Johns Creek Maintenance – Dredging Environmental Impact Assessment

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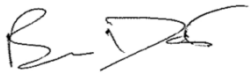

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Acronyms

AH	Aboriginal Heritage
AHIS	Aboriginal Heritage Inquiry System
ANZECC/ARMCANZ	Australian and New Zealand Environment and Conservation Council & the Agriculture and Resource Management Council of Australia and New Zealand
ASS	acid sulfate soils
BCH	benthic communities and habitat
BPPH	benthic primary producer habitat
BoM	Bureau of Meteorology
CA	Commonwealth of Australia
CS Act	Western Australian Contaminated Sites Act 2003
DAA	Western Australian Department of Aboriginal Affairs
DEIA	Dredging Environmental Impact Assessment
DEMP	Dredging Environmental Management Plan
DotEE	Australian Department of the Environment (Department of Energy and the Environment)
DoT	Western Australian Department of Transport
DPaW	Western Australian Department of Parks and Wildlife
DSEWPaC	Australian Department for Sustainability, Environment, Water, People and Communities (now DotEE)
DWER	Department of Water and Environmental Regulation
EAG	Environmental Assessment Guideline
EIA	Environmental Impact Assessment
EMF	Environmental Management Framework
EP Act	Environmental Protection Act 1986
EPA	Environmental Protection Authority
EPASU	Environmental Protection Authority Services Unit
EPBC	Environmental Protection and Biodiversity Conservation
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
FRP	filterable reactive phosphorous
ISQGs	interim Sediment Quality Guidelines
LAT	lowest astronomical tide
LoR	limit of reporting
m	metre
m3	cubic metre
MNES	Matters of National Environmental Significance
NAC	Ngarluma Aboriginal Corporation
NAGD	National Assessment Guidelines for Dredging
PASS	potential acid sulfate soils
PCOC	potential contaminants of concern
PSD	particle size distribution
SAP	Sampling and Analysis Plan
TBT	tributyltin

TOC	total organic carbon
WA	Western Australia

Executive Summary

Johns Creek Boat Harbour (the Boat Harbour) is a small facility located at Point Samson, ~40 km east of Karratha. Dredging of the Boat Harbour and Entrance Channel is required to restore navigable depths, and is planned for autumn 2018. The Boat Harbour was previously dredged in 2000. Dredging is proposed to occur within the Boat Harbour and Entrance Channel, with disposal to a sandbank ~1 km south of the Boat Harbour (Western Disposal area). The Proponent for the proposed dredging and disposal (the 'Proposal') is the Department of Transport (DoT).

A dredging environmental impact assessment (DEIA) has been completed for the Proposal (this document). The DEIA evaluates potential impacts of dredging on environmental receptors with reference to the specific dredging and disposal methods, as well as relevant environmental legislation and guidelines. The following environmental and socio-economic issues that may arise from the proposed dredging have been assessed:

- release of contaminants and nutrients
- hydrocarbon spills and waste
- vegetation disturbance
- heritage
- public safety and visual amenity
- navigational hazards
- threatened and migratory species
- sediment infauna
- noise
- introduced marine species
- acid sulfate soils (ASS)
- increase in water column turbidity and smothering
- hypoxia
- wind-blown dust and sand
- odour.

To support the DEIA, sediments were sampled within the proposed maintenance dredging and disposal areas, and at onshore reference sites. In accordance with the DoT's state-wide maintenance dredging – Environmental Management Framework, and as documented in the corresponding Sediment Sampling and Analysis Plan (SAP), the sediment was analysed for:

- particle size distribution and settling rates
- total organic carbon
- hydrocarbons (including polycyclic aromatic hydrocarbons, total recoverable hydrocarbons, benzene, toluene, ethylbenzene and xylene)
- organotins
- total and elutriate nutrients
- total bioavailable, and elutriate metals
- acid sulfate soils

It is anticipated this DEIA will support a referral to the Environmental Protection Authority (EPA) for a decision on whether the Project requires assessment under Part IV of the *Environmental Protection Act 1986*. Environmental Factors that may be potentially impacted requiring active monitoring and/or management are:

- Marine and terrestrial environmental quality
  - release of contaminants and nutrients (dredging and disposal)
  - hydrocarbon spills and waste
- Benthic communities and habitat (including mangroves)
- Heritage
- Amenity
  - impacts on public safety
  - navigational hazards

To support the DEIA, two additional technical studies were undertaken, an assessment of the material to be dredged, and mapping of mangrove communities within Johns and Popes Nose Creek (provided as appendices to this DEIA).

Marine and terrestrial environmental quality

The suitability of sediments to be dredged in the Boat Harbour and Entrance Channel were assessed for disposal to the Western Disposal area. The Boat Harbour and Entrance Channel potential contaminants of concern (PCOC) varied in the assessment of suitability for disposal to the Western Disposal Area. Acid sulfate soils were not present and hydrocarbons were not detected in any samples. However, the total chromium, nickel, copper, zinc and tributyltin concentrations within the Boat Harbour sediments exceeded the relevant marine sediment guidelines. Bioavailable testing indicated that the metals within sediments are not biologically available but elutriate results indicated potential release of copper into the water column during dredging and disposal. Further investigation showed that initial dilution could be managed to ensure copper released into the water during dredging and disposal remained below the relevant species protection level over the first four hours following disposal.

Elutriate nutrients also exceeded guideline levels across all Boat Harbour and Entrance Channel sites. However, further analyses of predicted dilution within 4 hours of disturbance and disposal indicated sufficient dilution of released metals and nutrients to meet relevant environmental guidelines. As a precaution, water quality monitoring of the dredge plume and return water is proposed during dredging and disposal. Risks to marine and terrestrial environmental quality from hydrocarbon spills and waste disposal will require active management during dredging and disposal activities.

Benthic communities and habitat

Impacts to benthic primary producer habitat (BPPH, including mangrove communities) were determined to be minor. Within the dredge area, a small invertebrate community was found between the entrance groynes at the Boat Harbour. Isolated mangrove trees are present at the proposed Western Disposal area. Disposal of sediments will be managed to avoid both direct and indirect impacts to mangal habitat.

Heritage

The Johns Creek dredging area occurs within a registered Aboriginal site. However it is not anticipated that any impacts to Aboriginal heritage will occur as a result of dredging and disposal operations given the dredging area has been previously dredged and is unlikely to contain historical artefacts. The Ngarluma Aboriginal Corporation (NAC) is the legal body for the Ngarluma people regarding development and heritage issues, and will be informed prior to any ground disturbing works.

Amenity, public safety and navigable hazards

The waters of Point Samson are widely utilised for recreational boating, fishing, swimming and other recreational pursuits. The operation of heavy machinery within the Boat Harbour area and Entrance Channel during dredging will temporarily impact visual amenity and pose a short-term risk to public safety when accessing the Boat Harbour and groynes (used for recreational fishing). Public safety and visual amenity will therefore require active management during the works.

A temporary notice to mariners will be issued to warn the public of navigational hazards associated with the dredging. Additionally, marine safety will be monitored and managed throughout the dredging operation.

Other environmental issues

The following potential environmental impacts from the Proposal were also assessed and are not considered likely to be key issues during maintenance dredging and disposal, provided that standard environmental management measures are adopted:

Marine fauna

- impact on threatened and migratory species
- noise
- introduced marine species
- sediment infauna

Marine environmental quality

- acid sulphate soils
- increase in water column turbidity and smothering
- hypoxia

Amenity

- increase in water column turbidity
- noise
- wind-blown dust and sand
- odour

To manage the above issues, in conjunction with the DoT, the dredging contractor will implement environmental monitoring (Table ES.1) and management measures during the dredging campaigns. Stakeholders will be consulted prior to the commencement of dredging and throughout the campaign, as necessary. If any environmental issues arise, contingency plans (with specific indicators, action criteria and management responses) will be implemented. The required consultation, monitoring, management and contingency measures will be outlined in a Dredging Environmental Management Plan (DEMP).

Table ES.1 Proposed environmental monitoring for the Johns Creek Boat Harbour dredging campaign

Monitoring		Frequency	Responsibility
Turbidity Monitoring	Site Photographs	Daily	Principal
	Plume sketches	Daily	Contractor
Water Quality monitoring	Water sampling	Fortnightly Once while Boat Harbour "hot spot" is being dredged	Principal
	Observations of excessive algal growth or poor water quality	At least daily	Contractor
Mangrove Habitat Monitoring	Site photographs, evidence of any erosion or damage to mangroves	At least daily	Contractor

1. Introduction

1.1 Background

Johns Creek Boat Harbour is a small facility comprising a boat harbour basin (hereafter; the Boat Harbour) and Entrance Channel, located south of the Point Samson town site and ~40 km north-east of Karratha, in the Pilbara region, Western Australia (WA) (Figure 1.1). The Boat Harbour is located within a mangrove tidal creek and has historically experienced siltation issues (JFA & Oceanica 2005). Recent complaints from users have highlighted varying areas of sediment accretion and the Department of Transport (DoT) is therefore proposing to complete maintenance dredging of the Boat Harbour, including disposal of sediments, in autumn 2018 (the 'Proposal').

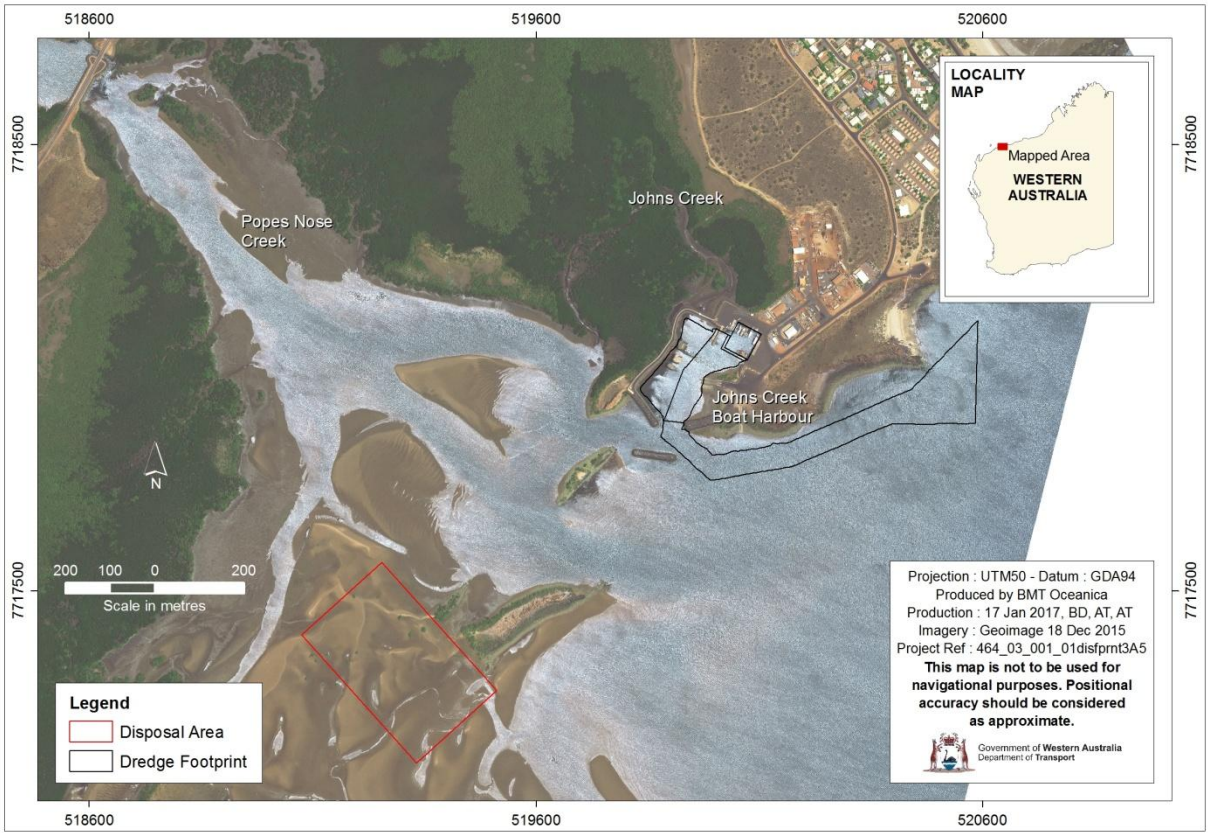


Figure 1.1 Location of Johns Creek Boat Harbour dredge and disposal areas

1.2 Purpose of this document

This document presents a Dredging Environmental Impact Assessment (DEIA) that assesses and evaluates the potential social and environmental risks posed by the maintenance dredging of the Boat Harbour and Entrance Channel. The potential effects of the dredging and disposal on relevant environmental receptors have been assessed, based on the specific nature of the works and results of sampling and analysis of the material to be dredged. This DEIA also summarises the environmental monitoring and management measures that will be implemented to control the impact of the dredging, with more details to be provided in a corresponding Dredging Environmental Management Plan (DEMP) that will be prepared and finalised prior to the commencement of dredging.

2. Proposed Dredging and Disposal

2.1 Dredging

The proposed maintenance dredging in autumn 2018 will restore the original design depths in most areas of the Boat Harbour and Entrance Channel down to -2.1 m LAT and 0.0 m LAT, respectively (refer to Drawing JFA 1530-06-01 Appendix A). To achieve this, up to 47 000 m^3 of material will be removed from the Boat Harbour and the Entrance Channel using a small cutter-suction dredge. The duration of the maintenance dredging campaign will depend on the final dredging design and specific dredging plant selected, however; the works are expected to occur over a period of ~2–3 months.

2.2 Disposal

Material from the Entrance Channel and the Boat Harbour will be pumped via pipeline to a sandbar south-west of the Boat Harbour (hereafter; the Western Disposal area). The proposed disposal site is within the subtidal zone but above the low-water mark and therefore not considered to be sea dumping. The Western Disposal area has been chosen as it is the only area within pumping distance of the Boat Harbour and Entrance Channel to have a large, bare subtidal sandy substrate.

Disposal area calculations have determined that the disposed sediment would theoretically create a total elevation gain of 50 cm following disposal of all dredge material. However, daily tidal movements, the duration of disposal (~3 months), dynamic nature of near shore sediments in the Point Samson region (Eliot et al. 2013) and ephemeral nature of prevalent sandbars at the entrance to tidal creeks (Eliot et al. 2013), the disposed sediments will be continuously reworked by natural forces and dispersed such that the theoretical maximum elevation gain is unlikely to be recorded. Given the dynamic nature of the Western Disposal area, accurate modelling of sediment movement is difficult and not justified by the negligible risk posed. It is unlikely that movement of material outside of the Western Disposal area will result in significant impacts to the environment, as the sandbars in the area have been demonstrated to move in response to differing tidal and current regimes (Eliot et al. 2013).

