

# ERAMURRA SOLAR SALT PROJECT

## ENVIRONMENTAL REVIEW DOCUMENT
## LEICHHARDT SALT PTY LTD

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PREPARED FOR LEICHHARDT SALT PTY LTD
BY PRESTON CONSULTING PTY LTD

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# ACKNOWLEDGEMENT OF COUNTRY

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

# DOCUMENT CONTROL

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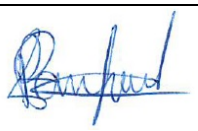
| **Author** | Phoebe Ranford – Environmental Consultant, Preston Consulting Pty Ltd |  | 30/04/2025 |
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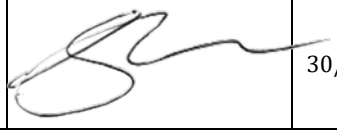
| **Authorisation** | Scott Nicholas – Chief Executive Officer, Leichhardt Salt Pty Ltd |  | 30/04/2025 |

# INVITATION TO MAKE SUBMISSION

The Environmental Protection Authority (EPA) invites people to make a submission on the environmental review for this Proposal. Leichhardt Salt Pty Ltd (Leichhardt) is seeking to construct and operate the Eramurra Solar Salt Project, a high-quality solar salt project and associated export facility located in the western Pilbara region of WA, approximately 55 km southwest of Karratha (Proposal). The Proposal will extract an average of 5.2 million tonnes per annum (Mtpa) of high-grade salt (Sodium Chloride (NaCl)) from seawater, using a series of concentration ponds, crystallisers and processing plant, transport corridor and stockpiling (the Proposal). The concentration ponds and crystallisers will be located on a Mining Lease.

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 and either offshore disposal of dredge material or the onshore use of dredge material within the Ponds and Infrastructure Development Envelope.

Leichhardt has prepared this Environmental Review Document (ERD) in accordance with the EPA's Procedures Manual (Part IV Divisions 1 and 2). The ERD is the report by the proponent on their environmental review which describes this Proposal and its likely effects on the environment. The ERD is available for a public review period of 8 weeks from 19 June 2025, closing on 14 August 2025. Information on the Proposal from the public may assist the EPA to prepare an assessment report in which it will make recommendations on the Proposal to the Minister for Environment.

***Why write a submission?***

The EPA seeks information that will inform the EPA's consideration of the likely effect of the Proposal, if implemented, on the environment. This may include relevant new information that is not in the ERD, such as alternative courses of action or approaches. In preparing its assessment report for the Minister for Environment, the EPA will consider the information in submissions, the proponent's responses and other relevant information. Submissions will be treated as public documents unless provided and received in confidence, subject to the requirements of the *Freedom of Information Act 1992.*

***Why not join a group?***

It may be worthwhile joining a group or other groups interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

***Developing a submission***

You may agree or disagree with, or comment on information in the ERD. When making comments on specific elements in the ERD, ensure that you:

- Clearly state your point of view and give reasons for your conclusions;

- Reference the source of your information, where applicable; and
- Suggest alternatives to improve the outcomes to the environment.

***What to include in your submission***

Include the following in your submission to make it easier for the EPA to consider your submission:

- Your contact details – name and address;
- Date of your submission;
- Whether you want your contact details to be confidential;
- Summary of your submission, if your submission is long;
- List points so that issues raised are clear, preferably by environmental factor;
- Refer each point to the page, section and if possible, paragraph of the ERD; and
- Attach any reference material, if applicable. Make sure your information is accurate.

The closing date for public submissions is: 14 August 2025.

The EPA prefers submissions to be made electronically via the EPA's Consultation Hub at https://consultation.epa.wa.gov.au.

Alternatively, submissions can be:

- Posted to: Chairman, EPA, Locked Bag 10, Joondalup DC, WA 6919; or
- Delivered to: the EPA, Prime House, The Atrium, 8 Davidson Terrace, Perth 6027.

If you have any questions on how to make a submission, please contact the EPA Services at the Department of Water and Environmental Regulation on 6364 7000.

# SCOPING CHECKLIST

| Task No. | Required work | Relevant section |
|---|---|---|
| **Benthic Communities and Habitats (BCH)** | | |
| 1. | Undertake a BCH targeted presence/absence field survey within proposed disturbance areas (including offshore dredge spoil disposal areas if they are to be used) and potential indirect impact areas (including dredge and bitterns disposal areas of impact) to determine if any key BCH (seagrass, macroalgae (*Sargassum*), filter feeders and corals) exist in these areas. If key BCH are located within proposed disturbance areas, a survey extension will be undertaken to identify a more suitable alignment or area of disturbance. Survey output: high level BCH map of the surveyed areas and a health assessment to determine the current status of the BCH. | 8.3, 8.4<br>Appendix 3.2 and 3.3 |
| 2. | Undertake a detailed BCH field survey within the final proposed disturbance areas and potential indirect impact areas (including dredge and bitterns disposal areas of impact). Survey other areas (that are not directly impacted) less intensively to form the basis for potential control monitoring sites. A BCH map will be developed which depicts community composition, condition and abundance in each relevant Local Assessment Unit (LAU). Mapping in relation to dredge impacts should be in accordance with the EPA's Technical Guidance – Environmental impact assessment of marine dredging proposals (EPA, 2021g). | 8.3, 8.4<br>Appendix 3.2 and 3.3 |
| 3. | Undertake a local bathymetry survey for the bitterns outfall location. | 8.3.1 |
| 4. | Develop appropriate LAUs in consideration of:<br>a) Existing LAUs for the Sino Iron Project and Cape Preston East ports;<br>b) Distribution, extent and condition of subtidal and intertidal BCH;<br>c) Management boundaries (e.g. regionally significant mangrove areas);<br>d) Bathymetry; and<br>e) Coastal geomorphology. | 8.3.2<br>Appendix 3.2 and 3.3 |
| 5. | Undertake an intertidal BCH field survey to produce local and regional scale maps of algal mats, mangroves, samphire and bare areas, as well as a list of species found. The survey will include:<br>a) Detailed mapping of key BCH boundaries such as mangroves, samphire and algal mats;<br>b) Regional assessment of key BCH such as mangroves, samphire and algal mats to quantify the extent of the BCH impacted by the Proposal. The survey effort associated with the regional assessment is to be proportional to the predicted impacts;<br>c) Health assessment to determine the current status of the BCH; and<br>d) Expert advice on the significance of the BCH impacted by the Proposal from a local and regional perspective. | 8.3<br>Appendix 3.2 |
| 6. | Revise the design and subsequent Development Envelope boundaries, if possible, to minimise direct impacts to key BCH. | 5 |
| 7. | Conduct detailed intertidal BCH mapping within the LAUs to ensure that any impact calculations are accurate. | 8.3<br>Appendix 3.2 |
| 8. | Undertake subtidal BCH surveys including an assessment of seasonal variation in the presence/absence of seagrass communities and their role in supporting MNES, and the spatial and temporal variation of BCH (including but not limited to seagrass communities). | 8.3 and 16<br>Appendix 3.3 and 4.1 |
| 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. | 7.5.1,<br>Appendix 2.6 |

| Task No. | Required work | Relevant section |
|---|---|---|
| 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 must consider the recommendations within Sun et al., (2020): Guidelines on dredge plume modelling for environmental impact assessment. Prepared for Dredging Science Node, Western Australian Marine Science Institution, Perth, WA. 37 pp and EPA's Technical Guidance – Environmental impact assessment of marine dredging proposals (EPA, 2021g). | 7.5<br>Appendix 2.5 |
| 11. | If the dredge plume dispersion modelling identifies potential impacts on coral BCH, then undertake a coral spawn study to determine accurate spawning times and assess the potential impacts dredging activities may have on successful coral colonisation. Discuss potential management strategies to avoid impacts during coral spawning. | There will be no irreversible loss of coral BCH as a result of dredge plume impacts and therefore a coral spawning study is not required<br>7.5.1 and 8.5.5<br>Appendix 2.5 and 3.1 |
| 12. | If the dredge plume dispersion modelling identifies potential significant impacts to macroalgae (including *Sargassum*) and/or bluespotted emperor recruitment BCH, then undertake a macroalgae and bluespotted emperor reproductive study to determine accurate spawning times in the area and assess the potential impacts dredging activities may have on successful macroalgae colonisation and bluespotted emperor recruitment. Discuss potential management strategies to avoid impacts during key lifecycle events for macroalgae and bluespotted emperor. | There will be no irreversible loss of macroalgae as a result of dredge plume impacts and therefore a spawning study is not required.<br>7.5.1 and 8.5.5<br>Appendix 2.5 and 3.1 |
| 13. | Undertake a benthic light study to define baseline light conditions at marine disturbance areas and inform selection of biologically relevant impact thresholds to facilitate the assessment of dredging impacts on BCH in accordance with the EPA's Technical Guidance - Environmental impact assessment of marine dredging proposals (EPA, 2021g). | 7.5.1<br>Appendix 2.5 |
| 14. | Assess sediments for particle size distribution in the dredge area (for modelling input) and also in the surrounding areas affected by the plume to assess the impacts post-dredging. | 7.3<br>Appendix 2.3 |
| 15. | Assess sediments in the dredge area for contaminants and at the dredge spoil location (to determine potential impacts of dredge spoil dumping). | 7.3<br>Appendix 2.3 |
| 16. | Assess 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. | 8.5 |

| Task No. | Required work | Relevant section |
|---|---|---|
| 17. | Prepare a Dredging Spoil and Disposal Monitoring and Management Plan (DSDMMP) which includes monitoring and management actions to minimise impacts on BCH from dredging and spoil disposal activities. The DSDMMP must be prepared in accordance with Instructions on how to prepare EP Act Part IV Environmental Management Plans (EPA, 2021f) and Environmental Management Plan Guidelines (Cth DotE, 2014). The DSDMMP will consider the results of dredge plume modelling, sediment quality investigation baseline water quality and BCH surveys to inform monitoring and management. It will include but not be limited to 'most likely best case' and 'most likely worst case' impacts and losses of BCH for each of the dredge timing scenarios (e.g. accounting for seasonal variation in BCH or current patterns). | Appendix 2.2 |
| 18. | Undertake a water level assessment of any potential intake creek. | 6.5.3 |
| 19. | Discuss the applicability and need for a permit under the *Environment Protection (Sea Dumping) Act 1981*. | 7.2, 7.6.2 |
| 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). It will incorporate weather data, accurate contour data and tidal information. The study will include the following:<br>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, and large storm flows through to one 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;<br>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);<br>c) Assessment of 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 Item 28; and<br>d) 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. This information will be utilised to assess potential impacts to the adjacent marine ecosystem, including BCH (e.g. mangroves and seagrass meadows). | 8.5, 6.5.2<br>Appendix 1.1, 1.2 and 3.1 |
| 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. | 8.5<br>Appendix 3.1 and 3.2 |
| 22. | Undertake modelling and assess the impacts of climate change on intertidal BCH based on sea level rise predictions for the next 100 years. | 8.5<br>Appendix 1.3, 3.1 and 3.10 |
| 23. | Identify any critical linkages between important marine fauna, shore and seabirds, and key BCH that are likely to be impacted. | 9, 11<br>Appendix 3.2, 3.3, 4.1 and 6.1 |
| 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 the potential for movement of hypersaline groundwater towards key BCH and assess potential impacts. | 6.5, 8.5<br>Appendix 1.6 and 1.7 |
| 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 brine surface runoff that could rapidly flow across the supratidal flat surface into sensitive BCH. | 8.5 |

| Task No. | Required work | Relevant section |
|---|---|---|
| 26. | Undertake an assessment of potential changes in sedimentation rates in the intertidal area downstream of the ponds and the consequent impacts to BCH. | 6.3, Appendix 1.3 |
| 27. | Provide figures of the proposed disturbance and predicted indirect impacts to BCH. | 8.5 |
| 28. | Undertake a BCH cumulative loss assessment in accordance with the EPA's Technical Guidance – Protection of BCH (EPA, 2016b). As a minimum, the cumulative loss assessment should include:<br>a) Clearly defined LAUs (Refer to Item 4);<br>b) Description and mapping of the BCH present in the LAUs (Refer to Item 4);<br>c) Identification of any tenure, conservation, ecological or social values associated with the BCH present in the LAUs;<br>d) An estimate of the spatial extent of each BCH type that was originally present within each LAU (i.e., prior to European disturbance);<br>e) An estimate of the spatial extent of each BCH that is currently present within the LAUs;<br>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); and<br>g) Comparison of the total area of each BCH type that would suffer 'irreversible loss' against the original BCH extent within the LAUs. | 8.5 Appendix 3.1 |
| 29. | An assessment of the functional ecological values and significance of BCH in relation to arid-tropical mangrove communities (Guidance Statement 1 – Protection of Tropical Arid Zone Mangroves along the Pilbara Coastline (EPA, 2001). | 8.3 Appendix 3.2 and 3.3 |
| 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 Instructions on how to prepare EP Act Part IV Environmental Management Plans (EPA, 2021f) and Environmental Management Plan Guidelines (Cth DotE, 2014). | 8.6 |
| 31. | Discuss management measures, outcomes/objectives sought to ensure residual impacts (direct and indirect) are not greater than predicted. | 8.6, 8.7 |
| 32. | Evaluate the combined direct and indirect impacts to BCH after the mitigation actions have been applied. This includes:<br>a) Aligning with the approaches and standards outlined in Technical Guidance - Protection of BCH (EPA, 2016b);<br>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;<br>c) Consideration of any spatial and temporal variability of BCH types within the study area and how this effects the predicted impacts;<br>d) Consideration of annual seasonal variability in nearshore current patterns and how this affects the predicted sediment plume and loss of BCH;<br>e) Consideration of historic cumulative impacts to BCH within the LAUs;<br>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;<br>g) Inclusion of an estimate of the level of confidence underpinning predictions of residual impacts; and<br>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). | 8.7 Appendix 3.1 |
| 33. | Discuss closure and rehabilitation management measures, outcomes/objectives to be implemented. If a Mine Closure Plan is to be developed to address specific impacts then it is to be developed in accordance with Guidelines for Preparing Mine Closure Plans (DEMIRS, 2020b). | 8.6.3 Appendix 1.8 |
| 34. | Demonstrate and document in the ERD how the EPA objective for this factor can be met. | 8.7 |

| Task No. | Required work | Relevant section |
|---|---|---|
| 35. | Determine and quantify any significant residual impacts by applying the Residual Impact Significance Model and the WA Offset Template both referenced in the WA Environmental Offsets Guidelines (Government of WA, 2014a), the EPBC Act Environmental Offsets Policy and include reference to the Commonwealth Offsets Assessment Guide for MNES. | 15 |
| 36. | Where significant residual impacts remain, propose an appropriate offsets package that is consistent with the WA Environmental Offsets Policy and Guidelines (Government of WA, 2011 and 2014a) and the EPBC Act Environmental Offsets Policy. Spatial data defining the area of significant residual impacts will be provided. | 15 |
| 37. | Where a contribution to a relevant scientific initiative or fund is proposed to offset the significant residual impacts, provide an impact reconciliation procedure prepared in accordance with the Instruction on how to prepare EP Act Part IV Reconciliation Procedures and Impact Reconciliation Reports and the Template for EP Act Part IV Reconciliation Procedure (EPA, 2021h, or any subsequent revisions). | 15 |
| 38. | Provide maps and spatial data which define BCH across the entire Development Envelope for the Proposal and any other areas where impacts (direct and indirect) are predicted to occur. | 8.5 |
| **Marine Environmental Quality** | | |
| 39. | Prepare suitable hydrodynamic model to adequately represent the existing movement of marine waters within the receiving marine environment (including both extreme and normal weather conditions). | 7.5.1<br>Appendix 1.7 |
| 40. | Undertake a dredge plume dispersion modelling study, utilising local conditions and proposed dredge sediment characteristics to understand potential impacts to marine environmental quality resulting from dredge and spoil disposal activities. | 7.5.1<br>Appendix 2.5 |
| 41. | Prepare a DSDMMP which includes monitoring and management actions to minimise impacts on marine environmental quality resulting from dredging and spoil disposal activities. | 7.6<br>Appendix 2.2 |
| 42. | Prepare an outline of the Environmental Quality Management Framework, including an Environmental Quality Plan (EQP) that identifies the Environmental Values to be protected and spatially defines the Environmental Quality Objectives to be met, including Levels of Ecological Protection applicable to the Proposal. The EQP will be based on the updated Pilbara Coastal Water Quality Consultation Outcomes – Environmental Values and Environmental Quality Objectives (DotE, 2006). | 7.3.1 |
| 43. | Describe and map the key sensitive biological receptors likely to be affected by the discharges. Provide a figure showing the receptors as an overlay on the EQP. | 2.2.4 |
| 44. | Discuss the applicability and need for a permit under the *Environment Protection (Sea Dumping) Act 1981.* | 7.2, 7.5.1 |
| 45. | Undertake a baseline water quality assessment at the intake and outfall locations including physiochemical (e.g., salinity, pH, dissolved oxygen) and chemical (e.g. metals, hydrocarbons, nutrients) characteristics for a minimum of 12 months. | 7.3.4,<br>Appendix 2.4 |
| 46. | Collect adequate baseline water quality, sediment quality and benthic community data to document background marine environmental quality (including spatial and temporal variation) within the receiving marine environment. Baseline data acquisition will be adequate for the derivation of draft environmental quality criteria for indicators relevant to the discharge(s) (e.g., water, sediment and/or infauna quality indicators). | 7.3.4<br>Appendix 2.3, 2.4, 3.2, 3.3. |
| 47. | Undertake a baseline sediment quality assessment at the outfall location including physical (i.e., particle size), chemical (metals, hydrocarbons) and biological (benthic infauna) characteristics. | 7.3.4<br>Appendix 2.3 |
| 48. | Undertake a study to predict the likely seepage from salt ponds and groundwater mobilisation into the receiving environment (including groundwater and surrounding tidal creeks/near shore marine waters) and potential flow-on effects to surrounding ecosystems (such as mangroves and algal mats). | 6.3.1, 6.3.2<br>Appendix 1.5 and 1.6 |
| 49. | Undertake a study to identify any Acid Sulfate Soils (ASS) or sediment that could potentially be disturbed by the Proposal. | 6.3.6, 6.5.3<br>Appendix 1.4 |





| Task No. | Required work | Relevant section |
|---|---|---|
| 50. | Undertake additional ASS investigations wherever roads and other infrastructure are planned to cross areas closer to the coast covered by mangroves and salt-marshes which are underlain by sulfidic soil materials. | 6.5.3<br>Appendix 1.4 |
| 51. | Conduct whole effluent toxicity (WET) testing or use results from toxicity estimates based on publicly available WET test results for waste bitterns in the Pilbara region to determine and describe the toxic effects of the bitterns discharge and predict the number of dilutions required to meet the different levels of ecological protection surrounding the outfall. Specifically utilise available information to undertake a marine biota ecotoxicology assessment of local marine indicator species for proposed marine discharges. | 7.5.1 |
| 52. | Undertake a bitterns outfall modelling study, utilising the hydrodynamic model together with published bitterns ecotoxicity concentrations to determine an appropriate discharge regime required to achieve the spatial levels of ecological protection defined in the proposed Marine Environmental Quality Monitoring and Management Plan (MEQMMP) described below. The modelling will utilise local conditions (bathymetry and tides) to determine:<br>a) Dilution contours around the outfall, using several outfall designs if required;<br>b) Dilution that can be achieved by discharge velocity alone (no underlying currents); and<br>c) Predicted mixing zones required to meet the level of ecological protection of the waters surrounding the mixing zone. | 7.5.1<br>Appendix 2.6 |
| 53. | Utilise the findings of the bitterns outfall modelling to the extent of the zone of influence of the bitterns plume and determine whether lower levels of ecological protection are justified and if so, proposed boundaries for these alternative levels of ecological protection. | 7.5.1 |
| 54. | Prepare a MEQMMP in accordance with the EPA's Technical Guidance – Protecting the Quality of WA's Marine Environment (EPA, 2016b). The MEQMMP should include but not be limited to:<br>a) A description and map of the key sensitive biological receptors likely to be affected by the discharges. A figure will show the receptors as an overlay on the MEQMMP;<br>b) An outline of the Environmental Quality Management Framework, including identification of Environmental Values, Environmental Quality Objectives and Spatial Levels of Ecological Protection applicable to the Proposal;<br>c) Clear, measurable and auditable Environmental Quality Criteria (EQC) for each indicator and the statistical methods for interpreting monitoring data against the EQC;<br>d) Diffuser validation;<br>e) Description of marine environmental quality monitoring;<br>f) Management strategies in the event that environmental quality criteria are exceeded; and<br>g) Emergency shut down procedures. | 7.6.2, 7.7<br>Appendix 2.1 |
| 55. | Assess risks of product and hydrocarbon spillages into the marine environment and provide a specific management plan designed to manage spillages. | 7.5<br>Appendix 2.1 |
| 56. | Provide management measures and outcomes/objectives that will be implemented to ensure residual impacts (direct and indirect) are not greater than predicted. | 7.6 |
| 57. | Demonstrate and document in the ERD how the EPA objective for this factor can be met. | 7.7 |
| 58. | Determine and quantify any significant residual impacts by applying the Residual Impact Significance Model and the WA Offset Template both referenced in the WA Environmental Offsets Guidelines (Government of WA, 2014a), the EPBC Act Environmental Offsets Policy and include reference to the Commonwealth Offsets Assessment Guide for MNES. | 15 |
| 59. | Where significant residual impacts remain, propose an appropriate offsets package that is consistent with the WA Environmental Offsets Policy and Guidelines (Government of WA, 2011 and 2014a) and the EPBC Act Environmental Offsets Policy. Spatial data defining the area of significant residual impacts will be provided. | 15 |





| Task No. | Required work | Relevant section |
|---|---|---|
| **Marine Fauna** | | |
| 60. | Undertake a desktop review to identify what marine fauna species would be expected to utilise marine waters surrounding the Proposal including those protected under the EPBC Act. | 9.3 |
| 61. | Undertake BCH field surveys as described in the BCH section. Utilise these BCH surveys to identify how the area may be utilised by species protected under the EPBC Act. | 9.3.1<br>Appendix 3.2, 3.3 |
| 62. | If the desktop review identifies that significant marine fauna (except turtles) are likely to be present within potential impact areas, undertake a marine fauna field survey or access relevant existing survey data to identify the potential significant species present and associated populations. If required, survey for relevant EPBC species listed in Appendix A in accordance with Commonwealth survey guidelines. Any deviations from these guidelines should be discussed and justified. | 9.3 |
| 63. | Undertake a baseline light survey to identify the current light environment and undertake a light spill study to consider the direction and intensity of the expected light sources to determine whether the Proposal will attract turtle hatchlings or otherwise alter their behaviour. The light spill study will consider cumulative lighting impacts on the turtle population of the North West Shelf. | 9.3<br>Appendix 4.2 and 4.3 |
| 64. | If significant turtle nesting activity is observed on either the mainland or offshore islands, undertake a study of hatchling orientation behaviour to determine the cause of any existing or future mis-orientation or disorientation. All field studies will be in accordance with the National light pollution guidelines for wildlife (DotEE, 2020). | 9.5.2<br>Appendix 4.2 |
| 65. | Undertake a desktop Introduced Marine Pests (IMPs) investigation for dredge vessels, including an assessment of likely risks associated with the introduction of IMPs during dredging operations. The investigation is to include a review of baseline IMPs. | 9.3.11, 9.5.1<br>Appendix 3.4 |
| 66. | Assess underwater noise risks that includes a sensitivity assessment of the marine fauna likely to occur in the area during construction activities such as dredging. The risk assessment is to include, but not limited to, disturbance to resting or nursing humpback whale mothers and calves. | 9.5.1<br>Appendix 4.6 |
| 67. | Quantify and assess the potential impacts of construction and maintenance boat traffic and identify mitigation measures to avoid and minimise marine fauna collisions and noise/light related impacts. | 9.4 |
| 68. | Quantify and assess the potential impacts of dredging and identify mitigation measures to avoid and minimise marine fauna dredging related impacts. | 9.4 |
| 69. | Identify any significant marine fauna (as well as ecological 'keystone' species and species important to commercial and recreational fishers) likely to be found in the area of influence of the Proposal, including commercially important species and migratory species. | 9.3<br>Appendix 4.1, 4.4 and 4.5 |
| 70. | Identify any known critical periods for key environmental/life cycle events for marine fauna (e.g. turtle nesting, southern whale migrations, sawfish pupping). | 9.3<br>Appendix 4.1 |

| Task No. | Required work | Relevant section |
|---|---|---|
| 71. | Identify the likelihood of significant marine fauna species (excluding shore and seabirds) occurring near the Development Envelopes, including:<br>a) Information on the abundance, distribution, ecology and habitat preferences of any listed species;<br>b) Information on the conservation value of each habitat type from a local and regional perspective;<br>c) If a population of a listed species is present, its' size and the importance of that population from a local and regional perspective;<br>d) Baseline mapping of local occurrences;<br>e) Discussion and determination of the significance of, potential direct, indirect (including downstream) residual and cumulative impacts to conservation significant marine fauna as a result of the Proposal at a local and regional level; and<br>f) Description of the application of the mitigation hierarchy in the Proposal design, construction, operation and closure. This will include detailed actions undertaken to avoid, minimise and mitigate Proposal impacts and management and/or monitoring plans to be implemented pre- and post-construction to demonstrate that residual impacts (direct and indirect) are not greater than predicted. Management and/or monitoring plans are to be presented in accordance with EPA instructions. If management and/or monitoring plans for IMPs are deemed to be required they must align with the Marine Pest Plan 2018-2023: The national strategic plan for marine pest biosecurity and comply with Environmental Management Plan Guidelines (Cth DotE, 2014). | 9.3<br>Appendix 4.1 |
| 72. | Identify the proposed activities and the potential scale and significance of potential direct and indirect impacts to marine fauna during construction and operation of the Proposal. Evaluate potential impacts on the behaviour of significant marine fauna (excluding shore and seabirds) including but not limited to marine turtles, dugongs, cetaceans, green sawfish and species important to commercial and recreational fisheries such as bluespotted emperor (an indicator of the broader number of species potentially impacted by the Proposal). The evaluation is to include:<br>a) An assessment of the risk of impact to any listed threatened species as a result of the Proposal;<br>b) For any impact identified, appropriate mitigation/management measures to reduce the level of impacts;<br>c) An assessment of residual impact to each species after all avoidance and mitigation measures are undertaken;<br>d) Due regard to any relevant EPBC Act Threat Abatement Plan, Recovery Plan or Approved Conservation advice; and<br>e) Consideration of known existing threats to any significant species, whether or not attributable to the Proposal, with reference to relevant impacts from the Proposal. | 9.5 |
| 73. | Prepare a DSDMMP as described in Item 17. The DSDMMP will include management actions to prevent injury and death to marine fauna. | Appendix 2.2 |
| 74. | Discuss management measures and outcomes/objectives sought to ensure residual impacts (direct and indirect) are not greater than predicted. | 9.7 |
| 75. | Demonstrate and document in the ERD how the EPA objective for this factor can be met. | 9.7 |
| 76. | Determine and quantify any significant residual impacts by applying the Residual Impact Significance Model and the WA Environmental Offsets Guidelines (Government of WA, 2014a, or any subsequent revisions) and include reference to the Commonwealth Offsets Assessment Guide for any MNES. | 15 |
| 77. | Where significant residual impacts remain, propose an appropriate offsets package that is consistent with the WA Environmental Offsets Policy and Guidelines (Government of WA, 2011 and 2014a, or any subsequent revisions) and the Commonwealth Offsets Assessment Guide for MNES. | 15 |
| 78. | Where a contribution to a relevant scientific initiative or fund is proposed to offset the significant residual impacts, provide an impact reconciliation procedure prepared in accordance with the Instruction on how to prepare EP Act Part IV Reconciliation Procedures and Impact Reconciliation Reports and the Template for EP Act Part IV Reconciliation Procedure (EPA, 2021h, or any subsequent revisions). | 15 |

| Task No. | Required work | Relevant section |
|---|---|---|
| 79. | Provide maps and spatial data which defines marine fauna across the entire Development Envelope for the Proposal and any other areas where impacts (direct and indirect) are predicted to occur including habitat for significant fauna. | 9.3 |
| **Flora and Vegetation** | | |
| 80. | Conduct surveys to identify and characterise the flora and vegetation of areas in a local and regional context in accordance with EPA Guidance and any relevant Commonwealth guidance documents. If multiple surveys have been undertaken to support the assessment, a consolidated report should be provided including the integrated results of the surveys. If previous surveys are relied on for context, justification should be provided to demonstrate that they are relevant and consistent with EPA Guidance. Specific survey methodology appropriate to *Tecticornia* species and *Tecticornia* dominated vegetation units should be agreed in consultation with the WA Herbarium expert taxonomist and Department of Water and Environmental Regulation (DWER) specialist staff. | 11.3<br>Appendix 5.1 and 5.4 |
| 81. | Submit all survey reports and data via the Index of Biodiversity Surveys for Assessments (IBSA) Submissions with the IBSA number provided for verification. | N/A |
| 82. | Provide a map of the survey effort applied in relation to the study area, and Development Envelope, identifying the direct and indirect impact areas. | 11.3.2 |
| 83. | Identify and describe the flora species detected by the studies and surveys. Describe significant flora and provide an analysis of local and regional context, (refer to Environmental Factor Guideline - Flora and Vegetation for definition of significant flora). Characterise the ecological values and significance of flora in the Development Envelopes and any areas that may be indirectly impacted by the Proposal. | 11.3.3<br>Appendix 5.1 |
| 84. | Provide maps showing the recorded locations of significant flora in relation to the Proposal and species distributions. | 11.3.3<br>Appendix 5.1, 5.3 and 5.4 |
| 85. | Identify and describe the vegetation present in the study area. Describe significant vegetation, and provide an analysis of local and regional context, (refer to Environmental Factor Guideline – Flora and Vegetation for definition of significant vegetation). Characterise the ecological values and significance of vegetation in the Development Envelopes and any areas that may be indirectly impacted by the Proposal. | 11.3.5<br>Appendix 5.1 |
| 86. | If groundwater abstraction is proposed for water supply then conduct an assessment to determine the presence or absence of potential or observed Groundwater Dependent Ecosystems (GDEs) within the potential drawdown zone. The assessment is to include reference to groundwater depths within the potential or observed GDEs. | 6.3.2 |
| 87. | Provide maps showing the extent of all vegetation, and significant vegetation, in the study area, Development Envelope, direct and indirect impact areas, and in the local and regional contexts. | 10.3.5 |
| 88. | Identify the proposed activities and describe and quantify the potential scale and significance of direct and indirect impacts to flora and vegetation. This will include an assessment of the extent of potential direct, indirect and cumulative impacts, including percentages, to all vegetation and significant flora and vegetation that may occur following implementation of the proposal during both construction and operation, in a local and regional context.<br>Provide tables with quantitative assessments of impacts;<br>a) For significant flora, this includes the:<br>i. Number of individuals and populations in a local and regional context;<br>ii. Numbers and proportions of individuals and populations directly or potentially indirectly impacted, and<br>iii. Numbers/proportions/populations currently protected within the conservation estate (where known);<br>b) For all vegetation units (noting Threatened and Priority Ecological Communities and significant vegetation) this includes:<br>i. Area (in ha) and proportions directly or potentially indirectly impacted, and<br>ii. Proportions/ha of the vegetation unit currently protected within conservation estate (where known). | 10.4 |

| Task No. | Required work | Relevant section |
|---|---|---|
| 89. | Outline the proposed avoidance and mitigation measures to reduce the potential impacts of the Proposal. Include proposed management and/or monitoring plans that will be implemented pre- and post-construction to demonstrate and ensure residual impacts are not greater than predicted. Management and/or monitoring plans are to be presented in accordance with the EPA's instructions and comply with the Environmental Management Plan Guidelines (Cth DotE, 2014). | 11.6.1, 11.6.2 |
| 90. | Predict the residual impacts from the Proposal on flora and vegetation after considering and applying the mitigation hierarchy. | 11.6, 11.7 |
| 91. | Undertake a groundwater abstraction study if GDEs are identified in areas within the extent of drawdown (horizontally and vertically). This will assess the abstraction requirements from each bore location and determine whether the drawdown rate or depth could potentially cause impacts to any GDEs, based on the risk categories for phreatophytic vegetation in Froend & Loomes (2004). | 6.5.3 |
| 92. | Assess the potential direct, indirect and cumulative impacts of the Proposal on the Great Sandy Island Nature Reserve (Class B, R 33831). | 7.5.1 |
| 93. | Identify, describe and address any potential direct, indirect and cumulative impact on current and proposed CALM Act reserves and their values resulting from the implementation of the Proposal. | 2.3.2 |
| 94. | Incorporate the findings of any investigations and studies undertaken for the Mardie Project (MS 1211) as part of their marine and intertidal research offsets (if completed prior to submission of the ERD). | 15 |
| 95. | Demonstrate and document in the ERD how the EPA objective for this factor can be met. | 11.7 |
| 96. | Determine and quantify any significant residual impacts by applying the Residual Impact Significance Model and the WA Environmental Offsets Guidelines (Government of WA, 2014a, or any subsequent revisions) and include reference to the Commonwealth Offsets Assessment Guide for any MNES. | 15 |
| 97. | Where significant residual impacts remain, propose an appropriate offsets package that is consistent with the WA Environmental Offsets Policy and Guidelines (Government of WA, 2011 and 2014a, or any subsequent revisions) and the Commonwealth Offsets Assessment Guide for MNES. | 15 |
| 98. | Where a contribution to the Pilbara Environmental Offsets Fund (PEOF) is proposed to offset the significant residual impacts, provide an impact reconciliation procedure prepared in accordance with the Instruction on how to prepare EP Act Part IV Reconciliation Procedures and Impact Reconciliation Reports and the Template for EP Act Part IV Reconciliation Procedure (EPA, 2021h, or any subsequent revisions). | 15 |
| 99. | Provide maps and spatial data which defines flora and vegetation across the Development Envelopes for the Proposal and any other areas where impacts (direct and indirect) are predicted to occur:<br>a) Vegetation condition (e.g. completely degraded, degraded, poor, good, very good, excellent); and<br>b) Specific flora and vegetation values proposed to be offset. | 11.3<br>Appendix 5.1 and 5.4 |
| 100. | Discuss closure and rehabilitation management measures, and outcomes/objectives to be implemented. If a Mine Closure Plan is to be developed to address specific impacts then it is to be developed in accordance with Guidelines for Preparing Mine Closure Plans (DMIRS, 2020b). | 10.6.3 |
| **Terrestrial Environmental Quality** | | |
| 101. | Undertake a baseline soil assessment across the potential disturbance areas associated with the Proposal including materials characterisation for soils and subsurface material. Physical (i.e., particle size) and chemical (metals, hydrocarbons) characteristics will be assessed. | 10.3 |
| 102. | Undertake a study to predict the quantity and quality of likely seepage of saline water from salt ponds and potential mobilization into the surrounding environment and potential for soil contamination. | 10.3, 10.5<br>Appendix 1.6 |





| Task No. | Required work | Relevant section |
|---|---|---|
| 103. | Undertake a study to identify any ASS that could potentially be disturbed by the Proposal and if required, prepare an ASS Management Plan to prevent contamination of the terrestrial environment. | 10.5.2, 10.6.2<br>Appendix 1.4 |
| 104. | Identify and discuss any potential direct, indirect and cumulative impacts on the terrestrial environment as a result of vegetation clearing, changes to the surface water regime, waste disposal, hydrocarbon spills or product spills. | 10.4 |
| 105. | Identify and discuss the potential direct, indirect and cumulative impacts to the terrestrial environment as a result of loss of sediment during construction. | 10.4 |
| 106. | Discuss the proposed monitoring, management and mitigation measures to be implemented, including an assessment of their effectiveness, at the design and operations stages to demonstrate that all reasonable and practicable avoidance and mitigation measures will be taken to ensure residual impacts and risks are acceptable. | 10.6 |
| 107. | Document management and monitoring measures to ensure residual impacts are not greater than predicted and achieve predicted outcomes/objectives. | 10.6 |
| 108. | Demonstrate and document in the ERD how the EPA objective for this factor can be met. | 10.7 |
| 109. | Determine and quantify any significant residual impacts by applying the Residual Impact Significance Model and the WA Offset Template both referenced in the WA Environmental Offsets Guidelines (Government of WA, 2014a). | 15 |
| 110. | Where significant residual impacts remain, propose an appropriate offsets package that is consistent with the WA Environmental Offsets Policy and Guidelines (Government of WA, 2011 and 2014a; or any subsequent revisions). Spatial data defining the area of significant residual impacts should also be provided. | 15 |
| 111. | Discuss closure and rehabilitation management measures and outcomes/objectives to be implemented. If a Mine Closure Plan is to be developed to address specific impacts then it is to be developed in accordance with Guidelines for Preparing Mine Closure Plans (DMIRS, 2020a). | 10.6 |
| **Terrestrial Fauna** | | |
| 112. | In accordance with EPA Guidance and Commonwealth survey guidelines conduct a desktop study to identify and characterise the vertebrate and Short Range Endemic (SRE) invertebrate fauna and fauna habitats in a local and regional context, and discuss the likely presence of listed threatened species or their habitat within/near the Proposal. Based on the results of the desktop study conduct:<br>a) A Basic (Level 1) survey and fauna habitat assessment; and/or<br>b) A Detailed (Level 2) survey including sampling inside and outside the impact areas that may be directly or indirectly impacted; and/or<br>c) Targeted surveys for significant fauna that may be directly or indirectly impacted, including the EPBC species listed in Appendix A;<br>Any deviations from EPA and Commonwealth guidelines will be discussed and justified. If multiple surveys have been undertaken to support the assessment, a consolidated report should be provided including the integrated results of the surveys. If previous surveys are relied on for context, justification should be provided to demonstrate that they are relevant and consistent with EPA Guidance. | 12.3<br>Appendix 6.1 |
| 113. | Submit all survey reports and data via IBSA Submissions with the IBSA number provided for verification. | N/A |
| 114. | Provide a map of the survey effort applied in relation to the study area, terrestrial fauna habitats, and Development Envelope, identifying the direct and indirect impact areas. | 12.3.1<br>Appendix 6.1 |
| 115. | Undertake a targeted migratory shorebird field survey conducted in accordance with EPBC Act Policy Statement 3.21 - Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listing migratory shorebird species (DotEE, 2017a). The survey is to provide individual counts to determine the significance of the area on a national and international scale. | 12.3<br>Appendix 6.1 and 6.4 |





| Task No. | Required work | Relevant section |
|---|---|---|
| 116. | Where the desktop study and basic survey identifies suitable habitat (roosting and breeding) for night parrot, undertake a targeted night parrot survey in accordance with Interim guideline for preliminary surveys of night parrot in WA (DPaW, 2017) and EPBC Act Survey Guidelines for Threatened Birds (DEWHA, 2010). Specialist opinion will be sought if required to confirm recordings of Night Parrot from persons with experience in this species. | 12.3<br>Appendix 6.1, 6.2 |
| 117. | Identify and describe the terrestrial fauna habitats identified by the studies and surveys. Describe significant fauna habitats, including but not limited to: SRE invertebrate microhabitats, refugia, breeding areas, key foraging habitat, movement corridors and linkages, areas of conservation significance and geological features, which may support unique ecosystems (refer to Environmental Factor Guideline – Terrestrial Fauna for definition of significant fauna habitat). Provide information, including maps, to differentiate habitat on the basis of use if required e.g. breeding habitat, foraging/feeding/dispersal habitat. Consider whether the remaining habitat has adequate carrying capacity. | 12.3<br>Appendix 6.1 and 6.3 |
| 118. | Provide maps showing the extent of terrestrial fauna habitats in relation to the Proposal and species distributions. | 12.3<br>Appendix 6.1 |
| 119. | Identify and describe the fauna assemblages present and likely to be present within the Development Envelope that may be impacted by the Proposal. | 12.3, 12.4 |
| 120. | Identify significant or restricted fauna and describe in detail their known ecology, likelihood of occurrence, habitats and known threats, (refer to Environmental Factor Guideline – Terrestrial Fauna for definition of significant fauna). | 12.3 |
| 121. | Map the locations of significant/restricted fauna records in relation to the terrestrial fauna habitats, the study area, the Development Envelope, and direct and indirect impact areas. | 12.3 |
| 122. | Describe and quantify the extent of potential direct, indirect and cumulative impacts, including percentages, to habitats and significant species that may occur following implementation of the proposal during both construction and operations, in a local and regional context. | 12.4 |
| 123. | Provide a table of the proportional extents of each habitat within the study area and Development Envelope, and the predicted amount to be directly impacted and remaining. Consider any local or regional cumulative impacts. | 12.5 |
| 124. | Outline the proposed avoidance and mitigation measures to reduce the potential impacts of the Proposal. Include proposed management and/or monitoring plans that will be implemented pre- and post-construction to demonstrate and ensure residual impacts are not greater than predicted. Include a discussion of the proposed management, monitoring and mitigation methods to be implemented including an assessment of the effectiveness of the methods, any statutory or policy basis for the methods and demonstrate that the design of the Proposal has addressed the mitigation hierarchy in relation to impacts on terrestrial fauna. If management plans are to be developed to address specific impacts they are to comply with the Instructions on how to prepare EP Act Part IV Environmental Management Plans (EPA, 2021f) and Environmental Management Plan Guidelines (Cth DotE, 2014). | 12.6 |
| 125. | Predict the residual impacts from the Proposal on terrestrial fauna after considering and applying the mitigation hierarchy. | 12.7 |
| 126. | Demonstrate how the EPA's objective for this factor will be met. | 12.7 |
| 127. | Determine and quantify any significant residual impacts by applying the Residual Impact Significance Model and the WA Environmental Offsets Guidelines (Government of WA, 2014a, or any subsequent revisions) and include reference to the Commonwealth Offsets Assessment Guide for any MNES. | 15 |
| 128. | Where significant residual impacts remain, propose an appropriate offsets package that is consistent with the WA Environmental Offsets Policy and Guidelines (Government of WA, 2011 and 2014a, or any subsequent revisions) and the Commonwealth Offsets Assessment Guide for MNES. | 15 |





