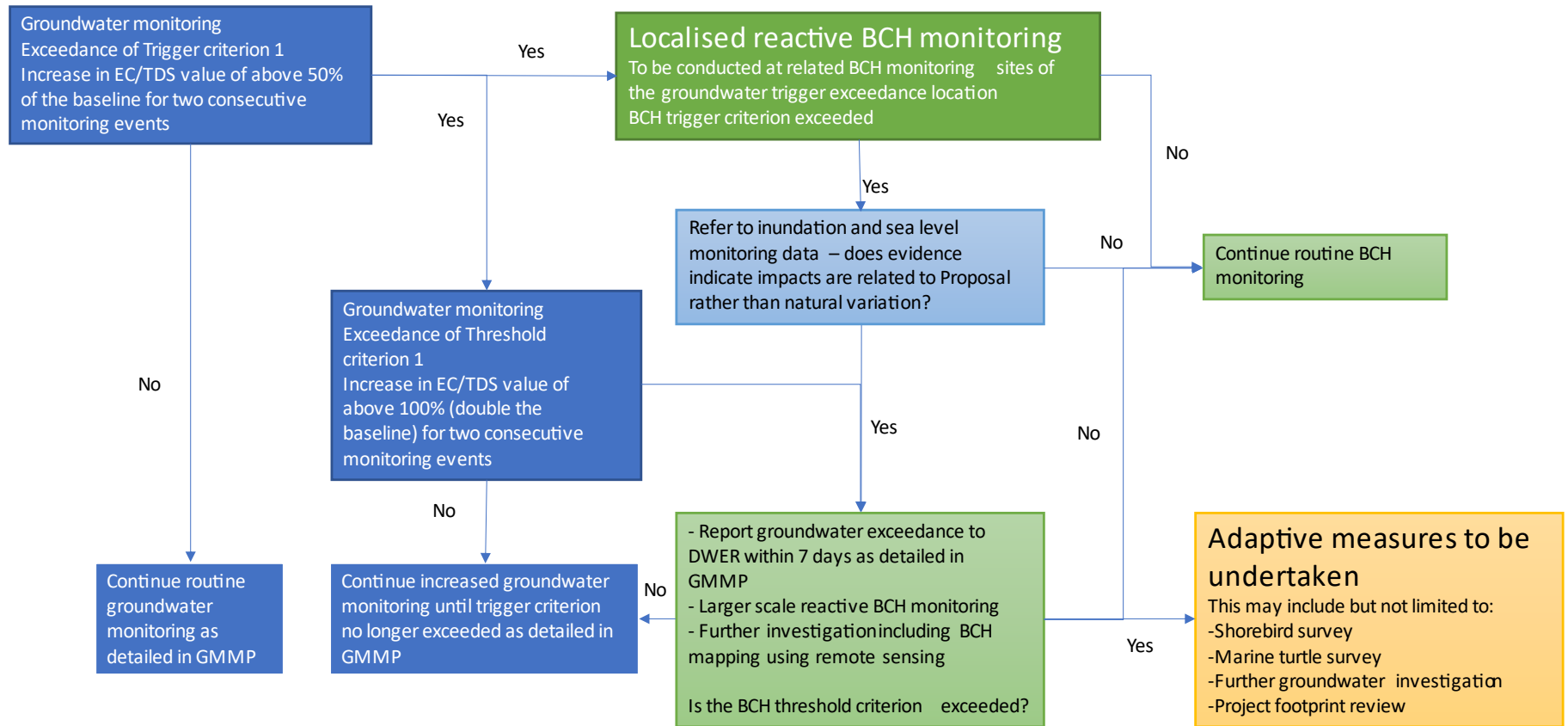


Figure 9: Flowchart for reactive BCH monitoring

3.1. Algal mats monitoring methodology

The algal mat monitoring program will consist of monitoring the health, diversity and extent of the algae at nominated monitoring locations.

3.1.1. Methods

Three permanent belt transects will be established at each monitoring site, each transect with comprise 16 quadrats of 1 x 1 m, with a 1 m corridor in between so that algal mats within the plots are not disturbed during the surveys. The quadrats will be established in a zig-zag patterns at 1 m intervals along the transect. Small samples for chlorophyll-a and species identification will be collected on the opposite side of the transect from the quadrats so the cover estimates are not disturbed.

Health of the algal mats will be determined using percent cover (active and dormant cover), species diversity, chlorophyll-a, colour, and texture within each quadrat.

Visual estimation of percent ground cover and observations of condition will be estimated within each quadrat. This will include the percent cover of both active and dormant mats. A core sample will also be collected for analysis of chlorophyll-a and species on the opposite sides to one quadrat along each belt transect, with a total of three replicate samples per monitoring location. This will ensure the quadrats measuring percent cover and condition are not disturbed during sampling. A trial of measuring chlorophyll-a concentrations will also be undertaken *in-situ* using a handheld pulse-amplitude modulated (PAM) fluorometer at the same location as the core is collected to investigate the potential to reduce disturbance of algal mats during sampling.

3.1.2. Locations

A total of 8 impact and 4 reference monitoring sites will be established along the Optimised Proposal area. The locations of these sites have been determined based on the proximity to the pond wall, as well as groundwater and tidal flood depth/surface water monitoring locations (Figure 10).

Three replicate belt transects will be established at each monitoring site at a similar distance parallel to the pond walls to reduce variation associated with distance from the pond or ocean. The coordinates of the monitoring locations are given in Table 7. Replicate belt transects within each monitoring site will be labelled with the suffix “a”, “b” or “c” as appropriate. Coordinates of each of the replicate belt transects will be recorded in the first report.

Table 7: Coordinates of algal mat monitoring locations

Algal mat monitoring locations	Easting	Northing	Purpose
AL1	383097	7652238	Impact monitoring site near groundwater monitoring site and Chevron pipeline
AL2	384828	7655022	Impact monitoring site near groundwater monitoring site
AL3	386446	7658925	Impact monitoring site near groundwater monitoring site



Algal mat monitoring locations	Easting	Northing	Purpose
AL4	386285	7660608	Impact monitoring site near surface water monitoring site
AL5	385508	7660772	Impact monitoring site near surface water monitoring site
AL6	390275	7667536	Impact monitoring site near tide monitoring site and causeway
AL7	390612	7667689	Impact monitoring site near causeway
AL8	392186	7669119	Impact monitoring site north of causeway
AR1	368499	7643836	Reference location on the southern end of the Proposal area
AR2	370730	7644330	Reference location on the southern end of the Proposal area
AR3	392712	7670415	Reference location on the northern end of the Proposal area
AR4	394901	7671812	Reference location on the northern end of the Proposal area

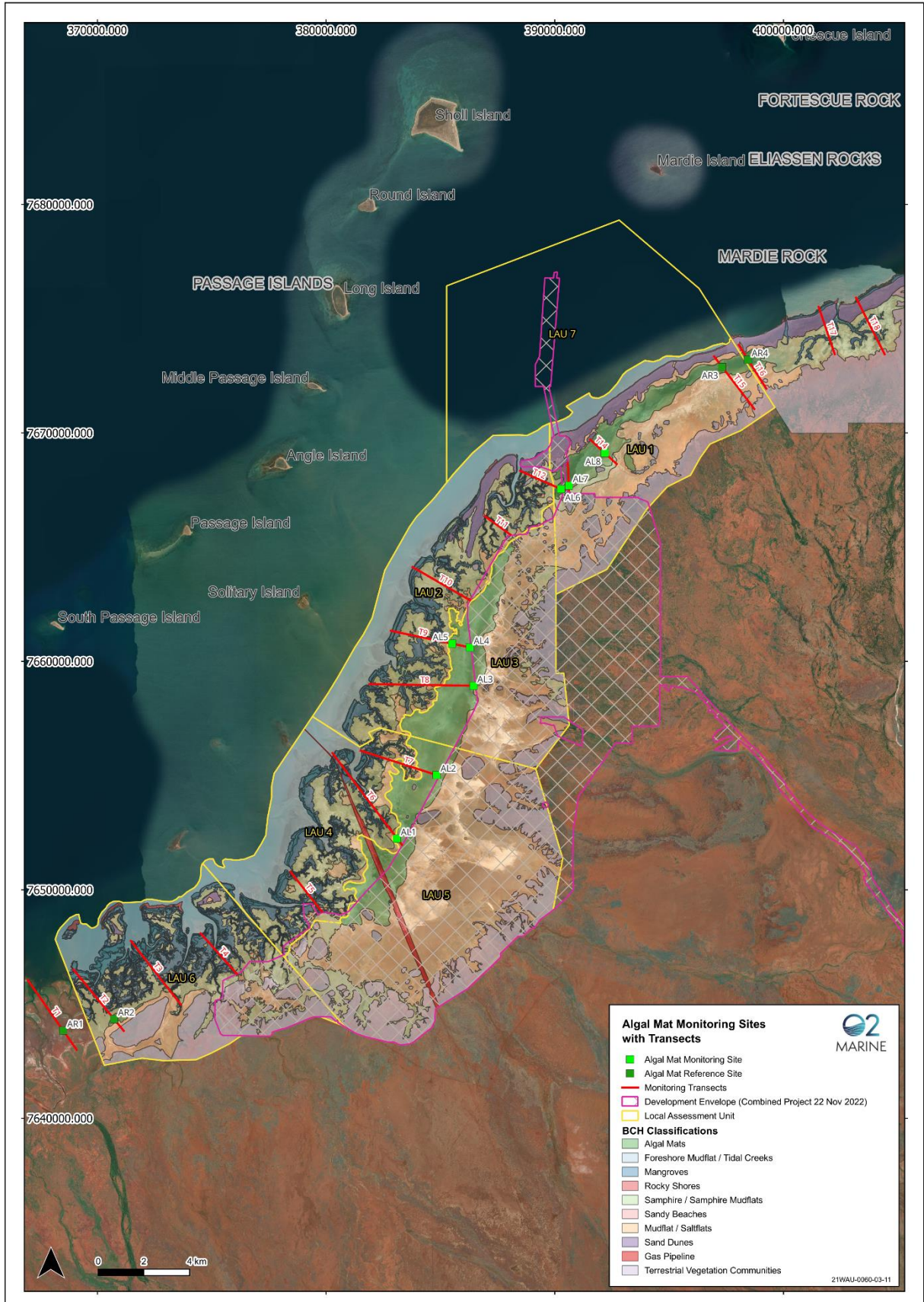


Figure 10: Algal mat monitoring locations

3.1.3. Frequency

3.1.3.1. Establishment survey

An establishment survey will be undertaken to establish the monitoring locations at the coordinates given in Table 7. Part of this work will be to confirm the suitability of the monitoring locations, including the suitability of reference sites as representative of similar communities. Consideration for groundwater and surface water monitoring locations will also be taken into account if any alterations need to be made to the site locations.

