Mardie Project

Dredge and Spoil Disposal Management Plan

ENVIRONMENT
An O2Marine company

CLIENT: BCI Minerals Limited

STATUS: Rev 5

REPORT NUMBER: R190043

ISSUE DATE: 21 August 2025

MARINE

WA MARINE PTY LTD | ABN 84 168 014 819 | www.o2marine.com.au

Important Note

Maps are created in WGS 84 - Pseudo-Mercator (EPSG:3857) coordinate reference system and are not to be used for navigational purposes. Positional accuracy should be considered as approximate.

Acknowledgement Of Country

In the spirit of reconciliation O2 Marine Pty Ltd acknowledge that this project is proposed on the lands of the Yaburara Mardudhunera People. We pay our respects to Elders past, present and emerging and recognise their continuing connection to land, sea, culture and community.

WA Marine Pty Ltd t/as O2 Marine
ACN 168 014 819
Fremantle Office – Western Australia
20 Mews Road FREMANTLE WA 6160
T 1300 219 801 | info@o2marine.com.au

Version Register

Version	Status	Author	Reviewer	Comment	Authorised for Release (signed and dated)
Version A	Draft	N Claydon B Campbell	G Motherwell	Inclusion of offshore disposal management	
Rev B	Draft	J Abbott N Claydon	G Motherwell	Update to new Project details	N Claydon 8/11/2024
Rev C	Draft	N Claydon	A Gartner	For client review	N Claydon 11/11/2024
Rev D	Draft	N Claydon	G Motherwell	For client review	N Claydon 4/12/2024
Rev 0	Final	N Claydon	G Motherwell	Issued for Use	N Claydon 9/12/2024
Rev 1	Final	S Webb-Martin	G Motherwell	RFI Amendments	S Webb-Martin 28/04/2025
Rev 2	Final	S Webb-Martin	J Abbott	Update to Project elements	J Abbott 2/07/2025
Rev 3	Final	S Webb-Martin N Claydon B Campbell	N Claydon	Issued for Use	N Claydon 11/7/2025
Rev 4	Final	S Webb-Martin B Campbell	N Claydon	Issued for Use	N Claydon 17/7/2025
Rev 5	Final	N Claydon	G Motherwell	Issued for Use	N Claydon 21/8/2025

Transmission Register

Controlled copies of this document are issued to the persons/companies listed below. Any copy of this report held by persons not listed in this register is deemed uncontrolled. Updated versions of this report if issued will be released to all parties listed below via the email address listed.

Name	Email Address
Karen Frehill	Karen.Frehill@bciminerals.com.au
Snyman Van Straaten	snyman.vanstraaten@bciminerals.com.au

Acronyms and Abbreviations

Term	Full term
BCH	Benthic Communities and Habitat
BCHMMP	Benthic Communities and Habitat Monitoring and Management Plan
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DSDMP	Dredge and Spoil Disposal Management Plan
DWER	Department of Water and Environmental Regulation
EPA	Environmental Protection Authority
EPO	Environmental Protection Outcome
ESD	Environmental Scoping Document
ha	hectares
Ktpa	Thousand tonnes per annum
M^3	Cubic metres
mAHD	Metres Australian Height Datum
Management Zone	Management zones include both the observation and exclusion zones for marine fauna observing
MEQ	Marine environmental quality
MFO	Marine Fauna Observer *Dedicated MFO: A suitably trained and dedicated person engaged by the proponent to undertake marine fauna observations and recommend mitigation measures associated with dredging. The person will have demonstrated knowledge and experience in marine fauna species observation, distance estimation and reporting. They will not have any other duties while engaging in visual observations.* *Trained MFO: A marine vessel crew member engaged by the dredging contractor who is trained in marine fauna species observations and mitigation measures, consistent with Project environment management plans. The trained MFO will be on duty on Project vessels during construction and operations and may have other vessel duties.*
MODIS	moderate resolution imaging spectroradiometer
MTs	Management Targets
Mtpa	Million tonnes per annum
MWQMP	Marine Water Quality Monitoring Program
NTC	National Tide Centre
PASS	Potential Acid Sulfate Soils
PER	Public Environmental Review
PERMANOVA	Permutational Multivariate Analysis of Variance

Term	Full term
The Proponent	Mardie Minerals Pty Ltd
The Proposal	The Mardie Project
SOP	Sulphate of Potash
SOPEP	Shipboard Oil Pollution Emergency Plan
SOW	Scope of Works
TMF	Tiered Management Framework
TTS	Temporary Threshold Shift
UAV	Unmanned Arial Vehicle
WA	Western Australia
ZoHI	Zone of High Impact
ZoI	Zone of Influence
ZoMI	Zone of Moderate Impact

Contents

Acronyms and Abbreviations **5**

1. Introduction **1**

1.1. Project description *1*

1.2. Purpose *2*

1.3. Condition requirements *5*

2. Existing Environment **5**

2.1. Climate *5*

2.2. Coastal *8*

2.3. Benthic communities and habitats *13*

2.4. Sediment Quality *21*

2.5. Marine Water Quality *21*

2.6. Marine Fauna *22*

2.7. Underwater Cultural Heritage *32*

3. Capital Dredging Program **33**

3.1. Scope of Works *33*

3.2. Sequence of Works *33*

3.3. Preliminary dredging schedule *34*

3.4. Pre- and post-dredge bathymetric surveys *34*

3.5. Dredging methodology *34*

3.6. Dredge plume modelling *35*

3.7. Offshore spoil disposal *36*

4. Maintenance Dredging Program **40**

4.1. Indicative Maintenance Dredging Methodology *41*

5. Roles and responsibilities **43**

6. Environmental Factors and Objectives **44**

7. Management **48**

7.1. Benthic Communities and habitats *48*

7.2. Marine Environmental Quality *55*

7.3. Marine Fauna *59*

8. Environmental Monitoring **65**

8.1. Marine Water Quality Monitoring Program *65*
8.2. Benthic Habitat Monitoring Program *76*
8.3. Marine Fauna Management *86*
9. Reporting **98**
9.1. Compliance reporting *98*
9.2. Additional reporting *98*
10. Document review **100**
11. References **101**
Appendix A. Condition Requirements **108**
Appendix B. Example Marine Fauna Observation Log **122**

Tables

Table 1: BCH classes recorded within and around the dredge footprint (O2 Marine 2019b) 14
Table 2: BCH category and the area and proportion of DMPA4. 18
Table 3: BCH classes recorded within and around the proposed DMPA4 area 19
Table 4: Ecological windows (Dark blue represents full duration of presence, light blue represents timing of specific behaviour) 24
Table 5: Summary of Baird modelling studies relevant to the Project 35
Table 6: Estimated volume of maintenance dredging disposal at DMPA4 42
Table 7: Project Roles and Responsibilities 43
Table 8: Potential Environmental Impacts, Environmental Protection Outcomes and Management Targets for Mardie Project 45
Table 9: Management actions to minimise impacts on Benthic Community Habitats 48
Table 10: Management actions to minimise impacts on Marine Environmental Quality 55
Table 11: Management actions to minimise impacts on Marine Fauna 59
Table 12: Threshold Limits for Modelled Suspended Sediment Concentration used to define ZoMI and ZoHI regions through the dredge and disposal program (from Fisher et. al. 2019) 66
Table 13: Indicative water quality monitoring stations (worst and best case were not modelled for disposal) 67
Table 14: Environmental Protection Outcomes, Management Targets and Management Criteria for protection of BCH from dredging/disposal 72
Table 15: *In-situ* classification details of sub-lethal indicators to be recorded for each colony during each survey 81

Table 16: Post-processing data for the following indicators 82
Table 17: The process for evaluation of management thresholds 84
Table 18: MFO requirements per activity and in relation to the time of year 87
Table 19: Dredging and disposal observation and exclusion zones 88
Table 20: Vessel approach distances (DoEE 2017a,b) 95
Table 21: Reporting requirement through the dredging and disposal scope 98

Figures

Figure 1: Regional location of the Optimised Proposal 3
Figure 2: Location of dredge footprint and spoil ground DMPA4 4
Figure 3: Wind rose plot for Mardie Airport between November 2019 and 2024 (Willy Weather 2024) 6
Figure 4: Climate statistics for Mardie (BoM 2024a) 7
Figure 5: Tracks of notable cyclones impacting Karratha (top) and Onslow (bottom) (BoM 2024b). 8
Figure 6: Bathymetry of jetty and dredge channel 10
Figure 7: Bathymetry of DMPA4 11
Figure 8: Wave conditions offshore of the Project location for Dry season months (left) and Wet season months (right) based on measured data April 2018-January 2019. Source: Baird 2020 13
Figure 9: Project subtidal BCH within and surrounding the dredge footprint (O2 Marine 2019b) 17
Figure 10: BCH map of DMPA4 and zones of impact 20
Figure 11: Zones of High and Moderate Impact for best and worst case based on Baird (2022) dredge plume modelling 38
Figure 12: Zones of High and Moderate Impact for disposal activities based on disposal plume modelling (Baird 2024) 39
Figure 13: Indicative water quality monitoring locations for dredging operations 69
Figure 14: Indicative water quality monitoring locations for disposal operations 70
Figure 15: Tiered Management Framework for Marine Water Quality Monitoring 75
Figure 16: BCH monitoring locations 79

1. Introduction

1.1. Project description

Mardie Minerals Pty Ltd (Mardie Minerals) have been granted approval for the Mardie Project (the Project) a greenfields high quality salt and sulphate of potash (SoP) project and an associated export facility at Mardie, approximately 80 km south west of Karratha, in the Pilbara region of Western Australia (WA) (Figure 1).

The original Proposal was assessed by the WA Environmental Protection Authority (EPA) under Part IV of the *Environmental Protection Act 1986* (WA) (EP Act) and approved by the WA Minister for Environment via Ministerial Statement (MS) 1175 on 24 November 2021. Environmental approval was also granted by the Department of Climate Change, Energy, the Environment and Water (DCCEEW) under the *Environmental Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) on 12 January 2022 via EPBC 2018/8236. The Project design was then revised following these approvals, and the new design was approved via the EPA MS 1211 dated 19 October 2023 and DCCEEW under EPBC 2022/9169 (dated 9 September 2024). EPBC 2018/8236 was varied to mirror the conditions of EPBC 2022/9169 approval on 9 October 2024.

The Project is an evaporative solar salt project that utilises seawater to produce raw salts as a feedstock for processing high purity salt, fertiliser grade sulphate of potash, and other commercial by-products. To meet this production, the Project will include seawater intakes and a series of evaporation and crystallisation ponds. Waste bitterns will be discharged through diffusers offshore.

Salt and SoP produced at the project will be exported offshore through the specially constructed port operations, and dredging will be required to construct the port. The proposed dredging footprint is shown in Figure 2. A 2.4 km long trestle jetty has been constructed to convey salt and SOP to the transhipment berth pocket for loading onto the transhipping barge. The jetty will not impede coastal water or sediment movement, thus ensuring coastal processes are maintained.

Capital dredging of an estimated 355,000 m^3 design volume (including 10% over-dredging volume) will be required to ensure sufficient depth for the transhipper berth pocket at the end of the trestle jetty, as well as along an approximately 4.9 km long channel out to deeper water. Disposal of the dredge material will be offshore at proposed Dredge Management Placement Area (DMPA) 4, located approximately 25 km (approximately 14.5 Nautical Miles) north-northwest of the dredging location, beyond Sholl Island (Figure 2). Maintenance dredging volumes on average are expected to be up to 50,000 m^3 annually to maintain sufficient depths for the project operations (WSP 2025). However, it is not expected that maintenance dredging will need to be undertaken every year, based on similar channels in the Pilbara, and due to annual variability in the sedimentation rate at the dredge site depending on a range of environmental factors (e.g., wave action, tidal currents and severe weather events (cyclones) in close proximity). Maintenance dredging is more likely to be every 2-4 years (WSP 2025). Mardie Minerals will manage the maintenance dredging effectively through implementation of a long term Dredge and Spoil Disposal Management Plan (DSDMP) once the available volume at DMPA4 is confirmed after capital dredging.

1.2. Purpose

The current approvals (MS 1211; EPBC 2018/8236 (as varied) and EPBC 2022/9169) include the dredging within the dredging footprint, and onshore disposal. However, offshore disposal to proposed Spoil Ground DMPA 4 will be required during capital and maintenance dredging for the efficiency of the Project. A new referral (EPBC 2024/10054) was therefore submitted for the unconfined ocean disposal of the dredge material. Therefore, the purpose of this Dredge and Spoil Disposal Management Plan (DSDMP) is to ensure compliance with project specific Environmental Protection Outcomes (EPOs) in the approvals documents, through proposed Management Targets (MTs) and specific management and monitoring actions to ensure that these EPOs are achieved for dredging and offshore disposal. It is noted that these EPOs and MTs may require a review upon referral assessment by DCCEEW. The intention of this DSDMP is also to replace the existing Dredge Management Plan (Revision 7; O2 Marine 2023a) for the Project as approved in accordance with EPBC 2018/8236 and EPBC 2022/9169. Mardie Minerals recognises a long term DSDMP for maintenance dredging will be developed and submitted to Decision-Making Authorities for assessment following the completion of capital dredging and further surveys have been conducted. Further details around maintenance dredging are provided in Section 4.

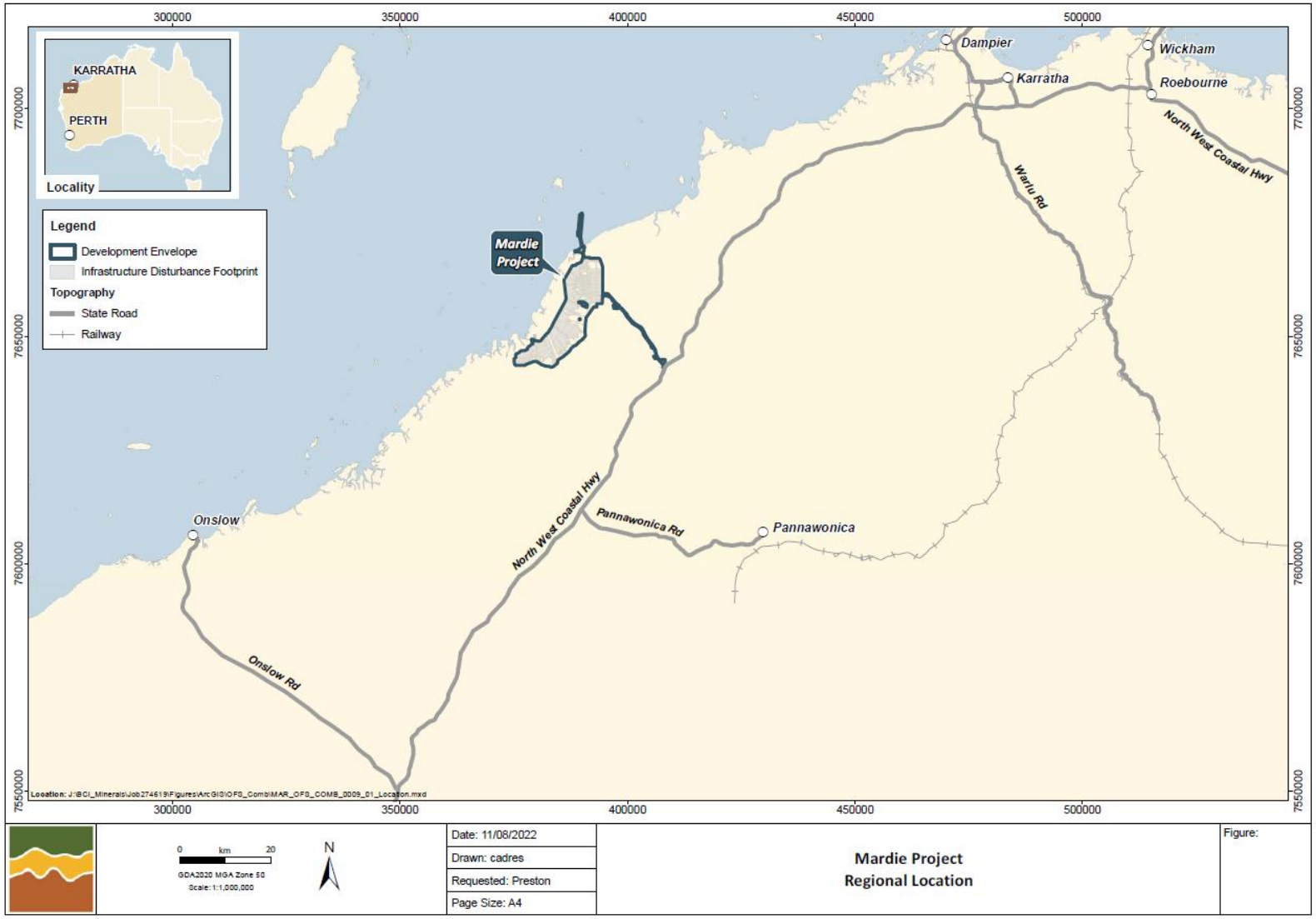


Figure 1: Regional location of the Optimised Proposal

Figure 2: Location of dredge footprint and spoil ground DMPA4

1.3. Condition requirements

The approval conditions under MS 1211 and Commonwealth approval conditions under EPBC 2018/8236 and EPBC 2022/9169 and how they are addressed in this DSDMP are presented in Appendix A.

2. Existing Environment

This section describes the existing environment within and around the dredging area and proposed offshore disposal area for the Project. The description is based on information derived from historical sources and investigations conducted as part of the environmental impact assessment process for the Project. A Cyclone Response Procedure has been prepared for the Project (000-HS-PRO-0010).

2.1. Climate

The Project is located in the southern Pilbara region, which has a tropical monsoon climate with distinct wet and dry seasons. The Pilbara coast is the most cyclone prone area along the Australian coastline, with the cyclone season running from 1 November to 30 April and peaking in February – March (Sudmeyer 2016).

2.1.1. Wind

The dry season extends from May to October, and is characterised by warm to hot temperatures, easterly to south-easterly winds from the continental landmass, clear and stable conditions as the subtropical high-pressure ridge migrates over this area. In the afternoons, the winds generally shift to north-westerly, particularly later in the dry season, associated with the onset of the land sea breeze as the temperature difference between the continent and the ocean increases throughout the day. In the wet season the wind climate is dominated by westerly and north-westerly winds. Figure 3 presents the wind records from Mardie Airport over the period between November 2019 and 2024.

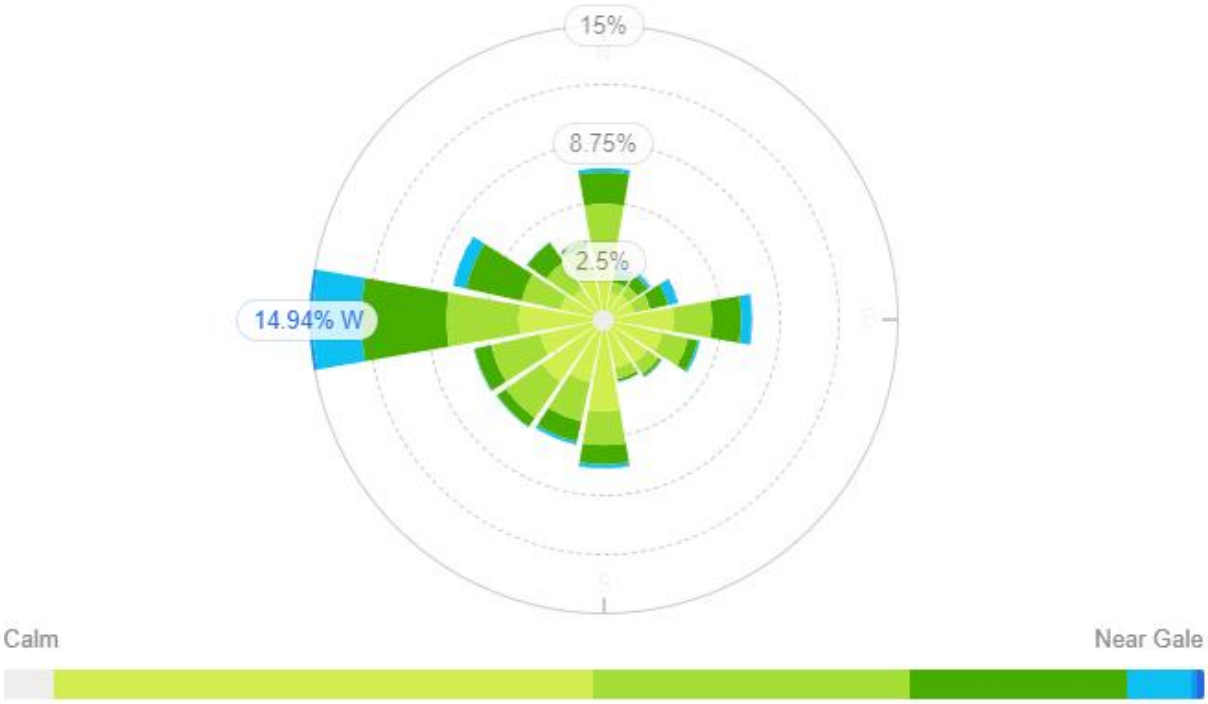


Figure 3: Wind rose plot for Mardie Airport between November 2019 and 2024 (Willy Weather 2024).

2.1.2. Temperature and rainfall

Mean maximum daily temperatures at Mardie between 1956 and 2024 have a yearly average of 34 °C, with monthly mean maximum temperatures peaking at 37.9 °C in January and falling to 27.8 °C in July (Figure 4) (BoM 2024a). The Pilbara is influenced by northern rainfall systems of tropical origin. These systems are responsible for heavy falls during the summer months, while the southern low-pressure systems sometimes bring limited winter rains. The annual average rainfall is 274.9 mm, and the mean monthly rainfall has a bimodal distribution, peaking in January to March and also May to June, with very little rainfall from July to December (BoM 2024a). Daily rainfall can reach over 300 mm during extreme events that may occur one to two times per decade. Evaporation rates in the region are high, estimated to exceed by ten times the annual rainfall.

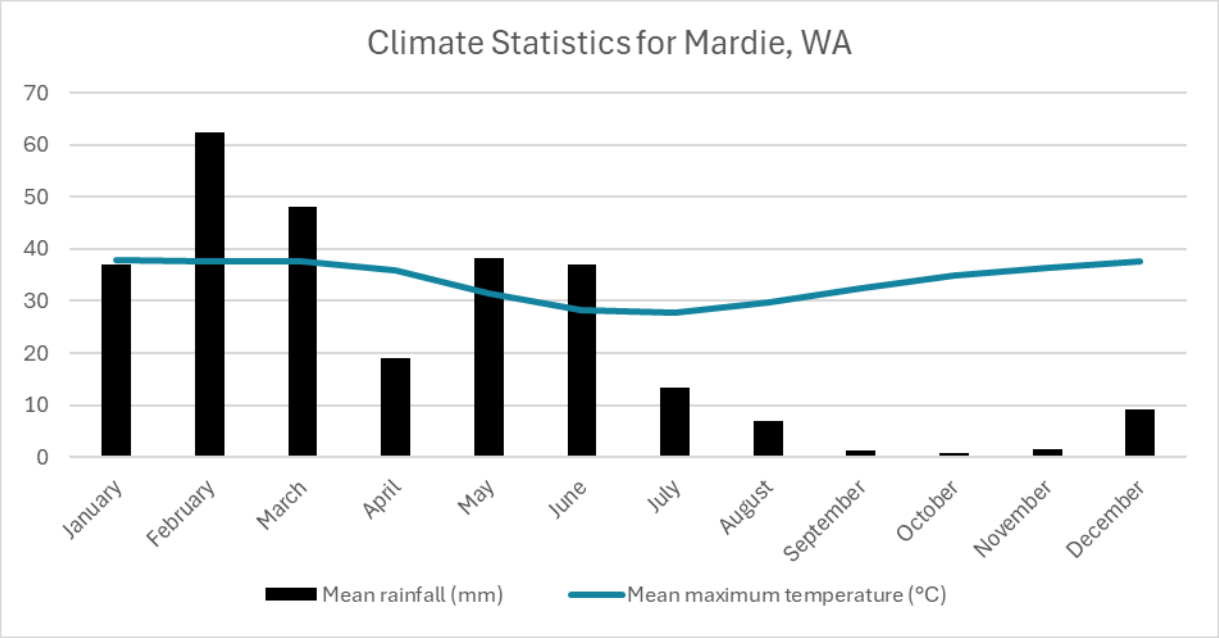


Figure 4: Climate statistics for Mardie (BoM 2024a)

2.1.3. Tropical cyclones and storm surge

The Australian cyclone season extends from November through to April with an average of 10 cyclones per year, although not all make landfall. Tropical cyclone winds can generate extreme coastal water levels through storm surge and these systems are frequently associated with heavy rainfall that can cause significant flooding. The Pilbara region of Western Australia has a high exposure to tropical cyclone events, with a typical cyclone track recurving and making landfall on the coastline between Broome and Exmouth. The season typically runs from 1 November to 30 April, peaking in February and March. The Karratha to Onslow coastline is the most-cyclone prone section of the Australian coast, typically experiencing one landfalling event every two years.

Historical events of significance impacting between Karratha and Onslow include Trixie in 1975, Chloe in 1984, Orson in 1989, Olivia in 1996, John in 1999, Monty in 2004, Clare in 2006 and Glenda in 2006 (Figure 5). In late March 2019 the passage of TC Veronica tracked west over the region from offshore of Karratha losing intensity as it continued west offshore of Mardie as a tropical low system.

The northwestern coastline of Western Australia is highly vulnerable to the occurrence of storm surge. This is due to the frequency of tropical cyclones, the wide continental shelf and relatively shallow ocean floor over the North West Shelf, as well as the low-lying nature of much of the coastline. In addition, tropical cyclone events are strongly associated with flooding due to widespread heavy rainfall.

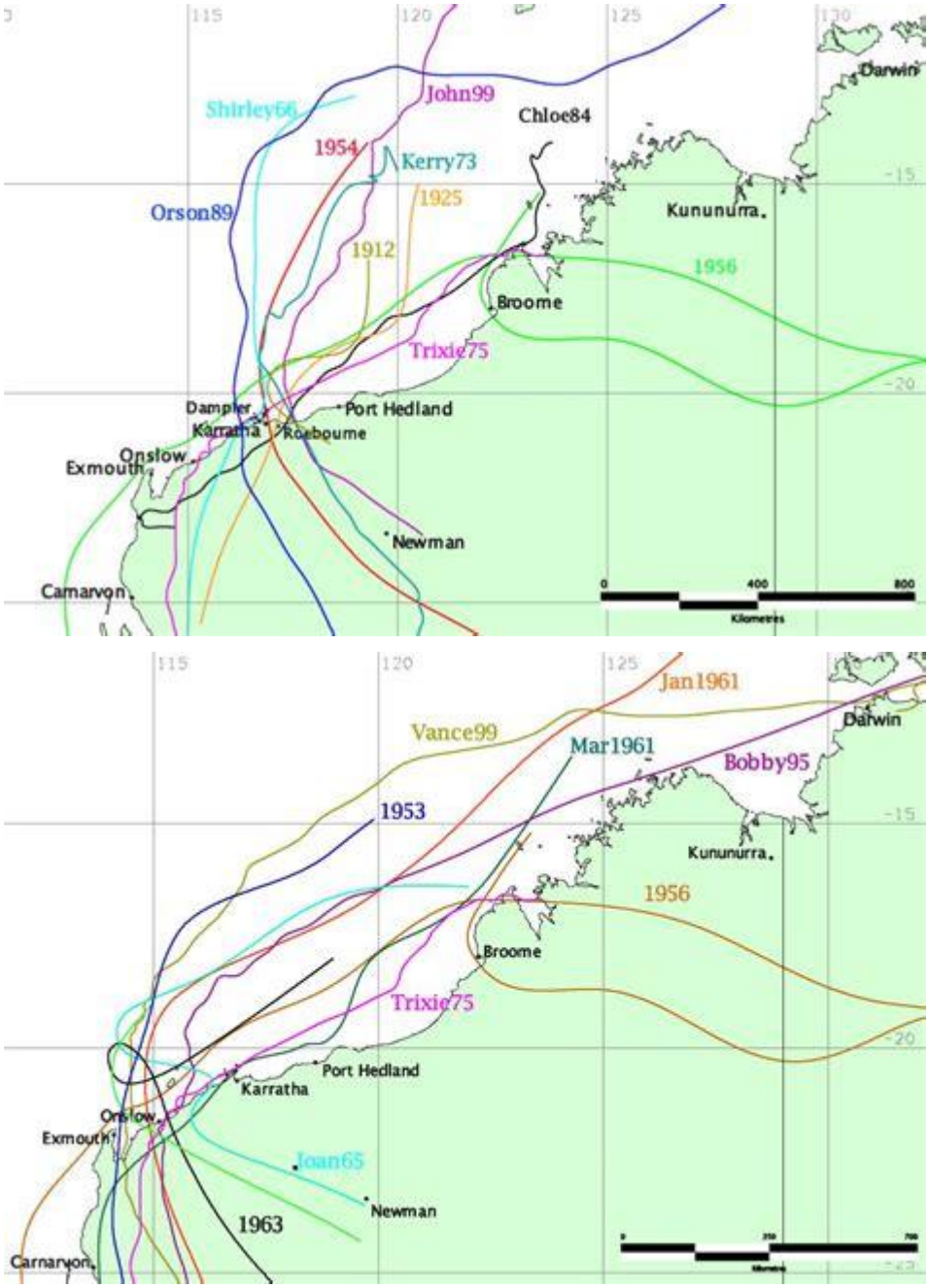


Figure 5: Tracks of notable cyclones impacting Karratha (top) and Onslow (bottom) (BoM 2024b).

2.2. Coastal

2.2.1. Bathymetry

The offshore components of the Project (jetty and dredge channel) are situated in an area shown as unsurveyed on marine charts. Mardie Minerals has conducted several detailed bathymetric studies over the previously unsurveyed area, as well as surrounding areas to verify chart soundings (e.g. Surrich and EGS 2019). The bathymetry of the dredge footprint is presented in Figure 6. The berth pocket at the end of the jetty has a design depth of – 6.9 mLAT (CD)and the dredge channel no deeper than -3.9 mLAT(CD) in accordance with EPBC 2018/8236 and EPBC 2022/9169 conditions.

A hydrographic survey of Spoil Ground DMPA4 was undertaken between 20 and 26 September 2024 to map the bathymetry, which ranged from approximately -22 mAHD to -21 mAHD (Figure 7) (O2 Metocean 2024).

