Port Hedland Channel Entry Project
Dredge Management Plan

Pilbara Ports Authority

28 October 2022

→ **The Power of Commitment**

Project name	Port Hedland Channel Entrance Sea Dumping Permit Application						
Document title	Port Hedland Channel Entry Project | Dredge Management Plan						
Project number	12586210						
File name	12586210 Port Hedland Channel Entrance Project Draft DMP						
Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S4	0	J. Munro	D. Petch		D. Petch		28/10/22

GHD Pty Ltd | ABN 39 008 488 373

Level 9, 180 Lonsdale Street

Melbourne, Victoria, 3000, Australia

T +614 3 8687 8000 **|** **F** +61 3 8732 7046 **|** **E** melmail@ghd.com **|** **ghd.com**

Abbreviations and Terms

Term / Abbreviation	Definition
BPP	Benthic Primary Producer - Organisms that use light to produce energy through photosynthesis. BPP marine species that photosynthesise include marine algae (macro-algae, turf algae, and benthic micro-algae), mangroves, seagrass and corals.
BPPH	Benthic Primary Producer Habitat - Examples of BPPH include coral reefs, seagrass meadows, mangrove forests, intertidal mud flats that support mangroves, intertidal algal mat communities, intertidal saltmarshes, algal dominated rocky reefs, and algal dominated biogenic reefs.
CD	Chart Datum
CEP	Channel Entry Project
COPC	Contaminant of Potential Concern
CSD	Cutter Suction Dredge
DAWR	Department of Agriculture and Water Resources
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DoT	Western Australia Department of Transport
DPIRD	Western Australia Department of Primary Industries and Regional Development
EIS	Environmental Impact Statement
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act (1999)*
HAT	Highest Astronomical Tide, the highest tide level which can be expected to occur under average meteorological conditions.
IMPs	Introduced Marine Pests
km	kilometre
LAT	Lowest Astronomical Tide, the lowest tide level which can be expected to occur under average meteorological conditions.
LTDMP	Long Term Dredge Management Plan
MFO	Marine Fauna Observer(s)
Mm^3	One million cubic metres
NAGD	National Assessment Guidelines for Dredging, Commonwealth of Australia 2009.
PPA	Pilbara Ports Authority
PSD	Particle Size Distribution
QA/QC	Quality Assurance and Quality Control
SAP	Sampling and Analysis Plan
Sea Dumping Act	Commonwealth *Environment Protection (Sea Dumping) Act 1981*
SDP	Sea Dumping Permit
SOPEP	Ship Oil Pollution Emergency Plan
TACC	Technical Advisory and Consultative Committee
TBT	Tributyltin
TOC	Total Organic Content
TSHD	Trailing Suction Hopper Dredge
TSS	Total Suspended Solids
VTS	Vessel Traffic Service

Contents

Table index

Figure index

Appendices

1. Introduction

1.1 Channel Entry Project

PPA is proposing to carry out capital dredging and associated sea dumping activities at the Port of Port Hedland (**Port**) as part of its proposed Channel Entry Project (**CEP**). The CEP aims to enable greater opportunities for vessels visiting the Port, primarily inbound empty bulk cargo vessels, to take a more direct route to enter the Channel closer to the Inner Harbour (near Beacons 30/31), thereby reducing a range of navigational risks and improving operational efficiency at the Port.

The main shipping channel into the Port (**Channel**) is 42 km long, unidirectional, and tidally restricted. Vessels that are greater than 35 metres in length require pilotage to enter the Channel, marine pilots are transferred to incoming vessels via helicopter, usually at the Pilot Boarding Ground (**PBG**) adjacent to Beacons 15/16. Depending on the vessel draft and the tide height, the Port Hedland Vessel Traffic Services (**VTS**) instructs the marine pilot to enter the Channel from one of the below entry points:

– Beacon 15/16 (13.00 m CD natural depth);
– Beacon 24/26 (10.50 m CD natural depth); and
– Beacon 30/31 (9.50 m CD natural depth)

The Beacon 15/16 entry provides the most under keel clearance, which is necessary for larger vessels with greater draft and during lower tide heights. However, traversing from the PBG via the Beacon 15/16 entry into the Channel requires an acute turn, which is difficult for larger bulk carriers, and increases the risk of vessel mechanical issues and failures. The Beacon 24/26 entry provides less depth for vessels but requires a less acute turn into the channel. The Beacon 30/31 entry is shallowest but provides the most direct route from the PBG to the inner harbour, minimising the risk of vessel mechanical issues and failures associated with undertaking acute turns.

The natural depth of the Beacon 30/31 entry point is limited by a relatively small area (10 hectares) of high bathymetry (~-9.5 m CD). The CEP aims to dredge this small area to a design depth of -10.2 m chart datum (**CD**) (plus an allowance for up to 0.5 m of over-dredging to achieve this depth) to allow the surrounding natural depth to be utilised. The area proposed to be dredged in the CEP is within Zone A shown in Figure 1. This will allow the Beacon 30/31 entry point to be utilised more often, which will:

– Reduce time taken by inbound vessels to enter the Inner Harbour, by enabling a more direct route for safe navigation between the PBG and the Channel;
– Reduce risk of vessel mechanical issues and failures (e.g. steering failure) by introducing a more direct route to enter the Channel (i.e. removing existing requirement for inbound vessels to make acute turn to enter Channel); and
– Increase operational efficiency for shipping within the Port by allowing inbound vessels to enter Channel as soon as outbound vessels have passed Beacon 30/31

Following capital dredging of the high area to achieve a design depth of -10.2 m CD, PPA has identified the potential requirement for future maintenance dredging of the route between the PBG and Beacon 26 and the Beacon 30/31 entry. This area is shown as Zone B in Figure 1. Maintenance dredging of this area may be required in future if gradual accretion or extreme events (e.g. tropical cyclones) cause loss of navigable depth (i.e. accretion above a design depth of -10.2 m CD). The inclusion of this area in PPA's future maintenance dredging footprint is the subject of a separate SDP application.

1.2 Dredging works and spoil disposal

The CEP's dredging program will generate approximately 180,000 m^3 of dredged material within Zone A which includes an allowance for over dredging. Zone B is not proposed to be dredged in the immediate future; however, there may be a need to remove material from this area in the future should there be an accretion of sediments that may limit safe navigation. If accretion of sediments results in a reduction of the navigable depth to less than the target depth of less than -10.2m CD then PPA would seek to dredge this area as part of the regular maintenance dredging activities in the port once the area has been included within the approved maintenance dredging area (under Permit).

It is proposed that the CEP's dredging works will be undertaken in parallel with PPA's annual maintenance dredging program at the Port between the years 2023 and 2026. This timing will limit dredging works to prescribed periods and gain the efficiencies of using the dredging plant and equipment already mobilised to the Port as part of the annual maintenance program. Dredged material is proposed to be placed in three established spoil grounds (**Spoil Grounds**) within the Port: Spoil Ground I, Spoil Ground 7B and Spoil Ground 9A. All disposal of dredged material will be in accordance with a Sea Dumping Permit (**SDP**) (to be obtained) and PPA's CEP Dredge Management Plan (this document).

The extent of the proposed dredging to support the CEP is shown in Figure 1 and described further in Section 2.

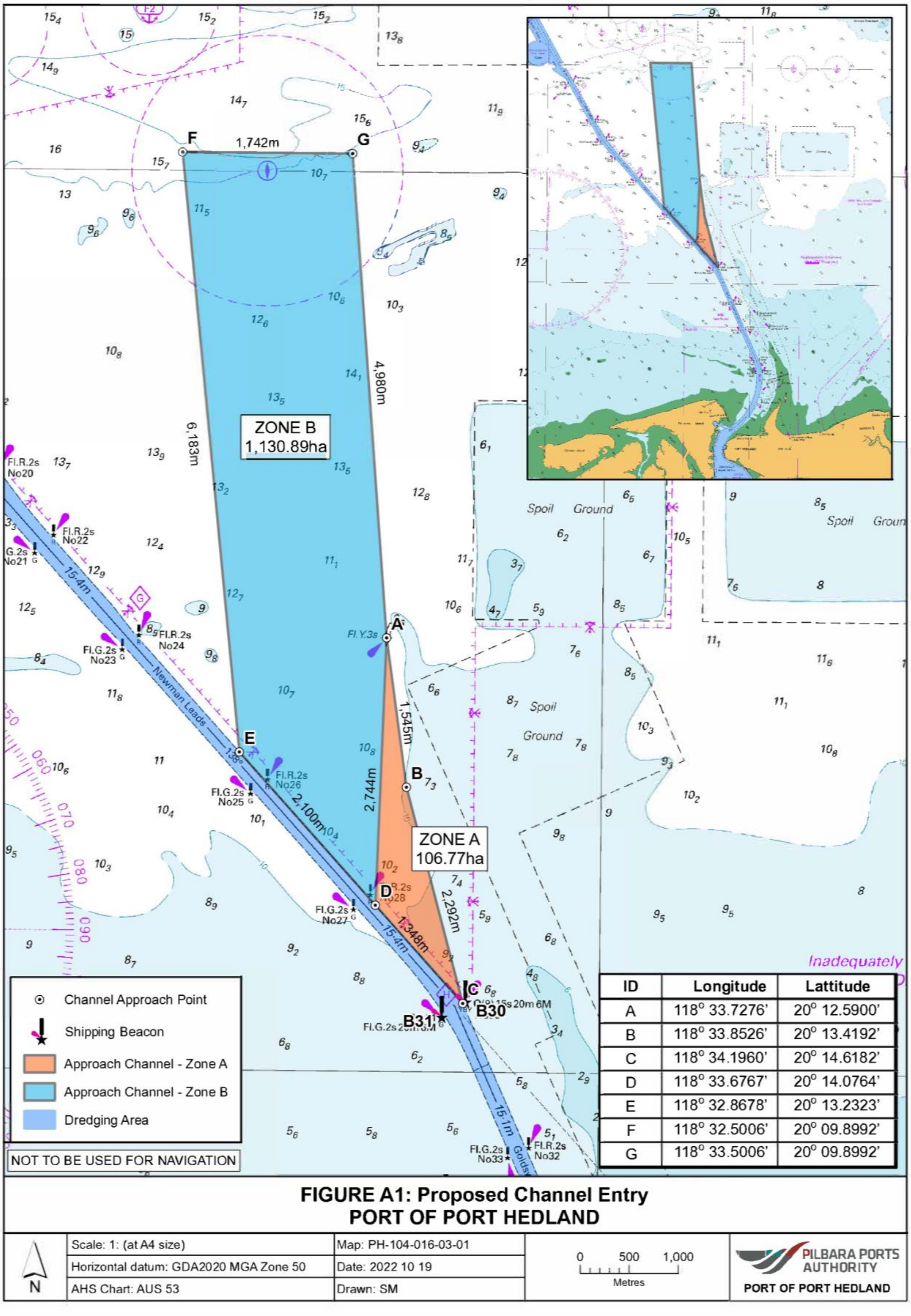


Figure 1 *Location of the Channel Entry Project*

1.3 Scope and limitations

This report: has been prepared by GHD for Pilbara Ports Authority and may only be used and relied on by Pilbara Ports Authority for the purpose agreed between GHD and Pilbara Ports Authority as set out in section 1.3 of this report.

GHD otherwise disclaims responsibility to any person other than Pilbara Ports Authority arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

Accessibility of documents

If this report is required to be accessible in any other format, this can be provided by GHD upon request and at an additional cost if necessary.

1.4 Purpose of this DMP

A three-year permit under the Commonwealth *Environment Protection (Sea Dumping) Act 1981* is required to undertake the CEP dredging program. This Dredge Management Plan (**DMP**) will form part of this permit application, as well as providing the framework for the CEP dredging activities, including:

- Overall management framework;
- The areas where dredging is to occur;
- Type of materials to be dredged;
- Offshore disposal locations;
- Legislation and regulations that apply to the CEP dredging program;
- Environmental values to be protected, the risks that dredging may pose, and the mechanisms to be implemented to mediate these risks (Management Strategies);
- Responsible parties;
- Monitoring and reporting; and
- Consultation

This DMP will also provide the framework to guide the preparation of a detailed operational dredge management plan to be developed by the appointed dredge contractor(s) or included within specific contract conditions accepted by the dredge contractor(s), prior to the commencement of the dredging activities.

This DMP, in accordance with leading practice for dredging projects internationally, uses risk-informed decision making as the basis for the management framework. The process was transparent, interactive through the engagement of a broad stakeholder base and sought to draw upon the best available information.

1.5 Management Framework

PPA will be the proponent for the CEP's dredging program in the Port. PPA's Dredging and Survey Manager has overall responsibility for the implementation of dredging at the Port and across all PPA ports within the Pilbara, including the CEP.

The CEP dredging program will be conducted in accordance with conditions of a SDP and the requirements of PPA as detailed in the contract between PPA and the dredging contractor(s) undertaking the CEP dredging works.

The dredging contractor(s), once appointed, will be responsible for the implementation of the dredging program within the constraints of the requirements of PPA and the SDP including this DMP.

1.6 Regulatory Framework

The Commonwealth Department of Climate Change, Energy, the Environment and Water (**DCCEEW**) is the primary Determining Authority for the assessment of any approvals under the *Environment Protection (Sea Dumping) Act 1981,* which may relate to the loading and any offshore disposal of sediment during the CEP dredging program at the Port of Port Hedland.

The following sections provide a brief overview of key Commonwealth and State legislation pertinent to this DMP.

1.6.1 Commonwealth legislation, regulation and guidelines

Commonwealth *Environment Protection (Sea Dumping) Act 1981*

In Australia, ocean disposal of dredged material within and outside of State and Territory waters is regulated by DCCEEW under the *Environment Protection (Sea Dumping) Act 1981* and the National Assessment Guidelines for Dredging 2009 (**NAGD**). The development of this legislation and guidelines has been guided by the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 (**the London Convention**) and the more recent 1996 Protocol to the London Convention, to which Australia is a signatory. These agreements aim to prevent pollution of the sea from the disposal of wastes or other matter, including dredged material.

The NAGD contains provision for the granting of permits for dredging on the following basis:

– An assessment of the applicant's capacity to meet their obligations under the *Environment Protection (Sea Dumping) Act 1981* and any permit granted;
– Establishment of a Technical Advisory and Consultative Committee (**TACC**) for long-term management; and
– Development and the implementation of a satisfactory Environment Management Plan for the loading and disposal activities, which provides for sampling and analysis to support any future permit applications

Commonwealth *Environment Protection and Biodiversity Conservation Act (1999)*

The *Environmental Protection and Biodiversity Conservation Act (1999)* (**EPBC**) establishes a process for the assessment and approval of proposed actions that are likely to have a significant impact on matters of national environmental significance or on Commonwealth land.

