Eramurra Solar Salt Project

Benthic Communities & Habitat Cumulative Loss Assessment

ENVIRONMENT
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MARINE

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Acronyms and Abbreviations

Acronyms and Abbreviations	Description
AEP	Annual Exceedance Probability
AGB	Above-ground biomass
Am1	*Avicennia marina* Seaward Edge
Am2	*Avicennia marina* Behind Am1
Am3	*Avicennia marina* Landward Edge
BC Act	*Biodiversity Conservation Act 2016*
BCH	Benthic Communities and Habitat
Ca	*Ceriops australis*
CALM Act	*Conservation and Land Management Act 1982*
CC	Closed canopy
CLA	Cumulative Loss Assessment
cm	Centimetres
CMW	CMW Geosciences Pty Ltd
CPE	Cape Preston East
DBCA	Department of Biodiversity Conservation & Attractions
DoT	Department of Transport
DSDDE	Dredge Spoil Disposal Development Envelope
DSDMMP	Dredging Spoil and Disposal Monitoring and Management Plan
EIA	Environmental Impact Assessment
EP Act	*Environmental Protection Act 1986*
EPA	Environmental Protection Authority
EPBC Act	*Environmental Protection and Biodiversity Act 1999*
EPO	Environmental Protection Outcome
ERD	Environmental Referral Document
ESD	Environmental Scoping Document
ESSP	Eramurra Solar Salt Project

Acronyms and Abbreviations	Description
ET	Evapotranspiration
FRM Act	*Fish Resources Management Act 1994*
GLpa	Gigalitres per annum
ha	Hectares
HC	High Cover
HEPA	High Ecological Protection Area
IMP	Introduced Marine Pest
km	Kilometre
km^2	Square kilometre
LAT	Lowest Astronomical Tide
LAU	Local Assessment Units
LEP	Level of Ecological Protection
LEPA	Low Ecological Protection Area
LS	Leichhardt Salt Pty Ltd
m	Metre
m^3	Cubic metre
MDE	Marine Development Envelope
MEPA	Moderate Ecological Protection Area
MEQMMP	Marine Environmental Quality Monitoring and Management Plan
mm	Millimetre
MS	Ministerial Statement
MT	Management Target
Mtpa	Million tonnes per annum
O2M	O2 Marine
O2Me	O2 Metocean (An O2 Marine Company)
PIDE	Pond and Infrastructure Development Envelope
ppt	Parts per thousand
Rs	*Rhizophora stylosa*

Acronyms and Abbreviations	Description
Rs/Am	Mixed Closed Canopy *Rhizophora stylosa/Avicennia marina*
RSMA	Regionally Significant Mangrove Area
SAA	State Agreement Act
SC	Scattered community
SPL	Species Protection Level
SSC	Suspended sediment concentration
SW	Southwest
TC	Tropical Cyclone
WA	Western Australia
WAMSI	Western Australian Marine Scient Institute
WET	Whole of Effluent Toxicity
ZoI	Zone of Influence
ZoHI	Zone of High Impact
ZoMI	Zone of Moderate Impact

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1. Introduction

Leichhardt Salt Pty Ltd (Leichhardt) is seeking to develop the Eramurra Solar Salt Project (the Proposal), a solar salt project east of Cape Preston, approximately 55 km west-southwest of Karratha in the Pilbara region of Western Australia (WA; Figure 1).The Proposal is an evaporative solar project that utilises seawater to produce raw salt as a feedstock for reprocessing to high purity salt. The Proposal aims for average annual production rates of 5.2 million tonnes per annum (Mtpa). To meet this production, the following infrastructure will be developed:

- Seawater intake, pump station and pipeline
- Concentration ponds totalling approximately 10,000 ha
- Crystallisers, totalling approximately 1,900 ha
- Drainage channels and bunds
- Process plant and product dewatering facilities
- Water supply (desalination plant)
- Bitterns disposal pipeline and outfall
- Pumps, pipelines, roads, and support buildings including offices and communications facilities
- Workshops and laydown areas
- Landfill, and
- Other associated infrastructure.

A general description of the of the Proposal is provided in Table 1, while the physical extent and Proposal content elements (e.g. development, action, activities or processes) are summarised in Table 2. The Proposal development envelopes are shown in Figure 2.

Table 1 Short Summary of the Proposal

Project Title	**Eramurra Solar Salt Project**
Proponent Name	**Leichhardt Salt Pty Ltd**
Short Description	Leichhardt Salt Pty Ltd (Leichhardt) is seeking to develop a solar salt project in the Cape Preston East area, approximately 55 km west-southwest of Karratha in WA (the Proposal). The Proposal will utilise seawater and evaporation to produce a concentrated salt product for export. The Proposal includes the development of a series of concentration ponds, crystallisers and processing plant. Supporting infrastructure includes bitterns outfall, drainage channels, product dewatering facilities, desalination plant, pumps, pipelines, power supply, access roads, administration buildings, workshops, laydown areas, landfill facility, communications facilities and other associated infrastructure. The Proposal also includes dredging at the Cape Preston East Port with disposal of dredge material at an offshore location and onshore within the Ponds and Infrastructure Development Envelope.

The export of salt is proposed to be via a trestle jetty. The jetty and associated stockpiles will be located at the Cape Preston East Port approved by Ministerial Statement (MS) 949. Dredging will be undertaken as part of this Proposal to remove high points at the Cape Preston East Port. Dredged material will either be disposed of at an offshore disposal location, or onshore within the Ponds and Infrastructure Development Envelope (PIDE). The Cape Preston East Port jetty and associated stockpiles are excluded from the Proposal. The Proposal will produce a salt concentrate according to the following processes:

- Seawater will be pumped into the first concentration pond and commence progressive concentration by solar evaporation as it flows through successive concentration ponds
- Salt is deposited onto a pre-formed base of salt in the crystallisers
- Salt will be removed from the drained crystallisers by mechanical harvesters and stockpiled adjacent to the processing facilities
- Salt concentrate will be trucked to the trestle jetty approved by MS 949 for export, and
- A maximum of 5.4 GL of bitterns (at 360 ppt salinity) will be generated in any given year and up to 0.59 GL (at 360 ppt salinity) in a peak summer month. The bitterns will be diluted 1:1 volume ratio with local seawater prior to discharge via ocean outfall diffuser within the Marine Development Envelope (MDE).

The Proposal may be developed in its entirety, or the East concentration ponds may be developed at a later stage.

O2 Marine was engaged by the proponent to undertake marine environmental investigations to help identify environmental risks of the Proposal, establish baseline conditions, help facilitate the environmental approvals process, and guide appropriate monitoring and management to minimise potential impacts to the marine environment during construction and operations.

Table 2 outlines the extent of the physical and operational elements of the Proposal.

Table 2 Location and proposed extent of physical and operational elements

Element	Location	Proposed Extent
Physical Elements		
Pond and Infrastructure Development Envelope – Concentration ponds and crystallisers. Process plant, desalination plant, administration, water supply, intake, associated works (access roads, laydown, water supply and other services).	Figure 2	Disturbance of no more than 12,201 ha within the 20,160 ha Ponds Development Envelope.
Marine Development Envelope – Seawater intake and pipeline, dredge channel, bitterns pipeline, outfall diffuser and mixing zone.	Figure 2	Disturbance of no more than 53 ha within the 703 ha Marine Development Envelope.
Dredge Spoil Disposal Development Envelope – Disposal location for dredge spoil.	Figure 2	Disturbance of no more than 100 ha within the 285 ha Dredge Spoil Disposal Development Envelope.
Operational Elements		
Bitterns discharge	Figure 2	Discharge of up to 5.9 Gigalitres per annum (GLpa) of bitterns within a dedicated offshore mixing zone within the Marine Development Envelope
Dredge Volume	Figure 2	Approximately 400,000 m^3

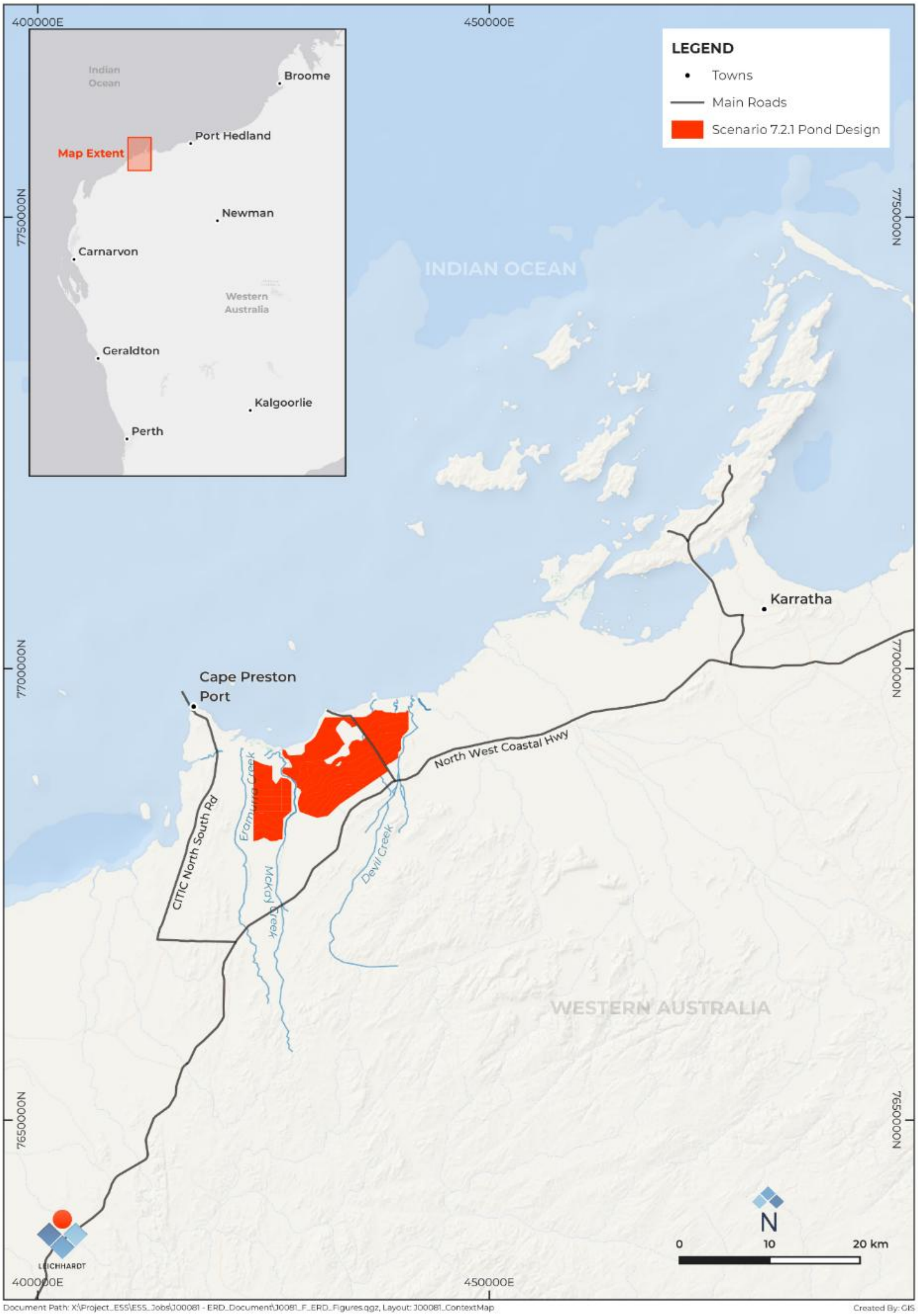

Figure 1 Regional location of the Proposal.

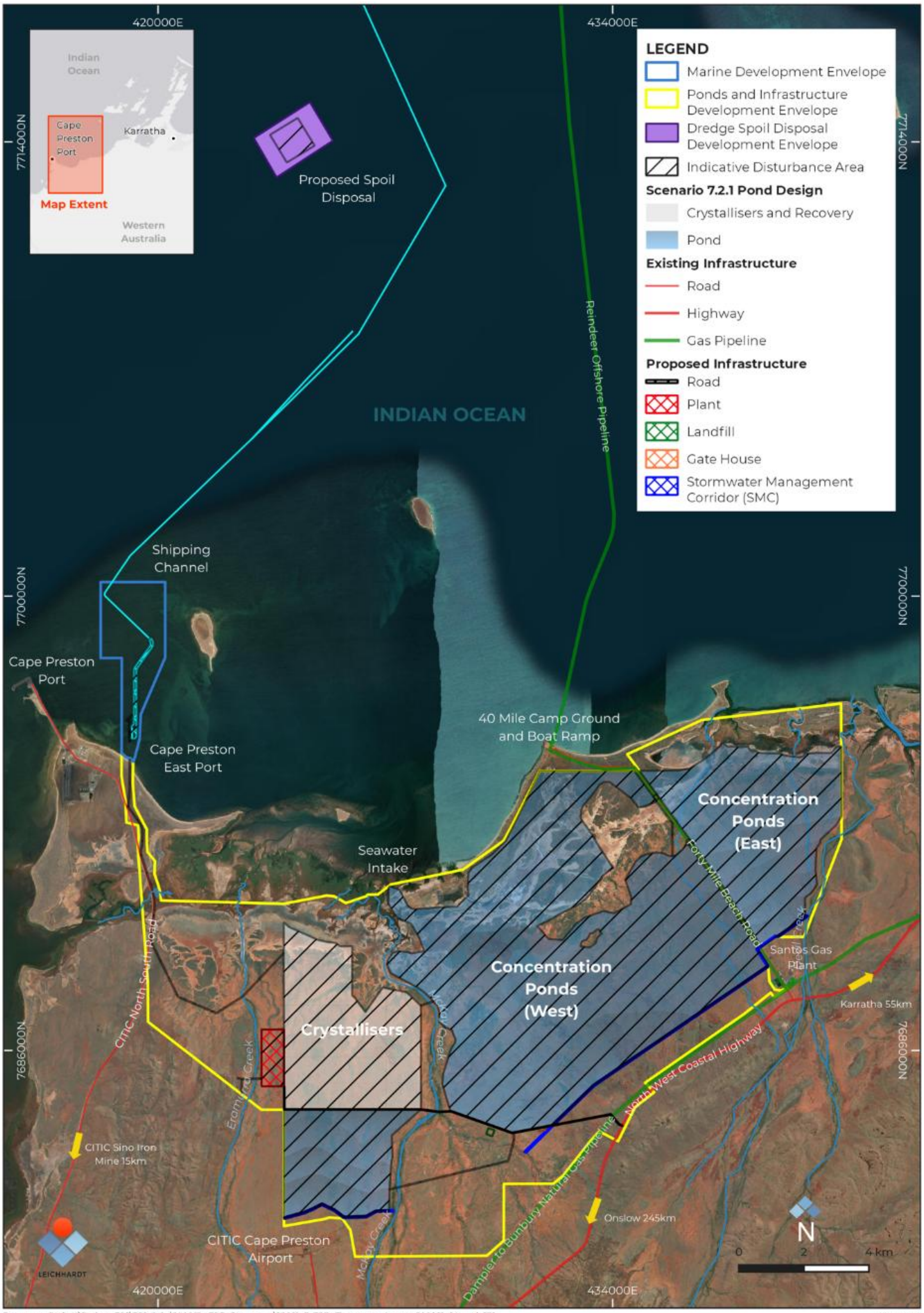

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Figure 2 Development Envelopes of the Proposal.

1.1. Scope and Objectives

This report has been prepared in accordance with the Environmental Scoping Document (ESD) for the Eramurra Solar Salt Project (Preston Consulting 2022) and addresses the tasks which pertain to benthic communities and habitats (BCH) cumulative loss assessment. This work will form part of the Environmental Impact Assessment (EIA) of the Proposal on BCH. Table 3 outlines the specific requirements from the ESD that are the focus of this report.

Table 3 Work items relevant to subtidal BCH identified in the ESD.

ESD Item	Requirement	Relevant Report Section
Required Work Item 4	Develop appropriate Local Assessment Units (LAUs) in consideration of: a) Existing LAUs for the Sino Iron Project and Cape Preston East ports b) Distribution, extent, and condition of subtidal and intertidal BCH c) Management boundaries (e.g., regionally significant mangrove areas) d) Bathymetry e) Coastal geomorphology.	Section 2
Required Work Item 6	Revise design and subsequent development envelope boundaries if possible, to minimise direct impacts to key BCH.	Refer to ERD. Brief Summary provided in Section 4.1
Required Work Item 9	Undertake a bitterns outfall modelling study, utilising local conditions (bathymetry and metocean conditions) together with published bitterns ecotoxicity concentrations to determine an appropriate discharge regime required to minimise detrimental effects to sensitive BCH.	Refer to O2Me (2023a). Brief Summary provided in Section 5.2.2
Required Work Item 10	Undertake a dredge plume dispersion modelling study, utilising local conditions and proposed dredge sediment characteristics to understand potential impacts to BCH resulting from dredge and spoil disposal activities. Model outcomes will be interpreted against the appropriate thresholds for the relevant BCH. Dredge plume modelling is to be undertaken in accordance with Sun C, Branson PM, and Mills D (2020). Guidelines on dredge plume modelling for EIA and EPA's Technical Guidance – Environmental impact assessment of marine dredging proposals (EPA, 2021b).	Refer to O2Me (2025). Brief Summary provided in Section 5.2.1
Required Work Item 16	Assessment of contemporary scientific information on pressure response pathways, bio-indicators, thresholds, tolerance limits and resilience (resistance and recovery potential) of BCH that may be impacted by the dredging.	Section 5.2.1

ESD Item	Requirement	Relevant Report Section
Required Work Item 20	Undertake a surface water flow and inundation study to produce a series of flood and storm surge maps for different event scenarios, with and without the Proposal (using confirmed Proposal general arrangement drawings and levels). The study will incorporate weather data, accurate contour data and tidal information. The study will include the following: a) Modelling and assessment of inland surface water flows before and after the development of the Proposal, using several inflow scenarios (i.e., general creek flow events, large storm flows through to 1 year flow events). This will determine which areas downstream of the Proposal will be starved of this water and any areas that will flood due to the development b) Modelling and assessment of tidal flows before and after the development of the Proposal, using several scenarios (i.e., spring high tide through to storm surge events). This will determine which areas will remain inundated under a range of scenarios after these events and for how long (pre and post development) c) Assess the likely dependency of the intertidal BCH on the low salinity inland surface water flows and predict the impacts of surface water flow changes to algal mat, mangrove and other intertidal BCH and include the predicted impacts in the BCH cumulative loss assessment described in Work Item 28 d) Undertake a literature review of current scientific knowledge regarding the potential changes in nutrient inputs and flow paths to coastal waters as a result of loss of mangrove and algal mat BCH. Utilise this information to assess potential impacts to the adjacent marine ecosystem, including BCH (e.g., mangroves and seagrass meadows).	Section 0
Required Work Item 21	Assess the likely dependency of the intertidal BCH on nutrient inflows from upslope/upstream and predict the impacts of changes in nutrient loading, to algal mat, mangrove, samphire, and other intertidal BCH and include the predicted impacts in the BCH cumulative loss assessment described in Item 28.	Section 5.2.3
Required Work Item 22	Undertake modelling and assess the impacts of climate change on intertidal BCH based on sea level rise predictions for the next 100 years.	Section 5.2.4
Required Work Item 23	Identify any critical linkages between important marine fauna and sea and shore birds, and key BCH that are likely to be impacted.	Section 7
Required Work Item 24	Conduct permeability assessment of pond floors and walls to determine the likelihood of groundwater seepage and mounding interactions with underlying groundwater. If significant interactions are predicted, then conduct hydrostatic modelling to determine if the potential for the movement of hypersaline groundwater towards key BCH and assess potential impacts.	Section 5.2.5