| Task No. | Required work | Relevant section |
|---|---|---|
| 129. | Where a contribution to the PEOF is proposed to offset the significant residual impacts, provide an impact reconciliation procedure prepared in accordance with the Instruction on how to prepare EP Act Part IV Reconciliation Procedures and Impact Reconciliation Reports and the Template for EP Act Part IV Reconciliation Procedure (EPA, 2021h, or any subsequent revisions). | 15 |
| 130. | Provide maps and spatial data which defines terrestrial fauna across the entire Development Envelope for the Proposal and any other areas where impacts (direct and indirect) are predicted to occur including habitat for significant fauna. | 12.3.1 |
| 131. | Discuss closure and rehabilitation management measures and outcomes/objectives to be implemented. If a Mine Closure Plan is to be developed to address specific impacts then it is to be developed in accordance with Guidelines for Preparing Mine Closure Plans (DMIRS, 2020a). | 12.6.3 |
| **Inland Waters** | | |
| 132. | Undertake a surface water flow and inundation study to produce a series of flood, tidal inundation and storm surge maps for different event scenarios, with and without the Proposal (using confirmed Proposal general arrangement drawings and levels). It will incorporate weather data, accurate contour data and tidal information. The study will include the following:<br>a) Modelling and assessment of inland surface water flows before and after the development of the Proposal, using several inflow scenarios (i.e. 100 year through to one year Annual Recurrence Interval 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 Proposal;<br>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);<br>c) An ecohydrological model that integrates the hydrological and ecological components to show the likely pathways by which the Proposal might impact on key resources; and<br>d) A desktop review of the likely changes to the frequency and intensity of inland surface water flow scenarios as a result of climate change. | 6.3.3<br>Appendix 1.1 and 1.2 |
| 133. | Provide a peer review of the modelling and predictions of groundwater and surface water impacts. | 6.3<br>Appendix 1.6 |
| 134. | Undertake baseline surface water quality sampling of the ephemeral creeklines that run through the Development Envelopes (i.e., if surface water is present). | 6.3<br>Appendix 1.5 |
| 135. | Identify and characterise any environmental receptors that may be impacted by changes to inland waters as a result of this Proposal. | 6.3.7 |
| 136. | Provide a detailed description of the Proposal aspects that have the potential to impact inland waters. | 6.3.7 |
| 137. | Undertake a desktop ASS risk assessment to determine the risk of presence of ASS. Undertake an ASS survey if results from the desktop risk assessment identify this to be necessary. | 6.3<br>Appendix 1.4 |
| 138. | Undertake a hydrogeological study (including drilling and hydraulic data acquisition). | 6.3<br>Appendix 1.6 |
| 139. | Undertake a groundwater model to assess the following:<br>a) Impacts on the surface-groundwater interaction, groundwater flow directions and hydraulic loading by proposed structures;<br>b) Hydraulic loading surface expressions and subsequent impacts on vegetation;<br>c) The influence of density-driven flow induced by seepage from structures, and subsequent impacts to vegetation and<br>d) The extent of seawater intrusion and how this may be influenced by the Proposal, with subsequent flow-on impacts. | 6.3<br>Appendix 1.6 |

| Task No. | Required work | Relevant section |
|---|---|---|
| 140. | Undertake a groundwater quality assessment to determine the quality of the groundwater underlying the pond areas. | 6.3<br>Appendix 1.5 and 1.6 |
| 141. | Ensure sufficient measures are taken in design, construction and operation to limit impacts to inland waters. | 6.6 |
| 142. | Undertake desktop water supply assessment to identify a contingency freshwater supply source for the Proposal (if required in addition to desalination) and estimate potential yields and impacts based on the available hydrogeological information. | N/A refer to 2.3.2 |
| 143. | Conduct pump-testing of the proposed groundwater supply bores identified in the desktop study, and collection of baseline data. Verify impact predictions provided in the desktop study. | N/A refer to 2.3.2 |
| 144. | Characterise the baseline hydrological and hydrogeological regimes and water quality, both in a local and regional context, including but not limited to the water levels·, stream flows (ephemeral and flowing), climate, flood patterns, and water quantity and quality. | 6.3<br>Appendix 1.1, 1.5 and 1.6 |
| 145. | Provide a detailed description of the design and location of the Proposal aspects that have the potential to impact inland waters. | 6.5.2 |
| 146. | Assess the potential impacts and risks from construction and operation of the Landfill Facility in the context of groundwater contamination, flooding and resilience to climate change. | 1.3 and 4.2.4.3 |
| 147. | Discuss the proposed management, monitoring and mitigation to avoid and minimise impacts to inland waters, and potential flow-on effects on the surrounding environment as a result of implementing the Proposal. If management plans are to be developed to address specific impacts, they are to comply with the Instructions on how to prepare EP Act Part IV Environmental Management Plans (EPA, 2021f) and Environmental Management Plan Guidelines (Cth DotE, 2014). | 6.6 |
| 148. | Detail the management, monitoring and mitigation measures to be implemented to ensure residual impacts on inland waters are not greater than predicted. | 6.6 |
| 149. | Demonstrate in the ERD how the EPA's objective for this factor will be met. | 6.7 |
| 150. | Determine and quantify any significant residual impacts by applying the Residual Impact Significance Model and the WA Offset Template both referenced in the WA Environmental Offsets Guidelines (Government of WA, 2014a). | 15 |
| 151. | Where significant residual impacts remain, propose an appropriate offsets package that is consistent with the WA Environmental Offsets Policy (Government of WA, 2011) and the WA Environmental Offsets Guidelines (Government of WA, 2014a). Spatial data defining the area of significant residual impacts should also be provided. | 15 |
| 152. | Discuss closure and rehabilitation management measures, outcomes/objectives to be implemented. If a Mine Closure Plan is to be developed to address specific impacts then it is to be developed in accordance with Guidelines for Preparing Mine Closure Plans (DMIRS, 2020a). | 6.6.3 |
| **Social Surroundings** | | |
| 153. | Undertake a community impact study to identify what public access areas (i.e. camping and fishing areas) will have restricted access once the Proposal is implemented. If areas are identified as being impacted, then additional work is to be conducted to identify the number of people that use the area and if/how access and amenity can be maintained. | 12.3.3, 12.6 |
| 154. | Undertake a desktop heritage assessment (European and Aboriginal) and ethnographic heritage survey to:<br>a. Make an assessment of listed heritage sites in consultation with the native title holders (Yaburara and Mardudhunera People);<br>b. Determine the cultural importance and value of the site from an Aboriginal perspective (i.e., bush tucker and medicine); and<br>c. Assess the likelihood of significant European or Aboriginal heritage sites being present on site. | 13.3.1 and 0 |

| Task No. | Required work | Relevant section |
|---|---|---|
| 155. | Ensure sufficient measures are taken in the design, construction and operation of the Proposal to limit impacts to social surroundings, including:<br>a. Conduct Aboriginal heritage surveys (archaeological and ethnographic) and avoid significant sites if practicable;<br>b. Consult with relevant stakeholders, primarily the native title holders, and seek approval under Section 18 of the *Aboriginal Heritage Act 1972* or consent under Part 6 of the *Aboriginal Cultural Heritage Act 2021*, if significant sites cannot be avoided;<br>c. Incorporate bush tucker and medicine information to allow avoidance and minimisation of impacts; and<br>d. Continue consultation with the Traditional Owners regarding the minimisation of impacts to traditional uses of the area. | 13.5, 13.6 |
| 156. | Discuss the proposed monitoring, management and mitigation measures to be implemented, including an assessment of their effectiveness, at the design and operations stages to demonstrate that all reasonable and practicable avoidance and mitigation measures will be taken to ensure residual impacts and risks are acceptable. | 13.6 |
| 157. | Demonstrate how the EPA's objective for this factor will be met. | 13.7 |
| 158. | Conduct consultation with Traditional Owners during the assessment process to determine the heritage and other cultural values of the Development Envelopes. | 13.6, 13.7 |
| 159. | Conduct community consultation to determine if there are any recreational areas that can be retained. | 13.6 |
| 160. | Characterise the values and significance of social surroundings in the vicinity of the Proposal. | 13.3, 13.4 |
| 161. | Identify the potential scale and significance of direct and indirect impacts to social surroundings from proposed activities. | 13.4, 13.5 |
| 162. | Determine and quantify any significant residual impacts by applying the Residual Impact Significance Model and the WA Offset Template both referenced in the WA Environmental Offsets Guidelines (Government of WA, 2014a). | 13.7, 15 |
| 163. | Where significant residual impacts remain, propose an appropriate offsets package that is consistent with the WA Environmental Offsets Policy (Government of WA, 2011) and the WA Environmental Offsets Guidelines (Government of WA, 2014a). Spatial data defining the area of significant residual impacts should also be provided. | 15 |
| 164. | Develop in consultation with the native title holders a Social, Cultural Heritage Management Plan to identify required actions to mitigate and manage impacts to social surroundings. | 13.6 |

# EXECUTIVE SUMMARY

## THE PROPOSAL

Leichhardt Salt Pty Ltd (Leichhardt) is seeking to develop the Eramurra Solar Salt Project (the Proposal) located in the western Pilbara region of Western Australia (WA), approximately 55 kilometres (km) southwest of Karratha (Figure 2-1). The three development envelopes encompassing the Proposal and an indicative layout are provided in Figure 2-1.

A summary of the Proposal is provided in Table ES1 and the key proposal elements (e.g. development, action, activities or processes) which have potential to cause an impact on the environment are summarised in Table ES2.

**Table ES1: Key characteristics of the Proposal**

| | |
|---|---|
| **Proposal 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 southwest of Karratha in WA (the Proposal). The Proposal will utilise seawater and evaporation to produce a concentrated salt product for export.<br>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 and both offshore and onshore disposal of dredge material. |

**Table ES2: Location and proposed extent of physical and operational elements**

| Proposal element | Location/description | Maximum extent, capacity, or range |
|---|---|---|
| **Physical elements** | | |
| 1. **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 2-1 | Disturbance of no more than 12,201 ha within the 20,157 ha Ponds and Infrastructure Development Envelope. |
| 2. **Marine Development Envelope** – Seawater intake and pipeline, dredge channel, bitterns pipeline, outfall diffuser and mixing zone. | | Disturbance of no more than 53 ha within the 703 ha Marine Development Envelope. |
| 3. **Dredge Spoil Disposal Development Envelope** – Disposal location for dredge spoil. | | Disturbance of no more than 100 ha within the 285 ha Dredge Spoil Disposal Development Envelope. |

| | | |
|---|---|---|
| **Construction elements** | | |
| Dredge Volume | Figure 2-1 | Approximately 400,000 $m^3$ |
| **Operational elements** | | |
| Bitterns discharge | Figure 2-1 | Discharge of up to 5.9 Gigalitres per annum (GLpa) of bitterns within a dedicated offshore mixing zone within the Marine Development Envelope. |
| **Greenhouse Gas Emissions** | | |
| **Construction elements:** | | |
| Scope 1 | 31,000 tonnes of carbon dioxide equivalent ($CO_2e$) from diesel usage over the construction period (estimated four years).<br>79,000 tonnes of $CO_2e$ from land use change over the construction period (estimated four years). | |
| Scope 2 | N/A. | |
| Scope 3 | Not able to be calculated at this early design stage. | |
| **Operation elements:** | | |
| Scope 1 | Electricity generation: 20,200 tonnes of $CO_2e$ per annum.<br>Diesel use: 10,300 tonnes of $CO_2e$ per annum.<br>Total: approximately 30,500 tonnes of $CO_2e$ per annum. | |
| Scope 2 | N/A. | |
| Scope 3 | Emissions associated with shipping the produced salt to customers (indicative only): 14,700 tonnes $CO_2e$ per annum. | |
| **Rehabilitation** | | |
| Progressive rehabilitation will take place where areas are not required for ongoing operations, such as laydown and stockpiling areas used during construction, exhausted borrow pits or tracks.<br>Infrastructure will be removed at closure and pond embankments removed or shaped to be similar to the surrounding landform. | | |
| **Commissioning** | | |
| No specific commissioning activities. | | |
| **Decommissioning** | | |
| Construction disturbance that is not required for operations is to be rehabilitated after construction.<br>Proposal infrastructure to be removed within five years of closure. | | |
| **Other elements which affect extent of effects on the environment** | | |
| Proposal time | Maximum project life | 64 years |
| | Construction phase | 4 years |
| | Operations phase | 60 years |
| | Decommissioning phase | 5 years |

# PRELIMINARY KEY ENVIRONMENTAL FACTORS

The Environmental Protection Authority (EPA) identified the following preliminary key environmental factors for this Proposal:

- Benthic communities and habitats (BCH);
- Marine environmental quality;
- Marine fauna;
- Flora and vegetation;

- Terrestrial environmental quality;
- Terrestrial fauna;
- Social surroundings; and
- Inland waters.

Table ES3 summarises relevant information on the potential impacts, mitigation and outcomes for each of the preliminary key environmental factors identified by the EPA. The appendices provide supporting studies and investigations undertaken to inform this Environmental Review, the key elements of which are included in this document.

**Table ES3: Summary of potential impacts, proposed mitigation and outcomes**

| **Inland Waters** | |
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| EPA objective | The EPA Objective for this key environmental factor is to maintain hydrological regimes and quality of groundwater and surface water so that environmental values are protected |
| Policy and guidance | • EIA (Part IV Divisions 1 and 2) Procedures Manual (EPA, 2024a).<br>• Statement of Environmental Principles, Factors, Objectives and Aims of EIA (EPA, 2023a).<br>• Statutory Guidelines for Mine Closure Plans (DMIRS, 2020a).<br>• EIA (Part IV Divisions 1 and 2) Administrative Procedures (EPA, 2024b).<br>• Instructions on how to prepare EP Act Part IV Environmental Management Plans (EPA, 2024c).<br>• Environmental Factor Guideline – Inland Waters (EPA, 2018a).<br>• Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018).<br>• Australian Groundwater Modelling Guidelines. (Waterlines Report Series No. 82) (Barnett et al., 2012).<br>• WA Water in Mining Guideline. Water licensing delivery report series. Report No. 12. (DoW, 2013).<br>• Operational Policy 5.12 – Hydrogeological reporting associated with a groundwater well licence (DoW, 2009).<br>• WA Environmental Offsets Policy (EPA, 2011).<br>• WA Environmental Offsets Guidelines (EPA, 2014a).<br>• WA Environmental Offsets Template (EPA, 2014b).<br>• WA Environmental Offsets Metric and relevant guidance (DWER, 2021b).<br>• Generic guidelines for the content of a draft EPBC Act Public Environment Report (PER)/EIS (including the objects and principles of the EPBC Act, 1999; DotEE, 2016).<br>• EPBC Act Environmental Offsets Policy (DSEWPaC, 2012a) – including the Offset Assessment guide.<br>• Environmental Management Plan Guidelines (DotE, 2014).<br>• EPBC Act Condition Setting Policy (DAWE, 2020).<br>• EPBC Act Outcomes-based conditions policy (DotE, 2016a).<br>• Relevant EPBC Act listed species-specific survey guidelines and protocols.<br>• Relevant EPBC Act listed species-specific Recovery plans, Threat Abatement Plans, Approved Conservation Advice and other documents. |
| Potential impacts | **Groundwater**<br>• Seepage and mounding from the concentration ponds and crystallisers may lead to changes in groundwater levels and flow paths;<br>• Seepage from ponds resulting in elevated salinity in underlying groundwater;<br>• Changes in groundwater salinity regimes due to mounding; and<br>• Groundwater mounding and elevated salinity may impact groundwater dependent terrestrial vegetation including the eucalypt species that reside within McKay Creek, Devil Creek, and Eramurra Creek.<br>**Inland surface waters**<br>• Intersection and diversion of drainage lines and floodwaters;<br>• Reduction in surface water flows due to the capture of rainfall within the ponds; and<br>• Surface water quality impacts associated with:<br>o Potential leaks or overflow of brine from the concentration ponds and crystallisers or pipelines;<br>o Sediment loss; and<br>o Hydrocarbon spills. |

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| | **Intertidal zone**<br>• Abstraction of up to 31 $m^3/s$ of seawater from a tidal creek, never abstracting below 0.0 m AHD;<br>• Alteration of tidal regimes due to a reduction in intertidal zone;<br>• Erosion and accretion within tidal creeks due to changes in tidal inundation regimes;<br>• Surface water quality impacts associated with:<br>  o Potential leaks or overflow of brine from concentration ponds and crystallisers or pipelines;<br>  o Sediment loss; and<br>  o Acidification of surface or groundwater as a result of the disturbance of ASS (if present).<br>• Restriction of inland movement of zone due to sea level rise. |
| Mitigation | **Avoid**<br>The key avoidance mechanism implemented by Leichhardt was the iterative design of the development envelopes to avoid key environmental features. Leichhardt has conducted numerous ecological surveys and this information has been utilised to design the Proposal and its Indicative Disturbance Footprint to avoid the following:<br>• Blockages or diversions of McKay Creek, Eramurra Creek and Devil Creek. The final Proposal design includes a significant exclusion to the pond footprint to ensure these creeks continue to flow through to the ocean; and<br>• Direct impacts to the majority of tidal creeks. The pond footprint was moved south to ensure the majority of tidal creeks are not intersected by the ponds. One exception is the intake creek where some direct impacts will be incurred.<br>In addition to the above, the following avoidance mitigation measures have been incorporated:<br>• Impacts associated with groundwater abstraction have been avoided by the use of seawater desalination and the use of third-party construction water supply as an interim measure.<br>**Minimise**<br>• Obtain and comply with approvals under Part IV and V of the EP Act, *Mining Act 1978* (Mining Act) and *Port Authorities Act 1999*;<br>• Installation and consideration of additional bore data in modelling work;<br>• Implement the Groundwater Monitoring and Management Plan (GMMP) in Appendix 1.9;<br>• Drainage control structures will be designed with key stakeholders to accommodate agreed AEP values;<br>• Ensure erosion and sediment control is included in contractor management plans;<br>• Verify inundation modelling results after construction;<br>• Concentration pond and crystallisers will be designed and constructed to be safe and stable;<br>• Routinely inspect the condition and performance of pond walls, pipelines, containment systems and internal drainage structures;<br>• Controls will be used to further reduce the risk of impact from unintentional brine pipeline spills;<br>• Monitor erosion at the outlets of the surface water corridors after each significant flow event;<br>• Comply with Water Quality Protection Guidelines and guidance notes;<br>• Ensure fuel is stored within self-bunded tanks or within a bunded area;<br>• Develop and implement a combined Proposal/Cape Preston East (CPE) Port Oil Spill Response Plan;<br>• If required, develop an ASS Management Plan (ASSMP);<br>• Embankment material will not be taken from ASS zones; and<br>• Abstract seawater from the designated tidal creek only when tides are at or above 0.0 m Australian Height Datum (AHD).<br>**Rehabilitate**<br>• Implement Mine Closure Plan (MCP) approved under the Mining Act;<br>• Salts will be harvested from each crystalliser prior to closure;<br>• Concentration pond walls will be flattened or opened up to allow tidal flows to enter the ponds;<br>• All above-ground infrastructure will be removed if not retained by Mardie Station or Pilbara Ports Authority (PPA); and<br>• Crystallisers will be rehabilitated to an acceptable landform allowing free surface drainage. |

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| Outcomes | The presence of the concentration ponds and crystallisers will result in changes to hydrological regimes, both tidal and overland. Leichhardt has incorporated a number of levees, channels and culverts into the Proposal to ensure catchment flows are managed. This will constrain extreme flows resulting from tropical cyclones and storms and avoid flooding into the salt ponds, damage to pond walls and other infrastructure. Additionally, the final Proposal design includes a significant exclusion in the pond footprint to maintain the overall hydrological regimes of the drainage catchments. As a result, the Proposal is predicted to be able to be developed without significant impacts to hydrological regimes.<br>Potential impacts to inland water quality can be appropriately managed under Part V of the EP Act via a works approval and licence, as the Proposal will be considered under the 'solar salt manufacturing' category in Schedule 1 of the Environmental Protection Regulations 1987. A Mining Proposal issued under the Mining Act will also provide additional regulation for activities that are considered under that Act, such as pond wall geotechnical design and erosion.<br>The seawater intake is considered to be adequately managed under Part V of the EP Act via a works approval and licence however an abstraction timing requirement (only at or above 0.0 m AHD) and an intake volume limit is expected to be required under Part IV of the EP Act to enforce the commitments made in Section 6.6.2.<br>The impacts of sea level rise are predicted to be relatively localised and mostly limited to the area immediately adjacent to the coast to the northwest of the Ponds and Infrastructure Development Envelope (PIDE).<br>Based on the above, the Proposal is expected to be able to be implemented in a way that maintains hydrological regimes and quality of groundwater and surface water so that environmental values are protected. The EPA objective for this factor is therefore able to be met. |
| **Marine Environmental Quality** | |
| EPA objective | The EPA Objective for this key environmental factor is to maintain the quality of water, sediment and biota so that Environmental Values (EV) are protected. |
| Policy and guidance | • EIA (Part IV Divisions 1 and 2) Procedures Manual (EPA, 2024a).<br>• Statement of Environmental Principles, Factors, Objectives and Aims of EIA (EPA, 2023a).<br>• Statutory Guidelines for Mine Closure Plans (DMIRS, 2020a).<br>• EIA (Part IV Divisions 1 and 2) Administrative Procedures (EPA, 2024d).<br>• Instructions on how to prepare EP Act Part IV Environmental Management Plans (EPA, 2024e).<br>• Environmental Factor Guideline – Marine Environmental Quality (EPA, 2016a).<br>• Technical Guidance – Protection of BCH (EPA, 2016b).<br>• Technical Guidance – Protecting the Quality of WA's Marine Environment (EPA, 2016c).<br>• Technical Guidance – EIA of Marine Dredging Proposals (EPA, 2021f).<br>• Identification and investigation of acid sulfate soils and acidic landscapes (DoER, 2015a).<br>• Treatment and management of soil and water in acid Sauropus soil landscape (DoER, 2015b).<br>• Pilbara Coastal Water Quality Consultation Outcomes – Environmental Values and EQOs, DotE, Government of WA, Marine Series Report No. 1 (DotE, 2006).<br>• Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018).<br>• WA Environmental Offsets Policy (EPA, 2011).<br>• WA Environmental Offsets Guidelines (EPA, 2014a).<br>• WA Environmental Offsets Template (EPA, 2014b).<br>• WA Environmental Offsets Metric and relevant guidance (DWER, 2021b).<br>• Generic guidelines for the content of a draft EPBC Act PER/EIS (including the objects and principles of the EPBC Act, 1999; DotEE, 2016).<br>• EPBC Act Environmental Offsets Policy (DSEWPaC, 2012a) – including the Offset Assessment guide.<br>• Environmental Management Plan Guidelines (DotE, 2014).<br>• EPBC Act Condition Setting Policy (DAWE, 2020).<br>• EPBC Act Outcomes-based conditions policy (DotE, 2016a).<br>• *Environment Protection (Sea Dumping) Act 1981.*<br>• National Assessment Guidelines for Dredging (DEWHA, 2009a).<br>• Relevant EPBC Act listed species-specific Recovery plans, Threat Abatement Plans, Approved Conservation Advice and other documents.<br>• Marine bioregional plan for the North-west Marine Region (DSEWPaC, 2012b).<br>• Environmental best practice port development; an analysis of international approaches (GHD, 2013a). |

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| Potential impacts | **Marine waters surrounding port infrastructure and dredge material disposal area.**<br>• Discharge of up to 5.9 GLpa of bitterns;<br>• Disposal of up to 400,000 m³ of dredged sediment through water column (construction only);<br>• Increased turbidity caused by dredging and the construction of the bitterns pipeline and diffuser; and<br>• Hydrocarbon spills from dredge vessels.<br>**Tidal creeks**<br>• Hydrocarbon spills associated with the seawater intake;<br>• Increase in salinity due to leaks or spills of brine from ponds or pipelines; and<br>• Sedimentation due to runoff during construction of seawater intake |
| Mitigation | **Avoid**<br>There are limited opportunities to avoid impacts to marine environmental quality.<br>**Minimise**<br>• Obtain and comply with approvals under Part IV and V of the EP Act, Mining Act and *Port Authorities Act 1999;*<br>• The Proposal Content document includes several limits that minimise impacts to Marine Environmental quality;<br>• Dilute bitterns at least 1:1 with seawater prior to discharge;<br>• Implement the Marine Environmental Quality Monitoring and Management Plan (MEQMMP; Appendix 2.1);<br>• Implement the Dredging and Spoil Disposal Management Plan (DSDMMP; Appendix 2.2);<br>• Ensure fuel is stored within self-bunded tanks or within a bunded area;<br>• Develop and implement an Oil spill response plan;<br>• Generators are to be installed within a bunded area at the primary seawater intake;<br>• Concentration ponds and crystallisers will be designed and constructed to be safe and stable according to Department of Energy, Mines, Industry Regulation and Safety (DEMIRS) requirements;<br>• A series of controls will be used to minimise the risk of impact from unintentional brine pipeline spills;<br>• Monitor erosion at the outlets of the drainage corridors after significant flow events and install erosion protection (i.e. rock baffles etc.) if required; and<br>• Contractually require silt curtains to be in place during the construction of the primary seawater intake.<br>**Rehabilitate**<br>• Implement MCP approved under the Mining Act;<br>• All marine infrastructure above the seabed including the seawater intakes and bitterns outlets will be removed and taken offsite; and<br>• The dredge channel will be left to gradually fill with sediment. |
| Outcomes | The EPA's environmental objective for this factor is to maintain the quality of water, sediment and biota so that environmental values are protected (EPA, 2016a).<br>The Proposal includes the offshore disposal of dredged material, which will result in impacts on water quality in the vicinity of the dredging and disposal sites during dumping and for a short period afterwards. These impacts may result in increased turbidity and reduced benthic light in the vicinity of the dredging (O2 Metocean, 2025). The dredging will be carefully managed via a DSDMMP to ensure these impacts are limited to the areas predicted.<br>This Proposal also includes the discharge of up to 5.9 GLpa of bitterns into the marine environment. The bitterns will be diluted at a 1:1 ratio prior to discharge by mixing with seawater from an intake located on the jetty (but outside the area heavily influenced by the bitterns disposal to avoid drawing in bitterns) and discharged through a 200 m multi-port diffuser to promote mixing. This discharge will result in unavoidable significant water quality impacts in the waters surrounding the diffuser. The pre-dilution method proposed, the use of a diffuser and the siting and alignment of the diffuser have all been proposed to limit the size of the Low Ecological Protection Area (LEPA) and Moderate Ecological Protection Area (MEPA) boundaries as far as practicable, and ensure they are located such that areas of high value BCH are not significantly impacted. Bitterns disposal will be regulated by a Licence issued under Part V of the EP Act and managed by DWER. The MEQMMP (Appendix 2.1) details the monitoring and management measures proposed to ensure the bitterns discharges meet appropriate criteria.<br>The primary seawater intake and general Proposal operations will increase the risk of water quality impacts (i.e., from oil or brine spills, product loss). The potential risks are however mitigated using a number of well-established measures, in this case it will be managed under a Works Approval and approvals under the Mining Act and the *Port Authorities Act 1999* (WA). A MEPA has been proposed |

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| | around the LEPA and port operating areas as per other ports in the Pilbara and a High LEP around the primary seawater intake.<br>In summary, the resultant potential impacts to marine environmental quality are not expected to be significant in the localised area around the bitterns diffuser and dredge / dredge spoil areas, with limited impacts outside those impact zones given the mitigation measures are provided in the MEQMMP and DSDMMP.<br>It is expected that the Ministerial Statement will include the limits described above in the Proposal Content Document. Solar salt manufacturing (including bitterns disposal) is a prescribed activity and therefore all associated emissions and discharges will be managed under Part V of the EP Act including bitterns, oil spills and brine spills.<br>The environmental outcomes for this factor are therefore predicted to be:<br>• Negligible ongoing impacts to water quality outside the LEPA and MEPA boundaries (monitored and managed by Part V of the EP Act and the MEQMMP);<br>• Negligible impacts to water quality outside the ZoI during dredging operations (monitored and managed by the DSDMMP and Sea Dumping Permit); and<br>• A remaining potential for rare localised short-term impacts associated with spill/pollutant incidents.<br>With the implementation of controls, the Proposal is able to be implemented while maintaining the quality of water, sediment and biota so that regional environmental values are protected. The Proposal is therefore able to meet the EPA's objective for this factor. |
| **Benthic Communities and Habitats** | |
| EPA objective | The EPA Objective for this key environmental factor is to protect BCH so that biological diversity and ecological integrity are maintained. |
| Policy and guidance | • EIA (Part IV Divisions 1 and 2) Procedures Manual (EPA, 2024a).<br>• Statement of Environmental Principles, Factors, Objectives and Aims of EIA (EPA, 2023a).<br>• Statutory Guideline for Mine Closure Plans (DMIRS, 2020a).<br>• EIA (Part IV Divisions 1 and 2) Administrative Procedures (EPA, 2025d).<br>• Instructions on how to prepare EP Act Part IV Environmental Management Plans (EPA, 2025e).<br>• Environmental Factor Guideline – BCH (EPA, 2016d).<br>• Technical Guidance – Protection of BCH (EPA, 2016b).<br>• Technical Guidance – Protecting the Quality of Western Australia's Marine Environment (EPA, 2016c).<br>• Technical Guidance – EIA of Marine Dredging Proposals (EPA, 2021f).<br>• Guidance Statement No. 1 – Protection of Tropical Arid Zone Mangroves along the Pilbara Coastline (EPA, 2001).<br>• Western Australian Prevention List for Introduced Marine Pests, Department of Fisheries (DPIRD, 2016).<br>• Pilbara Coastal Water Quality Consultation Outcomes – Environmental Values and EQOs, DotE, Government of Western Australia, Marine Series Report No. 1 (DotE, 2006).<br>• Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018).<br>• WA Environmental Offsets Policy (EPA, 2011).<br>• WA Environmental Offsets Guidelines (EPA, 2014a).<br>• WA Environmental Offsets Template (EPA, 2014b).<br>• WA Environmental Offsets Metric and relevant guidance (DWER, 2021b).<br>• Generic guidelines for the content of a draft EPBC Act PER/EIS (including the objects and principles of the EPBC Act, 1999; DotEE, 2016).<br>• EPBC Act Environmental Offsets Policy (DSEWPaC, 2012a) – including the Offset Assessment guide.<br>• Environmental Management Plan Guidelines (DotE, 2014).<br>• EPBC Act Condition Setting Policy (DAWE, 2020).<br>• EPBC Act Outcomes-based conditions policy (DotE, 2016a).<br>• Relevant EPBC Act listed species-specific survey guidelines and protocols.<br>• Relevant EPBC Act listed species-specific Recovery plans, Threat Abatement Plans, Approved Conservation Advice and other documents.<br>• Marine bioregional plan for the North-west Marine Region (DSEWPaC, 2012b).<br>• National Assessment Guidelines for Dredging (DEWHA, 2009a).<br>• Environmental best practice port development; an analysis of international approaches (GHD, 2013a). |

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| Potential impacts | **General Intertidal BCH**<br>• Up to 1,175.1 ha of intertidal BCH to be irreversibly impacted;<br>• Introduction of marine pests; and<br>• Indirect impacts associated with changes to water quality.<br>**Mangrove Habitat**<br>• Up to 8.3 ha of disturbance.<br>• Potential indirect impacts associated with changes to water quality, hydrology and the risk of introducing marine pests.<br>**Algal Mat Habitat**<br>• Up to 87.3 ha of disturbance to HDAM; and<br>• Potential indirect impacts associated with changes to water quality and the risk of introducing marine pests.<br>**Samphire shrublands Habitat**<br>• Up to 480.7 ha of disturbance; and<br>• Potential indirect impacts associated with changes to water quality and the risk of introducing marine pests.<br>**Subtidal BCH**<br>• Up to 47.0 ha of direct disturbance; and<br>• Up to 100.0 ha of bare 'unvegetated' substrate directly impacted; and<br>• Potential indirect impacts associated with changes to water quality and the risk of introducing marine pests. |
| Mitigation | **Avoid**<br>The key avoidance mechanism implemented by Leichhardt was the design of the development envelopes to avoid key BCH where practicable. Leichhardt has conducted numerous ecological surveys and this information has been utilised to design the Proposal and its development envelope boundaries to avoid the following:<br>• Impacts to three dredged material disposal sites previously proposed with the lowest impact site chosen (refer to Section 4);<br>• The majority of mangrove, higher productivity algal mats and tidal creek habitats (refer to Section 4); and<br>• The majority of the sandy beach BCH north of the Proposal.<br>In addition to the above, the following avoidance mitigation measures have been incorporated:<br>• Impact associated with large-scale dredging activities and OGV movements close to shore has been avoided by the use of a transhipment loading method.<br>**Minimise**<br>• Obtain and comply with approvals under Part IV and V of the EP Act, Mining Act and *Port Authorities Act 1999;*<br>• The Key Proposal Characteristics (Section 2.3.2) provide several limits that were included to minimise impacts to BCH;<br>• Minimise disturbance within mangrove communities, in particular Closed Canopy (CC) mangroves and within the Regionally Significant Mangrove Area (RSMA);<br>• Implement the MEQMMP (Appendix 2.1);<br>• Implement the DSDMMP (Appendix 2.2);<br>• Implement the BCH Monitoring and Management Plan (BCHMMP; Appendix 3.9);<br>• Implement the Hydrocarbon Spill Management Plan (Appendix C of the MEQMMP);<br>• A series of controls will be used to minimise the risk of impact from unintentional brine pipeline spills;<br>• Ensure product infrastructure wash down water is captured and not released to the surrounding environment;<br>• Implement measures to minimise the risk of introducing marine pests;<br>• Maintain primary drainage corridors through or around the ponds;<br>• Monitor erosion at the outlets of the drainage corridors after significant flow events and install erosion protection (i.e., rock baffles) if required;<br>• Verify inundation model within 12 months of the completion of the western pond walls to confirm indirect impact predictions associated with changes to tidal regimes; and<br>• Implement the GMMP, including monitoring of groundwater levels down-gradient of the concentration ponds and crystallisers to verify that the ponds will not result in the movement of hypersaline groundwater toward areas inhabited by mangrove communities.<br>**Rehabilitate**<br>• Implement MCP approved under the Mining Act; |

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| | • Salts will be harvested from each crystalliser prior to closure;<br>• Concentration pond walls will be flattened or opened up to allow tidal flows to enter the lower ponds;<br>• All above-ground infrastructure will be removed if not retained by PPA or the landowner; and<br>• All crystallisers will be rehabilitated to an acceptable landform. |
| Outcomes | The EPA's environmental objective for this factor is "to protect BCH so that biological diversity and ecological integrity are maintained." In the context of this objective "ecological integrity" is listed as the composition, structure, function and processes of ecosystems, and the natural range of variation of these elements (EPA, 2016d).<br>Intertidal BCH are important in primary and secondary productivity, as well as nutrient and carbon cycling in coastal environments. Given the scale and location of the Proposal, impacts to BCH are unavoidable. The Proposal will result in the loss of approximately 1,175.1 ha of intertidal BCH and 47.0 ha of subtidal BCH. The seaward BCH communities present, by far, the most ecologically valuable communities within the LAUs. The Proposal design was revised to avoid mangroves, resulting in only 8.3 ha of mangroves being disturbed.<br>The maximum estimate of irreversible loss of HDAM is 87.3 ha, or 12.5% of the total of this BCH type distributed across the intertidal LAUs. Algal mats are inferred to have the potential to act as important nutrient sources in the Pilbara intertidal BCH through their nitrogen-fixing properties in an otherwise nitrogen deficient system. The pond layout was revised to avoid large areas of algal mats, with a focus on conserving algal mats with higher productivity. As a result, the Proposal disturbance will reduce the overall productivity of algal mats within the LAUs by 11.2%.<br>Indirect impacts to BCH from dredging and bitterns disposal will be managed by a DSDMMP (Appendix 2.2) and MEQMMP (Appendix 2.1) respectively. It is anticipated that the requirement for a DSPMMP and MEQMMP will be a condition applied to the Proposal (if recommended for approval) and the plans will be updated to address comments through the assessment process.<br>With the implementation of controls, other indirect impacts to BCH are not predicted to be significant. Emissions from the construction and operation of the concentration ponds and crystallisers will be regulated under Part V of the EP Act (works approval and licence). Vessel hygiene (to prevent IMPs) is regulated by DPIRD.<br>At a local scale, and given the current uncertainty about algal mat significance, impacts to intertidal BCH are considered to be significant, even once mitigation measures are implemented. The Proposal is predicted to result in significant residual impacts to:<br>• Up to 8.3 ha of mangrove BCH, including losses within RSMA#9;<br>• Up to 87.3 ha of HDAM; and<br>• Up to 480.7 ha of samphire shrubland BCH.<br>Offsets are proposed to counterbalance the residual impact. These offsets are proposed in Section 15 and will be refined as further information and research findings become available.<br>The environmental outcomes for this factor are therefore predicted to be:<br>• No adverse impact on the ecological function of the RSMA #9 or the maintenance of ecological processes which sustain mangrove habitats within RSMA #9<br>• No adverse impacts on the broader ecological function of intertidal and subtidal benthic communities and habitats;<br>• No long-term (greater than five (5) years) net detectable loss of algal mat outside of the Proposal disturbance footprint from indirect impacts; and<br>• No loss of subtidal benthic communities and habitat (including subtidal algae) outside the LEPA and dredging Zones of Impact;<br>Based on the information provided in this assessment, the Proposal is predicted to be able to meet the EPA's objective for this factor. The implementation of the proposed mitigation is expected to minimise the potential for significant residual impacts to BCH to a level where offsets are suitable and appropriate to counterbalance the residual impacts, as detailed in Section 15. |
| **Marine Fauna** | |
| EPA objective | The EPA Objective for this key environmental factor is to protect marine fauna so that biological diversity and ecological integrity are maintained. |
| Policy and guidance | • EIA (Part IV Divisions 1 and 2) Procedures Manual (EPA, 2024a).<br>• Statement of Environmental Principles, Factors, Objectives and Aims of EIA (EPA, 2023a).<br>• Statutory Guideline for Mine Closure Plans (DMIRS, 2020a).<br>• EIA (Part IV Divisions 1 and 2) Administrative Procedures (EPA, 2024d).<br>• Instructions on how to prepare EP Act Part IV Environmental Management Plans (EPA, 2024e).<br>• Environmental Factor Guideline – Marine Fauna (EPA, 2016e).<br>• Technical Guidance – Protection of BCH (EPA, 2016b). |

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| | • Technical Guidance – Protecting the Quality of Western Australia's Marine Environment (EPA, 2016c).<br>• Technical Guidance – EIA of Marine Dredging Proposals (EPA, 2021f).<br>• National Light Pollution Guidelines for Wildlife (DCCEEW, 2023).<br>• Environmental Assessment Guideline No. 5 – Protecting Marine Turtles from Light Impacts (EPA, 2010).<br>• Status reports of the fisheries and aquatic resources of Western Australia 2020/21: State of the Fisheries (DPIRD, 2021a).<br>• WA Environmental Offsets Policy (EPA, 2011).<br>• WA Environmental Offsets Guidelines (EPA, 2014a).<br>• WA Environmental Offsets Template (EPA, 2014b).<br>• WA Environmental Offsets Metric and relevant guidance (DWER, 2021b).<br>• Generic guidelines for the content of a draft EPBC Act PER/EIS (including the objects and principles of the EPBC Act, 1999; DotEE, 2016).<br>• EPBC Act Environmental Offsets Policy (DSEWPaC, 2012a) – including the Offset Assessment guide.<br>• Environmental Management Plan Guidelines (DotE, 2014).<br>• EPBC Act Condition Setting Policy (DAWE, 2020).<br>• EPBC Act Outcomes-based conditions policy (DotE, 2016a).<br>• National Assessment Guidelines for Dredging (DEWHA, 2009a).<br>• Relevant EPBC Act listed species-specific survey guidelines and protocols.<br>• Relevant EPBC Act listed species-specific Recovery plans, Threat Abatement Plans, Approved Conservation Advice and other documents.<br>• Marine bioregional plan for the North-west Marine Region (DSEWPaC, 2012b).<br>• National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (DotEE, 2017a).<br>• Environmental best practice port development; an analysis of international approaches (GHD, 2013a). |
| Potential impacts | **General marine fauna**<br>• Direct disturbance of up to 47.0 ha of vegetated subtidal marine fauna habitat;<br>• Direct disturbance of up to 8.3 ha of intertidal marine fauna habitat (mangroves);<br>• Increased risk of death or injury as a result of vessel strike, dredging, dredging material disposal or entrapment in seawater intakes;<br>• Increased risk of introduction of marine pests by dredging vessels or other vessels used in construction and operations activities;<br>• Hearing or behavioural impacts as a result of construction-related noise (from dredging material disposal);<br>• Increased predation by aggregation of marine organisms around marine infrastructure;<br>• Changes in intertidal or freshwater inputs into the marine environment due to the presence of the ponds; and<br>• Indirect impacts to marine fauna habitat health from dredging, bitterns disposal or product/hydrocarbon spillages.<br>**Marine Reptiles**<br>• Direct disturbance of up to 47.0 ha of vegetated subtidal marine fauna habitat;<br>• Direct disturbance of up to 8.3 ha of intertidal marine fauna habitat (mangroves);<br>• Increased risk of death or injury as a result of vessel strike, dredging, dredge material disposal or entrapment in seawater intakes;<br>• Alterations to turtle and hatchling behaviour as a result of predation;<br>• Hearing or behavioural impacts as a result of construction-related noise (from dredging and dredging material disposal);<br>• Alterations to turtle and hatchling behaviour as a result of light emissions; and<br>• Indirect impacts to habitat health.<br>**Marine Mammals**<br>• Direct disturbance of up to 47.0 ha of vegetated subtidal marine fauna habitat; and<br>• Increased risk of death or injury as a result of vessel strike, dredging or dredging material disposal;<br>• Hearing or behavioural impacts as a result of construction related noise (from vessels, dredging or dredged material disposal); and<br>• Indirect impacts to habitat health.<br>**Sawfish**<br>• Direct disturbance of up to 47.0 ha of vegetated subtidal marine fauna habitat;<br>• Direct disturbance of up to 8.3 ha of intertidal marine fauna habitat (mangroves); |