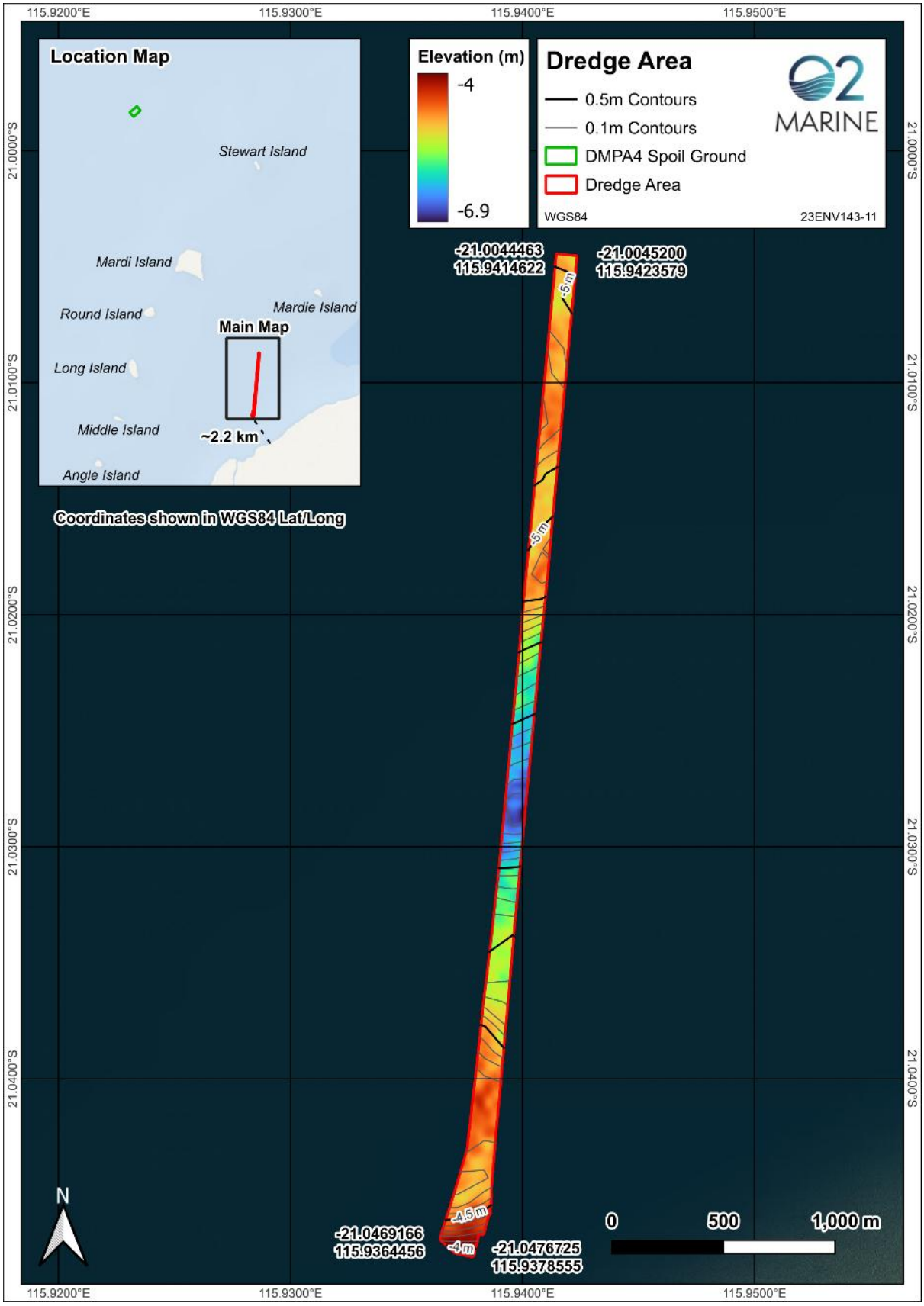


Figure 6: Bathymetry of jetty and dredge channel

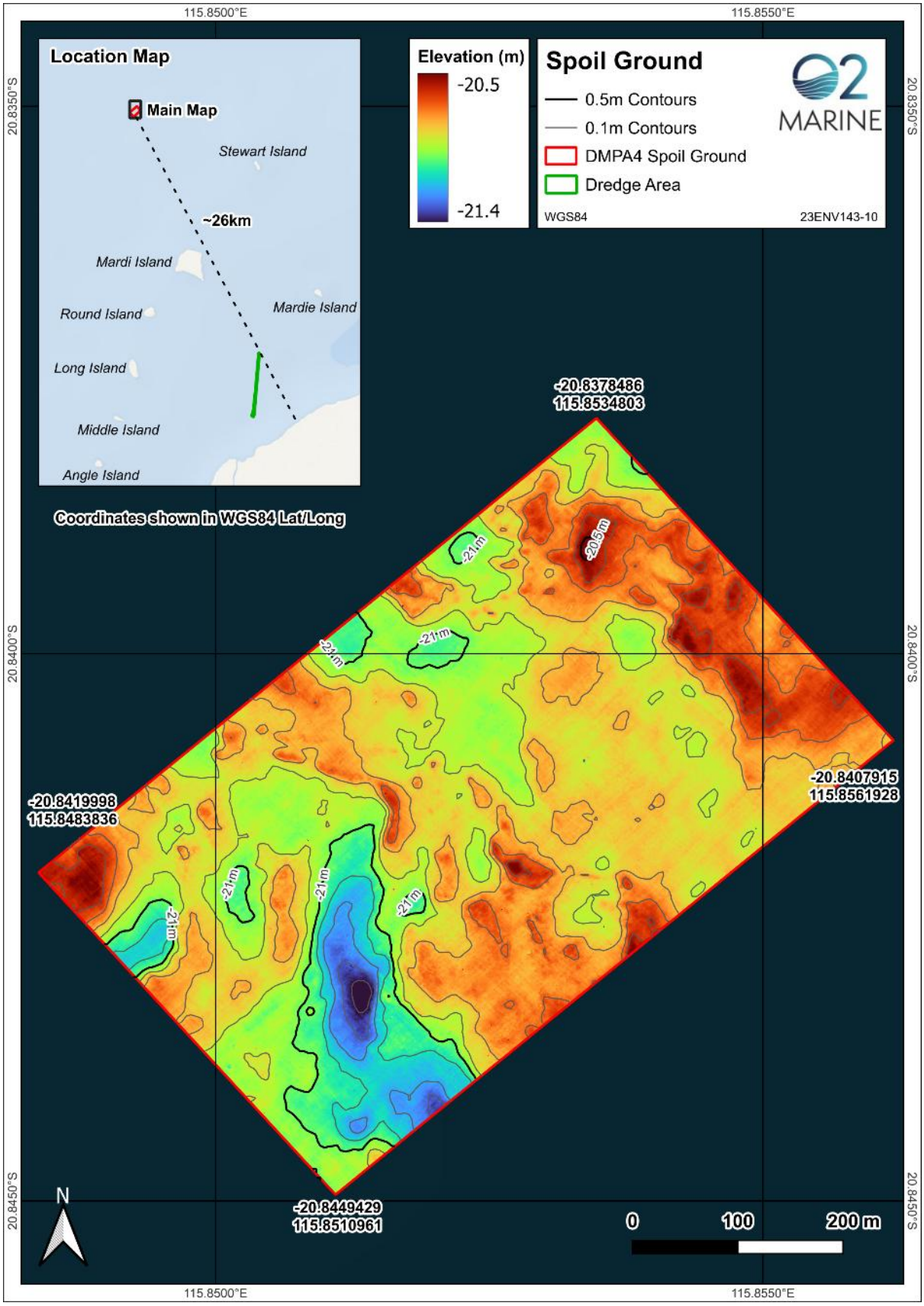


Figure 7: Bathymetry of DMPA4

2.2.2. Tides

The Mardie Project location experiences a semi-diurnal tide (two highs and two lows a day) with a range of 5.07 m (LAT to HAT) and mean sea level at 2.52 m LAT (MardieInner21LAT datum). For the nearshore region of the dredging footprint, the general tidal currents are aligned along a north-east to south-west axis for the ebb and flood tides. The current direction (current to) has been found to flow at 40-70^0 during the ebbs, and flood 220-250^0 (Baird 2022).

2.2.3. Waves

The northwest shelf of Western Australia experiences waves generated from three primary sources: Indian Ocean swell, locally generated wind-waves and tropical cyclone waves. Along the shoreline the ambient (non-cyclonic) wave climate is generally mild. In dry season months low amplitude swell originating in the Indian Ocean propagates to the site and occurs in conjunction with locally generated sea waves of short period (<5 s). In the wet season the wave climate is locally generated sea waves from the south to southwest. In general, the significant wave height is dominated by locally generated sea conditions within the range of 0.5 m to 1 m at short wave periods (Tp< 5 s). Measured data from an ADCP instrument deployed approximately 15 km offshore for the Project has been analysed to characterise the wave conditions in the wet and dry seasons as shown in Figure 8 (Baird 2020a).

Whilst the non-cyclonic ambient wave conditions are generally mild, in contrast the strong winds in a tropical cyclone can generate extreme wave conditions. It is noted that the offshore island features would provide some natural protection form extreme wave conditions depending on the direction of propagation. Extreme cyclonic waves contribute to the total water level through wave run-up which is the maximum vertical extent of wave uprush on a beach and is comprised both wave set-up and swash. The impact of cyclonic waves on the Project area is dependent on the prevailing water level conditions and direction of cyclone approach. If coincident with a spring tide and storm surge, waves could propagate beyond the typical position of the beach and induce erosion of the shoreline as well as sediment transport.

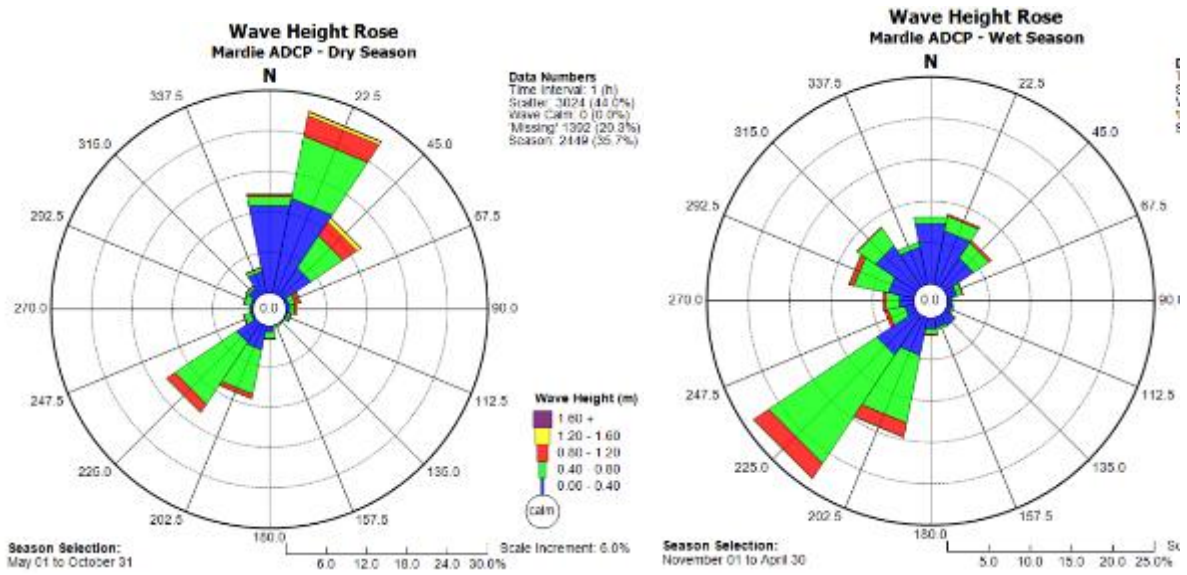


Figure 8: Wave conditions offshore of the Project location for Dry season months (left) and Wet season months (right) based on measured data April 2018-January 2019. Source: Baird 2020a

2.3. Benthic communities and habitats

2.3.1. Dredge footprint BCH

The Project area is in shallow (<6 m) nearshore waters located approximately 5 km offshore, north from the Mardie Coastline and southwest from the Fortescue River-mouth. The seafloor in this area is generally comprised of unconsolidated silt, sand and gravel.

O2 Marine (2019b) identified the nearshore subtidal zone to support benthic primary producers such as sparse patches of macroalgae, seagrass and corals (Table 1).

Most of the subtidal benthic substrata is abiotic, characterised by bare sand and silt with limited limestone pavement and ridges. Many of the limestone ridges also occur around the offshore islands and support assemblages of macroalgae, corals and sponges. Whilst the extensive subsea plains of sand/silt are often bare of any sessile mega-benthic taxa (such as coral and macroalgae), these habitats do support smaller infaunal species and surface-dwelling echinoderms and filter feeders such as hydroids.

A total of no more than 79 ha of benthic community habitat (BCH) will be cleared (i.e. directly impacted) by dredging and a further 202 ha is predicted to recover from the dredging operations. This BCH includes no more than 35 ha (cleared) and a maximum of 133 ha (recoverable) of filter feeder / microalgae / seagrass habitat and no more than 10 ha (cleared) and a maximum 103 ha (recoverable) of coral / macroalgae habitat[1]. These calculations have been based on the approved dredge footprint

[1] Although seagrass was identified in the impact area, it was present only in extremely low densities (i.e. almost undetectable), making coral the primary benthic community of concern with respect to dredging impacts. Seagrass, macro algae and filter feeder communities will still be monitored, however, these habitats are given less weight when identifying impacts from the proposed dredge activities and will be used to validate predicted impact to BCH.

and volumes, and therefore the reduced dredging volume will ensure that these are the maximum areas impacted.

Table 1: BCH classes recorded within and around the dredge footprint (O2 Marine 2019b)

BCH Class	Description	Example Image
Bare / bioturbated sand	Bare Silt / Sand Typically comprises of silt or sand with no or occasional very sparse macroalgae. Silt areas often comprised of bioturbation (burrows formed by living organisms). Sand areas often contain traces of shell grit. This habitat comprises 89% of the mapped subtidal BCH and is also widely dispersed across the region.	
	Sand / Sparse (<5%) Macroalgae Fine silt/sand and bioturbated bedform with a very patchy distribution of macroalgae and invertebrates. Macroalgae (*Phaeophyta*) was the dominant cover, but was very sparse, generally comprising <1% of the overall cover. Class was differentiated from the other macroalgal classes due to the very sparse nature of the cover and the much finer grained, and often bioturbated sediments. This habitat comprises 1% of the mapped subtidal BCH. It was also observed on the eastern fringing waters of Round Island, whilst the largest contiguous area was observed closer to the mainland in the shallow waters between Angle Island and the mainland.	
Filter feeder/ macroalgae/ seagrass	Sand / Sparse (<5%) Filter Feeders Sparse filter feeder habitat occurs where the relief is flat and is associated with fine to coarse sands. Although only present in sparse densities (<5% cover), hydroids are most common where there is no bedform, whilst sponges occur where there is some bioturbation. This habitat comprises 2% of the mapped subtidal BCH and is widely dispersed throughout the region.	

Filter feeder/ macroalgae/ seagrass	Low (5-10%) Cover Macroalgae / Filter Feeders Flat to low relief constituting either fine to coarse sands, including shell grit on occasions. Macroalgae, hydrozoan and sponge species are equally dispersed throughout this habitat although benthic cover is low (3-10%). Occasional very sparse (<1%) cover of *Halophila* sp. seagrass was also observed at some locations. This habitat comprises 6% of the mapped subtidal BCH and follows a patchy distribution throughout the region. This habitat was also observed in small patches fringing the shallow waters of Long Island, Mardie Island and close to the mainland.	
Coral/ macroalgae	Low (5-10%) Cover Coral Flat to low relief rock and rubble with coarse sand. Low (3-10%) cover of soft and hard corals, including *Faviidae, Dendrophyllidae, Mussidae and Octocroals*. Sparse macroalgae was also present. This habitat comprises 1% of the mapped subtidal BCH. This habitat was also found fringing Mardie Island and in small isolated patches between Angle Island and the mainland. It was generally recorded in waters between 1-3 m depth.	
	Moderate (10-25%) Cover Coral / Macroalgae Low to moderate relief rock and rubble/coarse sand. Low to moderate cover (3 – 25%) of soft and hard corals with macroalgae. Corals largely consisted of *Faviidae, Poritidae, and Octocorals,* while *Phaeophyceae* dominated the macroalgae communities. This habitat class comprises only 1% of the mapped subtidal BCH. However, it was also recorded in larger areas in fringing shallow waters south of Mardie Island and adjacent to the mainland coast.	
Coral/ macroalgae	Dense (>25%) Cover Macroalgae / Coral / Filter Feeders This habitat class occurs on low relief substrate with fine to coarse sands and areas of exposed limestone reef. Dense assemblages (>75%) of macroalgae and hydrozoan species predominately in waters at depths of 2.2-4.0 m. This habitat also supported sparse juvenile corals (*Faviidae, Dendrophyllidae, Mussidae)* with occasional larger coral (*Poritidae*) bommies (1–2 m diameter). This habitat class comprised <1% of the mapped subtidal BCH. It was also identified in the waters	

	fringing the eastern outer edge of Long Island, Round Island and Sholl Island.	
	Dense (>25%) Cover Coral Dominated Low relief limestone reef and rubble substrate which supports high coral cover (25-75%) of diverse coral species, including *Faviidae, Dendrophyllidae, Mussidae, Portitidae*, and *Octocoral* species. This habitat class was only recorded at one location and, as such, comprises <1% of the mapped subtidal BCH. However, it was also recorded in a much larger area fringing the northern edge of Mardie Island.	

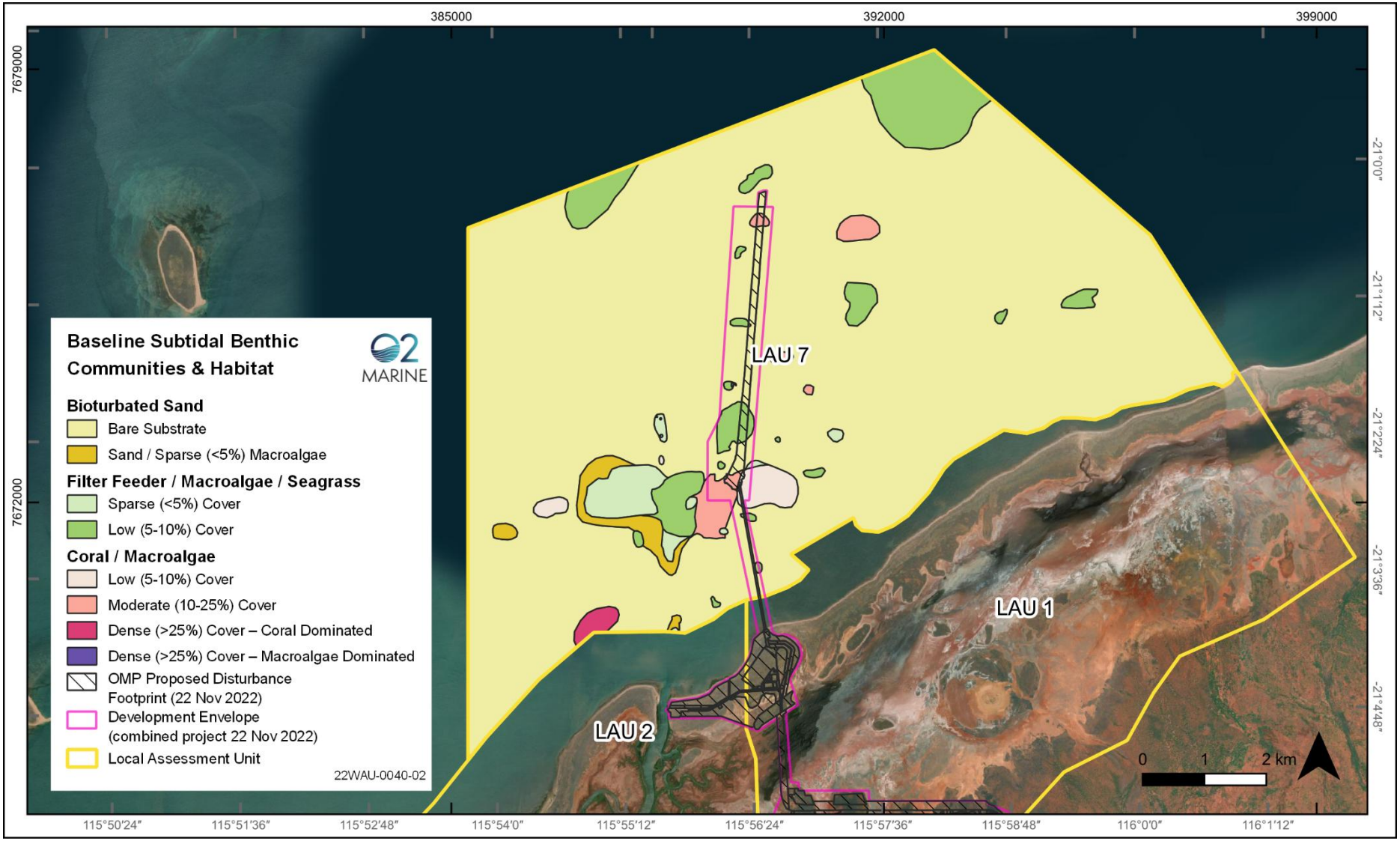


Figure 9: Project subtidal BCH within and surrounding the dredge footprint (O2 Marine 2019b)

2.3.2. DMPA4 BCH

A BCH survey of proposed DMPA4 and the surrounding predicted zones of impact was undertaken in September 2024 (O2 Marine 2024a). A detailed assessment for mapping was undertaken within the DMPA4 and parts of the zones of impact, and further spot-assessments were undertaken throughout the remaining area of the zones of impact. The results of this assessment are presented in O2 Marine (2024). The areas within the DMPA4, ZoHI and ZoMI have been calculated and presented in Table 2.

Table 2: BCH category and the area and proportion of DMPA4.

Area	BCH Classification	Area (ha)
DMPA4 (direct permanent loss predicted)	Sparse to moderate filter feeders on unconsolidated sediment	4.61
	Sparse to moderate filter feeders on low profile reef with sand veneer	25.65
	Total Sparse to moderate filter feeders within DMPA4	**30.26**
ZoHI (indirect permanent loss predicted and does not include DMPA4)	Sparse to moderate filter feeders	**309.06**
ZoMI (indirect recoverable impacts predicted and does not include DMPA4 or ZoHI)	Sparse to moderate filter feeders	**650.52**
Total Sparse to moderate filter feeder areas of impact		**989.84**

The entire area of DMPA4 and the zones were classified as Sparse to moderate filter feeder cover based on the dominant number of observations from ground truthing and associated lack of any clear pattern in the distribution of any BCH assemblage type (examples of observations of the area are given in Table 3 and mapped in Figure 10). Within DMPA4, additional survey information enabled further details for the mapping and substrate types to be mapped, namely unconsolidated sediment and low-profile reef with sand veneer (Figure 10). It is noted that irregular observations of other classes were observed in the survey area, however, it was not possible to further delineate to a more granular level or better represent the level of heterogeneity beyond ascribing a 'mixed' classification. Further details of these other classifications are presented in O2 Marine (2024).

Table 3: BCH classes recorded within and around the proposed DMPA4 area

BCH Class	Description	Example image
Sparse to Low Cover Filter Feeders	Sparse to low coverage (3 – 10%) of filter feeders on sand with shell fragments.	
Moderate Cover Filter Feeders	Moderate coverage (10 - 25%) of filter feeders on sand with shell fragments.	
Sparse to Low Cover Mixed Assemblage	Sparse to low cover (3 – 10%) mixed assemblage on sand with shell fragments. Mixed macroalgae, filter feeders, ascidians (*Polycarpa sp.*, *Pyura sp.*) sponges, hard corals (*Sinularia sp)*, Alcyonacea, gorgonians (*Juncella fragilis*).	

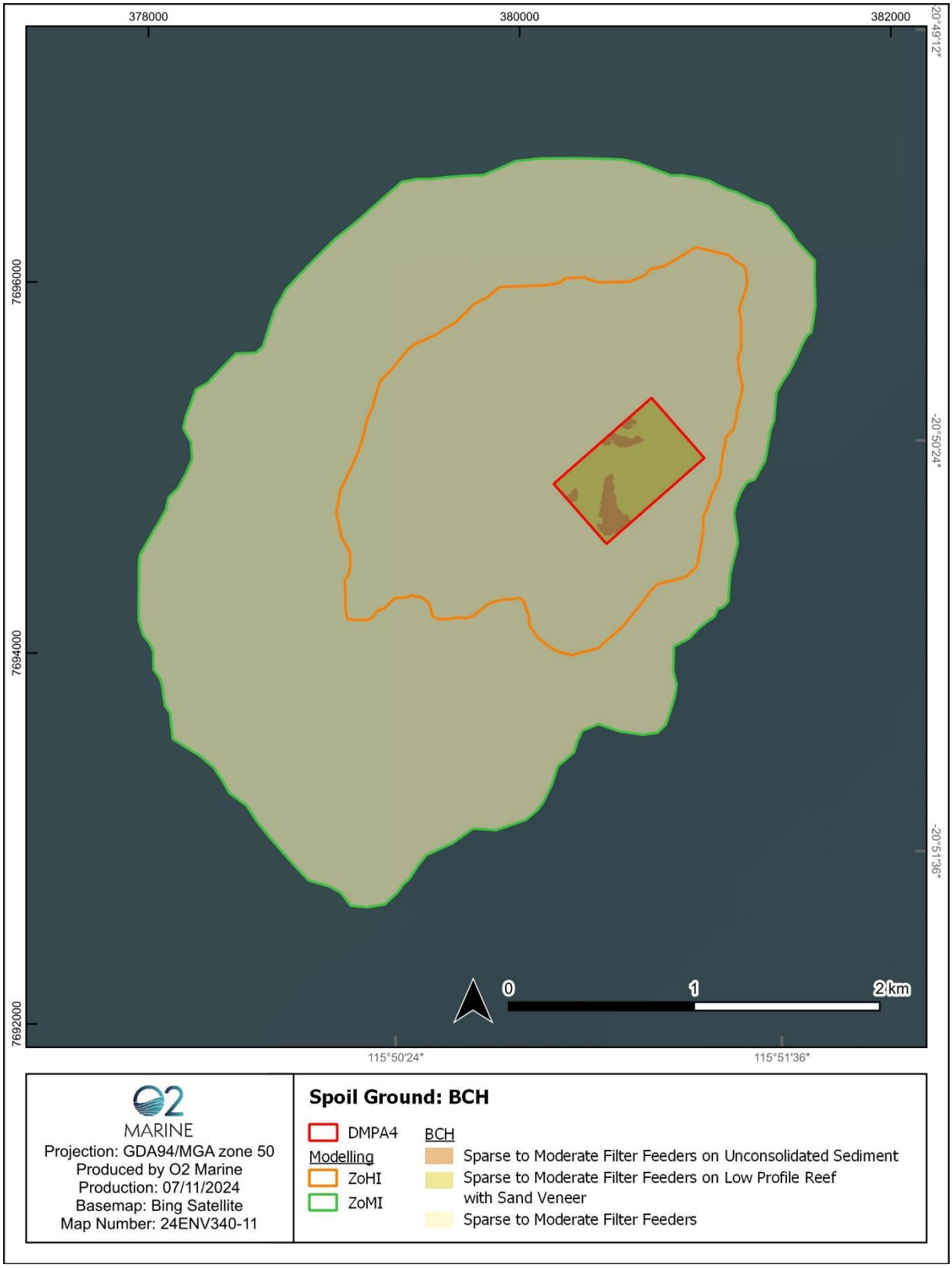


Figure 10: BCH map of DMPA4 and zones of impact

2.4. Sediment Quality

2.4.1. Dredging area and surrounds sediments

A baseline sediment assessment of the Project (O2 Marine 2019) identified that of the Contaminants of Potential Concern (CoPC) analysed, only arsenic and nickel (95% UCL of mean) concentrations exceeded the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018) and NAGD screening levels (ISQG-Low) (NAGD 2009). In comparison to other marine sediment programs in similar areas of the Pilbara (DEC 2006), some concentrations of metals and nutrients were naturally higher than previously recorded (O2 Marine 2019a). However, sediment is still deemed suitable for offshore disposal. Previous investigations (O2Marine 2019a; 2019b and 2023) have noted that all metals apart from naturally occurring metals (Arsenic, Nickel, Aluminium, Iron and Vanadium) (DEC 2006) were below the NAGD screening levels. Those that are naturally occurring, but exceed the NAGD screening levels, are representative of ambient natural levels.

As per the recommendations of O2 Marine 2019a, revised site-specific environmental quality criteria (EQC) were developed for the Project area (refer Table 18 in O2 Marine 2019a).

Further sediment sampling within the updated revised dredge footprint was undertaken in 2023 (O2 Marine 2023a). All contaminants analysed during this sampling campaign were below the NAGD screening levels (ISQG-Low). In comparison to the site-specific EQC developed, sediments were also below these EQC values.

2.4.2. Spoil Ground DMPA4 sediment

Sediments within proposed DMPA4 were sampled in September 2024 at four random locations and analysed for various analytes to characterise the sediments within the area (O2 Marine 2024b). Results generally reflect sediment characteristics expected from an offshore greenfield site in the Pilbara. The majority of the contaminants (metals, hydrocarbons, TBT and BTEXN) were either below the laboratory LoRs, below the NAGD (2009) ISQG-low screening levels, or comparable to concentrations along the Pilbara coast as documented in DEC (2006). Only Sample SG01 recorded comparatively higher concentrations of metals and hydrocarbons to the other three sites (SG02, SG03 and SG04), with arsenic marginally above the NAGD (2009) screening level of 20mg/kg (21 mg/kg), and TRH C10-C40 (total) was above the screening level of 550 mg/kg (670 mg/kg).Arsenic concentrations within the Pilbara are known to be naturally elevated, and likely related to the geology of the region (DEC 2006).

Particle size distribution results indicate that all four sites within DMPA4 are largely comprised of coarse sand (approximately 55% of each sample), with smaller proportions of fine sand and gravel. These results are comparable to five northern most sediment samples (SS1, SS2, SS3, SS4, and SS5) collected within the dredge channel in 2022 (O2 Marine 2022).

Full details of the DMPA4 sediment sampling are presented in Appendix A of O2 Marine (2024a).

2.5. Marine Water Quality

Nearshore waters typical of this region are characterised by variable turbidity and high sedimentation rates, with associated highly variable light regimes and seawater temperatures. Offshore waters exhibit

fewer extremes in the water quality, but still display occasional high levels of sedimentation and turbidity, low light and variable seawater temperatures (Pearce *et al*, 2003).

Light, turbidity, seawater temperature and sedimentation rates are typically weather dependent and show a strong seasonal transition from the dry to the wet seasons. Large daily tidal ranges (>5 m), strong winds (gusts >50 km/h) and increased wave activity (such as associated with cyclonic activity) can impact background conditions resulting in increased turbidity (in the form of increase suspended sediment concentration (SSC) due to coastal runoff and wind/wave driven sediment resuspension. In summary, waters in the vicinity of the project area are subject to naturally elevated levels of turbidity and a reduced light climate heavily influenced by discrete weather events (Pearce *et al*, 2003).

O2 Marine (2020a) identified the following from marine water quality baseline studies conducted at the Mardie Project study area:

- Salinity levels recorded a median value of 37.5 ppt, and appeared to be indicative of a sheltered bay, which was thought to be due to the influence of the Passage Islands which act as a natural barrier and appear to restrict mixing with lower salinity oceanic waters.
- Turbidity and SSC were found to be higher at the inshore monitoring location than at the offshore location, which is consistent with other Pilbara water quality investigations (Jones *et al*. 2019; MScience 2009; Pearce 2003).
- Derived Daily light Integral (DLI) around the coastal islands was highest during wet season and lowest during the dry season and correlated with seasonal change in solar elevation angle, which is a primary factor influencing the amount of available benthic light in these areas. Conversely, DLI was low year-round at the inshore location (i.e., dredging area). Factors influencing benthic light levels are different between the islands and dredging area. However, the lowest light levels in both areas corresponded closely with high SSC and turbidity levels, associated with the passing of several Tropical Cyclones and low-pressure systems over the sampling period.
- Importantly, the EPA (2021) SSC and DLI thresholds for *possible* and *probable* effects on coral were found to be poorly suited as criteria for monitoring dredging effects in the Mardie Project area. Frequent natural exceedances of SSC and DLI thresholds indicates that these thresholds are unsuitable for use as water quality and dredge activity monitoring criteria in the Mardie Project area. It is noted that EPA (2021) recognises these potential limitations of the thresholds and advises that WAMSI is in the process of developing thresholds for turbid water coral communities. Once these new turbid water thresholds are available, they should be evaluated against the baseline data collected in this program and as part of the pre-dredging baseline to determine suitability for use in dredge monitoring.
- Laboratory analysis of marine water samples showed no evidence of contamination and the current allocation of maximum and high levels of ecological protection are appropriate for the marine waters of the Mardie Project area.

2.6. Marine Fauna

O2 Marine (2020d) conducted an assessment of the likelihood of occurrence of conservation significant marine fauna species within the vicinity of the dredging area (with a 50 km buffer), based on the list of species provided in the ESD (Preston 2018). The following key marine fauna species were identified which are either known to occur or have a high likelihood of occurring in the vicinity of the Project:

- Marine mammals:
  - Humpback whale (*Megaptera novaeangliae*)
  - Dugong (*Dugong dugong*)
  - Australian humpback dolphin (*Sousa sahulensis*).
- Marine reptiles:
  - Loggerhead turtle (*Caretta caretta*)
  - Green turtle (*Chelonia mydas*)
  - Flatback turtle (*Eretmochelys imbricate*)
  - Hawksbill turtle (*Eretmochelys imbricata*)
  - Short-nosed sea snake (*Aipysurus apraefrontalis*).
- Elasmobranchs
  - Green sawfish (*Pristis zijsron*).
  - Reef manta ray (*Mobula alfredi*).

In addition to these, further key marine fauna have been identified for the offshore disposal area DMPA4 based on a new search of the Protected Matters Search Tool (PMST) (20 km buffer) and literature review. These additional key marine fauna are:

- Marine mammals:
  - Indo-pacific/spotted bottlenose dolphin (*Tursiops aduncus*)
- Marine reptiles:
  - Leaf-scaled sea snake (*Aipysurus foliosquama*)
- Elasmobranchs:
  - Narrow sawfish (*Anoxypristis cuspidate*)
  - Dwarf sawfish (*Pristis clavata*).

