



Report

East Arm  
Wharf  
Expansion  
Project

AUSTRALIA

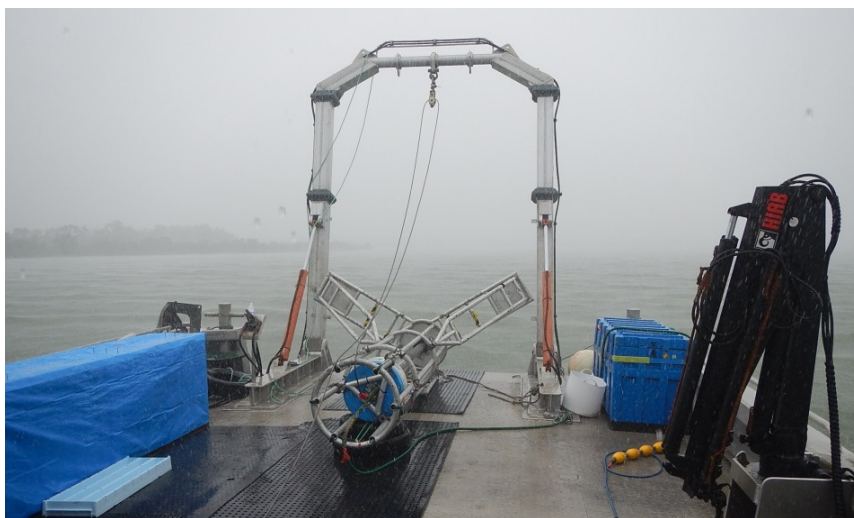


## Multi User Barge Ramp Facility Dredging and Dredge Spoil Placement Management Plan




20 March 2015  
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Prepared for:  
Land Development Corporation

Prepared by URS Australia Pty Ltd



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## ABBREVIATIONS

Abbreviation	Description
AHD	Australian Height Datum
AIMS	Australian Institute of Marine Science
ANZECC	Australian and New Zealand Environment Conservation Council
ARMCANZ	Agricultural Resource Management Council of Australia and New Zealand
ASS	Acid Sulfate Soils
BoM	Bureau of Meteorology
CD	Chart datum
CSD	Cutter Suction Dredge
DDSPMP	Dredging and Dredge Spoil Placement Management Plan
DEWHA	(former) Commonwealth Department of the Environment, Water, Heritage and the Arts
DHAC	Darwin Harbour Advisory Committee
DLP	(former NTG) Department of Lands and Planning
DLPE	Department of Lands, Planning and Environment
DLRM	Department of Land Resource Management
DO	Dissolved Oxygen
DoE	Commonwealth Department of the Environment
DoI	Department of Infrastructure
DPC	Darwin Port Corporation
EAG	Environmental Assessment Guideline
EAW	East Arm Wharf
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EMF/s	Environmental Management Framework/s
EMS	Environmental Management System
EMSP/s	Environmental Management System Procedure/s
EPA	Environmental Protection Agency
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
HSE	Health Safety and Environment
HSEQ	Health Safety Environment and Quality
IMO	International Maritime Organization
KPI/s	Key Performance Indicator/s
LDC	Land Development Corporation
MAGNT	Museums and Art Galleries of the Northern Territory
MARPOL	International Convention for the Prevention of Pollution from Ships
MBMP	Migratory Bird Monitoring Plan
MFO/s	Marine Fauna Observer/s
MSB	Marine Supply Base
MUBRF	Multiuser Barge Ramp Facility

Abbreviation	Description
NAGD	National Assessment Guidelines for Dredging
NATA	National Association of Testing Authorities
NEPC	National Environment Protection Council
NEPM/s	National Environment Protection Measure/s
NRETAS	Department of Natural Resources, Environment, the Arts and Sport
NT	Northern Territory
NTG	Northern Territory Government
NTU	Nephelometric Turbidity Units
OH&S	Occupational Health and Safety
PASS	Potential acid sulphate soil
PWC	Parliamentary Works Committee
PWCNT	Parks and Wildlife Commission of the Northern Territory
QASSIT	Queensland Acid Sulfate Soil Investigation Team
RL	Relative Level
SEWPaC	(former) Commonwealth Department of Sustainability, Environment, Water, Population and Communities
SSC	Suspended Sediment Concentration
TAG	Technical Advisory Group
TDMP	Turtle and Dugong Monitoring Program
TSS	Total Suspended Solids
URS	URS Australia Pty Ltd
VHF	Very High Frequency
WDL	Waste Discharge Licence
WQO/s	Water Quality Objective/s
WQPP	Water Quality Protection Plan
%S	Percent Sulphur

## 1 INTRODUCTION

### 1.1 East Arm Wharf Expansion Project

The Northern Territory Government (NTG) has proposed an expansion of the East Arm Wharf (EAW) in Darwin Harbour to accommodate the requirements of prospective wharf users. The major features of the project (refer Figure 1-1) are as follows:

- Developing a Marine Supply Base (MSB), primarily to service the existing and developing oil and gas industries in the Timor Sea, Browse Basin and adjacent areas.
- Constructing a Multi User Barge Ramp Facility (MUBRF) including a barge ramp and hardstand area, berthing for barges and facilities for loading and unloading.
- Developing a facility to accommodate tugs, customs boats and other smaller vessels.

The EAW Expansion Project was subject to an Environmental Impact Assessment (EIA) and an Environmental Impact Statement (EIS) was developed to investigate the potential impacts of the development on the surrounding marine and terrestrial environments [(former NTG) Department of Lands and Planning (DLP) 2011a,b]. The EIS was submitted to the Northern Territory (NT) Environmental Protection Agency (EPA) and the Department of the Environment<sup>1</sup> (DoE) for consideration.

The project received approval under the NT Environmental Assessment Act 1982 in December 2011 and conditional approval by DoE under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) in March 2012 in the form of Approval EPBC 2010/5304. A total of 49 environmental conditions were attached to the EPBC approval.

A document, East Arm Wharf Expansion Project (EPBC 2010/5304), Revision of the Multi-user Barge Ramp Facility (URS Australia Pty Ltd [URS] 2013), which detailed changes to the MUBRF location, was submitted in October 2013, and received approval by the NT EPA in December 2013 and conditional approval by DoE in January 2014.

This Dredging and Dredge Spoil Placement Management Plan (DDSPMP) has been prepared for the dredging required for the revised MUBRF location and addresses the requirements set out in Conditions 24 and 25 of the Commonwealth project approval (EPBC 2010/5304) under sections 130(1) and 133 of the EPBC Act.

### 1.2 Multi User Barge Ramp Facility

The MUBRF will be used for the berthing of barges and loading or unloading of cargo and equipment. The general operations of cargo consolidation, loading and unloading would comprise the greatest use of the facility. It is anticipated that, on occasions, tracked vehicles (tanks) and munitions could be loaded (with appropriate temporary buffers) prior to military exercises and then unloaded after the exercises. Similarly, an emergency response operation could initiate significant use of the barge ramp and laydown area (DLP 2011a). Under certain emergency circumstances, Defence may have full use of the facility for a period of time and all other users would be excluded.

It is anticipated that one or two barge operators would typically be operating from the barge ramp at any given time, and loads would be stored on site for short periods (prior to transfer to

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<sup>1</sup> Formerly Commonwealth Department of Sustainability, Environment, Water, Population and Communities

a barge). A marshalling area on the ramp will be included to facilitate loading and unloading of vehicles. Information presented in this section was derived from and is based on the report “Defence Barge Ramp Option 144” prepared for DLP by Aurecon (2012).

Figure 1-1 shows the revised location of the MUBRF, which is situated on the southern side of East Arm Peninsula, approximately 200 m east of the original location. The revised location site is owned by the Land Development Corporation (LDC). The facility will be accessed via a new access road from south of the existing drain to the proposed ramp site, connecting it with Berrimah Road and providing strategic access to the EAW, rail freight terminal and Darwin Business Park. A fence and gates are proposed to ensure controlled access to the MUBRF.

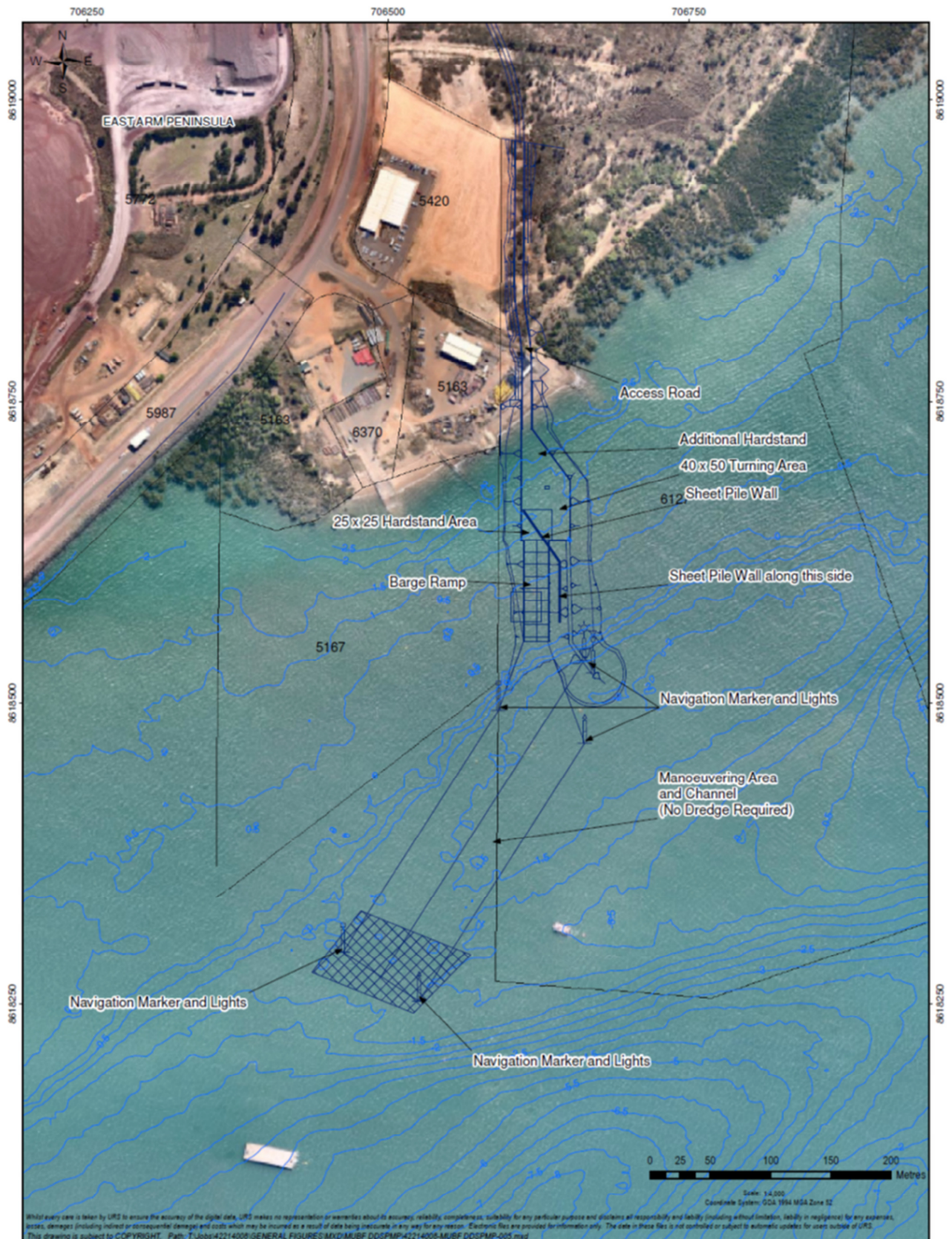
The MUBRF concept design (Figure 1-2) incorporates the following features:

- A dredged channel to -1.1 m CD (chart datum) to provide access to the barge ramp at most tide levels for vessels up to design vessel size (23.3 m length, 6.4 m beam and maximum draft of 1.2 m). There will be a restriction on access for Defence for up to five hours per month; the impacts on commercial uses of the ramp are unclear at this stage.
- Rock wall to provide protection to the reclaimed land forming the ramp access and a breakwater to provide protection to vessels at the end of the ramp. The breakwater and structure orientation has been designed to achieve the required currents of less than 1 knot.
- Ramp with hardstand and turning area.
- Lighting.
- Access road to onshore hardstand area.

Figure 1-1 East Arm Wharf Expansion project components



Figure 1-2 MUBRF Concept Design (adapted from Aurecon, 2014)



### 1.3 Overview of proposed dredging and dredge spoil placement

Dredging for the MUBRF approach channel and footprint is expected to be conducted by a cutter suction dredge (CSD) and/or a backhoe, barge and slurry pump combination. A final decision on the dredging methodology will be made as part of commercial negotiations and selection of a suitable dredging contractor.

It is proposed that the selected dredge will undertake initial dredging of the shallow portion of the approach channel followed by the western side of the footprint and then the eastern side of the footprint. The two proposed dredge zones are depicted in Figure 1-3.

The soft sediments under the MUBRF footprint will be dredged down to bedrock to prevent mud waving. The dredge volume for the proposed project will be approximately 16,000 m<sup>3</sup>.

As the majority of the dredged area will ultimately be beneath the MUBRF breakwater, no overdredging will be required. Further, mathematical modelling by AIMS has predicted a net sedimentation rate of about 1 mm/month on the western side of the breakwater head; equivalent to about 100 mm of sediment build up in approximately eight years which is considered too small a depth to warrant overdredging into bedrock.

Dredging in the access channel has also been planned to bedrock, with no required overdredging. The proposed location for dredge spoil disposal is within the existing ponds at EAW (outlined in red in Figure 1-1) which have a capacity large enough to accommodate the volume of dredge spoil to be generated. Section 2.5.1 outlines the available pond volume based on recent surveys undertaken by Douglas Partners (2014). The features of the program are detailed in Table 1-1.

**Table 1-1 Planned MUBRF dredging campaign details**

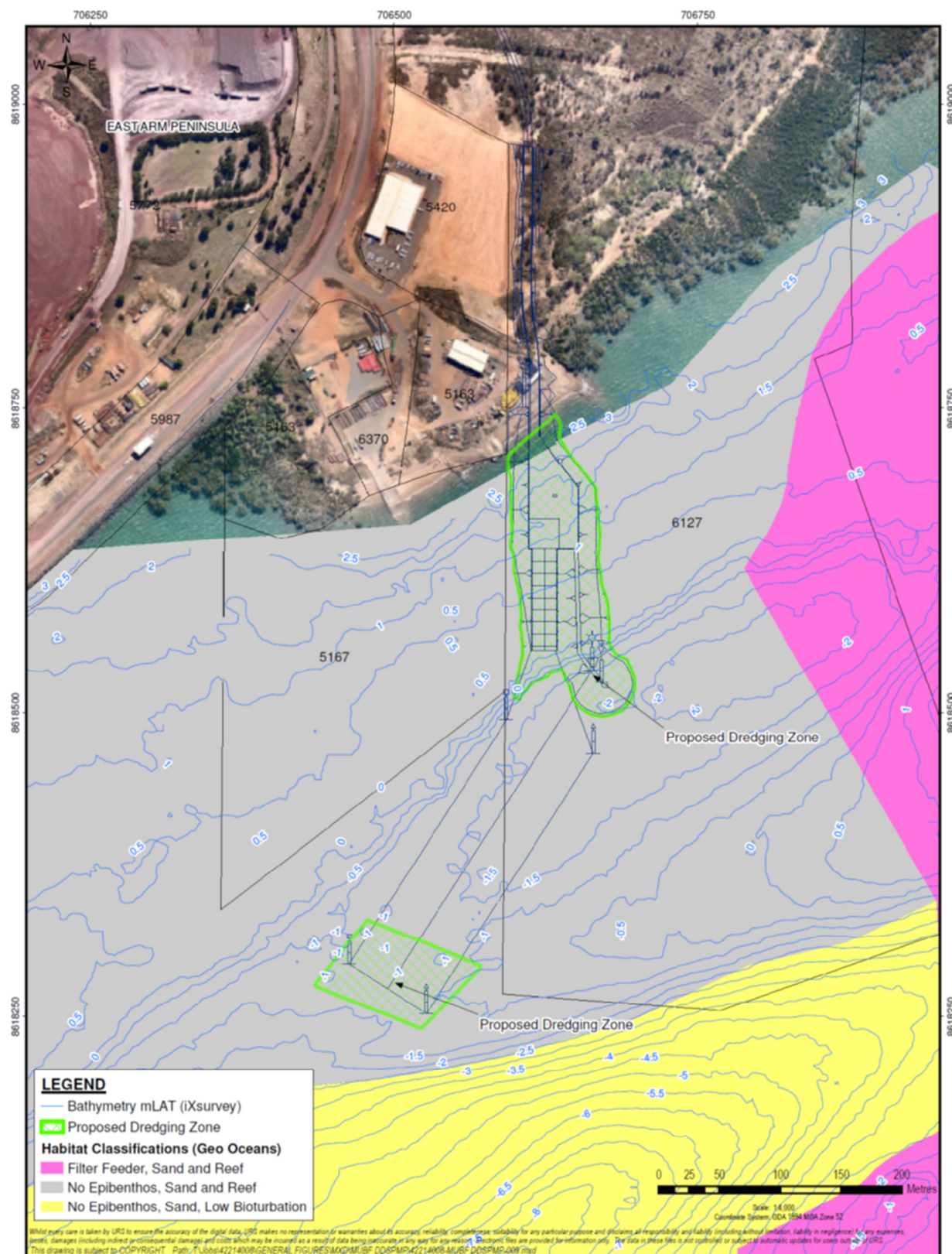
Feature	
Dredge depth	- 1.1 m CD
Estimated dredge footprint	25,426.7 m <sup>2</sup>
Estimated dredge volume	16,000 m <sup>3</sup>
Estimated 'soft' materials volume	16,000 m <sup>3</sup>

Dredge material is proposed to be placed into the existing East Arm Dredge Spoil Pond K or Pond E (North), with the tailwater flowing into Pond E (South) and returned to the receiving environment through a permeable section of the railway bund wall (see Figure 1-2).

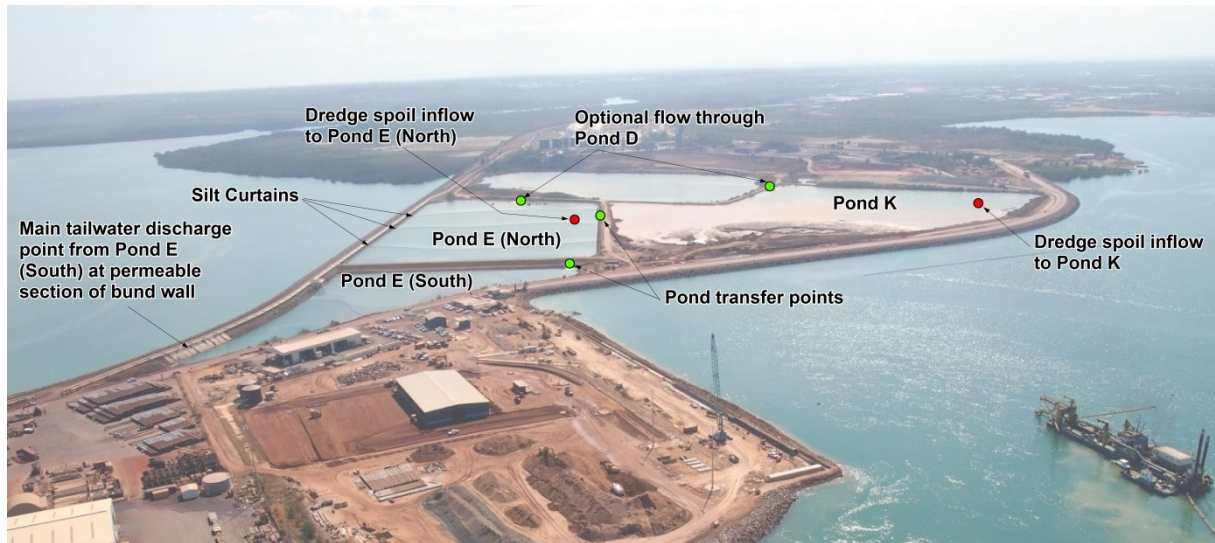
Dredge spoil will enter the pond system in the far eastern corner of Pond K in the first instance, with machinery on site if required to stockpile coarser material on the western side of Pond K to further contain dredge spoil in Pond K. Dredge spoil will potentially be pumped into the northern end of Pond E (North) in the event that Pond K becomes full or complete submersion of dredge spoil is determined to be required due to the detection of potential acid sulfate soils (PASS).

The flow rate of tailwater from the small CSD into the pond system will be sufficiently low to maintain required pond heights and residence times without the need to utilise a backup pump to pump tailwater back to the dredge footprint. The dredging and reclamation methodology is discussed in detail in Section 2.

Figure 1-3 MUBRF dredging zones



**Figure 1-4 Aerial photograph showing dredge spoil placement configuration**



#### 1.4 Purpose of this plan

This document relates to the management and monitoring of the dredging operations and onshore disposal of the dredged material. The plan incorporates the requirements stipulated in DoE approval conditions pertaining to the preparation of:

- a DDSPMP (Condition 16)
- a Water Quality Management Plan (Condition 27).

It also incorporates the commitment made by DLP (2011a) in their Draft EIS for the EAW Expansion Project to prepare an Acid Sulfate Soil (ASS) Management Plan. As the management and monitoring of dredging, dredge spoil placement, water quality and ASS are inextricably linked, it was deemed appropriate to combine the requirements of the three plans into a single plan.

This DDSPMP demonstrates that reasonable and practicable steps have been taken to manage the risks associated with, and the potential environmental impacts arising from, the dredging and spoil placement activities to be undertaken during the construction phase of the MUBRF.

The DDSPMP details how the potential impacts of the dredging and spoil placement activities will be minimised by identifying and implementing appropriate management and monitoring controls. It describes the proposed management, monitoring, reporting, review and auditing requirements for the dredging and spoil placement activities in order to meet the conditions of the various environmental approvals.

The DDSPMP and supporting documentation have been prepared for submission to the EAW Expansion Project Technical Advisory Group (TAG) for review and endorsement, and to the NT EPA and, via the DoE, to the Commonwealth Minister for approval.

## 1.5 Proponent and primary contractor

The Proponent of the EAW Expansion Project is the Department of Lands, Planning and Environment (DLPE).

Proponent's address:
Level 5, Energy House
18-20 Cavenagh Street
Darwin, NT 0800
[GPO Box 1680, DARWIN, NT 0801]
Ph (08) 8999 8963

The Department of Infrastructure (DoI) has been commissioned by the DLPE to manage the design consultant throughout the design phase of the project and also to manage the contractor and sub-contractors constructing the MUBRF project.

The primary contractor for the project has not yet been appointed.

## 1.6 Design consultant

Aurecon Australia Pty Ltd is the lead design consultant for the MUBRF project.

## 1.7 Project approvals

The EAW expansion project was initially assessed through an EIS (DLP 2011a), with additional information and responses to stakeholder comments presented in an EIS Supplement (DLP 2011b). Complete details of the environmental assessment process are provided in these documents which are available on the DLPE East Arm Wharf Expansion project web site. The project was assessed jointly by the NTG under the *Environmental Assessment Act 1982* and the Commonwealth Government under the EPBC Act.

### 1.7.1 Northern Territory approval recommendations

The NTG approved the project under the *Environmental Assessment Act 1982* in December 2011. Twenty-two recommendations were listed within the Environmental Assessment Report (Department of Natural Resources, Environment, the Arts and Sport [NRETAS] 2011), which have been addressed by the provision of additional information by the Proponent and commitments made in this DDSPMP. A copy of the NRETAS assessment report is available online at <http://www.ntepa.nt.gov.au>

### 1.7.2 Commonwealth approval conditions

The Commonwealth Government awarded conditional approval under the EPBC Act on 5 March 2012 as EPBC Approval 2010/5304 (Commonwealth Department of Sustainability, Environment, Water, Population and Communities [SEWPaC; now DoE] 2012a), with a variation to the approval issued on 28 May 2012 (SEWPaC 2012b).

Forty-nine ministerial conditions of approval were attached to the approval decision, all of which are legally binding to the Proponent. Four conditions (15, 17, 36 and 37) of the original approval were superseded in the variation issued 28 May 2012. These were:

Condition	Variation	Summary of change to condition
15	Condition deleted	Condition requiring all capital dredging and dredge spoil placement into ponds to be undertaken only in wet season.
17f and 36	Condition modified	Condition requiring the protection of 24 hectares of suitable migratory bird habitat in or in close proximity to EAW was modified to require the protection of Pond D including the management of dogs, feral animals and other invasive species.
37	Condition modified	Condition modified to require the submission of the Migratory Bird Monitoring Plan (MBMP) for approval by the Commonwealth Minister for approval no later than one year from the commencement of the action (previously five years).
Definitions	Modified	Definition of 'Wet Season' was re-defined to mean 1 December to 30 April each year.
Definitions	Modified	Definition of 'Marine works' was modified to exclude activities associated with piling and marine supply base works as well as to note that it does not include mobilisation of dredging equipment onsite.

A full copy of the Commonwealth approval decision is available online at <http://www.environment.gov.au>

DoE will be consulted for approval if any changes or revisions to the DDSPMP or the proposed action occur, as required by Condition 5 (revision/change approvals). The approved DDSPMP will be implemented in accordance with Condition 21. These approval conditions are also applicable to all other environmental management plans/strategies associated with the project.