ESD Item	Requirement	Relevant Report Section
Required Work Item 25	Obtain expert geotechnical advice on how pond-walls should be constructed on the supratidal flat to avoid breaches of the ponds caused by structural failure which could generate surface runoff of brine that could rapidly flow across the supratidal flat surface into sensitive BCH.	Section 5.2.6
Required Work Item 26	Undertake an assessment of potential changes in sedimentation rates in the intertidal area downstream of the ponds and the consequent impact on BCH.	Section 5.2.4
Required Work Item 27	Provide figures of the proposed disturbance and predicted indirect impact to BCH.	Section 5
Required Work Item 28	Undertake a BCH cumulative loss assessment in accordance with the EPA's Technical Guidance – Protection of BCH (EPA 2016a). As a minimum, the cumulative loss assessment should include: a) Clearly defined LAUs b) Description and mapping of the BCH present in the LAUs c) Identification of any tenure, conservation, ecological or social values associated with the BCH present in the LAUs d) An estimate of the spatial extent of each BCH type that was originally present within each LAU (i.e., prior to European disturbance) e) An estimate of the spatial extent of each BCH that is currently present within the LAUs f) Identification of the area of each BCH type that would suffer 'recoverable impacts' and 'irreversible loss' if the Proposal is implemented (results to be expressed as percentages of pre-existing conditions for each BCH type) g) Comparison of the total area of each BCH type that would suffer 'irreversible loss' against the original BCH extent within the LAUs.	This document.
Required Work Item 30	Discuss proposed management, monitoring and mitigation methods to be implemented demonstrating that the design of the Proposal has addressed the mitigation hierarchy in relation to impacts on BCH. If management plans are to be developed to address specific impacts, they are to comply with the EPA Instructions on how to prepare EP Act Part IV Environmental Management Plans and Commonwealth Environmental Management Plan Guidelines.	Section 4
Required Work Item 31	Discuss management measures, outcomes / objectives sought to ensure residual impacts (direct and indirect) are not greater than predicted.	Section 4

ESD Item	Requirement	Relevant Report Section
Required Work Item 32	Evaluate the combined direct and indirect impacts to BCH after the mitigation actions have been applied. This includes: a) Aligning with the approaches and standards outlined in Technical Guidance - Protection of BCH (EPA 2016a) b) Application of contemporary scientific information on pressure response pathways, bio-indicators, thresholds, tolerance limits and resilience (resistance and recovery potential) of BCH types in relation to dredging pressures c) Consideration of any spatial and temporal variability of BCH types within the study area and how this effects the predicted impacts d) Consideration of annual seasonal variability in nearshore current patterns and how this affects the predicted sediment plume and loss of BCH e) Consideration of historic cumulative impacts to BCH within the LAUs f) Inclusion of a description of the severity and duration of reversible impacts, and the consequences of impacts on, and risks to, biological diversity and ecological integrity at local and regional scales g) Inclusion of an estimate of the level of confidence underpinning predictions of residual impacts h) Consideration of plausible events with the potential to significantly impact BCH including the introduction of marine pests, breached levee walls, hydrocarbon and other spills, and extreme episodic events (e.g., tropical lows and cyclones).	Section 5

1.2. Legislation and Regulatory Guidance

This study has been completed in accordance with the relevant state and federal legislation, and technical guidance statements that are applicable to the Pilbara. The relevant legislation, specific to BCH, includes:

- Commonwealth *Environmental Protection and Biodiversity Act 1999* (EPBC Act)
- West Australian *Environmental Protection Act 1986* (EP Act)
- West Australian *Biodiversity Conservation Act 2016* (BC Act)
- West Australian *Conservation and Land Management Act 1982* (CALM Act)
- West Australian *Fish Resources Management Act 1994* (FRM Act).

The EPA provides guidance on how an EIA will be evaluated when determining whether or not an assessed proposal may be implemented. The EPA uses environmental principles, factors and associated objectives as defined within the Statement of environmental principles, factors, objectives and aims of EIA (EPA 2021a) as the basis for assessing whether a proposal's impact on the environment is acceptable. These principles, factors and objectives therefore underpin the EIA process.

1.2.1. Environmental Principles

The objective of the EP Act is to protect the environment of the State and identifies five environmental principles to achieve this. The third principle, conservation of biological diversity and ecological integrity, is directly relevant to subtidal BCH and will therefore be a fundamental consideration for the Proposal EIA.

1.2.2. Environmental Factors and Objectives

The EPA list 13 environmental factors, which are organised into five themes, including: Sea, Land, Water, Air and People. The environmental factors are those parts of the environment that may be impacted by an aspect of a proposal. An environmental objective has been established for each environmental factor. The EPA makes judgements against these objectives on whether the environmental impact of a proposal may be significant. BCH was identified by the EPA as one of the key environmental factors for the Proposal. The EPA's objective for BCH is *'to protect benthic communities and habitats so that biological diversity and ecological integrity are maintained'* (EPA 2016a; EPA 2021a).

The EPA provides the following guidelines to explain how impacts on BCH are considered during EIA, and to set out the type and form of the information that should be presented to facilitate the assessment of impacts on BCH in Western Australia's marine environment:

- Technical Guidance – Protection of Benthic Communities and Habitats (EPA 2016a)
- Environmental Factor Guideline – Benthic Communities and Habitats (EPA 2016b)
- Technical Guidance – Environmental Impact Assessment of Marine Dredging Proposals (EPA 2021b)
- Guidance Statement for the Protection of Tropical Arid Zone Mangroves Along the Pilbara Coastline (EPA 2001).

1.3. Related Documents

This report addresses the objectives and ESD work requirements specifically relating to BCH impact assessment, and will be used in conjunction with the following documents relevant to the Proposal:

- Marine Water Quality Baseline Study (O2M 2022)
- Intertidal Benthic Communities and Habitat Report (O2M 2025a)
- Subtidal Benthic Communities and Habitat Report (O2M 2025b)
- Dredging and Spoil Disposal Monitoring and Management Plan (O2M 2025c)
- Dredge Plume Modelling Study (O2Me 2025)
- Bitterns Outfall Modelling Study (O2Me 2023a)
- Coastal Processes Assessment (O2Me 2023b).

2. Local Assessment Units

Section 4.2 of EPA (2016a) outlines the requirement to clearly define spatially based LAUs within which cumulative losses for BCH can be calculated, assessed, and presented. LAUs are required to be location specific, assessed on a case-by-case basis and consider local aspects of bathymetry, substrate type, exposure, currents, biological attributes such as habitat types. Proposed LAUs for the Proposal were defined predominately based upon the following factors (in priority order):

- Existing LAUs for the Sino Iron Project and Cape Preston East ports
- Management boundaries (e.g., regionally significant mangrove areas or Port Authority boundaries)
- Distribution, extent, and condition of subtidal and intertidal BCH
- Bathymetry
- Coastal geomorphology.

A total of 13 LAUs were developed for the Project: LAUs 1-4 are primarily relevant to the intertidal zone, while LAUs 5-13 are primarily relevant to the subtidal zone. A description and area presented in hectares for each of the proposed LAUs is presented in **Table 4**. The location of each LAU for the Project are displayed in **Figure 3.**

Table 4 Description and spatial area (ha) for each proposed LAUs

LAU	Area	Description
LAU1	5,921 ha	• Existing LAUs and within regionally significant mangrove area #9 (RSMA #9) boundary • Incorporates a west and north-east facing coastline and wraps around Cape Preston • LAU southern, eastern, and western boundaries align with the Management Assessment Unit applied during the approvals phase for the Cape Preston Port Development • LAU is characterised by a large river delta system in the lower western edge and two smaller river deltas in the north-east. The river delta in the northeast becomes mudflats/salt flats and then algal mats in the central to lower east boundary • A large portion of the LAU is terrestrial vegetation, including coastal sand dunes and spinifex sandplains • BCH is characterised by mangrove communities along the main rivers and delta, which are supported by thin ribbons of samphire and surrounded by algal mats and mudflats/salt flats inland and an intertidal bay with extensive foreshore mudflats.
LAU2	3,790 ha	• Within RSMA #9 boundary • Predominantly north facing coastline • Northern boundary is determined by the -5m LAT bathymetry isobath • Eastern boundary is determined by the extent of the main mangrove community occurring within the sheltered bay behind Gnoorea Point and Great Sandy Island and the eastern extent of the river delta system occurring here • BCH is characterised by mangrove communities along the main rivers and delta, which are supported by thin ribbons of samphire and surrounded by algal mats and mudflats/saltflats inland and an intertidal bay with extensive foreshore mudflats • A series of terrestrial islands interspersed with the algal mat and mudflats/saltflats in the eastern central portion, and • Mangrove BCH typically declines with distance east.

LAU	Area	Description
LAU3	4,500 ha	• Coastal aspect is north-west up to Gnoorea Point and then north to the eastern border • Southern border typically follows the southern extend of intertidal zone • LAU characterised by a low-lying area of algal mats and mudflats/saltflats interspersed with terrestrial islands through the centre. A sandy beach and rocky shoreline extends from the west to the east, with a thin mangrove fringe extending approximately 50% of the north western facing shoreline up to Gnoorea Point • A large portion of the LAU comprises terrestrial vegetation including a long sand dune complex along the full northern shoreline and spinifex sandplains throughout the central terrestrial islands and along the landward extent of intertidal BCH.
LAU4	3,772 ha	• Coastline typically faces north with an anvil shaped headland in the far west • Southern boundary typically follows the southern extent of the intertidal zone, whilst the eastern zone completes the LAU past the development envelope • LAU comprises a series of small intertidal creeks which drain into low lying mudflats and algal mats along the southern extents • Mangrove communities occur along the edges of intertidal creeks and the foreshore from the western headland to the eastern border • The central portion of the LAU is characterized by extensive algal mats and mudflats/saltflats with some terrestrial islands in the western half and a freshwater river delta in the east. BCH is similar to LAU1, however tidal creek systems become increasingly complex in the south and support more extensive mangrove communities which are interspersed by samphire communities.
LAU5	2,661 ha	• Nearshore LAU characterised by algae dominated limestone pavement and coral reefs in depths <5 m, including previously recognised regionally significant reefs • Contains existing Marine Management Unit on east side of Cape Preston • Port of Cape Preston port waters boundary • From LAT to 10 m depth contour • Cape Preston significant geomorphological feature.
LAU6	8,133 ha	• Nearshore LAU characterised by coarse sand, shallow seagrass, and reef platforms off Cape Preston and South West Regnard Island supporting coral and macroalgae in depths <5 m, including previously recognised regionally significant coral reefs • Contains existing Marine Management Unit on west side of Cape Preston • Port of Cape Preston port waters boundary too close to edge of MDE, so eastern boundary extended to approximate predicted Zone of Moderate Impact area • From LAT to 10 m depth contour • Cape Preston and South West Regnard Island significant geomorphological features.
LAU7	7,819 ha	• Nearshore LAU characterised by silt/coarse sand and reef platform surrounding North East Regnard Island supporting coral and macroalgae in depths <5 m • Eastern boundary extended to approximate predicted Zone of Influence area • From LAT to 10 m depth contour • North East Regnard Island and small shoal ~6 km north north-east on subtidal reef platform significant geological features.
LAU8	9,623 ha	• Mid-shelf LAU characterised by coarse sand • Port of Cape Preston port waters boundary on east and west

LAU	Area	Description
		• Bathymetry from 10 m to 15 m depth contours • Geomorphology relatively low gradient and featureless seabed.
LAU9	5,353 ha	• Mid-shelf LAU characterised by coarse sand • Port of Cape Preston port waters boundary on west • Bathymetry from 10 m to 15 m depth • Geomorphology relatively low gradient and featureless seabed.
LAU10	7,610 ha	• Mid-shelf LAU characterised by coarse sand, occasional shoals possibly supporting macroalgae and filter feeders • Port of Cape Preston port waters boundary on east and west • 20 m depth contour forms northern boundary • Bathymetry from 8 m to 20 m depth • Geomorphology relatively low gradient and featureless seabed with occasional shoals and steep gradient from 10 m to 20 m on outer shelf.
LAU11	6,083 ha	• Mid-shelf LAU characterised by coarse sand, occasional shoals possibly supporting macroalgae and filter feeders • Port of Cape Preston port waters boundary on west • 20 m depth contour forms northern boundary • Bathymetry from 6 m to 20 m depth • Geomorphology relatively low gradient and featureless seabed with occasional shoals steep gradient from 10 m to 20 m on outer shelf.
LAU12	22,495 ha	• Offshore LAU characterised by coarse sand • Port of Cape Preston port waters boundary on north, east and west • Bathymetry from 20 m to ~30 m depth contours • Geomorphology relatively low gradient and featureless seabed.
LAU13	5,890 ha	• Offshore LAU characterised by coarse sand • Port of Cape Preston port waters boundary on north and west • Bathymetry from 20 m to ~30 m depth contours • Geomorphology relatively low gradient and featureless seabed.

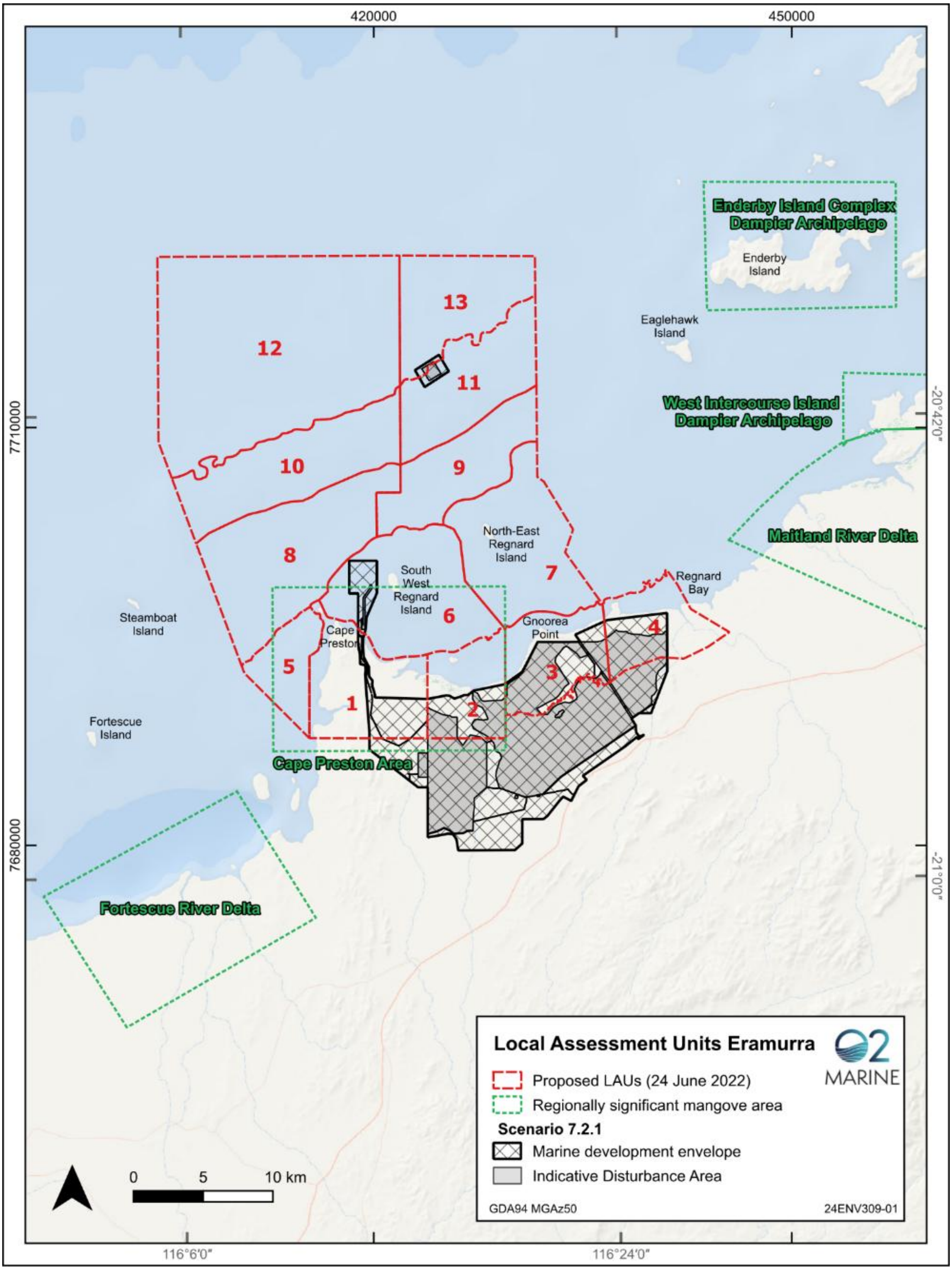


Figure 3 Local Assessment Units for BCH overlaid with the Proposal Development Envelope and regionally significant mangrove area

3. Benthic Communities and Habitat

3.1. Benthic Communities and Habitat Mapping

Extensive surveys of the intertidal and subtidal BCH were undertaken between 2019 and 2024 within and adjacent to the Proposal area. In October 2024 (in response to regulator comments), O2M undertook further studies which included revised mapping methodologies (including high-resolution satellite imagery analysis, refined ground-truthing, and improved classification techniques). Results from these updated intertidal and subtidal surveys are detailed in O2M (2025a) and O2M (2025b) respectively. The refined mapping techniques have improved the resolution and extent of BCH categorisation to alignment with regulatory guidelines.

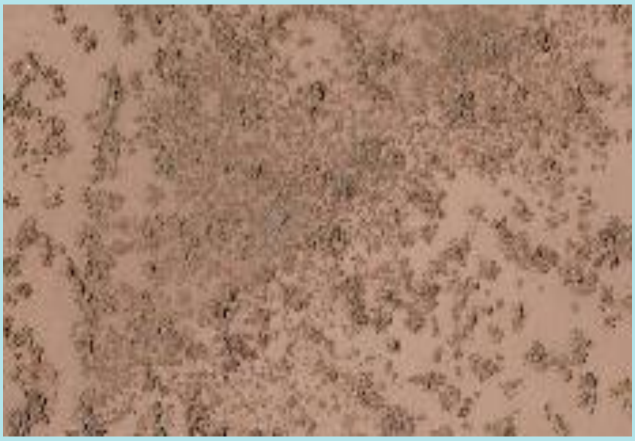
A total of eighteen (18) BCH classes were identified and mapped, including ten intertidal and eight subtidal BCH classes. For the purposes of this study (due it its significant representation within LAUs 1-4), the 'Terrestrial' BCH class, whilst not a true intertidal habitat, has been included under the intertidal category. A brief description of each BCH class is provided in Table 5 and the extent and distribution of these BCH classes are shown in Figure 4. The total area (expressed in hectares and as a percentage of each LAU) of each BCH class within each LAU is presented in Table 6.

Table 5 Description of the BCH categories within the Proposal LAUs

BCH Class	Description (Area)	Example Image
Intertidal BCH		
Terrestrial	Grassland and dune vegetation e.g. spinifex, hummock/tussock grassland. Includes roads and infrastructure.	 