2.3 Previous works

The construction of the Boat Harbour commenced in 1982. Construction of the pens, service jetty, a 40 tonne slipway and services was completed in 1984. The Boat Harbour was then redeveloped in October 1999 and after a nine month construction period was officially opened on 15 July 2000 (JFA & Oceanica 2005). The redevelopment involved the deepening of the basin to a depth of -2.1 m lowest astronomical tide (LAT) and was completed using excavators working from temporary bunds (JFA & Oceanica 2005). Excavated material was loaded directly into trucks and was either used as fill for the land-backed wharf construction or carted to the Shire of Roebourne (now City of Karratha) quarry site.

2.4 Alternatives to dredging and disposal

DoT has considered numerous options for disposal of dredged material in planning for the proposed Johns Creek maintenance dredging campaign to maintain safety at the Facility. The Western Disposal area is the preferred option for disposal of dredged material (Section 2.2) given the confidence provided through worst case dilution modelling (Appendix G) and the limitations associated with other disposal options investigated (Sections 2.4.2 to 2.4.6).

2.4.1 Not dredging

Not dredging was considered as an option to avoid potential environmental impacts of the proposed dredging and disposal. Currently, sedimentation in the Boat Harbour and Entrance Channel reduces safe navigational access to the Facility, and there have been reports of vessels touching bottom on Entrance Channel high spots. Therefore, not dredging is not considered a viable alternative to maintain navigational safety.

2.4.2 Disposal to mangrove area within harbour boundary

Boat Harbour sediments were proposed to be disposed of to a bunded area within the mangrove flats adjacent to Johns Creek Boat Harbour. However, an earlier environmental impact assessment determined there would be significant impacts to mangrove communities from clearing, and potential significant impacts to a registered Aboriginal Heritage site. These mean that this disposal optional was less environmentally and socially viable than the current proposed disposal area.

2.4.3 Channel re-alignment

Survey data indicated potential re-alignment of the Entrance Channel as an alternative to dredging. However, stakeholder consultation completed by the DoT in April 2017 determined Facility users did not support this option given the highly dynamic siltation rates around the area earmarked for the channel re-alignment. Feedback from facility users advised the areas of accretion in the existing Entrance Channel vary spatially and temporally over small scales, and, re-aligning the Entrance Channel will not remediate the areas of accretion as effectively as restoring navigational depths (P. Wilkins 2017, DoT, pers. comm.). As such, safe navigability was not guaranteed by the re-alignment option. Considering the stakeholder comments, associated costs for channel re-alignment and the ongoing issue that the Boat Harbour would require dredging in the near-future, this was not considered a viable alternative.

2.4.4 Disposal of dredged material to landfill

Disposal of dredged material to landfill was considered in the early stages of Project planning and deemed unviable due to logistical constraints with landfill acceptance and transportation. Disposal of sediments to landfill is not considered viable in accordance with principles of the *Waste Avoidance Recovery Act 2007*[1].

Boat Harbour sediment contaminants are classified according to Class IV thresholds for landfill waste as defined in DEC (2009) due to elevated nickel concentrations (Table 5.2). Regional landfills in Karratha and Exmouth currently only accept Class II and above. Red Hill Waste Management Facility located in Perth WA accepts Class IV waste, however; is currently at capacity and can only accept Class III waste. It is noted a new development for a Class IV and Class V landfill facility is proposed in Kalgoorlie, however; given the unknowns with planning and approval timeframes it is not considered a viable option. Additional options including recycling of the material were considered, however; the requirement to accept material at these facilities was Class III landfill waste thresholds (DEC 2009). Beneficial reuse of material was considered within the DoT harbour boundary, however; the sediments are required to be remediated with sand due to the high fines content to create land appropriate for building. This option required a large lay down area for remediation subsequently restricting access to the facility and would generate an elevation landscape profile of ~3 m of fill that was considered unviable for the facility usage.

A preliminary assessment was undertaken to determine the feasibility of transporting Boat Harbour sediments to the Red Hill Waste Management Facility in Perth WA. This option involved

[1] *The Waste Avoidance Recovery Act 2007 (WARR Act 2007) was introduced to minimise increasing waste avoidance and resource recovery in Western Australia through ambiguous targets for resource recovery and landfill levies.*

sourcing clean sand from external sand pits (subject to further testing requirements) to dilute sediments to meet Class III thresholds (DEC 2009). Due to the sediment volumes and required transport distance[2], this option was considered un-viable.

2.4.5 Beneficial re-use in local industry or development

Beneficial re-use of disposal sediments by local industry or development were also considered. Physical characterisation of the dredge spoil showed that sediment particle distribution size (PSD) varied among sampling sites and areas (Appendix F). Sediments within the Boat Harbour basin were representative of fine sands with a greater portion of silts and clays, while sediments within berth pockets located adjacent to the marine/terrestrial interface were dominated by clays and silts with low sand content (Appendix F). Entrance Channel sediments predominantly consist of fine to medium sized clean marine sands (Appendix F). The fines content of the material from within the Boat Harbour basin requires remediation to be considered appropriate fill for future harbour land developments. Consultation by DoT with local industry and the Johns Creek harbour master did not result in any options for beneficial re-use, or sufficient area for stockpiling within the existing development envelope.

2.4.6 Other disposal options

Disposal of sediments to unallocated Crown land and sea dumping were also considered. The approvals pathway for disposal to unallocated Crown land is extensive, and is likely to be time and cost prohibitive. Sediments to be dredged have been assessed as appropriate for ocean disposal according to CA (2009). However, a suitable sea dumping location could not be found within pumping distance from the dredge site; therefore this option was considered cost-prohibitive.

[2] *Sediments would require dilution within geotube bags at a 1:1 ratio to be transported via 26 truck loads to Perth WA with an estimated journey time of 16 hours and cost of ~$250 000.*

3. Relevant Legislation and Guidelines

The following legislation and guidelines were determined to be relevant and/or applicable to the Proposal:

- Department of Transport Maintenance Dredging – Environmental Management Framework (BMT Oceanica 2016a)
- *Environmental Protection Act 1986* (WA; EP Act)
- *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
- *Environment Protection (Sea Dumping) Act 1981* (Commonwealth)
- National Assessment Guidelines for Dredging (NAGD; CA 2009)
- *Contaminated Sites Act 2003* (WA)
- Contaminated Sites Guidelines (DER 2014)
- Acid Sulfate Soils Guidelines Series (DER 2015)
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000)
- *Aboriginal Heritage Act 1972* (WA)

Further information on each of these guidelines and legislation is contained in the sections below.

3.1 Department of Transport Maintenance Dredging – Environmental Management Framework

The DoT has a Maintenance Dredging Environmental Management Framework (EMF; BMT Oceanica 2016a) that provides guidance for the environmental management of their state-wide maintenance dredging operations. The EMF includes guidelines on sediment sampling and analysis with reference to relevant environmental guidelines. The intention of the EMF is to ensure that DoT's maintenance dredging activities fulfil the following objectives:

- protection of the environment
- clear, relevant and practical identification of environmental issues
- efficient management and completion of environmental assessments as required.

The EMF is updated annually, ensuring that best practice environmental management is applied to maintenance dredging. This DEIA has been designed and implemented in accordance with the latest revision of the EMF (BMT Oceanica 2016a) to ensure that the above objectives are achieved.

3.2 Environmental Protection Act 1986

The *Environmental Protection Act 1986* (WA) (EP Act) is the key legislation governing the requirement for environmental protection and management in WA including the assessment of the environmental impacts of any proposed works including maintenance dredging. The EP Act (mainly Part IV) defines the requirement for environmental impact assessment of proposed developments in WA. The EP Act (mainly Part IV) together with the *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2016* (EPA 2016a) specify the objectives and requisite procedures for Environmental Impact Assessment (EIA) of proposed works that must be complied with by all stakeholders including the proponent, the Environmental Protection Authority (EPA) and any other relevant party. The *Environmental Impact Assessment (Part IV Divisions 1 and 2) Procedures Manual 2016* (EPA 2016b) provides an overview of the decision making process used by the Department of Water and Environmental Regulation (DWER) EPA Services Unit (EPASU).

The approach taken by the EPA during the EIA process has been documented by the EPASU in a number of Environmental Factor Guidance documents, formerly known as Environmental Assessment Guidelines (EAGs). Each Environmental Factor defined in the *Statement of Environmental Principles, Factors and Objectives* (EPA 2016c) has a corresponding guidance document. The factors identified as being relevant to this Project are outlined Section 5.

Under Section 38(1) of the EP Act (Part IV), where a proposed project development is likely to have a significant effect on the environment, the proponent must refer the proposal to the EPA for a decision on whether it requires formal environmental impact assessment, and if so, at what level of assessment. The DoT will refer maintenance dredging projects to the EPA if they are anticipated to potentially have a significant effect on the environment and no environmental approvals have previously been obtained. It may also be appropriate to refer a project if there is a high level of community/stakeholder concern. Further detail on the referral process is provided in Section 5.6.

3.3 Environment Protection and Biodiversity Conservation Act 1999

If the maintenance dredging project is likely to have a significant impact on matters of national environmental significance (MNES) it will require assessment by the Department of Energy and the Environment) DotEE (formerly the Department for Sustainability, Environment, Water, People and Communities (DSEWPaC) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Environmental matters of national significance are defined by the EPBC Act as:

- listed threatened species and ecological communities
- migratory species protected under international agreements
- Ramsar wetlands of international importance
- the Commonwealth marine environment
- the Great Barrier Reef Marine Park
- World Heritage properties
- National Heritage places
- nuclear actions.

It is not anticipated that the Johns Creek Boat Harbour dredging will have a significant impact on any MNES (see Section 5), therefore; referral under the EPBC Act is not anticipated.

3.4 Environment Protection (Sea Dumping) Act 1981

The *Environment Protection (Sea Dumping) Act 1981* applies to the disposal of controlled material in Australian Waters other than waters within the limits of the State or of the Northern Territory. A permit is required under the Act for disposal of controlled material in Australian Waters extending from the low water mark seawards to the limits of the Exclusive Economic Zone. The NAGD (CA 2009) defines waters within the limits of a State as those waters that lie within the constitutional limits of the State and include features such as bays, gulfs, estuaries, inlets, ports and harbours. Disposal of dredged material is proposed to occur at the Western Disposal area, above the low water mark on an intertidal sand bar and, as such, a sea dumping permit is not anticipated under the *Environmental Protection (Sea Dumping) Act 1981*.

3.5 National Assessment Guidelines for Dredging

The NAGD (CA 2009) provide a framework for the review and assessment of ocean disposal of dredged material in support of the EP (Sea Dumping) Act and the EPBC Act. Although ocean disposal is not proposed at Johns Creek, the guidelines provide a useful reference for the

assessment and management of dredged material and operations that are useful to inform this DEIA. The guidelines include information on:

- evaluating alternatives to ocean disposal
- assessing sediment quality
- assessing dredging and disposal sites
- assessing potential impacts on the marine environment and other users
- determining management and monitoring requirements.

3.6 Contaminated Sites Act 2003 (WA) and Contaminated Sites Guidelines

Disposal of dredged material to the Western Disposal area may impact marine quality environmental values through unconfined disposal of potentially contaminated material. In addition, the disposal of potentially contaminated dredged material may create a contaminated site. The identification, management and remediation of contaminated sites are covered by the WA *Contaminated Sites Act 2003* (CS Act). The Contaminated Sites Guidelines (DER 2014) provides guidance on the assessment and protection of environmental values and, management of contaminated sites under the CS Act.

The proposed disposal of material is primarily within the marine environment on an intertidal sand bar and material will be entrained within the receiving environment through the action of dynamic tidal, near shore wave and currents. It is not anticipated that the disposal of dredged material will create new land. As such, it is considered potential sediment contamination from disposal of dredged material is suitable for comparison against the DER (2014) marine interim sediment quality guidelines (ISQGs; Dr P Bourgault, pers. comm. 1 December 2016). These guidelines are essentially equivalent to:

- NAGD (CA 2009) Screening Levels
- ANZECC/ARMCANZ (2000) Interim Sediment Quality Guidelines (ISQG).

3.7 Acid Sulfate Soils Guidelines

The proposed maintenance dredging is occurring in a tidal creek environment and therefore there may be environmental risks associated with acid sulfate soils (ASS). The disturbance of ASS can increase pH levels and acidity, and cause mobilisation of metals into the water column. The Acid Sulfate Soils Guidelines Series (DER 2015) contains guidance on how to identify ASS risk areas and the subsequent assessment methods, including sampling and reporting for material intended for land reclamation purposes. These guidelines outline a risk assessment approach for ASS under the CS Act.

3.8 Australian and New Zealand Guidelines for Fresh and Marine Water Quality

Dredging has the potential to cause the release of contaminants into the water column and within return water from disposal of dredged material. The assessment of potential during dredging water quality impacts is by comparison of the potential contaminants of concern (PCOC; of elutriate sample concentrations of the proposed material prior to dredging and/or of the return water concentrations during dredging) to ANZECC/ARMCANZ (2000) trigger values for physical and chemical stressors and toxicants[3].

[3] *'Toxicants' is a term used for chemical contaminants that have the potential to exert toxic effects at concentrations that might be encountered in the environment' (ANZECC/ARMCANZ 2000).*

The trigger values are for ‘chemical contaminants that have the potential to exert toxic effects at concentrations that might be encountered in the environment’ (ANZECC/ARMCANZ 2000). Trigger values for toxicants are defined for different levels of protection that signify the percentage of species expected to be protected within the ecosystem. 'Slightly-moderately' disturbed ecosystems, which describe most remote boat ramps and harbours, are generally assigned a 95% species protection level. However, the 99% or 90% protection levels may also be applied for particular contaminants or in specific environments. Therefore the application of the guidelines should be assessed on a case-by-case basis. It is important to note that trigger values were derived by toxicity testing from long-term chronic exposure to PCOC.

For contaminant concentrations within sediments that exceeded relevant guideline levels, further elutriate tests were initiated to assess the impacts of potential contaminants released in the water column during dredging and disposal operations. These results were compared to the 99% species protection levels and trigger values for physical and chemical stressors and toxicants.