Other Commonwealth legislation, regulation and guidelines

Other applicable Commonwealth legislation and guidelines include, but are not limited to, the following Acts, Regulations (and relevant amendments):

– Protection of the Seas (Prevention of Pollution from Ships) Act 1983;
– Australian Ballast Water Management Requirements 2001;
– Biosecurity Act 2015;
– Biosecurity Regulations 2016; and
– National Water Quality Management Strategy (Commonwealth Government of Australia 1992)

1.6.2 State legislation, regulation and guidelines

The key Western Australian legislation, regulation and guidelines relevant to dredging at the Port of Port Hedland include:

– *Port Authorities Act 1999*;
– *Navigable Waters Regulations 1958*;
– *Shipping and Pilotage (Port and Harbour) Regulations 1966*;
– *Western Australian Marine Act 1982*;
– *Pollution of Waters by Oil and Noxious Substances Act 1987*;
– *Marine and Harbours Act 1981*;
– *Environmental Protection Act 1986*;

– *Environmental Protection Regulations 1987*;
– *Fisheries Resource Management Act 1994* (the State Act addressing Introduced Marine Pests);
– Western Australia Environmental Protection Authority Technical Guidance - Assessment Guidelines of Marine Dredging Proposals (WA EPA, 2016);
– Western Australia Environmental Protection Authority Technical Guidance - Protecting the Quality of Western Australia's Marine Environment (WA EPA, 2016); and
– Western Australia Environmental Protection Authority Technical Guidance – Protection of Benthic Communities and Habitats (WA EPA, 2016)

1.7 Other requirements

1.7.1 Health and safety

The CEP dredging program shall be carried out in accordance with PPA health and safety requirements and a Health and Safety Management Plan shall be prepared by the dredging contractor(s) and approved by PPA prior to the commencement of dredging.

1.7.2 Quality assurance

PPA, and the dredging contractor(s) undertaking the dredging program, shall have a Quality System certified by a third party to be compliant with ISO 9001, or equivalent. Quality records shall be kept for dredging and surveys, data management presentation and interpretation.

1.7.3 Survey

Survey works will be the ultimate responsibility of PPA, however progress survey work may be undertaken by the dredging contractor(s) depending on the terms of the dredging contract. Surveys will be carried out in accordance with PPA's Hydrographic Survey Standards and Deliverables requirements (Available on PPA's website: www.pilbaraports.com.au) and with the requirements of the contract between PPA and the dredging contractor(s).

1.7.4 Port operations

The CEP's dredging program will be carried out within an operating port and channel. The requirements for operating in the Port of Port Hedland are outlined in PPA's Port of Port Hedland Port Handbook, the Port Standards and Procedures and in consultation with the responsible Harbour Master. The requirements of PPA shall be adhered to whilst any vessels associated with the dredging program are within Port waters.

1.8 Stakeholder consultation and availability of the DMP

Stakeholder consultation has taken place during the development of the CEP concepts, and in refining the ultimate design. Stakeholder engagement also occurred during the risk assessment phases of the project. Stakeholders consulted during this process included:

– Pilbara Ports Authority;
– Commonwealth Department of Climate Change, Energy, the Environment and Water;
– WA Office of the Environmental Protection Authority;
– WA Department of Transport;
– WA Department of Primary Industries and Regional Development;
– WA Department of Biodiversity, Conservation and Attractions
– Department of Jobs, Tourism, Science and Innovation;
– Town of Port Hedland;
– BHP Billiton;
– Fortescue Metals Group;

- Roy Hill;
- Yamatji Marlpa Aboriginal Corporation; and
- Care for Hedland

Ongoing involvement of stakeholders will be managed through a TACC, which has been in place for the Port since 2006. PPA currently holds a five-year SDP for maintenance dredging within the Port as well as a range of other SDP's for capital dredging. PPA facilitates the TACC, as part of the existing SDP, with the TACC meeting at least twice per annum. TACC members are informed on all matters relating to dredging in the Port and have been briefed on the CEP dredging program as the concept and final design has developed including at the most recent TACC meeting which was held in Port Hedland on Thursday 4 August 2022. The TACC is representative of industry, community and government at all levels and is inclusive of the stakeholders listed above.

The TACC will continue to meet at least twice per annum or more frequently as required, such as during dredging campaigns. The purpose of the TACC is to:

- Keep stakeholders informed on dredging activities;
- To provide continuity of direction and effort for environmental protection matters related to dredging and ocean disposal of dredged material;
- Provide a forum for communication and resolution of any issues that may arise that stakeholders would like to be addressed;
- Assist in establishment of long-term permitting arrangements, including review over development and implementation of:
  - Sampling and Analysis Plans;
  - Dredge Management Plans; and
  - Other research and monitoring programmes;
- Review on-going management of dredging and ocean disposal activities in accordance with guidelines and permits; and
- Make recommendations as appropriate

The main objective of the TACC is to ensure a transparent process with respect to dredging and ocean disposal of dredged material.

1.8.1 Availability of the DMP

This DMP will be made available on PPA’s website (www.pilbaraports.com.au).

1.8.2 Ongoing review of the DMP

PPA will undertake a review of the DMP following the results from each phase of dredging to ensure it remains current. Any review of the DMP will include consultation with the TACC.

2. Dredging and spoil disposal activities

2.1 History of dredging at the Port of Port Hedland

PPA are responsible for maintenance dredging of the berths, channel and turning basin at the Port. Maintenance and capital dredging has been undertaken at the Port since 1977. Table 1 summarises the dredging campaigns at the Port that have been approved by the Commonwealth under the *Environment Protection* (*Sea Dumping) Act 1981*.

Table 1 Previous approved and permitted dredging activities at the Port of Port Hedland

Year	Type of Dredging	Proponent*	Volume (m^3)
1977	Maintenance	PPA	150 000
1981	Maintenance	PPA	268,000
1985	Capital and Maintenance	PPA	7,000,000
1986	Capital	PPA	13,600,000
1990	Maintenance	PPA	350,000
1993	Maintenance	PPA	200,000
1994	Maintenance	PPA	114,000
1997	Maintenance	PPA	330,000
2001	Maintenance	PPA	580,000
2002	Capital	BHP Billiton	460,000
2004	Maintenance	PPA	550,000
2006-07	Capital	FMG	5,000,000
2007	Maintenance	PPA	730,000
2008	Capital	FMG	3,400,000
2009	Capital	BHP Billiton	3,900,000
2010	Capital	BHP Billiton	6,000,000
2010	Capital	PPA	8,800,000#
2010	Maintenance	PPA	930,000
2012	Capital	PPA	5,880,000#
2012	Maintenance	PPA	312,850
2012	Capital	BHP Billiton	1,720,000#
2013	Maintenance	PPA	680,839
2014	Maintenance	PPA	344,789
2015	Maintenance	PPA	473,395
2016	Maintenance	PPA	272,048
2017 onwards	Capital	PPA	3,361,000
2017	Maintenance	PPA	500,925
2018	Maintenance	PPA	102,686
2019	Maintenance	PPA	381,608
2021	Maintenance	PPA	974,512
2021	Capital	PPA	190,000#

** PPA includes the predecessor organisation Port Hedland Port Authority*
 # Volumes includes approved under Permit, but not necessarily dredged

2.2 Channel Entry Project

Empty bulk cargo vessels approaching the inner harbour at the Port from the designated anchorages and offshore pilot boarding grounds, generally enter the Channel on the eastern side of B30/31. These vessels take advantage of naturally deeper areas adjacent to the Channel to enter closer to the Port, reducing the need for capital dredging and potential for vessel interaction with departing vessels. In recent years, the larger physical size of the empty sailing draft of the vessels means that a depth of -10.2 m CD is required to safely navigate from the anchorages to the Channel. The ability of these vessels to continue to use this approach to the Channel is becoming limited due to isolated high spots one the seabed within the vicinity of B30/31 (i.e. areas of the seabed shallower than -10.2 m CD). As a result, the larger empty bulk cargo vessels are required to undertake a number of directional change manoeuvres to negotiate around these high spots. This presents a navigational risk due to the angle (more acute) in which the vessels have to execute their entry to the Channel. This results in both a risk to safe navigation and an efficiency loss as vessels are required to navigate around these hazards.

The proposed CEP will aim to remove the identified navigational hazards which exist adjacent to the existing Channel in the vicinity of B30/31 and deepen the channel entry area from -9.5 m to -10.2 m CD (plus an allowance for up to 0.5 m over dredge). The remainder of the approach is naturally deep and allows for safe passage. Removing these isolated high spots will allow for empty bulk vessels to sail a straight course into the Channel, avoiding directional change manoeuvres, improving both navigational safety and vessel efficiency as these vessels approach the inner harbour of the Port.

2.2.1 Dredging works and spoil disposal

The CEP's dredging program will generate approximately 180,000 m^3 of dredged material within Zone A which includes an allowance for over dredging. Zone B is not proposed to be dredged in the immediate future; however, there may be a need to remove material from this area in the future should there be an accretion of sediments that may limit safe navigation. If accretion of sediments results in a reduction of the navigable depth to less than the target depth of less than -10.2 m CD then PPA would seek to dredge this area as part of the regular maintenance dredging activities in the port once the area has been included within the approved maintenance dredging area (under Permit).

It is proposed that the CEP's dredging works will be undertaken in parallel with PPA's annual maintenance dredging program at the Port between the years 2023 and 2026. This timing will limit dredging works to prescribed periods and gain the efficiencies of using the dredging plant and equipment already mobilised to the Port as part of the annual maintenance program. Dredged material is proposed to be placed in three established Spoil Grounds within the Port: Spoil Ground I, Spoil Ground 7B and Spoil Ground 9A). All disposal of dredged material will be in accordance an SDP (to be obtained) and PPA's CEP Dredge Management Plan (this document).

2.2.2 Dredging methods

A range of dredging approaches and equipment may be used though it is likely that a Trailing Suction Hopper Dredge (**TSHD**) will be the primary type of dredging plant used. Matching the type of dredge to the specific dredging requirements and the nature of sediments will assist in optimising the utilisation of the dredging equipment and minimise environmental impacts. Dredging is likely to be done at same time as maintenance dredging within the Port and dredge choice may reflect the best vessels to suit both projects

2.2.3 Project vessels

Mobilisation of dredge plant and associated equipment will be carried out in accordance with the requirements of PPA through its contract with the dredging contractor(s) undertaking the dredging program, the requirements of the SDP and PPA's standards, procedures and regulations for the Port including the PPA Vessel Introduced Marine Species Risk Assessment Procedure.

2.3 Locations for offshore disposal of dredged materials

Disposal of dredged material is proposed at three established spoil grounds within the Port (**Spoil Grounds**): Spoil Ground "I", Spoil Ground 7B and Spoil Ground 9A. These established Spoil Grounds are of sufficient size to accommodate the entire volume of dredged materials targeted under the CEP dredging program. The location of these Spoil Grounds is shown Figure 2 with further detail provided in Table 2 and Table 3.

Spoil Ground "I"

Spoil Ground "I" has been used for disposal of sediment from approved maintenance and capital dredging campaigns over the last 30 years. An extension the spoil ground was approved in 2015 as a variation to the long-term SDP that was in place at the time and all references to Spoil Ground "I" in this document are inclusive of this approved extension. Monitoring of the sediments and the benthic habitats a Spoil Ground "I" has occurred regularly since 2008. Little change in the character of the soil ground has been detected during this time.

Spoil Grounds 7B and 9A

The spoil ground numbers 7 and 9 refer to two areas that were selected from nine potential sites originally investigated as part of a spoil ground site selection study for BHP's Outer Harbour Channel project (SKM, 2011c). Both of these spoil grounds were assessed and approved for use as part of the BHP Outer Harbour Project (SKM, 2011a) however that project did not advance, so neither spoil ground was used for disposal of dredged material for that project. PPA undertook additional assessment of these spoil grounds in 2016 (Jacobs, 2017) as part of the Channel Risk and Optimisation Project (**CROP**) to reconfirm the physical and chemical characteristics of sediments at the two spoil grounds. Data collected from the 2017 program was comparative to previous data sets presented for the sites, indicating little change had occurred.

Use of smaller sub areas within each of these spoil grounds, termed Spoil Ground 7A, 7B and Spoil Ground 9A were assessed, approved, and spoil placed in these spoil grounds under the sea dumping permit for the capital dredging for the CROP in 2017 (2017/3542), the capital dredging for the Stingray Creek Southern Swing Basin in 2018 (SD2018/3782 – 7B only), as well as the current permit for maintenance dredging (SD2017/3702).

Table 2 Coordinates for Spoil Grounds "I", 7B and 9A within the Port (WGS84)

Boundary	Latitude	Longitude
Spoil Ground 'I'		
NW	S 20º 11.267'	E 118º 34.233'
NE	S 20º 11.267'	E 118º 35.367'
SE	S 20º 12.483'	E 118º 35.367'
SW	S 20º 12.483'	E 118º 34.233'
Spoil Ground 7B		
NW	S 20°11.851'	E 118°27.343'
NE	S 20°11.830'	E 118°28.620'
SE	S 20°13.530'	E 118°28.630'
SW	S 20°13.532'	E 118°27.357'
Spoil Ground 9A		
NW	S 19°57.440'	E 118°24.340'
NE	S 19°57.440'	E 118°24.710'
SE	S 19°58.840'	E 118°24.720'
SW	S 19°58.850'	E 118°24.350'

Table 3 Summary of Spoil Grounds

Spoil Ground	Water Depth (m LAT)	Area (ha)	Approx. Capacity (Mm^3)*	Description
"I"	-5 to -11 m	443.1	16 Mm^3	Spoil Ground "I" is located in Commonwealth waters 11 km offshore from Port Hedland. Spoil Ground "I" has been used for disposal of sediment from approved maintenance and capital dredging campaigns over the last 30 years. Most recently, this spoil ground is being used for disposal of capital dredge material for the Spoilbank Marina Project. The disposal site is described as bare sandy bottom depauperate in macro-benthic flora and fauna (MScience 2022b).
7B	-8 to -14 m	694.7	30 Mm^3	Adjacent to the Channel and CROP Refuge Zone. The spoil ground is described as bare sandy bottom depauperate in macro-benthic flora and fauna.
9A	-7 to -19 m	165.9	10 Mm^3	Located at the end of the Channel and was the location for materials dredged from the outer Channel and CROP Passing Lane. The disposal site is described as bare sandy bottom depauperate in macro-benthic flora and fauna.