### **1.7.3 Waste discharge licence**

A Waste Discharge Licence (WDL187) pursuant to section 74 of the NT *Water Act* was granted to the Contractor responsible for the MSB dredging and expired on 22 May 2014. A new WDL will be obtained by the Contractor appointed for the MUBRF dredging prior to commencing work. The Contractor will comply with any conditions associated with the new WDL. NT EPA will be consulted for approval if any changes or revisions to the DDSPMP occur.

### **1.7.4 Environmental commitments**

Environmental commitments made in the Draft EIS (DLP 2011a) and the EIS Supplement (DLP 2011b) that are relevant to the dredging and spoil placement activities associated with construction of the MUBRF will be consolidated in a commitments and actions register. This register is not included in this DDSPMP and will be progressively updated to incorporate additional conditions of approval from secondary approvals (e.g. under the NT *Waste Management and Pollution Control Act* and the NT *Water Act*). It will also serve as an audit tool.

## 1.8 Legal requirements and guidelines

This DDSPMP has been developed to meet Commonwealth EPBC approvals conditions (approval 2010/5304), NT EPA Recommendations (Assessment Report 67) and the conditions of WDL 187 (WDL 187 conditions refer to the previously completed MSB dredging and have been applied here in anticipation of conditions in the new WDL to be obtained by the Contractor prior to MUBRF dredging). The pertinent conditions and recommendations have been incorporated into the commitments and actions register introduced in Section 1.7.4.

Other legislative requirements relevant to the dredging activities are presented in Table 1-2 (Commonwealth) and Table 1-3 (NT).

International conventions and guidelines relevant to the dredging activities are listed in Table 1-4.

A number of government strategy and guideline documents have been developed to provide advice to proponents in the development of environmental management and monitoring programs. In the development of this DDSPMP, the documents listed in Table 1-5 and

Table 1-6 have been taken into account.

In addition to Commonwealth and NT regulatory guidance, this DDSPMP takes account of the Environmental Assessment Guideline for Marine Dredging Proposals (EAG7) developed by the WA Environmental Protection Authority under s16(k) of the *Environment Protection Act* (EPA 2011). The guideline aims to provide guidance for the clear and consistent presentation of predicted impacts of dredging and dredge-generated sediment on benthic habitats. Aspects of these guidelines have been adopted in combination with the *Guidelines for the Environmental Assessment of Marine Dredging in the Northern Territory* (NT EPA 2013).

Best practice management will be implemented at all stages of the MUBRF project in order to comply with the legal requirements and guidelines identified in this section.

**Table 1-2 Commonwealth legislative requirements**

Commonwealth	
Title	Description
<i>Aboriginal and Torres Strait Islander Heritage Protection Act 1984</i>	The purposes of this Act are the preservation and protection from injury or desecration of areas and objects in Australia and in Australian waters, being areas and objects that are of particular significance to Aboriginals in accordance with Aboriginal tradition.
Australian Ballast Water Management Requirements 2001	Requirements designed to reduce the risk of introducing harmful aquatic organisms into Australia's marine environment through ships' ballast water. Australian ballast water management requirements are consistent with International Maritime Organization (IMO) guidelines for minimising the translocation of harmful aquatic species in ships' ballast water.
<i>Environment Protection and Biodiversity Conservation Act 1999</i>	This Act provides a national framework for environmental and heritage protection. It focuses on protecting "matters of national environmental significance" including listed, protected species and marine species.
<i>Hazardous Waste (Regulation of Exports and Imports) Act 1989</i>	An Act to provide for the regulation of the export, import and transit of hazardous waste, and for related purposes.

Commonwealth	
Title	Description
<i>Hazardous Waste (Regulation of Exports and Imports) Amendment Act 1996</i>	An Act to amend the Hazardous Waste (Regulation of Exports and Imports) Act 1989, and for related purposes. The object of this Act is to regulate the export, import and transit of hazardous waste to ensure that exported, imported or transited waste is managed in an environmentally sound manner, so that society and the environment, both within and outside Australia, are protected from the harmful effects of the waste.
<i>Protection of the Sea (Harmful Anti-fouling Systems) Act 2006</i>	An Act relating to the protection of the sea from the effects of harmful anti-fouling systems. It includes application or use of harmful anti-fouling and the required certificates and anti-fouling declarations.
<i>Protection of the Sea (Prevention of Pollution from Ships) Act 1983</i>	This Act relates to the prevention of pollution (in any form) from ships.
<i>Quarantine Act 1908 and Quarantine Regulations 2000</i>	An Act relating to quarantine, including the quarantine and quarantine procedures of vessels, persons and goods.

**Table 1-3 Northern Territory legislative requirements**

Northern Territory	
Title	Description
<i>Aboriginal Land Act 2010</i>	This Act provides for access to Aboriginal land, certain roads bordered by Aboriginal land and the seas adjacent to Aboriginal land.
<i>Aboriginal Sacred Sites Act and Regulations 2011</i>	An Act to effect a practical balance between the recognised need to preserve and enhance Aboriginal cultural tradition in relation to certain land in the NT, and the aspirations of the Aboriginal and all other peoples of the NT for their economic, cultural and social advancement.
<i>Crowns Land Act 2011</i>	An Act responsible for managing Crown land and facilitating (development consented) land use for economic development.
<i>Dangerous Goods Act 1998 and Amendment Act 2003 (Act No. 20, 2003)</i>	An Act to provide for the safe storage, handling and transport of certain dangerous goods. The goods will be classified and need to be taken care of by specialised persons. This Act will be controlled by competent authorities.
<i>Darwin Port Corporation Act 2005</i>	An Act to provide for the establishment of the Darwin Port Corporation for the control and management of the Port of Darwin and for related purposes.
<i>Environmental Protection (National Pollutant Inventory) Objective 2004</i>	National Environment Protection Measures (NEPMs) are broad framework-setting statutory instruments defined in the <i>National Environment Protection Council (NEPC) Act 1994</i> . They outline agreed national objectives for protecting or managing particular aspects of the environment. A NEPM will become law in each participating jurisdiction once it is made by NEPC.
<i>Environmental Offences and Penalties Act and Regulations 2011</i>	This Act establishes penalties for certain offences under prescribed Acts (such as an environmental offence) and for related purposes.
<i>Fisheries Act 1998</i>	An Act to provide for the regulation, conservation and management of fisheries and fishery resources so as to maintain their sustainable utilisation, to regulate the sale and processing of fish and aquatic life, and for related purposes.
<i>Heritage Act 2011</i>	This Act establishes the Heritage Council and the NT Heritage Register. It sets the process by which places become heritage places, allows for interim protection of places and sets out the process for getting permission to do work to heritage places and allows for fines and imprisonment for offences against the Act.

Northern Territory	
Title	Description
<i>Litter Act 2011</i>	An Act relating to litter. It includes that no person shall leave, throw, deposit or abandon litter in, onto or from a public place or land elsewhere than into authorised receptacles.
<i>Marine Act 2011 and Marine (Pilotage) Regulations 2001</i>	This Act regulates shipping within the NT and provides for the application to the NT of the uniform shipping laws code and for related matters such as required qualifications and actions and other related purposes.
<i>Marine Pollution Act 2004 and Marine Pollution Regulations 2010</i>	An Act to protect the marine and coastal environment by minimising intentional and negligent discharges of pollutants (such as oil, garbage, sewage, etc.) from ships into coastal waters and for related purposes.
<i>Waste Management and Pollution Control Act</i>	This Act aims to enforce appropriate waste management practices and protection against pollution on the one hand and, on the other, to provide the right tools and level of assistance for those wishing to adopt sustainable environmental practices. The Act protects and, where practicable, aims to restore and enhance the quality of NT environment. The Act facilitates the implementation of NEPM established by the National Environment Protection Council (NEPC).
<i>Water Act 2011</i>	This Act provides for the investigation, allocation, control, protection, management and administration of water resources in the NT. The Act prohibits waste to come in contact with water or water to be polluted unless under authorisation.

**Table 1-4 International conventions and guidelines**

International Conventions	
Title	Description
Guidelines for the Development of Garbage Management Plans for compliance with Regulation 9(2), Annex V of MARPOL	The use of three complementary techniques to manage garbage: source reduction, recycling and disposal. It must include the person in charge of carrying out the plan, procedures for garbage collection, and procedures for processing garbage, storing garbage and the disposing of garbage.
International Convention for the Prevention of Pollution from Ships (MARPOL 73/78)	The International Convention for the Prevention of Pollution from Ships (MARPOL) Convention is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. It covers the prevention of pollution by oil, chemicals, and harmful substances in packaged form, sewage and garbage.
International Convention for the Control and Management of Ships' Ballast Water and Sediments	The Convention aims to prevent the potentially devastating effects of the spread of harmful aquatic organisms carried by ships' ballast water from one region to another.
The Convention on the Conservation of Migratory Species of Wild Animals	Aims to conserve terrestrial, aquatic and avian migratory species throughout their range. It is an inter-governmental treaty, concluded under the aegis of the United Nations Environment Programme, concerned with the conservation of wildlife and habitats on a global scale.
International Convention for the Prevention of Pollution from Ships as modified by the Protocol of 1978 relating thereto and Annex V (Prevention of Pollution by Garbage from Ships) (IMO 1973)	This deals with different types of garbage and specifies the distances from land and the manner in which they may be disposed of. The requirements are much stricter in a number of "special areas" but perhaps the most important feature of the Annex is the complete ban imposed on the dumping into the sea of all forms of plastic.

**Table 1-5 Commonwealth Government strategy and guideline documents**

Commonwealth
National Assessment Guidelines for Dredging (Commonwealth of Australia 2009)
Guidelines for Fresh and Marine Water Quality - Australia and New Zealand Environment Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) 2000
National Water Quality Management Strategy (Commonwealth of Australia 1992)
Intergovernmental Agreement on a National System for the Prevention and Management of Marine Pest Incursions, April 2005

**Table 1-6 Northern Territory Government strategy and guideline documents**

Northern Territory
Guidelines for the Environmental Assessment of Marine Dredging in the Northern Territory (NTEPA 2013)
A Review of Environmental Monitoring of the Darwin Harbour Region and Recommendations for Integrated Monitoring (2005)
A Strategy for the Conservation of Marine Biodiversity in the Northern Territory of Australia, Parks and Wildlife Commission of the NT (PWCNT) (2000)
Declaration of Beneficial Uses and Objectives Darwin Harbour Region (June 2010)
Darwin Harbour Regional Management Strategic Framework 2009–2013 (Draft)
Darwin Harbour Water Quality Protection Plan (2014)
Darwin Port Corporation (DPC) Environmental Management System, Environment Policy and Occupational Health and Safety (OH&S) Policy 2002

## 1.9 Existing management frameworks in Darwin Harbour

The NTG developed the Darwin Harbour Water Quality Protection Plan (WQPP) (Department of Land Resource Management [DLRM] 2014) under the National Water Quality Management Strategy.

Phase 1 of the development of the WQPP was completed in 2009. The overall aim of the WQPP was to ensure that water quality objectives are maintained and that the community's values for waterways are protected. This included identifying key risks to water quality, development of interim water quality objectives (based on beneficial use declarations under the Water Act), improvements to monitoring activities and evaluation of pollutant loads (NRETAS 2010).

Phase 2 of the WQPP was released in February 2014 and aims to support good management and sustainable development by focussing on a range of management actions including monitoring, assessing and managing the impacts of sediment and nutrient (nitrogen, phosphorus) inputs to Darwin Harbour. It also highlights key considerations for future water quality protection (DLRM 2014).

The MUBRF dredging activities fall within the Darwin Harbour Declaration of Beneficial Uses and Objectives of Surface Water. The declared beneficial uses are environment, cultural (aesthetic, recreational and cultural) and aquaculture (NRETAS 2010).

Performance against the water quality objectives described in the WQPP is assessed by DLRM on the basis of the annual mean value of the measured parameter. It is noted that the guidelines do not apply during high flow events associated with Wet Season conditions and that the water quality objectives are intended for use in “catchment management and land use planning activities”. Hence the objectives could be considered as representing targets for long-term water quality rather than as limits to be adhered to during the dredging operations. However, they have been taken into account during the development of the environmental management frameworks detailed in Section 6. The environmental management frameworks have been developed in a manner that is consistent with the risk-based decision framework discussed above.

#### **1.10 DDSPMP review, approval and availability**

The Proponent is responsible for submitting the draft of this Plan to the TAG for review and comment, and the final revision submission to the NT EPA and the DoE for approval by the Minister. The Proponent is responsible for addressing all comments received and shall create and maintain a comment register for the purposes of tracking, managing and closing comments.

The approved DDSPMP will be included with the MUBRF construction request for tender documentation and the appointed contractor expected to comply with the plan. Should circumstances require an amendment to the DDSPMP, this will be the responsibility of the appointed Contractor, with the Proponent required to resubmit the revision to the DoE and the NT EPA.

Given the short duration of the dredging program, no review of this plan is anticipated during the program. However, if deficiencies in the effectiveness of this DDSPMP, changes in environmental risks, changes in business conditions, processes for monitoring environmental performance, or any relevant emerging environmental issues currently not addressed are experienced, then a review of the relevant components of the DDSPMP will be undertaken in consultation with the TAG. The Proponent would be responsible for resubmission of any revisions to the DoE and the NT EPA.

The approved DDSPMP shall be publicly available at: [www.eastarmwharf-eis.nt.gov.au/home](http://www.eastarmwharf-eis.nt.gov.au/home)

## **2 DREDGING AND DREDGE SPOIL PLACEMENT METHODOLOGY OVERVIEW**

### **2.1 Introduction**

This section describes the dredging and dredge spoil placement methodology that will be used by the contractor in constructing the MUBRF and the methodology described is the basis for this DDSPMP. The methodology presented provides for a number of possible scenarios for dredging and spoil placement. While it is considered to be highly developed, the methodology is by no means definitive; it is provided as a basis for development of this Plan. Depending on onsite conditions, some modifications may be required during the dredging execution, with all revisions and reactive management plans being submitted to the NTG for review by the TAG and then onto DoE for approval by the Minister prior to implementation. The contractor will be responsible for submitting all revisions and reactive management plans to NT EPA for review and approval.

Dredging is only required to a depth of -1.1 CD (current seabed surface levels over the proposed dredging area range from +2.5 m CD to -2.0 m CD) to provide access for Department of Defence barges. This will be achieved by dredging an estimated 16,000 m<sup>3</sup> of material, which is expected to be comprised entirely of soft sediment and will be dredged using a small CSD and/or a backhoe, barge and slurry pump combination. The sediment is proposed to be disposed of entirely onshore, with the dredge footprint and reclamation ponds displayed in Figure 1-1 and Figure 1-2. Dredging is expected to continue for two to three weeks to complete the dredging component of the project.

There is no requirement for bottom dumping of dredge material by the dredge and these practices will not be undertaken as part of this project. Pre-treating of the dredge spoil will be undertaken if high strength rock is found that cannot be efficiently removed with the CSD. Present indications are that all of the material to be removed is unconsolidated sediment, but the potential for some high strength rock to be present within the dredge footprint cannot be discounted. Pre-treatment breaks up the rock with equipment like an excavator on a barge normally fitted with a rock breaker or ripper attachment, or the use of a backhoe. In both instances once the rock is broken up it is then cut and pumped ashore by the CSD as per the requirements of this plan. Any pre-treatment undertaken will be subject to the same environmental conditions as the dredging works being undertaken as per this plan in the MUBRF footprint.

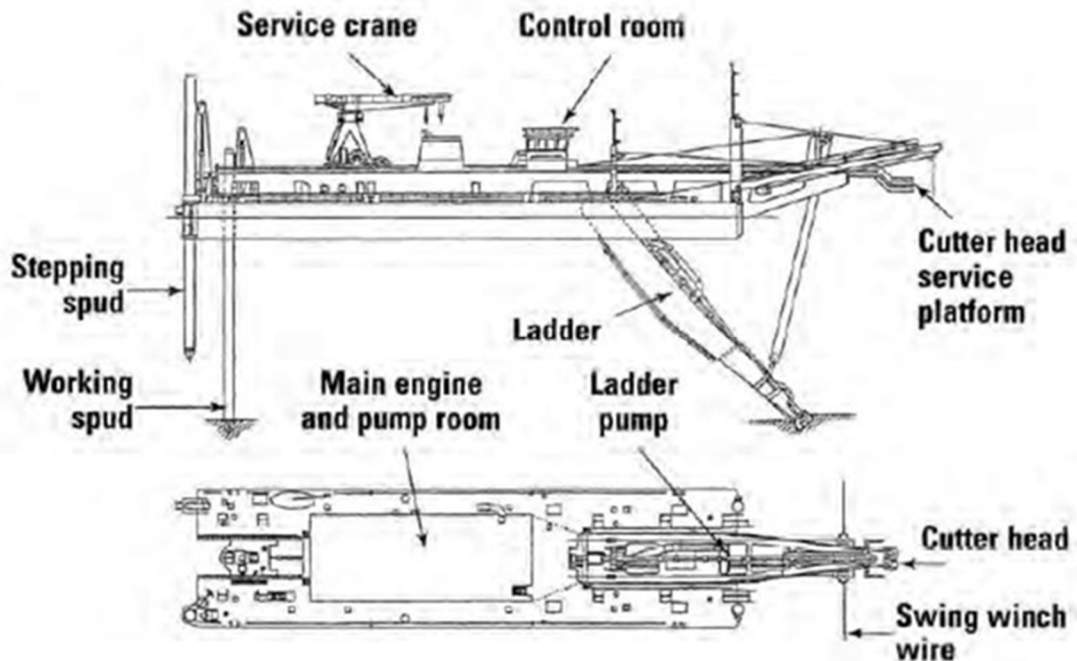
Cyclonic and otherwise bad weather would necessitate the temporary cessation of the dredging activities. The Dredge Master will make ongoing assessments regarding weather conditions to determine if a cessation in dredging is required. If the Port goes into cyclone alert or shut down then the dredging contractor will comply with all directions from the Harbourmaster.

### **2.2 Equipment**

#### **2.2.1 CSD**

It is anticipated that a small CSD (such as that shown in Figure 2-1) will be suitable to undertake the majority of the dredging. Typical flow rates from a dredge of this size have been estimated at 500 L/s. There are currently a number of small CSDs capable of undertaking work of this nature.

**Figure 2-1 Typical cutter suction dredge**



## 2.2.2 Backhoe and slurry pump

The use of a backhoe and slurry pump arrangement will also be considered as a potential dredge method in certain areas of the dredge footprint. A backhoe would be placed on a work barge and manoeuvred around the dredge site, dredging sediment from the seabed and placing it into a slurry pump on the barge. There would be no overflow of water permitted from the barge into the surrounding waters. The slurry pump will then pump the dredge spoil through the pipeline to the dredge spoil disposal ponds.

As indicated in Section 2.1, a backhoe or barge-mounted excavator may also be used to break up any high strength rock that may be present within the dredge footprint; with the broken rock cut and pumped ashore by the CSD.

## 2.3 Summary of work method

Final approval for funding for the construction phase of the MUBRF is to be addressed at the Parliamentary Works Committee (PWC) hearing in Darwin in late 2014 or early 2015 with a decision on funding expected in early 2015. Should the PWC approve funding for the construction phase of the MUBRF in early 2015 dredging would be anticipated to begin in mid-2015. The final schedule will depend on the appointment of the dredging contractor and associated commercial negotiations.

Dredging will generally be undertaken 12 hours a day six days per week (Monday to Saturday), however 24 hour seven day operations may be used depending on scheduling at the time of dredging. Dredging will continue until the required dredging is completed. The duration of dredging is expected to be approximately two to three weeks. Stoppages in dredging may occur for dredge maintenance or, while unlikely, to assist in the control of the quality of the water exiting the settling ponds at the point of discharge into Darwin Harbour.

The dredge will start in the deeper water advancing towards shallow waters, cutting and removing material as the dredge progresses. This methodology will be employed to reduce the amount of downtime incurred during low tides.

It is expected that tailwater flow rates into the pond system from the CSD will be approximately 500 L/s at a water to sediment ratio of 9:1 resulting in a dredge rate of 180 m<sup>3</sup>/hour of sediment inflow into the treatment ponds (Williams & Patterson 2014). A sediment loss rate of 1% at the CSD cutter head could be expected and a dry bulk density of 857 kg/m<sup>3</sup> was suggested to be likely based on field studies undertaken by the Australian Institute of Marine Science (AIMS) (Williams & Patterson 2014). However, it is recognised that losses may be higher (up to 5%) in shallower waters.

The sediment loss from a backhoe would differ from that from a CSD cutter head, depending on the material being dredged. Dredging of fine sediments with a backhoe dredge will likely result in greater sediment loss by a backhoe when compared to a CSD, while the opposite is likely when dredging consolidated sediments. In addition, sediment plumes from the backhoe would be discrete 'pulses' of turbidity and suspended sediments. Very few measurements of resuspension of dredge material around backhoes have been made (HR Wallingford 2010) and as such it is difficult to provide a definitive figure for expected loss for dredging with a backhoe. HR Wallingford (2010) adopted a value of 3% in modelling for the INPEX Ichthys dredging campaign in Darwin Harbour; however it should be noted that this was for dredging with a large backhoe with a bucket volume of 15 m<sup>3</sup> which is significant given factors affecting loss rates from a backhoe include bucket size and design. The backhoe size that would be employed for the dredging of the MUBRF would be substantially smaller than this.

## **2.4 Dredge spoil placement area**

Onshore disposal to existing decant ponds on the EAW (Figure 1-4) is a suitable option as it has been used for the disposal of material from capital dredging in East Arm and at the Darwin Waterfront, the disposal of maintenance dredge spoil and the MSB dredging campaign that was completed in January 2014. Offshore disposal is not being considered as part of the current development proposal.

Dredge spoil placement is discussed in detail in Section 2.5.4. The dredged material will be pumped through a temporary pipeline (a combination of 400 mm floating pipeline and submerged poly pipeline) from the dredge area, brought ashore under the bund wall through the existing pipe used during the MSB dredging, and deposited into the north-eastern corner of Pond K.

Depositing dredge spoil into Pond E (North) may also be considered with the pipeline extended across the bund wall between Pond E (North) and Pond E (South) (Figure 2-2). This would be undertaken in the event that PASS is detected; in which case it will be necessary to keep the dredged material submerged. If PASS material were to be deposited into Pond K then there would be a marginally higher risk of its exposure to air.

Transfer points between ponds (refer to Figure 2-2) have a reclamation box with an adjustable height weir. The weir boards are designed to be watertight to ensure sediment does not pass through, thus increasing the likelihood of a turbidity trigger event within Ponds K and E (North), but decreasing the likelihood of a turbidity trigger event in Pond E (South). The reclamation

weir boxes and associated weir boards are the same as those approved and used for the MSB dredging.

When dredge spoil is deposited in Pond K, the tailwater will flow around Pond K and into Pond E (North) through the weir box in the bund wall, through silt curtains in Pond E (North), then through a second weir box into Pond E (South) then out of the permeable section of the railway bund wall (Figure 2-2). When dredge spoil is placed into Pond E (North) tailwater will flow in the opposite direction to Pond K, then into Pond E (South) before leaving the pond system through the permeable section of the railway bund wall.

While it will not be the primary tailwater flow path, some tailwater may be routed into Pond E (North) via Pond D (outside of the Wet Season) after flowing through Pond K to increase the capacity and therefore residence time within the pond system. Tailwater will be transferred from Pond K into Pond D either using pipes embedded into the bund wall structures (reinstated as they were during the MSB dredging) or pumped over the top of the pond wall.

Should tailwater be routed through Pond D, it shall be under the same management measures implemented for the MSB dredging including water level management.

Should dredging take place during the Wet Season, dredging will require diversion of stormwater from Pond C, which has been mostly reclaimed, into Pond D so it can bypass around Pond K and into Pond E (North). This will be achieved via the previously installed pipes in and out of Pond D (Figure 2-2). Should this be required, any dredge activities undertaken during the Wet Season will have the dredge spoil deposited only into Pond K.

During dredging works, regardless of the initial dredge spoil deposition location (i.e. Pond K or Pond E [North]), the tailwater will be returned to the environment through the permeable section of the railway bund wall located in the south-west corner of Pond E (South) (Figure 2-2).

## **2.5 Dredge spoil and tailwater management**

The dredged material will be placed in the settlement ponds with tailwater stored for sufficient time to allow for settling of fine suspended sediments (residence time) prior to discharge of the tailwater back into Darwin Harbour. Water quality management and monitoring is discussed in detail in Section 6 and Section 7 of this plan.

The primary method of control over tailwater quality discharged from the pond system will be through control of the dredging regime. The flow rate of tailwater into the ponds will be controlled so that sufficient residence time is achieved to result in suspended sediment concentrations within allowable limits at the discharge point and surrounding the dredge location.

**Figure 2-2 Dredge spoil placement into EAW ponds**



## **2.5.1 Settling ponds system and available volume**

Settlement ponds are pre-existing ponds constructed during the previous development of East Arm Port and used during the recent MSB dredging.