3.9 Aboriginal Heritage Act 1972

Dredging activities have the potential to disturb sites of Aboriginal Heritage significance. The WA Department for Aboriginal Affairs maintain a register of over 22 000 Aboriginal Heritage sites (which can include artefacts, engravings, paintings, mythological or ceremonial places) in WA which have been defined under the *Aboriginal Heritage Act 1972* (AH Act). If evidence of Aboriginal Heritage is located during the assessment or implementation of a project development, it must be reported to the Registrar of Aboriginal Sites under the AH Act. Furthermore, where a project might impact upon an Aboriginal site, an Aboriginal Heritage survey should be commissioned, addressing anthropological and archaeological matters in the proximal area. If disturbance to an Aboriginal Heritage site is unavoidable, an application for consent to the disturbance must be submitted via a Notice under Section 18 of the AH Act.

4. Description of the Environment

4.1 Physical environment

4.1.1 Climate

The Point Samson region experiences both arid and tropical weather systems; with hot, wet summers between October and April, and mild, dry winters from May to September. Meteorological measurements at Karratha Airport from 1993–2015 indicate a maximum average temperature is 36.0°C in January and March and a minimum average temperature of 13.6°C in July (BOM 2016). Rainfall is variable and generally low throughout the region with the majority of the annual rainfall occurring between January and March as a result of summer storms and tropical cyclone activity; the average annual rainfall is ~294 mm/year (BOM 2016). Easterly winds are prevalent throughout the autumn and winter months (April-July), while during spring and summer (September-February) the dominant winds are from the west (BOM 2016).

Tropical cyclones can affect the region between mid-December and April with peaks in intensity in February and March. The Pilbara coastline (Exmouth to Broome) experiences the highest frequency and severity of tropical cyclones in Australia with an average of two cyclones crossing the coastline annually. Tropical cyclones can generate severe winds, large swells and torrential rain.

4.1.2 Geology and geomorphology

The bedrock geology of the Point Samson region is one of the oldest regions in the world and is largely comprised of granitic and volcanic rock of the late Archaean age (2700–3300 million years old; Powell & Horwitz 1994). The ancient igneous rocks are either exposed at the surface or covered by layers of predominantly younger Palaeocene limestone sediments deposited in the last 65 million years (Powell & Horwitz 1994). These sedimentary limestones and igneous rocks are either: 1) exposed to form pavements in the intertidal or sub-tidal zones off beaches and islands, as well as forming reefs or; 2) covered by sand gravel or mud associated with beaches, coastal deltas and mangrove communities (Pearce et al. 2003).

Water depths are generally <5 m up to ~3 km from the shore, and <10 m up to ~15 km from the shore (Eliot et al. 2013). The inshore waters cover mainly unconsolidated sediments and the tidal flats extend over 3 km seaward of the beach rock (Eliot et al. 2013). The backshore includes an area of mudflats that follow stream channels and extend over 5 km landwards with a wide mangrove zone in the upper intertidal reaches (Wells et al. 2003, Eliot et al. 2013).

4.1.3 Hydrodynamics

Tides in the Point Samson region are macro-tidal and semi-diurnal. The maximum tidal range is ~6.3 m; the mean spring tidal range is ~3.6 m, and the mean neap range is ~1.0 m (Pearce et al. 2003). The swell direction is generally from the north and local waves conform to the direction of prevailing winds, which are typically west to south-westerly in summer and easterly in winter. The sheltered nature of Point Samson also reduces the intensity and severity of cyclonic activity.

4.2 Biological environment

4.2.1 Ecology

The ecology of the Point Samson region is dominated by the presence of mangal habitat. Mangal habitats and intertidal areas are known to provide foraging and feeding habitat for a range of conservation significant fauna species, including bat species, migratory bird species, sea

snakes and other reptilian species, marine associated crustaceans, and fish species (refer to following sections for details).

4.2.2 Protected fauna

A search of the Protected Matters Database (DotE 2016a; Appendix B) indicated 21 threatened fauna species as potentially occurring near to the proposed works, including birds (4), mammals (5), marine reptiles (8), and sharks (4) (Table 4.1).

Table 4.1 Fauna listed under the *Environment Protection and Biodiversity Conservation Act 1999* potentially located at Johns Creek Boat Harbour and surrounding areas

Fauna group	Scientific name	Common name	EPBC Act status
Birds	*Macronectes giganteus*	Southern giant-petrel	Endangered
	Pezoporus occidentalis	Night parrot	Endangered
	Rostratula australis	Australian painted snipe	Endangered
	Sternula nereis nereis	Australian fairy tern	Vulnerable
Mammals	*Balaenoptera musculus*	Blue whale	Endangered
	Dasyurus hallucatus	Northern quoll	Endangered
	Macrotis lagotis	Greater bilby	Vulnerable
	Megaptera novaeangliae	Humpback whale	Vulnerable
	Rhinonicteris aurantia (Pilbara form)	Pilbara leaf-nosed bat	Vulnerable
Reptiles	*Aipysurus apraefrontalis*	Short-nosed sea snake	Critically endangered
	Caretta caretta	Loggerhead turtle	Endangered
	Chelonia mydas	Green turtle	Vulnerable
	Ctenotus angusticeps	Airlie Island Ctenotus	Vulnerable
	Dermochelys coriacea	Leatherback turtle	Endangered
	Eretmochelys imbricata	Hawksbill turtle	Vulnerable
	Liasis olivaceus barroni	Olive python	Vulnerable
	Natator depressus	Flatback turtle	Vulnerable
Sharks	*Carcharodon carcharias*	Great white shark	Vulnerable
	Pristis clavata	Dwarf Sawfish, Queensland Sawfish	Vulnerable
	Pristis zijsron	Green Sawfish, Dindagubba, Narrow snout Sawfish	Vulnerable
	Rhincodon typus	Whale shark	Vulnerable

Source: EPBC Act Protected Matters Search Tool (DotE 2016a)

Birds

The EPBC Act Protected Matters Search Tool identified a range of migratory birds that may be present in the vicinity of the Boat Harbour area and proposed Entrance Channel. The Australian fairy tern is the only bird known to breed in the area (DotE 2016a). The Boat Harbour and Entrance Channel is not located in close proximity (<5 km) to a wetland of International Importance under the Ramsar Convention (DotE 2016a). Therefore, given the migratory nature of birds, lack of important habitat surrounding the dredging and disposal areas, and low use of Johns Creek, the risk to birds is considered low.

Mammals

Two threatened marine mammal species may occur nearby to Point Samson: the blue whale and the humpback whale (DotE 2016a). Humpback whales use nearby Nickol Bay (~30 km west of Point Samson), during their annual northward migration to their breeding areas in April/May, and their southward migration in September/October. Studies have indicated that Nickol Bay is a short-term resting area for humpback whales (Cummins 2010), however; the whales remain in

the area for only a few days before migrating further south to the Exmouth Gulf which is the key resting area in the north-west region (DSEWPaC 2012a).

There are no known critical habitats for the blue whale in the vicinity of the dredging or disposal areas. Although these whale species are known to migrate and feed in deeper waters off the WA coastline, it is highly unlikely that large numbers will occur within the vicinity of the dredging or disposal areas.

Mangroves are not critical habitats for the northern quoll, Pilbara leaf nosed bat, or the greater bilby. Therefore the works are unlikely to affect these mammals.

Reptiles

Four species of marine turtle may occur in proximity to the Boat Harbour area and Entrance Channel: loggerhead, green, hawksbill and flatback turtles (DotE 2016a). These species are commonly found in coral and rocky reefs, sandy beaches and seagrass habitats (DSEWPaC 2012b). Loggerhead turtles are known to forage and feed and the green, hawksbill and flatback turtles are known to breed in the Nickol Bay/Point Samson area (DotE 2016a). The breeding season for the green turtle is November-April and for the flatback turtle is November-March. The hawksbill turtle nests all year round with a peak between October and January (DSEWPaC 2012b). Therefore it is possible that marine turtles may be sighted during the dredging works, particularly during dredging of the Entrance Channel.

The Airlie Island Ctenotus (*Ctenotus angusticeps*) has not been previously recorded at Point Samson (DotE 2016b), however; generally inhabits the landward fringe of salt marsh communities in samphire shrubland or marine couch grassland (Maryan et al. 2013) in the intertidal zone along mangrove (*Avicennia marina* with occasional *Rhizophora stylosa*) margins. Given the limited records at Point Samson, and no clearing of suitable habitats, it is unlikely that significant impacts of *Ctenotus angusticeps* will occur.

The Olive Python (*Liasis olivaceus barroni*, Pilbara subspecies) prefers escarpments, gorges and water holes in the ranges of the Pilbara region (DotE 2016c). Radio-telemetry has shown that individuals are usually in close proximity to water and rock outcrops that attract suitable sized prey species (DotE 2016c). The Burrup Peninsula population was found to prefer granophyre rock-piles, though occasionally were found in neighbouring spinifex grasslands. These habitats are not found within the dredging and disposal areas (see Section 4.2.4), therefore it is not anticipated that the Project will have a significant impact on *L. Olivaceus barroni*.

Sharks

Four shark species may occur in proximity to the Boat Harbour area and Entrance Channel, all of which are known to reside in warm temperate seas (DSEWPaC 2012c). It is possible that the green sawfish has breeding grounds within the area, as the species inhabits muddy shallow waters in tidal creeks, such as those nearby the Boat Harbour.

There are no known aggregation sites for great white sharks in the North-west Marine Region (DSEWPaC 2012c). Great white sharks have been recorded travelling northwards during spring months and then travelling south in summer months (DSEWPaC 2012c). They can be found in inshore (in rocky reefs and shallow coastal bays) and offshore areas (such as the continental shelf and slope). Despite this, sightings of a great white shark in the vicinity of the Boat Harbour area and Entrance Channel are likely to be extremely rare.

The largest congregation of whale sharks are known to occur in Ningaloo Reef in north-west WA (DSEWPaC 2012c), which is >300 km south-east of Point Samson. The North-west Marine

Region is an important foraging area for whale sharks. Although they have a wide range and broad distribution in tropical and temperate waters, it is unlikely that whale sharks will be sighted near the proposed dredging and disposal areas.

4.2.3 Protected flora

A search of the Department of Parks and Wildlife (DPaW) Nature Map Data Base (provided in Appendix B) showed only one protected flora species, *Eragrostis lanicaulis*, within 5 km of the Boat Harbour. *Eragrostis lanicaulis* is a priority 3 species which is defined as taxa that are poorly known but not believed to be under immediate threat. Previous studies (Cardno 2014) reported a single *E. lanicaulis* specimen northwest of the Johns Creek area. Given there is no proposed clearing of native vegetation during the dredging and disposal works, there will be no impact to protected flora.

4.2.4 Benthic primary producer habitat

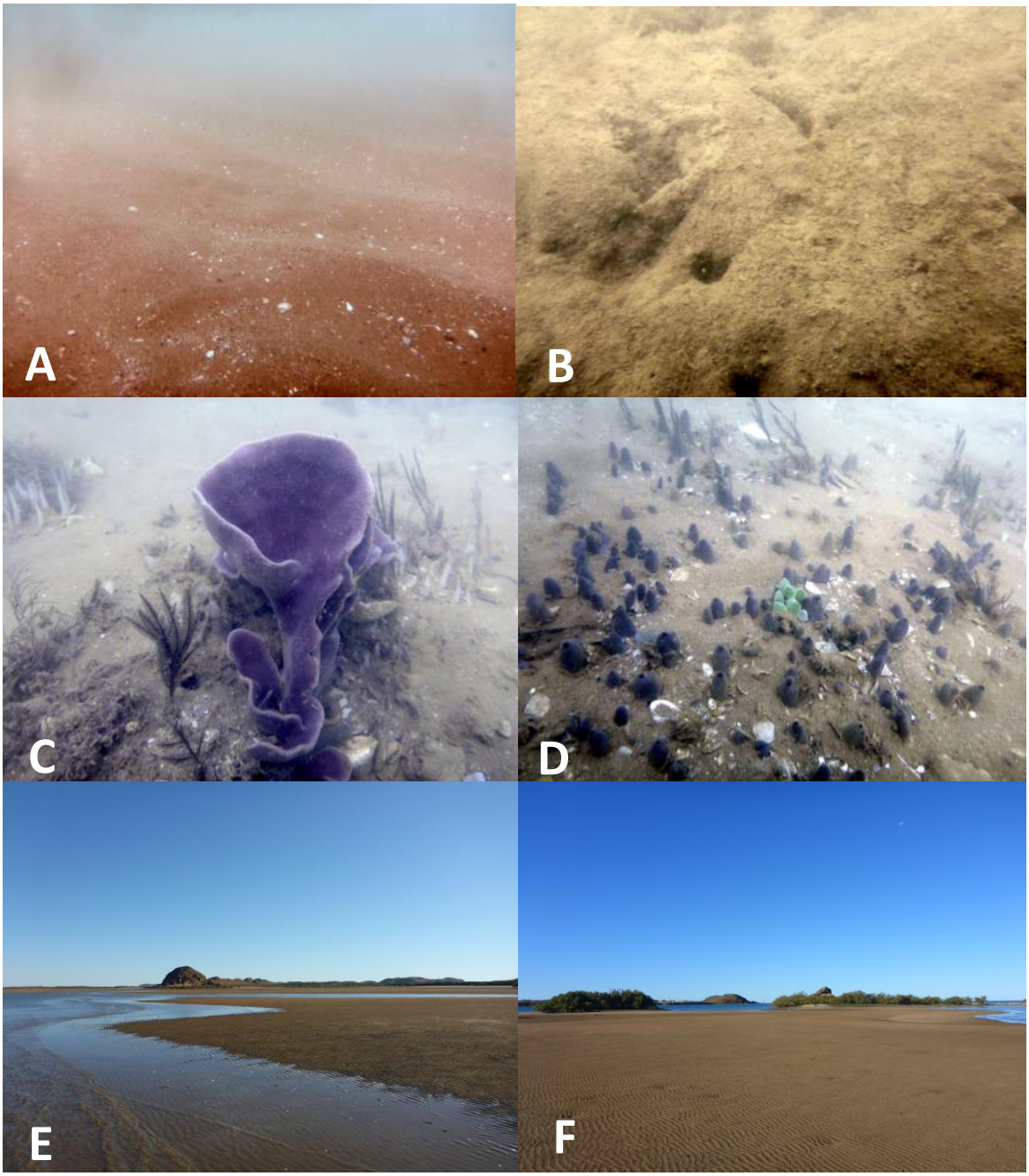
Benthic primary producer habitats (BPPH) are defined as functional ecological communities that inhabit the seabed within which algae (i.e. macroalgae, turfing algae, and benthic macroalgae), seagrass, mangroves, corals or mixtures of these groups are prominent components (EPA 2016d).

