360 environmental

Marine Support Base

Henderson, WA

Dredge Management Plan

Prepared for:

AME Pty Ltd

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people • planet • professional

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Executive Summary

AME Pty Ltd (AME) operate a waterfront marine support base within the Australian Marine Complex at Henderson Point. AME intend to expand their facility and further develop the waterfront infrastructure by undertaking a dredging programme within an area of Northern Harbour immediately adjacent to their site and utilising the dredge sediments to create a land-backed wharf adjacent to their existing landholding.

The proposal area, within Northern Harbour's marine industrial precinct, is afforded a Moderate Ecological Protection Area (MEPA) status and is located on seabed leased to AME by the Department of Transport (DoT).

Baseline investigations undertaken within the proposed dredge and reclamation areas concluded the following:

- The dredge material is unlikely to significantly impact the existing environment in the proposed reclamation area if considered for use as fill; and
- It is unlikely that the mobilisation of sediments within the dredge area will significantly impact the water quality or aquatic organisms within Jervoise Bay.

This Dredge Management Plan (DMP) has been prepared based on the existing site information and data obtained from the baseline investigations to ensure there is minimal impact resulting from the proposed activities, and more specifically that the proposal does not impact the ecosystem health of Cockburn Sound.

The DMP is a supporting document to the project referral under Part IV of the *Environmental Protection Act 1986*. Table A outlines the details of the preliminary project environmental impact assessment as discussed at a pre-referral meeting with the Office of the Environmental Protection Authority (EPA). The key factors considered further in the DMP are:

- Benthic Communities and Habitat;
- Marine Environmental Quality; and
- Marine Fauna.

Table A: Environmental Factors Summary

EPA Factor	Policy and Guidance	Consultation	Receiving Environment	Proposal Activities	Mitigation	Impacts	Assumptions
Benthic Communities and Habitat	Environmental Factor Guideline: Benthic Communities and Habitat Technical Guidance: Protection of Benthic Communities and Habitat	Liaison with Cockburn Sound Management Council (CSMC) and review of existing data indicates that there is no vegetated habitat within 1 km of the site.	The receiving environment of the site is soft, fine sediments devoid of benthic communities.	The project activities are not expected to impact benthic communities or habitat given the lack of vegetated habitat within Northern Harbour.	Dredge Management Plan detailing water quality monitoring requirements to protect benthic communities and habitat outside the expected impact zone.	Likely to meet EPA objective: *To protect benthic communities and habitats so that biological diversity and ecological integrity are maintained.*	Zone of Influence will not extend beyond the limit of Northern Harbour.
Marine Environmental Quality	Environmental Factor Guideline: Marine Environmental Quality Technical Guidance: Protecting the Quality of Western Australia's Marine Environment	Desktop study, including liaison with CSMC, on existing water quality. Baseline sediment investigations, which indicate trace levels of expected contaminants (copper and TBT) and nutrients.	The receiving environment is industrial with related contaminants, including heavy metals and organics, and high nutrient content from groundwater flow.	Potential impact to water quality of Northern Harbour during dredge/excavation operations, particularly nutrients, metals and organics released into the water column through sediment disturbance.	Implementation of this Dredge Management Plan including water quality monitoring and triggers for further investigation or management measures.	Likely to meet EPA objective: *To maintain the quality of water, sediment and biota so that environmental values are protected.*	Zone of Influence will not extend beyond the limit of Northern Harbour.

EPA Factor	Policy and Guidance	Consultation	Receiving Environment	Proposal Activities	Mitigation	Impacts	Assumptions
Marine Fauna	Environmental Factor Guideline: Marine Fauna	Desktop study of marine fauna in Cockburn Sound indicates the Indian Ocean Bottlenose Dolphin is the most likely to occur near the site.	The receiving environment is an industrial area with regular large vessel movements.	Potential impact to cetaceans from elevated turbidity and potential vessel interactions during dredging and vessel movements.	Implementation of measures within this Dredge Management Plan to ensure marine fauna are protected, including fauna observers and shut-down zones.	Likely to meet EPA objective: *To protect marine fauna so that biological diversity and ecological integrity are maintained.*	Project area does not represent key habitat.
Hydrological Processes	Environmental Factor Guideline: Hydrological Processes	Onsite surface and groundwater investigation.	Currently the regional groundwater flow is westerly into Northern Harbour (or the wider Cockburn Sound)	The reclamation area may alter the localised flow of groundwater however this impact is considered to be minimal on a regional scale.	No management measures are considered to be required.	Expected to meet EPA objective: *To maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.*	Negligible impact on the flow of groundwater.

EPA Factor	Policy and Guidance	Consultation	Receiving Environment	Proposal Activities	Mitigation	Impacts	Assumptions
Social Surroundings	Environmental Factor Guideline: Social Surroundings (EPA 2016)	Review of public use of the harbour and adjacent areas.	The distance to nearest known recreational boat use area (Woodman Point) ~1 km.	Potential disturbance to recreational boat users by vessel movement associated with dredging activities.	Exclusion zone to ensure public safety and a Notice to Mariners if deemed necessary by Department of Transport.	Expected to meet EPA objective: *To protect social surroundings from significant harm*.	The site is not typically utilised by the public for recreational purposes.
	Historical Shipwreck Act 1976	Liaison with WA Museum and the commonwealth Department of Environment and Energy regarding the Redemptora (shipwreck)	The Redemptora is located within the proposed reclamation area (refer Figure 2).	Potential disturbance to the Redemptora during dredging and reclamation activities.	Agreement with WA Museum to retain Redemptora within the reclamation area and clear demarcation of the shipwreck provided to Dredging Contractor prior to commencement.		*In-situ* preservation of the Redemptora is the best outcome for Heritage.
	Environmental Protection (Noise) Regulations 1997	N/A	The site is within an industrial area.	Potential impact to local amenity by increased noise levels.	Equipment to be well maintained.		24 hour works may be considered with necessary approvals.
	Aboriginal Heritage Act *1972*	Aboriginal Heritage Inquiry System search returned no registered sites within or adjacent to the project area.	The site is within an industrial area	Potential impact to unknown sites of heritage significance	Immediate reporting of any unexpected finds to Department of Aboriginal Affairs.		N/A

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Acronyms

ACRONYM	DEFINITION
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
COPC	Contaminants of Potential Concern
CS Act	*Contaminated Sites Act 2003*
CSMC	Cockburn Sound Management Council
DoT	Department of Transport
DWER	Department of Water and Environmental Regulation
EPA	Environmental Protection Authority
EQG	Environmental Quality Guideline
EQS	Environmental Quality Standard
mAHD	metres Australian Height Datum
MEPA	Moderate Ecological Protection Area
NAGD	National Assessment Guidelines for Dredging
NATA	National Association of Testing Authorities
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
PAH	Polycyclic Aromatic Hydrocarbon
QAQC	Quality Assurance / Quality Control
SAP	Sampling Analysis Plan
TBT	Tributyltin
TRH	Total Recoverable Hydrocarbon
TSS	Total Suspended Solids

1 Introduction

AME Pty Ltd (AME) operates a waterfront marine support base within the Australian Marine Complex at Henderson Point. The site is located within Northern Harbour in Cockburn Sound, approximately 22 km southwest of Perth, Western Australia (Figure 1).

1.1 Proposal

AME intends to expand the facility and further develop the waterfront infrastructure by undertaking a dredging programme within an area of Northern Harbour immediately adjacent to the site and utilising the dredged sediments to create a land-backed wharf adjacent to the existing lease (Figure 2). Table 1 provides an overview of the proposal.

Table 1: Project Summary

Title of proposal	Marine Support Base Dredge and Reclamation
Proponent name	AME Pty Ltd
Purpose	This Dredge Management Plan (DMP) provides a framework for the management of potential impacts for the duration of the proposed dredging and reclamation operations. The purpose of the DMP is to support a referral to the Office of the Environmental Protection Authority (Office of the EPA) under Part IV of the *Environmental Protection Act 1986* (EP Act).
Key environmental factors and objectives	**Benthic Communities and Habitat** *To protect benthic communities and habitats so that biological diversity and ecological integrity are maintained.*
	Marine Environmental Quality *To maintain the quality of water, sediment and biota so that environmental values are protected.*
	Marine Fauna *To protect marine fauna so that biological diversity and ecological integrity are maintained.*
Key provisions of the DMP	Please refer to Section 4.