Recent surveys of the ponds by Douglas Partners (2014) have shown:

- Pond K: Volume to Relative Level (RL) 6.5 m is 105,000 m<sup>3</sup> with available volume for dredge spoil to RL 6.0 m of 57,000 m<sup>3</sup>.
- Pond E North: Volume to RL 5.0 m is 460,000 m<sup>3</sup> with an available volume for dredge spoil to RL 4.0 m of 374,000 m<sup>3</sup>.

Based on the above, the pond system has a storage capacity of 431,000 m<sup>3</sup> for solids utilising only Ponds K and E North. It is likely that the dredging of the tug pens and small vessel berth will be undertaken prior to the MUBRF dredging. This will generate another 43,000 m<sup>3</sup> (plus some bulking after settlement) into Ponds K and E (North). Taking this additional spoil yet to be placed into the ponds, a storage capacity of 393,000 m<sup>3</sup> can be expected. The capacity of Pond K will be used as a priority with the option to utilise Pond E (North) for dredge spoil placement should it be required.

### ***2.5.2 Required pond volume***

The volume of sediment to be dredged from the MUBRF site is approximately 16,000 m<sup>3</sup>. Applying a conservative bulking factor in excess of 5 to 1, sufficient pond volume to hold 110,000m<sup>3</sup> of dredge spoil for adequate residence time is required.

When comparing these figures to those presented in Section 2.5.1 it can be seen that sufficient capacity in excess of that required for the tug pens and MUBRF dredging is available in the current pond system.

### ***2.5.3 Pond capacity management measures***

Given the sufficient pond capacity, it is not anticipated that achieving adequate residence times will be a problem. The required residence times will be achieved through a number of measures to be implemented as required based on the results of water quality monitoring at the tailwater discharge point throughout dredging operations. The proposed management measures are:

- Controlling and directing the flow of tailwater into the ponds such that residence times are sufficient. Should it be required, dredging may be slowed or ceased to extend pond residence times.
- Adding or removing silt curtains to Pond E (North) or Pond K to maximise efficiency of residence time in the pond.
- Stockpiling material in Pond K, with the final height to be confirmed by a geotechnical assessment to ensure stockpile and bund wall integrity is maintained.
- Though not forming part of the initial plan, should the use of Pond D be deemed suitable in the Dry Season as a route for tailwater to be transferred between Ponds E (North) and K, it may be used to extend residence times in the pond system.

### ***2.5.4 Pond fill sequence***

Tailwater will be pumped from the dredge site into Pond K, starting at the north-east corner. As the pond fills, the tailwater will make its way from Pond K into Pond E (North) via the weir. Tailwater will then flow from Pond E (North) into Pond E (South) where it will eventually pass

through a permeable section of the bund wall into Darwin Harbour. Where tailwater is deposited into Pond E (North), it will flow in the opposite direction through Pond K, into Pond E (South) before leaving the ponds through the permeable section of the bund wall.

The use of Pond D has not been ruled out during the Dry Season, however it will be used only if Pond E and K are both at capacity (which is not expected). Tailwater may be routed to Pond E (North) through Pond D after tailwater has passed through Pond K. Pond D will not be used for dredge spoil disposal, but rather to extend the capacity and residence time in the pond system. Minor sediment deposition may occur in Pond D, but it is anticipated that the majority of dredge spoil will have settled out in Pond K before entering Pond D.

To allow routing through Pond D, a link between Pond K and Pond D will be reinstated by either reinstalling pipes under the pond wall or by laying pipes over the pond wall into Pond D. Pre-existing links between Pond D and Pond E (North) will be used.

Silt curtains may be installed in Pond K if required to increase residence time. Silt curtains are already installed in Pond E (North) and may be removed or reconfigured as required to optimise the pond performance for residence time.

#### ***2.5.5 Pond water levels***

Pond K will operate between level 4.5 and 5.5 m Australian Height Datum (AHD) during normal dredge operation, but may go lower if the dredge is on standby and inflows stop, or may go up to 6.0 m AHD if required.

Pond E (North) will operate with a water level of between 3.5 and 5.0 AHD and be controlled by a reclamation box with an adjustable weir.

A water level between 1.5 and 2.5 m AHD will be maintained in Pond E (South). During the MUBRF dredging works, tailwater will pass through the permeable section of the railway bund (at the south-west corner of Pond E) at a rate which matches or exceeds the dredge output; hence this water level will be maintained. While it is not anticipated to be required based on experience with the MSB dredging which utilised a larger CSD pumping tailwater into the pond system at approximately 2000 L/s, a backup pump discharge outlet will be located in the south-east corner of Pond E (South) where a pump system capable of pumping 600 L/s will be on stand-by to return tailwater to Pond K or Pond E (North).

Pond D will be isolated from tailwater treatment during the Wet Season period and the water height will be regulated by the transfer pipes into Pond E (North), ensuring water levels will be as per previous Wet Seasons. If Pond D is brought into service outside of the Wet Season, the water level in Pond D will be maintained at 5.5 m AHD. Some wave action may be induced in Pond D due to wind and it is unknown if this will reduce the effectiveness of sediment removal. Pond D can accommodate a water depth of up to 6.0 m AHD and it will be allowable to raise the depth to this level to reduce the impact of wind and currents.

Each pond will operate with a minimum 0.5 m freeboard. While it is not anticipated to be required given the relatively low flow rates into the ponds, additional pipes may be installed at any transfer point and/or pumps may be used to supplement gravity flows to ensure transfer flows equivalent to the dredge output are maintained between ponds.

The water level of each pond will not vary substantially day to day during dredging and the daily water levels of each pond will be recorded and provided in the weekly reports. Where transfer pipes are fitted, the flow between ponds can be stopped by blocking the pipework between these ponds with steel plates and/or inserting rubber expanding plugs, with both options available on site.

Where a reclamation box is fitted the flow can be stopped by adding drop boards and raising the height of the weir. In both instances flow can be stopped within an hour as a corrective action if required (refer Table 6-2).

### **2.5.6 Stormwater and landform**

Stormwater from the pond network and adjacent Darwin Port Corporation (DPC) land ultimately flows into Pond E (South) for discharge to the harbour via the permeable section of the railway bund wall (refer Figure 2-3). During dredging operations, particularly if dredging is undertaken over the Wet Season, consideration will be given to possible storm events and the Contractor will ensure that a flow path is always available for stormwater to find its way through the ponds, or allow a sufficient catchment to ensure the stormwater can be retained for future release.

The runoff from DPC land historically ran into both Pond D and Pond K. This has been modified so that the portion of stormwater that normally ran into Pond K is diverted into Pond D, thus separating stormwater from the dredge deposition pond which is important if Pond K needs to be blocked off for any reason, or if the stormwater is adding to water quality issues in Pond K. This modification required a new transfer pipe to be installed between Pond C (of which only a small ponded area remains at the north-west corner) and Pond D, and is of the same design as per the existing pipes in and out of Pond D.

Stormwater from the road bund and a catchment area near the gatehouse, estimated to be 30,000 m<sup>2</sup>, is now diverted into a new stormwater channel in place along the boundary between Pond K and the former Pond C area, instead of flowing into Pond K. Stormwater from the highpoint on the road to the south of Pond K now flows along a stormwater channel and through the wall separating Pond K and Pond E North.

With Pond E divided into Pond E (North) and Pond E (South), the Contractor has the option of placing dredge spoil directly into Pond K or Pond E (North), although dredge spoil deposition will be limited to Pond K during the Wet Season where possible to allow stormwater to flow through Ponds D and E for settlement and discharge to the environment via the permeable section of the railway bund.

Figure 2-3 Stormwater flow paths through EAW ponds



Pond E (North) will only be filled with solids to a level which will allow sufficient capacity for stormwater and tailwater management.

The pond network has the ongoing function of stormwater management beyond the duration of this dredging project and will be maintained during and after the completion of this project. Therefore the pipe connections between ponds will be retained for ongoing stormwater management. When the dredging is complete a surface survey will be completed and a surface profile developed to minimise the risk of ponding against the access road causeway or in areas not forming part of the stormwater system. The final landform will be effective in directing surface water through Pond E (North) before entering into Pond E (South), then

discharging to the receiving environment through the permeable portion of the railway bund wall.

### 3 ENVIRONMENTAL PROJECT MANAGEMENT AND RESOURCING

Part of the procurement process to select a suitable dredging contractor (the Contractor) to undertake the dredging component of the MUBRF project is to ensure that the contractor has an adequate Environmental Management System (EMS) in place before commencing dredging.

#### 3.1 Environmental Management Systems and Procedures

##### ***3.1.1 Key roles and responsibilities***

Key roles and responsibilities will be identified by the Contractor on appointment and a project specific organisational chart will be developed and maintained by the Contractor.

Site management responsibilities will be defined and documented by the Contractor before dredging commences, including reporting and communication pathways between Contractor and DoI/LDC personnel.

Key roles to be identified include (but are not limited to):

- Project Manager
- Health Safety Environment and Quality (HSEQ) Advisor
- Supervisors / engineers
- Employees and subcontractors

##### ***3.1.2 Technical Advisory Group***

The NTG has established an independent TAG to provide advice on management of dredging and disposal works (and associated environmental impacts) for the EAW development project. The TAG is responsible for providing scientific, environmental and technical advice on all aspects of the dredging and disposal works. Once a Contractor is appointed, DoI and the Contractor will develop terms of reference for consultation with the TAG.

#### 3.2 Inductions and training requirements

Inductions and training requirements will be determined by DoI and the Contractor on appointment and will be in accordance with DoI and Contractor's policies and procedures. All relevant inductions will be completed by all personnel before they begin work on the project. A training and inductions register will be maintained by the Contractor.

##### ***3.2.1 Environmental inductions***

The Contractor will provide sufficient resources and training to achieve the targets defined in its EMS. DoI will assist the Contractor fulfil this commitment through provision of advice to the Contractor on required environmental inductions and information.

Environmental inductions may include but not be limited to the following environmental topics:

- providing an overview of key environmental issues and personnel responsibilities
- promoting awareness of significant environmental issues and personnel responsibilities

- reporting of environmental incidents - which will include how an event is reported and to whom the event is reported (all incidents are to be reported, including near misses)
- preparing emergency procedures - which will cover the procedure for an emergency and for evacuation of the site in the event of a catastrophic situation arising
- preparing contingency plans - e.g. for chemical spills or in the event that an unidentified Aboriginal heritage item is uncovered during the works.

### **3.2.2 Environmental awareness**

A schedule of toolbox meetings will be developed by the Contractor and approved by DoI and will be mainly aimed at operational staff. All Contractor and subcontractor personnel (if any) will be required to attend. Toolbox meetings will focus on environmental and safety items relevant for the project during that time, and are used as the main tool to further increase awareness of significant environmental and safety issues, and to communicate the relevant items contained in the Environmental and Safety Management Plans.

Typical items discussed in these toolbox meetings include environmental items such as new procedures or reinforcement of existing procedures relating to erosion control, handling of hazardous chemicals, weeds, clearing boundaries, management of waste/ recycling, biting insect problems, need to report all incidents and hazard/ near misses, etc.

### **3.2.3 Training**

Only qualified and experienced personnel will be engaged on the project. All personnel will have appropriate qualifications and experience for their role on the project.

## **3.3 Environmental documents and records management**

The Contractor appointed will have in place as part of their EMS, or will develop before the start of dredging, a document management system that meets the requirements of their EMS.

Project records, including subcontractor project records, will be maintained to provide evidence of conformity to DoI requirements and commitments in this DDSPMP.

Such records include, but are not limited to:

- correspondence to/from the DoI and interested parties
- permits, licences and approvals
- induction training records
- inspection and test documentation (including calibration)
- non-conformance and corrective action / complaints
- environmental incidents
- audits and inspections
- monitoring records
- delivery / waste dockets.

### **3.4 Performance management**

Performance management includes activities to ensure that goals are consistently being achieved in an effective and efficient manner. A key component of the environmental management process is the development and implementation of specific measures to ensure that the environmental risks arising from the dredging and dredge spoil disposal activities are minimised. The success of these objectives is measured with key performance indicators (KPIs) defined for environmental management.

#### **3.4.1 Environmental objectives**

The environmental objectives of dredge operations management are to:

- limit impacts of dredging and dredge spoil management operations on marine life and water quality
- ensure that protected marine species, including dolphins, dugongs, turtles and sawfish are not significantly adversely affected by dredging activities
- reduce the potential impacts from noise generated by dredging equipment
- limit sediment (turbid plume) mobilisation to an extent consistent with protecting the viability of specified communities
- ensure migratory bird species that use the dredge spoil deposition ponds are not directly adversely affected by dredge activities
- ensure that dredging and dredge spoil placement are undertaken in accordance with regulatory approvals, licences, permits or authorisations.

#### **3.4.2 Performance criteria**

The DDSPMP is the key reference document which identifies actions and commitments to be followed by the Contractor and subcontractor personnel throughout dredging operations. The broad performance criteria of the DDSPMP are as follows:

- compliance with the DDSPMP by all project personnel and activities
- adherence to discharge water quality parameters as identified in the Water Quality Monitoring Plan (Section 7.3 of this plan)
- no net adverse impacts on corals, mangroves, dolphins, dugongs, turtles, sawfish or migratory birds
- no injuries to protected marine species
- no complaints received in relation to noise, vibration and no impacts on protected species from these sources
- response to all registered complaints and completion of Complaint Record and/or Incident Report; appropriate corrective actions taken within three working days
- where performance criteria are not met, this will form a trigger for review of the Plan, in addition to initiating corrective actions specific to the scenario.

### **3.4.3 Environmental management KPIs**

In the environmental management frameworks detailed in Section 6 of this plan, specific objectives and targets are set for each significant environmental aspect. KPIs related to the objectives and targets for each of the environmental management frameworks can be found in Section 6.

General objectives and targets are:

- all personnel working on site have undergone an environmental induction
- internal audit score of 100% compliance with the DDSPMP
- client conducted audit score of 100% for compliance with the DDSPMP
- DoE conducted audit score of 100% for compliance with the DDSPMP
- no activity in breach of the provisions of any environmental legislation
- 100% investigation and reporting of any environmental incident at the site
- 100% compliance required for management measures relating to dredging and dredge spoil management.

### **3.4.4 Environmental incident reporting**

All Contractor and subcontractor site personnel will be required to report all environmental incidents immediately to the appropriate supervisor in accordance with their incident reporting procedures. The Contractor engaged will have (or will develop prior to the start of dredging) an Incident Reporting and Investigation Procedure.

Incidents shall be tracked through to close out using an incident tracking system or register. Complaints will be investigated by the Project Manager and action taken to enable satisfactory closeout. Any incidents that have caused environmental harm or that have the potential to cause environmental harm will also be reported to the DoI representative and to NT EPA Pollution Hotline (1800-064-567) within 24 hours. When in any doubt as to the seriousness of the event, the Contractor will notify the authorities, in liaison with the DoI. The DoI will be notified of any notices received from authorities.

## **3.5 Management review**

### **3.5.1 Inspections / monitoring**

Daily visual monitoring will be conducted by site supervisors. Any corrective actions resulting from inspections will be entered onto a 'Non-conformance and Corrective Action Register' and the progress tracked for completion.

### **3.5.2 Internal audits**

Given the short duration of dredging expected, an internal audit of this DDSPMP will be undertaken prior to commencement of dredging to assess the effectiveness of the Plan in the field and identify any opportunities for improvement.

### **3.5.3 External audits**

External audits can be conducted by DoI or third parties, such as other government departments. The NTG may conduct an audit at any time when they believe there is an issue in relation to environmental compliance. DoE can also conduct or direct an external audit. The Project Manager will assist with any external audit.

Results from any external audits will be reviewed by the Project Manager, with any necessary corrective actions assigned to project personnel to ensure appropriate and timely closeout. Any corrective actions will be entered into a project corrective action register and the progress tracked for completion.

### **3.5.4 Project corrective actions register**

Any environmental non-conformance (e.g. incidents, audit-related non-conformance, complaints, government notices, etc.) will be recorded in a project corrective actions register or similar to be developed by the Contractor. The corrective actions register will detail the non-conformance, allocate corrective action required, responsible persons, timeframes by which the action is to be completed, and the actual completion date. Each non-conformance shall be reviewed and it will be established if there are any actions available to reduce the severity or likelihood of re-occurrence.

### **3.5.5 Continuous improvement**

The Contractor will have in place mechanisms described to review performance and to identify opportunities for improvement. Records will be kept and reporting will be done according to contractor procedures for managing documentation. Observations will be detailed in project reporting to DoI.

Mechanisms may include but will not be limited to:

- prestart meetings
- toolbox meetings
- progress reports.

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## 4 EXISTING ENVIRONMENT AND RELEVANT STUDIES

### 4.1 Background

The marine environment within the project area is described in detail in the Draft EIS and EIS Supplement (DLP 2011a, b). This section of the DDSPMP provides a brief overview of those components of the existing environment that are pertinent to the consideration of impacts from dredging and spoil placement prior to construction of the MUBRF. It also provides information on studies that have been undertaken subsequent to the primary approvals process. This information provides the context for determining the management strategies detailed in Section 6 and the monitoring programs detailed in Section 7.

The Darwin Harbour region encompasses 2,417 km<sup>2</sup> and includes the catchments of the rivers and streams that flow into the harbour, including the Howard River, Elizabeth River and Blackmore River, as well as the large estuarine/marine water body that is Darwin Harbour. Within the harbour, shores are characterised by extensive intertidal mud flats and mangroves. Corals exist in several areas within the harbour.

The MUBRF is located approximately 1 km to the east of the EAW and recently completed MSB, within Darwin Harbour (Figure 1-1). Two small islands (South Shell Island and Catalina Island) lie in the vicinity of the project area (south-west and east respectively).

### 4.2 Existing physical environment

#### 4.2.1 Meteorological conditions

Darwin Harbour lies in the monsoonal (wet–dry) tropics of northern Australia and experiences two distinct seasons; a hot Wet Season from November to March (when winds are predominantly westerly) and a warm Dry Season from May to September (when winds vary from south-easterly through to northerly). The months of April and October are transitional. Maximum temperatures are defined as hot all year round, but November is the hottest month with a range of 25 °C minimum to 33 °C maximum, while June and July normally experience the lowest average daily temperatures with a range of 19 °C minimum to 30 °C maximum (Bureau of Meteorology [BoM] 2013).

The mean annual rainfall for Darwin is 1733 mm, with rain falling on an average of 113 days, mainly from November to March. A range of monthly rainfall averages received at Darwin International Airport (highest, mean and lowest monthly rainfall) is provided in Table 4-1 (BoM 2014). Daily mean evaporation ranges from 6 mm in February to 8 mm in October. The mean annual evaporation rate is 2482 mm (BoM 2012).

**Table 4-1 Average monthly rainfall for Darwin (mm)**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug*	Sep*	Oct*	Nov*	Dec*
Mean	426	375	319	102	21	2	1	5	16	71	142	251
Max	940	1110	1014	396	299	51	27	84	130	339	371	665
Min	136	103	88	1	0	0	0	0	0	0	17	19

\* Averages to 2013

Cyclone activity occurs intermittently in the Darwin region, mainly between November and April, with cyclones typically causing the most damage within a distance of 50 km from the coast. Aside from the impacts of strong winds, storm surges can be of concern to vessels and coastal developments surrounding Darwin Harbour. Storm surges (generally 2–5 m higher than normal tide levels) result from strong onshore winds and reduced atmospheric pressure (BoM 2012), and can cause flooding and damage through raised tidal levels and increased wave heights. The height of a storm surge is influenced by many factors, including the intensity and speed of winds within the associated cyclone, the angle at which the cyclone crosses the coast and the bathymetry of the affected area.

#### **4.2.2 Coastal geomorphology and bathymetry**

Darwin Harbour is a large ria system, or drowned river valley, formed by post-glacial marine flooding of a dissected plateau. The harbour, which has a surface area of some 500 km<sup>2</sup>, was formed by rising sea levels about 6000-8000 years ago. Since the formation of the harbour, surface erosion from the adjoining terrestrial environment has carried substantial quantities of sediment into the harbour. This sediment now forms much of the intertidal flats that which overlie bedrock around the harbour margins. The Elizabeth River flows into the East Arm of the harbour, within which lies the Project area.

The harbour extends for more than 30 km along a north-west to south-east axis. The main channel of the harbour is around 15-25 m CD deep, with a maximum depth of some 36 m. The channel favours the eastern side of the harbour and continues into East Arm, at water depths of more than 10 m CD. The bathymetry in this area has been already previously modified by dredging for the development of the EAW.

In 2010, iXSurvey Pty Ltd completed a hydrographic survey in the vicinity of East Arm. Figure 1-2 shows that the bathymetry under the footprint of the MUBRF falls from approximately 2.5 m above CD at the northern end to between 1.5 to 2 m below CD at its southern extremity. The approach channel bathymetry lies at approximately 1 to 1.5 m below CD.

#### **4.2.3 Marine sediments**

The sediment profile for the East Arm of Darwin Harbour consists of Quaternary age intertidal marine alluvium comprising mud, silt, sand and coral remnants, underlain by the Proterozoic metasediments of the Burrell Creek Formation, consisting of meta-siltstone, meta-sandstone and phyllite. The rocks strike close to north-south and are steeply dipping either to the east or west. Quartz veins are widespread within the Burrell Creek Formation.

Approximately 80% of the Darwin Harbour region's seafloor is estimated to be covered with soft surfaces consisting of mud and fine sand. Soft surfaces containing varying amounts of gravel and sand are found in the main channels around reefs, on beaches and on spits and shoals near the mouth of the harbour (Fortune 2006).

In January 2014, URS undertook a geochemical assessment of the sediments within the MUBRF dredging footprint. The report (URS 2014) contains a summary of the potential contaminant inputs to the dredging area. Land uses in the Darwin Harbour catchment represent potential sources of contaminants that may accumulate in the MUBRF dredging footprint. In the mid-1990s, the mean annual contaminant loads contributed to the harbour

from the Hudson Creek catchment (upstream of the MUBRF development) were calculated by Padovan (2001) to be 15 t of nitrogen, 3 t of phosphorus, 40 kg of arsenic, 6 kg of cadmium, 220 kg of chromium, 189 kg of copper, 327 g of lead, 43 kg of nickel and 1860 kg of zinc.

The key findings from the geochemical assessment (URS 2014) were:

- No contaminants of potential anthropogenic origin were detected at levels above the criteria levels within the National Assessment Guidelines for Dredging (NAGD). That is, all contaminants of potential anthropogenic origin were present at concentrations at which, under the NAGD, toxic effects on organisms are not expected. Hence there was no evidence of inputs of contaminants to the sediments arising from the operation of EAW.
- As expected, arsenic concentrations typically exceeded NAGD criteria levels. Previous studies have attributed elevated arsenic concentrations in Darwin Harbour sediments to local geological influence (e.g. weathering of bedrock in the catchment). Some of these studies have demonstrated that, in the natural marine environment, the arsenic has low bioavailability. That is, the arsenic is bound to the sediment in such a way that it will not readily enter the food chain.
- The distribution of potentially acid producing sediments within the material to be dredged cannot be accurately mapped. Hence it must be assumed that potentially acid-producing sediments could be dredged at any time during the campaign. It should be noted that these sediments will be intermixed with other sediments that will have neutralising capacity due to the presence of natural carbonates (e.g. calcareous sand, fine shell particles). Also, only the surface layer of the deposited sediments will be exposed to air and hence potentially acid producing. As sediments are progressively buried as the dredging campaign progresses, they will again become anoxic and their potential to generate acid will decrease accordingly.

The key focus to arise from the investigation is the need during the dredging program to monitor for, and manage, the pH levels within the dewatering pond system. As well as the need to ensure that the tailwater discharged from the pond system complies with pH criteria levels, there will also be a need to monitor metals concentrations in the tailwater as decreased pH levels could stimulate the release of metals into the overlying water column. There will need to be a particular focus on arsenic; whilst it is considered to have low bioavailability in the natural seawater of Darwin Harbour, in the presence of reduced pH the concentrations of arsenic in the tailwater may gradually trend upwards over the course of dredging.

In conclusion, the investigation has shown that the sediments are suitable, from a geochemical standpoint, to be disposed into the onshore reclamation area. Appropriate monitoring will need to be undertaken to detect any trends towards decreasing pH or increasing metals concentrations (especially arsenic) in the tailwater over the course of the dredging campaign. Suitable management measures will also need to be devised, to be implemented in the event that pH levels become unacceptably low or metals concentrations become unacceptably high.

While the geochemical assessment identified these risks, given the short period of the dredging campaign, the likelihood of these concerns being realised is small.

