Understanding the environment in which we operate

PORT OF GERALDTON MAINTENANCE DREDGE PROJECT 2021: ENVIRONMENTAL IMPACT ASSESSMENT

Prepared by Wavelength O2 MARINE

Purpose

The Environmental Impact Assessment (EIA) presents an assessment of the potential environmental impacts of the planned 2021 maintenance dredging of the Geraldton Port entrance channel and inner harbour, and the nearshore placement of dredged material off the coast of Bluff Point.

The purpose of this EIA is to assess the environmental impacts of the project in accordance with the WA Environmental Protection Act 1986 and EPA Technical Guidance for EIA of Marine Dredging Proposals.

Linkages

The EIA was informed by:

- Benthic Habitat Assessment of Champion Bay & Surrounds, Benthic Habitat Mapping Report (AECOM);
- Geraldton Port Baseline Sediment Characterisation & Assessment 2019 -SAP Implementation Report (O2 Marine);
- 2021 Assessment of Potential Dredge Material Placement Areas within Champion Bay (BMT); and
- MWPA Maintenance Dredging Simulations at Geraldton (GEMMS)

The EIA is the key input to the MWPA Draft Dredge Environmental Management Plan open for public comment.

Importance

The EIA:

- provides a detailed description of the project;
- outlines stakeholder engagement outcomes;
- identifies the potential environmental impacts;
- sets environmental objectives;
- identifies mitigation measures to minimise impacts; and
- assesses the overall potential impacts and benefits of the project.

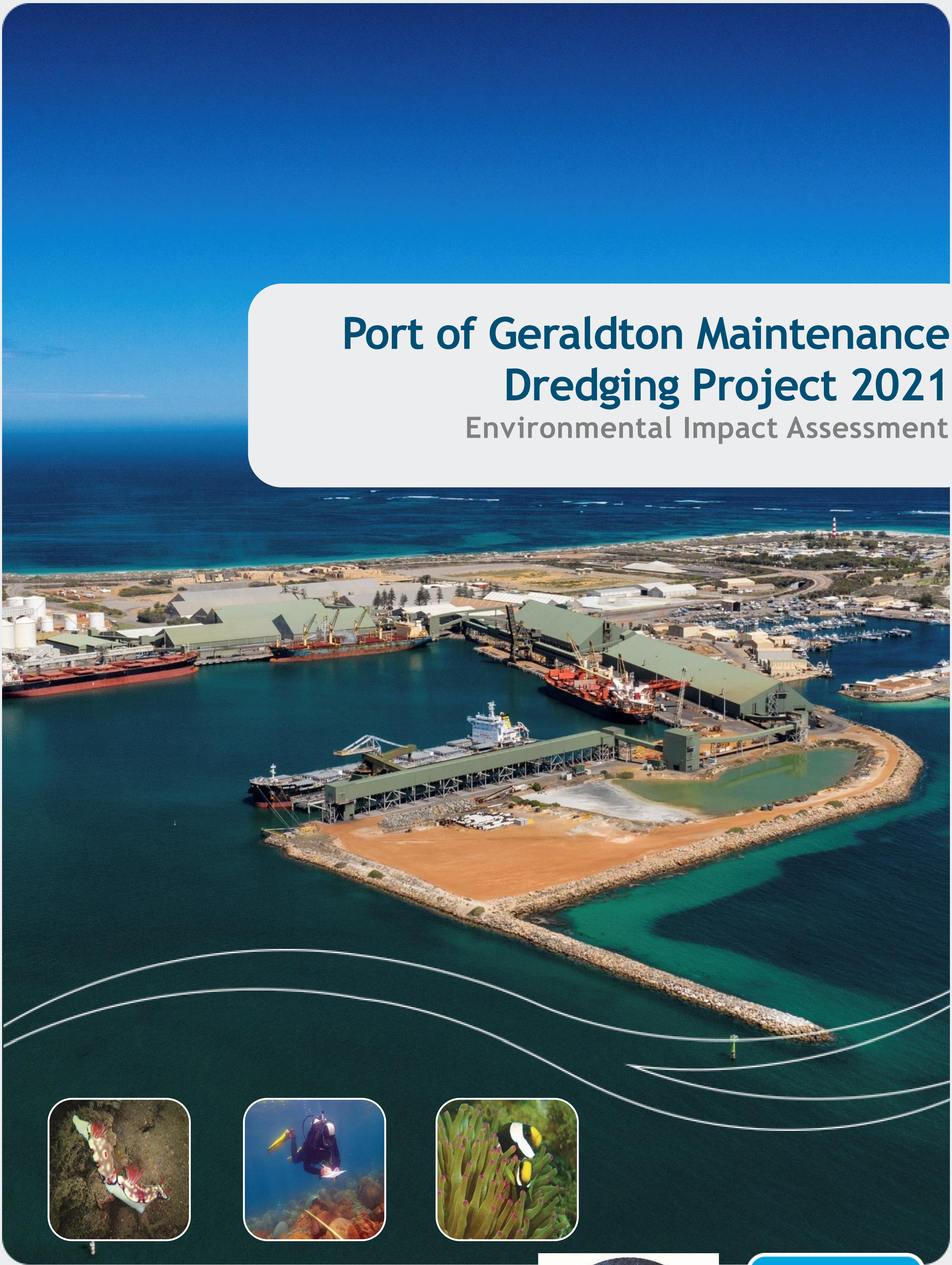
Outcomes

The EIA focused on the potential impacts to:

- Coastal Processes (including erosion and accretion of sediments);
- Marine Environmental Water Quality; and
- Benthic (Seabed) Communities and Habitats (specifically seagrass).

The outcomes of the EIA were:

- Sediments plumes were intermittent and short-lived;
- Sediments will slowly migrate out of the nearshore dredge material placement area with very localised accumulation of sediment at rates tolerable to seagrass species within Champion Bay;
- Placing the dredged materials nearshore makes sediments available to the northern beaches of Geraldton and the ecosystems of Champion Bay; and
- The project will not have significant impact and is likely to have an overall net benefit for the marine and coastal environments.



Port of Geraldton Maintenance Dredging Project 2021

Environmental Impact Assessment

CLIENT: Midwest Ports Authority

STATUS: Rev C **REPORT No.:** R210034

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Important Note

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Department of Biodiversity, Conservation and Attractions (2021) Threatened and Priority Fauna Database Search for Geraldton accessed on the 4 of May 2021. Prepared by the Species and Communities Program for Emmy Riboni, O2 Marine for the purpose of environmental assessment.

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Version Register

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Rev B	Draft	R Stevens	K Reynolds I Le Provost	Internal review comments addressed	R Stevens	02 July 2021
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Executive Summary

The Port of Geraldton is located approximately 430 km north of the Western Australian capital city of Perth on the Mid-west coastline. Locally the Port is situated on the northern side of Point Moore, in the southern end of Champion Bay. The Midwest Ports Authority (MWPA) are responsible for the ongoing management and environmental performance of the Port and Port Waters. MWPA is proposing to undertake maintenance dredging within the entrance channel and inner harbour at the Port of Geraldton, Western Australia.

Maintenance dredging was last completed at the Geraldton Port in 2012. The most recent hydrographic survey undertaken during February and March 2021 indicate sedimentation occurring in several locations within the inner harbour and entrance channel. Accumulated sediments are beginning to reduce available draft clearance and will require removal to continue safe navigation for vessels entering, loading and exiting the harbour.

Channel sedimentation has accumulated along the inside and outer edges of the channel causing a narrowing of the navigable area. Within the harbour, sedimentation typically occurs within the operational berth pockets, along the eastern breakwater adjacent to the channel entrance, with shoaling along the tug pen harbour rock walls north of the southeast berth pockets.

To ensure ongoing navigational safety and operational efficiency of the Port, MWPA are planning to undertake a maintenance dredging campaign to remove approximately 235,000 m^3 of sediment from the inner harbour (~45,000 m^3) and entrance channel (~190,000 m^3).

In alignment with MWPA's Sustainability Strategy the following goal was set:

To identify 100% beneficial use and environmentally sustainable placement options for the Geraldton Port maintenance dredge 2021 program; to place the dredge material with a purpose that would achieve a net environmental benefit and avoid sea dumping.

To facilitate this goal MWPA underwent a series of workshops to determine the potential beneficial use options for the sediment which identified the following two options:

1. Sustainable relocation at an approximately 530,000 m^2 nearshore dredge material placement area (DMPA) for all clean material identified within the entrance channel; and
2. Onshore land reclamation of the mildly contaminated inner harbour material at the existing reclamation cell located north of Berth 7.

This Environmental Impact Assessment (EIA) presents an assessment of a Project to conduct maintenance dredging of the Geraldton Port entrance channel and inner harbour, Geraldton WA (the Project). The purpose of this EIA is to conduct an environmental impacts assessment for the proposed project in accordance with Part IV of the *Environmental Protection Act 1986* (EP Act) and Technical Guidance – Environmental Impact Assessment of Marine Dredging Projects (EPA 2016a).

Overall actual and potential impacts of the Project on the environment are not considered to represent a significant environmental risk on the basis that:

- The EP Act principles and relevant Environmental Protection Authority (EPA) guidance documents have been considered in investigating and evaluating potential impacts of the Project on the EPA's environmental factors;
- A comprehensive set of monitoring and management measures have been developed to further mitigate potential impacts of the Project on the EPA's environmental factors;
- The proponent has committed to open and transparent reporting of environmental performance throughout the Project construction phase;
- Evaluation of impacts against all relevant environmental factors, including other environmental factors determined that the EPA's objectives were considered to be met. Specifically, for the key environmental factors the following outcomes were predicted:
- Coastal Processes:
  - No residual impact on coastal processes as a result of the Project and Project activities.
  - Supplementing the natural sediment budget within the Point Moore to Glenfield Secondary sediment cell potentially resulting in positive environmental outcomes including:
    - returning sediments confined within the entrance channel back to the original sediment cell it was derived from;
    - allowing sediments to continue to naturally migrate under the influence of natural coastal processes (waves and currents);
    - providing an ongoing source of sediment supply to the nearshore environment required for building resilience to coastal erosion.
- Marine Environmental Quality –
  - Low Ecological Protection Area (LEPA) maintained adjacent to tailwater release returned to a Moderate Ecological Protection Area (MEPA) within one month.
  - A temporary, localised reduction in Marine Environmental Quality during dredging in the immediate vicinity of the dredge footprint and Nearshore Dredge Material Placement Area (DMPA).
  - Manage vessel bunkering, chemical storage and spill response to ensure no adverse impacts to the marine environment.
  - Beneficial environmental outcome through the removal of contaminated sediments and relocation into a managed land reclamation cell.
- Benthic Communities and Habitat:
  - No irreversible loss, or serious damage outside the dredge footprint and Nearshore DMPA.
  - No detectible reduction from the baseline state of benthic communities outside the Zone of High Impact and the Zone of Moderate Impact.
  - LEPA maintained adjacent to tailwater release returned to a MEPA within one month.
  - Potential to promote improved seagrass health and increased biomass which may provide greater secondary services such as coastal resilience, sediment production, supporting the base marine food web and providing juvenile finfish and rock lobster habitats.
- Evaluation of impacts against Matter of National Environmental Significance determined that there are no predicted impacts.

Based on the outcomes of this EIA, it is recommended that MWPA implement a Dredge Environmental Management Plan in conjunction with an Acid Sulfate Soils Management Plan to ensure all potential impacts are adequately managed during and post dredging and material placement. Through the implementation of the recommended management plans, this assessment identifies that the associated risks from the project are considered adequately minimised and avoided where possible. The implementation of the Project in accordance with the recommendations is therefore assessed as not resulting in 'Significant Environmental Impact' and does not trigger the requirement for referral under Part IV of the EP Act 1986.

It is therefore recommended that MWPA undertake a comprehensive risk assessment for the project, continue to consult with and engage relevant stakeholders and implement the management and monitoring programs accordingly.

Acronyms and Abbreviations

Acronyms/Abbreviation	Description
AHIS	Aboriginal Heritage Inquiry System
ASS	Acid Sulfate Soils
ASSMP	Acid Sulfate Soils Management Plan
BCH	Benthic Communities and Habitat
CGG	City of Greater Geraldton
CoPC	Contaminants Of Potential Concern
CMP	Commonwealth Marine Park
DAWE	Department of Agriculture, Water and Environment
DGV	Default Guideline Values
DMPA	Dredge Material Placement Area
DoT	Department of Transport
DUKC	Draft Under Keel Clearance
DWER	Department of Water and Environmental Regulation
DSI	Detailed Site Investigation
EIA	Environmental Impact Assessment
EIL	Environmental Investigation Levels
EPA	Environmental Protection Authority
EQMF	Environmental Quality Management Framework
EQO	Environmental Quality Objectives
EV	Environmental Values
FBH	Fishing Boat Harbour
HEPA	High Ecological Protection Area
LAU	Local Assessment Unit
LEP	Levels of Ecological Protection
LEPA	Low Ecological Protection Area
LoR	Limits of Reporting
MCA	Multi-Criteria Assessment
MEPA	Moderate Ecological Protection Area
MNES	Matters of National Environmental Significance
MWPA	Mid West Ports Authority
NBSP	Northern Beaches Stabilisation Programme
Tp	Peak Spectral Wave Periods
PAH	Polycyclic Aromatic Hydrocarbons
PASS	Potential Acid Sulphide Soils
PIP	Project Information Package
PSD	Particle Size Distribution

Acronyms/Abbreviation	Description
Hs	Significant Wave Height
SAP	Sampling and Analysis Plan
SPL	Species Protection Level
SSC	Suspended Sediment Concentrations
TBTs	Tributyltins
TEC	Threatened Ecological Community
TOC	Total Organic Carbon
TSHD	Trailing Suction Hopper Dredge
UCL	Upper Confidence Limit
WAMSI	Western Australia Marine Science Institute

Table of Contents

Figures

Tables

Appendices

1. Introduction

1.1. Document Purpose and Scope

This Environmental Impact Assessment (EIA) presents an assessment of a Project to conduct maintenance dredging of the Geraldton Port entrance channel and inner harbour, Geraldton WA (the Project). The purpose of this EIA is to conduct an environmental impacts assessment for the proposed project in accordance with Part IV of the *Environmental Protection Act 1986* (EP Act) and Technical Guidance – Environmental Impact Assessment of Marine Dredging Projects (EPA 2016a).

The scope of the document includes:

> A description of the Project (**Section 2**);

> Summary of stakeholder engagement undertaken in support of the Project (**Section 3**);

> An assessment of the potential environmental impacts of the Project in accordance with the EPA's Environmental principles, factors and associated objectives (**Section 4**);

> An assessment of the potential environmental impacts of the Project on other environmental factors or matters against the environmental objective/s (**Section 5**);

> A holistic assessment of the impacts of the Project on the environment (**Section 6**).

1.2. Proponent

The Proponent for this Project is the Midwest Ports Authority (MWPA). The Proponent details are provided in **Table 1-1**.

Table 1-1 Proponent Details

Entity Name:	Midwest Ports Authority
Australian Business Number (ABN):	73 384 989 178
Address:	298 Marine Terrace, Geraldton Western Australia 6530
Key Contact (Role):	Damian Tully (A/CEO)
Key Contact Email:	communications@midwestports.com.au

1.3. Environmental Impact Assessment process

1.3.1. *Environmental protection Act 1986* (EP Act) (Part IV)

Pre-referral meetings were held on the 23 January 2020, 9 February 2021 and 10 June 2021 with the Department of Water and Environmental Regulation (DWER) to discuss the Project, the potential environmental impacts and the requirement for referral of the Project to the West Australian Environmental Protection Authority in accordance with Part IV (Section 38) of the Environmental Protection Act 1986 (EP Act). Outcomes of the pre-referral meeting are summarised in **Table 3-1**.

Environmental Factors

The following key environmental factors were identified for the Project activities which could pose a moderate risk of compromising their respective Environmental Objectives:

- Coastal Processes
- Marine Environmental Quality; and
- Benthic Communities and Habitat.

Eight other environmental factors relevant to the Project were identified, however, due to the low risk of environmental impacts, and in consideration of the mitigation measures proposed to manage potential impacts, these factors are deemed not necessary of assessment by the EIA. The following environmental factors are deemed less significant, largely due to the existing environment/land use in which they occur. The other environmental factors are:

- Marine Fauna;
- Flora and Vegetation;
- Landforms;
- Terrestrial Environmental Quality;
- Inland Water Environmental Quality;
- Social Surroundings;
- Hydrological Processes; and
- Air Quality.

1.3.2. *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act)

A Project briefing meeting was held on the 17 March 2020 with the Department of Agriculture, Water and Environment (DAWE) to discuss the Project, the potential impacts on Matters of National Environmental Significance (MNES) and the requirement for referral of the Project in accordance with the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). Outcomes of the consultation are summarised in **Table 3-1**.

The potential for impacts upon MNES are considered and discussed briefly in **Section 2.3.1** and as they relate to the relevant environmental factors in **Sections 4.3.**

1.3.3. *Environment Protection (Sea Dumping) Act 1981* (SD Act)

Project briefing meetings were held on the 17 March 2020 and 20 May 2021 with DAWE to discuss the Project and the requirement for application of a sea dumping permit in accordance with the *Environmental Protection (Sea Dumping) Act 1981* (SD Act). Outcomes of the consultation are summarised in **Table 3-1**.

Following this meeting, the Proponent determined that an application for a sea dumping permit was not required as the identified beneficial use option constitutes 100% placement for a purpose. Under the London Protocol placement of matter for a purpose other than the mere disposal is not contrary to the aims of this Protocol and therefore there is no requirement under the SD Act to apply for a sea dumping permit for this Project.

The beneficial use option is discussed in further detail within **Section 2.2**.

1.4. Other Approvals and Regulation

The Project is located within the area of water, land and seabed depicted as the 'Port Area' on Deposit Plan 410027 Sheet 1 as described in *Government Gazette No.34: Port Authorities (Description of Port of Geraldton) Order 2017.* The Port of Geraldton in vested in MWPA under the Port Authorities Act 1999 and is recognised within the City of Greater Geraldton Local Planning Scheme No. 1.

The under Part 4, Section 30 of the Port Authorities Act the functions of a port authority include:

'(a) to facilitate trade within and through the port and plan for future growth and development of the port;

(d) to be responsible for the safe and efficient operation of the port;

(e) to be responsible for maintaining port property; and

(f) to protect the environment of the port and minimise the impact of port operations on that environment.'

The key legislation that applies to this EIA includes, but is not limited to:

> *Aboriginal Heritage Act 1972* (AH Act);
> *Biodiversity Conservation Act 2016* (BC Act);
> *Environmental Protection Act 1986* (EP Act);
> *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
> *Heritage of Western Australian Act 1990* (HWA Act);
> *Underwater Cultural Heritage Act 2018* (UCH Act);
> *Maritime Archaeology Act 1973* (MA Act);
> *Port Authorities Act 1999* (PA Act); and
> *Ports Legislation Amendment Act 2014* (PLA Act*).*

2. The Project

Geraldton and the Port of Geraldton are located approximately 430 km north of the Western Australian capital city of Perth on the Mid-west coastline. Locally the Port is situated on the northern side of Point Moore, in the southern end of Champion Bay (**Figure 2-11**).

The Midwest Ports Authority (MWPA) are responsible for the ongoing management and environmental performance of the Port and Port Waters. MWPA is proposing to undertake maintenance dredging within the entrance channel and inner harbour at the Port of Geraldton, Western Australia.

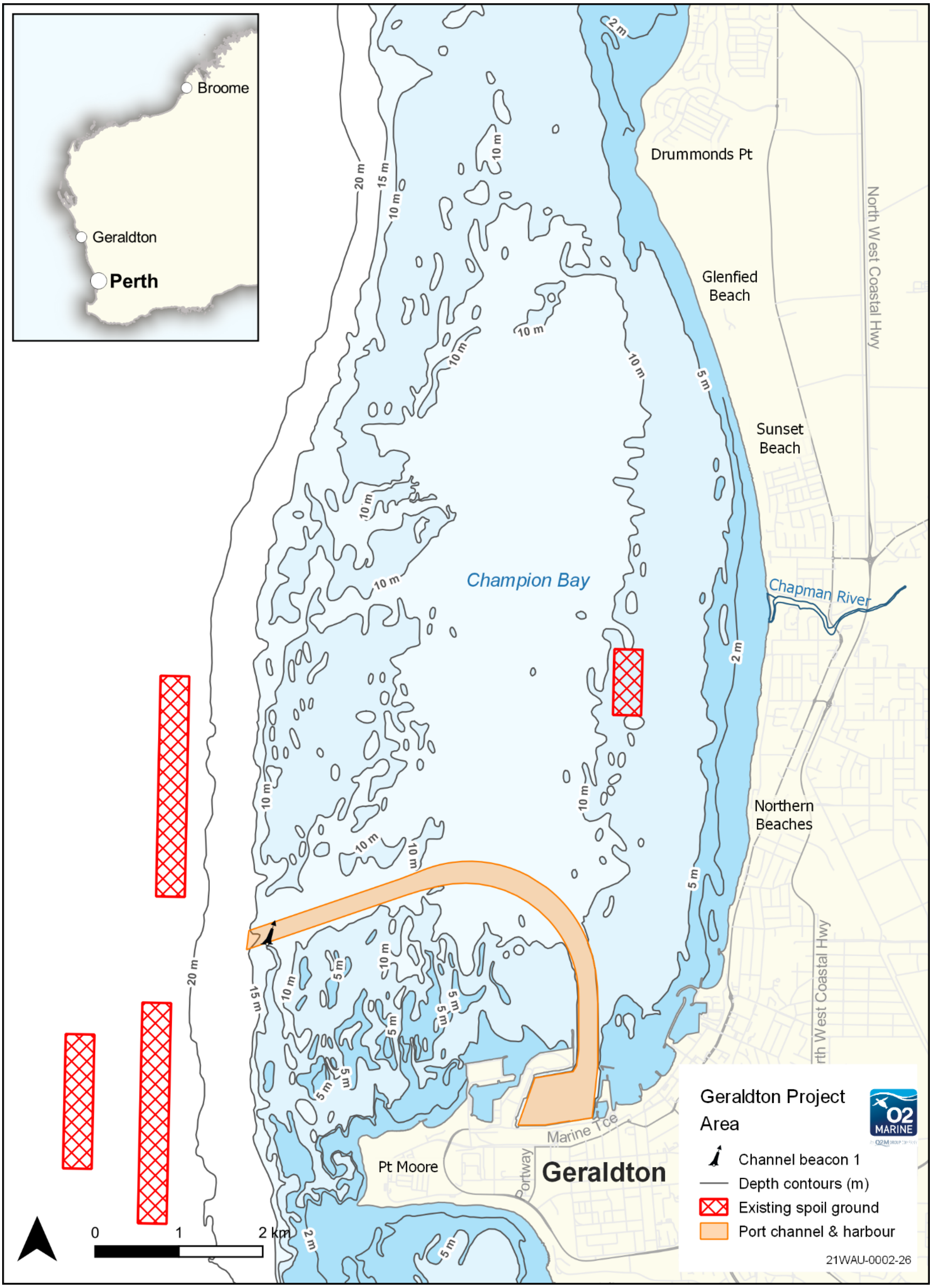

Figure 2-1 Geraldton Port environmental setting and context.

2.1. Background

MWPA held a pre-referral meeting with DAWE on the 17 March 2020 and DWER on 23 January 2020, 9 February 2021 and 10 June 2021 to discuss potential impacts, including MNES, possible preliminary key environmental factors, stakeholder consultation, proposed management measures and potential assessment pathways for the Project.

Additional Project consultation discussions with the Sea Dumping Section of DAWE presented the placement with a purpose scenario selected for all of the dredge material, whereby the London Protocol identifies ‘placement of matter for a purpose other than the mere disposal thereof, is not contrary to the aims of this Protocol’. Therefore, as the material is considered a resource, and nearshore placement a beneficial use option categorised as a ‘placement for a purpose’, the Project will not require a sea-dumping permit under the SD Act.

To support this EIA, MWPA commissioned the following technical studies:

- Benthic Habitat and Communities Mapping (**Appendix A**);
- Nearshore Seagrass Habitat Assessment (**Appendix B**);
- Seagrass Baseline Monitoring Survey (**Appendix C**)
- Dredging and Dredge Plume Hydrodynamic Modelling (**Appendix D**);
- Sediment Characterisation Sampling and Analysis Plan (SAP) (**Appendix E**);
- Sediment Characterisation SAP Implementation Report (**Appendix F**); and
- Marine Fauna Desktop Assessment (**Appendix G**).

Environmental Management Plans have also been prepared in accordance with instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans including:

- Dredging Environmental Management Plan (DEMP) (**Appendix H**); and
- Acid Sulfate Soils Management Plan (ASSMP) (**Appendix I**).

2.2. Project Description

2.2.1. Key Project Characteristics

Maintenance dredging was last completed at the Geraldton Port in 2012. The most recent hydrographic survey undertaken during February and March 2021 indicate sedimentation occurring in several locations within the inner harbour and entrance channel. Accumulated sediments are beginning to reduce available draft clearance and will require removal to continue safe navigation for vessels entering, loading and exiting the harbour. **Figure 2-2** presents the dredging footprint and dredge material placement areas.

Channel sedimentation has accumulated along the inside and outer edges of the channel causing a narrowing of the navigable area. Within the harbour, sedimentation typically occurs within the operational berth pockets, along the eastern breakwater adjacent to the channel entrance, with shoaling along the tug pen harbour rock walls north of the southeast berth pockets.

To ensure ongoing navigational safety and operational efficiency of the Port, MWPA are planning to undertake a maintenance dredging campaign to remove approximately 235,000 m^3 of sediment from the inner harbour and entrance channel.

In alignment with MWPA's Sustainability Strategy the following goal was set:

To identify 100% beneficial use and environmentally sustainable placement options for the Geraldton Port maintenance dredge 2021 program; to place the dredge material with a purpose that would achieve a net environmental benefit and avoid sea dumping.

To facilitate this goal MWPA underwent a series of workshops to determine the potential beneficial use options for the sediment (refer **Section 2.2.3**) which identified the following two options:

3. Sustainable relocation at an approximately 530,000 m^2 nearshore dredge material placement area (DMPA) for all clean material identified within the entrance channel; and
4. Onshore land reclamation of the mildly contaminated inner harbour material at the existing reclamation cell located north of Berth 7.

It is anticipated that dredging will commence during September, with the inner harbour completed within one month and the entire program completed in two months. Therefore, it is anticipated the program will be completed early November.

Consistent with the requirements outlined within the EPA's '*Instructions on how to define the key characteristics of a Project'*, a summary of the Project is provided in **Table 2-1** and the key characteristics, including operational elements are summarised in **Table 2-2** and presented in **Figure 2-2**.

Note that there are no physical elements requiring assessment associated with this Project.

Table 2-1 Summary of the Project

Project Title	Geraldton Port 2021 Maintenance Dredging Project
Proponent Name	Midwest Ports Authority
Short Description	Conduct maintenance dredging of accumulated sediments within the inner harbour (~45,000m^3) and entrance channel (~190,000m^3). Inner harbour sediments have been identified as mildly contaminated and will be placed into the existing land reclamation area north of Berth 7 with tailwater discharge returning to the north-western corner of the inner harbour. Entrance Channel sediments are considered of natural origins and free from contamination and will be sustainably relocated into the natural system at a designated 530,000 m^2 nearshore DMPA.

Table 2-2 Location and proposed extent of operational elements

Element	Location	Proposed Extent
Maintenance dredging of accumulated inner harbour sediments	**Figure 2-2**	Removal of up to ~45,000 m^3 sediments from an area of 334,869 m^2 via trailing suction hopper dredge.
Landside reclamation at existing Northern Reclamation DMPA	**Figure 2-2**	Placement of up to ~45,000 m^3 of dredge material from the inner harbour via pipeline into an existing land reclamation area of 21,833 m^2 north of Berth 7.
Tailwater return from the Northern Reclamation DMPA	**Figure 2-2**	Managed tailwater return from land reclamation into the north-western corner of the inner harbour into a temporary Low Ecological Protection Area.
Maintenance dredging of accumulated entrance channel sediments	**Figure 2-2**	Removal of up to ~190,000 m^3 sediments from an area of 851,948 m^2 via trailing suction hopper dredge.
Nearshore placement of dredge material from entrance channel at designated nearshore DMPA	**Figure 2-2**	Placement of up to ~190,000 m^3 of dredge material from the entrance channel directly at an ~530,000 m^2 nearshore DMPA from dredge hopper.

Figure 2-2 Proposed dredging and relocation footprints and associated development envelope.

2.2.2. Justification

The Port of Geraldton has played a key role since the 1840s for regional and economic development in the Midwest servicing the regions mining, general cargo, petroleum, agricultural industry through importing fertilisers and exporting livestock, commercial fishing, vessel related industries such as boat building and maintenance, cruise vessels and from time to time the federal police, navy and border force. In alignment with the Port Authorities regulated functions the proposed maintenance dredging project is required to reinstate the design depths and widths of the Port's navigable waterways due the accretion of sediments within the inner harbour and entrance channel. Therefore, the objectives of the Project are to;

- maintain a navigable entrance channel and access to the harbour;
- facilitate safe and efficient operations;
- meet trade commitments; and
- return sediments trapped by port infrastructure back to the natural environment and coastal processes to minimise the impact of port operations on the benthic habitats of Champion Bay.

If the sediments are not removed the impacts would result in unsafe navigable waterways, a decline in the efficiencies and profitability of the current Port for the state and Port users, and potentially increasing the risk of vessel grounding which could result in environmental impacts on the marine environmental quality of the harbour and wider Champion Bay.