* Actual capacity depends on the TSHD contracted, the greater the hopper capacity the greater the draft required and the lesser the spoil ground capacity

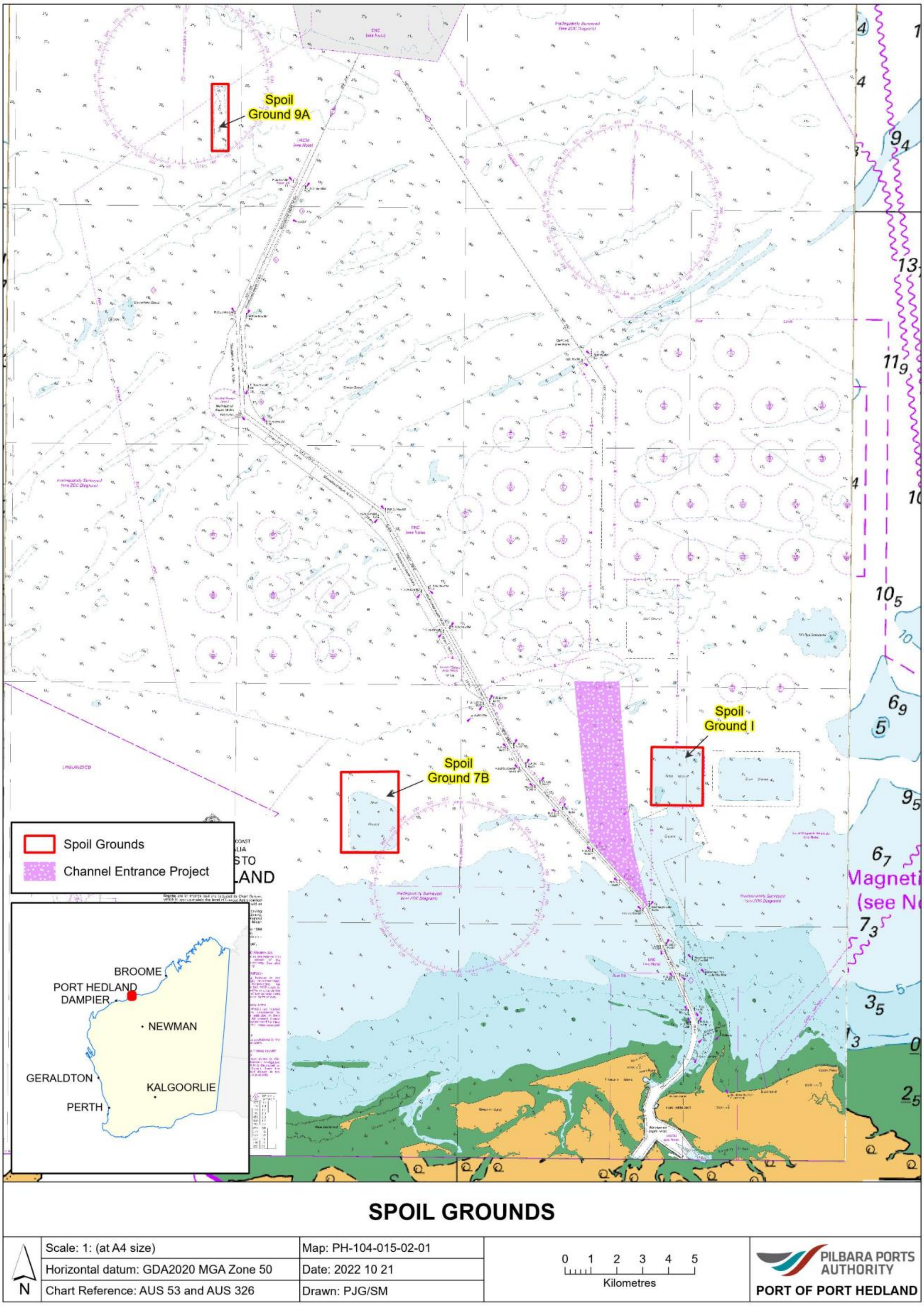


Figure 2 ***Location of the Spoil Grounds to be used to deposit material dredged during CEP dredging operations at the Port of Port Hedland.***

3. Environmental, Social and Amenity

3.1.1 Coastal Geomorphology and Hydrodynamic processes

The Port Hedland area is a limestone barrier coast with a large tidal range that has evolved into a mosaic of coastal landforms inclusive of offshore limestone ridges, protected embayments (such as the Inner Harbour), sandy substrata with mangroves, mud flats, salt flats and a number of islands and associated reefs.

Depths are generally shallow, gradually increasing with distance from the shoreline to around -16 m CD at approximately 13 km seaward of the shoreline. The tides at Port Hedland are predominantly semi-diurnal and range from 1.4 m during neap tides to 5.8 m during springs, with the highest astronomical tide (HAT) being 7.6 m.

The natural current direction in the local area is north westerly to south easterly. Influences on the currents and circulation in the North West Shelf include the Indonesian through-flow current, the Western Australian current, the Leeuwin current and large tidal ranges and cyclones.

Winds are generally moderate throughout the year, apart from sporadic cyclonic and strong storm events, leading to limited wind driven currents and a generally calm wave regime. Under cyclonic conditions, large waves, strong winds and storm surges can be created which can significantly alter current and wave energy patterns, and subsequent background water quality conditions. As an example, between December and May (wet season) the Pilbara region is subjected to sporadic, intense storms and an average of three to four cyclones occur each season.

3.1.2 Marine water quality

Typically, nearshore waters are characterised by variable turbidity and high sedimentation rates, with associated highly variable light regimes and seawater temperatures. Offshore waters exhibit fewer extremes in the water quality, but still display occasional high levels of sedimentation and turbidity, low light and variable seawater temperatures (SKM 2009; BHP Billiton 2011). In general, light, turbidity, seawater temperature and sedimentation rates are weather dependent and show a strong seasonal transition from the dry to the wet seasons. Large daily tidal ranges (>5 m), strong winds (gusts >50 km/h) and increased wave activity (such as associated with cyclonic activity) can impact background conditions resulting in increased turbidity (in the form of increase total suspended solids (TSS)) due to coastal runoff and wind/wave driven sediment resuspension. In summary, waters in the vicinity of the Port are subject to naturally elevated levels of turbidity and a reduced light climate heavily influenced by discrete weather events.

Marine water quality is unlikely to be significantly impacted by CEP dredging works except in the immediate vicinity of the dredging activity. Water quality modelling for BHP Billiton's Outer Harbour Project, a much larger dredging program, predicted that there would be a low probability of adverse impacts of dredging and disposal activities on water quality and identified sensitive receptors.

Water quality monitoring has been undertaken prior to and during dredging works associated with the combined CROP capital program (2017) and the 2017 maintenance dredging campaigns. Data collected indicates water quality impacts from this combined campaign (as of December 2017) have not exceeded set trigger levels (>5.7 NTU above the NTU at reference sites for 3 consecutive days). The current combined CROP and 2017 maintenance dredging program represents a significantly larger program than the CEP. The results to date confirm the assumptions (results) presented in the BHP modelling, that dredging and disposal activities within these areas are unlikely to adversely impact known and identified sensitive receptors.

The proposed CEP dredging and disposal campaign is significantly smaller than these capital dredging projects, as shown in Table 4, therefore the risk associated with turbid plumes (reduced water quality) impacting identified sensitive receptors (e.g., Benthic Communities and Habitat) is considered low. No further management actions or water quality monitoring is therefore proposed.

Table 4 Dredging project comparative volumes and duration

Project	Volume (Mm^3)	Duration
Outer Harbour Development	Up to 54	56 continuous months of dredging over 5 years
CROP	Up to 3.361	A single 3 to 4 month dredging block annually for 3 years
Maintenance Dredging	Up to 0.5 per annum	6-8 weeks per year over 5 years

3.2 Sediments

Data on the properties of the sediments in and around the CEP dredging areas and the three established Spoil Grounds was obtained during the implementation of an approved Sampling and Analysis Plan (**SAP**) (MScience, 2022). Sediment from most samples collected within Zone A were shown to be predominantly (80-90%) sorted into the fine to coarse sand (62 – 2000 µm) and gravel (2000 – 10000 µm) fractions, with only one sample reporting greater than 20% of the fines (<62 µm) fraction. The majority of the samples in this zone (16 of the 20 samples collected) consisted of sediments from the larger fractions tested, comprising over 50% coarse sand and gravel (500 – 10000 µm). Sediment samples collected within Zone B were similar to those in Zone A. Sediments within Zone B were shown to be predominantly (>90%) sorted into the larger fractions (fine to coarse sand and gravel). Eight of the ten samples collected consisted of over 50% coarse sand and gravel, with two samples reporting higher (55 to 80%) proportions of the fine to medium sand fractions." The sediments at the Spoil Grounds are predominately sand (>90%) and gravel.

The SAP Implementation Report (**SAPIR**) reported that concentrations of metals within Zone A and Zone B were all below the relevant NAGD (low) screening levels for all metals except arsenic. Concentrations of arsenic greater than the NAGD (low) screening level are commonly found in marine sediments from the Pilbara (Stoddart *et al*. 2019) and the SAPIR concluded that the sediments were of low risk for unconfined ocean disposal.

All other contaminants such as tributyltin, pesticides, herbicides and petroleum hydrocarbons were below the relevant NAGD (low) screening guidelines levels in all samples examined.

The sediments within Zone A and Zone B are considered to be of low risk for unconfined ocean disposal (MScience 2022a).

The results of the chemical analyses of sediments from the Spoil Grounds were very similar to those from Zones A and B. All parameters measured were below the relevant NAGD (low) screening levels for all metals except arsenic which has been determined to be of natural origin (Stoddart *et al*., 2019).

3.3 Biological environment

3.3.1 Benthic habitats

Benthic habitats offshore of Port Hedland comprise extensive plains of sand/silt with limited limestone pavement and ridges (SKM 2011a). Many of the offshore limestone ridges run parallel to the coastline and support sparse assemblages of macroalgae, corals and sponges. Whilst the extensive plains of sand/silt are often bare of any sessile mega-epibenthic taxa (such as coral and macroalgae) these habitats do support smaller infaunal species and surface-dwelling echinoderms.

Macroalgae occurs offshore on both hard and soft substrata however its abundance varies among different habitats and according to season. Seagrasses are common in the Port Hedland area but do not form dense communities or meadows. Seagrasses documented in the literature for the study area are ephemeral species such as *Halophila ovalis* that form patches of low to medium density.

The CEP footprint (including the Spoil Grounds) is comprised mostly of bare sediment, which is largely devoid of suitable benthic primary producer habitat (BPPH). Corals, sponges and other sessile invertebrates will be sparse, and only occur in patches where there are suitable hard substrata for colonisation.

The benthos of the areas to be dredged was surveyed again in May 2022 in order to provide a greater certainty and precision in the location and structure of known BCH within both Zones A and B. Details of the survey are reported in MScience (2022b). Overall, four habitat types were recorded within Zones A and B, with five community types found within one or more of those habitats. Close to 99% of Zone A and ~93 % of Zone B were mapped as bare sand (<2 % cover of biota). Sparse (2 to <10 % cover) to low density (10 to <20%) sessile invertebrates (non-coral) growing on consolidated hard substrate formed the remaining area of Zone A. Approximately 42 ha, or 3.7% of Zone B, consisted of mixed community (up to 40% cover of sponges, soft corals and mixed filter feeders and up to 15% of hard coral cover) growing on the hard substrate ridgeline running parallel to the coastline in the north of the zone which appears to be an extension of Minilya Bank to the east of the CEP area. MScience (2022b) concluded that benthic habitat, communities and biota found in the survey are common in the area offshore of Port Hedland and are not considered to be unique or of regional significance.

3.3.2 Marine Fauna

Marine fauna of the area includes both listed and non-listed species. Of particular interest to the CEP are the marine megafauna, including whales, dugongs (*Dugong dugon*), green turtles (*Chelonia mydas*), Hawksbill turtles (*Eretmochelys imbricata*), flatback turtles (*Natator depressus*) and loggerhead turtles (*Caretta caretta*). Many of these species potentially occur in or migrate through the area but are unlikely to be dependent upon habitat within the CEP footprint for population maintenance.

Port Hedland has known flatback turtle nesting beaches (Cemetery Beach and Pretty Pool Beach). The internesting habitat buffer zone that is critical to the survival of the species for flatback turtles is 60km (DotEE 2017). Spoil Ground “I” is within the internesting buffer zone for flatback turtles and is closest of the three Spoil Grounds to identified flatback turtle nesting areas. Potential impacts to turtles at Spoil Ground “I” would be confined to disposal activities as no dredging is to occur at this location. Dredging may impact upon turtles in terms of habitat modification and/or entrainment.

The Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017) identified dredging as a potential source of turtle injury and/ or mortality. There are a number of mechanisms for potential impact on turtles, and other marine megafauna, including:

- Direct impacts through entrainment, where animals are drawn into the dredge through the drag heads as a result of the suction used to collect sediment;
- Direct impacts though vessel strike where animals are physically struck by the dredge or associated vessels;
- Indirect impacts through destruction of food resources either through removal by the dredge or smothering with dredged material; and / or
- Indirect effects through increased turbidity or release of contaminants into the water column

Dredges can be a direct source of turtle mortality where animals become drawn into the dredge as a result of the suction applied through the process of removing sediments from the sea floor (entrainment). Entrainment is likely to be the only feasible pathway of impact on turtles and to a lesser extent other marine megafauna associated with maintenance dredging at Port Hedland. This should be considered as highly unlikely due to the suction field of influence being less than one metre (during dredging), and the protocols in place to only activate the drag heads when in close proximity to the seabed.

The Recovery Plan for Turtles identified that, in Australia, the adoption of soft start guidelines for dredging means that direct mortality through dredge operations is only likely to affect individual turtles rather than cause a population or community level impact. Nonetheless the aim of the dredging operations is to have no impacts on turtles where at all possible.

There are three main actions that can be taken to avoid entrainment of turtles. These are:

1. Provision of Marine Fauna Observers (**MFO**) on the dredge;
2. Use of turtle deflector devices.
3. Avoidance of pumping unless drag head of the dredge is on the sea floor.

The provision of MFO allows the dredge to move away from areas when turtles, and other Marine Fauna are observed in the area. Generally, a condition of all dredging permits in Australia, this techniques has been widely adopted to assist in the reduction of dredging impacts.

The use of a flexible chain deflectors attached to the drag heads to prevent entrainment of sea turtles during dredging operations has been widely adopted. These devices come into contact with any turtles that are on the sea floor in the pathway of the drag head. These turtles are then disturbed and swim away from the slow-moving drag head thus reducing the potential for entrainment into the dredge.

Habitat modification is not considered a key risk for maintenance dredging, as all dredging is being undertaken in previously disturbed areas and dumping is occurring in spoil grounds that have been selected based on their low environmental value and have previously been used under other permits.

Direct mortality through entrainment in dredge equipment is only likely to affect individual turtles rather than impact species stocks (DotEE 2017). Controls to minimise entrainment include drag head management (in which the dredge pumps are only engaged when the drag head is positioned on the sea floor), turtle deflecting devices and marine fauna observer practices.

Little research has been undertaken on the impacts of dredge spoil disposal as a direct form of impact on marine megafauna as it has been generally considered that this pathway of impact was very unlikely. The Great Barrier Reef Marine Park Authority (**GBRMPA**) in their publication Synthesis Report on the Effects of Dredging on the Great Barrier Reef by an Independent Expert Panel (McCook *et al.*, 2015 Table 5 p. 44) rated the potential for burial of megafauna as “not applicable”. Thus the independent panel GBRMPA assembled to consider this matter, did not consider that burial of turtles at the site of disposal was a plausible mechanism of impact. Whitlock *et al.* (2017) in their study of the effects of dredging on turtles in the Pilbara did not mention burial of turtles as an impact but referred to burial of habitat.

Light and noise pollution from dredge vessels may also impact on foraging or nesting turtles or hatchlings. However these impacts are very acute, only lasting for the duration of the CEP dredging campaign.