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| | • Increased risk of death or injury as a result of vessel strike, dredging or dredged material disposal;<br>• Hearing or behavioural impacts as a result of dredging;<br>• Presence of potential barriers to movement (pipelines, dredging);<br>• Indirect impacts to habitat health; and<br>• Long-term changes to coastal processes around tidal creek systems. |
| Mitigation | **Avoid**<br>The key avoidance mechanism implemented by Leichhardt was the re-design of the development envelopes to avoid key environmental features. Leichhardt has conducted numerous ecological surveys and this information has been utilised to design the Proposal and its development envelope boundaries to avoid the following (refer to Section 5):<br>• Two dredged material disposal locations (removed from the scope of the Proposal);<br>• The majority of the sandy beach north of the Proposal; and<br>• The majority of mangrove habitats and higher productivity algal mats.<br>In addition to the above, the following avoidance mitigation measures have been incorporated:<br>• Impacts associated with large-scale dredging activities and OGV movements close to shore have been avoided by the use of a transhipment loading method;<br>• Dredging will be conducted between the period of April to September to avoid key environmental windows including turtle nesting, sawfish pupping, whale migration, and spawning periods for coral and socio-economically important fish species; and<br>• Vessels will not be permitted to venture or operate outside of port waters unless conducting operational, monitoring or rescue activities.<br>**Minimise**<br>• Implement the MEQMMP (Appendix 2.1);<br>• Implement a DSDMMP (Appendix 2.2);<br>• Minimise potential noise impacts to marine fauna for the duration of the dredging operations by implementing marine noise controls;<br>• Minimise the risk of introducing marine pests by implementing control measures;<br>• Minimise the risk of fatal vessel strikes to marine fauna through training of vessel operators and implementing of control measures including maintaining minimum separation distances between vessels and prescribed fauna as described in the Biodiversity Conservation Regulations 2018 (BC Regulations);<br>• Obtain and comply with a Works Approval and Licence under Part V of the EP Act;<br>• Seawater intakes are to be fitted with intake screens designed to prevent marine fauna from being drawn into the intake, and designed such that intake speeds are limited to a maximum of 0.15 m/s;<br>• Implement the Artificial Light Management Plan for all lights within 15 km of a confirmed potential turtle nesting beach;<br>• Undertake additional turtle nesting surveys;<br>• Ensure key environmental windows (Section 9.3.14) are considered when planning construction activities; and<br>• Implement measures to minimise indirect impacts to marine fauna habitat.<br>**Rehabilitate**<br>• All marine infrastructure above the seabed including the seawater intakes and bitterns outlets will be removed and taken offsite; and<br>• The dredged channel will be left to gradually fill with sediment if not required for ongoing use of the CPE Port. |
| Outcomes | The EPA's environmental objective for this factor is "to protect marine fauna so that biological diversity and ecological integrity are maintained" (EPA, 2016e).<br>The assessment conducted in Section 9.5 determined there were a number of potential impacts that required controls to ensure they were made acceptable:<br>• Vessel strike;<br>• Entrapment and/or entrainment in seawater intakes;<br>• IMPs;<br>• Marine noise emissions, particularly during dredging activities; and<br>• Light impacts on marine turtles.<br>The mitigation measures for these potential impacts are well understood and established for marine projects (refer to Section 9.6).<br>Implementing an 8-knot speed limit for Proposal-related construction vessels will act to reduce marine fauna injury from vessel strike. While the probability of vessel strike is already low, reducing vessel speed has been shown to decrease the likelihood of fatal injury (to large whales) by |

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| | 30% (Vanderlaan and Taggart, 2006). In addition, vessel operators will be required to report the location of any sightings of large marine fauna (in particular marine turtles, mammals and sawfish) to other vessel operators in the area to allow them to be tracked (if visible) and avoided, and for minimum separation distances to be maintained between vessels and prescribed fauna as described in the BC Regulations. Given the low numbers of vessels to be used at the Proposal and the implementation of controls, the Proposal is expected to be able to be implemented without significant vessel strike impacts to marine fauna.<br><br>The Proposal will have two seawater intakes which could pose a risk of marine fauna entrapment if not designed and operated appropriately. Leichhardt has committed to two specific mitigation measures for these intakes; screens will be installed to prevent the majority of marine fauna from being drawn into the intake pipe, and the intakes have been designed such that the intake velocity is maintained below 0.15 m/s. This velocity is recommended by the US Environmental Protection Agency (2001) as it ensures the protection of 96% of fish species, and is lower than the swim speed of marine turtles (Bell and Richardson, 1978; Bustard and Limpus, 1970; Chung et al., 2009; de Silva, 1995; Frick, 1976; Hirth, 1971; Hughes, 1974; Papi et al., 1995; Prange, 1976; Salmon and Wyneken, 1987; Witherington, 1991; Wyneken, 1997). With the implementation of these two controls the risk of marine fauna entrapment is expected to be lowered to an acceptable level.<br><br>With the application of regulated controls, the Proposal is considered to present a 'low risk' of introducing marine pests to Eramurra marine waters. Standard industry controls (enforced by DAFF) relating to ballast water and vessel hygiene provide a level of confidence that IMPs will not be introduced.<br><br>Estimated marine noise from dredging activities is not significant, and marine noise mitigation measures are now well established within the marine construction industry. With the application of these measures, it is expected that dredging will be able to be conducted without significant noise impacts on marine fauna.<br><br>Hawksbill, Flatback and Green turtles were found to use beaches near the Proposal at low and varying levels. The highest density of nesting activity occurred on South West Regnard Island and Steamboat Island. Given the presence of marine turtles in the area, light mitigation measures will be implemented (documented within an Artificial Light Management Plan) to reduce the risk of light interfering with turtle navigation.<br><br>Water quality impacts from dredging and bitterns disposal (assessed in Section 6) were assessed as not being significant with the implementation of mitigation measures. Consequently, the impacts on marine fauna are subsequently not expected to be significant. Bitterns disposal and emissions from the salt production process will be managed under Part V of the EP Act via a works approval and licence.<br><br>Several significant fauna species listed under the BC Act and EPBC Act are known or expected to inhabit the waters surrounding the Proposal. Leichhardt considered these species when incorporating mitigation measures into the design and has proposed operational commitments to ensure that potential impacts on these species are not significant.<br><br>There may be some impacts to commercial and recreational fishery species, primarily associated with cumulative impacts across the extent of the fishery and the spatial range of the species that are being targeted. This is critical for some indicator species that may already be on the edge of triggering restrictions, where there is no buffer for additional cumulative impacts. Leichhardt will continue to liaise with EPA and WAFIC regarding the most appropriate method to accurately quantify these impacts and mitigate them as far as practicable.<br>The environmental outcomes for this factor are therefore predicted to be:<br>• No adverse impacts to marine fauna populations due to entrapment or entrainment within the seawater intake;<br>• Negligible impacts to marine megafauna behaviour from dredging;<br>• No introduction of IMPs;<br>• Negligible impacts to marine turtle nesting and hatchling behaviour;<br>• Losses of mangrove BCH that is considered significant and requires offsets to counterbalance the impact;<br>• Negligible ongoing impacts to BCH and water quality outside the LEPA and MEPA boundaries (monitored and managed by the MEQMMP);<br>• Negligible impacts to BCH and water quality outside the Zone of High Impact (ZoHI) and Zone of Moderate Impact (ZoMI) during dredging operations (monitored and managed by the DSDMMP); and<br>• A remaining potential for rare localised short-term impacts to water quality and BCH associated with spill/pollutant incidents.<br><br>Noting that there is some uncertainty regarding cumulative fishery stock impacts, Leichhardt will continue to seek to ensure that the Proposal can be implemented in a manner that meets the EPA's objective for this factor. |

| Terrestrial Environmental Quality | |
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| EPA Objective | The EPA Objective for this key environmental factor is to maintain the quality of land and soils so that environmental values are protected. |
| Policy and Guidance | • EIA (Part IV Divisions 1 and 2) Procedures Manual (EPA, 2024a).<br>• Statement of Environmental Principles, Factors, Objectives and Aims of EIA (EPA, 2023a).<br>• Statutory Guideline for Mine Closure Plans (DMIRS, 2020a).<br>• EIA (Part IV Divisions 1 and 2) Administrative Procedures (EPA, 2024d).<br>• Instructions on how to prepare EP Act Part IV Environmental Management Plans (EPA, 2024e).<br>• Environmental Factor Guideline – Terrestrial Environmental Quality (EPA, 2016m).<br>• Identification and investigation of acid sulphate soils and acidic landscapes (Department of Environmental Regulation, 2015a).<br>• Treatment and management of soil and water in acid sulfate soil landscapes (DER, 2015b).<br>• Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Commonwealth of Australia, 2018).<br>• WA Environmental Offsets Policy (EPA, 2011).<br>• WA Environmental Offsets Guidelines (EPA, 2014a).<br>• WA Environmental Offsets Template (EPA, 2014b).<br>• Generic guidelines for the content of a draft EPBC Act PER/EIS (including the objects and principles of the EPBC Act, 1999; DotEE, 2016).<br>• EPBC Act Environmental Offsets Policy (DSEWPaC, 2012a) – including the Offset Assessment guide.<br>• Environmental Management Plan Guidelines (DotE, 2014).<br>• EPBC Act Condition Setting Policy (DAWE, 2020).<br>• EPBC Act Outcomes-based conditions policy (DotE, 2016a). |
| Potential Impacts | **The ecosystem health values that the soils within the PIDE support, including biodiversity**<br>• Disturbance of soil structure and integrity;<br>• Disturbance of ASS;<br>• Contamination of soil from increase of salinity due to seepage from the concentration ponds and crystallisers;<br>• Erosion from pond walls spreads sediment into terrestrial environment; and<br>• Leaks or spills of hydrocarbons or chemicals. |
| Mitigation | **Avoid:**<br>The key avoidance mechanism implemented by Leichhardt was the iterative design of the development envelopes to avoid key environmental features. Leichhardt has conducted numerous ecological surveys and this information has been utilised to design the Proposal and its Indicative Disturbance Footprint. Additionally, Leichhardt will avoid using dispersive/erosive soils and subsurface materials for the construction of ponds, crystallisers, embankments, and perimeter bunds. In addition to the above, the development envelopes boundaries have been located to allow the use of existing tracks and port infrastructure wherever practicable.<br>**Minimise:**<br>• Obtain and comply with approvals under Part IV and V of the EP Act, Mining Act and *Port Authorities Act 1999;*<br>• If required, develop an ASSMP;<br>• Embankment material will not be taken from ASS zones and will not be constructed using dispersive/erosive materials;<br>• Implement the GMMP to minimise groundwater seepage and salinity impacts on terrestrial environment (Appendix 1.9);<br>• Ensure erosion and sediment control is included in contractor management plans;<br>• Monitor erosion at the outlets of the surface water corridors after each significant flow event;<br>• Design and construct concentration ponds, crystallisers and perimeter bunds to be safe and stable according to DEMIRS requirements including by avoiding the use of dispersive/erosive materials in their construction;<br>• Routinely inspect the condition and performance of pond walls, pipelines, containment systems and internal drainage structures;<br>• The following controls will be used to further reduce the risk of impact from unintentional brine pipeline spills:<br>  o Comply with Guidelines and guidance notes related to the storage and use of hydrocarbons and other harmful chemicals; and<br>  o Ensure fuel is stored within self-bunded tanks or within a bunded area. |

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| Outcomes | The EPA's environmental objective for this factor is to maintain the quality of land and soils so that environmental values are protected (EPA, 2016c). In the context of this objective: "terrestrial environmental quality" is defined as the chemical, physical, biological and aesthetic characteristics of soils (EPA, 2016c). The specific environmental values to be protected are 'the ecosystem health values that the soils support, including biodiversity.'<br>The Proposal is not expected to significantly impact terrestrial environmental quality. Soil structure and quality parameters, including but not limited to pH, landform, nutrients and salinity will be monitored and managed through the implementation of mitigation measures. These parameters will also be managed through relevant secondary approvals and environmental management plans during pre-construction, construction, operation and closure of the Proposal.<br>The key risks to terrestrial environmental quality are the disturbance of ASS, seepage and increase of salinity from concentration ponds and crystalisers and erosion from active or rehabilitated structures, topsoil stockpiles and overburden. The design and operation of all of these items will be regulated under Part V of the EP Act and the Mining Act.<br>The predicted outcome for terrestrial environmental quality is highly dependent on the implementation of mitigation measures. With the implementation of these measures the predicted outcomes for terrestrial environmental quality are considered to be:<br>• Negligible changes to soil salinity outside the area immediately surrounding the pond walls; and<br>• A remaining potential for rare localised short-term impacts associated with spill/pollutant incidents.<br>The implementation of design and operation mitigation measures, and regulation under Part V of the EP Act and the Mining Act, are expected to ensure that the Proposal does not significantly impact this factor. The EPA objective for this factor is therefore able to be met. |
| **Flora and Vegetation** | |
| EPA objective | The EPA Objective for this key environmental factor is to protect flora and vegetation so that biological diversity and ecological integrity are maintained. |
| Policy and guidance | • EIA (Part IV Divisions 1 and 2) Procedures Manual (EPA, 2024a).<br>• Statement of Environmental Principles, Factors, Objectives and Aims of EIA (EPA, 2023a).<br>• Statutory Guideline for Mine Closure Plans (DMIRS, 2020a).<br>• EIA (Part IV Divisions 1 and 2) Administrative Procedures (EPA, 2024d).<br>• Instructions on how to prepare EP Act Part IV Environmental Management Plans (EPA, 2024e).<br>• Environmental Factor Guideline – Flora and Vegetation (EPA, 2016f).<br>• Technical Guidance – Flora and Vegetation Surveys for EIA (EPA, 2016g).<br>• Guidance Statement 6 – Rehabilitation of Terrestrial Ecosystems (EPA, 2006).<br>• Environmental Protection Bulletin 20 – Protection of naturally vegetated areas through planning and development (EPA, 2013).<br>• Checklist for documents submitted for EIA of proposals that have the potential to significantly impact of Sea and Land factors (EPA, 2016h).<br>• *Biosecurity and Agriculture Management Act 2007*.<br>• WA Environmental Offsets Policy (EPA, 2011).<br>• WA Environmental Offsets Guidelines (EPA, 2014a).<br>• WA Environmental Offsets Template (EPA, 2014b).<br>• WA Environmental Offsets Metric and relevant guidance (DWER, 2021b).<br>• Generic guidelines for the content of a draft EPBC Act PER/EIS (including the objects and principles of the EPBC Act, 1999; DotEE, 2016).<br>• EPBC Act Environmental Offsets Policy (DSEWPaC, 2012a) – including the Offset Assessment guide.<br>• Environmental Management Plan Guidelines (DotE, 2014).<br>• EPBC Act Condition Setting Policy (DAWE, 2020).<br>• EPBC Act Outcomes-based conditions policy (DotE, 2016a).<br>• Relevant EPBC Act listed species-specific survey guidelines and protocols.<br>• Relevant EPBC Act listed species-specific Recovery plans, Threat Abatement Plans, Approved Conservation Advice and other documents. |
| Potential impacts | **General terrestrial flora and vegetation**<br>• Up to 11,401.1 ha of disturbance to vegetation, 11,287.7 ha of which is in Good to Excellent Condition; and<br>• Reduction in vegetation health as a result of potential indirect impacts.<br>***Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479)**<br>• Direct impact to two recorded locations of this species; |

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| | • Up to 7,352.1 ha disturbance to Ex vegetation type; and<br>• Reduction in vegetation health as a result of potential indirect impacts.<br>***Eremophila forrestii* subsp. *viridis***<br>• No direct impact to any records;<br>• Up to 16.9 ha of disturbance to AiElTw vegetation type; and<br>• Reduction in vegetation health as a result of potential indirect impacts.<br>***Rostellularia adscendens* var. *latifolia***<br>• No direct impact to any records;<br>• Up to 14.4 ha disturbance to EvAcCf vegetation type; and<br>• Reduction in vegetation health as a result of potential indirect impacts.<br>**Eleven other potential Priority Flora species**<br>• No direct impact to any records as none were recorded in the Study Area;<br>• Up to 11,401.1 ha of disturbance;<br>• Disturbance to individuals or potential habitat is possible if a species is present; and<br>• Reduction in vegetation health as a result of potential indirect impacts.<br>***Bergia henshallii* Range Extensions Flora**<br>• No direct impacts;<br>• Disturbance to individuals or potential habitat is possible if records are present; and<br>• Reduction in vegetation health as a result of potential indirect impacts.<br>**GDEs**<br>• Up to 35.1 ha of disturbance; and<br>• Reduction in vegetation health as a result of potential indirect impacts.<br>**Horseflat PEC**<br>• Up to 7,614.1 ha of disturbance (4% of regional mapped extent); and<br>• Reduction in vegetation health as a result of potential indirect impacts.<br>**Coastal Dune PEC**<br>• No direct impacts; and<br>• Reduction in vegetation health as a result of potential indirect impacts.<br>**Locally significant vegetation type (EvScSv)**<br>• Up to 5.8 ha of disturbance (75% of total mapped extent), all outside the AMIZ; and<br>• Reduction in vegetation health as a result of potential indirect impacts.<br>**Locally significant vegetation type (HscIlCc)**<br>• Up to 0.9 ha disturbance (14% of mapped extent); and<br>• Reduction in vegetation health as a result of potential indirect impacts.<br>**Locally significant vegetation type (MmTsppSv)**<br>• No direct impacts; and<br>• Reduction in vegetation health as a result of potential indirect impacts. |
| Mitigation | **Avoid:**<br>The key avoidance outcome achieved by Leichhardt was the iterative design of the development envelopes to avoid key environmental features. Leichhardt has conducted numerous ecological surveys and this information has been utilised to design the Proposal and its development envelope boundaries to avoid the following:<br>• The majority of riparian vegetation along Eramurra, McKay and Devil Creeks;<br>• The Coastal Dune PEC; and<br>• Vegetation types EcAcTe. TeWa, MmTsppSv, HscllCc/Tspp and HscllCc/Mudflat.<br>**Minimise:**<br>• Implement industry best-practice management measures for flora and vegetation;<br>• Obtain and comply with approvals under Part IV and V of the EP Act, Mining Act and *Port Authorities Act 1999;*<br>• Conduct additional targeted surveys for unidentified or undescribed flora species. The targeted surveys will be to ensure that no potentially novel species occur only within the disturbance area;<br>• Develop the final Proposal design with consideration of minimising impacts to known locations of priority flora, unidentified or undescribed flora species and range extensions flora;<br>• Implement the GMMP to reduce impacts to vegetation surrounding the ponds including GDEs (Appendix 1.9);<br>• Monitor the potential changes to tidal inundation regimes; |

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| | • Design and construct concentration ponds and crystallisers to be safe and stable according to DEMIRS requirements; and<br>• Implement controls to reduce the risk of impact from brine pipeline spills.<br>**Rehabilitate**<br>• Implement MCP approved under the Mining Act*;*<br>• Salts will be harvested and washed from each crystalliser prior to closure;<br>• Concentration pond walls will be flattened or opened up to allow tidal flows to enter the ponds and surface drainage through higher areas;<br>• Above ground infrastructure will be removed if not retained by PPA or the landowner; and<br>• Crystallisers will be rehabilitated to an acceptable landform. |
| Outcomes | The EPA's environmental objective for this factor is "to protect flora and vegetation so that biological diversity and ecological integrity are maintained." In the context of this objective: "ecological integrity" is listed as the composition, structure, function and processes of ecosystems, and the natural range of variation of these elements (EPA, 2016g).<br>Leichhardt has incorporated extensive avoidance and minimisation measures into the Proposal design and operational processes, and this section presents the predicted outcomes after those measures have been incorporated.<br>The Proposal will result in direct impacts to flora and vegetation that are unavoidable. All vegetation associations to be disturbed will have more than 84% of their pre-European extent remaining, even once cumulative disturbance associated with the Proposal and others such as CPE Port, Sino Iron Project, Mardie Project and 40-Mile Beach Road have been deducted. This means that all of the vegetation associations will remain in the 'Least Concern' category (Phoenix Environmental Services (Phoenix), 2025).<br>Impacts to Priority flora records have almost completely been avoided, with only two records of *Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479) (Priority 3) predicted to be disturbed. Leichhardt notes that *Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479) and *Eremophila forrestii* subsp*. viridis* remain taxonomically uncertain and their Priority flora status may change pending further taxonomic information. For the purposes of this assessment, they have been treated as Priority 3 flora species (i.e., their current status). Given that *Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479) has been recorded 31 times across multiple locations in the Pilbara bioregion and only two records are proposed to be disturbed for the Proposal, significant impacts to this species are unlikely.<br>Impacts to potentially new species and species with range extensions are proposed to be mitigated such that they are not considered significant. Leichhardt is proposing to undertake a targeted survey for *Polygala* aff. *galeocephala* prior to construction, following suitable rainfall. This survey is intended to identify these species, and demonstrate that it is not constrained to the disturbance footprint. Additional regional surveys will be undertaken if needed to achieve this outcome.<br>The Proposal includes large areas of ponds that contain salts or brine and as such revegetation will be impeded for some time post-closure. The Proposal is a long-life project with an infinite resource (seawater and solar energy), so consideration of altered ocean hydrodynamics and climate change will be necessary. Closure planning will continue through the life of the Proposal (with the MCP being revised every three years), with the purpose of refining the closure strategies already identified in the Interim MCP (Appendix 1.8), including:<br>• The concentration pond walls will be flattened or opened up to allow tidal flows and overland drainage to reinstate within the former pond areas. Over time this is expected to return the area to a state where salt-tolerant species can revegetate those pond areas; and<br>• Salts will be recovered from the crystallisers, which are to be located on terrestrial vegetation.<br>To summarise the above, with the implementation of mitigation measures (primarily the avoidance and minimisation of disturbance), the residual impacts to the following values are not considered significant:<br>• Priority flora and associated habitat;<br>• Potentially new flora; and<br>• Locally significant vegetation.<br>Some impacts were deemed to remain significant after the implementation of mitigation measures. The Proposal is predicted to result in residual impacts to up to 11,287.7 ha of Good to Excellent condition native vegetation which includes habitat for significant flora and the Horseflat PEC. The EPA considers that the clearing of native vegetation and impacts on other associated environmental values in the Pilbara IBRA bioregion is significant where the cumulative impact may reach critical levels if not managed. Leichhardt has assessed the vegetation loss in a similar manner, with the loss of Good to Excellent vegetation considered to be a significant residual impact. Offsets are proposed to counterbalance those impacts (Section 15). |

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| | The residual impacts to Good to Excellent condition vegetation includes residual impacts to up to 7,614.1 ha of Horseflat PEC (3.9% of regional extent). This residual impact is considered significant and additional offsets have been proposed to counterbalance the residual impact.<br>The environmental outcomes for this factor are therefore predicted to be:<br>• No more than 11,287.7 ha of Good to Excellent quality native vegetation to be cleared as a result of the Proposal, including no more than 7,614.1 ha of Horseflat PEC;<br>• No losses of Priority Flora that would significantly affect the viability of the species;<br>• No disturbance associated with the Proposal to more than 76% of the mapped extent of significant vegetation EvScSv;<br>• No disturbance associated with the Proposal to the mapped extent of restricted locally significant vegetation MmTsppSv;<br>• No indirect impacts from the introduction or spread of weeds compared with pre-construction condition; and<br>• No permanent impacts associated with spill/pollutant incidents.<br>With the implementation of mitigation measures and offsets detailed in Section 15, Leichhardt considers that the EPA objective for this factor can be met. |
| **Terrestrial Fauna** | |
| EPA objective | The EPA Objective for this key environmental factor is to protect terrestrial fauna so that biological diversity and ecological integrity are maintained. |
| Policy and guidance | • EIA (Part IV Divisions 1 and 2) Procedures Manual (EPA, 2024a).<br>• Statement of Environmental Principles, Factors, Objectives and Aims of EIA (EPA, 2023a).<br>• Statutory Guideline for Mine Closure Plans (DMIRS, 2020a).<br>• EIA (Part IV Divisions 1 and 2) Administrative Procedures (EPA, 2024d).<br>• Instructions on how to prepare EP Act Part IV Environmental Management Plans (EPA, 2024e).<br>• Environmental Factor Guideline – Terrestrial Fauna (EPA, 2016i).<br>• Technical Guidance – Sampling methods for terrestrial vertebrate fauna (EPA, 2016j).<br>• Technical Guidance – Terrestrial fauna surveys (EPA, 2020).<br>• Technical Guidance – Sampling of short range endemic invertebrate fauna (EPA, 2016k).<br>• WA Environmental Offsets Policy (EPA, 2011).<br>• WA Environmental Offsets Guidelines (EPA, 2014a).<br>• WA Environmental Offsets Template (EPA, 2014b).<br>• WA Environmental Offsets Metric and relevant guidance (DWER, 2021b).<br>• Generic guidelines for the content of a draft EPBC Act PER/EIS (including the objects and principles of the EPBC Act, 1999; DotEE, 2016).<br>• EPBC Act Environmental Offsets Policy (DSEWPaC, 2012a) – including the Offset Assessment guide.<br>• Environmental Management Plan Guidelines (DotE, 2014).<br>• EPBC Act Condition Setting Policy (DAWE, 2020).<br>• EPBC Act Outcomes-based conditions policy (DotE, 2016a).<br>• Relevant EPBC Act listed species-specific survey guidelines and protocols.<br>• Relevant EPBC Act listed species-specific Recovery plans, Threat Abatement Plans, Approved Conservation Advice and other documents. |
| Potential impacts | **General fauna species and habitat**<br>• Up to 12,174 ha of disturbance;<br>• Injury or death from vehicle strike; and<br>• Predation, competition or reduction in habitat health due to potential indirect impacts.<br>**Pilbara Leaf-nosed Bat and Ghost Bat**<br>• Up to 10,950.3 ha disturbance of foraging habitat;<br>• Injury or death from vehicle strike;<br>• Alteration of behaviour as a result of noise or light emissions; and<br>• Predation, competition, behavioural change or reduction in habitat health due to potential indirect impacts.<br>**North-Western Free-tailed Bat**<br>• Up to 8.3 ha disturbance of significant habitat.<br>• Up to 12,145.2 ha of disturbance of foraging habitat;<br>• Injury or death from vehicle strike; and<br>• Predation, competition, behavioural change or reduction in habitat health due to potential indirect impacts.<br>**Pilbara Olive Python** |

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| | • Up to 20.8 ha of disturbance of potential foraging habitat;<br>• Injury or death of individuals due to vehicle strike; and<br>• Predation, competition, behavioural change or reduction in habitat health due to potential indirect impacts.<br>**Grey Falcon**<br>• Up to 1,954.4 ha of disturbance of potential foraging habitat; and<br>• Predation, competition, behavioural change or reduction in habitat health due to potential indirect impacts.<br>**Migratory birds**<br>• Up to 576.3 ha of disturbance of migratory shorebird significant habitat;<br>• Up to 2,392.2 ha of additional disturbance of Oriental Pratincole foraging habitat;<br>• Predation, competition, behavioural change or reduction in habitat health due to potential indirect impacts; and<br>• Attraction and use of concentration ponds and crystallisers. |
| Mitigation | **Avoid**<br>The key avoidance outcomes achieved by Leichhardt was the iterative design of the development envelopes to avoid key environmental features, informed by ECU and expert consultants. Leichhardt has conducted numerous ecological surveys and this information has been utilised to significantly change the design the Proposal to avoid the majority of coastal habitats as these were identified as having a higher ecological value, as well as habitat originally thought to provide shelter/denning for the Northern Quoll and higher productivity algal mats (refer to Section 5). In addition, the following avoidance mitigation measures have been incorporated:<br>• The development envelope boundaries have been located to allow the use of existing tracks and port infrastructure wherever practicable; and<br>• No above ground power lines in coastal areas.<br>**Minimise**<br>• Implement industry best practice management measures for fauna;<br>• Obtain and comply with approvals under Part IV and V of the EP Act, Mining Act and *Port Authorities Act 1999;*<br>• Limit total and specific fauna habitat disturbance in the Proposal Content Document;<br>• Implement a GMMP and BCHMMP (Appendix 1.9 and 3.9);<br>• Verify inundation modelling results after construction to ensure potential indirect impacts to coastal habitats are within predicted outcomes;<br>• Monitor erosion at the outlets of the surface water corridors after each significant flow event;<br>• Incorporate features into the Proposal pond design to promote shorebird foraging and roosting;<br>• Preparation of a long-term shorebird management plan;<br>• Record the usage of the concentration ponds and crystallisers by fauna species;<br>• Record any fauna entrapment within the ponds as an incident and review whether additional egress mechanisms should be installed;<br>• Concentration ponds and crystallisers will be designed and constructed to be safe and stable according to DEMIRS requirements;<br>• Minimise lighting;<br>• Implement controls to reduce the risk of impact from brine pipeline spills; and<br>• Design of ponds to retain and support roosting and foraging habitat for migratory and other shorebirds.<br>**Rehabilitate**:<br>• Implement a MCP approved under the Mining Act;<br>• Salts will be harvested and washed from the crystallisers prior to closure;<br>• Concentration ponds walls will be flattened or opened up to allow tidal flows to enter the lower ponds, and surface drainage through higher areas;<br>• Above ground infrastructure will be removed if not retained by PPA or the landowner; and<br>• Crystallisers will be rehabilitated to an acceptable landform. |
| Outcomes | The EPA's environmental objective for this factor is to "protect terrestrial fauna so that biological diversity and ecological integrity are maintained." In the context of this objective: "ecological integrity" is listed as the composition, structure, function and processes of ecosystems, and the natural range of variation of these elements (EPA, 2016i).<br>Leichhardt has incorporated avoidance and minimisation measures into the Proposal design and operational processes, and this section presents the predicted outcomes after those measures have been incorporated. |

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| | The Proposal will result in direct impacts to fauna habitats that are unavoidable. At a regional scale, all vegetation associations to be disturbed will have more than 84% of their pre-European extent remaining, even once cumulative disturbance associated with the Proposal and others such as CPE Port, Sino Iron Project, Mardie Project and 40-Mile Beach Road have been deducted. This means that all of the vegetation associations will remain in the 'Least Concern' category (Phoenix, 2025).<br>The Proposal includes large areas of ponds that contain salts or brine and as such revegetation will be impeded for some time post-closure. The Proposal is a long-life project with an infinite resource (seawater and solar energy) so consideration of altered ocean hydrodynamics and climate change will be necessary. Closure planning will continue through the life of the Proposal (with the MCP being revised every three years), with the purpose of refining the closure strategies already identified in the MCP (Appendix 1.8), including:<br>• The concentration pond walls will be flattened or opened up to allow tidal flows to reinstate within the former pond areas. Over time this is expected to return the area to a state where current salt-tolerant species can revegetate the pond areas; and<br>• Salts will be recovered from the crystallisers, which are to be located on terrestrial vegetation.<br>At a local scale, impacts to numerous listed fauna species are considered to be significant, even after the extensive design changes and detailed mitigation measures are implemented. The Proposal is predicted to result in significant residual impacts to:<br>• 10,950.3 ha of foraging habitat for the Pilbara Leaf-nosed Bat and Ghost Bat;<br>• 8.3 ha of critical mangal community habitat for the North-Western Free-tailed Bat;<br>• 20.8 ha of potential foraging habitat for the Pilbara Olive Python;<br>• 1,954.4 ha of spinifex grassland foraging habitat for the Grey Falcon; and<br>• Up to 576.3 ha of disturbance to habitat for Migratory Shorebirds and 2,392.2 ha of additional disturbance to Oriental Pratincole habitat.<br>Offsets are proposed in Section 15 to counterbalance these impacts.<br>The environmental outcomes for this factor are therefore predicted to be:<br>• No change in the abundance and diversity of migratory shorebirds utilising coastal habitats;<br>• No losses of fauna habitat that would significantly affect the viability of any fauna species;<br>• Losses of Good to Excellent quality habitat for significant fauna;<br>• A remaining potential for localised impacts associated with weeds and feral fauna; and<br>• A remaining potential for rare localised short-term impacts associated with spill/pollutant incidents.<br>Based on the above, the Proposal is expected to meet the EPA's objective for this factor. The implementation of the proposed mitigation is expected to minimise the potential for significant residual impacts to terrestrial fauna or their habitats, and where these residual impacts remain significant, offsets are proposed and deemed to be appropriate, as detailed in Section 15. |
| **Social Surroundings** | |
| EPA objective | The EPA Objective for this key environmental factor is 'to protect social surroundings from significant harm.' |
| Policy and guidance | • EIA (Part IV Divisions 1 and 2) Procedures Manual (EPA, 2024a).<br>• Statement of Environmental Principles, Factors, Objectives and Aims (EPA, 2023a).<br>• Guidelines for Preparing Mine Closure Plans (DMIRS, 2020a).<br>• EIA (Part IV Divisions 1 and 2) Administrative Procedures (EPA, 2024d).<br>• Instructions on how to prepare EP Act Part IV Environmental Management Plans (EPA, 2024e).<br>• Environmental Factor Guideline – Social Surroundings (EPA, 2023b).<br>• Interim Technical Guidance – Environmental Impact Assessment of Social Surroundings – Aboriginal Cultural Heritage (EPA, 2023c).<br>• Guidance Statement 41 – Assessment of Aboriginal Heritage (EPA, 2004).<br>• Generic guidelines for the content of a draft EPBC Act PER/ EIS (including the objects and principles of the EPBC Act, 1999; DotEE, 2016).<br>• EPBC Act Condition Setting Policy (DAWE, 2020).<br>• EPBC Act Outcomes-based conditions policy (DotE, 2016a).<br>• Engage Early – Guidance for proponents on best practice Indigenous engagement for environmental assessments under the EPBC Act (DotE, 2016b). |
| Potential impacts | **Recreational and community uses**<br>• Loss of areas previously accessed for recreational activities;<br>• Access restrictions to marine environment and coastal areas during some construction activities; and |

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| | • Decline in amenity (visual, noise, light, dust) due to construction and operation of ponds and other infrastructure.<br>**Aboriginal Heritage Sites**<br>• Disturbance of 114 sites (84 of which are to be salvaged);<br>• Disturbance within the DPLH boundary to Registered Aboriginal Heritage Site 11871; and<br>• Impacts to sites due to changes to the hydrological regimes or the quality of water.<br>**Demarcated Recreational Areas**<br>• No direct impacts;<br>• Decline in amenity (visual, noise, light, dust); and<br>• Access restrictions.<br>**Land used for traditional purposes**<br>• 1,222 ha disturbance of coastal and marine habitat (intertidal and subtidal);<br>• Up to 28 culturally significant flora species occur within the indicative disturbance footprint;<br>• Up to 11,401 ha disturbance of terrestrial vegetation;<br>• Changes to vegetation health as a result of changes to hydrological and hydrogeological processes or quality, weed infestation;<br>• Decline in amenity (visual, noise, light, dust); and<br>• Access restrictions. |
| Mitigation | **Avoid**<br>Leichhardt's primary objective is to avoid Aboriginal sites and other places of cultural significance. Leichhardt has carried out numerous cultural heritage surveys, on-country consultations with Mardudhunera People, and held numerous workshops to understand the places that the WAC would like preserved. This consultation has also involved re-designing the Proposal disturbance footprint to avoid key features relevant to this factor, including:<br>• 268 Aboriginal Heritage sites, including 20 engraving places, Devils Pool, and seven fish traps;<br>• Five Demarcated Recreational and Cultural areas including setting back the Proposal from 40-Mile Beach; and<br>• The majority of the coastal zone.<br>Areas will continue to be accessible via 40-Mile Beach Road and the proposed access road.<br>To reduce the risk of inadvertent incursions into these areas Leichhardt and WAC has agreed to the following management measures:<br>• GPS recording of heritage values and establishment of a GIS database;<br>• Physical demarcation of sites will be implemented where WAC considers it necessary;<br>• Information on sites of cultural significance is provided as part of the site induction; and<br>• Approval must be obtained from the General Manager Operations prior to any land clearing taking place.<br>**Minimise**<br>• Finalise and implement the SCHMP that has been co-developed with WAC;<br>• Ensure the 84 salvaged Aboriginal cultural material sites are properly recorded, documented, and appropriately salvaged and relocated to the Keeping Place prior to disturbance;<br>• Minimise clearing and access restrictions within areas used for traditional purposes;<br>• Maintain or improve Traditional Owners' access to land for traditional uses;<br>• Undertake additional community surveys of recreational users of the 40-Mile Campground throughout the 2025 peak season;<br>• Implement a complaint/incident register;<br>• Liaise with the City of Karratha regarding ongoing support for the management of Gnoorea Point/40-Mile Beach areas;<br>• Implement low-noise equipment and shield pumps to minimise noise emissions; and<br>• Minimise light sources in proximity to recreational areas.<br>**Rehabilitate**<br>• Implement a MCP approved under the Mining Act;<br>• Salts will be harvested from each crystalliser prior to closure;<br>• Leichhardt will examine inundated demarcation sites and remediate to the satisfaction of the Mardudhunera People;<br>• Concentration pond walls will be flattened or opened up to allow tidal flows to enter the ponds; and |

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| | • All above ground infrastructure will be removed if not retained by Mardie Station, City of Karratha or PPA;<br>• All crystallisers will be rehabilitated to an acceptable landform. |
| Outcomes | The EPA's environmental objective for this factor is to "protect social surroundings from significant harm" (EPA, 2023a).<br>Leichhardt's approach has been to collect thorough and robust Aboriginal cultural information about the Proposal Survey Areas through heritage surveys and consultation with WAC. The feedback provided by the Mardudhunera People has been carefully considered and used when designing the Proposal, to avoid causing impacts to places of high cultural value. The revisions to the original disturbance footprint will result in the preservation of more than 160 Aboriginal sites of significance and will ensure that the five areas (Figure 13-9) where Mardudhunera People continue to recreate and practice culture are not directly impacted. However, the development of the Proposal will directly impact 114 sites. The impacts will occur during the clearing of land for pond walls or infrastructure, or when the ponds are flooded with seawater. Submerged sites cannot be meaningfully used by the Mardudhunera People and are therefore considered to be 'disturbed'. Leichhardt will salvage 84 sites however 29 Grinding Patch sites and the one freshwater soak will be impacted by water inundation and given the size of the grinding patch sites it is not possible to effectively salvage them. This has been agreed to by the Mardudhunera People.<br>Leichhardt continues to consult with the Mardudhunera People regarding these impacts, as well as the preservation and salvage of other sites, through the SCHMP. The SCHMP measures have been agreed to by the WAC Board on behalf of the Mardudhunera People and are endorsed by the wider WAC membership.<br>The Proposal avoids the majority of the coastal zone and creeklines, which were considered to be a traditional food source for Traditional Owners. Terrestrial vegetation will not be significantly impacted in a regional context. Leichhardt has also committed to maintaining access to land for the Mardudhunera People, and minimising disturbance within the areas noted to be used for traditional purposes. As a result of the above, the Proposal is not expected to significantly impact the traditional uses of the land.<br>The Proposal will have unavoidable access and visual amenity impacts on the recreational users of the Gnoorea Point/40-Mile Beach area. These impacts are unlikely to be significant based on the evidence and survey data gathered to-date, with very limited usage of the pond areas being recorded, and general neutral feedback about visual impacts. It is acknowledged however that the survey questionnaires present a 'snapshot' only. The online survey will remain open to verify this position and allow Leichhardt to plan and implement measures designed to further minimise impacts on recreational uses of the area.<br>The outcomes for this factor are therefore predicted to be:<br>• The preservation of more than 160 Aboriginal sites of significance;<br>• No direct impacts to the five areas (Figure 13-6) where Mardudhunera People continue to recreate and practice culture;<br>• The SCHMP will provide the ongoing legal management framework to ensure places that are important to the Native Title holders continue to be preserved and are accessible;<br>• No impact to the accessibility of camping areas at Gnoorea Point; and<br>• Negligible amenity impacts to the campers and recreational users of Gnoorea Point and surrounds.<br>Based on the above, the Proposal is expected to meet the EPA's objective for this factor. The implementation of the proposed mitigation is expected to ensure that there are no significant residual impacts to social surroundings. |

# HOLISTIC IMPACT ASSESSMENT

Leichhardt has revised the pond layout several times since referral, specifically to avoid and minimise environmental impacts. The latest revised pond layout has focused on reducing impacts to BCH, vegetation and fauna habitats that were deemed to be most significant (refer to Section 4). As a result, the following reductions in environmental impacts were able to be achieved (in comparison to design assessed in 2022):

- An 79% reduction in mangrove losses;
- A 60% reduction in algal mat losses;
- A 26% reduction in bitterns discharge volume;

- A 60% reduction in dredging spoil volume;
- Reduction in indirect impacts to BCH from tidal inundation, coastal processes, sea level rise and groundwater seepage/mounding;
- Complete avoidance of the Coastal Dune PEC; and
- An avoidance of significant Aboriginal Heritage Areas.

For each relevant Key Environmental Factor, the ERD provides a detailed assessment of the potential impacts associated with the Proposal, application of the mitigation hierarchy and the management strategies proposed. The Key Environmental Factors relevant to the Proposal include:

- Inland Waters;
- Marine Environmental Quality;
- BCH;
- Marine Fauna;
- Terrestrial Environmental Quality;
- Flora and Vegetation;
- Terrestrial Fauna; and
- Social Surroundings.

The Proposal relies on solar evaporation to produce product and as such the large-scale inundation of habitats is unavoidable. Ground disturbance, including the clearing and inundation of native vegetation and BCH is identified as a key impact as it will directly impact five key environmental factors. Ground disturbance will impact the Flora and Vegetation and Terrestrial Fauna key environmental factors by removing or disturbing flora species, significant ecological communities and significant fauna habitat. It will also impact the Social Surroundings factor by reducing the quality and availability of vegetation that may otherwise be used by the Traditional Owners for bush tucker or bush medicine, and affect the amenity of recreational users of the 40-Mile Beach area. Leichhardt also acknowledges that native vegetation values are related to the availability of faunal and botanical resources and represents a connection to Country.

Impacts to the marine environment as a whole are predicted to be localised, with short-term dredging, limited vessel movements during construction, and a dedicated mixing zone for the bitterns.

Changes to the quality and flow regimes of surface water and groundwater have the potential to affect all of the Key Environmental Factors, and mitigation will be critical in ensuring the impacts are minimised to an acceptable level.

Other Proposal impacts (contamination and amenity impacts) provide linkages between the other key environmental factors however these impacts are unlikely to be significant and therefore linkages are not considered to be as strong as the others mentioned above. All linkages have been considered in the design of the Proposal, application of the mitigation hierarchy and proposed management measures.

There are some potential impacts that require management and monitoring to ensure that the impacts are not significant. Many of these potential impacts are adequately regulated under other legislation:

- Bitterns discharge, brine spills and leaks, and sewage will be regulated under Part V of the EP Act;

- General environmental management will be regulated through a Mining Proposal assessed under the Mining Act or a Development Application and Construction Approval under the *Port Authorities Act 1999*; and
- Closure and rehabilitation on Mining Act tenure will be regulated through a MCP assessed under the Mining Act.

There are some potential impacts however that are expected to require limits or conditions in the Ministerial Statement, including:

- Limits on total disturbance within each development envelope;
- Limits on total bitterns discharge and dredging volumes;
- The implementation of a DSDMMP to regulate dredging;
- The implementation of a MEQMMP to outline marine environmental quality boundaries, and management and monitoring requirements for bitterns discharge;
- The implementation of a GMMP to monitor and manage impacts to groundwater; and
- The implementation of a BCHMMP to monitor and manage impacts to BCH.

With the application of the avoidance mechanisms in Proposal design and operations, and the limits and regulation of potential impacts discussed above, Leichhardt considers that many of the potential impacts to key environmental values can be reduced to an acceptable level with appropriate management. However, despite the outcomes and mitigation listed in this ERD, the unavoidable large-scale inundation of habitats will result in the following significant residual impacts:

- 11,287.7 ha of disturbance of Good to Excellent vegetation, a portion of which is the Horseflat Land System of the Roebourne Plains' (Priority 3; Horseflat PEC) and foraging habitat for several significant fauna species; and
- 1,175.1 ha of disturbance of intertidal BCH, which also provides foraging habitat for Migratory birds.