3.1.3.2. Routine monitoring

Monitoring will be undertaken quarterly at each site within the first two years, and decreased to bi-annually (at the end of the dry and the wet seasons) following the first two years, provided monitoring results do not suggest an unexpected level of impact. If results do suggest this level of impact, then quarterly monitoring will be ongoing until this is rectified and monitoring frequency can be decreased. Each monitoring survey will ideally be undertaken after a spring tide, to enable chlorophyll-a measurements. Chennu et al. (2015) found that wetting a sample of algal mat increased chlorophyll-a readings, which remained high within a period of 12 hours after. Therefore, the time of the survey (number of hours after the algal mats have been inundated) will be noted and, where practical, subsequent surveys will aim to be undertaken at a similar tidal regime to ensure similar conditions during subsequent surveys.

3.1.3.3. Reactive monitoring

If a trigger is exceeded, reactive monitoring will be undertaken to investigate any secondary impacts to the algal mats. A trigger for this reactive monitoring may include a groundwater or tidal flood/surface water trigger or threshold level exceedance, a wall breach, spill or cyclone. The reactive monitoring will be undertaken as soon as practicable after the trigger event, allowing for the appropriate tidal and weather conditions to effectively compare to the previous data.

Reactive monitoring may be subject to the nature of the trigger exceedance. For example, if a groundwater trigger level is exceeded, the location will be noted and a BCH reactive survey may be required at the closest site, across multiple sites (including reference sites), or additional reactive sites may need to be established.

If the algal mat health trigger level is exceeded, the frequency of monitoring at the sites where the trigger is exceeded may increase. If this occurs, monitoring at those sites may increase to monthly until the trigger level is no longer exceeded. The monitoring program may also be required to collect additional data onsite for determination of cause and whether attributable to the Optimal Proposal activities. For example, groundwater samples for measurements of conductivity/salinity and pH or additional tidal flood depth /surface water stations may be required to be collected and assessed in close proximity to BCH monitoring locations.

Reactive monitoring will include the measurement of all parameters as the routine monitoring. It may also include aerial photography over the monitoring locations to understand the extent of the algal mats and monitor if any losses are identified. Further management actions are given in Section 3.6.

3.1.4. Trigger and threshold levels

Trigger and threshold levels for algal mat health will be adopted for percentage cover to ensure algal mat cover is being retained. The trigger and threshold levels are presented in Table 8 and Table 9.

In the event of a trigger exceedance of percent cover, other health data collected during surveys, as well as information collected from other monitoring surveys, will be evaluated in a multiple lines of evidence assessment to determine if the change observed is natural or potentially attributable to Optimised Proposal activities.

Table 8: Trigger and threshold levels for algal mat health

Parameter	Trigger level
Percentage cover	Retain a minimum of 80% baseline algal mat percent cover calculated over three quadrats of the same site over time and is not significantly different ($p < 0.05$) to the changes in reference site data

Table 9: Threshold levels for algal mat health

Parameter	Threshold value
Percentage cover	Retain a minimum of 50% baseline algal mat percent cover calculated over three quadrats of the same site over time and is not significantly different ($p < 0.05$) to the changes in reference site data

3.1.5. Data analysis

Statistical data analysis will be conducted on percent cover concentrations to determine change over time and compared to the reference sites using Generalised Linear Model (GLM) multi-factorial Analysis of Variance (ANOVA) performed using fitted with a suitable selected distribution to determine pairwise contrasts of the change in cover between sites and surveys through time.

Statistical analysis may also be undertaken for the quantitative health assessment parameters, using multivariate control charts and ANOVA if significant differences ($p < 0.05$) are detected and further analysis is required.

3.2. Mangrove health monitoring

The mangrove monitoring program will consist of monitoring the health, diversity and extent of the assemblages at nominated monitoring locations.

3.2.1. Methods

For scattered mangrove communities, three 8 x 8 m replicate plots will be established parallel to the pond bund walls and coastline (where practical). Within each plot, five randomly placed quadrats measuring 1 x 1 m will be measured for fine scale indicators within each quadrat, resulting in 12 plots over the 3 replicate quadrats at each monitoring site.

For closed-cover mangrove communities, plot sizes will be reduced to 4 x 4 m due to increased density of trees.

Plot data

The plot area will be used to record indicators such as canopy cover, foliage density, leaf area index, species tree density & height, diameter breast height measurements for above ground biomass and chlorophyll a.

Canopy cover

Using a densiometer where possible, 20 readings will be taken in each quadrat at chest height to measure canopy cover. A set of four readings will be taken in each plot, one facing north, south, east and west. Where mangrove height is restricted (i.e. <2 m), densiometer readings will be collected from a lower height. Where mangrove height restricts readings using the densiometer, each surveyor will estimate the percent coverage visually and an average of the two readings recorded for each quadrat.

Mangrove individual counts

The number of trees within each plot will be counted, namely dead and alive adult individuals, and the number of seedlings and saplings counted separately from the adult counts. Invertebrate burrow numbers will also be recorded, and up to ten random adult trees will be selected to measure the height (where practicable).

Foliage density

Foliage density will be measured using an LAI-2000 plant canopy analyser (Li-Cor, Inc., Lincoln, NE) or similar. Leaf area index of plant canopies is estimated by the instrument indirectly from measurements of radiation above and below the canopy, based on a theoretical relationship between leaf area and canopy transmittance. Its optical sensor comprises of five detectors, arranged in concentric rings that measure radiation (below 490 nm) from different sections of the sky. Canopy transmittance for these different sections is computed as the ratio between below-canopy and above-canopy readings for each detector ring. The leaf area estimate assumes randomly distributed foliage elements.

Tagged branch leaf area

In each monitoring quadrat, five randomly oriented branches will be selected and tagged with tape for consistency between survey events. Tagged-branch leaf area can be measured using a specialised handheld scanning device to determine a leaf area index.

Diameter breast height

The number of stems from 10 random trees will be counted. Ten measurements of stem thickness will be collected at breast height (or lower if necessary) to determine above ground biomass using existing relationships for species present in the Pilbara.

Chlorophyll a

Five measurements of chlorophyll-a concentrations will be undertaken *in-situ* using a handheld pulse-amplitude modulated (PAM) fluorometer within each plot.

Qualitative health assessment

Photographs and qualitative observations will also be taken at each plot. Leaf health monitoring will be undertaken using the Duke et al. (2005) classification system, where 10 observations in the plot will be classified as Healthy (green leaves <10% dead/yellowing leaves), sick (yellow, wilting leaves, approx. 10-50% dead/yellowing leaves) or dead (>50% dead/yellowing leaves). Further qualitative observations recorded will include flowering, insect damage and invertebrates present.

3.2.2. Locations

A total of 21 impact and 6 reference monitoring sites will be established along the Optimised Proposal area, based on the proximity to the pond wall, groundwater monitoring locations and tidal flood depth/surface water stations. The density and productivity of mangrove assemblages also varies along the gradient from the pond wall to the sea, and therefore mangrove locations along the transect will include landward scattered and closed canopy seaward assemblages. Reference sites for mangroves have been selected at both the North and South of the Optimised Proposal development envelope.

At each monitoring site, there will be three replicate permanent plots. The replicate plots will be established parallel to the pond walls and coastline to reduce variation associated with distance from the pond or ocean. The coordinates of the monitoring locations are given in Table 10 and locations are presented in Figure 11.

Replicate plots within each monitoring location will be labelled with the suffix “a”, “b” or “c” as appropriate.

Table 10: Coordinates of mangrove monitoring locations

Mangrove monitoring locations	Easting	Northing	Purpose
Landward monitoring sites			
ML1	373573	7645055	Monitoring site within the RRDMMMA to ensure no impacts are detected
ML2	372878	7645948	Monitoring site within the RRDMMMA to ensure no impacts are detected
ML3	376085	7646326	Monitoring site within the RRDMMMA to ensure no impacts are detected
ML4	379514	7649424	Impact site near tide monitoring site
ML5	382836	7652631	Impact site next to groundwater monitoring locations near pond wall
ML6	383651	7655401	Impact site next to groundwater monitoring location
ML7	383667	7658974	Impact site along transect near groundwater monitoring location
ML8	384620	7660959	Impact site near surface water monitoring location
ML9	385889	7662910	Impact site next to groundwater monitoring locations near pond wall
ML10	385412	7663182	Impact site next to groundwater monitoring locations near pond wall
ML11	386890	7663852	Impact site where mangroves are closest to the pond wall, and next to a tide monitoring site



ML12	387846	7665736	Impact site next to groundwater monitoring locations near pond wall
ML13	386996	7666313	Impact site along transect related to groundwater monitoring locations closer to the seaward side
ML14	389754	7667770	Impact site near tide monitoring location
MR1	368044	7644484	Reference location on the southern end of the Proposal area
MR2	370098	7645101	Reference location on the southern end of the Proposal area
MR3	402047	7674025	Reference location on the northern end of the Proposal area
MR4	403920	7674428	Reference location on the northern end of the Proposal area
Seaward monitoring sites			
SML1	374536	7648061	Seaward mangrove monitoring site within RRDMMMA
SML2	378474	7650749	Impact site near tide gauge
SML3	380413	7655798	Impact site seaward of groundwater monitoring locations
SML4	381554	7656075	Impact site seaward of groundwater monitoring location
SML5	381947	7659001	Impact site seaward of groundwater monitoring locations
SML6	382889	7661323	Impact site seaward of tidal
SML7	383825	7664100	Impact site seaward of groundwater monitoring locations
SMR1	367335	7645503	Seaward mangrove reference site on the southern end of the Proposal area
SM2	369005	7646436	Seaward mangrove reference site on the southern end of the Proposal area