3.3.3 Introduced Marine Pests

Wells (2018) undertook a detailed literature search of marine biodiversity studies in the Pilbara and developed a database of 5,532 species that have been recorded by previous surveys of Introduced Marine Pest (**IMP**) species in the Pilbara. Wells (2018) reported that despite all of the survey work that has been done only one species on the Australian national and WA IMP register, the ascidian *Didemnum perlucidum*, also known as the white sea squirt, has been found within Pilbara coastal marine areas. This species was first detected in 2012 and was detected over some 2,800 km of WA coastline (Bridgewood *et al*., 2014).

The State-Wide Array Surveillance Program (**SWASP**) has been implemented in Western Australian Ports, including the PPA since 2016, as a result of a collaborative effort between WA Port Authorities and the Department of Primary Industries and Regional Development’s (**DPIRD**) Aquatic Biosecurity section. This program is a continuation of the “Early Warning System” surveillance program originally developed in 2010.

The primary aim of the SWASP is to identify the presence of any marine organisms (sessile and mobile) listed by the National System for the Prevention and Management of Marine Pest Incursions. This is achieved by soaking settlement arrays for two months, twice a year (summer and winter). This monitoring program is designed to quickly detect potential target marine pests in State waters primarily using Next Generation Sequencing (NGS) techniques. This method quickly and accurately determines the presence or absence of target marine pests on settlement arrays even at microscopic or larval life stages.

Monitoring for IMP at Port Hedland since 2010 has only conclusively detected one target pest species, *Didemnum perlucidum*, within the Port. *Didemnum perlucidum* was detected on the Tug Pen array for the first time at this location in winter 2020.

As discussed above, this species is already known from this region and throughout Western Australian waters and does not represent a new risk. *D. perlucidum* remains listed as a target marine pest and therefore suspected and confirmed detections continue to be reported. However, due to its extensive distribution in Western Australia, DPIRD’s advice regarding the management of the species is for reporting purpose only.

Since its establishment in just three ports, the SWASP program has collaboratively adapted, evolved, innovated and grown into an award-winning biosecurity surveillance program in 11 ports across Western Australia. It won the WA Golden Gecko Award for environmental excellence (2018), Australian Biosecurity Award (2019) and an Institute of Public Administration Australia Achievement Award (2020). However, the creation of a strong network of government regulators, port authorities and the general public who are now aware and involved in protecting WA from IMP, is valued as a greater achievement.

In 2020 the Australian Bureau of Agricultural and Resource Economics and Sciences (**ABARES**), the research division of the DCCEEW (under its predecessor DAWE), completed a case study of the program and its participants. The case study recognised that SWASP has succeeded in providing robust, coordinated, collaborative and consistent surveillance of potential marine pests within ports across WA, filling an important gap in the existing marine biosecurity surveillance for the state.

Strict adherence to quarantine and PPA's IMP management procedure will be a necessary requirement for any vessel associated with the CEP dredging program.

3.4 Social and economic uses of the area

The main current use of proposed dredging area is for the safe navigation of shipping traffic within the Port, where bulk carriers move from anchorages to enter the Channel near B30/31 and proceed to the inner harbour of the Port. Recreational fishing is popular in the region, and it is possible that some activity may occur in the area proposed to be dredged. However, large vessels have priority and 'right of way' within the proposed dredging area.

The waters surrounding the Port are also used for commercial fishing. Commercial fisheries in the immediate vicinity of the Port include:

– Pilbara Trap and Line Managed Fishery
– Pilbara Fish Trawl Managed Fishery
– Nickol Bay Prawn Managed Fishery
– Recreational fishing common around islands and reefs

All fisheries are considered sustainable (DPIRD 2022) and unlikely to be impeded by the short-term dredging operations associated with the CEP dredging program.

There are no existing or proposed marine parks or reserves, which overlap the proposed CEP footprint or are expected to be impacted by the CEP's proposed dredging activities. Similarly, the footprint of the proposed CEP does not contain any World Heritage Properties, National Heritage Properties or Ramsar Wetlands of International Significance.

4. Dredging environmental management

4.1 Environmental factors and objectives

Environmental objectives, or management goals for the CEP dredging program were drawn from the Western Australian government's Technical Guidelines *Environmental Impact Assessment of Marine Dredging Proposals* (WA EPA, 2016a), *Protecting the Quality of Western Australia's marine environment* (WA EPA 2016b) and *Protection of Benthic Communities and Habits* (WA EPA 2016c). These objectives provide a framework against which the environmental performance of the proposed dredging can be measured.

The Technical Guidance seeks to minimise the impact of dredging on:

– Direct loss of benthic communities and habitats by removal or burial
– Indirect impacts on benthic communities and habitats from the effects of sediments introduced to the water column by the dredging and disposal.
– Shorelines, bathymetry and habitats through modified ecological and physical processes
– Introduction of invasive pest species translocated in dredging (or ancillary) equipment that can have both ecological and economic consequences
– Adverse effects of contaminant release and dispersion (including impacts associated with reclamation or onshore disposal of acid sulphate soils) on marine environmental quality
– Conflict with fisheries and impacts on fish, their habitats and fisheries production
– Changes to coastal processes and water circulation that impact on the environmental values of the coast and coastal waters
– Impacts on the behaviour and survival of marine wildlife, including specially protected species

The environmental objectives for the management of the dredging for the CEP are summarised in Table 3.

Table 5 Environmental factors and objectives for Western Australia that may be influenced by CEP dredging

Factor	Objective
Benthic Communities and Habitat	To protect benthic communities and habitats so that biological diversity and ecological integrity is maintained.
Coastal Processes	To maintain the geophysical processes that shape coastal morphology so that the environmental values of the coast are protected.
Marine Environmental Quality	To maintain the quality of water, sediment and biota so that environmental values are protected.
Marine Fauna	To protect marine fauna so that biological diversity and ecological integrity are maintained.
Social surroundings	To protect social surroundings from significant harm.
Human Health	To protect human health from significant harm.
Heritage	To ensure that historical and cultural associations are not adversely affected.

4.2 Environmental Risk Assessment

Drawing upon existing data and information and consultation with stakeholders through the TACC and specialists within PPA and GHD, an environmental risk assessment (**ERA**) was conducted to identify and analyse the potential risks to the identified Environmental Factors and Objectives (Table 5). Risks associated with dredging at the Port are well understood. Risk assessment workshops have been conducted with the TACC for previous dredging projects since 2012 and the performance of controls have been monitored and reviewed by the TACC.

The ERA was conducted in accordance with a risk assessment procedure (Appendix A). This ERA procedure has been used several times previously for dredging within the Port, including in 2012 and 2017 for maintenance dredging and in 2017 for the CROP. The ERA considered the potential for the CEP dredging program to be run in parallel with PPA's annual maintenance dredging program over a period of three years.

The outcomes of the risk assessment workshop were presented to and reviewed by the TACC on 4th August 2022. No changes to the ERA were required to be made in response to feedback from TACC.

The outcomes of the final ERA were documented in an environmental risk register and are presented in Appendix A.

The only risk which may require management actions in excess of standard operational procedures was entrainment of turtles and other marine megafauna during dredging operations. All other environmental risks were considered to be low and can be suitably managed through standard best practice procedures under a business-as-usual model.

The management actions identified for the CEP are detailed in Section 5.

5. Monitoring and management plans

The following sections details specific actions for the management of environmental values and receptors during the CEP dredging campaign. The only risk which may require management actions in excess of standard operational procedures was entrainment of turtles and other marine megafauna during dredging operations. All other environmental values identified were considered to be at low risk and can be suitably managed through standard best practice procedures under a business-as-usual model. Table 6 provides the framework for each monitoring and management plan.

Table 6 Environmental monitoring and management plan framework

Element	Description
Objective	What is intended to be achieved.
Management Action	The actions required to assist in meeting the objective. These can be single actions or multiple liked actions to address the objective.
Responsibility	Who is responsible for implementing the actions.
Timing	The time period when the management actions need to be implemented.
Measures	The metrics for recording the outcomes.
Reporting	The way in which the compliance with the management actions and outcomes are reported.
Target	The thresholds, which, if exceeded, require differed management actions (contingency) to be implemented.
Contingency	Actions to be undertake if the management action is not met.

Using the framework presented in Table 6, six environmental management plans (Section 5.1 to Section 5.6) have been developed to guide the maintenance dredging programs. These include:

- Marine mega fauna (including turtles);
- Benthic habitats;
- Marine hydrocarbon pollution;
- Marine environmental quality;
- Introduced marine pests; and
- Shipboard waste

5.1 Marine megafauna including turtles

In order to ensure that the risk of entrainment of turtles posed by the CEP dredging program is low, management objectives as detailed in Table 9 are required to be implemented. The risk of collision between marine megafauna and the dredge (or other associated vessels) is considered low.

Management Actions and the environmental management processes are described in Table 8.

Table 7 Marine megafuna including turtles management objectives

Risk Area	Megafauna (including turtles)
Factor(s)	Marine Fauna
Objective(s)	To maintain the diversity, geographic distribution and viability of fauna at the species and population levels

Table 8 Management actions for marine megafuna including turtles

Task	Action	Responsibility	Timing
Management Actions	Entrainment of turtles will be mitigated through fitting of TSHD with drag heads with turtle tickler[1] chains or similar.	Dredging Contractor	During dredging
	Dredge pumps stopped as soon as practicable after completion of dredging to minimise intake of water whilst drag heads are off the sea floor.	Dredging Contractor	During dredging
	Prior to the commencement of the dumping activities, the dredging contractor must ensure that a check is undertaken, using binoculars from a high observation platform, for marine species[2] within the 'monitoring zone'[3]. If any marine species are sighted in the 'monitoring zone', dumping activities must not commence until the marine fauna is no longer observed in the monitoring zone, or the vessel is to move to another area of the disposal site to maintain a minimum distance of 300 metres between the vessel and any marine species.	Dredging Contractor	Prior to dumping activities, during daylight hours only
	Internal training of Marine Fauna Observer(s) (MFO), which provides clear direction on: – The area that comprises the 'monitoring zone' – How to identify marine fauna (i.e. whales, dolphins, dugong, turtles) that are known or likely to be encountered within the Port of Port Hedland – The actions to be undertaken by the observer in the event of marine fauna being sighted within the monitoring zone – The actions to be undertaken by the observer in the event of an incident resulting in injury or death of a marine species	Dredging Contractor	Prior to commencement of dredging project

[1] Tickler chains are chains suspended in front of the drag head that are designed to disturb any turtles resting on the bottom such that the swim away and avoid entrainment into the dredge.
[2] Means all whales, dolphins, dugongs and marine turtles listed under the *Environment Protection and Biodiversity Conservation Act 1999*
[3] Refers to the area within a 300 metre radius of the vessel

Task	Action	Responsibility	Timing
	Dredge pumps stopped as soon as practicable after completion of dredging to minimise intake of water whilst drag heads are off the sea floor noting that: – Dredge vessel to maintain sailing speed of no more than 2.5 knots whilst drag heads are being raised off the bottom and dredge systems are flushed. – PPA Supervisor dredging process monitor to display dredge pump velocity as an additional control for verifying that the pumps have been turned off after flushing, and before raising drag head through the water column.	Dredging Contractor	During Dredging
	Internal training of selected dredge crew on the requirements, role and responsibilities of MFOs so that integration of MFOs into the management of the dredging operations can occur.	Dredging Contractor	At appropriate times throughout dredging project
	Minimise impacts of the dredge through underwater noise through proper maintenance of equipment.	Dredging Contractor	At all times throughout dredging project
	Minimise impacts of light on fauna through the minimisation of unnecessary light sources not required for safe operation of the dredge.	Dredging Contractor	At all times throughout dredging project
Measures	Number of reported incidents involving marine fauna	Dredging Contractor	During Dredging
Reporting / Evidence	A log detailing all marine fauna observations within the monitoring zone (during daylight operations only) shall be maintained. If dredging is by TSHD then the log shall include (as a minimum) the following information: date, name of MFO, time (commencement of pre-dumping observations), time (completion of pre-dumping observations), whether fauna was sighted in the monitoring zone during the pre-dumping monitoring period, type of marine species identified (where possible), general comments on animal behaviour, description of mitigation measures undertaken (e.g. fauna sighted therefore pre-dumping observations recommenced), time (commencement of dumping) and time (completion of dumping). PPA will undertake on board supervision over the Dredging Contractor's compliance with requirements.	Dredging Contractor	Throughout dredging and disposal activities
	Document and record any incidents involving the dredging or dumping activities that result in injury or death to any marine species. The date, time and nature of each incident and the species involved, if known, must be recorded.	Dredging Contractor	Throughout dredging and disposal activities
	Report all incidents involving dredging or dumping activities that result in injury or death to any marine species, to PPA's Dredging and Survey Manager following PPA's procedures.	Dredging Contractor	Immediately, but no later than 12 hours from the time that the incident occurred.
	Dredging Manager will notify PPA Environment Department who will formally notify DCCEEW of any incidents involving the dredging or dumping activities that result in injury or death to any species of marine megafuna.	PPA Environment and Heritage Manager	In accordance with requirements in the SDP.
	Provide PPA with a copy of the training package delivered to Marine Fauna Observers, and records of training attendance / completion for each person trained.	Dredging Contractor	Throughout project
Target	No injury or death to any marine megafauna.	Dredging Contractor	Throughout the project

Task	Action	Responsibility	Timing
Contingency	Completion of detailed incident analysis and implementation of any corrective measures in consultation with DCCEEW.	PPA Environment and Heritage Manager	ASAP

5.2 Benthic habitats

The overall likelihood of significant impacts to benthic habitats (and dependant ecosystems) was considered low by the risk assessment process. The risk assessment for benthic habitat impacts was based on monitoring of the CROP and previous maintenance dredging campaigns. This monitoring of that project showed no impact on nearby coral reefs. The maintenance dredging and disposal is a much smaller program, over a much shorter duration, therefore the risk associated with turbid plumes (reduced water quality) impacting sensitive reef communities was considered Low risk. The objectives for marine benthic habitat are shown in Table 9 and the management approach to marine water quality is presented in Table 10.

Table 9 Benthic habitat management objectives.

Risk Area	Benthic habitats
Value(s)	1. Marine Environmental Quality 2. Benthic Communities and Habitat 3. Marine Fauna
Objective(s)	1. To maintain the quality of water, sediment and biota so that the environmental values, both ecological and social, are protected. 2. To protect benthic communities and habitats so that biological diversity and ecological integrity is maintained. 3. To protect marine fauna so that biological diversity and ecological integrity are maintained.