2.2.3. Project Design Evolution

Requirement for Dredging

Accumulation of sediments within the inner harbour and entrance channel have reduced the available draft and spatial extent such that the original designed depths are no longer being achieved. Hydrographic surveys are undertaken on a six-monthly basis for the inner harbour and entrance channel. It is these hydrographic surveys which have identified the areas where sediments have built up since 2012, and as such require removal to ensure ongoing navigational and environmental safety and ensure that Port efficiencies are maintained. The targeted dredge areas are presented in **Figure 2-2.**

Beneficial Use Assessment

A thorough report on the identification of beneficial use of dredge material summarised below is presented in MWPA (2021) in **Appendix J**.

To ensure that the Port goal of 100% beneficial use of dredge material is achieved a three-stage beneficial use assessment was conducted in accordance with PIANC (2009) which included:

1. Beneficial Use Options Identification Workshop;
2. Fatal Flaws Screening Analysis Workshop; and
3. Facilitated Multi Criteria Analysis Workshop

The properties of the sediment to be dredged along with the current and predicted future maintenance dredging requirements are key considerations for identification and analysis of potential beneficial use options. PIANC (2009) provides a framework for assessing the beneficial use of dredged material, summarised in **Figure 2-3**.

Through internally workshopping this process with key MWPA personnel, a total of 24 beneficial use options were identified. These were divided into the following environmental and engineering categories:

1. Environmental enhancement:
    a. Agricultural – use of sand for agricultural purposes;
    b. Sand replenishment (nearshore) – placement of sand within the nearshore zone, inside the 'depth of closure' where sand can be actively transported to the shoreline by waves and currents;
    c. Sand replenishment (beach) – placement of sand directly to the beach or within the surf-zone to enhance the beach; and
    d. Artificial Reefs – placement to support the creation of artificial reef systems.
2. Engineering:
    a. Reclamation (existing) – placement within existing land reclamation to advance the Port's future development;
    b. Reclamation (new) – placement within new land reclamations as part of the Port's future development;
    c. Export – use of material for general construction, outside of reclamation. Includes the option of exporting the material; and
    d. Other – other engineering solutions, which may beneficially utilise sediment temporary storage of material for future uses/demands.

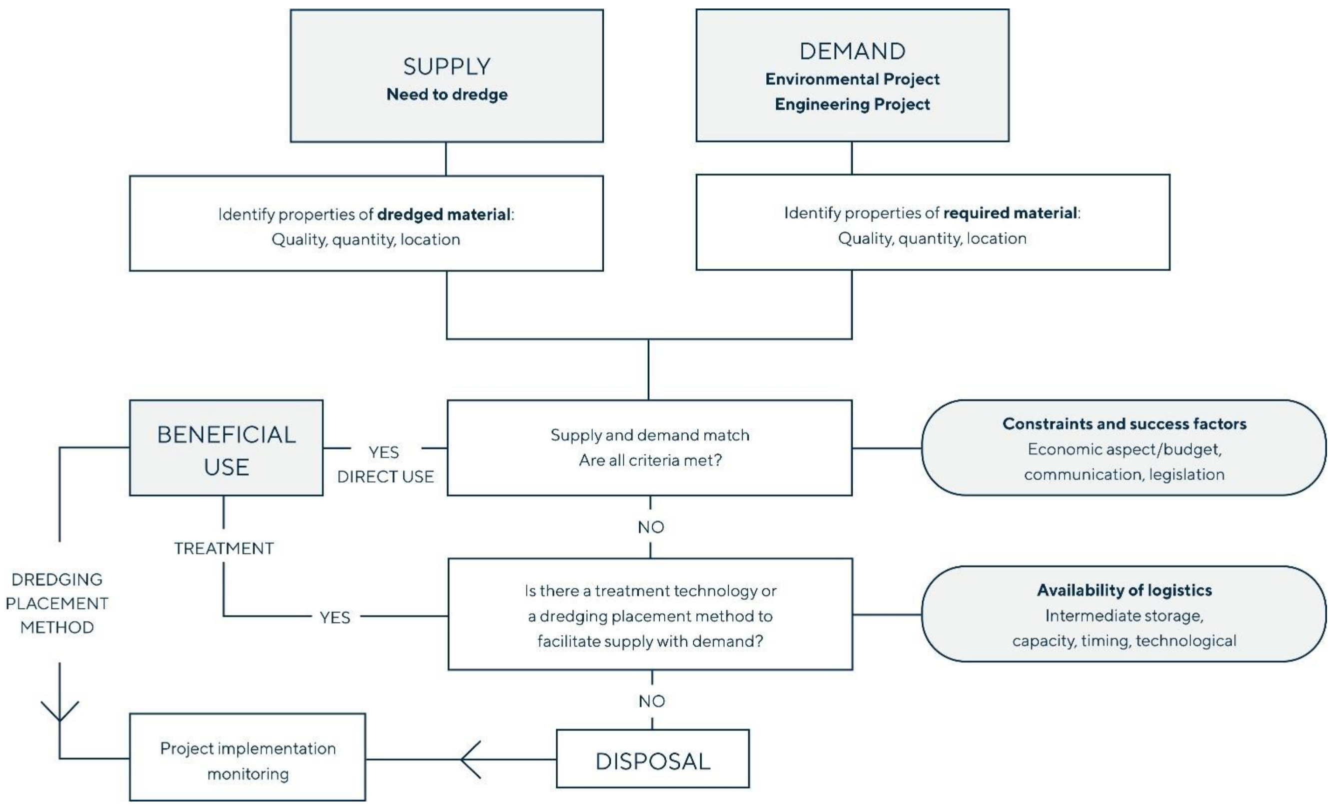

Figure 2-3 PIANC Framework for Dredge Material Beneficial Use

Following the identification of the preliminary 24 options, MWPA conducted a pre-screening against fatal flaws which included:

- Environmental fatal flaw:
  - Sediment sampling and analysis undertaken by O2 Marine (2021a) identified the sediments within the harbour basin and berth pockets contain varying levels of contamination. As there are limited treatment options the presence of contaminants precludes the harbour sediments from a number of potential uses.
- Engineering fatal flaw:
  - Where disposal cannot be achieved with the available equipment or where practical engineering constraints would preclude the consideration of this option.
- Demand fatal flaw:
  - Where there is no identified demand for the option, the option may be feasible and practical, however is superficial to community or stakeholder needs.

Following the fatal flaw assessment eight options remained. These are described in more detail within **Appendix J**.

MWPA enlisted the assistance of GHD to facilitate a four step multi-criteria assessment (MCA), held with key MWPA personnel and stakeholders on the 15 December 2020. The following flow chart presents the MCA process employed. Further details are provided in **Appendix J**.

Figure 2-4 Multi-criteria assessment process

Following the MCA workshop the Port identified the following two options:

1. Sustainable relocation at a nearshore DMPA for all clean material located within the entrance channel; and
2. Onshore land reclamation of the mildly contaminated inner harbour material at the existing reclamation cell located north of Berth 7.

Site Selection

Following the identification of beneficial uses for the dredge material as a viable option for the clean entrance channel sediments, MWPA identified two potential locations for dredge material placement. These two options became study sites as presented in **Figure 2-5**. To determine the suitability of these study sites for material placement, results from broadscale benthic community and habitat (BCH) mapping was overlaid, along with undertaking targeted towed and drop camera survey within these two areas. The results from the targeted BCH survey identified seagrass communities occurring within both potential placement areas.

Placement Area A was dominated by patches of bare sand and low relief reef (<1 m), particularly in the southern section, with a mixed seagrass and macroalgal community. The seagrasses on low relief reefs included *Amphibolis antarctica*, *A. griffithii, Thalassodendron pachyrhizum*, sparse patches of *Halophila spp*. and *Syringodium isoetifolium*, with occasional *Posidonia australis* and *P. sinuosa*. Within Placement Area B there were large sections of bare sand with small ripples as well as low relief reefs (<1 m) observed throughout containing a mixed community of seagrass including *A. antarctica, A. griffithii, Halophila spp., T. pachyrhizum*, and *S. isoetifolium*, and macroalgae (*Sargassum spp., Ecklonia spp*. and filamentous red algae).

Further south from Placement Area B towed camera results identified further patches of bare sand which corresponded with aerial photography obtained for this site. Therefore, the aerial photography was used as a further guide to identify a third study area, which was refined and ground-truthed to contained bare sand using drop camera and multibeam backscatter imagery.

The final placement area, including the aerial photography, multibeam backscatter and habitat mapping from drop camera is presented in **Figure 2-6**.

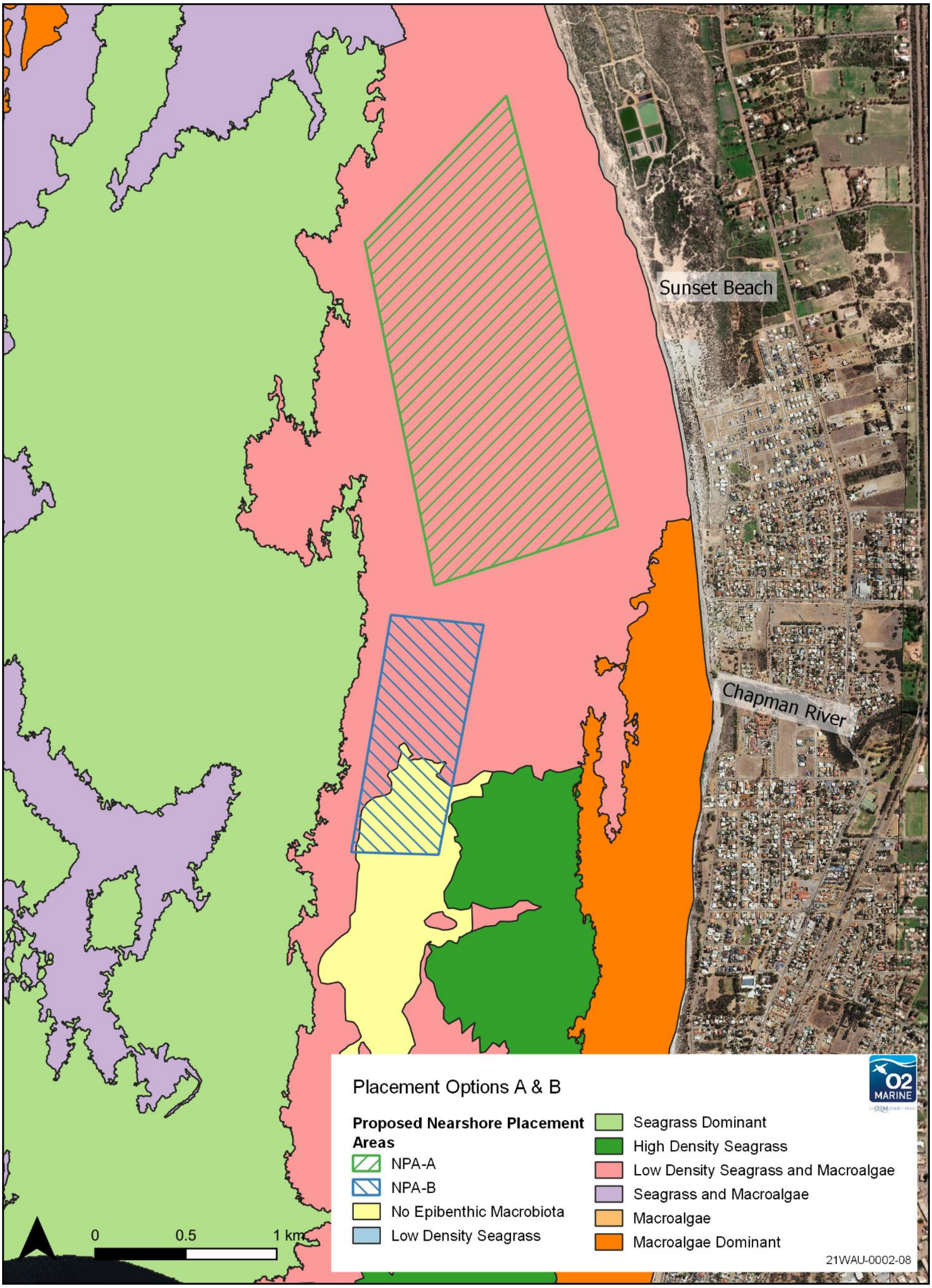

Figure 2-5 Placement Options A and B overlaid with existing Benthic Community and Habitat mapping data.

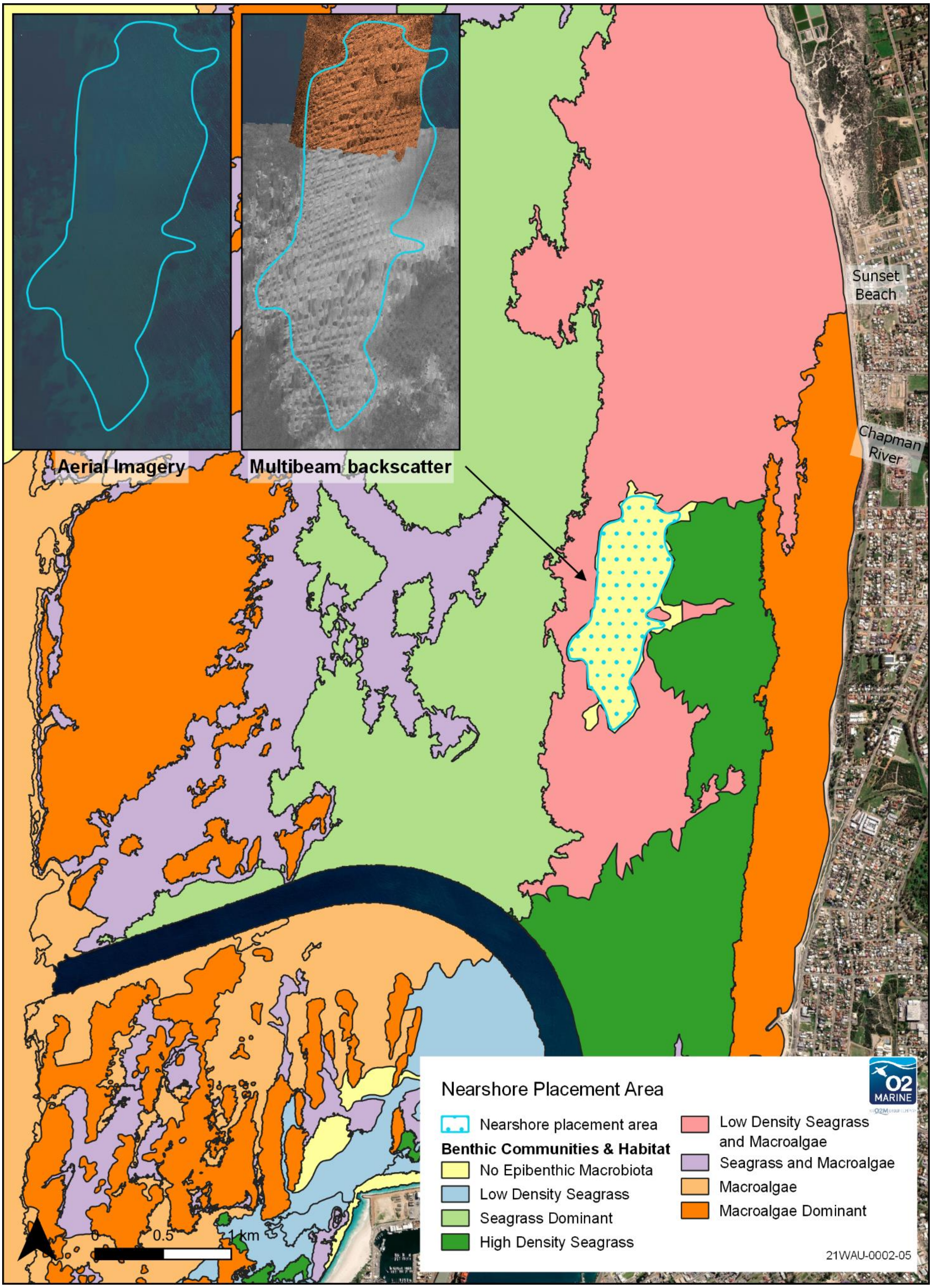

Figure 2-6 **Final Placement Area with corresponding aerial photography, multibeam backscatter and habitat mapping indicating the extent of bare sand and adjacent habitat.**

2.2.4. Beneficial Use Option for Dredge Material

Beneficial Use Options for Port of Geraldton

MWPA conducted a series of workshops and multi-criteria assessments which aimed to explore and evaluate all potential options for beneficial use of the dredge material. This process typically followed the framework as presented in PIANC (2009) to define the requirement to remove sediment, determine the source material and identify and select suitable options for beneficial use or sustainable relocation.

This was undertaken to find a sustainable purpose for sediments and to avoid sea-dumping which whilst providing a mechanism to remove sediments, provides no supplementary benefits from the material.

The options identified through this process for beneficial use at the Port of Geraldton included a combined environmental enhancement and engineering approach:

1. Nearshore relocation of clean entrance channel material to a Nearshore DMPA: and
2. Land reclamation of mildly contaminated harbour sediments into a suitably designed and constructed reclaim bund area (Northern Reclamation DMPA).

The purpose of these two options include:

1. Nearshore relocation
    a. Re-locating sediments within the natural system to a site where they can continue to be transported by natural processes, whereby the benefits may include:
        i. returning sediments confined within the entrance channel back to the sediment cell it was derived from;
        ii. allowing sediments to continue to naturally migrate under the influence of natural coastal processes (waves and currents);
        iii. provide an source of transportable surface sediments (‘top dressing’) to reduce seagrass habitat loss through wave and current scouring of sand from existing seagrass meadows,
        iv. provision of an ongoing source of sand nourishment required to support long-term health of seagrass communities within a naturally high energy environment (weather and waves) with changing rates of sand supplies,
        v. providing an ongoing source for sediment supply to the shoreline required for building resilience to coastal erosion.
2. Land Reclamation
    a. Re-locate sediments from the Inner Harbour to the Northern Reclamation DMPA to provide a construction material for land reclamation, whereby the benefits may include:
        i. Remove known contaminants from the commercial harbour to reduce ecological or human health impact;
        ii. provide additional usable land area to allow for Port growth and economic development as identified in the Port Master Plan; and
        iii. increase storm surge protection and climate change resilience by increasing the height of the existing reclamation area.

Classifying Dredge Material

Based upon the process undertaken and described within **Section 2.2.3**, MWPA have been able to identify beneficial use options for all dredge material. With respect to the London Protocol (amended 2006), 'Placement with a Purpose' (beneficial use) is considered contrary to the Protocol and therefore where beneficial use options can be identified, the Protocol does not consider this as 'dumping' and not subject to the requirements of a Sea Dumping Permit under the SD Act.

PIANC (2009) describes sustainable relocation as 'the introduction of dredged material into aquatic systems to maintain and/or supplement sediment supply in order to sustain the natural processes'. In addition to sustainable relocation, PIANC (2009) also identifies a range of beneficial uses for dredge material which has expanded greatly in recent years to include habitat creation or restoration, coastal protection, landscaping, road construction, brownfield reclamation, capping and as construction material.

Identifying Beneficial Use Environmental Outcomes

The approach outlined above is considered unique among dredging projects undertaken within Western Australia. As opposed to simply assessing the minimum environmental impacts associated with dredging and material placement, MWPA rather sought to identify, assess and determine the option which presented the greatest net environmental benefit. Applying this approach, combined with defined impact assessment processes, MWPA have been able to determine 100% beneficial use options for the dredge material without imposing any significant environmental risk. The net environmental outcomes are summarised in **Table 2-3**, whilst environmental impacts and benefits are further described in detail throughout **Section 4** and **Section 5**.

MWPA acknowledge that there is often limited literature, or previous project examples, particularly within Western Australia, to support the potential beneficial use environmental outcomes and therefore have developed a series of environmental monitoring programs to assist validating these beneficial uses. The environmental monitoring program is presented within the DEMP (**Appendix H**).

Table 2-3 Potential Beneficial Use Environmental Outcomes

Potential Environmental Outcome	Brief Summary	Supporting Environmental Studies	Reference
Enhancing Coastal Resilience	• Returning sediments confined within the entrance channel back to the sediment cell it was derived from. • Allowing sediments to continue to naturally migrate under the influence of natural coastal processes (waves and currents). • Providing an ongoing source for sediment supply to the shoreline required for building resilience to coastal erosion.	• Sediment Transport Modelling • Coastal Beach Profiling • Hydrographic Surveys	**Section 4.3.5**
Seagrass Health	• Provide a source of transportable surface sediments ('top dressing') to reduce seagrass habitat loss through wave and current scouring of sand from existing seagrass meadows. • Provision of an ongoing source of sand nourishment required to support long-term health of seagrass communities within a naturally high energy environment (weather and waves) with changing rates of sand supplies.	• Hydrodynamic Modelling • Seagrass Health Surveys • BCH Monitoring	**Section 4.4.5**
Reduce contaminants	• Remove known contaminants from the commercial harbour to reduce ecological or human health impact.	• Hydrodynamic Modelling • Marine Water Quality Monitoring • Sediment Sampling Program	**Section 4.5.5**

2.2.5. Project Operational Elements

Dredging Equipment

Dredging will be completed by a trailing suction hopper dredge (TSHD) (**Figure 2-7**). The dredge will be equipped with a suction pipe which ends in a drag head (**Figure 2-8**). The drag head is lowered to the seabed and then slowly moved along the channel removing accumulated sediments by suction. The mixture of sediments and seawater will be pumped into the dredge's hopper, as the hopper starts to fill excess waters will be overflowed until the hopper reaches capacity. Once the hopper capacity is reached the dredge will sail to the designated DMPA.

The dredge size and specification is expected to be similar to the previous 2012 maintenance dredging, a small to medium sized TSHD with the following specification:

- Hopper capacity: 3,400m3
- Length: 100m
- Breadth: 20m
- Draught loaded: 5m

Based on monitoring data collected during the 2012 maintenance dredging it is expected the hopper net capacity will be ~20% (~680m3) prior to overflowing and ~70% (~2,380m3) at full capacity following overflowing. Similarly, based on monitoring data collected during the 2012 maintenance dredging it is expected that an operational efficiency of 85% will be achieved, which allows for operational constrains such as weather and shipping. Based on similar conditions to 2012 an average production rate is expected to be ~170m3/hr.

Figure 2-7 Example TSHD (image source https://products.damen.com)

Figure 2-8 Example TSHD drag head (image source https://products.damen.com)

Inner Harbour Dredging

Sediments totalling ~45,000m3 will be removed within the Inner Harbour basin and berth shipping pockets as presented **Figure 2-2**. Dredged sediments from these locations will be transported to the Northern Reclamation DMPA and pumped from the dredge hopper to the DMPA via a pipeline.

Inner harbour and entrance channel dredging will be undertaken concurrently. It has been assumed that only one of every four dredge runs will be undertaken within the Inner Harbour and pumped to the Northern Reclamation DMPA. This will equate to only one to two hopper loads from within the inner harbour in a 24hr period. This extended time between loads will allow settlement of sediments within the reclamation and management of return waters.

Sediments from within this dredge area are known to contain contaminants, however O2 Marine (2021a) concluded that these sediments are typically fit for offshore disposal as the bioavailability and elutriate tests identify most contaminants, with the exception of some elutriate zinc and TBTs, at concentrations below the respective assessment guidelines. However, beneficial use of these sediments for engineering purposes within the Northern Reclamation DMPA was determined as a more suitable option therefore they will be relocated from the inner harbour and pumped into the Northern Reclamation DMPA (see below).

Northern Reclamation DMPA

In common with the 2002/2003 capital dredge and 2012 maintenance dredge projects, dredged inner harbour material (described above) will be placed within the existing reclamation area (Northern Reclamation DMPA). The reclamation area was constructed during 2001 and 2002 as part of the MWPA's (formerly the Geraldton Port Authority) Port Enhancement Project. The reclamation area is double-lined with a layer of geotextile cloth and plastic membrane on the northern, eastern and western sides (**Figure 2-9**). The geotextile was used to ensure the containment of silts, while the plastic membrane was used to reduce the permeability of the bund wall (URS 2001a). The southern wall (i.e. harbour side) of the reclamation area was considered impermeable to sediments and was intentionally left unlined so that any water would preferentially flow back toward the harbour (i.e. away from open waters and the intakes of the lobster processing plants).

The location of the discharge pipeline within the DMPA will be varied over the duration of the dredging to allow for the even placement of sediments within the area. Excess water ('tailwater') will return to the ocean via existing return water outlet pipes located in the south-western corner (i.e. northwest corner of the harbour) of the reclamation area (**Figure 2-2**). The tailwater pipes will have filters (interchangeable) fitted to the inside to minimise fine sediment release to the Harbour.

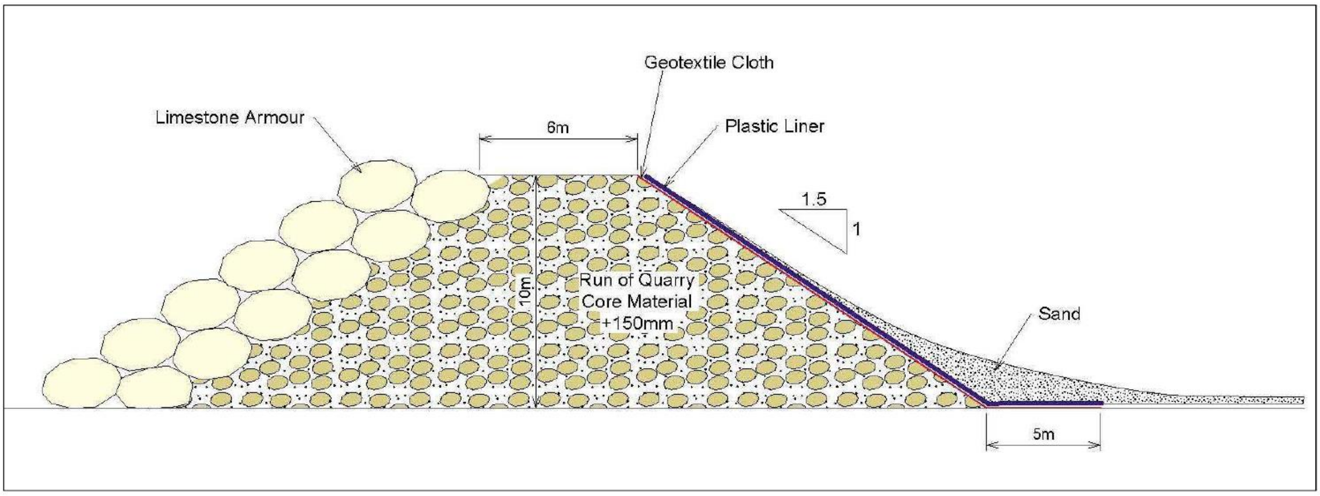

Figure 2-9 Bund Wall Cross Section

To allow for placement capacity within the reclamation and management of the tailwaters, bunds will be built around the edge of the reclamation area to allow the height of the reclamation to be increased. The most recent survey of the reclamation area indicates a capacity of approximately 145,000 m3 remains within this area (**Figure 2-10**). The total dredge material anticipated to be generated by the harbour dredging (~45,000 m^3) will not exceed this capacity.

At the completion of dredging and once dredged sediments have sufficiently consolidated to allow for trafficable access, placed material will be capped with 300 mm of clean material in accordance with the Acid Sulfate Soils Management Plan (ASSMP) (**Appendix I**).

Entrance Channel Dredging

As with inner harbour dredging, entrance channel sediments will be removed via trailing suction hopper dredge (TSHD) (**Figure 2-7**).

Sediments totalling ~190,000 m^3 will be removed from high spots occurring within the entrance channel as presented in **Figure 2-2**. Dredged sediments from the entrance channel will be transported to the Nearshore DMPA.

Dredging of the entrance channel will occur concurrently with the inner harbour, until the inner harbour dredging is completed. It is assumed that three in every four dredge loads will be from the entrance channel, while the inner harbour is being completed then all loads will be from the entrance channel. This will equate to 3-4 loads and then 4-5 loads in a 24-hour period.

Sediments from within this dredge area are characterised as medium to fine grained, yellow to grey sands of natural origins such as coastal silicate sands transported to the entrance channel via localised northern longshore drift, or marine carbonate sediments transported via oceanic currents and swell (O2 Marine 2021a). No contaminants of potential concern (CoPC) were identified for entrance channel sediments so they are considered to be clean. Therefore, sustainable relocation of these sediments from the entrance channel and harbour entrance via hopper discharge to the Nearshore DMPA is proposed (see below).