Subtidal

The benthic marine habitat within the Point Samson region consists predominantly of three habitat groups: sand and silty habitat (coastal and offshore areas); soft coral and sponge habitat; and hard coral habitat (shallow coastal and island areas) (SKM 2008). Near shore environments are typically dominated by sand and silt habitats (SKM 2008). Coastal habitats at nearby Honeymoon Cove are dominated by red and brown macroalgae, and turfing algae (Astron 2003). Sparse corals (Acroporidae, Faviidae and Pocilloporidae) are distributed throughout the intertidal and subtidal areas. Coral colonies are small (>40 cm diameter) and characteristic of those found in a highly turbid environment (Astron 2003). API (2010) mapped the near shore habitats of Honeymoon Cove as a "mosaic".

Coral communities also exist along the western shoreline of Cape Lambert, on the western side of Bezout Island, at Bezout Rock, Bells Reef, at several locations near Dixon Island and around Delambre Island (SKM 2008). The majority of these coral habitats have a low diversity with the coral colonies being sparsely distributed. SKM (2008) notes that habitat types are comprised of a suite of species that are commonly found in similar habitat types along much of the macro tidal coastline of Northern Australia and many of these species are widely distributed throughout the tropical Indo-West Pacific region.

The seafloor in the proposed dredging and disposal areas consists of sand and silt; with no BPPH as observed during diving for sediment samples in May 2016 (refer to Figure 4.1). The seafloor in the Entrance Channel was mostly characterised by bare sand, with one site between the Boat Harbour breakwaters having sparse, isolated sponges and invertebrates (Figure 4.1).



Note:

a) Entrance Channel sediment habitat
b) Boat Harbour basin silt/sand habitat
c) Sponges between breakwaters
d) Invertebrates between breakwaters
e) Western disposal site sand flat (low-tide)
f) Western disposal site sand flat (low-tide)

Figure 4.1 Benthic habitats of the Boat Harbour, Entrance Channel and Western Disposal area

Mangroves

Mangrove communities occur within the Point Samson area. Mangroves, along with coral reefs, seagrasses, estuaries and salt marshes, form the majority of the BPPH along the Pilbara coastline. Mangroves provide important habitat for juvenile fish and other fauna, and reduce erosion (Semeniuk et al. 1978). Mangroves also form the basis of marine food webs, which in turn support productive and potentially ecologically important fisheries (API 2011).

The mangrove communities of the Pilbara region as a whole hold a special importance, as they form the largest single unit of tropical arid zone mangroves in the world (EPA 2001). Specifically, the Pilbara region supports seven species, *Avicennia marina, Aegialitis annulata, Aegiceras corniculatum, Bruguiera exaristata, Ceriops australis, Osbornia octodonta* and *Rhizophora stylosa* (Wells & Walker 2003, API 2011).

The mangal habitats of Johns Creek and Popes Nose Creek were mapped as part of this DEIA (see Appendix C for further information on mapping methods and results). Mangrove communities in the vicinity of Johns Creek and Popes Nose Creek were determined to consist of *A. marina* and *R. stylosa*, with sparse *C. australis* (Figure 4.2). This assemblage is typical of arid-zone mangroves in northern Australia.

The mangroves of Point Samson are up to 200 years old. Some studies (API 2011, Cardno 2014) indicate that these mangrove communities require special protection, while others (LDM 1999) found the surrounding Boat Harbour mangroves are not of particular regional significance. Mangroves are protected under the *Wildlife Conservation Act 1950*, therefore any potential impact on mangrove species (or other native flora species) is required to be regulated through a Native Vegetation Clearing Permit issued by the Department of Water and Environmental Regulation (DWER) and/or form part of a WA EPA referral assessment.

The mangrove habitat at Johns Creek is classified as "*Guideline 4: Other mangrove areas – Inside designated industrial areas and associated port areas*" and lies outside of any mangrove management areas defined by EPA (2001) (Figure 4.3). The EPA's operational objective for the mangroves in this group is that "*the impacts of development on mangrove habitat and ecological function of the mangroves in these areas should be reduced to the minimum practicable level.*" (EPA 2001). No direct loss of mangroves is anticipated during the proposed dredge and disposal works (Section 5.2.1).

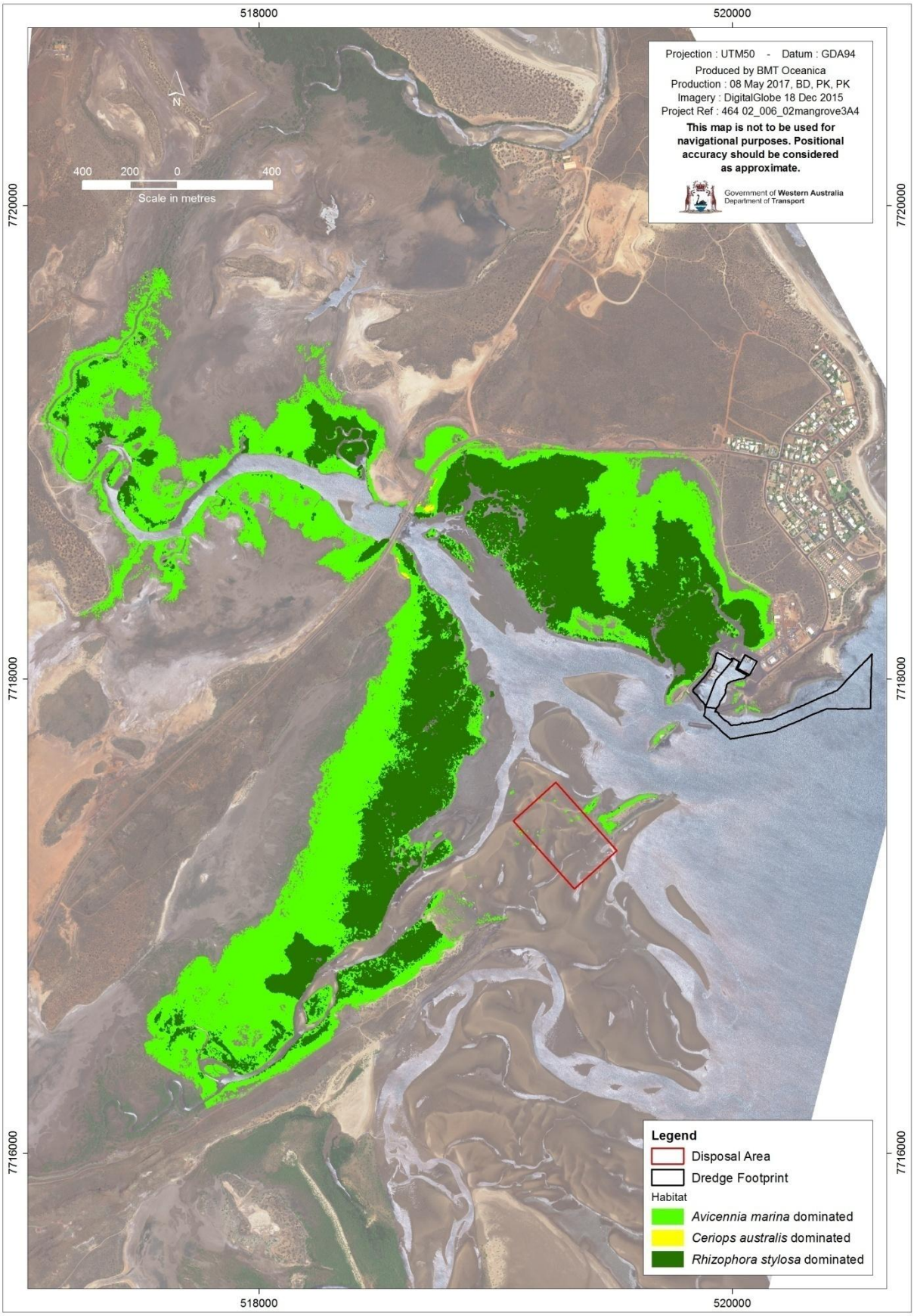
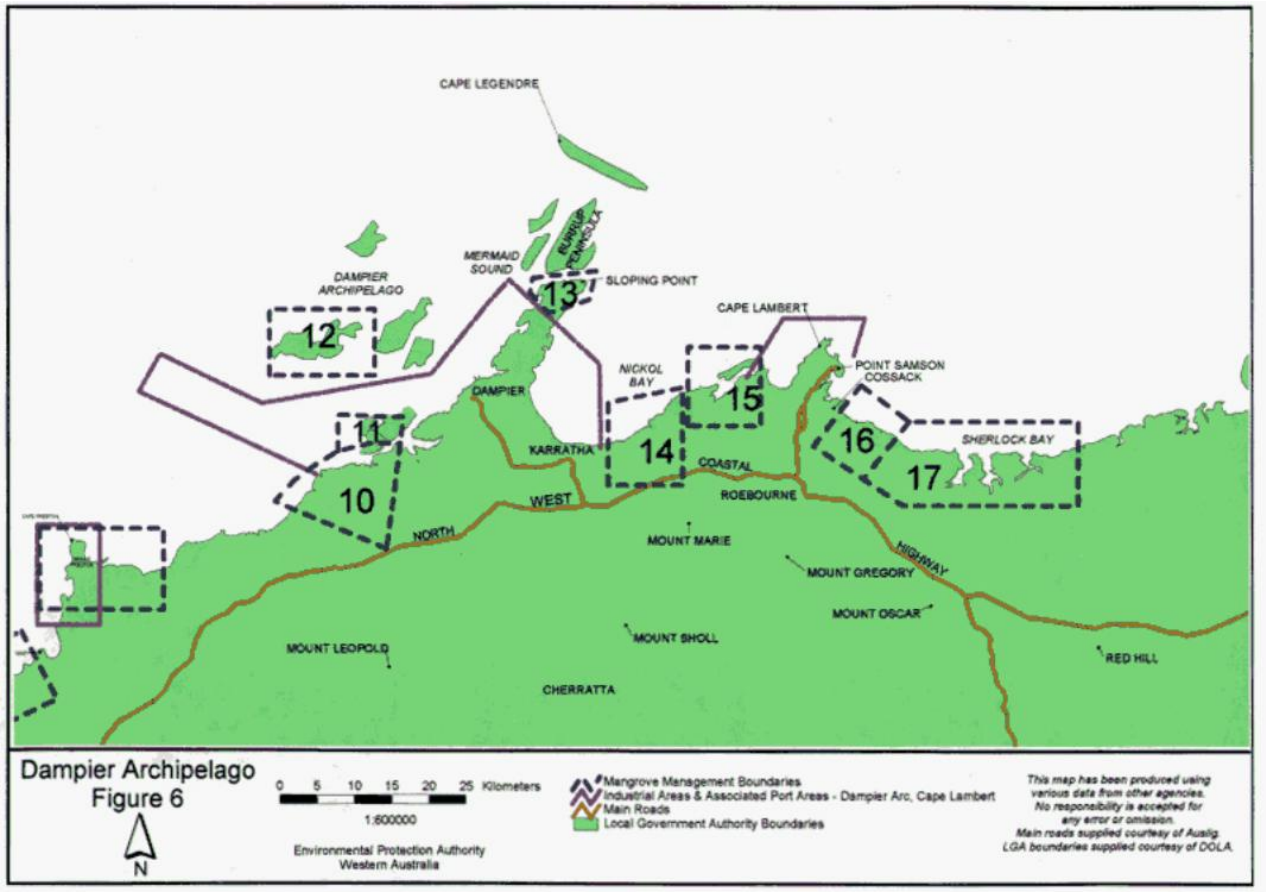


Figure 4.2 2015 mangrove community habitat map of Johns Creek and surrounds



Source: EPA (2001)

Figure 4.3 Mangrove management areas surrounding Johns Creek

4.3 Social environment

Point Samson is a small coastal town with a population of ~300. The Boat Harbour serves as the main launching and retrieval point for vessels from Point Samson, Wickham and Roebourne. As well as recreational boat use, the Boat Harbour provides facilities for commercial vessels (associated with fishing, mining activities and tourism), and a small industrial area. A refuelling facility, land backed wharf and seafood receival facilities supporting a trawl fishery, prawn fishery and line fishery (LDM 1999).

4.4 Aboriginal heritage

The Department of Aboriginal Affairs (DAA) Aboriginal Heritage Inquiry System (AHIS) was used to determine the existence of Aboriginal heritage sites in the vicinity of the Boat Harbour (DAA 2016, Appendix D). The search area contains three registered Aboriginal heritage sites, with Site 8797 (Point Samson 1) occurring within the boundaries of the Boat Harbour. Site 8797 contains scattered artefacts and middens, and is centred on the DoT land-backed service wharf. An Aboriginal heritage survey completed in 2009 (Anthropos Australia 2009) found two Aboriginal artefact sites to the east of Honeymoon Road, far from any potential disposal sites (Anthropos Australia 2009). Historical Aboriginal heritage surveys (Turner 1986) reported another eight Aboriginal heritage sites in the vicinity of the Boat Harbour, two of which (Anadara and Jintupi Middens) were located on the northern bank of Popes Nose Creek, west of the Point Samson Causeway. No places of sacred significance to Ngarluma elders existed within the study area (Turner 1986). Given that the area is highly modified and sediments have previously been dredged, it is highly unlikely that new artefacts or middens will be discovered from maintenance dredging activities. However, potential impacts to Aboriginal heritage are discussed in Section 5.3 .

5. Potential Environmental Impacts

The potential environmental and impacts that may arise due to the Johns Creek maintenance dredging campaign are listed in Table 5.1 with reference to discussion in the following report sections and categorised under relevant EPA environmental factors (EPA 2016b).