BCH Class	Description (Area)	Example Image
***Avicennia marina* Mangrove**	Am1 Closed canopy mangrove comprised of large, spreading trees, often with limbs that bend down onto the substrate. This community is usually only 10 -30 meters wide and backed by *Rhizophora stylosa* (Rs) either in a monospecific stand or mixed association (Am) or *Avicennia. marina* (landward edge).	
	Am2 The largest area of mangrove association comprised of trees that show a decline in height moving from seaward to landward and often backed by the scattered mangrove.	
	Am3 The point where *A. marina* landward edge displays canopy gaps, and these gaps eventually become larger in total area than the surrounding *A. marina* mangrove. Individual scattered mangroves were excluded if tree density was less than approximately five trees per 100 m^2	

BCH Class	Description (Area)	Example Image
***R. stylosa* Mangrove**	Rs Typically closed canopy and dense, occurring either at the seaward edge in bands 20 – 30 meters wide and behind *A. marina* seaward mangroves as sprawling forests. Also found as fingers extending into the landward *A. marina* mangroves along narrow shallow tidal channels.	
	RS/Am A mixed association of *R. stylosa* and *A. marina*, usually found in a transition zone between the *R. stylosa* monospecific stands and the monospecific stands of the landward edge *A. marina* closed canopy, however, also occurs at the seaward edge where trees are typically older and larger. *R. stylosa* / *A. marina* (closed canopy, mixed) was allocated where either species contributed approximately between 20% to 80% of the mangrove stand.	
Algal Mat	Algal mats are typically green to grey or black, and either contiguous or fragmented and they vary greatly in desiccation status, which is largely dependent on frequency of inundation relative to timing of surveys. Six species were identified in the Proposal LAUs, with filamentous cyanobacteria *Lyngbya* sp. then *Coleofasciatus chthonoplastes* and *Schizothrix* spp. the dominant species. *Note: Algal mats included within samphire habitat are not considered with this category.*	

BCH Class	Description (Area)	Example Image
Samphire incl algal mat (sparse)	Open samphire flats, including algal mats. Sparse level of cover (< 50%).	
Samphire incl algal mat (dense)	Open samphire flats, including algal mats. Dense level of cover (>50%).	
Samphire shrublands (sparse)	Samphire shrublands. Sparse level of cover (< 50%).	

BCH Class	Description (Area)	Example Image
Samphire shrublands (dense)	Samphire shrublands. Open samphire flats, including algal mats. Dense level of cover (>50%).	
Bare Intertidal Habitat	Sandy beaches Sandy beaches are typically flat, low energy, low profile beaches backed by gently rising dunes.	
	Mudflat / Saltflat Mudflat/Saltflats are extremely low in biodiversity and support little to no fauna or flora due to their characteristic high salinities. They typically occur on the higher intertidal gradients on the landward extent of Samphire's or Algal Mats.	

BCH Class	Description (Area)	Example Image
	Rock platform Fringing rock platform with occasional very sparse cover of turf algae. Occurs within the wave zone along some of the beaches in the west of Regnard Bay and around Gnoorea Point.	
Mixed Intertidal	Intertidal area with no dominant habitat class	
Subtidal BCH		
Macroalgae Dominated Habitat	Area of macroalgae with low (3 – 10%) to dense (> 75%) coverage. Growing on both unconsolidated (sand / mud) and consolidated (boulders, gravel, rock) substrates.	
Seagrass with macroalgae	Sparse to low seagrass cover (*Halophila*), interspersed with low/moderate brown macroalgae occurring on predominantly sand substrate with patches of sandy veneer on limestone pavement.	

BCH Class	Description (Area)	Example Image
Seagrass with Filter feeders	Habitat dominated by seagrass of elliptical (*Halophila sp.*) or strap-like form (*Halodule sp., Thalassia sp., Syringodium sp., Cymodocea sp.*) with low (3-10%) to dense (>75%) coverage, growing on sandy substrate, occasional sparse/very sparse hard corals/filter feeders.	
Filter Feeder Dominated Habitat	Filter feeders (sponges, sea whips, gorgonians, sea fans, feather stars, ascidians) with low (3 – 10%) to dense (> 75%) coverage, generally growing over sand, rubble, reef with sand veneer, or exposed reef.	
Filter feeders with *Pinna bicolor* beds	*Pinna bicolor* beds, observed in shallow to moderate depths, typically associated with areas of hard substrate and sand veneer. These beds provide structural habitat for a range of other benthic organisms	

BCH Class	Description (Area)	Example Image
Hard Coral Habitat	Hard and soft corals of varied forms growing on rocky reef with flat to moderate (1 – 3 m) relief, or rubble.	
Unvegetated Soft Sediment	Areas of bare substrate, devoid of biota. Predominantly unconsolidated (sand / mud), but also includes instances of consolidated substrates.	
Mixed Subtidal Habitat	Subtidal area with no dominant habitat class. Areas of mixed assemblages generally comprising of seagrass (*Halophila sp*., *Halodule sp., Thalassia sp., Syringodium sp., or Cymodocea sp*.) generally growing over sand, and or macroalgae (brown and other macroalgae), filter feeders (sponges, hydroids, and sea whips) and/or hard and soft coral, generally growing over rocky reef with flat to high (> 3 m) relief, or rocky rubble.	

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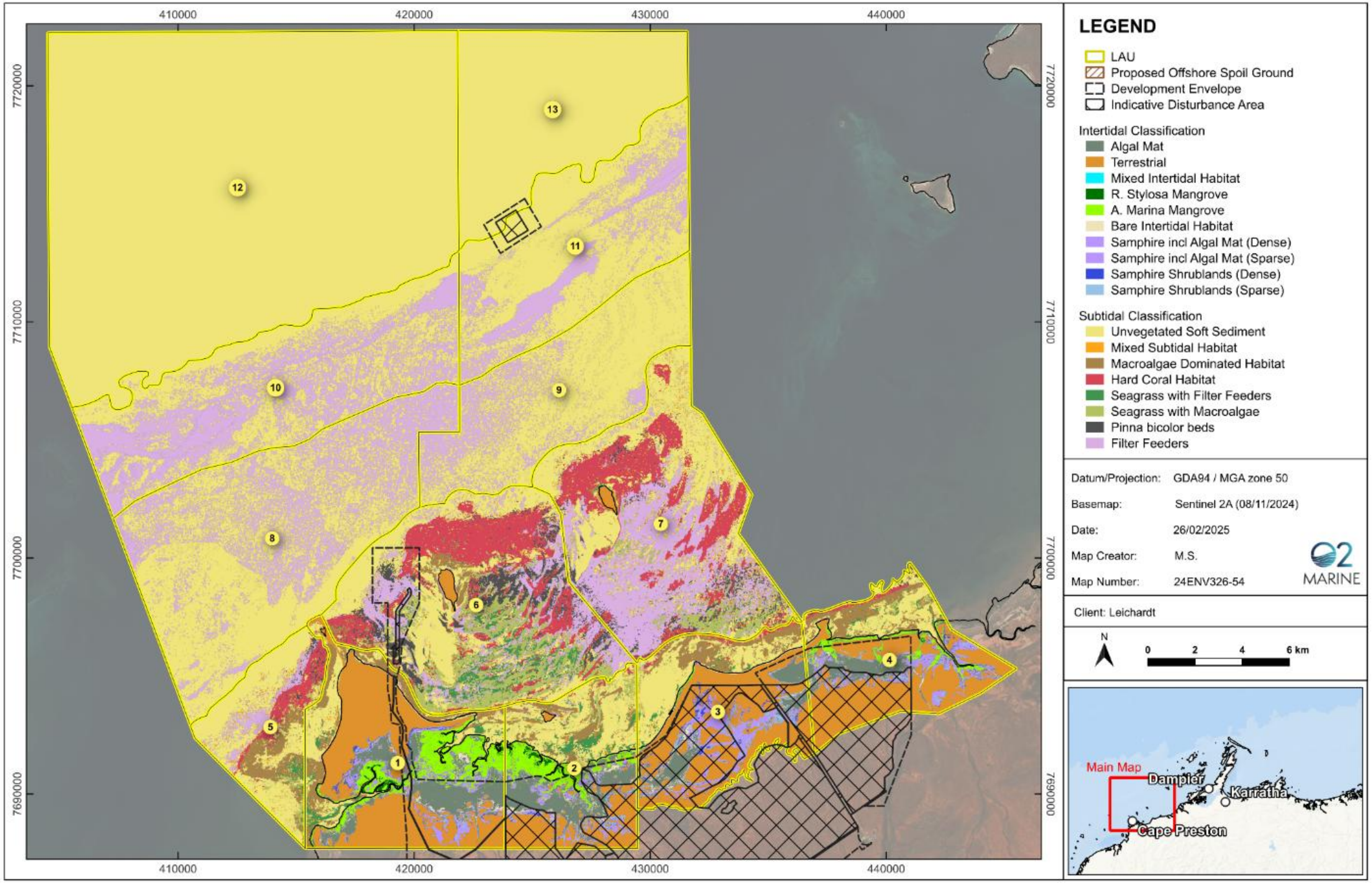

Figure 4 BCH of the Proposal coastline

Table 6 Area (presented as ha and %) of the BCH within each LAU.

		Intertidal										Subtidal							
		Algal Mat	Terrestrial	Mixed Intertidal	R. stylosa Mangrove	A. marina Mangrove	Bare Intertidal Habitat	Samphire incl algal mat (sparse)	Samphire incl algal mat (dense)	Samphire shrubland s (sparse)	Samphire shrublands (dense)	Unvegeta ted Soft Sediment	Mixed Subtidal	Macroalgae-Dominated Habitat	Hard Coral Habitat	Seagrass with Filter feeders	Seagrass with macroalgae	Filter feeders with Pinna bicolor beds	Filter feeders
LAU1	ha	816.7	2438.5	8.6	49.3	707.5	102.2	240.1	71.0	70.4	54.6	671.1	38.3	520.8	8.3	93.5	16.3	0.1	14.5
	%	13.8	41.2	0.1	0.8	11.9	1.7	4.1	1.2	1.2	0.9	11.3	0.6	8.8	0.1	1.6	0.3	0.0	0.2
LAU2	ha	616.9	795.3	6.0	37.2	375.6	67.6	194.2	33.0	68.5	31.8	960.3	61.5	277.5	18.3	145.8	79.6	1.0	20.3
	%	16.3	21.0	0.2	1.0	9.9	1.8	5.1	0.9	1.8	0.8	25.3	1.6	7.3	0.5	3.8	2.1	0.0	0.5
LAU3	ha	344.7	2061.6	6.2	0.7	17.8	54.6	372.4	14.7	176.8	79.7	810.6	40.6	348.4	90.7	34.6	35.4	2.6	8.2
	%	7.7	45.8	0.1	0.0	0.4	1.2	8.3	0.3	3.9	1.8	18.0	0.9	7.7	2.0	0.8	0.8	0.1	0.2
LAU4	ha	379.4	1759.9	4.9	7.3	186.1	36.9	208.6	63.4	98.6	37.7	491.9	34.8	315.5	65.2	31.0	35.0	11.7	4.6
	%	10.1	46.7	0.1	0.2	4.9	1.0	5.5	1.7	2.6	1.0	13.0	0.9	8.4	1.7	0.8	0.9	0.3	0.1
LAU5	ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1472.6	100.9	363.3	301.3	40.8	84.2	46.3	252.4
	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	55.3	3.8	13.6	11.3	1.5	3.2	1.7	9.5
LAU6	ha	0.0	70.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2215.0	332.3	223.1	1750.2	358.9	1086.8	758.8	1337.9
	%	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.2	4.1	2.7	21.5	4.4	13.4	9.3	16.4
LAU7	ha	0.0	61.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2493.5	315.2	18.1	1572.5	53.7	345.6	254.7	2704.8
	%	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.9	4.0	0.2	20.1	0.7	4.4	3.3	34.6
LAU8	ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6161.0	0.0	0.0	0.0	0.0	0.0	0.0	3462.8
	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	64.0	0.0	0.0	0.0	0.0	0.0	0.0	36.0
LAU9	ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4112.8	0.0	0.0	0.0	0.0	0.0	0.0	1240.5
	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	76.8	0.0	0.0	0.0	0.0	0.0	0.0	23.2
LAU10	ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3868.9	0.0	0.0	0.0	0.0	0.0	0.0	3741.5
	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.8	0.0	0.0	0.0	0.0	0.0	0.0	49.2
LAU11	ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4461.2	0.0	0.0	0.0	0.0	0.0	0.0	1622.4
	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	73.3	0.0	0.0	0.0	0.0	0.0	0.0	26.7
LAU12	ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22495.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LAU13	ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5890.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Totals	ha	2157.7	7055.3	25.7	94.5	1287.0	261.3	1015.3	182.1	414.3	203.8	56104.3	923.6	2066.7	3806.5	758.3	1682.9	1075.2	14409.9
	%	2.3	7.5	0.03	0.1	1.4	0.3	1.1	0.2	0.4	0.2	60.0	1.0	2.2	4.1	0.8	1.8	1.1	15.4

3.2. Pre-European Extent

BCH in the Proposal LAU's has been historically impacted by the development of the Cape Preston Port in 2010, which resulted in the direct loss of approximately 60 ha of BCH in LAU1 from the original estimated pre-European extent. A further approximated 2.7 ha of BCH has also been lost in LAU3 from the construction of the road to Gnoorea Point. The direct *irreversible loss* of BCH, which can be attributed to these developments has been determined using GIS and is estimated to include:

- Algal Mat – 8.5ha
- Mixed Intertidal – 0.004 ha
- *A. marina* Mangrove – 1.4 ha
- Samphire incl. algal mat (sparse) – 3.6 ha
- Unvegetated Soft Sediment – 15.7 ha
- Hard Coral Habitat – 28 ha

There is insufficient information to inform loss of BCH which may be attributable to other post-European habitation activities in the region, such as commercial trawling. Therefore, any losses attributable to these other activities are unable to be quantified.

3.3. Tenure and Conservation

3.3.1. Tenure

The MDE area currently resides within the Port of Cape Preston (CP) boundaries (see Figure 5). CP is declared under the Shipping and Pilotage Act 1967 (WA) and administered by the Department of Transport (DoT). CP was created for CITIC-Pacific's Sino Iron Project export facilities at Cape Preston and is located several kilometres west of the of the ESSP development envelop. Under Tranche 2 of the State Government's 2014 port governance reform, regulation of CP will transition to the Port Authorities Act 1999 (Pilbara Ports) and responsibility for oversight of the port from the DoT to the regional port authority, the Pilbara Ports, at some future stage.

The MDE is located within the greenfield Port of Cape Preston East. In 2008, the State Government secured 6,147ha of land at Cape Preston for the development of a future multi-user export port. A variation to the Iron Ore Processing (Mineralogy Pty Ltd) Act 2002 (State Agreement Act (SAA)) resulted in the excision of the land back to the State. In May 2017, a reserve 'for port purposes' was created over the CPE land and seabed areas with a Management Order in favour of Pilbara Ports.

The CPE land area is largely undeveloped, apart from grazing cattle and minor clearing for tracks and pastoral activities. A road, causeway and bridge were constructed in the north-western portion of CPE in 2010 by CITIC-Pacific, as part of its Sino Iron Project. This infrastructure was subsequently bequeathed to the State (Pilbara Ports), as per the variation to the SAA, to be used as common user infrastructure facilitating access to both the Sino Iron Project export facilities in CP and the future CPE port facilities.

The proposed port waters for CPE will be created by excising a portion of the existing CP port waters and State waters to facilitate transhipping routes, anchorages and the construction of marine infrastructure for CPE; and vested in the Pilbara Ports. The State has agreed the boundary amendments to the ports and the declaration process for CPE is progressing.

Gnoorea Point, also known as 40 Mile, is a natural, coastal camping area managed by the City of Karratha and occurs immediately adjacent to the Proposals PIDE. The camp area offers a natural boat ramp, public toilets for day users and sullage disposal points. Recreational fishing from the shoreline or small boat is the most common activity undertaken by visitors.

Native Title Determination of the Proposal area identifies the Mardudhunera people as Traditional Owners. The Determination enables Traditional Owners to undertake cultural and spiritual activities including camping, hunting, fishing, collecting bush medicine and other plants and animals, and imparting knowledge through being on country.

3.3.2. Conservation

Features of State and Commonwealth conservation significance are shown Figure 5. The Proposal does not occur within or adjacent to any Commonwealth features of conservation significance, with the nearest being the Dampier Archipelago National Heritage Place. The 'Great Sandy Islands Reserve' and 'Regionally Significant Mangrove Area (RSMA) #9' are the only two areas of State conservation significance which occur within or immediately adjacent to the Proposals PIDE. These areas are briefly discussed below.

Great Sandy Islands Reserve

The Proposal is located immediately adjacent to the Great Sandy Island Reserve, which encompasses 29 islands off the Pilbara coast within an area extending generally from about 15 km east of Cape Preston to the mouth of the Robe River and ranging from approximately 10 to 35 km offshore. This reserve is managed under the CALM Act.

The surrounding coastal marine waters are not included within the protected areas. The nearest islands to the Proposal area include Southwest Regnard Island and Northeast Regnard Island. The islands within the Great Sandy Reserve are considered conservation significant breeding and resting places for migratory and resident shorebirds and seabirds, and marine turtles. The islands are recognized as Nature Reserves which are protected and managed by the Department of Biodiversity, Conservation and Attractions (DBCA).

Regionally Significant Mangrove Area #9

The intertidal disturbance area of the Proposal includes a section of mangrove that is considered regionally significant within the Pilbara region. The RSMA #9 (Figure 5) is referred to in the EPA Advice: Protection of Tropical Arid Zone mangroves Along the Pilbara Coastline (EPA 2001), underlining its regional significance. EPA (2001) is a guidance statement developed to provide advice to proponents, and the public generally, about the minimum requirements for environmental management which the EPA would expect to be met when the Authority considers a proposal during the assessment process. It specifically addresses the protection of tropical arid zone mangroves, habitats, and dependant habitats along the Pilbara coastline, stretching from Cape Keraudren at the end of the Eighty Mile Beach to Exmouth Gulf (EPA 2001). The guidelines contained within EPA (2001) are based on a report titled *Selection of mangrove Stands for Conservation in the Pilbara region of Western Australia – A Discussion* (Semenuik 1997) (unpublished).

The designation of mangrove areas is based on the following criteria that address significance:

- Extent or rarity of the habitat
- Internal diversity of the habitat
- Ecological significance of a given stand
- Nationally to internationally significant features of a given site.

Semeniuk (1997) determined RSMA #9 to be of 'very high conservation value' based on coastal type, habitat, species diversity and plant form, while also being of international, national, and regional significance, supporting unusual biodiversity or occurrence of uncommon species, and containing mangrove stands that explicitly exhibit mangrove/habitat relationships.

The remaining mangroves along this part of the Pilbara coast, although not "regionally significant", are also regarded as important and considered to be of high conservation value (EPA 2001). As per EPA (2001), four types of management areas have been identified for which guidelines have been prepared as summarised in Table 7.

Table 7 Mangrove management areas and associated guidelines (EPA 2001).