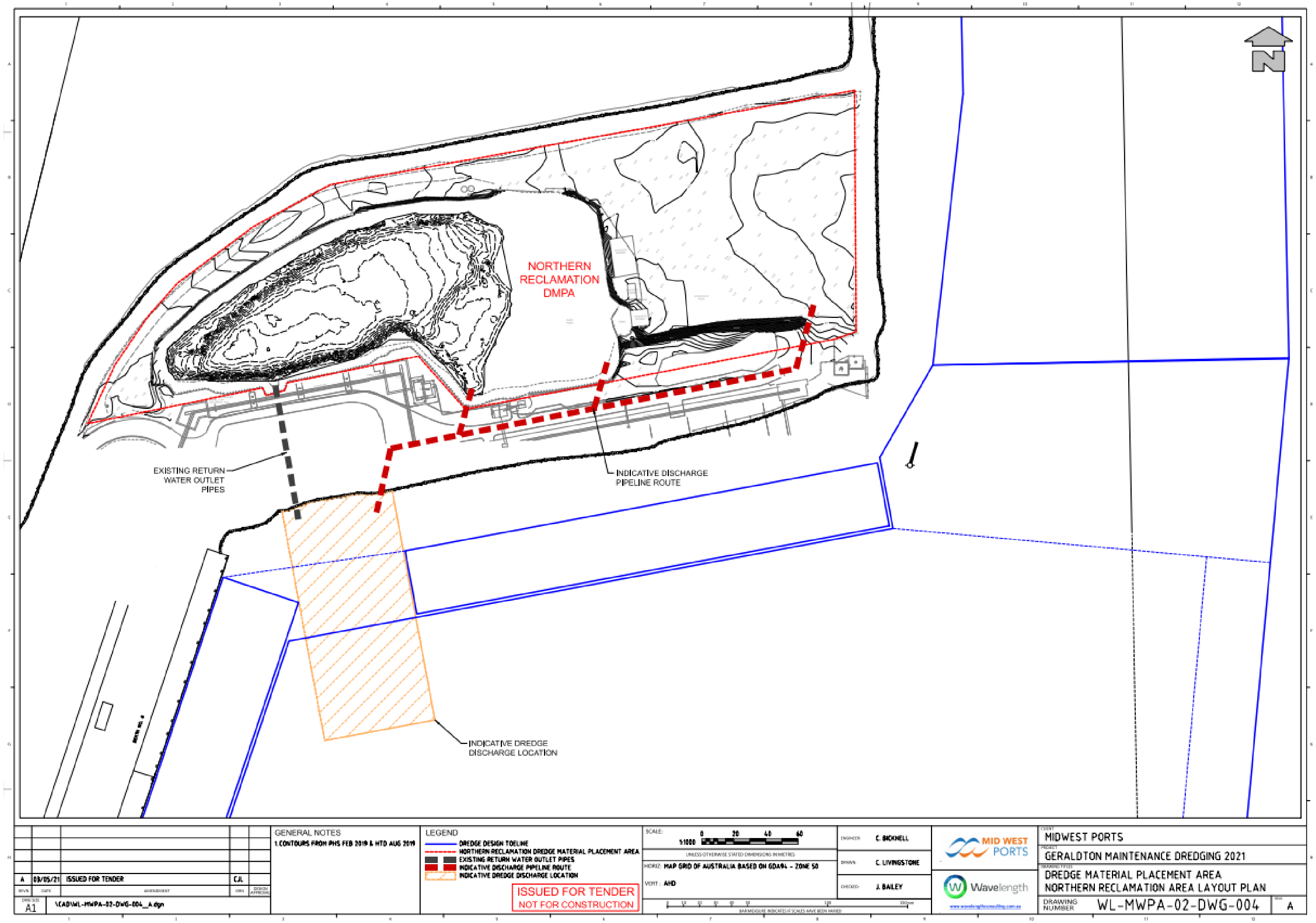

Figure 2-10 August 2019 survey of the existing Northern Reclamation DMPA

Nearshore DMPA

Material dredged from the entrance channel (~190,000m^3) will be relocated within the dredge hopper to the Nearshore DMPA (**Figure 2-2**). Once the dredge reaches the Nearshore DMPA the sediments will be released from the hopper by opening doors on the underside of the vessel and allowing the sediments to fall to the ocean floor. Each time the dredge will place material to a different location within the DMPA to allow for the even placement of material across the whole area.

Hydrographic surveys will be used during the placement to ensure the material is not being deposited in favour of one location rather than evenly being deposited which could result in high spots. A final hydrographic survey will take place, and areas greater than one metre in height from pre-existing levels will be levelled using an underwater drag plough or similar to ensure uniform distribution, and minimum height of material at the Nearshore DMPA. At the completion of the dredging, the placed material is not anticipated to be greater than one metre in height above the natural seabed levels and have an average placement height of ~0.5m.

2.3. Local and Regional Context

The proposed dredging and Nearshore DMPA is situated near to the town of Geraldton, in Champion Bay between Point Moore in the south and Drummonds Point in the north, in the Midwest Region of Western Australia (**Figure 2-11**). The Project and all activities will occur entirely within the designated Port Waters of Geraldton Port.

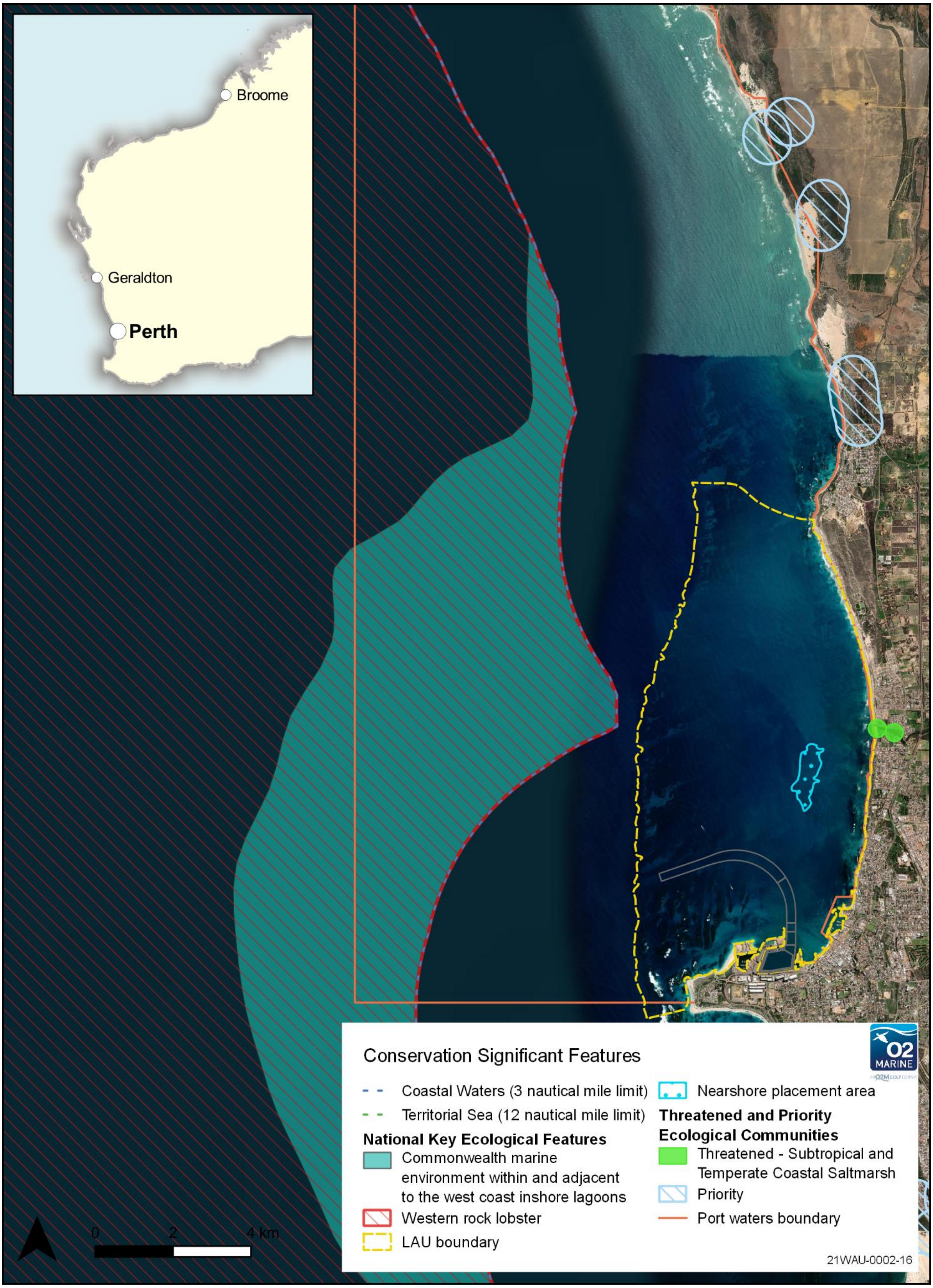

Figure 2-11 Proposed maintenance dredging Project – Local and Regional Context

2.3.1. Environmental Assets

Other than protected or conservation significant species which may occur in the Project Area, the following key features of conservation significance were identified within or adjacent to the Project area:

Commonwealth Features of Conservation Significance

- ***Abrolhos Commonwealth Marine Park (CMP) – Special Use Zone*** - The nearest CMP to the Project area is the Abrolhos CMR, which is located approximately 27 km south-west of the Project area. Given the distance from the Project area, impacts to this CMR are not predicted; and
- ***Threatened Ecological Community: Subtropical and Temperate Coastal Saltmarsh*** – Subtropical and temperate coastal saltmarsh Threatened Ecological Community (TEC) is known to occur adjacent to the Project area with an established community occurring within the Chapman River. The community occurs within the rivermouth area, typically an enclosed river system which intermittently flushes post heavy localised rainfall. Further discussion on the potential indirect effects upon this TEC are discussed in **Section 4.3**.
- ***Underwater Cultural Heritage*** – Eighty three (83) shipwrecks were identified through a search of the Australasian Underwater Cultural Heritage Database within the Midwest Region – Geraldton, with 32 occurring along the coastline between Dongara and Port Gregory. Eight of these occur within the wider Champion Bay area however there are no recorded wrecks within the Nearshore DMPA, nor is there any predicted impacts from this Project to identified existing wrecks.

State Features of Conservation Significance

- ***Abrolhos Islands National Park and Fish Habitat Protection Areas*** - The dredging area of influence lies entirely within MWPA Port Limits. Around 60km offshore from the Port of Geraldton is the Abrolhos Islands National Park and Fish Habitat Protection Areas, jointly manged between the Departments of Biodiversity, Conservation and Attract ions and Primary Industry and Regional Development.
- ***Aboriginal Heritage*** - Two registered Aboriginal Heritage Sites are recorded in the Aboriginal Heritage Inquiry System (AHIS) as being in the vicinity of the Project area. These include site ID 5561 Chapman River Mouth and 5874 Bluff Point Midden. To better understand and mitigate impacts to Aboriginal heritage, MWPA engaged with the Yamatji Southern Regional Corporation to ensure that key cultural and environmental sensitivities are not impacted by the Project. The outcomes of the initial engagement identified no concerns, however consideration of the impact upon the TEC was raised and discussed. Further assessment of potential impacts upon the TEC are discussed in **Section 4.3.** There is no requirement to seek approvals for the Project, however MPWA are committed to ongoing stakeholder consultation up to, during and post dredging as required. Further details are provided in **Section 3**.
- ***Other Heritage*** - A search of the Heritage Council database indicates no maritime or coastal heritage structures within the Project Area. The Point Moore Lighthouse cottage are listed, however these are not considered within the Project area as such no impacts from this Project are predicted.

There are 18 Shipwrecks identified on the WA Museum Shipwrecks database that are located off the coast of Geraldton with eight occurring within Champion Bay. Shipwrecks in State Waters are protected under the MA Act.

3. Stakeholder Engagement

3.1. Key Stakeholders

MWPA has been working with key Project stakeholders to advance the Project since 2020.

Given the proximity of the maintenance dredging Project to the town of Geraldton, and the visibility of the key Project operations, there are a substantial number of relevant stakeholders. MWPA has undertaken targeted consultation with the following stakeholders:

- City of Greater Geraldton;
- Department of Agriculture, Water and the Environment (DAWE);
- Department of Primary Industries and Regional Development – Fisheries (DPIRD);
- Department of Biodiversity, Conservation and Attractions (DBCA);
- Department of Planning Lands and Heritage (DPLH);
- Department of Transport (DoT) - Coastal Infrastructure Team;
- Department of Transport (DoT) – Geraldton Local Office;
- Department of Water and Environmental Regulation (DWER) – EPA Branch;
- Department of Water and Environmental Regulation (DWER) – CS Branch:
- Geraldton Chamber of Commerce & Industry
- Geraldton Open Community Forum;
- Geraldton Fishermen's Cooperative;
- Geraldton Fishing Boat Harbour Stakeholder Consultation Group
- Indian Ocean Fresh;
- Mineral Importers and Exporters Liaison Group (MEILG);
- MWPA Staff;
- Northern Agricultural Catchments Council (NACC);
- Yamatji Southern Regional Corporation;
- Western Australian Marine Science Institution (WAMSI);

3.2. Stakeholder Consultation

Engagement with key stakeholders involved a combination of face-to-face meetings, online 'virtual meetings', open forums, exchange of emails and provision of a comprehensive stakeholder Project Information Package (PIP) which included an overview of the Project and summary of the potential environmental impacts and proposed management and mitigation. The outcomes of stakeholder consultation that relate to assessment of the Project in accordance with Part IV of the EP Act are summarised in **Table 3-1**. Other unrelated comments that were raised by key stakeholders are being addressed by the Proponent directly with those stakeholders.

Table 3-1 Stakeholder Consultation Outcomes

Stakeholder	Date	Method	Purpose	Outcome	Response
DWER EPA	23-Jan-2020	Face to Face Meeting - DWER Offices Joondalup	MWPA Presented on several marine scopes of work including the potential Tug Pen and FBH Drag Plough works and Planned 2021 Maintenance Dredge. Provided an overview and initial high-level scope of work.	Mtn Dredge: Recommended meeting again when the Port had a defined scope of work.	MWPA to progress planning and future consultation
DAWE	17-Mar-2020	Microsoft Teams Meeting	MWPA Maintenance Dredge overview and initial high-level scope	DAWE acknowledged presentation highlighting that a key part of a sea dumping permit was to demonstrate all other alternatives have be adequately considered and extensive public consultation can be demonstrated.	Beneficial Use Assessment Development of a Communications Plan
DAWE	10-Nov-2020	Phone Conversation	Sort advice on the need for a sea dumping permit based on new option for nearshore disposal.	DAWE proposed to review the project informally and provide the business certainty that the Project meets regulatory requirements.	Future consultation to be arranged with DAWE once a defined scope of works for the dredging and spoil material placement options.
City of Greater Geraldton	29-Jan-2021	Face to Face Meeting - MWPA Board Room	Proposed Project Scope: Alignment with Coastal Hot Spot remediation strategies Key Agency used by EPA for Referral Assessment Nearshore Placement and Beneficial Use Assessment	CGG interested to explore opportunities to address the Bluff Point erosion hot spot. Suggested the public will be concerned that the port is trying to address erosion issues to far north of the current City priority areas.	Present at Concept Forum 2/03/2021 Revise messaging: The port is targeting sustainable relocation of sediments not erosion hotspots.
DoT - Coastal Infrastructure Team	05-Feb-2021	Microsoft Teams Meeting	Proposed Project Scope: Alignment with Coastal Hot Spot remediation strategies Key Agency used by EPA for Referral Assessment Nearshore Placement and Beneficial Use Assessment	Initial feedback positive. Queried concept of 'beach nourishment'. Suggested if the material isn't being placed into the active wave zone then the material won't likely migrate onto adjacent beaches.	Meet again once plume modelling is completed Revise messaging: The port is targeting sustainable relocation of sediments not erosion hotspots. Replenishing natural sediment systems/cycles.
DWER EPA	09-Feb-2021	Microsoft Teams Meeting	Proposed Project Scope	DWER acknowledge update. Suggested MWPA on track with key studies. Recommended letters of endorsement and public consultation records would be critical in the assessment.	Meet once model has been setup and validated with current data. Confirm validation and methodology aligns with the Departments expectations.

Stakeholder	Date	Method	Purpose	Outcome	Response
				Identified that planning for a "non-assessment" outcome risky for planning. Agreed to meet again once modelling has been conducted.	Sought WAMSI advice on light attenuation modelling expectations.
DPIRD (Fisheries)	10-Feb-2021	Face to Face Meeting - MWPA Chapman Rd	Proposed Project Scope	Positive feedback overall. Supported location chosen and timing of the project. Suggested key outcomes of modelling would need to demonstrate no impact to nearshore reef systems particularly north around Drummonds.	MWPA to consult again once plume modelling is completed.
DWER CS Branch	25-Feb-2021	Face to Face Meeting - MWPA Ord St Boardroom	Proposed Project Scope	DWER CS Branch acknowledged overview. Confirmed branch generally consulted by EPA during referral assessment. Provided key names and was open to being presented information early with respect to land reclamation at the Northern Reclamation DMPA.	Review VAR and summary related to Land Reclamation activities. Ensure EIA refers to past ASS Management and site investigations, GMP and Landside EMF.
City of Greater Geraldton	02-Mar-2021	Council Chambers	Proposed Project Scope	CGG positive on approach. Sustainable relocation received well. Inquire about shore placement options and alignment of Port and City projects.	MWPA CEO to meet with CGG CEO to discuss future projects and alignment.
DWER EPA	03-Mar-2021	Email	Presentation Follow-up & Project Update	No Response	
DPIRD (Fisheries)	04-Mar-2021	Email	Presentation Follow-up & Project Update	No Response	
DoT - Coastal Infrastructure Team	05-Mar-2021	Presentation	To provide a project update To discuss intended hydrodynamic modelling	Advice provided on the requirements for hydrodynamic modelling. Recommendation to consider modelling the fate of sediments with/without the port to demonstrate the benefits of the placement site selection. Preference for the sand to be placed directly to the beach to provide a direct benefit to coastal erosion hot spot of Sunset Beach.	Hydrodynamic modelling undertaken with/without the entrance channel to understand natural processes. Modelling demonstrates that the placement of sediments to nearshore placement area improves the ability of sediments to naturally migrate to the coastal erosion hotspot of Sunset Beach.

Stakeholder	Date	Method	Purpose	Outcome	Response
MWPA Workforce	01-Apr-2021	Lunch and Learn	To inform the workforce of the project. Build advocates for the sustainable sediment strategy.	High level interest. Interest in both understanding the triggers for maintenance dredging and nearshore placement options.	High level interest. Interest in both understanding the triggers for maintenance dredging and nearshore placement options.
WAMSI	22-Apr-2021	Presentation	To provide an overview of the project, work undertaken to date To seek advice on the selection of seagrass impact criteria To seek opportunities for research linkages To understand the longer term impacts/benefits of nearshore placement	Positive feedback provided on the general approach and placement site selection. Recommendations provided on sourcing of comparable information from the previous work undertaken to support the proposed Oakajee Port. Interest in being involved in the project and to seek linkages to similar research being undertaken to support Westport. Recommendation for early engagement with EPA.	Oakajee supporting studies utilised in the selection of seagrass impact criteria. Early engagement with EPA planned.
DAWE	02-May-2021	Presentation	To provide an update on the 2021 Maintenance Dredging Project to the Sea Dumping Section of DAWE To seek confirmation on the requirements for a Sea-Dumping Permit under the Environmental Protection Regulation (Sea Dumping) Act 1981	Positive feedback on the work undertaken by MWPA to identify beneficial use options for dredge material. Agreement with MWPA's assessment that the placement of dredge material to the nearshore for the intended beneficial use is considered placement with purpose and as such does not require a Sea Dumping Permit. Recommended detailed consideration be given to hydrodynamic modelling, sediment characteristics, seagrass impacts and community engagement.	Formal referral for a sea dumping permit not require. DAWE interested to be keep informed on the project as a reference project for beneficial use. Hydrodynamic modelling work undertaken by independent consultant GEMMS with technical peer review. Impact on sediment cell, material characteristics, coastal processes included in EIA. Community engagement being undertaken by MWPA and outcomes included in EIA.
Yamatji SRC - Board	18-May-2021	Presentation	To provide a project overview and present the proposed material placement location.	Positive feedback on project. Questions raised: Could the material placement impact on the Chapman River mouth by a build up of material preventing flow?	Hydrodynamic modelling indicates that sediment continue to migrate to the north with no long-term accumulation at the Chapman River mouth.

Stakeholder	Date	Method	Purpose	Outcome	Response
				Has the Port consulted with Water and Rivers Commission. Where would the sand eventually end up? What employment opportunities might be available?	DWER now replaces Waters and Rivers Commission and included in the EIA engagement process. Some employment opportunities may be available to support the land based operations.
MIELG - Minerals Importers & Exports Liaison Group	19-May-2021	Presentation	To provide an update on the project to port users. To provide a project overview and present the proposed material placement location.	Positive feedback. Question raised if scheduling could consider existing planned shutdowns to minimise disruption to port users?	Continued consultation to be undertaken over the duration of the project.
SEC - Stakeholder Engagement Committee - Community Representees	31-May-2021	Presentation	To provide a project overview and present the proposed material placement location.	Positive feedback. No questions of concern raised.	
City of Greater Geraldton	01-Jun-2021	Presentation to Council	To provide an update on the project to Councillors To provide a project overview and present the proposed material placement location.	Positive feedback. Questions raised: Will there be any impacts to seagrass and how will this be monitored in the longer-term? How will the sediment placement be monitored? Will there be any opportunity for school education and potential university student studies? What is the expected future/ongoing frequency of dredging?	Email of support from CGG provided in Attachment A. Seagrass impacts will be a key consideration within the EIA, both in identifying potential impact and proposed monitoring measures. MWPA has baseline monitoring and a commitment to ongoing monitoring. CGG shared an interested in sharing coastline monitoring data to improve future understanding of sediment movement. MWPA will monitor the seabed by ongoing hydrographic survey. MWPA are in discussions with WAMSI to identify opportunities for longer term research studies. A Public Information Package has been developed which can be used to assist in school education.

Stakeholder	Date	Method	Purpose	Outcome	Response
					The MWPA long term maintenance dredging strategy is currently to undertake dredging on a 5year basis. This will be reviewed following this campaign.
NACC	02-Jun-2021	Presentation	To provide a project overview and present the proposed material placement location.	Positive feedback on the process followed to select the placement locations. Interested in future collaboration opportunities. Interested in how the seagrass and benthic habitat mapping, who was validated to determine the nearshore placement location. Interested in the northern stabilisation programme and future beach monitoring. Interested in the frequency of future dredging and the opportunity to re-review beneficial uses for future project.	MWPA is supportive of seeking future opportunities to collaborate with NACC. The nearshore DMPA was selected based on benthic habitat survey validated by backscatter interpretation, aerial photographs and tow video survey. The MWPA long term maintenance dredging strategy is currently to undertake dredging on a 5year basis. This will be reviewed following this campaign.
DoT - Geraldton Local Office	03-Jun-2021	Face to Face	To provide a project overview and present the work undertaken to support the EIA.	Positive feedback on process followed. General questions raised on other stakeholder and community engagement being undertaken, timing contingencies if dates are not met for dredging, when would be the next opportunity. Interested in opportunities to calibrate and share data.	MWPA have undertaken extensive engagement and intend to continue this in the lead up and during the dredging campaign. If dredging can not be undertaken prior to Nov, MWPA will seek to undertake dredging starting in Feb 2022. MWPA will be seeking to make dataset available to other government agencies and research institutes.
DWER	10-Jun-2021	Presentation	To provide a project overview and present the work undertaken to support the EIA.	DWER acknowledged the extensive technical assessment is beyond that normally seen for this scale of project and confirmed referral under the Environmental Protection Act 1986 is only required if significant environmental impacts are predicted.	Work undertaken to complete the EIA has identified that there are no significant environmental impacts expected to result from the project.

Stakeholder	Date	Method	Purpose	Outcome	Response
Community	14-Jun-2021	Community Information Session	To provide a project overview and present the proposed material placement location. Two community information session held. Advertising through local news paper, social media and 650 letter drops to targeted local residences.	Small number of attendance. No significant concerns or questions raised.	MWPA have provided a Public Information Package which is available to be downloaded from their website.
FBH	22-Jun-2021	Presentation	Risk Workshop. To provide a project overview and present the proposed material placement location. To workshop potential concerns and risks to relevant industries.	Observation of historic change in lobster habitats within Champion Bay from 10 years ago to now. No significant concerns, general support for the selected placements sites. Timing for dredging appeared good choice. Questions raised: - Risk of plume impacting on lobster habitat & seagrass - Long-term dredging plans - Previous plumes 'leaking' from Northern Reclamation DMPA through the northern wall.	Dredge plume modelling indicates that any plume will be short lived and sporadic. Due to the short duration no impact is expected to seagrass due to dredge plumes. MWPA will monitor the success of the proposed dredging understand the long-term benefits, with the objective of developing a long-term sustainable sediments strategy. The Northern Reclamation DMPA is documented as being constructed with a impermeable liner. It is not expected that any further loss of sediment through the northern wall is possible. However, this will included in the monitoring during the dredging.
DOT, DWER, DPIRD local offices	14-Jun-2021	Presentation	To provide a project overview and present the proposed material placement location.	No significant concerns were raised, appreciative of the project update.	
MWPA Workforce	31-May-2021 to -Jun-2021	Presentation	Information sessions for the MWPA workforce.	No significant concerns were raised, general support, questions raised: - What will occur next time after the reclamation is filled? - Where will the sand go? - Will it impact on the surf? - How will it impact port operations during dredging?	- The proposed dredging campaign is expected to complete the Northern Reclamation. An alternative placement site will need to be selected for future dredging for any material unsuitable for ocean placement. Prior to future dredging and as part of longer-term sustainable sediment management MWPA will repeat the assessment of beneficial use options for sediment to

Stakeholder	Date	Method	Purpose	Outcome	Response
					determine the most appropriate placement site(s). - Hydrodynamic modelling indicates that sediment will move predominantly northwards from the Nearshore DMPA, joining natural sediment movements. - Sediment is expected to assist in replenishing nearshore sediment supply. However, the scale of placement and water depth is not expected to provide any significant change to the surf or wave conditions. - The proposed dredging is not expected to have any significant impact on port operations.
DoT - Coastal Infrastructure Team	13 July 2021	Presentation	To provide a project overview and present the proposed material placement location. Also to present findings from modelling study and application of the beneficial uses, typically coastal resilience.	No Significant concerns were raised, though there is some doubt as to the definition of 'Beneficial use' being achieved by this project, particularly with regards to coastal erosion. DoT welcomed the approach however as a case study to learn from and welcomed the opportunity to work with MWPA to further define the monitoring program and to collaborate assessment of data recovered and ongoing sustainable sediment management.	MWPA welcomed the offer for a collaborative approach to data collection and assessment from this case study and for future sustainable sediment management. With regards to beneficial use assessment MWPA still believe this project fits the purpose and follows the process as defined by PIANC (2009) and has a range of potential beneficial environmental outcomes from an ecological, coastal process and contamination management aspect.
Mid West Chamber of Commerce & Industry	Planned - TBA	Presentation	To provide a project overview and present the proposed material placement location.		

3.3. Ongoing Stakeholder Consultation

The Proponent has committed to further ongoing consultation with all key stakeholders as the project progresses. One of the primary mechanisms for undertaking this consultation is through the regular update to the public PIP and MWPA's dedicated project webpage, targeted emails and social media posts will also provide project updates. MWPA meets regularly with several consultative committees such as:

MWPA Stakeholder Consultation Committee with representatives:

- Community member;
- City of Greater Geraldton;
- Yamatji Southern Regional Corporation;
- Geraldton Fishermen's Cooperative; and
- Geraldton community and tourism organisations.

Port customers and work force:

- Mineral Exporters and Importers Liaison Group (MEILG);
- Geraldton Fishing Boat Harbour Stakeholder Consultation Group; and
- MWPA Staff Consultative Committees;

Ongoing updates with national, regional and local government agencies:

- Department of Agriculture, Water and the Environment (DAWE);
- Department of Transport (DoT) - Coastal Infrastructure Team;
- Department of Transport (DoT) – Geraldton Local Office;
- Department of Primary Industries and Regional Development – Fisheries (DPIRD);
- Department of Water and Environmental Regulation (DWER) – EPA Branch; and
- Western Australian Marine Science Institution (WAMSI).

4. Environmental Impact Assessment

4.1. Principles

A summary of how the EP Act principles have been considered in relation to the Project is presented in **Table 4-1**.

Table 4-1 EP Act Principles

Principle	Consideration
1. The precautionary principle *Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.* *In application of this precautionary principle, decisions should be guided by:* *a) Careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and* *b) An assessment of the risk-weighted consequences of various options.*	A Pre-referral meeting with DWER was undertaken to identify and consider all environmental risks of the Project. This enabled the Project Team to identify key risks, information gaps, monitoring and management requirements and to consider any appropriate alternatives to those aspects of the Project that posed the most significant environmental risks. Key changes made to the Project design to preserve the environment include: > Avoidance of offshore sea dumping of dredge material; > Workshopping all available dredge placement options to define placement with purpose options for beneficial use of dredge material; > Further refinement of the nearshore DMPA to avoid and mitigate impacts to existing BCH, particularly seagrass; > Placement of all inner harbour 'contaminated' materials to purpose constructed land reclamation; > Relocation of clean sediments into the same secondary sediment cell to allow natural processes to act on this material > Identification of a key environmental window to avoid impacts to key receptors, such as seagrasses, whales and rock lobsters.
2. The principle of intergenerational equity *The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.*	The Project will enable existing industry to continue whilst minimising potential environmental impacts for the required sediment removal. The Proponent considers that the Project is **unlikely to result in any significant environmental impacts** that would pose a threat to the health, diversity and productivity of the environment.
3. The principle of the conservation of biological diversity and ecological integrity *Conservation of biological diversity and ecological integrity should be a fundamental consideration.*	The potential impacts of the Project activities on the conservation of biological diversity and ecological integrity has been considered and discussed in relation to the following environmental factors: > Coastal Processes (**Section 4.3**) > Marine Environmental Quality (**Section 4.4**); and > Benthic Communities and Habitat (**Section 0**).

4. Principles relating to improved valuation, pricing and incentive mechanisms *i. Environmental factors should be included in the valuation of assets and services.* *ii. The polluter pays principles – those who generate pollution and waste should bear the cost of containment, avoidance and abatement.* *iii. The users of goods and services should pay prices based on the full life-cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste.* *iv. Environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentive structure, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solution and responses to environmental problems.*	Environmental factors were considered in the Project design. The Project is not expected to generate any significant pollution or waste. Where possible, MWPA will: > Employ appropriately trained local personnel and source local goods and services; > Ensure leading best practice standards during construction to minimise emissions and discharges as far as reasonably possible; > Where possible, source goods and services that have the least environmental impact.
5. The principle of waste minimisation *All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.*	The Project aims for 100% beneficial use for the Geraldton Port maintenance dredge material and to avoid treating the dredge material as a waste and dumping offshore with no net environmental or commercial benefits. Waste generated from the Project will be minimised through the implementation of the hierarchy of waste controls: reduce, re-use, recycle, recover and dispose.