Table 5.1 Identified potential environmental and socio-economic impacts associated with Johns Creek maintenance dredging campaign

EPA Environmental Factor	Potential environmental impact	Report section
Benthic Communities and Habitat	Direct damage to benthic habitat	5.2
Marine and Terrestrial Environmental Quality	Increase in water column turbidity	5.5.2
	Hypoxia	5.5.2
	Release of metals and nutrients	5.1.1
	Acid sulfate soils	5.5.2
	Hydrocarbon spills and waste generation	5.1.2
Marine Fauna	Noise	5.5.1
	Threatened or endangered species	5.5.1
	Introduced marine pests	5.5.1
	Sediment infauna	5.5.1
Social Surroundings	Navigational hazards	5.4.2
	Public safety, harbour amenity and access	5.4.1
	Wind-blown dust and sand	5.5.3
	Noise	5.5.3
	Odour	5.5.3
	Aboriginal Heritage	5.3

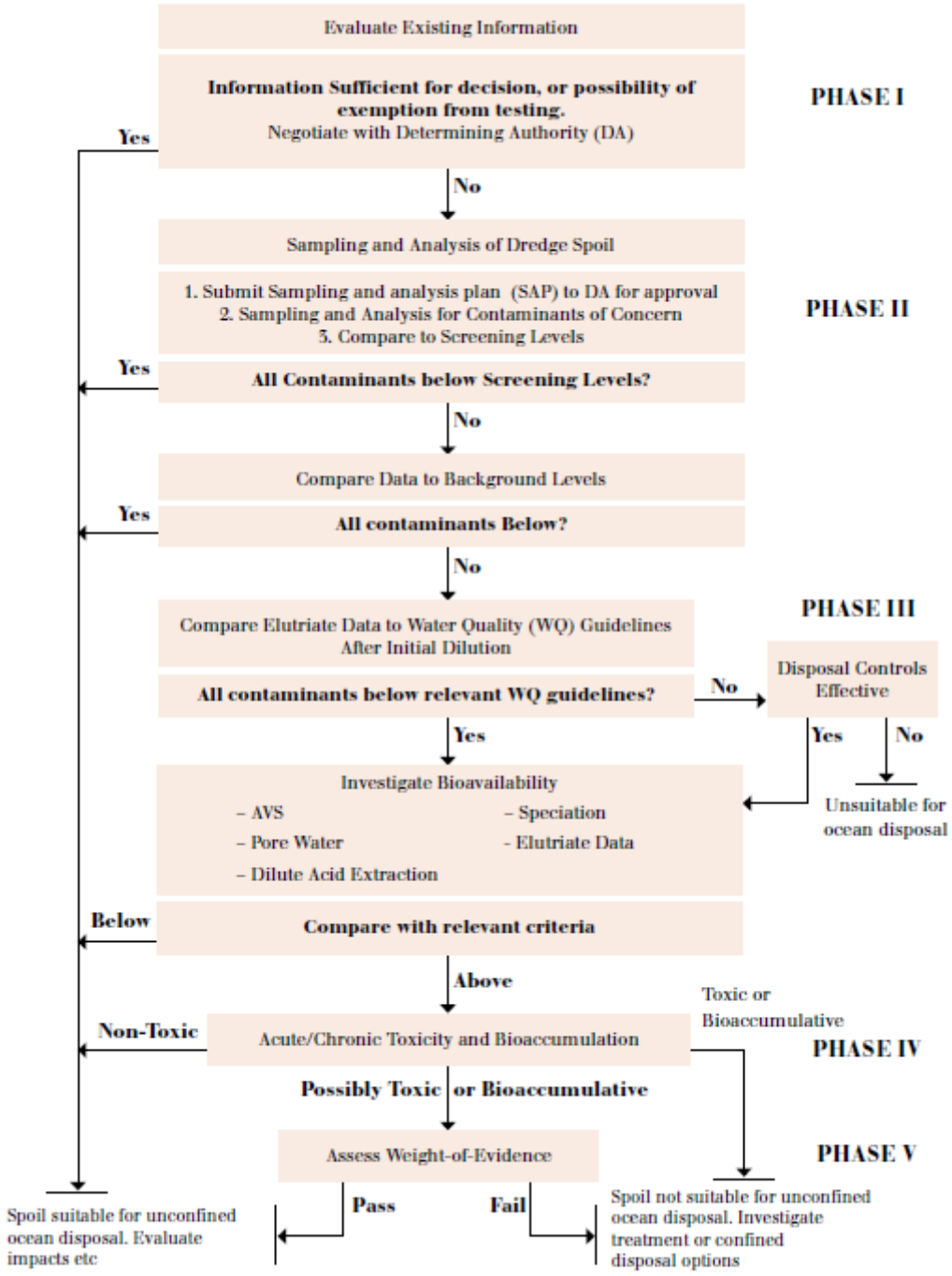
5.1 Marine and terrestrial environmental quality

5.1.1 Release of contaminants

Although sea dumping is not proposed for this Project (see Section 2.2) the NAGD assessment framework (CA 2009; Figure 5.1) was adopted for determining the suitability of sediment for disposal. The framework (Figure 5.1) was considered suitable because:

- the NAGD (CA 2009) provides a framework for assessing the suitability of sediment for disposal into the marine environment
- the major impacts of dredging and disposal are expected to be on the marine environment
- The Western Disposal site is underwater at most stages of the tidal cycle and environmental impacts are likely to be similar to sea dumping

Existing sediment data for Johns Creek were >5 years old, considered not suitable for assessment of sediment quality (as per BMT Oceanica 2016a) and a Phase 1 assessment (Figure 5.1) could not be completed. Sediments from Johns Creek Boat Harbour and Entrance Channel were sampled in accordance with the Sediment Sampling and Analysis Plan on 14–17 May 2016 (SAP; BMT Oceanica 2016a; Appendix E) and results reported in a SAP Implementation Report (BMT Oceanica 2017; Appendix F).



Source: CA (2009)

Figure 5.1 Framework for assessing the suitability of sediments for dredging and disposal

Metals

Sediment samples were analysed for metals in accordance with the NAGD (CA 2009) framework (Figure 5.1). The 95% upper confidence limit (UCL) concentrations of total arsenic, chromium, and nickel in Boat Harbour and Entrance Channel sediments exceeded NAGD Screening Levels and ISQG-Low guidelines, but met sediment quality high guidelines (CA 2009, DER 2014; Table 5.2). Elevated concentrations of arsenic, chromium and nickel are not uncommon in Pilbara coastal sediments and concentrations vary with sediment grain size (DEC 2006, CA 2009; BMT Oceanica 2015).

Arsenic is naturally elevated region-wide in Pilbara coastal sediments (80th percentile 21 mg/kg DEC 2006) and similar to concentrations in Boat Harbour and Entrance Channel sediments (Table 5.2,). Nickel and chromium are elevated in fine/silty (<63 µm sized particulates) coastal

sediments adjacent to rivers (DEC 2006). The sampling area is surrounded by tidal creeks, (Johns Creek and Popes Nose Creek) and Boat Harbour sediments are predominantly comprised of the fine silts and clays (<63 µm sized particulates) so high background metal concentrations would be expected (DEC 2006). Natural background concentrations of nickel and chromium in coastal sediments adjacent to rivers are as high as 42.0 mg/kg and 90.8 mg/kg, respectively (DEC 2006) and not substantially different to the worst case concentrations encountered within Boat Harbour and Entrance Channel sediments (95% UCL concentrations of 47.3 mg/kg for nickel and 105.6 mg/kg for chromium; Table 5.2). The Western Disposal area, located away from potential sources of contamination, reported individual nickel concentrations that were elevated relative to guideline levels and concentrations of arsenic, chromium were elevated to other regional areas (Table 5.2; DEC 2006).

A defined spatial gradient from the highest metal concentrations observed at enclosed, nearshore waters adjacent to the marine/terrestrial interface and decreasing with distance offshore correlate with sediment grain size and is consistent with expectations based on exposure to riverine sources versus the high energy ocean environment (Table 5.2).

Table 5.2 Total metal concentrations in sediments sampled at Johns Creek Boat Harbour, Entrance Channel and Western Disposal Area

Guideline/sample	Arsenic	Cadmium	Trivalent Chromium	Hexavalent Chromium	Total Chromium	Copper	Lead	Mercury	Nickel	Zinc
Unit	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
Screening Level[2]/ISQG-low[3]	**20**	**1.5**	**-**	**-**	**80**	**65**	**50**	**0.15**	**21**	**200**
Sediment Quality High Value[2]/ISQG-high[3]	**70**	**10**	**-**	**-**	**370**	**270**	**220**	**1**	**52**	**410**
JCH1_S	14.0	<0.1	46.0	<0.5	46.0	3.0	1.4	<0.1	17.0	7.9
JCH2_S	12.0	<0.1	32.0	<0.5	32.0	1.8	1.0	<0.1	10.0	5.1
JCH3_S	12.0	<0.1	33.0	<0.5	33.0	1.9	1.2	<0.1	11.0	5.0
JCH4_S	13.7	<0.1	76.0	<0.5	76.0	13.5	3.4	<0.1	32.0	22.0
JCH5_S	14.0	<0.1	88.0	<0.5	88.0	21.0	4.5	<0.1	37.0	34.0
JCH5_0.5–1.0	-	-	76.0	0.6	77.0	-	-	-	30.0	-
JCH5_1.0–1.5	-	-	74.0	<0.5	74.0	-	-	-	29.0	-
JCH6_S	18.0	<0.1	96.0	0.6	97.0	26.0	6.3	<0.1	39.0	49.0
JCH6_0.5–1.0	-	-	88.0	0.6	89.0	-	-	-	35.0	-
JCH6_1.0–1.5	-	-	69.0	0.5	70.0	-	-	-	28.0	-
JCH7_S	15.0	<0.1	99.5	0.6	100.0	33.0	6.4	<0.1	44.0	52.0
JCH7_0.5–1.0	-	-	79.0	<0.5	79.0	-	-	-	34.0	-
JCH8_S	14.0	<0.1	66.0	<0.5	66.0	21.0	4.5	<0.1	25.0	32.0
JCH9_S	9.9	<0.1	55.0	<0.5	55.0	15.0	7.3	<0.1	24.0	37.0
JCH9_0.5–1.0	-	-	-	-	-	-	-	-	32.0	-
JCH10_S	35.7	0.1	160.0	0.7	160.0	35.7	9.8	<0.1	63.7	45.3
JCH11_S	18.0	0.1	130.0	0.7	130.0	56.0	9.1	<0.1	55.0	100.0
JCH11_0.5–1.0	-	-	140.0	1.1	140.0	-	-	-	52.0	-
JCH12_S	20.0	0.1	120.0	0.6	130.0	72.0	9.9	<0.1	78.0	130.0
JCH12_0.5–1.0	21.0	0.1	150.0	1.0	150.0	68.0	12.0	<0.1	64.0	120.0
JCH12_1.0–1.5	21.0	0.1	140.0	0.8	140.0	54.0	9.5	<0.1	89.0	100.0
Boat Harbour and Entrance Channel and maximum	**35.7**	**0.1**	**160.0**	**0.7**	**160.0**	**72.0**	**9.9**	**<0.1**	**78.0**	**130.0**
Boat Harbour and Entrance Channel 95% UCL[4]	**20.4**	**n/c**	**104.2**	**n/c**	**105.6**	**36.2**	**7.10**	**n/c**	**47.3**	**62.9**

Guideline/sample	Arsenic	Cadmium	Trivalent Chromium	Hexavalent Chromium	Total Chromium	Copper	Lead	Mercury	Nickel	Zinc
Unit	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
Boat Harbour and Entrance Channel mean[4]	**16.4**	**n/c**	**83.5**	**n/c**	**84.4**	**25.0**	**5.4**	**n/c**	**36.3**	**43.3**
Boat Harbour and Entrance Channel standard deviation[4]	**7.4**	**n/c**	**33.2**	**n/c**	**34.1**	**19.7**	**2.4**	**n/c**	**18.2**	**35.6**
WD1_S	16.0	<0.1	53.0	<0.5	53.0	3.5	1.2	<0.1	17.0	8.3
WD2_S	16.0	<0.1	51.0	<0.5	51.0	3.3	1.2	<0.1	20.0	7.9
WD3_S	17.0	<0.1	57.0	<0.5	57.0	3.6	1.2	<0.1	23.0	8.2
Western Disposal maximum	**17.0**	**<0.1**	**57.0**	**<0.5**	**57.0**	**3.6**	**1.2**	**<0.1**	**23.0**	**8.3**
Western Disposal 95% UCL[5]	**n/c**	**n/c**	**n/c**	**n/c**	**n/c**	**n/c**	**n/c**	**n/c**	**n/c**	**n/c**
Western Disposal mean	**16.3**	**<0.1**	**53.7**	**<0.5**	**53.7**	**3.5**	**1.2**	**<0.1**	**20.0**	**8.1**
Western Disposal standard deviation	**0.6**	**n/c**	**3.1**	**n/c**	**3.1**	**0.2**	**0.0**	**n/c**	**3.0**	**0.2**

Notes:

1. Refer to Figure 1.1 for explanation of sampling areas
2. NAGD Screening Levels and Sediment Quality High Values from CA (2009)
3. ISQG = interim sediment quality guideline value from DER (2014)
4. UCL = Upper Confidence Limit. Calculated using surface data only
5. Calculation of 95% UCL not possible due to small dataset size
6. Bold red text indicates 95% UCL exceeds NAGD (CA 2009) Screening Levels/DER (2014) ISQG-Low, non-bold red text indicates an individual site has exceeded NAGD (CA 2009) Screening Levels/DER (2014) ISQG-Low
7. - indicates no guideline available or sample not tested for that analyte
8. n/c - not calculated due to small sample size or >25% of values below the LoR (BMT Oceanica 2017)
9. Triplicate sample results have been averaged for inclusion in this table
10. Blue shading indicates a sample from deep sediment layers (>0.5 m)

Each of the sediment samples that exceeded an NADG Screening Level (CA 2009, Table 5.2) were analysed for bioavailable concentrations of the relevant metals, including cases where the overall 95% UCL concentrations were below the NAGD Screening Level (i.e. copper at site JCH12; CA 2009). Concentrations of bioavailable metals were all below their respective NAGD Screening Level indicating that contaminants within sediments are not biologically available and not anticipated to impact marine life during dredging and disposal (Table 5.3).

Table 5.3 Bioavailable metal concentrations in sediments sampled at Johns Creek Boat Harbour

Guideline/sample		**Arsenic**	**Total Chromium**	**Copper**	**Nickel**
Unit		**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
NAGD Guidelines (CA 2009)	**Screening Level**	**20**	**80**	**65**	**21**
	Sediment Quality High Values	**70**	**370**	**270**	**52**
JCH4_S[2]		-	8.9	-	1.5
JCH5_S		-	9.8	-	1.3
JCH5_0.5		-	-	-	1.1
JCH5_1.0		-	-	-	1.2
JCH6_S		-	11.0	-	1.7
JCH6_0.5–1.0		-	10.0	-	1.6
JCH6_1.0–1.5		-	-	-	1.1
JCH7_S		-	11.0	-	1.8
JCH7_0.5–1.0		-	-	-	5.0
JCH8_S		-	-	-	1.6
JCH9_S		-	-	-	2.0
JCH9_0.5–1.0		-	-	-	1.7
JCH10_S		4.7	13.0	-	3.4
JCH11_S		-	15.0	-	2.4
JCH11_0.5–1.0		-	11.0	-	2.9
JCH12_S		2.3	16.0	31.0	2.5
JCH12_0.5–1.0		2.4	20.0	28.0	3.1
JCH12_1.0–1.5		1.9	15.0	-	2.1
95% UCL[3]		**4.7[3]**	**15.5**	**31[3]**	**2.5**

Notes:

1. Refer to Figure 1.1 for explanation of sampling areas and sites
2. Included for bioavailable analysis as one triplicate sample (JCH4_S1) exceeded the guideline level, despite the average falling below the guideline level.
3. Calculation of 95% UCLs not possible due to small data set size, so maximum value used for comparison to guidelines
4. Calculated using surface data only
5. – sample not tested for that analyte
6. Blue shading indicates a sample from deep sediment layers (>0.5 m)

Despite the sediment quality being deemed acceptable after appropriate comparison to relevant guidelines, elutriate testing was also undertaken on each of the sediment samples that exceeded NAGD Screening Levels (CA 2009) and ISQG-Low guidelines (DER 2014) to assess potential release of contaminants from sediments during dredging and disposal, and subsequent impacts to water quality . The proposed Western Disposal Area is located ~1 km from Johns Creek Boat Harbour in a relatively undisturbed environment and has been considered to be a high ecological protection area (Figure 1.1). Contaminant concentrations estimated from elutriated water results were assessed against the ANZECC & ARMCANZ (2000) 99% species protection level (Table 5.4).