Table 10 Management actions for benthic habitats

Task	Action	Responsibility	Timing
Management Actions	Dredge hopper doors and seals to be inspected and maintained to prevent loss of dredge spoil during transport.	Dredging Contractor	Prior to dredging commencing
	Dredge spoil to only be dumped within the area allocated by PPA, inside the designated Spoil Grounds listed within the SDP.	Dredging Contractor	Throughout project
	Dredge spoil shall be dumped in a manner that minimises mounding.	Dredging Contractor	Throughout project
	Dredge hoppers to only be washed within boundaries of the designated Spoil Grounds.	Dredging Contractor	Throughout project
Measures	Dredging only occurs within nominated maintenance dredging footprint (as specified in this DMP and SDP.	Dredging Contractor	Throughout project
	All dredge spoil dumped within designated Spoil Grounds.	Dredging Contractor	Throughout project
Reporting / Evidence	Plotting sheets or a certified extract of the ship’s log which shall include (as a minimum): – The dates and times of when each dumping run commenced and finished;	Dredging Contractor	Throughout project

Task	Action	Responsibility	Timing
	– The track of all dredge vessels (as determined by GPS) during: (a) dredging activities, and (b) transit between the dredging area(s) and the nominated spoil ground (s); and – The position (as determined by GPS) of the dumping vessel at the commencement of dumping (i.e. hopper doors opened) and at the completion of dumping (i.e. hopper doors closed), including the path / track taken during dumping		
	Minutes of contractor meetings	PPA Dredging and Survey Manager	Following Meeting
	Undertake bathymetric survey of the disposal site (by a suitably qualified person).	PPA Dredging and Survey Manager	Prior to dredging; and Following completion of dumping
Target	No direct disturbance outside approved dredging footprint and designated Spoil Grounds, with minimal mounding of spoil within the Spoil Grounds	Dredging Contractor	Throughout project
Contingency	Investigate and report any breaches of dredge material placement to DCCEEW and commence processes to investigate any impact.	PPA	ASAP after breach is identified

5.3 Hydrocarbon management

The discharge of oil and oily mixtures (of any volume or concentration) from any ship to the Port waters is prohibited. This prohibition includes any discharges from oily water separators, as this would be in contravention of Western Australia's *Pollution of Waters by Oil and Noxious Substances Act 1987*.

Management objectives are shown in Table 11 and the management processes are described in Table 12.

Table 11 Management objectives for hydrocarbon management

Risk Area	Sediment quality
Factor(s)	1. Marine Environmental Quality 2. Benthic Communities and Habitat 3. Marine Fauna
Objective(s)	1. To maintain the quality of water, sediment and biota so that the environmental values, both ecological and social, are protected. 2. To maintain the structure, function, diversity, distribution and viability of benthic communities and habitats at local and regional scales. 3. To maintain the diversity, geographic distribution and viability of fauna at the species and population levels.

Table 12 Management actions for hydrocarbons.

Task	Action	Responsibility	Timing
Management Actions	Undertake an environmental Inspection of all dredging vessel(s).	PPA	Prior to dredging / dumping activities
	Emergency response management actions as described in PPA's Marine Oil Pollution Contingency Plan for the Port of Port Hedland.	Dredging Contractor	Duration of dredging / dumping activities
	All vessels to be maintained in accordance with the dredging contractor's vessel management systems.	Dredging Contractor	Duration of dredging / dumping activities
	Industry standard hydrocarbon management practices including implementation of SOPEP. Equipment shall be designed and operated to prevent spills and leaks through the provision of in-built safeguards including, but not limited to, relief valves, overflow protection, and automatic and manual shut-down systems.	Dredging Contractor	Duration of dredging / dumping activities
	Use of appropriately-licensed bunkering facilities.	Dredging Contractor	Duration of dredging / dumping activities
	Hydrocarbons (including hydrocarbon wastes) shall be stored in accordance with AS1940-2004.	Dredging Contractor	Duration of dredging / dumping activities

Task	Action	Responsibility	Timing
	Spill control equipment/materials held on board the dredging vessel(s) as required under the Ship Oil Pollution Emergency Plan – SOPEP) shall be commensurate with risk of the activity being performed, and shall be available at all times.	Dredging Contractor	Duration of dredging / dumping activities
Measures	Number of spill incidents	Dredging Contractor	Duration of dredging operations
Reporting / Evidence	Report any discharge of oil or other hydrocarbons to the marine environment of the Port of Port Hedland (irrespective of quantity / volume) to PPA Vessel Traffic Services without delay.	Dredging Contractor	Immediately
	Evidence of implementation of SOPEP.	Dredging Contractor	Duration of dredging operations
	“Pollution Report" (POLREP) is to be submitted electronically to the Western Australian Department of Transport and a copy of this sent to PPA.	Dredging Contractor	Immediately (but no later than 12 hours from the incident occurring)
	A documented report on the incident shall be submitted to PPA, including (as a minimum) details of the incident, the measures taken, the success of those measures in addressing the incident or risk and any additional measures proposed to be taken	Dredging Contractor	Immediately (but no later than 12 hours from the incident occurring)
Target	No discharges of hydrocarbons to the marine environment.	Dredging Contractor	All times during dredging operations
Contingency	Implementation of oil spill response measures in accordance with the requirements of PPA’s Marine Oil Pollution Management Plan for the Port of Port Hedland.	PPA	Immediately on notification of spill incident

5.4 Marine environmental quality

A SAP was developed by GHD (2020) and implemented by MScience (2022a) to characterise marine sediment quality and determine suitability for unconfined ocean disposal. Sediment concentrations of contaminants of potential concern (**COPCs**) were shown to be either below the initial screening levels described in the NAGD or of natural origin. The SAPIR concluded that sediments from the proposed capital dredging footprint and future maintenance dredging footprint of the CEP meet NAGD criterial for unconfined ocean disposal at the approved spoil grounds.

It is proposed that a sediment monitoring sampling and analysis program (**SAP**) be developed and implemented by PPA as part of PPA's ongoing maintenance dredging program (a separate SDP is being submitted for this program). This SAP will build upon the outcomes of the comprehensive CEP SAP (GHD 2020). The design of this SAP will allow for ongoing regular assessment of sediments within the CEP, building knowledge on sediment characteristics and any changes over time. The proposed sediment monitoring program will be submitted by PPA separately for review and approval by DCCEEW, however an overview of the proposed monitoring has been incorporated into Table 12 below.

Given much larger dredging projects in the past have repeatedly shown no exceedances of water quality triggers (see Section 3.1.2) risks to water quality are considered low and no water quality monitoring is proposed as part of the CEP.

The management objectives for marine environmental quality are shown in Table 13 environmental management processes are described in Table 14.

Table 13 Management objectives for marine water sediment quality

Risk Area	Marine water and sediment quality
Value(s)	1. Marine Environmental Quality 2. Benthic Communities and Habitat 3. Marine Fauna
Objective(s)	1. To maintain the quality of water, sediment and biota so that the environmental values, both ecological and social, are protected. 2. To protect benthic communities and habitats so that biological diversity and ecological integrity is maintained. 3. To protect marine fauna so that biological diversity and ecological integrity are maintained.

Table 14 Management actions for marine water quality and sediment quality.

Task	Action	Responsibility	Timing
Management Actions	Following capital dredging and prior to undergoing maintenance dredging, undertake marine sediment sampling and analysis to confirm suitability for unconfined ocean disposal. Approved maintenance SDP to be in place prior to any maintenance dredging.	PPA	Prior to undertaking maintenance dredging at new subareas
	All dumping activities shall occur within the Spoil Grounds approved under the SDP and identified within this DMP, and as approved by PPA.	Dredging Contractor	Throughout dredging and dumping activities
	The track of dredge vessel(s) shall not be within 100m of the boundary of the nominated spoil ground during dumping.	Dredging Contractor	Throughout dredging and dumping activities

Task	Action	Responsibility	Timing
	The dredge material shall be dumped in a manner over the nominated spoil ground to minimise mounding from dumping activities.	Dredging Contractor	Throughout dredging and dumping activities
Measures	All dredged material placed within approved spoil grounds as per the SDP.	PPA	Throughout dredging and dumping activities
Reporting / Evidence	Plotting sheets or a certified extract of the ship's log which shall include (as a minimum): – The dates and times of when each dumping run commenced and finished; – The track of all dredge vessels (as determined by GPS) during: (a) dredging activities, and (b) transit between the dredging area(s) and the nominated spoil ground (s); and – The position (as determined by GPS) of the dumping vessel at the commencement of dumping (i.e. hopper doors opened) and at the completion of dumping (i.e. hopper doors closed), including the path / track taken during dumping	Dredging Contractor	Throughout project
	Minutes of PPA / dredging contractor meetings	PPA Dredging and Survey Manager	Following Meeting
	Undertake bathymetric survey of the disposal site (by a suitably qualified person): – Prior to the commencement of dumping activities – Following completion of all dumping activities authorised under the SDP.	PPA Dredging and Survey Manager	Prior to dredging; and Following completion of dumping
Target	No direct disturbance outside approved dredging footprint and designated Spoil Grounds, with minimal mounding of spoil within the Spoil Grounds	Dredging Contractor	Throughout project
	Maintain current (within 5 years old) marine sediment quality data over the life of this SDP and report results to the TACC.	PPA	Throughout lifetime of SDP
Contingency	Investigate and report any breaches of dredge material placement to DCCEEW and commence processes to investigate any impact.	PPA	ASAP after breach is identified

5.5 Introduced Marine Pests

Non-indigenous species, if introduced, could result in adverse environmental impacts by altering the composition and function of natural ecosystems.

Management Actions and management objectives are shown in Table 15 and the environmental management processes are described in Table 16.

Table 15 Management objectives for Introduced Marine Pests

Risk Area	Sediment quality
Factor(s)	1. Benthic Communities and Habitat 2. Marine Fauna 3. Marine Environmental Quality
Objective(s)	1. To maintain the structure, function, diversity, distribution and viability of benthic communities and habitats at local and regional scales 2. To maintain the diversity, geographic distribution and viability of fauna at the species and population levels 3. To maintain the quality of water, sediment and biota so that the environmental values, both ecological and social, are protected.

Table 16 Management actions for Introduced Marine Pests

Task	Action	Responsibility	Timing
Management Actions	All vessels will comply with DCCEEW – Biosecurity requirements as well as all State legislation relating to management of introduced marine organisms.	Dredging Contractor	Prior to dredge vessel(s) entering Australian Waters or moving from one Australian port to the Port of Port Hedland
	All vessels will comply with PPA's Port of Port Hedland Vessel Introduced Marine Species Risk Assessment Procedure	Dredging Contractor	Prior to dredge vessel(s) entering Australian Waters or moving from one Australian port to the Port of Port Hedland
	All vessels that mobilise to the Port of Port Hedland to undertake / support dredging will be required to complete the WA DPIRD's 'Vessel Check' risk assessment (https://vesselcheck.fish.wa.gov.au).	Dredging Contractor	Prior to dredge vessel(s) entering Australian Waters or moving from one Australian port to the Port of Port Hedland

Task	Action	Responsibility	Timing
Measures	Implement PPA's Port of Port Hedland Introduced Marine Species Risk Assessment Procedure	PPA and Dredging Contractor	From prior to dredge vessel(s) entering Australian waters or mobilising to the Port of Port Hedland until all dredging operations have ceased.
	Incidence of non-compliance with Biosecurity and/or PPA requirements.	PPA and Dredging Contractor	From prior to dredge vessel(s) entering Australian waters or mobilising to the Port of Port Hedland until all dredging operations have ceased.
Reporting / Evidence	A copy of the Vessel Check report will be submitted to PPA for assessment along with any supporting documentation including antifoul certificates and inspection reports.	Dredging Contractor	Prior to dredge vessel(s) entering Australian Waters or moving from one Australian port to the Port of Port Hedland
Target	No introductions or movement of marine pests.	Dredging Contractor	From prior to dredge vessel(s) entering Australian waters or mobilising to the Port of Port Hedland until all dredging operations have ceased.
	No noncompliance with Biosecurity and PPA requirements	Dredging Contractor	Within 12 hours of any incident.
Contingency	Implementation of contingency measures as required by PPA and DPIRD quarantine requirements.	Dredging Contractor	Within 12 hours of any incident.
	Notification to DCCEEW and the DPIRD in the event of an introduction of a marine pest species.	Dredging Contractor	Within 48 hours of any incident.

5.6 Solid and liquid waste management

The disposal of garbage from any ship to the Port of Port Hedland waters is prohibited. The definition of garbage is consistent with MARPOL 73/78 Annex V and includes (but is not limited to):

- Plastics;
- Synthetic ropes;
- Fishing gear;
- Plastic garbage bags;
- Lining and packing materials;
- Paper, rags, glass, metal, bottles, crockery and similar refuse;
- Food scraps and cooking waste;
- Scrap metal; and
- Domestic sewage

The accidental discharge of waste material (without appropriate dilution or treatment) to the environment may:

- Contaminate food sources for marine organisms;
- Result in toxicity to marine organisms; or
- Result in death or injury of marine fauna if ingested or entangled

Consistent with the requirements of MARPOL Annex V and the WA *Pollution of Waters by Oil and Noxious Substances Act 1987* and the WA *Environmental Protection (Unauthorised Discharges) Regulations 2004*, it is prohibited to discharge wastes into the Port of Port Hedland from the deck (or other external surfaces) of a ship during deck cleaning and or washing.

Management Actions and the objectives are shown in Table 17 environmental management processes are described in Table 18.

Table 17 Management objectives for waste management

Risk Area	Sediment quality
Factor(s)	1. Marine Environmental Quality 2. Benthic Communities and Habitat 3. Marine Fauna
Objective(s)	1. To maintain the quality of water, sediment and biota so that the environmental values, both ecological and social, are protected. 2. To maintain the structure, function, diversity, distribution and viability of benthic communities and habitats at local and regional scales. 3. To maintain the diversity, geographic distribution and viability of fauna at the species and population levels.

Table 18 Environmental management processes for waste management

Task	Action	Responsibility	Timing
Management Actions	The dredging contractor to establish a waste management plan that complies with the requirements of PPA.	Dredging Contractor	Duration of dredging operations
	The dredging contractor to ensure that waste management systems are maintained to ensure systems are efficient, fully operational and discharging treated water in accordance with MARPOL 73/78 Convention Annex IV (sewage) and Annex V (garbage).	Dredging Contractor	Duration of dredging operations
	Garbage (including galley waste) from internationally trading ships must not be landed ashore at the Port of Port Hedland without permission from the Department of Agriculture and Food.	Dredging Contractor	Duration of dredging operations
	Only licenced Controlled Waste Carrier to be used for any controlled waste discharged ashore.	Dredging Contractor	Duration of dredging operations
	Solid and liquid wastes and hazardous materials shall be stored in appropriately labelled drums or tanks and be correctly disposed of and not discharged to the environment.	Dredging Contractor	Duration of dredging operations
	Reporting of any discharge of solid or liquid wastes to the marine environment of the Port of Port Hedland (irrespective of quantity / volume) to PPA Vessel Traffic Services without delay.	Dredging Contractor	Duration of dredging operations
Measures	Number of incidents where waste has entered the marine environment.	Dredging Contractor	Duration of dredging operations
Reporting / Evidence	Any incident where discharge of solid or liquid wastes to the marine environment has occurred (irrespective of quantity / volume) shall be reported to PPA Vessel Traffic Services without delay. A documented report on any solid or waste spill incident shall be submitted to PPA's Dredging Manager, including (as a minimum) details of the incident, the response measures taken, the success of those measures in addressing the incident or risk and any additional measures proposed to be taken.	Dredging Contractor	Within 12 hours of a reportable incidence.