4.2. Preliminary Key Environmental Factors

The preliminary key environmental factors for the Project were determined by MWPA through a preliminary environmental impact assessment process and discussed with EPA Services during the Pre-referral meeting. The preliminary key environmental factors are:

- Coastal Processes;
- Marine Environmental Quality; and
- Benthic Communities and Habitat.

These factors are addressed individually in **Sections 4.3** to **Section 0**. Other relevant environmental factors are addressed in **Section 5**.

4.3. Coastal Processes

4.3.1. EPA Objective

The EPA's objective for the factor 'Coastal Processes' is:

> *'To maintain the geophysical processes that shape coastal morphology so that the environmental values of the coast are protected.'*

4.3.2. Policy and Guidance

The following EPA policies and guidance have been considered in evaluating potential impacts on this factor:

- EPA (2016b). *Environmental Factor Guideline: Coastal Processes,* EPA, Western Australia.

4.3.3. Receiving Environment

Studies of coastal processes that are relevant to the Project are identified in **Table 4-2**.

Table 4-2 Receiving Environment Studies – Coastal Processes

Author (Date)	Study
GEMMS (2021)	Geraldton Port Maintenance Dredging Hydrodynamic and Sediment Transport Modelling 2021
O2 Metocean (2021)	Metocean Measurements at Sunset Beach – City of Greater Geraldton
O2 Marine (2021a)	Baseline Sediment Characterisation Assessment – SAP Implementation Report
O2 Marine (2021b)	Sediment Characterisation – Sampling and Analysis Plan 2019
Tecchiato S *et al* (2016)	Carbonate sediment dynamics and compartmentalisation of a highly modified coast: Geraldton, Western Australia
Tecchiato S *et al* (2012)	Geraldton Embayments Coastal Sediment Budget Study - Final Project Report
Stul *et al* (2014)	Coastal Sediment Cells for the Mid-West Coast between the Moore River and Glenfield Beach, Western Australia.
DoT (2012)	The Coast of the Shires of Coorow to Northampton, Mid West, Western Australia: Geology, Geomorphology and Vulnerability
Oceanica (2010a)	Geraldton Port Channel Maintenance Dredging – Dredging Environmental Impact Assessment
GPA (2006)	Northern Beaches Stabilisation Programme
URS (2001a)	Port Enhancement Project and Preparatory Works for Town Beach Foreshore Redevelopment – Public Environment Review
ATA (1994)	ATA (1994). Deepwater Port at Point Moore, Public Environmental Review, Volume 1 General Report.

Regional Setting

Geraldton is located within the Midwest region on the west coast of Western Australia, approximately 400 km north of Perth. The Port is located on the northern side of the Point Moore peninsula with the

Port and city centre facing north into Champion Bay (**Figure 2-1**). Champion Bay is a semi-sheltered embayment protected from raw ocean swell conditions by a series of shallow subtidal reef systems extending off Point Moore and a deeper parallel limestone ridge which runs north towards Drummond Cove. East of the limestone ridge, water depths up to approximately 11 m occur within two kilometres of the coast. To the west of the limestone ridge, water depths rapidly increase to 20-30 m, and then gradually deepen to 50 m before shallowing again at the Houtman Abrolhos Islands located some 50 km offshore.

To the north and south of Point Moore, the coast is comprised primarily of sandy beaches generally overlying beach rock. Occasional areas of shallow beach rock and limestone platform are exposed at locations such as at Drummond Cove, Bluff Point, Point Moore and adjacent to the mouth of the Greenough River. Two main rivers, the Greenough River (~10 km south of Point Moore), and Chapman River (~5 km north of Point Moore), periodically discharge into coastal waters in the Geraldton area. These rivers are typically closed at the river mouth discharging only after significant rain falls within the two catchments.

Oceanographic Conditions

Offshore coastal waters, west of Champion Bay and Point Moore, experience moderate to high wave-energy. O2 Metocean (2021) undertook a metocean measurement programme on behalf of the City of Greater Geraldton in 2020. Waves, water levels, currents, and water temperature measurements collected at two sites distanced 1,100 m from each other, both approximately 500 m west of Sunset Beach foreshore in 10 m water depth, were collected to improve the understanding of the metocean conditions contributing to beach change at Sunset Beach. Anticipating that most severe beach erosion would occur in winter, the measurement campaign commenced in March 2020 and extended to October 2020. Summer conditions were later added to the programme, with the summer measurement campaign lasting six weeks from late November 2020 to early January 2021.

The significant wave height (Hs, total) at the measurement sites (10 m depth) peaked at Hs~2.6 m during a late May 2020 (winter) storm. The data revealed that Hs>2 m is a relatively common occurrence during winter, where Hs>1.4 m occurs approximately 30% of the time between June and October. Long period swells with peak spectral wave periods (Tp) longer than 20s were very rarely observed (<2%), however winter swells presented a peak period of 10<Tp<20s. Substantially more benign conditions were recorded in summer, with Hs>1.4 m less than 1% of the time and Hs<1m 83% of the time.

The currents are tidally driven and predominantly parallel to the coast, rotating from northward to southward (and vice versa) with the tidal cycle. Depth averaged peak current speeds typically range from 0.10 to 0.20 m/s in winter and rarely exceed 0.10 m/s in summer. Only once during the measurement campaign the current exceeded 0.25 m/s (May 2020 storm). Geraldton experiences diurnal tides with a small range (~0.9 m spring).

Geraldton experiences a seasonal wind pattern on which is superimposed a diurnal land-sea breeze system. During winter, night and morning winds are generally moderate (6–30 km/hr) and prevail from the north-east, then swing through north-west to south in the afternoon (URS 2001a). Summer morning winds are moderate (11–30 km/hr) and generally originate from the east to south-east. In the afternoon the winds shift to moderate to strong (generally 21–40 km/hr) through south to south-west (URS 2001a). Typically, December is the windiest month and July the least windy. Extreme winds occur mainly in summer and generally are isolated events associated with thunderstorms and tropical cyclones (ATA 1994).

Geomorphology

The Central West Coast Region is an area where the continental shelf is relatively narrow and there is a diversity of moderate energy coastal landforms developed. The coast is formed over the Perth Sedimentary basin. Through the Pleistocene (10,000 to 2,000,000 years ago) there was a succession of transgressions and regressions of the sea over the Swan Coastal Plain. As sea level fell during each regression it left behind a coastal dune field, the oldest of which have consolidated to form North-South aligned ridges of aeolianite limestones (URS 2001a). Ridges that occur above present-day sea level usually bear a mantle of Holocene dunes. Those below sea level form sublittoral reefs, often undercut and cavernous on the seaward side. Small islands, representing high points of flooded ridges, are a relatively common feature within a few kilometres of the shore.

Semi-sheltered lagoonal habitats are developed behind offshore limestone reefs in many localities. The degree of shelter is variable, depending on the depth and continuity of the offshore reefs and islands. The shore is commonly comprised of long sandy beaches with occasional rocky cliffs and headlands where the limestone outcrops. Notched intertidal rock platforms are a feature of this coast.

The sediments of the littoral and shallow water zone of Champion Bay are primarily seagrass derived (i.e. mainly composed of microscopic shells of seagrass-associated organisms), with secondary riverine quartz sediment input and dune related carbonate sediment input (Tecchiato *et al* 2012). There is an overall south to north transport pattern driven by south-westerly swell waves and strong sea breeze wave fields, however, temporary reversal can occur during powerful north-west swells potentially associated with tropical storms or large winter storms (Tecchiato *et al* 2012, Stull *et al* 2014).

Champion Bay is one of many partially protected embayments that occur along the coast within the Central West Coast Region. While the Bay has extensive reef along its western side, this generally rises to only 8 to 10 m below sea level and there are no offshore islands to provide protection from wave energy. Swell height at the coast is attenuated by coastal limestone ridges; however, wave heights and periods are sufficient to initiate bottom sediment particle movement over the entire Geraldton inshore platform (Tecchiato *et al* 2012). The limited protection of Champion Bay is evidenced by the relatively narrow, high energy beaches found along most of its length and the relatively small amount of sediment which is present on the floor of the Bay. Only the south-eastern corner of the Bay has a level of protection sufficient to allow the development of extensive seagrass beds on thick sand veneers overlying the limestone basement.

Regional Sediment Cells

Stull *et al* (2014) defines sediment cells as ‘spatially discrete areas of the coast within which marine and terrestrial landforms are likely to be connected through processes of sediment exchange, often described using sediment ‘budgets’. They include areas of sediment supply (sources), sediment loss (sinks), and the sediment transport processes linking them (pathways). Sediment transport pathways include both alongshore and cross-shore processes, and therefore cells are best represented in two-dimensions. They are natural management units with a physical basis and commonly cross jurisdictional boundaries.

Stull *et al* (2014) defined the primary, secondary and tertiary sediment cells for the Mid-west coast, including the Project study area. The wider Geraldton Region occurs within the Primary sediment cell between Phillips Road to Glenfield, whilst the immediate Project area occurs within the Point Moore to Glenfield secondary cell. These are presented within **Figure 4-1**.

Figure 4-1 Primary and Secondary Sediment Cells – source Department of Transport.

Sediment Budget

Tecchiato *et al* (2012) identified that fine modern bioclastic sand, medium-coarse modern and relict bioclastic sand and river derived sand represent the greatest proportion of marine and coastal sediment types within the Point Moore to Glenfield secondary cell. Fine sands were typically found along the low energy beaches in the south-east and also along the east. Fine sands are typically redistributed by wave energy along the coast from south to north. Medium-coarse grained sand was typically mapped in the deeper areas (~10 m) surrounding underwater limestone ridges, typically forming north-south sinks between the reef systems. Three typical sediment sources were identified including:

1. Local biological production of sediment associated with the sparse seagrass meadows and the dense macroalgal communities colonising shallow limestone reef systems provides most of the sediment input in the study area. This production is limited to the shallower sectors (<10 m deep).
2. Limited supply of quartz sand into Champion Bay from the Chapman River making up minor component of sediment budget, but approximately 45% of sediments deposited in central Champion Bay.
3. Southgate dune system supplies carbonate sands into the Geraldton littoral zone during strong offshore and sea breezes.

Tecchiato *et al* (2012) identified a clear distinction between the littoral (<10 m) and offshore sediment mobility zones, with the offshore zone comprising no seagrass derived fine carbonate sands which are dominant within the littoral zone. Fine carbonate sands were also mapped along the coastal beaches identifying wave action responsible for the transport of these sediments from the seagrass communities to the coastal areas. Littoral sediment pathways are typically south to north, with smaller temporal reversals occurring during infrequent large north-west swell patterns. Locally derived, or modern, fine sediments are dominant within the littoral system comprising the bulk of the northwards sediment transport system. Coarser riverine materials contribute to the littoral transport system and generally accumulate within the middle of Champion Bay, with a slower migration north occurring only during higher energy periods. These sediments are contributing to beach nourishment at Glenfield's Beach and further north. The Southgate dune system supplies sediment to the coastal system which deposits offshore and is distributed to the north by the littoral currents. This typically accretes around Separation Point with a significant volume transported north of Point Moore, generally forming sinks within depositional areas between limestone ridges and the Port channel. Once situated within sink areas, further migration of this material north and east into Champion Bay is restricted.

4.3.4. Potential Impacts

The following activities have the potential to adversely impact on coastal processes within the Project area:

1. Relocation of sediment within the Point Moore to Glenfield secondary sediment cell impacting natural transport mechanisms;
2. Sustainable relocation of dredge material resulting in localised alteration of the morphology of the coastal zone potentially resulting in changes to erosion/deposition patterns;
3. Sustainable relocation of dredge material resulting in localised alteration of the morphology of the coastal zone potentially impacting Chapman River hydrology with secondary impacts to the TEC – Tropical and Subtropical Coastal Saltmarshes;

4. Alterations to the existing physical characteristics of the designated nearshore DMPA; and
5. Alteration of the structure of adjacent marine communities through placement of material.

Assessment of Impacts

Relocation of dredge material within existing sediment cell (1)

The Project includes the sustainable relocation of ~190,000 m^3 of clean, natural sediments which have accreted within the entrance channel over the past ~nine years. It is proposed that this material is relocated to the Nearshore DMPA presented within **Figure 2-2**. The proposed nearshore DMPA was defined through a process which assessed a range of options and then assessed the final possibilities through a multiple criteria assessment (refer to **Section 2.2.3).** Within this process, one of the main drivers for site selection, with respect to coastal processes, was to avoid potential environmental impacts associated with the relocation of sediments out of the identified secondary cell. This is typically the case with dredging campaigns that categorise dredge material as a 'waste' which then required the designation of an offshore spoil ground and requires an approved sea-dumping permit. This process typically relocates the dredge material from the secondary sediment cell where it is removed from the natural processes occurring within that cell, potentially creating ecological and/or coastal stability issues.

The Port Authority's process of identifying a sustainable relocation option for this material has applied both avoidance and mitigation of potential coastal processes impacts by maintaining the material within the defined secondary sediment cell (**Figure 4-1**). Sustainable relocation of dredge material to the proposed nearshore DMPA allows natural mechanisms which ordinarily occur within the secondary sediment cell to apply to the material resulting in an increase in coastal resilience, supplementing material into the littoral drift and to provide a buffer for the stability of existing seagrass meadows.

Whilst the sustainable relocation option will place ~190,000 m^3 over two months, rather than smaller ongoing volumes, (estimated to be between 1,700-1,800 m^3 monthly) that would naturally be contributed to the sediment cell if not trapped in the entrance channel, there are not identified to be any associated impacts within the sediment cells natural functions. Hydrodynamic modelling undertaken by GEMMS (2021) indicates that the material typically behaves similar over time. Modelling results indicate that without the entrance channel in place 90.5% of the source material would remain within the secondary sediment cell over the two-year modelling period. Similarly, predictive modelling of sediment transport from the Nearshore DMPA over the same time period identifies 90.2 % of the material remaining within the secondary sediment cell. Other similarities which are observed under both scenarios include:

- Coarser material remains within sinks, migrating northwards only during high energy storm or wave events;
- Finer material is drawn into the coastal littoral drift which moves from south to north;
- Finer and medium material is deposited along the coast typically between Sunset Beach to Glenfield's Beach
- Minor volumes are lost to the secondary sediment cell north of Drummonds Point;

The modelling prediction of sediment fate over time corresponds to the finding from Tecchiato et al (2012) whereby finer sediment particles were associated with the coastal littoral transport system whilst coarser particles occur within sinks and are subjected to a slower northwards migration during high energy periods.

Modelling of the nearshore DMPA identifies some dissimilarities with the natural scenarios with the entrance channel removed. These typically include:

- Under the no-channel scenario sediment material typically remains within the central region of champion bay with lower contribution to the coastal littoral drift or for coastal resilience.
- Under the nearshore placement scenario sediment is typically more available to the coastal littoral drift and has a higher potential to support coastal resilience between Town Beach to Drummonds Point (**Figure 4-4**).
- Modelling of the nearshore placement scenario indicates that only the finer particles are subject to regular littoral transport, whilst the coarser particles typically remain at the placement area and are subjected to a slower rate of transport, whilst these course particles would naturally be more dispersed through the north-south sink systems further to the west.

Whilst there are identified differences between the sediment fate between the two scenarios, these are not considered to be unacceptable with regards to coastal processes occurring within the sediment cell. In fact, by relocating the material to the nearshore DMPA there are likely to be additional benefits for coastal resilience through the increased sediment supply to the coastal and littoral transport system.

Based upon these findings there are no anticipated or unacceptable risks to the EPA Factor Coastal Processes through removing sediments from secondary sediment cells, or by the placement of the relocation volume over a short period of time.

Alteration of hydrodynamics impacting coastal erosion (2)

The placement of ~190,000 m^3 of dredge material into the nearshore environment at the proposed nearshore DMPA may have the potential to alter the hydrodynamic environment resulting in coastal erosion or altered coastal processes. To avoid and mitigate the potential for associated impacts, the MWPA commissioned several key environmental and technical investigations which were undertaken to support the placement location of the proposed nearshore DMPA. Studies included bathymetric surveying, towed and drop camera habitat assessment and sediment sampling. The final nearshore DMPA was selected over bare sand, thus reducing impacts on Benthic Communities and Habitat (refer to **Section 4.5**). The area was surveyed and validated through towed camera and video and placed upon the maximum available area of bare sand. The final placement area is ~530,000 m^2, therefore with a total volume of ~190,000 m^3 of dredge material being relocated the final height of the placed material is estimated to be less than one meter.

During placement of material from the dredge hopper, there are contractual obligations which direct the placement methodology. During dredging, part of the dredge management practices at the nearshore DMPA require the dredge to slowly place the material within the area at slow speeds to maximise the distribution, thus minimising the final height. Furthermore, any high spots are required to smoothed off through spreading the material evenly using a sweep bar or similar mechanism if identified during bathymetric surveys.

Whilst there is no specific data available on the average height of natural sand sheet drift through Champion Bay, video data collected by O2 Metocean (2021) during metocean studies for the City of

Greater Geraldton identified significant sand sheet movement during winter at locations adjacent to the designated nearshore DMPA. During this survey sandy substrates were identified using remote operated vehicles with video to allow suitable positioning of seaframe with metocean equipment which remained in-situ for three-month periods. During two sets of deployments, at two locations over the winter of 2020, the seaframes were identified sitting on bare limestone pavement upon recovery, suggesting that the initially identified sand had been completely moved by swell energy, exposing the underlying limestone pavement. These sand sheets were estimated to be up to 50cm based upon the relief of the exposed pavement and final position of the frames upon recovery. This study therefore identified a high level of natural movement of sand occurring adjacent to the placement area, thus indicating the maximum height allowance of one meter for the nearshore DMPA as unlikely to result in any alteration in the hydrodynamics within the immediate or wider area, such that coastal erosion occurs.

By minimising the height of the final placement area, impacts upon coastal stability and erosion have been mitigated as the overall height of the altered bathymetry is insignificant to result in any significant hydrodynamic alterations. Furthermore, scenarios for 6-, 12- and 24-month sediment transport modelling indicate that sediment from the nearshore DMPA will be deposited along the coast, potentially accreting on beaches between town beach to Drummonds Point, thus there is more likely to be benefits, rather than impacts from the proposed placement methodology. Modelling indicates that accretion up to 20 cm may be possible, adjacent to the beaches, over the modelled period.

Based upon these findings there are no anticipated or unacceptable risks to the EPA Factor Coastal Processes through alteration of hydrodynamics which may result in coastal erosion.

Alteration of Chapman River Mouth impacting TEC – Subtropical and Temperate Coastal Saltmarsh (3)

The placement of ~190,000 m^3 of dredge material into the nearshore environment at the proposed nearshore DMPA may have the potential to contribute to sediment accretion at the Chapman River mouth which may potentially alter the frequency of intermittent flows from this system. A potential indirect impact from reduced the frequency of intermittent flows from this system is the potential to alter water quality, water levels and salinity within the system which may lead then impacts the health of the TEC. The spatial distribution of the TEC is presented in **Figure 2-11**.

Flushing of the river mouth and control of the water quality is typically driven by factors independent from coastal processes so this assessment will deal with the potential for the flows to be restricted due to sediment build-up at the river mouth which is considered a driver for maintaining healthy water quality required to support the TEC.

Hydrodynamic modelling results predict an accretion of ~5-20 cm occurring adjacent to the rivermouth area over the 6-, 12- and 24-month. It should be noted that the model does not predict sediment accretion on the beaches as this is not within the capacity of hydrodynamic modelling. Rather as particles exit the model domain, they are ‘considered’ to be deposited at the coast. Typically, it is the finer particles, rather than the coarse material, which is deposited at the coast. This supports Tecchiato *et al* (2012) who stated that finer material being drawn towards the coast and then northwards via the coastal littoral drift whilst coarser particles remain within the ‘sinks’ and are only migrated northwards during larger energy events.

Based upon the current coastal processes occurring in this area, whereby the beaches are subjected to erosive process, rather than accretion, sediments which exit the model and deposit onto beaches are likely to provide a temporary supplement to coastal resilience, however their final fate is most likely to be entrained into the northward littoral drift, being replaced by further sediments which then migrate from the placement area. This cycle is likely to continue over the modelled period of two years with sediments accreting temporarily before being entrained into the coastal littoral drift and being replaced by additional sediments. Whilst this will support coastal resilience along the coast, it is not anticipated that sediments will accrete in sufficient volumes, or at a height that result in restriction to the natural river flushing scenarios.

Based upon these studies it is predicted that whilst 5-20 cm of sediment will accumulate at the rivermouth, this material will be subjected to the northwards littoral drift, rather than accreting over time to a height that would be able to reduce intermittent river flushing. Based upon these results there are no predicted indirect impacts upon the identified TEC community.

Alteration of physical properties (4)

The placement of ~190,000 m^3 of dredge material into the nearshore environment at the proposed nearshore DMPA may have the potential alter the physical properties of the sediments that occur within the existing environment. Therefore, O2 Marine (2021a) undertook a technical sediment study to determine the physical properties of the dredge material, and the existing material at the proposed nearshore DMPA.

O2 Marine (2021a) collected samples from 19 sites distributed randomly across the proposed dredging area and five sites within the nearshore DMPA. Particle size distribution (PSD) was analysed by Microanalysis Australia at 10 entrance channel sites and five nearshore DMPA sites.

Entrance channel sediments PSD are presented in **Figure 4-2.** They are generally consistent across the sample sites, predominately comprising medium to fine 'beach' sands of natural origins. Very little organic matter is present, typically confined to the surface 1 cm. Surface sediments are typically a yellow-light brown colour, becoming progressively greyer with depth. Most cores were quite densely packed but soft once removed and placed into the sampling container. Living biota (infauna) are typically present within sediments, dominated by echinoderms and small crustaceans. PSD analysis for the entrance channel samples indicate sediments are predominately composed of sand sized particles ($\bar{x}$ = 89.7%). The proportion of sand fraction within samples are predominantly fine sand ranging from 54.1% to 78.2%, whilst medium sand ranged between 5.3% to 41.6%. The proportion of gravel, coarse sand and clay was low, typically <4%.

Nearshore sediment PSD are presented in **Figure 4-3**. They are generally consistent across the sample sites, predominately comprising medium to fine 'beach' sands of natural origins. Organic matter is very low and they are typically a yellow-light brown colour. Most cores were quite densely packed but soft once removed and placed into the sampling container. Living biota (infauna) were not observed from any of the five samples. PSD were dominated by medium sand, with fine sand comprising the second highest percentage. Clays, silts, coarse sands and gravels represent a very low proportion of the PSD.

The determination of both the entrance channel dredge material dredge and the existing sediments within the nearshore DMPA being dominated by fine to medium sand sized particles suggests that alteration of the natural physical properties is not considered an environmental impact from this Project.

Based upon these findings there are no anticipated or unacceptable risks to the EPA Factor Coastal Processes through alteration of the natural physical properties of sediments within the natural system.

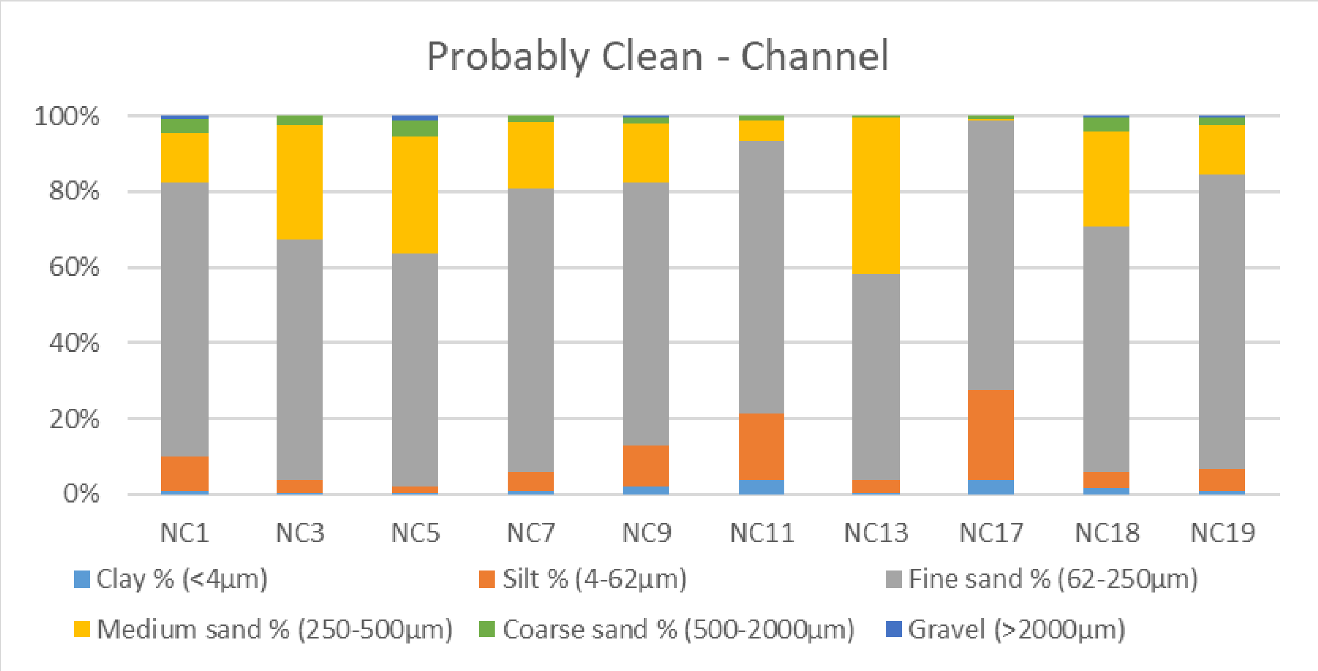

Figure 4-2 Particle size distribution of entrance channel sediments (Source O2 Marine 2021a)

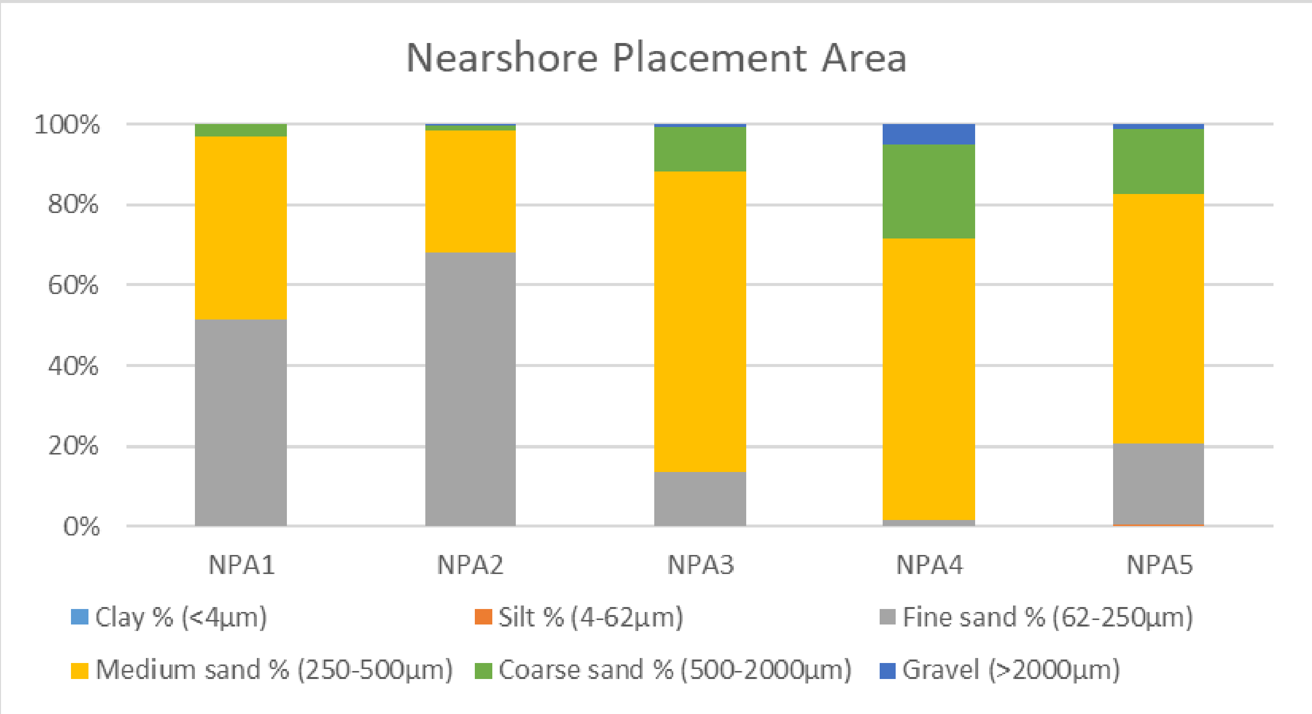

Figure 4-3 Particle size distribution of nearshore DMPA sediments (Source O2 Marine 2021a)

Alteration to adjacent marine communities (5)

Placement of dredge material poses a risk to adjacent BCH and marine fauna. This potential impact is discussed and assessed in the context of the extent, duration and severity of the potential impact on BCH in **Section 4.5**, respectively.