Ecological windows for key species are presented in Table 4 based on results from the literature review (Bayliss and Hutton 2017; DoE 2022; Raudino et al. 2018; Hanf et al. 2022; Irvine et al.2018; Jenner et al. 2010; Jenner and Jenner 2010; O2 Marine 2023b; O2 Marine in prep; DoEE 2017; Peel et al. 2024; Pendoley Environmental 2022; D'Anastasi et al. 2016; Morgan et al. 2015; Morgan et al. 2017; Lear and Morgan 2022; Lear et al. 2023; Armstrong et al. 2020a;2020b; Gilmour et al. 2016). The table also includes a brief description of the marine fauna.

Table 4: Ecological windows (Dark blue represents full duration of presence, light blue represents timing of specific behaviour)

Species	Listing	Ecological Window		Relevance to the Project area
		Behaviour	J F M A M J J A S O N D	
Indo-Pacific bottlenose dolphin (*Tursiops aduncus*)	EPBC Act: Migratory BC Act: Migratory	*Presence*		Likelihood of occurrence **High** Likely to be present in the transit area and surrounding the disposal site. Frequently sighted adjacent to the Project search area with a known distribution throughout the Pilbara along the coast and around islands. Likely to be foraging, socialising or travelling in all areas of the Project, at any time of the year, but are not restricted to the area.
Australian humpback dolphin (*Sousa sahulensis*)	EPBC Act: Vulnerable, Migratory BC Act: P4, Migratory	*Presence*		Likelihood of occurrence **High** Likely to be present in the transit area and the surrounding the disposal site. With the species frequently recorded around the Great Sandy Islands and the Dampier Archipelago. It is highly likely that the species will be present in the wider area, including DMPA4, based on current and historical distribution patterns, habitat use and the mobile nature of the species.
Dugong (*Dugong dugon*)	EPBC Act: Migratory BC Act: Migratory	*Presence*		Likelihood of occurrence **High** Known to occur around DMPA4 and sighted in close proximity, including significant activity near DMPA4. Surveys of the Pilbara region suggest that dugongs consistent use of the region (Prince 2001; RPS 2010). DMPA4 is close to critical dugong habitats, particularly seagrass meadows essential for foraging. It is highly likely they will transit through the area and forage in nearby waters with suitable seagrass habitats. May be present any time of year, as no ecological windows for their activity identified.
Humpback whale (*Megaptrea novaeangliae*)	EPBC Act: Migratory, Cetacean BC Act: CD, Migratory	*Northern migration*		Likelihood of occurrence **Very High** The transit area and the DMPA4 are located within the humpback whale Migration BIA and IMMA which represents their migratory corridor. The area is not recognised as a major resting ground, cow-calf pairs may mill and socialise transiently while migrating (O2 Marine 2023b). Humpback whales have been recorded in the highest numbers in the waters adjacent to DMPA4 from mid-June onwards, the peak abundance being in August and September (O2 Marine 2023b; Sprogis et al. 2024). The species is especially likely to be present in the waters adjacent to DMPA4 during their southern migration, July to November, when they are closer to the coast and in shallower water when it is highly likely that mother-calf pairs would be present milling or resting.
		Southern migration		
Australian snubfin dolphin (*Orcaella heinsohni*)	EPBC Act: Vulnerable, Migratory BC Act: P4, Migratory	*Presences (noting not likely to be present)*		Likelihood of occurrence **Low** The Project is located outside the species recognised range, however vagrant individuals may be present in the waters around the Project from time to time.
Blue whale (*Balaenoptera musculus*) Pygmy blue whale (*B. m. brevicauda*)	EPBC Act: Endangered, Migratory, Cetacean BC Act: Endangered	*Northern migration*		Likelihood of occurrence **Low** Pygmy blue whales BIAs are further offshore than the Project area and the species has not been recorded in the waters around the transit and disposal area. The species is not expected to be present with research indicating that the species would be found in deeper waters offshore from DMPA4 (deep waters and >238±13.9 km offshore; Thums et al. 2022). Unlikely that the species would be present.
		Southern migration		
Green turtle (*Chelonia mydas*)	EPBC Act: Vulnerable, Migratory, Marine BC Act: Vulnerable	*Foraging*		Likelihood of occurrence **High** Frequently sighted close to DMPA4 and known to nest on nearby offshore islands. While the species BIA does not overlap with DMPA4, the BIAs for green turtles are likely to be underestimated (Ferreira et al. 2021). Nesting is known to occur on Sholl and Long Islands, and during nesting periods females use nearby shallow waters for thermoregulation and resting. It is likely that the species utilise waters and islands around DMPA4 for foraging and nesting/inter-nesting. Therefore, it is highly likely that green turtles, including hatchlings will be present in the waters around DMPA4.
		Nesting and inter-nesting		
		Peak nesting		
		Hatchlings		

Species	Listing	Ecological Window Behaviour	J	F	M	A	M	J	J	A	S	O	N	D	Relevance to the Project area
Hawksbill turtle (*Eretmochelys imbricata*)	EPBC Act: Vulnerable, Migratory, Marine BC Act: Vulnerable	*Foraging*	■	■	■	■	■	■	■	■	■	■	■	■	Likelihood of occurrence **High** Known to occur in the area and frequently sighted close to and within the Project search area (DBCA 2024). The species BIA (foraging and inter-nesting) habitat critical for the survival of the species overlaps with DMPA4 and the Project search area. Area should be considered key inter-nesting habitat for the species. Hawksbill turtles are known to nest on islands adjacent to DMPA4; Sholl and Long Island (Pendoley Environmental 2019; 2023). It is highly likely that the species would be present within the vicinity of DMPA4, likely using the waters for foraging and inter-nesting, and nesting on offshore islands.
		Nesting and inter-nesting	■	■	■							■	■	■	
		Peak nesting										■	■	■	
		Peak hatchlings	■	■										■	
Flatback turtle (*Natator depressus*)	EPBC Act: Vulnerable, Migratory, Marine BC Act: Vulnerable	*Foraging*	■	■	■	■	■	■	■	■	■	■	■	■	Likelihood of occurrence **High** Known to occur in the waters surrounding DMPA4 and the islands surrounding DMPA4 are known to provide important nesting habitat (Pendoley Environmental 2019; 2023). The species inter-nesting BIA and habitat critical for the survival of the species overlaps with DMPA4. Flatback turtles are reliant on neritic environments, therefore it is likely that flatback turtles would be present in the waters of the Project throughout the year using the area for inter-nesting, migration, and foraging behaviours (Peel et al. 2024), and nesting at island beaches. These behaviours are not restricted to the area and is well represented along the Pilbara and Kimberley coastlines.
		Nesting and inter-nesting	■	■	■							■	■	■	
		Peak nesting	■										■	■	
		Hatchlings		■	■							■	■	■	
Loggerhead turtle (*Caretta caretta*)	EPBC Act: Endangered, Migratory, Marine BCT Act: Endangered	*Foraging*	■	■	■	■	■	■	■	■	■	■	■	■	Likelihood of occurrence **Medium** BIA and habitat critical for the survival of the species does not overlap with the Project. Loggerhead turtles are infrequently sighted adjacent to DMPA4. The islands adjacent to the Project do not represent important nesting habitat for the species with no nesting turtles identified (Pendoley Environmental 2019). Loggerhead turtles may be infrequently present migrating or foraging in the waters adjacent to the Project.
		Nesting and inter-nesting	■	■	■							■	■	■	
		Peak nesting	■										■	■	
		Hatchlings		■	■										
Leatherback turtle (*Dermochelys coriacea*)	EPBC Act: Endangered, Migratory, Marine BC Act: Vulnerable	*Foraging(noting not expected to be present)*	■	■	■	■	■	■	■	■	■	■	■	■	Likelihood of occurrence **Low** BIA and habitat critical for the survival of the species does not overlap with the Project. Leatherback turtles are rarely observed in the Pilbara (DSEWPaC 2012), and no sightings have been recorded within the Project search area. Islands around DMPA4 do not represent nesting habitat for the species. Given the species' wide geographical range they may be infrequently present, but their occurrence in unlikely.
Short-nosed sea snake (*Aipysurus apraefrontalis)*	EPBC Act: Critically Endangered, Marine BC Act: Critically Endangered	*Presence*	■	■	■	■	■	■	■	■	■	■	■	■	Likelihood of occurrence **High** Based on the habitat suitability maps and known population at Barrow Island, the leaf-scaled sea snake is likely to have preferred habitat within the vicinity of DMPA4. It is possible that suitable habitat exits and the species may be present, given the species high conservation value, a high likelihood of occurrence has been given to the species.
Leaf-scaled sea snake (*Aipysurus foliosquama*)	EPBC Act: Critically Endangered, Marine BC Act: Critically Endangered	*Presence*	■	■	■	■	■	■	■	■	■	■	■	■	Likelihood of occurrence **High** Leaf scaled sea snakes are highly cryptic and thought to be in depleted numbers in northwestern WA. Habitat suitability modelling suggests the adjacent waters, around Barrow Island, provides suitable habitat for the species, and the waters around the disposal and transit having slightly lower habitat suitability. Therefore, it is possible that suitable habitat exits and the species may be present, given the species high conservation value, a high likelihood of occurrence has been given to the species.
Green sawfish (*Pristis zijsron*)	EPBC Act: Endangered, Marine BC Act: Vulnerable	*Foraging and/or migration*	■	■	■	■	■	■	■	■	■	■	■	■	Likelihood of occurrence **High** Green sawfish have also been recorded offshore around Barrow Island and are frequently caught by trawl fisheries in the area (Bateman et al. 2024; Harry et al. 2024). Project is located along the coast from sawfish nursery habitat (Ashburton River ~130 km and Fortescue River – ~30 km). Likely that the areas around the disposal and transit sites provide foraging and migratory habitat, and possibly using this the Project search are in general as a migratory corridor.
		Pupping								■	■	■	■	■	
	EPBC Act:	*Foraging*	■	■	■	■	■	■	■	■	■	■	■	■	Likelihood of occurrence: **High**

Species	Listing	Ecological Window												Relevance to the Project area
		Behaviour	J	F	M	A	M	J	J	A	S	O	N	D	
Narrow sawfish (*Anoxypristis cuspidata*)	Migratroy BC Act: Migratory	*Pupping*													Known to occur in offshore waters, given it is frequent bycatch in the Pilbara Trawl (Interim) Managed Fishery (Harry et al. 2024). Known to be reliant on connected coastal and offshore ecosystems, and likely to be present (Dulvy et al 2016). While DMPA4 and transit areas do not represent pupping or nursery habitat, it is likely that the species is travelling or foraging in the waters of and around the Project in suitable soft sediment habitats present.
Dwarf sawfish (*Pristis clavata*)	EPBC Act: Vulnerable, Migratory BC Act: P1, Migratory	*Presences*													Likelihood of occurrence: **High** DMPA4 and transit areas are located in the northwestern Australia's extensive sawfish habitat, a globally significant stronghold for the species. Adult dwarf sawfish are known to seasonally migrate between shallow inshore waters and potentially offshore areas, particularly during the breeding and pupping seasons, typically associated with the wet season. Therefore, it is likely that the species could be present given suitable habitat is likely to be present.
		Pupping													
Scalloped hammerhead (*Sphyrna lewini*)	EPBC Act: CD BC Act: Not listed	*Presences*													Likelihood of occurrence: **High** The disposal site and transit area overlaps with the species' known distribution and habitat preferences and the species is known to occur in highest numbers in the north-western Pilbara region (TSSC 2024). It is likely they travel through waters surrounding the Project
		Pupping													
White shark (*Carcharodon carcharias)*	EPBC Act: Vulnerable, Migratory BC Act: Vulnerable	*Presences (noting not likely to be present)*													Likelihood of occurrence **Low** The species is not expected to be present. DMPA4 does not represent preferred habitat for the species, with the species primarily found in the southern half of Australian waters, from Central Queensland to the North West Cape WA (McAuley et al. 2017). It is unlikely that the species would be present.
Grey nurse shark (*Carcharias taurus*)	EPBC Act: Vulnerable BC Act: Vulnerable	*Presences (noting not likely to be present)*													Likelihood of occurrence **Low** Historically the species has been recorded around Barrow Islands, but occurrence northward is limited (Hoschke et al. 2023). The species appears to have a temperature threshold of 24˚C and is not expected to be present in water temperatures exceeding this threshold. It is possible the present could be infrequently present during their seasonal occurrence June to December if water temperatures are favourable.
Reef manta ray (*Mobula alfredi*)	EPBC Act: Migratroy BC Act: Migratory	*Presences (noting not likely to be present)*													Likelihood of occurrence **Medium** Known to occur around Barrow Island and the Dampier Archipelago. However, less likely to be present within the waters around DMPA4 and transit area compared to the giant manta given the species preference for shallow water (<20m). Reef manta rays may be infrequently present in the waters, more likely present in areas closer to the coast or around islands.
Giant manta ray (*Mobula birostris*)	EPBC Act: Migratroy BC Act: Migratory	*Presence*													Likelihood of occurrence **High** Giant manta rays are known to occur in the waters around the disposal and transit sites. The species offshore waters, and no defined ecology windows of activity, it is likely that giant manta rays will be present throughout the year (travelling, socialising or foraging) in the waters of and surrounding the Project.

The Project overlaps with commercial fisheries operational areas and supports habitat for fish species that are of socio-economic value. These species are discussed in Section 2.6.4.

2.6.1. Marine Mammals

Humpback Whale

Humpback whales migrate annually from Antarctic feeding grounds to the Kimberley coast for calving during the winter. They predominantly occur offshore in open oceanic environments though they are known to stopover in the lee of offshore islands. Humpback whales have been observed on several occasions during the humpback southerly migration within 5 km of the Mardie Project. The southern migration is the period when they are closest to shore at an average of 36 km, with whales present from late June through to October, and the peak occurring between August and September in the Mardie region (O2 Marine 2023b). The Project dredge area is a shallow embayment (i.e. generally <5 m deep) and does not represent critical habitat for any whale species.

Proposed DMPA4 is located approximately 41 km to the east of Barrow Island, 37 km west of Cape Preston and overlaps the humpback whale migration pathway. Jenner and Jenner (2010) completed aerial surveys offshore of Onslow for the Wheatstone Project. These surveys found that humpback whales were present in this area from mid-June through to mid-December (only 1 pod sighted in December surveys), with peak sightings from mid-June to late August (Jenner and Jenner 2010). The surveys identified a relatively high proportion of humpback whales milling/resting, with an increasing number resting or milling during the southern migration (Jenner and Jenner 2010). During the northern migration whales were predominantly found 50 km offshore and 35 km offshore during the southern migration. Humpback whale mother-calf pairs are the most vulnerable group, and they are known to rest offshore of Onslow, with the highest number of resting pairs observed within the 50 m depth contour (within 35 km of the coast). A precautionary approach (i.e. ensuring precautions are taken as set out in Section 7) should be implemented for Offshore disposal during humpback whale migration.

Dugong

Dugongs are found throughout the Pilbara region, particularly close to the coast or in the lee of reef-fringed islands and often in areas where seagrass has previously been recorded. Although dugong have been previously recorded in the nearshore waters of the Mardie coastline, the nearest known dugong aggregations have been recorded near Cape Preston in the North and Coolgra Point in the South, generally in areas that consistently support extensive seagrass meadows (O2 Marine 2020d).

No dugong were observed in the waters around Mardie during over 700 hours of vessel-based observations. O2 Marine (2020d) concluded that this was most likely due to the lower value of the subtidal BCH in the area as suitable feeding or foraging habitat for dugong. However, surveys for seagrass (and dugong) were not undertaken during peak seagrass season (October-December). Nevertheless, dugong may be present in the Project area and management measures have taken the precautionary approach that consider impacts to this species (i.e. ensuring precautions are taken as set out in Section 7).

Seagrass was also not found to present within the spoil ground DMPA4, and therefore it would not represent preferred habitat, indicating that dugong would likely not reside in the area (though they may travel through).

Australian humpback dolphin

The Australian humpback dolphin (*S. sahulensis)* has been recorded throughout the year at the Montebello Islands (Raudino et al. 2018) and in the Mardie Project area. They are likely to be one of the most common dolphin species occurring in the Project area. This species together with the Indo-Pacific bottlenose dolphin (*T. aduncus*) are likely to be the most abundant dolphin species in the Mardie Project area inside the 20 m isobath (20 m includes dredge area, transit route and disposal area).

Aerial surveys completed for the Wheatstone Project (offshore of Onslow, east of the Project area) found that larger dolphin pods (> 100 individuals) can be sighted offshore though the majority of dolphin sightings were recorded in water depths less than 50 m (Jenner and Jenner 2010). Within shallower waters, smaller groups were more common. They are also more likely to be found in relatively shallow and protected coastal habitats such as inlets, estuaries, major tidal rivers, shallow bays, inshore reefs and coastal archipelagos, rather than in open stretches of coastline (Parra & Cagnazzi 2016) like the Project area. Therefore, the Australian humpback dolphins are likely to be present within the vicinity of the dredging footprint and the DMPA4 location but it does not represent important habitat for the species, being more likely to be present closer to protected waters.

Indo-pacific bottlenose dolphin

The indo-pacific bottlenose dolphin (*T. aduncus*) has been recorded throughout the year within the region and share similar behavioural activities with the Australian humpback dolphin, with some degree of spatial overlap. At a regional scale, there may be some partitioning between the species with bottlenose dolphins preferring deeper waters close to sloping bathymetry (Hanf et al. 2022). Finer scale studies support this, with significant differences in habitat use and fine-scale habitat selection (e.g. Hunt et al. 2017). Therefore, while this species was not considered likely to be present within the dredging area, it is considered a key marine fauna species at the spoil ground site DMPA4.

2.6.2. Marine Reptiles

Turtles

Only a small part of potential marine turtle nesting beach lies within the development envelopes, a narrow section of the beach labelled as ‘Mardie Creek East’. The Pendoley Environmental (2019) survey identified only very minor nesting effort by flatback turtles (*N. depressus)* and a single hawksbill turtle (*E. imbricata*), along the 15 km stretch of coastline to the east of the creek. These results indicated that the mainland beaches do not support regionally important rookeries. Recent surveys for the Project have also consistently found that onshore locations within and around the Project are not used for nesting. The results of the temperature loggers also confirmed that mainland beaches were significantly warmer than the offshore islands, impacting the success rate of any marine turtle nests on these beaches. More recently the Pendoley Environmental marine turtle monitoring program for the Project (2023) found that the marine turtle nesting activity was greatest on Sholl and Long islands. With the exception of the single hawksbill nest recorded on the mainland in December during the 2018/18

survey (albeit past the peak of the hawksbill nesting season), turtles nested most successfully on the offshore islands during all surveys (Pendoley Environmental 2023).

The main species recorded on the offshore islands was flatbacks, with relatively less nesting effort seen for hawksbill and green turtles at the same locations (Pendoley Environmental 2023). The snapshot monitoring data from Round, Middle, and Angle islands confirmed similar species composition and abundance at these sites. These results are consistent with turtle activity throughout the Pilbara where flatback and hawksbill nesting is dominant on nearshore island habitat, and flatback turtles are the most common mainland nesting species (Pendoley et al. 2016).

Therefore, turtles are not likely to nest near the dredging footprint, preferring instead to return to the islands.

DMPA4 does not represent preferred foraging habitat for turtles, as it is dominated by bare sand and filter feeders (O2 Marine 2024a) and turtle foraging studies completed in the region finding higher densities of foraging turtles over reef habitats (Jenner et al. 2010; Jenner and Jenner 2010. However, the nesting islands such as Sholl Island will be near the transport route to the spoil ground and precautions will be in place for artificial light and vessel strike.

Baseline artificial light results found the overhead skies at the Project location are typically very dark and representative of pristine, natural dark skies unaffected by artificial light. The only light source visible from all mainland and offshore light monitoring sites was the Sino Iron facilities located over 30 km away on the easterly horizon. However, artificial lighting is considered to have an impact on marine turtles and will be managed using the Mardie Project Illumination Plan (0000-EV-PLN-0014).

Seasnakes

The short-nosed sea snake (*A. apraefrontalis*) has not been previously recorded in the Mardie Project area. This species is typically found in coral reef habitats, which in the waters of the Project area are largely confined to the nearshore islands with fringing coral reefs and/or isolated reef patches. However, recent modelling and surveys undertaken have found the species may utilise nearshore habitats (Udyawer et al. 2020). Modelling results indicate that spoil ground DMPA4 represents suitable habitat for the short-nosed sea snake, with a new species distribution extending from Exmouth Gulf and around the Muiron Island to the Montebello Islands Marine Park (Udyawer et al. 2020). Although the spoil ground location represents suitable habitat, no sea snakes have been identified at the location and BCH of the spoil ground does not represent preferred reef habitat. Other species of sea snake that have preferred habitat within the vicinity of the offshore DMPA4 include the leaf-scaled sea snake (Udyawer et al 2020). Therefore, the Project has the potential to impact the habitat of these species and the precautionary approach for management (Section 7) has been applied.

2.6.3. Elasmobranchs

Sawfish

The Northwest Marine Region is considered a particularly important area for several sawfish species including the green sawfish, freshwater sawfish, narrow sawfish and dwarf sawfish as the region and adjacent inshore coastal waters and riverine environments contain nationally and globally significant

populations of sawfish species (DSEWPaC 2012). However, relatively little is known about the distribution and abundance of sawfish species in north-western Australia (Morgan 2011).

Green sawfish occupy estuaries, mangrove creeks and river mouths for their first few years of life (Morgan et al. 2015; 2017). In the Pilbara, green sawfish are known to utilise the mouths of major river systems as pupping and nursey areas (i.e., Ashburton River), before juveniles migrate into adjacent creeks at approximately 3 to 6 months old, and then further offshore to mature at a length of about 3 m (Morgan 2011). Pupping normally occurs in the tidal creeks between September to October, however the Project area is unlikely to represent a nursery site based on recent field surveys (Morgan et al. 2022).

The Mardie coastline contains creeks, mangroves and rivers which is suitable habitat for the green sawfish. No sawfish recorded during the recent sawfish survey completed within the Project location by Murdoch University and O2 Marine (Lear and Morgan 2022). The habitats surveyed included mangrove creeks and mudflats, which are known sawfish habitats and are similar to habitats where sawfish are found elsewhere in the region. The lack of sawfish recorded in this study indicates that the area is not likely a major habitat or a pupping ground for any species of sawfish. The occasional sightings of green sawfish in the general region and abundance of this species in nearby nursery habitats (e.g., Ashburton River) suggests that this area is likely an occasional foraging habitat along the migratory corridor for juvenile and sub-adult. Freshwater sawfish are known to migrate along this coastline, with several sightings of adult freshwater sawfish in this region and to the south of the study site that all were likely originally pupped in the Fitzroy River region of the Kimberley. Previous research has suggested that juvenile sawfish do not readily migrate past solid barriers along the coastline which would force them to swim into deeper water (D. Morgan and K. Lear, unpublished data; Lear and Morgan 2022).

Acoustic tracking of green sawfish from the Ashburton showed that the species does not travel more than 700m upstream from the mouth of the river. In the Western Pilbara they are assumed to be present in all tidal creeks. In the Project area larger systems are represented by the Robe River and Fortescue River. Green sawfish are currently known from Exmouth Gulf, Whim Creek, Beagle Bay, Pender Bay, King Sound in WA. Tidal mangrove systems, river estuaries, and rivers of the King Sound provide ideal nursery habitat for juveniles <0.5m (Whitty et al. 2011; Whitty 2017; Elhassan 2018).

Narrow sawfish are found from Onslow up to the Northern Kimberley. They are commonly found offshore in deeper waters and are more likely to be recorded within the offshore spoil ground area (DMPA4) than the dredging area, based on recent sawfish capture records from the Pilbara Trawl Fishery (Harry et al 2024). Therefore, a precautionary approach for management (Section 7) will be applied for this species.

Manta rays

Manta ray presence has been recorded within the waters of the Project area. As these records are not from targeted studies, the species are unidentified and there is no data to determine occupancy rates or abundance. Based on their general ecology, it is reasonable to assume that the species recorded is more likely to be the reef manta ray (*M. alfredi*), rather than the giant manta ray (*M. birostris*). In contrast to the pelagic giant manta ray, reef manta rays have a more localised distribution and inhabit shallower

waters closer to the coast. Reef manta rays are distributed throughout the Pacific and Indian Ocean. The Australian distribution is ~30°S on the east and west coastlines, with a continuous distribution north from Shark Bay (WA) (26°S) to the Solitary Island Marine Park (NSW) (26°S) (Armstrong et al. 2020). Giant manta rays are found throughout the Atlantic, Pacific and Indian Oceans, in tropical, subtropical, and temperate waters (Armstrong et al. 2020a). Information on the global distribution of giant manta rays and their population sizes is lacking. Manta ray are filter feeders (Couturier et al. 2012) and therefore are potentially at risk from the Project if water quality is not adequately managed and therefore potentially impacting the food web which supports them.

Giant manta rays were identified offshore of Onslow during aerial surveys for the Wheatstone Project and were predominantly in water depths ranging from 50 to 150 m, they were broadly and sparsely distributed (Jenner and Jenner 2010). Giant manta rays may be present within the vicinity of the spoil ground from time to time though it is unlikely as the spoil ground is less than 50 m depth (approximately 20 m depth).

2.6.4. Commercial Fisheries Species

Bluespotted emperor

Bluespotted emperor (*Lethrinus punctulatus*) is endemic to north-western Australia and found in the waters off WA from Geraldton to the Kimberly region, with some occurrences in the NT. The Pilbara region has the highest relative abundance of the bluespotted emperor, with commercial catch of this species concentrated across the continental shelf from 115°E to 120°E, being a major component of the catch of the Pilbara Fish Trawl Fishery (Newman et al. 2004). Therefore, they are likely to be present within the Project area. Spawning and nursey areas of the species are thought to be restricted to the west Pilbara, being the area from which the species disperse more widely from (Newman et al. 2020). Juvenile phase for the bluespotted emperors is directly associated with inshore macroalgae beds, often in water depths less than 10 m (DPIRD Draft Report, *unpublished*). Two cohorts per year are recruited in the inshore macroalgae beds in the Dampier Archipelago, with the biannual recruitment corresponding with the biannual peaks in spawning (DPIRD Draft Report, *unpublished*). Adult bluespotted emperors in the western Pilbara have high abundance in the continental shelf waters adjacent to large expanses of inshore macroalgae beds. The adults are also found in coral reef or lagoon habitats, over hard coral, gravel, or rubble substrates (DPIRD Draft Report, *unpublished*; Harvey et al. 2021). This evidence suggests that juveniles may be present within the dredging area, though less likely to be in the deeper waters of the spoil ground, which is more likely to be visited by the adult individuals.

Western king prawn

Western king prawns are distributed throughout the temperate, subtropical, and tropical waters of Australia, including the Project area. The species occurs from SA, WA, NT, Queensland (QLD) and northern New South Wales (NSW) (Grey et al. 1983). Spawning occurs in offshore waters, with post-larval and juvenile western king prawns occupying shallow waters, often in shallow tidal flats with sand or mud substrate. They are often associated with mangrove habitats and seagrass beds. Juveniles can inhabit areas with higher salinity like those of the dredging area. Juvenile western king prawns spend about three to six months in the nursery grounds before they reach maturity and migrate offshore,

entering the trawl fishing grounds (Penn and Stalker 1979). This migration takes place in April/May of each year and spawning occurs from August to May, with juveniles present in shallow embayments from September to April, with peak abundance in January. Therefore, spawning may occur within the area of DMPA4, though during summer when dredging and disposal activities will not be occurring.

Brown tiger prawn

Brown tiger prawns are generally regarded as endemic to Australia and are distributed around the northern coast, from central NSW in the east to Shark Bay in WA. They are found in tropical and subtropical waters (Ward et al. 2006). Brown tiger prawns spawn in offshore waters, and post-larval brown tiger prawns occupy shallow seagrass and algal communities, generally in water less than 2 m deep (Ovenden et al. 2007). Juvenile brown tiger prawns are generally found in dense patches of seagrass, with higher densities of juveniles found in seagrass beds that are in close proximity to mangroves. Tiger prawn recruitment and landings are significantly correlated with macroalgae and seagrass bed cover (Loneragan et al. 2013). Larger juveniles and adult brown tiger prawns are less dependent on seagrass and macroalgal beds, with larger juveniles moving further offshore into deeper waters, and adults often being found over mud or sand substrates in waters less than 30 m depth. Most spawning females are found in water 13 to 20 m deep (Kangas and Sporer 2015). In the context of the Project area, spawning females may be present within the spoil ground, though the low coverage of seagrass within and near the dredging footprint means it is less likely that post-larval brown tiger prawns will be present in the shallow areas.

2.7. Underwater Cultural Heritage

Underwater Cultural Heritage (UCH) was not considered a key environmental factor in the referral document for the project for the following reasons:

- The PMST search tool showed no National or World Heritage Areas within the project vicinity
- The Australasian Underwater Cultural Heritage Database (AUCHD) showed no significant underwater cultural heritage areas within the project vicinity
- Bathymetry Surveys conducted by O2 Metocean (2024) showed no evidence of any underwater artefacts (remains of vessels, submerged aircraft and other archaeological heritage located underwater).

Mardie Minerals will comply with the UCH Act and associated guidelines (DCCEEW, 2024) in the event that something is uncovered during dredging and/or spoil disposal.

3. Capital Dredging Program

3.1. Scope of Works

The scope of capital dredging elements of the Project includes:

- Dredging of materials from within the dredging area and relocation to the designated dredge material placement area, which includes:
  - Dredging under and adjacent to existing structures, including the jetty,
  - Dredging and working in shallow waters,
  - Maintaining design depths within the dredging area and removing any material deposited in the dredging area caused by the contractor's activities, naturally occurring events during dredging
- Undertaking hydrographic surveys required to support and monitor the dredging operations, including:
  - Baseline survey,
  - Progress surveys,
  - Surveillance surveys,
  - Clearance survey,
- Management of the dredging operations to avoid or minimise environmental impacts
- Management of the dredging operations to minimise the volume of over-dredging.

3.2. Sequence of Works

The project allows for capital dredging works to be carried out 24 hours a day, 7 days per week, during suitable weather conditions. The planned project sequence is as follows:

1. Equipment preparation, inspection, certification prior to departing for site
2. Preparation of all relevant detailed management plans to ensure compliance with conditions and specifications
3. Pre-dredge bathymetric survey of the dredge and spoil ground areas
4. Mobilisation of all plant and equipment
5. Site set-up
6. Commence and complete dredging of access channel and berth pocket, and disposal of dredged materials
7. Progressive hand-over hydrographic surveys for each section
8. Final hydrographic survey of "as-placed" dredged materials (inclusive of design volume, over-dredge and taking into account the bulking factor) within the spoil ground
9. Demobilisation and site clearing.

3.3. Preliminary dredging schedule

Capital dredging activities are forecast to be completed within the approved period for dredging based on the ecological windows, which is between April and September (inclusive). This may be undertaken within one calendar year, though it may extend into a second calendar year.

3.3.1. Ecological windows

The following measures will be applied during ecological windows (Refer to Table 4):

- Dredging will not occur at any time over a period extending from 3 days before until 7 days after the predicted night of a coral mass spawning[2] (EPA 2021).
- Dredging will avoid the turtle nesting, hatching and post-hatching window (October – March).
- Dedicated Marine Fauna Observers (MFOs) will be used during the humpback whale migration (humpback whale migration is June – November but dredging will only be undertaken prior to 1 October each year) (refer to Section 8.3.2 for description of a dedicated MFO). During northern and southern migration humpback whales likely to be present within the vicinity of DMPA4. During the southern migration, humpback whale mother-calf pairs are most likely to utilise inshore waters thus representing the most sensitive time where they could be impacted by dredging activities.

3.4. Pre- and post-dredge bathymetric surveys

Pre-dredge hydrographic surveys will be performed to determine as accurately as possible the total volume which is to be removed. Progress hydrographic surveys will also be undertaken to determine if the specifications for each area have been met. Both survey types (pre- and post) will serve to calculate the final volumes removed.

A bathymetric survey of DMPA4 was undertaken between 20 and 26 September 2024 (refer to Section 2.2.1), and a post-disposal survey will also be undertaken to inform available disposal volume at the site for maintenance dredging.

3.5. Dredging methodology

3.5.1. Capital dredging operations

Dredging of the proposed transhipment approach channel, manoeuvring area and berthing pocket for the Project will most likely be conducted using conventional marine dredging plant and equipment such as a backhoe dredge (BHD) and split hull hopper barge to transport the material to proposed spoil ground DMPA 4.