Task	Action	Responsibility	Timing
	Copies of all controlled waste tracking forms to be provided to PPA including but not limited to: – Controlled waste tracking forms completed for all waste discharged ashore – Discharge logs correspond with controlled waste tracking forms – Approval certification to demonstrate that an IMO certified sewage treatment unit is on board POLREPs for discharge of waste.	Dredging Contractor	Prior to during and following dredging activities
Target	No unauthorised discharges of wastes to the marine environment.	Dredging Contractor	All times during dredging operations
Contingency	Implementation contingency measures as required by PPA's waste management guidelines.	Dredging Contractor and PPA	Immediately on notification of discharge incident

6. Overall roles and responsibilities

Roles and responsibilities are described in Table 19. The dredging contractor(s) is responsible for the organisation of the environmental management including appropriate staffing of the dredge in accordance with PPA contract conditions, the DMP and the SDP.

Table 19 Positions and responsibilities for the CEP dredging operations at the Port of Port Hedland

Position	Responsibility
PPA Dredging and Survey Manager	Overall responsibility for implementation of the DMP Overall responsibility for compliance with relevant legislation, standards and guidelines. Ensures dredging activities are conducted in an efficient and safe manner
PPA Environment and Heritage Manager	Overall responsibility for monitoring and environmental reporting. Responsibility for compliance with relevant legislation, standards and guidelines. Ensures dredging activities are conducted in an environmentally sustainable manner
Dredge Contractor(s)	Develops and implements an operational environmental management plan consistent with and aligned to this DMP or is assigned contractual arrangements consistent with the requirements of this DMP. Ensures all personnel are equipped with training appropriate to their area of responsibility. Compliance and reporting with the requirements of the DMP and the contract with PPA Ensures that all equipment is adequately maintained and properly operated to minimise risk of environmental or safety incident. Responsible for compliance reporting requirements.
Project Personnel	Act in accordance with the requirements of the DMP. Exercise a Duty of Care to the environment at all times. Report all environmental incidents

7. Audit and Review

The CEP's dredging operations will be the subject of internal and external reviews against this DMP and the SDP under which dredging operations occur. The performance of the dredging operations against these requirements will be reported to the Port Hedland TACC at scheduled meetings of the TACC.

The reporting on the performance of the dredging operations in meeting the requirements of the DMP and the SDP will be considered by PPA and appropriate revisions of the DMP may occur should the need arise.

8. References

APASA (2009) Quantum Project: Modelling of the Dredge Disposal Programme. Report prepared for Sinclair Knight Merz 10th Oct 2009.

BHP Billiton (2009) Environmental Impact Statement for the Outer harbour Project Port Hedland.

Bridgewood, SD, Muňoz J and JI McDonald (2014) Catch me if you can! The story of a colonial ascidian's takeover bid in Western Australia. Bioinvasions Records 3: 217-223.

Commonwealth of Australia (2017) Recovery Plan for Marine Turtles in Australia.

Commonwealth of Australia (2009) *National Assessment Guidelines for Dredging,* Canberra

Department of Environment and Conservation (2006), Background quality of the marine sediments of the Pilbara coast. Department of Environment and Conservation, Marine Technical Report Series, No. MTR 1

DPIRD (2022) Status reports of the fisheries and aquatic resources of Western Australia. WA Department of Primary Industries and Regional Development.

Dickerson D (2015) Dredging impacts on sea turtles in the south-eastern USA. Assessing risks and protection methods. Paper presented to PIANC USA Conference 2015,

DotEE (2017) Recovery Plan for Marine Turtles in Australia. Department of the Environment and Energy, Canberra

DSEWPAC (2012), Marine bioregional plan for the North-west Marine Region. Canberra ACT

GHD (2020) Pilbara Ports ASuthority Port Hedland Channel Entry Project Sampling and Analysis Plan March 2020

GHD (2012) Port Hedland Port Authority Summary of Historic Sediment Sampling Report to Port Hedland Port Authority December 2012

Hallegraeff GM and Bolch CJ (1992) Transport of diatom and dinoflagellate resting spores in ships' ballast water: implications for plankton biogeography and aquaculture. Journal of Plankton Research 14: 1067-1084

Huisman JM, Jones DS, Wells, FE and Burton T (2008) Introduced Marine Biota in Western Australian Waters. Records of the Western Australian Museum 24: 323-366.

Humphrey C, Weber M, Lott C, Cooper T and Fabricius K (2008) Effects of suspended sediments, dissolved inorganic nutrients and salinity on fertilisation and embryo development in the coral Acropora Millepora (Ehrenberg, 1834). Coral Reefs 27: 837-850.

Jacobs (2017) Port Hedland Channel Risk and Optimisation Project, SAP implementation report. Report for Pilbara Ports Authority 24 March 2017

Koskela Group (2007a) Port of Port Hedland Maintenance Dredging Campaign 2007 Sediment Sampling and Analysis Report. Report prepared for PHPA.

Koskela Group (2007b) Port of Port Hedland Maintenance Dredging Campaign 2007 Supplementary Report - Bioavailability. Report prepared for PHPA.

Kutser, T, L Rohlta, E Vahtmäe and R Aps (2007) Operative monitoring of the extent of dredging plumes in coastal ecosystems using MODIS satellite imagery. Journal of Coastal Research: SI50 (Proceedings of the 9th International Coastal Symposium). 180-184. Gold Coast, Australia.

Manap, N and N Voulvoulis (2016) Data analysis for environmental aspects of dredging. Journal of Cleaner Production 137: 394-404

McCook, L., Schaffelke, B., Apte, S., Brinkman, R., Brodie, J., Erftemeijer, P., Eyre, B., Hoogerwerf, F., Irvine, I., Jones, R., King, B., Marsh, H., Masini, R., Morton, R., Pitcher, R., Rasheed, M., Sheaves, M., Symonds, A., and Warne, M.St.J. (2015) Synthesis of current knowledge of the biophysical impacts of dredging and disposal on the Great Barrier Reef: report of an Independent Panel of Experts. Report. Great Barrier Reef Marine Park Authority, Townsville, QLD, Australia

MScience (2022) ASAP Implementation Report, 2022

MScience (2022a) Port of Port Hedland Channel Entry Project – Capital Dredging SAPIR, 2022

MScience (2022b) Port of Port Hedland Channel Entry Project Benthic Habitat Assessment

O2 Marine (2020a) ASAP Implementation Report, Year 2. . Unpublished report for Pilbara Ports Authority

Pendoley Environmental Pty Ltd (2019) Technical Review – Spoilbank Marina Proposal: Review of Potential Impacts to Flatback Turtles, report prepared for Department of Transport.

SKM (2011) Port Hedland Outer Harbour Development, Water Quality Thresholds. Report prepared as part of the BHPB Outer Harbour PER/EIS.

SKM (2011a) Port Hedland Outer Harbour Development Sea Dumping Application Report to BHPBilliton 15 Feb 2011

SKM (2011b) Port Hedland Outer Harbour Sampling and Analysis Plan Implementation Report. Report to BHPBilliton 11 Feb 2011

Stoddart, J. A., Welsh, J. Q., & Stoddart, C. W. (2019). Concentrations of some metals in the nearshore marine sediments of Western Australia's Pilbara Region. Environmental Monitoring and Assessment, 191(7), [476].

WA EPA, (2016a) Technical Guidance Environmental Impact Assessment of Marine Dredging Proposals **https://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/Technical%20Guidance%20-%20EIA%20of%20Dredging%20Proposals-131216.pdf**

WA EPA (2016b) Technical Guidance *Protecting the Quality of Western Australia's marine environment*

https://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/TechnicalGuidance_ProtectingTheQualityOfWAMarineEnvironment-131216_0.pdf

WA EPA (2016c) *Protection of benthic communities and habits*
https://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/TechnicalGuidance_ProtectionOfBenthicCommunitiesAndHabitats-131216.pdf

Wells FE (2018) A low number of invasive marine species in the tropics: a case study from Pilbara (Western Australia). Management of Biological Invasions Volume 9, Issue 3: 227–237

Wells FE, McDonald JI and Huisman JM (2009) Introduced Marine Species in Western Australia. Fisheries Occasional Publications, 57. Dept. of Fisheries, Perth, 98pp.

WorleyParsons (2011) Outer Harbour Geotechnical Investigation Factual Report Additional Environmental Sampling – Outer Harbour Development. Report to BHPBilliton 25 Oct 2011

WorleyParsons (2012) PHPA Long Term Sediment Sampling SAP Implementation Report. Report to Port Hedland Port Authority 5 Nov 2012

WorleyParsons (2012a) PHPA Long Term Sediment Sampling SAP Implementation Report. Report to Port Hedland Port Authority 5 Sep 2012

WorleyParsons (2012b) PHPA Long Term Sediment Sampling SSAP Implementation Report. Report to Port Hedland Port Authority 5 Nov 2012

WorleyParsons (2014) PHPA Sediment Quality Assessment Compliance Report. Report to Port Hedland Port Authority 04 April 2014

Appendix A

Risk Assessment

Environmental Risk Assessment to Assess Potential Impacts

Port Hedland Channel Entrance Project

The risk assessment framework to be used will assist in identifying whether there are any risks (real or perceived) to the environment from the proposed dredging activities. We propose to do this by drawing upon known and credible information, together with the experiences and concerns of a broad stakeholder group, the attendees at the workshop.

The process has been undertaken in a number of risk workshops (including the maintenance dredging in 2012 and 2017, the Channel Risk and Optimisation Project in 2016, niche dredging in 2021 and a number of other dredging projects in and around Port Hedland) to provide a transparent process that gives the stakeholders the opportunity to be involved in the assessment process. As the dredging activity for maintenance dredging is very similar to these two previous projects and that the risk assessment process for each of these has been undertaken with the TACC in a workshop situation it was felt that redoing the full workshop was not required. As such the risk register has been modified to reflect the risks of maintenance dredging. This information will be key in developing a Dredge Material Management Plan for the dredging activity.

Risk Process

The following gives some of the framework for the risk assessment and outlines the process to be taken and defines the inputs (Figure 1).

This risk assessment is conducted in three phases (shown in the following diagram):

- **Phase 1** - Problem Formulation
    - What is the activity to be undertaken and what are the values are to be protected? (Tables 1 and 2 below)
- **Phase 2** - Risk analysis
    - Determination of probability and magnitude of an impact to identified values
    - Risk Workshop
- **Phase 3** - Risk Characterisation
    - Reponses to manage identified risks

We would like you to consider the information provided and where you think that there are matters that have not been covered please let us know.

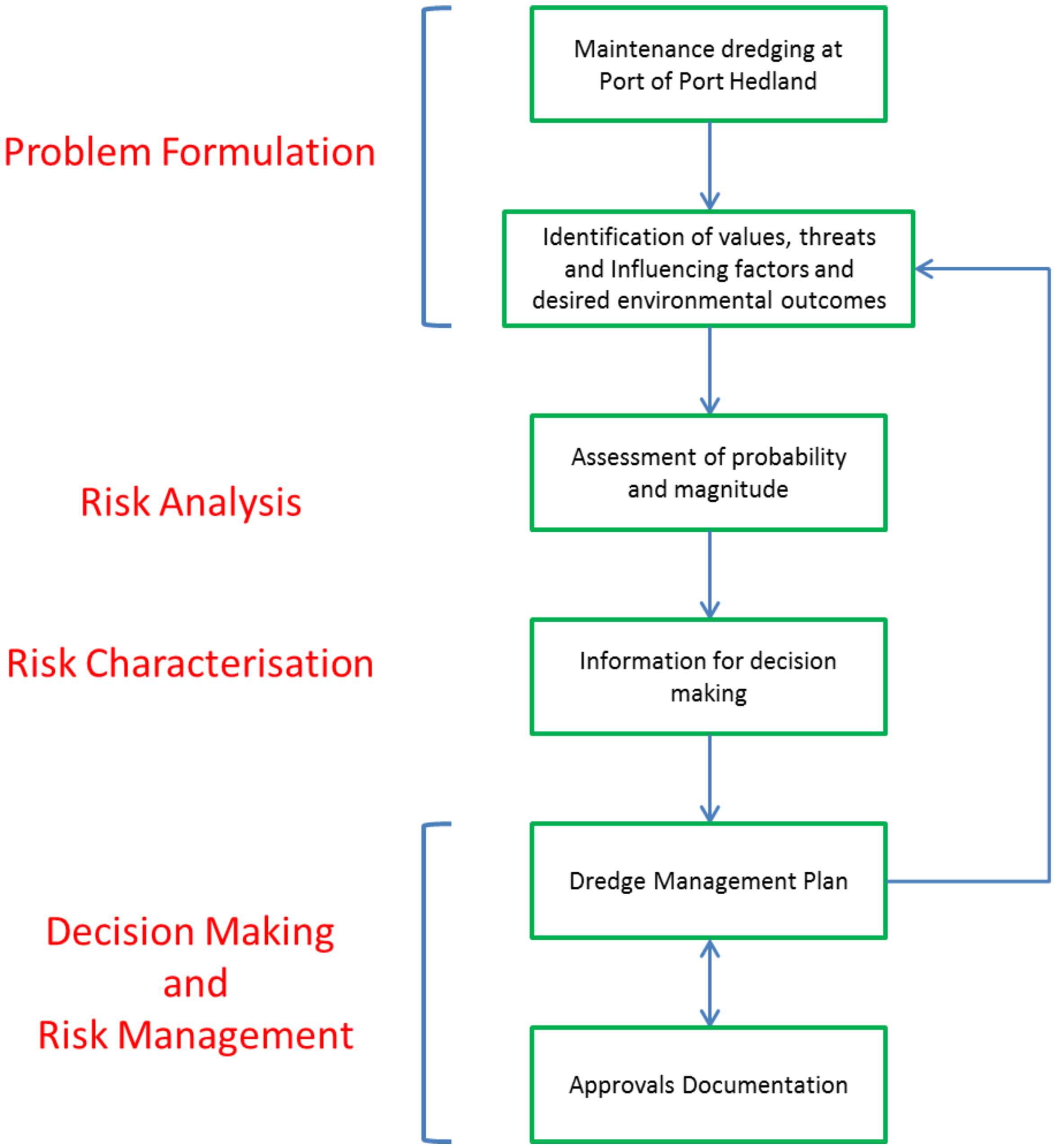


Figure 1: Process for undertaking the environmental risk assessment.