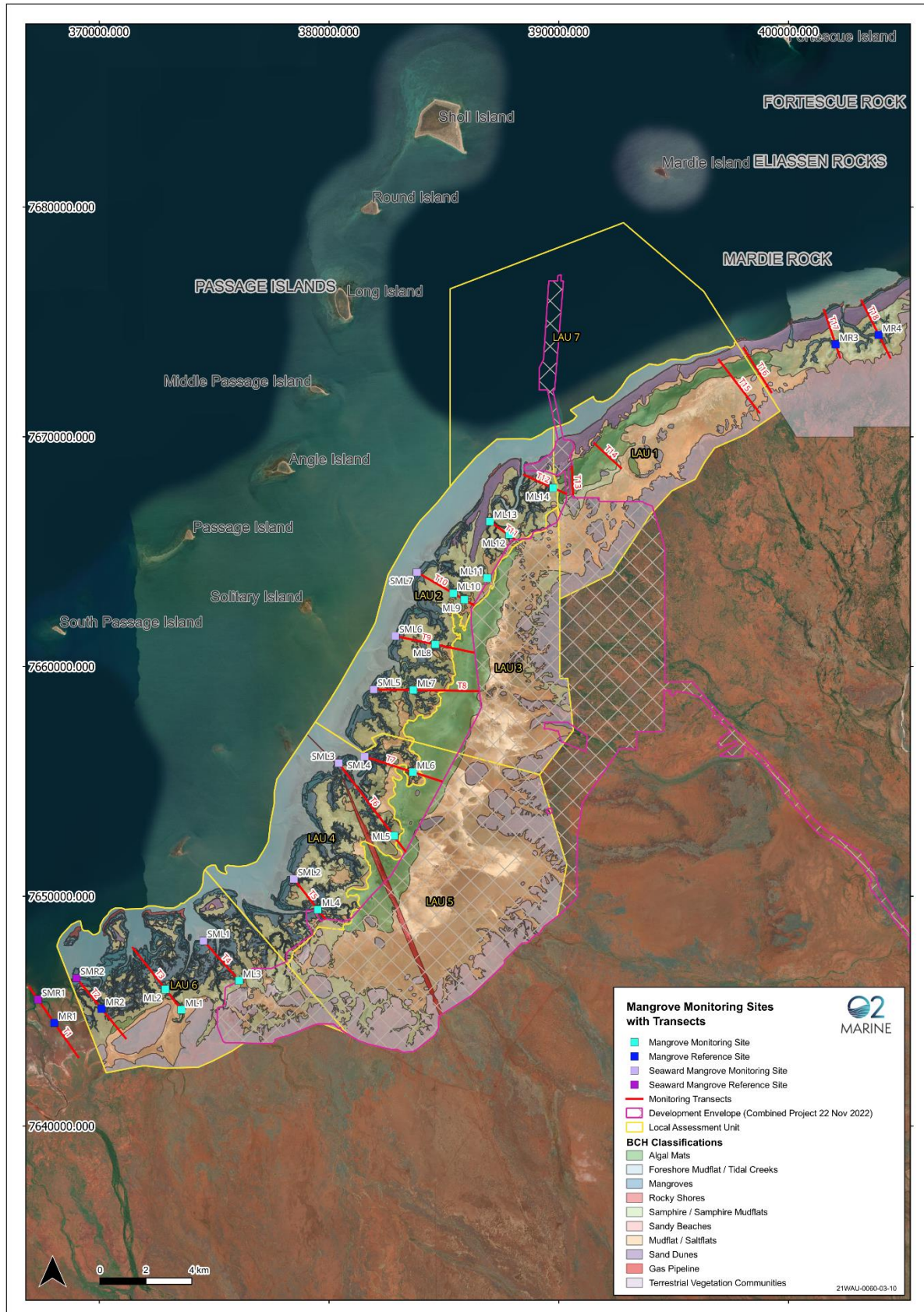


Figure 11: Mangrove monitoring locations

3.2.3. Frequency

3.2.3.1. Establishment survey

An establishment survey will be undertaken to establish the monitoring locations at the coordinates given in Table 10. Part of this work will be to confirm the suitability of the monitoring locations, including the suitability of reference sites as representative of similar communities. Consideration for groundwater and surface water monitoring locations will also be taken into account if any alterations need to be made to the site locations.

3.2.3.2. Routine monitoring

Monitoring will be undertaken quarterly at each site within the first two years, and decreased to bi-annually (at the end of the dry and the wet seasons) following the first two years, provided monitoring results do not suggest an unexpected level of impact. If results do suggest this level of impact, then quarterly monitoring will be ongoing until this is rectified and monitoring frequency can be decreased. Routine monitoring will be undertaken quarterly for the scattered mangrove assemblage sites inland, closer to the pond walls. Seaward closed canopy assemblages will be monitored annually. Seaward mangrove locations are less likely to be impacted by the ponds, and therefore these locations will be surveyed annually (rather than quarterly or bi-annually).

Consideration may be required for access to the sites based on the tidal cycle. Some seaward sites may require to be surveyed during low tide in a spring tide cycle. All sites will be established during the first survey.

3.2.3.3. Reactive monitoring

A trigger for reactive monitoring includes a groundwater or tidal flood depth/surface water trigger or threshold level exceedance, or a bund wall breach, spill or cyclone. The reactive monitoring will be undertaken as soon as practicable after the trigger event, allowing for the appropriate tidal and weather conditions to effectively compare to the previous data.

Reactive monitoring locations will be subject to the nature of the trigger exceedance. For example, if a groundwater trigger level is exceeded, the location will be noted and a BCH reactive survey may be required at the closest site, across multiple sites (including reference sites), or additional reactive sites may need to be established.

If the mangrove health trigger level is exceeded, the frequency of monitoring at the sites where the trigger is exceeded may increase. If this occurs, monitoring at those sites may increase to monthly until the trigger level is no longer exceeded. The monitoring program may also be required to collect additional data onsite for determination of cause and whether attributable to the Optimal Proposal activities. For example, groundwater samples for measurements of conductivity/salinity and pH or additional tidal flood depth /surface water stations may be required to be collected and assessed in close proximity to BCH monitoring locations.

Reactive monitoring will include the measurement of all parameters as the routine monitoring. It will also include aerial photography over the monitoring locations to understand the extent of the mangroves and monitor if any losses are identified.

3.2.4. Trigger and threshold levels

Trigger levels for mangrove health will be adopted for percentage cover, number of dead individuals and number of saplings/seedlings. The intention is to retain mangrove health and overall numbers of individuals is being retained. Investigations into trigger exceedances will be undertaken if any of the three trigger parameters are exceeded (i.e. percentage canopy cover OR number of dead adults OR number of seedlings and saplings). A threshold is considered to be exceeded if all three parameters are exceeded (i.e. percentage canopy cover AND number of dead adults AND number of seedlings and saplings). Therefore, the number of dead adult and number of seedling/sapling trigger and threshold explanations may be the same, but a threshold is exceeded if all parameters are exceeded. A summary triggers is given in Table 11, and thresholds in Table 12. Mangroves within the Robe River Delta Mangrove Management Area (RRDMMA) require a more conservative approach, and the triggers and thresholds for these monitoring locations are given in Table 13 and Table 14.

In the event of a trigger or threshold exceedance, other health data collected during surveys and information collected from previous monitoring surveys will be evaluated in a multiple lines of evidence assessment to determine if the change observed is natural or potentially attributable to Optimised Proposal activities.

Associated management actions are described in Section 3.6.

Table 11: trigger level for mangrove health

Parameter	Trigger level
Percentage canopy cover	A minimum of 80% baseline canopy cover retained as calculated over three plots within the same site and any loss is not significantly different ($p < 0.05$) to the reference site data OR
Number of dead adult mangroves	No significant increase in the average number of dead adult mangroves from the baseline as calculated over three plots within the same site and any loss is not significantly different ($p < 0.05$) to the reference site data OR
Number of saplings and seedlings	No significant decrease in the average number of seedlings/saplings counted from the baseline as calculated over three plots within the same site and any decrease is not significantly different ($p < 0.05$) to the reference site data

Table 12: threshold levels for mangrove health

Parameter	Trigger level
Percentage canopy cover	A minimum of 50% baseline canopy cover retained as calculated over three plots within the same site and any loss is not significantly different ($p < 0.05$) to the reference site data AND
Number of dead adult mangroves	No significant increase in the average number of dead adult mangroves from the baseline as calculated over three plots within the same site and any loss is not significantly different ($p < 0.05$) to the reference site data AND
Number of saplings and seedlings	No significant decrease in the average number of seedlings/saplings counted from the baseline as calculated over three plots within the same site and any decrease is not significantly different ($p < 0.05$) to the reference site data

Table 13: trigger level for mangrove health at RRDMMMA monitoring locations

Parameter	Trigger level
Percentage canopy cover	A minimum of 90% baseline canopy cover retained as calculated over three plots within the same site and any loss is not significantly different ($p < 0.05$) to the reference site data
Number of dead adult mangroves	No significant increase in the average number of dead adult mangroves from the baseline as calculated over three plots within the same site and any loss is not significantly different ($p < 0.05$) to the reference site data
Number of saplings and seedlings	No significant decrease in the average number of seedlings/saplings counted from the baseline as calculated over three plots within the same site and any decrease is not significantly different ($p < 0.05$) to the reference site data

Table 14: threshold levels for mangrove health at RRDMMMA monitoring locations

Parameter	Trigger level
Percentage canopy cover	A minimum of 80% baseline canopy cover retained as calculated over three plots within the same site and any loss is not significantly different ($p < 0.05$) to the reference site data
Number of dead adult mangroves	No significant increase in the average number of dead adult mangroves from the baseline as calculated over three plots within the same site and any loss is not significantly different ($p < 0.05$) to the reference site data
Number of saplings and seedlings	No significant decrease in the average number of seedlings/saplings counted from the baseline as calculated over three plots within the same site and any decrease is not significantly different ($p < 0.05$) to the reference site data

3.2.5. Data analysis

Statistical data analysis will be conducted on percent cover and number of adults and saplings/seedlings to determine change over time and compared to the reference sites using Generalised Linear Model (GLM) multi-factorial Analysis of Variance (ANOVA). This will be performed using a suitable selected distribution to determine pairwise contrasts of the change in cover between sites and surveys through time.