Dredging would commence within the outer channel (within the approved disturbance envelope) working towards inner channel and jetty. Dredging modelling anticipated dredging activities to take 98 days, potentially using a BHD to dredge the material, and a split hull hopper barge to transport the

[2] Mass coral Spawning is predicted for the following dates for the project during 2026: 11 – 20 March (full moon 3 March), 10 – 19 April (full moon 2 April), 1 – 10 November (full moon 26 October) and 1 – 10 December (full moon 24 November).

material to DMPA4 (Baird 2024). The modelled scenario assumes that there would be three hopper loads per day of 1,200 m^3 each or a total of 3,600 m^3 in total being disposed each day. It should be noted that the duration modelled does not account for on-site delays or interruptions due to marine fauna avoidance / management actions during dredging that may extend the time required to complete the works. Due to the nature of the dredging and being in the vicinity of the already constructed jetty, other equipment may be required and dredge volumes may be reduced on certain days which may lead to a longer dredging campaign.

Dredging and disposal operations will require marine fauna observations, including pre-start (observation period) and soft starts (dredging only) as relevant to dredging equipment. The monitoring protocols and procedures have been informed by underwater acoustic modelling, Policy Statement 2.1 and informed by the standard exclusion zone distances required for Sea Dumping Permits to determine appropriate exclusion areas around the noise-making activities (Talis 2019). No Temporary Threshold Shift (TTS) in significant marine fauna is expected from dredging activities, only behavioural response; therefore, the proposed exclusion zones are conservative and based on limiting behavioural response where possible. Dredging produces non-impulsive noise and is unlikely that dredging-induced noise will lead to any population consequences, although harm to individuals via auditory, masking or behavioural effect is possible (McQueen et al. 2013). The monitoring and management actions required to protect marine fauna from project dredging activities are outlined in Table 11 and Section 8.3 and represent a precautionary approach.

3.6. Dredge plume modelling

Baird Australia Pty Ltd was engaged to undertake dredge plume modelling in relation to the proposed dredge scope at Mardie. The objectives of the modelling were to:

1. Determine the location, extent and duration of a potential dredge plumes
2. Model realistic sediment plume outputs over the proposed dredge period relevant to the scale of the dredging (including potential worst-case impact scenarios) to guide appropriate management (discussed in this document)
3. Assess the likely dredge plume impact in relation to turbidity on biota and BCH.

Initially, onshore disposal was proposed and since then the preferred option of offshore disposal has been identified and modelled separately. Several dredge and dredge disposal modelling studies have been conducted by Baird between February 2020 and April 2021, as summarised in Table 5.

Table 5: Summary of Baird modelling studies relevant to the Project

Study	Reference	Summary
Mardie Project: Hydrodynamic Modelling report	Baird 2020a	Establishment of a regional hydrodynamic model to inform subsequent dredge and disposal plume modelling.
Mardie Project: Dredge Plume Modelling Report	Baird 2020b	First dredge plume modelling study of the Proposal, outlining zones of impact associated with dredging of the navigational channel and berth pocket. No modelling of any offshore disposal

Study	Reference	Summary
		plume was included in the report, as onshore disposal was considered at the time of the study.
Memorandum: Mardie Project, Offshore Disposal Modelling	Baird 2020c	Disposal plume modelling considering offshore disposal of dredge material west of Stewart Island in approximately 14.5 m LAT water depth. No modelling of dredging activities included.
Mardie Project: Offshore Disposal Plume Modelling Report	Baird 2020d	A detailed summary of the disposal plume modelling study for disposal located west of Stewart Island. This report includes a detailed summary of the disposal programme, modelling methodologies, geotechnical information and assessment of the associated zones of impact.
Mardie Project – Maintenance Dredging Estimate.	Baird 2020e	The estimate of annual maintenance dredging volumes is based on sediment transport modelling of ambient wet and dry season periods applying a calibrated hydrodynamic model from the environmental approvals phase of the project.
Letter: Mardie Project – Offshore Disposal Model Factoring	Baird 2021	Estimate of the zones of impact resulting from disposal of dredged materials offshore according to the changes to the dredging footprint (Worley 2021) and updated geotechnical information (Advisian 2020). Baird (2021) compared the latest geotechnical data to the earlier CMW (2019) to derive source inputs to the hydrodynamic modelling of disposal material.
Letter: Mardie Dredge Plume Modelling – Model Results Summary	Baird 2024	Estimate of the zones of impact resulting from disposal of dredge material offshore at spoil ground DMPA4. No modelling of dredging was included.

The results of the dredge plume modelling (Baird 2020b) and disposal plume modelling (Baird 2024) were used to inform the monitoring and management programs for Marine Water Quality and Benthic Communities and Habitat, which are defined in Section 8. The results of the dredge plume modelling are presented in Figure 11, and the disposal plume modelling at DMPA4 results are presented in Figure 12.

3.7. Offshore spoil disposal

Dredge material will be transported out to Spoil Ground DMPA 4 by barges and placed within the spoil ground. DMPA4 is located approximately 25 km (14.5 NM) from the dredging area.

Spoil disposal modelling for capital dredging was undertaken by Baird (2024) to determine the zones of impact around the spoil ground. As shown in Figure 12, the plume generated will result in both the ZoHI and ZoMI to be confined to waters deeper than 16 m and generally extend in a northeast-

southwest direction, which mimics the tidal flow movement in the area. The ZoHI covers an area of approximately 309.16 ha and ZoMI covers an area of approximately 650.52 ha.

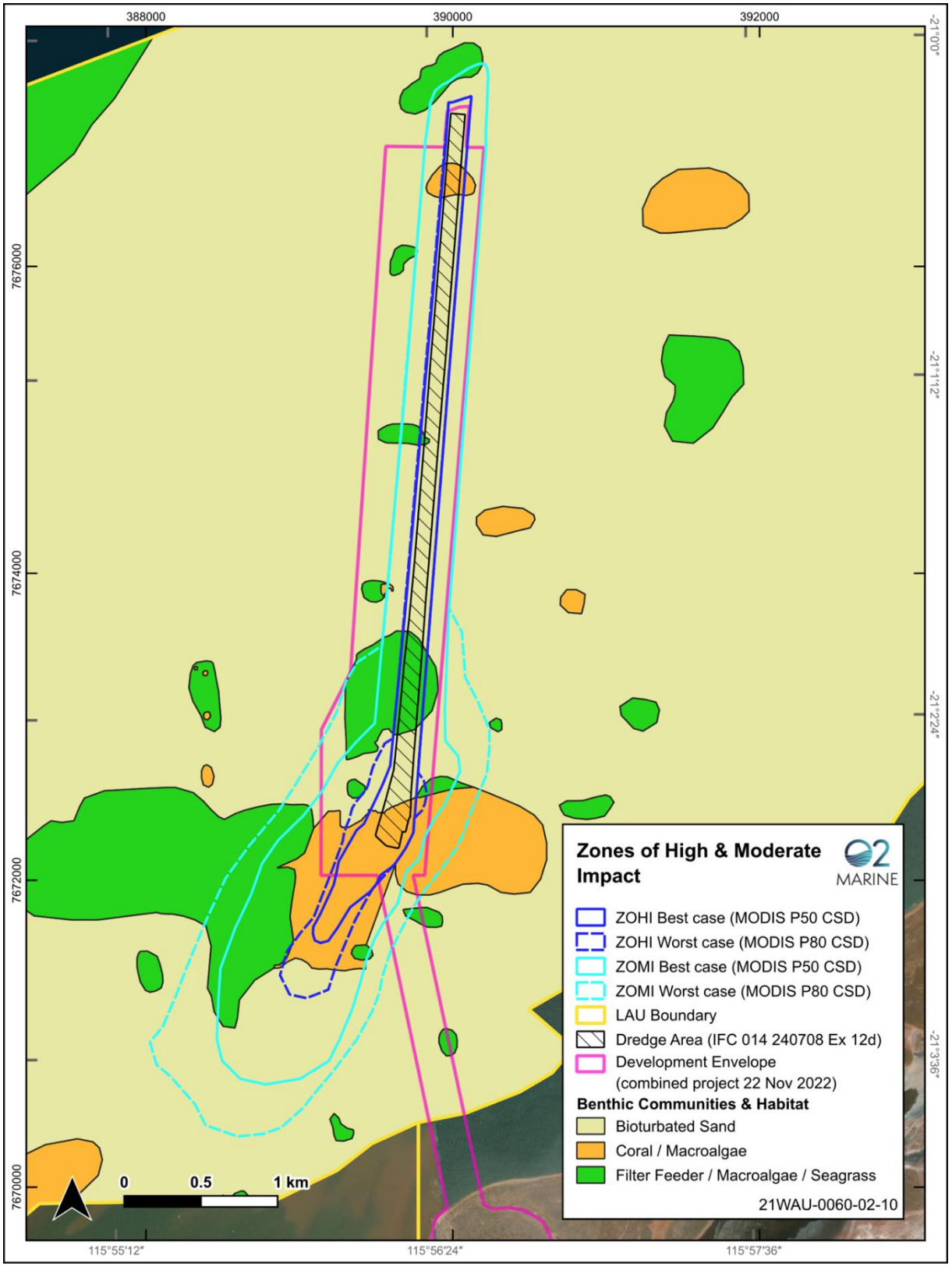
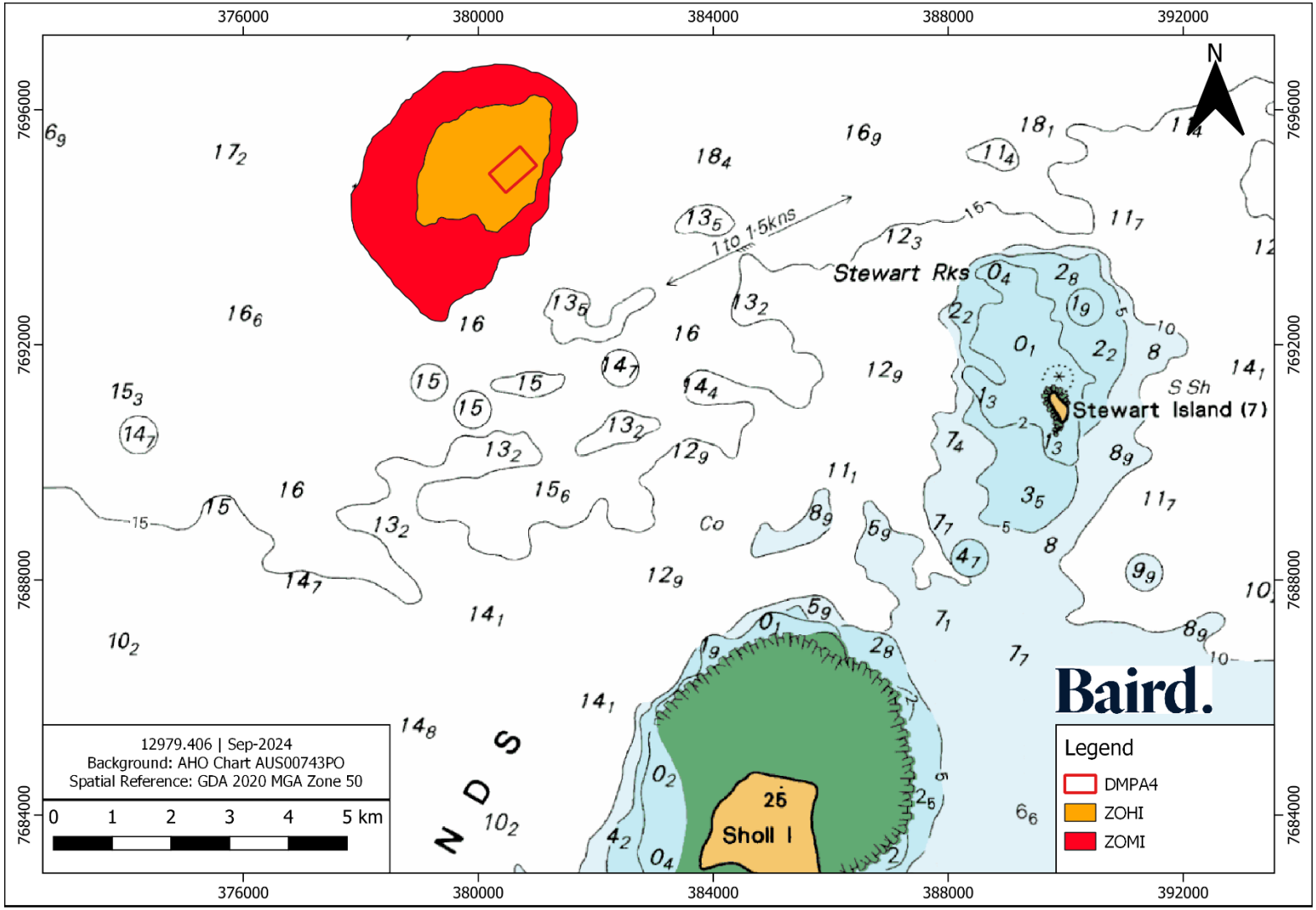


Figure 11: Zones of High and Moderate Impact for best and worst case based on Baird (2022) dredge plume modelling



N:\12979.406_MardieOffshoreDisposalModelUpdate\09_GIS\10_QGIS\Figures\OffshoreDisposal_DMPA4_MODISP80.png

Figure 12: Zones of High and Moderate Impact for disposal activities based on disposal plume modelling (Baird 2024)

4. Maintenance Dredging Program

Mardie Minerals acknowledges that maintenance dredging activities will be effectively managed through the implementation of a Long Term DSDMP. The development of a Long Term DSDMP will follow the completion of the capital dredge program, and will be consummate to the likely level of impact, taking into consideration the results of the capital dredge plume validation studies and achievement/exceedance of EPOs. Due to the reduced sediment volume and duration of the maintenance dredge program (discussed below in Section 4.1), it is likely that environmental impacts will be notably less when compared to the capital program. Review and learnings from the capital dredge program will support the development and implementation of appropriate environmental mitigation strategies specific to maintenance dredging and spoil disposal.

As a preliminary approach, Mardie Minerals anticipates that the maintenance dredging campaign will follow the methods described in Section 4.1 below. Furthermore, maintenance dredging timing will avoid key ecological windows as described in this DSDMP for capital dredging. This approach is intended to ensure that the same level of environmental protection as defined by the EPOs and MTs is applied to the relevant environmental factors during maintenance dredging.

The capital dredging monitoring program will provide information on turbidity plume generation to inform the required spatial extent and design of the maintenance dredging program. Depending on the volume and duration of maintenance dredging/disposal this may involve daily water quality profiles or re-installation of telemetered water quality monitoring stations at specific locations. Indicatively, Mardie Minerals will install telemetered water quality monitoring stations 1-month prior to maintenance dredging and will record continuous data throughout the program. Monitoring equipment will be removed no sooner than 1-month following completion of the maintenance program. Once developed, the Long Term DSDMP will supersede this DSDMP in relation to maintenance dredging activities, and will provide revised and specific details around the maintenance dredging SoW, sequence of activities, methodology (including timing and frequency of dredging/disposal activities), environmental monitoring and management measures, allocated responsibilities, and reporting requirements

4.1. Indicative Maintenance Dredging Methodology

Based on consultation with Pilbara Ports and taking into consideration the volume and frequency of dredging undertaken at the nearby Port of Ashburton facility, an upper limit of 50,000 m^3 is considered a practical and realistic estimate as an annual maintenance dredging volume (Table 6); Mardie Minerals considers this to be a very conservative (high) upper limit estimate. The most efficient maintenance dredging method traditionally used for most ports and the method intended for maintenance dredging, is a trailer suction hopper dredger (TSHD). A TSHD drags an arm along the seabed and extracts the sediments as a slurry into the vessel's hopper, prior to transport for disposal at the spoil ground. There will be limitations on the size of TSHD that can be utilised for maintenance dredging for the Project. It is therefore assumed that maintenance dredging would likely be undertaken with a small sized TSHB with a hopper capacity of 1,400 m^3.

The time spent actively dredging to fill the dredge hopper barge with dredged spoil will be dependent on the material being dredged and the thickness of sediments. As the sediments requiring maintenance dredging are expected to be predominantly finer silts and in relatively thin layers, loading times are expected to be relatively slow. They will vary over the dredging duration, but on average have been assumed to be 3 hours per load. DMPA 4 is approximately 14.85 NM from the dredge area, assuming an average sailing speed of 6 knots, the transit duration would be 2.5 hours. It has been conservatively assumed that the time spent at DMPA 4 would be 1 hour . An overall cycle time (i.e. dredging, transit, disposal) can be expected be on average 9.5 hours, which would allow for on average 2.5 barge hopper loads per day, over a 24-hour period, with approximately 1,778 m^3 dredged per day (Table 6).

Maintenance dredging is not expected to be needed every year due to annual variability in the sedimentation rate at the dredge site depending on a range of environmental factors (e.g., wave action, tidal currents and severe weather events (cyclones)). Mardie Minerals will manage the maintenance dredging effectively through implementation of a Long Term DSDMP and the maintenance Sea Dumping Permit approval, once available volume is confirmed at DMPA4 after capital dredging, which includes regular survey and sediment sampling to characterise the sediment (i.e., silt and sand percentages).

Table 6: Estimated volume of maintenance dredging disposal at DMPA4

	Unit	Amount		
Maintenance dredging cycle time				
Dredging	hr	3		
Sailing Loaded (15nm @6knts)	hr	2.5		
Dumping	hr	1		
Sailing Empty (15nm @6knts)	hr	2.5		
Allowance for Delays (5%)	hr	0.45		
Cycle Time	hr	9.45		
Average Number of Loads Per Day (24hr operations)	no	2.5		
Maintenance dredge capacity				
Hopper Capacity	m^3	1,400		
Loading Efficiency	%	50		
Net Hopper Volume Per Load	m^3	700		
Average Volume Dredged Per Day	no	1,778		
Maintenance dredging scenario (2)		1-yearly	2-yearly	5-yearly
Upper Volume of Dredging (1)	m^3	50,000	100,000	250,000
Total Number of Hopper Loads	no	71	143	357
Total Duration	days	28	56	141
Average Volume Dredged per Day	m^3/day	1,778	1,778	1,778

Notes:

(1) Subject to site survey of dredging and disposal sites after dredging event/s.

(2) It is predicted that maintenance dredging year 1 will be in 2028

5. Roles and responsibilities

The roles and responsibilities for the implementation of this DSDMP are summarised in Table 7.

Table 7: Project Roles and Responsibilities

Position	Responsibility
Proponent (as Principal)	• Overall responsibility for implementation of this DSDMP. • Overall responsibility for complying with all relevant legislation, standards and guidelines. • Ensures dredging and disposal activities are conducted in an environment safe for both site personnel and the public. • Reports on environmental performance for the project to relevant DMAs and to the Key Stakeholders. • Responsible for the implementation of the environmental monitoring programs and inspections. • Prepares environmental monitoring reports. • Responsible for environmental compliance reporting in accordance with State Ministerial Conditions and Commonwealth approvals • Responsible for reporting all environmental non-compliance incidents in accordance with State Ministerial Conditions and Commonwealth approvals.
Dredging Contractor	• Prepares and implements an environmental management plan in accordance with the requirements of this DSDMP. • Implements the management actions of this DSDMP. • Ensures adequate training of all staff (including subcontractors) within its area of responsibility. • Ensures all equipment is adequately maintained and correctly operated. • Responsible for reporting all environmental incidents to Proponent Environmental Advisor within 24 hours in accordance with incident reporting procedures.
All persons involved in the project.	• Comply with the requirements of this DSDMP. • Comply with all legal requirements under the approvals documents and relevant Acts. • Exercise a Duty of Care to the environment at all times. • Report all environmental incidents to the Proponent Environmental Advisor.
Dedicated Marine Fauna Observers (MFOs)	• Undertake management and recommend mitigation measures for dredging and disposal • MFOs will be suitably trained and qualified • Adhere to the requirement of the (Closed Season Marine Mammals) Wildlife Conservation Notice 1998 • Knowledge of marine wildlife species in the Project area, including Threatened and Migratory Species listed under the EPBC Act and BC Act • Evidence of MFO suitability will be kept on record through staff curriculum vitae, training certifications and daily MFO logs, which may be used in future audits.

6. Environmental Factors and Objectives

The key environmental factors and objectives to be managed under this DSDMP have been derived from the WA EPA Statement of Environmental Principles, Factors and Objectives (EPA 2023) and in accordance with EPA MS1211, include the following for dredging:

- Benthic communities and habitats
- Marine environmental quality
- Marine fauna.

MS 1211 identified the environmental outcomes which are required to be met by the Project for each of these key environmental factors for dredging. Due to the addition of offshore disposal, proposed amended outcomes are presented in Table 8. In order to ensure these outcomes are achieved by the Project, management targets (MT) have been derived for these and are also presented in Table 8. Though these have been identified to address the recommendations and requirements of the WA EPA, these also in turn address the requirements of EPBC 2018/8236 (as varied) and EPBC 2022/9169.

Table 8: Potential Environmental Impacts, Environmental Protection Outcomes and Management Targets for Mardie Project

Environmental Factor	EPA Objective	Potential Environmental Impact Pathway	Environmental Protection Outcome (EPO)	Management Target	Management Measures
Benthic Communities and Habitats	To protect BCH so that biological diversity and ecological integrity are maintained.	• Direct loss of BCH through dredging and smothering during disposal.	• No direct loss of BCH outside of the dredge and disposal disturbance footprints.	• Direct loss is limited to within the dredge footprint and spoil ground footprint.	Table 9
		• Indirect impacts on BCH associated with changes to water quality (increased suspended sediment and/or sedimentation).	• No irreversible loss of BCH outside of the authorised dredging and disposal ZoHI. • No detectable change from the baseline state of BCH outside of the ZoHI and ZoMI.	• No negative change from the baseline state of BCH outside of the ZoHI • Turbidity from disposal activities is managed to protect offshore BCH communities.	
		• Indirect impacts on BCH associated with leaks or spills of hydrocarbons or chemicals.		• Manage vessel bunkering, chemical storage and spill response to minimise impacts to the marine environment.	
		• Indirect impact to BCH health due to Introduced Marine Pests (IMP).	• No introduction or establishment of marine pests in State Waters as a result of the Project	• Manage project vessels activities to prevent IMP impacts on the environment.	
Marine Environmental Quality	To maintain the quality of water, sediment and biota so that	• Changes to the physico-chemical properties of the water column as a result of dredging or disposal activities.	• No impacts on the environmental values of Ecosystem Health, Fishing and Aquaculture, Recreation	• Ensure that the MTs within the MWQMP are met.	Table 10

Environmental Factor	EPA Objective	Potential Environmental Impact Pathway	Environmental Protection Outcome (EPO)	Management Target	Management Measures
	environmental values are protected.	• Contamination of water resulting from a vessel/hydrocarbon spill (i.e. bunkering operations).	and Aesthetics, Industrial Water Supply, Cultural and Spiritual.	• Manage vessel bunkering, chemical storage and spill response to minimise impacts to the marine environment.	
		• Disturbance of contaminants during dredging activities. • Release of contaminants during disposal activities.		• Assess and manage sediment disposal area to maintain the quality of the marine environment.	
Marine Fauna	To protect marine fauna so that biological diversity and ecological integrity are maintained.	• Disturbance, Injury or death of marine fauna as a result of dredge and disposal operations.	• No reported negative impacts of marine fauna attributable to dredging or disposal works. • No mortality, injury, disturbance or displacement of humpback whales within the migration of the biologically important area	• Manage dredge and disposal operations so no injury or death of marine fauna occurs.	Table 11
		• Injury or death of marine fauna due to vessel movement (strike).		• Manage vessel speed so no injury or death of marine fauna occurs as a result of vessel strike.	
		• Indirect impacts on marine fauna habitat through decreased water quality.		• Manage dredge and disposal activities to minimise turbid plumes as to not impact marine fauna habitats.	
		• Noise impacts from dredging and disposal operations		• Manage dredge and disposal activities to minimise noise and impacts from noise • Comply with marine noise management procedures EPBC Act Policy Statement 2.1 – Interaction	

Environmental Factor	EPA Objective	Potential Environmental Impact Pathway	Environmental Protection Outcome (EPO)	Management Target	Management Measures
				between offshore seismic exploration and whales	
		• Disturbance, Injury or death from contaminated water from hydrocarbon spills.		• Manage vessel bunkering, chemical storage and spill response to minimise impacts to marine fauna.	
		• Disturbance from artificial light from vessels during dredging and disposal		• Manage dredge and disposal activities, including maintenance, to minimise light spill, in accordance with Project Illumination Plan	
		• Introduced Marine Pests (IMP) translocation from construction or operational vessels.		• All relevant vessels to comply with Commonwealth Department of Agriculture and Water Resources – Australian Ballast Water Management Requirements.	

7. Management

The potential environmental impacts identified above in Table 8 have been assigned monitoring and management actions to measure compliance against the EPOs[3] and MTs. Management measures for each environmental factor (EPA 2018) are detailed below for dredging events (capital and maintenance) and disposal events (capital and maintenance).

7.1. Benthic Communities and habitats

Management proposed to minimise potential impacts on the environmental factor 'Benthic Communities and Habitat' are described in Table 9.

Table 9: Management actions to minimise impacts on Benthic Community Habitats

Environmental Factor	Benthic Communities and Habitats
Activity	Dredging and offshore disposal (capital and maintenance)
Potential Impacts	• Direct loss of BCH through dredging and disposal. • Indirect impacts on BCH associated with changes to water quality (increased suspended sediment and/or sedimentation). • Indirect impacts on BCH associated with leaks or spills of hydrocarbons or chemicals. • Indirect impact to BCH health due to Introduced Marine Pests (IMP).

[3] EPOs identified in Table 8 are not presented in the following tables as it is assumed that if the MT is achieved then the corresponding EPO will also be achieved.

Management Targets	Management Actions		Environmental Performance		
	Actions	Responsibility	Reporting/Evidence	Timing	Contingency[4]
Direct loss is limited to within the dredge and spoil ground footprints.	• Undertake a HAZID risk assessment with all parties to ensure potential impacts on BCH are known and understood.	• Proponent / Contractor	• Minutes of HAZID	• Prior to commencement of dredging.	• N/A - Completed

	• Utilise a satellite-based vessel monitoring system on dredge vessel and transport barges to ensure no works outside the approved disturbance area.
	• All dumping activities shall occur within the spoil grounds approved under the Sea Dumping Permit.
	• The dredge spoil shall be dumped in a manner over the nominated spoil ground to minimise mounding from the dumping activities.
		• Contractor	• Inspection of satellite-based vessel monitoring system.
			• Daily dredge logs submitted to the proponent throughout construction.
				• Prior to and during dredge and disposal operations.
				• Weekly throughout construction.
					• Cessation of dredging/disposal activities.
					• Maintenance of tracking system.
					• Undertake Bathymetric survey of the disposal site:
					  • Prior to the commencement of dumping activities and;
					  • Following completion of all dumping activities.

[4] 'Trigger point' column is not considered necessary to include as the 'contingency' column describes the non-compliance with a MT from an operation or process associated with the scope of works.

Management Targets	Management Actions		Environmental Performance		
	Actions	Responsibility	Reporting/Evidence	Timing	Contingency[4]
No negative change from the baseline state of BCH outside of the ZoHI	• Monitor dredge/disposal operations (duration, intensity, overflow rates etc) to minimise and control SSC where possible.	• Contractor	• Daily dredge and disposal logs submitted to the proponent throughout construction.	• Weekly throughout construction.	• Modify or cease dredging/disposal activities if required.
	• Implement Benthic Habitat Monitoring Program (BHMP) as per Section 8.2.	• Contractor	• BCH Assessment Report including data (photographs)	• Quarterly during baseline period (12 months) • Reactive during dredging, following level 3 management trigger • Within 12 months following completion of dredging.	• Determine source of impact and modify dredge operations if required. • If impacts are detected, then continue monitoring on an annual basis for up to 5 years post-dredging to monitor recovery. • Where BCH has not shown evidence of recovery within the authorised ZoMI after 3 years, consider options for restoration (artificial reef, seagrass transplantation) • In the event the water quality triggers are exceeded at the outer boundary of the authorised ZoMI, the pre- and post-dredging BCH surveys will consider a variety of health measures of BCH in the areas outside the authorised ZoMI and ZoHI, which can be used to provide evidence that

Management Targets	Management Actions		Environmental Performance		
	Actions	Responsibility	Reporting/Evidence	Timing	Contingency[4]
					this EPO has or has not been met.
	• Implement the Marine Water Quality Monitoring Program (MWQMP), refer Section 8.1	• Contractor/ Proponent	• Telemetered Water Quality Data (i.e., DLI) • Water Quality Report	• Data recorded hourly provided daily. • Monthly	• Determine source of impact and modify dredge operations if required.
	• Undertake dredge plume and disposal plume validation /verification monitoring with Aerial Multisectoral Imagery	• Proponent	• Dredge Plume and Disposal Plume Validation Report	• Validation at commencement of Dredging. • Verification following a Level 3 management trigger (Table 12)	• Cease dredging and/or disposal if Level 3 management trigger is exceeded and dredge plume validation indicates it is likely to be attributed to the plume.

Manage vessel bunkering, chemical storage and spill response to minimise impacts to the marine environment.	• Develop and implement project specific management procedures:
	  • Chemical Storage and Handling Procedure.
	  • Vessel Bunkering Procedure.
	  • Shipboard Oil Pollution Emergency Plan (SOPEP).
	  • Use of appropriate bunkering facilities.
		• Contractor	• Approved Management Procedures/Plans	• Prior to commencement of work.	• Develop and implement management procedures.
					• Update procedures where necessary.

Management Targets	Management Actions		Environmental Performance		
	Actions	Responsibility	Reporting/Evidence	Timing	Contingency[4]
	• All project vessels to maintain adequate spill response equipment on board. • All crew to be trained in emergency spill response. • Hydrocarbons (including hydrocarbon wastes) shall be stored in accordance with AS1940-2004.	• Contractor	• Pre work inspection • Monthly Inspections • Crew training logs • Pollution report to be submitted to regulator/s.	• Prior to commencement of works • Monthly during dredge and disposal operations • Refresh training regularly throughout project	• Source spill response equipment. • Train all vessel crew in emergency spill response and provide support from land-based HSE team as required.
Manage project vessels activities to prevent IMP impacts on the environment.	• All relevant vessels to comply with the Marine Pest Management Procedure (0000-EV-PRO-0009; O2 Marine 2022)	• Contractor	• Vessel management procedures • Copy of vessel check report.	• Throughout Project	• Vessels are not to mobilise to Project unless the Procedures are to be utilised. • Notification to DCCEEW and the DPIRD in the event of an introduction of a marine pest species.
	• All relevant vessels will comply with Commonwealth Department of Agriculture and Water Resources – Australian Ballast Water Management Requirements, the National Biofouling Management	• Contractor	• Vessel management procedures.	• Prior to vessel entering Australian Waters or moving from one Australian port to the project site.	• Vessels are not to mobilise to project site without PPA - approved IMP documentation.

Management Targets	Management Actions		Environmental Performance		
	Actions	Responsibility	Reporting/Evidence	Timing	Contingency[4]
	Guidelines for commercial vessels.				
	• All vessels that mobilise to the project site are required to complete the WA Department of Fisheries (DoF's) 'Vessel Check' risk assessment (https://vesselcheck.fish.wa.gov.au)	• Contractor	• A copy of the Vessel Check report is to be submitted to PPA for assessment along with any supporting documentation including antifoul certificates and inspection reports.	• Prior to dredge entering Australian Waters or moving from one Australian port to the project site.	• Vessels are not to mobilise to project site without PPA - approved IMP documentation.
No unauthorized discharges of wastes to the marine environment.	• Contractor to have in place a waste management plan. • Contractor to ensure that waste management systems are maintained to ensure systems are efficient, fully operational and discharging treated water in accordance with MARPOL 73/78 Convention Annex IV (sewage) and Annex V (garbage). • Solid and liquid wastes and hazardous materials shall be stored in appropriately	• Contractor	• Reporting of any discharge of solid or liquid wastes to the marine environment to Proponent and Regulator(s). • Controlled waste tracking forms to be provided to Proponent.	• Throughout Project	• Implement contingency measures as required by Proponent's waste management guidelines.

Management Targets	Management Actions		Environmental Performance		
	Actions	Responsibility	Reporting/Evidence	Timing	Contingency[4]
	labelled drums or tanks and be correctly disposed of and not discharged to the environment.				