These significant residual impacts are proposed to be counterbalanced by:

- Contributions to the Pilbara Environmental Offsets Fund (PEOF), to counterbalance the disturbance of Good to Excellent vegetation and significant fauna habitat; and
- The development and implementation of intertidal conservation and management programs, informed by the findings and recommendations of intertidal research programs listed in Ministerial Statement (MS) 1211 for the Mardie Project, to counterbalance the disturbance of intertidal BCH.

With the application of the mitigation hierarchy (avoid, minimise, rehabilitation and offsets), Leichhardt considers that potential impacts to key environmental values can be reduced to a level that ensures the EPA's objectives can be met.

## CUMULATIVE IMPACT ASSESSMENT

The Proposal will not affect any creeklines and the majority of surface water flow through to the marine environment will be maintained. There are no other major regional impacts on surface water flow or groundwater in the vicinity of the Proposal. Impacts associated with inland waters are expected to be localised and therefore there are no cumulative impacts for inland waters associated with the Proposal.

Each of the discharges identified has a relatively localised impact area around the discharge point with the cumulative discharge likely to only impact a small proportion of the coastal waters. The prospect that these distributed salt emissions can combine to create a substantial impact appears unlikely due to the wide geographic spread of the salt discharge sources. This makes the impact of these salt emissions on a regional scale very small compared to the magnitude of natural processes and quantities within the relevant coastal zone. The total salinity impact of these coastal projects is a small fraction of the proximal natural processes, which are not themselves considered of any concern.

The regional extent of mangroves is predicted to be 33,706 ha and up to 8.3 ha of this BCH type is proposed to be disturbed to implement the Proposal. In general, cumulative pressures in the area are relatively low compared to the total extent, with 17 ha approved at the Mardie Project and less than 5 ha proposed to be disturbed at the Ashburton Salt Project. It is likely that the Dampier Salt Project would have the most extensive historic mangrove losses however this cannot be determined given the lack of pre-development data. Some other minor losses would have occurred during port developments. Mangroves remain at high pre-European extents throughout the Pilbara and are expected to remain at high levels given their level of protection through the EIA process.

The regional extent of algal mats is predicted to be 41,574 ha and up to 611.0 ha of algal mats (87.3 ha of which is HDAM) is proposed to be disturbed as a result of the Proposal. The Mardie Project is the only other recent or proposed project in the region that is likely to have a significant impact on algal mats, with almost 900 ha of disturbance approved. The Dampier Salt Project may also have resulted in significant losses of algal mats however cannot be determined given the lack of pre-development data. The Ashburton Salt Project includes negligible losses of algal mats. Cumulative impacts are therefore likely to be in the order of 5 – 10%, depending on the historic losses associated with the Dampier Salt Project. It is also noted that Western Australia Marine Science Institute (WAMSI) is currently conducting detailed cumulative impact research on algal mats on the west Pilbara Coastline.

The potential cumulative impacts to marine fauna are associated with dredging; bitterns discharge; vessel movements; entrapment and /or entrainment within the additional seawater intake at the jetty (for the pre-dilution of bitterns); and changes to light spill. Dredging will be conducted in accordance with the DSDMMP provided in Appendix 2.2 and mitigation measures implemented to ensure that impacts to marine fauna are minimised as much as practicable. Seawater intakes are likely to result in localised reductions in marine fauna, however, these reductions are unlikely to represent a significant cumulative loss when considered in the context of regional Pilbara waters. An Artificial Light Management Plan (ALMP) for marine and terrestrial fauna will be developed, which will incorporate the requirements of EPA (2010) and DCCEEW (2023) guidance. With the implementation of this plan the local light emissions are not expected to significantly increase and therefore cumulative light impacts in the area will also not be significantly increased.

The potential cumulative environmental impacts to terrestrial environmental quality are associated with disturbance of ASS, hydrocarbon spills and other soil contamination. Impacts to terrestrial environmental quality from the Proposal is expected to be minimal and managed appropriately under Part V Licence under the EP Act. Impacts associated with terrestrial environmental quality are expected to be localised and therefore there are no cumulative impacts to this factor associated with the Proposal.

Section 11.5.2 assessed the predicted cumulative impacts to regional vegetation associations, which can be used at a high level to assess cumulative impacts to vegetation. When assessing the disturbance associated with the Proposal at a regional scale, disturbance mainly occurs within two vegetation associations; '175: Short bunch grassland – savanna/grass plain' and '127: Bare areas, mud flats.' Disturbance within the remaining associations 93, 43, and 117 is relatively minor with impacts unlikely to affect the overall distribution of these associations.

Leichhardt determined that the cumulative native vegetation clearing across the Proposal is estimated to be 11,401.1 ha, representing habitat for the Pilbara Olive Python, North-Western Free-tailed Bat, Pilbara Leaf-nosed Bat, Ghost Bat and/or the Grey Falcon. The findings of that assessment imply that cumulative losses of shorebird habitat on the Western Pilbara coastline are in the order of 5 – 10%. Leichhardt has assessed the loss and considers the residual impact to be significant. Offsets are proposed to counterbalance those impacts.

The Proposal avoids a large proportion of heritage values identified in Section 12. There is limited commercial activity in the Mardudhunera Native Title Determination Area such that there are no existing significant projects which may cumulatively impact on the cultural and heritage values for the Mardudhunera People.

There will be no significant impacts to recreational activity and access around the Proposal. Access to campsite and four-wheel drive areas will be maintained. There are no other projects in the vicinity of the Proposal which may also impact on the recreational use of the area. As such, there are no cumulative impacts to recreational activity as a result of the Proposal.

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# 1 INTRODUCTION

## 1.1 PURPOSE AND SCOPE

This Environmental Review Document (ERD) has been prepared for Leichhardt Salt Pty Ltd (Leichhardt) and provides a detailed description of the Eramurra Solar Salt Project (the Proposal), enabling the assessment of potential environmental impacts that may result, should the Proposal be implemented. The ERD also outlines the key elements (characteristics) required for the construction and operation of the Proposal. The assessment will be completed by the Environmental Protection Authority (EPA) under the provisions of Part IV of the *Environmental Protection Act 1986* (Western Australia (WA)) (EP Act).

This ERD has been prepared in accordance with the following EPA guidance:

- Environmental Impact Assessment (Part IV divisions 1 and 2) Procedures Manual (EPA, 2024a);
- Statement of Environmental Principles, Factors, Objectives and Aims of EIA (EPA, 2023a);
- Instructions on how to prepare an Environmental Review Document (EPA, 2024b); and
- Instructions on how to identify the content of a Proposal (EPA, 2024c).

This ERD focuses on the environmental factors that were deemed to be 'key' environmental factors by the EPA; those with the potential to be significantly impacted and could not be appropriately managed under other existing legislation. Potential impacts to these key environmental factors are described in detail and assessed using relevant studies specific to the Proposal. This ERD describes the most relevant characteristics and impacts of the Proposal for Environmental Impact Assessment (EIA) and provides all relevant biological and technical reports and survey results as Appendices (Appendix 1.1 – 7.5).

The Proponent for the Proposal is Leichhardt Salt Pty Ltd (ABN: 82 613 581 614).

**Contact Person:** Scott Nicholas – Chief Executive Officer
**Email:** environment@leic.com.au
**Address:** U7/435 Roberts Road, Subiaco 6008, WA

## 1.2 ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

### 1.2.1 PART IV OF THE ENVIRONMENTAL PROTECTION ACT 1986

Part IV of the EP Act makes provisions for the EPA to undertake EIA of significant proposals, strategic proposals and land use planning schemes. The Proposal was considered to be a significant proposal and as such requires assessment under Part IV of the EP Act.

The EPA uses environmental principles, factors and associated objectives as the basis for assessing whether a proposal or land use planning scheme's impact on the environment is acceptable. The environmental principles, factors and objectives, therefore, underpin the EIA process.

The Proposal was referred under Section 38 of the EP Act on 28 June 2021. The EPA released its decision to assess the Proposal as a Public Environmental Review (s. 40(2) (b) and s. 40(4)) on 6 September 2021. A proponent-prepared Environmental Scoping Document (ESD) was then submitted to the EPA and formally approved on 22 December 2022.

An application to amend the Proposal was approved under Section 43A of the EP Act. This ERD has been prepared to align with the scope of the amended Proposal (refer to Section 4.3 for more detail).

### 1.2.2 Section 87 of the Environment Protection and Biodiversity Conservation Act 1999

The Proposal was referred to the Department of Climate Change, Energy, the Environment and Water (DCCEEW) on 13 September 2021 (EPBC 2021/9027). DCCEEW determined that the Proposal was a 'controlled action' and required assessment and approval under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act), due to the potential impacts on the following relevant controlling provisions:

- Listed threatened species and communities (sections 18 & 18A);
- Listed migratory species (sections 20 & 20A); and
- Commonwealth marine areas (sections 23 & 24A).

DCCEEW provided comment and input into the content of the ESD.

The Proposal will be assessed as an 'accredited assessment' under Part IV of the EP Act. Section 87 of the EPBC Act makes provisions for the EPA to undertake this accredited assessment of the potential impacts to Matters of National Environmental Significance (MNES) on behalf of DCCEEW.

An application to amend the Proposal was approved under Section 156A of the EPBC Act. This ERD has been prepared to align with the scope of the amended Proposal (refer to Section 4.3 for more detail).

## 1.3 Other Approvals and Regulation

The majority of the aspects of the Proposal lie within Exploration Licences held by Leichhardt under the Mining Act. Leichhardt will transfer portions of these exploration licences to Mining Leases (M) prior to construction. Mining leases have been applied for and grant is pending.

Table 1-1 identifies the other approvals and legislation relevant to the Proposal, as well as the decision-making authorities (DMA) associated with these approvals.

Table 1-1: Other approvals and regulation

| DMA and department (if relevant) | Legislation or agreement regulating the activity | Approval required and relevant Proposal element | Whether and how can the statutory decision-making process mitigate impacts on the environment? (Yes/No and summary of reasons. Include a separate line item for each relevant impact, and discuss how the EPA's factor objective will be met) | | |
|---|---|---|---|---|---|
| | | | Relevant Impact | Relevant Key Environmental Factor and Objective | Can the DMA mitigate impacts and how will the EPA's factor be met? |
| Minister for Environment<br>Department of Water and Environmental Regulation (DWER) | EP Act Part V | **Works Approval and Licence -** required for solar salt manufacturing, sewage treatment and disposal, landfill, crushing and screening | Bitterns disposal | **Benthic Communities and Habitats (BCH)**<br>EPA's objective: *To protect BCH so that biological diversity and ecological integrity are maintained.*<br>**Marine Environmental Quality (MEQ)**<br>EPA's objective: *To maintain the quality of water, sediment and biota so that environmental values are protected.*<br>**Marine Fauna**<br>EPA's objective: *To protect marine fauna so that biological diversity and ecological integrity are maintained.* | Yes.<br>The design and operation of the bitterns outfall will be assessed under Part V of the EP Act to ensure bitterns discharge impacts are minimised and maintained in line with ecological protection area boundaries presented in the ERD. |
| | | | Groundwater seepage from ponds | **BCH**<br>EPA's objective: *To protect BCH so that biological diversity and ecological integrity are maintained.*<br>**MEQ**<br>EPA's objective: *To maintain the quality of water, sediment and biota so that environmental values are protected.*<br>**Marine Fauna**<br>EPA's objective: *To protect marine fauna so that biological diversity* | Yes.<br>The design of the ponds will be assessed under Part V of the EP Act to ensure seepage impacts are minimised and maintained in line with predictions presented in the ERD. |

| DMA and department (if relevant) | Legislation or agreement regulating the activity | Approval required and relevant Proposal element | Whether and how can the statutory decision-making process mitigate impacts on the environment? (Yes/No and summary of reasons. Include a separate line item for each relevant impact, and discuss how the EPA's factor objective will be met) | | |
|---|---|---|---|---|---|
| | | | **Relevant Impact** | **Relevant Key Environmental Factor and Objective** | **Can the DMA mitigate impacts and how will the EPA's factor be met?** |
| | | | | *and ecological integrity are maintained.* | |
| | | | Dust emissions | **Flora and Vegetation**<br>EPA's objective: *To protect flora and vegetation so that biological diversity and ecological integrity are maintained.*<br>**Social Surroundings**<br>EPA's objective: *To protect social surroundings from significant harm*. | Yes.<br>While not expected to be significant, a primary source of dust emissions from the Proposal is the processing facilities for solar salt manufacturing and the design of the Proposal will be assessed under Part V of the EP Act to ensure dust emissions are minimised and do not result in significant impacts to any sensitive receptors.<br>In addition to regulation under Part V of the EP Act, dust emissions from all aspects of the site are regulated under the Mining Act (refer below) and are not expected to be significant. These emissions are unlikely to require additional regulation under Part IV of the EP Act in order to meet the objective for this factor. |
| | | | Noise emissions | **Social Surroundings**<br>EPA's objective: *To protect social surroundings from significant harm.* | Yes.<br>While not expected to be significant, the primary sources of noise emissions from the Proposal will be the mobile plant and pump stations. The design of the plant and pumping will be assessed under Part V of the EP Act to ensure noise emissions are minimised and do not result in significant impacts to any sensitive receptors.<br>Noise emissions from other aspects of the site are not expected to be significant and are unlikely to require additional regulation under Part IV of the EP Act in order to meet the objective for this factor. |
| | | | Waste disposal (sewage and putrescible) | **Terrestrial Environmental Quality (TEQ)**<br>EPA's objective: *To maintain the quality of land and soils so that environmental values are protected.* | Yes.<br>The design of the sewage disposal facilities and landfill will be assessed under Part V of the EP Act to ensure waste impacts are minimised. |

| DMA and department (if relevant) | Legislation or agreement regulating the activity | Approval required and relevant Proposal element | Whether and how can the statutory decision-making process mitigate impacts on the environment? (Yes/No and summary of reasons. Include a separate line item for each relevant impact, and discuss how the EPA's factor objective will be met) | | |
|---|---|---|---|---|---|
| | | | **Relevant Impact** | **Relevant Key Environmental Factor and Objective** | **Can the DMA mitigate impacts and how will the EPA's factor be met?** |
| | *Biodiversity Conservation Act 2016* (WA) (BC Act) | Licence to take threatened fauna | Impacts to threatened fauna individuals | **Terrestrial Fauna**<br>EPA's objective: *To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.* | Partially.<br>A licence mitigates impacts to the threatened fauna individuals that need to be taken for the Proposal however it does not mitigate habitat loss or other indirect impacts to fauna or their habitat. |
| Minister for Mines and Petroleum<br>Executive Director, Resource and Environmental Compliance Division<br>(Department of Energy, Mines, Industry Regulation and Safety (DEMIRS))<br>State Mining Engineer (DEMIRS) | Mining Act<br>*Mine Safety and Inspection Act 1994* (WA) | **Mine Proposal (MP) and Mine Closure Plan (MCP)**<br>Required for any mining-related disturbance within tenements | Changes to the stability of the landscape | **Terrestrial Environmental Quality**<br>EPA's objective: *To maintain the quality of land and soils so that environmental values are protected.*<br>**Inland Waters**<br>EPA's objective: *To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.*<br>**Flora and Vegetation**<br>EPA's objective: *To protect flora and vegetation so that biological diversity and ecological integrity are maintained.*<br>**Terrestrial Fauna**<br>EPA's objective: *To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.* | Yes.<br>A MP will be submitted to DEMIRS prior to any disturbance at the Proposal and will include auditable outcomes for key DEMIRS factors (Biodiversity, Water Resources, Land and Soils). These outcomes will be defined and approved by DEMIRS to ensure that the impacts on the key DEMIRS factors are mitigated to an acceptable level. In the context of landscape stability this will include an auditable outcome that the landscape will be safe and stable during operational activities to prevent slumps or collapsed walls which could have environmental impacts.<br>A MCP will be submitted to DEMIRS with the MP prior to any disturbance at the Proposal and will be revised every three years. It will include auditable closure and rehabilitation outcomes and criteria which will be defined and approved by DEMIRS to ensure that impacts on key DEMIRS factors are mitigated to an acceptable level.<br>The implementation of the MP and MCP under the Mining Act is considered suitable to mitigate this impact such that the EPA's objectives can be met.<br>By meeting DEMIRS's Factors, the Proposal will also meet the EPA's objectives for the relevant factors. Additional regulation under Part IV of the EP Act is, therefore, unlikely to be required for this potential impact. |
| | | | Clearing of native vegetation | **Flora and Vegetation**<br>EPA's objective: *To protect flora and vegetation so that biological* | Partially.<br>A MP will be submitted to DEMIRS prior to any disturbance for the Proposal and will include auditable |

| DMA and department (if relevant) | Legislation or agreement regulating the activity | Approval required and relevant Proposal element | Whether and how can the statutory decision-making process mitigate impacts on the environment? (Yes/No and summary of reasons. Include a separate line item for each relevant impact, and discuss how the EPA's factor objective will be met) | | |
|---|---|---|---|---|---|
| | | | **Relevant Impact** | **Relevant Key Environmental Factor and Objective** | **Can the DMA mitigate impacts and how will the EPA's factor be met?** |
| | | | | *diversity and ecological integrity are maintained.*<br>**Terrestrial Fauna**<br>EPA's objective: *To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.* | outcomes for the key DEMIRS factor: Biodiversity. These outcomes will include requirements for minimising the clearing footprint and keeping accurate records.<br>A MCP will be submitted to DEMIRS with the MP prior to any disturbance for the Proposal and will be revised every three years. It will include auditable closure and rehabilitation outcomes and criteria which will be defined and approved by DEMIRS to ensure that cleared areas are rehabilitated to an acceptable level. In the context of vegetation clearing this will include an auditable outcome that the rehabilitated areas will meet specific closure criteria designed to ensure flora, vegetation and fauna values are reinstated.<br>The implementation of the MP and MCP under the Mining Act is considered suitable to mitigate rehabilitation and impacts during clearing, however it is not considered suitable to mitigate impacts associated with the loss of vegetation. This is expected to require assessment under Part IV of the EP Act to ensure that the EPA's objectives can be met. |
| | | | Introduction and spread of weeds | **Flora and Vegetation**<br>EPA's objective: *To protect flora and vegetation so that biological diversity and ecological integrity are maintained.* | Yes.<br>The approved MP and MCP will define outcomes to ensure that the factors defined in DEMIRS's Environmental Objectives - Policy and Mining (DEMIRS, 2020b) are met for the Proposal. The DEMIRS Factor: Biodiversity, is relevant to this impact: DEMIRS's objective for this factor is:<br>*Maintain representation, diversity, viability and ecological function at the species, population, and community level.*<br>These outcomes will be defined and approved by DEMIRS to ensure that impacts associated with weeds are mitigated to an acceptable level. This will include an auditable outcome to prevent the introduction or spread |

| DMA and department (if relevant) | Legislation or agreement regulating the activity | Approval required and relevant Proposal element | Whether and how can the statutory decision-making process mitigate impacts on the environment? (Yes/No and summary of reasons. Include a separate line item for each relevant impact, and discuss how the EPA's factor objective will be met) | | |
|---|---|---|---|---|---|
| | | | **Relevant Impact** | **Relevant Key Environmental Factor and Objective** | **Can the DMA mitigate impacts and how will the EPA's factor be met?** |
| | | | | | of any new weed species or populations during construction, operation, or closure.<br>By meeting these outcomes and the objective of DEMIRS's Biodiversity Factor, the MP and MCP will ensure that the EPA's objective for flora and vegetation is met. Therefore, further regulation for the impact of the introduction and spread of weeds is not required to be assessed by the EPA. |
| | | | Alteration to the post mining land use | **Social Surroundings**<br>EPA's objective: *To protect social surroundings from significant harm.* | Yes.<br>Approval of a MP and MCP will ensure that the Factors defined in DEMIRS' Environmental Objectives - Policy and Mining (DEMIRS, 2020b) are met for the Proposal. The DEMIRS Factor: Rehabilitation and Mine Closure, is relevant to this impact. DEMIRS' objective for this factor is:<br>*Mining activities are rehabilitated and closed in a manner to make them physically safe to humans and animals, geo-technically stable, geo-chemically non-polluting/non-contaminating, and capable of sustaining an agreed post-mining land use, and without unacceptable liability to the State.*<br>By meeting the objective of DEMIRS' Rehabilitation and Mine Closure Factor, the Proposal will also meet the EPA's objectives for social surroundings that are relevant to this impact. Additional regulation under Part IV of the EP Act is, therefore, unlikely to be required for this potential impact. |
| Minister for Mines and Petroleum<br>Chief Dangerous Goods (DG) Officer (DEMIRS) | *Dangerous Goods Safety Act 2004* (WA) (DG Act) | **DG Licence**<br>May be required for the bulk storage of fuel if above specified limits | Contamination of soils, groundwater, and surface water | **Terrestrial Environmental Quality**<br>EPA's objective: *To maintain the quality of land and soils so that environmental values are protected.* | Yes.<br>The storage and management of hydrocarbons will already be regulated under Part V of the EP Act and the MP/MCP; however, the DG licence provides additional mitigation for the design and storage of larger volumes of |

| DMA and department (if relevant) | Legislation or agreement regulating the activity | Approval required and relevant Proposal element | Whether and how can the statutory decision-making process mitigate impacts on the environment? (Yes/No and summary of reasons. Include a separate line item for each relevant impact, and discuss how the EPA's factor objective will be met) | | |
|---|---|---|---|---|---|
| | | | **Relevant Impact** | **Relevant Key Environmental Factor and Objective** | **Can the DMA mitigate impacts and how will the EPA's factor be met?** |
| | | | (hydrocarbon spills)<br>Fire (combustion of stored fuel) | **Inland Waters**<br>EPA's objective: *To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.*<br>**Flora and Vegetation**<br>EPA's objective: *To protect flora and vegetation so that biological diversity and ecological integrity are maintained.*<br>**Terrestrial Fauna**<br>EPA's objective: *To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.* | DG (if large volumes of hydrocarbons (>100,000 L) are required to be stored on site).<br>A DG licence sets standards for the way in which DGs are stored on site. These standards are aimed at ensuring DGs are stored safely and in such a way that will not result in impacts to the environment. Having a DG licence ensures potential spills and combustion risks from the Proposal are mitigated. A DG licence (in combination with the Part V and Mining Act approvals) will meet the objectives of the EPA for both factors by minimising the risk of contamination of soils and water, and protecting flora and vegetation, and terrestrial fauna by minimising the risk of fire.<br>Regulation of the potential impacts on the environment from the storage of DG is, therefore, not expected to be required under Part IV of the EP Act. |
| Minister for Lands<br>Minister for Planning<br>Chief Executive Officer (City of Irwin) | *Local Government Act 1995* (WA)<br>*Planning and Development Act 2006* (WA) | N/A - a development application is not required as this Proposal will be approved under the Mining Act and *Port Authorities Act 1999*. | | | |
| Chief Executive Officer (DWER)<br>Minister for Water | *Rights in Water and Irrigation Act 1914* (WA) | **26D licence**<br>Required for the construction of bores to abstract groundwater<br>**5C licence**<br>Required for the abstraction of groundwater | Abstraction of groundwater (for seepage management only) | **Inland Waters**<br>EPA's objective: *To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.* | Yes.<br>A 26D licence ensures that bores are drilled, constructed and maintained appropriately to ensure the aquifer and the groundwater resource is not compromised. A 5C licence regulates the taking of water and assesses the impacts of the abstraction on the environment and other users. A 5C licence is only granted if the impacts from the abstraction are shown to be acceptable with minimal environmental impacts or impacts to other users. |

| DMA and department (if relevant) | Legislation or agreement regulating the activity | Approval required and relevant Proposal element | Whether and how can the statutory decision-making process mitigate impacts on the environment? (Yes/No and summary of reasons. Include a separate line item for each relevant impact, and discuss how the EPA's factor objective will be met) | | |
|---|---|---|---|---|---|
| | | | **Relevant Impact** | **Relevant Key Environmental Factor and Objective** | **Can the DMA mitigate impacts and how will the EPA's factor be met?** |
| | | | | | Licence holders are obligated to comply with their resource allocation and any conditions included in the licence. Licence holders are also required to use water efficiently and responsibly, minimising impacts on the water resource.<br>These licences will ensure the Proposal meets the EPA's objective for Inland Waters by maintaining the hydrological regime of groundwater. Regulation of the potential impacts on the environment from the drilling and abstraction of groundwater is, therefore, not expected to be required under Part IV of the EP Act. |
| | | **Bed and Banks Permit** | Diversion of surface water | **Inland Waters**<br>EPA's objective: *To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.* | Partially.<br>A Bed and Banks Permit ensures that surface water diversions are designed appropriately to ensure the surface water system is not compromised.<br>Permit holders are obligated to comply with any conditions included in the Permit.<br>The implementation of the Bed and Banks Permits under the *Rights in Water and Irrigation Act 1914* is considered suitable to mitigate impacts to surface water systems however it is not considered suitable to mitigate impacts associated with the broad range of potential impacts that may occur. This is expected to require assessment under Part IV of the EP Act to ensure that the EPA's objectives can be met. |
| Commissioner for Main Roads Western Australia | *Main Roads Act 1930* (WA) | **Application to 'Undertake Works within Road Reserve'**<br>Intersection works within the North West Coastal Highway road corridor | N/A - this approval is safety and planning based and, therefore, is not expected to regulate impacts to the environment. | | |

| DMA and department (if relevant) | Legislation or agreement regulating the activity | Approval required and relevant Proposal element | Whether and how can the statutory decision-making process mitigate impacts on the environment? (Yes/No and summary of reasons. Include a separate line item for each relevant impact, and discuss how the EPA's factor objective will be met) | | |
|---|---|---|---|---|---|
| | | | **Relevant Impact** | **Relevant Key Environmental Factor and Objective** | **Can the DMA mitigate impacts and how will the EPA's factor be met?** |
| Minister for Aboriginal Affairs | *Aboriginal Heritage Act 1972* (WA) (AH Act) | **Application for a permit under Section 18 of the AH Act.** Required for consent to impact any Aboriginal Heritage sites (if not able to be avoided) | Disturbance of Aboriginal Heritage Sites | **Social Surroundings** EPA's objective: *To protect social surroundings from significant harm.* | Yes. An application for a permit under Section 18 of the AH Act will assess the significance of the proposed disturbance and determine what mitigation measures are required to obtain consent for any disturbance to an Aboriginal Heritage Site. This consultation and assessment process will meet the EPA's objective for Social Surrounds by protecting registered Aboriginal Heritage sites from significant harm. |
| | | | Disturbance or indirect impacts to areas or artefacts of Aboriginal cultural value | **Social Surroundings** EPA's objective: *To protect social surroundings from significant harm.* | No (if avoidance is not possible). If disturbance or indirect impacts within these areas cannot be avoided, then assessment and potential regulation under Part IV of the EP Act may be required. |
| Minister for Ports; Transport Pilbara Ports Authority | *Port Authorities Act 1999* and the associated Port Authorities Regulations 2001 | **Port lease and Development Application** | This approval is not directly part of this Proposal as it relates to Cape Preston East (CPE), however there may be components of the Proposal that form part of the application (i.e., the bitterns pipeline). | | |
| | *Marine and Harbours Act 1981* – section 12 | **Seabed Lease** | This approval is not directly part of this Proposal as it relates to CPE, however there may be components of the Proposal that form part of the lease application (i.e., the bitterns pipeline and diffuser, and the dredge channel). | | |
| City of Karratha | *Health Act 1911* and Health (Treatment of Sewage and Disposal of Effluent and Liquid waste) Regulations 1974 | **Approval to construct or operate an apparatus for the treatment of sewage** Required for the construction and operation of sewage storage and treatment infrastructure on site | Management of sewage from workforce toilets. | **Terrestrial Environmental Quality** EPA's objective: *To maintain the quality of land and soils so that environmental values are protected.* | Partially. This approval ensures that sewage is treated to specific quality requirements to protect human health, which has an indirect outcome of providing some protection to the environment. This approval, in combination with approval under Part V of the EP Act, is expected to be sufficient in regulating emissions and discharges related to sewage at the Proposal. |

| DMA and department (if relevant) | Legislation or agreement regulating the activity | Approval required and relevant Proposal element | Whether and how can the statutory decision-making process mitigate impacts on the environment? (Yes/No and summary of reasons. Include a separate line item for each relevant impact, and discuss how the EPA's factor objective will be met) | | |
|---|---|---|---|---|---|
| | | | **Relevant Impact** | **Relevant Key Environmental Factor and Objective** | **Can the DMA mitigate impacts and how will the EPA's factor be met?** |
| | *Building Act 2011* | **Building Licence**<br>Required for the construction of public facilities | N/A – this approval is a planning approval and, therefore, is not expected to regulate impacts to the environment. | | |
| Minister for the Environment (Cth) | EPBC Act | **s.133 Approval** - required for the assessment of the Proposal's impacts on MNES | Direct impacts to Threatened Fauna (Vehicle Strike) | **Terrestrial Fauna**<br>EPA's objective: *To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.* | No<br>While there is likely to be significant overlap in regulation, the EPBC Act is a Commonwealth Act and as such cannot be relied upon to regulate impacts under WA legislation. |
| | | | Clearing of potential Threatened Flora or Fauna habitat | **Flora and Vegetation**<br>EPA's objective: *To protect flora and vegetation so that biological diversity and ecological integrity are maintained.*<br>**Terrestrial Fauna**<br>EPA's objective: *To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.* | |

# 2 THE PROPOSAL

## 2.1 BACKGROUND

The Proposal was referred to the EPA on 28 June 2021. The level of assessment was set as Public Environmental Review (s.40(2)(b) and s.40(4)) on 6 September 2021. An ESD was submitted to the EPA and formally approved in December 2022.

## 2.2 PROPOSAL DESCRIPTION

### 2.2.1 PROPOSAL LOCATION

The Proposal is located in the western Pilbara region of WA, approximately 55 kilometres (km) southwest of Karratha. The regional location of the Proposal is shown in Figure 2-1.




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| CREATED BY | JOB | DATE | REVISION |
|---|---|---|---|
| ENVIRONMAPS | PC2900212 | 6/04/2023 | 0 |

**Leichhardt Salt Pty Ltd**

## Figure 2-1: Regional location of the Proposal

0 25 50 100 km

Scale: 1:2,000,000 @ A3

N

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

**LOCALITY**




Legend

- Dredge Spoil Disposal Development Envelope
- Marine Development Envelope
- Pond and Infrastructure Development Envelope

ENVIRONMAPS | 0406 500 006 | Environmental Mapping Solutions | www.environmaps.com.au

C:\GIS\Jobs\Preston Consulting\PC2900212 - ERD Project Management - Leichhardt Industrials\Figures\PC2900212_Regional Location of the Proposal_230406.mxd

### 2.2.2 Proposal Content Elements

Leichhardt has referred to the EPA's *How to identify the Content of a Proposal - Instructions and Template* (EPA, 2024c) - which focuses on how to identify the content of a Proposal for the purposes of an EIA under Part IV of the EP Act. In accordance with these instructions, a general Proposal content description is provided in Table 2-1 and the Proposal content elements (e.g. development, action, activities or processes) are summarised in Table 2-2.

**Table 2-1: General proposal content description**

| | |
|---|---|
| **Proposal 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 southwest of Karratha in WA (the Proposal). The Proposal will utilise seawater and evaporation to produce a concentrated salt product for export.<br>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 and both offshore and onshore disposal of dredge material. |

**Table 2-2: Proposal content elements**

| Proposal element | Location/description | Maximum extent, capacity or range |
|---|---|---|
| **Physical elements** | | |
| 1. **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 2-1 | Disturbance of no more than 12,201 ha within the 20,157 ha Ponds and Infrastructure Development Envelope. |
| 2. **Marine Development Envelope** – Seawater intake and pipeline, dredge channel, bitterns pipeline, outfall diffuser and mixing zone. | | Disturbance of no more than 53 ha within the 703 ha Marine Development Envelope. |
| 3. **Dredge Spoil Disposal Development Envelope** – Disposal location for dredge spoil. | | Disturbance of no more than 100 ha within the 285 ha Dredge Spoil Disposal Development Envelope. |
| **Construction elements** | | |
| Dredge Volume | Figure 2-1 | Up to 400,000 $m^3$ |
| **Operational elements** | | |
| Bitterns discharge | Figure 2-1 | Discharge of up to 5.9 Gigalitres per annum (GLpa) of bitterns within a dedicated offshore mixing zone within the Marine Development Envelope. |

| | | |
|---|---|---|
| **Greenhouse Gas Emissions** | | |
| **Construction elements:** | | |
| Scope 1 | 31,000 tonnes of carbon dioxide equivalent ($CO_2$-e) from diesel usage over the construction period (estimated four years)<br>79,000 tonnes of $CO_2$-e from land use change over the construction period (estimated four years). | |
| Scope 2 | N/A. | |
| Scope 3 | Not able to be calculated at this early design stage. | |
| **Operation elements:** | | |
| Scope 1 | Electricity generation: 20,200 tonnes of $CO_2$-e per annum.<br>Diesel use: 10,300 tonnes of $CO_2$-e per annum.<br>Total: approximately 30,500 tonnes of $CO_2$-e per annum. | |
| Scope 2 | N/A. | |
| Scope 3 | Emissions associated with shipping the produced salt to customers (indicative only): 14,700 tonnes $CO_2$-e per annum. | |
| **Rehabilitation** | | |
| Progressive rehabilitation will take place where areas are not required for ongoing operations, such as laydown and stockpiling areas used during construction, exhausted borrow pits or tracks.<br>Infrastructure will be removed at closure and pond embankments removed or shaped to be similar to the surrounding landform. | | |
| **Commissioning** | | |
| No specific commissioning activities | | |
| **Decommissioning** | | |
| Construction disturbance that is not required for operations is to be rehabilitated after construction.<br>Proposal infrastructure to be removed within five years of closure. | | |
| **Other elements which affect extent of effects on the environment** | | |
| Proposal time | Maximum project life | 64 years |
| | Construction phase | 4 years |
| | Operations phase | 60 years |
| | Decommissioning phase | 5 years |

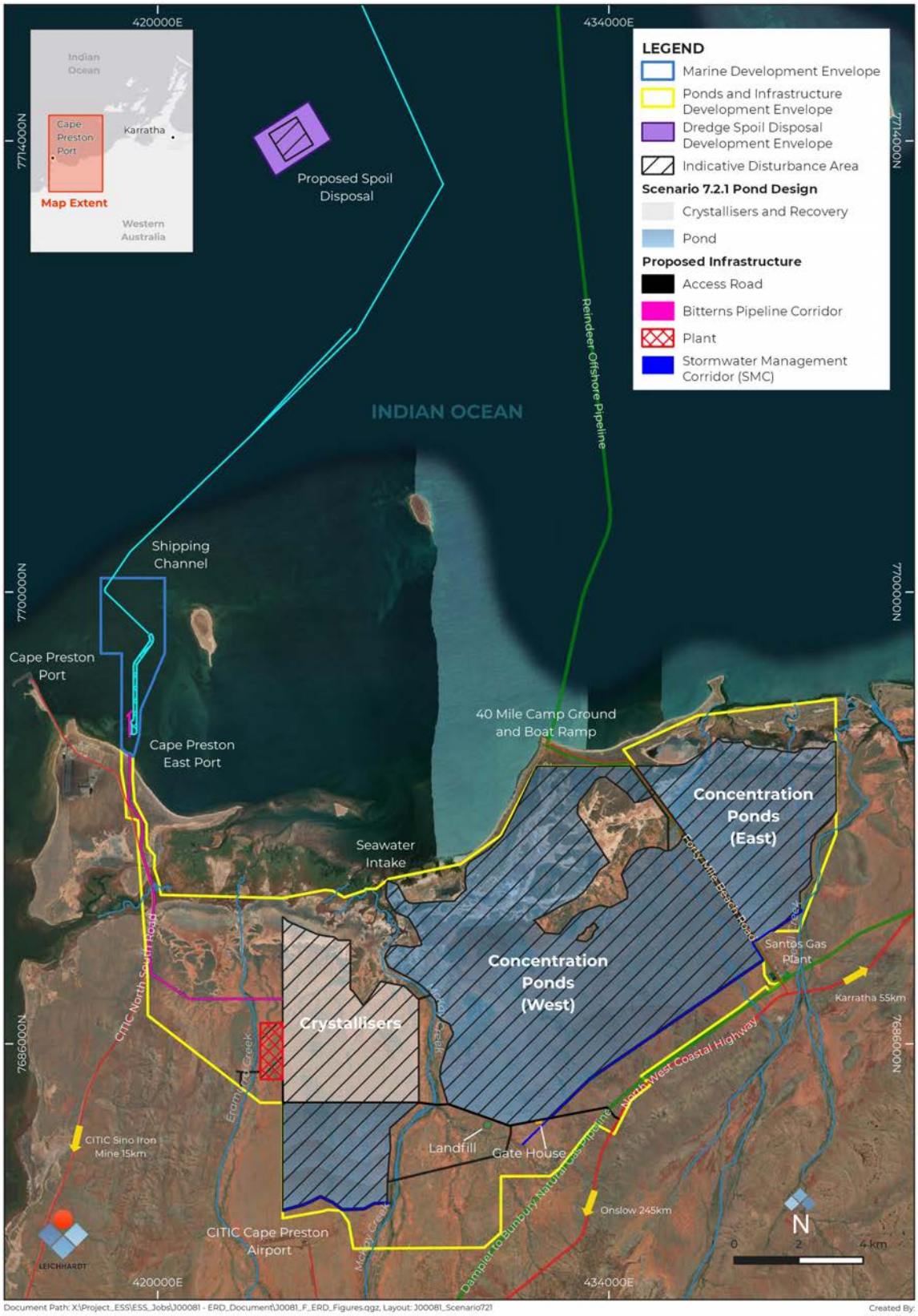


Figure 2-2: Proposed development envelopes and indicative layout

### 2.2.3 DETAILED DESCRIPTION

Leichhardt seeks to develop the Proposal, a high-quality salt project in the Pilbara region of WA. Leichhardt is an independent, Australian owned company headquartered in Perth, Western Australia, with salt and gypsum operations at Lake MacLeod close to Carnarvon and the Proposal near Karratha in Western Australia. Leichhardt was founded in 2016 to actively identify and pursue the ownership of solar salt operations in Australia. Leichhardt's vision was formed as a result of the impending supply shortfall of industrial salt in the Asia-Pacific region. Leichhardt's vision is aligned with its purpose to support and sustain regional communities by exporting industrial grade solar salt from Australia to the Asia-Pacific region. Leichhardt is committed to investing in the local communities in which we operate including the Gascoyne and Pilbara regions. Major shareholders include the Liveris Family Office, Victor Smorgon Group (VSG), Knauf and Ontario Teachers' Pension Plan.

The Proposal is an evaporative solar project that utilises seawater to produce raw salt as a feedstock for dedicated processing facilities that will produce a high purity salt. The Proposal aims for average annual production rates of 5.2 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.

***Seawater Intake***

The seawater intake will feed the concentration ponds and wash water for the wash plant and feed to the desalination plant. Figure 2-3 and Figure 2-4 illustrate the proposed intake design and cross-section.

The proposed intake is in a tidal zone just east of McKay Creek (Figure 2-5). Pumping is dependent on tidal windows with pumps sized to satisfy the demand associated with peak monthly evaporation. The seawater will be transferred directly into the first concentration pond.

The design concept utilises multiple axial flow pumps housed within a screened enclosure to abstract water from a sump, which draws from the mouth of McKay Creek. It discharges through the embankment wall to concrete risers inside the concentration pond. The concrete risers are used to avoid scouring the pond floor, and prevent backflow when pumps are stopped.

The seawater intake will operate when tidal levels are at or above 0.0 m Australian Height Datum (AHD) to ensure there is sufficient intake flow capacity from the ocean and the flow rate through the screen surrounding the enclosure does not exceed 0.15 metres per second (m/s) (to minimise marine fauna entrapment). Extraction will be over 2 x 6-hour tidal periods per day with a maximum abstraction rate up to 31 $m^3/s$ at high tide and never abstracting below 0 m mean sea level (MSL) (Table 2-3).

The design will allow for construction, maintenance and operation of the pump station while minimising disturbance to mangroves in the area.