Statistical analysis may also be undertaken for other quantitative health assessment parameters, using multivariate control charts and ANOVA if significant differences ($p < 0.05$) are detected and further analysis is required.

3.3. Samphire health monitoring

The samphire monitoring program will consist of monitoring the health and extent at nominated monitoring locations.

3.3.1. Methods

At each monitoring location, quantitative and qualitative indicators will be measured within three 8 x 8 m replicate plots will be established parallel to the pond bund walls and coastline (where possible).

Quantitative data

Number of individuals present within the plot will be recorded. Heights and size distribution will be determined from up to 10 random measurements. Total percent cover will be visually estimated using five randomly placed 1 x 1 m quadrats within the plot. The number of dead plants will also be counted. Tip die off will also be noted, by counting the number of dead tips on plants within the plots. Tagging plants may have a detrimental effect on the plant health over a long period of time, and therefore tagged branches for measurement will not be used for this program.

Qualitative data

The plant health for each *Tecticornia* shrub will be classified based on a modified classification system from Casson et al. (2009). Photos of the plots within the quadrats will also be taken and may aid in species identification as required. The qualitative data will include observations of colour, flowering and growth forms.

Table 15: Modified plant health scale based on Casson et al. (2009)

Health rating	Description
0	Healthy, no dead articles
1	Occasional dead articles
2	Tips of branches stressed or dying
3	Entire or whole branches dying or dead
4	More than half shrub dead
5	Shrub dead

3.3.2. Locations

Nine impact and three reference permanent monitoring sites will be established along the study area. As previously discussed, the locations of these sites have been determined based on the proximity to the pond bund wall, groundwater monitoring locations and tidal flood depth/surface water stations.

At each monitoring site, there will be three replicate plots measuring 8 x 8 m. The three replicate plots will be established parallel to the pond bund walls and coastline (where possible) to reduce variation associated with distance from the pond or ocean. The coordinates of the monitoring locations are given in Table 16 and locations are presented in Figure 12. Replicate quadrats within each monitoring location will be labelled with the suffix “a”, “b” or “c” as appropriate.

Table 16: Coordinates of samphire monitoring locations

Samphire monitoring locations	Easting	Northing	Purpose
SL1	376000	7646425	Monitoring site within RRDMMA, near groundwater monitoring sites and tide gauge
SL2	382827	7652550	Impact site along transect near groundwater monitoring locations
SL3	383715	7655380	Impact site along transect near groundwater monitoring location
SL4	384599	7658959	Impact site along transect near groundwater monitoring location
SL5	386268	7662687	Impact site along transect near groundwater monitoring location
SL6	385889	7662854	Impact site along transect near groundwater monitoring location
SL7	387915	7665649	Impact site along transect near groundwater monitoring location
SL8	389970	7667673	Impact site along transect near surface water monitoring location
SL9	390617	7667518	Impact site along transect near causeway
SR1	368198	7644266	Reference location on the southern end of the Proposal area
SR2	370512	7644596	Reference location on the southern end of the Proposal area
SR3	402123	7673796	Reference location on the northern end outside the Proposal area
SR4	404064	7674156	Reference location on the northern end outside the Optimised Proposal area

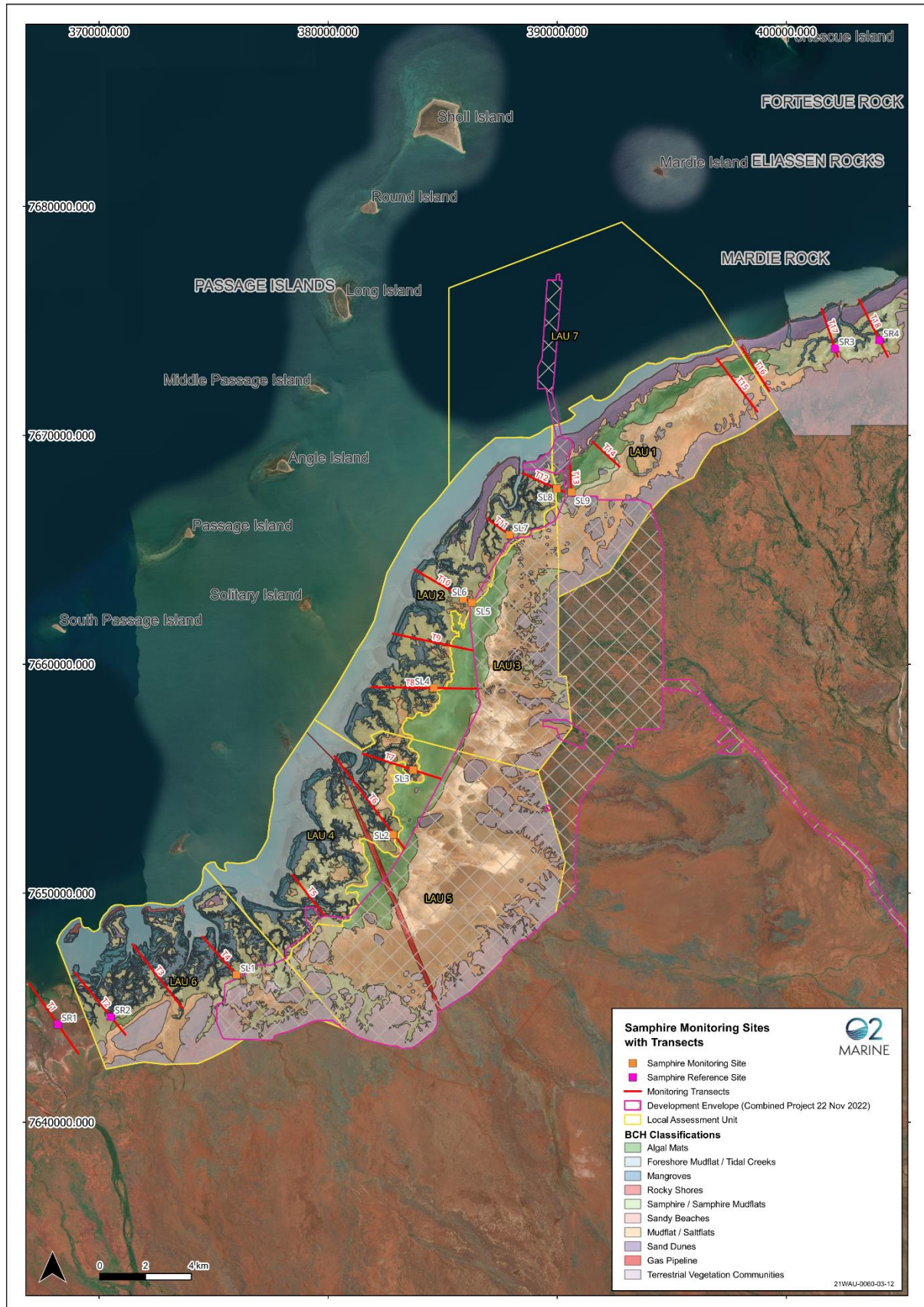


Figure 12: Samphire monitoring locations

3.3.3. Frequency

3.3.3.1. Establishment survey

An establishment survey will be undertaken to establish the monitoring locations at the coordinates given in Table 16. Part of this work will be to confirm the suitability of the monitoring locations, including the suitability of reference sites as representative of similar communities. Consideration for groundwater and surface water monitoring locations will also be taken into account if any alterations need to be made to the site locations.

3.3.3.2. Routine monitoring

Monitoring will be undertaken quarterly at each site within the first two years and decreased to bi-annually (at the end of the dry and the wet seasons) following the first two years, provided monitoring results do not suggest an unexpected level of impact. If results do suggest this level of impact, then quarterly monitoring will be ongoing until this is rectified and monitoring frequency can be decreased. The frequency will also be reviewed at the end of five year following the commencement of operations.

3.3.3.3. Reactive monitoring

A trigger for reactive monitoring includes a groundwater or tidal flood depth/surface water trigger or threshold level exceedance, or a bund wall breach, spill or cyclone. The reactive monitoring will be undertaken as soon as practicable after the trigger event, allowing for the appropriate tidal and weather conditions to effectively compare to the previous data.

Reactive monitoring may be subject to the nature of the trigger exceedance. For example, if a groundwater trigger level is exceeded, the location will be noted and a BCH reactive survey may be required at the closest site, across multiple sites (including reference sites), or additional reactive sites may need to be established.

If the algal mat health trigger level is exceeded, the frequency of monitoring at the sites where the trigger is exceeded may increase. If this occurs, monitoring at those sites may increase to monthly until the trigger level is no longer exceeded. The monitoring program may also be required to collect additional data onsite for determination of cause and whether attributable to the Optimal Proposal activities. For example, groundwater samples for measurements of conductivity/salinity and pH or additional tidal flood depth /surface water stations may be required to be collected and assessed in close proximity to BCH monitoring locations.

Reactive monitoring will include the measurement of all parameters as the routine monitoring. It will also include aerial photography over the monitoring locations to understand the extent of the samphire and monitor if any losses are identified.