7.2. Marine Environmental Quality

Management proposed to minimise potential impacts on the environmental factor 'Marine Environmental Quality' are described in Table 10.

Table 10: Management actions to minimise impacts on Marine Environmental Quality

Environmental Factor	**Marine Environmental Quality**
Activity	Dredging and offshore disposal (capital and maintenance)
Potential Impacts	• Contamination of water resulting from a vessel/hydrocarbon spill (i.e., bunkering operations). • Disturbance of contaminants during marine construction activities (dredging and disposal).

Management Targets	**Management Actions**		**Environmental Performance**		
	Actions	**Responsibility**	**Reporting/Evidence**	**Timing**	**Contingency**[5]
Ensure that the MTs within the MWQMP are met	• Implementation of the Marine Water Quality Monitoring Program (MWQMP) detailed in Section 8.1	• Contractor	• Telemetered Water Quality Data (i.e., DLI) • Water Quality Report	• Data recorded hourly provided daily. • Monthly	• Determine source of impact and modify dredge and/or disposal operations if required.

Manage vessel bunkering, chemical storage and spill response to minimise impacts to the marine environment	• Develop and implement project specific management procedures:
	  • Emergency Response Procedure
	  • Chemical Storage and Handling Procedure.
		• Contractor	• Approved Management Procedures	• Prior to commencement of work	• Develop and implement management procedures
					• Contractor to update procedures where necessary

[5] 'Trigger point' column is not considered necessary to include as the 'contingency' column describes the non-compliance with a MT from an operation or process associated with the scope of works

Management Targets	Management Actions		Environmental Performance		
	Actions	Responsibility	Reporting/Evidence	Timing	Contingency[5]
	• Bunkering Procedure. • Shipboard Oil Pollution Emergency Plan (SOPEP). • Use of appropriate bunkering facilities.				
	• All vessel equipment to be designed and operated to prevent spills and leaks through the provision of in-built safeguards such as, but not limited to, relief valves, overflow protection, and automatic and manual shut-down systems.	• Contractor	• Monthly Inspections • Approved vessel management procedure which includes emergency response procedures	• Monthly	• Rectify any equipment that is damaged or missing as soon as practicable. • Dredge /disposal operations not to commence prior to development and approval of vessel management procedures.
	• The proponent is to be notified immediately in the event of a hydrocarbon spill of any volume. An incident report will be submitted for each spill.	• Contractor	• Approved vessel management procedure which includes emergency response procedures • Verbal communication • Incident Report • Pollution Report to be submitted to regulator/s.	• Immediately verbal communication. • Initial incident report submitted within 24 hours of incident.	• Dredge/disposal operations to cease until spill investigation is complete, and or Proponent has given authority to proceed.

Management Targets	Management Actions		Environmental Performance		
	Actions	Responsibility	Reporting/Evidence	Timing	Contingency[5]
	• Inspections of all dredge equipment and pipelines to check for leaks or damage	• Contractor	• Approved vessel management procedure which includes emergency response procedures • Daily inspections • Vessel and Site Environment Safety and Health inspection checklist	• Prior to the commencement of dredging • Daily throughout dredging	• Cease works if significant spillage or damage observed • Activate spill response actions (control drainage, clean up) as required • Undertake incident investigation and implement recommendations • Continue MWQMP
Assess and manage sediment disposal area to maintain the quality of the marine environment	• Implementation of the Marine Water Quality Monitoring Program (MWQMP) detailed in Section 8.1	• Contractor	• Telemetered Water Quality Data (i.e.,DLI) • Water Quality Report	• Data recorded hourly provided daily. • Monthly	• Determine source of impact and modify dredge and/or disposal operations if required.
No unauthorised discharges of wastes to the marine environment.	• Contractor to have in place a waste management plan. • Contractor to ensure that waste management systems are maintained to ensure systems are efficient, fully operational and discharging treated water in accordance with MARPOL 73/78 Convention Annex IV (sewage) and Annex V (garbage).	• Contractor	• Reporting of any discharge of solid or liquid wastes to the marine environment to Proponent and Regulator(s). • Controlled waste tracking forms to be provided to Proponent.	• Throughout Project	• Implement contingency measures as required by Proponent's waste management guidelines.

Management Targets	Management Actions		Environmental Performance		
	Actions	Responsibility	Reporting/Evidence	Timing	Contingency[5]
	• Solid and liquid wastes and hazardous materials shall be stored in appropriately labelled drums or tanks and be correctly disposed of and not discharged to the environment.				

7.3. Marine Fauna

Management proposed to minimise potential impacts on the environmental factor 'Marine Fauna' are detailed in Section 8.3 and summarised in Table 11.

Table 11: Management actions to minimise impacts on Marine Fauna

Environmental Factor	Marine Fauna				
Activity	Dredging and offshore disposal (capital and maintenance)				
Potential Impacts	• Disturbance, injury or death of marine fauna as a result of dredge and disposal operations. • Injury or death of marine fauna due to vessel movement (strike). • Indirect impacts on marine fauna habitat through decreased water quality. • Disturbance, injury or death from contaminated water from hydrocarbon spills. • Direct impacts from underwater noise from dredging and disposal operations • Direct impacts from artificial light pollution • Introduced Marine Pests (IMP) translocation from construction or operational vessels.				
Management Targets	**Management Actions**		**Environmental Performance**		
	Actions	**Responsibility**	**Reporting/Evidence**	**Timing**	**Contingency**[6]
Manage dredge and disposal operations so no injury or death of marine fauna occurs.	• Implement pre-start (observation period) and soft start (dredging only) procedure, as relevant to dredging equipment, prior to activating below surface operations.	• Contractor	• Daily dredge logs.	• Each occasion, prior to activating backhoe dredge	• Dredge operations not to commence unless a pre-start (observation period) and soft-start (dredging only) procedure, as relevant to dredging equipment, has been implemented.

[6] 'Trigger point' column is not considered necessary to include as the 'contingency' column describes the non-compliance with a MT from an operation or process associated with the scope of works

Management Targets	Management Actions		Environmental Performance		
	Actions	**Responsibility**	**Reporting/Evidence**	**Timing**	**Contingency[6]**
	• Implement marine fauna monitoring and management outlined in Section 8.3 for dredging and disposal works. • Dedicated MFO on all dredges/barges during humpback whale season (June to November) including transit to Spoil Ground DMPA4 (See Section 8.3). • Install overflow screen on dredgers to visually assess for turtles and/or turtle remains that may have been entrained during dredging after each load.	• Contractor	• Marine Fauna Observer (MFO) daily records • Final summary report • Refer to Section 8.3	• Prior to commencement of dredging and disposal. • Daily • Refer Section 8.3	• Dredge and disposal operations not to commence unless at least one crew member is a trained MFO for each activity. • Where marine fauna are observed within an Exclusion zone then dredging/ disposal will cease immediately when it is safe to do so. • Investigate why dredge /disposal operations were not ceased and apply required correction actions. • Vessel is to move to another area of the dredge area or disposal site to maintain a minimum distance of 300 meters between the vessel and any marine species
	• Report any injured or deceased marine fauna (whale, dugong, turtle, manta ray or dolphin, fish) or indications of coral mass spawning on the project site	• Contractor	• Verbal/written communication • Incident Report	• Site manager to be notified immediately upon observation • DBCA and DWER notified within 2 hours and DCCEEW within 2 business days in accordance with EPBC2018/8236 and EPBC 2022/9169 • Full incident report completed within 12 business days to	• Investigate fauna death and apply required corrective actions and or modifications to dredge and disposal operations.

Management Targets	Management Actions Actions	Responsibility	Environmental Performance Reporting/Evidence	Timing	Contingency[6]
				DBCA, DWER and DCCEEW.	
Manage dredge and disposal activities to minimise noise and impacts from noise **Comply with marine noise management procedures EPBC Act Policy Statement 2.1- Interaction between offshore seismic exploration and whales**	• Implement marine fauna monitoring and management outlined in Section 8.3 • Soft starts procedure outlined in Section 8.3 • Ensure all vessel equipment and machinery is in good condition and subject to regular maintenance. When in transit, all Project vessels will be operated in accordance with EPBC Regulations 2000- Part 8 Division 8.1 • Ensure all vessels understand and comply with EPBC Act Policy Statement 2.1 • Minimise the duration of run-time for vessel engines, thrusters and dredging plant by avoiding stand-by or running mode to the degree practical and consistent with safe operations	• Contractor	• Refer to Section 8.3	• Daily • Refer to Section 8.3	• Where marine fauna are observed within an exclusion zone then dredging/disposal will be ceased immediately.

Management Targets	Management Actions		Environmental Performance		
	Actions	Responsibility	Reporting/Evidence	Timing	Contingency[6]
Manage vessel speed so no injury or death of marine fauna occurs as a result of vessel strike.	• Implement marine fauna monitoring and management as outlined in Section 8.3 • Dedicated MFO on all dredges/barges during humpback whale season (June to November) including transit to DMPA 4 (See Section 8.3)	• Contractor	• In accordance with Condition 28 of EPBC2018/8236 and EPBC 2022/9169 • Refer to Section 8.3	• Refer to Section 8.3	• Where marine fauna are observed with an Exclusion Zone then dredging or disposal will be ceased immediately when it is safe to do so • Investigate fauna death and apply required corrective actions and or modifications to dredge operations.
	• Vessels to operate at a safe speed with a maximum speed of 8 knots to avoid interaction with marine fauna at all times within port operational waters, and a maximum of 12 knots outside the port operational waters	• Contractor	• Vessel GPS monitoring system	• Continuous throughout vessel operations.	• Investigate why vessel was recorded in excess for the defined speed limit and amend vessel operations and activities as appropriate.
Manage dredge and disposal activities to minimise turbid plumes as to not impact marine fauna habitats.	• Implement the MWQMP, refer Section 8.1	• Contractor/ Proponent	• Telemetered Water Quality Data (DLI) • Water Quality Report	• Data recorded hourly provided daily. • Monthly	• Determine source of impact and modify dredge operations if required.
Manage dredge activities, including maintenance, to minimise light spill, in accordance with	• Implement the Mardie Illumination Plan (0000-EV-PLN-0014)	• Contractor/ Proponent	• Routine inspections • Light monitoring at set locations	• Daily	• Address non-compliant light sources immediately • Review lighting on vessels • Minimise unnecessary light sources not required for safe

Management Targets	Management Actions		Environmental Performance		
	Actions	Responsibility	Reporting/Evidence	Timing	Contingency[6]
Project Illumination Plan					operation of the dredge or barge vessels at night time

Manage vessel bunkering, chemical storage and spill response to minimise impacts to marine fauna	• Develop and implement project specific management procedures:
	  • Chemical Storage and Handling Procedure.
	  • Bunkering Procedure.
	  • Shipboard Oil Pollution Emergency Plan (SOPEP).
	  • Use of appropriate bunkering facilities
		• Contractor	• Approved Management Procedures	• Prior to commencement of work.	• Develop and implement management procedures
					• Update procedures where necessary.

	• All vessel equipment to be designed and operated to prevent spills and leaks through the provision of in-built safeguards such as, but not limited to, relief valves, overflow protection, and automatic and manual shut-down systems.	• Contractor	• Vessel management procedure • Monthly Inspections	• Prior to commencing dredging/disposal. • Monthly	• Rectify any equipment that is damaged or missing as soon as practicable. • Dredge /disposal operations not to commence prior to development and approval of vessel management procedures.
	• The proponent is to be notified immediately in the event of a hydrocarbon spill of any volume. An incident report will be submitted for each spill.	• Contractor	• Verbal communication • Incident Report • Pollution Report to be submitted to regulator/s.	• Immediately verbal communication. • Incident report submitted with 24 hrs of incident.	• Dredge /disposal operations to cease until spill investigation is complete, and or Proponent has given authority to proceed.

Management Targets	Management Actions		Environmental Performance		
	Actions	Responsibility	Reporting/Evidence	Timing	Contingency[6]
All relevant vessels to comply with Commonwealth Department of Agriculture and Water Resources – Australian Ballast Water Management Requirements.	• All relevant vessels should comply with Commonwealth Department of Agriculture and Water Resources – Australian Ballast Water Management Requirements (CoA 2020), and the National Biofouling Management Guidelines for commercial vessels (CoA 2009).	• Contractor	• Vessel management procedures.	• Prior to vessel entering Australian Waters or moving from one Australian port to the project site.	• Vessels are not to mobilise to site without approved IMP documentation.
	• All vessels that mobilise to the project site are required to complete the WA DPIRD's 'Vessel Check' risk assessment (https://vesselcheck.fish.wa.gov.au)	• Contractor	• A copy of the Vessel Check report is to be submitted to PPA for assessment along with any supporting documentation including antifoul certificates and inspection reports.	• Prior to dredge entering Australian Waters or moving from one Australian port to the project site.	• Vessels are not to mobilise to project site without approved IMP documentation.

8. Environmental Monitoring

8.1. Marine Water Quality Monitoring Program

8.1.1. Monitoring rationale

The Marine Water Quality Monitoring Program (MWQMP) for capital dredging is to be implemented to ensure the EPOs for Benthic Community Habitats, Marine Environmental Quality and Marine Fauna are met.

Marine dredging and disposal activities have the potential to increase suspended sediment and sedimentation in marine waters. This change in water quality has potential to indirectly impact BCH by reducing light penetration through the water column and smothering of biota due to sedimentation.

To assist the design of the MWQMP and to select suitable monitoring locations, the dredge and disposal plume models (Baird 2022 and Baird 2024 respectively) were used to identify the zones of impact around the dredge and disposal disturbance footprints. A brief presentation of the model results is presented in Section 3.5.1. The proposed dredge footprint and proposed disposal footprint is in Figure 2.

Dredge pocket and navigation channel

Dredge modelling results show that the dredge plume impacts are most pronounced when dredging nearshore, which is associated with dredging large volumes of material over a comparatively small spatial area with a high proportion of fine content in the sediment. For the offshore section of the channel, the dredging requirements are spread out over a much larger area and the dredge plume impacts significantly less due to sediments possessing a much higher grain size and quicker settling rate (Baird 2021). Moreover, the model shows a preferential plume direction along a north-east to south-west axis, with dredge plume impacts elongated to the southwest driven by the stronger flood tides in comparison to ebb tide.

The proposed monitoring locations have been selected based on the predicted plume distribution and aligned along the predicted plume direction north-east to south-west axis. Further details are given in Section 8.1.4.

Spoil Ground DMPA4

BCH mapping has shown that there were no significant communities or habitats near the spoil ground, with sparse to moderate filter feeders and the very occasional coral. It is predicted that the disposal plume will extend in a general northeast-southwest direction out from the spoil ground, and monitoring locations will be concentrated along this axis. There will also be an “early warning” BCH monitoring location within the ZoHI closer to the spoil ground.

8.1.2. Predicted zone of impact and thresholds

The capital dredge plume model was used to develop “best-case” and “worst-case” zonation within and around the dredging area (Figure 11) using the WAMSI threshold limit for suspended sediment concentration (SSC) derived for corals (Fisher et al 2019) as presented in Table 12. These threshold

limits have also since been adopted by EPA in the environmental impact assessment of marine dredging proposals Technical Guidance (EPA 2021). The modelled SSCs were assessed against a combination of the 7, 14 and 28-day thresholds, which were applied across the model domain throughout the construction period. This resulted in the definition of likely best and worst-case Zones of High Impact (ZoHI) (irreversible loss) and Zone of Moderate Impact (ZoMI) (recoverable impact).

While the threshold limits in Fisher et al. (2019) and EPA (2021) are considered appropriate to develop the modelled suspended sediment concentration to define the different zones of potential impact for dredging, these thresholds have been developed in an offshore low turbidity environment and therefore are not considered to be suitable to be used as trigger thresholds for a dredging program in an inshore environment with high turbidity levels such as the Mardie Project. Therefore, to monitor the effects of dredging and disposal activities of the project and to establish triggers for management actions, project specific thresholds will be derived relative to turbidity (NTU) baseline conditions of the project area.

Prior the commencement of dredging, a site-specific calibration of SSC vs Turbidity (NTU) with an R^2 >0.7 shall be derived. The site-specific nature of calibrations has been emphasised by a number of previous studies including Fisher et. al. (2019), Sternberg et. Al. (1986, 1991) and today many of the best practice guidelines for the analysis of suspended sediment state the need for site specific calibrations, see for example Judd (2012). This is also aligned with guidance in EPA (2021).

The calibration coefficient will be applied to the real time NTU data allowing post conversion to SSC and monitoring of established triggers.

Trigger values for monitoring will be derived in accordance with EPA (2021) for coral monitoring using 12 months of baseline data which will be collected within 24 months prior to the commencement of dredging.

Table 12: Threshold Limits for Modelled Suspended Sediment Concentration used to define ZoMI and ZoHI regions through the dredge and disposal program (from Fisher et. al. 2019)

Threshold	Running Mean Period	ZoMI Threshold (>SSC)	ZoHI Threshold (>SSC)
Running Mean (SSC)	7 day	14.7 mg/l	24.5 mg/l
	14 day	11.7 mg/l	18.0 mg/l
	28 day	9.3 mg/l	13.2 mg/l

Spoil Ground DMPA4

Disposal plume modelling of capital dredge spoil disposal at proposed DMPA4 was undertaken prior to BCH mapping of DMPA4. The modelling used impact thresholds for coral (similar to the modelling at the dredging site) to generate the zones of impact as these are considered the most sensitive receptor. However, BCH mapping showed very few corals in the study area which contains mostly sparse to moderate filter feeders (e.g. sponges) which are considered more resilient to higher SSC. As such, the modelling presents a conservative ZoHI and ZoMI larger than the direct loss footprint and likely also larger than what the actual impacts to BCH from disposal will be, although a visual plume may be seen across the ZoHI and ZoMI.

8.1.3. Telemetered in-situ water quality monitoring

Telemetered in-situ instruments will be installed to provide continuous one-hour interval water quality data throughout the dredge program. This data will be transmitted to an online data portal, to enable live updates allowing responsive monitoring and management. Each water quality sensor will be weighted to the seabed and positioned approximately 0.5m above the seabed. Each station will be tethered to a special designed telemetry marker boy (with navigation lighting) containing a battery and 4G/satellite telemetry components. Monitoring stations will be designed to be relocated as required based on dredge location.

8.1.4. Monitoring locations and frequency

In-situ monitoring stations will be installed either side (east and west) of dredge operations along the predicted plume southwest-northeast axis, and on the north and south sides of the disposal spoil ground DMPA4 to monitor potential plume impacts on BCH. Impact monitoring stations and corresponding reference site locations are identified below in Table 13, Figure 13 and Figure 14.

Monitoring stations located at the ZoHI/ZoMI best case scenario boundary location will be used to monitor EPOs and MTs associated with recoverable impacts on BCH. While stations at the ZoMI/ZoI worst-case scenario location will be used to monitor EPOs and MTs associated with no negative change of BCH from baseline conditions.

Monitoring stations will be installed 8 weeks prior to commencement of dredging and monitoring will continue until no less than 30 days post dredge/disposal completion. Maintenance dredging monitoring locations will be refined following the completion of capital dredging, as per the proposed Long Term DSDMP.

Table 13: Indicative water quality monitoring stations (worst and best case were not modelled for disposal)

Station ID	Zone of Impact Boundary
Dredging	
RNE	Reference site - Northeast
RNW	Reference site - Northwest
RSE	Reference site - Southeast
RSW	Reference site - Southwest
ZHSE	Zone of High Impact / Zone of Moderate Impact (Best Case) – Southeast Boundary
ZHSW	Zone of High Impact / Zone of Moderate Impact (Best Case) – Southwest Boundary
ZME	Zone of Moderate Impact / Zone of Influence (Worst Case) – East Boundary
ZMN	Zone of Moderate Impact / Zone of Influence (Best Case) – North Boundary
ZMNE	Zone of Moderate Impact / Zone of Influence (Best Case) – Northeast Boundary
ZMSW	Zone of Moderate Impact / Zone of Influence (Best Case) – Southwest Boundary
ZMW	Zone of Moderate Impact / Zone of Influence (Worst Case) – West Boundary
Disposal	

Station ID	Zone of Impact Boundary
ZoMI1	Zone of Moderate Impact / Zone of Influence
ZoMI2	Zone of Moderate Impact / Zone of Influence
ZoMI3	Zone of Moderate Impact / Zone of Influence
ZoEW	Within the Zone of High Impact – early warning location close to DMPA4
ZoHI1	Zone of High Impact / Zone of Moderate Impact
ZoHI2	Zone of High Impact / Zone of Moderate Impact
REF1	Reference site – south western side
REF2	Reference site – north eastern side

Figure 13: Indicative water quality monitoring locations for dredging operations

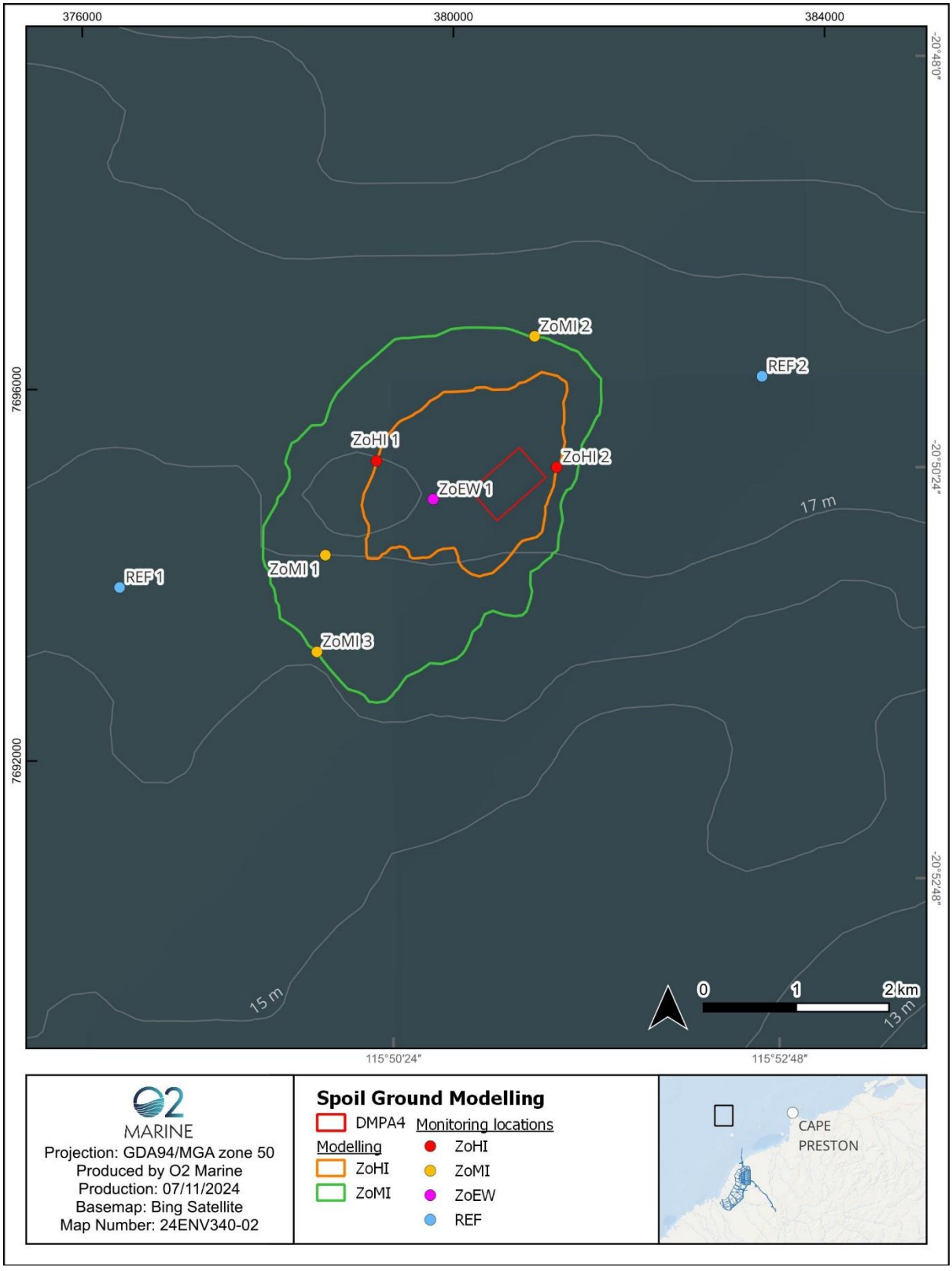


Figure 14: Indicative water quality monitoring locations for disposal operations

8.1.5. Parameters and procedures

In order to ensure that the EPOs and MTs are being achieved for dredging and spoil disposal, management criteria have been proposed as shown in Table 14 based on the guidance in EPA (2021). Turbidity (Nephelometric Turbidity Units (NTU)) and daily light integral (DLI) will be monitored at each site and the management criteria are based on the results of this information and unique for the different zones of impact.

Each monitoring station will measure turbidity (NTU) and photosynthetic active radiation (PAR) captured at 10 bursts every 30 minutes which will be interrogated to derive DLI data throughout the dredging/disposal program. NTU and PAR measurements every 30 minutes will be based on the median value from the 10 burst measurements. DLI and NTU daily values will be calculated midnight to midnight for each calendar date. DLI values will be calculated from PAR values based on the following equation:

$$DLI = \frac{1}{1 \cdot 10^6} \int_0^{24} PAR \, dt$$

The derived coefficients from the SSC/NTU calibration will be used to convert NTU to SSC to allow comparison against EPA (2021) thresholds. Turbidity and DLI data will be downloaded daily using the telemetry system incorporated within the instrument buoy.

Turbidity sensors will be calibrated during regular maintenance and in accordance with manufacturer specifications to ensure accurate datasets are acquired. Water quality monitoring locations are focussed on the Eastern side of the plume, as these habitats are dominated by coral habitats, which are the primary habitat for the benthic habitat monitoring program detailed in Section 8.2.

8.1.6. Data analysis

The likelihood of a link between dredging/disposal and water quality decline will be assessed in terms of the following factors:

1. Correct instrument function and operation
2. Locations of and status of dredging/disposal activities in relation to the site(s) at the time of the exceedance
3. Hydrodynamic conditions, for example wind, tide, wave and swell state at the time of the exceedance
4. Assessment against background conditions (reference site) and extreme weather events in the region.

Table 14: Environmental Protection Outcomes, Management Targets and Management Criteria for protection of BCH from dredging/disposal

Sites	Early Warning (Level 1)	Management Target (Level 2)	Environmental Protection Outcome (Level 3)
Zone of High Impact / Zone of Moderate Impact Boundary			
Dredging ZHSW ZHSE Disposal ZoEW1 ZoHI1 ZoHI2	Not Applicable (ZoEW1 is located closer to the spoil ground and its location provides early warning for disposal. This is not required for dredging)	Rolling mean DLI for either 7, 14 or 28 days to remain above the 20th percentile of seasonal baseline data* for the same period. **AND** Median DLI to remain above the 20th percentile of reference site data for the same period. **AND** Rolling mean daily# NTU for either 7, 14 or 28 days to remain below the 80th percentile of seasonal baseline data* for the same period. **AND** Median daily NTU to remain below the 80th percentile of reference site data for the same period.	Rolling mean DLI for either 7, 14 or 28 days to remain above the 5th percentile of seasonal baseline data* for the same period. **AND** Median DLI to remain above the 5th percentile of reference site data for the same period. **AND** Rolling mean daily# NTU for either 7, 14 or 28 days to remain below the 95th percentile of seasonal baseline data* for the same period. **AND** Median daily NTU to remain below the 95th percentile of reference site data for the same period
Zone of Moderate Impact / Zone of Influence Boundary			
Dredging ZMNE ZMN Disposal ZoMI1 ZoMI2 ZoMI3	Not Applicable	Rolling mean DLI for either 3, 10 or 21 days to remain above the 20th percentile of seasonal baseline data* for the same period. **AND** Median daily DLI to remain above the 20th percentile of reference site data for the same period. **AND** Rolling mean daily# NTU for either 3, 10 or 21 days to remain below the 80th percentile of seasonal baseline data* for the same period. **AND** Median daily NTU to remain below the 80th percentile of reference site data for the same period.	Rolling mean DLI for either 7, 14 or 28 days to remain above the 20th percentile of seasonal baseline data* for the same period. **AND** Median daily DLI to remain above the 20th percentile of reference site data for the same period. **AND** Rolling mean daily# NTU for either 7, 14 or 28 days to remain below the 80th percentile of seasonal baseline data* for the same period. **AND** Median daily NTU to remain below the 80th percentile of reference site data for the same period.

Sites	Early Warning (Level 1)	Management Target (Level 2)	Environmental Protection Outcome (Level 3)
ZMW ZME ZMSW	Rolling mean DLI for either 3, 10 or 21 days to remain above the 20th percentile of seasonal baseline data* for the same period. **AND** Median daily DLI to remain above the 20th percentile of reference site data for the same period. **AND** Rolling mean daily# NTU for either 3, 10 or 21 days to remain below the 80th percentile of seasonal baseline data* for the same period. **AND** Median daily NTU to remain below the 80th percentile of reference site data for the same period.	Rolling mean DLI for either 7, 14 or 28 days to remain above the 20th percentile of seasonal baseline data* for the same period. **AND** Median daily DLI to remain above the 20th percentile of reference site data for the same period. **AND** Rolling mean daily# NTU for either 7, 14 or 28 days to remain below the 80th percentile of seasonal baseline data* for the same period. **AND** Median daily NTU to remain below the 80th percentile of reference site data for the same period.	Rolling mean DLI for either 7, 14 or 28 days to remain above the 5th percentile of seasonal baseline data* for the same period. **AND** Median DLI to remain above the 5th percentile of reference site data for the same period. **AND** Rolling mean daily# NTU for either 7, 14 or 28 days to remain below the 95th percentile of seasonal baseline data* for the same period. **AND** Median daily NTU to remain below the 95th percentile of reference site data for the same period

*Baseline seasonal (i.e., Summer, Winter & Transitional) percentile values (i.e. 5th, 20th, 80th & 95th) will be calculated from 12 months of baseline data collected prior to dredging. Baseline data to be collected in the vicinity of the dredging area for at least 12-months prior to dredging.

Rolling mean daily NTU is to be calculated once per calendar day

8.1.7. Tiered management framework

A Tiered Management Framework (TMF) has been developed based on monitoring and reporting against the three trigger levels to ensure EPOs and MTs for protection of BCH are achieved during dredging and disposal. The TMF presented in (Figure 15) will be implemented by the Proponent/Contractor.

Where EPOs for coral are not achieved, the CEO of the EPA will be notified by the Proponent within 24 hours of the determination and a report will be sent within seven days of the determination, including any management actions which have been undertaken.

8.1.8. Recommencement Criteria

In the event that dredging/disposal is ceased as a result of failure to achieve the nominated water quality criteria (i.e., Management Action Level 3), then an Interim Reactive BCH Survey as described in Section 8.2 (and particularly in 8.2.5) will be undertaken to evaluate the extent of impact (if any) to BCH arising from the relevant activity (i.e. dredging or disposal). In this instance, the activity may only recommence under the following circumstances:

1. Interim reactive BCH survey confirms that no impact to BCH has occurred as a result of dredging/disposal activities
2. BCH impacts have been confirmed and reported to DWER. DWER subsequently advise that dredging /disposal in the affected area can continue under certain conditions, OR
3. Dredging/disposal can be undertaken in other unaffected areas (i.e. where Level 1 exceedances have not occurred) without impacting on BCH. Monitoring as per the Benthic Habitat Monitoring Program in Section 8.2.