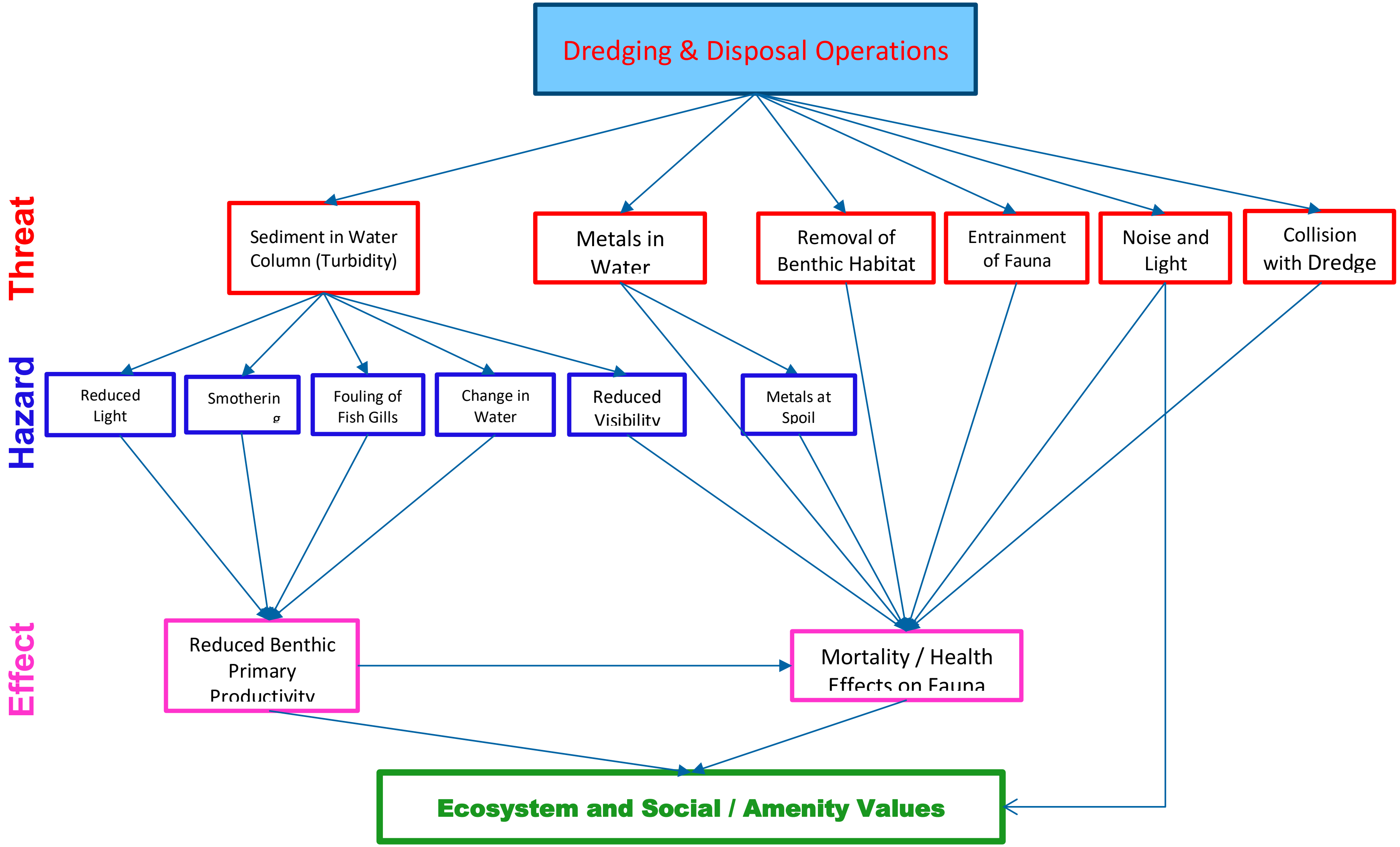
Table 1 Values to be Protected

Factor	Objective
Benthic Communities and Habitat	To maintain the structure, function, diversity, distribution and viability of benthic communities and habitats at local and regional scales.
Coastal Processes	To maintain the morphology of the subtidal, intertidal and supratidal zones and the local geophysical processes that shape them.
Marine Environmental Quality	To maintain the quality of water, sediment and biota so that the environmental values, both ecological and social, are protected.
Air Quality	To maintain air quality for the protection of the environment and human health and amenity.
Amenity	To ensure that impacts to amenity are reduced as low as reasonably practicable.
Heritage	To ensure that historical and cultural associations are not adversely affected.
Human Health	To ensure that human health is not adversely affected.
Marine Fauna	To maintain the diversity, geographic distribution and viability of fauna at the species and population levels

Table 2 Potential Areas of Environmental Impact from maintenance dredging activities

Fauna (listed species) under the Environmental Protection and Biodiversity Conservation Act (1999) (EPBC Act) or State legislation);
Fauna other than listed species;
Marine mammals;
Turtles;
Benthic primary producers, including coral, seagrasses;
Amenity - Sensory Perception (Air, Noise, Vibration);
Indigenous Cultural Heritage;
Non-indigenous Cultural Heritage;
Landscape & Visual.

Conceptual Model Maintenance Dredging Impacts



Phase 2 – Risk Analysis

The risk analysis phase assesses potential risk posed by the maintenance dredging on environmental values. This phase of the assessment involves the development of a risk assessment matrix based on the data available.

There are three steps to undertaking the risk analysis. These include:

- **Step 1** - Determining variable consequence score which is based on the magnitude of impact, duration of the impact and the level of significance of the environmental issue being assessed.
- **Step 2** - Working out a threat score based on likelihood of the event occurring using information on past events where possible to support the conclusion. For sediment quality we use the dredging guidelines
- **Step 3** – Defining the risk based the level of association or how well linked is the threat to the environmental issue.

These steps are outlined in further detail in the following sections.

Step 1 - Assigning a consequence rating of the stressor / threat

This type of risk assessment is a semi quantitative assessment. The risk method results in consequence (or impact) being defined by three separate metrics that more clearly defines consequence component of the risk assessment.

The calculation of consequence scores includes the following metrics:

- ***Magnitude of impact*** - which was based on the potential magnitude of the impact on the environmental values;
- ***Duration of impact*** - which identifies if the length or period of the impact on the environmental value; and
- ***Significance of impact*** - which considers that conservation significance of all values may not be the same and considers significant species, habitats etc. in accordance with their conservation status under state and national legislation.

Magnitude

Magnitude of impacts descriptors are based on a scale of 1 to 5 where 1 represented little or no impact and 5 was a significant impact. Specific descriptors are developed for each of the environmental values and are provided in Table 3 below. Where possible, descriptors are semi-quantitative and are related to possible impacts within the influence of the dredging operations.

Table 3: Consequence Criteria - stressors / risks and impacts to environmental values – Magnitude.

	Insignificant	Minor	Moderate	Major	Catastrophic
Environmental Value	Minimal, if any, impact which have an overall negligible net effect	Localised, reversible short term reversible event with minor effects which are contained to an onsite level	Localised but reversible event with moderate impacts on a local level	Extensive, long term, but reversible event with high impacts on a regional level	Long term, extensive, irreversible with high level impacts at potential state wide levels
Magnitude Rating	1	2	3	4	5
Fauna listed under the EPBC Act or State legislation) or marine megafauna	No detectable impacts on population of a listed species.	Disturbance to local population of listed species impacting normal foraging roosting or reproductive behaviour. Short and long term viability of individual species not impacted.	Permanent removal of >10% of the regional population but <1% of the state population of a listed species; AND/OR short term removal of >1% of the state or national population of a listed species.	Permanent removal of >20% of the regional population but <1% of the state population of a listed species; AND/OR short term removal of >1% of the state or national population of a listed species.	Permanent removal of >50% of the regional population. Permanent removal of >1% of the state or national population of a listed species.
Fauna other than listed species	No measurable impacts on marine ecological values.	Minor short term impacts on local marine ecological values, Annual recruitment should still occur. Short and long term viability of individual species not impacted.	Medium term (<6 month) impacts on local species, life cycle disrupted and resulting in no recruitment for a year. Short term viability of individual species impacted recovery within 1 -5 years. Long term viability of species not impacted.	Long term (>6 month) impacts on local species, life cycle significantly disrupted no recruitment for successive years. Short term and long term viability individual species impacted recovery time frame (5-10 years).	Loss of local species and population. Minimal possibility of recovery.
Marine mammals	No measurable impacts on marine megafauna.	Injury to one individual.	Injury to several individuals.	Death to at least one individual or injury to several individuals.	Death of at least 10 individuals.
Turtles	No measurable impacts.	Impact to one individual.	Impact to up to five individuals.	Disruption to turtle nesting in the vicinity of Port Hedland. Deaths of 10 or more individuals.	Significant disruption to turtle nesting neat Port Hedland.
Benthic primary producers including coral	No measurable impacts on the extent of a coral community.	Permanent loss of up to 5% of benthic primary producer communities within 5 km of the Port of Port Hedland.	Permanent loss of 5 to 20% of benthic primary producer communities within 5 km of the Port of Port Hedland.	Permanent loss of at between 20 to 40% of benthic primary producer communities within 5 km of the Port of Port Hedland.	Permanent loss of > 40% of benthic primary producer communities within 5 km of the Port of Port Hedland.
Amenity - Sensory Perception (Air, Noise, Vibration)	No noticeable impact of dredging activity.	Short term impacts to residents and travellers, but do not effect regional amenity.	Localised impacts which occur over a long term (< 2 months).	Community perception that the region is damaged and recovery greater than 1-2 years.	Region-wide damaged permanently and recovery, if possible, greater than 2 years.
Indigenous Cultural Heritage	No measurable alterations to indigenous heritage sites.	Partial impact to one indigenous heritage sites.	Partial or complete removal of a significant indigenous archaeological site.	Regional effects (loss or damage) to significant indigenous archaeological heritage values.	Complete loss or irreparable damage of significant indigenous archaeological records.
Non-indigenous Cultural Heritage	No measurable alterations to state or commonwealth heritage values.	Detectable impact to state or commonwealth heritage values, but no significant reduction in heritage value.	Detectable impact to state or commonwealth heritage impacts with some reduction in heritage value.	Permanent impact to state or commonwealth heritage value with substantial reduction in value.	Complete loss of heritage value intrinsic to state or commonwealth site.
Landscape & Visual	No change to landscape character.	Localised, short term (less than 1 day duration) low level visual impact or change to landscape character affecting travellers and/or landowners.	Localised, low visual impact or change to landscape character (<2 months) duration.	Localised, low visual impact or change to landscape character 2-6 months duration.	Permanent high level visual impact or change to landscape character affecting visual amenity for wider community.

Duration

The length of time that environmental values such as coral are exposed to stressors such as turbidity will affect the potential impact. We have brought into the Risk Assessment the duration of exposure to the threat to allow for this.

Table 4 Duration of impact scores

Score	Duration
0	< 1 week
1	>1 week and <1 month
2	>1 month and <3 months
3	>3 months

Significance

Some of the species of fauna are covered by WA or Federal legislation. The Risk Assessment considers these listings as they raise the importance of any impact. For other environmental issues that are not covered by environmental legislation we have used common for most but have given indigenous cultural heritage the highest ranking of National.

Table 5 Significance of Environmental Value scores

Score	Significance of Environmental Value
1	Common
2	State significant listed
3	Commonwealth significant listed under the EPBC Act or commonwealth state legislation

Step 2 - Evaluating a threat / likelihood score

Using existing information where possible such as from the approvals for Wheatstone and experience from elsewhere such as Port Hedland Maintenance Dredging we will agree a likelihood of the impact occurring. We propose the following scale of likelihood.

Table 6 Likelihood scores for the risk assessment.

Descriptor	Score	Description
Almost Certain	5	The event is expected to occur in most circumstances during the period under review.
Likely	4	The event is likely to occur during the period under review.
Possible	3	The event might occur during the period under review
Unlikely	2	The event is not likely to occur during the period under review
Rare	1	The event will only occur in exceptional circumstances during the period under review. No previous occurrence in similar circumstances.

When we are dealing with sediment quality issues such as contaminants in the sediments we can use the dredging sediment guidelines in lieu of a likelihood rating. As the sediments will always have a likelihood of 5 (almost certain) another measure is needed to assess and the guideline levels which are based on risk anyway are proposed as per Table 7.

Table 7 Threat score related to National Assessment Guidelines for Dredging sediment guideline levels

Score	Description
0	Below Level of Reporting
1	< NAGD Low Screening Levels
2	> NAGD Low Screening Levels < NAGD High Screening Levels
3	> NAGD High Screening Levels
4	2 x NAGD High Screening Levels
5	5 x NAGD High Screening Levels

Step 3 - Determining the level of association of the threat to the Environmental Value

The term “association” is used to define the strength of the linkage between the threat / stressor and the environmental, social or economic value. The level of association defines the extent of impact a stressor could have on an Environmental Value. Association is rated low, medium or high.

Figure 2 shows a conceptual model of the linkages between the dredging operations and the environmental / social / amenity values. From this we can develop an assessment of the strength of the relationship between the dredging, its environmental impact and the values. The strength of these relationships is included is shown in Tables 7 and 8.

Risk Register

The information has been together using the risk register (spreadsheet). This has been completed using the risk assessments undertaken for the existing maintenance dredging permit and also that undertaken for other projects. As there are not expected to be any major changes to the risk register we have pre-populated the spreadsheet. The TACC is however requested to review the document and suggest any changes that any members may feel need to be discussed.

Figure 2 Conceptual model of potential linkages between Dredging Operations and Ecosystem and Social / Amenity Values.

Table 8 Association ratings definitions

Score	Significance of impact
High	Strong association between stressor and environmental value
Medium	Some associations between stressor and environmental value
Low	Unlikely to have an association between value and stressor
None	No association

Association ratings are provided in the Table below.

Table 9 Association ratings applied to Environmental Values / threats interactions

Environmental Value	Threat	Association	
Listed Fauna and Fauna	**Metals – Water Column**	High	Metals can cause direct acute toxicity and chronic toxicity via bioaccumulation in tissue as well as direct reduction in food availability (i.e. reduced benthic infauna due to toxicity).
	Metals – Sediments	Medium	Metals in the sediments have some ability to pass into the food chain though potential is low.
	Entrainment	Medium	Some potential for entrainment

Environmental Value	Threat	Association	
	Dredge Movements	Low	Some small potential for collision with dredge. Potential for some impacts from introduction of marine pests.
	Noise and Light	Medium	Potential for disturbance to feeding and other activities
	Turbidity	High	Potential for interactions with gills etc and impacts on feeding and prey items
	Destruction of Benthic Habitat	Low	Small impact on prey items. No listed species are sessile.
Non-listed Marine Fauna	**Metals – Water Column**	High	Metals can cause direct acute toxicity and chronic toxicity via bioaccumulation in tissue as well as direct reduction in food availability (i.e. reduced benthic infauna due to toxicity).
	Metals – Sediments	Medium	Metals in the sediments have some ability to pass into the food chain though potential is low.
	Entrainment	Medium	Some potential for entrainment
	Dredge Movements	Low	Some small potential for collision with dredge. Potential for some impacts from introduction of marine pests.
	Noise and Light	Medium	Potential for disturbance to feeding and other activities

Environmental Value	Threat	Association	
	Turbidity	High	Potential for interactions with gills etc and impacts on feeding and prey items
	Destruction of Benthic Habitat	Low	Small impact on prey items. .
Turtles	Metals – Water Column	Medium	Metals can cause direct acute toxicity and chronic toxicity via bioaccumulation in tissue as well as direct reduction in food availability (i.e. reduced benthic infauna due to toxicity).
	Metals – Sediments	Low	Toxicants would impact in a secondary manner by affecting prey items.
	Entrainment	Low	Some potential for entrainment though literature suggests that this is rare
	Dredge Movements	Low	Some small potential for collision with dredge.
	Noise and Light	Medium	Potential for disturbance to feeding and other activities
	Turbidity	Low	Localised impact
	Destruction of Benthic Habitat	Low	Small impact on prey items. No listed species are sessile.
Marine mammals	Metals – Water Column	Medium	Metals can cause direct acute toxicity and chronic toxicity via bioaccumulation in tissue as well as direct reduction in food availability (i.e. reduced benthic infauna due to toxicity) but potential here is low.