1.1.1 Dredging

To allow safe and unrestricted access for vessels, dredging is required to create a navigable area with a draft of -8.0 m Australian Height Datum (AHD). The bathymetry within the proposed dredging area currently ranges from -2.0 mAHD to -7.0 mAHD. The proposed capital dredge volume is ~80,000 m^3 over an area of ~29,000 m^2.

The dredge methodology is yet to be finalised but is proposed to be undertaken by either backhoe dredge (BHD) or cutter suction dredge (CSD).

1.1.1.1 Excavation Method

The BHD methodology involves a barge mounted excavator loading material directly onto a barge, which is then transferred to the reclamation area via land based equipment (i.e. excavator or crane mounted grabs).

1.1.1.2 Hydraulic Method

Hydraulic dredging by the CSD methodology typically uses a "cutting head" that loosens the substrate via mechanical cutting or high pressure jets to create a slurry, which is then recovered by a suction tube behind the cutting head. The dredge slurry is then pumped through a tube directly into the reclamation area.

It is possible, depending on the nature of the underlying natural consolidated material, that a combination of both methods may be utilised. In both cases, a land-based long reach excavator will work continuously to retrieve and stockpile the disposed material to progressively form the reclamation area outward from the existing shoreline.

1.1.2 Reclamation

The dredge material will be utilised as fill to reclaim a parcel of land adjacent to the existing landholding; the proposed reclamation area is ~10,500 m^2 (approximately 155 m along the shore and extending 30-80 m offshore, refer Figure 2).

It is proposed that all of the dredge sediments will be used for the creation of the land backed wharf. If there is any remaining material, it will be disposed of at a licensed landfill facility following appropriate testing and data assessment. Should any additional material be required to complete the proposed reclamation area, suitable material will be sourced from an offsite location and assessed for contamination prior to use onsite.

The reclamation area will be progressively created from the placement of dredge sediments followed by the formation of the wharf by sheet piling or rock armour wall. Final excavation of mounded material from the dredge area will be undertaken from the newly formed wharf.

1.1.3 Project Schedule

The proposed dredging methodology is yet to be finalised, however initial discussions with contractors indicate that the works will take between eight (8) and 30 weeks.

The works are planned to commence during the summer of 2017/18.

1.2 Key Environmental Factors

A summary project environmental impact assessment was discussed at a pre-referral meeting held on 14 October 2015. Table A presents the summary, which has since been updated following further investigation and stakeholder consultation.

The key environmental factors that require management include:

- Benthic Communities and Habitat;
- Marine Environmental Quality; and
- Marine Fauna.

1.2.1 Social Surroundings – Heritage

The *Redemptora* shipwreck, which is protected under the *Historic Shipwrecks Act 1976*, was identified through the impact assessment process. Liaison with the Western Australian Museum (WA Museum) and subsequent investigations led to a more sound understanding of the nature of the wreck and assisted discussions on management options. A report prepared by the WA Museum (Richards 2016) concluded that the most appropriate action would be *in-situ* preservation of the *Redemptora* by burial within the reclamation area. This has now been incorporated into the design and will not be discussed further herein.

1.3 Rationale

A desktop review of existing information, along with site baseline investigations have contributed to the preparation of this DMP. The following assumptions have been made:

- The zone of influence will not extend beyond the physical boundary of Northern Harbour. This assumption is based on the high residence time (low flushing rate) of the Northern Harbour, which will allow suspended sediments ample time to re-settle following disturbance, and the limited spatial and temporal extent of the proposed disturbance.
- The proposed activities can be undertaken at any time of the year.

1.3.1 Structure

The DMP provides the following:

- Outline of the dredging and reclamation proposal (Section 1);
- Summary of the existing environment (Section 2);
- Overview of the baseline investigation results (Section 3);
- Consideration of the potential impacts associated with the proposal and framework to ensure appropriate environmental management (Section 4); and
- Summary of the stakeholder consultation undertaken as part of the assessment process (Section 5).

2 Existing Environment

2.1 Setting

Cockburn Sound is managed by the Cockburn Sound Management Council (CSMC) under specific policy and guidance:

- State Environmental (Cockburn Sound) Policy 2015 (EPA 2015);
- Environmental quality criteria reference document for Cockburn Sound – a supporting document to the State Environmental (Cockburn Sound) Policy 2015 (EPA 2017); and
- Manual of Standard Operating Procedures: For Environmental Monitoring against the Cockburn Sound Environmental Quality Criteria (2003-2004) – a supporting document to the State Environmental (Cockburn Sound) Policy 2005 (now 2015), Report 21 (EPA 2005).

Within Cockburn Sound there are two levels of environmental quality criteria:

- **Environmental quality guidelines (EQG)** – which, if met, indicate there is a high degree of certainty that the associated environmental quality objective has been achieved. If a guideline is not met, there is uncertainty whether the environmental quality objective has been achieved. This triggers a more detailed assessment against an environmental quality standard.
- **Environmental quality standards (EQS)** – which indicate a level beyond which there is a significant risk that the associated environmental quality objective has not been achieved. This triggers an adaptive management response. The response would normally focus on identifying the cause (or source) and reducing loads of the contaminant of concern.

Of the five environmental values described (Ecosystem Health, Fishing and Aquaculture, Recreation and Aesthetics, Cultural and Spiritual, and Industrial Water Supply), Ecosystem Health is the key value that requires management for the duration of the proposed activities.

The proposal area is afforded a Moderate Ecological Protection Level (MEPA) status (EPA 2013) and is located within an area of seabed leased to AME by the Department of Transport (DoT) in the marine industrial precinct in Northern Harbour, Cockburn Sound.

Jervoise Bay Northern Harbour has an approximate size of 77 hectares and a volume of 6.2M m^3. The average residence time of water (or flushing rate) in the harbour is approximately 9.3 to 9.7 days (CSMC 2012).

2.2 Terrestrial Vegetation

The presence of vegetation is noted along the shoreline within the proposed reclamation area. It is acknowledged that if the proposed activities are "not assessed" under Part IV of the EP Act, then the necessary approvals for clearing under Part V of the EP Act will be considered.

2.3 Benthic Communities and Habitat

A benthic habitat study undertaken across the eastern portion of Cockburn Sound (Figure A, DALSE et al. 2004) indicated that the site lies within an area of fine sediment and that no seagrass is located within approximately 2 km of the site (1 km from the site to the opening of Northern Harbour and a further 1 km from the opening to the nearest mapped seagrass).

Further, considering the highly disturbed nature of the project area and high light attenuation (Keesing et al. 2016) observed throughout Northern Harbour, the fine sediments are unlikely to support benthic communities that are important for regional primary production.

An onsite assessment of the *Redemptora*, which lies partially within both the proposed dredge and reclamation areas, noted the presence of algal growth on the wreck structures, but did not note the presence of any benthic habitat (Richards 2016). Further confirmation was provided during the baseline sediment investigations where there was no benthic habitat observed by divers during the dredge area investigation (pers. comm. MAFRL Field Manager 2017) nor field staff during sediment sample retrieval during the reclamation area investigation.