**Table 2-3: Seawater intake abstraction rate**

| Tidal level | Maximum abstraction rate | Estimated drawdown | Delay in upstream flooding |
|---|---|---|---|
| 0 m MSL | 25 $m^3/s$ | 8 - 9 cm | 11 minutes |
| +0.5 m | 27 $m^3/s$ | 1-2 cm | 2 minutes |
| +1.0 m | 29 $m^3/s$ | 0.5 cm | <1 minute |
| +1.5 m | 31 $m^3/s$ | <0.5 cm | <1 minute |

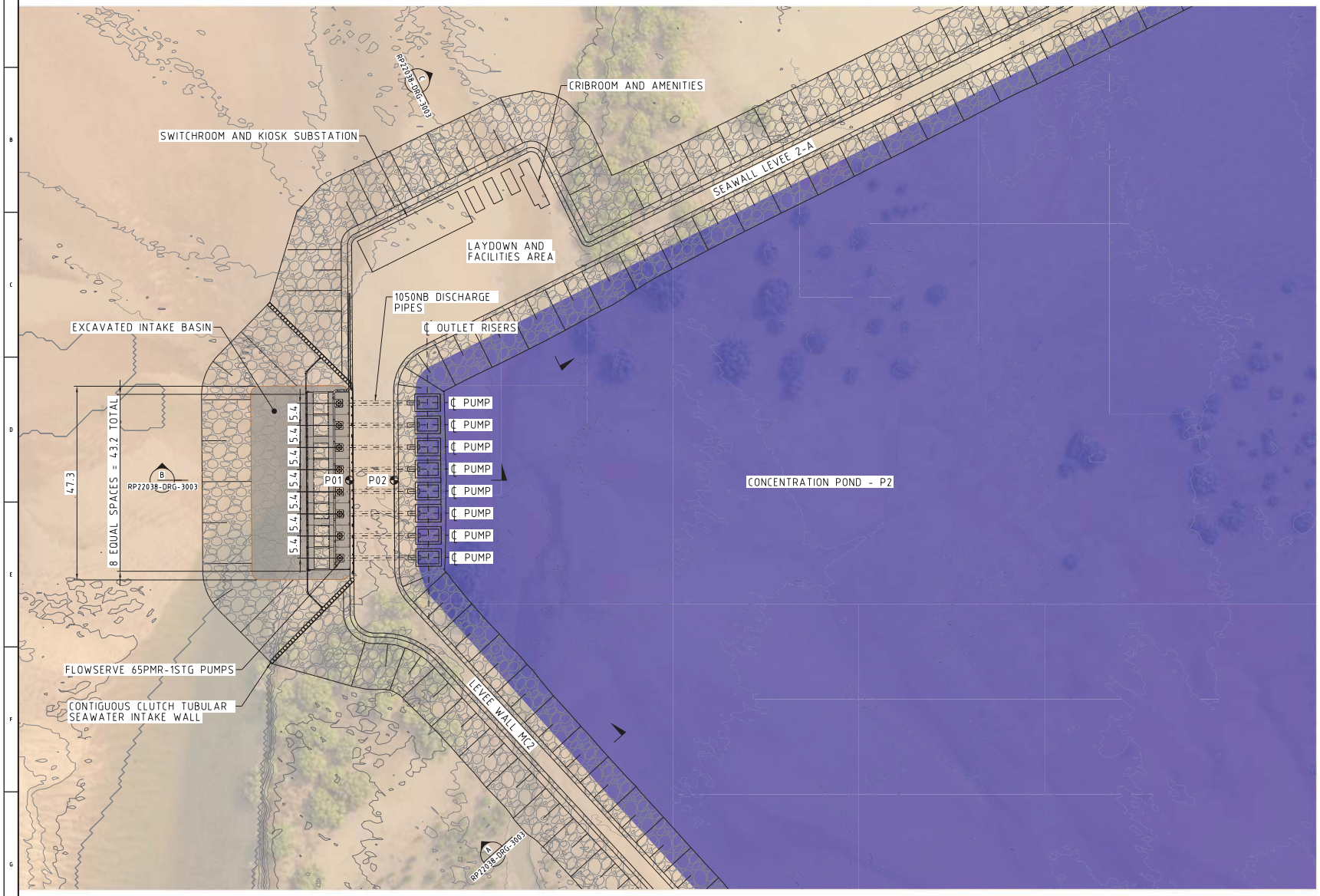


**Figure 2-3: Seawater intake pump station design**

PLAN
SCALE 1:500

NOTES:

1. ALL CO-ORDINATES ARE IN METRES TO MGA 2020 ZONE 50.
2. ALL ONSHORE LEVELS ARE IN METRES TO AHD.
3. ALL DIMENSIONS ARE IN METRES U.N.O.
4. CONCENTRATION POND BRINE LEVELS BASED UPON LEICHHARDT PROCESS DESIGN VERSION 6.2 - APRIL 2022.

| POND | BRINE LEVEL (m) | DENSITY (kg/m³) |
|---|---|---|
| P2 | 4.0 | 1.034 |

5. SEAWATER PUMP STATION DESIGNED FOR LEICHHARDT MASS BALANCE WITH AVERAGE ANNUAL INTAKE OF 263 GL/YEAR.

LEGEND:

- MINOR CONTOUR (0.2m INTERVAL)
- MAJOR CONTOUR (0.6m INTERVAL)
- P01 SETOUT POINT
- BATTER
- CONCENTRATION PONDS
- ROCK ARMOUR

| SETOUT TABLE | | |
|---|---|---|
| POINT | NORTHING | EASTING |
| P01 | 7691041.474 | 427118.249 |
| P02 | 7691033.820 | 427126.009 |

PRELIMINARY
NOT FOR CONSTRUCTION

SCALE OF METRES 1:500

| DRAWING NUMBER | REFERENCE DRAWING TITLE | REV | DATE | DESCRIPTION | DRN | CHK | APP |
|---|---|---|---|---|---|---|---|
| | | A | 09.06.22 | ISSUED FOR CLIENT REVIEW | GVD | JH | |

LEICHHARDT

BG&E Resources

| | |
|---|---|
| DESIGNED | GVD |
| DRAWN | JB |
| CHECKED | JH |
| APPROVED | |
| APPROVED DATE | |
| DATUM | |

PROJECT NUMBER: RP22038

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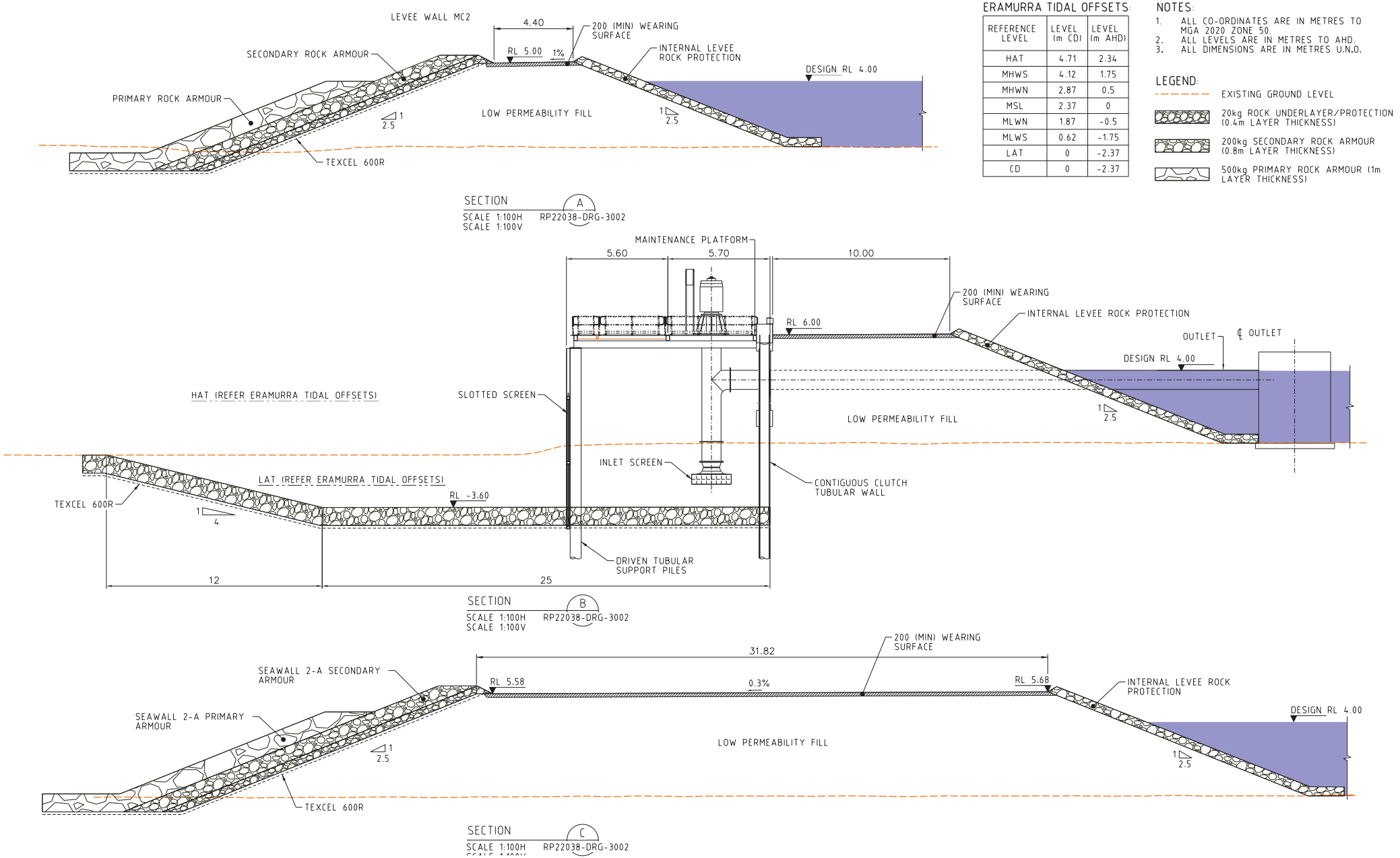
ERAMURRA SOLAR SALT PROJECT
TRADE OFF STUDIES
SEAWATER INTAKE PUMP STATION PS-01
GENERAL ARRANGEMENT - PLAN

A1 | SCALE 1:500 | DRG No: RP22038-DRG-3002 | REV: A




ERAMURRA TIDAL OFFSETS:

| REFERENCE LEVEL | LEVEL (m CD) | LEVEL (m AHD) |
|---|---|---|
| HAT | 4.71 | 2.34 |
| MHWS | 4.12 | 1.75 |
| MHWN | 2.87 | 0.5 |
| MSL | 2.37 | 0 |
| MLWN | 1.87 | -0.5 |
| MLWS | 0.62 | -1.75 |
| LAT | 0 | -2.37 |
| CD | 0 | -2.37 |

NOTES:
1. ALL CO-ORDINATES ARE IN METRES TO MGA 2020 ZONE 50.
2. ALL LEVELS ARE IN METRES TO AHD.
3. ALL DIMENSIONS ARE IN METRES U.N.O.

LEGEND:
- EXISTING GROUND LEVEL
- 20kg ROCK UNDERLAYER/PROTECTION (0.4m LAYER THICKNESS)
- 200kg SECONDARY ROCK ARMOUR (0.8m LAYER THICKNESS)
- 500kg PRIMARY ROCK ARMOUR (1m LAYER THICKNESS)

**Figure 2-4: Seawater intake pump station design cross section**

PRELIMINARY
NOT FOR CONSTRUCTION

SCALE OF METRES 1:100

| DRAWING NUMBER | REFERENCE DRAWING TITLE | REV | DATE | DESCRIPTION | DRN | CHK | APP |
|---|---|---|---|---|---|---|---|
| | | A | 09.06.22 | ISSUED FOR CLIENT REVIEW | GVD | JH | |

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| | | |
|---|---|---|
| DESIGNED | GVD | PROJECT NUMBER |
| DRAWN | JB | RP22038 |
| CHECKED | JH | |
| APPROVED | | |
| APPROVED DATE | | |
| DATUM | | |

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ERAMURRA SOLAR SALT PROJECT
TRADE OFF STUDIES
SEAWATER INTAKE PUMP STATION PS-01
CROSS SECTIONS

| A1 | SCALE 1:100 | DRG No: RP22038-DRG-3003 | REV: A |
|---|---|---|---|

***Concentration ponds and crystallisers***

The layout of the concentration ponds has been determined by the Proposal design requirements, including the existing topography, geotechnical, hydraulic environmental and heritage conditions, and the position of existing infrastructure (Figure 2-5).

To achieve 5.2 Mtpa production, a total area of 11,900 ha will be developed into evaporation ponds. Approximately 10,000 ha of the area will serve as concentration ponds and 1,900 ha as crystallisers (Figure 2-5).

The intention is to locate the wash plant and associated non-process infrastructure within the Pilbara Ports Authority (PPA) Lease, west of Proposal Mining Lease Application (MLA) area.

*Brine transfer between concentration ponds*

Seawater will be pumped from the seawater intake into the concentration ponds. The flows are progressively elevated, one to three ponds at a time, and transferred to and from the eastern ponds through multiple pump stations and pipelines. Gravity flow through intermediate ponds will be controlled by overflow weirs or stop gated culverts. Pumped and gravity flows will be adjusted as required to maintain target pond salinities and levels.

*Brine transfer from concentration ponds to crystallisers and bitterns channel*

The crystallisers are flat rectangular ponds which crystallise salt from the dense brine. The crystallisers will be operated in continuous or batch mode, whereas the concentration ponds will always be operated in a continuous mode. Each crystalliser will be periodically drained, and the salt recovered as raw feed for the washing facilities. The bitterns recovery crystallisers will be operated at a higher salinity. Seawater will be pumped in to redissolve the salt. Once the salt has been redissolved it is pumped back to the concentration ponds for recycling into the lower salinity crystallisers. This improves the efficiency of the salt production process.

The crystalliser design uses the natural gradient in the local landscape to achieve gravity flow throughout the crystalliser area. Brine transfer structures convey the brine from the brine channel, through to the crystallisers and subsequently release brine into the bitterns channel. The bitterns will feed into secondary higher salinity crystallisers, then to the final bitterns channel and bitterns discharge. The transfer structures will be ditches with culverts and isolation gates or overflow weirs.

*Embankment design*

The primary purpose of the embankments is to contain the brine within the concentration ponds and crystallisers. To achieve this, the core of the embankment will be constructed from locally sourced, low permeability clay and soils. This will be contiguous and (if necessary) keyed with the floor of the pond. Baseline soil and sediment testing was completed by LWC (Appendix 1.4) and reported on the composition of soil samples from the site. LWC reported sulfate levels in 134 near-surface soil samples with the median value determined as 0.16% by weight. Of 32 samples, four reported gypsum with the highest value of 8% at 12.5-18 m below ground level from borehole MBH017.

Soils to be used for bund construction will be sourced from shallow pits outside the playa regions i.e. above the tidal zone. Based on test data available, most of the potential borrow material is low in gypsum content, avoiding the noted shrink-swell risk. Borrow locations will be assessed for geotechnical properties, ASS and gypsum content before they are confirmed for use.

The top of some embankments will be used as roads to access weirs and valves which regulate flow between the ponds. Maintenance personnel will use these roads to conduct inspections and maintenance of the rock armour. On the seawalls, the width of the road will be sufficient to accommodate light vehicles, light trucks and cranage for placement of large armour rock. In the crystalliser area roads are more generous to facilitate the large trucks used for salt haulage.

The height of the internal embankments will be set by the required pond depth, adjusted to account for significant rainfall events and wind set up and fetch within the concentration ponds. The preliminary design has a nominal 700 mm freeboard between the brine level and the top of embankment. The sections with direct coastal exposure will be rock armoured to protect against erosion. The height of the external sea wall at the northern boundary of the site will be 5.0 m AHD or higher, which exceeds the storm surge level of a one in 100-year storm event.

Further inland, the walls will be constructed to limit permeability between adjacent ponds with some rip-rap protection against internal wave erosion. The southern boundary of the ponds will generally follow natural topography. Minor bunds will be provided to contain brine and external channels will divert external runoff from storm events. Some of the embankments on low-lying areas will be constructed on clay which compresses under load. Provision will be made for settlement, in accordance with recommendations by the geotechnical consultant.

***Bitterns Discharge***

*Bitterns processing*

Brine will remain within the initial crystallisers up to a density of 1.25 kg/L. At this density, the brine is discharged into the bitterns channel.

The brine is then taken to second stage crystallisers. The brine will remain in the secondary crystallisers up to a density of 1.29 kg/L. The final bitterns are drained to a channel feeding into the bitterns discharge pump station. A small stream of fresh seawater is fed into the bitterns pump station to avoid precipitation of salts in the pipeline. Bitterns discharge will be variable relative to seasonal variation in evaporation and brine flows through the salt operations.

*Bitterns discharge*

The bitterns discharge pipeline will run approximately 12 km from pumps at the recovery ponds to the jetty at the port facility. The discharge pipeline will extend along the jetty then transfer along the seabed, potentially trenched, to a discharge diffuser. The parameters for the bitterns diffuser, based on the current flowsheet data, are estimated as:

- Seafloor pipeline and diffuser: high-density polyethylene pipe ~0.55 m inner diameter
- Diffuser length: 200 m;
- Number of outlet nozzles: 21; and
- Size of outlet nozzles: 61-63 mm inner diameter.





The final bitterns are saturated in salt (approximately ten times seawater concentration) with higher relative concentrations of potassium and magnesium. The final high-salinity bitterns (up to 5.9 GLpa) will be mixed 1:1 with seawater from a pump installed on the jetty structure. This dilutes the bitterns before discharge to the marine environment through a diffuser system. The diffuser outlet heads achieve a further local dilution before the stream disperses into the local ocean environment.

The bitterns pipeline and diffuser are within the scope of this Proposal however the product loading jetty forms part of the CPE port approved under MS 949 and MS 1149 and is therefore outside of the scope of this Proposal.

The design and operation of the discharge pipeline, diffusers and offshore discharge location has been assessed by engineering consultants and marine experts engaged by Leichhardt to undertake dispersion modelling.

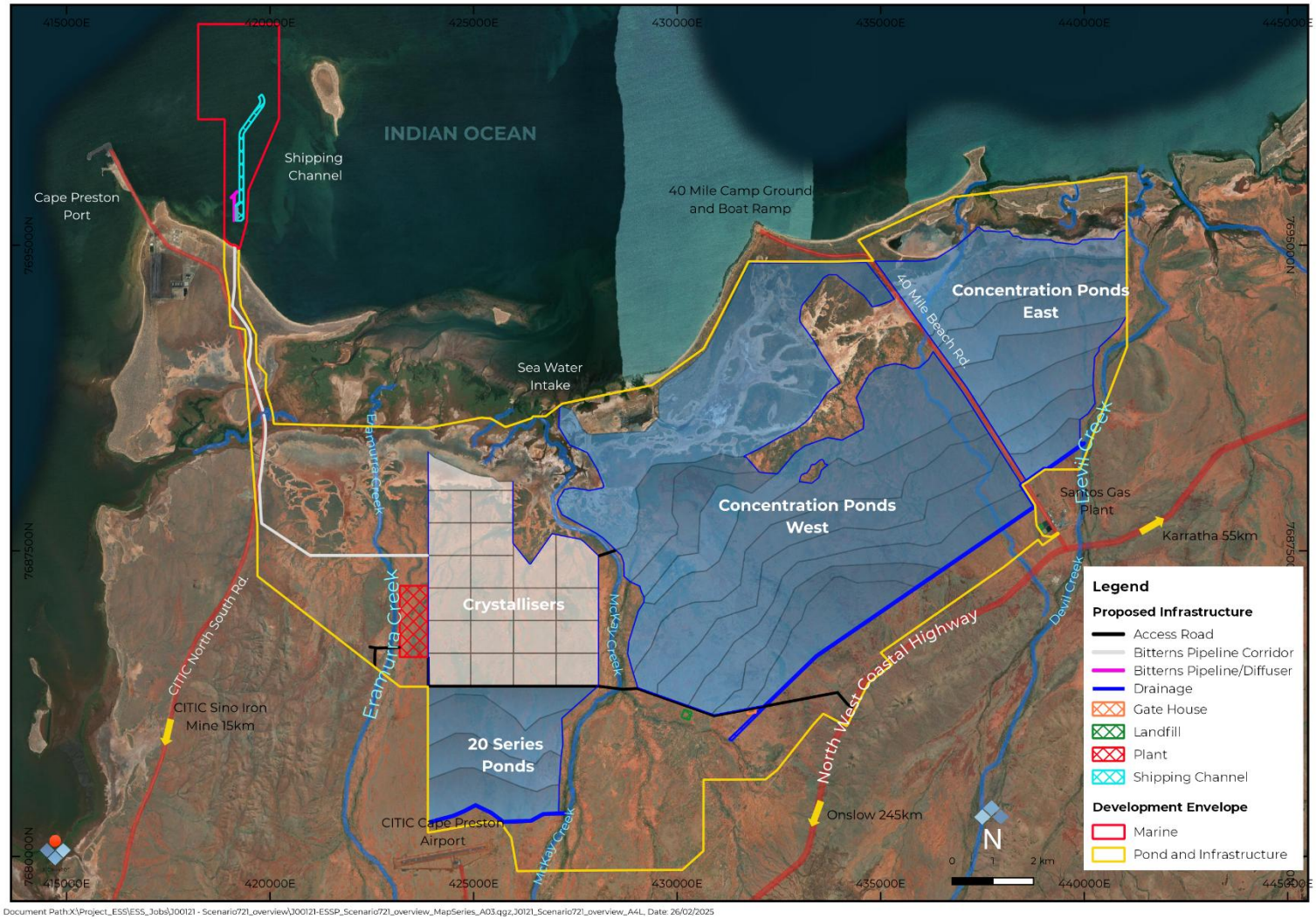



Figure 2-5: Pond layout and configuration

### *Drainage*

The Proposal includes a number of levees, channels and culverts designed to ensure catchment flows are managed. These works will prevent extreme flows resulting from tropical cyclones and storms from flooding into the salt ponds or causing damage to pond walls and other Proposal infrastructure.

Flood control diversions are established within the Devil Creek and McKay Creek catchments. No overland flows will be directed down the Reindeer gas pipeline corridor, to ensure the integrity of the pipeline.

Any drainage control structures will be designed with key stakeholders to accommodate agreed AEP values, and may consist of the following:

- Armoured bunding along either side of the McKay Creek watercourse where it abuts the ponds; and
- Diversion channels along the southern edge of the ponds, westward into McKay Creek and eastward into Devil Creek.

A floodway will be installed for the site access road where it crosses McKay Creek. The floodway will pass up to a 10-year ARI flood event underneath the road through culverts.

Direct rainfall on concentration ponds and crystallisers (up to a 300 mm event) will be contained within the ponds. Brine transfer will pause for major rain events to allow brine densities to recover by evaporation. Internal spillways will provide local balancing of excess pond water levels. Emergency pond spillways will be included discharging to McKay Creek or Devil Creek to avoid catastrophic failures of bunds through overtopping due to major storm events or wind runup of excess water levels.

### *Salt Wash Plant*

*Capacity*

Seawater will be used to remove impurities from the salt, taking the salt from 98% sodium chloride to 99.8% sodium chloride by dry weight. The process of washing will remove around 2% mass of impurities in the feed and dissolve 5-10% of the incoming sodium chloride. Waste brine from the wash plant will be recycled back into concentration ponds to recover the sodium chloride dissolved in the washing process. The wash plant process is outlined in Figure 2-6.

The proposed salt wash plant design capacity is estimated to be 1,500 tonnes per hour (tph) raw salt input. The wash plant will be based on counter-current classifiers with screens for de-watering. The plant will operate 24 hours a day in campaigns of 1-3 weeks, aligned to the crystalliser harvest schedule.

*Contingency production*

The planned 5.2 Mtpa capacity is based on average weather patterns. Annual fluctuations can be significant. During good growing years, the operation will build-up additional crystalliser stocks which can buffer the inevitable poor weather-impacted seasons. Care will be taken to balance capacities such that crystallisers are kept covered with brine and not filled to capacity with salt.

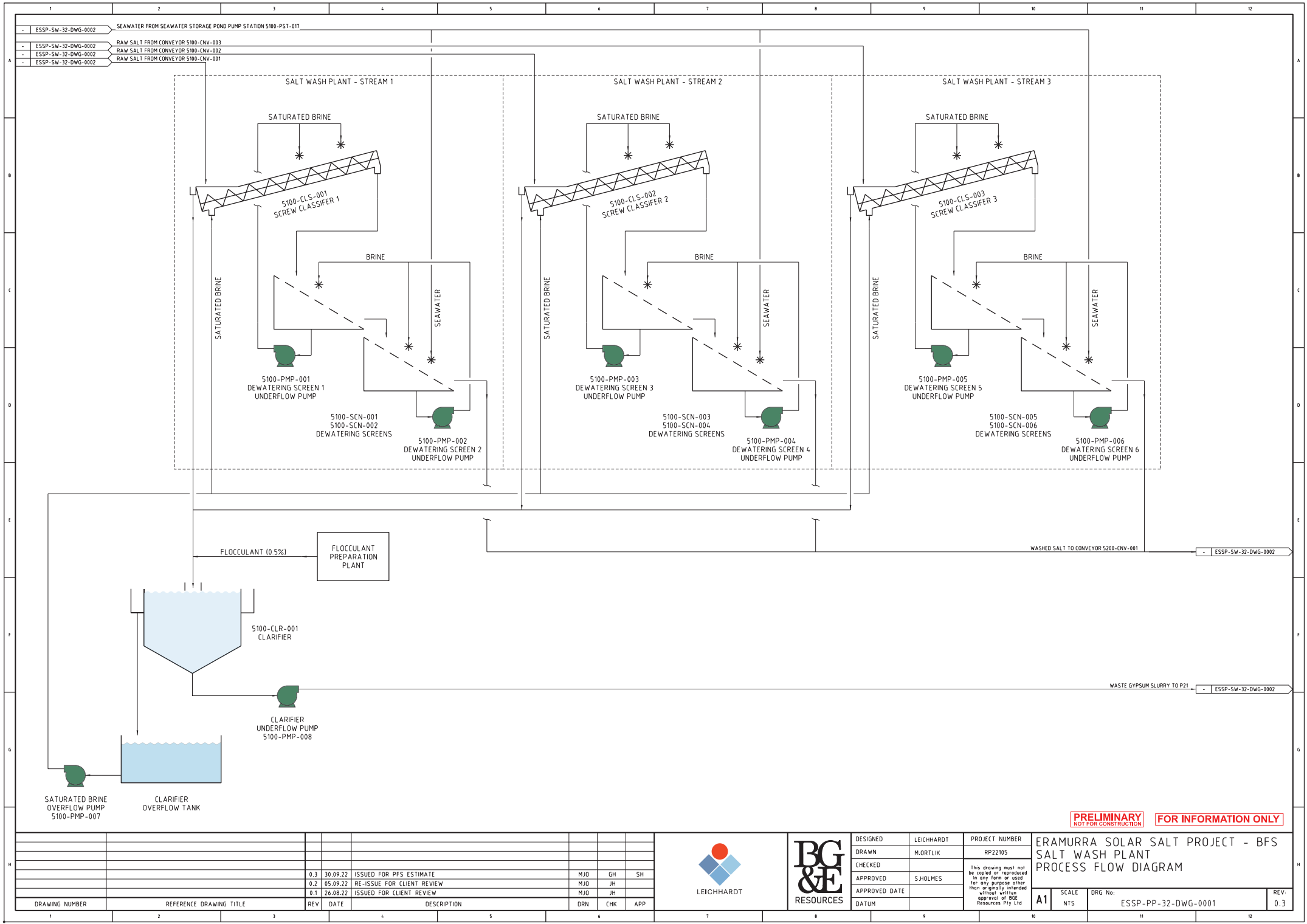



Figure 2-6: Indicative wash plant process flow diagram

***Mobile equipment***

*Harvester*

The standard industry salt harvest operation begins with a grader ripping and windrowing the crystalliser salt floor which allows the harvester to achieve required production rates (Figure 2-7). The harvester configuration follows the industry standard design of a specialised tractor-towed unit. The harvester elevates the windrowed salt via a boom into the truck's 50 $m^3$ trailers at a rate of 2,000 tph.

The typical ripped cut depth for harvester pick-up ranges from 20 – 25 cm, which represents approximately one year of growth. Depth is to be controlled by the grader using Global Positioning System (GPS) level control. The crawling speed of the truck is matched to the harvest speed for efficient loading.



**Figure 2-7: Harvester loading triple trailer haul truck**

*Haul trucks – Crystalliser to wash plant*

The harvesting truck fleet is likely to have four units, each consisting of a truck and two trailers. This fleet will typically deliver between 1,300 – 1,500 tph to the wash plant, depending on crystalliser distances. The units operate on dedicated roads through the crystalliser area and into the wash plant.

*Haul trucks – Wash plant stockpile to jetty stockyard*

Product is to be hauled to port by triple road trains configured for Main Roads Performance Based Standards compliance. The trucks are loaded from stockpiles by a front-end-loader. The loader will be supported by a dozer, keeping the stockpile face height at a safe and stable level.

The round trip is approximately 23 km, in part along Leichhardt's dry haul road, followed by a section along the Cape Preston access road to the port terminal.

***Marine Facility***

*Jetty and stockyard*

The CPE port facility that will be used for the export of the salt is already approved under the EP Act (Ministerial Statement (MS) 949 and 1149). The CPE port was designed with a 1.5 km long piled jetty eliminating the requirement for near shore dredging of a berth pocket or channel. Approval for navigation of transhipment vessels to deep water anchorages was considered obtainable through waters controlled by the adjacent Port of Cape Preston, with no dredging component associated with the scope. Detailed port studies completed during the Proposal Definitive Feasibility Study identified that the CPE piled jetty structure could be reduced in length by approximately 700 m with the introduction of limited near shore dredging. The use of Port of Cape Preston water for access to deep water anchorages was reviewed and tenure concerns resulted in the detailed bathymetric survey of an alternative route, which resulted in dredging of a channel for use by the transhipment vessels (TSVs).

As such, in order to reduce the piled jetty length and to avoid marine tenure issues , dredging has been included within the scope of this Proposal, as described below. However, the development of the product loading jetty remains within the scope of CPE and is therefore excluded from this Proposal and the detail below has been provided for information purposes only.

Incoming product trucks will discharge product over a dump hopper, feeding either the port stockpile stacker, or direct to the shipping conveyor. The stockpile will be reclaimed by dozer pushing to feed the shipping conveyor which runs 700 m along the jetty to the loader. The transhipment loader will be a simple telescopic unit with a luffing boom and no other degrees of movement. It is mounted on a 1,000 $m^2$ apron at the loading wharf, which is at the head of the 700 m long outload jetty.

*Berth pocket and dredging*

A berth pocket will be dredged at the end of the trestle jetty and will provide a three-kilometre route out to deeper water. Material will be dug up and placed into a hopper barge or pumped to shore. The barge will travel to a designated offshore spoil area (Figure 2-2) to dispose its contents. An onshore spoil area may be developed within the CPE port area for use in the construction of the CPE Port.

Dredging will be undertaken with a Cutter Suction Dredge (CSD). The CSD consists of a U-shaped pontoon which is held in position by a fixed spud and anchors. During the dredging activities, the CSD swings around the main spud with the help of its side winches. The operation of the CSD consists of cutting the seabed with the cutter head and pumping the mixture of water and solids by a centrifugal pump into either a split hopper barge, or via a floating line to the shore disposal.

The average dredging depth will be approximately one metre below the current sea floor. It is anticipated that up to 400,000 $m^3$ of dredge spoil will be generated.

*Transhipment*

Product will be transported via TSV from the jetty to Ocean-going Vessels (OGVs) at offshore anchorages. The preferred unit is a self-propelled, self-unloading TSV with a laden draft of approximately 4 m at 6,500 deadweight tonnage (dwt), ranging up to 6 m at 12,000 tonnes. This activity forms part of the CPE Port and is approved under MS 949 (i.e. it is not part of this Proposal).

OGV sizes will be governed by the export shipment size, and the draft constraints of the CPE Port anchorages. Visiting vessels are expected to range from 35,000 dwt to 60,000 dwt. A loading rate of 20,000 t/day will be achieved with the nominated loading and transhipping equipment.

The TSV will be designed to operate in wind up to 20 knots. The equipment will be specified to operate in sea-states consistent with achieving the required annual capacity and loading the vessels selected.

***General works equipment***

Roads will be maintained to a high standard to maintain safety and efficiency of vehicle fleet operation. Damage due to weather erosion will be restored promptly to protect salt production and quality. In-house civil works equipment will be used to ensure that repairs can be addressed whenever a need is identified.

***Light vehicles***

The Proposal will operate a fleet of light vehicles (LVs) consistent with similar operations within the industry. This will include emergency response vehicles (ambulance and fire response units) kept on site.

A chartered bus will transport shift workers between Karratha and site at shift changes. Day shift workers will utilise pooled company vehicles for commuting. Company LVs will be used to transfer personnel to the port and remote operating locations on the site.

***Non-process Infrastructure***

The following non-process infrastructure (NPI) will be required:

- Access road from North West Coastal Highway;
- Product haulage road to the Cape Preston access road;
- Emergency response and training centre;
- Administration building;
- Workshop and store facilities;
- Vehicle washdown facility with an oil/water separation facility;
- Amenities, crib and pre-start buildings;
- “Go-line” area for the large mobile plant;
- Helicopter landing area for emergency evacuations;
- Diesel fuel storage and dispensing area;
- Port area diesel fuel storage and dispensing, including TSV fuelling;
- Laboratory facilities;
- Sewage treatment and disposal facilities at hub;
- Power generation and distribution facilities;
- Potable water supply from on-site desalination plant;

- Communication facilities;
- Layout, pedestrian ways and parking provisions; and
- Borrow pits and material stockpiles for civil repairs.

*Leichhardt access road*

A site access road is required from Karratha via the Great Northern Coastal Highway to facilitate construction of the site and to provide ongoing access to the site for operations and maintenance. The access road will be designed as an 8 m wide, two-way road to Main Roads WA standards, to link into the existing road network, as illustrated in Figure 2-2.

*Haul and service roads*

The heavy vehicle haul roads from the crystallisers to wash plant will be a 12 m wide unsealed road with edge protection for elevated sections. Other roads will be a minimum of 4 m lane width for one-way traffic.

*Administration Hub*

The administrative hub will be located on PPA land, in close proximity to the wash plant and salt stockyard.

This hub will include the following facilities:

- Administration building;
- Boom gate access to site;
- Emergency response/training centre;
- Amenities; and
- Wet and dry laboratory for chemical and biological assessment.

These facilities will be laid out to facilitate interaction of the operational workforce with the administrative and managerial personnel.

*Workshop and store facilities*

A workshop and vehicle parking area will be constructed in the vicinity of the wash plant site. Based on the preliminary study, the workshop area may include the following amenities:

- Heavy vehicle maintenance workshop for the servicing of salt harvester, load and haul vehicles;
- Light vehicle maintenance for repairs of all light vehicles (servicing likely within Karratha);
- General maintenance workshop for the maintenance of installed equipment (i.e. pumps, drives, valves, etc.);
- Electrical and instruments workshop;
- Washdown facilities for light and heavy vehicles;
- Oil separation facility to remove washdown water from all maintenance workshops and to separate and store oil for disposal offsite;
- Enclosed storage facility for spare parts; and
- Uncovered storage area.

*Electrical power supply*

Power for the salt production facilities is intended to be generated in a hybrid power station with both Liquefied Natural Gas (LNG) generating engines and a solar farm area. The electrical load for the project has been estimated to be six Megawatts (MW). Gas for the generators will be delivered by truck from Karratha as cryogenic LNG.

*Re-fuelling facilities*

Proposal construction will utilise diesel fuel for the major earthworks and other construction energy needed. For Proposal operation, diesel fuel storage and dispensing facilities will be provided at the salt hub and port to service the respective mobile equipment.

*Laboratory*

A chemical and biological laboratory will be supplied to enable adequate monitoring of the salt production process.

*Potable water*

The use of freshwater on site is limited to that required for potable purposes and minor washdown. A packaged desalination plant at the production hub will draw seawater from the wash plant supply and discharge concentrated brine back into the process. Groundwater abstraction is not proposed as part of this Proposal except for control of brine seepage.

Water for potable use will be further treated to meet Australian Drinking Water Guidelines.

***Closure and Rehabilitation***

At closure of the Proposal the surface infrastructure will be removed (or repurposed). The civil works will be breached locally to drain any remaining brine from the lower salinity initial ponds to the ocean. Crystalliser ponds will have the salt removed prior to breaching.

Partial or entire removal of bunds and embankments at closure will reinstate natural drainage of surface water, ingress and egress of tides and storm surges. Each pond will be individually assessed for water quality and pond walls will be flattened or gradually opened up to tidal flows to allow flushing of saline sediments. Additional seawater may be pumped into individual ponds as required to address potential impacts to downstream sensitive areas.

Treatments to manage closure and rehabilitation environmental risk, including premature / unexpected closure will be implemented as follows:

- Triennial updates of the MCP;
- Cost estimation and provisioning to International Financial Reporting Standard;
- Mine Rehabilitation Fund (MRF) reporting and contributions;
- Modelling of tidal discharge salinity and hydrology of tidal and stormwater flows in response to removal of bunds completed before closure;
- Removal of salt product from crystallisers, stockpile and spillage areas;
- Sequenced embankment removal to control surface flows (sections of modified landform will be retained post-closure where permitted);
- Drafting and implementation of a Care and Maintenance Plan specific to the circumstances;

- Agreement with stakeholders to accept responsibility for any retained infrastructure; and
- Post-closure water quality monitoring (salinity and pH).

Information describing how Leichhardt will progress toward rehabilitating and closing the Project consistent with an agreed set of outcomes relevant to closure is provided in the MCP.

### 2.2.4 Disturbance and Development Envelopes

A total disturbance limit of 12,354 ha is proposed, within a total development envelope area of 21,148 ha. Three separate development envelopes are proposed, as the type of disturbance varies greatly between activity types (Figure 2-2):

- The Ponds and Infrastructure Development Envelope (PIDE) contains the concentration ponds and crystallisers, seawater intake, process plant, desalination plant, administration, water supply, intake, associated works (access roads, laydown, water supply and other services);
- The Marine Development Envelope contains the pipeline, dredge channel, bitterns pipeline, outfall diffuser and mixing zone; and
- The Dredge Spoil Disposal Development Envelope (DSDDE) contains the offshore disposal location for dredge spoil.

Leichhardt has completed a series of environmental surveys and has established the key environmental values of the development envelopes. The boundaries of the proposed development envelopes identified in Figure 2-2 have been adjusted where practicable to avoid and minimise potential environmental impacts relevant to mangroves, algal mats and other sensitive biological receptors.

Table 2-2 provides a breakdown of the anticipated areas of disturbance associated with the Proposal, within the three specified development envelope.

## 2.3 Local and Regional Context

The Proposal is approximately 55 km southwest of Karratha, in the western Pilbara region (Figure 2-1). The Proposal will utilise seawater and evaporation to produce a high purity salt product for export.

The following sections have been sourced from State Government reports describing the characteristics and values of the region.

### 2.3.1 Land Use

The Proposal lies within the Pilbara bioregion and almost entirely within the Roebourne (PIL4) Interim Biogeographic Regionalisation for Australia (IBRA) subregion. This subregion is described as coastal and subcoastal plains with a grass savannah and undulating granite and basal plains (Kendrick and Stanley, 2001).

The Proposal includes part of the former Mardie and Karratha pastoral lease areas that are currently being managed by the Department of Biodiversity, Conservation and Attractions (DBCA) for the control of fire, feral animals and weeds and proposed for formal reservation under the *Conservation and Land Management Act 1984* (CALM Act).

The Proposal extends across terrestrial, coastal and marine ecosystems. The terrestrial land forms part of Mardie Station, which is primarily used for cattle. The coastal and marine areas of the Proposal are used for bulk material export (Cape Preston), commercial fishing and recreation (fishing, boating and camping).

There is a recognised recreational area immediately north of the Proposal, which includes Gnoorea Point, 40-Mile Beach and associated camping and fishing areas.

### 2.3.2 Environmental Assets

***WA Conservation Reserves***

No conservation reserves or other Environmentally Sensitive Areas, as defined under section 51B of the EP Act, are located within the development envelopes. The closest conservation reserves are the numerous offshore islands within the Passage Island Archipelago, associated with the Great Sandy Island Nature Reserve (Class B). This reserve is located offshore with no impacts proposed. The closest of these islands are an unnamed island, South West Regnard Island and North East Regnard Island (Figure 2-8). The unnamed island is located approximately three kilometres north of the PIDE. South West Regnard Island is located approximately one kilometre east of the Marine Development Envelope. North Regnard Island is located approximately four kilometres south of the DSDDE. These islands are managed by DBCA for the conservation of flora and fauna and are vested with the Conservation and Parks Commission of WA.

There is a recommended EPA Redbook Marine Conservation Reserve where the Proposal is located, spanning from Mary Anne Islands to Cape Keraudren (Figure 2-8).

Other conservation reserves in the area include:

- Dampier Archipelago Nature Reserves, located 50 km northeast;
- Murujuga National Park, located 60 km northeast;
- Dolphin Island Nature Reserve, located 70 km northeast;
- Barrow Island Marine Management Area, located 80 km northwest;
- Barrow Island Nature Reserve (Class A), located 90 km northwest; and
- Montebello Islands Conservation Reserve, located 90 km northwest.

No CALM Act reserves are proposed to be directly or indirectly impacted as a result of the Proposal. Impacts to island reserves as a result of lighting have been discussed in Section 9 under Marine Fauna. The Proposal intersects two areas which have been identified as lands of interest for DBCA (Figure 2-8). These areas are ex-Karratha Station and ex-Mardie Station which have been identified for conservation purposes. Up to 4,400.9 ha and 2,579.2 ha of the ex-Karratha Station and ex-Mardie Station lands of interest occur within the PIDE, respectively.

***EPA Management Areas***

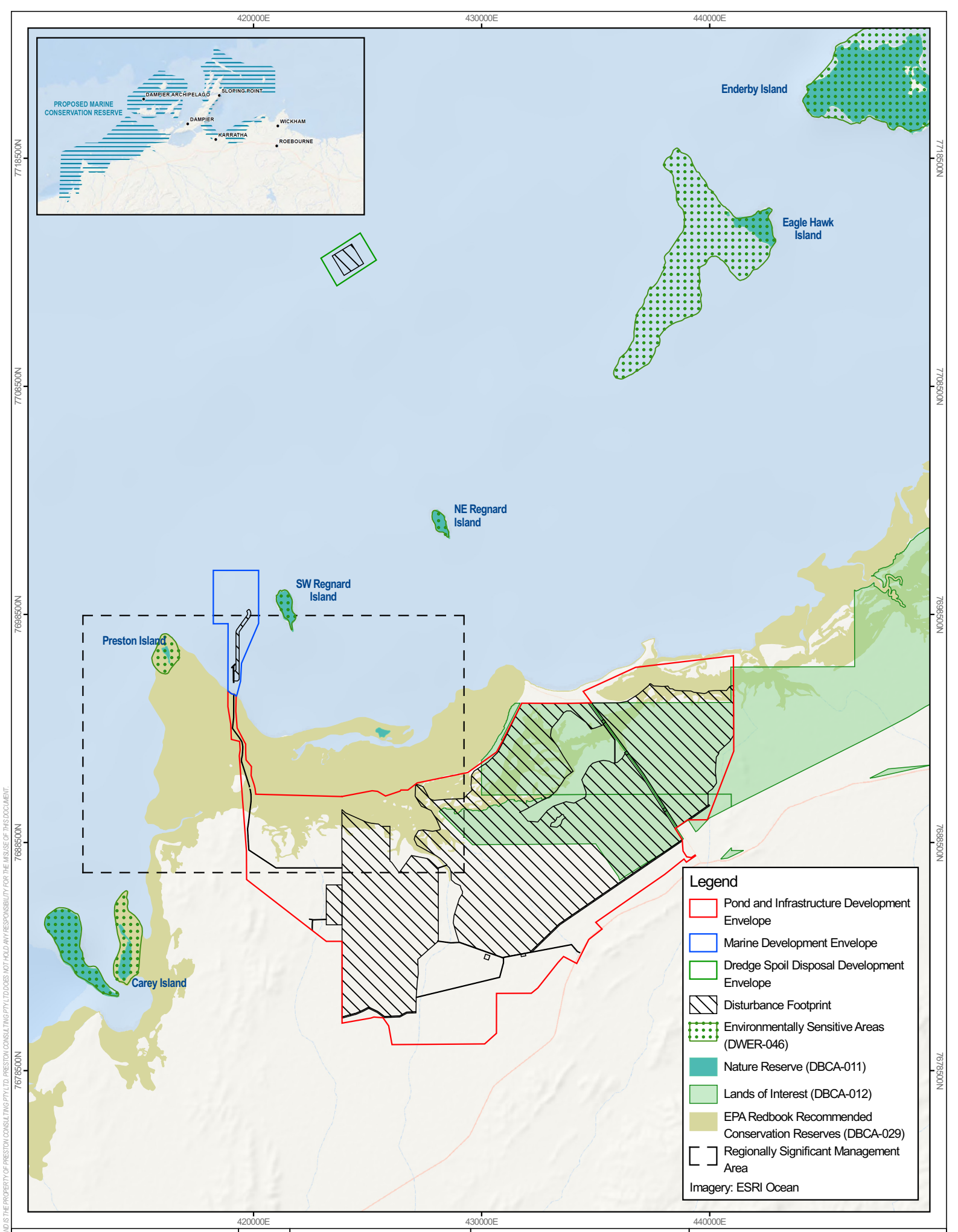
*EPA Guidance Statement No. 1 for protection of tropical arid zone mangroves along the Pilbara coastline* (2001) has identified that mangroves are an important component of the coastal ecosystem. Consistent with this statement, the EPA has identified several areas along the Pilbara coastline containing regionally significant mangroves. The Cape Preston Mangrove Management Area overlaps the northern portion of the PIDE (Figure 2-8). The Fortescue River Delta Mangrove Management Area lies approximately 20 km southwest of the Proposal.