	Mangrove areas of very high conservation value (designated "regionally significant")	Mangrove areas of high conservation value
Mangrove areas outside designated industrial and associated port areas	Guideline 1 Areas: 1, 2, 3, 4, 6, 7, 8, 12 13, 14, 16, 17, 18, 19, 20, 21, 22	Guideline 2 All other mangrove areas outside designated industrial and associated port areas
Mangrove areas inside designated industrial and associated port areas	Guideline 3 Areas: 5, 9[1], 10, 11, 15	Guideline 4 All other mangrove areas inside designated industrial and associated port areas

RSMA #9 falls under Guideline 3 (Table 7), the objective of this guideline states: '*no development should take place that would significantly reduce the mangrove habitat or ecological function of the mangroves in these areas*' (EPA 2001).

Under Guideline 3, proposals will be expected to meet the following performance objectives for an assessment of acceptability by the EPA:

- Demonstrate a significant understanding of the mangrove systems, in terms of habitats, dependent habitats and ecological functions, which are likely to be affected if development is implemented
- With the above understanding, evaluate how the mangrove system (the mangroves, habitats, dependent habitats, ecological function, and ecological processes which sustain the mangrove habitats) would be affected and the environmental significance of any such impacts, including cumulative impacts

[1] The RSMA #9 boundary overlaps with LAU 1 and LAU 2.

- Demonstrate that the proposed development adopts good engineering design and 'best practice' processes for minimising potential environmental impacts and maintains the ecological function and overall biological value and environmental quality of the area, and
- Demonstrate that all feasible and prudent alternative (industry siting) to impacting detrimentally on mangroves have been considered.

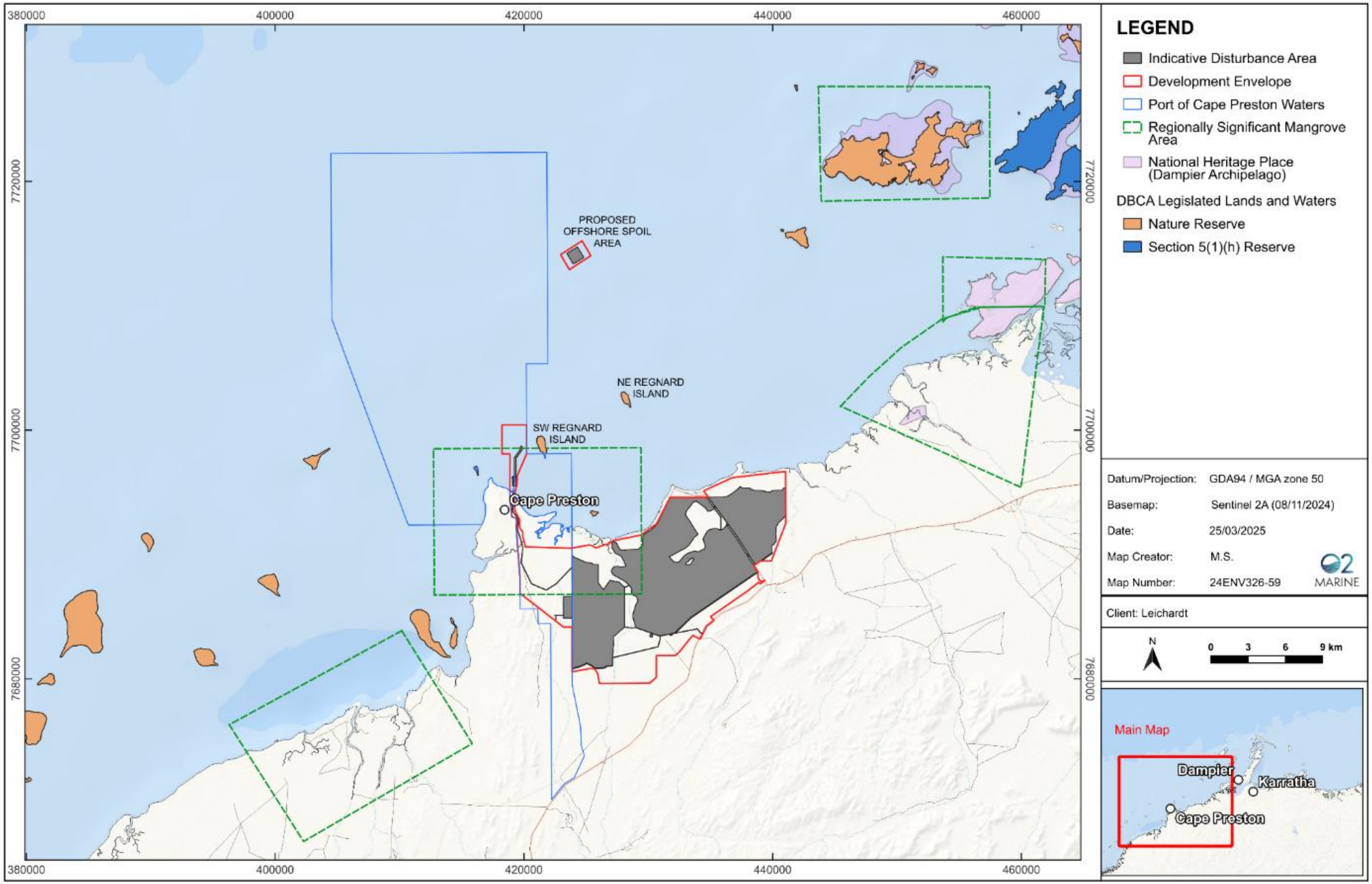

Figure 5 Tenure and areas of State and Commonwealth conservation significance

3.4. Regional Significance

With the exception of some areas of mangrove, most BCH identified and mapped within the Proposal area are commonly distributed throughout the wider Pilbara region, with many BCH having distributions either throughout the Australian tropics or internationally (O2M 2025a; O2M 2025b). Many of the individual species identified during the assessment are also typically found within a much broader geographical distribution (O2M 2025a; O2M 2025b).

Despite the widespread distribution of all BCH present in the Proposal area, O2M (2025a) determined that in the intertidal zone, the mangrove associations in LAU1 and LAU2 are considered to be regionally significant and are afforded additional protection through EPA (2001) as described in Section 3.3.2. These areas are shown in Figure 5. The regional significance of all intertidal BCH is discussed further in O2M (2025a).

In addition, areas of coral reef in the subtidal zone of the Proposal LAUs, although not afforded any additional protection, are considered regionally unique due to their high cover and diversity (O2M 2025b), including three regionally significant coral communities in the vicinity of Cape Preston that were identified in LeProvost (2008) having >50% cover (and in parts up to 100% live coral cover) comprised primarily of large colonies of massive species such as *Porites*, *Favites*, *Lobophyllia* and *Goniastrea*. These significant reefs were located:

- Approximately 3 – 5 km to the southwest of Cape Preston
- 4 km to the east-northeast of Cape Preston on the southeast end of SW Regnard Island, and
- 5 km east of Cape Preston

The regional significance of all subtidal BCH is discussed further in O2M (2025b).

3.5. Functional Ecological Value

The functional ecological values[2] of the intertidal and subtidal BCH in the Proposal are discussed extensively in O2M (2025a) and O2M (2025b), respectively. The following key conclusions were made in O2M (2025a) with respect to the functional ecological values of the intertidal BCH in the Proposal area:

- Seaward to landward characteristics within intertidal BCH are often associated with an initial sharp decline in ecological functionality, structural complexity, and above ground biomass (AGB), and then a gradual decline therein through to the terrestrial communities, with the closed canopy (CC) mangrove communities representing the most productive, structurally complex, and ecologically diverse BCH within the Proposal area.
- Functional ecological diversity, structural complexity and AGB continue to decline further landward, represented by the low and scattered mangroves, samphire BCH, then mudflats, algal mats and finally the Saltflats, which in turn support continued decline in functional ecological value.
- Seaward of the CC mangroves, foreshore mudflats have been identified to support BCH habitats such as macroalgae and seagrasses in varied densities. These ecosystems are likely to have a lower primary productivity in comparison to subtidal BCH, due to the more extreme environments in which they are

[2] Functional ecological value is a consideration of the role and importance of different BCH to the maintenance of ecological integrity, biological diversity and/or coastal values at local or regional scales due to the net contribution of benthic primary production, structural complexity, trophic connectivity, and importance as marine fauna habitat.

located (e.g., exposure to terrestrial climate during spring tides), however support a wide array of secondary productivity and have been identified as important foraging areas for migratory birds (Phoenix 2023).

- Intertidal BCH ecosystems serve as shelter, feeding, nursery and breeding zones for crustaceans, molluscs, fish, and resident and migratory birds. The importance of these ecological functions delivered by intertidal BCH are directly proportional to the structural complexity, AGB and their spatial distributions.
- Targeted faunal surveys undertaken by Phoenix (2023) clearly identify faunal diversity being higher within the seaward BCH and declining with distance from the coast. Phoenix (2023) surveys demonstrated a strong relationship between identified terrestrial fauna (Amphibia, Aves, Magnoliopsida, Mammalia and Reptilia) and their location within the more structurally complex seaward intertidal BCH classes, which are used for shelter and foraging during their visiting periods. Further information on the importance of these habitats for faunal assemblages is detailed in Phoenix (2023).
- Although mangrove systems are generally highly productive and rich in organic matter, they are generally nutrient poor, especially in nitrogen and phosphorus, which are often limiting in estuarine and marine ecosystems (Holguin *et al* 2001; Alongi 2009). There is evidence of a close microbe-nutrient-plant relationship that functions as a mechanism to recycle and conserve nutrients in the mangrove ecosystem (Alongi 2009). Freshwater inundation events are considered to supply an important source of phosphorus to these mangrove systems (O2M 2025a).
- Mangroves are the most significant primary and secondary producers in the intertidal ecosystem, with all other BCH being near negligible in comparison (Alongi 2009; Holguin *et al* 2001; O2M 2025b).
- Mangroves and algal mats are considered to play an important role in the cycling and export of carbon and nutrients from the intertidal zone to the nearshore marine environment (Alongi 2009; O2M 2023b). However, whilst all studies agree that mangrove communities are a significant exporter of carbon and nutrients to the nearshore marine environment, there is no decisive evidence that demonstrate the relative contribution of algal mats, with some studies suggesting these communities may act as nutrient and carbon sinks (Burford *et al* 2012; O2M 2019b).
- Many studies have inferred the importance algal mats play as an important nutrient source in Pilbara intertidal BCH through their nitrogen fixing properties in an otherwise nitrogen deficient system (Paling and McComb 1994; Biota 2005; URS 2010 and Stantec 2018). However, there have been limited studies quantifying specific nitrogen fixing and export loads for BCH classes or the indirect impacts on BCH and coastal environments due to loss, removal, or degradation of these communities, particularly in tropical arid zones of the Pilbara region.
- Burford *et al*. (2012) concluded that supratidal algal mat production on the Norman River system potentially contributed to higher trophic levels in years when the period of inundation was sufficiently long. Periods of inundation were related to episodic floods and there were many years where there was no flooding of the supratidal flats with freshwater and consequently negligible export of carbon or fixed nitrogen to coastal waters.
- A nutrient flux study (O2M 2025a) for the Proposal was inconclusive in assessing whether nutrient exchange from algal mats to the nearshore marine environment occurs during normal spring tidal cycles, suggesting that nutrient exchange may be limited to significant freshwater inundation events. Further research is required to adequately explain the role of algal mats in nutrient and carbon exchange with the nearshore marine environment.

- Primary productivity that occurs within algal mats is directly related to the nitrogen fixing characteristics of the cyanobacteria that dominate the species composition within this BCH type. Whilst there are specific areas located within the study area assigned to the BCH classification Algal Mat, it is widely understood that nitrogen fixing cyanobacteria are present within most intertidal BCH, including mangroves (Alongi 1994; Holguin *et al*. 2001 and Alongi 2009), though there is little in the literature through which a direct comparison can be determined with respect to distinct BCH types and their respective nitrogen fixing rates or export loads. Whilst the predominately cyanobacterial algal mat communities form a higher standing biomass, the cyanobacterial communities associated with CC mangroves are likely to be higher in primary productivity (non-seasonal) and due to lower associated soil salinities also support significant secondary productivity (grazing by primary heterotrophs) and therefore play a more valuable ecological function within the system.
- Algal mats support a limited number of grazing heterotrophs that are associated with adjacent BCH along seaward edges. During certain tides or seasons, these heterotrophs migrate from their associated BCH to the edges of algal mats whereby they graze directly on the 'crust'. Penrose (2011) undertook a study in Exmouth Gulf to investigate the potential role of nekton as transport pathways for the export of cyanobacterial mat primary production and nutrients from supratidal flats to adjacent habitats and thereby into coastal food webs. The results show a clear link between several fish species and cyanobacterial primary productivity using carbon and nitrogen isotope tracing. Evidence is presented that several species are dependent on cyanobacterial sources of carbon (Penrose 2011). Attribution of the cyanobacterial 'mats' as the likely source of the cyanobacterial carbon (Penrose 2011) is however problematic, because there is substantial cyanobacterial primary productivity in the adjacent habitats, where grazing prevents the formation of mats. The majority of the mats form at levels on the shore where soil salinities exclude virtually all the grazers such as molluscs, crustaceans and especially polychaetes (osmoconformers) which have limited tolerances of high salinities.

4. Mitigation

4.1. Avoidance

During pre-feasibility stages of project conception and design, a variety of environmental studies were undertaken. The aim of these studies was to identify environmental characteristics of the Proposal area to inform project design and engineering. In response, the project design footprint was refined to avoid the high and medium complex BCH types effectively reducing the likelihood of inducing either direct or indirect impacts.

Specific considerations addressed during the design phase include:

- The marine disturbance footprint was optimised to avoid impacts to known high value BCH areas, such as dense cover coral and seagrass and habitats
- The pond disturbance footprint has been optimised to minimise impacts to structurally complex (i.e., CC) mangrove BCH and higher productivity algal mats
- The seawater intake design and location went through multiple iterations to minimise impacts to structurally complex (i.e., CC) mangrove BCH and to avoid substantial changes to the natural tidal creek systems
- Port design was optimised to reduce overall dredging volumes (and associated dredging duration) from >1,1000,000 m^3 to <400,000 m^3
- Pond design was optimised to allow surface water flows to be maintained for McKay Creek, which is the most significant surface water creek in the Proposal area and is the primary source of freshwater to the mangrove areas on the northern extent of the Proposal area, and
- Bitterns outfall design was optimised to maximise mixing after discharge and subsequently minimise the spatial extent of the toxic bitterns outfall plume.

4.2. Dredging and Spoil Disposal Monitoring and Management Plan

Dredging and Spoil Disposal Monitoring and Management Plan (DSDMMP) developed for the Proposal includes project specific Management Targets (MTs) to mitigate the potential impacts on BCH and subsequently ensure that the EPA's objective for BCH is met, and the predicted Environmental Protection Outcomes (EPOs) are achieved. The project specific MTs for BCH include:

- Recoverable impact to BCH within the probable Zone of Moderate Impact (ZoMI)
- No reduction in the BCH outside of the probable ZoMI (within the Zone of Influence [ZoI])
- Dredging operations do not occur outside the defined dredging footprint
- Disposal operations do not occur outside the defined spoil grounds

For each of the above project specific MTs, a comprehensive set of management actions and environmental performance measures have been established and are described in the DSDMMP. The plan also includes a comprehensive tiered management framework for minimising the extent of any impacts to coral, seagrass or macroalgae BCH.

4.3. Marine Environmental Quality Monitoring and Management Plan

The Marine Environmental Quality Monitoring and Management Plan (MEQMMP) developed for the Proposal includes project specific MTs to mitigate the potential impacts on BCH because of waste bitterns discharge and operational activities, and subsequently ensure that the EPA's objective for BCH is met, and the predicted EPOs are achieved. The EPOs for Marine Environmental Quality include maintenance of:

- A Low LEP area (LEPA) designated based on modelled predictions of the bitterns plume, which determined that a 90% SPL would be achieved at the Low Ecological Protection Area (LEPA)/Moderate Ecological Protection Area (MEPA) boundary (O2Me 2023a). WET testing results presented in O2 Marine (2019a) were used to inform the number of dilutions required to meet the 90% SPL.
- A MEPA which is designated for all waters (excluding the LEPA) based on modelled predictions of the bitterns plume, which determined that a 99% SPL would be achieved at the MEPA/High Ecological Protection Area (HEPA) boundary (O2Me 2023a). WET testing results presented in O2 Marine (2019a) were used to inform the number of dilutions required to meet the 99% SPL.
- Existing LEPs as presented in DoE (2006) were retained for all other areas which include HEPA and Maximum Ecological Protection Areas (XEPA). Based on WET testing results presented in O2 Marine (2019a), O2Me 2023a) determined that a 99% SPL would be achieved at the MEPA/HEPA boundary.

5. Potential Impacts

The recently updated BCH mapping methodologies have refined the estimated extent of direct disturbance to different BCH classes. Improvements in habitat delineation have resulted in minor adjustments to the overall area of predicted impacts. The classification of BCH has been refined, particularly in areas previously categorized under broader habitat groups, leading to a more accurate representation of habitat distribution. As a result, the disturbance calculations have been updated to provide a more precise allocation of direct loss and recoverable impacts across the LAUs. These refinements ensure that impact predictions more accurately reflect the environmental conditions within the Proposal area and provide a stronger basis for environmental management and mitigation strategies. An overview of the Proposal development envelopes in relation to the refined BCH mapping is displayed in Figure 4.

5.1. Direct Impacts

Direct impacts to BCH can be attributed to the indicative area of direct disturbance as shown in Figure 6 and Figure 7. The disturbance within each of the PIDE and MDE are discussed below.

5.1.1. Pond and Infrastructure Development Envelope (PIDE)

Within the PIDE, construction of the concentration and crystalliser ponds, processing plant, desalination plant, administration, accommodation camp and associated works (access roads, laydown, etc.) will result in direct *irreversible loss* of 1175.1 ha of intertidal BCH[3], equivalent to approximately 20% of the total intertidal LAU areas. Based on the immediate nature of the proposed impacts, and spatial accuracy of the mapping, there is a high level of confidence of these impacts occurring as a result of the Proposal. Direct *irreversible loss* areas (ha) and percent of the specific BCH within the PIDE include:

- 8.3 ha (0.6%) of *A. marina* mangroves
- 415.5 ha (19.6%) of algal mat
- 676.1 ha (37.2%) of samphire shrublands, including:
  - 24.0 ha (13.2%) of samphire shrublands with dense algal mat
  - 366.9 ha (36.1%) of samphire shrublands with sparse algal mat
  - 195.1 ha (47.1%) of sparse samphire shrublands
  - 90.1 ha (44.2%) of dense samphire shrublands
- 7.5 ha (29.2%) of mixed intertidal habitat
- 67.7 ha (25.9%) of bare intertidal habitat.