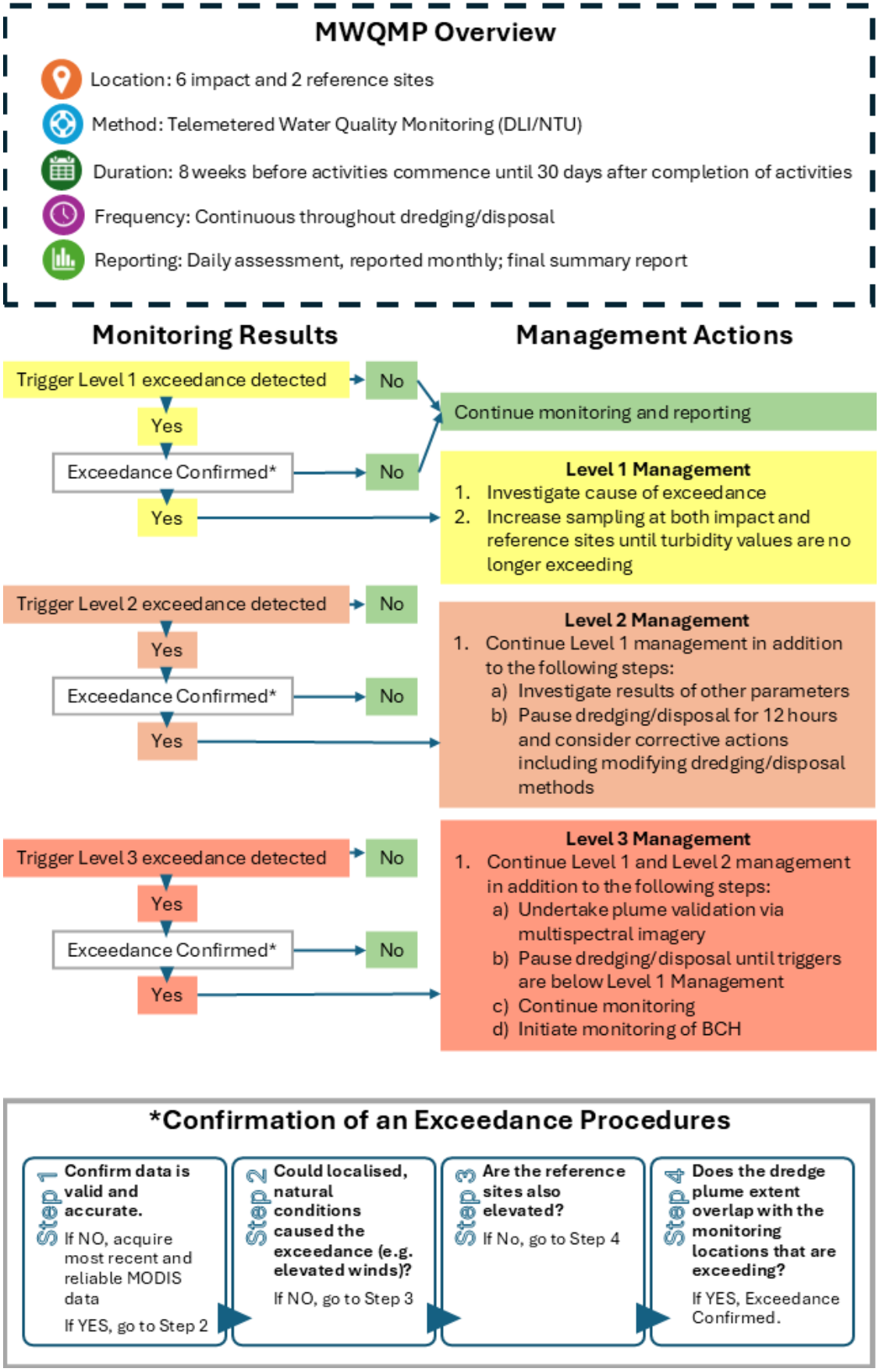


Figure 15: Tiered Management Framework for Marine Water Quality Monitoring

8.1.9. Aerial Plume Validation / Verification

Aerial multispectral imagery will be used to quantitatively assess and validate the dredge plume model for dredging activities. High spatial resolution multispectral imagery validated with real-time Total Suspended Solids (TSS) samples will be captured via Unmanned Aerial Vehicle (UAV) at the start of dredging. This data will allow assessment of TSS levels from dredge plumes, which are not likely to be visible via broad scale moderate resolution imaging spectroradiometer (MODIS) imagery due to the method of dredging and expected small scale plumes. This data will increase the accuracy of impact assessment on BCH and will help inform the predictive plume model.

Multispectral imagery verification will also be implemented if a Level 3 Trigger exceedance is breached (Figure 15). A dredge plume verification report will be prepared following each survey event. Aerial plume monitoring (particularly at the spoil ground) is not considered an appropriate tool for assessing MTs and EPOs as the majority of the plume impact is at seabed level and not detectable by aerial analysis. However, it can offer further lines of evidence of the dredge plume to understand the nature of the Level 3 exceedance. It is not to be confused with aerial plume validation studies, which should be conducted at the dredge channel and spoil ground to verify model accuracy. Aerial multispectral imagery will also be used to quantitatively assess and validate the disposal plume model for disposal activities once disposal plume modelling has been undertaken.

8.2. Benthic Habitat Monitoring Program

8.2.1. Outcomes

The Benthic Habitat Monitoring Program (BHMP) together with the WQMP is designed to provide an assessment against the following EPOs, and the outcomes established in MS 1211 (Condition B1-1):

1. No direct loss of BCH outside of the dredge and disposal disturbance footprints
2. No irreversible loss of BCH outside of the authorised dredging and disposal ZoHI[7]
3. No detectable change from the baseline state of BCH outside of the ZoHI and ZoMI.

The associated management targets being addressed in this BHMP to ensure these EPOs are met are as follows:

- Direct loss is limited to within the dredge and spoil ground footprints
- No negative change from baseline state of BCH outside the ZoHI.

8.2.2. Monitoring rationale

As identified in Section 2.3, corals are the most vulnerable (of those BCH present in the dredging and disposal impact areas) to the effects of increased SSC and the associated decline in benthic light availability. Therefore, coral health has been selected as the lead indicator for monitoring of benthic community health within the ZoMI and the ZoMI/ZoI boundary.

[7] *The EPA considers impacts within the ZoMI as reversible, provided that recovery of the benthic communities and habitats occurs within five years post-impact. If recovery is anticipated to take longer than five years, the impact may be classified under the ZoHI, indicating irreversible loss (EPA 2021)*

However, due to differences in the density and type of BCH cover across the dredge and disposal locations, different methods have been applied at the two survey areas to ensure sufficient coverage for a robust statistical assessment.

Dredging monitoring

The BHMP is designed to identify and measure changes in condition of BCH that are attributable to dredging activities, and which are greater than the changes occurring naturally at control sites. Low-moderate density coral reef assemblages are present within limited locations within the predicted dredge spoil dispersion area (2 of the monitoring sites, both within the predicted ZoI). Within these locations, monitoring of individual tagged coral colonies will be undertaken at designated potential impact and control (reference) sites to achieve a statistical power of 0.8.

The remainder of the area surrounding the dredging location consists of mostly bare sediments occupied by very low densities (<5%) of mixed (typically ephemeral) BCH types (seagrass, macroalgae, filter feeder and solitary corals). Given the low density and ephemeral nature of the BCH in the area, it is not possible to robustly define trends in density or cover. Therefore, presence/absence surveys will be undertaken by the Proponent (or environmental contractor) at potential impact and reference sites.

It is important to note that initial baseline monitoring has already been undertaken for the dredging impact and reference locations and results are presented in O2 Marine (2023a).

Disposal monitoring

BCH surrounding the DMPA4 disposal area has been determined as being bare sediments occupied by mostly sparse – moderate density filter feeders with the very occasional solitary coral colony. Accordingly, monitoring of tagged corals was not deemed to be a suitable approach to assess any impacts associated with disposal activities. Therefore, replicate quadrats will be monitored at each site and BCH contained within each will be assessed for percent cover, relative abundance and composition and compared to baseline information collected prior to the commencement of disposal activities.

8.2.3. Management thresholds

The proposed management thresholds, to ensure the management targets and therefore management outcomes are met, for assessment of dredging-related impacts to BCH are:

1. No irreversible loss of, or serious damage to, BCH outside of the ZoHI
2. For coral monitoring sites, protection of at least 70% of baseline tagged coral BCH colonies on each designated reef formation outside of the ZoHI
3. For mixed assemblage monitoring sites, no detectable negative change to mixed assemblage BCH outside of the ZoHI.

For disposal activities, the proposed management targets for assessment of disposal-related impacts to BCH are:

1. No irreversible loss of, or serious damage to, BCH outside of the ZoHI
2. Retention of at least 70% of baseline BCH cover at each monitoring site within the ZoMI
3. No negative change in net live BCH cover outside the ZoMI/ZoI boundary, beyond natural variation.

8.2.4. Monitoring locations

Dredging monitoring

Monitoring locations have been selected in areas of at least moderate benthic coral cover and these are presented in Figure 16 and include:

- Five (5) locations within the ZoMI (ZM1, ZM2, ZM3, CT, PT) to assess recoverable impacts (only mixed assemblage monitoring locations were able to be monitored in this zone due to the existing BCH)
- Two (2) locations within the ZoI (ZI1, ZI2 which both had coral sites and mixed assemblage BCH sites giving this zone four monitoring sites) to assist in validating potential impact.

A further four (4) reference monitoring locations (two coral and two missed assemblage) are required to be determined as suitable control locations.

Disposal monitoring

Due to the homogenous nature of the BCH within and around DMPA4, indicative monitoring locations have been selected across the mapped plume model at the same locations as the WQMP in Section 8.1 and presented in Figure 14.

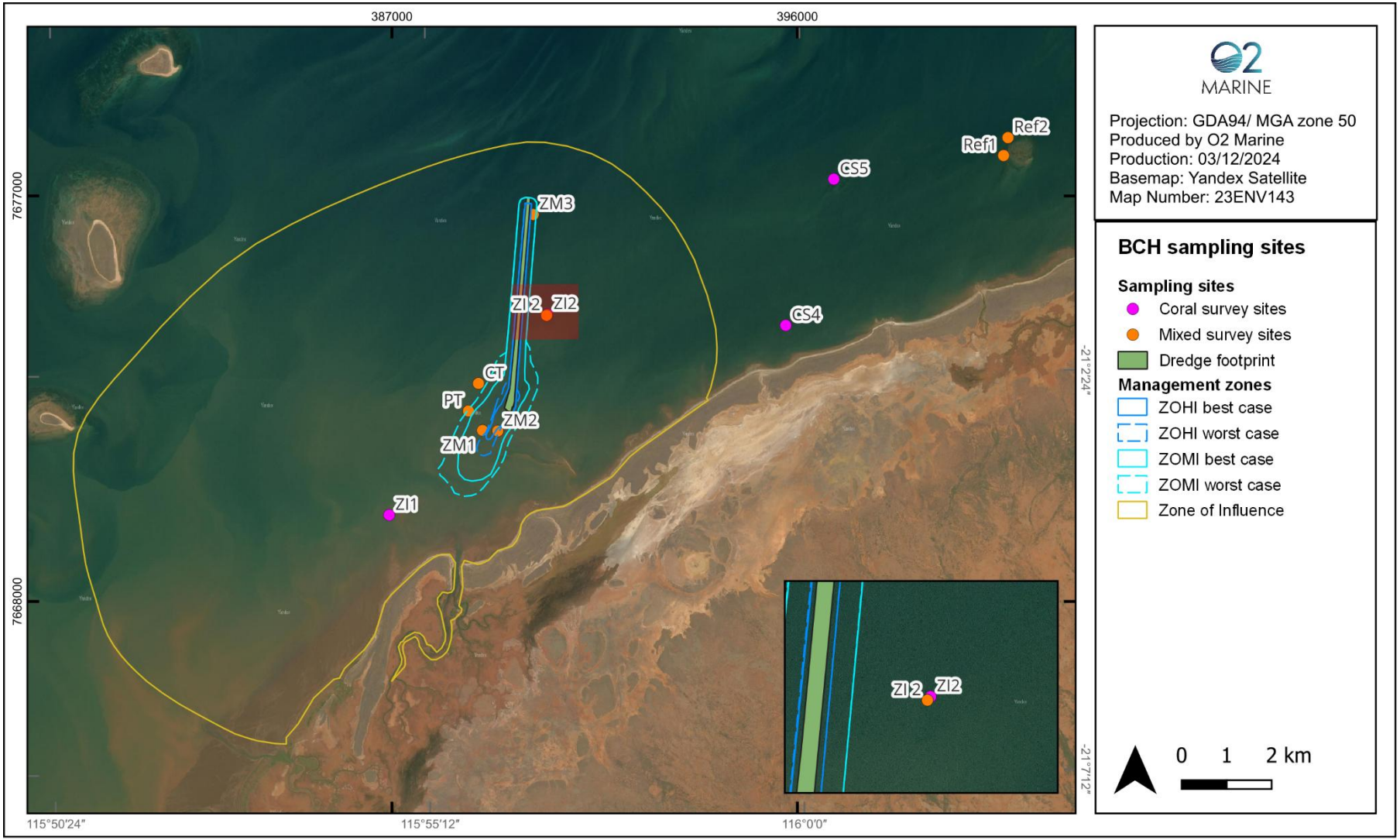


Figure 16: BCH monitoring locations

8.2.5. Frequency

Baseline surveys

BCH surveys to establish suitable BCH types for and to facilitate baseline condition assessment will be undertaken quarterly and commence at least 12 months prior to (but no more than 5 years before) commencement of dredging and disposal activities.

It is important to note that baseline BCH monitoring has been conducted in 2022/2023 for to establish a pre-construction and pre-dredging baseline of different BCH assemblages that may be affected by the Project (O2 Marine 2023c). Quarterly surveys were conducted over a period of 12 months, and focussed on mixed assemblages, seagrass and coral reef assemblages. An additional pre-dredging survey of all dredging related sites will be undertaken within three (3) months prior to the commencement of dredging and associated activities, to validate outcomes of the baseline survey program and establish BCH condition immediately prior to activities. If dredging does not commence within 5 years of the baseline assessment, another 12 months of quarterly assessments will be undertaken.

This baseline survey did not include the offshore sites, and therefore a baseline condition assessment for the disposal monitoring sites will still be required at least 3 months prior to the commencement of disposal activities.

Reactive surveys

During dredging and disposal activities, a reactive BCH survey is only required in the event that a level 3 management event is triggered (i.e., DLI EPO Trigger as defined in Table 14). A reactive survey will be undertaken at the monitoring sites associated with the exceedance, and a relevant reference site/s, and therefore a survey of disposal sites will not be required if an exceedance is associated with dredging, and visa-versa.

Completion of works survey

A post-dredging survey will be undertaken within six (6) months following completion of dredging and disposal to evaluate status of EPOs within the ZOMI and the ZOI. Where EPOs are not met, then post-completion BCH surveys will continue, on at least an annual basis, for up to 5 years, until management targets and/or EPO's are met, or until impacted BCH as a result of dredging/disposal (i.e. in the ZOMI) are considered to have recovered to baseline conditions based on DWER and DCCEEW review of the outcomes of the monitoring program. Like the reactive surveys, these post-completion surveys will only be undertaken for the monitoring sites with a recorded exceedance, in addition to a relevant reference site/s, and therefore long-term monitoring of disposal sites will not be required if an exceedance is associated with dredging, and visa-versa.

8.2.6. Dredge monitoring program

Survey methods

At each monitoring site, four 20 m permanent transects will be located approximately 5 m apart. If transects are lost or damaged they will be re-established to provide robust statistical power to the survey design and allow for more confidence in comparison between years.

Percent Cover

Percent cover will be undertaken at all dredge monitoring sites. At each transect within the sites, video footage will be collected approximately 1 m from the seafloor along the entire length of the transect, ensuring the line is within the field of view at all times. Once downloaded, a total of 20 random images will be extracted from each video and uploaded into ReefCloud, an online benthic image analysis program, and 10 random points per image will be annotated for classification by suitably qualified marine scientists. Where seagrass is captured, shoot density will also be recorded.

Tagged corals

At each coral site (i.e. ZI1 and ZI2, and relevant reference sites), a minimum of 16 colonies per transect will be selected (i.e. at least 80 colonies per site), with priority given to colonies identified in previous surveys. Selected colonies will be 'tagged', identified to genus level, photographed and location recorded along the transect. Where possible, colonies will be selected from a broad range of species, representative of different family groups and morphologies at each site, including sensitive genera (e.g., *Acropora*) and less sensitive genera (e.g. *Turbinaria*). If additional colonies are required to supplement those found along the transect, the area between 1-2 m either side of the transect may be searched.

Each tagged colony will be measured (width) *in-situ* and sub-lethal indicators will be recorded as per Table 15. Digital photographs will be collected at distances which allow the colony to fit within the field of view on the image. A set of Coral Reference Photographs taken during the first baseline survey showing the original image of each of the corals with the location bearings and distances from the transect will then be used to compare against each colony to ensure that the same corals are assessed on each sampling occasion as much as possible.

Colonies will be photographed from the same orientation/perspective (from start of transect) and distance. Where an area of colony is covered in sediment, it will not be cleared away from the colonies before photographs are taken. Where macroalgae obscure a colony, the macroalgae will be moved to allow a clear photograph to be taken, unless the macroalgae are growing on or within the colony and its removal would damage either the coral or the macroalgae.

Table 15: *In-situ* classification details of sub-lethal indicators to be recorded for each colony during each survey

Indicator	1	2	3	4	5
Partial mortality	<10%	10-30%	30-60%	60-80%	>80%
Sediment deposition					
Coral colour	Paling	Focal bleaching	Non-focal bleaching	Partial bleaching	Total bleaching
Mucous production	Presence/absence				

Indicator	1	2	3	4	5
Disease	Presence/absence & Type (i.e., White syndrome, black band, brown band, other)				
Predation/Type	Presence/absence & Type (i.e., Fish scars, Polychaetes, Trematodes, other)				

Data Analysis

Percent cover

Percent cover data will be aggregated by site, transect and benthic category, and percent cover per transect used to characterise each site, along with diversity indices. Percent cover of assemblages will be compared between impact and reference sites. An assessment against baseline data (total and seasonal) will also be conducted.

Tagged corals

The sub lethal indicators recorded in the field will be evaluated to determine the metrics presented in Table 16. The mean of the scores from the assessment of partial mortality, coral colour and sediment deposition will be compared to the baseline record. A shift of three points on the six-point classification (including zero) will constitute an adverse change in sub-lethal coral indicators. The incidence of colonies exhibiting evidence of coral mortality, bleaching, mucous production, predation and disease will be calculated by summing the number of colonies with evidence of these effects divided by the total number of colonies. This will be expressed as a percentage reduction in coral condition from the baseline level.

Table 16: Post-processing data for the following indicators

Indicator	Analysis description
Partial Mortality	Total mean partial mortality[1] scores from ReefCloud (or similar program)
Colony mortality	Proportion of colonies in Category 5
Coral colour	Total mean coral colour scores[1]
Colony bleaching	Proportion of colonies in Category 4 & 5
Sediment deposition	Total mean sediment cover[1] scores
Sedimentation	Proportion of colonies in Category 5
Mucous production	Proportion of colonies with evidence of the presence of mucous
Disease	Proportion of colonies with evidence of the presence of coral disease
Acanthaster	Incidence of *Acanthaster* species along transects
Drupella	Proportion of colonies with evidence of the presence of *Drupella*
Predation	Proportion of colonies with evidence of predation

[1] All colonies included in the assessment (i.e., colonies scoring zero are included in calculating the mean)

8.2.7. Disposal monitoring program

Survey methods

At each site, three (3) 10 x 10 m replicate quadrats will be surveyed by diverless method, for the purpose of producing high resolution, georeferenced 2D orthomosaics. Each corner will be marked by GPS to support accurate re-capture between surveys. Video and still imagery of the entire quadrat will be captured by Remote Operated Vehicle (ROV), Autonomous Underwater Vehicle (AUV) or similar. Following the survey, the orthomosaics for each site will be created using a photogrammetric software such as Agisoft Metashape.

Each orthomosaic will be analysed in ReefCloud or similar benthic habitat analysis program to extract percent cover, diversity and relative abundance of individuals. Semi-qualitative indicators will also be recorded such as observations of bleaching, disease or damage. Once the image analysis is complete, comprehensive data output is able to be extracted from ReefCloud for data analysis.

Data analysis

Percent cover data will be aggregated by site, quadrat and benthic category, and percent cover per quadrat used to characterise each site, along with diversity indices. Percent cover of assemblages will be compared between impact and reference sites. An assessment against baseline data (total and seasonal) will also be conducted.

8.2.8. Comparison to management thresholds

The process for analysis of lethal and sub-lethal data and comparison against the management thresholds is shown in Table 17. The first step of the analysis is a statistical paired-samples t-test of gross negative change in coral colour/bleaching, partial/colony mortality and coral cover at the impact location. This uses a null hypothesis of no difference between the impact location at time 'x' during dredging compared to baseline to test the one-tailed alternative hypothesis that the negative change at the impact location is significantly greater than the negative change at reference locations.

This is followed by a similar test, but of net negative change at the impact location (i.e., factoring in change in cover that occurred concurrently at reference locations). Specifically, the (one-tailed) hypothesis being tested is that difference in the negative change is greater at the impact location than at the reference locations. The appropriate statistical test is a two-(independent)-sample t-test between the average of the impact locations and the average of reference locations. This uses a null hypothesis of no difference between the impact location at time 'x' during dredging compared to baseline to test the one-tailed alternative hypothesis that the negative change recorded between baseline and time 'x' at impact locations is greater than the negative change recorded at impact locations.

The t-tests of changes within sites proposed here are equivalent to the main interaction test (before–after × control–impact) in a standard Multiple Before–After, Control–Impact (MBACI) design (Keough and Mapstone 1997; Downes et al. 2002; Quinn and Keough 2002). The only difference is that there will only ever be one measurement in the "after" (during dredging) period that is being assessed, so there is additional temporal imbalance compared to a usual MBACI design. The statistical analysis is also based on an asymmetrical design, characterised by a before versus after contrast at multiple control

sites but only a single impact site. The impact sites for the tests may be grouped together to form an additional balanced statistical test where three sites represent each of the impact zones and provide greater confidence that EPOs have been achieved for the Project. Results will be compared against the results from the control reference sites to confirm impact.

A conventional Type I error rate of 0.05 will be applied across the tests. Type II error rates of statistical power will be determined during the baseline study.

Table 17: The process for evaluation of management thresholds

Name	Description	Objective
Average Baseline	Calculate average measurements for each colony across each site over multiple sampling times before dredging	To determine natural levels of change before dredging
Gross Change	Subtract the Average Baseline from recent dredging survey for each colony/transect and average across each site	To calculate the average change from baseline to recent dredge survey at each impact and control site
Test of Gross Change	Paired-sample t-tests performed between baseline and recent dredge survey averages where negative change was recorded at impact site.	A statistically significant negative change might provide evidence supportive of a dredging-related impact.
Test of Net Change	Two-(independent)-sample t-test performed to compare negative changes between impact and control sites where negative change was recorded at impact site.	A statistically significant negative change might provide evidence supportive of a dredging-related impact.
Multiple Lines of Evidence	Detailed interrogation of all data collected using supportive univariate and multivariate analyses where Test of Net Change is exceeded	To rigorously assess whether the detected change at an affected reef was due to dredging or simply the result of natural change

Multiple Lines of Evidence

In the event that management thresholds are exceeded, a series of investigations and statistical analyses will be initiated in a structured decision-making framework to rigorously assess whether the detected change at an affected reef was due to dredging or simply the result of natural change.

The first step will be an assessment of the magnitude of change (effect size and its confidence interval) in coral cover for the individual colonies between the impact and reference locations, from before dredging to the current survey period (that is, whether the difference in coral cover between the affected reef and the control reefs had increased or remained consistent since dredging). The purpose of this method is to compare the effect size during baseline with the effect size after dredging. A confidence interval approach provides important information for decision-making not gained from a test of a null hypothesis and focuses on the magnitude of change, with some measure of uncertainty. A larger mean effect size following dredging may provide evidence supportive of the dredge impact hypothesis.

A comparison of trends in mean coral cover through time will then be compared among the impact and reference locations. Evidence supportive of the dredge impact hypothesis would be a decline in cover at the impact location following dredging, but no corresponding decline at the reference location.

An inference assessment will then be undertaken, which includes the collation and synthesis of all available circumstantial evidence supporting or refuting the conclusion that either dredging or a natural agent of disturbance resulted in an observed decline in coral cover at the impacted location.

Multiple lines of evidence, based on causal indicators, are used to assess the impact hypothesis and may apply a variety of univariate or multivariate analysis. With lines of evidence there is a need to seek evidence not only to support the impact prediction, but evidence to rule out plausible alternative predictions, such as that the observed difference was due to natural processes (Beyers 1998; Downes et al. 2002). Potential natural or other anthropogenic causes of impact within the Project area may include thermal bleaching from warm water temperatures, natural mortality, pollution, predation, cyclonic events, salinity change and anthropogenic causes for elevated turbidity (e.g. ship propeller disturbance). Potential natural and anthropogenic causes not related to the dredging activities will be monitored and noted during routine surveys as part of the MQMP, and in some cases during the reactive monitoring program. A reactive monitoring program will be activated when there is a potential for a decline in BCH occurring, such as a spill, cyclone, or bleaching event, triggered. A number of factors are relevant to the likelihood and level of severity of an impact occurring, including existing stress levels, age, size and health status of colonies, associated biota and adaptations to localised conditions. Differences in the physical characteristics between reference and impact locations and how this could affect the scale of effect observed between the corals should also be considered. The data will be compiled to provide a weight of evidence as to whether or not dredging /disposal activities were reasonably considered to cause or contribute to the impact.

To verify this, continuation of the post-dredging surveys on an annual basis up to 5 years will be undertaken as required to identify evidence of BCH recovery within the authorised ZoMI. Where BCH has not shown evidence of recovery within the authorised ZoMI after 3 years, options for translocation, artificial reef, seagrass transplantation and/or restoration will be considered. In the event that water quality triggers are exceeded at the outer boundary of the authorised ZoMI, the pre- and post-dredging BCH surveys will consider a variety of health measures of BCH in the areas outside the authorised ZoMI and ZoHI, which can be used to provide evidence that this EPO has or has not been met.

8.2.9. Reporting

Baseline report

A baseline report will be prepared following the final quarterly baseline surveys completed for both the dredging (including maintenance dredging) and disposal activities. The results of the baseline surveys will be summarised and assessed with the intention to characterise natural background changes in the condition of BCH in the areas likely to be affected by the dredging and disposal activities.

A baseline report has been completed for the baseline surveys undertaken in 2022/23 of the dredging impact and reference sites (O2 Marine 2023c) and characterised natural variation in BCH assemblages in the areas likely to be affected by capital dredging and in the reference locations. If dredging has not commenced prior to 5 years after the completion of the baseline monitoring in 2022/2023, an additional 12 months' monitoring will be undertaken.

A baseline report will also be prepared at the completion of the baseline surveys for the disposal impact monitoring sites and associated reference sites.

An additional pre-dredging monitoring report will be provided following the completion of the verification monitoring to be undertaken at the dredging impact and reference sites three (3) months prior to the commencement of dredging and associated activities.

Reactive survey reports (if required)

In the event that level 3 management criteria are triggered, a reactive survey investigation will be immediately (i.e., within 72 hours) commenced. The investigation will consider relevant field observations, comparison of reference sites, water quality and sediment deposition data collected, dredge/disposal operations and metocean conditions to delineate impacts detected from natural causes or other anthropogenic sources as part of a multiple lines of assessment approach. Each reactive survey report will include:

1. A summary of data collected during the survey
2. Comparison of coral community condition with baseline and against reference locations (for dredging) or comparison of percent cover and community condition with baseline and against reference locations (for disposal)
3. Multiple lines of evidence assessment (including the outcomes from the Marine Environmental Quality Monitoring & Management Plan)
4. Evaluation of whether BCH EPOs been achieved or not
5. Recommendations for additional investigations / management / monitoring if required.

Where EPOs for BCH are not achieved, the CEO will be notified within 24 hours of the determination and a report will be sent within seven days of the determination, including any management actions which have been undertaken.

Post-dredging/disposal report

The post-dredging/disposal report will be prepared following completion of each annual post-dredging/disposal survey. The post-dredging/disposal report will include:

1. A summary of data collected during the survey
2. Comparison of BCH community condition with baseline and against reference locations
3. Multiple lines of evidence assessment (including the outcomes from the Marine Environmental Quality Monitoring & Management Plan)
4. Evaluation of whether BCH EPOs been achieved or not
5. Evaluation of the effectiveness of the BHMP and WQMP
6. Recommendations for additional investigations / management / monitoring if required.

8.3. Marine Fauna Management

8.3.1. Management Zones and Observers

The risk of noise exposure, interaction or collision with vessels to marine fauna from dredging resulting in injury or fatality will be managed through the use of management zones (i.e. observation and exclusion zones). There will always be at least one suitably trained MFO on duty during dredging and disposal works. During humpback whale migration, June to November (though dredging will only occur during April to September inclusive), there will also be a dedicated MFO (in addition to the trained MFO)

for dredging and disposal works (including transit to disposal site) (Table 18). These measures focus on species who bask/rest on the surface and/or are air breathers but will be implemented for other marine fauna species if observed.

Table 18: MFO requirements per activity and in relation to the time of year

Activity	Outside whale season	Inside whale season (June -November*)
Dredging	Trained MFO	Dedicated MFO Trained MFO
Transit to spoil ground	Trained MFO	Dedicated MFO Trained MFO
Disposal	Trained MFO	Dedicated MFO Trained MFO
***Noting no dredging or disposal will occur from 1 October to 31 March**		

The monitoring protocols and procedures have been informed by Australian National Guidelines for Whale and Dolphin Watching 2017 (Commonwealth of Australia 2017) and underwater noise modelling (Talis 2019) and consideration has been given to Policy Statement 2.1. These zones are presented in (Table 19). The disposal Exclusion zone has been informed from advice from other Sea Dumping Permit applications, and if required will be updated to reflect the Mardie Sea Dumping Permit requirements. These distances are larger than the modelling results and the whale observation zone is smaller than EPBC Policy statement 2.1, but still considered to be of a conservative nature for managing potential noise impacts as EPBC Policy statement 2.1 zones are designed for seismic surveys. BHD generally have the lowest source levels (163-179 dB re 1µPa rms at 1 m), whereas, a TSHD generally have the highest source level for a dredge (172-190 dB re 1µPa rms at 1 m) (Seudel et al. 2019). Both dredging methods produce a non-impulsive continuous noise, which have a lower source level than the impulsive noise of seismic shots which have a source level of 260 to 262 re 1µPa rms at 1 m (Seudel et al. 2019).

The noise modelling from Talis (2019) found that dredging and barging operation effect on sawfish is not expected to result in any behavioural disturbances, and TTS threshold level were no expected to be exceeded. Sawfish are not included in observations as they are highly cryptic and non-surface breathers and unlikely to be detected by observers. Based on the limited knowledge of manta rays and elasmobranch hearing it is thought that elasmobranch hearing band width ranges from 25 to 1500 Hz and have thresholds ranging from ~90 to 170 dB re 1uPa (Mickel and Higgs 2022), which is similar to turtles, so the turtle distances have been applied to manta rays. Noting that manta rays may be difficult to observe based on limited surface activity with the species not being airbreathers.

Table 19: Dredging and disposal observation and exclusion zones

Marine Fauna Group	Dredging		Disposal	
	Observation Zone (m)	Exclusion Zone (m)	Observation Zone (m)	Exclusion Zone (m)
Whales	3,000	500	3,000	300
Dolphins*	3,000	500	3,000	300
Dugongs*	3,000	500	3,000	300
Turtles*	3,000	500	3,000	300
Manta rays*	3,000	500	3,000	300
Sea snakes*	3,000	500	3,000	300

**A roaming dedicated MFO will be required in addition to one on the dredge equipment to ensure the 3,000 m observation zone can be observed*

A 1,500 m Observation zone for whales is consistent with the approximate maximum detection distance for whale's moderate surface activities, noting that binoculars will be implemented to improve MFO detection ability and increase detectability of smaller blows and passive surface behaviour and therefore 3,000 m will be precautionary and implemented to be in accordance with MS 1211. Exclusion zones are also to meet the conditions of MS 1211 (and in turn the conditions of EPBC 2018/8236 and EPBC 2022/9169). For disposal, the zones are smaller as the associated impacts are also likely to be lower regarding noise and disturbance.

It is vital to ensure the protection of marine fauna for the duration of the Project. The frequency and location of the observer are paramount to ensure the safety of the marine fauna, with the continuity of the Proposal depending on their response to potential interactions with marine fauna. Sharks and elasmobranch species are not surface breathers; therefore, they do not bask at the surface which makes observations an ineffective mitigation measure. However, larger elasmobranchs may be present (e.g. sawfish and sharks) and can occasionally be viewed from the surface if weather conditions and water clarity allows for it. As a precautionary approach, if rays or sharks are sighted within the manta rays zones the procedures outlined below will be implemented.

8.3.2. Marine Fauna Observers

Dedicated Marine Fauna Observer

Training and qualifications

One dedicated MFO will be on duty during dredging and disposal operations during the humpback whale migration, June to November. The dedicated MFO will be suitably trained, and dedicated persons engaged to undertake marine fauna observations and mitigation measures associated with dredging. The person will have demonstrated knowledge and experience in marine fauna species observation, distance estimation and reporting within the North West region of Western Australia. In accordance with MS 1211, it is expected that they hold Internationally recognised MFO qualifications in accordance with industry standards and at least five years' experience in Australian waters, including

demonstrated knowledge of significant marine fauna in the North-West region. They will not have other duties while engaging in visual observations.