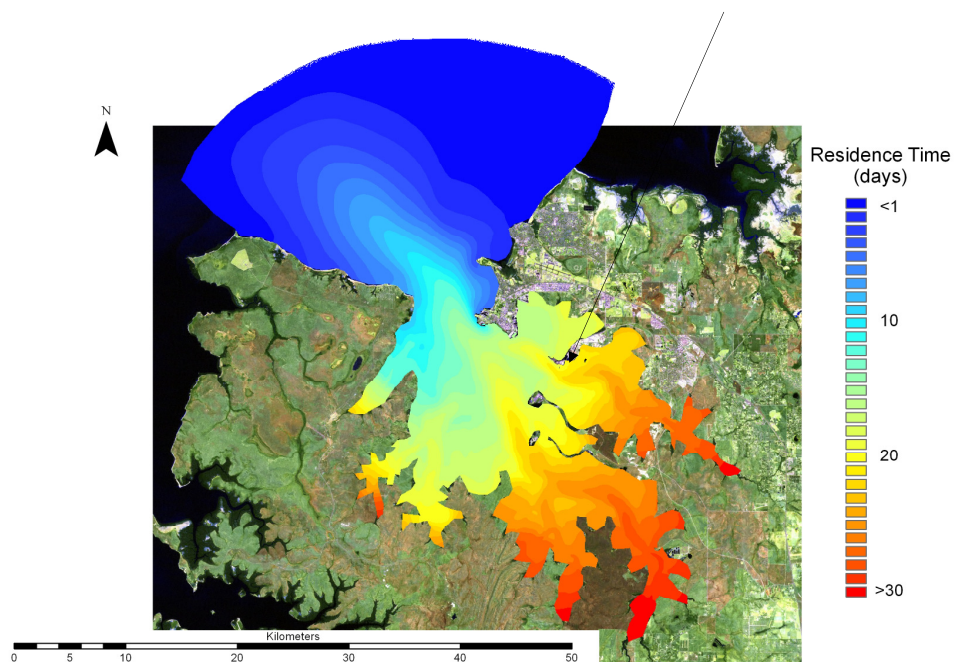
#### 4.2.4 *Metoccean conditions*

Darwin Harbour has semidiurnal macro-tides (two highs and two lows per day) with a strong diurnal inequality. The highest astronomical tide is 8 m CD. The mean spring tidal range is 5.5 m and the mean neap tidal range is 1.9 m, with a maximum range of 7.8 m. It is a well-mixed system with large volumes of water moving within the harbour with tidal fluctuations. Tidal movement plays an important role in re-suspending material from the harbour floor into the water column.

Williams, Wolanski and Spagnol (2006) investigated the link between hydrodynamics, sediment and nutrient dynamics in the harbour to assist in the management of infrastructure developments. Near headlands and embayments, a complex circulation occurs that includes jets, eddies, separation points and stagnation zones. These currents are different at flood and ebb tides and the asymmetric dispersion of particles results in trapping at headlands and embayments. Sediment is delivered to the upper arms by runoff. Despite being macrotidal the harbour was found to be poorly flushed, with much of the riverine fine sediment remaining trapped in mud flats and mangroves with little escaping to the sea. The residence time of pollutants in the upper reaches of the harbour was found to be in the order of 20 days (Williams, Wolanski & Spagnol 2006).

The MUBRF is located in an area where the Dry Season flushing is estimated to be around 20 days (Figure 4-1), hence it is defined as being in the Upper Estuary Zone.

**Figure 4-1** Dry season flushing zones of Darwin Harbour (MUBRF site as indicated by arrow)



#### 4.2.5 *Marine water quality*

Water quality in Darwin Harbour is described as generally high, although naturally turbid most of the time (DLP 2011a). Water quality parameters vary greatly with the tide (spring versus neap), location of sampling point (inner versus outer harbour), and with the season (Wet Season versus Dry Season).

During the Dry Season the salinity is quite uniform and the estuary well mixed. This contrasts with Wet Season conditions where the saline water of the harbour is met in the upper estuary by a buoyant plume of freshwater (from the catchment). A strong salinity gradient can persist during and after rainfall events in the upper reaches of the estuary and the tidal creeks. The Wet Season effects on harbour water quality (through high surface runoff from the land) can last until April or May, depending on the amount and duration of rainfall.

Duggan (2006) conducted research on the water quality of Darwin Harbour from 2002 to 2004. Seasonal aspects, rather than spatial or tidal aspects, were found to be the most important determinant of water quality, with rainfall considered to have the greatest impact on water quality (increasing nutrients, suspended solids and chlorophyll a).

There is no evidence of widespread water or sediment pollution in the harbour, although some localised pollution has been identified in the past (e.g. Padovan 2003; Water Monitoring Branch 2005; Drewry 2011). Anthropogenic influences to harbour water quality include the EAW port operations, historic industrial activities at Darwin Waterfront, Sadgroves Creek and wastewater outfalls (URS 2014), however there is no evidence of hydrocarbon or pesticide pollution in the harbour (Darwin Harbour Advisory Committee [DHAC] 2007).

Darwin Harbour water quality has been monitored against a series of Water Quality Objectives (WQOs) and reported by DLPE in annual report cards since 2009 (DLPE 2013). The DLPE report cards provide a score based on the following parameters:

- dissolved oxygen (DO)
- Total Suspended Solids (TSS) (by way of TSS – turbidity relationship)
- chlorophyll a (as an indicator of algae)
- nutrients (nitrogen and phosphorus)
- temperature, pH and salinity are also measured but not included in the determination of the report card score.

Water quality at 14 sites in East Arm is monitored through this process and has consistently met water quality objectives over this period. In 2009 East Arm received a B grade rating, meaning three out of four of the water quality indicators above met desired levels. Between 2010 and 2012 an A grade was given meaning all four indicators met desired levels. The 2013 report card for East Arm delivered a B grade as a result of DO concentrations outside of the WQO limits on four occasions. These exceedances were not harmful and are considered within the limits of natural variation for this area and not indicative of pollution (DLPE 2013)

#### **4.2.6 Water quality baseline data**

Between 2008 and 2011, a number of water quality investigations were undertaken by URS on behalf of INPEX Browse, Ltd (INPEX) to characterise the existing conditions in East Arm (URS 2009, 2011). Table 4-2 presents summary statistics for Dry and Wet Season water quality, as recorded at a site off the southern tip of South Shell Island (URS 2011).

These data were collected every 15 minutes over a year-long program. Data were grouped and averaged based on tidal cycle and seasonal variation, allowing seasonal means, medians, and percentiles to be calculated. This gives a robust body of data to compare background

levels of turbidity with potential increases associated with various natural and artificial turbidity-generating events in the harbour.

Water quality data from South Shell Island is relevant to the present project as this location is the nearest significant receptor (coral communities) to the dredging location and will also be monitored for biological impact, although modelling does not indicate an impact at this site (refer to Section 5). The two other locations identified, Old Man Rock and Catalina Island, while located closer to the dredge site to the east, have no well-developed coral communities. Accordingly it is appropriate that South Shell Island water quality data have been used to set trigger levels for monitoring, as described in Section 7 of this DDSPMP.

**Table 4-2 Summary of water quality parameters at South Shell Island (URS 2011)**

	Dry Season			Wet Season		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
Temperature (°C)	28.1	25.3	32.1	30.4	28.1	32.0
Conductivity (mS/cm)	48.7	40.2	52.9	46.2	36.7	49.8
Depth (m)	6.3	2.4	11.0	6.7	2.5	11.3
pH	8.0	7.7	8.5	8.0	7.6	8.2
DO (%)	93.5	73.4	121.1	88.5	67.3	106.4
Turbidity (NTU)	4.4	0.1	46.4	8.3	0.2	68.0
Suspended sediment concentration (SSC) (mg/L)*	10.8	7.1**	46.4	14.1	7.2**	64.7

\* Calculated from NTU using relationship in URS (2011):  $SSC = 0.848 * NTU + 7.0477$

\*\* These values are an artefact of applying a linear equation to the SSC/NTU relationship and the actual SSCs are likely to have been considerably lower. This does not affect the veracity of the trigger levels presented in Sections 6.2 and 6.3 of this DDSPMP, which are closer to the maximum NTU and SSC values.

## 4.3 Environmental receptors

### 4.3.1 Marine habitats

A comprehensive survey of the marine habitats around South Shell Island, Old Man Rock and Catalina Island was undertaken in May 2012 by Geo Oceans Pty Ltd (Geo Oceans 2012). A habitat map (Figure 4-2) was produced from interpolated substrate and biological community data collected on the survey. The map also incorporated data from previous habitat mapping in the area (Geo Oceans 2011), along with digital imagery and acoustic survey data (including that of iXSurvey [2010]). It should be noted that “no epibenthos” refers to areas in which the cover of epibenthic macrobiota (e.g. corals, filter-feeders, macroalgae) was less than 10%.

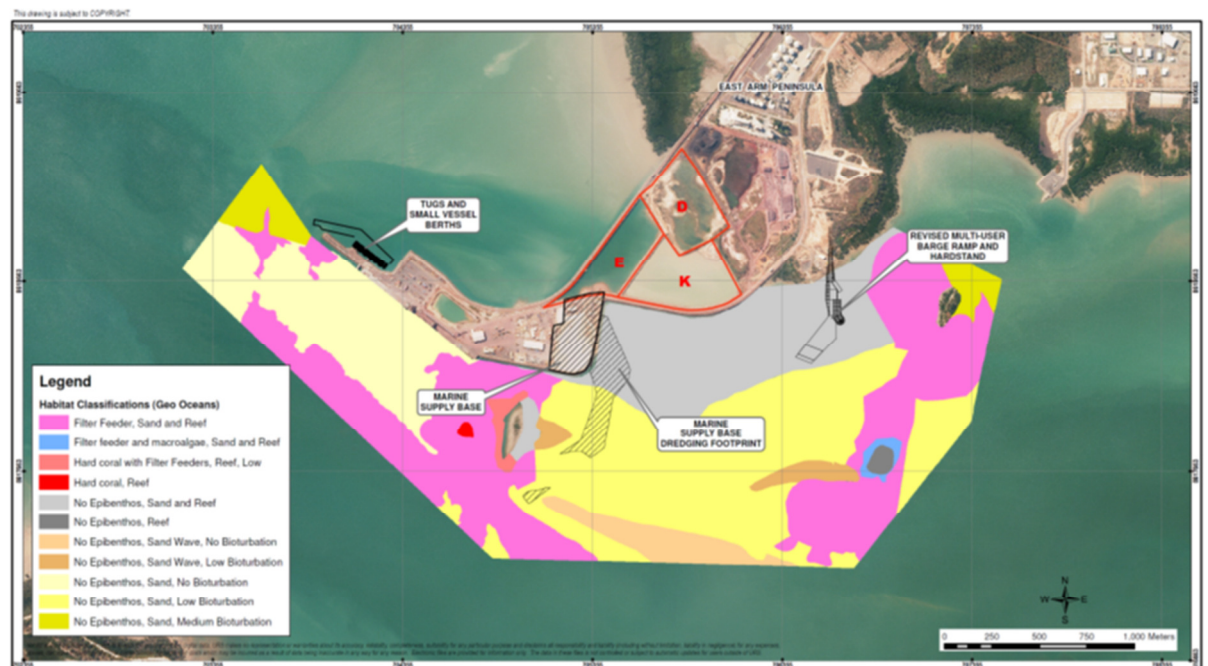
Subsequent to the baseline habitat survey, Geo Oceans has undertaken the benthic habitat monitoring program associated with the MSB dredging. This monitoring involved habitat surveys to identify significant changes in percent cover of benthic habitats from baseline levels

on two occasions (at the end of phase one dredging and pre-phase two dredging in April 2013; Geo Oceans [2013]).

DoI (2014) summarised and presented the key findings of Geo Oceans in the Annual Monitoring Report for the MSB dredging. The benthic habitat monitoring program found:

- there was no significant difference in hard coral at sites between survey periods
- there is evidence of a marginally significant decline in hard coral cover at site 5 between the two time periods, though not above the ministerial threshold level of a 10% change
- filter-feeder communities demonstrated no significant difference in cover between baseline and survey 3
- a comparison of hard coral percentage cover data between survey 2 (i.e. post phase 1 dredging) and survey 3 (i.e. pre-phase 2 dredging) revealed an increase in coral cover at all sites between the two dredge phases
- filter feeder communities have demonstrated much less variability in percentage cover over the three survey periods.

**Figure 4-2 Benthic habitats, East Arm (Geo Oceans 2012)**



#### 4.3.2 *Hard coral communities*

Hard coral communities occur in Darwin Harbour where the substrate is rocky in the lower intertidal and shallow subtidal zones and where hydrodynamic conditions permit. Hard corals are dominant within some of the benthic communities around South Shell Island (Figure 4-2), mainly on the western side of the island (the opposite side to that directly exposed to the proposed dredging activities at the MUBRF).

Other well-known hard coral communities in Darwin Harbour include:

- off the north-east shore of Wickham Point, within 4 km of the proposed MUBRF dredging works
- Weed Reef, Plater Rock and Kurumba Shoal on the western side of the harbour, and Dudley Point at the northern end of Fannie Bay, all more than approximately 10 km from the MUBRF
- Channel Island coral community in Middle Arm, on the intertidal platform between Channel Island and the mainland. This is listed on the Register of the National Estate and is a declared Heritage Place under the NT *Heritage Conservation Act 1991*. It is some 15 km (by sea) from the MUBRF.

With the exception of the coral community off the north-east shore of Wickham Point, all of these communities are sufficiently remote from the MUBRF that the proposed dredging works pose no credible risk of impact to them. Sediment plume modelling (Section 5) predicts that the South Shell Island and north-east Wickham Point hard coral communities are also sufficiently distant from the proposed dredging works to be at no risk of impact.

When comparing results of the benthic habitat monitoring surveys undertaken for the MSB dredging monitoring program, Geo Oceans found an increase in coral cover at all sites. No statistical analysis of the hard coral data between the survey periods was undertaken to determine if the apparent increases in cover are statistically significant, however the data suggests that the coral cover has increased while MSB-related dredging was not being undertaken (DoI 2014).

### **4.3.3 Filter-feeder communities**

Filter-feeder communities are those that primarily comprise sponges, gorgonians (sea fans and sea whips) and other soft corals. They primarily occur on intertidal or subtidal hard substrates and may co-occur with hard corals, giving rise to “mixed species” communities. However, they also occur at depths shallower than, and deeper than, those at which hard corals thrive and can be the dominant component of the benthic community in areas where a soft sediment veneer overlies hard substrate (Figure 4-2).

It should be noted that, during the environmental approvals process for the East Arm Wharf Expansion project, the publications of Hooper, Kennedy and Quinn (2002) and Alvarez, Browne and Horner (2002) were misquoted as indicating South Shell Island is a “biodiversity hotspot” for sponges, soft corals and hard corals. While the first of these publications refers to the region between Darwin and the Wesel Islands (a distance of some 650 km) as being a “biodiversity hotspot”, it makes no specific mention of South Shell Island. The second publication does not present any new data, but simply references the first, indicating that Darwin Harbour is “located in one of the hotspots of sponge diversity within Australia”. Neither publication discusses hard or soft corals.

When comparing results of the benthic habitat monitoring surveys undertaken for the MSB dredging monitoring program Geo Oceans (2012) found little variability in filter-feeder communities across the three surveys undertaken. This pattern is somewhat unsurprising as these communities are generally less sensitive than corals to the physiological pressures of reduced benthic light availability and sedimentation associated with dredging activities or natural environmental conditions (i.e. tidal flows).

#### **4.3.4 Protected marine species**

##### **4.3.4.1 Cetaceans**

Three species of coastal dolphin inhabit the Darwin Harbour region: the Australian humpback (*Sousa sahalensis*; formerly known as the Indo-Pacific humpback [refer to Jefferson et al (2014) for taxonomic results]), Indo-Pacific bottlenose (*Tursiops aduncus*) and Australian snubfin (*Orcaella heinsohni*) dolphins. All three species are listed as Marine and Migratory species and are therefore matters of National Environmental Significance under the EPBC Act.

Brooks & Pollock (2014) undertook the most extensive and recent study of the abundance, movements and habitat use of coastal dolphins in the Darwin region (Darwin Harbour, Bynoe Harbour and Shoal Bay) between 2011 and 2014, a program initiated as part of the environmental approvals for the Ichthys LNG project. Their study revealed that together, these three species are more commonly observed in Shoal Bay while in Darwin Harbour, dolphins are more commonly seen in East Arm and West Arm than other parts of Darwin Harbour.

Brooks & Pollock (2014) analysed the results of the first six primary samples from dolphin surveys undertaken between October 2011 and March 2014 concluding:

- Australian humpback dolphins were the most abundant at all three sites monitored with the number estimated across the six surveys in Darwin Harbour remaining relatively consistent at between 37 and 49 individuals.
- Bottlenose dolphin numbers in Darwin Harbour were more abundant than at Bynoe Harbour and Shoal Bay with numbers varying between 13 and 30 across the surveys. Temporary emigration between sites is thought to account for higher variation in numbers of bottlenose dolphins.
- Snubfin dolphins were the least observed species in the Darwin Harbour region with highly irregular numbers observed between surveys. Only one snubfin dolphin was detected in the vicinity of Darwin Harbour East Arm during the surveys.
- While significant changes in detection rates in East Arm were evident through this study, these differences occurred prior to any construction activity associated with the Ichthys project. Significant changes were also observed at Bynoe Harbour, a site distant from any potential construction impact.

##### **4.3.4.2 Dugongs**

Dugongs are known to occur in Darwin Harbour waters, although in relatively low numbers. Dugongs have been recorded in higher densities at Gunn Point and the Vernon Islands, some 30–50 km to the north-east of the mouth of the harbour. Dugongs have also been observed in relatively high numbers at Bare Sand Island and Dundee Beach in Fog Bay, 60 km south-west of Darwin Harbour, and are known to travel long distances (Whiting 2008).

Cardno (2014) compared the results of baseline surveys with four surveys undertaken throughout the dredging phases of the Turtle and Dugong Monitoring Program associated with the INPEX Ichthys project. This study revealed that dugongs were observed in varying numbers between surveys however no trends (including seasonal trends) were evident. There was a higher number of dugong observed in shallower waters (6 – 10 m), generally in foraging

areas where seagrass was present. Variation in dugong observed between surveys within sites was concluded to most likely be a result of short term movement of dugongs to visit optimum foraging areas of seagrass.

During baseline surveys (June to October 2012) most sightings in Darwin Harbour were around Weed Reef, West Arm and near Bladin Point, as well as in the shallow regions of Shoal Bay. During later baseline surveys, most dugong sightings were around outer Darwin Harbour, with aggregations around mapped seagrass near Casuarina Beach.

During the first of the Dredging Phase surveys (May 2013), dugongs were predominantly sighted in outer Darwin Harbour, with only one dugong sighted near Weed Reef and another in the shallow areas in West Arm. During the Dredging Phase surveys in July/August and October 2013, no dugongs were sighted in the inner Darwin Harbour, while during the end of dredging survey (May 2014) three dugongs were sighted near Weed Reef.

During the two surveys undertaken in October 2013, sightings were concentrated around Casuarina Beach and were associated with areas of seagrass (*Halodule* sp.). Lower numbers were observed in this area in wet season surveys and it was considered that the reduced seagrass coverage in this season was likely to have been a contributing factor (Cardno 2014).

In general, it is considered that dugongs could occur anywhere in the harbour that could support seagrasses or algae. The only benthic community in the vicinity of the MUBRF that was found by Geo Oceans (2012) to support a notable amount of macroalgae was on the mixed sand and rocky reef habitat around Old Man Rock, some 500 m to the south-east of the MUBRF (Figure 4-2). Substantially greater areas of potential foraging habitat for dugong exist elsewhere in the harbour (INPEX 2011).

#### **4.3.4.3**     *Turtles*

Six species of marine turtles are known to occur in NT waters. Of these, four (the green, hawksbill, olive ridley and flatback turtles) are considered to occur in the Darwin Harbour region, while loggerhead turtles are suspected to be infrequent users (Cardno 2014). The leatherback turtle is considered to be an oceanic species and is unlikely to occur in Darwin Harbour (Whiting 2003).

Turtles recorded during surveys associated with the Ichthys Turtle and Dugong Monitoring Program (Cardno 2014) showed a general trend of decreasing numbers with depth (62% observed in water 0 – 5 m deep) with the majority of turtles observed in the Darwin Harbour region over sand, gravel or reef habitats. There were only a few turtles sighted in association with mangroves and mud habitats (0.5% and 3%, respectively), which are those habitats that occur in the vicinity of the tug pens dredging area.

The shoreline throughout Darwin Harbour, and particularly in East Arm, consists largely of mangrove forests and mudflats and does not provide suitable nesting habitat for any species of turtle. The nearest nesting beach (used by the flatback turtle) is located in the Casuarina Coastal Reserve near Lee Point on the north-eastern shore of the harbour. Turtles visiting the harbour are more likely to be foraging for food. Flatback and hawksbill turtles forage on the filter-feeder communities which are extensive in the harbour. The hawksbill turtle also forages on seagrass and macroalgal communities in addition to filter-feeders. Green turtles forage amongst seagrass and macroalgal communities (INPEX 2011a).

Cardno (2014a) implemented the most recent Turtle and Dugong Monitoring Program (TDMP) survey for INPEX in Darwin Harbour between 11 October 2013 and 27 October 2013 which included aerial and land survey techniques to monitor the abundance and distribution of turtles and dugongs around Darwin Harbour (Cardno 2014).

The most recent report for this monitoring program, Cardno (2014) concluded that:

- Statistical analysis of population and density estimates formed in this study do not indicate that the distribution or abundance of these animals have changed since the baseline phase.
- Eight hundred and thirteen turtles were sighted during survey D4, which was higher than the average number of turtles sighted per survey during the baseline phase (634 turtles), but approximately 17% lower than the number of turtles recorded during survey B3 (984 turtles), undertaken at the same time of year (October 2012).
- Statistical analyses of turtle population densities did not detect any significant difference between the impact and control treatments in either phase or between baseline and dredging phases, for either treatment. In contrast, estimates of turtle density based on raw observations were significantly higher at the control blocks compared with the impact block during the baseline phase but not the dredging phase. This variability is likely to be a result of short-term movements in and out of specific areas or from the ongoing pursuit of optimal foraging grounds.
- Turtle sightings to date have most frequently been recorded within relatively shallow water habitat, most commonly sighted in waters less than 5 m in depth; however, a small number was sighted in the deep water channels near the Vernon Island in waters greater than 30 m depth.
- Where benthic habitat type has been identified and mapped, turtle sightings were primarily sighted in association with gravel, sand and reef.
- The temporal and spatial variation in dugong and turtle distribution and abundance observed may be a result of movement in and out of specific areas, possibly due to avoidance behaviour and/or the pursuit of more optimal foraging areas.

#### 4.3.4.4 Sawfish

The EPBC protected matters database indicates that dwarf sawfish (*Pristis clavata*), freshwater sawfish (*Pristis microdon*) and green sawfish (*Pristis zijsron*) may potentially inhabit Darwin Harbour. The three species of sawfish are widely distributed throughout Australian tropical waters and are thought to be uncommon within the harbour.

No records have been found of sightings of the freshwater or green sawfish within the harbour. The Atlas of Living Australia ([biocache.ala.org.au](http://biocache.ala.org.au)) contains only two records of the dwarf sawfish in the Darwin Harbour region:

- Buffalo Creek, which discharges into Shoal Bay, outside of the main harbour (Museums and Art Galleries of the Northern Territory [MAGNT] record)
- An Australian Museum record with an imprecise location, possibly from Rapid Creek which is in the middle harbour approximately 10 km to the north of the MUBRF.

These are both tidal creeks; quite a different environmental setting from the area to be dredged for the MUBRF, which is primarily comprised of an intertidal sand and reef flat, with some subtidal sand and pavement habitat in the access channel.

#### **4.3.5 Migratory bird species**

Migratory bird species recorded around the East Arm area have been predominantly within the mangroves, the saline wetlands and beside the water in the dredge spoil ponds. Although historical counts suggest that migratory shorebird numbers within Darwin Harbour are modest (Chatto [2003] survey Block 4), the EAW does seasonally support nationally significant numbers of some migratory shorebirds (Table 4-3).

Shorebird monitoring has been continued at EAW and the dredge sediment disposal ponds in accordance with the MBMP developed in accordance with EPBC Approval EPBC 2010/5304 since November 2009.

The criteria for determining the importance of habitat for migratory shorebirds in Australia (EPBC Act policy statement 3.21) rates a site as nationally important habitat if:

- the site is identified as internationally important under Ramsar: or
- the site supports:
  - at least 0.1% of the fly away population of a single migratory shorebird species; or
  - at least 2000 migratory birds; or
  - at least 15 shorebird species.

The EAW area meets the criteria for supporting nationally important migratory shorebird habitat in that:

- five migratory shorebird species (lesser sand plover, greater sand plover, far eastern curlew, terek sandpiper and sharp-tailed sandpiper) have been recorded within the EAW area at numbers greater than 0.1% of the fly away population by Chatto (2003) (see Table 4-3)
- six migratory shorebird species (whimbrel, far eastern curlew, common greenshank, sharp-tailed sandpiper, lesser sand plover and greater sand plover) have been recorded within Pond D at numbers greater than 0.1% of the fly away population by Lilleyman, Lawes and Garnett (2013) (see Table 4-4)
- at least 2000 migratory birds have been recorded
- twenty-two migratory shorebird species have been recorded within the study area (EMS 2011).