[3] Note this does not include calculated loss of Terrestrial habitat (not considered intertidal BCH)

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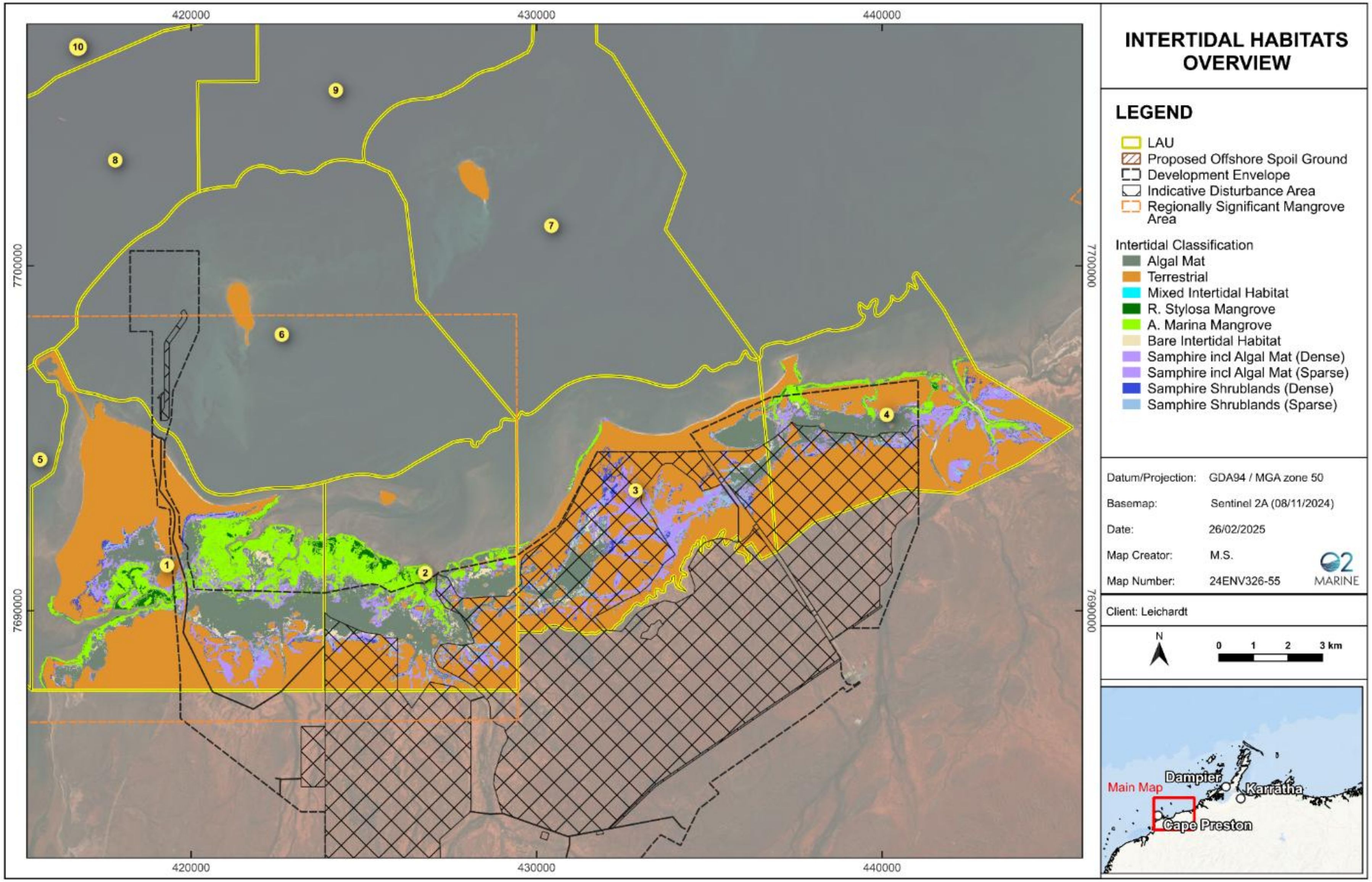

Figure 6 Direct disturbance footprints of the Proposal on terrestrial BCH

5.1.2. Marine Development Envelope (MDE)

Within the MDE and the Dredge Spoil Disposal Development Envelope (DSDDE), the indicative disturbance areas exist for the dredging footprint and the offshore disposal area respectively (Figure 7). Direct disturbance within these disturbance footprints will result in *irreversible loss* of 47ha of vegetated subtidal BCH, comprising:

- 26.5 ha (0.18%) of filter feeders dominated habitat
- 12.5 ha (1.16%) of *Pinna bicolor* beds
- 3.8 ha (0.10%) of hard coral habitat
- 3.7 ha (0.22%) of seagrass with macroalgae
- 0.4 ha (0.05%) of seagrass with filter feeders
- 0.1 ha (<0.01%) of macroalgae-dominated habitat

5.2 ha (0.009%) of bare 'unvegetated soft sediment' will also be directly impacted as a result of dredging and/or construction activities. However, this area will remain classified as bare substrate after the completion of construction and so has not been considered further in the cumulative loss assessment. Figure 7 shows the marine disturbance footprint with associated BCH mapping. Based on the immediate nature of the proposed impacts, and spatial accuracy of the mapping, there is a high level of confidence of these impacts occurring as a result of the Proposal

5.1.3. Dredge Spoil Disposal Development Envelope (DSDDE)

A further 100 ha (0.18%) of 'unvegetated soft sediment' will also be directly impacted as a result of dredge disposal activities within the DSDDE. As no BCH loss exists, this has not been considered further in the cumulative loss assessment

5.2. Indirect Impacts

5.2.1. Dredge and Disposal Sediment Plume

Indirect impacts to subtidal BCH associated with dredging may be caused due to increased suspended sediment concentration (SSC), resulting in increased turbidity, reduction in available benthic light and localised increase in sedimentation.

In accordance with guidance provided in EPA (2021b), a dredge plume impact assessment was undertaken to develop predictions of the dredging Zone of Influence (ZoI), Zone of Moderate Impact (ZoMI) and Zone of High Impact (ZoHI) for BCH in the vicinity of the dredging (O2Me 2025a).

Within the Proposal area, the BCH most at risk from indirect dredging related impacts include coral, macroalgae and seagrass BCH, whilst filter feeder communities have been shown to be tolerant to dredging related impacts (Abdul Wahab *et al.* 2019).

While baseline water quality monitoring in the Proposal area determined that the light and SSC conditions naturally exceed EPA (2021b) tolerance thresholds for coral and seagrass on occasions, the reported exceedances from site were generally confined to storm events when SSC is naturally elevated (O2M 2025c). Therefore, the EPA (2021b) thresholds for coral and seagrass were still considered appropriate for impact assessment purposes. Furthermore, seagrasses and corals are more sensitive to the effects of shading than macroalgae (EPA 2021b), and as such the assessment has focused on these BCH types. Seagrass thresholds in particular were considered to provide a reliable and conservative basis to evaluate potential impacts to macroalgae BCH, particularly as these communities are mixed in the majority of the Proposal area.

O2 Metocean undertook dredge and dredge disposal plume modelling for the refined Proposal design and updated model inputs in January 2025. Full details on the modelling rational, inputs and results are detailed in O2ME (2025). In summary, the resultant predicted impact zones[4] associated with the subtidal BCH for both disposal options (A -offshore only, and B - offshore and onshore) include:

- Moderate and High impact criteria for Seagrass (ZoMI and ZoHI) was not exceeded.
- Moderate impact criteria for Corals (ZoMI) was exceeded for possible thresholds only.
- High impact criteria for Corals (ZoHI) was not exceeded.

Irreversible Loss

Dredge plume modelling results for both coral and seagrass thresholds presented in O2Me (2025a) are shown in **Figure 7** and indicate that the Proposal will not result in any indirect *irreversible loss* impacts for either coral, seagrass or macroalgae BCH. Therefore, the disturbance area shown in **Figure 7** represents the ZoHI for coral and seagrass / macroalgae, where BCH will be directly removed from dredge activities.

Recoverable Impacts

The ZoMI was used to determine the extent of predicted *recoverable impacts* to subtidal BCH as a result of dredging. The area of *recoverable impact*s for coral BCH is shown in **Figure 7** (light blue shaded area). Model results indicate the threshold for *recoverable* impacts for seagrass/macroalgae was not exceeded, and as such no impacts to seagrass / macroalgae are anticipated.

The following estimated *recoverable impact*s to subtidal BCH as a result of indirect dredging effects include:

- 5.4 ha (0.5%) of *Pina bicolor* beds
- 0.9 ha (0.1%) of hard coral habitat
- 0.1 ha (<0.1%) of Subtidal area with no dominant habitat class

Indirect impacts are estimated from modelled scenarios layered over mapped BCH. As with all models, there are assumptions and limitations to output accuracy. Considering the relatively small spatial and temporal scale of indirect impacts related to the dredge plume, there is a moderate to high level of confidence with the calculated impacts below. Technical details related the dredge plume modelling for the Proposal is found in O2Me (2025a). The DSDMMP (O2M 2025c) outlines a conservative water quality monitoring and management program to ensure Environmental Protection Objective (EPO) are met for the respective zones of impact.

[4] Note: predicted plume impacts do not include direct loss of BCH within the dredge footprint.

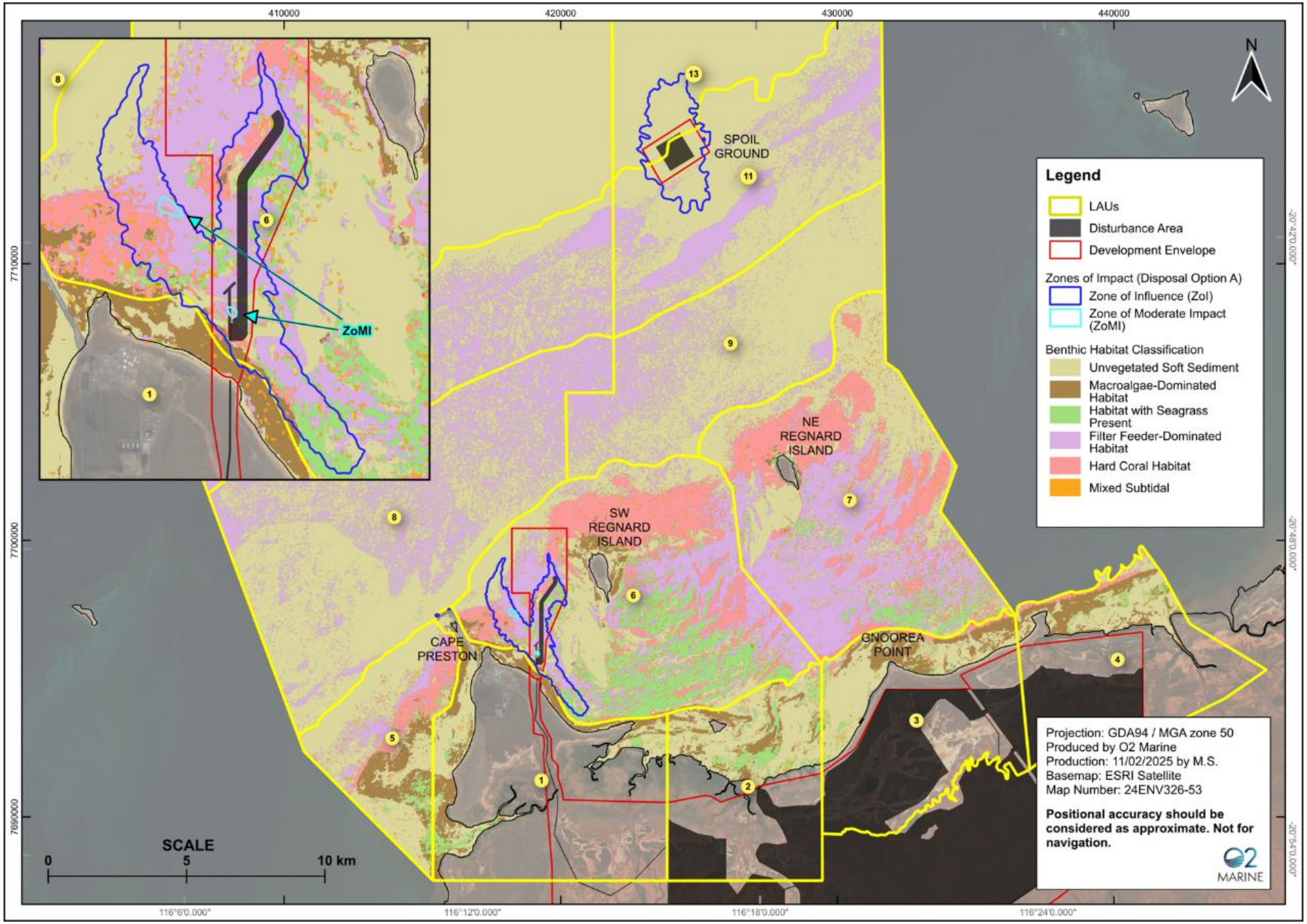

Figure 7 Predicted area of direct and indirect Impacts to coral reef BCH from dredging and dredge related operations

5.2.2. Bitterns Discharge

Indirect impacts to subtidal BCH are likely to be caused due to the discharge of hyper saline waste bitterns, which will result in a plume with increased toxicity and salinity characteristics, along with alterations to natural physico-chemical parameters (i.e., lower dissolved oxygen) (O2Me 2023a).

In accordance with guidance provided in EPA (2016b), bitterns outfall modelling (O2Me 2023a) based upon whole of effluent toxicity (WET) testing (O2M 2019a) was undertaken to predict the spatial boundaries of the LEPA and MEPA to achieve an 80% and 90% Species Protection Level (SPL), respectively. Following the testing undertaken in 2019, further work on the properties of dense brine streams has shown that previous process recovery estimates for salt were conservative. Consequently, the salt mass within the bitterns stream is estimated to be reduced by at least 15% compared to the bitterns dispersion modelling basis. This may marginally reduce the LEPA and MEPA areas, however a conservative approach has been taken, and the original LEPs have been maintained. The LEP areas are presented within Figure 8.

In the absence of an existing bitterns sample for the Proposal, the WET testing undertaken for the Mardie Project (50 km South of the Proposal) using a representative sample from Onslow Salt (O2M 2019a) was considered to be appropriate to inform impact assessment until such time as the Proposal has generated an actual representative sample for testing and model validation (required of the MEQMMP; refer Section 4.3). It is acknowledged that although the Mardie testing had some limitations due to species tested and bitterns processing procedures, the results are considered to be an appropriate proxy sample for impact assessment purposes. Since this testing, project-specific WET testing has been undertaken by Leichhardt using a comparable bitterns solution further evaporated to match the predicted concentration for the Proposal. This testing produced results which were nominally equivalent to the previous estimates based on published data for the Mardie Project WET testing.

Within the Proposal area, all subtidal BCH types (coral, macroalgae, filter feeders and seagrass) were determined to be at risk from the bitterns discharges. The discharge's plume toxicity would impact vulnerable life stages for some taxa (in accordance with the specified SPL), or from altered water quality through increased salinity or other physicochemical alterations (i.e. dissolved oxygen, pH, etc.).

Irreversible Loss

Bitterns outfall modelling (O2Me 2023a) indicates that the required 90% SPL will be achieved at the boundary of the LEPA/MEPA. Discharge of hyper saline waste bitterns is predicted to result in an indirect *irreversible loss* of the subtidal BCH within the Low LEP.

The following estimated *irreversible losses* are predicted to subtidal BCH as a result of indirect toxic effects of bitterns (these losses are inclusive of the direct disturbance impacts already present within the bitterns LEPA):

- 0.1 ha (<0.1% of LAU6) of macroalgae-dominated habitat
- 3.8 ha (<0.1% of LAU6) of hard coral habitat
- 0.4 ha (<0.1% of LAU6) of seagrass with filter feeders' assemblages
- 3.7 ha (<0.1% of LAU6) of seagrass with macroalgae-
- 12.5 ha (0.2% of LAU6) of *Pinna bicolor* beds
- 26.5 ha (0.3% of LAU6) of filter feeders' assemblages
- 1.9 ha (<0.1%) of Subtidal area with no dominant habitat class

There is a small spatial scale of estimated impacts resulting from the bitterns discharge, however, impacts may not be immediately measurable as they largely relate to changes in physico-chemical water quality conditions caused by bitterns-induced vertical stratification, leading to osmotic stress from elevated salt content or oxygen depletion and impacts to BCH. It should be noted that the bitterns outfall modelling does not predict vertical stratification occurring at known coral, seagrass or macroalgae communities. There is a reasonable level of confidence in the above mentioned irreversible loss numbers, however, the assumption and limitations of the bitterns dispersion model should be considered and are discussed further in O2Me (2023a).

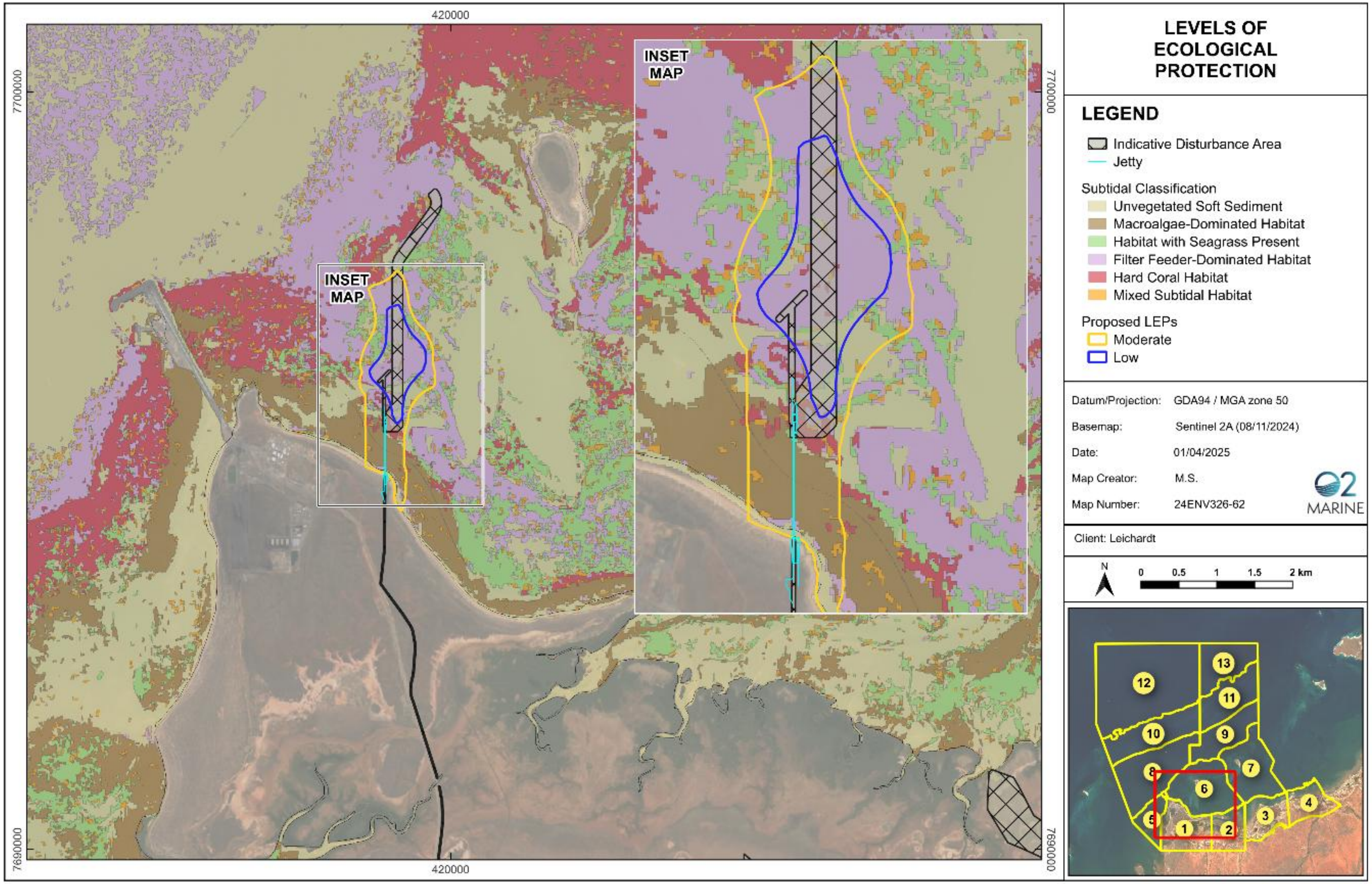

Figure 8 Predicted bitterns outfall plume shown as designated LEPs to be achieved during mixing

Surface Water Flow

The primary surface water drainage channel to the marine environment in the project area is McKay Creek. The proponent has designed the pond layout to allow surface water drainage to continue through McKay Creek to the marine environment - an area that supports intertidal samphire shrubland and algal mat – effectively directing / concentrating flows along this drainage channel.