Environmental Value	Threat	Association	
	Metals – Sediments	Low	Toxicants would impact in a secondary manner by affecting prey items but the association is low
	Dredge Movements	Low	Some small potential for collision with dredge.
	Noise and Light	Low	Small potential for disturbance to feeding and other activities
	Turbidity	Low	Potential for interactions on feeding and prey items
	Destruction of Benthic Habitat	Low	Small impact on prey items.
Benthic Primary producers including Corals	Metals – Water Column	Medium	Metals can cause direct acute toxicity and chronic toxicity via bioaccumulation in tissue of corals as well as direct reduction in food availability (i.e. reduced benthic infauna due to toxicity).
	Metals – Sediments	High	Metals in sediments can be directly toxic and harmful to some BPP if there is some exposure.
	Turbidity	High	Potential for smothering and light attenuation.
	Destruction of Benthic Habitat	High	Dredging can directly remove or smother benthic communities.
	Dredge Movements	Low	Some noise and Visual Impact
	Noise and Light	Low	Some impacts.

Environmental Value	Threat	Association	
	Turbidity	Low	Suspended solids cause turbidity and reduce water clarity, thereby reducing aesthetic enjoyment.
	Dredge Movements	Low	Some noise and Visual Impact
	Noise and Light	Low	Some impacts.
	Turbidity	Low	Suspended solids cause turbidity and reduce water clarity, thereby reducing aesthetic enjoyment.

Value	Location	Stressor	Consequence Rating: Magnitude	Duration	Significance	Cons. Score	Association	Inherent Risk - Current Situation: Threat / Likelihood	Risk Score	Comments
Fauna listed under the EPBC Act or State legislation	Dredge Areas	Dredge Operations	1	2	National	1	Low	1	L	Likelihood of impact of operations on listed fauna other than marine megafauna is low.
Fauna listed under the EPBC Act or State legislation	Dredge Areas	Destruction of benthic habitat	1	3	National	2	Low	1	L	Benthic surveys have indicated that the area is not important habitat for listed species.
Fauna listed under the EPBC Act or State legislation	Dredge Areas	Noise and Light	1	2	National	1	Low	2	L	Light and noise from the dredge are localised. Consequences are low.
Fauna listed under the EPBC Act or State legislation	Dredge Areas	Entrainment of fauna	1	2	National	1	Low	2	L	Low potential for entrainment of listed marine fauna.
Fauna listed under the EPBC Act or State legislation	Spoil Grounds	Dredge Operations	1	3	National	2	Low	1	L	Likelihood of impact of dredge operations is low as area is not important for listed fauna.
Fauna listed under the EPBC Act or State legislation	Spoil Grounds	Destruction of benthic habitat	1	3	National	2	High	2	L	Surveys have shown that the spoil grounds are not likely to be important habitat for any of the listed fish and reptiles and certainly not the avian species. The association is low.
Fauna listed under the EPBC Act or State legislation	Spoil Grounds	Noise and Light	1	2	National	1	Low	2	L	Light and noise from the dredge are localised. Consequences are low.
Fauna listed under the EPBC Act or State legislation	Spoil Grounds	Toxicants in water column - metals	1	2	National	1	Low	1	L	Metals below NAGD screening levels except for occasional naturally occurring Arsenic, Nickel Chromium and Cadmium. Elutriate bioavailability testing has shown levels below NAGD screening levels. Period of exposure generally low as time in water column is hours at spoil ground only. Pathway of impact is indirect at best.
Fauna listed under the EPBC Act or State legislation	Spoil Grounds	Toxicants in sediment - metals	1	3	National	2	Low	3	L	Metals below NAGD screening levels except for occasional naturally occurring Arsenic, Nickel Chromium and Cadmium. Elutriate bioavailability testing has shown levels below NAGD screening levels. Sampling at spoil grounds has shown that contaminants below screening levels.
Fauna listed under the EPBC Act or State legislation	All Areas	Sediment in water column - turbidity	1	2	National	1	Low	1	L	Sediment in the water column from niche dredging will be very localised and confined to within the operational port area.
Fauna listed under the EPBC Act or State legislation	All Areas	Toxicants in water column - metals	1	2	National	1	Low	1	L	Sediment in the water column from niche dredging will be very localised leading to very limited distribution of contaminants which are in low levels in any case.
Fauna listed under the EPBC Act or State legislation	All Areas	Toxicants in water column - TBT	1	2	National	1	Low	1	L	Sediment in the water column from niche dredging will be very localised leading to very limited distribution of contaminants which are in low levels in any case..
Fauna listed under the EPBC Act or State legislation	All Areas	Toxicants in sediment - metals	2	2	National	2	Low	1	L	Sediment in the water column from niche dredging will be very localised leading to very limited distribution of contaminants which are in low levels in any case..
Non-listed Fauna	Dredge Areas	Dredge Operations	1	2	Common	1	Low	1	L	Low risk of adverse impacts of dredge operations.
Non-listed Fauna	Dredge Areas	Destruction of benthic habitat	1	3	Common	1	Low	3	L	Dredged areas and spoil grounds are not likely to be important habitat for species apart from infauna. Limited marine plants if any at the spoil grounds. The channel is an area of continual disturbance in any case.
Non-listed Fauna	Dredge Areas	Noise and Light	0	2	Common	0	Medium	3	NA	Light and noise from the dredge are localised. Consequences are negligible
Non-listed Fauna	Dredge Areas	Entrainment of fauna	1	3	Common	1	Medium	2	L	Likelihood of entrainment of marine fauna such that there are ecological consequences is considered low.
Non-listed Fauna	Dredge Areas	Sediment in water column - turbidity	1	2	Common	1	High	2	L	Modelling and monitoring of previous dredging campaigns suggests that turbidity levels will not impact upon non-listed fauna

Value	Location	Stressor	Consequence Rating: Magnitude	Duration	Significance	Cons. Score	Association	Inherent Risk - Current Situation: Threat / Likelihood	Risk Score	Comments
Non-listed Fauna	Spoil Grounds	Toxicants in water column - metals	1	1	Common	1	High	2	L	Metals below NAGD screening levels except for occasional naturally occurring Arsenic, Nickel Chromium and Cadmium. Elutriate bioavailability testing has shown levels blow NAGD screening levels. Period of exposure generally low as time in water column is hours at spoil ground only.
Non-listed Fauna	Spoil Grounds	Toxicants in sediment - metals	1	1	Common	1	Medium	1	L	Metals below NAGD screening levels except for occasional naturally occurring Arsenic, Nickel Chromium and Cadmium. Sampling at spoil ground after dredging has shown that sediment contamination is no different to surrounding sediments.
Non-listed Fauna	All Areas	Sediment in water column - turbidity	1	1	Common	1	Low	1	L	The limited period of time that the sediment plume will existing in the water column poses a low risk for turtles. Secondary impacts of turbidity on turtles are likely to be negligible.
Non-listed Fauna	All Areas	Toxicants in water column - metals	1	1	Common	1	Low	1	L	The short duration of exposure and limited geographic extent of any plume as well as the low concentration of metals present and that testing has shown the concentrations of metals to be of low risk to the wider environment.
Non-listed Fauna	All Areas	Toxicants in water column - TBT	1	1	Common	1	Low	1	L	The short duration of exposure and limited geographic extent of any plume as well as the low concentration of TBT present and that testing has shown the concentrations of TBT to be of low risk.
Marine mammals	All Areas	Dredge Operations	2	2	National	2	Low	1	L	Generally migration pathways outside dredging ops area. Likelihood of collision with slow moving dredge is low.
Marine mammals	All Areas	Destruction of benthic habitat	1	2	National	1	Low	1	L	No habitat for marine mammals in the dredged areas and limited habitat at spoil ground.
Marine mammals	All Areas	Noise and Light	1	2	National	1	Low	2	L	Noise and light from dredge unlikely to cause anything but smallest impact on marine mammals.
Marine mammals	All Areas	Entrainment of fauna	1	3	National	2	Low	2	L	Entrainment into dredge from drag head operating only at the bottom is likely not to occur. Certainly for large fauna like whales there is no pathway.
Marine mammals	All Areas	Sediment in water column - turbidity	1	2	National	1	Low	2	L	Small areas of turbidity unlikely to impact upon the behaviour or health of marine mammals.
Turtles	All Areas	Dredge Operations	2	2	National	2	Low	1	L	Dredge slow moving but still chance of collision though serious impact unlikely. Location of drdging is offshore and not near turtle sensting or internesting areaas.
Turtles	All Areas	Destruction of benthic habitat	1	3	National	2	Low	1	L	Areas where dredging will occur and spoil grounds are not core foraging habitat for turtles and so removal should have little impact.
Turtles	All Areas	Noise and Light	1	2	National	1	Medium	2	L	Light can distract turtles and cause confusion. Whilst an operating dredge will also be lit for safety and navigational purposes, it is unlikely that this lighting would impact upon nesting turtles and hatchlings.
Turtles	Dredge Areas (ex Niche)	Entrainment of fauna	3	2	National	3	Medium	4	M	If no mitigation measures then there is potential for entrainment of turtles from the Trailer Suction Hopper Dredge (TSHD).

			Consequence Rating					Inherent Risk - Current Situation		
Value	**Location**	**Stressor**	**Magnitude**	**Duration**	**Significance**	**Cons. Score**	**Association**	**Threat / Likelihood**	**Risk Score**	**Comments**
Turtles	All Areas	Sediment in water column - turbidity	1	2	National	1	Medium	2	L	Turbidity for short periods unlikely to have major impact upon turtle populations. Turbidity is not around foraging areas and offshore from nesting areas so impact on hatchlings would be expected to be low.
Turtles	All Areas	Toxicants in water column - metals	1	1	National	1	Low	1	L	Short duration exposure. Indirect pathway and sediments below NAGD screening levels except for naturally occurring metals.
Turtles	All Areas	Toxicants in sediment - metals	1	3	National	2	Low	1	L	No direct pathway of impact. Risk included in table for due diligence purposes.
Benthic Primary Producer Habitat (BPPH)	All Areas	Dredge Operations	0	3	State	0	Low	0	NA	No direct pathway of impact. Risk included in table for due diligence purposes.
Benthic Primary Producer Habitat (BPPH)	All Areas	Destruction of benthic habitat	1	3	State	1	High	4	L	Small area of impact in already dredged areas of the channel and at spoil grounds with little benthic primary producer habitat (BPPH) recorded.
Benthic Primary Producer Habitat (BPPH)	All Areas	Noise and Light	0	3	State	0	Low	0	NA	No direct pathway of impact. Risk included in table for due diligence purposes.
Benthic Primary Producer Habitat (BPPH)	All Areas	Entrainment of fauna	1	1	State	1	High	2	L	Small area of impact in already dredged areas and at spoil grounds with little BPPH recorded. Therefore impacts on those BPPH entrained into the dredge are low.
Benthic Primary Producer Habitat (BPPH)	All Areas	Sediment in water column - turbidity	2	2	State	1	High	3	L	Impacts from light attenuation and smothering are well linked with BPPH. Duration short and extent small.
Benthic Primary Producer Habitat (BPPH)	All Areas	Toxicants in water column - metals	1	1	State	1	Low	1	L	Metals likely below NAGD screening levels except for occasional naturally occurring Arsenic, Nickel Chromium and Cadmium. Time in water column is short and pathway not strong.
Benthic Primary Producer Habitat (BPPH)	All Areas	Toxicants in sediment - metals	1	3	State	1	High	1	L	Limited BPPH at spoil grounds where sediments below NAGD screening levels after disposal.
Coral	All Areas	Dredge Operations	1	2	State	1	Low	1	L	No pathway of impact as corals not present in areas to be dredged including niche areas..
Coral	All Areas	Destruction of benthic habitat	1	1	State	1	Low	1	L	Only a few isolated patches of coral occur in the channel other dredged areas have very limited coral and niche areas have no coral.
Coral	All Areas	Entrainment of fauna	0	3	State	0	Low	0	NA	Only a few isolated patches of coral occur in the channel.
Coral	All Areas	Sediment in water column - turbidity	3	2	State	2	High	2	L	Turbidity likely to be short-lived over coral areas and only infrequently will this occur.
Coral	All Areas	Dredge Operations	1	1	State	1	Medium	1	L	No pathway of impact.
Coral	All Areas	Destruction of benthic habitat	1	1	State	1	High	1	L	Only a small number of isolated patches of coral exist in the refuge area.
Coral	All Areas	Sediment in water column - turbidity	2	2	State	1	High	1	L	Monitoring undertaken during the South West Creek Project suggest that there is a very low likelihood of high levels of turbidity reaching identified areas of environmental sensitivity such as Minilya Bank and Spoil Ground Reef
Coral	All Areas	Toxicants in water column - metals	3	3	State	3	Low	1	L	No coral at spoil ground and sediments unlikely to pose threat to coral.
Amenity - Sensory Perception (Air, Noise, Vibration)	All Areas	Dredge Operations	1	3	Common	1	High	4	L	Although frequent consequence is low.
Amenity - Sensory Perception (Air, Noise, Vibration)	All Areas	Noise and Light	2	3	Common	1	High	4	L	Although frequent consequence is low.
Indigenous Cultural Heritage	All Areas	Dredge Operations	0	0	National	0	Low	1	NA	Low impact likely
Indigenous Cultural Heritage	All Areas	Destruction of benthic habitat	0	0	National	0	Low	1	NA	Indirect impacts through effects on other environmental values.
Indigenous Cultural Heritage	All Areas	Noise and Light	0	0	National	0	Low	1	NA	Low impact likely.
Indigenous Cultural Heritage	All Areas	Entrainment of fauna	0	0	National	0	Low	1	NA	Indirect impacts through effects on other environmental values and as these are considered low risk is considered low.

Value	Location	Stressor	Consequence Rating: Magnitude	Duration	Significance	Cons. Score	Association	Inherent Risk - Current Situation: Threat / Likelihood	Risk Score	Comments
Indigenous Cultural Heritage	All Areas	Sediment in water column - turbidity	2	3	National	3	Low	1	L	Indirect impacts through effects on other environmental values and as these are considered low risk is considered low.
Non-indigenous Cultural Heritage	All Areas	Destruction of benthic habitat	0	0	Common	0	Low	1	NA	No pathway of impact
Non-indigenous Cultural Heritage	All Areas	Noise and Light	0	2	Common	0	Low	1	NA	No pathway of impact
Non-indigenous Cultural Heritage	All Areas	Entrainment of fauna	0	2	Common	0	Low	1	NA	No pathway of impact

ghd.com

The Power of Commitment