3.3.4. Trigger and threshold levels

Trigger and threshold levels for samphire health will be adopted for percentage cover and overall samphire health using the modified plant health scale. Investigations into trigger exceedances will be undertaken if either trigger parameter is exceeded (i.e. percentage cover OR samphire health). A threshold is considered to be exceeded if both parameters are exceeded (i.e. percentage cover AND samphire health). Therefore, the overall plant health trigger and threshold explanations may be the

same, but a threshold is exceeded if all parameters are exceeded. These are presented in Table 17 and Table 18.

In the event of a trigger or threshold exceedance, other health data collected during surveys and information collected from previous monitoring surveys will be evaluated in a multiple lines of evidence assessment to determine if the change observed is natural or potentially attributable to Optimised Proposal activities.

Table 17: trigger levels for samphire health

Parameter	Trigger level
Percentage cover	Retain a minimum of 80% baseline samphire percent cover calculated over three quadrats of the same site over time and is not significantly different ($p < 0.05$) to the changes in reference site data OR
Overall plant health	No significant increase in the average plant health scores (i.e. decline in overall health) over three plots at the same site and is not significantly different ($p < 0.05$) to the changes in reference site data

Table 18: Threshold levels for samphire health

Parameter	Trigger level
Percentage cover	Retain a minimum of 50% baseline samphire percent cover calculated over three quadrats of the same site over time and is not significantly different ($p < 0.05$) to the changes in reference site data AND
Overall plant health	No significant increase in the average plant health scores (i.e. decline in overall health) over three plots at the same site and is not significantly different ($p < 0.05$) to the changes in reference site data

3.3.5. Data analysis

Statistical data analysis will be conducted on percent cover concentrations to determine change over time and compared to the reference sites using Generalised Linear Model (GLM) multi-factorial Analysis of Variance (ANOVA) fitted with a suitable selected distribution to determine pairwise contrasts of the change in cover between sites and surveys through time.

Statistical analysis may also be undertaken for the quantitative health assessment parameters, using multivariate control charts and ANOVA if significant differences ($p < 0.05$) are detected and further analysis is required.

3.4. Subtidal BCH health monitoring

While risks to marine subtidal communities as a result of the Optimised Proposal are predicted to be minimal, to account for any uncertainty in the impact assessment and to ensure that important nearshore subtidal BCH remains protected, monitoring of key subtidal BCH (including seagrass and macroalgae) is to occur in nearshore locations adjacent to the development envelope susceptible to potential changes to surface water, groundwater quality groundwater regimes, and marine environmental quality.

Inshore coastal bays, lagoons, and estuarine environments that are typically influenced by freshwater run-off and low salinity surface waters are known to be an important habitat for some commercial fish species during the larval stage (e.g. grey mackerel). The dominant sub-tidal BCH in the nearshore zone is seagrass. It is for this reason that seagrass is considered a more suitable BCH type to monitor than other sub-tidal BCH types, such as macroalgae, which has very low cover due to lack of hard substrate to colonise. However, macroalgae occurring within subtidal communities will still be recorded.

A tiered monitoring program has been designed to detect any sublethal changes in seagrass that may occur as a result of implementation and ongoing operation of the Optimised Proposal. This program assumes a cause-effect continuum between changes to ground water flow/quality or surface water/nutrient flow and reductions in seagrass health. Criteria have been developed based on baseline monitoring programs to ensure appropriate and timely management actions are implemented, including multiple lines of evidence approach to verify impacts and ensure the key outcomes of the BCHMMP are achieved.

Baseline monitoring has been undertaken to verify monitoring locations and methods are fit for purpose and to ensure any changes in the environment beyond natural variation (i.e. as a result of Optimised Proposal activities) can be detected. Part of baseline survey intent is to identify suitable sites co-located as close to groundwater, surface water and tidal inundation monitoring locations as possible which support sufficient seagrass cover for statistical evaluation of change.

The key stressors of concern include:

1. enhanced salinity in sediment porewater (originally emanating from below salt production ponds)
2. alteration to surface water and nutrient flows (due to salt production ponds).

3.4.1. Methods

Seagrass Health

Diver based transects will be used to collect data from each site, which will be analysed to determine seagrass 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. As per Vanderklift et al (2016), at each site, three 50 m transects will be surveyed, with a 0.25 x 0.25 m image collected every meter (n=150 per site; noting this sampling intensity is double that of Vanderklift et al 2016). Additional qualitative observations will also be recorded such as canopy height and presence of epiphytes.

Sediment Porewater

Sediment porewater (salinity) will be monitored at seagrass monitoring sites using porewater sippers (or equivalent). At each site, three sippers will be permanently deployed to enable in situ sampling of porewater from ~15 cm sediment depth, noting the root system for most ephemeral seagrasses is typically shallow (<5 cm depth).

Ambient porewater salinity will be determined during this baseline monitoring program with specific criteria applied at the completion of the baseline monitoring period. Timing of sampling will coincide with seagrass health monitoring during the baseline monitoring period.

3.4.2. Locations

A total of 5 impact and 3 reference monitoring sites will be established within the subtidal zone, close to the Optimised Proposal area. These locations have been based on habitat mapping results which highlighted the areas of higher density seagrass and other BCH including macroalgae within subtidal areas where changes in health due to groundwater may be detected as early as possible. Coordinates of the BCH monitoring locations are given in Table 19 and locations are presented in Figure 13.

Table 19: Coordinates of subtidal BCH monitoring locations

Subtidal monitoring locations	BCH	Easting	Northing	Purpose
SG14		376891	7652924	Impact monitoring site
SG23		382082	7662423	Impact monitoring site
SG24		383461	7665400	Impact monitoring site
SG34		387508	7669211	Impact monitoring site
SG36		391275	7671453	Impact monitoring site
SG3		370588	7651221	Reference monitoring site
SG4		371247	7649658	Reference monitoring site
SG6		367145	7647446	Reference monitoring site

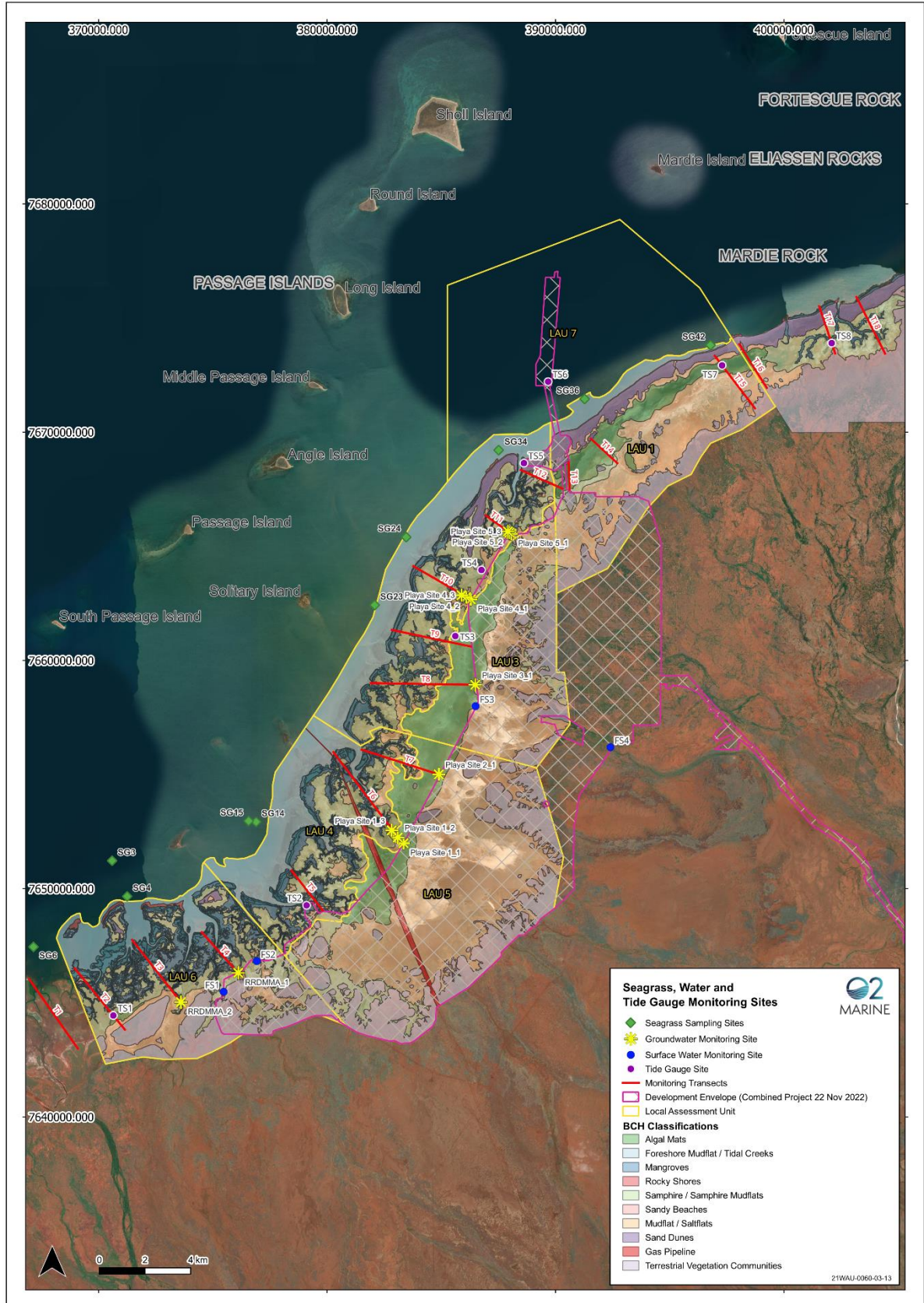


Figure 13: Subtidal BCH monitoring locations

3.4.3. Frequency

3.4.3.1. Baseline monitoring

Baseline monitoring included four surveys, undertaken quarterly for a year between May 2022 and January 2023 prior to operations. This data will be used to compare to subsequent routine monitoring surveys. The baseline report is currently being prepared.