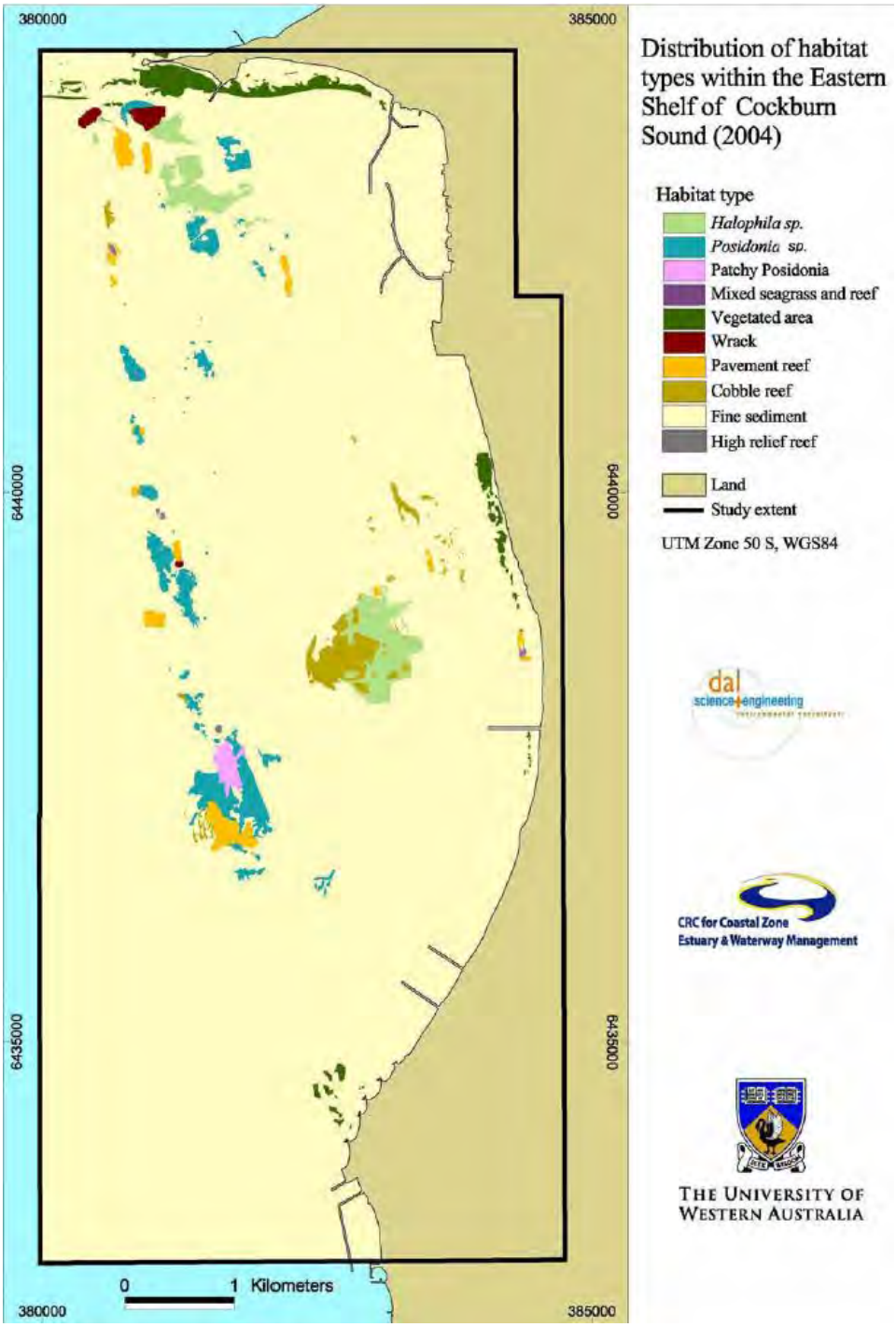

Figure A: Benthic Habitat within Cockburn Sound (DALSE et al. 2004).

2.4 Marine Environmental Quality

2.4.1 Sediment Quality

Vessel construction, repair and maintenance undertaken at the majority of facilities within the Marine Complex includes works undertaken on vessels with an antifouling treatment coating, which historically contained tributyltin (TBT), and/or heavy metals

such as copper and lead. When vessel repairs are undertaken on the dry dock facility there is the potential for these contaminants to discharge to the waterway and bind to the surface sediments.

Historic site operations, relating to boat manufacturing and maintenance at this and adjacent sites, have contributed to the contamination of sediments in Northern Harbour. This has been confirmed by numerous investigations undertaken in the vicinity to the proposal area (refer Figure 3); the closest investigation undertaken by Coffey (2011) reported EQG exceedances of copper and TBT.

2.4.2 Water Quality

Annual water quality monitoring results in Jervoise Bay Northern Harbour have been reported exceeding the Environmental Quality Standards and Guidelines (EQS/G) for many years, since the construction of the breakwater in 1997. The phytoplankton biomass EQS in Jervoise Bay Northern Harbour has not been met since 2003 when reporting began. This is attributed to high levels of nitrogen in groundwater flowing into the Northern Harbour from contaminated groundwater plumes (refer Figure 4) and increased residence times associated with the construction of the northern breakwater (CSMC 2012).

The most recent phytoplankton biomass (chlorophyll a) data for Jervoise Bay Northern Harbour reported a site median of 3.6 µg/L (values ranged from 2.0-5.8 µg/L[1]) against an EQG of not exceeding 3.0 µg/L on 50% or more occasions. This site also exceeded the EQS of not exceeding the criteria in two consecutive years (CSMC 2016b).

2.5 Marine Fauna

A desktop study of Cockburn Sound indicates that it is an important spawning ground and nursery area for Pink Snapper, an important foraging area for Little Penguins, and an important nursery and feeding area for resident Bottlenose Dolphins (CSMC 2012, CSMC 2016). However, the project area, within Northern Harbour, is a highly disturbed industrial precinct that is unlikely to support the foraging and/or breeding habitat of these species.

[1] Raw data from 2015-16 provided by email on request by CSMC, September 2017.

3 Baseline Investigations

Baseline investigations were undertaken within the proposed dredge and reclamation areas to determine sediment quality status prior to commencing the proposed activities.

3.1 Dredge Area

A baseline investigation was undertaken within the dredge area to characterise the sediments and determine the potential for mobilisation of contaminants into the water column via sediment disturbance. The Baseline Sediment Investigation – Dredge Area (360 Environmental 2017a) is briefly summarised below.

The contaminants of potential concern (COPC) determined through assessment of previous data and consideration of historical and current land uses included:

- nutrients (total nitrogen [TN] and total phosphorous [TP]);
- heavy metals (Cu, Ni, Pb, Zn);
- tributyltin (TBT);
- total recoverable hydrocarbons (TRH); and
- polycyclic aromatic hydrocarbons (PAH).

Particle size distribution (PSD) was also analysed to understand the composition of the sediments planned for disturbance.

3.1.1 Sediment

The initial sediment results indicated that copper and TBT levels exceeded the interim sediment quality criteria (ISQG, ANZECC/ARMCANZ 2000) and environmental quality criteria (EQC, EPA 2017), however further analysis by dilute acid extraction as a closer approximation to bioavailability (copper only) and elutriation (copper and TBT) reported results compliant with the corresponding sediment (copper) and water quality (copper and TBT) guidelines.

There are no applicable sediment nutrient guidelines, so elutriate analysis was performed on all samples to compare against water quality guidelines. Raw elutriate results exceeded the inshore marine trigger levels for south-west Australian slightly disturbed ecosystems (ANZECC/ARMCANZ 2000), however it is considered that the site (a MEPA within Cockburn Sound) is more highly disturbed and furthermore the NAGD (CA 2009) suggests dilution of 100x or more may occur following mobilisation of contaminants. It is acknowledged that contaminants may not disperse as readily in Northern Harbour so a calculation of the raw elutriate data against the guidelines was undertaken and indicates that much lower dilutions are required for guideline compliance (1:6 for TN and TP, 1:15 for ORP, and <1:2 for NO_x). These dilutions are expected to be achieved following disturbance of sediments at the site and nutrients, among other COPC, will be monitored during the proposed activities as outlined in Section 4.2.

3.1.2 Water

There were no reported exceedances of the EQC or 90% SPL for any COPC in the integrated water samples taken at two locations within the dredge area.

3.2 Reclamation Area

A baseline sediment and groundwater quality investigation was undertaken within and adjacent to the proposed reclamation area to determine the extent of existing contamination, prior to the placement of artificial fill (dredge spoil). The Baseline Sediment Investigation – Reclamation Area (360 Environmental 2017b) is briefly summarised below.

The COPC determined through assessment of previous data and consideration of past and current land uses include:

- nutrients (TN and TP);
- heavy metals (Cu, Ni, Pb, Zn);
- TBT;
- TRH; and
- PAH.

3.2.1 Sediment

TBT exceeded the sediment quality criteria (ANZECC/ARMCANZ 2000) and environmental quality criteria (EPA 2017) in all three samples analysed, however the reported levels were comparable to the dredge area where all raw elutriate TBT results were compliant with the guidelines. Considering the similarity of the sediment composition within the dredge and reclamation areas it is expected that the mobilisation of TBT would be similar between the dredge and reclamation areas and is not expected to pose an unacceptable risk to the ecological environment.

There were no other exceedances.

3.2.2 Groundwater

TN exceeded the ANZECC (2000) and EQG (EPA 2017) criteria, however the value (2.9 mg/L) is lower than the 25-year target background level of 4 mg/L (CSMC 2012).