4.3.5. Potential Environmental Benefits

Sediment relocation activities from the entrance channel to the Nearshore DMPA has the potential to positively impact coastal processes within the Project area:

1. Returning sediments confined within the entrance channel back to the sediment cell it was derived from.
2. Allowing sediments to continue to naturally migrate under the influence of natural coastal processes (waves and currents).
3. Providing an ongoing source of sediment supply to the nearshore environment required for building resilience to coastal erosion.

Assessment of Potential Environmental Benefits

The Project includes the sustainable relocation of ~190,000 m^3 of clean, natural sediments which have accreted within the entrance channel over the past ~nine years. It is proposed that this material is relocated to the nearshore DMPA presented within **Figure 2-2**. One of the main drivers for relocation of these sediments within Champion Bay is to ensure that the material remains within the same secondary sediment cell as defined by Stull *et al* (2014) and presented within **Figure 4-1**.

Whilst sediments typically remain within secondary sediment cells, a percentage of sediments migrate northwards over time (Tecchiato *et al* 2012). Within the Phillips Road Coast to Glenfield Primary sediment cell sediments enter the Point Moore to Glenfield cell from the Cape Burney South to Point Moore cell and then migrate north to the Glenfield to Coronation Beach cell. Through the construction of the entrance channel, locally derived sediments from the southern portion of the Point Moore to Glenfield cell (i.e. local biological production associated with seagrass meadow and algal communities (Tecchiato *et al* 2012), and sediments derived from the Cape Burney South to Point Moore cell have essentially been restricted from their natural functions within the Point Moore to Glenfield cell. Over time this may have resulted in coastal process impacts such as increased coastal erosion and restricted sediment migration north to the Glenfield to Coronation Beach cell. Additionally, this restriction of the sediment to perform its natural function within the Point Moore to Glenfield cell may also have led to indirect impacts, such as restricting sediments to support healthy seagrass meadow distributions.

Through the process of relocating sediments currently trapped within the entrance channel and relocating them to a suitable site within the Point Moore to Glenfield cell they are being re-introduced to natural processes, such as wind, waves and current allowing them to be redistributed within the cell and to supplement the northwards migration into the Glenfield to Coronation Beach cell. As described above, GEMMS (2021) undertook sediment transport modelling under the natural scenario of removing the entrance channel and on sediments from the Nearshore DMPA. Results presented within GEMMS (2021) confirm that sediments under both scenarios act similar within the Point Moore to Glenfield and Glenfield to Coronation Beach cells. Based upon this predictive modelling and previous technical studies within the secondary sediment cells, it is considered that relocating sediments from the entrance channel to the Nearshore DMPA will have a positive net environmental outcome for the potential impacts described above.

By relocating sediments trapped within the entrance channel to the Nearshore DMPA and allowing natural processes to act on them, it is possible that there will be a long-term environmental benefit of reducing or slowing coastal erosion along the Champion Bay coastline. Results of sediment migration out of the model domain entering the nearshore environment from the two modelled sediment transport scenarios are presented in **Table 4-3** whilst sediment transport modelling results are presented in **Figure 4-4**. Model results indicate an increased eastern migration of sediments into water depths less than three meters (i.e. the extent of the model domain) under the Nearshore DMPA scenario (8.7% after 180 days) than under modelled natural scenario assuming no-channel (5.5%) (GEMMS 2021). This is compared to the current scenario where 0% of the trapped sediments are free to replenish nearshore sediments. Once within this zone it can be assumed that they will enter the natural northern littoral drift where they are intermittently deposited in the surf zone or on beaches, and then resuspended and remobilised northwards. Modelling results also indicate that the new source of sediments will remain for greater than two years, therefore any predicted or potential impacts will be long-term, rather than instant. However, as there is an ongoing source over time, any benefits are also expected to be ongoing, rather than temporary, such as through shoreline deposition. Through shoreline deposition, whereby material is deposited directly onto beaches, erosion is temporarily suspended by the nourishment, however there is not considered to be an ongoing source and material can rapidly be eroded away during winter storm events with no ongoing form of nourishment.

Table 4-3 The Fate of Sediments from the Placement Area and the No-Channel Scenario (Source GEMMS 2021)

Elapsed Time (days)	% sediments outside domain from the Placement Area	% sediments outside domain for the no-channel scenario	% sediments from the Placement Area found near the shoreline	% sediments from channel region found near the shoreline if the channel is removed	% Sediments trapped within Channel found near shoreline
90	4.0	5.0	6.7	2.8	0
180	4.6	6.5	8.7	5.5	0
365	7.1	8.8	7.0	5.0	0
730	9.8	9.5	6.2	4.5	0

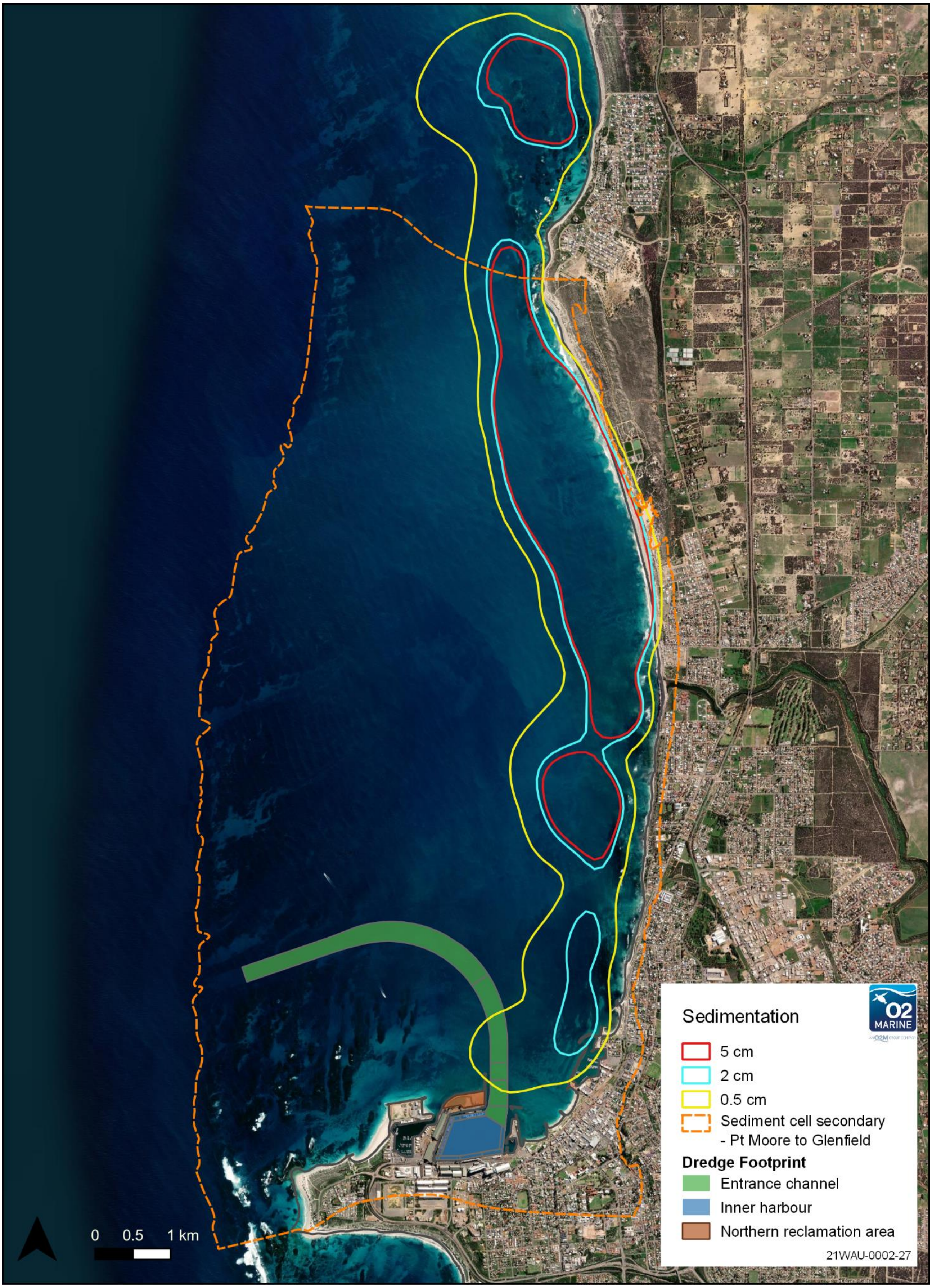

Figure 4-4 Sediment distribution from the Nearshore DMPA >0.5cm, 2cm and 5cm after 2 year modelling period (Source - GEMMS 2021)

4.3.6. Mitigation

Management proposed to minimise potential impacts on the environmental factor ‘Coastal Processes’ are described in and presented in accordance with the EPA’s mitigation hierarchy (Avoid, Minimise, Rehabilitate).

Table 4-4 Mitigation measures to minimise impacts on Coastal Processes.

Potential Impact	Avoidance	Minimisation	Residual Impact
Altering natural transport mechanisms (1)	> MWPA have avoided classification of the material as 'waste' and the offshore sea dumping process typically employed for dredging projects. > MWPA have identified a suitable sustainable relocation option which is commensurate with maintaining sediments within the existing secondary sediment cell avoiding potential impacts of relocating this material to a separate sediment cell, thereby allowing the natural coastal processes to act on this material.	> Hydrodynamic modelling was used to provide an understanding of the sediment fate under natural conditions and through sustainable relocation. Modelling results support the Project purpose that natural processes will then apply to the material similar to under natural conditions with materiel available to support coastal resilience.	No residual negative impacts are predicted. There is the potential for beneficial impacts through increased coastal resilience from the proposed sustainable relocation.
Coastal Erosion (2)	> MWPA executed a series of environmental and technical surveys to facilitate selecting the largest spatial position for the nearshore DMPA to provide the maximum distribution of material and effectively mitigated creation of a high area to minimise impacts upon coastal processes.	> MWPA undertook hydrodynamic modelling which identified an increase rate of sediment deposition at the coastline over natural conditions thus providing a potential increased resilience for coastal erosion. > Management of the nearshore placement through the dredge management plan and MWPA contracts with the dredge company to ensure bathymetric surveys do not identify sediment high points and that sediments are distributed evenly across the nearshore DMPA	No residual impacts are predicted. There is the potential for beneficial impacts through increased coastal resilience from the proposed sustainable relocation.
Health of TEC (3)	> MWPA elected to provide sediments into the nearshore rather than rainbowing, or	> MWPA undertook hydrodynamic modelling to determine the fate of	No residual impacts are predicted.

Potential Impact	Avoidance	Minimisation	Residual Impact
	transporting sediments directly to the eroding coastline adjacent to the rivermouth.	sediments from the nearshore DMPA over 3-, 6-, 12- and 24-month periods to ensure no impacts to intermittent river flushing occur and therefore no indirect impacts to the health of the TEC occur from the Project.	
Altering physical characteristics (4)	> MWPA undertook studies to determine the similarity of the proposed dredge material with sediments at the nearshore DMPA to ensure no impacts occur from the Project.	N/A	No residual impacts are predicted.
Impacts to adjacent BCH (5)	Assessed in **Section 4.5**		

4.3.7. Ongoing Coastal Management and Monitoring

MWPA currently undertake the following management and monitoring with respect to coastal processes:

1. Implements the annual requirements of the Northern Beaches Stabilisation Programme (NBSP) (GPA 2006), including:
    a. Annual sand bypassing of a minimum of 12,500 m^3 of sand from Pages Beach to local beaches in consultation with the City of Greater Geraldton. This is currently a condition of Ministerial Statement 600.
    b. Monitoring beach erosion/accretion through repeating annual beach profile surveys along the coastline from Separation Point to Glenfield's Beach at 68 locations.
    c. Annual aerial surveys of the northern beaches areas.
2. Six monthly hydrographic surveying of navigable waters.

Part of the EPA's conditions for implementing the Port Enhancement Project issued via Ministerial Statement 600, required the Port to develop and implement the northern beaches stabilisation program. This typically required annual sand bypassing from Pages Beach to the northern beaches, annual shoreline surveys and annual aerial photography of the northern beaches area. These are discussed below.

Additionally, as part of the Ports navigational requirements, six monthly hydrographic surveys are completed within the navigable waters. MWPA are committed to extending the spatial distribution of these surveys to validate the sediment modelling fate with regards to sediment transport and distribution.

Sand Bypassing Program

Annual sand bypassing was identified as a mitigating management strategy for coastal erosion impacts during the preparation of the environmental review documentation and assessment of impacts associated with the Port Enhancement Project back in 2001. As a requirement of the project approvals, the EPA requires MPA to bypass a minimum of 12,500m3 of sand from Pages Beach to a location or locations on the town beaches determined in consultation with the City of Greater Geraldton. This has occurred every year since 2003 with the outcome to supplement sediments potentially trapped within the entrance channel and assist slowing the current erosion of the Geraldton northern beaches.

MWPA are committed to the ongoing bypassing of these sediments, supplementary to the material proposed to be placed and the nearshore DMPA to assists with coastal resilience in accordance with the NBSP.

Beach Profiling

Annual beach profiling is conducted at 68 locations between Separation Point to Glenfield's Beach. This monitoring program was designed to provide an ongoing assessment tool for monitoring, assessing and managing coastal erosion along the northern beaches. The program was also designed to assess the success of the annual sand bypassing, identify target areas for sand nourishment and provide feedback on where the sand bypassing volumes typically distribute.

MWPA are committed to the ongoing implementation of this program as it will provide a valuable long-term dataset with which the impact assessment and beneficial use predictions for the nearshore DMPA can be determined.

Aerial Photography

To support the interpretation of beach profiling, the MWPA undertake annual high resolution aerial photography long the Champion Bay coastline. This survey typically encompasses the coastline from Point Moore up to Glenfield's Beach. These photos have been completed ad-hoc over a long period, with them increasing to an annual frequency during 2003.

MWPA are committed to ongoing implementation of shoreline monitoring via aerial photography in accordance with the NBSP and considering the potential benefits of coastal resilience from this Project, to validate project and modelling predictions.

Hydrographic Surveys

As a requirement for the Draft Under Keel Clearance (DUKC) assessment of shipping drafts for navigational safety, MWPA conduct six monthly hydrographic surveying to Special Order certification. As a commitment to validate the dredging placement of sediment at the nearshore DMPA a post dredging survey will be conducted to ensure no high spots remain post dredging and ascertain the revised bathymetry of the Nearshore DMPA. MWAP are also committed to conducting annual surveys of this site for a two-year period to validate the sediment fate predicted by hydrodynamic modelling, along with quantifying the predicted impacts (**Section 4.5.4**) with respect to sedimentation and smothering on benthic communities.

Ongoing Consultation

In addition, MWPA is committed to ongoing engagement with DoT and City of Greater Geraldton with respect to town planning and building coastal future resilience strategies. A current example is the recent support offered by MWPA to the City of Greater Geraldton and DoT metocean monitoring program conducted offshore from Sunset Beach. This will ultimately feed into coastal modelling studies being undertaken by the City, DoT and MWPA to further understand the dynamics and processes shaping the coastline. The outcomes of this study will provide a greater understanding of the coastal processes to better inform future strategies for coastal planning and reduce impacts associated with any coastal infrastructure projects or port expansion.

4.3.8. Predicted Outcome

The Project will result in the following predicted Environmental Protection Outcomes (EPOs) with respect to Coastal Processes:

- No residual impact on coastal processes as a result of the Project and Project activities; and
- Supplementing the natural sediment budget within the Point Moore to Glenfield Secondary sediment cell potentially resulting in positive environmental outcomes including:
    - returning sediments confined within the entrance channel back to the sediment cell it was derived from;

- allowing sediments to continue to naturally migrate under the influence of natural coastal processes (waves and currents);
- providing an ongoing source for sediment supply to the shoreline required for building resilience to coastal erosion.

Based on the above EPOs, and in consideration of the proposed monitoring and management strategies, the Project activities are not expected to pose a significant residual risk to the protection of geophysical processes, thus ensuring that the environmental values of the coast are protected. In relation to the Project, the Proponent considers that the EPA's objective for coastal processes has been met. Additionally, project outcomes may include potential environmental outcomes that are able to support the natural system which will essentially provide coastal resilience and support natural ecological functions associated with Coastal Processes.

4.4. Marine Environmental Quality

4.4.1. EPA Objective

The EPA's objective for the factor 'Marine Environmental Quality' is:

'*To maintain the quality of water, sediment and biota so that environmental values are protected*.'

4.4.2. Policy & Guidance

> EPA (2016c). *Environmental Factor Guideline: Marine Environmental Quality*, EPA, Western Australia; and

> EPA (2016d). Technical Guidance: *Protecting the Quality of Western Australia's Marine Environment, EPA, Western Australia*. EPA, Western Australia.

4.4.3. Receiving Environment

Studies of marine environmental quality that are relevant to the Project are identified in **Table 4-5**.

Table 4-5 Receiving Environment Studies – Marine Environmental Quality

Author (Date)	Study
Coffey (2021)	Acid Sulphate Soils Management Plan
MWPA	Marine Water Quality Sampling Results Database
O2 Marine (2021a)	Baseline Sediment Characterisation Assessment – SAP Implementation Report
O2 Marine (2021b)	Sediment Characterisation – Sampling and Analysis Plan 2019
Coffey (2017)	Geraldton Port Risk Assessment
Coffey (2015)	Geraldton Port Detailed Site Investigation
GPA (2013a)	2012 Maintenance Dredge Project – Environmental Water Quality Monitoring Report
GPA (2013b)	2012 Maintenance Dredge Project – Environmental Monitoring Report
Oceanica (2010a)	Geraldton Port—Channel Maintenance Dredging - Dredging Environmental Impact Assessment
URS (2001a)	Port Enhancement Project and Preparatory Works for Town Beach Foreshore Redevelopment – Public Environment Review

Environmental Quality Plan

An Environmental Quality Management Framework (EQMF) has not yet been formerly established for the Port of Geraldton or the wider Champion Bay marine waters. However, MWPA has been implementing a comprehensive Marine Water Quality Monitoring Program and as a prescribed premise is required to conduct annual Compliance Sediment Sampling in accordance with the Environmental Licence at the Port of Geraldton. These programs allow MWPA to monitor and manage potential impacts to marine environmental quality which may arise as a result of Port operations.

In addition, MWPA are currently developing an EQMF consistent with the EPA's Technical Guidance for *Protecting the Quality of Western Australia's Marine Environment* (EPA 2016d), which defines the Environmental Values (EVs), Environmental Quality Objectives (EQOs) and spatial Levels of Ecological Protection (LEPs) that are appropriate to the Port of Geraldton and adjacent Champion Bay. These are defined in **Table 4-6** and presented in **Figure 4-5**.

Table 4-6 Proposed Environmental Values and Environmental Quality Objectives applicable to the Port of Broome and surrounding waters (O2 Marine 2020a)

Environmental Values	Environmental Quality Objectives
Ecosystem Health	EQO1: Maintenance of ecosystem integrity. EQO1 can be split into four sub-objectives, being: Maximum, High, Moderate and Low Levels of Ecological Protection (LEPs). However, the following sub-objectives are applicable to the Project Area: > High LEP: Assigned to all marine waters outside of the moderate LEP, including Champion Bay; and > Moderate LEP: Assigned to a 250m buffer of the operational berths and the inner harbour of Geraldton Port, the Fishing Boat Harbour and Batavia Coastal Marina. LEPs are presented in **Figure 4-5**.
Fishing & Aquaculture	EQO2: Seafood (caught) is of a quality safe for human consumption. EQO3: Water quality is suitable for aquaculture purposes.
Recreation & Aesthetics	EQO4: Water quality is safe for primary contact recreation (e.g. swimming and diving). EQO5: Water quality is safe for secondary contact recreation (e.g. fishing and boating). EQO6: Aesthetic values of the marine environment are protected.
Cultural & Spiritual	EQO7: Cultural and spiritual values of the marine environment are protected.
Industrial Water Supply	EQO8: Water quality is suitable for industrial supply purposes.

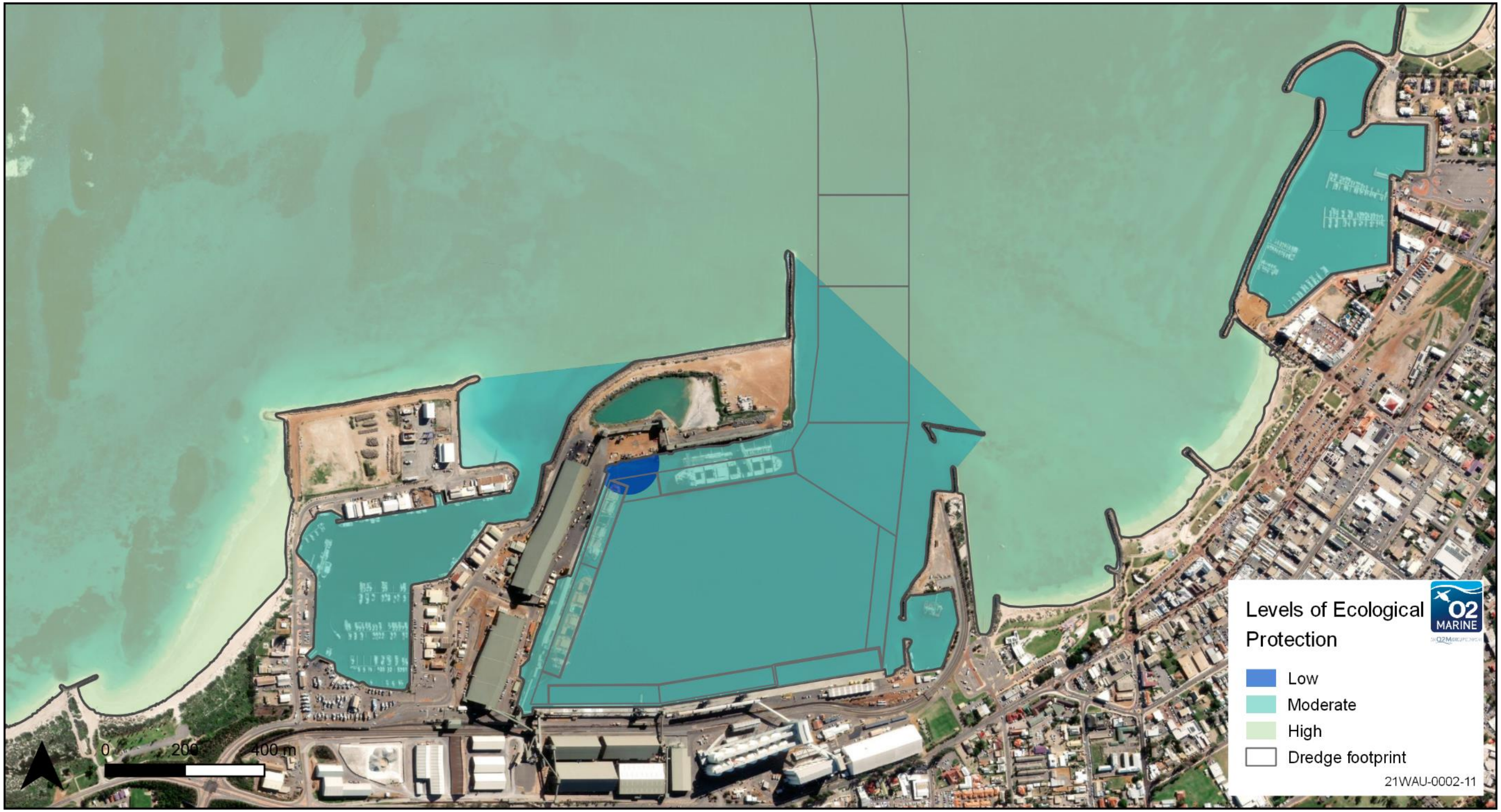

Figure 4-5 Proposed levels of ecological protection for the Port of Geraldton and surrounding waters

Marine Water Quality

Water clarity in Champion Bay is variable during the year as a result of wind driven current strengths and wave energy, as well as intermittent rainfall runoff in the catchments of the rivers, such as the Greenough and Chapman Rivers that drain the hinterland. Typically, the season of lowest water clarity is winter as a higher energy swells mobilising bottom sediments and due to this being the main time during which the intermittent discharge to the Bay of alluvial sediments from river discharge. In wet years, the Bay remains turbid for many months and salinity of nearshore waters slightly decreases as a result of river inflow. Strong winds in summer create waves that also cause an increase in suspended particulate matter which can also reduce water clarity. The period of greatest water clarity is usually in late summer to autumn (February to May) and occurs in response to reduced wind strengths and wave energy and absence of riverine sediment input.

Turbidity within Champion Bay typically increases closer to shore, mostly as a consequence of wave action that lifts sands and silt-sized particles into the water column (URS 2001a). During spring and summer there is often a marked diurnal effect, with the increased wave action generated by the strong mid-morning to evening sea breezes increasing coastal turbidity compared to the early morning and dawn calms. During autumn and winter, turbidity and cloudiness (discolouration) is also often elevated in the inner half of Champion Bay, a period when fine organic material from the nearshore and shoreline wracks of decaying seaweed and seagrass is suspended and dispersed through the nearshore water column. Apart from the natural sources and cycles of turbidity, propeller wash from ship and tug movements along the inner sector of the entrance channel also contributes to turbidity. Marked variations in turbidity therefore occur within hourly, daily, weather-system and seasonal time cycles, as well as with depth.

MWPA have implemented a passive water quality monitoring program targeting key metal contaminants since November 2012. This involves the collection of time weighted average samples at three locations within the Inner harbour (Berths 4, 5 and 6) and one reference site within Champion Bay north of the entrance channel. Analytes collected during this period include cadmium, cobalt, copper, lead, nickel and zinc as these are known elements occurring withing exported metal concentrate ores. A summary of the water quality sampling results are provided below.

- General:
    - No exceedances of the 90% species protection level (SPL) (typically applied to Ports) or the 95% SPL have occurred within the inner harbour throughout the monitoring program.
    - Water quality within the inner harbour is considered to be of a very high quality with slight elevations from natural conditions occurring for copper, lead and zinc.
    - Two exceedances of the copper 99% SPL were reported from the reference sites however detections to the ultra-trace for copper may result in handling or laboratory errors.
- Cadmium:
    - Cadmium concentrations at impact sites are typically very low, ranging from below the laboratory detection levels to 0.046 µg/L. The 90% SPL typically applied to a Port environment is 14.0 µg/L.
    - Inner harbour and reference sites typically have comparable concentrations.
- Cobalt:

- Cobalt concentrations at impact sites are typically very low, ranging from below the laboratory detection levels to 0.031 µg/L. The 90% SPL typically applied to a Port environment is 14.0 µg/L.
- Inner harbour and reference sites typically have comparable concentrations.

> Copper:

- Copper concentrations at impact sites are typically low, ranging from low level detections of 0.24 µg/L to 2.65 µg/L. The 90% SPL typically applied to a Port environment is 3.0 µg/L.
- Whilst there have been no exceedances of the 90% SPL, copper concentrations are generally elevated within the inner harbour compared to reference sites which range from below the laboratory detection level to 1.46 µg/L.

> Lead:

- Lead concentrations at impact sites are typically very low, ranging from low level detections of 0.05 µg/L to 0.89 µg/L. The 90% SPL typically applied to a Port environment is 6.6 µg/L.
- Whilst there have been no exceedances of the 90% SPL, lead concentrations are generally elevated within the inner harbour compared to reference sites which range from below the laboratory detection level to 0.43 µg/L.

> Nickel:

- Nickel concentrations at impact sites are typically very low, ranging from low level detections of 0.10 µg/L to 0.32 µg/L. The 90% SPL typically applied to a Port environment is 200 µg/L.
- Inner harbour and reference sites typically have comparable concentrations.

> Zinc:

- Zinc concentrations at impact sites are typically low, ranging from 2.0 µg/L to 11.3 µg/L. The 90% SPL typically applied to a Port environment is 23 µg/L.
- Whilst there have been no exceedances of the 90% SPL, zinc concentrations are generally elevated within the inner harbour than reference sites which range from 0.3 µg/L to 6.2 µg/L.

A water quality monitoring program was also implemented by GPA (2013a) as part of the environmental management program developed for the 2012 maintenance dredging program. The program was typically identified to determine the water quality within the moderate ecological protection area (i.e. the inner harbour) and the high ecological protection area (i.e. Champion Bay).

It should be noted that during this program no low ecological protection area (LEPA) was established and it is likely that several monitoring sites may have been located within a defined LEPA. As the LEPA has a lower SPL assigned within, several exceedances reported in GPA (2013a) may be overestimated.

The sampling program incorporated collection and laboratory analysis of dissolved metals, tributyltin (TBT) and polycyclic aromatic hydrocarbons (PAH). TBT and PAHs were dismissed during post dredging as no detection occurred in pre dredge or during dredge monitoring.

Sampling events included one round pre-dredging, two rounds during dredging and seven events post dredging.

A summary of the key sampling results is provided below.

- Pre-dredging:
  - No results exceeded the 90% SPL within the MEPA;
  - Copper exceeded the 99% SPL at six of seven sites in the HEPA;
  - PAH and TBT concentrations were all below the LoRs.
- During Dredging:
  - Zinc exceeded the 90% SPL on both sampling events at one location within the MEPA;
  - Lead exceeded the 90% SPL on one occasion at one site within the MEPA;
  - Copper and zinc exceeded the 99% SPL within the HEPA at several sites on both sampling rounds;
  - Silver (two sites) and nickel (one site) exceeded the 99% SPL on the second sample round only:
  - PAH and TBT concentrations were all below the LoRs.
- Post Dredging
  - TBT and PAH were not samples based upon no detection during or pre dredging;
  - No concentrations exceeded the 90% SPL within any sample round for MEPA sites;
  - Zinc and copper exceeded the 99% SPL at some sites during the first two rounds;
  - Silver exceeded the 99% SPL at one site during round two;
  - No exceedances occurred at MEPA or HEPA sites during rounds three to seven.