3.4.3.2. Routine monitoring

Monitoring will be undertaken quarterly at each site within the first two years and decreased to bi-annually (at the end of the dry and the wet seasons) following the first two years, provided monitoring results do not suggest an unexpected level of impact. If results do suggest this level of impact, then quarterly monitoring will be ongoing until this is rectified and monitoring frequency can be decreased. The frequency will also be reviewed at the end of five year following the commencement of operations.

3.4.3.3. Reactive monitoring

Should enhanced groundwater salinity levels, or altered surface water flows, be detected at relevant monitoring locations (e.g., trigger events from this Plan or established within the GMMP), reactive monitoring will investigate signs of sublethal stress in BCH.

Sampling locations for reactive monitoring will be determined based on the trigger event (e.g., sites where seagrass communities have been impacted), possibly incorporating monitoring at suitable reference sites, while routine sites would potentially be monitored post cyclone).

Reactive monitoring may also include broader scale mapping of BCH cover using drop camera/snorkelling surveys to understand the extent of the poor health subtidal BCH and monitor if any losses are identified.

3.4.4. Trigger levels and management actions

Trigger levels for subtidal BCH health will be based on porewater salinity criteria defined based on comparison of the median against the 80th percentile of baseline data.

The trigger and thresholds for subtidal BCH will be based on percentage cover as given in Table 20 and Table 21.

In the event of a trigger or threshold exceedance of percent cover, other health data collected during surveys, as well as information collected from other monitoring surveys, will be evaluated in a multiple lines of evidence assessment to determine if the change observed is natural or potentially attributable to Optimised Proposal activities.

Management actions will be associated with loss of BCH described in Section 3.6.

Table 20: Trigger levels for subtidal BCH health

Parameter	Trigger level
Percentage cover	Retain a minimum of 80% baseline subtidal BCH percent cover calculated over three quadrats of the same site over time and is not significantly different ($p < 0.05$) to the changes in reference site data
Porewater Salinity	Porewater salinity median at impact sites within 80 th percentile of reference site data

Table 21: Threshold levels for subtidal BCH health

Parameter	Trigger level
Percentage cover	Retain a minimum of 60% baseline subtidal BCH percent cover calculated over three quadrats of the same site over time and is not significantly different ($p < 0.05$) to the changes in reference site data

3.4.5. Data analysis

Statistical data analysis will be conducted on percent cover concentrations to determine change over time and compared to the reference sites using Generalised Linear Model (GLM) multi-factorial Analysis of Variance (ANOVA) fitted with a suitable selected distribution to determine pairwise contrasts of the change in cover between sites and surveys through time.

Statistical analysis may also be undertaken for the quantitative health assessment parameters, using multivariate control charts and ANOVA if significant differences ($p < 0.05$) are detected and further analysis is required.

3.5. Tidal flood depth/surface water monitoring

Tidal flood depth/surface water monitoring will be undertaken at the Optimised Proposal to determine:

- Actual tidal inundation changes associated with the Optimised Proposal (i.e. due to the presence of the causeway, pond bund walls or due to seawater abstraction)
- Actual freshwater inundation changes associated with the Optimised Proposal (i.e. due to drainage diversions and rainfall capture within the ponds)
- Sea level monitoring to record changes in sea water levels due to climate change.

The monitoring information will be used to inform whether boundary changes to BCH are occurring as a result of changes to tidal inundation, sea level rise or surface runoff diversion. Tidal flood depth/surface water will be monitored by telemetered radar water level (RWL) meters with continuous sampling and real time display on a dedicated webpage. Monitoring will commence as soon as practicable so that baseline information can be collected.

3.5.1. Methods

During the establishment survey campaign for the intertidal BCH monitoring locations, the RWL and telemetry will also be established. The RWL and telemetry will be mounted on a pole above predicted flood surge levels and sea level rise from climate change. The RWL is a downward facing radar measurement that will calibrate from the substrate and record reductions in the readings when surface or tidal water is present. The difference in the reduced height will be equivalent to the depth of water above the substrate (or depth height surveyed back to LAT).

3.5.2. Locations

The Tidal flood depth/surface water stations will be located along the length of the Proposal area, at the locations given in Table 22 and Figure 14. Surface water locations target areas where water has been diverted.



Table 22: Coordinates of tidal flood depth/surface water monitoring locations

Tidal/ surface water monitoring locations	Easting	Northing	Purpose
FS1	375468	7645477	Southern end of the Project area
FS2	376925	7646823	Southern end of the Project area
FS3	386498	7657990	Western edge of the ponds
FS4	392400	7656192	On the eastern side of the ponds
TS1	370638	7644437	Southern end of the Project area
TS2	379099	7649264	Southern end of the Project area
TS3	385611	7661061	Near Transect 8, close to intertidal BCH monitoring locations
TS4	386795	7663887	Next to the mangrove monitoring site closest to pond walls
TS5	388614	7668640	Tide gauge at the mouth of creek
TS6	389673	7672212	In dredging area, northern end of the project
TS7	397289	7672925	Within algal mat habitat, northern end of the project
TS8	402087	7673899	Within reference mangrove and samphire habitat, northern end of the project

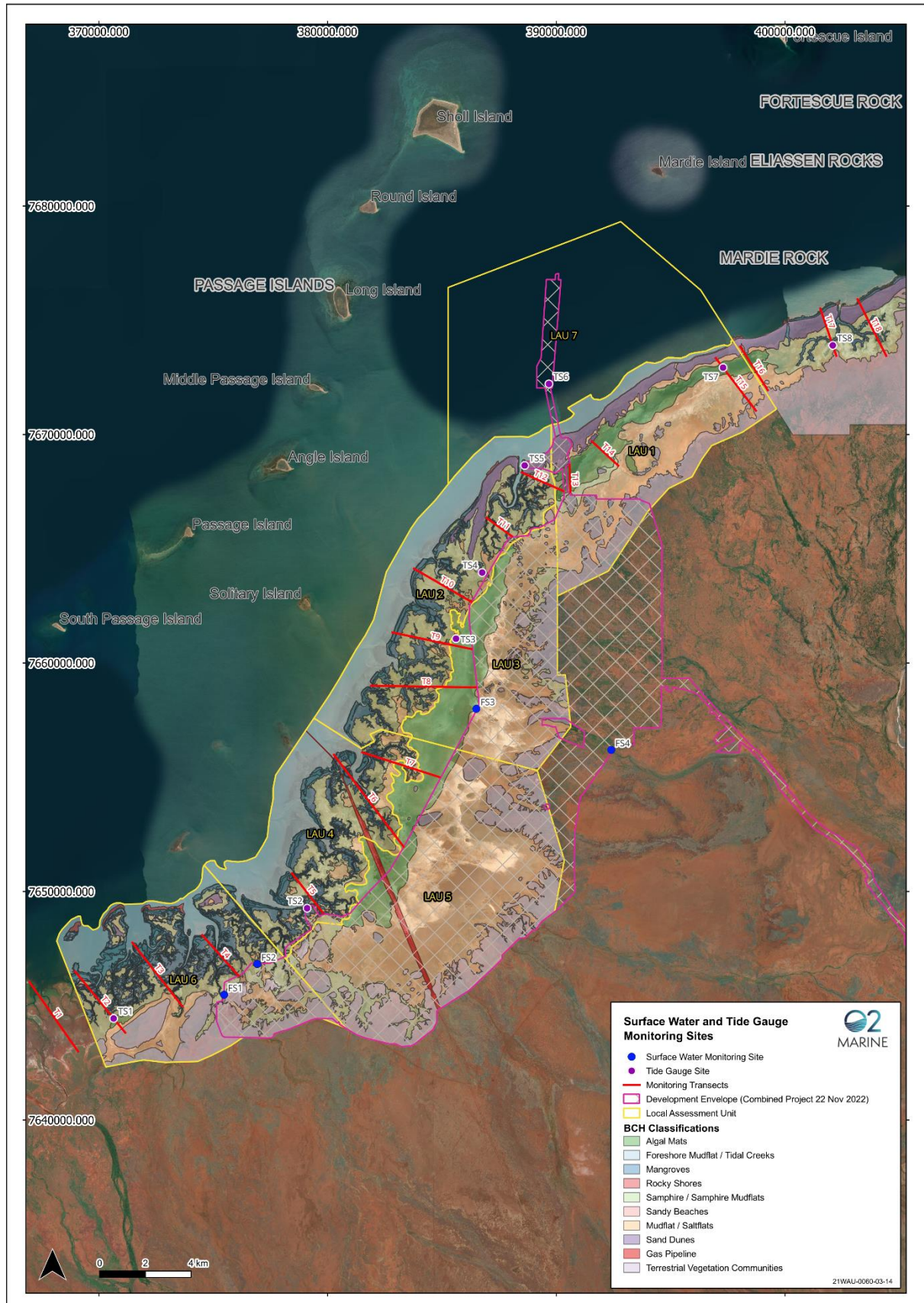


Figure 14: tide and surface water monitoring locations

3.5.3. Frequency

During the establishment survey campaign for the intertidal BCH monitoring locations, the RWL and telemetry will also be established. This survey campaign will occur as soon as practicable following the approval of the BCHMMP. Once the tidal flood depth/surface water stations have been established, data will be collected in 30-minute intervals and will be available in real-time through telemetry on a dedicated webpage. Baseline data will be collected prior to the construction of Pond 1 walls.

The data collected will be used to annually undertake post-hoc modelling of tidal inundation and surface water flows to evaluate changes, including from the baseline where possible (i.e. where construction has not yet occurred).

Reporting of the data will be presented within the BCHMMP reports following each survey.

3.5.4. Management Actions

No trigger levels or threshold criteria will be required for inundation monitoring programs, as data will only be included into desktop exceedance investigations of trigger criteria exceedances to ascertain if there was any influence from these factors on the exceedance (i.e., multiple lines of evidence). However, if significant changes are observed in post-hoc modelling from that which was predicted, triggers may need to be derived based on potential or predicted impacts to BCH. Appropriate levels of change to utilise for such a trigger is not able to be evaluated quantitatively at present.

Where tidal or surface water hydrological regimes may have impacted a trigger criteria exceedance but is not related to Optimised Proposal activities (i.e., rainfall and sea level rise), then no further action may be required (i.e., reactive monitoring).