The concentration of metals in the discharge after the material is combined during dredging is conservatively approximated as the average of these "worst-case" results. On this worst case basis, only copper concentrations in the elutriated samples exceeded the ANZECC/ARMCANZ (2000) 99% species protection guideline prior to any dilution following disposal (Table 5.4).

Table 5.4 Elutriate metal concentrations in sediments sampled at Johns Creek Boat Harbour

Analyte	Arsenic	Trivalent Chromium	Hexavalent Chromium	Total chromium	Copper	Nickel
Unit	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
ANZECC & ARMCANZ (2000) 99% species protection level	-	**7.7**	**0.14**[3]	**-**	**0.3**	**7**
JCH4_S[2]	-	1	<1	1	-	2
JCH5_S	-	<1	<1	9	-	2
JCH5_0.5–1.0	-	-	-	-	-	8
JCH5_1.0–1.5	-	-	-	-	-	7
JCH6_S	-	<1	<1	8	-	2
JCH6_0.5–1.0	-	31	<1	31	-	8
JCH6_1.0–1.5	-	-	-	-	-	8
JCH7_S	-	<1	<1	3	-	3
JCH7_0.5–1.0	-	-	-	-	-	100
JCH8_S	-	-	-	-	2	2
JCH9_S	-	-	-	-	2	4
JCH9_0.5–1.0	-	-	-	-	-	8
JCH10_S	3	2	<1	2	2	4
JCH11_S	12	<1	<1	1	7	2
JCH11_0.5–1.0	-	28	<1	28	-	8
JCH12_S	11	<1	<1	<1	7	2
JCH12_0.5–1.0	9	<1	<1	<1	13	5
JCH12_1.0–1.5	10	<1	<1	1	9	5
Mean[4]	**9**	**1**	**<1**	**1**	**6**	**3**

Notes:

1. Refer to Figure 1.1 for explanation of sampling areas and sites
2. Included for elutriate analysis as one triplicate samples (JCH4_S1) exceeded the guideline level, despite the average falling below the guideline level
3. Laboratory detection limit above guideline level
4. Calculated using surface data only
5. For results below the LoR, means were calculated using half the LoR as the replacement value
6. Bold red text indicates mean value exceeds ANZECC & ARMCANZ (2000) species protection level, non-bold red text indicates an individual site has exceeded ANZECC & ARMCANZ (2000) species protection level
7. - indicates no guideline available or sample not tested for that analyte
8. Blue shading indicates a sample from deep sediment layers (>0.5 m)

Organotins

Tributyltin (TBT) exceeded the NAGD [CA 2009] Screening Level at only one site in the Boat Harbour. The 95% UCL concentrations of normalised TBT were below the NAGD (CA 2009) Screening Level (Appendix F) and these sediments would therefore be deemed suitable for unconfined disposal to the ocean under the NAGD framework (Figure 5.1). It is assumed that these sediments are suitable for disposal in this application.

Hydrocarbons

Concentrations of TRH, BTEX, and PAH were below the limit of reporting in all samples. Fluoroanthene (a PAH) concentrations were below the limit of reporting in all but one sample (which was at the limit of 0.10 mg/kg, 0.21 mg/kg normalised to 1% total organic carbon; TOC). The 95% UCL concentrations of normalised hydrocarbons were below the NAGD (CA 2009) Screening Levels and these sediments would therefore be deemed suitable for unconfined disposal to the ocean under the NAGD framework. It is assumed that these sediments are also suitable for disposal in this application.

Nutrients

Potential impacts from nutrients released during dredging are not considered by the NAGD (CA 2009). Elutriate nutrients (filterable reactive phosphorus [FRP] and nitrate+nitrite [NO_X]) were determined as an indicator of the potential for nutrient release from pore waters. Median concentrations of nitrate+nitrite [NOX] met the ANZECC/ARMCANZ (2000) tropical guidelines for nutrients as stressors before any further dilution (Appendix F). Median concentrations of filterable reactive phosphorus [FRP] met the ANZECC/ARMCANZ (2000) tropical guidelines for nutrients as stressors after just a 1:9 dilution with background seawater. The ANZECC/ARMCANZ (2000) guidelines for nutrients as stressors are intended for use as an indicator of the potential effects from chronic exposure rather than short term disturbances such as dredging. The conservative nature of this comparison suggests that nutrient related impacts are highly unlikely. However the potential impacts from elevated nutrients in the water column will be managed in accordance with the EMF (BMT Oceanica 2016a). Monitoring required is detailed in Section 6.1.2.

5.1.2 Hydrocarbon spills and waste generation

Various hydrocarbons will be used during the dredging and disposal works, including fuel, oil and lubricants for the operation of dredge machinery. There is a risk of hydrocarbon spills to the environment, potentially impacting flora and fauna. Rubbish and hazardous waste may also be generated, which can pollute the environment if not contained and removed from site. Therefore, hydrocarbon use and waste will require management by the dredge operators during the dredging campaign.

5.2 Benthic communities and habitat

5.2.1 Damage to benthic habitat

The Boat Harbour is within a disturbed system that has previously been dredged and is mostly devoid of BPPH (Section 4.2.4; LDM 1999). A small, isolated community of invertebrates at one site between the breakwaters and some isolated mangrove trees were found at the edges of the Western Disposal area and throughout the shorelines of Johns' and Popes Nose Creeks (refer Section 4.2.4). As a result, mangroves were identified as a potential environmental receptor.

Potential damage to BPPH can occur directly via burial[4] or removal during dredging, or indirectly via smothering or shading from an increase in water column turbidity during dredging and disposal. Direct impacts on BPPH will not occur during disposal activities and indirect impacts to BPPH resulting from turbidity or release of contaminants are discussed in Sections 5.5.2 and 5.1.1, respectively. No significant impact on BPPH is anticipated, however monitoring of BPPH (see Section 6.1.3) will occur to ensure that burial or clearing does not occur and that indirect impacts (resulting from reduced water quality) are negligible.

5.3 Aboriginal heritage

The Johns Creek dredging area occurs within a registered Aboriginal Site (Appendix E). Given the dredging areas are highly modified within a previously disturbed dredge footprint it is unlikely the dredging area contains historical Aboriginal artefacts. Therefore, a Section 18 Notice under the *Aboriginal Heritage Act 1972*, and associated Heritage surveys, is not anticipated. Point Samson occurs within the Ngarluma Aboriginal Corporation (NAC) Determination Area. The NAC is the legal body for the Ngarluma people regarding development and heritage issues, and will be informed prior to any ground disturbing works.

5.4 Social surroundings

5.4.1 Impacts on public safety visual amenity and access

The waters of Point Samson are widely utilised for recreational boating, fishing, swimming and other recreational pursuits. The operation of heavy machinery within the Boat Harbour area and Entrance Channel during dredging will temporarily impact visual amenity and pose a short-term risk to public safety when accessing the Boat Harbour and groynes (used for recreational fishing). Additionally, pipeline lay-down areas could restrict public access to the Boat Harbour and Entrance Channel. However, any short-term negative impacts of the dredging campaign to public amenity are likely outweighed by the long-term improvement in access to the Boat Harbour and Entrance Channel as a result of the dredging. The dredging is not expected to have an adverse impact on recreational users of the Point Samson area since the impact on users and public safety shall be limited due to:

- the duration of the dredging campaign being short-term and minimised where possible with no dredging will occur over holiday periods
- fencing and public information signs will be installed on site
- pipeline lay-down areas will be specifically designated and sign-posted to preserve public safety, and
- dredging and disposal areas not being accessible to the public.

Public safety and visual amenity will require active management during the works.

[4] *Burial can result in reduced vigour, or if burial is >10 cm, death (Ellison 1998).*

5.4.2 Navigational hazards

The project is designed to reduce navigation hazards as natural sedimentation in the Boat Harbour and Entrance Channel creates a navigational hazard to vessels, restricting safe access. The dredging campaign may create a short-term navigational hazard to these vessels, as the dredge has no self-propulsion (using only anchors and spuds to move) and deploys a floating pipeline from its stern to the disposal area.

Dredging at the Boat Harbour area and Entrance Channel is expected to have a limited impact on vessel access. The dredge vessel and pipeline will be clearly visible on the water surface during the day and will be lit by flashing lights at night. The dredge vessel will maintain a navigable channel (where possible) and manage vessel access to the Boat Harbour and mooring areas throughout the dredging campaign. A temporary notice to mariners will be issued to warn the public of navigational hazards associated with the dredging campaign. Additionally, marine safety will need to be monitored and managed throughout the dredging operation (Section 6).

5.5 Other environmental issues

5.5.1 Marine fauna

Impact to threatened and migratory species

Under the EPBC Act there is a provision for the protection of threatened and migratory species (Section 4.2.2). The EPBC Act Protected Matters Database identified a number of threatened fauna species as potentially occurring within and near to the proposed works (Section 4.2.2), including whales, turtles, sawfish, and migratory birds.

Turtles nest on sandy beaches, particularly beaches backed by high dunes. Johns Creek is not a known turtle nesting area primarily due to unsuitable nesting habitat and therefore it is considered unlikely there will be significant impacts to marine turtles during dredging and disposal operations.

Sawfish are not naturally inquisitive and are therefore not expected to approach the dredge machinery whilst in operation. Any dredge vessel to be used for the proposed dredging will likely be a small cutter-suction dredge and will move relatively slowly, thus sawfish are likely to move away from the area while dredging (Dr Glen Young, Chevron Australia, 2013, pers. comm., 25 June). Additionally, dredging will only occur over a relatively small area and duration. It is anticipated that the noise generated and the vessel movements associated with the maintenance dredging will be similar to those associated with the previous campaigns at other locations and there have been no known impacts to any sawfish during these works. In addition the Johns Creek is a commercial Boat Harbour with periods of high vessel traffic from medium to large-scale vessels, and, as such, it is anticipated sawfish will avoid these areas of high vessel movements.

Whales are unlikely to occur in the Boat Harbour vicinity Species distribution maps show these marine whale species are known to migrate and feed in deeper waters along the WA coastline (DSEWPaC 2012a) and it is highly unlikely these species will occur in the shallow, estuarine internal waters where dredging and disposal works are proposed.

Therefore the risk of impacts on the threatened marine species (i.e. turtles, whales and sawfish) in the Boat Harbour area and Entrance Channel will be relatively low but may need to be monitored and managed if works are done within these nesting/migratory seasons. In addition, the Protected Matters Database Search did not indicate that the Western Disposal area may be a wetland of international importance. Given the small extent of the Western Disposal area in

comparison to the area of intertidal mudflats in the immediate vicinity Johns and Popes Nose Creeks, the risk of having an adverse impact on birds from the use of the Western Disposal area is considered low.

A large proportion of native habitat in the local and regional context will remain undisturbed by the works. There is limited mangal habitat within the proposed disposal area and it is not anticipated the area contains suitable habitat for protected fauna (see Section 4.2.2) and, as such the proposed disposal of dredged material is not anticipated to impact on local fauna and flora.

Impact to sediment infauna

Sediment infauna has been shown to be able to migrate through up to 30 cm (Wilber & Clarke 2007). Recovery of shallow areas with unconsolidated fine grain sediments typically occurs within months (Wilber & Clarke 2007). Given the deposition of dredged sediment will be up to 50 cm (Section 2.2), and the likelihood that this sediment will re-mobilise and "thin out" within the recovery time for infauna, the risk of having a significant impact on infauna is considered low.

Environmental impact of noise

Noise generated by dredging has the potential to disturb marine and terrestrial fauna, causing temporary or long-term avoidance of an area that may be important for feeding, reproduction or sheltering. Underwater sounds may interfere with communication systems of fish and marine mammals, masking important biological cues or causing behavioural disturbance (Richardson et al. 1995, National Research Council 2005, Southall et al. 2007). Intense underwater sounds in close proximity to marine fauna may cause temporary or permanent hearing damage or death (Southall et al. 2007). These impacts may affect critical behaviours and functions, such as feeding, migration, breeding and response to predators, all of which may ultimately affect an individual animal's survival (National Research Council 2005). Depending on the duration and intensity of underwater noise, an animal may avoid the source of the disturbance completely, thereby altering the overall use and ecology of that marine environment.

The marine habitat in the vicinity of the Boat Harbour and Entrance Channel is not considered to be an important area for feeding, reproduction or sheltering by marine fauna. Dredging works will be small-scale and temporary and, the low-frequency sounds generated by the dredge equipment are not anticipated to cause physiological damage to occasional marine fauna that may occur in the dredging and disposal areas.

Introduced marine pests

The arrival of machinery at the dredging and disposal areas may introduce non-native marine species from other areas, thereby disrupting the local ecosystem. Marine species may be transported between locations within ballast water and on vessel hulls (i.e. biofouling).

The dredge and associated vessels/equipment to be used during the dredging campaign shall be thoroughly cleaned to ensure that no water or sediment remains to minimise the intrastate movement of aquatic pests when loading the vessel onto the trailer for transport. The vessel will likely be travelling to Johns Creek by road, from a location within WA State waters. It is therefore not likely that any marine pests not native to WA will be introduced into the area. No management associated with introduced marine species is required if the dredge vessel is coming from within WA, however; should the vessel be sourced from external waters, active management is required.

Land-based equipment is owned and operated by the dredge operator for internal use in the Boat Harbour boundary premises. Therefore, it is unlikely that marine pests will be introduced into the environment from land-based equipment.