3.3 Risk Assessment

Based on the findings of the dredge area and reclamation area investigations completed at the site, a Conceptual Site Model (CSM, Table 2) has been prepared as part of the risk assessment and has incorporated consideration of the following additional information:

- The presence or absence of COPCs;

- Exceedances of Tier 1 screening criteria;
- Potential toxicological exposure risks associated with the key COPCs; and
- Fate and transport mechanisms associated with the key COPCs.

The linkages between the sources, pathways, receptors and exposure routes will determine if a complete, potential or incomplete exposure pathway exists. The status of the exposure pathway will determine the presence of potential risk to human health and/or environment. Exposure pathway categories are summarised as follows:

COMPLETE	All elements are present. Actual risk exists.
POTENTIALLY COMPLETE	One or more of the elements may not be present, and/or information is insufficient to eliminate or exclude the element. The potential for risk exists.
INCOMPLETE	One or more of the elements are absent. There is no risk.

As a result of the information gathered through the dredge area and reclamation area baseline investigations, a qualitative assessment of the likelihood of risk at the site has been provided using the following risk ranking criteria:

- An **Insignificant** risk ranking has been applied where:
  - concentrations of COPCs are below the LOR,
  - the exposure pathway has been defined as incomplete.
- A **Low** risk ranking has been applied where:
  - concentrations of COPCs exist above LOR,
  - no visual signs of impact are reported within the receptor (e.g. the boundary vegetation is not stressed), and/or
  - potential receptors are located at a significant distance from the site and are unlikely to be impacted
- A **Moderate** risk ranking has been applied where:
  - concentrations of COPCs exist above LOR and Tier 1 Assessment criteria but toxicity risk has not been quantified and
  - a sensitive receptor is present that would have continuous exposure to impacts.
- A **High** risk ranking has been applied where:
  - concentrations of COPCs exist above LOR and Tier 1 Assessment criteria and toxicity risk has been quantified; and
  - a sensitive receptor is present that would have continuous exposure to impacts.

Table 2: Conceptual Site Model

POTENTIAL SOURCE	COPC	RELEASE MECHANISM	SECONDARY SOURCE	SECONDARY RELEASE MECHANISM	MIGRATION PATHWAY	RECEPTOR	EXPOSURE ROUTE	EXPOSURE PATHWAY	RISK ASSESSMENT
Impacted Dredge Sediments	• Copper • TBT • TN	• Potential desorption of COPCs from leaching	Sediments within the Reclamation area	• Potential desorption of COPCs from leaching	**Sediments:** • The dredge and reclamation sediments may contain contaminants that may desorb and mobilise into the water column.	Human Health: • Current and Future Site workers • Future site workers undertaking dredging works Ecology: • Future Terrestrial Ecosystems	• Direct Contact • Accidental ingestion	INCOMPLETE	• The site and surrounding land uses are currently used for commercial/industrial purposes • The future land use for the site is not proposed to be changed. • Detected concentrations of TBT, heavy metals (Cu, Hg, Ni, Pb and Zn) and PAHs did not exceed Human Health Investigation Levels (HIL) in any of the sediments collected from the proposed reclamation and dredge areas. In the absence of Tier 1 exceedances, a **low** risk has therefore been applied for direct contact and ingestion of sediment.
					Biotic: • Sediment contamination could be taken up via marine ecological processes.	Ecology: •Marine water ecosystems	• Direct Contact • Ingestion • Biotic uptake	INCOMPLETE	• Copper and TBT concentrations exceeded the NAGD (CA 2009) Screening Level, the EPA (2017) EQG and the ANZECC/ARMCANZ (2000) ISQG-low in the sediments collected from the proposed reclamation and dredge areas. However elutriate tests investigating the bioavailability and/or desorption of contaminants from sediment particulates to waters indicated that all samples for TBT and copper reported results below the 90% species protection levels (ANZECC/ ARMCANZ 2000) prior to any dilution factor being applied. • It was considered that the TBT and copper in the sediments is unlikely to become mobilised into the water column or become bioavailable to organisms. • Further, it is proposed that the dredge material be disposed of to the reclamation area adjacent to the dredge area and when TBT is exposed to oxygen and ultraviolet light, it degrades rapidly and hence this disposal method will act to effectively remediate these sediments. • TN, TP and PO4-P exceeded the criteria at all sites within the proposed dredge area. There was however only one reported exceedance of the NOx-N criteria at Site S1. It is noted that groundwater is a major contributing source of nutrients in sediment and surface water within the Cockburn Sound area from former nitrogen-rich plumes (CSMC 2012). A **low** risk has therefore been applied to biotic receptors.
			Groundwater	• Dispersion, diffusion, advection of COPCs	**Groundwater:** • Vertical migration of contaminants through the vadose zone to groundwater and lateral migration in continuous water-bearing zones, is present.	Human Health: • Current and Future Site workers	• Direct Contact • Accidental ingestion	INCOMPLETE	• Groundwater is not currently used and is not planned to be used onsite An **insignificant** risk has therefore been applied to human receptors.
					Biotic: • Groundwater contamination could be taken up via roots • The Indian Ocean is located directly hydraulically down-gradient of the site • The ocean (tides) is interacting with groundwater.	Ecology: • Marine water ecosystems	• Direct Contact • Ingestion • Biotic uptake	INCOMPLETE	• With the exception of total nitrogen which was reported to exceed ANZECC/ARMCANZ 2000 Marine Water, detected concentrations of copper, total phosphorous and naphthalene were all below the adopted Tier 1 assessment guideline. • Groundwater within the Cockburn Sound area is known to have been historically impacted by former nitrogen-rich plumes (CSMC 2012). A **low** risk has therefore been applied to biotic receptors.
			Marine Water (Indian Ocean)	• Dispersion, diffusion, advection of COPCs	**Water:** • Due to the proximity of the Indian Ocean to the edge of the site, surface water and groundwater are likely to interact	Human Health: • Current and Future Site workers • Future site workers undertaking dredging works Ecology: • Marine Water Ecosystems	• Direct Contact • Accidental ingestion	INCOMPLETE	• Two marine water samples were analysed for the nominated COPC and all results were reported below the applicable criteria (ANZECC 2000, EPA 2017). In the absence of Tier 1 exceedances, an **insignificant** risk has therefore been applied to human and ecological receptors.

3.4 Outcome

It is apparent via visual observation that the sediments within the proposed dredge area are disturbed on a regular basis by large vessels associated with other operators within Northern Harbour. It is therefore considered a long-term benefit to deepen this area of the harbour and reduce the continued mobilisation of nutrients into the water column via ongoing vessel movements.

The following was concluded following the baseline investigations:

- The dredge material is unlikely to significantly impact the existing environment in the proposed reclamation area if considered for use as fill; and
- It is unlikely that the mobilisation of sediments within the dredge area will significantly impact the water quality or aquatic organisms within Jervoise Bay.

4 Impacts and Management

The following sections describe the potential impacts and management of the three identified key factors.

4.1 Benthic Communities and Habitat

4.1.1 Potential Impact

The potential impacts to benthic communities and habitats include direct loss by removal or burial, and/or indirect impacts from the effects of sediments introduced to the water column by the dredging and disposal.

There will be no direct impact to benthic vegetated areas due to the absence within the project area, or the wider Northern Harbour. Furthermore, it is unlikely that the highly disturbed fine sediments within the project area could support benthic communities that are important for regional primary production.

4.1.2 Project Objective

No impact to the nearest mapped area of seagrass (refer Figure A).

4.1.3 Management

Specific management measures are not considered to be required to limit indirect impacts given the separation distance to the nearest known benthic communities in Jervoise Bay, Cockburn Sound.

4.1.4 Monitoring

Visual monitoring will be undertaken on a daily basis. Physical monitoring and tracking of the plume (turbidity and light attenuation) via a vessel will be undertaken if a significant visible plume is extending >50 m beyond the project boundary, defined as the northern limit of the "site location" extending west to the seawall. The data will be assessed against the annual EQG[2] and baseline readings undertaken prior to works commencing and a suitable control site outside of Northern Harbour[3].

Should the physical monitoring result in confirmation that a turbid plume emanating from the dredging operations has potential to impact the nearest vegetated benthic habitat (i.e. if the plume is confirmed present beyond the limits of Northern Harbour[4]), the dredging operations will cease until the issue is rectified, in consultation with CSMC.