**Table 4-3**      **Migratory shorebirds recorded in numbers greater than thresholds for nationally significant habitat in Darwin Harbour prior to start of the EAW development project (Survey Block 4. Chatto 2003)**

Species	Recorded Numbers Darwin Harbour Survey Block 4
Lesser sand plover	1800 (6% Figure 104)
Greater sand plover	3410 (11% Figure 106)
Far eastern curlew	200 (4% Figure 64)
Terek sandpiper	1099 (7% Figure 74)
Sharp-tailed sandpiper	370 (2% Figure 92)

**Table 4-4**      **Migratory shorebirds counted in Pond D where numbers exceeded EPBC threshold for nationally significant habitat between November 2009 and October 2013 as part of MSB dredging monitoring (Lilleyman 2013).**

Shorebird	Counts	Maximum count	No. Counts > EPBC threshold	Threshold (DEWHA 2009)
Whimbrel	22	69	2	55
Far eastern curlew	18	101	5	38
Common greenshank	46	112	3	100
Sharp-tailed sandpiper	26	200	1	180
Lesser sand plover	9	300	1	40
Greater sand plover	12	210	1	100

Nationally significant numbers of some migratory birds listed under the EPBC Act roost on the dredge spoil ponds at EAW. Numbers of waterbirds counted varied from 50 to 1333 (EMS 2011). This variation is likely to reflect variation in both time of the year and tidal heights at the time of the survey, given the macrotidal nature of Darwin Harbour and thus the variability in the number and quality of natural roosting sites that might be available. This suggests that alternative roosting sites are both available and currently being used by migratory birds when they are not present at the EAW.

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## **5 SEDIMENT TRANSPORT MODELLING AND IMPACT ASSESSMENT**

### **5.1 Synthesis of approach**

LDC commissioned AIMS to undertake sediment transport modelling to assess the impact of dredging of the MUBRF site on the local water quality and potential sedimentation impacts in the local area. The assessment of potential environmental impacts from the dredging works at the MUBRF site was informed by:

- two-dimensional hydrodynamic models that incorporated water levels, currents and waves
- sediment transport models that determined suspended sediment dispersion and sediment accumulation
- GIS analyses to quantify and depict potential impacts on habitats on the basis of tolerance limits.

### **5.2 Hydrodynamic model**

The hydrodynamic model used by AIMS (2014) was the 'Darwin Harbour community model'. This model was developed for the original EAW development and, over a period of 16 years, was applied to many of the dredging campaigns within Darwin Harbour. Over the past five years the model has been further refined and developed by AIMS to assist in understanding the general movement of cohesive and non-cohesive sediments and nutrients in the harbour. It has formed the foundation for the NTG's WQPP for the harbour (refer Section 1.7).

Boundary conditions for the model were taken from observations recorded at Buoy 5 at the entrance to Darwin Harbour. Buoy 5 is a DPC channel marker that is equipped with instrumentation to measure wind speed and direction; tidal depth, current and direction; and waves. This model was applied to the dredging and tailwater management method proposed for the dredging works (as described in Section 2).

### **5.3 Sediment transport model**

AIMS undertook sediment transport modelling to predict the dispersion of sediment plumes over a 16 day dredging period plus an additional 30 day period to model likely post dredging recovery. The model used in the AIMS April 2014 LDC report, updated with recent bathymetry since the dredging of the MSB, was used to carry out dredge modelling for the proposed MUBRF dredging. The assumptions incorporated into the AIMS model were made in consultation with LDC and represent a likely scenario based on the use of a small CSD.

The major assumptions made included:

- a dredge rate of 180 m<sup>3</sup>/hr
- water to sediment ratio of 9:1
- 1% leakage (it has subsequently been contended by the TAG that leakage of up to 5% may occur; however, when the model outputs [Figures 5-1 to 5-4] are considered it is evident that there would be no greater risk of impact to sensitive receptors if the leakage was 5% as opposed to 1%).

- dry bulk density of 857 kg/m<sup>3</sup> (based on field observations [Williams & Patterson 2014]).

If a backhoe on a spudded barge is used to dredge, sediment plume patterns from the backhoe would be discrete 'pulses' of turbidity and suspended sediments rather than the steady streams arising from a CSD head. The plume generated by a backhoe is dependent on the bucket size, type, speed of the dredge operation and depth of water.

While loss rates and resulting plume patterns at the dredge site may differ depending on the dredging method employed (CSD or backhoe), it is reasonable to conclude that the short duration of dredging and relatively small quantity of spoil to be removed from the site will result in little difference in dredge plume. Considering this, dredge plume modelling has not been undertaken for a scenario utilising a backhoe as the modelling provided for a CSD is considered to provide results applicable to both methods at this scale.

The dredge plume was modelled for a period of 16 days with simulated dredging between 7:00 am and 5:00 pm. Model outputs are presented as:

- 90th percentile plot of modelled suspended sediment concentration (mg/L) (Figure 5-1)
- 95th percentile plot of modelled suspended sediment concentration (mg/L) (Figure 5-2)
- dredge plume recovery after 30 minutes of ceasing dredge operations (Figure 5-3)
- sediment accumulation after one month (Figure 5-4).

## 5.4

### **Tolerance limits for biological communities**

Tolerance limits used for the MSB dredging will be adopted for this project.

Given that the schedule for dredging has not yet been defined, the tolerance limits applicable to the dredging will be dependent on whether dredging takes place in the Wet or Dry Season.

Tolerance limits were calculated from the appropriate (Dry or Wet Season) subset of a one-year baseline dataset of water quality (URS 2011a), on the presumption that biological communities in East Arm are adapted to local conditions but will be stressed if exposed to conditions that regularly exceed the 95th percentile of normally prevailing background concentrations (calculated from URS 2011a).

As the sediment transport model calculates excess (above background) SSC caused by the dredging and tailwater disposal, the median of the background concentrations was subtracted from the 95th percentile of the background concentrations to provide a comparable tolerance limit. This yielded a tolerance limit for Dry Season dredging of 10 mg/L and a Wet Season SSC tolerance limit of 25 mg/L.

Tolerance limits for sediment deposition on mangroves were derived by INPEX (2010, 2011a) from a review of the outcomes of habitat-specific dose-response experiments and field observations reported in the scientific literature. These tolerance limits were adopted for the MSB dredging program and will also be applied to the MUBRF dredging program – i.e. 50 mm accretion may lead to reduced health or mortality; above 100 mm accretion mortality of trees was considered "likely". For corals and filter-feeder communities, INPEX (2011a) contended that a meaningful sedimentation threshold could not be derived from the literature due to factors such as wide variations in tolerances between species, and between morphologies within species.

Figure 5-1 90th Percentile modelled suspended sediment concentration (mg/L)

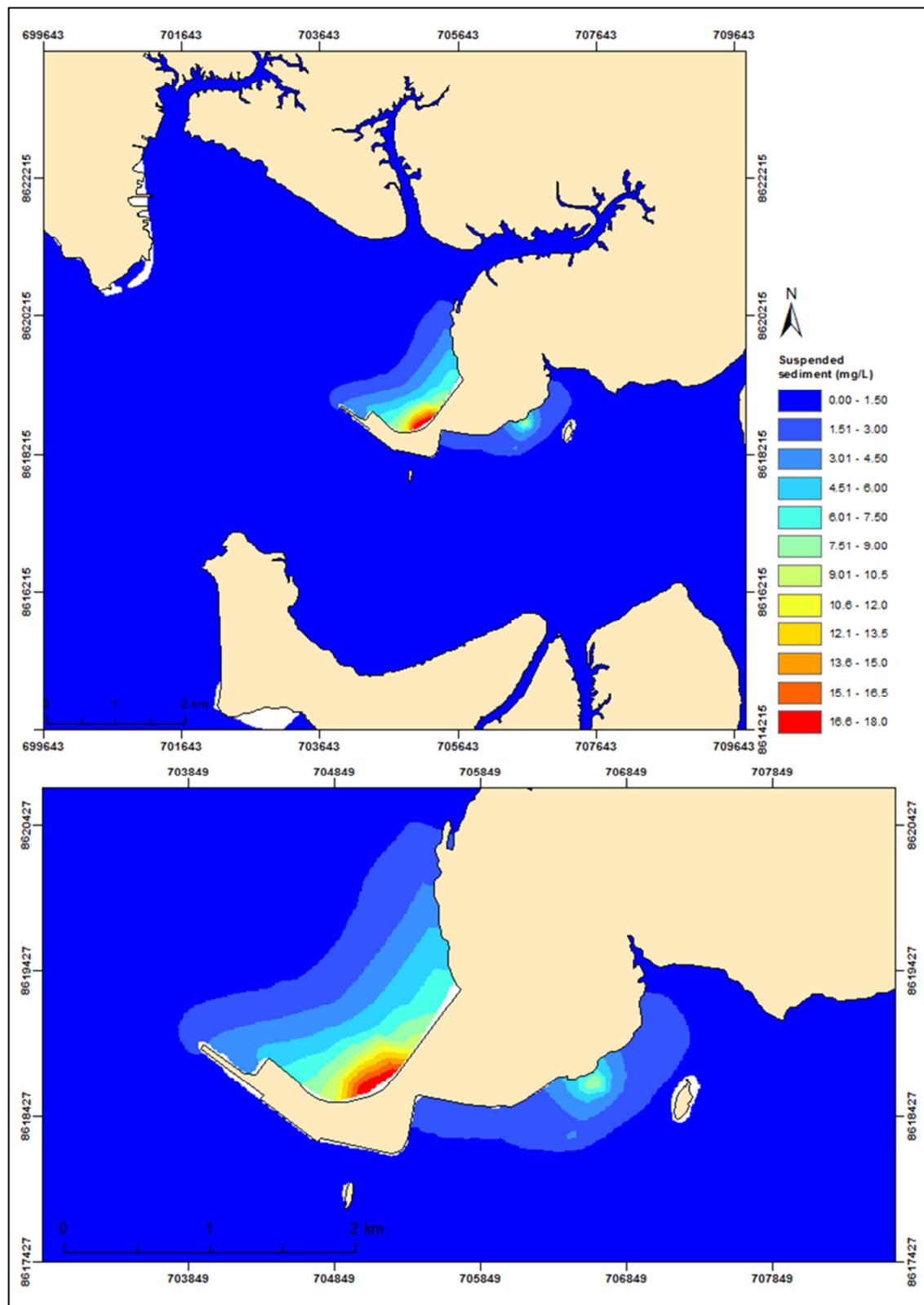


Figure 5-2 95th percentile modelled suspended sediment concentration (mg/L)

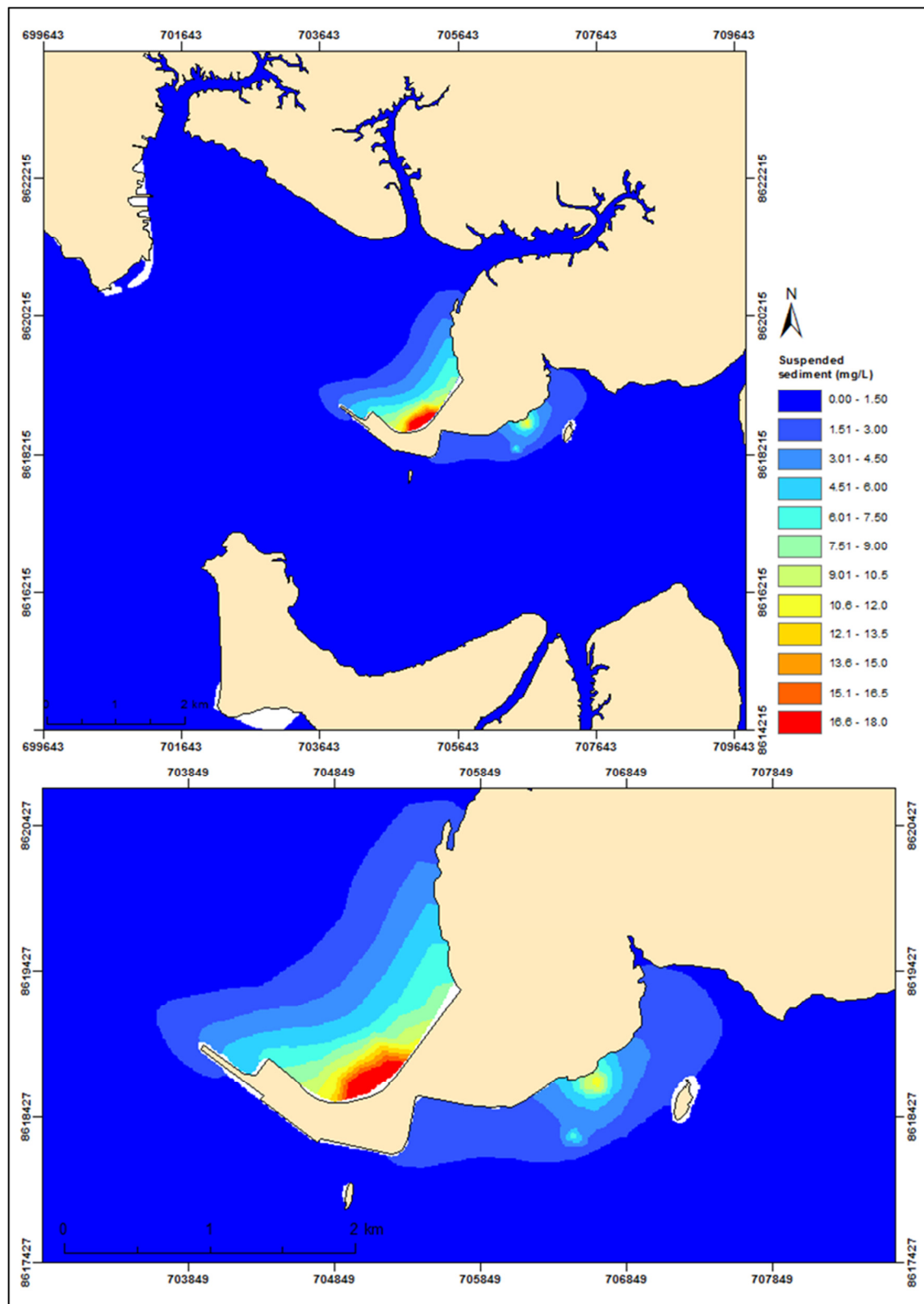


Figure 5-3 Dredge plume recovery after one hour of ceasing dredge operations

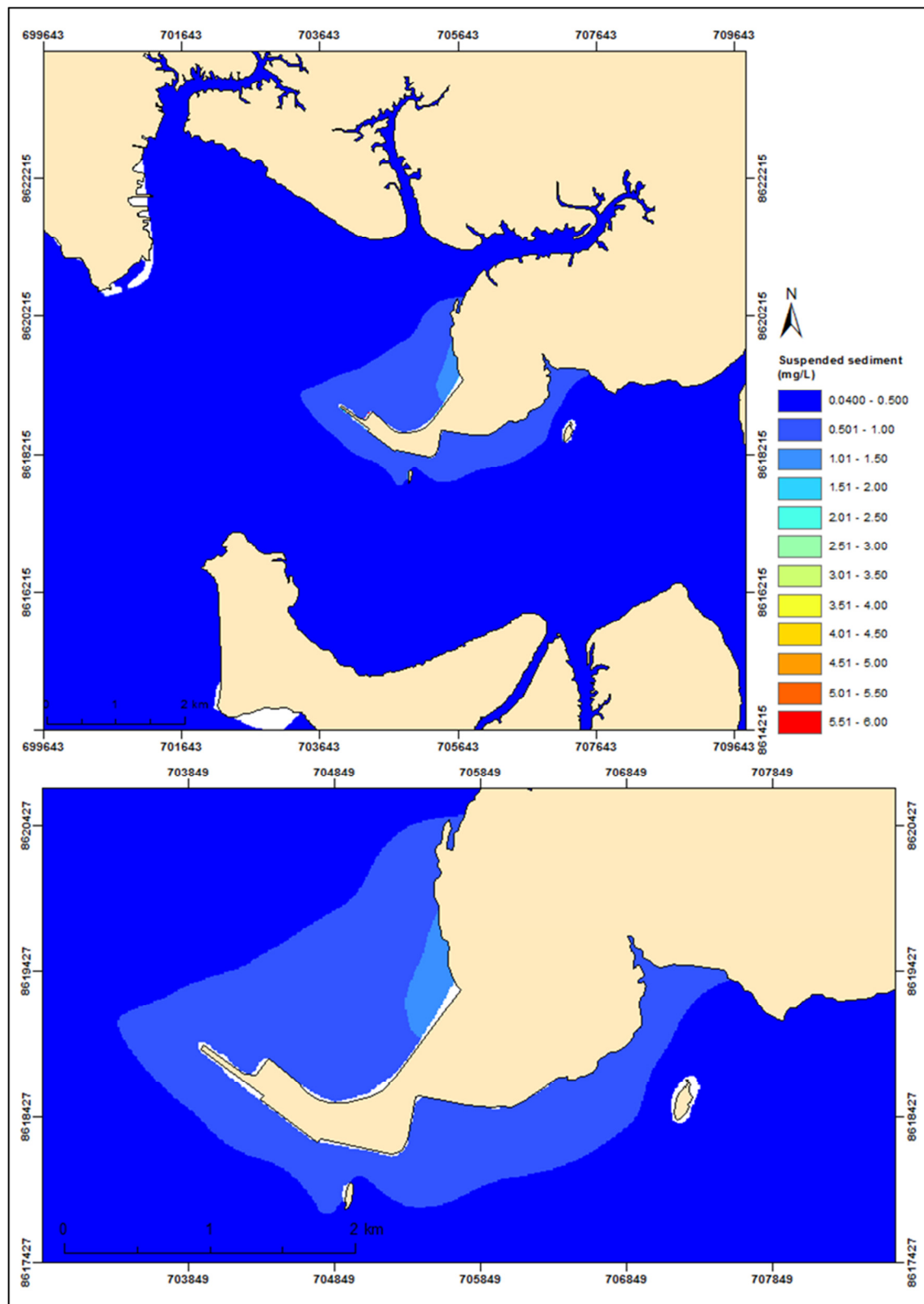
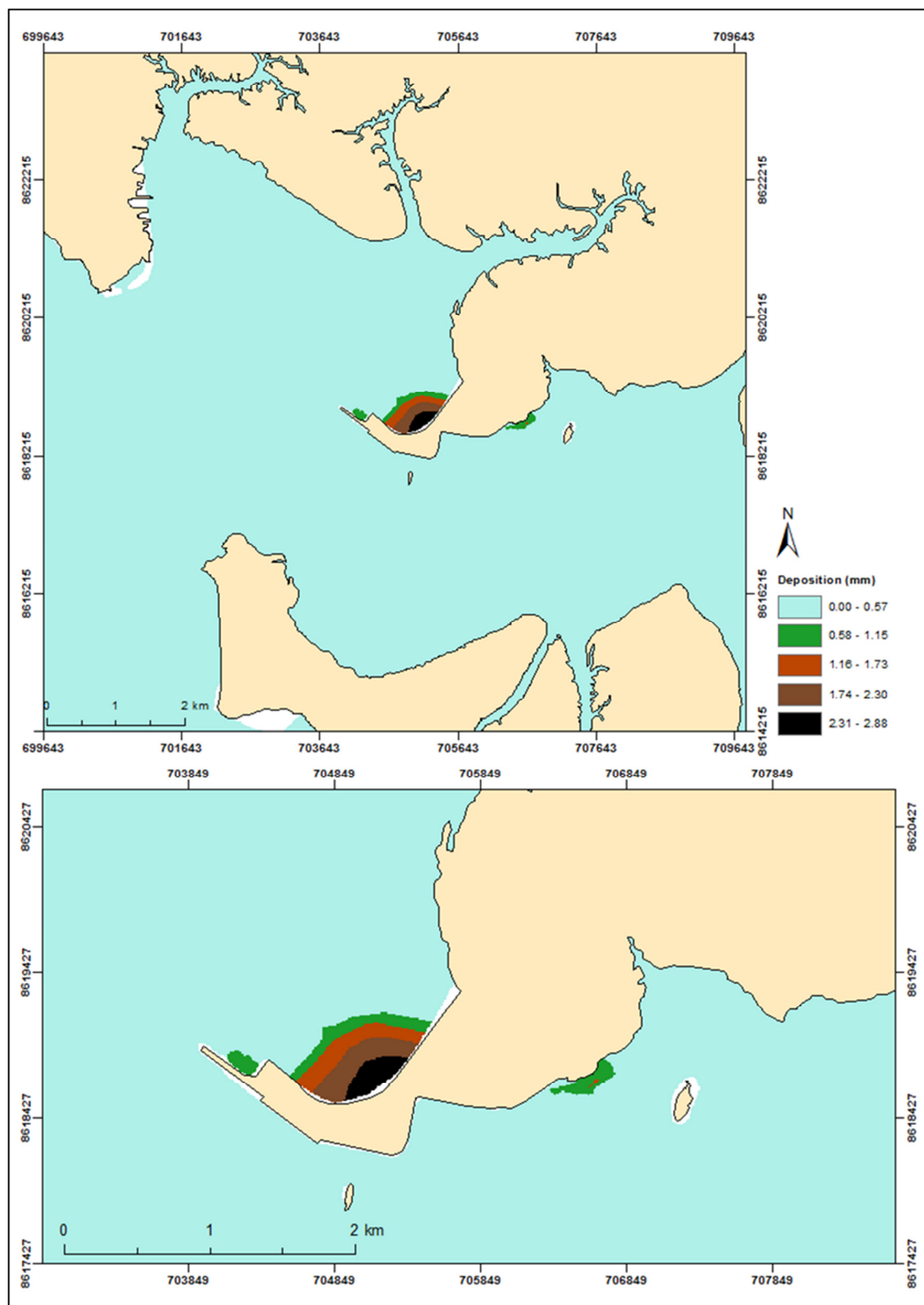


Figure 5-4 Modelled sediment accumulation after one month



## 5.5 Zones of impact and influence

For the assessment of potential dredging-related impacts upon benthic communities, definitions of Zones of Impact and Influence consistent with the EPA (2011) EAG7 (introduced in Section 1.8) were adopted:

- Zone of High Impact:** this zone constitutes the direct footprint of the dredged area and a 20 m wide annulus around the footprints to account for smothering from coarse sediments liberated from the cutter head during dredging. Impacts in these areas are predicted to be severe and often irreversible.
- Zone of Moderate Impact:** within this zone, damage to benthic habitats and mortality of benthic biota may occur, primarily as a result of the indirect impacts from increased turbidity and sedimentation that may occur at times over areas within the zone. Impacts within this zone are predicted to occur, but the disturbed areas may recover (after completion of the dredging and disposal operations). It is expected that there will be no long-term modification of the benthic habitats in this zone. The outer edge of the Zone of Moderate Impact is delineated by the 90th percentile contour plot for SSC, as defined by dredge plume modelling. This delineates the areas where, for 90% of the time, the predicted SSC is below the calculated tolerance for benthic communities (dredging-related SSC of 10 mg/L for East Arm communities during the Dry Season, 25 mg/L during the Wet Season, refer Section 5.4). The 10% of time during which the SSC threshold is predicted to be met or exceeded is likely to represent periods of mid-flow tidal states (particularly during spring tides) and any one exceedance event is not likely to exceed two hours.
- Zone of Influence:** this zone includes the areas in which, at some time during the dredging works, benthic communities may experience (detectable) changes in sediment-related environmental quality outside the natural ranges that are normally expected. However, the intensity, duration and frequency of these changes is such that any damage to benthic habitats is likely to be reversible, and no mortality of benthic biota is expected to occur. The outer boundary of this zone is delineated by the 95th percentile contour plot for SSC, as defined by dredge plume modelling. This reflects the area where, for 95% of the time, excess SSC from the dredging will be below the calculated tolerance for benthic communities (10 mg/L in the Dry Season, 25 mg/L in the Wet Season, refer Section 5.4).

The sediment transport modelling predicts a 90<sup>th</sup> percentile SSC of 9 mg/L at the cutter head (see Figure 5-1) below the Dry Season and Wet Season tolerance limits of 10 mg/L and 25 mg/L respectively and as such the Zone of Moderate Impact falls completely within the Zone of High Impact. It can be seen from Figure 5-2 that at the 95<sup>th</sup> percentile, a maximum SSC of 12 mg/L was modelled. This exceeds the tolerance limit for the Dry Season (10 mg/L). The 10 mg/L contour extends to a distance of 40 m from the cutter head. This results in a Zone of Influence extending beyond the Zone of High Impact a distance of approximately 20 m as shown in Figure 5-5.

The expected upper SSC limit that was predicted by the modelling was also shown to reduce quickly back below the tolerance limit for Dry Season of 10 mg/L. As can be seen in Figure 5-3, the SSC was predicted by the modelling to fall back below 1.5 mg/L above background levels across the project area within one hour of ceasing dredging.

Figure 5-5 Predicted potential Dry Season zones of impact and influence (SSC)



Boundaries of the Zones of Moderate Impact and Influence at the tailwater discharge point at the permeable section of the railway bund wall were defined by the 90th and 95th percentile plots (Figure 5-1 and Figure 5-2) produced by the modelling as follows:

- The outer edge of the Zone of Moderate Impact is delineated by the 90th percentile contour plot for SSC. On Figure 5-1, the outer edge of the Zone of Moderate Impact for the Dry Season is shown as the yellow contour, extending a maximum of approximately 250 m from the railway bund wall. With a maximum SSC modelled on the seaward side of the bund wall of 18 mg/L, the wet season SSC tolerance limit of 25 mg/L is not exceeded; hence no Zone of Moderate Impact can be defined for the Wet Season.
- The outer boundary of the Zone of Influence is delineated by the 95th percentile contour plot for SSC. On Figure 5-2, the outer edge of the Zone of Influence for the Dry Season is shown as the yellow contour, extending a maximum of approximately 250 m from the railway bund wall. With a maximum SSC modelled on the seaward side of the bund wall of 18 mg/L, the wet season SSC tolerance limit of 25 mg/L is not exceeded; hence no Zone of Moderate Impact can be defined for the Wet Season.