5.5.2 Marine environmental quality

Acid sulfate soils

Acid sulfate soils are naturally occurring soils, sediments and peats that contain iron sulfides, primarily in the form of pyrite materials. They are commonly found in low-lying land areas bordering the coast or estuarine and saline wetlands and freshwater groundwater-dependent wetlands throughout WA. In an anoxic state (i.e. waterlogged), these materials remain benign and do not pose a significant risk to human health or the environment. However, disturbance to ASS by draining or excavation exposes these soils to oxygen, which subsequently reacts with the mineral elements within the soils resulting in the production of sulfuric acid. This acidity can mobilise elements such as metals and nutrients from the soil profile that can be transported to nearby waterways, wetlands and/or groundwater systems. Acid leachate can persist over long periods of time or peak seasonally after dry periods with first breaking rains and has the potential to cause significant environmental and economic impacts (DER 2015).

Characterisation of the sediments within the dredging and disposal areas indicated that pH of the sediment samples were all >8.5 and the acid neutralising capacity of the sediment was shown to be sufficient to buffer any acidity generated during dredging and disposal of sediments (Appendix F).

Increase in water column turbidity and smothering

The dredging campaign will likely result in small-scale, temporary increased turbidity in the water column at the proposed dredging and disposal areas. Elevated turbidity in the water column may have two types of impact:

- reduced light penetration through the water column, causing a reduction in marine flora and fauna productivity if turbidity is sufficiently persistent in time and space
- smothering of benthic habitats when suspended sediment settles to the seabed.

Environmental impacts of turbidity

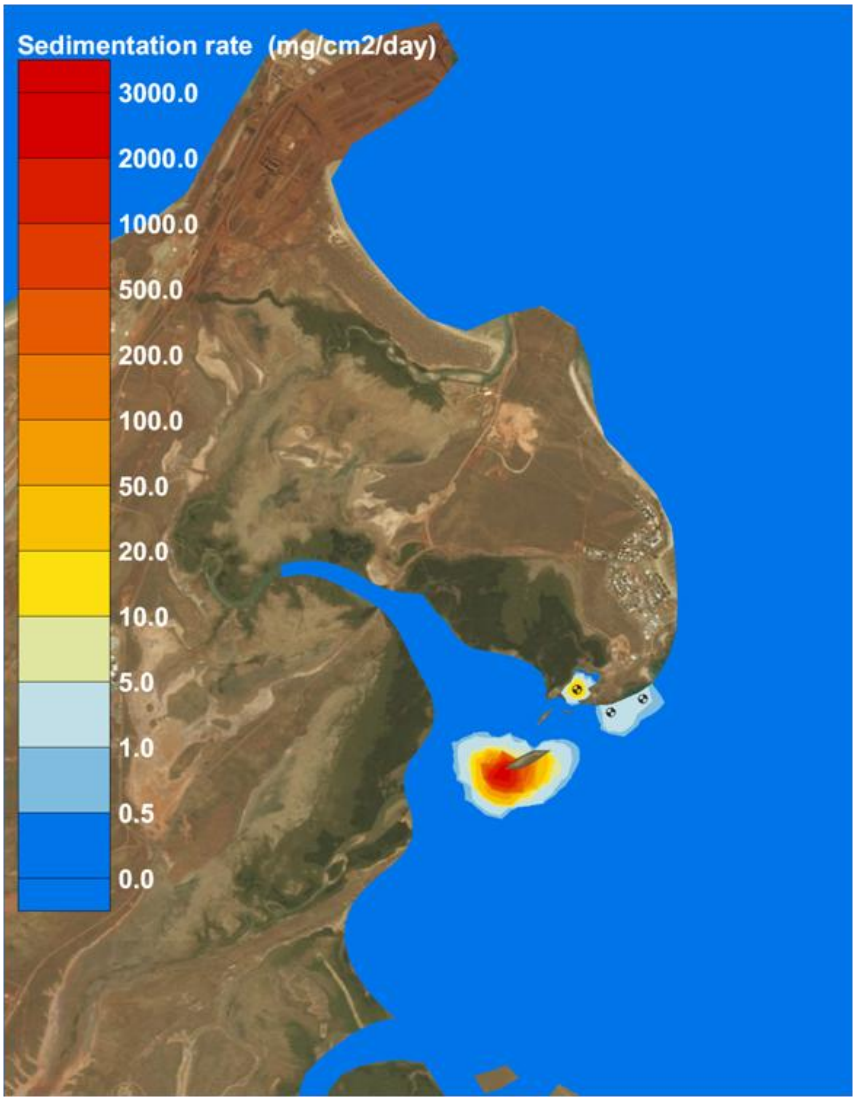
Smothering is regularly observed in dredging projects, and occurs because sedimentation rates exceed natural rates that corals have previously experienced (Jones et al. 2016). Smothering occurs when the sediment cannot be cleared fast enough by the coral, and sediment begins to accumulate over successive days. Laboratory-based studies (summarised in Jones et al. 2016) have shown that coral species can typically achieve clearance of settled sand (62–2000 µm) in <24 hours. Signs of coral stress (bleaching, excess mucus production) became apparent after a few days, with mortality occurring after 15 days, with continuous exposure to 200 mg cm^2 day^{-1} sediment rate (Jones et al. 2016). Sedimentation rates of 200 mg cm^2 day^{-1} for periods of days to weeks are not uncommon on fringing reefs of the Great Barrier Reef (Stafford-Smith 1993).

It is important to note that the proposed dredging method (cutter suction dredge, with a slurry pumped to a disposal area) means that one of the primary dredging related turbidity generating mechanisms, overflow from the dredge hopper (Jones et al. 2016) will not occur. The Johns Creek maintenance dredging campaign is expected to be completed within a period of ~3 months, with half of the campaign duration occurring within the Entrance Channel. Dredging in the Entrance Channel is likely to be completed in periods of suitable weather; therefore any plume generated will only be present for a short period of time.

A desktop hydrodynamic and sedimentation assessment (BMT JFA 2017; Appendix G) was undertaken to provide a modelled estimate of average sedimentation rates following disposal to the Western Disposal Area for the duration of the maintenance dredging campaign (94 days). Modelling was not completed on plumes generated by the dredge, as the coarse particle size of

Entrance Channel sediments (BMT Oceanica 2017; Appendix F) combined with the spill rate associated with the dredging method proposed[5] meant that the plume extent generated at the dredge was not significant when compared to the plume generated from disposal activities.

Calculated settlement times for 90% of sediments through 1 m of water ranged from 1–2 minutes (BMT Oceanica 2017; Appendix F). Average sedimentation (mg/cm^2/day) rates were modelled for cutter head plumes at three separate locations, one within the Boat Harbour and two within the Entrance Channel (Figure 5.2). Cutter head plume modelling results (Figure 5.2) conservatively used a 7.5% source rate from Kemps and Masini (2017). Modelling indicated that the coral mortality sedimentation rate of 200 mg/cm$^{2/}$day^{-1} as outlined in Jones et al. (2016) is anticipated to be localised (150 m radius) at the Western Disposal area, and will not extend to shoreline benthic communities and habitats (BCH) adjacent to the Entrance Channel (Figure 5.2). Plume trajectory and extent is highly dependent on tidal currents, and plumes are not anticipated to persist for long periods of time in any single location. Therefore, no increased sedimentation to coral habitat is anticipated from disposal of dredged material during the Johns Creek maintenance dredging campaign.



Note: Three separate dredge locations (one in the Boat Harbour and two in the Entrance Channel) are shown in the model output. Therefore the cutter head plume within the Entrance Channel is an over-exaggeration.
Source: BMT JFA (2017)

Figure 5.2 Average daily sedimentation rate during disposal to the Western Disposal Area

[5] *Cutter suction dredges have been shown to only generate a small plume at the dredge head due to the large volumes of water pulled into the dredge pipe while dredging*

Given the short, sporadic nature of dredging operations in the Entrance Channel, short settling times and sparse coral habitat, it is unlikely that any plume generated will have a significant impact on BCH. Turbid plumes associated with the dredging will be temporary with limited spatial dispersion, as sediments will settle out of the water column before significant mobilisation by local currents. Coral communities that do experience sedimentation during dredging will likely be able to clear themselves of sediment, with sediment loads likely to be similar to those experienced in the area during times of high natural turbidity (i.e. during large rainfall events, strong tidal flows or storms). However, dredge plume monitoring will be completed as part of the Project environmental management commitments, with the extent of any plume experienced while dredging and disposal activities are occurring mapped at least daily.

Hypoxia

Hypoxia occurs when the concentration of dissolved oxygen in the water column drops below the level necessary to sustain most animal life (CENR 2000). If large amounts of organic material were released into the water column at the dredging area, bacterial decomposition of this material could deplete oxygen levels and lead to hypoxia.

The sediments sampled in 2016 had low TOC (maximum 1.2%) contents and negligible amounts of organic matter (Appendix F). Due to the highly dynamic water movement of Point Samson, there will be frequent exchanges of oxygenated water over the dredging and disposal areas during the campaign. Therefore hypoxia is considered to be a low risk during the dredging campaign and will not require monitoring and management.

5.5.3 Amenity

Social impacts of turbidity

Increased turbidity adjacent to the proposed dredging and disposal areas has the potential to reduce aesthetics and recreational value of the marine environment. However, it is unlikely that turbidity generated will have a significant negative social impact because turbidity effects on visual amenity are outweighed by improvements to safe vessel navigational access within the Entrance Channel and the Boat Harbour. In addition, Johns Creek is a naturally turbid environment, and the increase in turbidity is unlikely to be greater that what occurs naturally during high creek flows/high rainfall event.

Social impact of noise

The dredging and disposal machinery generates noise that can disturb people and wildlife located within auditory range of the works. The impact of noise on the local community and wildlife ('receptors') will depend mainly on:

- noise sensitivity levels of the receptors
- proximity of receptors to the noise
- presence of barriers between the noise source and receptors
- levels of ambient background noise regularly experienced by the receptors
- timing and duration of the noise
- level of noise generated by the dredge machinery.

Residential areas are usually considered to be the most sensitive receptors to noise, whereas commercial and recreational areas are considered to be less sensitive. The closest residential properties are located ~400 m northeast of the dredging and disposal area. Given that the proposed dredging and disposal areas are in the vicinity of commercial Boat Harbour operations, there is already an elevated level of ambient noise in the area.

The dredging campaign will be over a short-term duration, restricted to day time operations Monday-Saturday and, as such, exposure to noise will be limited and it is unlikely that noise generated by dredging will significantly impact local residents.

Wind-blown dust and sand

If wind-blown material is transported or deposited in public areas, it has the potential to cause a number of social and environmental problems including:

- build-up of wind-blown material on and around structures, on roads, houses, cars, vessels, etc.
- reduced visibility for vehicles and pedestrians
- increased wind erosion via attrition
- elevated water turbidity if considerable quantities are deposited in the sea
- health issues.

The dredging campaign is unlikely to cause an increase in wind-blown dust and sand because the disposal of wet dredged material is proposed to occur to a marine intertidal sand bar, and is comprised of very well sorted, cohesive clays. As a result, mobilisation of material within the disposal area will be limited and the generation of wind-blown dust and sand is unlikely to occur at levels causing environmental or social impacts during dredging.

Odour

Bacterial decomposition of organic material can deplete oxygen levels and lead to hypoxia and production of unpleasant odours. Odour is not expected to be an issue during the dredging campaign as:

- the sediments sampled in 2016 had low TOC contents and negligible amounts of organic matter (see Appendix F)
- odour was not recorded in any samples during the 2016 sampling (Appendix F).

Therefore it is not considered necessary to monitor or manage odour during the campaign.

5.5.4 Summary of key environmental and socio-economic issues

The following are considered to be key issues that may arise during the maintenance dredging at the Boat Harbour, and will require monitoring and/or management during the campaign (in order of importance):

- Marine and terrestrial environmental quality
  - release of metals and nutrients (dredging and disposal)
  - hydrocarbon spills and waste
  - increase in water column turbidity and smothering
- Benthic communities and habitat (including mangroves)
- Heritage
- Amenity
  - impacts on public safety, visual amenity and access
  - navigational hazards
- Marine fauna
  - introduced marine pests

The following are not considered likely to be key issues during the maintenance dredging and do not require active monitoring and management:

- Marine fauna
  - impact on threatened and migratory species
  - noise
- Marine environmental quality
  - acid sulphate soils
  - hypoxia
- Social surroundings
  - increase in water column turbidity
  - noise
  - wind-blown dust and sand
  - odour

5.6 Anticipated approvals pathway

Projects and developments in the State of WA that may potentially have a significant effect on the environment are required to be referred to the EPA for assessment under the EP Act (Section 3.2). Projects affecting MNES (see Section 3.3), or in Commonwealth lands and waters, are required to be referred to the DotE for assessment under the EPBC Act, however; the proposed Johns Creek maintenance dredging campaign is not located in Commonwealth lands and waters and is not anticipated to impact MNES.

5.6.1 Western Australian approvals pathway

Environmental Protection Act 1986

Due to the potential impact on the EPA factors of marine and terrestrial environmental quality (associated with release of contaminants during dredging and disposal) and public amenity, it is likely that the project will warrant referral to the EPA.

6. Monitoring and Management

6.1 Monitoring

Environmental monitoring shall be outlined in further detail in a DEMP to be prepared prior to the commencement of dredging. The sections below summarise the monitoring recommended based on the results of this DEIA.

6.1.1 Turbidity monitoring

While increased turbidity is not considered an environmental impact that requires active monitoring and management, in the absence of baseline data to determine plume extent within the offshore dredging and disposal locations, turbidity monitoring will be implemented. Monitoring in the form of daily site photographs and plume sketches will be completed within dredging and disposal areas.

6.1.2 Water quality monitoring

Copper concentrations in water elutriated from sediment samples within the Boat Harbour (Table 5.4) suggest small exceedances of the 99% species protection level (ANZECC/ARMCANZ 2000) are possible prior to dilution after discharge. The highest concentration of copper in elutriate were in a 'hot spot' area surrounding site JCH12 which will be managed to ensure potential copper release from the dredged slurry does not exceed the ANZECC/ARMCANZ (2000) 99% species protection guidelines (Figure 6.1). The hot spot has a surface area of 258 m^2 and estimated volume of 258 m^3 (Figure 6.1).

Elutriate testing applies a dilution of 1:4 (wet sediment: added seawater) as a highly conservative estimate of the concentrations expected after dredging and subsequent dilution in the marine environment four-hours after release.