Alternatively, tidal or surface water hydrological regimes may result in impacts to BCH, reactive post-hoc modelling and/or engineering modification to provide optimal tidal or surface water flows across the intertidal zone may be required (i.e., diversion or drainage modifications, pumping water etc.) to protect BCH from Optimised Proposal activities.

3.6. Outcomes-based management actions summary

Table 23 presents a summary of the triggers, thresholds and associated response and other actions to be undertaken if there is an exceedance. If a trigger is exceeded, further modelling will be conducted to understand the most suitable management action. This modelling may include the following:

- Surface water modelling:
 - Undertake surface water modelling to determine alternative diversions, trenching or drainage alternatives to reinstate natural conditions to prevent further decline of BCH, and to facilitate recovery of ecosystem
- Tidal inundation
 - Undertake tidal inundation modelling water modelling to determine alternative diversion, trenching or drainage to reinstate natural conditions to prevent further decline of BCH, and to facilitate recovery of ecosystem
- Groundwater
 - Undertake ground water modelling to run scenarios for reducing groundwater mounding or salinity levels, including but not limited to:
 - Installation of recovery bores to pump water away from impacted areas and reduce water or salinity levels
 - Trenching to capture mounding and either allow evaporation to lower the water levels or pump to equivalent salinity pond
 - Installation of additional groundwater sampling bores if required to better understand the impacts and management
 - Implement the most suitable corrective actions as determined by the modelled scenarios.

Dependent on the results of the modelling, ecosystem restoration may also be considered to rehabilitate the sites.

Table 23: Outcomes-based management actions summary

EPA factors and objectives - BCH: “to protect benthic communities and habitats so that biological diversity and ecological integrity are maintained”				
Outcomes:				
<ul style="list-style-type: none"> • MS 1175: 2-1 (1) no development that would have an adverse impact on the ecological function of the RRDMMMA or the maintenance of ecological processes which sustain mangrove habitats within the RRDMMMA. • MS 1175: 3-1 (4) no changes to the health, extent or diversity of more than five (5) hectares (ha) of intertidal benthic communities and habitat, including mangrove, samphire and algal mat as a result of changes to groundwater regimes or groundwater quality associated with the Proposal • Aspects of the proposal, including bitterns discharge, are managed to meet the levels of protection in established ecological protection as defined by Condition 4-2 of MS 1175 • Implementation of the Proposal ensures no direct or indirect impacts, or attributable loss greater than limits set by Condition 6-1 of MS 1175 				
Key environmental values: Intertidal BCH including mangrove communities, algal mat habitat and samphire, and subtidal BCH including seagrass and macroalgae.				
Key impacts and risks (related to this BCHMMP):				
<ul style="list-style-type: none"> • Clearing of up to 8,282 ha of intertidal BCH, including up to 4 ha of mangrove habitat within the RRDMMMA, 13 ha of mangrove habitat outside the RRDMMMA and 880 ha of algal mat habitat and 296 ha of coastal samphire • Indirect impact associated with changes to salinity and hydrological regimes due to design of pond wall and causeway and /or saline spillage of seepage 				
Trigger Criteria	Response actions	Monitoring	Timing/frequency of actions	Reporting
<ul style="list-style-type: none"> • Trigger Thresholds 	<ul style="list-style-type: none"> • Trigger level actions • Threshold contingency actions 			
<p>Algal Mats</p> <p>Trigger criteria</p> <p>Retain a minimum of 80% baseline algal mat percent cover calculated over three quadrats of the same site over time and is not significantly different (p<0.05) to the changes in reference site data.</p> <p>Threshold</p> <p>Retain a minimum of 50% baseline algal mat percent cover calculated over three quadrats of the same site over time and is not significantly different (p<0.05) to the changes in reference site data</p>	<p>Trigger level actions</p> <p>Investigate the cause of impact, to be undertaken within one month of the detection of the exceedance. This includes referring to surface water and tide data, weather conditions and groundwater monitoring data.</p> <p>Implement modelling and recommended actions from the modelling results.</p> <p>Threshold contingency actions</p> <p>Undertaken further modelling as required and implement recommended actions based on the modelling. Prepare a remediation plan as described in Section 4.5 and investigate requirements set out in the long-term migratory Shorebird survey program and the Turtle monitoring program.</p>	<p>Groundwater, surface water and tide monitoring will continue to aid the investigation, and algal mat reactive monitoring will be undertaken at the sites of the exceedance to investigate further</p>	<p>Investigate within one month of the detection of the exceedance</p> <p>Reactive monitoring to be undertaken at the next practical opportunity, taking into account tidal and inundation conditions</p>	<p>Refer to Section 4.4 for exceedance regulatory reporting</p>

EPA factors and objectives - BCH: “to protect benthic communities and habitats so that biological diversity and ecological integrity are maintained”

Outcomes:

- MS 1175: 2-1 (1) no development that would have an adverse impact on the ecological function of the RRDMMMA or the maintenance of ecological processes which sustain mangrove habitats within the RRDMMMA.
- MS 1175: 3-1 (4) no changes to the health, extent or diversity of more than five (5) hectares (ha) of intertidal benthic communities and habitat, including mangrove, samphire and algal mat as a result of changes to groundwater regimes or groundwater quality associated with the Proposal
- Aspects of the proposal, including bitterns discharge, are managed to meet the levels of protection in established ecological protection as defined by Condition 4-2 of MS 1175
- Implementation of the Proposal ensures no direct or indirect impacts, or attributable loss greater than limits set by Condition 6-1 of MS 1175

Key environmental values: Intertidal BCH including mangrove communities, algal mat habitat and samphire, and subtidal BCH including seagrass and macroalgae.

Key impacts and risks (related to this BCHMMP):

- Clearing of up to 8,282 ha of intertidal BCH, including up to 4 ha of mangrove habitat within the RRDMMMA, 13 ha of mangrove habitat outside the RRDMMMA and 880 ha of algal mat habitat and 296 ha of coastal samphire
- Indirect impact associated with changes to salinity and hydrological regimes due to design of pond wall and causeway and /or saline spillage of seepage

Trigger Criteria	Response actions	Monitoring	Timing/frequency of actions	Reporting
<ul style="list-style-type: none"> Trigger Thresholds 	<ul style="list-style-type: none"> Trigger level actions Threshold contingency actions 			
<p>Mangroves</p> <p>Trigger criteria</p> <p>A minimum of 80% baseline canopy cover retained as calculated over three plots within the same site and any loss is not significantly different ($p < 0.05$) to the reference site data OR</p> <p>No significant increase in the average number of dead adult mangroves from the baseline as calculated over three plots within the same site and any loss is not significantly different ($p < 0.05$) to the reference site data OR</p> <p>No significant decrease in the average number of seedlings/saplings counted from the baseline as calculated over three plots within the same site and any decrease is not significantly different ($p < 0.05$) to the reference site data</p> <p>Threshold</p> <p>A minimum of 50% baseline canopy cover retained as calculated over three plots within the same site and any loss is not significantly different ($p < 0.05$) to the reference site data AND</p> <p>No significant increase in the average number of dead adult mangroves from the baseline as calculated over three plots within the same site and any loss is not significantly different ($p < 0.05$) to the reference site data AND</p> <p>No significant decrease in the average number of seedlings/saplings counted from the baseline as calculated over three plots within the same site and any decrease is not significantly different ($p < 0.05$) to the reference site data</p>	<p>Trigger level actions</p> <p>Investigate the cause of impact, to be undertaken within one month of the detection of the exceedance. This includes referring to surface water and tide data, weather conditions and groundwater monitoring data.</p> <p>Implement modelling and recommended actions from the modelling results.</p> <p>Threshold contingency actions</p> <p>Undertaken further modelling as required and implement recommended actions based on the modelling. Prepare a remediation plan as described in Section 4.5 and investigate requirements set out in the long-term migratory Shorebird survey program and the Turtle monitoring program.</p>	<p>Groundwater, surface water and tide monitoring will continue to aid the investigation, and reactive monitoring will be undertaken at the sites of the exceedance to investigate further</p>	<p>Investigate within one month of the detection of the exceedance</p> <p>Reactive monitoring to be undertaken at the next practical opportunity, taking into account tidal conditions</p>	<p>Refer to Section 4.4 for exceedance regulatory reporting</p>

EPA factors and objectives - BCH: “to protect benthic communities and habitats so that biological diversity and ecological integrity are maintained”

Outcomes:

- MS 1175: 2-1 (1) no development that would have an adverse impact on the ecological function of the RRDMMMA or the maintenance of ecological processes which sustain mangrove habitats within the RRDMMMA.
- MS 1175: 3-1 (4) no changes to the health, extent or diversity of more than five (5) hectares (ha) of intertidal benthic communities and habitat, including mangrove, samphire and algal mat as a result of changes to groundwater regimes or groundwater quality associated with the Proposal
- Aspects of the proposal, including bitterns discharge, are managed to meet the levels of protection in established ecological protection as defined by Condition 4-2 of MS 1175
- Implementation of the Proposal ensures no direct or indirect impacts, or attributable loss greater than limits set by Condition 6-1 of MS 1175

Key environmental values: Intertidal BCH including mangrove communities, algal mat habitat and samphire, and subtidal BCH including seagrass and macroalgae.