Limited data is available for the wider Champion Bay marine environment, though there are limited activities which are likely to result in any marine environmental impacts. Identified activities and their potential, temporary impacts may include:

1. Aquaculture fish farming within Champion Bay may have a localised impact over short duration on water quality, such as minor nutrient loading.
2. Shipping and tug movement within the entrance channel result in localised, short duration turbidity plumes on a regular basis.
3. Commercial and recreation vessel activities may have minor, highly localised impacts on water quality from hydrocarbon spillages, rubbish or vessel anode deterioration.

During periods of warmer water, when swell and wind conditions result in very calm sea surface condition, temporary blooms of *Trichodesmium*, a filamentous cyanobacteria, may occur within Champion Bay. These blooms typically dissipate quickly when wind or sea state become more unsettled and are considered natural events, however they may have short duration impacts upon water quality during periods of extended blooms.

Marine Sediment Quality

O2 Marine developed a Sediment Characterisation Sampling and Analysis Plan (SAP) (2021b) and conducted SAP Implementation sampling and reporting (2021a) to determine the quality of the material to be dredged and disposed of within the two proposed DMPA's (**Appendix E** and **Appendix F**). The assessment included both preliminary and detailed site investigations in accordance with the DER (2014) guidelines for the *Assessment and Management of Contaminated Sites*.

<u>Preliminary Site Investigation</u>

The preliminary site investigation reviewed historical sediment investigations and sources of contaminants. The desktop assessment identified that existing contaminants occur within the inner with current extent typically limited to the Berth 3, 4 and 5 shipping pockets, whilst the central and eastern sediments had limited information and entrance channel sediments were likely to clean and free from contamination. Assessment of the accumulated sediments was divided into three categories in accordance with the NAGD (2009) to include:

1. 'Probably Clean' channel sediments;
2. 'Probably Contaminated' harbour sediments associated with the Berths 3, 4 and 5 pockets; and
3. 'Suspect' sediments within the remaining harbour sediments.

Within the berth 3, 4 and 5 pockets copper, zinc lead and TBT have historically exceeded the respective guideline values. Historical sampling has also identified potential acid sulphide soils (PASS) within sediments.

Outcomes of the preliminary site investigation provided a basis for determining the scope of the detailed site investigation, including defining the contaminants of potential concern (CoPC) and identifying the number, depth and location of required sampling (O2 Marine 2021b).

<u>Detailed Site Investigation</u>

Detailed site investigations to characterise sediments were undertaken during June 2019, February 2020 and March 2021 (O2 Marine 2021a). A total of 31 surface and subsurface samples were collected and analysed from 28 sediment sampling locations during the field survey. Sediment samples were collected using SCUBA divers and push cores. Observations and photos were taken prior to sediments being homogenised and packed into laboratory containers. Collected sediment samples were sent to a NATA-accredited laboratory for testing of:

- Physical Sediment Characteristics: PSD, total organic carbon (TOC), moisture content;
- Inorganic Compounds: Metals and Metalloids (Al, Ag, As, Cd, Cr, Cu, Fe, Pb, Hg, Ni and Zn);
- Nutrients (Sediments: TKN & TP; Porewater NH4, NO2+NO3, FRP);
- Organotins (TBT, DBT and MBT); and
- Acid sulfate soils (SCr).

Additional sediment samples were also collected and analysed for SPOCAS to inform the Acid Sulphate Management Plan (Coffey 2021).

'Probably Clean' sediments were characterised by fine grained, yellow to grey sands of natural origins such as coastal silicate sands transported to the entrance channel via localised northern longshore drift, or marine carbonate sediments transported via oceanic currents and swell. No COPC were identified for probably clean sediments, which is consistent with previous assessments of entrance channel sediments.

Nearshore DMPA sediments were characterised by fine grained, yellow to light brown sands of natural origins such as coastal silicate sands and marine carbonate sediments. No COPC were identified at any of the five sites assessed.

‘Suspect’ and ‘Probably Contaminated’ sediments occurring within the harbour were typically comprised of consistently finer material than entrance channel sediments with the exception of sites near the channel entrance which were physically similar to those within the channel. The sediments occurring in Berths 3-7 were comprised of slightly coarser material, described as medium/fine silty sands, than the south-eastern corner of the harbour characterised by fine silty sands. Appearance ranged from grey to dark grey and brown throughout the berth pockets and the south-eastern corner.

Total copper, zinc and mercury at ‘Suspect’ sediment sites were detected above Default Guideline Values (DGV) levels, with the 95% upper confidence limit (UCL) of the mean for copper and zinc exceeding the DGV. Total cadmium, copper, lead and zinc in ‘Probably Contaminated’ sediment sites were detected above the DGV screening levels, with the 95% UCL of the mean for copper and zinc exceeding the DGV. Terrestrial based ecological and health-based investigation levels were also referenced within this report with the aim of providing a generalised comparison with soil guidelines to consider an option for onshore disposal of dredge spoils. The terrestrial investigation levels indicate contaminants would not exceed soil Environmental Investigation Levels (EILs).

Comparison of total metals to ambient background was undertaken through normalising raw results using aluminum as a normalising element to represent differences in metal concentrations based on particle size between samples for total metals cadmium, copper, lead, iron, manganese, mercury, vanadium and zinc. All metals display a strong linear correlation with aluminum. Normalised ‘Suspect’ sediments indicated ‘Minor’ to ‘Moderate’ enrichment for copper, ‘Moderately Severe’ to ‘Severe’ enrichment for zinc and ‘No Enrichment’ for mercury. Manganese, iron and vanadium, with no screening guideline values, recorded ‘No Enrichment’ to ‘Minor’. Normalised ‘Probably Contaminated’ sediments indicated ‘Minor’ to ‘Moderately Severe’ enrichment for cadmium, copper and lead, with ‘Severe’ to ‘Extremely Severe’ zinc enrichment. Manganese, iron and vanadium, with no screening guideline values, recorded ‘No Enrichment’ to ‘Minor’.

Except for mercury, all samples of total metals that exceeded DGV screening levels were tested using elutriate (dissolved metals) and bioavailable (dilute acid extraction) techniques. Dissolved metal concentrations from ‘Suspect’ sediments for copper were below the laboratory LoR and zinc concentrations from two samples exceed the 90% SPL. Dissolved metal concentrations from ‘Probably Contaminated’ sediments for cadmium, copper and lead were below the LoR, with zinc concentrations exceeding the 95% SPL at one site and 90% SPL at two sites. The dilute acid extraction assessment returned results below the LoR for all cadmium and lead samples, whilst copper was only detected at two sites. Zinc ranged between 2-8 mg/kg for all sites within the harbour. All dilute acid extraction test results were below DGV levels and recorded levels considered acceptable for ocean disposal or onshore placement/beneficial use.

TBT was assessed for all ‘Suspect’ sites and three ‘Probably Contaminated’ sites. TBTs normalised to 1% total organic carbon are below the SQG of 9.0 μgSn/kg at all ‘Suspect’ sites, while the 95% UCL of the means and two sites from the ‘Probably Contaminated’ sites exceed this level. Subsequent assessment undertaken on three samples from the ‘Probably Contaminated’ sites CH4, CH5 and CH6 were analysed for elutriate TBTs. All results were reported below the laboratory LoR and the 95% recommended for moderately disturbed ecosystems (ANZG 2018).

The ASS Action level criteria were exceeded at all inner harbour sites and at one ‘Probably Clean’ site. Acid based accounting results indicate that the potential acidity of these sediments are effectively buffered from the acid neutralising capacity, and therefore there would be a negative net acidity following disturbance of these sediments. However, as the DER (2015) action criteria was exceeded an Acid Sulfate Soils Management Plan will need to be developed for the project.

Nutrients in sediments and porewaters were assessed from ‘Probably Contaminated’ soils. Results identified typically consistent results for total nitrogen and total phosphorous ranging between 870 mg/kg to 2,300 mg/kg and 370 mg/kg to 710 mg/kg, respectively. Total nitrogen was typically of 100% organic origins, as nitrate/nitrite results for all sites were below the laboratory detection levels. Nutrients in porewater were considered very low in comparison with nitrate and nitrate are typically very low, with only one real detection at CH2. Ammonia was quite variable with results ranging from 0.06 mg/L (CH7) to 29 mg/L (CH1). FRP results are all very low ranging between 0.03 mg/L (CH7) to 0.94 mg/L (CH1). Interestingly, ammonia and FRP results for CH1 and CH2 show a high level of variability, considering they are sampled from the same shipping pocket at Berth 3.

4.4.4. Potential Impacts

During the operational phase of proposed dredging activities, the following activities and resulting impacts have the potential to adversely affect marine environmental quality within the Port and surrounding waters:

1. Dredging activities in the inner harbour and entrance channel have the potential to
   a. Increase turbidity, suspended sediment concentrations and deposition rates;
   b. Mobilise contaminants contained within the sediments; and
   c. Reduce water clarity and light over potentially large areas.

2. Tail water discharge from the reclamation DMPA to the north-western corner of the inner harbour has the potential to:
   a. Result in localised increases in turbidity and suspended sediment concentrations;
   b. Release contaminants to the marine environment;
   c. Result in localised changes to the physical and/or chemical characteristics of the receiving waters;
   d. Cause nutrient enrichment within the receiving environment.

3. Nearshore placement of dredged material has the potential to:
   a. Increase turbidity and suspended sediment concentrations; and
   b. Alter the physical characteristics of natural sediments.

4. There is potential for a hydrocarbon release into the marine environment from a vessel spill and or bunkering operations during dredging operations.

Assessment of Impacts

Dredging: Increased Turbidity, Suspended Sediment Concentration and Deposition Rates (1a)

Dredging operations are expected to result in localised increases to turbidity, Suspended Sediment Concentrations (SSC) and deposition rates. This potential impact on EQO1 for the EV ‘*Ecosystem Health*’, is discussed and assessed in the context of the extent, duration and severity of the potential impact on BCH **Section 4.5**.

Increases in turbidity may also have the potential to temporarily compromise EQO3 for the protection of the EV '*Fishing and Aquaculture*' at the Indian Ocean Fresh aquaculture sea-cages (located approximately 3,300 m from the harbour entrance and ~800 m north of the entrance channel and '*Industrial Water Supply'* at the Live Crays seawater intake (located just within the FBH at the Live Crays jetty facility). Early stakeholder engagement with both facility management identified:

> Indian Ocean Fresh are not anticipating to have any aquaculture stock in the Champion Bay Sea Cages during the September-October 2020 nominated dredge window (Bruce Starling pers.comms.); and
> Impacts from turbidity on the Live Lobster factory are considered a low risk to the operations based upon the previous dredging campaign in 2012.
> Impacts from water quality on the Live Lobster factory are considered a low risk to the operations based upon the previous dredging campaign in 2012.

To allow assessment of impacts from dredge plume turbidity and SCC, GEMMS (2021) were engaged to conduct hydrodynamic modelling. Hydrodynamic modelling results indicate that there is likely to no impacts upon the seawater intakes for the Live Cray Factory based upon:

> Spatial distribution of the dredge plume does not encompass the Fishing Boat Harbour entrance as the dredge plumes are considered to be highly localised around the dredge vessel (GEMMS 2021);
> Turbidity levels are considered to be low to moderate in terms of SCC concentration; and
> Dredge plumes are very short in terms of duration as they typically occur during dredging, and then dissipate returning to normal conditions within several hours once the dredge vessel relocates.

These results are validated by observations and aerial surveillance from the 2012 dredge campaign where it was identified that the dredge plume extent was of a small spatial area, typically surrounding the dredge vessel, was short in duration and of a moderate level of SCC concentration (GPA 2012).

There were no reported impacts from Indian Ocean Fresh or the Live Cray Factory during the 2012 dredge programme, and as the predicted results from hydrodynamic modelling indicate that there are no anticipated impacts from turbidity or increases SCC from the Proposed 2021 dredging Project.

Proposed monitoring and management strategies are provided in **Section 4.4.6**.

Dredging: Mobilisation of Contaminants in Sediments (1b)

Dredging of 45,000 m^3 of sediments from within the inner harbour has the potential to mobilise contaminants into the water column, within suspended sediments or as dissolved metals in water, potentially impacting marine environmental quality within the inner harbour MEPA or the adjacent HEPA designated within Champion Bay.

A Sediment Quality Assessment was conducted by O2 Marine (2021a and 2021b) to determine the suitability of sediments for dredging and disposal with respect to impacts upon marine environmental quality. O2 Marine concluded that all entrance channel sediments were clean and free from contamination and therefore pose no risk from mobilisation of contamination in sediments. Inner harbour sediments contain total copper, zinc and TBTs with their 95% UCL of the means calculated above respective guideline values in both the 'Suspect' and 'Probably Contaminated' areas.

Subsequently, bioavailability and elutriate testing was conducted on these sediments to determine the level of risk posed by total metal and TBT concentrations to marine environmental quality through dredging and disposing of these sediments. Bioavailability concentrations were well below the guidelines for copper, zinc and TBTs from all sediments testing indicating a very low risk to marine organisms from contaminated sediments. Elutriate concentrations of copper and TBTs were below the relevant guideline values whilst zinc exceeded the 90% SPL at three of the eight sites. Therefore, zinc within sediments poses a slight risk of impacting marine environmental quality from the proposed dredge activities.

Historically, dissolved zinc exceeded guidelines at some water quality monitoring locations within the MEPA and the HEPA during the 2012 dredge project. As identified above, no LEPA was applied to the immediate area surrounding the tailwater discharge and it is likely that this influenced the number of exceedances from sites within the MEPA as several sites were adjacent to the tailwater discharge. Whilst zinc concentration exceeded guidelines within the MEPA and the HEPA, post dredge sampling results identified an immediate return to acceptable water quality suggesting that any temporary impacts from harbour dredging are localised, and of a short duration.

Furthermore, sediment fate modelling identified that any dredge plume which emanates during inner harbour dredging and disposal typically remain within the inner harbour and only very minor volumes of sediment actually leave the inner harbour (GEMMS 2021). It is unlikely that these minor volumes would results in impacts that are not commensurate with those accepted within the designated HEPA.

This assessment identifies that dredging or disturbance of sediments is unlikely to result in prolonged or adverse impacts to marine environmental quality. Therefore, in consideration of potential impacts associated with mobilisation of contaminants, EQO1 for the EV '*Ecosystem Health*' is unlikely to be affected in either the MEPA or HEPA as presented in **Figure 4-5**.

Dredging: Reduced Water Clarity and Light (1c)

Reduction in water clarity and light as a result of increased SSC, poses a risk to BCH and marine fauna. This potential impact on EQO1 for the EV '*Ecosystem Health*', is discussed and assessed in the context of the extent, duration and severity of the potential impact on BCH in **Section 4.5**.

Tail Water Discharge: Increased Turbidity and Suspended Sediment Concentration (2a)

Tailwater discharge from the land reclamation area has the potential to result in localised increases to turbidity and SSC within the north-western corner of the inner harbour. To provide for an initial mixing area for tailwater release, a small LEPA has been established immediately adjacent to the release pipes. Increased turbidity and SSC typically reduce the available light in which benthic organism require for photosynthetic activity. In this case the MEPA is contained within a working harbour which features daily turbidity plumes from ship and tug propwash and regularly experiences low water clarity impacts to BCH within the harbour are not assessed. Also, there is not considered to be any BCH occurring within the harbour due to the historical modifications, depth and frequency of dredging.

However, management actions have been identified to manage dredge tailwater to minimise the turbidity and release of suspended sediments to ensure that the HEPA is protected. These typically include:

- Only one discharge is permitted into the reclaim during every 12 hours;
- Dredge material will be placed as far as practicable from the release pipes to maximise residence times before discharge;
- The weir box can be closed off if visible plumes exceed the dredging plumes within the MEPA;
- The weir box is to be located above the highest astronomical tide to increase the residence time of tailwater within the reclaim pond; and
- Outflow pipes will be covered with geofabric to remove remaining fines.

Using this combination of dredging and tailwater release management the level of resulting turbidity release back into the harbour is unlikely to result in plumes which are greater than standard everyday shipping prop wash plumes, or the dredging plume from the dredge operations. It is anticipated that tailwater release will only occur during the first month of dredge operations due to the lower volume of material require removal from the inner harbour. Therefore, any impacts will be very short in duration, and as observed from hydrodynamic modelling (GEMMS 2021) and previous dredging campaigns, any resultant plumes from inner harbour operations typically remain within the designated MEPA.

Further details regarding proposed monitoring and management to mitigate this risk are provided in **Section 4.4.6** and **Appendix H**.

Although uncontrolled tail water discharge poses a moderate risk of increasing turbidity and SSC within the LEPA, the proposed monitoring and management strategies to mitigate this risk are considered sufficient to reduce the likelihood of the risk, such that the resulting potential impacts will not be significant. Therefore, in consideration of potential impacts associated with mobilisation of contaminants, EQO1 for the EV '*Ecosystem Health*' is unlikely to be affected within the MEPA or HEPA as presented in **Figure 4-5.**

Tail Water Discharge: Release Contaminants to the Environment (2b)

Tailwater discharge from the land reclamation area has the potential to result in localised increases to turbidity and SSC within the north-western corner of the inner harbour. To provide for an initial mixing area for tailwater release, a small LEPA has been established immediately adjacent to the release pipes.

The Sediment Quality Assessment undertaken by O2 Marine (2021b) found that the concentrations of CoPC (i.e. total metals, organic compounds and nutrients) in the material to be dredged and disposed of onshore were below the relevant screening levels for both onshore and ocean disposal. These results indicate that onshore disposal and subsequent dewatering of this material is unlikely to result in adverse effects on marine environmental quality. Of all the contaminants only zinc was identified to exceed the 90% SPL at three of the eight sites tested. Given the likely level of dilution and flushing which will occur within the LEPA, combined with the low daily volumes placed into land reclamation, it is likely that zinc will meet 90% SPL at the LEPA/MEPA boundary.

However, acid sulphate soils testing indicated that there is the potential for sediment acidification during onshore disposal which has the potential to alter the low risk profile identified from elutriate and bioavailability testing identified above. Soil acidification has the potential to digest metals from the sediment resulting in elevated dissolved metals concentrations within tailwater. To ensure that the risk posed from acid sulphate soils are adequately managed, MWPA engaged Coffey (2021) to develop an ASSMP for the associated land reclamation activities (**Appendix I**). During the 2012 maintenance dredge campaign no acid sulphate soils management was in place and the volume of sediments and tailwater release was substantially greater than anticipated for this Project. If managed in accordance with the ASSMP it is unlikely that soils will be able to acidify releasing dissolved contaminants with tailwater into the inner harbour.

Furthermore, water quality monitoring undertaken during the 2012 maintenance dredging program identified only minor concentration increases of dissolved zinc and lead during dredging at sites adjacent to the tailwater return (GPA 2013). No other metals, including copper, were identified above any screening levels. The subsequent post dredge sampling program (12 months post dredging) indicated water quality typically commensurate with a high level of ecological protection (99% SPL) with respect to metals concentrations which is above the requirement for a Port harbour to achieve a moderate protection level (90% SPL) (EPA 2016c).

However, despite the low risk of potential contaminant release through tail water discharge, monitoring of contaminants at the LEPA/MEPA and MEPA/HEPA boundaries and within the HEPA is proposed to ensure predicted impacts are commensurate with the actual risks. Further details regarding the proposed monitoring and management to mitigate this risk is provided within the DEMP (**Appendix H**).

Based on the outcome of sediment quality assessment and in consideration of the monitoring and management actions proposed, the risk of contaminant release to the marine environment through tail water discharge is considered to be very low. Therefore, in consideration of potential impacts associated with release of contaminants within tailwater, EQO1 for the EV '*Ecosystem Health*' is unlikely to be affected within the MEPA or HEPA as presented in **Figure 4-5.**

Tail Water Discharge: Changes to the Physical and/or Chemical Characteristics of the Receiving Waters (2c)

Tailwater discharge from the land reclamation area has the potential to result in localised alterations to physicochemical parameters within the north-western corner of the inner harbour. To provide for an initial mixing area for tailwater release, a small LEPA has been established immediately adjacent to the release pipes.

Any alterations to the physicochemical parameters with the potential to cause impacts are associated with the risk of soil acidification. As described above MWPA engaged Coffey (2021) to develop an ASSMP for the associated land reclamation activities (**Appendix I**). If the land reclamation activities are adequately managed within the requirements of this plan, there is only a very low possibility that physicochemical parameters will result in marine environmental impacts within the MEPA or HEPA.

However, to ensure that actual predicted marine environmental impacts are aligned to predicted, a water quality monitoring program will be established and tied to management actions within the ASSMP. If water quality reduces to levels where impacts are possible, tailwater release will be stopped at the weir box and management of the soils will occur, as per the ASSMP, with the tailwater quality assessed prior to further discharge.

It is therefore anticipated that any deleterious effects to the physical and/or chemical characteristics of the receiving environment water quality as a result of tail water discharge are expected to be temporary and confined to a relatively localised area within the inner harbour. Furthermore, the proposed monitoring and management strategies to mitigate this risk are considered sufficient to reduce the likelihood of the risk, such that the resulting potential impacts will be insignificant. Therefore, in consideration of potential impacts associated with alteration of physicochemical parameters within tailwater, EQO1 for the EV '*Ecosystem Health*' is unlikely to be affected within the MEPA or HEPA as presented in **Figure 4-5.**

Tail Water Discharge: Nutrients Enrichment of Receiving Environment (2d)

Tailwater discharge from the land reclamation area has the potential to result in nutrient enrichment within the inner harbour. To provide for an initial mixing area for tailwater release, a small LEPA has been established immediately adjacent to the release pipes. Nutrient enrichment has the potential to reduce water and sediment quality with possible secondary impacts to marine ecosystems and organisms.

Coffey (2017) identified an existing diffuse nutrient impact across the Northern Reclamation DMPA, typically present as nitrogen likely associated with organic material from previous dredged material and uncontrolled fill placement. Coffey identified the biological attenuation process as degradation of organic nitrogen containing compounds to ammonia, nitrification of ammonia to nitrate where oxygen is present in the tidally influenced upper portion of the aquifer, and denitrification of nitrate at depth where reducing conditions are present in groundwater. Coffey defined a contribution of ~40 tonnes per/year of nitrogen into the commercial harbour being discharged as nitrate, with the bulk coming from the Berth 5 and 6 vicinity, with groundwater concentrations ranging from 1.1 to 11 µg/L. Both the estimated and measured nitrogen concentration were below the adopted criteria identifying no current impacts to Marine Environmental Quality within the inner harbour.

The Sediment Quality Assessment undertaken by O2 Marine (2021b) identified nutrient concentrations typically occurring as organic nitrogen and phosphorous, with inorganic forms of nitrogen at very low concentrations. Nutrients within sediment porewater were typically very low with only ammonia and reactive phosphorous typically detected. These nutrients concentrations are orders of magnitude lower than existing nutrient concentrations within the land reclamation area. As the current nutrients are not identified as having any impacts on marine environmental quality, it is very unlikely adverse effects on marine environmental quality will occur outside the LEPA.

Interaction between the tailwater and existing groundwater is also unlikely due to the differences in salinity and the short residence times that tailwater will remain within the cell. Therefore, the nutrients that are currently identified within groundwater within the cell are unlikely to interact with, or release nutrients into, the tailwater before it is released. Whilst there is identified groundwater nutrient contamination occurring within the cell, the placement of dredge material and tailwater release through the Northern Reclamation DMPA is not likely to result in any significant alteration of this groundwater regime and nutrient release. Limited interaction between tailwater and underlying groundwater is likely due to short residence times and any additional release of nutrients would likely be significantly diluted due to the dredge tailwater volumes and therefore any impacts would be considered short term and localised.

Therefore, in consideration of potential impacts associated with alteration of physicochemical parameters within tailwater, EQO1 for the EV '*Ecosystem Health*' is unlikely to be affected within the MEPA or HEPA as presented in **Figure 4-5.**

Nearshore Placement: Increase Turbidity and Suspended Sediment Concentration (3a)

Dredging operations are expected to result in localised increases to turbidity, SSC and deposition rates. This potential impact on EQO1 for the EV '*Ecosystem Health*', is discussed and assessed in the context of the extent, duration and severity of the potential impact on BCH **Section 4.5.**

Nearshore Placement: Alteration of the Physical Characteristics of Natural Sediments (3b)

The placement of ~190,000 m^3 of dredge material into the nearshore environment at the proposed nearshore DMPA may have the potential alter the physical properties of the sediments that occur within the existing environment. This potential impact on EQO1 for the EV '*Ecosystem Health*', is discussed and assessed in the context of coastal processes in **Section 4.3.**

Vessel Operations: Potential Hydrocarbon Spill (4)

There is potential for a hydrocarbon release into the marine environment from a vessel spill and or bunkering operations during dredging. However, this risk is inherent in all dredging and port-based vessel operations and can be effectively managed through application of standard operating procedures. Nevertheless, the DEMP (**Appendix H**) includes proposed monitoring and management strategies to mitigate this risk.

4.4.5. Potential Environmental Benefits

Sediment relocation activities from the inner Harbour to the Northern Reclamation DMPA has the potential to positively impact marine environmental quality within the inner harbour through removing contaminants within sediments and relocation within a purpose-built land reclamation area.

Assessment of Potential Environmental Benefits

Dredging of 45,000 m^3 of sediments from within the inner harbour and relocating them into the existing northern Reclamation DMPA has the potential to result in an overall net environmental benefit for Marine Environmental Quality. Historical and current sediment quality investigations undertaken within the Port of Geraldton have identified metals and variable TBT concentrations in exceedance of accepted industry standards. Reports have identified historical material handling and washdown practices as being responsible for the majority of identified contamination, with smaller ongoing contributions from minor spillages and fugitive sources.

The process of dredging and land reclamation will assist to reduce the current volumes and levels of contaminants which typically occur within the Berths 3, 4 and 5 shipping pockets. Once removed and placed into managed land reclamation the contaminants will be unable to have ongoing potential impacts upon the ecological system within the inner harbour or wider surrounding water body (i.e. Champion Bay). Therefore, whilst the dredging activities has the potential to result in a short, temporary decline in marine environmental quality (as described above) the Project indicates a longer-term benefit likely to occur with respect to reducing current contamination levels. Combined with improved handling and shiploading practices future sediment contamination is likely to be of a lower threat to Marine Environmental Quality.

4.4.6. Mitigation

Mitigation measures proposed to minimise potential impacts on the environmental factor 'Marine Environmental Quality' are described in **Table 4-7** and presented in accordance with the EPA's mitigation hierarchy (Avoid, Minimise, Rehabilitate[1]).

[1] Rehabilitation measures are excluded from Table 10 as these are not expected to be required to mitigate impacts to marine environmental quality.

Table 4-7 Mitigation measures to minimise impacts on Marine Environmental Quality

Potential Impact	Avoidance	Minimisation	Residual Impact
Localised Turbidity increases from dredging (1a)	Impacts upon BCH assessed in **Section 4.5**		
	> No aquaculture stock contained within offshore sea-cages. > Stakeholder consultation to identify risks and management requirements. > Hydrodynamic modelling results indicate very low likelihood of dredge plume entering FBH entrance.	> Dredge plumes identified to be highly localised and of short duration. > Water quality monitoring program – refer to the DEMP (**Appendix H**). > Ongoing consultation during dredging. > Water quality monitoring program to validate results.	No residual impacts predicted.
Mobilising contaminants from inner harbour during dredging (1b)	> Undertake a sediment assessment, including bioavailability and elutriate testing, in accordance with the NAGD (2009). > Conduct hydrodynamic modelling to determine sediment fate predictions. > Placement of contaminated material into land reclamation.	> Implement management of tailwater return (See 2b). > Short duration of inner harbour dredge program (<4 weeks). > Annual sediment monitoring. > Management of dredge operations under the DEMP.	No residual impacts predicted. Potential environmental benefits predicted from removal of contaminants into managed land reclamation.
Reduced water clarity due to dredge plumes (1c)	Assessed in **Section 4.5**		
Tailwater discharge resulting in increased turbidity (2a)	> Placement of material into land reclamation avoiding release into natural environment.	> The DEMP will contain the following management actions: ○ Only one discharge is permitted into the reclaim during every 12 hours; ○ Dredge material will be placed as far as practicable from the release pipes	No residual impacts predicted.

Potential Impact	Avoidance	Minimisation	Residual Impact
		to maximise residence times before discharge; ○ The weir box will be manufactured to allow tailwater discharge to cease if/as required; ○ The weir box is to be located above HAT to increase the residence time of tailwater within the reclaim pond; and ○ Outflow pipes will be covered with geofabric to remove remaining fines.	
Tailwater discharge resulting in release of contaminants (2b)	> Sediment characterisation assessment conducted in accordance with the NAGD (2009) which included bioavailability and elutriate testing to identify risk posed from existing contaminants. > Placement of contaminated material into land reclamation avoiding contaminant release into natural environment.	> Management of land reclamation in accordance with the ASSMP (**Appendix I**) > Water quality monitoring program implemented in accordance with the DEMP (**Appendix H**) > Only one discharge is permitted into the reclaim during every 12 hours	No residual impacts predicted.
Tailwater discharge resulting in altered physicochemical characteristics (2c)	NA	> Management of land reclamation in accordance with the ASSMP (**Appendix I**) > Water quality monitoring program implemented in accordance with the DEMP (**Appendix H**) > Tailwater discharge into a temporary LEPA for initial tailwater mixing located within the inner harbour to prevent any potential impacts to the HEPA.	No residual impacts predicted.