Dedicated MFOs will adhere to the requirements of the Wildlife Conservation (Closed Season Marine Mammals) Notice 1998. MFOs must demonstrate a knowledge of marine wildlife species in the North-west region, including Threatened and Migratory Species listed under the EPBC Act, and BC Act and priority listing, including morphological and behavioural characteristics.

Evidence of personnel suitability will be kept on record through staff curricula vitae, training certificates and in-field record keeping, which may be used in future audits. Information will include:

- MFO names and contact details
- Details of MFOs training (including provider and course dates)
- Previous experience as MFOs on dredge surveys
- Other MFO experience.

Shifts

Dedicated MFO shifts will be set prior to field mobilisation to prevent observer fatigue which could reduce the quality of observations and data recording. This will be done so making sure they are on shift during dredge operations and resting when the dredge is not operating. From a health and safety perspective, having coordinated shifts will ensure that observers have amenity breaks and reduced weather exposure.

Platform

MFOs observations will be undertaken from a suitable elevated point that provides appropriate vantage of the Management Zones and with unimpeded views around the noise source. This point may need to shift pending the location of the noise source on any given day (i.e. site construction activities).

Trained Marine Fauna Observers

Training and Qualifications

Trained MFOs are marine vessel crew members trained in marine fauna species observations and mitigation measures, consistent with the Project environmental management plans. Trained MFOs will be on duty on Project vessel during dredging and related activities and may have other vessel duties but not during observation periods. There will be always at least one Trained MFO on duty during dredging operations. Crew will be scheduled so that they are able to conduct MFO duties while not undertaking other tasks.

All vessel crews engaged in by the Client for dredging operations associated with the Project will attend a minimum of one marine fauna induction to become familiar with the range of conservation significant marine fauna that could be present in the operational area and the risks the dredging works may present to this fauna. All commitments made by the Client to manage vessel interactions with conservation significant marine fauna will be included in the induction. The content of the induction will be updated as required to ensure it remains current and reflects the marine fauna being observed in the operational area and any vessel interactions with the fauna that have occurred. This marine fauna induction can be combined with other crew inductions that may be required.

Platform

MFOs observations will be undertaken from a suitable elevated point that provides appropriate vantage of the Management Zones and with unimpeded views around the noise source. This point may need to shift pending the location of the noise source on any given day (i.e. site construction activities).

Protocols and Procedures

It is vital to ensure the protection of marine fauna for the duration of the Project. The frequency and location of the observer are paramount to ensure the safety of the marine fauna, with the continuity of the project depending on their response to potential interactions with marine fauna.

MFO observations will be undertaken from a suitable elevated point that provides appropriate vantage of the Management Zones and with unimpeded views around the noise source or dredging activity. This point may need to shift pending the location of the noise source or activity on any given day (i.e. site construction activities).

To mitigate the potential impacts of the proposed works on significant marine fauna the Contractor must implement the following management and monitoring protocols during dredging, transit and disposal activities.

Dredging

Prestart procedures

Prior to the commencement of dredging (following a break of more than 30-minutes) the MFO (trained and dedicated during humpback whale migration) will undertake continuous observations of the Management Zones for 30-minutes. If target marine fauna is observed within the Exclusion Zone, dredging operations shall be delayed until target marine fauna have been observed exiting or have not been seen for 30-minutes. If target marine fauna is not observed within the Exclusion Zone within 30-minutes, dredging can commence with soft-start procedures, as relevant to the dredging equipment.

Soft-start

30-minute soft-start (i.e. slower speed and building up as relevant to the dredging equipment) procedure apply to dredging operations at all times and during this period the MFOs will maintain continuous observations of the Management Zones. Soft start involves activating the bucket or cutter in a slow and controlled manner as relevant to the dredging equipment, increasing in energy/speed over a 30-minute period, prior to dredging, to passively disturb and deter resident marine fauna. Full energy/speed dredging may only be used after the 30-minute soft-start period.

Soft-starts involves commencing dredging operations at low energy, gradually increasing to full energy over a 30-minute period, as relevant to the dredging equipment being used.

The MFOs will continually monitor the management zones during soft-start procedure and the following procedures will be implemented:

- If target marine fauna is observed in the Observation Zone, soft-start procedures will continue and the MFOs will continue to monitor.
- If target marine fauna is observed in the Exclusion Zone shut-down procedures apply, soft-start procedures will cease until the observed target marine fauna is sighted leaving the Exclusion Zone or has not been seen for 30-minutes.

Further, the 30-minute soft-start procedure will be implemented following a shut-down or a break >30 minutes.

Dredging and shutdown procedures

A suitably trained MFO must monitor the observation radius of 3 km (Observation Zone) around the dredging activities continuously during these works to identify if there are any cetaceans, dugongs, manta rays, marine turtles or other protected species. If fauna is observed within the Observation Zones (but outside the Exclusion Zones) during dredging activities (including Soft-Start procedures), then following action shall be taken:

- If target marine fauna is sighted and is in distress (where distress can be described as unusual surfacing, laboured breathing, disorientation, stranding, bleeding or visible wounds, lethargy, unusual vocalisation and separation from group) then dredging activities shall be suspended within two minutes of the sighting, or as soon as safely possible.
- If target marine fauna is not showing signs of distress and remains within the Observation Zones (but outside the Exclusion Zones), dredging activities will continue and the MFO will continue to monitor the target marine fauna.
- Dredging works will cease if target marine fauna enters the Exclusion Zone

If target marine fauna is observed within the Exclusion zone during dredging (including soft-start procedures), then the following actions shall be taken:

- Dredging must be suspended within 2 minutes of sighting or as soon as safely possible.
- Dredging activities that have been suspended must not recommence until the sighted marine fauna have moved beyond their respective Exclusion zone or not sighted for at least 30 minutes; alternatively, the dredger might relocate and recommence operations beyond the extent of the Exclusion zone.
- Once able to resume, dredging will recommence following Soft-start procedures.
-

Low-visibility

During periods of low visibility e.g. between dusk and dawn, where a distance out to 3 km cannot be clearly viewed, dredging may only be undertaken, provided that all other limitations are met and that during the preceding 24-hour period:

- there have not been 3 or more marine fauna shutdowns at the dredging location
- a 2-hour period of continuous observation was undertaken in good visibility (to a distance of 500 m) and no cetaceans, dugongs, marine reptiles, manta rays, and sawfish were sighted.

If marine fauna is detected in the exclusion zone during poor visibility, operations must cease until visibility improves to enable full visual monitoring of the management zones.

Transit to disposal ground

- During humpback whale migration, one dedicated and one trained MFO will be on duty on all dredges/transit vessels during dredging works, transit to the spoil ground and during disposal activities
- During other times (i.e. not during humpback whale migration, and still within the ecological windows), one suitably trained MFO will be on duty on all dredges/transit vessels during dredging works, transit to the spoil ground and during disposal activities

- Barges/transit vessels must maintain vessel approach distances and speeds outlined in Section 8.3.4
- Monitor and log the occurrence of sick, injured and dead marine fauna within the development envelope or during disposal.

Disposal

Prestart procedures

Prior to the commencement of disposal, the MFO (trained and dedicated during humpback whale migration) will undertake continuous observations and must check that no marine fauna are present within the disposal exclusion zone (300 m) for 30-minutes. If target marine fauna is observed within the disposal site exclusion zone, then dumping activities must not commence until no marine fauna has been sighted for 30 minutes or vessel has moved to another area within disposal site which is >300 m from marine fauna.

Disposal

Disposal activities are expected to be quick, given the use of split hopper barges or similar. The direct act of opening the barge and allowing the disposal material to be released is also not possible to be suspended, and therefore the pre-start procedures are extremely important, however, closing the barge and preparing to move may be suspended if it is safe to do so. During disposal activities MFOs are to maintain continuous observations of the Management Zones (refer to Table 19). If fauna is observed within the Observation Zones (but outside the Exclusion Zones) during disposal activities, then following action shall be taken:

- If target marine fauna is sighted and is showing signs of injury or illness or distress (distress (where distress can be described as unusual surfacing, laboured breathing, disorientation, stranding, bleeding or visible wounds, lethargy, unusual vocalisation and separation from group) then barge activities such as closing the gates shall be suspended within two minutes of the sighting, or as soon as safely possible.
- If target marine fauna is not showing signs of injury or illness or distress and remains within the Observation Zones (but outside the Exclusion Zones), barge activities will continue and the MFO will continue to monitor the target marine fauna.
- Barge works will cease if target marine fauna enters the Exclusion Zone as soon as safely possible.
- If the barge has started to move away from the disposal zone, it may continue to move in accordance with vessel strike avoidance management actions.

If target marine fauna is observed within the Exclusion zone during disposal, then the following actions shall be taken:

- Barge activities following disposal must be suspended within 2 minutes of sighting or as soon as safely possible.
- Barge activities that have been suspended must not recommence until the sighted marine fauna have moved beyond their respective Exclusion zone or not sighted for at least 30 minutes. Following this, disposal is able to recommence.

Low-visibility

During periods of low visibility e.g. between dusk and dawn, where a distance out to 500 m at the disposal site cannot be clearly viewed, disposal may only be undertaken, provided that all other limitations are met and that during the preceding 24-hour period:

- There have not been 3 or more marine fauna shutdowns at the disposal location
- A 2-hour period of continuous observation was undertaken in good visibility (to a distance of 500 m) and no cetaceans, dugongs, marine reptiles, manta rays, and sawfish were sighted.

If marine fauna is detected in the exclusion zone during poor visibility, operations must cease until visibility improves to enable full visual monitoring of the management zones.

Adaptive management

EPBC 2022/9169 requires the Proponent to undertake all marine clearing and marine construction in accordance with EPBC Act *Policy Statement 2.1 – Interaction between offshore seismic exploration and whales: Industry guidelines*, Commonwealth of Australia 2008. Given that the Project location overlaps with the humpback whale migration route BIA, there is an increased likelihood of encountering a whale during the migration period (especially during the southern migration). Therefore, adaptive management may be required during night-time operations. If there have been three consecutive days on which there have been three or more whale-instigated shut-downs, the Proponent will contact the Department to discuss appropriate night-time provisions and whether additional management measures should be employed.

8.3.3. Noise Management

Protocols and Procedures

The use of trained MFOs for the duration of dredging and additional dedicated MFOs during the humpback whale migration, the Management zones (Observation and Exclusion zones), soft-start and shut down measures described in Sections 8.3.1 and 8.3.2 above will be implemented to manage the potential impacts of underwater noise. To further mitigate vessel noise and vibrations during dredging of the Project will be managed by implementing the following measures:

- All equipment and vessels should be operated and be maintained in accordance with appropriate industry and equipment standards including specifications for noise levels and manufacturer's specifications.
- Avoid, where possible, leaving engines and thrusters in standby or running mode unnecessarily.
- Regular monitoring (i.e. by vessel crew during pre-start vessel checks and during operation) will be conducted to assess compliance with noise and vibration levels.

The soft-start procedure will be implemented when re-starting all below surface operations. Soft-start aims to gradually increase the level of dredging activity following a shut-down or lengthy break, with the expectation that nearby animals respond to the soft-start via avoidance to the sound and have an early opportunity to move away before the equipment is in full operation, at a louder sound exposure level.

8.3.4. Vessel Strike Avoidance

The risk of construction and dredging vessels impacting marine fauna by vessel strike will be minimised through restricted vessel speed and the use of trained MFO when vessels are in transit. The distances have considered the Australian National Guidelines for Whale and Dolphin Watching (DoEE 2017a) and the BC Act (Table 20). Vessel speeds below meet condition 27 in EPBC 2018/8236 and EPBC 2022/9169 (maximum speed of 8 kn within port operational waters and 12 kn outside port operational waters) and the precautionary approach has also been informed considering both the Australian National Guidelines for Whale and Dolphin Watching (DoEE 2017a), the National Strategy for Reducing Vessel Strikes on Cetaceans and other Marine Megafauna (DoEE 2017b), and the BC Act Regulations (WA 2024) (Table 20).

- A suitably trained MFO must maintain a watch for cetaceans (i.e. whales and dolphins), dugongs, marine turtles or other protected marine species during dredge or ancillary vessel transits. If any of these organisms are sighted within 300 m of the vessels the maximum vessel speed must be limited to 6 kn, and the observation recorded.
- The dredge and barge speed limited of 8 kn applies at all other times when marine fauna isn't present within port operational limits, and 12 kn outside of port operational limits.
- Vessel captain and crew must maintain a vigilant watch for all protected marine fauna species and slow down, or alter course, as appropriate, to avoid striking any protected species. The presence of a single individual at the surface may indicate the presence of submerged animals in the vicinity; therefore, precautionary measures should always be exercised
- Transiting vessels captain and crew must maintain a vigilant watch for all protected marine fauna species. If protected fauna is identified within 500 of the vessel, the operator must steer a course away from the animal at 8 kn or less until the 500 m minimum separation distance (Table 20) has been established.
- Should a travelling dolphin enter the no approach zone, including with an attempt to 'bow ride', the vessel shall either maintain its course and speed, or maintain its course and gradually slow down.
- No approach zones are a zone of total vessel exclusion. Caution zones are those where speed must be no more than 6 knots (Table 20). They cannot be entered by a vessel if there is an animal that is injured, stranded, entangled or distressed, or if a single calf or pod of calves are present.
- No more than three Project vessels are allowed to be within a whale or dolphin Caution Zone at the same time.

Table 20: Vessel approach distances (DoEE 2017a,b)

Marine Fauna Group	Vessel speed	Caution Zone (m)	No Approach Zone (m)	Distress/ disturbance	Frequency	Responsibility
Adult whales	No faster than 6 knots within 300 m	300	100 to the side of the whale 300 m in front or to rear of the whale	Withdraw from caution zone at speed less than 6 knots	Entire duration of dredging and disposal	Contractor
Whale and calf*	No faster than 6 knots within 300 m	NA	300 m from mother and calf	Withdraw from No approach zone at speed less than 6 knots	Entire duration of dredging and disposal	Contractor
Adult dolphins	No faster than 6 knots within 150 m, with the exception of animals bow-riding	150	50 to the side of the dolphin 150 m in front or to rear of the dolphin	Withdraw from caution zone at speed less than 6 knots	Entire duration of dredging and disposal	Contractor
Dolphin and calf*	No faster than 6 knots within 150 m, with the exception of animals bow-riding	NA	150 m from mother and calf	Withdraw from No approach zone at speed less than 6 knots	Entire duration of dredging and disposal	Contractor
Turtle	No faster than 6 knots within 50 m	300	50 m	Withdraw from caution zone at speed less than 6 knots	Entire duration of dredging and disposal	Contractor
Dugong	No faster than 6 knots within 100 m	300	100 m	Withdraw from caution zone at speed less than 6 knots	Entire duration of dredging and disposal	Contractor
Whale shark**	No faster than 6 knots within 30 m	250	30 m	Withdraw from caution zone at speed less than 6 knots	Entire duration of dredging and disposal	Contractor

Marine Fauna Group	Vessel speed	Caution Zone (m)	No Approach Zone (m)	Distress/ disturbance	Frequency	Responsibility
*As defined in Australian National Guidelines for Whales and Dolphin Watching (Commonwealth of Australia 2017) a calf is an animal which is less than half the length of the mother to which it usually remains in close proximity. ** Noting it is not expected to be present, however if infrequently sighted than the standard BC Regulation separation distances apply						

8.3.5. Records and Reporting

Field Log

Trained MFOs and Dedicated MFOs (during humpback whale migration) will use pre-designed datasheets to record observer effort (as per the example provided in Appendix B), fauna observations and mitigation measures. They will be based on those developed by the Australian Government to record marine fauna sightings made during seismic surveys. Datasheets will include:

- Location, date and start time of survey
- Name, qualifications and experience of MFOs involved in the survey
- Location, times and reasons when observations were hampered by poor sighting conditions
- Location and time of start-up delays, power downs, or stop work procedures as a result of marine fauna sightings
- Location, time and distance of any fauna sightings including species where possible
- If marine fauna species are sighted, any behaviours that may be indicative of stress or disturbance.

Reportable Incidents

All employees of Mardie and Contractor shall immediately report all environmental incidents as a non-conformance (i.e. performance indicators are not met or management actions are not followed) to the site supervisor who will investigate the incident with both the Mardie Project Manager and Contractor Project Manager.

Reportable incidents include injury or death to wildlife as a result of Project activities or general observations of injured, sick or deceased wildlife not related to Project activities are to be reported to the Contractor Project Manager. The Contractor Project Manager is to notify the Client, who will notify the Department of Biodiversity Conservation and Attractions (DBCA) within 2 hours and Department of Climate Change, Energy, the Environment and Water (DCCEEW) within 2 business days.

All marine fauna sightings will also be reported in the next compliance reporting period for the Project and published on the website when each compliance report is submitted to the Department.

Completion Report

On completion of the program, the contractor will submit a completion report to the Client, which will allow compliance auditing. The completion report will comprise:

- All logs detailing marine fauna sightings during dredging
- All environmental incident reports (including injured wildlife reports).

Response

A log detailing marine fauna sightings and activities will be maintained on all vessels (including support vessels).

Any incidents that relate to marine fauna injury or mortality will be documented and reported to DBCA and DWER within 2 hours and a full report to DBCA, DWER and DCCEEW within 2 business days.

9. Reporting

9.1. Compliance reporting

Compliance reporting will be conducted and distributed in accordance with the requirements of the Ministerial Statement 1211 and conditions of EPBC 2018/8236 and EPBC 2022/9169.

9.2. Additional reporting

A summary of the additional reports that are expected to inform compliance reporting commitments (Section 9.1) are listed in Table 21.

Table 21: Reporting requirement through the dredging and disposal scope

Name of Report	Content	Timeframe	Responsibility	Recipient
Baseline Benthic Community Habitat Survey Report	Results and discussion of pre-dredge benthic habitat surveys. Recommendations for any amendments to the monitoring program.	Prior to commencement of dredging.	Proponent	DWER, DCCEEW
Reactive Benthic Habitat Survey Report	Results and discussion of reactive survey if a reactive survey is undertaken. Evaluation of monitoring results against EPO.	Reporting to be prepared within 2 weeks of reactive survey.	Proponent	DWER, DCCEEW
Post Dredging Benthic Community Habitat Survey Report	Results and discussion of post-dredge benthic habitat survey. Describe BCH status and any further management required.	Within 12 months following completion of dredging.	Proponent	DWER, DCCEEW
Marine Water Quality Monitoring Report	Summary of monthly telemetered water quality data. Discuss any management actions implemented during period.	Monthly	Proponent	Internal
Dredge commencement Plume Validation Report	Results of plume validation with multispectral camera at commencement of dredging.	Within first month of dredging	Proponent	DWER, DCCEEW
Reactive Plume Verification Report	Results of reactive aerial plume verification with multispectral camera. Following a level 3management target exceedance.	Two weeks following level 3 management target exceedance	Proponent	DWER, DCCEEW
Final Marine Water Quality Monitoring Report	Summary of all water quality data collected over the construction period. Discussing trends,	Following the completion of dredging	Proponent	DWER, DCCEEW

Name of Report	Content	Timeframe	Responsibility	Recipient
	exceedances and implemented management actions.			
Marine Fauna Observer Logs	Logs continuous monitoring for Marine Fauna during dredge operations. Outlines necessary management actions where required.	Daily during dredge operations	Contractor	Proponent
Marine Fauna Observer Final/Completion report	On the completion of the dredging campaign, the contractor will submit a completion report to the client. This will include all logs detailing marine fauna sightings during dredging and disposal and all environmental incidents.	Within 12 months following completion of dredging.	Contractor / Proponent	Proponent DWER, DCCEEW
IMP Risk Assessment	Department of Primary Industries and Regional Development (DPIRD) 'Vessel check risk assessment', copy of Vessel Check report, supporting documentation including antifoul certificates and inspection reports. Statement from lead inspector on marine pest status of the vessel.	Within 72 hours of inspection.	Contractor	DPIRD
Vessel Quarantine Report	Checklist of vessel components checked during vessel inspection. Statement from lead inspector.	Within 14 days of inspection or risk assessment.	Contractor	DRIRD

10. Document review

This DSDMP has been developed to meet the Conditions for the Project specified in MS 1211, EPBC 2018/8236 and EPBC 2022/9169. Approval will be sought from the Department of Water and Environmental Regulation (DWER) and DCCEEW for any revisions in accordance with Conditions C2 of MS 1211, and Condition 84 of EPBC 2018/8236 and EPBC 2022/9169. Once approval is confirmed, this DSDMP will replace any previously approved versions. Also, in accordance with C2-6, any revisions made to the DSDMP which are confirmed by the CEO will be published on the BCI website for the Project.

The DSDMP will be reviewed as required in response to monitoring data or changes in Project design, and one year prior to the first maintenance dredging event. The DSDMP will be updated based on review outcomes, considering best practice and management targets are being achieved or are likely to be achieved and will identify any updates required to realise the targets.

A long term DSDMP will be developed and submitted to Decision-Making Authorities for assessment in due course post capital dredging to ensure the remaining capacity of DMPA4 and associated dredge plume modelling outputs are understood to confidently execute the appropriate environmental mitigation strategies for maintenance dredging and disposal. The long term DSDMP will supersede monitoring and management actions for maintenance dredging activities as stated in this DSDMP upon its establishment.

11. References

ANZG (2018) Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines

Armstrong AJ, Armstrong AO, Bennett MB, McGregor F, Abrantes KG, Barnett A, Richardson AJ, Townsend KA and Dudgeon CL (2020a) The geographic distribution of reef and oceanic manta rays (Mobula alfredi and Mobula birostris) in Australian coastal waters. Journal of Fish Biology. 96(3):835–840. doi: 10.1111/jfb.14256

Armstrong A, Armstrong AO, McGregor F, Richardson AJ., Bennett MB, Townsend KA, Hays GC, Keulen MV, Smith J and Dudgeon CL (2020b) Satellite tagging and photographic identification reveal connectivity between two UNESCO world heritage areas for reef manta rays. Frontiers in Marine Science. 7(725):1-18. doi:10.3389/fmars.2020.00725.

Baird (2020a) Mardie Project Hydrodynamic Model Report, 12979.101.R1.Rev1. Prepared for BCIM February 2020.

Baird (2020b) Mardie Project Dredge Plume Modelling Report. 12979.101.R4.RevB. Prepared for BCIM March 2020.

Baird (2020c) Memorandum: Mardie Project, Offshore Disposal Modelling. 12979.101/R7.Rev_A.Prepared for BCIM September 2020.

Baird (2020d) Mardie Project: Offshore Disposal Plume Modelling Report.12979.R4.Rev_B. Prepared for BCIM March 2020.

Baird (2020e) Mardie Project – Maintenance Dredging Estimate, 12979.101.L1. Prepared for BCIM May 2020.

Baird (2021) Letter: Mardie Project – Offshore Disposal Model Factoring. R190043. 33. Prepared for BCIM

Baird (2022) Mardie Project: Cutter Suction Dredge Plume Modelling Report. 28 January 2022. https://www.epa.wa.gov.au/sites/default/files/PER_documentation2/8.2%20Baird%20%282022%29%20Cutter%20Suction%20Dredge%20Plume%20Modelling%20Report.pdf.

Baird (2024) Mardie Dredge Plume Modelling - Model Results Summary. 2979.406.M2 Prepared for BCIM September 2024.

Bateman RL, Morgan DL, Wueringer BE, McDavitt M and Lear KO (2024) Collaborative methods identify a remote global diversity hotspot of threatened, large-bodied rhino rays. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *34*(1), e4047. doi: 10.1002/aqc.4047

Beyers DW (1998). Causal inference in environmental impact studies. Journal of the North American. Benthological Society 17: 367–373.

BoM (Bureau of Meteorology) (2024a) Climate statistics for Australian locations: Mardie. http://www.bom.gov.au/climate/averages/tables/cw_005008.shtml. Accessed October 2024.

BoM (2024b) tropical cyclone reports. http://www.bom.gov.au/cyclone/tropical-cyclone-knowledge-centre/history/past-tropical-cyclones/

CEDA (Central Dredging Association) (2011) CEDA Position Paper: Underwater Sound in Relation to Dredging. Available from: https://www.iadc-dredging.com/wp-content/uploads/2017/02/article-ceda-position-paper-underwater-sound-in-relation-to-dredging-125-4.pdf

Commonwealth of Australia (CoA) (2009) National biofouling management guideline for commercial vessels. https://www.marinepests.gov.au/sites/default/files/Documents/commercial-vessels-biofouling-guidelines.pdf.

CoA (2017) Australian National Guidelines for Whale and Dolphin Watching 2017. Commonwealth of Australia 2017

CoA (2020) Australian Ballast Water Management Requirements. Version 8. https://www.agriculture.gov.au/sites/default/files/documents/australian-ballast-water-management-requirements.pdf.

Couturier L.I.E., Marshall A.D., Jaine F.R.A., Kashiwagi T, Pierce S.J., Townsend K.A., Weeks S. J., Bennett M.B. and Richardson A.J. (2012) Biology, ecology and conservation of the Mobulidae. Journal of Fish Biology. 80:1075-1119. doi: 10.1111/j.1095-8649.2012.03264.x,

D'Anastasi BR, Van Herwerden L, Hobbs JA, Simpfendorfer CA and Lukoschek V (2016) New range and habitat records for threatened Australian sea snakes raise challenges for conservation. Biological Conservation. 194:66-70. doi: 10.1016/j.biocon.2015.11.032

DBCA (Department of Biodiversity, Conservation and Attractions) (2024a) *DBCA Threatened Species Database*. Accessed July 2024. Prepared by the Species and Communities Program for O2 Marine for the purpose of environmental assessment.

Department of Climate Change, Energy, the Environment and Water (2024). *Assessing and Managing Impact to Underwater Cultural Heritage in Australian Waters - Guidelines on the application of the Underwater Cultural Heritage Act 2018.* Commonwealth of Australia, 2024. June 2024. Available from: https://www.dcceew.gov.au/sites/default/files/documents/guidelines-assessing-managing-impacts-underwater-cultural-heritage.pdf

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

DoE (Department of the Environment). (2022). Dugong dugon in Species Profile and Threats Database. Department of the Environment, Canberra. Available from: https://www.environment.gov.au/sprat

DoEE (Department of the Environment and Energy). (2017). Recovery Plan for Marine Turtles in Australia. Australian Government, Canberra. Available from: http://www.environment.gov.au/marine/publications/recovery-plan-marine-turtles-australia-2017.

Downes BJ, Barmuta LA, Fairweather PG, Faith DP, Keough MJ, Lake PS, Mapstone BD and Quinn GP(2002) *Monitoring Ecological Impacts: Concepts and practice in flowing waters*. Cambridge University Press, Cambridge, UK.

DPRID (Department of Primary Industries and Regional Development) (unpublished) Draft Resource Assessment Report Northern Coast Demersal Scalefish Resource. Department of Primary Industries and Regional Development, Perth, Western Australia.

DSEWPaC (Department of Sustainability, Environment, Water, Population and Communities) (2012) *Marine bioregional plan for the North-west Marine region*. Department of Sustainability, Environment, Water, Population and Communities. Prepared under the Environment Protection and Biodiversity Conservation Act 1999. Commonwealth of Australia.

EPA (Environmental Protection Authority) (2016). Technical Guidance for Protecting the Quality of Western Australia's Marine Environment. Environmental Protection Authority, Western Australia

EPA (Environmental Protection Authority) (2021). Technical Guidance for Environmental Impact Assessment of Marine Dredging Proposals. Environmental Protection Authority, Western Australia

EPA (Environmental Protection Authority) (2023). Statement of Environmental Principles, Factors and Objectives. EPA, Western Australia.

Ferreira LC, Thums M, Fossette S, Wilson P, Shimada T, Tucker AD, Pendoley K, Waayers D, Guinea ML, Loewenthal G, King J, Speirs M, Rob D and Whiting SD (2021) Multiple satellite tracking datasets inform green turtle conservation at a regional scale. *Diversity and Distribution*. 27(2):249-266. doi: 10.1111/ddi.13197

Fisher R, Jones R, Bessell-Browne P, (2019) Effects of dredging and dredging related activities on water quality: Impacts on coral mortality and threshold development Report of Theme 4 - Project 4.9, prepared for the Dredging Science Node, Western Australian Marine Science Institution, Perth, Western Australia, 94 pp.

Grey D.L., Dall W and Baker A (1983). A Guide to the Australian Penaeid Prawns. Northern Territory Department of Primary Production, Darwin.

Hanf D, Smith J, Hodgson A.J., Kobryn H and Bejder L.B. (2022) Dolphin distribution and habitat suitability in coastal north Western Australia: Applications of a broadscale, opportunistic dataset. Frontiers in Marine Science. 8(733841):1-18. doi: 10.3389/fmars.2021.733841

Harry A, C Wakefield, S Newman, J Braccini (2024) *Trends in catch rates of sawfish on the Australian North West Shelf.* Endangered Species Research. Vol 53:23-33, 2024. https://doi.org/10.3354/esr01289

Harvey E.S., McLean D.L., Goetze J.S., Saunders B.J., Langlois T.J., Monk J, Barrett N, Wilson S.K., Holmes T.H., Ierodiaconou D, Jordan A.R., Meekan M.G., Malcolm H.A., Heupel M.R., Harasti D, Huveneers C, Knott N.A., Fairclough D.V., Currey-Randall L.M.,Travers M.J., Radford B.T., Rees M.J., Speed C.W., Wakefield C.B., Cappo M and Newman S.J. (2021). The BRUVs workshop – An Australia-wide synthesis of baited remote underwater video data to answer broad-scale ecological questions about fish, sharks and rays. Marine Policy. 127(1004430). doi: 10.1016/j.marpol.2021.104430.

Hoschke AM, GJ Whisson and D Haulsee (2023) Population distribution, aggregation sites and seasonal occurrence of Australia's western population of the grey nurse shark *Carcharias taurus*. *Endangered Species Research.* 50:107-123. doi: 10.3354/esr01225

Irvine L.G., Thums M, Hanson C.E., McMahon C.R and Hindell M.A. (2018) Evidence for a widely expanded humpback whale calving range along the Western Australian coast. Marine Mammal Science. 34(2):294-310. doi: 10.1111/mms.12456

Jenner C and Jenner M (2010) A Description of Megafauna Distribution and Abundance in the SW Pilbara Using Aerial and Acoustic Surveys–Final Report. Prepared by Centre for Whale Research (WA). Available from: https://australia.chevron.com/-/media/australia/our-businesses/documents/wheatstone-draft-eis-ermp-technical-appendices-o8-to-o12-web3223D746DD0D.pdf

Jenner K, Jenner M, Gales N and Double M (2010) Satellite tracking of south-bound female humpback whales in the Kimberley region of Western Australia. Final Report for the Australian Marine Mammal Centre.

Jones R, Fisher R, Bessell-Brown P, Negri A, Duckworth A (2019) Theme 4 | Synthesis Report: Defining thresholds and indicators of coral response to dredging-related pressures. Western Australian Marine Science Institution (WAMSI). Perth, Western Australia pp. 36.

Kangas M, McCrea J, Fletcher W, Sporer E and Weir V (2006). Exmouth Gulf Prawn Fishery. ESD Report No. 1. Department of Fisheries, Western Australia. 128pp.

Kangas M and Sporer E (2015). Brown Tiger Prawn (Penaeus esculentus) In: Management implications of climate change effect on fisheries in Western Australia Part 2: Case studies. FRDC Project 2010/535. Fisheries Research Report 261 eds. Caputi N, Feng M, Pearce A, Benthuysen J, Denham A, Hetzel Y, Matear R, Jackson G, Molony B, Joll L and Chandrapavan A. Department of Fisheries, Western Australia. pp. 25-34

Lear K and Morgan (2022) Sawfish Monitoring Project- Mardie Salt. eds Hanf D. Report Prepared for Mardie Minerals Pty Ltd.

Lear KO, Fazeldean T, Bateman RL, Inglebrecht J and Morgan DL (2023) Growth and morphology of Critically Endangered green sawfish Pristis zijsron in globally important nursery habitats. *Marine biology*, 170(6), 70.