Sedimentation after 30 days of completion of dredging was modelled to identify any potential areas of concern for the exceedance of the sedimentation in mangrove areas. Figure 5-4 shows the maximum expected sediment accumulation 30 days after the completion of dredging at the MUBRF site to be 1.73 mm while at the outfall of the sedimentation ponds sedimentation of up to 2.88 mm was predicted by the model.

Mangroves adjacent to the dredging site may experience sediment deposition up to 1.15 mm, however the model indicates that the mangrove communities in the wider region may experience between 0 and 0.57 mm of sediment deposition.

All sediment deposition modelled was well below the tolerance limits proposed for mangrove health (50 mm and 100 mm for reduced mangrove health and likely mangrove mortality respectively).

## **5.6 Conclusions**

### **5.6.1 Suspended sediment**

The modelling indicates that suspended sediments are not predicted to extend beyond the dredging area at concentrations that could result in detectable changes to environmental quality.

Suspended sediments around the dredge footprint may exceed the Dry Season tolerance limit of 10 mg/L in the Zone of Influence, however this will occur only in close proximity where benthic habitat mapping indicates no coral or filter feeder communities (refer Figure 4-2).

Suspended sediments may potentially impact a small area of benthic habitat up to 250 m from the settlement pond discharge point. While the habitat within this small area has not been mapped in detail, observations from low tide aerial imagery indicate that it is an intertidal sandflat which would support benthic invertebrates living on and in the surface sediments. The suspended sediments could impact upon these organisms through clogging of feeding or respiratory structures, though any impacted areas would be expected to be recolonised by similar fauna once tailwater discharge has ceased.

It is considered that monitoring and management of suspended sediment levels within the area immediately adjacent to the dredge location and pipeline (within 150 m) and within the

pond system will provide an appropriate level of mitigation against the risk of impacts upon the receiving environment.

#### **5.6.2      *Sedimentation***

Figure 5-4 shows that the accumulation of dredging-derived sediment is not predicted to exceed 50 mm in any of the mangrove communities that are potentially reached by the turbid plumes generated by the dredging and tailwater disposal.

Although it has not been possible to derive reliable sedimentation thresholds for coral and filter-feeder communities, it is noted that, as shown in Figure 5-4, there is no net sedimentation of >5 mm predicted to occur within the coral and filter-feeder communities in East Arm (refer Figure 4-2).

If the rate of sediment deposition adjacent to the settlement pond discharge point is sufficiently high, then some of the benthic fauna may be smothered. However, any impacted areas would be expected to be recolonised by similar fauna once tailwater discharge has ceased.

It is concluded that potential sedimentation effects need not be given further detailed consideration in this plan, and that monitoring and management of suspended sediment levels within the pond system will provide an appropriate level of mitigation against the risk of impacts upon the receiving environment.

## 6 ENVIRONMENTAL MANAGEMENT

### 6.1 Introduction

This section describes the Environmental Management Frameworks (EMFs) that have been developed for the key risks associated with the dredging works, as identified through the environmental risk assessment process (DLP 2011a, 2011b). The EMFs are instrumental to effectively manage and mitigate environmental risks to sensitive receptors identified in Section 4.

EMFs have been developed for the following aspects:

- water quality – dredge spoil placement ponds
- water quality – East Arm
- protected marine species – physical interaction
- protected marine species – underwater noise
- migratory birds.

Each EMF states the relevant project commitments made and objectives to be met, and contains specific, measurable targets to achieve the objectives. It also summarises the management actions required to meet these targets, the relevant KPIs, and the monitoring activities to be employed to measure success in meeting the requirements and identify the need for corrective actions.

It should be noted that:

- management actions are routine tasks that will be undertaken to meet the objectives of each EMF
- corrective actions are those tasks that are possible to be undertaken if monitoring indicates that trigger levels have been exceeded.

Where trigger levels are proposed, it should be noted that these are triggers for further investigation and are set well below levels at which significant adverse ecological effects could be anticipated. Monitoring is described in greater detail in Section 7. Each EMF also indicates the relevant reporting requirements (detailed further in Section 8) and the responsibilities of project personnel.

### 6.2 Water quality - dredge spoil placement ponds

#### 6.2.1 *Potential impacts*

Potential impacts upon the water quality within the dredge spoil placement ponds (reduced pH) may occur as a result of generation of acid if dredged sediments that contain PASS are exposed to air within the ponds for extended periods. Synergistic impacts may arise if the more acidic water leaches metals (arsenic in particular) from the dredged sediments, or from the existing sediments in the ponds.

If acidic water is pumped from the ponds into East Arm, then impacts around the discharge location could include:

- injury to, or mortality of, protected marine species, fish, crustaceans, mangroves, etc.
- reduction of bicarbonates in the receiving water, potentially resulting in deformities in shellfish development
- release of contaminants from sediment in the receiving environment
- corrosion of metals and weakening of concrete structures, potentially impacting on infrastructure and/or engineering works.

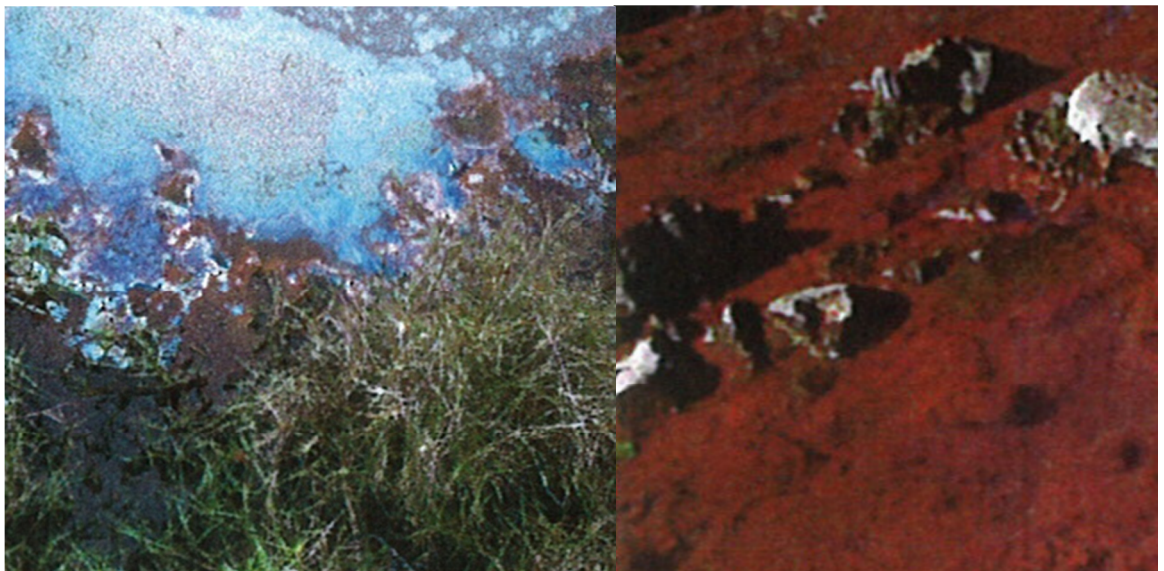
Potential impacts upon the receiving environment from the discharge of tailwater with elevated concentrations of suspended sediments are addressed in Section 5.6.

## 6.2.2 *Potential indicators of impact*

Some indicators for the presence of acid leachate arising from oxidation of PASS (Figure 6-1) are:

- green-blue water, sometimes cloudy but sometimes extremely clear due to the presence of metals that have leached from the soils (aluminium)
- rust-coloured stains on soils, and rust-coloured slime on water (due to iron oxidising bacteria)
- yellow patches on soils as they dry out (“jarosite”).

**Figure 6-1** Potential indicators of acid leachate



### 6.2.3 Water quality criteria for disposal of tailwater

The key water quality guidelines that are relevant to the MSB development are the Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (hereafter 'ANZECC Guidelines', ANZECC & ARMCANZ 2000) and the WQOs for the Darwin Harbour Region 2010 (hereafter 'Darwin Harbour Region WQOs' [Fortune & Maly 2009; NRETAS 2010]). The Darwin Harbour Region Report Cards (e.g. Drewry et al. 2011; Aquatic Health Unit 2012; DLRM 2013) are also relevant as they contain data from ongoing NTG water quality monitoring in Darwin Harbour.

The National Water Quality Management Strategy recommends that "the guidelines for each indicator should be based on locally derived data to reflect local (ambient) conditions. Where derivation of guidelines based on local monitoring is not possible, it is recommended that the national ANZECC Guidelines are used instead (for tropical Australia)". Therefore, the most applicable guidelines for this project are Darwin Harbour Region WQOs, and in the absence of guidelines for certain parameters, reference will be made to the national ANZECC Guidelines.

The Darwin Harbour Region WQO reports (Fortune & Maly 2009; NRETAS 2010) state that, in the case of Darwin Harbour, the most stringent water quality criterion is the environmental beneficial use category. This is because the intent of environmental beneficial use is to maintain the health of aquatic ecosystems, and a water body that meets an environmental beneficial use will in almost all circumstances also meet the requirements for all other beneficial uses. Human health related guidelines are also provided to protect recreational and cultural values in the region.

NRETAS (2010) has adopted the ANZECC Guidelines approach for physico-chemical indicators for slightly to moderately disturbed systems. The ANZECC guidelines have defined acceptable effect sizes for each level of protection for different indicator types (Table 6-1).

**Table 6-1 ANZECC Guidelines default effect size for varying levels of protection**

Indicator Class	Effect Size or Departure from Reference		
	High Conservation Value Systems	Slightly to Moderately Disturbed Systems	Highly Disturbed Systems
Toxicants in water	No change to natural values	95% of species protected	80-90% spp. protected
Toxicants in sediments	No change to natural values	>90% individuals protected	
Physico-chemical*	No change to natural values	Median lies within 20 <sup>th</sup> /80 <sup>th</sup> percentile of reference range*	Locally determined (10 <sup>th</sup> /90 <sup>th</sup> percentile of range)
Biological	No change to natural values	Median lies within 20 <sup>th</sup> /80 <sup>th</sup> percentile of reference range	Locally determined (10 <sup>th</sup> /90 <sup>th</sup> percentile of range)

\* Applicable to the approach taken with WQOs for the Darwin Harbour region

NRETAS (2010) states that the Darwin Harbour Region WQOs can be used as a tool for monitoring water quality and supporting decision making on the management of activities affecting coastal marine waters in the Darwin Harbour catchment. They apply to ambient waters (i.e. the receiving waters) and should not be regarded as individual discharge criteria. The values include protection of aquatic ecosystems and recreational activities associated

with the use of marine waters such as swimming, boating and fishing. Where the values are not being met, planning and management of these areas should move towards achieving the objectives over time.

The Darwin Harbour Region WQOs and the ANZECC Guidelines can be used to provide guidance to those undertaking water quality monitoring programs by providing key water quality indicators that can be monitored over time. Measured water quality can be compared with the criteria to determine whether management goals are being achieved or where management action is required.

The ANZECC Guidelines and Darwin Harbour Region WQOs apply to the receiving environment, rather than to the tailwater. However, if the tailwater meets the following criteria then it will be considered suitable for continued disposal:

- The daily mean pH of the three water samples collected during monitoring at the discharge point from Pond E (South) (see Section 7.3.2) is greater than 6.0 and less than 8.5. This will meet the criterion for an Upper Estuary setting, as presented in the Darwin Harbour Region Water Quality Objectives.
- For toxicants<sup>2</sup> (including arsenic) the Darwin Harbour Region WQOs defer to the ANZECC Guidelines. Hence concentrations of toxicants will be compared against the ANZECC Guidelines for slightly to moderately disturbed ecosystems (i.e. for 95% species protection) (ANZECC & ARMICANZ 2000, Table 3.4.2). For some toxicants (including arsenic) the ANZECC Guidelines have no criteria levels for marine waters as there are considered to be insufficient data to derive reliable trigger values. In these instances it is proposed to adopt the criteria levels for fresh water. The list of metallic toxicants to be tested (presented in Section 7.3.3) is based on the potential presence and toxicity of these metals in Darwin Harbour. It is noted that none of these metals (with the exception of arsenic) were found at concentrations exceeding the ANZECC Guidelines during testing for this project.
- The target SSC for the tailwater will be 100 mg/L (140 NTU). As SSC cannot be monitored directly in the environment therefore turbidity (in NTU) is used as a surrogate measure. A mathematical relationship between NTU and SSC has been derived from water samples collected within the pond system and analysed for both SSC and turbidity as part of the MSB dredging monitoring program. The project specific SSC / NTU relationship reported in the annual monitoring report for the Darwin Marine Supply Base Dredging and Dredge Spoil Placement Activities (DoI 2014) is 100 mg/L = 140 NTU. This relationship will be applied during interpretation of water quality monitoring undertaken during the MUBRF dredging.

Measures to reduce the acidity of the pond system (refer to Section 6.2.4) if pH is below 6 or contaminant concentrations exceed ANZECC guidelines, and to improve settlement rates if SSC exceeds the target value at the perimeter of the tailwater discharge point, will be implemented and confirmed as successful by monitoring before recommencing discharge.

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<sup>2</sup> The ANZECC Guidelines define a toxicant as a chemical capable of producing an adverse response (effect) in a biological system at concentrations that might be encountered in the environment, seriously injuring structure or function or producing death. Examples include pesticides and heavy metals.

## **6.2.4 Management of water quality**

### **6.2.4.1 Management of PASS**

The dredging contractor will disturb only the minimum footprint necessary for dredging the MUBRF footprint.

Contingency PASS management options that will be applied include:

- use of Pond E (North) for placement of PASS dredge spoil through a submerged dredge discharge pipe at the far northern end of the pond
- neutralisation of PASS using lime (refer to detailed description below)
- strategic reburial (without prior lime treatment). Reburial within the ponds at East Arm is likely to be the most suitable management option, at depth and covered with non-PASS materials.

In the first instance, should PASS sediments be detected, dredge spoil placement into the ponds will shift to the northern end of Pond E (North) which has a permanent water level as opposed to Pond K which will dry out after completion of dredging, exposing PASS to the atmosphere and potentially allowing oxidation and acidification.

Alternatively, PASS sediments will be dredged into the lower portion of the ponds and sediments that are not PASS can then be deposited on top, allowing for strategic burial of the underlying PASS materials within the ponds. Depending on the sulphur levels, additional treatment may be necessary. In liaison with the DLPE, NT EPA and DoE, actions such as lime treatment, covering with clean soils or water, etc., may be required.

### **6.2.4.2 Neutralisation of PASS**

The preference for the treatment of PASS is to avoid contact with the atmosphere and the potential acidification of sediments. To achieve this, PASS would remain buried or submerged at all times through the strategic placement of dredge spoil into ponds where the PASS will remain submerged or can be strategically buried beneath non-PASS material already in the pond system.

If this is not practical or is not successful, physically incorporating neutralising alkaline materials such as lime into the soil is a common technique used in managing PASS. It is important that sufficient lime is used to ensure that existing soil acidity and all potential acidity that can be generated is neutralised over time. Lime treatment is an option whereby the soils can be reused as clean fill (noting that the soils are often unsuitable for geotechnical reasons).

The laboratory analysis of the oxidisable sulphur in each soil sample is used to calculate the amount of acid that can be generated if the sulphides are completely oxidised or totally exposed to the air. The results are generally given by the laboratory in percent sulphur (%S).

The analytical results from the laboratory chromium reducible sulphur test provide a liming rate (kg lime/tonne of soil). These rates can also be estimated using Table 3 in the Queensland Acid Sulfate Soils Investigation Team guidelines (QASSIT 1998). These include a safety factor of 1.5. An approximate weight can be obtained from volume by multiplying volume (m<sup>3</sup>) by bulk density (t/m<sup>3</sup>).

It is important to mix adequate neutralising material so that all acid that can be produced is neutralised and to bring the pH of the soil to 5.5 as a minimum. Suggested neutralising agents for the treatment of ASS should be slightly alkaline with low solubility (pH 7–9). Fine aglime ( $\text{CaCO}_3$ ) is the preferred neutralising agent for treating ASS, using the purest form available.

The guidelines recommend constructing a treatment pad, including a compacted clay layer, leachate collection system and containment with bunding.

Where excavation and mechanical mixing are not feasible, a more soluble material such as hydrated lime  $\text{Ca(OH)}_2$  or sodium bicarbonate  $\text{NaHCO}_3$  can be used.

Soil that has been treated using a neutralising agent such as lime should follow the following performance criteria:

- an excess of the neutralising agent (lime) should be used to allow for potential acidity of the soil
- post neutralisation of the soil, the pH is to be 5.5 or greater
- the excess lime should remain in the soil until all acid generation reactions are complete.

Validation samples will be collected of the mixed material, at a rate of to be determined. This will determine if the criteria have been met. Soil that has not met the above criteria must be retreated until it meets the performance criteria. Normal turnaround time for samples is two weeks. If needed, additional lime can be mixed in at any time after the sample results have been received.

#### **6.2.4.3**      *Water quality management (ponds)*

The tailwater will be managed within the settling ponds such that the quality of the water discharging through the railway bund wall is within the guideline criteria discussed in Section 6.2.3. If trigger levels are exceeded within any of the ponds then this will be reported to DOI within 24 hours of the exceedance occurring. Should the exceedance occur at either of the two critical monitoring locations – Pond E (South) or in Pond E (North) at the weir into Pond E (South), the contractor shall notify DOI and the NT EPA (on behalf of DOI).

Exceedances occurring in Pond E (North) at the weir into Pond E (South) or in Pond E (South) shall trigger management actions requiring the cessation of flow from Pond E (North) into Pond E (South). Monitoring results approaching or exceeding the trigger levels at all other monitoring locations shall be used as an early indication that pre-emptive management actions should be considered to prevent an exceedance in Pond E (North) prior to the weir into Pond E (South) or within Pond E (South). Where an exceedance requires the closing of the weir into Pond E (South), Pond E (South) shall remain isolated from the tailwater management system until corrective actions (see Table 6-2) can be implemented to preserve the quality of the receiving waters. It will remain isolated until such time that it can be demonstrated that the pond can be reinstated into the tailwater management system without causing the water quality in Pond E (South) to exceed trigger levels.

The frequency of monitoring within the ponds (refer Section 7.3) limits the risk of trigger level exceedances within Pond E (South) arising from tailwater effects. Trends identified within the preceding ponds will enable corrective actions to be implemented before exceedances occur within Pond E (South). In this manner Pond E (South) is effectively considered to be the

‘receiving environment’, with the railway bund wall providing an additional buffer against impacts upon the environment of Frances Bay and the wider Darwin Harbour.

**Table 6-2 Water quality EMF – dredge spoil placement ponds**

Water Quality Management Framework - dredge spoil placement ponds	
Element	Maintenance of water quality within dredge spoil placement ponds.
Commitments	EPBC 2010/5304 conditions 27 and 28 Conditions likely on WDL to be obtained by contractor.
Objectives	<ul style="list-style-type: none"> <li>No increase in acidity within pond waters to the extent that the tailwater is unacceptable for discharge due to low pH or elevated toxicant concentrations.</li> <li>No adverse impacts upon migratory birds utilising the ponds.</li> <li>To protect receiving waters from dredging-related impacts.</li> </ul>
Target	<ol style="list-style-type: none"> <li>No occasions when tailwater pH is outside the guideline range (6.0-8.5) at the point of discharge to the marine environment, as a result of acid leachate generation.</li> <li>No exceedances of ANZECC &amp; ARMICANZ (2000) water quality criteria for arsenic or other bioavailable toxicants at the point of discharge to the marine environment (refer to Section 7.2).</li> <li>100% of tailwater ready for discharge has SSC less than 100 mg/L (measured as turbidity, refer Section 6.2.3 and Table 7 1).</li> <li>Pond D tailwater level must not exceed 5.5 m AHD.</li> <li>No occasions when tailwater discharging from Pond E (South): <ol style="list-style-type: none"> <li>Contains floating oil or grease or petroleum hydrocarbon sheen or scum, or litter or other objectionable matter.</li> <li>Causes or generates odours which would adversely affect the use of surrounding waters.</li> <li>Causes algal blooms.</li> <li>Causes visible change in the behaviour of, or mortality of, fish or other aquatic organisms.</li> <li>Causes adverse impacts on plants.</li> </ol> </li> </ol>
KPIs	<ul style="list-style-type: none"> <li>Number of instances when pH or bioavailable toxicant concentrations are outside of acceptable guidelines (pH &lt;6.0 or &gt;8.5; bioavailable toxicant concentrations &gt;ANZECC Guidelines) within the ponds or at the point of discharge to the marine environment.</li> <li>Number of instances when SSC in Pond E (South) is &gt;100 mg/L (measured as turbidity, refer Section 6.2.3 and Table 7-1 ).</li> <li>Number of instances when target criteria 5 (a)-(e) are not met.</li> </ul>
Management	<ul style="list-style-type: none"> <li>Ensure that all site personnel are aware of potential issues with PASS (via induction and toolbox meetings).</li> <li>The dredged sediments are pumped via pipeline into the ponds, and the sludge is allowed to settle within the ponds. PASS sediments will not be stockpiled or transported to where they may be exposed to the atmosphere.</li> <li>Placement of dredged PASS into Pond E (North) through a submerged dredge discharge pipe to avoid exposure to the atmosphere and subsequent oxidation.</li> <li>Placement of dredged PASS material in a designated area, at a deeper level within the dredge spoil disposed in Pond K than the subsequent layers, preventing oxidation of PASS material.</li> <li>Ensure direct discharge of dredge spoil into Pond E (North) only takes place when the risk of large stormwater events is low i.e. in the Dry Season.</li> <li>Pond K maintained with a minimum freeboard of 0.5 m to ensure sufficient water to facilitate settlement of suspended sediments and to minimise mobilising</li> </ul>

### Water Quality Management Framework - dredge spoil placement ponds

	<ul style="list-style-type: none"> <li>existing sediments.</li> <li>During the Wet Season, dredge spoil will be deposited only into Pond K or Pond E (North).</li> </ul>
Monitoring (Section 7.3)	<ul style="list-style-type: none"> <li>Water quality monitoring within ponds – pH, toxicants, NTU as detailed in Section 7.3.</li> <li>Visual monitoring of target criteria 5 (a)-(e) outside the permeable section of railway bund (during the water quality monitoring events indicated in Section 7.3).</li> </ul>
Reporting (Section 8)	<ul style="list-style-type: none"> <li>Weekly reporting of data to DoI.</li> <li>Monitoring report to NT EPA at conclusion of dredging.</li> <li>Trigger level exceedances will be reported to DoI, and to DoE (on behalf of DoI), within 24 hours of the exceedance occurring. DoI will also notify the TAG.</li> <li>Trigger level exceedances will also be reported by the Contractor direct to NT EPA within 24 hours of the exceedance occurring and a report on corrective actions implemented to address the cause of the exceedance within five business days of the notification.</li> </ul>
Corrective Action(s)	<ul style="list-style-type: none"> <li>If pH falls below 6.0 or exceeds 8.5 or toxicant concentrations exceed ANZECC Guidelines in Pond E (South) or Pond E (North) at the weir into Pond E (South) then tailwater flows out of Pond E (North) will be blocked at the transfer weir within one hour of detection (refer to Section 2.5.4).</li> <li>If SSC exceeds 100 mg/L in Pond E (South) at the railway bund wall then tailwater flows out of Pond E (North) will be blocked at the transfer weir until SSC levels at the transfer point between Pond E (North) and Pond E (South) have fallen below 100 mg/L.</li> <li>If deemed by the Contractor to be potentially effective in returning the pH of the water in any of the ponds to above 6.0, lime may be applied to discrete areas within the ponds. Lime may also be applied to pond sediments that are exposed to air if it is apparent they are a source of acidification of the water. Water will be recirculated until the pH at the point of discharge into the next pond is &gt;6.0 (but below 8.5).</li> <li>If pH is &gt;8.5 in any pond, then the water will not be discharged into Pond E (South) until such time as the pH decreases to below 8.5 (but not below 6.0). The elevated pH will add to the buffering capacity of the pond system to neutralise acid that may be generated from the exposure to air of ASS.</li> <li>If toxicant concentrations exceed ANZECC Guidelines in Pond E (North) at the weir into Pond E (South) then tailwater flows out of Pond E (North) will be blocked at the transfer weir within one hour of detection. The water may be diluted using water with lower toxicant concentrations (either from within the pond system or from within the dredging footprint) until toxicant concentrations are returned to below ANZECC Guideline levels.</li> </ul>
Term	For the duration of tailwater disposal.
Responsibility	<ul style="list-style-type: none"> <li>Dredging Contractor to ensure documents are compliant with the DDSMP.</li> <li>Dredging Contractor project manager to ensure monitoring program and water quality management measures are implemented.</li> <li>Dredging Contractor is required to take direction from the Project Manager.</li> </ul>

## 6.3

### Protected marine species – physical interaction

The main risk of physical interaction with protected marine species will be in relation to the movement of dredge support vessels (e.g. crew transfer vessel, tender vessel). The risk of direct impact to protected marine species from the operating dredge is considered to be very low. As the dredge will be stationary during most of the works, with the most mobile part of the

equipment (the cutter head when a CSD is being used) generating noise and vibration which is likely to discourage any species that may be present from approaching sufficiently close to the dredge for them to be exposed to the risk of impact. When moving between or within the dredging footprint, the dredge will transit at low speeds (<5 kn) and only over small distances (tens of metres).