Key impacts and risks (related to this BCHMMP):

- Clearing of up to 8,282 ha of intertidal BCH, including up to 4 ha of mangrove habitat within the RRDMMMA, 13 ha of mangrove habitat outside the RRDMMMA and 880 ha of algal mat habitat and 296 ha of coastal samphire
- Indirect impact associated with changes to salinity and hydrological regimes due to design of pond wall and causeway and /or saline spillage of seepage

	Response actions	Monitoring	Timing/frequency of actions	Reporting
<ul style="list-style-type: none"> • Trigger Criteria • Trigger Thresholds 	<ul style="list-style-type: none"> • Trigger level actions • Threshold contingency actions 			
<p>Samphire</p> <p>Trigger criteria</p> <p>Retain a minimum of 80% baseline samphire percent cover calculated over three quadrats of the same site over time and is not significantly different ($p < 0.05$) to the changes in reference site data OR</p> <p>No significant increase in the average plant health scores (i.e. decline in overall health) over three plots at the same site and is not significantly different ($p < 0.05$) to the changes in reference site data</p> <p>Threshold</p> <p>Retain a minimum of 50% baseline samphire percent cover calculated over three quadrats of the same site over time and is not significantly different ($p < 0.05$) to the changes in reference site data AND</p> <p>No significant increase in the average plant health scores (i.e. decline in overall health) over three plots at the same site and is not significantly different ($p < 0.05$) to the changes in reference site data</p>	<p>Trigger level actions</p> <p>Investigate the cause of impact, to be undertaken within one month of the detection of the exceedance. This includes referring to surface water and tide data, weather conditions and groundwater monitoring data.</p> <p>Implement modelling and recommended actions from the modelling results.</p> <p>Threshold contingency actions</p> <p>Undertaken further modelling as required and implement recommended actions based on the modelling. Prepare a remediation plan as described in Section 4.5 and investigate requirements set out in the long-term migratory Shorebird survey program and the Turtle monitoring program.</p>	<p>Groundwater, surface water and tide monitoring will continue to aid the investigation, and reactive monitoring will be undertaken at the sites of the exceedance to investigate further</p>	<p>Investigate within one month of the detection of the exceedance</p> <p>Reactive monitoring to be undertaken at the next practical opportunity, taking into account tidal and inundation conditions</p>	<p>Refer to Section 4.4 for exceedance regulatory reporting</p>
<p>Subtidal monitoring</p> <p>Trigger criteria</p> <p>Retain a minimum of 80% baseline subtidal BCH percent cover calculated over three quadrats of the same site over time and is not significantly different ($p < 0.05$) to the changes in reference site data</p> <p>Threshold</p> <p>Retain a minimum of 50% baseline subtidal BCH percent cover calculated over three quadrats of the same site over time and is not significantly different ($p < 0.05$) to the changes in reference site data</p>	<p>Trigger level actions</p> <p>Investigate the cause of impact, to be undertaken within one month of the detection of the exceedance. This includes referring to surface water and tide data, weather conditions and groundwater monitoring data.</p> <p>Implement modelling and recommended actions from the modelling results.</p> <p>Threshold contingency actions</p> <p>Undertaken further modelling as required and implement recommended actions based on the modelling. Prepare a remediation plan as described in Section 4.5 and investigate requirements set out in the long-term migratory Shorebird survey program and the Turtle monitoring program.</p>	<p>Groundwater, surface water and tide monitoring will continue to aid the investigation, and reactive monitoring will be undertaken at the sites of the exceedance to investigate further</p>	<p>Investigate within one month of the detection of the exceedance</p> <p>Reactive monitoring to be undertaken at the next practical opportunity, taking into account tidal conditions</p>	<p>Refer to Section 4.4 for exceedance regulatory reporting</p>

3.7. Pilot Study Program

Several projects in recent times have used remotely-sensed multispectral data to monitor mangrove health within the northern region of Australia. This includes the long-term mangrove monitoring program for Darwin Harbour (DEPWS 2022), a similar environment with dense mangrove habitats. However, this method of health monitoring has not been adopted as frequently for samphire and algal mats and this pilot study aims to develop a monitoring method for all three intertidal BCH for this Proposal for long-term monitoring. This pilot study will be undertaken concurrently with the routine intertidal BCH health monitoring over the first five years of the Proposal. The objectives of the pilot study are:

- Collect sufficient data over the initial five year period to compare with on-ground data capture
- Determine the sensitivity and resolution of multispectral imagery to detect changes in intertidal BCH health
- Assess potential inefficiencies and uncertainties of multispectral imagery to detect changes in intertidal BCH health and present techniques to eliminate or reduce them
- Determine the suitability of multispectral imagery to replace conventional on-ground methods for early warning indicator of intertidal BCH health decline
- Present the statistical summary used to determine:
 - The suitability of multispectral imagery analysis
 - The revised early warning triggers for routine health monitoring
 - Ongoing assessment against the trigger criteria.

A report will be prepared at the end of the five-year data collection period, which will present this information to inform the review process of the BCHMMP.

The imagery will be taken along the transects, with a field of view of approximately 100 m. Imagery along replicate transects will also be collected on either side of the primary transect, giving 3 replicate transects at each location.

4. Reporting

4.1. Preliminary Report

Reporting for each of the monitoring survey will occur as soon as practicable after each survey. A report will be prepared following the first survey outlining the following:

- Finalised monitoring locations
- Finalised methods of surveying
- Any additional sampling or observations
- Presentation of data from the first surveys of all monitoring sites.

4.2. Routine Report

For the first 5 years, routine monitoring reports will then be quarterly, following each quarterly survey and present the results compared to previous and reference sites. These reports will be based on providing a brief overview of results in a technical note to inform management requirements.

Reporting frequency will be reviewed during the monitoring plan review at the end of the 5 years.

The data collected during reactive surveys will also have dedicated reports in addition to the routine reporting with similar objectives.

In the event of an exceedance or triggers or thresholds, more comprehensive analysis would be undertaken as an investigation into the exceedance (see Section 3.6).

4.3. Annual Report

The data collected from monitoring programs will be compiled into a more comprehensive and interpretive annual report to provide an overview perspective of the data collected. This may be included as a single report for all monitoring program or separate reports for each program, whilst considering the results from the other programs for determination on the influences of the Optimised Project activities on BCH.

Annual monitoring reports will be provided to DWER on an annual basis. These monitoring reports will include an assessment of cumulative spatial impacts to determine compliance against conditions 3-1(4), 6-1, 6-2(2) and 14-1(1).

4.4. Exceedance Regulatory Reporting

In accordance with Condition 6-8 of MS 1175 and EPBC 2018/8236, if monitoring or investigations at any time indicate an exceedance of management targets or threshold criteria specified in the BCHMMP, Mardie Minerals will report any exceedance to the CEO and DCCEEW (in writing) within 7 days of the exceedance being identified along with a Management Action Plan attached to the exceedance report. Implement the threshold contingency actions required by the BCHMMP and as outlined within the EPA approved Management Action Plan. Mardie Minerals will continue to implement those actions until the CEO (and DCCEEW) has confirmed by notice in writing that it has been demonstrated that the threshold criteria are being met and implementation of the threshold contingency actions are no longer required

and that Mardie Minerals has demonstrated that the environmental outcomes detailed in conditions 2-1(1) and 6-1 and the objectives in condition 6-2 have been met.

Mardie Minerals will further investigate to determine the cause of the exceedance, to determine any potential environmental harm or alteration of the environment. Within 21 days of the exceedance being reports, Mardie Minerals will provide a report to the CEO (and DCCEEW), detailing the following:

- Implemented threshold contingency actions
- Their effectiveness against management targets and threshold criteria
- Investigation findings
- Measures to prevent the threshold criteria being exceeded in the future
- Justification (where relevant) of the threshold criteria remaining or being adjusted based on better understanding.

These actions will be conducted in accordance with criteria set by MS 1175.

4.5. Remediation Plan

In accordance with Condition 23(f) of EPBC 2018/8236, exceedance of threshold criteria specified in the BCHMMP will also trigger the development of a Remediation Plan to be reviewed alongside the BCHMMP by a suitably qualified intertidal and subtidal benthic ecologist within 6 months of the exceedance being reported. If the independent review recommends that the BCHMMP be revised, Mardie Minerals will submit a revised BCHMMP to DCCEEW for the approval of the Minister within 8 months of any such exceedance, and an offset strategy to manage impacts where required.

5. Adaptive management and review

5.1. Adaptive management

Mardie Minerals is committed to improving environmental results and management practices throughout the implementation of the Proposal and therefore will use an adaptive management approach for this BCHMMP. Adaptive management practices will include:

- Quarterly review and comparison of monitoring data and information gathered against established baseline, ongoing monitoring and reference data
- Annual evaluation of monitoring and management outcomes against management targets and the objectives of this BCHMMP
- Review of management actions throughout the implementation of the Proposal, and identification of potential new management measures and technologies that may be more effective
- Following selection and confirmation of offset research programs, review of objectives, targets and completion criteria detailed in the Proposal's Offsets Strategy document every five years.

5.2. Review requirements

The BCHMMP will be reviewed annually through the construction phase and every two years during operation. It will also be updated based on review outcomes. The review will take into account whether best practice and management targets are being achieved or are likely to be achieved and will identify any updates required to realise the targets.

Five years after the commencement of operations, the BCH health pilot study (using remote sensing multispectral imagery) will be due for completion. Data and outcomes of the on-ground monitoring methods and the pilot study will be reviewed, and a revised BCHMMP based on this information will be submitted to the DCCEE following the completion of the pilot study. Following this, the BCHMMP will continue to be reviewed every two years as described above.

5.3. Approval requirements for revised BCHMMP

This BCHMPP has been developed to meet the Ministerial Conditions for the Proposal specified in MS 1175. Approval will be sought from the Department of Water and Environmental Regulation (DWER) for any revisions for the BCHMMP due to information gained through adaptive management in accordance with Condition 3-8 and 3-9 of MS1175.

6. Stakeholder consultation

The Proposal ERD and Optimised Proposal Supplementary Report (including a previous version of this BCHMMP) were released for public comment and this BCHMMP has been reviewed considering the comments received from the public, DWER, DPIRD and DCCEEW. Mardie Minerals has also consulted with the following stakeholders specifically regarding the content of this BCHMMP:

- EPA Services at DWER
- DCCEEW
- Phoenix Environmental Services
- O2 Marine
- Actis Environmental Services (Bindy Datsun)
- Edith Cowan University (Dr Kathryn McMahon)
- Preston Consulting.

Ongoing consultation with EPA Services, DCCEEW, DPIRD, WAMSI, WAFIC and other interested fishing groups will be undertaken throughout the implementation of this BCHMMP.

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