Loneragan N.R., Kangas M, Haywood M.D.E., Kenyon R.A., Caputi N and Sporer E (2013). Impact of cyclones and aquatic macrophytes on recruitment and landings of tiger prawns penaeus esculentus in Exmouth gulf, Western Australia. Estuarine, Coastal and Shelf Science. 127:46–58. doi: 10.1016/j.ecss.2013.03.024.

McAuley RB, BD Bruce, IS Keay, S Mountford, T Pinnell and FG Whoriskey (2017) Broad-scale coastal movements of white sharks off Western Australia described by passive acoustic telemetry data. *Marine and Freshwater Research*, 68(8), 1518–1531. doi: 10.1071/MF16222.

Mickel M.F., and Higgs, D. M (2022) Towards a new understanding of elasmobranch hearing. Marine Biology. 169(12):1-14. doi: 10.1007/s00227-021-03996-8

Morgan D.L., Allen M, Ebner B, Whitty J and Beatty S (2015). Discovery of a pupping site and nursery for critically endangered green sawfish Pristis zijsron. Journal of Fish Biology. 86(5):1658–1663. doi: 10.1111/jfb.12668

Morgan D.L., Ebner B, Allen M, Gleiss A, Beatty S and Whitty J (2017). Habitat use and site fidelity of neonate and juvenile green sawfish Pristis zijsron in a nursery area in Western Australia. Endangered Species Research. 34:235–249. doi: 10.3354/esr00847

MScience (2009) Wheatstone LNG Development: Baseline Water Quality Assessment Report. Report to URS Australia Pty Ltd, November 2009.

Newman S, Wakefield C, Skepper C, Boddington D and Blay N (2020). North Coast Demersal Resource Status Report 2019. In: Status Report of the Fisheries and Aquatic Resources of Western Australia 2018/19: The State of the Fisheries eds. Gaughan DJ and Santoro K. Department of Primary Industries and Regional Development, Western Australia. pp. 159-167

Newman SJ, Young GC and Potter IC (2004). Characterisation of the inshore fish assemblages of the Pilbara and Kimberley coasts. Department of Fisheries, Research Division, WA Marine Research Laboratories, North Beach.

O2 Marine (2019a). Mardie project – Sediment Quality Assessment Results. Prepared for Mardie Minerals Pty Ltd. Report Number R190033.

O2 Marine (2019b). Mardie Project – Subtidal Benthic Communities and Habitat Baseline Assessment. Prepared for Mardie Minerals Pty Ltd. Report Number R190045.

O2 Marine (2020a). Mardie Project – Marine Water Quality. Prepared for Mardie Minerals Pty Ltd. Report Number R190056.

O2 Marine (2020b). Mardie Project Marine Fauna Review. Report prepared for Mardie Minerals Pty Ltd.

O2 Marine (2022) Marine Pest Management Procedures. Prepared for BCI Minerals for the Mardie Project. Reference 21WAU-0060-08/T210234. 1 September 2022.

O2 Marine (2023a) Mardie Project Sediment Quality Assessment 2023. Report prepared for Mardie Minerals Pty Ltd.

O2 Marine (2023b) Humpback Whale Migration Study. Report prepared for Mardie Minerals Pty Ltd.

O2 Marine (2023c). Mardie BCH Baseline Investigations. Report prepared for Mardie Minerals Pty Ltd.

O2 Marine (2024a) DMPA4 Benthic Communities and Habitats Report. Report prepared for Mardie Minerals Pty Ltd. Report No. R240358

O2 Marine (2024b) Technical Memorandum – Mardie Offshore Spoil Ground Sediment Assessment. Report prepared for Mardie Minerals Pty Ltd. Report No. T240370.

O2 Marine (2025). Mardie Project Dredge and Spoil Disposal Management Plan. Revision 1. Report prepared for Mardie Minerals Limited. Report No. R190043

Ovenden J.R., Peel D, Street R, Courtney A.J., Hoyle S.D., Peel S.L. and Podlich H (2007). The genetic effective and adult census size of an Australian population of tiger prawns (Penaeus esculentus). Molecular Ecology. 16(1):127-138. doi: 10.1111/j.1365-294X.2006.03132.x.

Parra, G.J., & D. Cagnazzi (2016). Conservation Status of the Australian Humpback Dolphin (Sousa sahulensis) Using the IUCN Red List Criteria. *Advances in Marine Biology*. 73:157-192.

Pearce, A. F.; Buchan, S.; Chiffings, T.; D'Adamo, N.; Fandry, C. B.; Fearns, P. R. C. S.; Mills, D. J.; Phillips, R. C.; Simpson, C. A review of the oceanography of the Dampier Archipelago, Western Australia. In: Wells, F. E.; Walker, D

I.; Jones, D. S. Editors, editor/s. (2003) The Marine flora and fauna of Dampier, Western Australia: proceedings of the Eleventh International Marine Biological Workshop; 24 July-11 Aug. 2000; Dampier, Western Australia. Perth, W.A.: Western Australian Museum; 2003. 13-50.

Peel LR, Whiting SD, Pendoley K, Whittock PA, Ferreira LC, Thums M, Whiting AU, Tucker AD, Rossendell J, McFarlane G and Fossette Sabrina (2024) I still call Australia home: Satellite telemetry informs the protection of flatback turtles in Western Australian waters. *Ecosphere,* 15(5):1-26. doi: 0.1002/ecs2.4847

Pendoley Environmental. (2019). Mardie Salt Project: Marine Turtle Monitoring Program 2018/2019. Report prepared for BCI Minerals Ltd.

Pendoley Environmental (2023) Mardie Salt Project: Marine turtle monitoring program. Prepared for BCI Minerals Limited, 6 July 2023.

Pendoley, K.L., Whittock, P.A., Vitenbergs, A and Bell, C. (2016) Twenty years of turtle tracks: marine turtle nesting activity at remote locations in the Pilbara, Western Australia. Australian Journal of Zoology. 6.Penn J.W and Stalker R.W (1979). The Shark Bay Prawn Fishery (1970-1976). Department of Fisheries Wildlife Western Australia Report 38: 1-38.

Prince, R. I. T. (2001). Aerial survey of the distribution and abundance of dugongs and associated macrovertebrate fauna–Pilbara coastal and offshore region, Western Australia. Completion Report to Environment Australia. Department of Conservation and Land Management, Perth.

Raudino, H.C., Hunt, T.N and Waples, K.A. (2018) Records of Australian humpback dolphins (Sousa sahulensis) from an offshore island group in Western Australia. Marine Biodiversity Records. 11(14):1-6. doi: 10.1186/s41200-018-0147-0.

RPS (2010) Technical Appendix Dugong Aerial Survey Report Wheatstone Project. Prepared for Chevron Australia Pty Ltd.

Sprogis KR, Sutton AL, Jenner MN and Jenner KCS (2024). Spatiotemporal distribution of humpback whales off north-west Australia quantifying the Exmouth Gulf nursery area. *Australian Journal of Zoology*, *72*(5).

Sudmeyer, R (2016) 'Climate in the Pilbara', Bulletin 4873, Department of Agriculture and Food, Western Australia, Perth

Surrich and EGS (2019) Detailed Bathymetry data provided by the Mardi Project, Surrich_EGS_Datasets_Merged_Mardie_Creek_MGAZ50_1m_Shoal_Final_GRIDDED_DepthPos_AHD.

Thums MC, L Ferreira, C Jenner, M Jenner, D Harris, A Davenport, V Andrews-Goff, M Double, L Möller, CRM Attard, KG Bilgmann, P Thomson and R McCauley (2022) Pygmy blue whale movement, distribution and important areas in the Eastern Indian Ocean. *Global Ecology and Conservation,* 35:1-20. doi: 10.1016/j.gecco.2022.e02054.

TSSC (2024) *Listing Advice for Sphyrna lewini (scalloped hammerhead)*. Canberra: Department of Climate Change, Energy, the Environment and Water. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/85267-listing-advice-27022024.pdf. In effect under the EPBC Act from 27-Feb-2024.

Udyawer, V., Somaweera, R., Nitschke, C., d'Anastasi, B., Sanders, K., Webber, B.L., Hourston, M. and Heupel, M.R. (2020) Prioritising search effort to locate previously unknown populations of endangered marine reptiles. Global Ecology and Conservation 22: e01013.

WA (Western Australian Legislation) (2024) Biodiversity Conservation Act 2016 - Biodiversity Conservation Regulations 2018. [PCO 00-h0-00]. Available from: https://www.legislation.wa.gov.au/legislation/statutes.nsf/law_s50938.html

Ward R.D, Ovenden J.R, Meadows J.R.S, Grewe P.M and Lehnert S.A. (2006). Population genetic structure of the Brown tiger prawn, Penaeus esculentus, in tropical northern Australia. Marine Biology. 148(3). doi: 10.1007/s00227-005-0099-x.

Whitty J.M., Morgan D.L., Peverell S.C., Thorburn D.C and Beatty S.J. (2009). Ontogenetic depth partitioning by juvenile freshwater sawfish (Pristis microdon: Pristidae) in a riverine environment. Marine Freshwater Resource. 60:306–316

Willy Weather (2024) Maride Station Airport Wind Forecast. https://wind.willyweather.com.au/wa/pilbara/mardi-station-airport.html

WSP (2025) Mardie Maintenance Dreding Estimate Memo. Memo reference 222383-WSP-PER-MAR-MEM-003. 4 July 2025 (draft).

Appendix A. Condition Requirements

Table A-1: Relevant Ministerial Statement 1211 approval conditions

Condition	Requirement	Plan Reference	Commitments
B1	Benthic Communities and Habitats		
B1-1	The proponent must ensure the implementation of the proposal achieves the following environmental outcomes: 4. No direct loss of benthic communities and habitats outside of the dredge disturbance footprint defined in Figure 3 [of MS 1211] 5. No irreversible loss of benthic communities and habitats outside of the authorised Zone of High Impact as spatially defined in Figure 3 [of MS 1211] 6. No detectable change from the baseline state of benthic communities and habitats outside of the Zone of High Impact and authorised Zone of Moderate Impact as spatially defined in Figure 3 [of MS 1211]	Sections 2.3, 5, 6.1 and 7.2	Based on the existing BCH in the area, the monitoring program has been designed to provide early warning indicators to prevent a change in health, extent of coverage or species diversity in the dredging and disposal zones of high impact.
B1-3	The proponent must implement the proposal to meet the following environmental objectives: 1. Minimise impacts to subtidal habitats 2. Changes to the health, diversity and extent of benthic communities and habitat (including subtidal macroalgae) as a results of changes to surface, water, groundwater quality, groundwater regimes, and marine environmental quality associated with the proposal ae detected as early as possible 3. Adverse impacts to benthic communities and habitat (including subtidal macroalgae) are addressed using best-practice available management mitigation and contingency measures	Sections 2.3, 5, 6.1 and 7.2	Based on the existing BCH in the area, the monitoring program has been designed to provide early warning indicators to prevent a change in health, extent of coverage or species diversity outside the dredging and disposal zones of high impact.
B2	Marine Pests		
B2-1	The proponent must ensure the implementation of the proposal achieves the following environmental outcomes:	Section 5 and 6	Marine pests management and vessel movements and

Condition	Requirement	Plan Reference	Commitments
	4. No introduction or establishment of marine pests in the State Waters as a result of the proposal		activities are managed under the Environmental Factors BCH and Marine Fauna.
B2-2	The proponent must implement the Marine Pest Management Procedure (Rev 1, dated 1 September 2022) environmental management plan, with the purpose of ensuring the environmental outcomes in Condition B1-1 (the benthic community and habitat) and B2-1 are achieved, monitored and substantiated.	Section 5 and 6	Marine pests management and vessel movements and activities are managed under the Environmental Factors BCH and Marine Fauna.
B4	Marine Environmental Quality		
B4-1	The proponent must ensure the implementation of the proposal achieves the following environmental objective: 1. No impacts on the environmental values of Ecosystem Health, Fishing and Aquaculture, Recreation and Aesthetics, Industrial Water Supply, Cultural and Spiritual.	Section 5, 6.2 and 7.1	The marine water quality monitoring program has been designed to provide early warning indicators to prevent a change in the marine environment associated with dredging and disposal beyond what has been predicted to be lost.
B5	Marine Fauna		
B5-1	The proponent shall implement the proposal to achieve the following environmental outcomes: 1. No mortality, injury, disturbance or displacement of humpback whales (*Megaptera novaeangliae*) within the migration of the biologically important area 2. No change in marine turtle orientation (i.e. misorientation or disorientation) nesting beach utilisation, nesting success or hatchling survivorship as a result of artificial light emissions at both sandy beach habitat adjacent to the development and Long Island, Sholl Island and the Passage Islands (Angle, Middle and Round) 3. Significant marine fauna are not prevented/deterred from undertaken critical behaviours in biologically important areas	Section 5, 6.3 and 7.3	Dredging, disposal and travelling in between the two areas will be managed through vessel speeds, and utilising marine fauna observers (MFOs) throughout activities.

Condition	Requirement	Plan Reference	Commitments
B5-2	The proponent shall implement the proposal to achieve the following environmental objectives: 4. Minimise the risk of physical injury or mortality from vessel strike on significant marine fauna 5. Minimise the risk of behavioural changes, health impacts, physical injury or mortality from underwater noise emissions from construction or operations to significant marine fauna (including temporary or permanent hearing loss).	Section 5, 6.3 and 7.3	Dredging, disposal and travelling in between the two areas will be managed through vessel speeds, and utilising marine fauna observers (MFOs) throughout activities. Impacts associated with noise emissions will be managed through the use of MFOs and ensuring activities are not undertaken when marine fauna are within nominated exclusion zones.
B5-4	The proponent must implement the Dredge Management Plan environmental management plan (Rev 6, O2 Marine March 2023) with the purpose of ensuring that Marine Fauna, Benthic communities and habitats and marine environmental quality environmental outcomes in conditions B5-1(1), B1-1 and B4-1 and objectives in conditions B5-2, and B103 are achieved, monitored and substantiated	Whole document	This DSDMP has been prepared as an updated version of the Dredge Management Plan (DMP); Rev 6, O2 Marine March 2023). Outcomes and management targets for dredging have remained the same or updated to reflect MS 1211 and monitoring programs have not been changed. Changes to the DMP for this updated DSDMP include offshore disposal, and the management targets and actions for disposal activities have been proposed to meet the objectives of the Ministerial conditions.
B5-5	The proponent must impose a speed limit of eight (8) knots an all project related vessels and export	Sections 6.3 and 7.3.4	Speed limits have been outlined to ensure the maximum speed of 8 kn

Condition	Requirement	Plan Reference	Commitments
	vessels within a five (5) kilometre radius of the export jetty		is adhered to, and slower speeds if necessary marine fauna are observed.
B5-7	During dredging, spoil disposal and seabed levelling activities, the proponent shall: (1) implement measures to avoid vessel strikes with significant marine fauna (2) implement measures to minimise direct entrainment impacts to significant marine fauna, including not operating dredge pumps during transit and dredge cutterhead lowered to surface before commencement of soft start procedure (3) install overflow screen on dredgers to visually assess for turtles and/or turtle remains that may have been entrained during dredging after each load (4) implement a significant marine fauna observation zone consisting of a at least three (3) kilometre radius from the dredging activity whereby an observer must undertake significant marine fauna observation for a minimum of thirty (30) minutes prior to the commencement of dredging and at all times during dredging activities (5) implement an exclusion zone consisting of at least 500 metre radius from the dredging activity whereby: a) dredging cannot commence should a significant marine fauna be within the exclusion zone; and (b) dredging activities to cease should a significant marine fauna enter the exclusion zone during dredging and are not to recommence until the significant marine fauna have moved outside the exclusion zone; (6) must engage a suitably qualified and experienced marine fauna observer who has a demonstrated knowledge of significant marine fauna in the North- West region to undertake	Section 7.3	These management actions are addressed in Section 7.3

Condition	Requirement	Plan Reference	Commitments
	observations in the observation zone and exclusion zone (7) maintain a log of recorded sightings, locations and behaviours indicative of stress or disturbance of significant marine fauna and submit these to the National Cetacean Sighting Database (8) document and report to relevant regulators: (a) any incidents relating to significant marine fauna injury / mortality; and (b) where turtles are a consideration the effectiveness of mitigation measures to prevent turtle injury and mortality.		
B5-8	The Proponent shall not conduct dredging during the period October – March (inclusive) or pile driving during the period September – January (inclusive), unless the CEO has confirmed otherwise by notice in writing.	Section 2.6, 3.3 and 7.3	The dredging schedule has been determined based on the ecological windows and this Condition
B5-9	Clearing in the fauna habitat type identified as low-quality turtle nesting habitat (sandy beach habitat) in the Mardie Project – Environmental Review Document (June 2020) is limited to a width of fifty (50) metres, parallel to the high water mark.	Section 1	The dredging footprint has been determined based on various factors including the marine fauna habitats.
Part C – Environmental Management Plans and Monitoring			
C1	**Environmental Management Plans: Conditions Related to Commencement of Implementation of the Proposal**		
C1-1	The proponent must not undertake: (1) dredging activities until the CEO has confirmed in writing that the environmental management plan required by condition B1-4 and condition B5-4 meets the requirements of that condition and condition C4 (2) dredging activities, marine construction or operations associated with the Mardie Project until the CEO has confirmed in writing that the environmental management plan required by condition B5-3 meet the requirements of that condition and condition C4	Whole document	A DMP (O2 Marine 2023) has been approved by the CEO and is currently being implemented, particularly baseline studies. A revision to this plan is being undertaken through this DSDMP, in accordance with the following conditions.
C2	Environmental Management Plans: Conditions Relating to Approval,		

Condition	Requirement	Plan Reference	Commitments
	Implementation, Review and Publication		
C2-1	Upon being required to implement an environmental management plan under Part B, or after receiving notice in writing from the CEO under condition C1-1 that the environmental management plan(s) required in Part B satisfies the relevant requirements, the proponent must: (1) implement the most recent version of the confirmed environmental management plan; and (2) continue to implement the confirmed environmental management plan referred to in condition C2-1(1) other than for any period which the CEO confirms by notice in writing that it has been demonstrated that the relevant requirements for the environmental management plan have been met, or are able to be met under another statutory decision-making process, in which case the implementation of the environmental management plan is no longer required for that period.	Section 9	This DSDMP is a revised version of the DMP and will replace the existing DMP. Until such time that this DSDMP is accepted in writing from the CEO, the existing DMP will be implemented.
C2-2	The proponent: (1) may review and revise a confirmed environmental management plan provided it meets the relevant requirements of that environmental management plan, including any consultation that may be required when preparing the environmental management plan; (2) must review and revise a confirmed environmental management plan and ensure it meets the relevant requirements of that environmental management plan, including any consultation that may be required when preparing the environmental management plan, as and when directed by the CEO: and (3) must revise and submit to the CEO the confirmed environmental management plan if there is a material risk that the outcomes or objectives it is required to achieve will not be complied with, including but not limited to as a result of a change to the proposal.	Section 9	This DSDMP is a revised version of the DMP and will replace the existing DMP. Until such time that this DSDMP is accepted in writing from the CEO, the existing DMP will be implemented.

Condition	Requirement	Plan Reference	Commitments
C2-3	Despite condition C2-1, but subject to conditions C2-4 and C2-5, the proponent may implement minor revisions to an environmental management plan if the revisions will not result in new or increased adverse impacts to the environment or result in a risk to the achievement of the limits, outcomes or objectives which the environmental management plan is required to achieve.	Section 9	This DSDMP will be revised in accordance with this condition.
C2-4	If the proponent is to implement minor revisions to an environmental management plan under condition C2-3, the proponent must provide the CEO with the following at least twenty (20) business days before it implements the revisions: (1) the revised environmental management plan clearly showing the minor revisions; (2) an explanation of and justification for the minor revisions; and (3) an explanation of why the minor revisions will not result in new or increased adverse impacts to the environment or result in a risk to the achievement of the limits, outcomes or objectives which the environmental management plan is required to achieve.	Section 9	This DSDMP will be revised in accordance with this condition.
C2-5	The proponent must cease to implement any revisions which the CEO notifies the proponent (at any time) in writing may not be implemented.		This DSDMP will be revised in accordance with this condition.
C2-6	Confirmed environmental management plans, and any revised environmental management plans under condition C2-4(1), must be published on the proponent's website and provided to the CEO in electronic form suitable for online publication by the DWER within twenty (20) business days of being implemented, or being required to be implemented (whichever is earlier).		This DSDMP will be revised in accordance with this condition.
C4	Environmental Management Plans: Conditions Relating to Monitoring and Adaptive Management for Outcomes Based Conditions		

Condition	Requirement	Plan Reference	Commitments
C4-1	The environmental management plans required under condition B1-4, condition B2-2, condition B3-2, condition B4-3, condition B5-3, condition B5-4, condition B6-4, condition B6-6 and condition B8-3 must contain provisions which enable the substantiation of whether the relevant outcomes of those conditions are met, and must include: (1) threshold criteria that provide a limit beyond which the environmental outcomes are not achieved (2) trigger criteria that will provide an early warning that the environmental outcomes are not likely to be met (3) monitoring parameters, sites, control/reference sites, methodology, timing and frequencies which will be used to measure threshold criteria and trigger criteria. Include methodology for determining alternative monitoring sites as a contingency if proposed sites are not suitable in the future (4) baseline data (5) data collection and analysis methodologies (6) adaptive management methodology (7) contingency measures which will be implemented if threshold criteria or trigger criteria are met (8) reporting requirements.	Whole document	This DSDMP has been prepared with consideration to the EPA guidance for Environmental Management Plans, which also includes outcomes. Targets, thresholds and triggers to be monitored at sites for marine environmental quality and BCH. Baseline data will be collected at each of these sites on accordance with the data collection methodology given in Section 7, and tiered management frameworks have been put in place foe adaptive management of dredging and disposal activities and contingency measures. Reporting for the aspects of the DSDMP are included in Section 8.
C5-3	Without limiting condition C2-1, the failure to achieve an environmental objective, or implement a management action, regardless of whether contingency measures have been or are being implemented, represents a non-compliance with these conditions.	Section 7 and Section 9	Non-compliance and other reporting requirements are included in the DSDMP for each of the key environmental factors and for Project compliance
C5-4	Without limiting condition C3-1, the failure to achieve an environmental objective, or implement a management action, regardless of	Section 5, 7 and 9	The environmental objectives and outcomes to be met by the Project are outlined in Section 7,

Condition	Requirement	Plan Reference	Commitments
	whether contingency actions have been or are being implemented, represents a noncompliance with these conditions.		and reporting requirements are presented in Section 7 and 9.

Table A-2: Relevant EPBC 2018/8236 and EPBC 2022/9169 approval conditions

Condition	Requirement	Plan Reference	Commitments
Waste Management			
Condition 22) d	The approval holder must securely contain all waste that is present within the development envelope from the commencement of the Action until completion of the Action and ensure: d) no waste from the development envelope enters marine fauna habitat	Sections 5 and 6	Manage vessel bunkering, chemical storage and spill response to minimise impacts to the marine environment.
Vessel Management			
25	The approval holder must ensure that any vessel strike or incident involving marine turtles, green sawfish, short-nosed sea snake, giant manta ray, humpback whale, Australian humpback dolphin, or dugong is reported to DBCA within 2 hours of the occurrence of the vessel strike and/or incident and that any consequent request made by DBCA is implemented	Section 7.3.5	Reporting requirements mirror those in this condition
26	To avoid harm to marine fauna individuals as a result of vessel use, the approval holder must comply with condition B5-2 and B5-5 of the WA approval, to the extent that the WA Approval conditions relate to protected matters	Section 5, 6.3 and 7.3	Dredging, disposal and travelling in between the two areas will be managed through vessel speeds, and utilising marine fauna observers (MFOs) throughout activities. Impacts associated with noise emissions will be managed through the use of MFOs and ensuring activities are not undertaken when marine fauna are within

Condition	Requirement	Plan Reference	Commitments
			nominated exclusion zones.
27	To avoid vessel strikes to marine fauna individuals as a result of the Action, the approvals holder must ensure all: a) Vessels which are at least 20 metres in length do not exceed: i) 8 knots within the port operational waters ii) 12 knots outside the port operational waters b) Vessels are only operated within the port operational waters during operations to reduce the spatial extent of vessel strike risk c) Ensure that all vessels operated or contracted by the approval holder do not exceed 8 knots within 500 metres of any identified cetacean, dugong, or marine turtle d) Vessel operators have completed training on observing marine fauna and techniques to avoid vessel strikes to marine fauna individuals, and immediately report and sightings of marine fauna to other vessel operators in the area to enable them to be tracked and avoided e) All sightings of marine fauna individuals are reported immediately to all other vessel operators within 5 km of the location where the marine fauna individual was observed	Section 7.3	The use of dedicated and trained MFOs are defined in Section 7.3.2 and vessel speeds will be no more than defined in the conditions. If marine fauna are observed, speeds will also be reduced.
28	The approval holder must ensure a record is taken of all sightings of marine fauna individuals, including details of the: a) Date and time of the sighting b) Observed marine fauna species c) Location where the marine fauna individual was observed from d) Location of the observed marine fauna individual	Section 7.3.5	MFO logs and vessel logs will record all required information as relevant to each log.

Condition	Requirement	Plan Reference	Commitments
	e) Identity of all other vessels notified of the presence of the marine fauna and the time at which each vessel was notified f) Qualifications and experience of the person who observed the marine fauna individual.		
29	The approval holder must ensure that all marine fauna sightings are reported in the next compliance reporting period and published on the website when each compliance report is submitted to the Department.	Section 7.3.5	Compliance reports will be separate from the dredging marine fauna reports
Dredge management			
35	During all marine clearing and marine construction, and until all marine clearing and marine construction has been completed, the approval holder must: a) undertaken all marine clearing so as to not cause harm to marine fauna as specified in Section 3.3.1 of the Mardie Dredge Management Plan b) comply with conditions B5-2, B5-6, B5-7, B5-8, B5-9 of the WA approval conditions relate to protected matters, avoid and mitigate harm as a result of marine noise associated with the Action c) undertake all marine clearing and marine construction in accordance with the EPBC Act *Policy Statement 2.1 – Interaction between offshore seismic exploration and whales: Industry guidelines*, Commonwealth of Australia 2008.	Section 3.3.1, 5, 6.3 and 7.3	Section 3.3.1 outlines the ecological windows to be avoided when undertaking dredging and disposal. Other commitments relating to WA Approval conditions are described in Table A-1. The EPBC Act *Policy Statement 2.1 – Interaction between offshore seismic exploration and whales: Industry guidelines*, Commonwealth of Australia 2008 has been considered when determining the observation and exclusion zones for marine fauna.
36	To avoid and mitigate harm to marine fauna and their habitats from dredging operations, the approval holder must: a) comply with condition B1-1 of the WA Approval, to the extent that this WA Approval condition relates to protected matters	Whole Document	Dredging is now proposed to be less than the approved volume. Surveys will be undertaken as per Section 7. This DSDMP also currently relates to capital dredging

Condition	Requirement	Plan Reference	Commitments
	b) not dredge outside of the dredge channel c) not dredge more than 800,000 cubic metres (m^3) of substrate d) not dredge deeper than -6.9 m below the lowest astronomical tide (mLAT) within the berth pocket e) not dredge deeper than -3.9 mLAT within the dredge channel f) not harm any subtidal habitat for marine fauna outside of the Zone of High Influence g) ensure that all dredged material is deposited onshore within the ponds and terrestrial infrastructure h) undertake post-dredging surveys according to the schedule specified in the Mardie Dredge Management Plan i) at least once during each compliance reporting period, submit to the Department a report of the outcomes of the monitoring required by the Marine Environmental Quality Monitoring and Management Plan and the Benthic Communities and Habitat Monitoring and Management Plan, and include in the report an assessment of whether the environmental objectives of condition B1-1 of the WA Approval have been achieved j) continue to undertake post-dredging surveys at the same frequency as specified in the Mardie Dredge Management Plan unless the Department notifies the approval holder in writing that it can reduce or discontinue undertaken post-dredging surveys k) at least 12 months prior to undertaking any maintenance dredging, the approval holder must submit to the department for the Minister's approval a version of the Mardie Dredge Management Plan		only, and maintenance dredging will be addressed in a separate plan.

Condition	Requirement	Plan Reference	Commitments
	revised to address how maintenance dredging will be undertaken to achieve the environmental objectives of condition B1-1 of the WA Approval. The approval holder must not commence any maintenance dredging until the revised plan has been approved by the Minister in writing.		
37	To avoid and mitigate harm to marine turtles, the approval holder must: a) comply with conditions B5-1, B5-3, and B5-9 of the WA Approval, to the extent that the WA Approval conditions relate to protected matters	See Table A-1	Commitments are described in Table A-1 for these WA approval conditions.
Mardie Dredge Management Plan			
72	To avoid and mitigate harm to marine fauna and their habitats from dredging operation, the approval holder must commence implementation of the approved Mardie Dredge Management Plan prior to the commencement of dredging operations and continue to implement the Mardie Dredge Management Plan until the completion of all dredging operations.	Whole document	Baseline BCH surveys have already commenced, and this DSDMP will replace the existing DMP.
73	To avoid and mitigate harm to protected matters and their habitats from onshore spoil disposal, the approval holder must submit to the Minister for approval a revised Dredge Management Plan. The revised Dredge Management Plan must be approved in writing by the Minister prior to the commencement of dredging operations. The revised Dredge Management Pan must: a) be consistent with the Environmental Management Plan Guidelines b) include a risk assessment of the proposed onshore dredge spoil disposal location to ensure there will be no harm to protected matters c) include and consider results of surveys undertaken to determine the presence of *Minuria Tridens* within the dredge spoil disposal location	Section 1.2, 3.7	Onshore disposal options were considered, however the presence of *Minuria Tridens* within the area meant that other options were required. Therefore, offshore disposal has been considered the best alternative and this DSDMP reflects this change.

Condition	Requirement	Plan Reference	Commitments
	d) identify the dredge spoil disposal location as informed by condition 74c, and ensure the dredge disposal location will not results in any impact to *Minuria Tridens* e) once approved, the revised Dredge Management Plan must be implemented		
Marine Pets Prevention Plan			
74	To avoid and mitigate harm to marine fauna and their habitats from marine pests, the approval holder must: a) comply with conditions B2-1 and B2-2 of the WA approval and b) implement the Marine Pest Management Procedure until the expiry date of this approval	See Table A-1	Commitments are described in Table A-1 for these WA approval conditions. Marine pest management is also compliant with the Marine Pest Management Procedure (O2 Marine 2022).

Appendix B. Example Marine Fauna Observation Log

MARINE FAUNA OBSERVATION RECORD

Date: _____ Dredge method: _____ Marine Observer: _____ Sign: _____

Vessel: _____ dredge type: _____ Marine Observer: _____ Sign: _____

OBSERVATION AND EXCLUSION ZONES (m)		
Fauna	OBSERVATION	EXCLUSION
Whales	500	300
Dolphins	500	300
Dugongs	500	300
Turtles	500	300

Definitions:			**Height** – Platform plus observer eye height
Time – To be filled out in 24hr			**Distance** – Of observer to animal
Sea State – Beaufort scale			**Condition** – Animal distressed, calm, injured, dead
Species certainty– Certain or uncertain			**Group composition - number in each age class** – Adult / juvenile / calf
Number – Number of individuals			**Condition** – Animal distressed, calm, injured, dead
Notification – Method and whom			**Behaviour** – Travelling, foraging, resting, socialising, unknown

Page 1 Page 2

	Time	Full or low light?	Observer	Weather	Sea State	Dredging lat.	Dredging long.	Is Marine Fauna within the Observation Zone?		Is Marine Fauna in the Exclusion Zone?		Time	Zone	Whale / Dolphin / Dugong / Turtle	Species	Species certainty	Number	Time Entered (your vision / the mitigation zone)	Time Exited (your vision / the mitigation zone)	Observer lat.	Observer long.	Height (of observer on vessel)	Distance (of animal from observer)	Distance of animal from dredging	Condition	Group composition	Behaviour	Action Taken	Stop Work?		Notification/ Comments
						dd.ddd	dd.ddd	If Yes – fill in next page		If Yes, fill in next page		(24hr)	(Ob or Ex)							dd.ddd	dd.ddd								Y	N	
								Yes	No	Yes	No																			
Example record	08:00-08:30	Full Light	LW	Sunny	2	S 19.21675	E 146.21675	Yes			No	08:14:00	Ob	Dugong	Dugong	Certain	2	08:14:00	08:17:00	S 19.24487	E 146.87501	5	50	450	calm	1 adult, 1 calf	travelling	Alerted crew of dugongs in observation area & keeping eyes on it to confirm do not resurface closer or in exclusion zone		N	NA