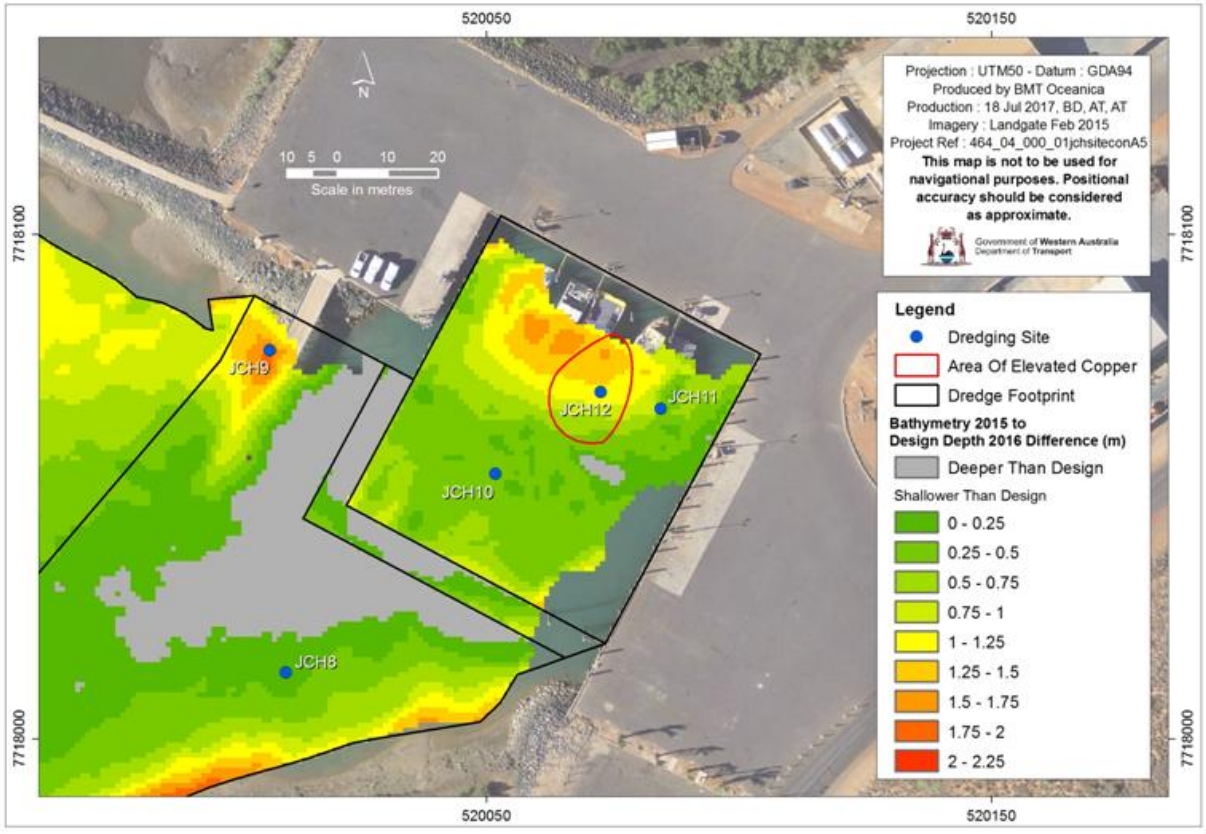


Figure 6.1 Estimated hot spot area surrounding site JCH12 of elevated copper in sediments and water

The mean concentration of copper in elutriate water (after a 1 part sediment to 4 parts of background seawater) from the 258 m^3 hot spot is 6 µg/L (Table 5.4). In reality, dredging mixes the 258 m^3 of sediments with 3,600 m^3 of background seawater over the 4 hour period (1 part sediment in 14.4 parts background seawater). Scaled accordingly, the anticipated copper concentration in dredge slurry disposed over this 4 hour period is estimated to be 2.01 µg/L.

VPLUMES initial dilution modelling was undertaken to determine the dilution of the dredge slurry after discharge. Modelling inputs are shown in Table 6.1. For a worst-case current speed of 0 m/s at the Western Disposal Area the dilution achieved from a single discharge outlet 200 mm in diameter (the size that will be used for disposal of dredge slurry to the Western Disposal Area) is 1:13. Applying the modelled dilution of 1:13 to the dredge slurry copper concentration of 2.01 µg/L with an assumed background concentration of 0.12 µg/L (Wenziker et al. 2006) results in a final copper effluent concentration after initial dilution of 0.26 µg/L. This is sufficient to meet the required ANZECC/ARMCANZ (2000) 99% species protection guideline for copper of 0.3 µg/L and provides confidence that the EPA's objective for marine environmental quality can be met during the disposal to the Western Disposal Area.

Table 6.1 VPLUMES initial dilution modelling inputs

Factor	Modelled value
Current speed	0 m/s
Average water depth	2.0 m
Pipeline diameter	200 mm

Calculating dilution based on a 0 m/s background current speed is highly conservative. The hydrodynamics of the Point Samson marine environment represent a complex combination of wind-forced waves, tides and currents that are further influenced by local bathymetry (API 2010). A desktop hydrodynamic and sedimentation assessment (BMT JFA 2017, Appendix G) was undertaken to provide a modelled estimate of current speed at the Western Disposal Area. The hydrodynamic model was run for 100 days (including two days' model warm up and 4 days after dredging completion). The simulated hydrodynamic period covers ~7 full typical tidal cycles (~14 days each cycle) including neap and spring tides. The simulated current and water level time series at the proposed Western Disposal Area showed the area is intertidal within strong tidal currents, up to 0.25 m/s (BMT JFA 2017). Complex interactions among local wind, wave and swell interactions are not considered in the desktop assessment and it is expected greater current speeds and further dilution would be achieved from these interactions.

DoT intends to include the following management and monitoring controls during disposal activities to demonstrate that the ANZECC/ARMCANZ (2000) 99% species protection guidelines are met and provide greater confidence that EPA factor - marine environmental quality is achieved:

- regular water testing for (at a minimum) metals (including copper) at the Boat Harbour, within the dredge plume, disposal area and reference site, while dredging within the Boat Harbour area
- daily plume monitoring
- daily benthic habitat (mangrove) monitoring

In addition to the above, the following management and monitoring controls will be implemented specifically while the site with the highest contamination concentrations (Figure 6.1) is being dredged, to ensure dilution is sufficient to meet the EPAs objective for marine environmental quality:

- additional water sampling for (at a minimum) metals (including copper) at the Boat Harbour, within the dredge plume, disposal area and reference sites
- pipe layout and diameter as per Table 5.2
- dredge and disposal over a four hour period encompassing a spring high tide (2 hours prior and 2 hours after) to maximise water currents and water depth at the disposal area and subsequently increasing dilution.
- control of dredge slurry so the hot spot is dredged over a four hour period, and the water:sediment ratio in the slurry is 3 600:258 m^3

6.1.3 Mangrove habitat monitoring

Habitat observations also are recommended for the Western Disposal area by the dredging contractor. Observations of any erosion or damage to the mangrove habitats near the disposal area will be completed. Should erosion or damage be noted, then evidence, in the form of photographs, will also be collected.

6.2 Management

Hydrocarbon spills and waste generation, navigational hazards, public safety, visual amenity and access impacts to threatened and migratory marine species, and introduced marine pests will require active management during the dredging campaign. Further details of the management procedures shall be detailed in the DEMP. To help manage any public concerns relating to the maintenance dredging, local government and community groups will be consulted prior to commencement of dredging. Further details on stakeholder consultation shall be provided in the DEMP. Public complaints will be managed in accordance with the DEMP for the Project.

The dredge contractor will also be required to ensure that no impacts are caused from the placement of dredge infrastructure (pipeline, machinery etc) on benthic habitats, including mangroves and corals. Pipelines will be stabilised to ensure abrasion of BPPH does not occur. Additional management measures will be included in the DEMP to ensure that BPPH will not be directly impacted.

6.3 Contingency plans

In the event of an environmental or safety issue arising during dredging, contingency measures will be implemented. Full details of contingency measures and procedures, and the reporting requirements to local government and environmental regulators, shall be detailed in the DEMP.

7. Stakeholder Consultation

The following agencies/individuals have been contacted regarding the capital dredging works:

- City of Karratha
- The Ngarluma Aboriginal Corporation
- Harbour lease holders and users

No objections to the work have been received to date (Table 7.1).

As part of the Dredging Management Plan, a public information sign and complaints phone number will be established and displayed at site prior to and for the duration of dredge works. Relevant stakeholders (including the City of Karratha, the Department of Water and Environmental Regulation and the Department of Biodiversity, Conservation and Attractions will be informed of works prior to commencement.

Table 7.1 Stakeholder consultation completed to date for the Johns Creek Boat Harbour maintenance dredging

<table>
<tr><th>Stakeholder</th><th>Consultation Status</th><th>Feedback/Queries</th></tr>
<tr><td>General Stakeholders</td><td>24 Nov 2016: the Department of Transport consulted with local Harbour users and lease holders during a site visit.

Public information signage and a complaints phone line will be maintained throughout the Project.</td><td>Local harbour users and lease holders did not concur with the proposed channel realignment. Based on user feedback, the Department of Transport decided to maintain the existing channel alignment with maintenance dredging.</td></tr>
<tr><td>City of Karratha</td><td>5 Jan 2018: email sent to the City of Karratha to provide a brief project description and current project status

9 Jan 2018: Comments were received from the City of Karratha

BMT and the Department of Transport will continue to liaise with the City of Karratha throughout the Project.</td><td>Email received from Ron Van Weile (Operations Coordinator, City of Karratha), 9 January 2018 8 and responses were provided to the City of Karratha on 12 January 2018.
<table>
<tr><th>City of Karratha feedback/queries</th><th>BMT/DoT's response</th></tr>
<tr><td><u>Environmental and Health.</u>
I don't think the City has any jurisdiction in land below the high tide mark. I may be wrong, but that's how I understand it.
On the other hand, it is highly likely that they need some form of environmental authorisation to carry out these works. Again, not sure if this falls under some marine authority (Dampier Port Authority will be able to provide guidance here, as they dredge the main shipping channel up to the RIO and Woodside wharfs and discharge the sediment out at sea away from reefs, etc.), Department Water and Environment Regulation (DWER), etc.
My only concern is the quality of the silt they will dredge up and what it contains (e.g. high levels of hydrocarbons, heavy metals, etc. accumulated over time in a harbour environment) and how this will impact the environment around the proposed dumping site</td><td>Environmental "authorisation" is provided through the referral process with the DWER under the EP Act, and through the DoT (as leaseholder) under the Maintenance Dredging Environmental Management Framework (EMF)

The quality of dredged material has been sampled and analysed for physical and chemical properties including a range of contaminants (hydrocarbons, heavy metals, etc) to assess the potential impacts on the environment and in line the DoT Environmental Management Framework (and National Assessment Guidelines for Dredging NAGD 2009). The outcome of this assessment indicated that the dredged material is suitable for placement in the nearshore disposal area. This process will be managed in accordance with the monitoring and management measures outlined in the Environmental Impact Assessment (EIA).

The DWER will also assess suitability during their assessment of the referral information</td></tr>
<tr><td><u>Operations</u>.
That all access to the public boat ramp, carpark and facilities used by the public are not impacted upon, minimised or result in restricting community usage of the facility including access to open</td><td>Disturbance to the public boat ramp, carpark and facilities will be kept to the minimum. The dredging contractor will be launching its dredging vessel from the southern boat ramp. The launching process will occur around the high tide and is typically completed</td></tr>
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</table>

<table>
<tr><td></td><td></td><td colspan="2"><table>
<tr><td>waters for private and public marine activities.
Communications with the City of Karratha's media team is undertaken enabling solid community advice and allowing feedback.
Safety of the site is paramount and monitored.
That works that are undertaken are in conjunction with the lease agreement between City of Karratha's and the Department of Transport currently in place for the area.</td><td>within 1-2 hours.

The dredge will maintain a navigational passage for other users during its operations inside and outside the boat harbour. Public and private access to and from the harbour is not planned to be restricted. In addition,

• Temporary Notice to Mariners will be issued by the Dept. of Transport's navigational safety team
• Communication with the City of Karratha will be maintained before and during the execution of works through project updates and weekly progress reports.
• We agree that safety is paramount. The dredging contractor (CGC Dredging) is required to manage the safety of the work site in accordance with the approved Health and Safety Management Plan.</td></tr>
<tr><td><u>Planning</u>
From a land tenure perspective generally, I am unsure who would be required to be consulted in regard to the proposed dredging outside of the immediate harbour area and the disposal area but probably it is DoT themselves. In fact I have just looked at Landgate and there is a huge Reserve (Reserve 51015) over the waters of nearly all of Nickol Bay right round Cape Lambert and includes the area they want to dredge and dispose of material. This Reserve has a Management Order to Dept of Transport for the purpose of 'Harbour Purposes'. In any case that is their responsibility to do those types of checks with any relevant Dept such as Dept of Lands, Dept of Water& Environmental Regulation, Fisheries etc… not ours. You may want to recommend that they consult those departments. They may already have just like they are consulting with us?</td><td>Johns Creek Boat Harbour (Harbour Reserve 39027) is under the Department of Transport's management order. The DoT is responsible to maintain the harbour waters and to maintain its navigational safety. The DoT will be consulting with other relevant external stakeholders.</td></tr>
</table></td></tr>
<tr><td>Ngarluma Aboriginal Corporation</td><td>21 Sep 2016: a query was sent to Richard Walker (Heritage Manager – Ngarluma Aboriginal Corporation) from BMT to determine if Section 18 Notice with the Minister for Aboriginal Affairs will be required.</td><td colspan="2">Consultation with Richard Walker commenced when it was realised that the original disposal area occurred within a Aboriginal heritage area. Subsequently, the Department of Transport has moved the proposed disposal area to outside of any registered aboriginal heritage area. The construction methodology has also been amended to avoid any land disturbance. All of the dredged material will be placed outside of the harbour.

Based on the following considerations, we (BMT) believe that the dredging campaign will not adversely impact on any Aboriginal Heritage Sites:</td></tr>
</table>

	7 Nov 2016: Richard Walker advised that Section 18 Notice will be required. The disposal site was subsequently moved outside of the registered aboriginal heritage site, and consultation is ongoing to determine if a Section 18 Notice is required	• the works to be carried out involve removal of recently deposited sediment that has accreted in the Johns Creek Boat Harbour and Entrance Channel through natural processes, since the construction of the boat harbour; • land based excavation or land disturbance is not required as part of the works; • all of the dredging works will occur on the water; • dredged material disposal will be placed outside of the boat harbour and away from the registered Aboriginal Heritage Site or an Other Heritage Place. Consultation process is ongoing

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