Potential Impact	Avoidance	Minimisation	Residual Impact
		> Only one discharge is permitted into the reclaim during every 12 hours	
Tailwater discharge resulting in nutrient enrichment (2d)	> Sediment characterisation assessment conducted in accordance with the NAGD (2009) to identify risk posed from existing contaminants. > Placement of contaminated material into land reclamation avoiding contaminant release into natural environment.	> Management of land reclamation in accordance with the ASSMP (**Appendix I**). > Water quality monitoring program implemented in accordance with the DEMP (**Appendix H**). > Tailwater discharge into a temporary LEPA for initial tailwater mixing located within the inner harbour to prevent any potential impacts to the HEPA > Only one discharge is permitted into the reclaim during every 12 hours.	No residual impacts predicted.
Nearshore material placement resulting in increased turbidity (3a)	Assessed in **Section 4.5**		
Nearshore material placement altering physical sediment characteristics (3b)	Assessed in **Section 4.3**		
Hydrocarbon Spills (Vessel Operations) (4)	> Follow all reasonable directions given by the harbour master to ensure vessel collisions are avoided. > Ensure all construction vessels are compliant with the International Maritime Organisation	> Supply and maintain adequate hydrocarbon spill kits on site and within immediate access during refuelling. > Implement procedures to maintain clean and tidy work areas, including the safe	No residual impacts predicted.

Potential Impact	Avoidance	Minimisation	Residual Impact
	International Convention for the Prevention of Pollution from Ships (MARPOL). > Store all fuels, oils and lubricants on site to ensure that they do not pose a threat to the environment or the safety of staff and the public. > Follow the MWPA Procedural site requirements for all bunkering activities > Vessel Bunkering induction is required for persons involved in bunkering activities. > Inspect and maintain all construction vessels and equipment on a daily basis. > Maintain vessel speeds below 8 knots whilst within the construction zone, to limit the potential for vessel collisions. > Maintain an exclusion zone around the dredging activity to minimise the risk of non-project related vessels entering the area.	storage of all hydrocarbons and chemicals. > Implement water quality monitoring during and post dredge in accordance with the DEMP.	

4.4.7. Ongoing Marine Environmental Management and Monitoring

As described within the DEMP, MWPA are committed to monitoring water quality at the LEPA/MEPA and MEPA/HEPA and within the HEPA pre- and during-dredging and post-dredging for one month, or until water quality returns to meet the objectives within the MEPA and HEPA. Please refer to **Appendix H** for further water quality monitoring details.

As described in **Section 4.4.3** MWPA are currently drafting an EQMF which aligns with EPA (2016d) for ongoing monitoring and management of Marine Environmental Quality within the Port and surrounding Champion Bay.

In addition, MWPA are required to conduct annual sediment sampling in accordance with Prescribed Premisses Licence L4275/1982/15.

4.4.8. Predicted Environmental Protection Outcome

The Project will result in the following predicted EPOs with respect to marine environmental quality:

- A temporary decline in marine water quality in the immediate vicinity of dredging operations due to increased turbidity and SSC, release of mobilisation of contaminants is not expected;
- A potential slight decline in marine water quality in the LEPA in the north-western corner of the inner harbour during dewatering operations;
- No residual impact on marine environmental quality as a result of the Project activities;
- Beneficial environmental outcome through the removal of contaminated sediments and relocation into a managed land reclamation cell.

Based on these EPOs, and in consideration of the proposed monitoring and management strategies, the Project activities are not expected to pose any significant residual risks to maintaining the quality of water, sediment and biota and therefore the environmental values can be protected. In relation to the Project, the Proponent considers that the EPA's objective for marine environmental quality has been met.

4.5. Benthic Communities and Habitat

4.5.1. Policy and Guidance

The following EPA policies and guidance have been considered in evaluating potential impacts on this factor:

- EPA (2016e). Environmental Factor Guideline: Benthic Communities and Habitats, EPA, Western Australia;
- EPA (2016f). Technical Guidance – Protection of Benthic Communities and Habitats, EPA, Western Australia; and
- EPA (2016g). Technical Guidance – Environmental Impact Assessment of Marine Dredging Projects, EPA, Western Australia.

4.5.2. EPA Objective

The EPA's objective for the factor 'Benthic Communities and Habitats' (BCH) is:

'To protect benthic communities and habitats so that biological diversity and ecological integrity are maintained.'

4.5.3. Receiving Environment

Studies of BCH that are relevant to the Project are identified in **Table 4-8**.

Table 4-8 Receiving Environment Studies – Benthic Communities and Habitat

Author (Date)	Study
BMT (2021a)	Seagrass Communities in Champion Bay and Surroundings
BMT (2021b)	Technical Note – Benthic Habitat Assessment of Proposed Nearshore Placement Areas
AECOM (2020)	Benthic Habitat Mapping Report – Champion Bay and Surrounds
Lavery *et. al* (2019)	Defining thresholds and indicators of primary producer response to dredging-related pressures - Synthesis Report
Oceanica (2010b)	Benthic Primary Producer Impacts from Construction of the Proposed Oakajee Port
Lavery *et. al* (2009)	Interactive effects of timing, intensity and duration of experimental shading on *Amphibolis griffithii.*
Mackey (2004)	Effects of Temporary PAR reduction on the seagrass *Amphibolis griffithii* (Black) den Hartog
URS (2001b)	Marine Habitats of Champion Bay, Port Grey and Geelvink Channel
Coupland (1997)	Rhizome and shoot structure, growth and response to sediment burial in *Amphibolis griffithii* (Black) den Hartog.

Characteristics, Distribution and Condition of Benthic Habitat and Communities

Broad Scale Habitat Mapping – Champion Bay

Habitat mapping undertaken by AECOM (2020) (**Appendix A**) identified that the benthic habitats of Champion Bay and the surrounding area can be broken down into a range of habitats, with the key feature of the Bay the limestone substrate which underlies most of the bay and surrounds. Limestone reef presence, relief or reef profile, and the depth of sand overlaying reef, are key factors which influence the epibenthic communities in the bay and surrounding areas. Exposure from prevailing south westerly swell and seas is also a key factor as they play a pivotal role in the movement and dispersal of sand within the bay. Deposition, erosion or frequent resuspension of sand due to wave and tidal water movement greatly influences what type of epibenthic communities colonise certain areas in the bay. Key distinctions can be seen in habitats with similar depths, topography and substrate slope but with varying levels of protection from swell and waves. AECOM described the following natural habitat types, and associated communities:

1. Deep water sand, No epibenthic macrobiota;
2. Deep water pavement with sand, Macroalgae dominant;
3. Deep water reef slope, Macroalgae;
4. High profile deep reef 1-4 m, Macroalgae dominant;

5. Sloping pavement with sand, Low density macroalgae and seagrass;
6. Pavement with sand, No macrobiota;
7. Pavement with sand, Low density seagrass;
8. Pavement with sand, High density seagrass;
9. Pavement with shallow sand, Seagrass dominant;
10. Pavement with sand, Macroalgae
11. Low profile reef with sand, Macroalgae and seagrass codominant;
12. Low profile reef with deep sand, Low density seagrass and macroalgae;
13. Low profile reef with sand, seagrass and macroalgae; and
14. High profile shallow reef 1-4 m, Macroalgae dominant.

A summary of the habitat mapping is described below. Please refer to **Appendix A** for further details.

Deep Water Communities and Habitat (1-4)

The deep-water habitats typically occur west of a series of north south orientated limestone reef systems which run from Point Moore to the north of Champion Bay and continue on past Drummonds Point. These habitats occur where the low-profile reef with sand become the high-profile reef line which forms the western edge of Champion Bay and the deep-water offshore habitats of Geelvink Channel. The habitat is highly variable as it transitions from high profile macroalgae dominated reef in relatively shallow waters (8–12 m) to the deeper (>20 m) sand and sand covered pavement offshore habitats. The area is characterised by very high profile (> 4 m) reef walls and overhangs which give way to sloping pavement into deeper water. Epibenthic biota were also highly variable.

Benthic communities associated with low and high relief reef are macroalgal with common species such as red and brown algae (*Sargassum* and *Ecklonia*) with a conspicuous understory of *Amphibolis* and *Thalassodendron* seagrass. Interspersed amongst these floral assemblages are substantial patches of completely bare, heavily rippled deep sand. The deep-water reef slope benthic communities are highly variable with small red and brown algae, brown lobed algae, crustose coralline algae, and sporadic sponges and solitary hard corals including *Turbinaria*, *Faviids* and small *Acropora* species. Deep water pavement and sand habitats typically comprised no benthic communities or were dominated by *Sargassum* and *Ecklonia* some patches of low cover *Amphibolis* and *Thalassodendron*.

Limestone Pavement and Sand Communities and Habitats (5-10)

Limestone pavement, with overlying sand of varying depth which receives regular resuspension from swell waves and currents, comprise most of the habitat type in the eastern side of Champion Bay. It's characterised by gradually sloping sand veneered pavement and supports a mosaic of mixed assemblages of macroalgae and seagrass interspersed with equal areas of bare sand. The south-eastern corner of Champion Bay and directly north of the fishing boat harbour entrance is characterised by areas of stable sand generally overlaying pavement. The area receives some protection from swell waves and consequently supports large high-density seagrass meadows, typically dominated by *Halophila, Syringodium* and *Posidonia* with up to 90% coverage mapped.

The seabed in the central part of Champion Bay is the deepest continuous area in the bay forming a natural basin between the eastern nearshore area and the high-profile western reefs. The topography is relatively flat with no sloping in either direction. The area is predominantly sand covered substrate with seagrass meadows of mostly moderate to dense (up to 70% cover) *Amphibolis* with *Halophila* and *Syringodium*. Low densities of small red and brown algae, *Ecklonia* and *Sargassum* also occur.

Several areas in shallow water fringing the fishing boat harbour, and north of the Northern Reclamation DMPA, consisted of deeper sand on pavement which supported little to no benthic communities. The area is often characterised by loose seagrass and macroalgal wrack. Two areas further seaward also featured sand across large areas with very little benthic communities.

Low density seagrass meadows on sand veneered pavement account for a large area directly north of the fishing boat harbour up to the start of the entrance channel. The 10 m isobath appeared to be the depth limit for seagrass dominance in this habitat. West of the fishing boat harbour a band of low-density meadows stretching from the 4 m isobath seaward to the start of the low profile reef areas gradually curving south towards Point Moore. Substrate in the area was characterised by moderately deeper sand veneers on pavement with seagrass density ranging from 5% to 50% and dominated by *Halophila*. Smaller patches of low cover *Posidonia* and *Syringodium* were also observed.

Shallow Reef Communities and Habitats

Running along the south-eastern shoreline of the Bay from Sunset Beach southwards to just north of the marina, and extending out ~400 m from shore, is an area of dissected limestone shoreline platform with high relief at the offshore end. The habitat contains numerous holes and depressions and supports predominantly large *Ecklonia* and *Sargassum*, with occasional patches of high density *Amphibolis* and *Thalassodendron* seagrass.

North of the entrance channel, low profile reef with sand encompasses the transition between the central basin and the high-profile western reefs. Topographically, the area is predominantly moderate profile (0-1 m) with a gradual rise of approximately 2-4 m from the border of the central basin to the base of the high-profile western reefs. Macroalgae dominate the higher relief areas, while seagrass dominate the lower relief areas which also feature sand. Both biota groups were recorded at up to 50% cover with *Amphibolis* dominating the seagrass taxa and *Sargassum* with *Ecklonia* dominating the macroalgae.

The south-eastern corner of the Bay is characterised by a shallow nearshore area of low-profile reef consisting of rocks, cobbles and low-profile limestone outcrops, surrounded by areas of mostly bare sand. As the seabed becomes shallower towards the shoreline, progressively less limestone is exposed, and deep sand becomes more prominent. Reef areas support low density small algae, with areas of sand supporting low density *Posidonia* and *Halophila* seagrasses. The area also comprised areas of dense seagrass wrack on bare sand.

South of the entrance channel areas of undulating substrate comprising a mix of low-profile limestone rises interpreted with sandy patches and higher relief reef occur. Low-profile limestone predominantly comprises macroalgae, whilst sand inundated pockets support seagrass such as *Halophila* and *Posidonia*. Sections of higher relief support dense communities of small red and brown algae, *Ecklonia* and *Sargassum.* Notably, *Posidonia* is distinct to the southern areas as the northern low profile reef areas are dominated by *Amphibolis*.

Fine Scale Habitat Mapping – Nearshore DMPA

To support the final spatial location of the Nearshore DMPA, BMT (2021b) (**Appendix B**) undertook further habitat investigations at a much finer scale. These fine scale investigations targeted three proposed placement areas. A brief description if the findings are summarised below.

Nearshore Placement Area A

Nearshore placement area A was dominated by patches of bare sand and low relief reef (<1 m) with a mixed seagrass and macroalgal community. The seagrasses on low relief reefs included *Amphibolis antarctica*, *A. griffithii*, *Thalassodendron pachyrhizum*, sparse patches of *Halophila* spp. and *Syringodium isoetifolium*, with occasional *Posidonia australis* and *P. sinuosa*. The macroalgae growing on low relief reefs were *Sargassum* spp., *Ecklonia* spp., *Padina* spp. and other brown algae. Small patches to relatively large extensive meadows (ranging from 5–50 m) of *A. antarctica* and *A. griffithii* were recorded in some sections, along with sparse meadows of *S. isoetifolium* and *Halophila* spp. The sections of bare sand observed were either flat (no profile) or contained small ripples with undulations 1–10 cm arranged in a westerly to south-westerly direction.

Nearshore Placement Area B

Nearshore Placement Area B was dominated by large sections of bare sand with small ripples (1–10 cm undulations) aligned in a south-westerly direction and floating wrack comprised of primarily *Sargassum* spp., *Ecklonia* spp., other brown algae and some *Amphibolis* spp. leaves. The southern end comprised the largest section of bare sand. Low relief reefs (<1 m) were observed throughout the area with a mixed community of seagrass including *A. antarctica*, *A. griffithii*, *Halophila* spp., *T. pachyrhizum*, and *S. isoetifolium,* and macroalgae (*Sargassum* spp., *Ecklonia* spp. and filamentous red algae). Dense and sparse patches of *A. antarctica* were also observed throughout the area.

Nearshore Placement Area C

Nearshore placement area C comprised unconsolidated sediments with few areas of low relief reef (<1 m). Benthic communities were largely dominated by mixed seagrasses and macroalgae. Seagrasses included *Posidonia sinuosa, Amphibolis antarctica, A. griffithii, Halophila spp*. and *Syringodium isoetifolium*. The macroalgae growing on low relief reefs were *Sargassum spp., Ecklonia spp., Padina spp.* and other brown and red algae. The sections of bare sand observed throughout Disposal Site C were either flat (no profile) or contained small ripples with undulations 1–10 cm.

Seagrass Condition

To determine the current baseline, or pre-dredging, seagrass health and condition, BMT (2021a) undertook a health investigation at key locations previously incorporated into Geraldton Port dredging programs (2002/2003 and 2012). BMT (2021a) collected data on six key seagrass health indicators across 14 sites within Champion Bay, along with sites at Greenough, Dongara and Jurien Bay to provide regional context. As many of these sites have historical data a comparison with previous data to provide statistical assessment on the current health was completed.

Overall BMT (2021a) summarised that seagrass indicators, such as shoot density, shoot height, leaves per shoot/cluster and aboveground biomass measured at *A. antarctica* and *P. sinuosa* sites showed a relative increase compared to the historical dataset. BMT (2021a) also identified fluctuations within community composition and health over the years. It was identified that this had also occurred within the wider monitoring program and also worldwide. BMT (2021a) surmised that the dynamic nature of Champion Bay (strong waves and currents) are continuously responsible for redistributing sand within the Bay, which is responsible for both creating new, and destroying old BCH communities. It is also possible that global water temperature rise, and the marine heatwave from 2011 may have been responsible for community shifts observed during 2021. It is therefore reasonable to assume that a high level of natural variability occurs within Champion Bay BCH habitats, particularly for seagrasses.

Local Assessment Unit (LAU)

Section 4.2 of EPA (2016f) outlines the requirement to clearly define spatially based LAUs within which BCH can be quantified, assessed and presented. LAUs are required to be location specific, assessed on a case-by-case basis and consider local aspects of bathymetry, substrate type, exposure, currents, biological attributes such as habitat types. EPA (2016f) suggests that LAUs should typically be established in units approximately 50 km2. Applying this guidance for the Project scale the DoT defined secondary sediment cell for Point Moore to Glenfield (Stul *et. al.* 2014) is considered to represent a suitable boundary for the LAU related to this Project. Sediment cells define natural units with each cell encompassing adjoining marine and terrestrial environments, thereby providing a base for integrated coastal management in which the component of each cell is considered holistically as an interactive system.

Relevant aspects for application of the Point Moore to Glenfield Beach secondary sediment cell as an LAU considered are as follows:

- The spatial are of the sediment cell is 47.6 km^2;
- The spatial boundary extends for a similar distribution as the modelling domain and the habitat assessment work completed for this Project;
- The sediment cell is defined by the offshore 15 m bathymetric depth which incorporates the high relief reef system extending north to south between Point Moore and Drummonds Point marking the western extent of Champion Bay;
- The sediment cell classification considered reef systems, substrate types, water circulation, wave exposure and currents occurring when defining the boundary;
- The boundary extends from Point Moore in the south to Drummonds Point in the north, defined at the western extent by the 15 m bathymetric contour and incorporates all of the shoreline, including Chapman Rivermouth.

The LAU is presented in **Figure 4-6.**

Figure 4-6 Spatial Local Assessment Unit boundary for the Geraldton Maintenance Dredging Project.

Benthic Habitat Mapping

Based on data from AECOM (2020) and BMT (2021b), O2 Marine created a consolidated habit map for the Project area. The consolidated habitat map is presented in **Figure 4-7**. The areas of BCH which occur within the LAU are described in **Table 4-10**.

For the purposes of the habitat classification, the AECOM BCH descriptions have been assigned to categories in accordance with **Table 4-9**.

Table 4-9 Description categories used for this CLA as they relate to BCH descriptors from AECOM (2020)

CLA Category	Density	AECOM BCH Description
Bare Sand	NA	Deep water sand, No epibenthic macrobiota.
		Pavement with sand, No macrobiota.
Macroalgae	NA	Deep water pavement with sand, Macroalgae dominant.
		Deep water reef slope, Macroalgae.
		High profile deep reef 1-4 m, Macroalgae dominant.
		Pavement with sand, Macroalgae.
		High profile shallow reef 1-4 m, Macroalgae dominant.
Seagrass	High	Pavement with sand, High density seagrass.
	Medium	Pavement with shallow sand, Seagrass dominant.
	Low	Pavement with sand, Low density seagrass.
Mixed Assemblage – Seagrass and Macroalgae	NA	Sloping pavement with sand, Low density macroalgae and seagrass;
		Low profile reef with sand, Macroalgae and seagrass codominant
		Low profile reef with deep sand, Low density seagrass and macroalgae.
		Low profile reef with sand, seagrass and macroalgae.
Coral	NA	Seal Rocks Breakwater, Coral Habitat

Table 4-10 Description of the BCH groups presented in Figure 4-7 within the proposed Local Assessment Unit Boundaries for the Project. Note percentages rounded to nearest whole figure.

CLA Category	Density	Area (% LAU)	Area (m^2)
Bare Sand	NA	3	1,281,294
Seagrass	Low density	3	1,586,982
	Medium Density	17	8,293,113
	High Density	6	3,061,551
Macroalgae	NA	33	15,555,526
Mixed Assemblage – Seagrass and Macroalgae	NA	33	15,878,474
Coral	NA	<1	3,628
Infrastructure (Dredge footprint, groynes, marina etc.)	NA	4	1,982,888

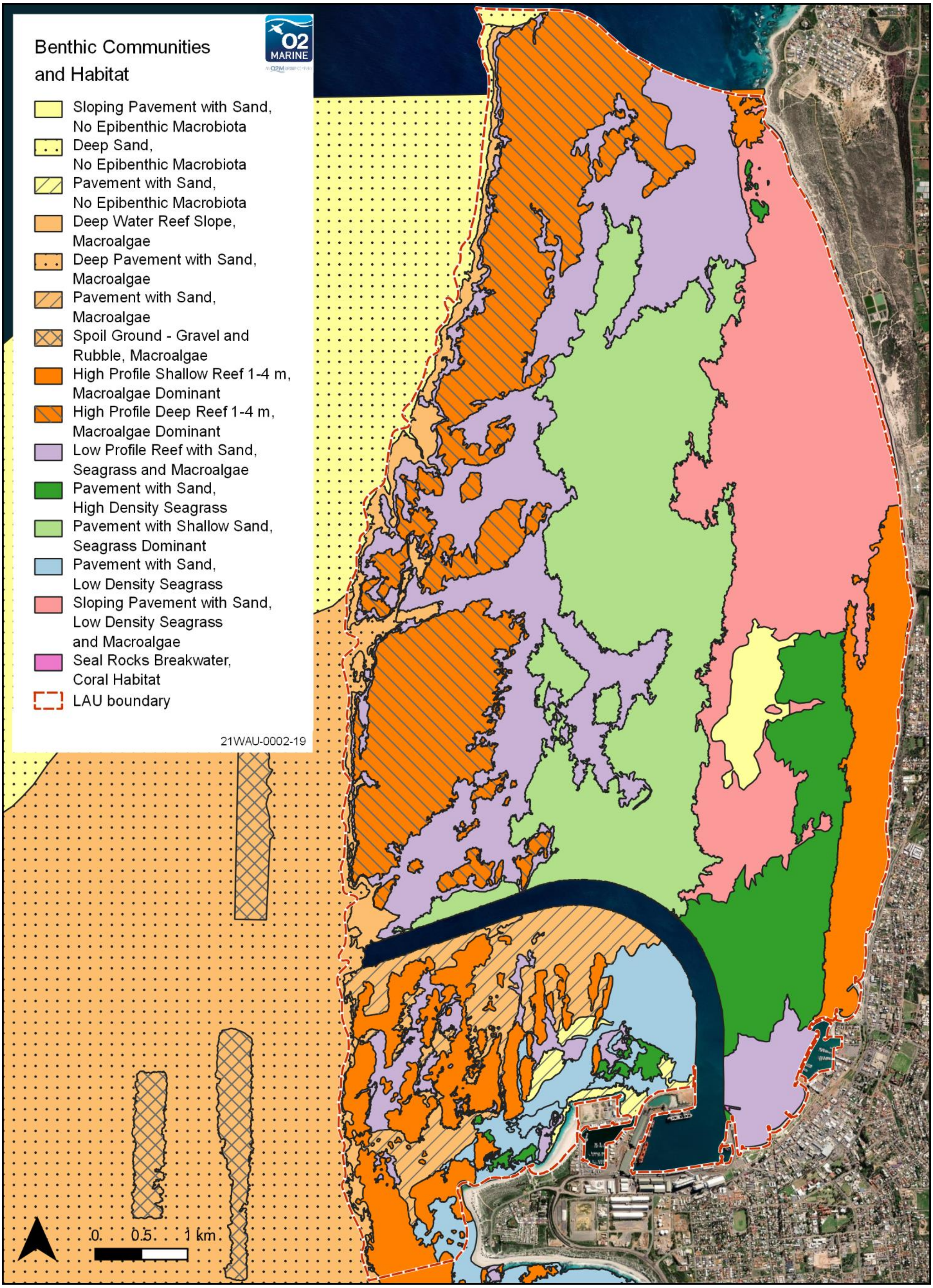

Figure 4-7 Champion Bay Habitat Map – source data AECOM (2020) and BMT (2021b)

Regional Significance and Conservation Status

The marine habitats mapped during 2020 are largely comparable to previous BCH mapping undertaken during technical studies during 2001 in preparation for the capital dredging project referred to the EPA. URS (2001b) identified no habitats or species that are confined in their distribution to the Champion Bay – Port Grey area, identifying their distributions occurring widely throughout the Central West Coast Region.

Whilst this is still the case, seagrasses, and to a lower extent macroalgae, are still widely considered as important habitats as the provide a variety of ecological functions. Lavery *et. al.* (2019) identifies seagrasses as offering the following ecological services:

- Contribute to the base of the marine food web;
- Provide habitats important for nursery areas for a variety of species;
- Provide foraging and shelter for a variety of species, including western rock lobster;
- Play an important role in recycling nutrients, filtering water and sequestering carbon;
- Protect the coastline form erosion; and
- Provide habitat for a variety of sand forming organisms, contributing vast amounts of sediments into the natural system.

Therefore, seagrasses warrant special protection during marine activities which may impact their ability to deliver these functions. The seagrass species identified have been widely mapped in their distribution, not only within Champion Bay, but also further north and south. There are no particular areas, or species, of conservation significance occurring within the Project area.

Predicting Zones of Influence and Moderate and High Impacts

In accordance with guidance provided in EPA (2016e), a dredge plume and sedimentation impact assessment was undertaken to develop predictions of the Zone of Influence (ZoI), Zone of Moderate Impact (ZoMI) and Zone of High Impact (ZoHI) for BCH in the vicinity of the dredging (GEMMS 2021).

Light Reduction Impact Studies

The 2002/2003 Geraldton Port Enhancement Project employed a cutter suction dredge technique to complete a channel deepening and widening activity to facilitate larger vessels. During this program the dredging activities produced a very high-density TSS plume associated with the fines produced when cutting and grinding the underlying limestone pavement. This plume was highly persistent due to the very fine sediment particle sizes which were associated with extremely long settlement timeframes. Due to the density of the plume and the duration of the project, benthic light was significantly reduced over an extended time period resulting in an observed decline of seagrass health and distribution.

In response to observed post dredging impacts on seagrasses, a shading study was conducted on *A. griffithii* seagrasses in Jurien Bay, some 200 km south of Geraldton (Lavery *et. al* 2009). This study looked at the cumulative impacts from shading intensity (moderate shading [13-19% of ambient] and high shading [5-11% of ambient]), duration (three-, six- and nine-month periods) and timing (post-summer and post-winter). After each plot of seagrass was subjected to the associated shading and duration, health assessments were conducted through measuring and collecting a variety of seagrass health metrics to determine where sublethal and lethal impacts where observed.

Study results identified the greatest impacts related to timing, with greater impacts recorded from moderate shading after three-months during post-summer (57% loss leaf biomass and 67% reduction n rhizome carbohydrates) compared to the same light reduction and duration during post-winter (no loss leaf biomass and 25% decline in rhizome carbohydrates).

In a separate, albeit similar study, Mackey (2004), looked at post shading recovery of *A. griffithii* at a similar study site in response to the 2002/2003 Geraldton Port dredge project. This study shaded plots of *A. griffithii* around 10% of ambient light over 106 days (~three months) during post-summer and then measured the physiological responses of recovery. As with the Lavery *et. al* (2009) post summer shading experiment, physiological and morphological changes were recorded. However, whilst this was the case after ~three months of high shading, post impact recovery for most variables measured occurred within 42 days.

Whilst these studies were focused on the high density TSS plume associated with the 2002/2003 Geraldton Dredge project, using longer term duration and very high levels of benthic light reduction (80-90%), they are considered applicable to the assessment of impacts related to this dredge Project. As previously described this dredge project is estimated to be up to eight weeks in length with dredge material typically sand sized particles associated with very low levels of fines, therefore having short length settlement timeframes. Therefore, modelling by GEMMS (2021) concluded that plumes associated with dredging and placement activities are typically localised, dissipate rapidly and are highly episodic.

Based on the dredge scenario for this Project, along with experimental knowledge that during post winter *A. griffithii* can withstand high levels of shading for up to three months, it is not predicted that this Project will results in light reduction impacts typically associated with sub-lethal or lethal impacts. Therefore, for this project there are no precited light reduction Zone of High or Moderate Impacts associated with dredge plume light reduction impacts.

Light Reduction Impact Modelling

Whilst there is no predicted ZoMI associated with this study, GEMMS (2021) conducted hydrodynamic modelling to determine where any potential ZoMI may occur using a highly conservative approach of applying the approach described in Oceanica (2010b). Oceanica (2010b) collected data at the proposed Oakajee site, some 20 km north which was applied to the modelling undertaken for this study as per the following:

- To calculate surface photosynthetic active radiation (SPAR) the following approach was employed:
    - Subsurface downwelling spectral irradiances Ed(Lambda;-0m) were computed using Hydrolight 6.0 using a clear sky atmosphere and windspeed 5m/s for solar zenith angles 0 - 87.5.
    - Hourly solar zenith angles (SZA) were calculated for Geraldton WA (-28.76187;114.613278) for the Sep-Oct 2017 period.
    - Corresponding PAR values were calculated and interpolated to the full hourly SZA array.
- To calculate the ambient photosynthetic active radiation (PAR) at the seafloor for the Project area during the proposed dredge period the light attenuation coefficient (LAC) experimentally established from field investigations for spring was applied (Oceanica 2010b).

- GEMMS (2021) conducted hydrodynamic modelled to determine the dredge plume as TSS based upon actual dredge material PSDs.
- The predicted benthic PAR during the dredge period was then calculated using the SPAR data applied to the LAC obtained from laboratory studies of the predicted dredge material from Oceanica (2010b).
- The difference in the number of hours of saturation irradiance was then calculated in accordance with the calculation in Oceanica (2010b).
- Highly conservative threshold values were then defined by interrogating those presented within Oceanica (2010b) from annualised thresholds to derive representative two-monthly thresholds for application to this short duration Project.
- The zones as describe above were then plotted using QGIS software and presented herein.