### *Important Wetlands*

The Proposal does not overlap any listed or proposed wetlands of national or international importance. The closest important wetland to the Proposal is Exmouth Gulf East (Wetland of National Importance), located 190 km southwest of the Proposal.

### *Commonwealth Marine Parks*

The Montebello, Barrow Island and Dampier Marine Parks lie more than 60 km from the Proposal will not occur within the boundaries of these marine parks.

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Project: LEI_0535_016
Date: 29/04/2025
Size: A4
Author: ASmithers (Preston Consulting Pty Ltd)

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Preston Consulting

**Figure 2-8: Environmental Assets in proximity to the Proposal**

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# 3 STAKEHOLDER ENGAGEMENT

## 3.1 KEY STAKEHOLDERS

### 3.1.1 GOVERNMENT STAKEHOLDERS

Commonwealth, State and Local Government authorities have been briefed on the Proposal to ensure any issues, concerns or suggestions are identified and, where appropriate, addressed or responded to by Leichhardt. The consultations have resulted in some changes to Proposal design; however, in most cases the purpose was to provide the Government stakeholder with relevant information.

The following Government stakeholders have been consulted:

- Commonwealth:
  - DCCEEW;
  - Minister for Finance;
  - Minister for the Environment;
  - Northern Australia Infrastructure Facility (NAIF);
  - Regional Development Association Pilbara; and
  - Assistant Minister for Regional Development and Territories.
- State:
  - DWER;
  - Department of Jobs, Tourism, Science and Innovation (DJTSI);
  - DEMIRS;
  - DBCA;
  - Department of Transport (DoT);
  - PPA;
  - EPA;
  - Minister for Mines and Petroleum, Energy and Industrial Relations;
  - Minister for Regional Development; and
  - Minister Price (Member for Durack).
- Local:
  - City of Karratha.

### 3.1.2 CORPORATE AND COMMUNITY STAKEHOLDERS

Leichhardt recognises that individuals, companies, and communities may also be interested in the impacts of the Proposal. The following corporate and community stakeholders were deemed to be relevant to this Proposal:

- CITIC Pacific Mining;
- City of Karratha;
- Hampton Harbour Boat and Sailing Club;
- King Bay Sporting Fishing Club;
- Nickol Bay Sporting Fishing Club;
- Pastoral Management Pty Ltd;
- Recfishwest;

- SANTOS Limited;
- WA Fishing Industry Council (WAFIC);
- WAMSI;
- Wirrawandi Aboriginal Corporation (WAC); and
- Yaburara and Coastal Mardudhunera Aboriginal Corporation (YACMAC).

## 3.2 STAKEHOLDER ENGAGEMENT PROCESS

Leichhardt has a Consultation Strategy which identifies key external stakeholders and determines how they will be impacted by the Proposal and what influence they have over its implementation. The aim of such extensive consultation is to develop productive relationships that ensure the Proposal is underwritten by sustainable agreements and necessary statutory approvals. The Consultation Strategy has also been developed to secure the approvals necessary for the construction and operation of the Proposal, which will require consultation with the following stakeholders:

- Local Government;
- State Government;
- Commonwealth Government;
- Aboriginal groups with a connection to the Proposal lands; and
- Corporate, industry and community stakeholders.

## 3.3 STAKEHOLDER CONSULTATION

Leichhardt has a Stakeholder Consultation Register which maintains records of all consultations with stakeholders. The Register summarises key issues raised by stakeholders during the consultation process and describes how Leichhardt has responded to those issues. A summarised version of the Stakeholder Consultation Register is provided in Table 3-1, detailing the stakeholder consultation undertaken for the Proposal. Generic discussions with DMAs have not been included in Table 3-1 as per the guidance provided in EPA (2021a).

A Stakeholder Consultation Plan is maintained by Leichhardt. This plan outlines the key stakeholders, type of consultation, purpose of the engagement, issues/subjects to be raised and the timing of those engagements. A summarised version of this plan is provided in Table 3-2, detailing the planned future and ongoing stakeholder consultation relevant to the Proposal and this ERD.

Table 3-1: Stakeholder Consultation Register

| Stakeholder | Date/s | Relevant issues/topics raised | Proponent response/outcome |
|---|---|---|---|
| **Government Stakeholders** | | | |
| Assistant Minister for Regional Development and Territories | Sep 2020 – Teleconference. | • Follow up from November 2019 Canberra meeting with Minister for Regional Development and Territories.<br>• Proposal update and lead agency status. | N/A |
| City of Karratha | • 2016 - Email and Phone.<br>• Jun, Dec 2019 – Meetings.<br>• Jun, Jul, Sep 2020 – At 40-Mile beach, meeting, teleconference.<br>• Jan, Feb, Mar, May, Aug, Sep 2021 – Telephone, emails, meetings, conference/seminar.<br>• Feb, May, Jul, Nov, Dec 2022 – Meetings, presentation.<br>• Apr, Jul 2023 – presentation.<br>• Jan 2025 – Phone. | • Local Government and community engagement.<br>• Recreational areas and access/Proposal interaction.<br>• Proposal overview.<br>• Proposed revegetation programs.<br>• Potential for WAC involvement and engagement.<br>• Drone turtle surveys.<br>• Camp improvements.<br>• Introduction to new City of Karratha Chief Executive Officer<br>• Draft Memorandum of Understandings & Gnoorea Foreshore Management Plan<br>• New pond design, discussion on campground and 40-Mile Beach Road.<br>• 40- Mile road access. | • Engage in ongoing discussions and negotiations.<br>• Strengthen relationship with Shire and community.<br>• Undertake a survey of campers to improve understanding of demographic.<br>• Investigate stakeholder requirements for recreational and creek areas.<br>• Draft a Memorandum of Understanding.<br>• Investigate local opportunities through engaging the City of Karratha. |
| DCCEEW | • Jan, Dec 22 – MS Teams meeting.<br>• May – July 2023- 156A application and approval.<br>• Jun 2024 – MS Teams<br>Ongoing in relation to assessment. | • EPBC Act referral.<br>• Information required from DCCEEW.<br>• ESD.<br>• Section 156A application.<br>• Draft ERD review.<br>• Project timeline discussion.<br>• Offshore dredging spoil disposal, consideration of onshore dredging spoil disposal.<br>• The potential overlap/ interaction between the Sea Dumping Act and EPBC Act | • Leichhardt to provide written response to DCCEEW regarding latest queries.<br>• Continue liaising with DCCEEW during assessment process.<br>• Study on shore dredging spoil disposal options in more detail. |
| DBCA | Jun, Sep, Nov 2020 – Telephone, in person meeting | • Overview of the Proposal. | • DBCA to send data sharing agreement to O2 Marine. |

| Stakeholder | Date/s | Relevant issues/topics raised | Proponent response/outcome |
|---|---|---|---|
| | and MS Teams (PowerPoint presentation) with EPA Services. | • Horseflat conservation area status and guidance.<br>• DBCA marine survey data.<br>• Flora and vegetation.<br>• Conservation significant fauna.<br>• Availability of DBCA dolphin, dugong and turtle data.<br>• Unmanned Aerial Vehicles (UAV) use for turtle monitoring.<br>• Timing for turtle surveys.<br>• Marine data for local impact assessment. | • Investigate validation surveys and determine if they are required for nesting turtles.<br>• Obtain permits for UAV for turtle monitoring.<br>• Provide a letter confirming the Pilbara Leaf-nosed Bat record and evidence that it is not a resident.<br>• Compare Barrow Island SRE samples to mainland samples. Some species may be excluded as SREs based on significant range extensions. |
| DJTSI | • Jan 2018 - 2019 – Meetings.<br>• Jun, Sep, Nov 2020 – Meetings, teleconference.<br>• May, Aug, Nov 2021 – Meetings, site visit.<br>• May, Oct 2022 – Meetings, MS Teams, in-person.<br>• Mar 2023 – Meetings, MS Teams.<br>• Jan, Apr, May, July, Sept, Nov 2023 – MS Teams.<br>• Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct 2024 – MS Teams, meetings.<br>• Jan 2025 – Phone.<br>• Feb 2025 Meeting, in-person. | • General Proposal update.<br>• Proposal approvals.<br>• Guidance on Proposal and port tenure.<br>• MS 949 and MS 1149.<br>• WAC.<br>• Mineralogy General Purpose Lease alternative shipping channel.<br>• Mining Proposal.<br>• Bilateral EPA assessment.<br>• Overview on Santos pipeline, Santos position discussed.<br>• Approvals across a range of sections (EPA, NT, Santos, DEMIRS).<br>• Eramurra site and CPE Port.<br>• Cape Preston East Stage 3 Development Approval.<br>• Maitland Strategic Industrial Area.<br>• Resolution of tenure for the port landslide area.<br>• Discussion on the Port Co concept.<br>• Long term tenure for monitoring bores in the port area. | Leichhardt to apply for a S43A once consensus has been reached with the Leichhardt Board on the key changes to the Proposal as referred. Leichhardt to continue preparing PPA Stage 3 Development Application. |
| DEMIRS | • 2013 –Meetings, phone calls and emails.<br>• Aug, Sep, Oct, Nov 2017 – Emails, phone calls.<br>• May 2018 – Emails and phone calls. | • Proposal update.<br>• Tenement applications.<br>• Tenement technical report.<br>• Tenure acquisition strategy.<br>• Salt production royalty.<br>• MRF rates. | • Ongoing discussions required.<br>• Regional standard heritage agreement required.<br>• Complete the tenement technical report.<br>• Progress towards a mining lease application.<br>• Consider submission of the Proposal for State Significance. |

| Stakeholder | Date/s | Relevant issues/topics raised | Proponent response/outcome |
|---|---|---|---|
| | • Jan, May, Jun, Nov 2019 – Emails and meeting.<br>• Apr, May, Jun 2020 – Emails, meeting.<br>• Jan 2021 – MS Teams meeting. | • Wardens Court Matters.<br>• Mining title and forfeiture matters.<br>• Statistics yearbook pricing of salt.<br>• Alternative pricing structure.<br>• Advice and contents of operational report.<br>• Mineralisation report versus MP/MCP as the support mechanism.<br>• Native Title and heritage.<br>• Safety approvals.<br>• Regional mining registrar - Impact of conservation area on exploration tenure.<br>• Information requirements and limitations for MP/MCP preparation.<br>• Environmental setting and approvals.<br>• MP/MCP information issues.<br>• Risk assessment. | • Provide timeline including funding and EPA process and how Proposal is progressing. |
| Department of Primary Industry and regional Development (DPIRD) | Jul 2022 – Meeting. | • Fish and Fisheries Desktop Report.<br>• Report Structure.<br>• Current work to date.<br>• Key findings.<br>• Stakeholder engagement.<br>• Guidance and feedback.<br>• Plan for review of the draft report. | • Recommended O2 Marine contact Recfishwest for recreational fishing data.<br>• Ongoing consultation recommended, particularly regarding impact assessment. |
| DoT | • Mar 2019 – Meeting.<br>• Apr 2020 – Meeting.<br>• Apr, May 2022 – Meetings with PPA and Oropesa.<br>• Jul 2023– Meeting.<br>• May, Sep, Oct 2024 – Phone.<br>• Jan 2025 – Phone | • Shipping and pilotage.<br>• Pylon platform shipping/loading concept.<br>• Related shipping deconfliction issues.<br>• Best configuration of transhipping operations.<br>• Shipping deconfliction at the new port.<br>• Trestle jetty shipping operation.<br>• Logic for proposed realignment of CPE port boundary.<br>• Port declarations, tenure and licenses. | • Ongoing discussions required.<br>• Formal acceptance of proposed CPE boundary realignment.<br>• CITIC mooring to be relocated. |

| Stakeholder | Date/s | Relevant issues/topics raised | Proponent response/outcome |
|---|---|---|---|
| EPA Services (DWER) | • Nov 2018 – Meeting.<br>• Mar 2020 – Meeting.<br>• May 2020 – Teleconference.<br>• Sep 2020 – In person meeting and MS Teams (PowerPoint presentation) with DBCA.<br>• Nov 2020 – MS Teams meeting and PowerPoint.<br>• Apr, Nov 2021 –Meetings.<br>• Jun 2021 – Meeting.<br>• 22 Sep 2021- ESD Rev A<br>• Nov 2021 – Meeting<br>• Feb 2022 – Telephone.<br>• 14 Mar 2022 – ESD Rev B.<br>• 30 Aug 2022 – ESD Rev C.<br>• 27 Oct 2022 – ESD Rev D.<br>• 30 Nov 2022 – ESD Rev E.<br>• May – Jun 2023 – S43A application and approval.<br>• Aug 2023 – MS Teams.<br>• Jan 2025 – MS Teams. | • Company and Proposal overview.<br>• Next steps in assessment process.<br>• Stakeholder engagement.<br>• Infrastructure changes.<br>• Design review and changes to the development envelopes.<br>• Approvals pathways were presented and reviewed.<br>• Cumulative effect (inland water, BCH, marine environment).<br>• Consultation with key stakeholders (WAMSI, WAFIC etc.).<br>• Legislation changes (impact to ESD, need to be clear outcomes).<br>• DBCA marine survey data.<br>• Flora and vegetation.<br>• Conservation significant fauna.<br>• Referral of Proposal.<br>• Proposal update.<br>• Cumulative effect (inland water, BCH, marine environment).<br>• Consultation with key stakeholders (WAMSI, WAFIC etc.).<br>• Legislation changes.<br>• Comments on draft ESD.<br>• Status of EPBC Act referral.<br>• Submission and approval of ESD.<br>• S43A application.<br>• Draft ERD review.<br>• ERD Feedback.<br>• Mardie Offsets and the introduction of that information into the Proposal EIA Process. | • Expand stakeholder engagement to include all DMAs.<br>• Complete all baseline surveys.<br>• EPA to assess whether dredging and brine discharge can be included in MS 949.<br>• Maintain focus on heritage.<br>• DWER to email DEMIRS ESD comments.<br>• Continue liaison during assessment process.<br>• EPA Services agreed the SCHMP will not be a public document.<br>• Leichhardt to consider the request for management plans in the context of the process implications of providing later.<br>• ERD progress will not be affected by the delay in the Mardie offset studies as relevant information can be captured in the response to public comments. |
| Federal Minister for Finance | Aug 2020 – Meeting. | Overall Proposal update/briefing. | N/A |
| Minister for Housing | Apr 2023 - Meeting | Housing in Karratha | N/A |

| Stakeholder | Date/s | Relevant issues/topics raised | Proponent response/outcome |
|---|---|---|---|
| Minister for Mines and Petroleum, Energy and Industrial Relations. | • Jun 2020 – Meeting.<br>• Aug 2020 – Letter.<br>• Sep 2020 – Formal event.<br>• Oct 2021 – Meeting. | • Mining lease application process (Section 74) for solar salt projects while under pending approval under Part IV of the EP Act.<br>• Legal advice regarding the application of Section 74 of the Mining Act and Part IV of the EP Act.<br>• Fundraiser boardroom dinner for member for Pilbara.<br>• Open discussion on Proposal.<br>• Surrender of exploration tenure. | • Leichhardt and BCI Minerals Ltd to provide advice on Section 74 application to the Minister for review by DEMIRS and the state solicitor's office. |
| Minister for Regional Development | Sep 2019 – Meeting. | Discuss port and infrastructure access. | Develop and submit Proposal definition document to DJTSI. |
| Minister for the Environment (State) | • Jul 2020 – Meeting.<br>• Apr 2023 - Meeting | • General project update.<br>• Bilateral assessment.<br>• Conditional approval.<br>• ERD submission date. | Follow up meeting to be scheduled for Q3 2023 |
| Minister Price (Member of Durack) | Sep 2020 – Teleconference. | • General Proposal update.<br>• Lead agency informed. | N/A |
| Northern Australia Infrastructure Fund | • May, Aug 2020 – Meetings.<br>• May 2021 – Meeting.<br>• Mar 2022 – Meeting. | • Indigenous engagement.<br>• Northern Australia Infrastructure Fund funding of CPE port infrastructure.<br>• Project schedule and timing of funding Proposal.<br>• Commonwealth consultation with all interested Commonwealth Departments.<br>• Off take agreement.<br>• Production commitment.<br>• WA Government contact. | N/A |
| PPA | • 2015-2018 – Meetings, phone calls, emails.<br>• Dec 2019 – Phone call, email.<br>• May, Jul, Oct 2020 – Meetings. | • Port approvals.<br>• Non confliction with competing port users and applications to be foundation proponent at CPE Port.<br>• Biological surveys.<br>• New layout plan. | • Ongoing discussions required.<br>• Advise PPA of the channel from CPE to OGVs.<br>• Leichhardt to obtain investigation licence. |

| Stakeholder | Date/s | Relevant issues/topics raised | Proponent response/outcome |
|---|---|---|---|
| | • Mar, Apr, May, Jun, Jul 2021 – Site Visit, Meetings, Presentation.<br>• Mar, Apr, May 2022 – Teams Meeting, Workshop, Meeting.<br>• Apr, May 2022 – Meetings with DoT and Oropesa.<br>• Oct, Nov 2022 – Meeting with Dampier Technical Advisory and Consultative Committee (TACC) Chair, TACC presentation.<br>• Jan, Feb, Mar, Sept 2023 – Meeting.<br>• May 2023 – Attended and presented at Ashburton Technical Advisory and Consultative Committee (TACC)<br>• Nov 2023 – MS Teams, Ashburton TACC.<br>• Jan, Mar, May, Jun, Aug, Sep, Nov 2024- Meeting and Teleconference.<br>• Jan 2025 – Phone. | • Port access and shipping.<br>• Alternative transhipping route from CPE Port.<br>• Road access to Port areas.<br>• Site visit.<br>• Draft development approval submission.<br>• Extent of submission, topics covered.<br>• Dredging and port development.<br>• Stage 3 development approval.<br>• PowerPoint presentation for briefing PPA personnel in Dampier late June.<br>• Proposed anchorage locations.<br>• Proposed changes to port marine boundaries.<br>• Logic for proposed realignment of CPE port boundary.<br>• Formal acceptance of proposed CPE boundary realignment.<br>• Dredging.<br>• Project update.<br>• Cape Preston boundary discussions.<br>• Development Application Summary.<br>• Government strategy.<br>• PPA Resources.<br>• Capital costs.<br>• Tenure and Licences discussed.<br>• Introduction of the Port Co concept to the State.<br>• Port operational matters<br>• Ashburton TACC.<br>• Long term tenure for monitoring bores in the port area. | • Proceed with stage 3 development application without the marine boundary between Cape Preston/CPE being resolved.<br>• Causeway to be removed from layouts.<br>• Leichhardt to define short-term and ultimate plans.<br>• Proposed new OGV anchorage coordinates to be submitted for ratification.<br>• Stockpile to be located behind sand dune.<br>• Add separate access to jetty, explain third party access in development approval.<br>• CITIC mooring to be relocated, minor impact.<br>• PPA to discuss a path forward on what can and cannot be committed to.<br>• Leichhardt to provide the dredging plan once finalised for environmental approvals. |
| Regional Development Australia Pilbara | Sep 2020 – Meeting.<br>Feb 2023 - Meeting | • Proposal update and follow-ups from November 2019 Canberra meetings.<br>• Regulatory barriers to development.<br>• Housing for employees<br>• Future land releases in the Pilbara | • Ongoing discussions required.<br>• Schedule a meeting for the next Proposal milestone. |

| Stakeholder | Date/s | Relevant issues/topics raised | Proponent response/outcome |
|---|---|---|---|
| **Community and Corporate Stakeholders** | | | |
| CITIC Pacific Mining (Local miner) | • Aug 2015-May 2020 – Emails, phone calls.<br>• Sep 2020 – Teleconference.<br>• Oct 2024 – Phone. | • Proposal updates.<br>• Access agreement and legal negotiations. | • Ongoing discussions required.<br>• Leichhardt to provide a detailed description of Proposal disturbance underlying Mardie pastoral lease. |
| ECU | • Jun 2020 – Meeting.<br>• Sep 2020 – Meeting. | • Shorebird conservation and research program at 40-Mile Beach.<br>• Outcome of the research program.<br>• Indigenous involvement.<br>• Development of a proposal for birds.<br>• Habitat creation with the pond group. | • Ongoing discussions required.<br>• ECU to provide a proposal. |
| Hampton Harbour Boat and Sailing Club | Jun 2020 – Meeting. | • Proposal Overview.<br>• Informing the 40-Mile Beach recreation boat ramp users of Leichhardt plans for the area.<br>• Aspects of importance to local recreational users. | • Investigate stakeholder requirements for recreational area.<br>• Leichhardt to develop a Proposal overview to be distributed to the member base. |
| Karratha & Districts Chamber of Commerce and Industry | May 2023 – Leichhardt hosted event | • Update on the Proposal.<br>• Update on community opportunities.<br>• Update on L community support. | N/A |
| King Bay Game Fishing Club | • Sep 2020 – Teleconference and Meeting. | Community support program. | Organise a meeting in Karratha. |
| Local/broader community (Media Release) | • Mar, Jun, Sep 2020 – Website, newspaper, Project briefing paper, media release.<br>• Jun 2022 – General media release. | • Community access/involvement with consultation for the Proposal.<br>• Website for job opportunities and interaction with the Proposal team.<br>• Proposal advertisement. | Ongoing community engagement required. |
| Nickol Bay Sport Fishing Club | Oct 2020 – Meeting. | Community support program. | Nickol Bay Sport Fishing Club provide details of club membership and levels of sponsorship expected. |

| Stakeholder | Date/s | Relevant issues/topics raised | Proponent response/outcome |
|---|---|---|---|
| Recfishwest | • Oct 2022 – Meeting.<br>• Feb 2023 – Teleconference.<br>• May, Aug 2023 – Information sheet | • Introduction and project briefing.<br>• Project update and feedback.<br>• ERD submission.<br>• Feeback on FAQ.<br>• Recreational fishing species of interest.<br>• Information from ERD that would interest constituents for summary pack. | • Establish quarterly meetings.<br>• Send revised pond layout and FAQ questions for review.<br>• Interested in cumulative impacts.<br>• Estuarine and nearshore fish of interest.<br>• Interested in areas impacted by dredging and bitterns discharge and how it will affect fish abundance – infographics. |
| Santos | • Jan, Jul, Sep, Dec 2020 – Meetings, teleconferences.<br>• Jan, Feb, May, Jun, Aug, Oct, Nov 2021 – Meetings, telephone calls.<br>• Apr, Oct, Dec 2022 – Teams meeting, meeting.<br>• Dec 2022 – Meeting.<br>• Jan, March, Apr, May, Jun 2023 – Teams meeting, meeting | • Land use and energy requirements.<br>• Interaction with the pipeline.<br>• Revised general design.<br>• Groundwater monitoring system at the Devil Creek Facility.<br>• Proposal overview.<br>• Data availability.<br>• Schedule and timelines for technical and commercial process.<br>• Feedback on the draft negotiation framework.<br>• Borehole Project overview.<br>• Exclusion zone and affected areas.<br>• Update on geothermal licences.<br>• Pipeline access agreement. | • Further consultation on pipeline issue required.<br>• Consider technical requirements for the crossing.<br>• Principle agreement on the process to crossing agreement required.<br>• Leichhardt to formally notify/seek permission prior to works activity in the vicinity of the pipeline. |
| WAFIC | • Mar, Dec 2021 – Meeting and email.<br>• Mar, Jun and Jul 2022 – Meetings.<br>• Oct 2023 - Meeting | • Overview of the Proposal.<br>• Update on the approvals process.<br>• Engagement with commercial fishing sector.<br>• Proposal Schedule.<br>• Consultation with key stakeholders.<br>• Response to fee-for-service information.<br>• Feedback on scope of work for fisheries consultation and potential providers.<br>• Key issues of the Proposal.<br>• Cumulative and incremental impacts.<br>• Fish and Fisheries Desktop Report. | • Leichhardt to include aquatic resources and habits and cumulative impacts in scope of work.<br>• WAFIC to provide comments on the scope of work and contact details for DPIRD researchers.<br>• Leichhardt and WAFIC keep in contact and work together.<br>• Recommended O2 Marine contact Recfishwest for recreational fishing data.<br>• Further consultation required, particularly regarding impact assessment. |

| Stakeholder | Date/s | Relevant issues/topics raised | Proponent response/outcome |
|---|---|---|---|
| | | • Key findings, guidance and feedback.<br>• Changes to the Proposal.<br>• Engagement process with other proponents.<br>• Current timeline.<br>• Future engagement. | |
| WAMSI | • Feb 2022 – Teams meeting.<br>• Jul, Aug 2023 – Meeting<br>• Jan 2025 – Meeting. | • Overview of the Proposal.<br>• Remote-sensing and GIS work on BCH cumulative and regional impacts in the context of the Mardie Project offsets.<br>• Addressing cumulative and regional impacts for the Proposal.<br>• Existing protocols and procedures around BCH remote-sensing and GIS work on cumulative and regional impacts.<br>• Informal discussion regarding research program funding.<br>• Commercial aspects of data provision.<br>• Mardie offset research projects. | • Agreement on the process for the provision of the LiDAR data. |
| WAC | • 2018 - Email and phone.<br>• Feb 2019 – Meeting.<br>• Apr 2019 – Meeting with YACMAC.<br>• Jun 2020 – Meeting.<br>• May, Sep, Oct, Nov, Dec 2021 – Heritage surveys, meeting, sundowner.<br>• Apr, May, Jun, Jul, Sept and Oct 2022 – Ethnobotanical Reconnaissance site visit, Social Cultural Heritage Management Plan.<br>• Jan, Feb, May, Jul, Sept, Oct, Nov 2023 – Meeting<br>• Feb, Jun, Oct, Nov, Dec 2024 - Meeting and phone.<br>• Feb, Mar 2025 – Meeting. | • Native Title Agreement.<br>• Meeting at 40-Mile Beach.<br>• Proposal update.<br>• Layout flexibility.<br>• Heritage surveys.<br>• Ethnobotanical areas of interest.<br>• Heritage agreement and negotiation protocol.<br>• Visual impacts.<br>• Access restrictions.<br>• Devil Creek Accommodation.<br>• The Voice.<br>• Investigation licenses.<br>• Engagement re further ethnobotanical studies and organising native title authorisation meeting of WAC membership | • Ongoing negotiations and discussions required.<br>• Progress towards Native Title Agreement.<br>• Follow up on Heritage agreement delays.<br>• Conduct regular on country visits with WAC members.<br>• Conduct regular workshops in Karratha office.<br>• Further ethnobotanical surveys to be arranged. |

| Stakeholder | Date/s | Relevant issues/topics raised | Proponent response/outcome |
|---|---|---|---|
| YACMAC | • May 2018 – Meeting.<br>• Jan, Feb, Apr 2019 – Emails, phone call, meetings and meeting with WAC. | • Native Title negotiation and completion of Heritage Agreement.<br>• Informal Board meeting.<br>• Proposal overview.<br>• Meeting at 40-Mile Beach. | • Ongoing negotiations.<br>• Progress towards completion of Heritage Agreement.<br>• Progress towards Native Title Agreement. |

**Table 3-2: Stakeholder Consultation Plan**

| Stakeholder | Type | Purpose of planned engagement | Issues to be raised |
|---|---|---|---|
| City of Karratha | Letters and meetings | Letter summarising the Proposal status (i.e., approvals to date and path forward).<br>Meetings to agree City of Karratha support for establishment of a public road to access the Proposal. | • Approvals required for the City (e.g., building).<br>• Approvals required to support the gazetting of Mardie Road.<br>• Future applications.<br>• Path forward for the Proposal.<br>• Ongoing support of 40-Mile camping and recreational area. |
| CITIC Pacific Mining | Emails, phones calls, meetings | Correspondence summarising the Proposal status and timing on pathway forward. | • Proposal summary, status, timing.<br>• Invitation for comment.<br>• Tenement applications. |
| DBCA | Telephone, email and meetings | Correspondence to obtain approval under the EP Act.<br>Ongoing monitoring data.<br>Potential input to offset programs | • Potential impacts to species listed under BC Act or by DBCA.<br>• Additional information requirements.<br>• Approval conditions.<br>• Management Plans.<br>• Ongoing monitoring of Migratory birds.<br>• Offsets. |
| DCCEEW | Telephone, email and meetings | Correspondence to obtain approval under the EPBC Act. | • Potential impacts to MNES.<br>• Additional information requirements.<br>• Approval conditions.<br>• Management Plans.<br>• Ongoing monitoring of Migratory birds.<br>• Offsets. |

| Stakeholder | Type | Purpose of planned engagement | Issues to be raised |
|---|---|---|---|
| DEMIRS | Telephone, email and meetings | Correspondence to obtain grant of mining tenements and approval of Programme of Works (PoWs), MP and MCP.<br>Agreement on salt royalty rates. | • Tenement applications.<br>• MP and MCP assessment.<br>• Timing.<br>• Proposal specific requirements.<br>• Closure requirements.<br>• Salt royalty rates. |
| DPIRD | Letters and meetings | Correspondence to ensure Proposal has minimal impacts on commercial and recreational fishing. | • Proposal summary, status, timing.<br>• Invitation for comment/discussion.<br>• Proposal operations to minimise impacts. |
| DWER (Industry Regulation) | Telephone, email and meetings | Correspondence to obtain works approvals under Part V of the EP Act. | • Future Works Approvals and Licence requirements (concentration ponds and crystallisers, bulk material export, landfill etc.).<br>• Proposal timing (i.e., construction).<br>• Potential environmental impacts. |
| DWER - EPA Services | Telephone, email and meetings | • Correspondence to obtain approval under Part IV of the EP Act.<br>• EPA Board meeting. | • Minor or Preliminary Works approval (if required).<br>• Mangrove Management Area.<br>• Review of draft ERD.<br>• Response to public comments.<br>• Draft conditions.<br>• EPA Board meeting. |
| Main Roads WA | Letter | Letter summarising the Proposal status and future planning. | • Future applications.<br>• Site access.<br>• Timing (i.e., construction and operation).<br>• Operating hours.<br>• Site access/routes. |
| Mardie Station | Ongoing meetings and formal access agreement | • Correspondence summarising the Proposal status and timing on pathway forward.<br>• Formal access agreement. | • Proposal summary, status, timing.<br>• Invitation for comment.<br>• Tenement applications.<br>• Access agreement. |
| PPA and Dampier Technical Advisory and Consultative Committee | Letters and meetings | Correspondence to: negotiate terms of port leases; gain port Development and Construction Application approvals and | • Future applications.<br>• Export options.<br>• Path forward for the Proposal.<br>• Ongoing management of dredging and dumping activities. |

| Stakeholder | Type | Purpose of planned engagement | Issues to be raised |
|---|---|---|---|
| | | support the Taking of the Lands required for the Port. | |
| Relevant Ministers | Letters and meetings | Letter summarising the Proposal status (i.e. approvals to date and path forward). | • Approvals and tenure status.<br>• Future applications.<br>• Studies undertaken.<br>• Key findings.<br>• Path forward for the Proposal. |
| Santos | Phone calls and meetings | Correspondence summarising the Proposal status and timing on pathway forward. | • Proposal summary, status, timeline.<br>• Notify/seek permission prior to works in vicinity. |
| WAC and YACMAC | Letter, copies of draft approval documents and meetings | Correspondence summarising feedback on Proposal design and ongoing negotiations regarding Native Title agreement. | • Approvals to date.<br>• Future applications.<br>• Studies undertaken and key findings.<br>• Path forward for the Proposal.<br>• Potential for Indigenous contracting and employment opportunities.<br>• Bush tucker/bush medicine management. |
| WAFIC | Letters and meetings | Correspondence to ensure Proposal minimises impacts on commercial fishing. | • Proposal summary, status, timing.<br>• Invitation for comment/discussion.<br>• Proposal operations to minimise impacts. |
| RecFishWest | Letters and meetings | Correspondence to ensure Proposal minimises impacts on recreational fishing. | • Proposal summary, status, timing.<br>• Invitation for comment/discussion.<br>• Proposal operations to minimise impacts. |

# 4 DESIGN REVIEWS

## 4.1 DO NOTHING APPROACH TO THE PROPOSAL

Leichhardt has conducted a review of the current salt markets, utilising leading industry market research reports and market enquiries. It was identified that the salt market has a positive long-term outlook. Strong demand for salt, driven by the growing industrial and chemical sectors, is forecast to result in a supply gap emerging over the next decade.

Based on this outlook, Leichhardt predicts a strong demand for its salt products. The 'do nothing' approach to the Proposal represents a lost commercial opportunity to Leichhardt, the Pilbara region and the State.

## 4.2 ALTERNATIVE LOCATIONS AND DESIGNS CONSIDERED

Solar salt projects are intrinsically linked to the area available for pond evaporation; the larger the area, the greater the salt production capacity. Other constraints are then incorporated into the pond design as study information progresses during the investigation stage. The following sections describe the design iterations that have occurred as more environmental, commercial, social and engineering information was gathered during the investigation phase of the Proposal.

### 4.2.1 2018 DESIGN AND SECTION 38 REFERRAL

A previous iteration of the Proposal (the 'Eramurra Industrial Salt Project') was referred under Section 38 of the EP Act in December 2018 (Figure 4-1). That Proposal represented a design based on several commercial, environmental and social constraints, such as a lack of port access, avoidance of coastal areas (including 40-Mile Beach), while keeping options available for access and seawater intake locations.

As the Proposal design progressed it became evident that the scope of the Proposal was becoming significantly different from what was referred in December 2018. A decision was made to terminate the assessment in August 2021 and refer the current Proposal in its place.

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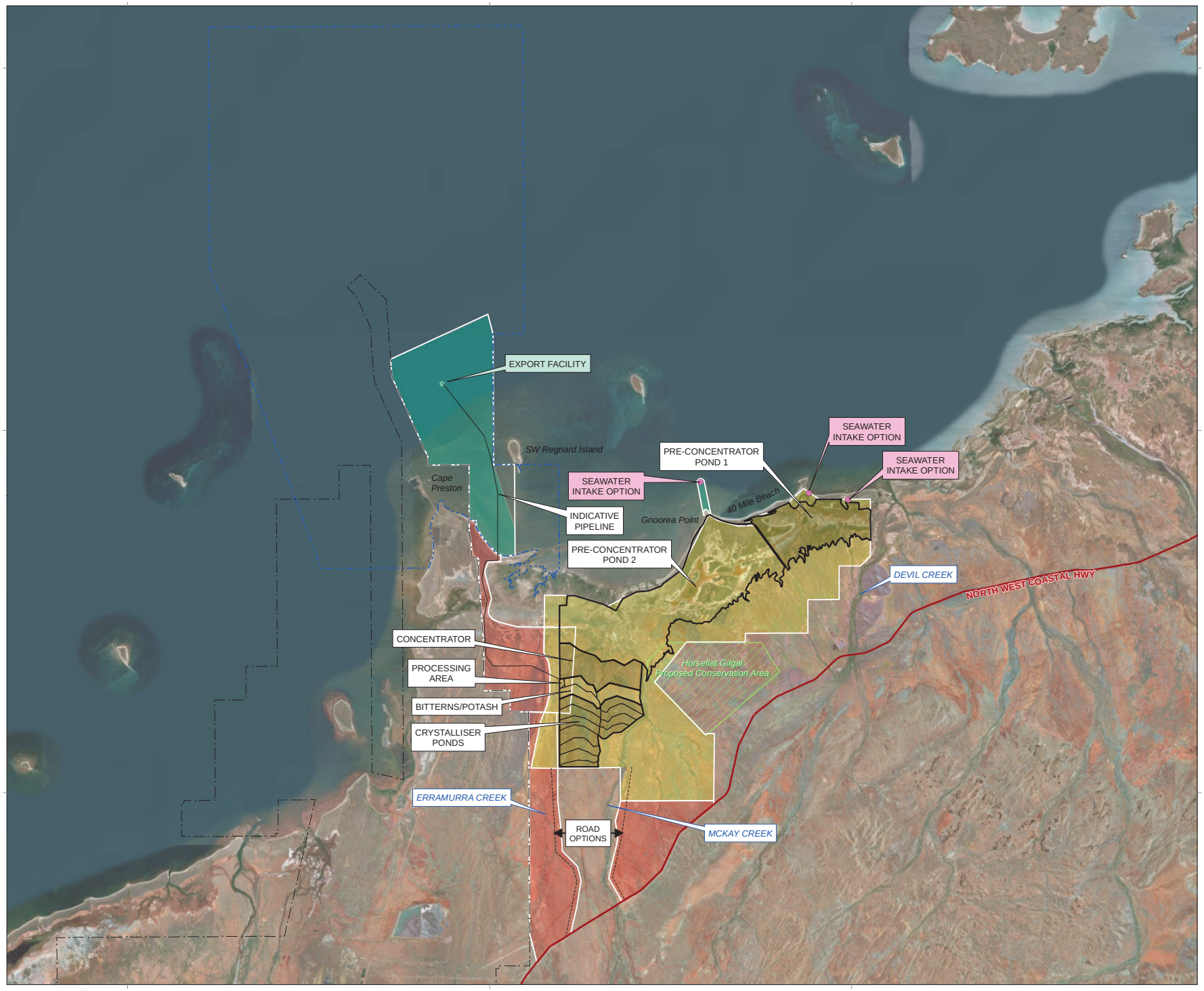


**Legend**

- State Agreement Act Area
- DoT Pilotage & Shipping
- Export Facilities Options
- Seawater Intake Options
- Infrastructure (Indicative)
- Proposed Conservation Area

Development Envelopes

- Marine Development Envelope
- Corridor Development Envelope
- Pond Development Envelope

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- CADASTRE SOURCED LANDGATE 2016
- LOCALITY MAP SOURCED LANDGATE 2006
- AERIAL PHOTOGRAPHY SOURCED ESRI WORLD IMAGERY

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0 2.5 5 7.5 10
Kilometers
Scale: 1:200,000 @ A3

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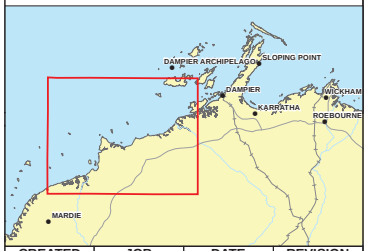
**LOCALITY MAP**




| CREATED | JOB | DATE | REVISION |
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| ENVIRONMAPS | EISP | 4/12/2018 | 0 |

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Environmental Mapping Solutions

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**Figure 4-1: 2018 design of the Proposal**

### 4.2.2 2021 Design

The '2021 Design' of the Proposal commenced with the largest possible pond footprint, but with the consideration of the following initial constraints (Figure 4-2):

- Utilisation of the approved CPE Port infrastructure, removing the requirement for separate stand-alone export infrastructure;
- Relocation of ponds to reduce impacts to mangrove habitat. The concentration ponds and crystallisers could have been located closer to the coast, in order to maximise the use of existing topography and minimise wall length and heights. Initial desktop surveys identified areas of high ecological value due to the presence of mangrove habitats. The ponds and subsequent development envelope were then aligned to exclude the majority of these higher value habitat areas;
- Avoidance of impacts to camping and recreational areas at 40-Mile Beach. This area was noted as being of high value for recreational users and avoidance of all accessible areas was a key constraint factored into the initial design; and
- The basis of this design involved concentration of brine to SG 1.25 at which point around 77% of the sodium chloride has been removed from the concentrated seawater. This design represented bitterns discharge of up to 12 GLpa at salinity near 330 ppt.

This design pre-dated the collection of detailed environmental, Aboriginal Heritage and social data and therefore many of the associated constraints were not incorporated into the design at this stage.

### 4.2.3 2022 Design Review

During the study phase the boundaries of constraints and the presence of new constraints became more evident, requiring further refinement of the Proposal design. Completion of the environmental studies indicated that the footprint intersected some significant environmental and Aboriginal Heritage values. As a result, Leichhardt reviewed the footprint and proposed a new layout, the '2022 Design' (Figure 4-3). The key changes to the layout included:

- Refinement of the seawater intake location and design;
- Maintenance of the McKay Creek primary drainage line by excluding it from the pond footprint to maintain the overall hydrological regime of the drainage catchment;
- Additional concentration of the bitterns to SG 1.29 to recover 88% of the sodium chloride from concentrated seawater prior to discharge, yielding a reduction in bitterns discharge to 8 GLpa discharge (undiluted) at near 410 ppt salinity;
- Removal of groundwater abstraction from the scope of the Proposal. Water supply will be sourced from internal desalination or external water source; and
- Additional dilution of bitterns. Leichhardt incorporated a seawater intake along the jetty to allow seawater to be abstracted and used for the dilution of the bitterns before discharge.