[2] The EQG for light attenuation is currently 0.113 m^{-1}
[3] It should be noted that direct comparison of turbidity and light attenuation between sites inside and outside of Northern Harbour is not possible and rather the difference in levels from baseline measurements will be used for comparison, not the raw data.
[4] Turbidity and/or light attenuation values recorded >20% above baseline.

Water quality monitoring will be undertaken as part of the protection of Marine Environmental Quality and is discussed further in Section 4.2.

4.1.5 Reporting

If it is confirmed that a turbid plume related to the dredging operations extends beyond the limits of Northern Harbour, CSMC will be notified in writing within 48 hours of this being recorded.

4.2 Marine Environmental Quality

4.2.1 Potential Impact

The potential impacts of the proposed activities include:

- mobilisation of contaminants via sediment disturbance; and
- hydrocarbon spill from working vessels.

4.2.2 Objective

The key objectives of the project are:

- No significant[5] impact to the water quality adjacent to the site from mobilised contaminants, when compared to applicable guidelines and baseline data.
- No significant[5] increase in phytoplankton biomass, when compared to the most recent CSMC adapted annual value and actual reported data.
- No spills to the marine environment.

4.2.3 Management

The following management measures will be implemented during the proposed activities:

- Trained contractors to ensure minimal loss of sediments;
- Dredging undertaken from well maintained and inspected vessels which are free from structural defects and potential sources of leakages;
- Well-maintained equipment used for transport of dredged material;
- A suitable positioning system, that ensures reasonable accuracy of dredging both horizontally and vertically;
- Waste management, including spill kits, storage and disposal bins, to be undertaken in accordance with Integrated Management System (IMS)-15 Waste Management Procedure;

[5] The term "significant" is used here to mean a measureable change of greater than 20% increase for a continued period of more than one week.

- Refuelling of equipment will be undertaken in accordance with AME Work Instruction (WI)-06 Refuelling; and
- Spill response in accordance with the AME Work Instruction WI-16 Hydrocarbon and Chemical Spill Response.

4.2.4 Monitoring

4.2.4.1 Water Quality

Locations

Monitoring will be undertaken at four locations (refer Figure 4):

- Site 1 – immediately adjacent to the dredge area, to characterise the contaminant release from the disturbance zone within the site boundary;
- Site 2 – north of the site boundary, to characterise the potential impact beyond the site boundary;
- Site 3 – near the entrance to Northern Harbour; and
- Site 4 – a site outside of Northern Harbour, within Jervoise Bay, for the purpose of assessing the wider impact, if assessment criteria are exceeded.

It is not considered appropriate to directly compare the water quality of sites within Northern Harbour to sites within the wider Jervoise Bay and Cockburn Sound due to the existing poor water quality identified within Northern Harbour (CSMC 2016a, CSMC 2012). It may be possible to assess the difference between sites inside and outside of Northern Harbour to determine if exceedances are attributable to the project activities (i.e. if any COPC increases comparably at Site 2 and Site 4 and there is no evidence that the project activities could be impacting Site 4, then other sources, or natural occurrence will be investigated and discussed with CSMC).

Schedule

A baseline WQ monitoring event will be undertaken within one week prior to the commencement of any staged project activities that may cause sediment disturbance (i.e. dredging, wharf construction, and/or piling).

Visual monitoring will be undertaken on a daily basis for turbid plumes and algal blooms. Physical monitoring and tracking (turbidity and light attenuation) via a vessel will be undertaken during the subsequent water quality monitoring event if a visible plume is extending beyond the project boundary. The data will be assessed against the baseline readings undertaken prior to works commencing and a suitable control site outside of Northern Harbour[6].

[6] It should be noted that direct comparison of turbidity and light attenuation between sites inside and outside of Northern Harbour is not possible and rather the difference in levels from baseline measurements will be used for comparison, not the raw data.

Water quality monitoring[7] will be undertaken weekly during the initial phase of dredging activities and scheduled for expedited analysis to ensure prompt response to any confirmed exceedances. If the initial results (first four events) indicate that project activities are not adversely impacting the surrounding environment, ongoing monitoring will be undertaken fortnightly for the remainder of the dredge and reclamation activities.

Laboratory Analysis

Based on the outcome of the baseline investigations, the COPCs that will be scheduled for analysis are:

- nutrients (TN, TP, NH_4-N, PO_4-P, NO_x)
- metals (Cu, Hg, Ni, Pb, Zn);
- tributyltin; and
- chlorophyll-a (to determine if the phytoplankton biomass EQG/EQS are met).

Data Assessment

Site 2 was selected to indicate if any COPCs are mobilised beyond the site boundary. Where Site 2 COPC > applicable ANZECC (2000) trigger criteria[8], and/or EQG (EPA 2017)[9], a staged assessment process will be applied as follows:

1) Stage 1 comparison:
    a. Site 2 COPC compared to Site 1 COPC to determine if the elevated COPC may be attributed to project activities (i.e. if Site 1 < Site 2, alternate sources of the exceeding COPC will be investigated).
2) Stage 2 comparisons:
    a. Site 2 COPC compared to EQS criteria, where applicable;
    b. Site 2 compared to Site 3 – particularly for nutrients and chlorophyll, as an indicator for potential phytoplankton growth; and
    c. Site 3 COPC compared to EQG/EQS criteria, where applicable.
3) Stage 3 comparisons:
    a. Turbidity and light attenuation at Site 3 compared to Site 4 (relative levels based on known differences from baseline data); and
    b. Baseline data at each location compared to current results – to assess the potential impact as a result of project activities.

Where Site 2 COPC are compliant with the applied criteria[8,9], the staged assessment will not be required and activities will continue as scheduled.

[7] It is understood that CSMC undertake routine water quality monitoring during the summer months so the possibility of collaboration will be discussed in due course.
[8] Application of 90% assessment criteria for metals and organics.
[9] Assessment of chlorophyll a as an indicator of phytoplankton biomass, or moderate protection EQG for metals and organics.

Where compliance is achieved in the Stage 2 comparisons, no further assessment will be required and activities will continue as scheduled.

If the outcome of the complete staged assessment indicates that project activities are likely to be contributing to the decline in water quality, activities will cease until there is no turbid plume emanating from the site and a confirmatory water quality event concludes that Site 2 is compliant with baseline conditions or EQG/EQS, whichever is considered more appropriate, in consultation with CSMC.

4.2.4.2 Hydrocarbons

All refuelling activities will be continuously monitored to ensure no spill occurs.

All hazardous substances will be accompanied by their material safety data sheet (MSDS) and appropriate storage and handling methods will be employed.

4.2.5 Reporting

4.2.5.1 Water Quality

Any confirmed exceedance of the staged assessment criteria for COPC and/or confirmed turbid plume beyond the project boundary will be reported to CSMC within 48 hours.

4.2.5.2 Spill Response

Any hydrocarbon spills, regardless of volume, will be immediately reported to the AME Site Manager and then in writing to CSMC within 24 hours of initial notification, where it is deemed necessary (i.e. where a significant spill of >5L occurs and triggers further management actions). Significant spills (>5L) will also be reported to the DoT maritime safety oil response unit (24 hour reporting on 9480 9224).

4.3 Marine Fauna

4.3.1 Potential Impact

The following potential impacts may occur during the proposed activities:

- Impacts to marine cetaceans during dredging and/or piling, including:
    - direct vessel strike
    - underwater noise.
- Introduction of marine pests via biofouling on the vessel hull. Potential impacts include:
    - establishment of non-indigenous marine pest species;
    - competition for food and space with native species;
    - removal of native species;

- predation of native species; and/or
- introduction of associated pests and disease.

4.3.2 Objective

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

4.3.3 Management

4.3.3.1 Marine Fauna

Final design of the reclamation area is not yet complete, however if piling is proposed, a "soft start" procedure will be employed to warn off potential fauna in the project area.

During all dredge and reclamation activities, observation and shut-down zones will be implemented as follows:

- Observation zone will extend 500 m north of the project area within the limits of Northern Harbour and if any marine fauna enter this zone, the Dredging Contractor will be notified.
- Shut-down zone will extend to the limit of the site boundary and in a direct line west to the seawall and if any marine fauna enter this zone during activities, all works will cease until the fauna has departed the area of their own accord.

4.3.3.2 Marine Pests

All vessels and associated equipment will be sourced from the Perth Metropolitan area and therefore present a low risk in terms of the introduction of marine pest species. However, if any vessels are sourced from outside the Perth Metropolitan area, a risk assessment will be undertaken in consultation with the WA Department of Fisheries (DoF) prior to entry into Cockburn Sound.