Based upon the assumptions applied to the process above, the predicted impacts zones are considered highly conservative based upon the following:

- The LAC derived under laboratory conditions published in Oceanica (2010b) were based upon sediments with a far greater proportion of fines due the dredge methodology, therefore the LAC would be a much higher value than an LAC derived using the dredge material from this Project. Therefore, when applied to the SPAR using the process above, the resulting light reduction is considered to be greater than the actual light reduction, hence overestimation of the zones of impact would be likely.
- The thresholds developed from studies by Lavery *et. al.* (2009) were annualised to allow application to the Oakajee project (Oceanica 2010b), and then interrogated to make them relevant to the duration of this study (i.e. two months). However, results from Lavery *et. al.* (2009) identified impacts commensurate with a ZoMI after three months, in post winter studies, therefore based upon the duration of the Project being less than eight weeks, there are not anticipated to be any dredge plume related ZoMI, thus the modelled ZoMI is likely to be highly conservative and therefore highly unlikely to occur based upon the morphology and physiology of *Amphibolis*.

Whilst interpretation from the literature suggests there will be no High or Moderate seagrass impacts from this Project, MWPA elected to conduct this conservative modelling approach to guide selection of appropriate sites for pre- and post-dredge BCH monitoring programs. These programs are described further in the DEMP (**Appendix H**).

Sedimentation Impact Studies

Limited research has been conducted to interpret and define appropriate sedimentation or smothering heights and/or durations for seagrass species occurring within Champion Bay, an unpublished honours thesis conducted by Coupland (1997) looked at the impacts of smothering heights and duration on *A. griffithii* in two separate experimental plots. In plot one *A. griffithii* was buried with low sediment (between 10-14 cm), whilst plot two was moderately buried (between 15-19 cm). In both experimental plots the duration was fixed at eight weeks. Results from the experimental investigation identified no morphological impacts from the low sediment burial, however minor observations between control plots and moderate burial were observed. No physiological measurements were sampled within this study and therefore based upon conversation with Dr Grey Coupland the experimental study results may be slightly biased in the reported findings.

Whilst limited sub-lethal impacts were potentially recorded by Coupland (1997) during the moderate burial, investigations conducted within Champion Bay have identified significant sediment sheets and sediment transport occurring, particularly during the winter months. O2 Metocean (2020) studies conducted adjacent to the Nearshore DMPA identified significant sediment movement over three-month periods during deployments of metocean equipment on seabed frames. Comparing pre-deployment Remote Underwater Vehicle video footage with post deployment significant changes to habitat substrate types were observed. In all deployments, seabed frames were placed horizontally over rippled sand flats, however after three months of deployment at several sites, the substrate type had altered to low relief limestone pavement (<0.5m) with no presence of the sand sheets previously observed. Furthermore, BMT (2021b) noted that bare sand adjacent to the Nearshore DMPA footprint contained ripples up to 100 cm, concluding that the Bay is a highly dynamic environment with ripples and sand sheets migrating in a south-west to north-east direction. BMT (2021a), Lavery *et al* (2009) and Coupland (1997) surmised that morphological and physiological adaptations of *A. griffithii* including, high stem lengths (up to one meter), vertical shoots and horizontal rhizomes, seasonal and high growth rates, rhizome carbohydrate storage, have been natural adaptations that *Amphibolis* seagrass species evolved due to the high level of natural disturbances (natural turbidity and smothering) these seagrasses are typically exposed to, such as within Champion Bay.

As with light reduction impacts the approach to defining the ZoMI described below is also considered highly conservative due to the understanding of the natural levels of sediment transport that occurs throughout Champion Bay. During winter the high swell energies continuously shift sand sheets and ripples up to 100 cm around within the Bay. Seagrasses have therefore developed morphological and physiological adaptations to continue to thrive in these conditions. It is considered that placement of this material into the natural environment, with a height less than one meter is highly unlikely to cause any lethal or sub-lethal impacts as the sand sheet would be considered representative of natural heights occurring naturally within the Bay. However, due to limited experimental published studies, the lower level of the moderate smothering (15 cm) from Coupland (1997) over an eight-week duration has been applied to describe the boundary for potential recoverable impacts.

Sediment Transport Impact Modelling

To predict and spatially define the ZoI, ZoMI and ZoHI with respect to impacts from sedimentation arising from sediments migrating from the Nearshore DMPA, GEMMS (2021) conducted sediment transport modelling of sediment particles over a two year period. Data from the model was interrogated over the two-year modelling period according to the thresholds for the ZoMI and ZoI described below to provide areas where sub-lethal, or recoverable impacts are possible, albeit highly unlikely based upon that natural environment within Champion Bay.

Zones of Influence and Impact

Based upon the described rationale above, the following thresholds have been applied to derive the ZoHI, ZoMI and ZoI:

1. ZoHI – This is considered to represent the direct footprint of the dredge area and boundary of the Nearshore DMPA.
2. ZoMI:
    a. Sedimentation/smothering - *A. grifithii* experience smothering heights >15 cm for a duration >eight weeks at any time during the two year modelling period.

3. ZoI:
    a. Shading - *A. grifithii* experience a reduction during dredging of >71 hours of PAR above saturation irradiance from precited ambient levels.
    b. Sedimentation/smothering - *A. grifithii* experience smothering >4 cm for a duration >six weeks.

The modelling results for the ZoI, ZoMI and ZoHI are presented in **Figure 4-8**.

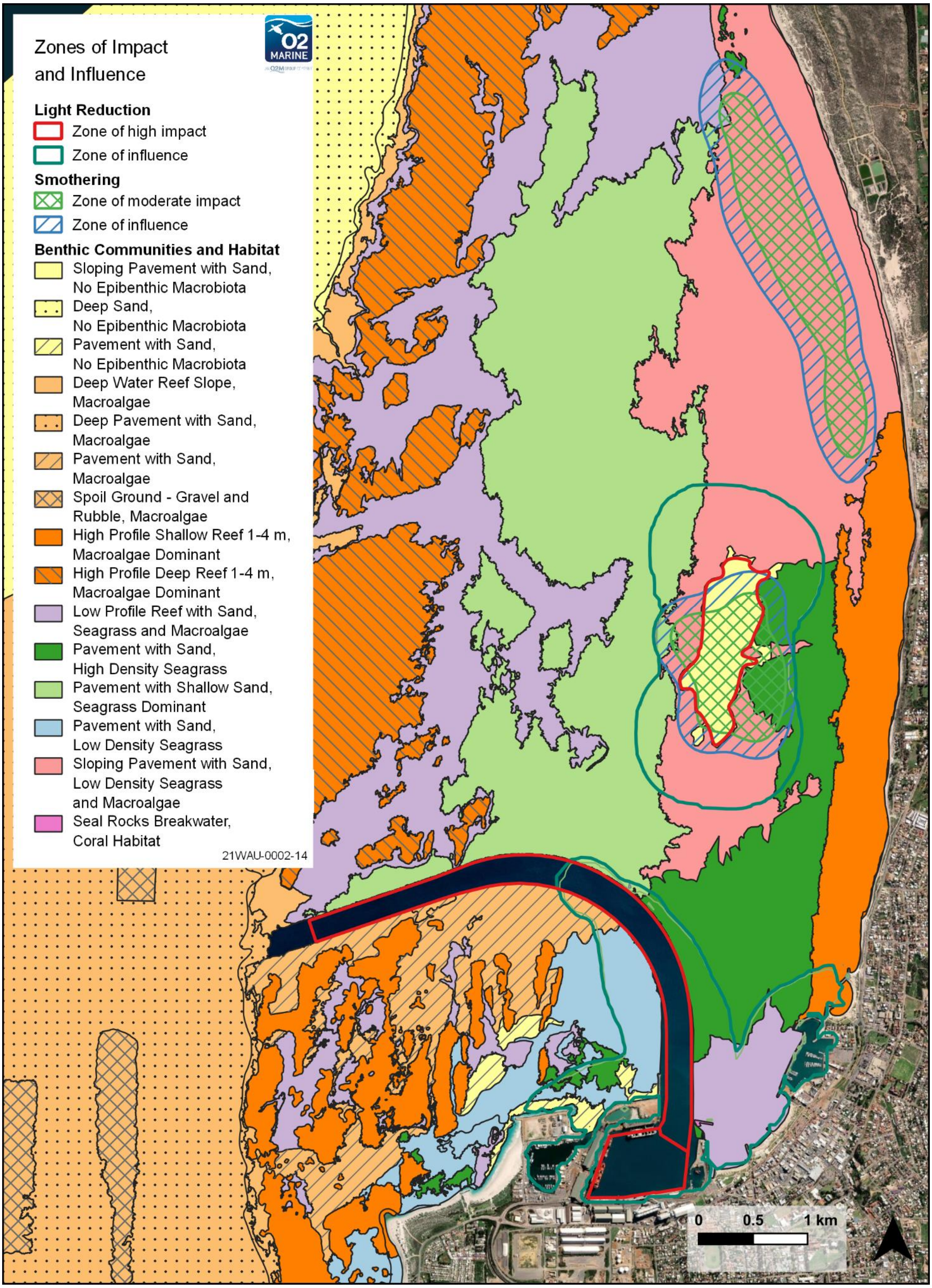

Figure 4-8 Predicted Zones of Influence, Moderate Impact and High Impact associated with the dredging Project.

4.5.4. Potential Impacts

During the operational phase of proposed dredging activities, the following activities and resulting impacts have the potential to adversely affect BCH adjacent to dredging and material placement activities:

1. Dredging and material placement activities within the inner harbour and entrance channel have the potential to cause:
    a. Direct removal (irreversible loss) of subtidal BCH within the dredge footprint;
    b. Direct burial (irreversible loss) of intertidal BCH within the proposed Nearshore DMPA footprint;
    c. Indirect potential impacts (recoverable impacts) on subtidal BCH from increased turbidity, reduced light, sedimentation;

Assessment of Impacts

Direct removal (irreversible loss) of subtidal BCH within the dredge footprint (1a)

Dredging within the inner harbour and entrance channel has the potential to remove BCH from a footprint of ~1 km^2. However, as this footprint has previously been dredged and acts as a navigational entrance channel for the Port, there is not considered to be active BCH communities within this modified environment. Therefore, no BCH was accounted for within the current habitat type and extent assessment conducted by AECOM (2020).

Therefore, there is no predicted direct removal to existing BCH from this Project.

Direct burial (irreversible loss) of intertidal BCH within the proposed Nearshore DMPA (1b)

Material placement at the Proposed MPA has the potential to completely bury BCH over an area of ~530,000 m^2 up to a height of one meter. The Nearshore DMPA has been refined and selected through application and interpretation of a series of investigations as described in **Section 2.2** and included:

1. Broad scale BCH mapping within Champion Bay;
2. Aerial imagery analysis;
3. Bathymetric backscatter analysis;
4. Fine scale BCH mapping at the proposed sites; and
5. Sediment transport modelling.

These investigations were instigated to ensure that the final placement of clean dredge material do not impact sensitive BCH communities. Sensitive BCH communities within Champion Bay, and within the area of the Nearshore DMPA typically include seagrass communities and mixed seagrass and macroalgae communities occurring over limestone pavement of sand and macroalgae occurring over low relief reef (BMT 2021b). However, through combining these investigations the proposed nearshore DMPA has been assigned to a location that is mapped as bare sand, thus avoiding any impacts on sensitive BCH, such as seagrass meadows.

Through the identification of this bare sand area, there are no predicted direct impacts to key or sensitive BCH from this Project.

Indirect potential impacts (recoverable impacts) on subtidal BCH through increased turbidity, reduced light, sedimentation (1c)

In accordance with guidance provided in EPA (2016f), a dredge plume and sedimentation impact assessment was undertaken to develop predictions of the ZoHI, ZoMI and ZoI for BCH within the defined LAU. These are presented in **Figure 4-8**. Separate zones of impact were created based on defined light reduction and sediment burial thresholds for seagrass, which are identified as the most sensitive and ecologically significant BCH. As described above, the ZoHI is defined by the dredging and Nearshore DMPA footprints and represents the predicted area of *irreversible loss* and the ZoMI represents the predicted *recoverable impacts* of BCH.

As the ZoMI represents the previously dredge entrance channel and an area of bare sand there is no predicted *irreversible loss* of BCH from the dredging and material placement activities. Furthermore, there are no predicted *recoverable impacts* from light reduction based upon the short duration and intermittent plumes associated with the project. Therefore, any precited impact thresholds which define the ZoMI are not triggered by this project and therefore no light reduction ZoMI is presented herein. The predicted *recoverable impacts* for BCH from material placement activities include (expressed as total area and percentage of area within the LAU):

- 7,044 m^2 (<0.5%) Medium density seagrass
- 154,526 m^2 (<0.5%) High density seagrass
- 1,208,706 m^2 (2.5%) Mixed assemblage
- 36,028 m^2 (<0.5%) Bare sand

Therefore, the total predicted *recoverable impacts* within the ZoMI are 1,417,375 m^2, or just under 3% of the LAU. Less than 0.5% of the *recoverable impacts* occur to high density seagrass communities.

As aforementioned, multiple assumptions have led to a highly conservative approach to predicting impacts. Therefore, the presented extent of *recoverable impacts* within the ZoMI on BCH described above are likely to be greater than any actual *recoverable impacts* within the LAU. Furthermore, multiple investigations have described the key seagrass species occurring within the ZoMI (*A. grifithii and A. antarctica*) as having multiple growth strategies allowing them to be highly resilient to disturbance (BMT 2021a, Coupland 1997, Lavery *et. al* 2009). These morphological and physiological growth strategies have evolved to allow these species to occur within a highly dynamic environment which experience naturally high disturbances, such as sedimentation loads and light reduction from swell and storm events, but also to anthropogenic disturbance such as reduced light from dredging. Studies undertaken post dredging in 2002/2003 identified sub-lethal impacts on seagrass communities from reduced light had occurred, these communities were seen to recover over a five-year period. The dredging activities during 2002/2003 created a turbidity plume that was far denser, far longer in duration and over a much greater extent than any plumes associated with this Project. Therefore, whilst there are no real predicted *recoverable impacts* previous research indicates that any disturbances are certainly recoverable within a five year timeframe.

When assessed against the naturally high levels of disturbance which occur from severe weather events within Champion Bay, the predicted impacts within the ZoMI are not anticipated to be markedly different from these natural winter storm events that these species are able to tolerate. Given the proposed timing of the Project, there are no precited impacts during key periods, such as seeding (November/December) or significant active growth periods (February – June).

Therefore, given the likely predicted *recoverable impacts* and no *irrecoverable impacts* the proponent considered that the EPA Objective for BCH is met.

4.5.5. Potential Environmental Benefits

As previously described, sediment relocation from the entrance channel to the Nearshore DMPA will provide the opportunity for previously trapped sediments to be exposed to natural processes supporting the health and long-term distribution of seagrasses occurring within the Point Moore to Glenfield secondary sediment cell.

Assessment of Potential Environmental Benefits

The placement of ~190,000 m^3 of dredge material into the nearshore environment at the proposed nearshore DMPA may have the potential to supply supplementary sediments required to support long term health and distribution throughout the Bay. Whilst many of the benefits of this relocation are likely to occur with respect to coastal resilience, these sediments will also have the indirect benefit of top-dressing seagrass meadows. Seagrass meadows require an ongoing source of sediments to sustain healthy growth, particularly within Champion Bay, as sediments are continuously being relocated and moved within the Bay and trapped within the entrance channel. Where sediments are starved, seagrass meadows can begin to scour along their edges which ultimately reduces the available sediment volume for healthy and stable root and rhizomes growth. Where sediments become starved seagrasses may be removed through wave and current action resulting in receding boundaries and reduced overall biomass. With any loss of seagrass biomass, there is a proportional net loss of the benefits they provide within the ecosystem as previously described by Lavery *et al* (2019).

Whilst there is limited experimental studies designed to explore the benefits of top dressing, or the impacts of sediment starvation on seagrass distribution and health, particularly within the Champion Bay, providing this supplementary material is considered beneficial to the maintenance of their longer-term health. Furthermore, sediments which are trapped along seagrass boundaries will continue to promote rhizome growth resulting in greater habitat distribution and therefore a greater biomass of seagrass within the Bay. Any increase in biomass of seagrasses within the Bay will promote an increase in the beneficial services they provide, such as increased coastal resilience, increased contributions of sediment volumes into the natural system, increased contribution to the marine food and provision of nursery areas to key finfish and western rock lobster juveniles and other services as described by Lavery *et al* (2019).

4.5.6. Mitigation

Mitigation measures proposed to minimise potential impacts on the environmental factor 'Marine Environmental Quality' are described in **Table 4-11** and presented in accordance with the EPA's mitigation hierarchy (Avoid, Minimise, Rehabilitate[2]).

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[2] Rehabilitation measures are excluded from Table 10 as these are not expected to be required to mitigate impacts to marine environmental quality.

Table 4-11 Mitigation measures to minimise impacts on Benthic Communities and Habitats

Potential Impact	Avoidance	Minimisation	Residual Impact
Direct removal during dredging (1a)	> Dredge in existing footprint only – no new extent.	> Hydrodynamic modelling against seagrass thresholds. > Management of dredge operations under the DEMP (**Appendix H**). > Seagrass monitoring Program.	No residual impacts predicted.
Direct burial during material placement (1b)	> Site selection to avoid sensitive BCH – area is bare sand. > Timing – dormancy of seagrass and no seeding	> Seagrass light thresholds from Oakajee applied. > Sediment transport modelling for ZoMI and ZoI. > Short duration of dredge program (<8 weeks). > Marine habitat mapping. > DEMP ○ Seagrass monitoring program	No residual impacts predicted. Ongoing sediment migration from the Nearshore DMPA has the potential to increase seagrass health and distribution thus promoting the beneficial services they provide within the Bay.
Reduced water clarity due to dredge plumes (1c)	> Hydrodynamic and sediment transport modelling indicates no ZoMI. > Timing – dormancy of seagrass and no seeding > Sediment physical characteristics	> Hydrodynamic and sediment transport modelling for ZoMI and ZoI. > Seagrass light thresholds from Oakajee applied. > Seagrass sedimentation thresholds from Grey (1997) and EPA (draft dredge guidance) applied. > Marine habitat mapping. > DEMP: ○ Seagrass monitoring program; ○ Light monitoring; ○ Dredge continuously moving; ○ Dredge hopper overflow management.	No residual impacts predicted.

4.5.7. Predicted Environmental Protection Outcomes

The predicted EPOs of the Project include:

- No irreversible loss, or serious damage outside the dredge footprint and Nearshore DMPA (ZoHI);
- No detectible reduction from the baseline state of benthic communities outside the ZoHI and the ZoMI;
- LEPA maintained adjacent to tailwater release returned to a MEPA within one month; and
- Potentially promoting greater seagrass health and biomass which provides greater secondary services such as coastal resilience, sediment production, supports the marine food web and provides juvenile fish and crustacea habitats.

The combined impact of the Project activities and the consequent outcomes are not considered to pose significant residual risks to the protection of BCH and therefore biological diversity and ecological integrity can be maintained. In respect of the proposed design and management of the Project, the Proponent considers that the EPA's objective for BCH has been met.

5. Other Environmental Factors

In addition, to those key environmental factors identified in **Section 4**, nine other relevant environmental factors were also identified. However, due to their being either no risk, or a very low risk of environmental impact on these factors, and in consideration of the mitigation measures that the Proponent proposes to implement to manage any impacts, these factors are not expected to be required for assessment by the EPA. These other environmental factors are presented in **Table 5-1** and included:

- Flora and Vegetation;
- Landforms;
- Terrestrial Environmental Quality;
- Inland Water Environmental Quality;
- Hydrological Processes;
- Marine Fauna;
- Terrestrial Fauna;
- Air Quality; and
- Social Surroundings.

Table 5-1 Other Environmental Factors and Potential Impacts of the Proposed Dredge Project

Environmental Factor	Receiving Environment	Project Activities	Management, Monitoring & Mitigation	Impacts
Marine Fauna	O2 Marine (2021c) completed a desktop assessment search of the online EPBC Act Protected Matters Search Tool (**Appendix D**). The desktop assessment revealed that a number of threatened or migratory marine species may occur within the vicinity of the Geraldton Port channel. The main species identified include: > Australian sea lion (*Neophoca cinerea*); > Humpback whale (*Megaptera novaeangliae*); > Indo-Pacific bottlenose dolphin (*Tursiops aduncus*); and > Western rock lobster (*Panulirus cygnus*). Geraldton is home to a small, non-breeding (male) colony of Australian sea lions (*Neophoca cinerea*). Approximately 17 to 20 mainly sub-adult males and the occasional female are known to use the breakwaters of the Port as haul-out sites. The sea lion is native to Western Australia and is listed in Schedule 4 of the WA Wildlife Conservation (Specially Protected Fauna) Notice 1998. Humpback whales (*Megaptera novaeangliae*) are found in the Geraldton area between late-May to early-December with the peak of the southern migration occurring in September to November. The humpback whale is a listed threatened migratory species (Vulnerable) under the Environmental Protection and Biodiversity Conservation (EPBC) Act 1999 and is listed as rare or likely to become extinct under the Wildlife Conservation Act 1950. Western rock lobsters occur widely along the mid-west coastline. Juveniles are observed closer along the shoreline and within the protection of bays, such as Champion Bay and use seagrass area and shallow rocky reef areas for foraging and protection. The Geraldton region supports one of the largest commercial and recreation rock lobster fisheries in Australia, although the range is wide and extends far greater than Champion Bay. The Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) is likely to occur in the area though is considered a key species. It has a low conservation status level and is not listed under the EPBC or BC Act. However, it is listed as	> Dredging of the entrance channel and inner harbour. > Material placement at the nearshore DMPA. > Sediment transport from the nearshore DMPA smothering habitats	> Dredge crew trained in Marine fauna observation. > DEMP, including: • Marine fauna exclusion zones. • Vessel speeds. • Nearshore Placement. • MFO recording and reporting of marine fauna observations, injury or death. > Marine fauna desktop assessment completed. > September – October identified as lowest environmental risk as it avoids key periods such as: Whale migration and rock lobster migration from nearshore reefs to deeper waters (walk of the whites).	**Meets EPA Objective** Although there are identified marine fauna within the Project area the activities posed to these are typically low risk. Previous dredge projects (2002/2003 and 2012) did not report any significant impacts, and with adequate management proposed there are no anticipated impacts to Marine Fauna from this Project. Potential indirect benefits through increases to seagrass habitat health and extent which support juvenile life stages and supports the marine food web.

	near threatened according to the IUCN Red List. They occur over a very wide region and are regularly seen within Champion Bay and surrounding waters.			
Flora & Vegetation	There is no significant flora or vegetation within the proposed Project area.	> NA	> NA	**Meets EPA Objective**
Landforms	No significant landforms occur within the development footprint. However, the Project area is located within close proximity of the Geraldton Town foreshore and the Chapman River.	> Dredging of the entrance channel and inner harbour. > Material placement at the nearshore DMPA.	> Dredging will only impact previously impacted areas > Nearshore DMPA has been carefully selected to minimise any disturbance to natural landforms > Monitoring at Chapman River is proposed to ensure no adverse impacts	**Meets EPA Objective** The Chapman River landform has been assessed under the factor Coastal Processes. The Geraldton foreshore impacts would be restricted to coastal erosion. This is assessed under the Factor Coastal Processes.
Terrestrial Fauna	The Project area only contains the Bert 7 Reclaim area. This is an industrial area and does not contain any significant terrestrial fauna.	> NA	> NA	**Meets EPA Objective**
Terrestrial Environmental Quality	The onshore land reclamation area is the only terrestrial component of the dredge Project. The existing land reclamation area consist of dredge material from the 2002/2003 and 2012 maintenance dredge projects. A detailed site investigation (DSI) has been conducted by MWPA, of which the land reclamation area was included. The DSI identified numerous contaminants of concern (CoPC) occurring at the site and undertook a detailed sampling program targeting soil groundwater and surface across the site. The main CoPCs confirmed were metals, typically coper and zinc, and nutrients which exceeded the designated trigger levels. Further studies investigated the groundwater to marine water flux and determined that the export of metals or nutrients into the marine environmental was not sufficient to result in any impacts to Marine Environmental Quality.	> Placement of up to 45,000 m3 of inner harbour material, known to be mildly contaminated into the land reclamation area.	> ASS Management Plan > Sediment characterisation assessment, including elutriate and bioavailability testing. > DEMP > Industrial land use zoning at the land reclamation area	**Meets EPA Objective** The placement of material at the existing land reclamation area is not expected to alter the existing profile of that area as identified within the DSI. Th eland is designated for future industrial use, therefore the buried contaminants pose no risk to terrestrial receptors. Tailwater release and the groundwater/marine water interface and impacts to MEQ are assessed under the Factor Marine Environmental Quality.

Hydrological Processes	There are no wetlands or watercourses within the Project footprint & surface water flows are limited to natural stormwater and tidal interface through the existing pipelines.	> NA	> NA	**Meets EPA Objective**
Inland Waters Environmental Quality	There are no inland waters within the Project footprint.	> NA	NA	**Meets EPA Objective**
Air Quality	There are no construction activities associated with the Project which will result in air quality impacts. The dredging and material placement activities do not pose a risk to air quality	> NA	> NA	**Meets EPA Objective**
Social Surroundings	<u>Cultural Heritage</u> European: There are no significant European sites located within the Project area. Aboriginal: Two registered Aboriginal Heritage Sites are recorded in the Aboriginal Heritage Inquiry System (AHIS) as being in the vicinity of the Project area. These include site ID 5561 Chapman River Mouth and 5874 Bluff Point Midden. To better understand and mitigate impacts to Aboriginal heritage, MWPA engaged with the Yamatji Southern Regional Corporation to ensure that key cultural and environmental sensitivities are not impacted by the Project. <u>Shipwrecks</u> There are 18 Shipwrecks identified on the WA Museum Shipwrecks database that are located off the coast of Geraldton with eight occurring within Champion Bay. Shipwrecks in State Waters are protected under the MA Act. The exact location of many of these shipwreck sites is unknown. <u>Vessel Traffic</u> Port waters are utilised already by both commercial & recreational vessels.	> Disturbance of a shipwreck. > Disturbance of an aboriginal heritage site. > Disturbance of public amenity (i.e. mixed-use wharf zone). > Increased vessel traffic & maritime safety.	> DEMP > Timing to avoid key recreation boating times > Consultation undertaken with Yamatji SRC for Project design > Multibeam survey of the Nearshore DMPA prior to material placement.	**Meets EPA Objective** No known shipwrecks of significance in the Project footprint. Multibeam survey completed at Nearshore DMPA identified no possible shipwreck sin area. Aboriginal heritage guidance and consultation undertaken Yamatji SRC. Vessel traffic limited to only one additional vessel in Project area which is restricted to a maximum speed of eight knot at a very in the area immediately around the Port where majority of recreational activities do not occur.

6. Holistic Impact Assessment

Overall actual and potential impacts of the Project on the environment are not considered to represent a significant environmental risk on the basis that:

- The EP Act principles and relevant EPA guidance documents have been considered in investigating and evaluating potential impacts of the Project on the EPA's environmental factors;
- A comprehensive set of monitoring and management measures have been developed to further mitigate potential impacts of the Project on the EPA's environmental factors;
- The proponent has committed to open and transparent reporting of environmental performance throughout the Project construction phase;
- Evaluation of impacts against all relevant environmental factors, including other environmental factors determined that the EPA's objectives were considered to be met. Specifically, for the key environmental factors the following outcomes were predicted:
- Coastal Processes:
  - No residual impact on coastal processes as a result of the Project and Project activities.
  - Supplementing the natural sediment budget within the Point Moore to Glenfield Secondary sediment cell potentially resulting in positive environmental outcomes including:
    - returning sediments confined within the entrance channel back to the sediment cell it was derived from;
    - allowing sediments to continue to naturally migrate under the influence of natural coastal processes (waves and currents);
    - providing an ongoing source for sediment supply to the shoreline required for building resilience to coastal erosion.
- Marine Environmental Quality –
  - LEPA maintained adjacent to tailwater release returned to a MEPA within one month.
  - A temporary, localised reduction in MEQ during dredging in the immediate vicinity of the dredge footprint and NPA.
  - Manage vessel bunkering, chemical storage and spill response to ensure no adverse impacts to the marine environment.
  - Beneficial environmental outcome through the removal of contaminated sediments and relocation into a managed land reclamation cell.
- Benthic Communities and Habitat:
  - No irreversible loss, or serious damage outside the dredge footprint and NPA.
  - No detectible reduction from the baseline state of benthic communities outside the ZoHI and the ZoMI.
  - LEPA maintained adjacent to tailwater release returned to a MEPA within one month.
  - Potential to promote improved seagrass health and increased biomass which may provide greater secondary services such as coastal resilience, sediment production, supporting the base marine food web and providing juvenile finfish and rock lobster habitats.
- Evaluation of impacts against MNES determined that there are no predicted impacts.

Based on the outcomes of this EIA, it is recommended that MWPA implement a Dredge Environmental Management Plan in conjunction with an Acid Sulfate Soils Management Plan to ensure all potential impacts are adequately managed during and post dredging and material placement. Through implementation of comprehensive management plans, this assessment identifies that the associated risks from this project are considered adequately minimised and avoided so as the implementation of the Project does not result in 'Significant Environmental Impacts' thus warranting referral under Part IV of the Environmental Protection Act 1986.

It is therefore recommended that MWPA undertake a comprehensive risk assessment for the project, continue to consult with and engage relevant stakeholders and implement the management and monitoring programs accordingly.

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Appendix A Benthic Communities and Habitat Mapping

Appendix B Nearshore Seagrass Habitat Assessment

Appendix C Seagrass Baseline Monitoring Survey

Appendix D Dredging and Dredge Plume Hydrodynamic Modelling

Appendix E Sediment Characterisation Sampling and Analysis Plan

Appendix F Sediment Characterisation SAP Implementation Report

Appendix G Marine Fauna Desktop Assessment

Appendix H Dredging Environmental Management Plan

Appendix I Acid Sulfate Soils Management Plan

Appendix J Beneficial Use Options Assessment