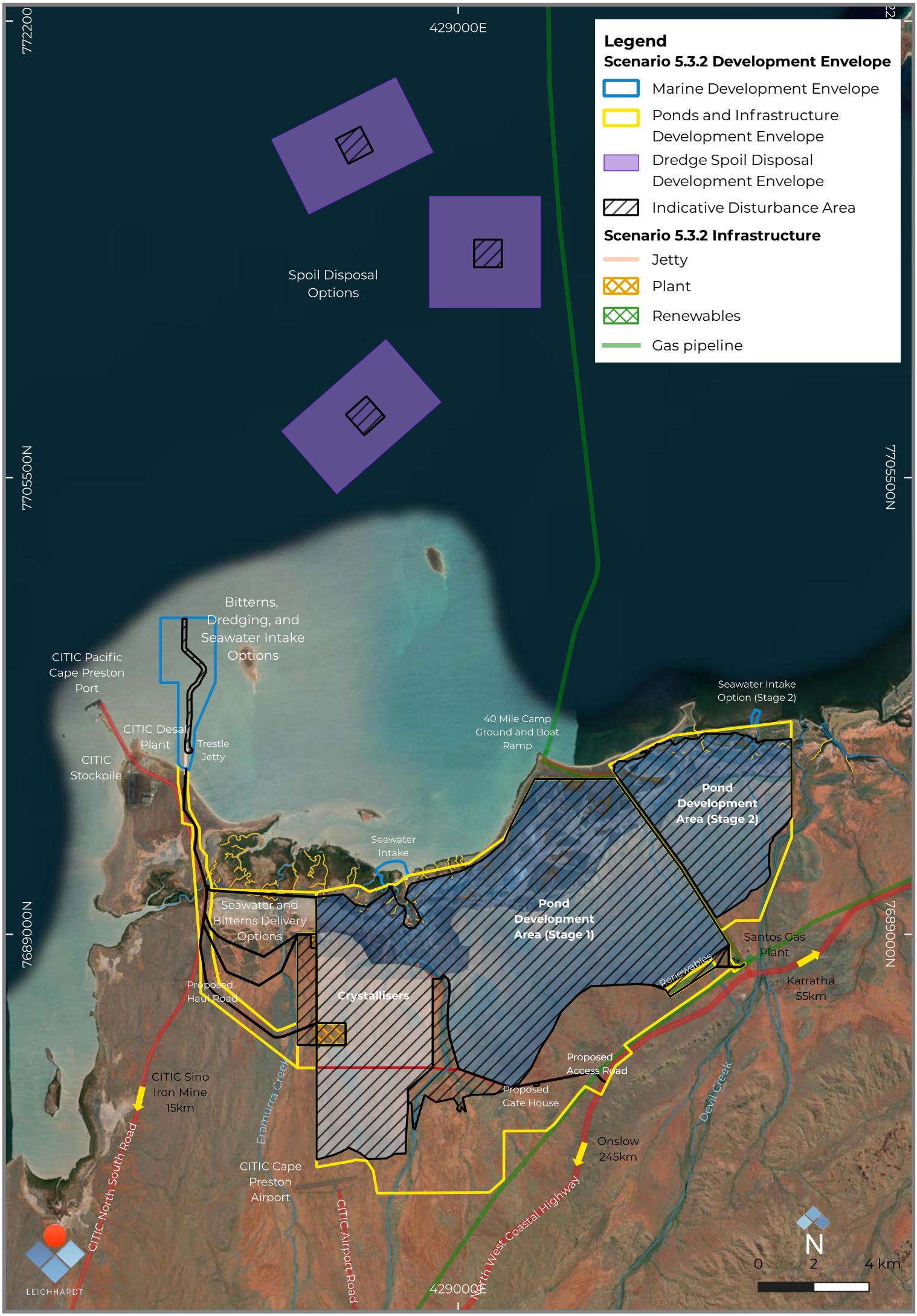
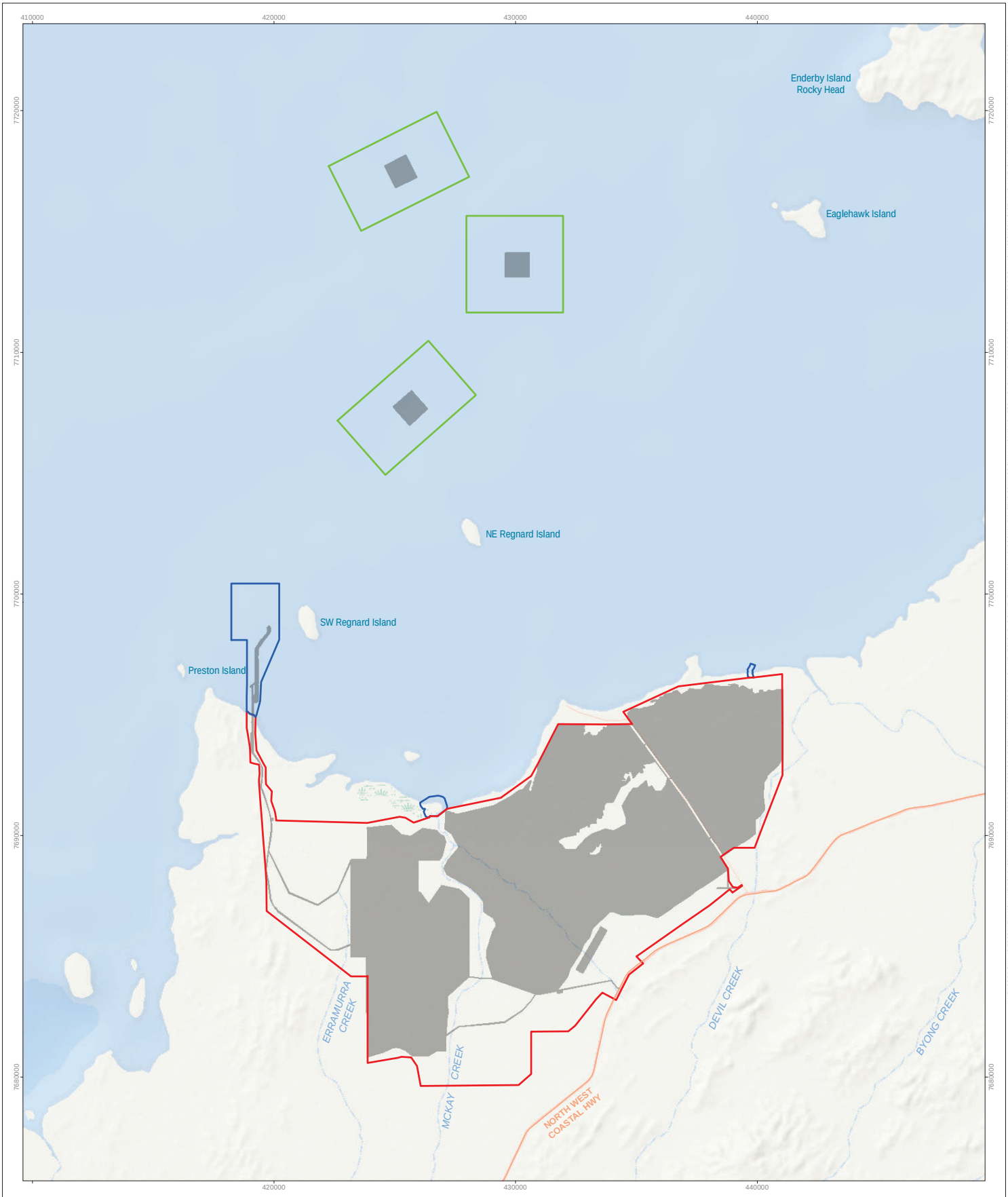



Figure 4-2: Proposal design as referred in August 2021 (Original Indicative Disturbance Footprint)

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**Leichhardt Salt Pty Ltd**

0 1.25 2.5 5 km

Scale: 1:150,000 @ A3

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- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

**LOCALITY**




Legend

- Marine Development Envelope
- Ponds and Infrastructure Development Envelope
- Dredge Spoil Disposal Development Envelope
- Indicative Disturbance Area

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**Figure 4-3: 2022 Proposal design**

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### 4.2.4 2023 Detailed Environmental Constraints Design Review

***Outcomes of 2022 Environmental Impact Assessment***

A detailed EIA was undertaken in the second half of 2022, based on the 2022 Design (Figure 4-3) described in Section 1.2.1 with an intention to submit a draft ERD in December 2022. The assessment identified that despite the design changes already made, the 2022 Design could still result in significant impacts to intertidal BCH, Priority Ecological Communities (PECs) and migratory shorebird habitat (overlaps with intertidal BCH). This was primarily a result of direct disturbance associated with clearing and construction of ponds and seawater intakes. There were also potential indirect impacts associated with groundwater mounding and increased salinity. The environmental values with significant impacts were identified as being:

- PECs, disturbance of up to:
    - 7,247 ha (61% of local extent) of the Horseflat Land System of the Roebourne Plains' (Priority 3; Horseflat PEC);
    - 118 ha (39% of local extent) of the local extent of the Coastal dune native tussock grassland dominated by *Whiteochloa airoides* (Priority 3; Coastal Dune PEC);
- Intertidal BCH (and Migratory shorebird habitat), disturbance of up to:
    - 39.9 ha (21% of local extent) of mangrove habitat;
    - 1,538 ha (57% of local extent) of algal mats;
    - 695 ha (51% of local extent) of samphire shrublands;
- Disturbance of Aboriginal Heritage sites.

An assessment was undertaken to review the scale and significance of these impacts and determine whether the EPA's objectives could be met with the 2022 Design. This assessment determined that:

1. The proportional scales of some impacts were high;
2. There was uncertainty that the scale of impacts would have on the nearshore and broader marine environment; and
3. There was significant uncertainty about the contribution of algal mats in the nearshore environment, therefore the impacts of the loss of a high proportion of algal mats could not be quantified.

Based on this, Leichhardt commissioned a further detailed review of the Proposal design, with a key focus on reducing impacts on the environmental and Aboriginal Heritage values above.

***Design Workshop 1***

Two design workshops were held in order to review the Proposal design and develop a strategy for the development of a new design that had lower environmental and Aboriginal Heritage impacts. The first workshop was held on 18 January 2023 and included specialists from a range of fields including marine scientists, ecologists, EIA specialists, engineering, approvals and heritage. The aim of the first workshop was to identify the key issues and develop clear criteria for the design of a viable Proposal.

One of the key issues identified was that the most environmentally valuable areas in the northernmost section of the PIDE were unfortunately also the least capital-intensive to construct (higher value economically). After some discussion, the following steps were agreed:

1. A multi-criteria analysis (MCA) will be undertaken that incorporated key environmental, Aboriginal Heritage and commercial criteria;

2. Leichhardt would use the findings of the MCA to prepare an updated Proposal design; and
3. Leichhardt would prepare an updated financial evaluation based on the new layout.

The MCA was developed based on the outcomes of the workshop and applied different weightings to different criteria. From an environmental perspective the weightings were grouped by values:

1. Very High – mangroves;
2. High – PECs, corals, medium to high productivity algal mats; coastal samphire communities, areas of higher migratory shorebird usage; and
3. Moderate – Low productivity algal mats; inland samphire communities, locally significant vegetation, priority flora, areas of low migratory shorebird usage.

The MCA was then used to determine which pond layout had the best outcome, taking into account environmental, Aboriginal Heritage, social, economic and schedule factors. This was key tool in determining four Proposal design options for a second workshop on 8 February 2023 to select the preferred option to take forward.

An economic evaluation was undertaken which determined that further modifications were needed to ensure the Proposal would be economically viable. As a result, Leichhardt developed a fifth development option which involved moving the ponds further south in a way that minimised additional environmental impacts and also maintained economic viability of the Project. This new design represented the pond layout presented in the July 2023 Draft ERD as the most conservative design option (2023 Revised Indicative Disturbance Footprint; Figure 4-4). The design significantly reduced the area of the ponds and relocated the pond walls further south in some areas as outlined in Figure 4-4.

***Q4 2023 Design Refinements - Current Indicative Footprint***

Following submission of the ERD in July 2023, Leichhardt completed a further revision to the Indicative Disturbance Footprint as a result of ongoing consultation with the City of Karratha and additional planning outcomes. This consultation and planning resulted in the following positive environmental outcomes:

- **Avoidance of Crown Reserve 46588** due to a reduction in the area for the concentration ponds;
- **Avoidance of potential habitat for the Northern Quoll (no longer identified as habitat based on recent monitoring data)** as a result of the reduction and realignment of the seepage drain along 40-Mile Beach Rd (Figure 4-8); and
- **Relocation of the landfill** to avoid risks associated with flooding from surface water drainage.

***Environmental Outcomes of the 2023 Design Changes***

Numerous positive environmental outcomes resulted from these design changes, including:

- **Significant reduction in impacts to mangrove habitat**, 31.6 ha (79.2%) reduction in impacts to mangroves from 39.9 ha to 8.3 ha (Figure 4-5);
- **Significant reduction in impacts to algal mats**, 927.0 ha (60.2%) reduction in impacts to algal mats from 1,538.0 ha to 611.0 (only 87.3 of which is high density algal mat (HDAM) ha (Figure 4-6), with a focus on the avoidance of higher productivity algal mats (refer to Section 6 for more detail);
- **Reduction in indirect impacts to BCH from tidal inundation, coastal processes, sea level rise and groundwater seepage / mounding.** Relocating the ponds further south

has maintained more coastal habitat and increased distances between ponds and BCH values;

- **Avoidance of Coastal Dune PEC,** the new pond layout has allowed Leichhardt to completely avoid the Coastal Dune PEC (Figure 4-7);
- **Reduced bitterns discharge volume,** process improvements have reduced the amount of bitterns being discharged from 8 GLpa to 5.9 GLpa (26% reduction);
- **Heritage exclusion area,** heritage values identified within the PIDE have been excluded from the pond layout, significantly reducing disturbance to Aboriginal Heritage values; and
- **Reduction in visual amenity, light, dust and noise impacts,** relocating the ponds further south has reduced the indirect impacts of the Proposal on Gnoorea Point campground and migratory birds.

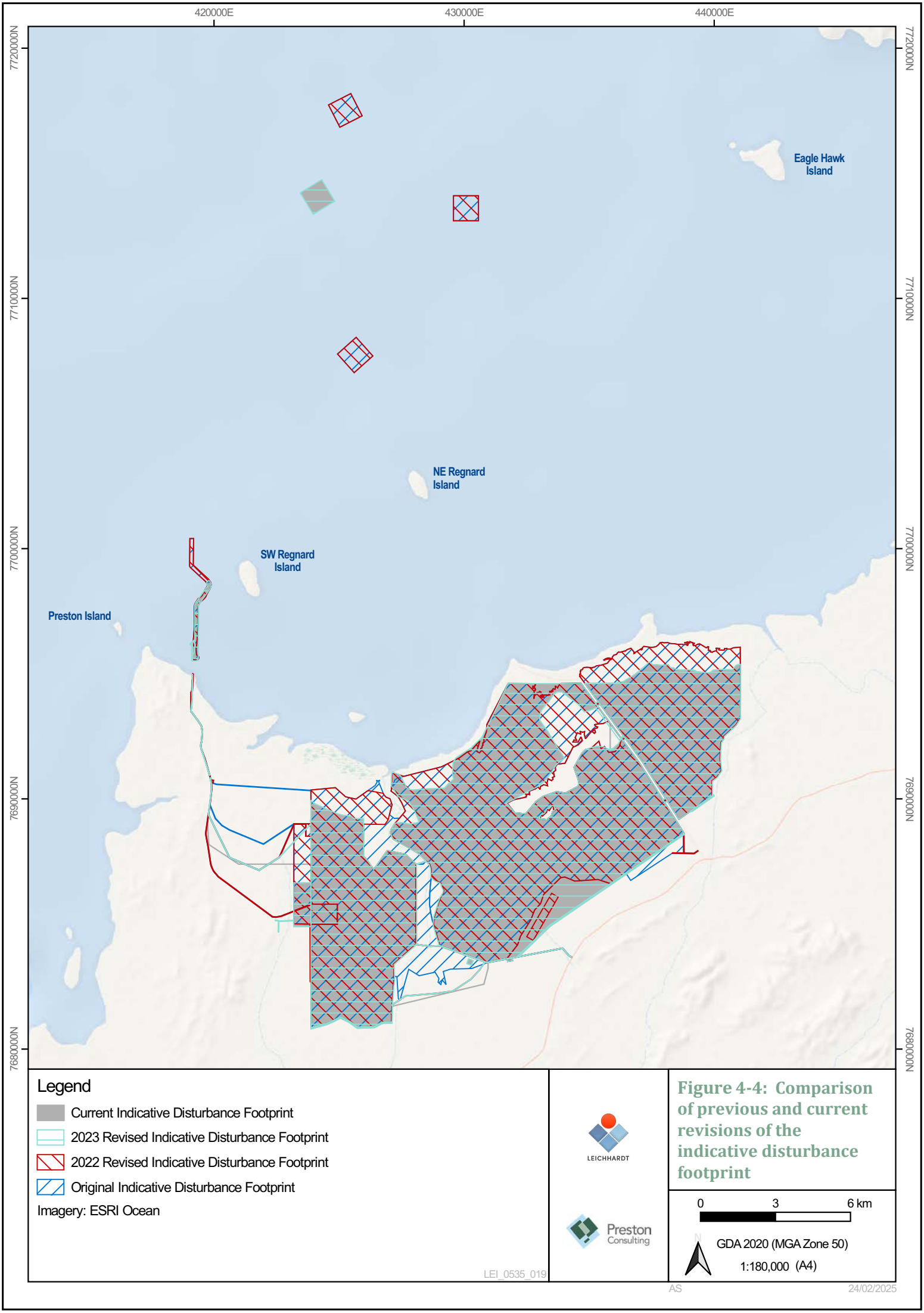
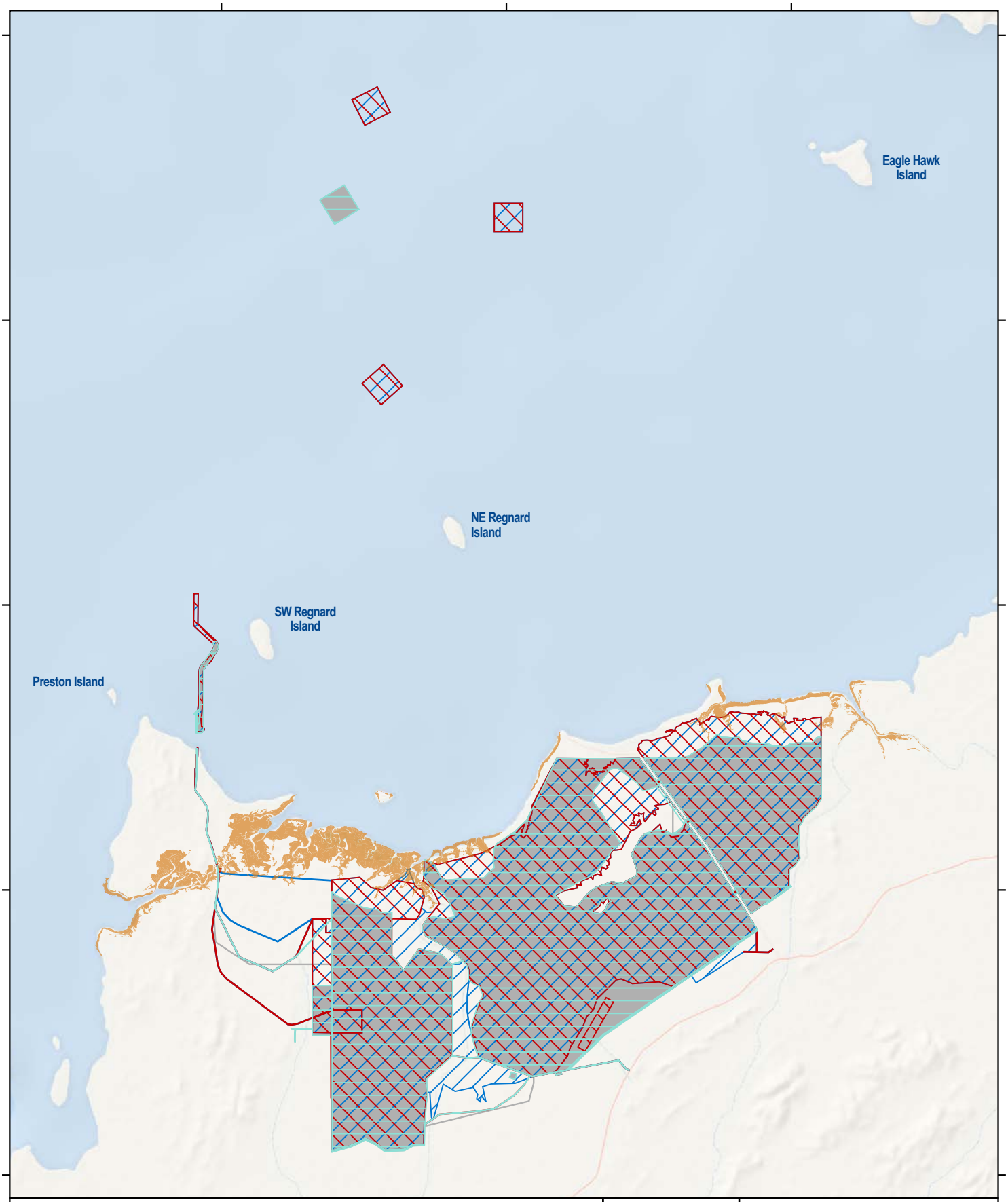



**Figure 4-4: Comparison of previous and current revisions of the indicative disturbance footprint**




## Legend

- Current Indicative Disturbance Footprint
- 2023 Revised Indicative Disturbance Footprint
- 2022 Revised Indicative Disturbance Footprint
- Original Indicative Disturbance Footprint
- Mangroves

Imagery: ESRI Ocean

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**Figure 4-5: Indicative disturbance footprints and mangroves**

0 3 6 km

N

GDA 2020 (MGA Zone 50)

1:180,000 (A4)

LEI_0535_021

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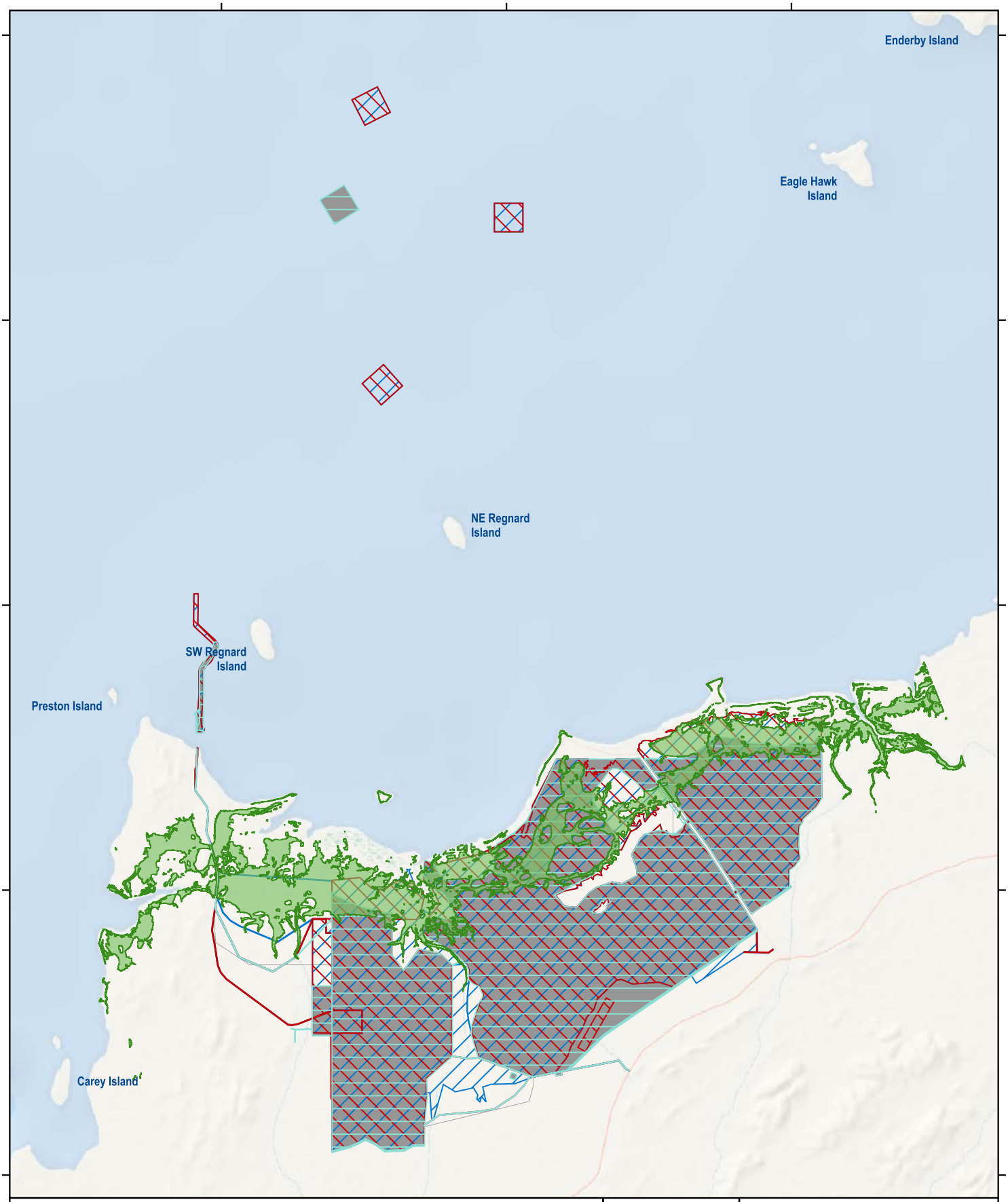
24/02/2025




## Legend

- Current Indicative Disturbance Footprint
- 2023 Revised Indicative Disturbance Footprint
- 2022 Revised Indicative Disturbance Footprint
- Original Indicative Disturbance Footprint
- Algal Mat

Imagery: ESRI Ocean

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**Figure 4-6: Indicative disturbance footprints and algal mats**

0 3 6 km

N

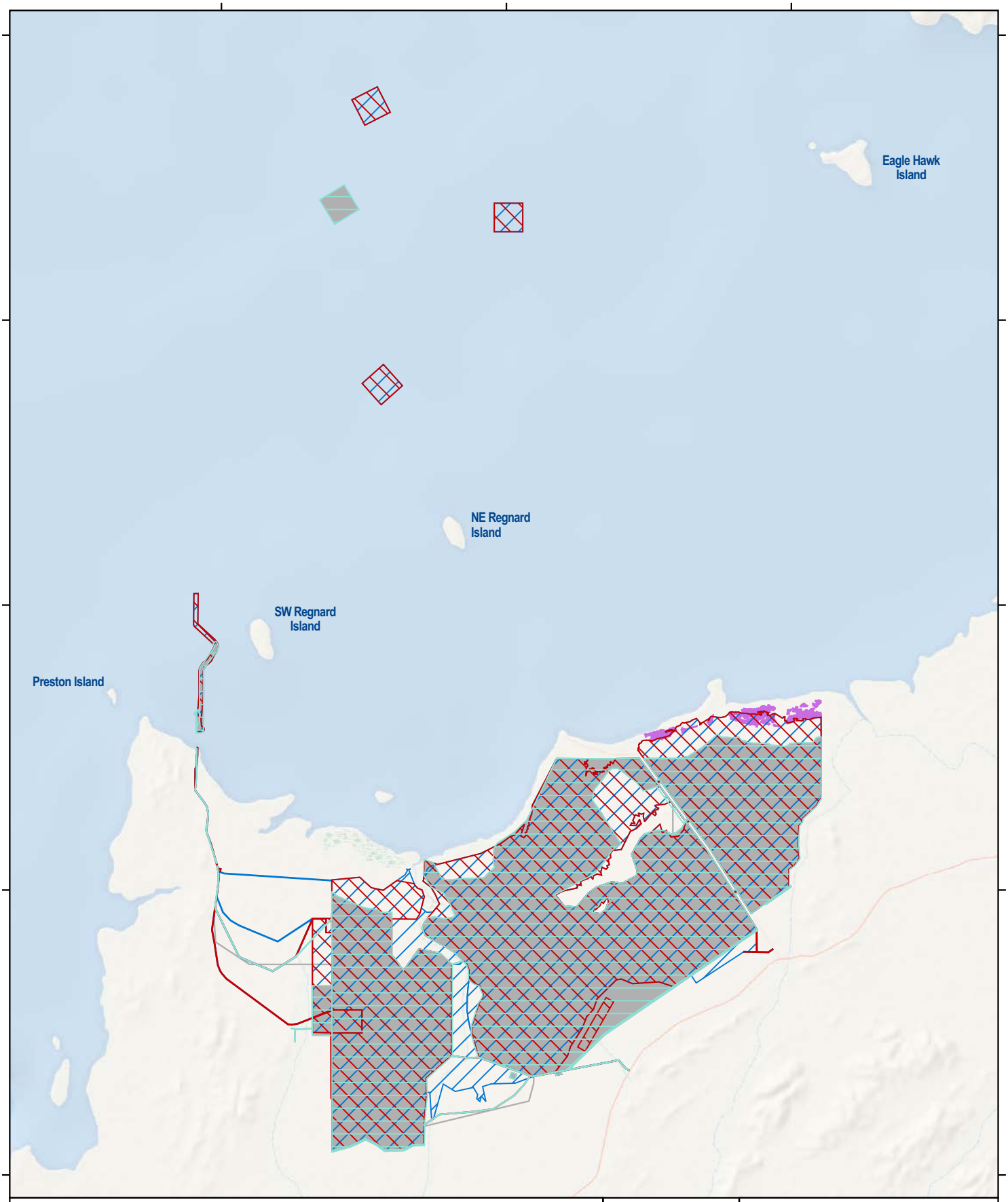
GDA 2020 (MGA Zone 50)

1:180,000 (A4)

LEI_0535_020

AS

12/06/2025




## Legend

- Current Indicative Disturbance Footprint
- 2023 Revised Indicative Disturbance Footprint
- 2022 Revised Indicative Disturbance Footprint
- Original Indicative Disturbance Footprint
- Priority 3: Coastal dune native tussock grassland dominated by *Whiteochloa airodies*

Imagery: ESRI Ocean

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**Figure 4-7: Indicative disturbance footprints and Coastal Dune PEC**

0 3 6 km

N

GDA 2020 (MGA Zone 50)

1:180,000 (A4)

LEI_0535_019

AS

24/02/2025

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Legend

- Current Indicative Disturbance Footprint
- 2023 Revised Indicative Disturbance Footprint
- 2022 Revised Indicative Disturbance Footprint
- Original Indicative Disturbance Footprint
- Northern Quoll Critical Habitat

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

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0 100 200 300 400 500 Meters

Scale: 1:10,000 @ A3

N

**LOCALITY MAP**




| CREATED BY | JOB | DATE | REVISION |
|---|---|---|---|
| ENVIRONMAPS | PC2900212 | 28/11/2023 | 0 |

**Leichhardt Salt Pty Ltd**

ENVIRONMAPS | t: 0406 590 006 | Environmental Mapping Solutions | www.environmaps.com.au

**Figure 4-8: Indicative disturbance footprints and area previously identified as potential Northern Quoll habitat (recently confirmed unsuitable)**

## 4.3 FORMAL AMENDMENTS TO THE PROPOSAL

A Section 43A application under the EP Act was submitted on 19 May 2023. This application was submitted in order to define the revised design in the assessment and included:

- A reduction of the in the overall extent of disturbance, including:
  - A 2,099 ha reduction within the PIDE;
  - A 37 ha reduction within the Marine Development Envelope; and
  - A 220 ha reduction within the DSDDE;
- A relocation of the DSDDE and reduction in size from 4,605 ha to 285 ha (4,320 ha reduction);
- An 87 ha reduction of the Marine Development Envelope from 790 ha to 703 ha;
- A reduction of the annual bitterns discharge volume from 8 GLpa to 5.9 GLpa;
- A reduction in the dredge volume limit from 1,100,000 $m^3$ to 400,000 $m^3$; and
- The removal of groundwater abstraction from the operational elements.

The Section 43A application was approved in June 2023.

# 5 ENVIRONMENTAL PRINCIPLES

The EP Act identifies a series of principles for environmental management (Section 4a, EP Act, as amended). Leichhardt has considered these principles in relation to the development and implementation of the Proposal. Table 5-1 outlines how the principles relate to the Proposal.

**Table 5-1: *Environmental Protection Act 1986* Principles**

| Principle | How it will be addressed by the Proposal |
|---|---|
| **1. The precautionary principle**<br>Where there are threats of serious irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.<br>In the application of the precautionary principle, decisions should be guided by:<br>a. careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and<br>b. an assessment of the risk-weighted consequences of various options. | While Leichhardt has commissioned numerous studies in order to inform the design of the Proposal, there are still several examples where a precautionary approach has been taken, such as:<br>• Utilising the existing approved CPE Port as an export solution;<br>• Relocation of the Proposal away from significant BCH along the coastline, reducing impacts on areas with greater biodiversity;<br>• Diluting bitterns with seawater prior to discharge; and<br>• Maintaining the main drainage line through the ponds (McKay Creek). |
| **2. The principle of intergenerational equity**<br>The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations. | The Proposal targets a relatively infinite seawater resource and as such it has been designed as a long-term Proposal. |
| **3. The principle of the conservation of biological diversity and ecological integrity**<br>Conservation of biological diversity and ecological integration should be a fundamental consideration. | Survey work has been used to confirm the range and status of environmental values within the vicinity of the Proposal. Disturbance within areas of noted higher biological diversity (i.e., mangroves, coral communities) have been avoided or minimised, and further investigations are underway to determine acceptable disturbance of other habitats. Priority has been given to maintaining natural ecological and landscape processes wherever practicable. |
| **4. Principles relating to improved valuation, pricing, and incentive mechanisms**<br>1) Environmental factors should be included in the valuation of assets and services.<br>2) The polluter pays principle – those who generate pollution and waste should bear the cost of containment, avoidance, or abatement.<br>3) The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste.<br>Environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentive structures, including market mechanisms, which benefit and/or minimise costs to develop their own solutions and responses to environmental problems. | As discussed in Section 2.3.2, the Proposal design and management controls have been revised to reduce the potential impacts to environmental factors.<br>These revisions resulted in additional costs that have been considered in the Proposal costing phases and this will continue through the final feasibility stages of the Proposal. |
| **5. The principle of waste minimisation** | Waste will be minimised by adopting the hierarchy of waste controls; avoid, minimise, re-use, recycle and safe disposal. |

| Principle | How it will be addressed by the Proposal |
|---|---|
| All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment. | There are several examples of how the Proposal will minimise the generation of waste and its discharge to the environment:<br>• Utilising the desalination plant waste brine by adding it to the concentration pond sequence, where suitable;<br>• Additional process which recovers additional salt from bitterns prior to discharge;<br>• Targeting land with low permeability soils to avoid the requirement for pond liners for concentration ponds and crystallisers; and<br>• Utilising internally sourced earth fill for construction of pond walls. |

# 6 INLAND WATERS

The Inland Waters factor was noted as being linked to several other key environmental factors, such as BCH, Marine Environmental Quality, Flora and Vegetation, Terrestrial Fauna and Social Surroundings. As such, this section was moved ahead of these other factors to provide a logical flow to this ERD.

## 6.1 EPA OBJECTIVE

The EPA Objective for this key environmental factor is to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.

## 6.2 POLICY AND GUIDANCE

Relevant EPA and Commonwealth Government guidance documents for Inland Waters are summarised in Table 6-1.

**Table 6-1: Policy and guidance relevant to the Inland Waters key environmental factor**

| Policy and Guidance | How guidance has been considered |
|---|---|
| **WA Government** | |
| Key EPA documents | |
| EIA (Part IV Divisions 1 and 2) Procedures Manual (EPA, 2024a). | This document has been considered in planning for the Part IV approval process and has been used to inform the preparation of this ERD. |
| Statement of Environmental Principles, Factors, Objectives and Aims of EIA (EPA, 2023a). | This document was considered in the preparation of this ERD and to inform EIA. It was used to identify the Key Environmental Factors likely to be impacted by the Proposal and the EPA's objective for each factor. |
| Statutory Guidelines for Mine Closure Plans (DMIRS, 2020a). | This document has been considered in the design and planning of the Proposal, it has also been considered in the preparation of mitigation measures for the Proposal. |
| EIA (Part IV Divisions 1 and 2) Administrative Procedures (EPA, 2024d). | This document has been considered in planning for the Part IV approval process and has been used to inform the preparation of this ERD. |
| Instructions on how to prepare EP Act Part IV Environmental Management Plans (EPA, 2024e). | This document was considered, although not deemed to be relevant to this section of the ERD. |
| Relevant EPA Factor Guidelines | |
| Environmental Factor Guideline – Inland Waters (EPA, 2018a). | This document was considered in the preparation of this section (Section 6) of the ERD. |
| Other Policy and Guidance | |
| Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018). | This document was considered in the preparation of this section (Section 6) of the ERD. |
| Australian Groundwater Modelling Guidelines. (Waterlines Report Series No. 82) (Barnett et al., 2012). | This document was considered during groundwater assessments (CDM Smith, 2023). |

| Policy and Guidance | How guidance has been considered |
|---|---|
| WA Water in Mining Guideline. Water licensing delivery report series. Report No. 12. (DoW, 2013). | This document was used during groundwater assessments (CDM Smith, 2023). |
| Operational Policy 5.12 – Hydrogeological reporting associated with a groundwater well licence (DoW, 2009). | This document was used during groundwater assessments (CDM Smith, 2023). |
| WA Environmental Offsets Policy (EPA, 2011). | This document was considered when determining whether offsets were expected to be required for this factor. |
| WA Environmental Offsets Guidelines (EPA, 2014a). | This document was considered when determining whether offsets were expected to be required for this factor. |
| WA Environmental Offsets Template (EPA, 2014b). | This document was considered when determining whether offsets were expected to be required for this factor. |
| WA Environmental Offsets Metric and relevant guidance (DWER, 2021b). | This document was considered when determining whether offsets were likely to be required for the Flora and Vegetation environmental factor, and the adequacy of any proposed offsets. |
| **Commonwealth Government** | |
| Key Documents | |
| Generic guidelines for the content of a draft EPBC Act Public Environment Report (PER)/EIS (including the objects and principles of the EPBC Act, 1999; DotEE, 2016). | These documents were considered in the preparation of this ERD and while undertaking EIA. |
| EPBC Act Environmental Offsets Policy (DSEWPaC, 2012a) – including the Offset Assessment guide. | This document was considered when determining whether offsets were expected to be required for this factor. |
| Environmental Management Plan Guidelines (DotE, 2014). | This document was considered during the preparation of environmental management plans to support this ERD. |
| EPBC Act Condition Setting Policy (DAWE, 2020). | This document was used as guidance for the referral process and EIA of the Proposal. |
| EPBC Act Outcomes-based conditions policy (DotE, 2016a). | This document was used as guidance for the referral process and EIA of the Proposal. |
| Relevant Technical Guidance | |
| Relevant EPBC Act listed species-specific survey guidelines and protocols. | Not specifically relevant to this section of the ERD, however these documents were used as guidance when undertaking surveys of EPBC listed species and potential survey limitations. |
| Relevant EPBC Act listed species-specific Recovery plans, Threat Abatement Plans, Approved Conservation Advice and other documents. | Not specifically relevant to this section of the ERD, however these documents were used as guidance to assess and manage EPBC-listed species that may be impacted by the Proposal. |

## 6.3 RECEIVING ENVIRONMENT

### 6.3.1 STUDY EFFORT

Baseline data relevant to this section has been sourced from the following:

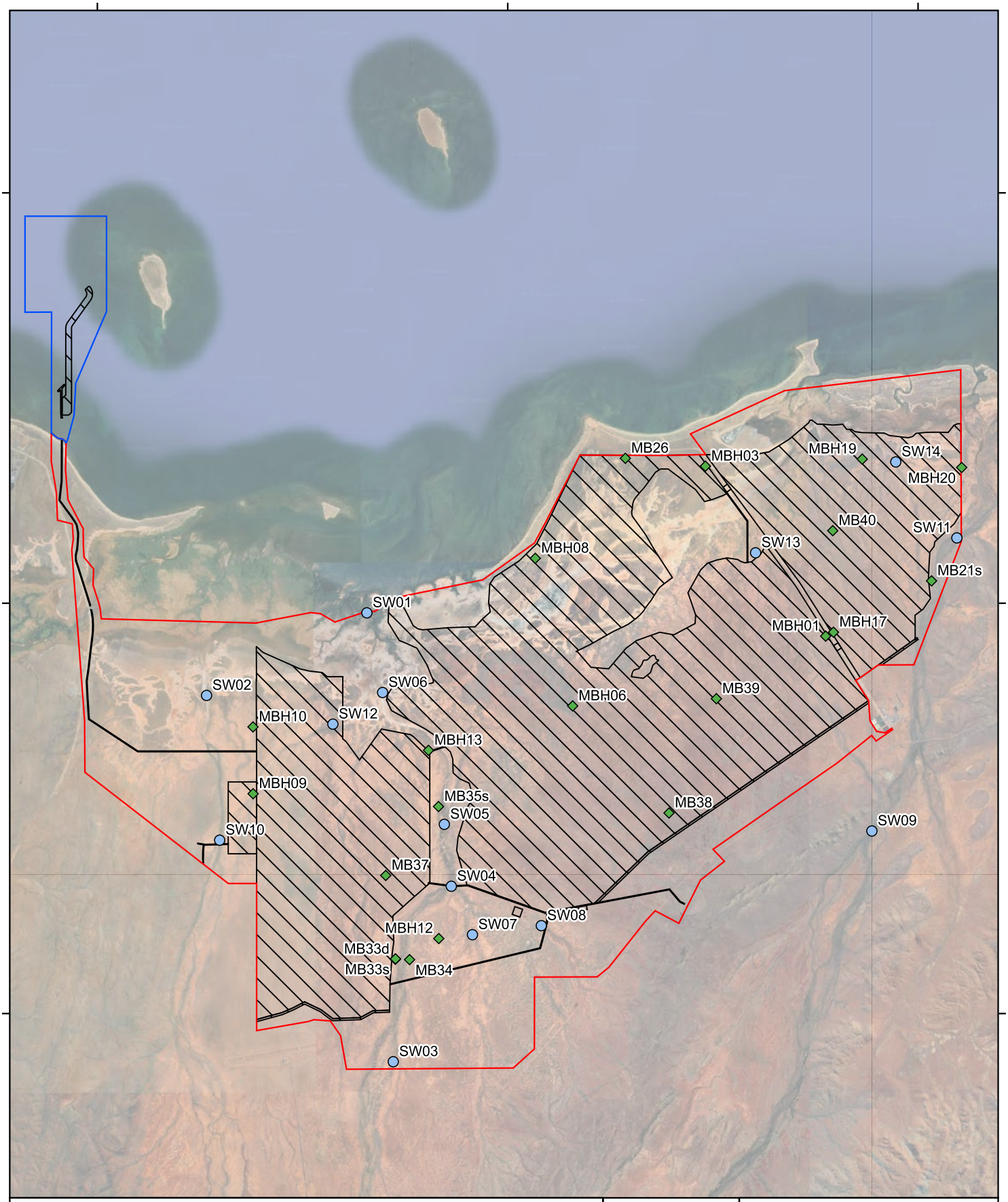
- Climate data from the Bureau of Meteorology (BoM), in particular the Mardie Station certified weather station (IDW60801), as well as on site temperature and humidity loggers;

- Topographical data (land contours) was sourced from Landgate and subsequently corrected and expanded using on-ground and LiDAR aerial surveys;
- Bathymetry (including for accessible intertidal areas) was sourced from government and commercial charts, and subsequently added to and adjusted following extensive bathymetric surveys undertaken by O2 Marine and Guardian Geomatics;
- Soil samples were collected as part of ongoing geotechnical studies, with relevant samples being analysed for acid sulfate soil (ASS) indicators, and other soil samples tested for permeability (following compaction to field specification);
- Marine sediments from areas to be dredged were also assessed for ASS indicators; and
- Groundwater samples collected from a groundwater monitoring well network established from December 2021.