4.3.4 Monitoring

4.3.4.1 Marine Fauna

A daily visual inspection of the area within the site boundary will be undertaken for 15 minutes prior to the commencement of any activities to ensure that no marine fauna are within the immediate area.

All site personnel will be briefed to be aware, and notify the Site Manager and/or Dredging Contractor, of marine fauna approaching the project area. Continuous (hourly) visual monitoring will be undertaken by suitably trained and dedicated site personnel[10]

[10] The nominated personnel shall demonstrate a knowledge of local marine species, have the ability to safely make observations, be on-duty during all marine activities, and maintain a log of any observations (within both observation and shut-down zones).

during all dredging and reclamation activities to ensure that no marine fauna enter the shut-down zone.

4.3.4.2 Marine Pests

Vessel inspections are not considered a requirement given the low risk rating associated with locally sourced vessels.

4.3.5 Reporting

4.3.5.1 Marine Fauna

Any incidents of injured or trapped (and visibly distressed) fauna will be reported to the Department of Biodiversity, Conservation and Attractions (DBCA) immediately (within one hour) of the observation. The Site Manager, or appropriate site delegate, is required to call the DBCA Wildcare Helpline on 9474 9055.

CSMC will be notified in writing of the outcome within 24 hours of any occurrence of injured or trapped and distressed fauna.

Should any fauna enter and exit the shut-down zone of their own accord, and the management response is successfully implemented (cessation of marine works), then no reporting will be deemed necessary.

4.3.5.2 Marine Pests

Any risk assessment, where applicable, will be submitted to DoF for approval.

4.4 Monitoring and Reporting

Weekly environmental reporting will be undertaken by AME, which will include a summary of monitoring results, plume observations and a complaints register. The weekly report will remain an internal document unless one of the reporting requirements outlined in Table 3 is triggered, or a complaint is received.

Table 3 details the monitoring and reporting requirements outlined in the previous sections.

Table 3: Monitoring and Reporting Summary

KEY FACTOR	MONITORING	REPORTING
Benthic Communities and Habitat	Daily visual monitoring of turbid plume.	N/A
	Physical monitoring via vessel if plume is confirmed to extend beyond the project boundary.	Written notification to CSMC if the plume is confirmed to extend beyond the boundary of Northern Harbour.
Marine Environmental Quality	Baseline water quality prior to the commencement of works.	N/A

KEY FACTOR	MONITORING	REPORTING
	Daily visual monitoring and photo log of turbid plume from an appropriately elevated vantage point.	N/A
	Daily visual monitoring of algal blooms.	N/A
	Weekly monitoring at four locations for in-situ (light attenuation, conductivity, pH and dissolved oxygen) and laboratory (nutrients, chlorophyll and metals) parameters.	Exceedance of assessment criteria outlined in Section 4.2.4 will be reported to CSMC by email within 48 hours of confirmation.
	Continuous monitoring of refuelling activities.	Written notification to CSMC within 24 hours of a spill. Notify DoT maritime safety oil response unit (9480 9224) depending on significance.
Marine Fauna	Daily inspections of the observation and shut-down zones prior to commencement of works.	Written notification to DBCA and CSMC within 24 hours of notification of trapped or injured fauna.
	Continuous (hourly) visual observations by dedicated site personnel during all marine activities.	Immediate notification to DBCA of any injured or trapped and visibly distressed fauna. CSMC to be notified of outcome within 24 hours.

4.5 Roles and Responsibilities

As the proponent, AME is ultimately responsible for implementation of the proposal and adherence to the obligations of this DMP. However, contractors and other site personnel will be responsible for complying with and implementing the DMP. Table 4 provides an overview of the roles and responsibilities for this project.

Table 4: Roles and Responsibilities

AUTHORITY	RESPONSIBILITY
AME	Overall accountability for the implementation of the DMP.
	Overall accountability for compliance with statutory obligations.
	Environmental Reporting, including complaints register
AME Site Manager	Provides advice to the Dredging Contractor

AUTHORITY	RESPONSIBILITY
	Supervises implementation of environmental controls, monitoring programmes and inspections.
	Completes compliance reporting requirements to regulatory authorities.
Dredging Contractor	Implementing the requirements of the DMP.
	Compliance with statutory obligations.
	Daily co-ordination of the project.
	Liaison with monitoring personnel during project activities.
	Ensure adequate training of all staff within their area of responsibility.
	Co-ordinate required training and inductions.
	Capture and log photos of turbid plume.
All Site Personnel	Comply with the requirements of the DMP.
	Compliance with statutory obligations.
	Practice a high standard of work and “duty of care” to the environment at all times.
	Report all environmental incidents to the AME Site Manager.

5 Adaptive Management

Following commencement of project activities, the DMP will be reviewed to ensure it is appropriate to meet the objectives.

Management/mitigation measures and monitoring requirements may be adjusted based on learnings from, but not limited to, the following:

- evaluation of monitoring data;
- review of assumptions;
- re-evaluation of the risk assessment;
- further understanding, or new information, regarding the ecological regime; and/or
- significant changes to the detail of the proposal.

Any changes to the DMP will be discussed with DoT and the CSMC prior to implementation.

6 Stakeholder Consultation

Table 5 outlines the stakeholder consultation undertaken in the preparation of this DMP.

Table 5: Summary of Stakeholder Consultation

Stakeholder	Discussion Point	Comments
Office of the Environmental Protection Authority	Pre-referral meeting on 14/10/15 to discuss proposal.	A referral will be required given the "legacy" of assessing all Cockburn Sound dredge operations. Likely outcome will be "Not Assessed" provided that supporting documentation and information is appropriate (i.e. DMP, Redemptora)
	Dredge Management Plan	This DMP forms part of the referral under Part IV of the EP Act.
Department of Transport	Baseline Investigations	Liaison and meetings undertaken to amend and finalise sampling plans. Comments and discussions surrounding the baseline sediment investigation reports for the dredge and reclamation areas.
	Dredge Management Plan	Please refer to Table 6.
Cockburn Sound Management Council	Baseline Investigations	Requested and received a copy of the baseline investigation reports.
	Dredge Management Plan	Requested a copy of the water quality results from the monitoring undertaken as part of the proposed activities (as outlined in this DMP).
WA Museum	Redemptora (shipwreck)	Preference for *in-situ* preservation of the shipwreck via burial within the reclamation area.

Table 6 outlines the comments and responses and/or edits to the DMP following a technical review by DoT. The revised DMP was issued to DoT and an email of support for the AME dredging was received from Peter Wilkins (Manager Asset Management, Coastal Infrastructure) on 13th November 2017.

Table 6: DMP Review Comments

Section	Comment	Response/Edit
Executive Summary	'And located on seabed leased by the Department of Transport (DoT) to AME' ~~waters~~	Noted and wording amended.
1.1.2	Consider if material can be accepted for landfill waste and the appropriate Landfill Class to assess in the instance surplus material remains it can be disposed of, and the appropriate landfill has capacity to accept the waste. Further post testing of sediments may be required to meet the required analyte suite for landfill acceptance.	Comment included relating to additional testing prior to landfill disposal, if this option is required.
1.2.1	Consider inclusion of 'other factors' to detail potential impacts to EPA factor 'social surroundings' and consideration of noise management as per environmental noise regulations, dust, odour, public safety and access, recreational/commercial fisheries, navigational hazards (i.e. issue of Temporary notice to mariners' etc. Indicate if a search using DAAs search tool and inherit data to assess Aboriginal and European Heritage.	Applicable elements under social surroundings are covered by Table A. Comment relating to DAA search is now included.