It should be noted that physical interactions between dredging vessels and marine species are a higher risk when mobile dredges such as Trailer Suction Hopper Dredges are used and when dredged material is disposed offshore. Neither of these scenarios is applicable to the MUBRF dredging.

Nevertheless there will be monitoring (refer Section 7.4) and management measures implemented to reduce the risk of physical interaction with protected marine species, as described in the following EMF and depicted in Figure 6-3. These measures will apply to the operation of the dredge and also to any other vessels engaged in the works (e.g. crew transfer vessels). Night time dredging will be subject to the same management measures as for dredging during daylight hours. These will be facilitated with the use of spotlights/vessel searchlights to increase visibility for Marine Fauna Observers (MFOs).

**Table 6-3 Protected marine species EMF - physical interaction**

Protected Marine Species Management Framework – physical interaction	
Element	Vessel interaction with protected marine species.
Commitment	EPBC 2010/5304 condition 17(e).
Objective	Minimise the risk of injury to, or mortality of, protected marine species. Develop and maintain awareness of the need to protect marine species.
Target	<ul style="list-style-type: none"> <li>No incidents of vessel interaction with protected marine species.</li> <li>All dredging personnel to complete a Health Safety and Environment (HSE) induction, including protected marine species awareness and management requirements.</li> <li>All Vessel Masters competent in protected marine species interaction procedures.</li> <li>At all times that the dredge is operational, at least one crew member is a trained MFO.</li> </ul>
KPIs	<ul style="list-style-type: none"> <li>Number of audits and incident reports.</li> <li>Number of reported sightings of live, injured or dead marine fauna.</li> <li>Number of personnel completing an HSE site induction.</li> <li>Availability of MFO trained dredge operator</li> </ul>
Management	<ul style="list-style-type: none"> <li>Training of Vessel Masters in interaction procedures and specified crew as MFOs.</li> <li>A trained MFO must be on duty, above deck with good visibility, during all dredging operations.</li> <li>On each occasion that the dredge has been non-operational for a period exceeding 30 minutes, a visual assessment shall be undertaken of the 150 m radius Observation Zone by the MFO for a period of 10 minutes. Dredging will not recommence until no protected marine species have been sighted within the 150 m radius Observation Zone for a period of 10 minutes.</li> <li>The assessment of the Observation Zone will be made from an elevated position on the dredge, where a clear line of sight is achievable to the edge of the zone.</li> <li>The MFO shall not be engaged in any other activities during the 10 minute assessment period.</li> <li>The MFO will maintain ongoing visual scanning of the Observation Zone for protected marine fauna and, every 30 minutes, will dedicate a period of five</li> </ul>

## Protected Marine Species Management Framework – physical interaction

	<p>minutes for observation (from an elevated position) for protected marine fauna.</p> <ul style="list-style-type: none"> <li>• Night observations will be carried out with aid of spotlights/vessel searchlights.</li> <li>• Respond in accordance with vessel interaction procedures if protected marine species are sighted within the Observation Zone. Cease dredging if turtles, dugongs or dolphins enter within 50 m of the cutter head or backhoe, or dolphins with calves enter within 150 m of the cutter head or backhoe.</li> <li>• When a CSD is in operation rotation of the dredge cutter head will only start when it is positioned near the seafloor, and rotation will be stopped before the cutter is raised through the water column.</li> <li>• Vessels to adhere to DPC speed restrictions.</li> <li>• Follow DoE guidelines (Figure 6-2).</li> <li>• Do not approach, circle or wait in front of wildlife for the purposes of casual viewing.</li> <li>• Maintain watch for stranded, injured or dead marine fauna and contact the DLRM Marine Wildwatch (1800-453-941) for retrieval, treatment or post-mortem.</li> <li>• Install propeller guards on all dredge support vessels with propellers extending below the keel beam.</li> </ul>
Monitoring (Section 7.4)	Regular monitoring for the presence of stranded, injured or dead marine fauna Marine fauna observations (refer to management section)
Reporting (Section 8)	<ul style="list-style-type: none"> <li>• Daily submission of marine fauna observations sheets (Figure 7-2).</li> <li>• Weekly summary reporting of number of sightings, incidents and corrective actions.</li> <li>• Monitoring report to NT EPA at conclusion of dredging.</li> <li>• Any vessel interaction incidents and protected species injury or mortality will be reported to DoI, and to DoE (on behalf of DoI), within 24 hours of the incident occurring. DoI will also notify the TAG. Incidents will also be reported by the Contractor direct to NT EPA within 24 hours of the incident occurring.</li> </ul>
Corrective Action(s)	<ul style="list-style-type: none"> <li>• In the event that an incident or near miss occurs between vessels and protected marine species, the incident will be investigated and discussed to further improve awareness to reduce risk of collision.</li> <li>• For mobile vessels, a 5 kn vessel speed limit will be applied in areas where frequent sightings (an average of &gt;1 per day in any one week) are made of protected marine species.</li> <li>• If protected marine species approach within the Caution Zone (Figure 6-2), vessels that are under way will proceed at a “no wash” speed.</li> </ul>
Term	For the duration of dredging activities.
Responsibility	<ul style="list-style-type: none"> <li>• Dredging Contractor to ensure their documents are compliant with the DDSPMP</li> <li>• Dredging Contractor implements protected marine species management and monitoring program</li> <li>• Contractor Project Manager to liaise with DLRM on response to stranded, injured or dead marine fauna and potential recovery, treatment or post-mortem</li> </ul>

Figure 6-2 DoE guidelines on approach distances for dolphins

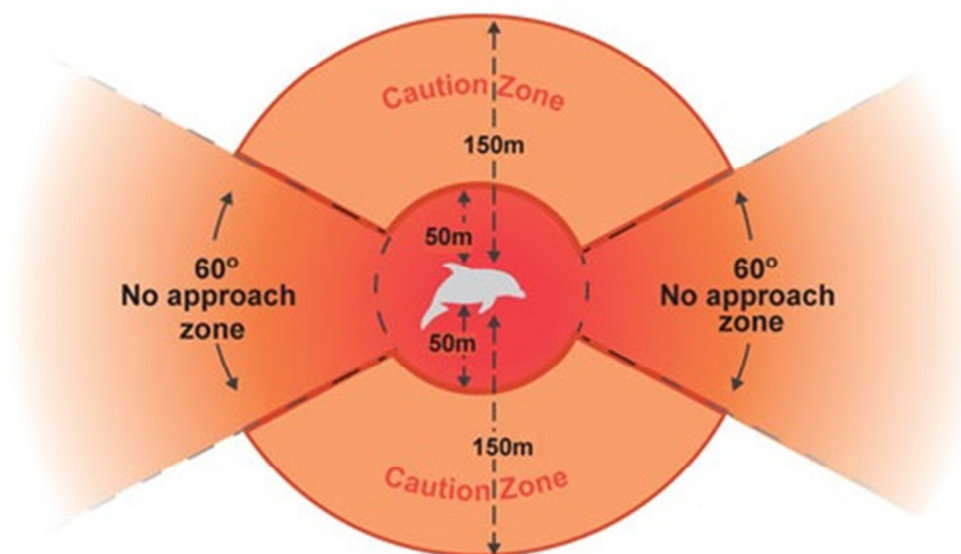
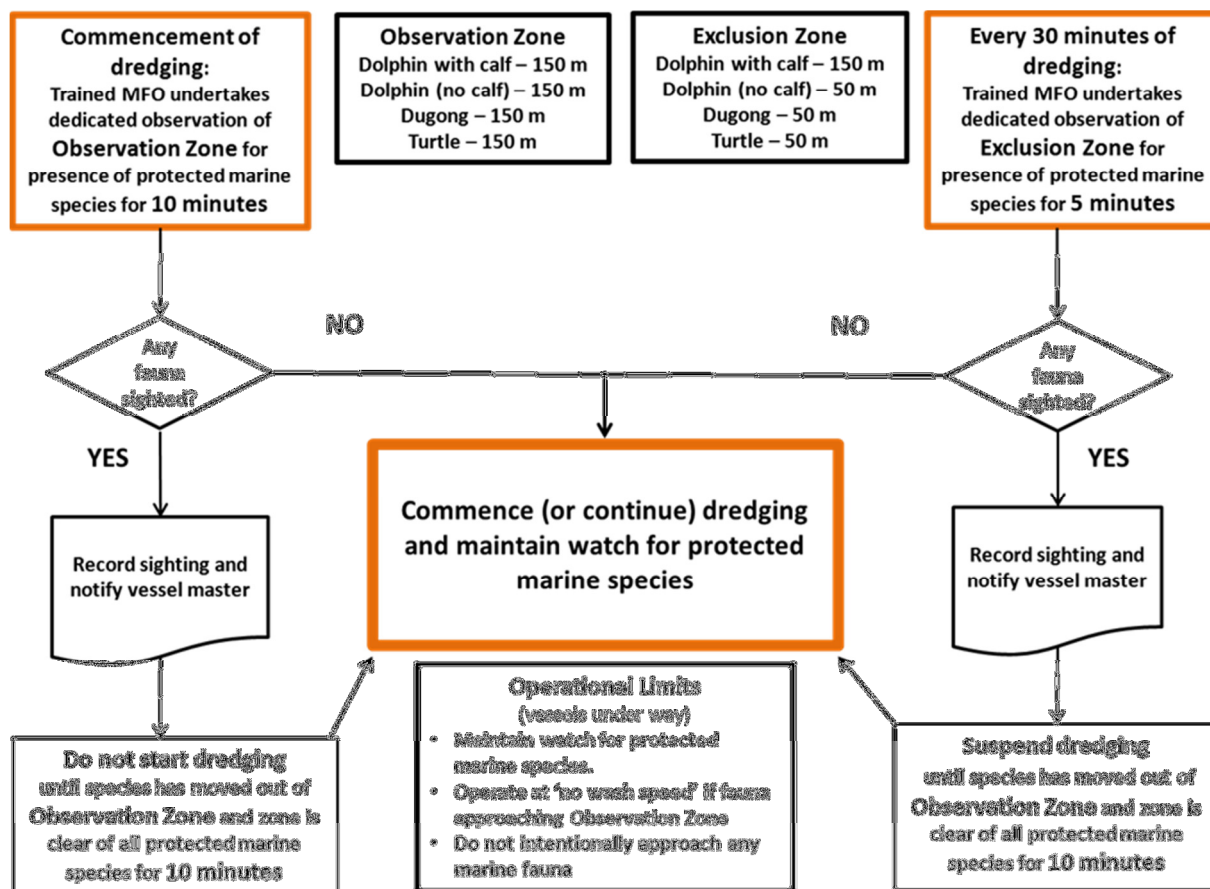


Figure 6-3 Vessel interaction management flowchart



## 6.4 Protected marine species – underwater noise

Dredging for construction of the MUBRF will create additional underwater noise in various forms and intensity above current ambient levels in Darwin Harbour.

Coastal dolphins use sound for navigation, feeding and avoiding predators (through echo location) and also for communication (through narrow band frequency modulated sound). The ability of dolphins to communicate, navigate and echo locate can be compromised by sound generated by human activity. While the ocean is naturally noisy, marine mammals are well adapted to natural levels of ambient noise. However, anthropogenic noise can cause masking (i.e. the blocking of the perception stimulus due to the presence of another stimulus in the same range) to occur (Jensen et al. 2009). Dolphins may be temporarily displaced from the vicinity of the MUBRF site by the increase in noise levels. Alternatively the dolphins may adapt (dolphins are known to frequent busy harbours such as Singapore) or may tolerate the increased noise to feed on fish attracted to the operating dredge in search of food.

Turtle auditory morphology is adapted for hearing in water. They hear largely in the low frequency range (<1000 Hz), though the bandwidth and peak sensitivity varies between species. The use of sound by turtles is little understood. Experimentally, turtles have initially shown avoidance behaviour, then eventually habituating to the noise (Moein Bartol & Musick 2003). Observation of dredge activities around Australia is that turtles largely avoid coming in close proximity to the dredge. In part this is attributed to the sound of the dredge.

Little information is available on the auditory systems of dugongs and little research has been undertaken to investigate the sensitivity of dugongs to noise. There are only anecdotal reports of dugongs avoiding areas with high boat traffic.

Monitoring of protected marine species is described in Section 7.4. Management measures implemented to reduce the risk of disturbance of protected marine species by underwater noise generated by the dredging works are listed in the following EMF.

**Table 6-4 Protected marine species - underwater noise EMF**

Protected Marine Species Management Framework – underwater noise	
Element	Impact of underwater noise on protected marine species.
Commitments	EPBC 2010/5304 condition 17(e)
Objectives	<ul style="list-style-type: none"> <li>Minimise the risk of disturbance to protected marine species from underwater noise.</li> <li>Establish and maintain awareness of the importance of protecting marine species.</li> </ul>
Target	<ul style="list-style-type: none"> <li>No avoidable disturbance to protected marine species as a result of noise generated during dredging activities.</li> <li>All dredging personnel to complete an HSE induction.</li> <li>At all times that the dredge is operational, at least one crew member is a trained MFO.</li> </ul>
KPIs	<ul style="list-style-type: none"> <li>Number of audits and incident reports.</li> <li>Number of reported sightings of live, injured or dead protected marine species.</li> <li>Number of personnel completing an HSE site induction.</li> <li>Availability of MFO trained dredge operator</li> </ul>

### Protected Marine Species Management Framework – underwater noise

Management	<ul style="list-style-type: none"> <li>Ensure that all equipment is maintained in good operating condition (balancing, greasing, etc.) and have proper noise control systems in place.</li> <li>Ensure all noise minimisation measures such as mufflers, special enclosures and sound-insulation mounts are fitted and working.</li> <li>Ensure revolving equipment such as propellers and drive shafts are balanced to reduce vibration.</li> <li>Minimise the noise generation of equipment (thrusters and auxiliary plant) by switching them off when not used (i.e. avoid running on standby mode).</li> </ul>
Monitoring (Section 7.4)	<ul style="list-style-type: none"> <li>Marine fauna observations.</li> <li>Regular monitoring for stranded, injured or dead marine fauna.</li> </ul>
Reporting (Section 8)	<ul style="list-style-type: none"> <li>Daily submission of marine fauna observations sheets (Figure 7-2).</li> <li>Weekly summary reporting to DoI of number of sightings of protected marine species.</li> <li>Monitoring report to NT EPA at the conclusion of dredging.</li> <li>Any suspected noise related incidents will be reported by the Contractor to DoI, and to DoE (on behalf of DoI), within 24 hours of the incident occurring. DoI will also notify the TAG. Incidents will also be reported by Contractor direct to NT EPA within 24 hours of the incident occurring.</li> <li>Any corrective actions implemented in response to suspected noise related incidents will be detailed in the weekly report to DoI. This report will also be provided to NT EPA. DoI will provide this report to the TAG and DoE.</li> </ul>
Corrective Action(s)	In the event that noise-related impact is suspected, the incident will be investigated to confirm a noise-related impact has occurred and identify the most appropriate action(s) to reduce the impact. This may include one or more of the following: noise reduction measures; soft-start start-up procedures; restriction on vessel movements/activities; increase the radius of the Observation Zone to 200 m.
Term	For the duration of dredging activities
Responsibility	<ul style="list-style-type: none"> <li>Dredging Contractor to ensure their documents are compliant with the DDSPMP.</li> <li>Dredging Contractor to implement noise management aboard vessels.</li> </ul>

## 6.5 Migratory Birds

### 6.5.1 Pond system characteristics

The filling of the dredge spoil placement ponds will reduce the pond area at EAW. However, most of the bird observations during the bird surveys conducted by EMS (2011) were at Pond D (2169 individuals observed out of 3722 observed at 14 sites in total).

Pond D will not be used for direct placement of dredge spoil during dredging of the MUBRF site with Pond K and Pond E (North) being the only ponds used for direct placement. However Pond D may be used for routing tailwater between Pond K and Pond E (North) should it be required. For this reason, migratory birds are considered in this plan to provide for the possible use of Pond D.

Pond D is subject to disturbance from surrounding industrial activities associated with the EAW, such as bulk mineral stockpiling and rail operations. This pond fills to capacity during the Wet Season as a result of storm water inundation and dries out completely by the end of the Dry Season. When dry the site is unattractive for roosting shorebirds. Ongoing settlement of the fine dredge spoil currently contained in Pond D is contributing to a gradual change in the

surface profile of the pond, leading to an increase in water depth of the pond at the end of the Wet Season and decreasing the duration of the period for which it is dry.

It is anticipated that the birds that currently roost on the banks of Pond K in small numbers will use Pond D instead, or roost at the natural habitat types within Darwin Harbour that they used before EAW was constructed, and continue to use under many tidal and seasonal conditions.

The most likely reasons Pond D is chosen by migratory shorebirds for roosting is that it:

- is in close proximity to the coast
- is fenced from disturbance
- is sufficiently open so that aerial predators are readily detected
- contains shallow water, allowing thermoregulation through the legs while roosting.

During the Wet Season Pond D will operate as it normally would during any other Wet Season, and storm water will flow though into Pond E.

The regular wetting and drying of the edge of this pond will keep it free of vegetation and thus retain its attractiveness to roosting shorebirds. Although not envisaged due to Pond D being isolated from the treatment system, any remedial work that may be required in Pond D will be undertaken during the latter part of the 2014 Dry Season when the pond is at its driest and before migratory birds have arrived.

## **6.5.2      *Triggers for corrective actions***

### **6.5.2.1      *Pond water height***

It is not anticipated that Pond D will be used, however, if it is, Pond D water height will be maintained as per previous Wet Seasons (refer Section 7.5.2.1). This is the only time that there may be an impact on migratory birds.

### **6.5.2.2      *Migratory birds***

To comply with EPBC approval Condition 15, monitoring of migratory birds will be implemented (as described in Section 7.6). Two triggers are to be adopted for management actions with reference to migratory birds during dredging and shall apply when Pond D is open to tailwater flow between Pond E (North) and Pond K from the MUBRF dredging.

The first action (to analyse causation and to implement targeted management responses) will be taken should the total number of shorebirds counted fall by greater than 50% from one week to the next. The figure of 50% is adopted because these counts cannot be compared with baseline surveys and are being used only to attempt to detect sudden changes in pond suitability during dredging.

Action will also be taken should the maximum number of shorebirds counted during the month fall below 60% of maximum baseline numbers (from MSB dredging data) in total for that month, or for any of the four species which have been recorded at Pond D in nationally significant numbers, or have fewer than 60% of the number of species recorded during baseline surveys. The figure of 60% is adopted as being a threshold that allows for the high

levels of daily and seasonal variation expected and the megatidal environment of Darwin Harbour, while still demonstrating that the site retains its value to migratory shorebirds.

### 6.5.3 Responses to trigger exceedances

If any of the triggers described in Section 6.5.2 are exceeded, the Contractor will notify the DoI within 24 hours of the exceedance being determined and will provide all monitoring data relevant to the pond systems to the TAG for consideration within three business days of the relevant count. In conjunction with the Contractor, the TAG will investigate to determine whether changes detected are attributable to the condition within the ponds or the management of the ponds (e.g. water levels too high, water quality, roost area) or whether changes are more likely to be caused by extrinsic factors (e.g. condition of the tide, on-migration, local rainfall). The changes will be compared to any counts under the auspices of the Australian Wader Studies Group at other sites in the Darwin region and elsewhere in Australia to determine if they are part of a larger trend. A review of the conditions at the site will also be undertaken to determine if any local habitat variables have altered, particularly whether water has been available, whether the potential roost sites have become excessively vegetated or any other matters that might have discouraged birds from roosting at the site.

Where the variation is considered by the TAG to be site specific, a more detailed investigation of all of the pond monitoring and environmental data will be undertaken. If the cause can be identified as relating to pond management or dredge spoil placement and handling practices, the TAG will advise the Contractor of required corrective actions. The TAG will ensure that analysis and consideration of relevant contributing factors is undertaken within a period of 15 business days of its receipt of initial trigger exceedance data from the Contractor.

Management measures to be implemented to reduce the risk of adverse impacts upon migratory birds are listed in the following EMF (Table 6-5). If required due to trigger exceedances, corrective actions will be considered. During the Wet Season Pond D will be removed from the settling pond system and water quality will therefore not be affected by tailwater. As a result, water level monitoring will be reduced to weekly intervals in order to maintain data to support consideration of potential changes in migratory bird numbers as described in Table 6-5.

**Table 6-5 Migratory Birds EMF**

Migratory Birds Management Framework	
Element	Impact of spoil placement on protected migratory birds.
Commitments	EPBC 2010/5304 condition 17(e)
Objectives	<ul style="list-style-type: none"> <li>Minimise the risk of adverse impacts upon migratory birds from the operation of the dredge spoil placement ponds.</li> <li>Establish and maintain awareness of the importance of protecting migratory birds and their habitat.</li> </ul>
Targets	<ul style="list-style-type: none"> <li>No adverse impacts upon migratory birds from placement and management of dredge spoil.</li> <li>Maintenance of Pond D at normal Wet Season water level (5.5 m AHD) from 1 November to 30 April if in use at this time.</li> <li>During dredging, total number of shorebirds counted during monitoring does not fall by &gt;50% between weeks.</li> <li>Maximum number of shorebirds counted during any month does not fall below</li> </ul>

Migratory Birds Management Framework	
	<p>60% of the maximum total baseline numbers for that month.</p> <ul style="list-style-type: none"> <li>Maximum number of shorebirds counted during any month does not fall below 60% for any of the four species that have been recorded at Pond D in nationally significant numbers.</li> <li>The number of shorebird species present during any month does not fall below 60% of the number of species recorded during baseline surveys.</li> <li>All personnel engaged in the operation of the pond system to complete an HSE induction, including migratory bird awareness and management requirements.</li> </ul>
KPIs	<ul style="list-style-type: none"> <li>Number of audits and incident reports.</li> <li>Water height in Pond D (if in use).</li> <li>Number of migratory birds utilising the pond system as habitat.</li> <li>Number of personnel completing an HSE site induction.</li> </ul>
Management	<ul style="list-style-type: none"> <li>Minimise the area of mangrove, salt pan and tidal mudflat areas disturbed for any works or reclamation.</li> <li>Protect the high tide roost site in Pond D if it is used.</li> <li>Control activities or facilities that might cause additional disturbance to feeding and roosting birds (e.g. excessive noise, additional nocturnal lighting).</li> <li>Continue restricted access to the public and animals (dogs) to areas where migratory shorebirds roost and feed.</li> <li>If Pond D is used and where access allows, non-PASS residual silt in Pond D will be mounded to a small island for greater security for roosting migratory shorebirds.</li> <li>Implementation of the approved EAW Migratory Shorebird Management Plan in consultation with DoE to compensate for residual detriment of Project activities on migratory bird species.</li> <li>If used, ensure the water level in Pond D does not exceed the normal Wet Season level (5.5 m AHD) for the period between 1 November and 30 April inclusive.</li> </ul>
Monitoring (Section 7.5)	<ul style="list-style-type: none"> <li>Monitor shorebirds at EAW in accord with DoE recommendation</li> <li>If in use for spoil placement, Pond D will be monitored to measure changes in water depth with reference to the potential to explain migratory bird habitat impacts.</li> <li>An adapted monitoring approach will be considered in consultation with the TAG (approved and directed by DoE) if significant decline in bird use is observed.</li> <li>Ongoing Migratory Bird monitoring for five years post-dredging undertaken to satisfy EPBC approval condition 17(f).</li> </ul>
Reporting (Section 8)	<ul style="list-style-type: none"> <li>Monitoring report to NT EPA at conclusion of dredging.</li> <li>In the event of an exceedance of a bird abundance trigger (Section 6.5.2), DoI and NT EPA will be notified within 24 hours. All relevant pond monitoring data will be provided to the TAG within three business days of the relevant count. A report on corrective actions implemented to address the cause of the exceedance will be submitted by the Contractor to NT EPA within five business days of the notification.</li> <li>Any mortality of protected migratory birds from dredge spoil placement activities will be reported to DLPE, and to DoE (on behalf of DLPE), within 24 hours of the mortality occurring. DLPE will also notify the TAG. Mortality will also be reported by the Contractor direct to NT EPA within 24 hours of mortality occurring.</li> </ul>
Corrective Action	Removing Pond D from the pond system used for settling or reducing the water level in Pond D if it is in use.

Migratory Birds Management Framework	
Term	For the duration of dredging activities, continuing into operations phase.
Responsibility	<ul style="list-style-type: none"> <li>Dredging Contractor to ensure their documents are compliant with the DDSPMP.</li> <li>Dredging Contractor is to implement monitoring program and water quality management measures.</li> </ul>

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## **7 ENVIRONMENTAL MONITORING**

### **7.1 Overview**

The environmental monitoring program to be implemented as a part of this DDSPMP comprises the following:

- monitoring of water quality surrounding the dredge and pipelines transporting spoil to the pond system for disposal (Section 7.2)
- monitoring of water quality within the dredge spoil placement ponds (Section 7.3)
- monitoring for presence of protected marine species in the vicinity of the MUBRF dredging works (Section 7.4)
- monitoring of migratory birds around the dredge spoil placement ponds (Section 7.5).