A surface water hydrology study was undertaken by Surface Water Solutions (SWS), who determined that the net effect of the proposed ponds would act to reduce the contributing catchment area draining freshwater runoff to the marine environment by approximately 17%. SWS (2025) concluded, that in a 10% Annual Exceedance Probability (AEP)[5] event, a maximum depth reduction of 350 mm will be experienced for approximately 1.5 km downstream of the ponds, with an overall area of 6.9 km^2 experiencing a surface water reduction of >10 cm (**Figure 9**). Thus, the total volume of fresh water typically available to flush the intertidal areas downstream of the ponds during a flooding event would be appreciably reduced due to the reduced catchment surface area. Water surface elevation increases along the perimeter of the proposed ponds are limited to within approximately 500 m of the proposed pond embankments (**Figure 10**) (SWS 2025).

Despite the concentration of surface water flows through McKay Creek (as a result of engineering design), SWS (2025) predict that the ponds are not expected to significantly alter the sediment dynamics of the main creek channel, thus the risk of amplifying any natural burial or scouring patterns of BCH is considered negligible.

The overall reduction in surface water has the potential to adversely affect the intertidal samphire shrubland and algal mat BCH which occur downstream of the ponds, and which rely on this seasonal freshwater inundation. To this end, very little is known on the reliance of BCH on surface water inundation and so the severity of any impacts is unable to be accurately quantified.

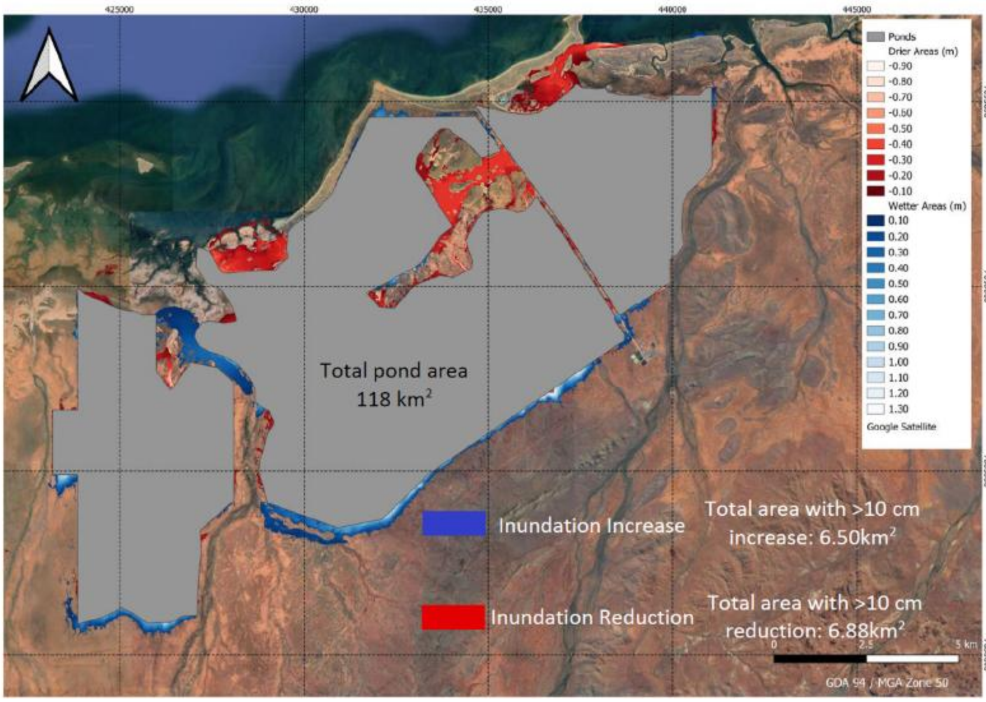

Figure 9 10% AEP maximum water surface elevation afflux (metres) area. Blue represents areas with predicted >10 cm reduction in water depth. Red areas represent a predicted >10cm increase in water depth. Source SWS (2025).

[5] An AEP event refers to the chance or probability of a natural hazard event (usually a rainfall or flooding event) occurring annually, typically expressed as a percentage.

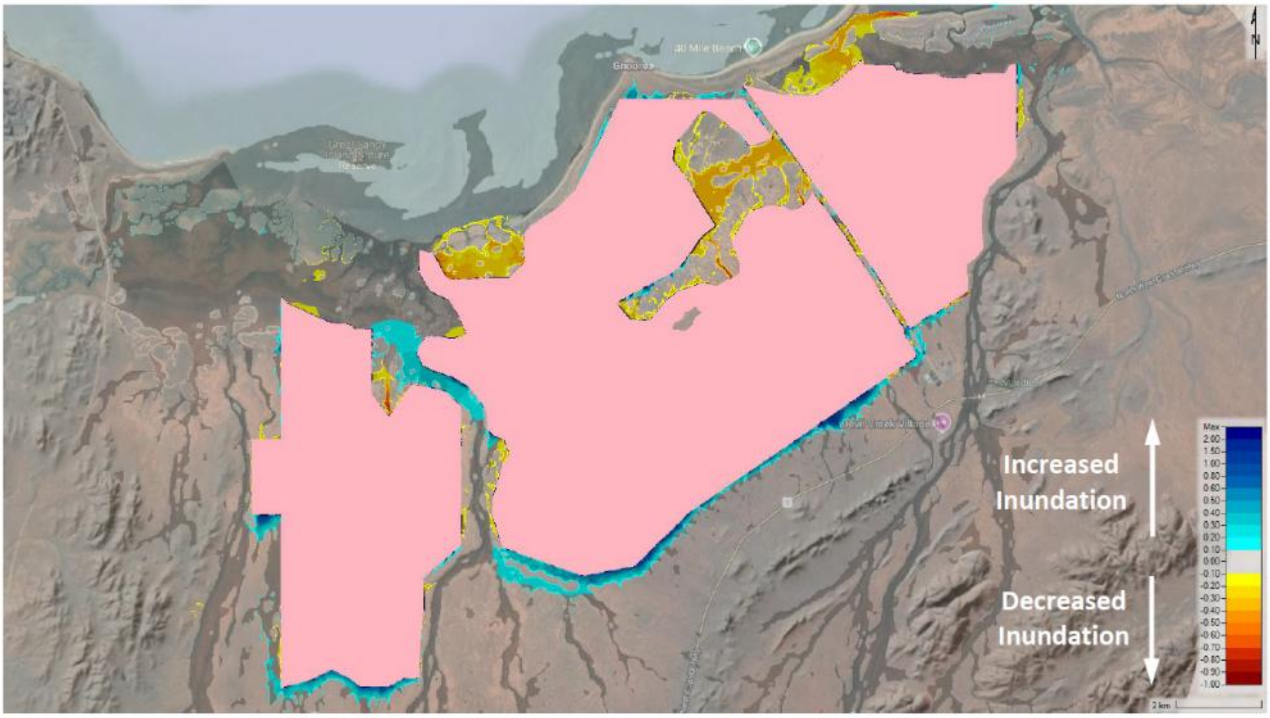

Figure 10 10% AEP maximum water surface elevation afflux (metres). Source SWS (2025).

It is considered probable that the increased concentration of flow through McKay Creek may result in some improvement in ecosystem health of mangrove and samphire communities in locations subject to greater flow. Conversely, intertidal samphire shrubland and algal mat may also be impacted in areas where flow is reduced. Given that the overall flow reduction is within the natural variability range for rainfall in the area, it is considered that decline in health in one area of BCH, may be offset by an increase in health in another area of BCH.

5.2.3. Nutrient Budget

Direct removal of BCH or disturbance to tidal flows and surface water inundation has the potential to disrupt nutrient and carbon cycling within the intertidal system and nearshore marine environment. Emplacement of the Proposal ponds will result in loss of intertidal BCH, including mudflats, algal mats, samphire shrublands and mangroves. It is well known that that CC Mangroves and their related ecosystems (especially cyanobacterial non-mat forming communities) are the single most important contributor to the nutrient budget within the Proposal area, however, the relative contribution of nutrients from other intertidal BCH to the nearshore marine environment is less well understood.

Many studies have inferred the importance algal mats play as an important nutrient source in Pilbara intertidal BCH through their nitrogen fixing properties in an otherwise nitrogen deficient system (Paling and McComb 1994; Biota 2005; URS 2010 and Stantec 2018). However, there have been limited studies quantifying specific nitrogen fixing and export loads for BCH classes or the indirect impacts on BCH and coastal environments due to loss, removal, or degradation of these communities, particularly in tropical arid zones of the Pilbara region.

A nutrient flux study (O2M 2025a) for the Proposal showed no significant increase in nutrient exchange from algal mats to the nearshore marine environment during normal spring tidal cycles.

Where possible, alterations to surface water flows from the Proposal have been avoided, with the design and location of drainage channels, which will ensure that tidal creek and coastal waters will still receive any supplementary nutrients that they may derive from stormwater and rainfall run off.

Whilst nutrient inputs via terrestrial surface water runoff will be maintained to the nearshore environment, the significant losses of algal mats predicted (i.e., 25.8%) across the Proposal LAUs mean that these episodic surface water flows will no longer have the opportunity to collect nutrients during freshwater inundation from algal mat areas. As identified above, although tidal inundation of these areas was not identified as a source of nutrient exchange to the nearshore environment, the relative contribution of nutrients during periods of freshwater inundation is not well understood and is the subject of further investigation by the Western Australian Marine Science Institute (WAMSI) as part of the offset research programs for the Mardie Project.

Nevertheless, it is known that nutrient exchange is closely linked to AGB and primary productivity, therefore any contribution of algal mats to the nearshore marine environment is likely to be near negligible in comparison to the relative contribution of the more structurally complex BCH, such as CC mangroves.

5.2.4. Coastal Processes

O2Me (2023b undertook a coastal processes assessment in accordance with the Environmental Factor Guideline – Coastal Processes (EPA 2016b) to evaluate the potential changes to intertidal BCH from altered coastal processes resulting from the Proposal. The study included a thorough review of local geology and geomorphology, sediment transport processes, analysis of historical imagery and shoreline evolution data, and assessment of project specific tidal inundation hydrodynamic modelling results.

The following key findings were made in O2Me (2023c) with regard to the coastal processes resulting from the Proposal:

- Alterations to coastal processes from the Proposal may indirectly impact tidal creeks, mudflats, mudflats with algal mats, beaches, and mangroves. Tidal creeks are considered critical feeding and reproduction habitats for marine species such as fish, crustaceans, turtles, rays, and sawfish.
- Limited historical shoreline change was observed within the studly area between 1988 and 2021 and average rates of change being less than ± 0.2 m/y.
- The mouth of McKay Creek (intake area) is currently subject to erosion on the southern bank and accretion on the northern bank, with an active erosive morphology shown in several sections of the creek.
- The largest coastal change in the study area between 1988 and 2021 occurred in 1999, most certainly following Tropical Cyclone (TC) Vance. Erosion of sandy beach (60 m) and mangrove habitat (100 m) was observed in the study area, indicating a degree of natural variability in the coastal habitats. The eroded beach widths were observed to recover to pre-erosion trends within three to four years.
- The Proposal pond footprint will likely reduce the area available for temporary retention of rainfall and storm surge-derived water supply to the intertidal habitats, which will lead to the modification of creek erosion-recovery cycles.
- Localised changes due to the combined effects of sea level rise and pond development include the increased sedimentation at McKay Creek and in the creek east of Pelican Point
- The shoreline east of McKay Creek is eroding, and this trend could be enhanced by the localised increases in current speed and bed shear stress post-development leading to localised loss of mangrove and creek habitats.

- The dredged shipping channel could trap sediment and modify post-cyclone beach recovery in that coastal compartment.

Irreversible Loss

It is likely that indirect BCH loss resulting from Proposal attributable alterations to coastal processes will be realised over a scale extending from years to decades. As such, it is difficult to accurately quantify these changes. O2Me (2023c) identified areas of natural accretion and erosion within the study area (Figure 11), and notes that the Proposal may accelerate both these processes in certain locations (i.e., McKay Creek mouth – intake). Therefore, while it is likely that some habitat will be lost; areas that support biota will also be generated. A conservative approach has been taken to estimate irreversible loss only (not gains) and focuses on impacts within five years of the Proposal construction, as per guidance in EPA (2016a).

The estimated indirect loss resulting from alterations to coastal processes includes:

- 1.7 ha (0.7% of LAU2 or 0.2% of all LAUs) of CC mangroves (*A. marina*) located adjacent to seawater intake at McKay Creek.

The area of loss represents a worst-case scenario, which assumes shoreline areas identified to be naturally eroding, will retreat faster than they would otherwise naturally (1 m every year for five years has been used to calculate BCH loss). Given the huge variability in the coastal processes in this environment, combined with the long temporal scales at which changes occur, the confidence in the accuracy of these estimated losses is considered low.

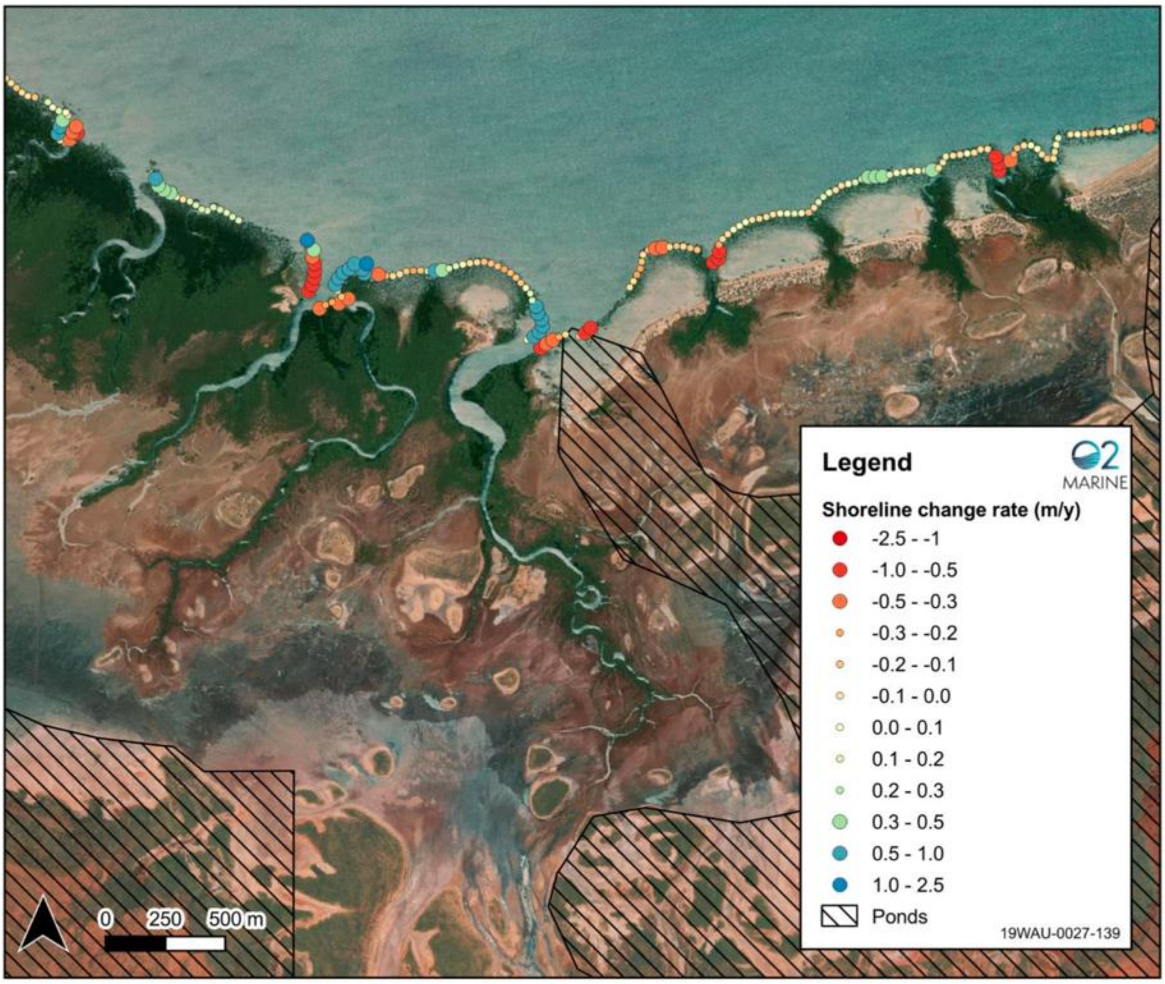

Figure 11 Predicted natural shoreline change at the entrance to McKay Creek.

5.2.5. Groundwater Seepage

The results of groundwater modelling studies undertaken by CDM Smith (2024) found that:

- Under pre-operation (baseline) conditions, the majority of groundwater inflow occurs from the sea, while the groundwater outflow occurs mostly as groundwater evapotranspiration (ET) in low-lying backwater areas (not discharged to the sea)
- Seepage recharge from the evaporation ponds may lead to greater groundwater discharge to the sea. This impact, however, will likely be dampened by increased groundwater ET in the backwater areas as a result of additional infiltration from the evaporation ponds
- The impact of sea level rise is expected to be limited to the area immediately adjacent to the coast in the northwest of the Proposal area, possibly due to the buffering of groundwater ET within the backwater areas
- The long-term seepage recharge rate is estimated to range between 34 and 54 mm/y.

In consideration of the above hydrogeological conceptualisation, the CDM Smith (2024) study concluded the following regarding risk of groundwater seepage impacts to BCH in the Proposal:

- Algal mat and samphire communities are unlikely to be threatened by the Proposal due to their tolerance of hypersaline conditions

- Mangrove communities are unlikely to be affected by the Proposal as the direct effects from water impoundment are buffered by increased groundwater ET within the backwater area separating the mangrove communities from the evaporation ponds.

Considering these determinations, it was considered unlikely that a quantitative assessment of impacts of groundwater intrusion on BCH would lead to a more informed outcome and as such, no further modelling was considered necessary to understand impacts. More detail regarding groundwater and potential impacts from hypersaline water is contained within the CDM Smith (2024), and is presented as a separate appendix within the Environmental Referral Document. Please refer to this study for more information.

5.2.6. Pond Wall Failure

The Proposal pond walls have been designed in accordance with international standards. The specifications of the pond wall design are presented together with expert review of the risk of pond wall failure in CMW Geosciences (2022). The CMW Geosciences (2022) geotechnical review found that the pond wall design includes a significant safety factor, which sufficiently mitigates the risk of pond wall failure. As such no impacts to BCH are predicted as a result of pond wall failure.