SECTION	COMMENT	RESPONSE/EDIT
1.3	Consider inclusion of likely project timings/season	Project timing will depend on approvals.
2.1	Second paragraph from bottom – 'DoT waters' change to seabed lease	Updated.
2.2	Consider confirming presence/absence of benthic habitat within the dredge/disposal areas from observations/photos potentially collected during diver sediment survey given habitat map is dated (2004). Recent aerial imagery from Nearmap indicates the potential presence of Benthic Primary Producer Habitat (BPPH) within the Project area. Consider disturbance and clearing of native vegetation within dredge/disposal areas (inc terrestrial fringing vegetation that may be damaged) if the Project is not assessed and managed under Part V of the EP Act and required permits.	Further consultation with dive team confirmed there was no benthic habitat sighted or recorded during the investigation. Reference to terrestrial vegetation and approvals that may be required now included in Section 2.2.
2.3	Suggest including further context for water and sediment quality within the project area to provide an indication of previous sediment/water quality data. Report references to CMSC (2012, 2016a) indicate additional existing data is available.	A figure and additional commentary is now included for previous investigations.
3	As indicated in previous consultations, sediments may be potentially under characterised for a capital dredging from halving sample numbers based on previous data from 2008-2011. The NAGD requires current (in the last 5 years) of good quality QAQC'd data to allow for having sampling numbers.	As discussed through the consultation process the previous investigations provided an extensive and robust dataset to assist with the assessment of this proposal.
3.1.1	Consider defining the appropriate level of protection as per ANZECC/ARMCANZ (2000) (assumed moderate protection applied - 90%)	Reference to 90% SPL now included.
3.1.1	Consider comparison to background/reference sediment quality data within the area to help inform high/low concentrations of TP/TN in sediments	CSMC were contacted but no applicable datasets were available.
3.1.1	Suggest a brief narration on the basis of selection a 1:25 dilution– suggest considering dilution estimates or back calculating the amount of dilution required to meet guidelines, demonstrating the assumptions used to determine dilution to meet triggers.	Explanation of the expected dilution factors and those required to meet compliance now included.
3.1.2	Consider clarifying the "applicable guidelines" and associated protection level.	Noted and amended.
3.2.1	Given the sporadic nature of the TBT in marine sediments, there may be potential risk sediments are under characterised for TBTs in the reclamation area from total analysis of 3 sediment samples and no further elutriate analysis of these samples. Comparison to elutriate data in dredge area sediments given similar total TBT concentration between the two areas cannot be assumed given the binding nature of TBTs to sediments varies under certain conditions both chemically and biologically. Further comments are provided in Section 4.2.4.1 below.	The potential risk related to mobilisation of TBT from within the reclamation is considered minimal compared to the dredge area where the intensive investigation and further testing was undertaken.
4.1	Nearmap aerial imagery visually indicates potential BPPH within the Project area and "no direct impact' may be unavoidable. Assessment against EPA BPPH (EPA 2016) technical guidance may be required during the referral process to determine the anticipated loss.	The lack of BPPH was confirmed via correspondence with the dive team and other field personnel.
4.1.3	Consider defining how 'dredge methodologies' will be designed to reduce impact.	Section amended.

SECTION	COMMENT	RESPONSE/EDIT
4.1.4	Suggest providing brief justification of assuming the project boundaries for an BPPH impact to nearest vegetated habitat. Consider including details of defining an impact to BPPH and how compliance may be assessed (i.e consider what order of magnitude above baseline will constituent a level that is not appropriate to BPPH?) DoT is not the appropriate Determining Authority to consult if there are water quality/turbidly exceedances to inform management solutions. AME may consider direct appropriate management actions and potential environmental impacts to the relevant environmental regulators (DWER/DBCA/CMCS) . DoT would expect to be notified for information and works were occurring in accordance with management responses approved by regulators in the DMP.	Further justification and definitions included.
4.2.3	Consider other waste management i.e. spill kits/storage bins/ waste disposal bins etc on vessels.	Reference to Waste Management included.
4.2.4.1	DMP states "It may be possible to assess the difference between two sites (in and out of Northern Harbour) to determine if a perceived impact is directly related to the project activities, or a natural occurrence". Suggest elaborating how this comparison will be made and how it will attribute between the project and natural occurrence.	Further clarification now included.
	The DMP states that "Where Site 2 COPC > Site 1 COPC, a two-tier assessment process will be applied." Consider further clarifications/elaboration for the reader to understand the tiered assessment for the magnitude of the disturbance at Site 1. Currently the DMP suggests any impact can occur at Site 2 (without triggering assessment), as long as the impact at Site 1 is larger. Consider assessing site data in their own right should meet relevant marine protection guidelines and not be influenced by concentrations at any other Site. Consider clarifying how the two-tier assessment process is applied – whether both tiers have to exceed to trigger management as compliance with the secondary nutrient criteria does not rule out an environmental effect if the primary criteria were exceeded for metals. The primary criteria includes assessment for metals and organics but the second criteria is only specific to nutrients. The second tier assessment should consider chlorophyll (as in indicator of actual phytoplankton growth) rather than just nutrients (indicator of potential growth). The DMP says "If the Site 1COPC < Site 2 COPC then consideration will be given to potential alternate sources of the relevant COPC prior to any further investigation". Where the previous paragraph outlines a monitoring approach, this paragraph reads that the implementation of proposed monitoring will not occur based on an assessment for alternative sources. In reality, determining the alternative contaminant sources requires assessment in itself. It is recommended determining alternative sources of contamination would be conducted concurrently to the formal monitoring once triggered. It appears that management actions in response to water quality exceedances have not been defined and mechanisms to respond to exceedances should be outlined.	Clarification surrounding the staged assessment approach and how it will be applied has been included. Exceedance response/contingency measures now included.

SECTION	COMMENT	RESPONSE/EDIT
	Consider the timing for water quality monitoring will result in a lag-time between returned laboratory results and continued dredging. Increased frequency of sampling upon commencement of dredging (i.e. tiered approach with fast turnaround times) may provide greater confidence there is no release of COPC to marine environment at water quality monitoring sites. Consider habitat monitoring observations that include visual indicators i.e. algae blooms generated during dredging as the precursor to potential nutrient related impacts.	The first event will be scheduled for expedited analysis to ensure fast response to any exceedances. Algal bloom observations now included.
4.2.4.2	Consider correct storage and handling of other fuels and lubricants with appropriate MDS's	Reference included.
4.2.5.1	DoT is not the appropriate Determining Authority to consult if the dredge plume extends beyond the northern harbour. AME should direct potential environmental impacts, management actions in response to exceedances and to the relevant Environmental Regulators (DWER/DBCA/CSMC). DoT would expect to be notified for information and works were occurring in accordance with management responses approved by regulators in the DMP.	Amended to remove reference to DoT.
4.2.5.2	Consider reporting spills to the DoT maritime safety oil response unit (24hr reporting number 9480 9224)	Reference included.
4.3.1	DoT's review of the document is limited to dredging works and does not address other marine works such as piling and wharf constructions works which other construction management plans may have been prepared and consideration to piling environmental impacts/management (for example 'soft start procedures' to warn off potential fauna in the project area)	Noted. Piling impacts and management are addressed in Section 4.3.3.1. Reference to soft start now included.
4.3.3.2	Consider if project vessels (including the dredge and pipes) will be cleaned prior to project commencement or have appropriate antifouling applied.	Cleaning and/or antifoul treatment is not considered to be required for locally sourced vessels.
4.4	Consider requesting the dredge contractor to capture and report site photos during dredging to monitor plume extent.	Photo log requirement included.
General	Consider including weekly environmental reporting pre and during dredging (i.e. baseline and during dredging water quality, plume observations, community/industry complaints register etc. Consider brief comparison on the difference between CSD and barge excavation (equipment, production, durations, constraints etc), sediment disturbance and impact. Comparison/description to specify how the dredged material will be delivered to the reclamation area.	Weekly environmental reporting now included in Section 4.4. Two dredge options now discussed in further detail in Section 1.1.

7 Limitations

This report is produced strictly in accordance with the scope of services set out in the contract or otherwise agreed in accordance with the contract. 360 Environmental makes no representations or warranties in relation to the nature and quality of soil and water other than the visual observation and analytical data in this report.

In the preparation of this report, 360 Environmental has relied upon documents, information, data and analyses ("client's information") provided by the client and other individuals and entities. In most cases where client's information has been relied upon, such reliance has been indicated in this report. Unless expressly set out in this report, 360 Environmental has not verified that the client's information is accurate, exhaustive or current and the validity and accuracy of any aspect of the report including, or based upon, any part of the client's information is contingent upon the accuracy, exhaustiveness and currency of the client's information. 360 Environmental shall not be liable to the client or any other person in connection with any invalid or inaccurate aspect of this report where that invalidity or inaccuracy arose because the client's information was not accurate, exhaustive and current or arose because of any information or condition that was concealed, withheld, misrepresented, or otherwise not fully disclosed or available to 360 Environmental.