Key aspects of each of the monitoring programs are summarised in Table 7-1. The testing frequencies noted are applicable if the dredge is working, inclusive of any dredging activities over the Wet Season. Altered frequencies are noted for monitoring when the dredge is not working.

### **7.2 Darwin Harbour surrounding dredge and dredge pipelines – water quality**

#### **7.2.1 Objectives**

The objectives of monitoring water quality in the vicinity of the dredge and dredge spoil pipelines are to:

- Determine if the detectable plume is exceeding the expected range (150 m) and intensity (140 NTU) during dredging.
- Detect exceedances in the allowable suspended sediment levels of 100 mg/L (measured as turbidity, 140 NTU) at a distance of 150 m from the dredge location or pipelines.
- Provide a trigger for dredge management measures to be implemented to control the plume surrounding the dredge and pipelines.

#### **7.2.2 Monitoring locations**

Monitoring locations will be dependent on the plume extent and location but will include measurements at a distance of 150 m from the dredge or pipelines where the plume extends beyond this distance.

#### **7.2.3 Methodology**

A visual survey of the area surrounding the dredge and associated pipelines will be undertaken on a regular basis to determine the extent of the dredge plume. Should the visual survey determine that the plume may extend beyond 150 m from the dredge or pipelines, a small vessel or dredge tender will be used to inspect the distance from the dredge to the edge of the plume using a GPS. The GPS will be used to locate and record a point 150 m from the dredge at which point a surface turbidity measurement will be taken using a hand held water quality probe to measure the turbidity against the allowable limit of 140 NTU. Procedures

detailing instrument calibration, sample collection and processing methods will be developed by the Contractor.

#### **7.2.4 Data Analysis**

NTU levels measured in the field as required shall be assessed against the turbidity trigger level of 100 mg/L using the project specific SSC / NTU relationship of 100 mg/L = 140 NTU.

#### **7.2.5 Outcomes**

Based on the surface SSC determined at a distance of 150 m from the dredge or pipelines, dredge management procedures will be initiated to reduce the surface SSC to below 100 mg/L at distances greater than 150 m from the dredge. This may include modification of dredge operation during certain tidal phases or other steps deemed appropriate by the dredge operator. These management measures shall remain in place until the surface SSC of the dredge plume waters greater than 150 m from the dredge or pipelines falls below 100 mg/L (measured as turbidity, 140 NTU).

### **7.3 Dredge spoil placement ponds – water quality**

#### **7.3.1 Objectives**

The objectives of monitoring water quality within the dredge spoil placement ponds are to:

- detect trends in tailwater pH that may indicate the generation of acid from dredged PASS material pumped into the ponds
- detect trends in toxicant concentrations within the ponds that may indicate the mobilisation of toxicants from the dredged sediments, or from material placed in the ponds during past dredging programs (EAW development, Darwin City Waterfront, etc.)
- confirm the physico-chemical properties (pH, toxicants and SSC) of the tailwater are suitable for discharge from the ponds to the harbour waters.

#### **7.3.2 Monitoring locations**

Water quality monitoring locations are shown in Figure 7-1. The pH, turbidity and toxicant concentrations of the tailwater will be monitored:

- within 20 m (or as close as practical) from the dredge spoil discharge point into Pond K or into Pond E (North)
- at any pond discharge point where dredge tailwater is flowing
- within Pond E (South).

In the event that stormwater enters Ponds D, E or K from existing reclamation areas or ponds within East Arm Port, then pH and toxicants will be monitored weekly by the Contractor unless, in the view of TAG, the results of such monitoring require more frequent sampling and analysis. This will inform the assessment of potential causes of any trends in pH and toxicant concentrations that may become evident in Ponds D, E or K. It is noted that there are no controls on entry into the dredge spoil placement ponds of stormwater from the port areas to the north of the ponds. However, if there is a need to transfer stormwater from Pond F (at

EAW) into Pond E, then this would be done by a pump system; hence the water in Pond F shall be tested to assess its suitability for transfer prior to pumping.

**Figure 7-1 Water quality monitoring locations**



### 7.3.3 Methodology

Over the course of discharge of tailwater from the pond system:

- tailwater pH will be monitored by extracting water samples daily from each monitoring location and testing the water with a hand-held pH meter
- turbidity will be monitored at each location using a hand-held probe
- one water sample per week to be collected from each of the monitoring locations and sent to a National Association of Testing Authorities (NATA) accredited laboratory for analysis of toxicant concentrations (including arsenic). Prior to analysis, the samples will be filtered to remove particles >45 µm in diameter, reducing the potential for sediment-bound toxicants to be included in the analyses.

Procedures detailing instrument calibration, sample collection and processing methods will be developed by the Contractor.

Based on potential toxicity and presence within Darwin Harbour sediments, the metallic toxicants to be monitored through collection of water samples are displayed below. The toxicant trigger levels are set at the 95% level of protection (% of species) within the ANZECC Guidelines. Where marine water quality triggers are not available due to insufficient data, freshwater trigger levels applicable to slightly–moderately disturbed systems are adopted<sup>3</sup>.

<sup>3</sup> It is recognised that freshwater trigger levels are not strictly applicable to marine ecosystems. However, as noted in Section 6.2.3, the ANZECC Guidelines indicate that there are insufficient ecotoxicity data for these toxicants to set reliable trigger levels. Similarly, the available dataset for concentrations of these metals within Darwin Harbour waters is insufficient for

• Arsenic (AsIII)	24 µg/L (freshwater)
• arsenic(AsV)	13 µg/L (freshwater)
• cadmium	5.5 µg/L
• chromium (CrIII)	27.4 µg/L
• chromium (CrVI)	4.4 µg/L
• copper	1.3 µg/L
• lead	4.4 µg/L
• mercury (inorganic)	0.4 µg/L
• nickel	70 µg/L
• selenium (total)	5 µg/L (freshwater)
• zinc	15 µg/L.

Speciated toxicants (arsenic and chromium) will be analysed for total values, and if any total exceeds the trigger level of one of the species, then the samples will be reanalysed for the individual species

#### **7.3.4 Data analysis**

pH, turbidity and metals (toxicants) will be plotted and considered for trends. Any trends towards allowable limits will be used as an early warning mechanism and dredging operations reconsidered to avoid exceedance of water quality limits.

#### **7.3.5 Outcomes**

The data outputs from the monitoring enable ongoing assessments to be made of the need to implement further tailwater (or stormwater) management measures to maintain water quality parameters within the pond system below trigger levels and to render the water suitable for disposal from Pond E (South) (see Section 6.2.4).

### **7.4 Protected marine species**

At all times that the dredge is operational, the crew will include at least one member that is trained (by a training provider whose capability is recognised by the TAG) as an MFO. As described in Table 7-1, the MFO will be responsible for undertaking visual assessments (for protected marine species) of the 150 m radius Observation Zone around the dredge. The assessment of the Observation Zone will be made from an elevated position on the dredge, where a clear line of sight is achievable to the edge of the zone. The MFO will not be engaged in any other activities during the dedicated assessment periods.

During dredging, at 30 minute intervals, the designated MFO will check the Observation Zone for a period of five minutes. If any protected marine species are present within the zone, the sighting will be recorded (including details of the time and results of observation) and the management measures described in Section 6.3 will be implemented.

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the determination of reliable 'natural background levels'. It is noted that, for toxicants, the Darwin Harbour Region Water Quality Objectives (Fortune & Maly 2009; NRETAS 2010) defer to the ANZECC Guidelines.

The Dredging Contractor will provide awareness training to selected crew members to inform them about the protected marine species which may occur within Darwin Harbour; to provide a description of the record form to be used for recording protected marine species sightings; and to explain how to apply appropriate avoidance mitigation measures to minimise potential impacts or collisions with marine fauna. The purpose of the training is to raise awareness; to encourage recording and reporting of protected marine species sightings; and to emphasise the requirement to report stranded, injured or dead marine species regardless of what caused the injuries or deaths.

The Dredging Contractor will undertake observations for protected marine species and will report all positive sightings by the MFO to the project manager who ensures sightings are logged and information is provided to DoI. All sightings of protected marine species are recorded by the MFO on marine fauna observation forms similar to that presented in Figure 7-2 which will be available on all project vessels. These records are then logged into the project marine fauna sighting register.

The Contractor will be responsible for reporting sightings of any EPBC-listed marine fauna to the relevant authorities within 24 hours. This includes the requirement under EPBC condition 17(g) to report to the relevant Minister, within one business day, where there is injury or mortality to a listed threatened or migratory species that may be attributable to the dredging activity. The report will include details of the individual species observed, the frequency, location and timing of observations, and photos (if available). The objective of these reports is to identify potential interaction areas which will be incorporated by the Dredging Contractor into pre-starts, toolboxes, marine fauna awareness training, or other general awareness sessions as required.

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## **7.5 Migratory birds**

### ***7.5.1 Recent monitoring***

Surveys of migratory birds utilising Pond D have been undertaken since November 2009 as part of the EAW Expansion Project.

The Migratory Shorebirds Management Plan (MBMP) has been developed and implemented in accordance with DoE Approval EPBC 2010/5304 condition 36.

Two migratory shorebirds reports have been written since the MBMP was approved (Lilleyman et al 2013, Lilleyman et al 2014).

During 2014, in addition to regular surveying of Pond D, a trapping and tagging program was undertaken with very high frequency (VHF) tracking devices applied to shorebirds (Lilleyman et al 2014).

Weekly surveys were completed between May to December 2013 during the MSB dredging program with results reported in the Annual Monitoring Report for Dredging Activities (DoI, 2014).

The MBMP and above-mentioned reports are available on the EAW EIS webpage at <http://www.eastarmwharf-eis.nt.gov.au/home>

### ***7.5.2 Planned monitoring***

#### ***7.5.2.1 Pond water height***

If Pond D receives tailwater during the Dry Season, then pond water height measurements will be taken daily throughout dredging, and used to reference current pond height against natural high water levels.

#### ***7.5.2.2 Migratory bird monitoring***

Ongoing migratory bird counts will be undertaken throughout the dredging of the MUBRF area in accordance with the MBMP. This monitoring will include counting and tracking of migratory birds utilising Pond D.

As part of the MBMP, survey results will be analysed to compare the total numbers, numbers of species and numbers of four species (i.e. those previously identified to have used Pond D for roosting in numbers exceeding the threshold for national significance) with the mean value in baseline surveys, allowing for the month of survey.

Contractor will be required to arrange weekly surveys for the duration of the MUBRF dredging program, due the expected short timeframe of the program.

## **7.6 Summary of monitoring programs**

Key aspects of each of the monitoring programs are summarised in Table 7-1.

**Table 7-1 Summary of environmental monitoring programs**

Locations	Parameter	Methods	Frequency	Triggers	EMF
<b>DREDGE PLUME 150 m FROM DREDGE OR PIPELINE</b>					
<b>Section 7.2</b> Surface waters where the dredge plume extends beyond 150 m from the dredge or pipeline	Turbidity	Visual Hand-held probe	As required by visual monitoring	SSC>100 mg/L (measured as turbidity, 140 NTU) 150 m from the dredge or pipeline. Continue to monitor and implement management actions to reduce SSC levels below 100 mg/L at a distance of 150 m from the dredge or pipeline. Relevant monitoring locations: within the dredge plume at a point 150 m away from the dredge or pipeline	
<b>DREDGE SPOIL PLACEMENT PONDS (Corresponding relevant monitoring locations from Figure 7-1 are shown as ⊗ in the text)</b>					
<b>Section 7.3</b> At all pond outlets where tailwater is flowing. <i>If required:</i> Stormwater from existing Port land.	pH	Hand-held probe	Daily from the commencement of dredging until the cessation of tailwater discharge	pH<6.0 or pH>8.5 Continue to monitor and consider pre-emptive management actions to prevent exceedance in Pond E (North) at the weir into Pond E (South) or in Pond E (South) if either trigger exceeded (Section 6.2.4). Relevant monitoring locations: ③ ④ ⑤ ⑥ ⑦.	Water Quality Management - Dredge Spoil Placement Ponds
	Toxicants	Laboratory	Sample collected once per week from the commencement of dredging	Exceedance of any ANZECC Guidelines trigger levels (Section 6.2.3; trigger levels detailed in Section 7.3.3). Continue to monitor and consider pre-emptive management actions to prevent exceedance in Pond E (North) at the weir into Pond E (South) or in Pond E (South). Relevant monitoring locations: ③ ④ ⑤ ⑥ ⑦	

Locations	Parameter	Methods	Frequency	Triggers	EMF
	Turbidity (NTU)	Hand-held probe	Daily from the commencement of dredging until the cessation of tailwater discharge	Use project specific SSC/NTU relationship (Section 6.2.3) 100 mg/L SSC = 140 NTU Continue to monitor and consider pre-emptive management actions to prevent exceedance in Pond E (North) at the weir into Pond E (South) or in Pond E (South) if trigger exceeded. Relevant monitoring locations: ③ ④ ⑤ ⑥ ⑦	
<b>Section 7.3</b> Pond E (North) at the weir prior to flow into Pond E (South) and in Pond E (South) prior to discharge through the railway bund wall.	pH	Hand-held probe	Daily from the commencement of dredging until the cessation of tailwater discharge	pH<6.0 or pH>8.5 Discharge from Pond E (North) into Pond E (South) discontinued if either trigger exceeded (Section 6.2.3). Relevant monitoring location: ① ②	Water Quality Management - Dredge Spoil Placement Ponds
	Toxicants	Laboratory	Once per week from the commencement of dredging until the cessation of tailwater discharge	Exceedance of any ANZECC Guidelines trigger levels (Section 6.2.3; trigger levels detailed in Section 7.3.3). Discharge from Pond E (North) into Pond E (South) discontinued. Relevant monitoring locations: ① ②	
	Turbidity (NTU)	Hand-held probe	Daily from the commencement of dredging until the cessation of tailwater discharge.	Use project specific SSC/NTU relationship (Section 6.2.3) 100 mg/L SSC = 140 NTU. Discharge from Pond E (North) into Pond E (South) discontinued if trigger exceeded. Relevant monitoring locations: ① ②	
<b>Section 7.4</b> All ponds	Pond water level	Water height marker in pond	Daily, commencing at start of tailwater flow through the relevant pond.	Pond D water level above 5.5 m AHD (from 1 November to 30 April only). All other ponds – water height at least 0.5 m below bund height. Discontinue tailwater flow into the pond and open outlet points to lower water level.	Migratory birds management

Locations	Parameter	Methods	Frequency	Triggers	EMF
<b><u>Section 7.4</u></b> Pond D	Migratory birds: species presence, abundance, mortality	Observation by trained observer	In accordance with ongoing monitoring outlined in the EAW MBMP.	Fall in numbers >50% between weekly counts. 60% below monthly maximum levels for total numbers, number of four key species, total number of species (See Section 7.4.2.2 for details).	
<b>EAST ARM</b>					
<b><u>Section 7.3</u></b> Observation Zone and Exclusion Zone around dredge	Protected Marine Species - presence	Observation by trained observers (MFOs)	1. On each occasion that the dredge has been non-operational for a period exceeding 30 minutes, a visual assessment will be undertaken of the 150 m radius Observation Zone by the MFO, for a period of 10 minutes prior to the recommencement of dredging. 2. Every 30 minutes, the Observation Zone will be assessed by the MFO for a period of five minutes.	Trigger – entry of protected marine species into the Exclusion Zone: 150 m for dolphin with calf 50 m for all other protected marine species, including dolphin without calf. 1. Dredging shall not commence until no protected marine species have been sighted within the Observation Zone for a period of 10 minutes. 2. If protected marine species enter into the Exclusion Zone, then dredging will cease until such time as there have been no protected marine species sighted within the Observation Zone for a period of 10 minutes. (Section 6.3)	Protected Marine Species Management – physical interaction and underwater noise

## **8 REPORTING**

### **8.1 Routine reporting**

#### ***8.1.1 Daily reporting***

Brief daily reports will be provided by the Contractor to DoI and will include:

- a summary of the dredging completed on that day and status of dredging operations
- information relating to any exceedances detected through monitoring
- proposed schedule for dealing with exceedances reported and next steps to be followed
- records of sightings of protected marine species (Section 7.4)
- dredge daily logs showing work area and availability.

#### ***8.1.2 Weekly monitoring report***

Each week during the dredging and tailwater discharge activities, a weekly summary report of monitoring data will be submitted to the Proponent for dissemination to the TAG and to other stakeholders that may be designated by the TAG. The report will include:

- pH and turbidity (NTU) data within the dredge spoil placement ponds, from the commencement of dredging and spoil placement (Section 7.3)
- toxicants data for pond waters, once available from the laboratory (Section 7.3)
- comments on any apparent trends in the data, both over time and between ponds (Section 7.3.4)
- summary of daily data reports (Section 8.1.1)
- discussion of any trigger level exceedances (Section 8.2)
- corrective actions taken to address exceedances (Section 6)
- summary of observation data for migratory birds (numbers and species) (Section 7.4)
- details of any injuries to, or mortalities of, turtles, dugongs, dolphins or migratory birds as a result of dredging activities or pond water management (Section 8.3)
- a summary of environmentally significant equipment failures or events and an outline of corrective actions taken, or proposed, to reduce environmental harm arising therefrom (Section 8.3).

#### ***8.1.3 Dredge operation records and reporting***

The Dredging Contractor will maintain daily records of areas dredged, the volumes of material removed and dredge availability. These records will be provided to TAG weekly, and the findings from the hydrographic survey will be included in the Contractor report to the DoI on completion of the dredging (see Section 8.1.4). Copies of the daily environmental inspection checklists and other relevant environmental records will be provided by the Dredging Contractor to DoI for circulation as appropriate.

#### **8.1.4 Completion of dredging reporting**

Within one month of the conclusion of dredging, Contractor will submit a monitoring report to the TAG, DoI and NT EPA which includes, but will not be limited to, a trend analysis and interpretation of analytical data collected under the conditions of the licence.

#### **8.1.5 Compliance reporting**

The NTG, as the holder of the EPBC approval, will report to the Commonwealth Government DoE on a yearly basis (by 30 March of each year after the commencement of the Action). The Contractor will provide information to the NTG as required to facilitate this reporting requirement, including:

- summaries of all monitoring program outcomes
- summaries of any monitoring exceedances
- details of corrective actions implemented to dredging and tailwater discharge methods in response to monitoring exceedances
- recommendations for dredge program conduct for the next period.

On award of the contract, the Contractor will be required to acquire a WDL for the dredging to be completed. As licensee under the WDL, Contractor will submit to NT EPA any reports, data and/or information required by the licence. These reports, data and / or information will be submitted in accordance with any timeframes required by the licence.

During dredging, the Contractor will notify NT EPA of any non-compliance with the WDL, as required by that licence.

### **8.2 Exceedance notification and reporting**

The following notifications of exceedances will be made to the Proponent, TAG, DoI and DoE, within 24 hours of the exceedances occurring:

- within the dredge spoil placement ponds in Pond E (North) at the weir into Pond E (South) or in Pond E (South), exceedance of:
  - pH, toxicant or SSC (measured as NTU) trigger levels (Section 6.2.3)
  - triggers for reduction in numbers of migratory birds (Section 6.5.2.2)
- where the exceedances occur at the other monitoring locations, the contractor will notify the Proponent and DOI within 24 hours of the exceedance occurring.

Exceedances will also be reported to NT EPA in accordance with Conditions of the WDL and, as and when required, under the *Waste Management and Pollution Control Act* and the *Water Act*.

For each exceedance in Pond E (North) at the weir into Pond E (South) or in Pond E (South), the Contractor will provide NT EPA with a report on the corrective actions implemented to address the cause of the exceedance. This report will be submitted in accordance with the required timeframe stipulated in the WDL.

### 8.3 Environmental incident notification and reporting

In the event of the following environmental incidents, the DoI will be notified and will in turn notify the TAG and DoE within 24 hours of the incident occurring:

- vessel interaction with protected marine species, including details of injury to, or mortality of, individuals in accordance with EPBC approval Condition 17(g) (Section 6.3)
- suspected disturbance of protected marine species related to noise generated by MUBRF dredging activities (Section 6.3)
- mortality of protected migratory birds in dredge spoil placement ponds (Section 6.4).

Other environmental incidents (spills, etc.) will also be recorded. If the incident is a notifiable incident under the *Waste Management and Pollution Control Act*, then NT EPA will also be notified within 24 hours.

All incidents will be investigated and recorded on a Contractor 'Incident Report Form', 'Environmental Incident Details Form' or similar in accordance with Contractor's accident investigation and reporting procedures. Preventative and corrective actions will be established and these will be recorded on the Contractor's 'Non-conformance and Corrective Action Register', and the progress tracked for completion.

### 8.4 Complaints reporting

In the event of a complaint received as a result of dredging activities, they will be entered and tracked using Contractor's incident management system. Details to be recorded include:

- date, time and method of complaints
- description of complaint
- complainant details
- cause, action and proposed action, including allocation of a person to action the complaint and an action date
- follow-up and close-out.

Corrective action in response to valid complaints is to occur within 48 hours following receipt of the complaint. Records will be made available to the DOI and authorities upon request, taking into account any privacy issues of the complainant as appropriate.

### 8.5 Reporting and notification summary

The Proponent will report as required to the Commonwealth Government under the EPBC approval. The Proponent will publish the results on the following web site, in accordance with EPBC Condition 17(h):

Website: [www.eastarmwharf-eis.nt.gov.au](http://www.eastarmwharf-eis.nt.gov.au)

Reporting and notifications will be sent to the following stakeholders as per the requirements detailed within Section 6 of this DDSPMP:

Proponent: [Graeme.Finch@nt.gov.au](mailto:Graeme.Finch@nt.gov.au) and [Mike.Butler@nt.gov.au](mailto:Mike.Butler@nt.gov.au)

NT EPA: [environmentops@nt.gov.au](mailto:environmentops@nt.gov.au)

DoE: [post.approvals@environment.gov.au](mailto:post.approvals@environment.gov.au)

The reporting and notification requirements for the Project are summarised in Table 8-1.

**Table 8-1 Reporting and notification summary**

Reporting Type	Time	Reporting to	Content/Comments
<b>Routine reporting</b>			
Start up	14 days 1 month (from commencement)	Proponent, DoE Websites	Notice of dredging commencement as per EPBC approval Condition 1 Post DDSMP on Proponent website as per EPBC approval Condition 8 and as per WDL Conditions to be determined.
Protected marine species sightings (Section 7.4)	24 hours (from sighting)	Proponent	Marine Fauna Observations sheet (Figure 7-2)
Weekly monitoring reports (Section 8.1.2)	Weekly	Proponent, TAG	Water quality data from monitoring within the dredge spoil placement ponds and at the perimeter of the dredging footprint and seaward of the permeable section of the railway bund wall. Protected marine species sightings (summary from daily observations sheets).
End of dredging reports (Section 8.1.4)	Within one month of conclusion of each dredging phase	Proponent, TAG, DoE and NT EPA,	Monitoring report as per any relevant WDL conditions to be determined.
Yearly compliance and monitoring reports (Section 8.1.5)	30 March 2015	Proponent, DoE, Website	Compliance report as per EPBC approval Condition 3. All monitoring as per EPBC approval Condition 17(h).
	TBC on receipt of WDL	NT EPA	Audit and compliance report as per relevant WDL conditions to be determined.
<b>Exceedance reporting</b>			
Water quality exceedance – initial notification (Section 8.2)	24 hours (from occurrence)	Proponent, TAG, NT EPA, DoE, DoI	Location and value of exceedance.
Water quality exceedance – attributability review (Section 8.2)	24 hours (from end of three day attributability review period)	Proponent, TAG, DoE, DoI	Details of determination and logic used to support the conclusions.
Water quality exceedance – corrective actions (Section 8.2)	Five business days (from notification)	NT EPA	As per relevant WDL conditions to be determined

Reporting Type	Time	Reporting to	Content/Comments
Migratory bird monitoring – initial notification (Section 8.2)	24 hours (from occurrence)	Proponent, TAG, NT EPA, DoE	Nature of exceedance.
Migratory bird monitoring – pond monitoring data summary (Section 8.2)	Three business days (from trigger exceedance)	Proponent, TAG, DoE	Daily numbers and species of migratory birds sighted in pond network (Section 7.5.2.2)
Migratory bird monitoring - corrective actions (Section 8.2)	Five business days (from notification)	NT EPA	As per relevant WDL conditions to be determined
<b>Environmental incident reporting</b>			
Injury to, mortality of, or disturbance of, a protected species (Section 8.3)	24 hours (from occurrence)	Proponent, TAG, NT EPA, DoE	Time, location and photos.
Other environmental incidents (Section 8.3)	24 hours (from occurrence)	NT EPA	Report generated from Contractor incident management system
<b>Complaints reporting</b>			
Complaints (Section 8.4)	48 hours (from occurrence)	Proponent	Report generated from incident management system
<b>Ongoing monitoring reporting</b>			
Migratory bird monitoring (Section 7.5.2.2)	Ongoing	DoE	Ongoing survey with reporting identified in the MBMP developed in accordance with EPBC approval Conditions 17(f) and 36.
<b>TAG advice reporting</b>			
TAG advice relating to EPBC approval Condition 13(a)	1 week	DoE	A copy of all advice and recommendations made by the TAG and an explanation of how this advice and recommendations will be implemented or an explanation of why the person taking the action does not propose to implement certain recommendations
TAG advice relating to EPBC approval Condition 13(b)	48 hours	DoE	

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