5.2.7. Leaks or Spills of Hydrocarbons or Chemicals

Leaks or spills of hydrocarbons have the potential to impact on BCH communities. However, the Proponent will develop and implement environmental management plans incorporating controls to mitigate the risk of hydrocarbon spills to the marine environment. Therefore, the risk of any significant impacts as a result of hydrocarbon spill are very low and as such resultant impacts are not predicted.

5.2.8. Introduction of Marine Pests

MScience (2025) identified the introduction of marine pests or invasive marine species to the Proposal area as a low risk. Pilbara Ports is also responsible for oversight Port operations, and they have extensive monitoring and management procedures in place which further mitigate marine pest risks. Therefore, no impacts to BCH are predicted for the Proposal as a result of this risk.

6. Cumulative Loss Assessment

Cumulative loss of each BCH type in each affected LAU (i.e., LAUs with no impacts are not included in these tables) are presented in Table 8. Consistent with EPA (2016a), these tables include:

- The pre-European extent (ha) of each BCH type
- The current extent (ha and % of pre-European conditions) of each BCH type
- The extent (ha and % of pre-European conditions) of *irreversible loss* and *recoverable impacts* for each affected BCH type after the mitigation hierarchy has been applied
- The extent (ha and % of pre-European conditions) of cumulative loss (excluding *recoverable impacts*) for each BCH type, considering historic loss (i.e., difference between current extent and pre-European conditions) and *irreversible loss* associated with the Proposal activities.

Refinements in BCH mapping and classification have improved the accuracy of these cumulative loss estimates, ensuring a more precise evaluation of potential impacts. These updates allow for better differentiation between recoverable and irreversible impacts.

In summary Table 8 demonstrates that the Proposal will result in cumulative *irreversible loss* of the following BCH over the entire Proposal area (i.e., including all LAUs):

- 7.5 ha (29.2%) of mixed intertidal habitat
- 67.7 ha (25.9%) of bare intertidal habitat
- 9.7 ha (0.7%) of *A. marina* mangroves
- 679.7 ha of samphire habitats, including:
  - 370.5 ha (36.4%) of samphire shrublands (sparse) including algal mat
  - 24.0 ha (13.2%) of samphire shrublands (dense) including algal mat
  - 195.1 ha (47.1%) of sparse samphire shrublands
  - 90.1 ha (44.2%) of dense samphire shrublands
- 424.0 ha (19.6%) of algal mat
- 120.9 ha (0.2%) of unvegetated soft sediment
- 1.9 ha (0.2%) of mixed subtidal habitat
- 0.1 ha (<0.1%) of macroalgae-dominated habitat
- 31.8 ha (0.8%) of hard coral habitat
- 0.4 ha (0.1%) of seagrass with filter feeders
- 3.7 ha (0.2%) of seagrass with macroalgae
- 12.5 ha (1.2%) of *Pinna bicolor* beds
- 26.5 ha (0.2%) of filter feeders dominated habitat

Recoverable impacts were also predicted for:

- 0.9 ha (0.0%) of hard coral habitat
- 5.4 ha (0.5%) of *Pinna bicolor* beds.

Table 8 BCH cumulative loss assessment (Area expressed hectares & % of current or pre-European extent per LAU). Any losses greater than 10% of the pre-European extent are bold. Note LAUs with no impacts are not included.

LAU	Loss Assessment	Area (ha) & % within LAU	Intertidal BCH										Subtidal BCH							
			Algal Mat	Terrestrial	Mixed Intertidal	R. stylosa Mangrove	A. marina Mangrove	Bare Intertidal Habitat	Samphire incl algal mat (sparse)	Samphire incl algal mat (dense)	Samphire shrublands (sparse)	Samphire shrublands (dense)	Unvegetated Soft Sediment	Mixed Subtidal	Macroalgae-Dominated Habitat	Hard Coral Habitat	Seagrass with Filter feeders	Seagrass with macroalgae	Filter feeders with Pinna bicolor beds	Filter feeders
LAU1	Pre European	Ha	825.2	2381.2	8.6	49.3	708.9	102.2	243.7	71.0	70.4	54.6	686.8	38.3	520.8	36.3	93.5	16.3	0.1	14.5
	Current Extent	Ha	816.7	2438.5	8.6	49.3	707.5	102.2	240.1	71.0	70.4	54.6	671.1	38.3	520.8	8.3	93.5	16.3	0.1	14.5
		%	99.0	102.4	100.0	100.0	99.8	100.0	98.5	100.0	100.0	100.0	97.7	100.0	100.0	22.9	100.0	100.0	100.0	100.0
	Irreversible Loss	Ha	0.2	17.7	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		%	0.0	0.7	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Recoverable Impact	Ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Cumulative Loss	Ha	8.7	-39.6	0.0	0.0	1.4	0.1	3.6	0.0	0.0	0.0	15.7	0.0	0.0	28.0	0.0	0.0	0.0	0.0
		%	1.1	-1.7	0.0	0.0	0.2	0.1	1.5	0.0	0.0	0.0	2.3	0.0	0.0	**77.1**	0.0	0.0	0.0	0.0
LAU2	Pre European	Ha	616.9	795.3	6.0	37.2	375.6	67.6	194.2	33.0	68.5	31.8	960.3	61.5	277.5	18.3	145.8	79.6	1.0	20.3
	Current Extent	Ha	616.9	795.3	6.0	37.2	375.6	67.6	194.2	33.0	68.5	31.8	960.3	61.5	277.5	18.3	145.8	79.6	1.0	20.3
		%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Irreversible Loss	Ha	93.6	631.0	1.8	0.0	6.4	21.9	80.9	11.3	48.1	18.2	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		%	15.2	79.3	30.1	0.0	1.7	32.4	41.7	34.2	70.2	57.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Recoverable Impact	Ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Cumulative Loss	Ha	93.6	631.0	1.8	0.0	4.7	21.9	80.9	11.3	48.1	18.2	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		%	**15.2**	**79.3**	**30.1**	0.0	1.3	**32.4**	**41.7**	**34.2**	**70.2**	**57.2**	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LAU3	Pre European	Ha	344.7	2061.6	6.2	0.7	17.8	54.6	372.4	14.7	176.8	79.7	810.6	40.6	348.4	90.7	34.6	35.4	2.6	8.2
	Current Extent	Ha	344.7	2061.6	6.2	0.7	17.8	54.6	372.4	14.7	176.8	79.7	810.6	40.6	348.4	90.7	34.6	35.4	2.6	8.2
		%	100.0	100.0	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Irreversible Loss	Ha	221.2	1210.6	4.7	0.0	0.8	40.9	237.5	10.2	113.2	64.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		%	64.2	58.7	75.8	0.0	4.5	74.9	63.8	69.4	64.0	80.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Recoverable Impact	Ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Cumulative Loss	Ha	221.2	1210.6	4.7	0.0	0.8	40.9	237.5	10.2	113.2	64.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		%	**64.2**	**58.7**	**75.8**	0.0	4.5	**74.9**	**63.8**	**69.4**	**64.0**	**80.6**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LAU4	Pre European	Ha	379.4	1759.9	4.9	7.3	186.1	36.9	208.6	63.4	98.6	37.7	491.9	34.8	315.5	65.2	31.0	35.0	11.7	4.6
	Current Extent	Ha	379.4	1759.9	4.9	7.3	186.1	36.9	208.6	63.4	98.6	37.7	491.9	34.8	315.5	65.2	31.0	35.0	11.7	4.6
		%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Irreversible Loss	Ha	100.5	816.4	1.0	0.0	1.1	4.8	48.5	2.5	33.8	7.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		%	26.5	46.4	20.4	0.0	0.6	13.0	23.3	3.9	34.3	20.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Recoverable Impact	Ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Cumulative Loss	Ha	100.5	816.4	1.0	0.0	1.1	4.8	48.5	2.5	33.8	7.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		%	**26.5**	**46.4**	**20.4**	0.0	0.6	**13.0**	**23.3**	3.9	**34.3**	**20.4**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LAU6	Pre European	Ha	0.0	70.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2215.0	332.3	223.1	1750.2	358.9	1086.8	758.8	1337.9
	Current Extent	Ha	0.0	70.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2215.0	332.3	223.1	1750.2	358.9	1086.8	758.8	1337.9
		%	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Irreversible Loss	Ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	1.9	0.1	3.8	0.4	3.7	12.5	26.5

LAU	Loss Assessment	Area (ha) & % within LAU	Intertidal BCH										Subtidal BCH							
			Algal Mat	Terrestrial	Mixed Intertidal	R. stylosa Mangrove	A. marina Mangrove	Bare Intertidal Habitat	Samphire incl algal mat (sparse)	Samphire incl algal mat (dense)	Samphire shrublands (sparse)	Samphire shrublands (dense)	Unvegetated Soft Sediment	Mixed Subtidal	Macroalgae-Dominated Habitat	Hard Coral Habitat	Seagrass with Filter feeders	Seagrass with macroalgae	Filter feeders with Pinna bicolor beds	Filter feeders
		%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.6	0.0	0.2	0.1	0.3	1.6	2.0
	Recoverable Impact	Ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.9	0.0	0.0	5.4	0.0
		%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.7	0.0
	Cumulative Loss	Ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	2.0	0.1	4.7	0.4	3.7	17.9	26.5
		%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.6	0.0	0.3	0.1	0.3	2.4	2.0
LAU11	Pre European	Ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4461.2	0.0	0.0	0.0	0.0	0.0	0.0	1622.4
	Current Extent	Ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4461.2	0.0	0.0	0.0	0.0	0.0	0.0	1622.4
		%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
	Irreversible Loss	Ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	79.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Recoverable Impact	Ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Cumulative Loss	Ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	79.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LAU13	Pre European	Ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5890.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Current Extent	Ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5890.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Irreversible Loss	Ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Recoverable Impact	Ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Cumulative Loss	Ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Totals	Pre European	Ha	2166.2	6998.0	25.7	94.5	1288.4	261.3	1018.9	182.1	414.3	203.8	56120.0	923.6	2066.7	3834.5	758.3	1682.9	1075.2	14409.9
	Current Extent	Ha	2157.7	7055.3	25.7	94.5	1287.0	261.3	1015.3	182.1	414.3	203.8	56104.3	923.6	2066.7	3806.5	758.3	1682.9	1075.2	14409.9
		%	99.6	100.8	100.0	100.0	99.9	100.0	99.6	100.0	100.0	100.0	100.0	100.0	100.0	99.3	100.0	100.0	100.0	100.0
	Irreversible Loss due to the Proposal	Ha	415.5	2675.7	7.5	0.0	8.3	67.7	366.9	24.0	195.1	90.1	105.2	1.9	0.1	3.8	0.4	3.7	12.5	26.5
		%	19.3	37.9	29.2	0.0	0.6	25.9	36.1	13.2	47.1	44.2	0.2	0.2	0.0	0.1	0.1	0.2	1.2	0.2
	Recoverable Loss due to the Proposal	Ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.9	0.0	0.0	5.4	0.0
		%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0
	Cumulative Loss since Pre-European Extent	Ha	424.0	2618.4	7.5	0.0	9.7	67.7	370.5	24.0	195.1	90.1	120.9	1.9	0.1	31.8	0.4	3.7	12.5	26.5
		%	19.6	37.4	29.2	0.0	0.8	25.9	36.4	13.2	47.1	44.2	0.2	0.2	0.0	0.8	0.1	0.2	1.2	0.2

7. Consequences

7.1. Mangroves

O2 Marine (2025a) determined that the two mangrove species identified during this survey (*R. stylosa* and *A. marina*) are known to have broader distributions across the Asia-Pacific, are characteristic of the regional area, and have no elevated conservation significance. Mangrove associations and functional groups identified are typical of mangrove communities within the regional Pilbara area, along with the wider Pilbara and Canning coasts of North-western Australia.

Of the 1,381.5 ha of mangroves identified across the Proposal area, an irreversible loss of 8.3 ha (0.6%) is predicted. The cumulative loss since pre-European times is 9.7 ha (0.7%).

The area of impact has been significantly reduced as a result of the Proponent re-designing and minimising the development footprint, which previously had a predicted impact of 39.9 ha of mangrove.

All irreversible loss is contained within LAU2, which importantly, is encompassed by the RSMA #9. The Proposal design was modified to ensure minimal loss occurred within LAU2, and that zero irreversible loss to mangroves will occur in LAU1, LAU3 or LAU4.

O2 Marine (2025a) identified mangroves as being the most ecologically important intertidal BCH within the Proposal area, particularly CC mangroves, due to the range of ecological services in which they provide to adjacent BCH and coastal waters. Mangroves are the most significant primary and secondary producers in the intertidal ecosystem, with production rates among all other BCH being near negligible in comparison (Alongi 2009; Holguin *et al* 2001; O2M 2025a). Due to their structural complexity and biomass, they also serve as shelter, feeding, nursery and breeding zones for crustaceans, molluscs, fish, and resident and migratory birds.

All efforts have been made during the Proposal design and engineering stages to maintain maximum mangrove extent and biomass. This has resulted in a very limiting irreversible loss to 8.3 ha. No further indirect effects are predicted. No further net indirect effects are predicted from this Proposal. To put this in another context, approximately 1373.2 ha of healthy and resilient mangrove habitat will remain within the Proposal study area which equates to 99.5% of all mangroves that existed since pre-human disturbance. Considered within this context, the predicted irreversible impact to mangrove habitat and cumulative loss from the Proposal is not considered to pose a significant risk to ecological integrity and biological diversity within the LAUs or the broader marine environment. Therefore, the risk of impact to biological diversity and ecological integrity of mangrove communities is not considered significant.

In the context of RSMA #9 Guideline 3 (EPA 2001), the proponent has demonstrated a significant understanding of the mangrove habitats, dependant habitats and ecological function of mangroves (Section 7.4 and 9.1.1 of O2M (2023a)), and within this document, identifies the environmental significance of the predicted cumulative loss of 1% of all mangroves across the Proposal area. The Proponent has implemented several design changes (Section 4.1) to minimise impacts to mangroves (and algal mats), with the aim to maintain biological value and environmental quality of the area. All efforts have been made to meet the EPA's operational objective for

Guideline 3 (EPA 2001), which states: "no development should take place that would significantly reduce the mangrove habitat or ecological function of the mangroves in these areas' (EPA 2001).

7.2. Samphire Shrublands

An *irreversible loss* of 676.1 ha (37.2%) of habitats containing samphire shrublands is predicted to occur as a result of the Proposal with a cumulative loss of 679.7 ha (37.4%) since pre-European times.

The predicted losses include the following four samphire habitat categories:

- 370.5 ha (36.4%) of sparse samphire including algal mat
- 24.0 ha (13.2%) of dense samphire including algal mat
- 195.1 ha (47.1%) of sparse samphire shrublands
- 90.1 ha (44.2%) of dense samphire shrublands

These losses are likely to be considered significant, however, the functional ecological value and regional significance of this habitat is considered and assessed as part of the Terrestrial Flora and Vegetation impacts, and such are not discussed further within this BCH CLA report.

7.3. Algal Mats

An *irreversible loss* of 415.5 ha (19.2%) of algal mat habitat is predicted to occur as a result of the Proposal with a marginally higher cumulative impact of 424.0 ha (19.6%) predicted. Algal mats have been included across three BCH categories 'Algal mat' , 'Sparse Samphire shrublands (inclusive of algal mat)' and Dense Samphire shrublands (inclusive of algal mat)'. Therefore, the total irreversible loss across all three categories is 806.4 ha (23.9%), with a cumulative loss of 818.5 ha (24.3%).

Prior to the Proponent re-designing the pond and infrastructure to boundaries to minimise impacts, 1537.5 ha of algal mat were predicted to be lost, meaning the current Proposal will have less impact to algal mats by 731.1 ha, lowering the total predicted loss to 806.4 ha.

The importance of algal mats to the broader marine environment are not well understood. If significant losses of tidal samphire mudflats and blue green algal mats are predicted, such as for this Proposal, the EPA expects that studies are undertaken to understand the ecological role of these habitats and the potential consequences of any losses.

O2 Marine (2025a) determined that the diversity and species composition of algal taxa are representative of algal mat habitats occurring regionally within the Pilbara, whilst the taxa identified are typically those associated with algal communities found elsewhere in Australia and overseas. Although mats are known to play an important role in nitrogen fixing within the Pilbara, it is also the case that nitrogen fixing cyanobacteria are present within most intertidal BCH, including areas with mangroves. Whilst the predominately cyanobacterial algal mat communities form a higher standing biomass, the cyanobacterial communities associated with mangroves are likely to be higher in primary productivity (non-seasonal) and due to lower associated soil salinities also support significant secondary productivity (grazing by primary heterotrophs) and therefore play a more valuable ecological function within the intertidal ecosystem. Algal mat communities as mapped, are limited in their ability to export significant nutrient loads due to their lack of connectivity via nutrient flow pathways. Algal mats also do not provide three-dimensional structural complexity that can provide ongoing support and maintenance of the biodiversity, ecological integrity, and functionality within the study area.

Given the considerable area of algal mats which occur within the Proposal area, the Proponent has undertaken studies (implemented by Actis Environmental Services (AES)), with the aim to quantifying algal mat loss as a proportion of primary productivity from within the intertidal zone, and to better understand the nutrient exchange with the nearshore marine environment (AES 2023). The rationale for considering the impacts in this way is underpinned by the assumptions that:

- Some algal mats are more productive than others and as such design mitigation measures may be applied to avoid or minimise more productive mats
- Algal mats only contribute an extremely small proportion of the overall productivity of the intertidal zone (when compared to mangrove areas).

The AES (2023) study provides a more informed assessment of the ecological significance of potential losses associated with the Proposal in terms of primary productivity, delivery of ecosystem services, ecological resilience and potential consequences to intertidal and offshore habitats and ecosystems. The study determined that Chlorophyll *a* provides a useful tool for determining the activity of the tidal benthic mat. The active section of the mat is the top layer, and little photosynthesis occurs below this layer. Results identified that the highest Chlorophyll *a* concentration sampled across the Proposal study area did not approach the concentration found elsewhere in the Pilbara. Based on these results, the Proposal disturbance area is not considered a major contributor of primary productivity to the nearshore environment as other areas (AES 2023). However, ongoing studies and data collection will add certainty to this conclusion (AES 2023). The study (AES 2023) has been supplied as an additional appendix to the ERD.

7.4. Coral

An *irreversible loss* of 3.8 ha (0.1%) of coral reef is predicted to occur as a result of the Proposal across the total study area (all LAUs). The cumulative loss of coral reef is 31.8 ha (0.8%). O2M (2025b) determined that the low-moderate coral predicted to be lost is well represented throughout the LAUs and is extensively well represented throughout the region. This area of coral is not considered to have conservation significance, and the level of change is far less than what would likely occur as a result of annual variation associated with natural disturbance events such as anomalous water temperatures and cyclones (O2M 2025b).

Although this BCH is also known to provide suitable habitat for a variety of marine fauna species, the cumulative loss of 31.8 ha is not considered a significant risk to the ecological integrity and biological diversity of this BCH.

7.5. Seagrass

An *irreversible loss* of 4.1 ha (0.5%) of seagrass habitat is predicted to occur as a result of the Proposal across the total study area (all LAUs). The cumulative loss of seagrass is also 4.1 ha, representing 0.17% of the pre-European seagrass extent.