Aspects of this report, including the opinions, conclusions and recommendations it contains, are based on the results of the investigation, sampling and testing set out in the contract and otherwise in accordance with normal practices and standards. The investigation, sampling and testing are designed to produce results that represent a reasonable interpretation of the general conditions of the site that is the subject of this report. However, due to the characteristics of the site, including natural variations in site conditions, the results of the investigation, sampling and testing may not accurately represent the actual state of the whole site at all points.

It is important to recognise that site conditions, including the extent and concentration of contaminants, can change with time. This is particularly relevant if this report, including the data, opinions, conclusions and recommendations it contains, are to be used a considerable time after it was prepared. In these circumstances, further investigation of the site may be necessary.

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FIGURES

Legend

- Site Location
- Cadastre

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- LOCALITY MAP SOURCED LANDGATE 2006
- CADASTRE SOURCED FROM LANDGATE 22 DEC 2015
- AERIAL PHOTOGRAPHY SOURCED LANDGATE DEC 2012 / SEPT 2015
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0 1 2 3 4 5
Kilometers
1:150,000 @ A4

LOCALITY MAP

PROJECT ID	DATE
1293	5/10/2017

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 50

CREATED	CHECKED	APPROVED	REVISION
EW	AW	AW	0

AME Pty Ltd
AME Dredge and Reclamation Programme

Dredge Management Plan

Figure 1
Site Location

K:\Projects\5.0 SWA\Projects from 1 July 2013\1293 - AME Offshore Dredge & Reclamation\Figures\1293 F1 - Site Location.mxd

Legend

- Site Location
- Cadastral Boundaries
- Shipwreck *Redemptora*
- Reclamation Area*
- Dredge Footprint*

Notes:
* areas indicative and subject to final design

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- LOCALITY MAP SOURCED LANDGATE 2006
- CADASTRE SOURCED FROM LANDGATE 22 DEC 2015
- AERIAL PHOTOGRAPHY SOURCED LANDGATE SEP 2015
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0 25 50 75 100 125
Meters
1:4,000 @ A4

LOCALITY MAP

PROJECT ID	DATE
1293	5/10/2017

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 50

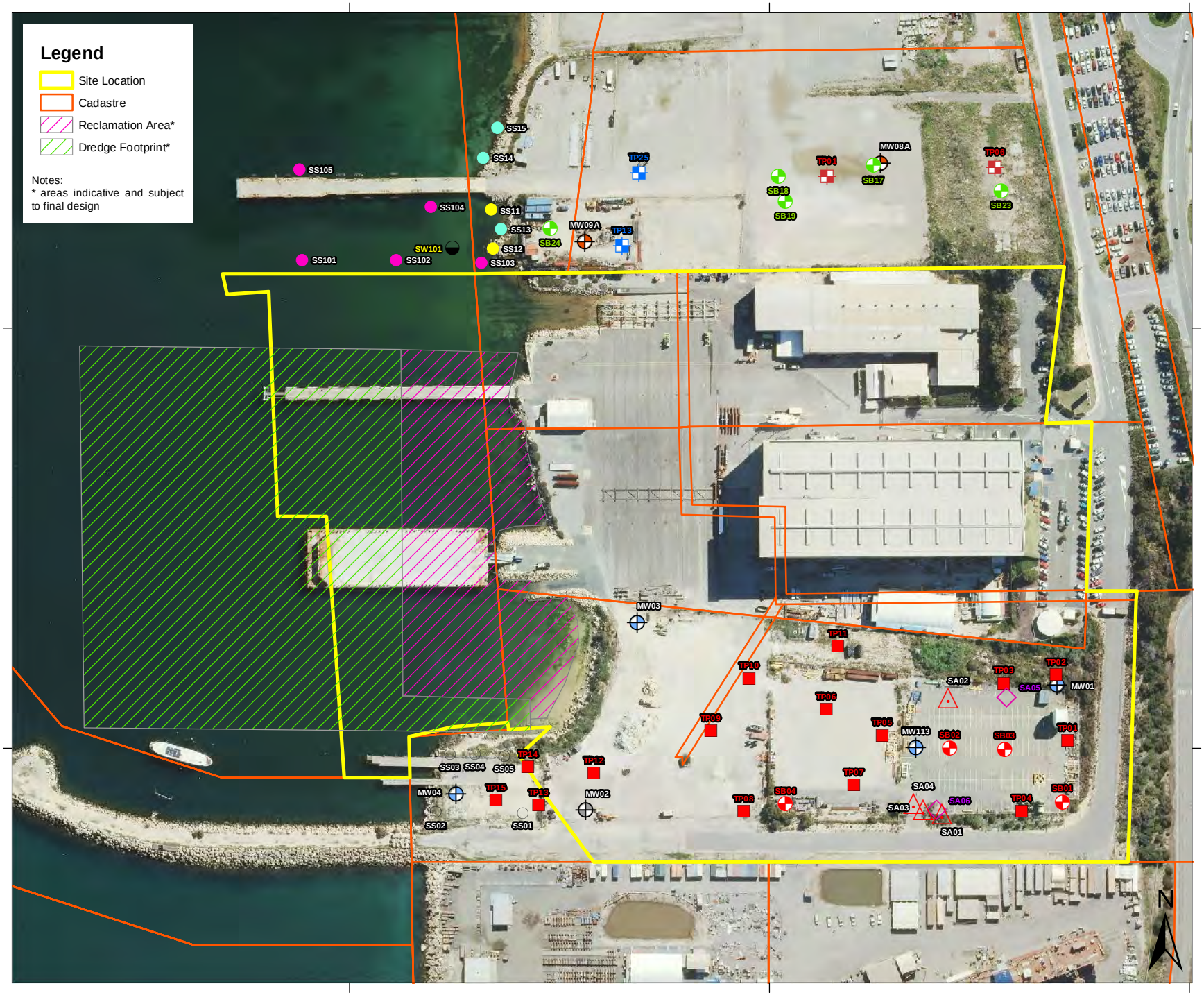
CREATED	CHECKED	APPROVED	REVISION
EW	AW	AW	0

AME Pty Ltd
AME Dredge and Reclamation Programme

Dredge Management Plan

Figure 2
Site Details

K:\Projects\5.0 SWA\Projects from 1 July 2013\1293 - AME Offshore Dredge & Reclamation\Figures\1293 F2 - Site Details.mxd



Legend

- Soakwell water sample (ERM, October 2012)
- Soakwell sediment sample (ERM, October 2012)
- Test pit (Coffey, April 2010)
- Test pit (Coffey, August 2010)
- Trial pit (ERM, October 2012)
- Suface sediment sample (ERM, August 2013)
- Soil Bore (ERM investigations, 2008)
- Soil Bore (ERM, October 2012)
- Sediment Sample (Coffey, November 2011)
- Sediment Sample (Coffey Environments, 2010)
- Sediment Sample (ERM investigations, 2008)
- Surface Water Sample (Coffey, November 2011)

Groundwater Monitoring Well

- Destroyed
- Groundwater Monitoring Well (ERM, August 2013
- Groundwater Monitoring Well (Coffey Environments, 2011)

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- LOCALITY MAP SOURCED LANDGATE 2006
- CADASTRE SOURCED FROM LANDGATE 22 DEC 2015
- AERIAL PHOTOGRAPHY SOURCED LANDGATE 2016 (© Western Australian Land Information Authority 2015)

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0 20 40 60 80 100
Meters
1:2,500 @ A4

LOCALITY MAP

PROJECT ID	DATE
1293	23/11/2016

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 50

CREATED	CHECKED	APPROVED	REVISION
ST	AW	BH	0

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Figure 3
Previous Investigations

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Legend

- Site Location
- Northern and Southern Groundwater Plumes (CSMC 2012)
- Reclamation Area*
- Dredge Footprint*
- Water Quality Monitoring Locations*

Notes:
*indicative and subject to final design

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- LOCALITY MAP SOURCED LANDGATE 2006
- CADASTRE SOURCED FROM LANDGATE 22 DEC 2015
- AERIAL PHOTOGRAPHY SOURCED LANDGATE SEP 2015
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0 100 200 300 400
Meters
1:12,000 @ A4

LOCALITY MAP

PROJECT ID	DATE
1293	5/10/2017

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 50

CREATED	CHECKED	APPROVED	REVISION
EW	AW	AW	0

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Dredge Management Plan

Figure 4
Monitoring Locations

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