Seagrass BCH has been categorised into two distinct habitat types: 'Seagrass with Filter Feeders' and 'Seagrass with Macroalgae'. O2M (2025b) determined that the seagrass habitats are well represented throughout the LAUs and the region generally. All of the 2441.2 ha of seagrass mapped was identified as low to moderate benthic cover. This very small amount of cumulative loss is well within the temporal range of abundance to this habitat type (Vanderkilft *et al* 2017a), including seasonal variation and constantly changing substrate in response to physical disturbance from cyclones, wave mobilisation of sediments during the wet season and potential flash flooding and attendant sediment loads during heavy rainfall events.

Many Pilbara seagrass species also have the capacity to recover from disturbance within relatively short time frames. Small-leaved species of seagrasses are often characterised by natural patterns of loss and recovery over time periods spanning months or longer. Recovery from disturbances that remove seagrass from relatively small areas should occur within months, via vegetative growth or seeds, provided that sufficient meadow remains for rhizomes to colonise from (Vanderklift *et al*. 2017b).

Although this BCH is also known to provide suitable habitat for a variety of marine fauna species, the loss of 4.1 ha is not considered a significant risk to the ecological integrity and biological diversity of this BCH.

7.6. Macroalgae

An *irreversible loss* of 0.1 ha (<0.01%) of macroalgae -dominated habitat is predicted to occur as a result of the Proposal across the total study area (all LAUs). No irreversible loss of HC Macroalgae is predicted. Macroalgae is included in a second category (seagrass with macroalgae), with an irreversible loss of 3.7 ha, therefore, the total irreversible loss for macroalgae across the two categories is 3.8 ha (<0.01%).

O2M (2023b) determined that the Macroalgae BCH is well represented throughout the LAU and is extensively well represented throughout the region. Due to varied methods of reproduction and regrowth potential of macroalgae some of this direct loss is predicted to recover within the marine disturbance footprint post-dredging where suitable benthic substrate remains e.g., on the dredged channel slope.

Although this BCH is also known to provide suitable habitat for a variety of marine fauna species, the small predicted loss is not considered a significant risk to the ecological integrity and biological diversity of this BCH.

7.7. Filter Feeders

An irreversible loss of 12.5 ha (1.2%) of *Pinna bicolor* beds, 0.4 ha (0.1%) of seagrass with filter feeders, and 26.5 ha (0.2%) of general filter feeder BCH is predicted to occur as a result of the Proposal across the total study area (all LAUs). The total cumulative loss of filter feeders (across the three categories) is 39.4 ha (0.2%).

O2 Marine (2023b) determined that filter feeders, including *Pinna bicolor* beds, are well represented throughout the LAUs and are extensively well represented throughout the region. Further benthic filter feeder habitat in the vicinity of the Proposal is comprised mostly of sparse communities. Given the extensive distribution of filter feeder assemblages and their ability to recruit to suitable substrate, the predicted loss is not considered a significant risk to the ecological integrity and biological diversity of this BCH.

8. Conclusion

The Proposal will contribute to cumulative irreversible loss of BCH across the entire Proposal area, with the most notable impacts occurring in intertidal and subtidal habitats. Refinements in BCH classification and mapping have allowed for a more accurate assessment of these losses, ensuring that impact calculations align with updated environmental guidelines and methodologies.

The cumulative irreversible loss associated with the Proposal includes:

- 8.3 ha (0.6%) of mangroves, including:
  - 8.3 ha (0.6%) of *A.marina* mangrove
  - 0.0 ha (0.0%) of *R. stylosa* mangrove
- 679.7 ha (36.7%) of samphire shrublands, including:
  - 370.5 ha (36.4%) of sparse samphire shrublands (inclusive of algal mat)
  - 24.0 ha (13.2%) of dense samphire shrublands (inclusive of algal mat)
  - 195.1 ha (47.1%) of sparse samphire shrublands
  - 90.1 ha (44.2%) of dense samphire shrublands
- 424.0 ha (19.6%) of algal mats
- 7.5 ha (29.2%) of mixed intertidal BCH
- 31.8 ha (0.8%) of coral reef
- 39.0 ha (0.3%) of filter feeders, including:
  - 12.5 ha (1.2%) of *Pinna bicolor* beds
  - 26.5 ha (0.2%) of general filter feeder BCH
- 0.1 ha (<0.01%) of macroalgae dominated habitat
- 4.1 ha (<0.01%) of macroalgae, including:
  - 3.7 ha (0.2%) of seagrass with macroalgae
  - 0.4 ha (0.1%) of seagrass with filter feeders
- 1.9 ha (0.2%) of mixed subtidal BCH

Overall, this cumulative loss assessment determined that the impacts to subtidal BCH, were unlikely to result in a significant risk of impacting biological diversity and ecosystem integrity. The subtidal BCH found within the study area included areas of high value coral reef and seagrass habitats, however, where losses were identified, these were typically the lowest density of BCH mapped within the study. In addition, it is further considered that the predicted recoverable impacts to subtidal BCH can be managed through the implementation of a comprehensive DSDMMP and MEQMMP, respectively. If managed effectively, project impacts to subtidal BCH are not considered to be significant.

The intertidal BCH assessed within the Proposal study area were found to be commonly distributed throughout the wider Pilbara region, with many having distributions within the Australian tropics and or internationally. All of the species identified during the assessment are also typically found within a broader geographical distribution.

The coastal habitats within the Proposal study area have not been identified as supporting significant ecological communities warranting protection through the introduction of marine or terrestrial reserves. There are no implications from any of the proposed Commonwealth Marine Reserves for the Proposal as the coastal location is contained completely within State Waters. Whilst no formal reserves have been established, one area relevant to the Proposal (and which applies to LAU 1 and LAU2) has been identified by (EPA 2001) as regionally significant for mangroves and is considered to have very high conservation value (RSMA #9).

The pre-feasibility studies and environmental investigations have directed appropriate mitigation through the engineering and development phases of the Proposal. This has ensured that the structurally complex BCH, such as mangroves, coral, seagrass and macroalgae, which are required for ongoing support and maintenance of the biodiversity, ecological integrity, and functionality within the study area, will not incur any significant cumulative losses. Where cumulative losses have been calculated, the impact upon biodiversity and ecological integrity is predicted to be negligible.

The majority of the direct losses will be of BCH types that are both well represented elsewhere in the respective LAUs and the wider region and therefore the contribution of these BCH types to ecosystem functions, integrity and biodiversity will not be impaired.

The Proponent's assessment of impacts from the Proposal to BCH has considered the following aspects:

- Avoidance and minimisation measures to reduce potential impacts from the Proposal including:
  - The marine disturbance footprint has been optimised to avoid impacts to known high value BCH areas such as dense cover coral and seagrass and habitats
  - Limiting dredging to April to September to avoid sensitive ecological windows such as coral spawning and peak seagrass abundance This period also results in the smallest ZoMI of the modelled scenarios
  - Setting the pond layout behind and away from regionally significant mangroves and algal mats where possible
  - Seawater intake limited to one creek and use of best practice seawater intake design to avoid substantial changes to the natural tidal creek systems
  - Bitterns outfall design has been optimised to maximise mixing after discharge and subsequently minimise the spatial extent of the toxic bitterns outfall plume
  - Pond design has been optimised to allow surface water flows to be maintained for McKay Creek, which is the most significant creek in the Proposal area and is the primary source of freshwater to the highest value mangroves in LAU2
- The proportion of predicted permanent loss to structurally complex BCH, known to have ecological importance, represents a very small proportion of each habitat type across the total study area
- The proposed monitoring of changes to physical and ecological processes, during the construction and operational phase of the Proposal (within DDMMP and MEQMMP), that could lead to further potential indirect loss of BCH
- The proposed management actions (within DDMMP and MEQMMP), should changes to physical or ecological processes be detected, to prevent further indirect impacts to BCH.

Given the above, it is considered that the Proposal, if implemented, will not have a significant impact on the structurally complex, high value subtidal BCH (i.e., coral, seagrass and macroalgae) and that it would meet the EPA's Objective for these BCH with ecological integrity and biological diversity being maintained.

In consideration of impacts to intertidal BCH, the overall loss of mangroves is not considered to be significant with ecological integrity and biological diversity of these communities being maintained. It is noted that a small area of mangroves (6.6 ha) is expected to be lost within the RSMA #9. However, it is suggested the operational objective for Guideline 3 (EPA 2001), which states: "no development should take place that would significantly reduce the mangrove habitat or ecological function of the mangroves in these areas" has been met.

For the remaining intertidal BCH, consistent with other solar salt facilities, the losses of algal mats, mudflats and samphire are significant as this BCH is dominant across ideal solar salt production areas. However, the functional ecological value of these communities is not well understood. Therefore, biodiversity and ecological integrity of these BCH should be considered as at risk as a result of this Proposal.

9. Cumulative Impacts of Existing and New Salt Projects

Although the impacts (individual and cumulative) to BCH from this Proposal are considered to be acceptable, there is potentially broader and more significant cumulative impacts to BCH from the numerous existing and other proposed solar salt farms across the West Pilbara. Following its recent assessment of a new salt farm Proposal in the West Pilbara, the EPA provided advice that the risk of cumulative impacts specifically relates to intertidal BCH in the region and that future proposals need to assess potential cumulative impacts to these habitats.

Solar salt farms have the potential to significantly impact intertidal BCH in the West Pilbara region and disrupt the ecological services which they provide. There are currently three existing solar salt farms in the West Pilbara region, one new approved proposal currently being developed and two new proposals that are being assessed by the EPA. Given the number and scale of these developments within the intertidal zone there is a need to understand the cumulative impact to BCH at both local and regional scales.

Mangroves are well known to deliver the highest level of ecosystem services in terms of coastal stabilisation, carbon sequestration, habitat, and enrichment of coastal waters (Almahasheer *et al*. 2017, Kathiresan and Bingham 2001). Mangroves are also known to have a particularly important role in the intertidal zone, so potential loss at a regional scale is a significant concern, particularly to mangroves identified in the EPA's Advice: Protection of Tropical Arid Zone Mangroves Along the Pilbara Coastline (EPA 2001).

Mangrove loss from older salt farms was higher (more than double) than new or future proposals which are required by the EPA to avoid or minimise loss to mangroves. For example, for this Proposal the ponds have been located behind and away from regionally significant mangroves (where possible) resulting in a loss of only 0.6% of mangroves across the total study area and only 0.03% of highest value CC mangroves. If this proportion of permanent loss to mangroves (which is critical fish habitat) was experienced from all salt farms across the West Pilbara it would be reasonable to consider this would meet the EPA's Objective for BCH and that ecological integrity and biological diversity would be maintained at local and regional scales.

However, this does not consider the potential cumulative impacts to tidal samphire mudflats and blue green algal mats from existing and proposed farms which compared to mangroves is much greater in terms of spatial extent. It is estimated that in the West Pilbara up to approximately 30% of this habitat type could be lost due to existing and proposed salt farms. The tidal samphire mudflats and algal mats are at the other end of the scale, supporting little life with low ecosystem value (Biota 2005).

The ecological role and importance of tidal samphire mudflats and blue green algal mats is not well understood, even though it is one of the key community types affected by salt farms. The current lack of knowledge on the importance of these habitats makes it challenging to predict subsequent impacts to intertidal mangrove habitat and the broader marine environment across the West Pilbara.

Algal mats do not provide three-dimensional structural complexity that can provide ongoing support and maintenance of biodiversity and ecological integrity and functionality. The Proponent, therefore, committed to quantifying algal mat loss as a proportion of primary productivity from within the intertidal zone. This study (AES 2023) includes a more informed assessment of the potential loss of significant mudflat/algal mat habitat from this Proposal, and potential consequences to offshore aquatic resources in terms of primary productivity, delivery of ecosystem services and ecological resilience.

References

Abdul Wahab MA, Fromont J, Pineda MC, Strehlow B, Duckworth A, Jones R, Webster N (2019). Defining thresholds and indicators of filter feeder responses to dredging-related pressures - final synthesis report. Report of Theme 6 – prepared for the Dredging Science Node, Western Australian Marine Science Institution, Perth, Western Australia 26 pp.

AES (2023). Benthic Mat Study. Eramurra Solar Salt Project. Prepared for Leichhardt. Actis Environmental Services, Western Australia.

Almahasheer, H., Serrano, O., Duarte, C. M., Arias-Ortiz, A., Masque, P., & Irigoien, X. (2017). Low carbon sink capacity of Red Sea mangroves. Scientific reports, 7(1), 9700.

Alongi, D.M. (1994). The role of bacteria in nutrient recycling in tropical mangrove and other coastal benthic ecosystems. Hydrobiologia, 285: 19-32

Alongi, D.M. (2009). Paradigm shifts in mangrove Biology: Coastal Wetlands and Integrated Ecosystem Approach. Elsevier Science, Ch 22: 615-640.

Biota. (2005). Yannarie Salt Project Mangrove and Coastal Ecosystem Study: Baseline Ecological Assessment. Prepared for Straits Salt Pty Ltd, September 2005.

Burford, M.A., Webster, I.T., Revill, A.T., Kenyon, R.A., Whittle, M., Curwen, G. (2012). Controls on phytoplankton productivity in a wet-dry tropical estuary. Estuarine, Coastal and Shelf Science, 113, 141-151.

CDM Smith (2024). Eramurra Solar Salt Project, Site Setting and Groundwater Baseline. Report prepared by CDM Smith for Leichardt Salt Pty Ltd.

CMW Geosciences (2022) Preliminary Embankment Design Eramurra Salt Project, Cape Preston East, WA. Letter prepared by CMW Geosciences for Leichardt Salt Pty Ltd.

DoE (2006). Pilbara Coastal Water Quality Consultation Outcomes – Environmental Values and Environmental Quality Objectives. Department of the Environment, Government of Western Australia, Marine Series Report No. 1. pp. 67

EPA (2001) Protection of Tropical Arid Zone Mangroves Along the Pilbara Coastline, Environmental Protection Authority of Western Australia, Perth, Western Australia

EPA (2016a) Technical Guidance: Protection of Benthic Communities and Habitats. Environmental Protection Authority of Western Australia, Perth, Western Australia.

EPA (2016b) Environmental Factor Guideline: Benthic Communities and Habitats. Environmental Protection Authority of Western Australia, Perth, Western Australia.

EPA (2021a) Statement of Environmental Principles, Factors and Objectives. Environmental Protection Authority of Western Australia, Perth, Western Australia.

EPA (2021b) Technical Guidance Environmental impact assessment of marine dredging proposals. Environmental Protection Authority of Western Australia, Perth, Western Australia.

Holguin, G., Vazquez, P., and Bashan, Y. (2001). The role of sediment microorganisms in the productivity, conservation, and rehabilitation of mangrove ecosystems: an overview. Biology and Fertility of Soils, volume 33, 265–278.

Kathiresan, K., and Bingham, B.L. (2001) Biology of mangroves and mangrove ecosystems. Advances in Marine Biology 40: 81-251.

LeProvost Environmental (2008) Sino Iron Project Marine. Prepared for CITIC Pacific Mining Management Pty Ltd in association with GEMS URS Australia and CP Mining Management Pty Ltd.

MScience (2025) Eramurra Solar Salt Project. Marine Fauna Underwater Noise and Vehicle Collision Risk Assessment. Report prepared by MScience for Leichardt Salt Pty Ltd.

O2M (2019a) Mardie Project Bitterns Outfall Ecotoxicity Assessment. Report prepared for Mardie Minerals Ltd.

O2M (2019b) Mardie Project: Intertidal Benthic Communities and Habitat. Appendix A02-3 of Environmental Review Document for the Mardie Project. Report prepared by O2 Marine for BCI Minerals Limited.

O2M (2022) Eramurra Solar Salt Project: Water Quality Baseline Study. Report prepared by O2 Marine for Leichardt Salt Pty Ltd.

O2M (2025a) Eramurra Solar Salt Project: Intertidal Benthic Communities and Habitat. Report prepared by O2 Marine for Leichardt Salt Pty Ltd.

O2M (2025b) Eramurra Solar Salt Project: Subtidal Benthic Communities and Habitat. Report prepared by O2 Marine for Leichardt Salt Pty Ltd.

O2M (2025c) Eramurra Solar Salt Project: Dredging and Spoil Disposal Monitoring and Management Plan. Report prepared by O2 Marine for Leichhardt Salt Pty Ltd

O2Me (2023a) Eramurra Solar Salt Project: Bitterns Outfall Modelling. Report prepared by O2 Metocean for Leichardt Salt Pty Ltd.

O2Me (2023b) Eramurra Solar Salt Project: Coastal Processes study to support BCH Assessment. Report prepared by O2 Metocean for Leichardt Salt Pty Ltd.

O2Me (2025) Eramurra Solar Salt Project: Dredge Plume Modelling. Report prepared by O2 Metocean for Leichardt Salt Pty Ltd.

Paling, E. I., and McComb, J. (1994). Cyanobacterial mats: a possible nitrogen source for arid-coast mangroves. International Journal of Ecology and Environmental Sciences 20, 47–54.

Penrose, H. (2011). Arid zone estuaries: nekton and trophic connectivity over heterogeneous landscapes. PhD Thesis. The University of Queensland.

Phoenix (2023). Detailed terrestrial fauna and Migratory Shorebird surveys for the Eramurra Solar Salt Project. Phoenix Environmental Sciences Pty Ltd, Osborne Park, WA. Report prepared for Leichhardt Salt Pty Ltd. Preston Consulting (2012). Section 38 Referral – Supporting Information Document. Cape Preston East Project. Prepared for Iron Ore Holdings LTD.

Preston Consulting (2022) Eramurra Solar Salt Project: Environmental Scoping Document. Prepared for Leichardt Salt Pty Ltd by Preston Consulting Pty Ltd, 2022.

Semeniuk, V. (1997). Selection of mangrove Stands for Conservation in the Pilbara Region of Western Australia – A Discussion. Warwick, Western Australia.

Sun, Chaojiao; Branson, Paul; Mills, Des. Guideline on dredge plume modelling for environmental impact assessment. Perth, Western Australia: Western Australian Marine Science Institution; 2020. CSIRO: EP207995. https://doi.org/10.25919/jc7h-n351

Stantec Australia. (2018). Assessment of Mangal and Algal Mat Communities for the Mardie Solar Salt Project. Appendix 1, Mardie Project Referral to the EPA. Report prepared for Mardie Minerals, February 2018.

SWS (2025) Eramurra Solar Salt Project: Hydrologic Assessment. Report prepared by Land and Water Consultants for Leichardt Salt Pty Ltd.

URS (2010). Report: Wheatstone Project – Intertidal Habitats of the Onslow Coastline. Prepared for Chevron Australia Pty Ltd, May 2010.

Vanderklift M, Bearham D, Haywood M, Lozano-Montes H, McCallum R, Mc Laughlin J, McMahon K, Mortimer N and Lavery P (2017a) Natural dynamics: understanding natural dynamics of seagrasses of the north west of Western Australia. Report of Theme 5 - Project 5.3 prepared for the Dredging Science Node, Western Australian Marine Science Institution, Perth, Western Australia, 55 pp.

Vanderklift M, Bearham D, Haywood M, McCallum R, McLaughlin J, McMahon K, Mortimer N and Lavery P (2017b) Recovery mechanisms: understanding mechanisms of seagrass recovery following disturbance. Report of Theme 5 - Project 5.4 prepared for the Dredging Science Node, Western Australian Marine Science Institution, Perth, Western Australia. 25pp.