The following data collected was used to calibrate a number of predictive models developed to inform Proposal design and this ERD:

- Surface Water Solutions (SWS) modelled storm surge and potential flood flows from inland catchments (SWS, 2025; Appendix 1.1) to inform engineering design and to provide numerical outputs and maps of changes to water levels and inundation frequencies to enable an assessment of indirect impacts to terrestrial habitats and BCH;
- O2 Metocean developed a tidal inundation model of the Proposal by extending the hydrodynamic model of Cape Preston to incorporate the intertidal region south of Regnard Bay using LiDAR data specifically gathered for the Proposal, which was validated against water level measurements at McKay Creek, Straight Creek and a station within Regnard Bay (O2 Metocean, 2023b; Appendix 1.2);
- Larcombe et al., provided an assessment of sedimentation rates in the intertidal area downstream of the ponds and the consequent impact on BCH, as well as assessing potential alterations to coastal processes as a result of the coastal and marine infrastructure for the Proposal ( Larcombe et al., 2025; Appendix 1.3);
- Land and Water Consulting (LWC) completed baseline soil and sediment testing at the Proposal, additionally identifying any ASS that could potentially be disturbed (LWC, 2022; Appendix 1.4);
- LWC completed surface water monitoring of the Proposal (LWC, 2025; Appendix 1.5);
- CDM Smith provided a Groundwater Effects Assessment and Seepage Modelling report to LWC, addressing the Proposal's potential groundwater impacts (CDM Smith, 2023; Appendix C of Appendix 1.6);
- CDM Smith provided an update to the site setting and conceptualisation presented in the previous groundwater effects assessment report (CDM Smith, 2024; Appendix C of Appendix 1.6); and
- O2 Metocean prepared a hydrodynamic nearshore model (water and wave levels, current velocity and direction, wind effects and seasonal effects), which incorporated bathymetric and metocean information (O2 Metocean, 2022; Appendix 1.7).

Surface water and groundwater monitoring locations and data logger locations are shown in Figure 6-1 and Figure 6-2, respectively.




## Legend

- Pond and Infrastructure Development Envelope
- Marine Development Envelope
- Disturbance Footprint
- Groundwater Monitoring Locations
- Surface Water Monitoring Locations

Imagery: Google Satellite

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# Figure 6-1: Surface Water and Groundwater monitoring locations

0 2 4 km

N

GDA 2020 (MGA Zone 50)

1:125,000 (A4)

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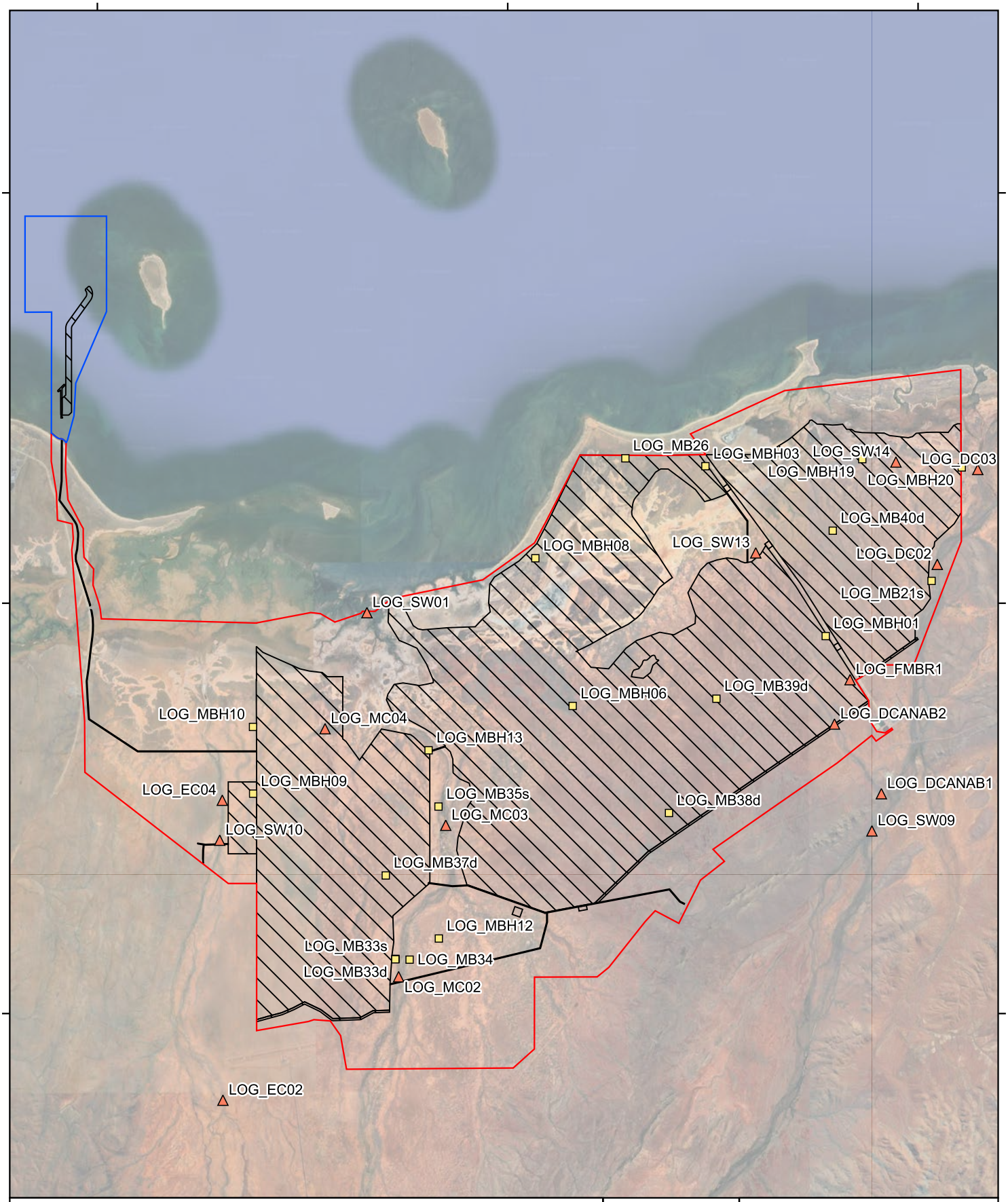
21/02/2025




## Legend

- Pond and Infrastructure Development Envelope
- Marine Development Envelope
- Disturbance Footprint
- Groundwater Data Logger Location
- Surfacewater Data Logger Location

Imagery: Google Satellite

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# Figure 6-2: Surface Water and Groundwater Logger locations

0 2 4 km

N

GDA 2020 (MGA Zone 50)

1:125,000 (A4)

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AS

21/02/2025

### *Climate*

The Pilbara bioregion has an arid to tropical climate with average maximum temperatures over 40°C from November to February and an average maximum of 25°C during the winter months (Leighton, 2004; McKenzie et al., 2009). Annual rainfall across the broader Pilbara region averages approximately 290 mm and is most prevalent over the summer months in association with cyclonic activity to the north and northwest, though annual rainfall is highly variable (McKenzie et al., 2009). The climate of the Roebourne subregion is described as arid (semi-desert) tropical with highly variable rainfall, falling mainly in summer. Cyclonic activity is significant, with several systems affecting the coast and hinterland annually (Kendrick & Stanley, 2001).

The nearest BoM weather station with comprehensive data collection and recent historic climate data is Mardie (Site number 005008), located 44 km southwest of Cape Preston. Mardie records its highest maximum mean monthly temperature (37.9°C) in January and lowest (27.8°C) in July, with its highest minimum mean (25.4°C) in February and lowest (11.9°C) in July. Average annual rainfall is 276.3 mm, with highest monthly average rainfall recorded in February (62.4 mm) (BoM, 2022) (Figure 6-3).

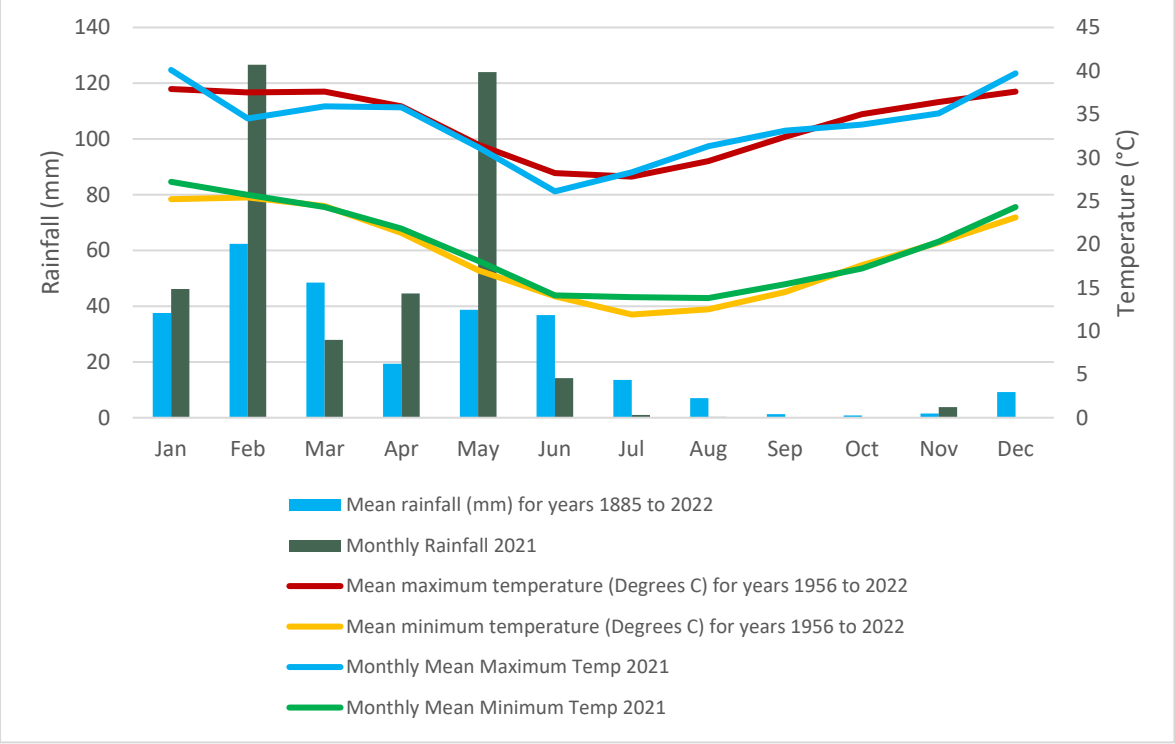


**Figure 6-3: Mardie climate data (Station number 005008)**

### *Rainfall Intensity-Frequency-Duration*

Intensity-Frequency-Duration (IFD) data to characterise the Annual Exceedance Probability (AEP) has been compiled by SWS (2025; Appendix 1.1) and are shown in Table 6-2.

Table 6-2: IFD values

| Duration | Rainfall Depth in mm | | | | |
|---|---|---|---|---|---|
| | 63.2% AEP | 10% AEP | 5% AEP | 2% AEP | 1% AEP |
| 1 minute | 2 | 3 | 4 | 5 | 5 |
| 5 minutes | 6 | 12 | 14 | 16 | 19 |
| 10 minutes | 10 | 20 | 24 | 28 | 32 |
| 15 minutes | 12 | 26 | 30 | 37 | 41 |
| 30 minutes | 18 | 36 | 43 | 51 | 58 |
| 1 hour | 23 | 47 | 56 | 67 | 77 |
| 2 hours | 27 | 60 | 71 | 87 | 100 |
| 3 hours | 30 | 68 | 82 | 102 | 118 |
| 6 hours | 37 | 89 | 109 | 137 | 160 |
| 12 hours | 45 | 117 | 145 | 186 | 220 |
| 24 hours | 56 | 152 | 190 | 244 | 289 |
| 48 hours | 69 | 186 | 232 | 294 | 345 |
| 72 hours | 75 | 200 | 248 | 312 | 363 |

### *Cyclones and tropical lows*

In February 2020, severe tropical cyclone Damien resulted in substantial rainfall across the Proposal area catchments. Gauge results from loggers onsite were compiled and assessed against rainfall records for the period from 8 - 10 February 2020. The maximum recorded 24-hour rainfall depth of 150 mm was found to be equivalent to the predicted one in ten AEP event.

The region is exposed to tropical storms and cyclones during the wet season. The coastline from Karratha to Onslow is the most-cyclone prone section of the Australian coast, with one cyclone making landfall every two years on average. Cyclones affecting the Pilbara typically form in the tropical waters between the Kimberley and the Timor Sea and intensify as they propagate westward and poleward, however, tracks of significant cyclones impacting Cape Preston within the last 30 years are varied. In addition to tropical storms, troughs of low pressure also bring rain, strong winds, and sharp changes in wind direction (O2 Metocean, 2023b; Appendix 1.2).

### *Climate Change*

The latest Intergovernmental Panel on Climate Change (IPCC) report (IPCC, 2021) confirms climate change poses a serious risk to WA under all emissions scenarios. By 2050 the following changes are projected:

- Sea levels are projected to rise by about 24 cm along the WA coast;
- Rainfall variability and extreme rain events are projected to become more intense, leading to more very wet and very dry years;
- There is a very high confidence that oceans will become more acidic and that the rate of ocean acidification will be proportional to carbon dioxide emissions; and
- Tropical cyclones are projected to decrease in frequency, but it is expected that a greater proportion will have higher intensity.

The north-west coastline between Exmouth and Broome is the most cyclone-prone region of the Australian coast. The frequency of cyclones has remained relatively stable in WA, but the intensity has increased. This trend is expected to continue with medium confidence. There is high confidence in a future increase in the intensity of extreme rainfall events. However, the magnitude of the increases cannot be confidently projected.

### 6.3.2 GROUNDWATER

Groundwater abstraction for water supply was included in the referral documentation for the Proposal under Section 38 of the EP Act, however it has since been decided that potable water requirements for the Proposal will be sourced via onsite desalination of seawater. Potential impacts from groundwater abstraction for water supply are therefore no longer applicable to the Proposal.

The hydrogeological study by CDM Smith (2024; Appendix 1.6) has therefore focused on:

- Characterising the existing hydrogeological systems, and describing their relationships with key surface water processes; and
- Determining the extent and nature of changes to those systems as a result of seepage and/or mounding from the proposed ponds.

The text in this section has been sourced from CDM Smith (2023 & 2024) and O2 Metocean (2023b) unless stated otherwise.

***Geology and Geomorphology***

The Pilbara coast is one of the most geologically and geomorphologically diverse and complex arid coasts in the world (Semeniuk, 1996). The region harbours a major tidal estuary which contains tidal creeks of various forms and sizes. The tidal creeks contain extensive areas of subtidal and intertidal flats, fringing and estuarine mangroves. The coastline immediately seawards of the proposed ponds is about 18 km long, and contains a variety of coastal morphologies, inferred sediment transport regimes and sediment transport pathways. At the eastern margin of the ponds are a number of tidal creeks. Further east are the wave-dominated deltas of some relatively small rivers, the Yanyare and Maitland, beyond which is the complex array of islands of the Dampier Archipelago.

The regional bedrock geology and boreholes from Cape Preston (Table 6-3) indicate that the Cape Preston promontory is underlain by igneous and similar hard basement rocks, and the nearby islands are probably cemented limestones. Across almost the entire PIDE, these sediments overlie granitic rock belonging to the Dampier Granitoid Complex present in creek beds and encountered in boreholes. This granite was encountered at elevations around 0 m AHD immediately south of the 40-Mile Beach foredune and at shallow levels in test pits further south along the Santos pipeline route out towards the North West Coastal Highway. At the proposed jetty area, basement rocks are finer-grained and metamorphosed igneous rocks.

Table 6-3: Generalised coastal stratigraphy, based on boreholes at Cape Preston (SKM, 2013a)

| Lithology | Depth range to top of layer (m) | Layer thickness range (m) | Strength range | Typical description |
|---|---|---|---|---|
| Coastal sand deposit | - | 0.5 to 6.0 | Very loose to medium dense, Standard Penetration Test (SPT) number ranges from 1 - 20. | Fine to coarse grained, well graded, sub-rounded, dark brown and grey, with silt and sub-angular gravels, shells, corals and rootlets. Encountered in all the boreholes. |
| Calcrete | 0.5 - 6.0 | Absent to 4.0 | Strength variable; highly fractured in some areas. | Fine, off-white, distinctly weathered. Encountered in all the boreholes. |
| Ferricrete | 0.5 - 5.0 | 0.5 to 9.0 | Extremely low to high strength. | Fine, yellow brown, massive, distinctly weathered. Encountered in all the boreholes. |
| Dacite | 6.0 - 9.0 | Absent to base of borehole | Highly variable, extremely low to high strength. | Fine, much quartz, off-white, extremely weathered to fresh. Encountered in BH 05 to BH 10. |
| Basalt | 4.0 - 12.0 | Base of borehole | Medium to very high strength, highly fractured in some areas. | Fine, grey, massive, distinctly weathered to fresh. Encountered in all the boreholes except BH 05 and BH 07. |

CMW Geosciences (2022) describe the main surface units as:

- Mangrove and marine “muds” fringing the coast but about 1 km wide in the west;
- Shelly sand in coastal dunes and old beach deposits;
- Coastal limestone, lime-cemented shelly sand, dune sand and beach conglomerate;
- Silt and mud in supratidal and intertidal flats and a low lagoon landward of the tidal creek systems, including being 2 - 3 m thick at the Cape Preston Causeway; and
- Quartzo-feldspathic windblown sand with quartz and rock fragments – mostly occurring at the base of granitic outcrops.

The pond areas are located in a flat area, where the surface sediments are interpreted as Holocene and recent muds and sandy muds. The pattern of sea-level change for the last 7,000 - 8,000 years indicates that there will be little modern sediment on the upper tidal flats and supratidal coastal plain.

### *Hydrogeology*

The information provided in this section has been sourced from SWS (2025) provided in Appendix 1.1, LWC (2025) provided in Appendix 1.5 and CDM Smith (2023 & 2024) provided in Appendix 1.6.

CDM Smith (2023) developed a conceptual hydrogeological model of the Proposal (Figure 6-4 and Figure 6-5). The model has been revised since earlier versions to include to include additional information obtained from drilling and sampling programs completed during 2023 and 2024, expected salinity gradients, further descriptions of hydrogeological processes and predicted groundwater flow from the groundwater modelling.

The Proposal is located within the Pilbara Craton geological province which comprises Archean aged volcanic and sedimentary rocks. The Pilbara Craton has been subject to a long history of tectonic and orogeny with various igneous intrusions occurring and deposition of shelf sediments such as the Hamersley Basin containing extensive banded iron-formation (BIF) deposits.

Local to the Proposal, the Pilbara Craton is overlain by a number of Cainozoic sedimentary units comprising marine muds and silts, coastal sands and beach deposits, limestone, alluvial/colluvial sands and clays as well as residual calcretes and eluvial sands from weathered granitoid rocks (Hickman & Strong, 2000). These sediments are underlain by granitic basement belonging to the Dampier Granitoid Complex which has been intruded by a series of cross cutting dolerite and gabbro dykes. Geological investigations by CMW Geosciences (2022) indicate surface expressions of the basement exist within the central and eastern portions of the Proposal often within eroded creek beds. However, in general, the depth to basement distribution is currently not well understood.

The monitoring bore drilling completed between 2023 and 2024 identified the presence of an extensive covering of eluvium comprising of highly weathered crystalline basement rocks belonging to undifferentiated volcanics and the Dampier Granitoid Complex (CDM Smith, 2024). Drilling indicates the eluvium acts as an aquifer of low to moderate permeability and likely forms the main water bearing unit over the PIDE.

Hydro Geo Enviro (2023b) also conducted a peer review of CDM Smith (2023) and noted that the seepage impact assessment was considered fit for purpose and particular attention should be paid to collecting addition data to better define the variable evapotranspiration depth across the Proposal.

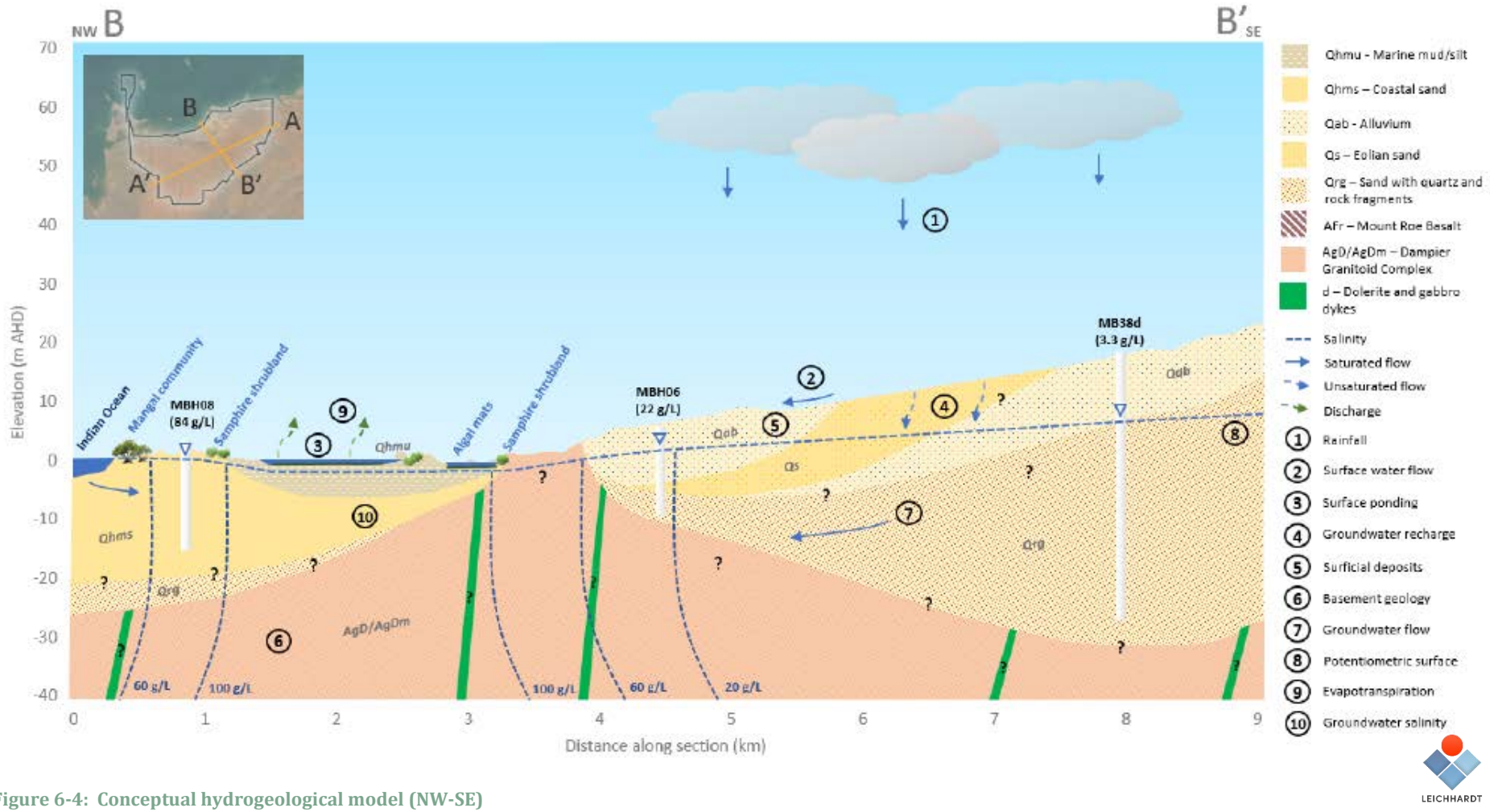


Figure 6-4: Conceptual hydrogeological model (NW-SE)

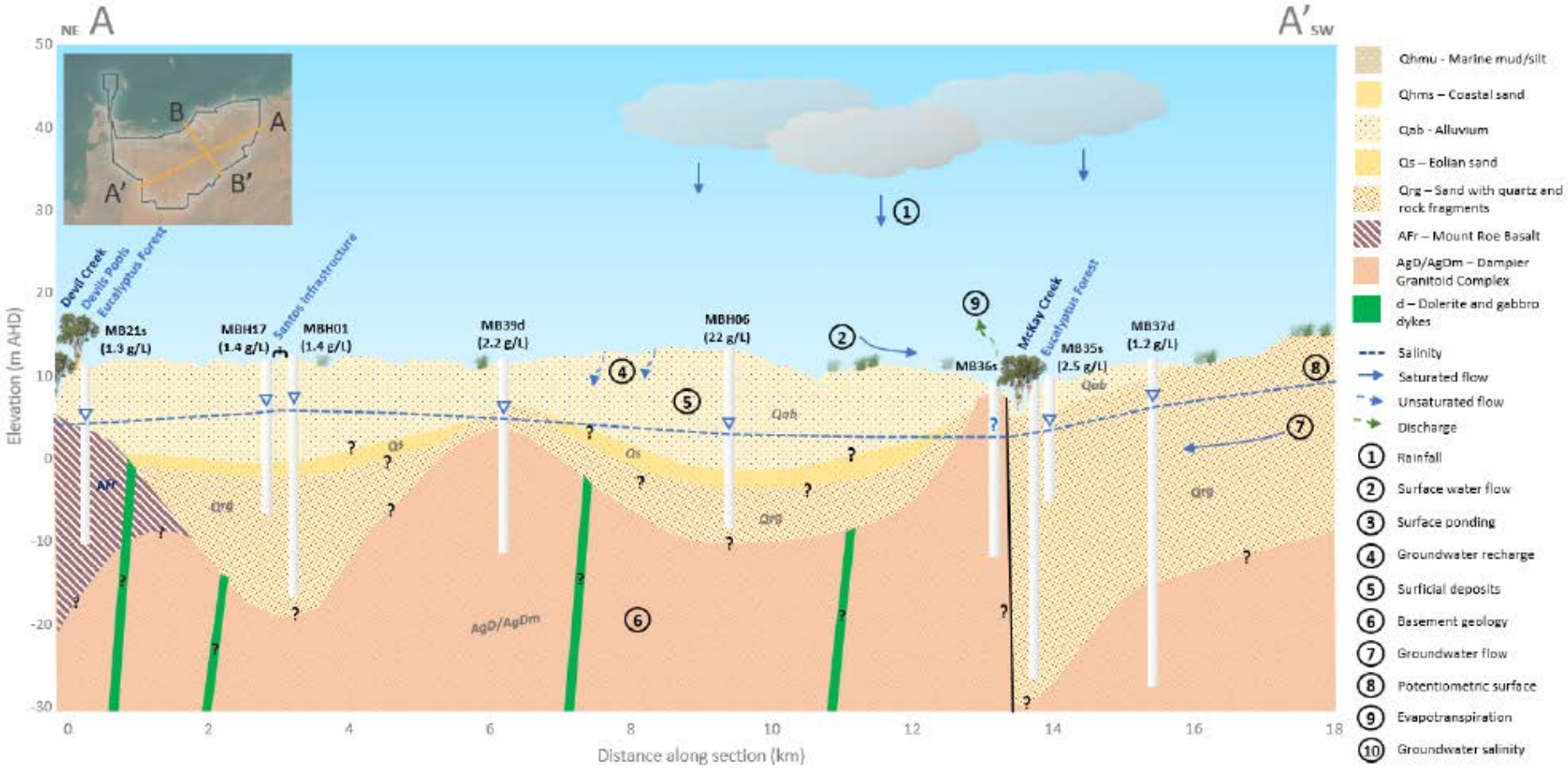


Figure 6-5: Conceptual hydrogeological model (NE-SW)

***Groundwater Quality***

LWC (2025; Appendix 1.5) were engaged to undertake groundwater quality monitoring in March, May and November 2022, June 2023, November 2023 and July 2024. They have also completed monitoring in January and February 2025 however these results are not available at this stage. Groundwater samples were collected from targeted locations and were analysed for key potential chemical substances of concern. Key findings of the monitoring events included the following:

i. The reported concentrations of pH, total dissolved solids, major cations/anions (calcium, chloride, sodium, sulfate and hardness), various metals/metalloids and nutrients were observed above the adopted guideline criteria for drinking water, recreation, freshwater, marine water, irrigation and/or livestock water use in groundwater; and
ii. The data quality assessment indicates that the chemical and physical hydrogeological data reported for the March, May and November 2022, June 2023, November 2023 and July 2024 programs of work is suitable to inform the baseline hydrogeological assessment for the Proposal. An acceptable degree of field and laboratory Quality Assurance/Quality Control (QA/QC) was collected and reported, providing confidence in the accuracy and precision of all reported results.

The results showed numerous natural exceedances of various water quality guidelines for a detailed assessment of groundwater quality, refer to Appendix 1.5.

***Calibrated Groundwater Level Contours, Flow Direction***

Groundwater head contours have been developed using the latest available groundwater level data and are presented in Figure 6-6. The contours are representative of groundwater heads measured during the July 2024 monitoring event undertaken by LWC (2025). Groundwater elevations range from approximately 11 m AHD in the southeast to near sea level (i.e., 0 m AHD) adjacent to the coast. Within the inter- and supratidal flats (i.e., sabkha), where a natural low point in the topography exists, groundwater modelling by CDM Smith (2023b) predicts the high levels of evapotranspiration experienced within the PIDE, contribute to lower the groundwater levels below sea level causing groundwater inflow from the ocean. A drilling program targeting coastal Environmental Values (EV), cultural EVs (Noorea Soak) and basement stratigraphy (including incomplete monitoring bores in the 2023/2024 program), is planned as part of further environmental baseline studies to obtain a more detailed understanding of groundwater levels and flow conditions within the backwater area.

Water level data from monitoring bores adjacent to the ephemeral drainages (within 150 m) within the PIDE suggests groundwater could be encountered at around 2 m beneath creek beds. Eucalypt vegetation is documented to occur within the creeks and would be expected to access groundwater at such depths through evapotranspiration (Phoenix, 2025). When accounting for evapotranspiration, water levels beneath the creeks are expected to be several metres deep. This aligns with the depth in which water has generally been encountered during drilling (10 - 12 m bgl) (CDM Smith, 2024) and the lack of streamflow observations and permanent inundation along creek beds.

In general, the water level data indicates that groundwater flows in a north to northwest direction across the PIDE which is observed through a steady decline in groundwater elevation in this direction at an average gradient of around 0.001 (~10 m of fall over a 7 km horizontal distance).

Groundwater flow is also understood to occur in a southeast direction as inflow from the ocean. The information gathered from the newly installed monitoring wells (MB21 - MB40) did not change the groundwater flow direction from prior assessments, however, does provide greater resolution of groundwater heads across the site and suggests a flatter gradient than previously shown by CDM Smith (2023).

***Salinity Distribution***

The most recent available water quality data for the site was collected in November 2023 and February 2024 by LWC (2025) which indicated that groundwater salinity within the PIDE ranges from 710 mg/L (MBH33S) to 130,000 mg/L (MBH26D) TDS, with the highest reported concentrations tending to closest to the coast. All groundwater wells exceed the salinity criterion of 600 mg/L for Australian Drinking Water Guidelines Aesthetic and Recreational Water – Aesthetics and groundwater is generally neutral to acidic (6.4 – 8.8 pH) with the exception of MBH012 (pH = 12), MB33D (pH = 13) and MB40D (pH = 12) (LWC, 2024).

The latest groundwater quality data has been used to provide an updated map of groundwater salinity over the PIDE (Figure 6-7). Figure 6-7 shows a strong hypersaline interface in the backwater (sabkha) areas adjacent to the coast with relatively steep salinity gradients to the north and south of this feature. To the north of the feature, a reverse saline water interface exists between the backwater areas and the ocean, whereas to the south of the backwater areas and coastline, groundwater salinity decreases substantially with distance from these features and in proximity of ephemeral drainages where it is likely recharge occurs. Although the groundwater salinity of the basement monitoring bores is consistent with shallow monitoring bores, a notable difference in salinity is observed (>16,000 mg/L) between nested sites MB33s (710 mg/L) and MB33d (17,000 mg/L). This observation supports the conceptualisation of shallow recharge occurring through the ephemeral drainages and may also suggest groundwater salinity increases with depth, either as a function of longer residence times of recharging groundwater or MB33d intersecting deeper fractures hosting saline groundwater.

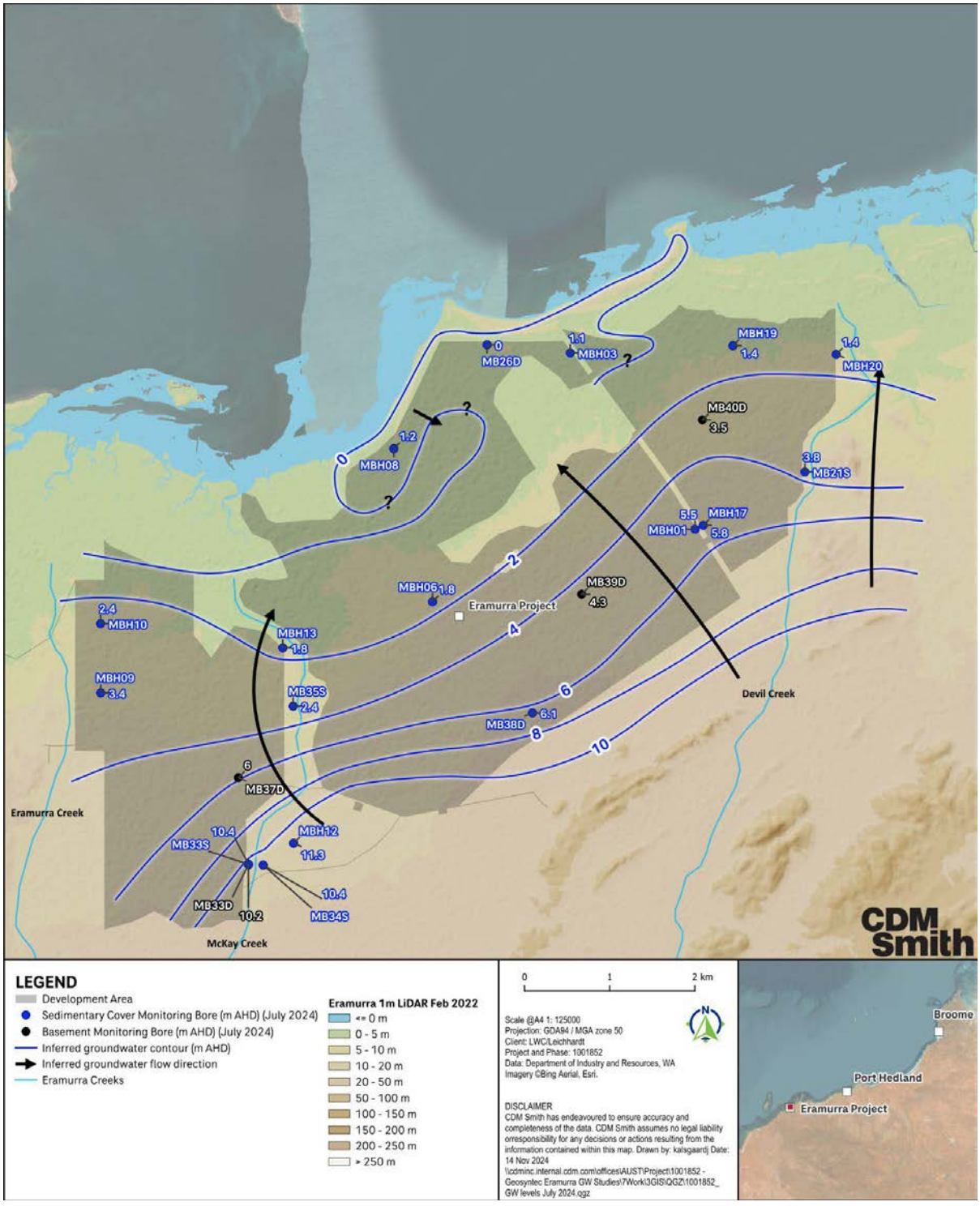


Figure 6-6: Inferred groundwater elevation contours and flow direction (July 2024)

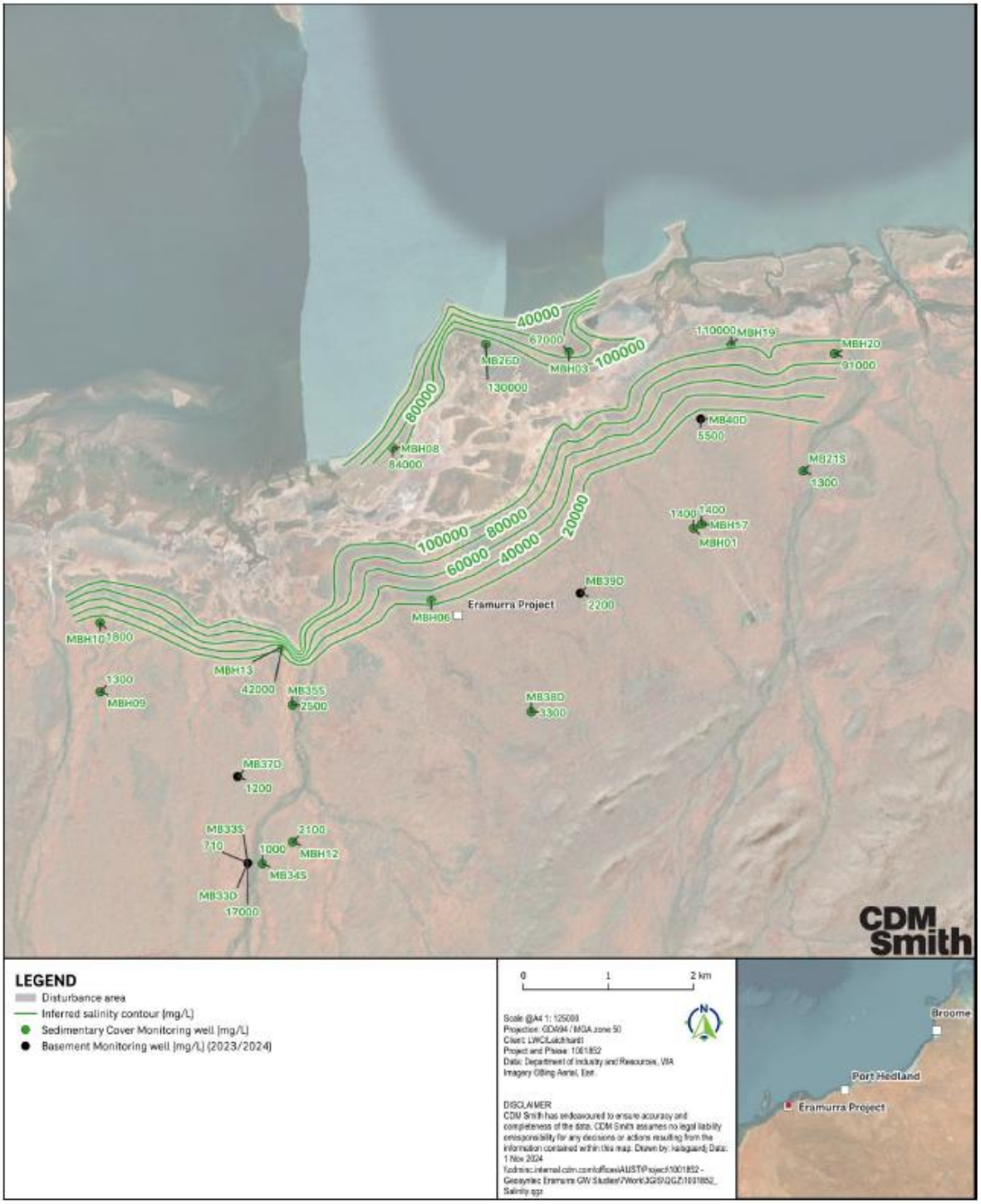


Figure 6-7: Interpreted groundwater salinity 2023/2024 sampling periods

While the updated salinity contours share some spatial similarities with those previously interpreted for the density flow model (CDM Smith, 2023), the latest results show notable fluctuations in groundwater salinity when compared to historical measurements (Figure 6-8). From a spatial sense, monitoring bores with the highest fluctuations are generally located to the northeast of the PIDE and closer to the coast. For many of these wells, the TDS measurements taken in November 2023 represent the lowest concentration to date and appears to reflect a downwards trend in salinity over time. It should be noted that the size of the current monitoring dataset limits the ability to draw definitive and statistical conclusions from the current data. Further investigation is required to better understand the process(Es) which could be contributing to the salinity fluctuations.

***Model Limitation***

The existing groundwater model (CDM Smith, 2023) uses groundwater salinity measurements from earlier in the dataset that are generally higher than the most recent monitoring results. A limitation of the model is that the predictions are dependent on the initial density condition such that an environment with higher baseline concentrations (such as those reported in the existing groundwater model) is likely to experience a smaller change in salinity than an environment with lower baseline salinity due to hypersaline seepage from the evaporation ponds. Recognising this limitation, future groundwater models developed to inform groundwater management and monitoring will need to consider both a low and high salinity baseline scenario to account for the uncertainty in salinity fluctuations and the potential changes to the baseline salinity as a result of the Proposal.

The pre-operational salinity distribution from the calibrated model is also shown in Figure 6-9, with a spatial pattern that largely follows the initial concentration. Some salinity highs are found near the creeks where evapo-concentration causes salinity to rise over time.

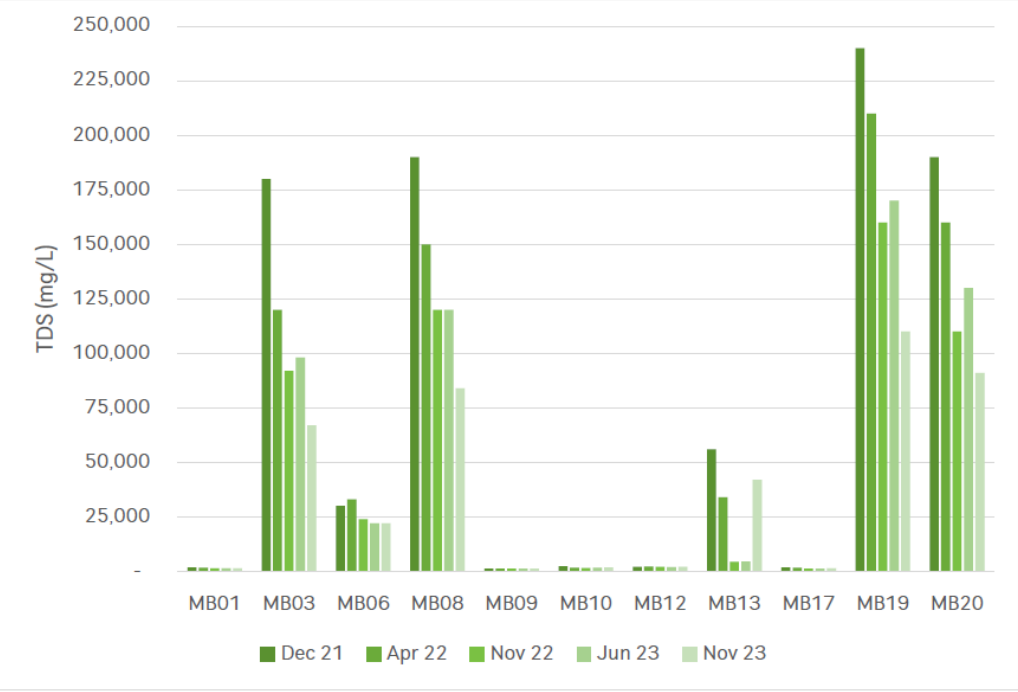


Figure 6-8: Summary of TDS measurements over groundwater monitoring events (LWC, 2023a; 2025)

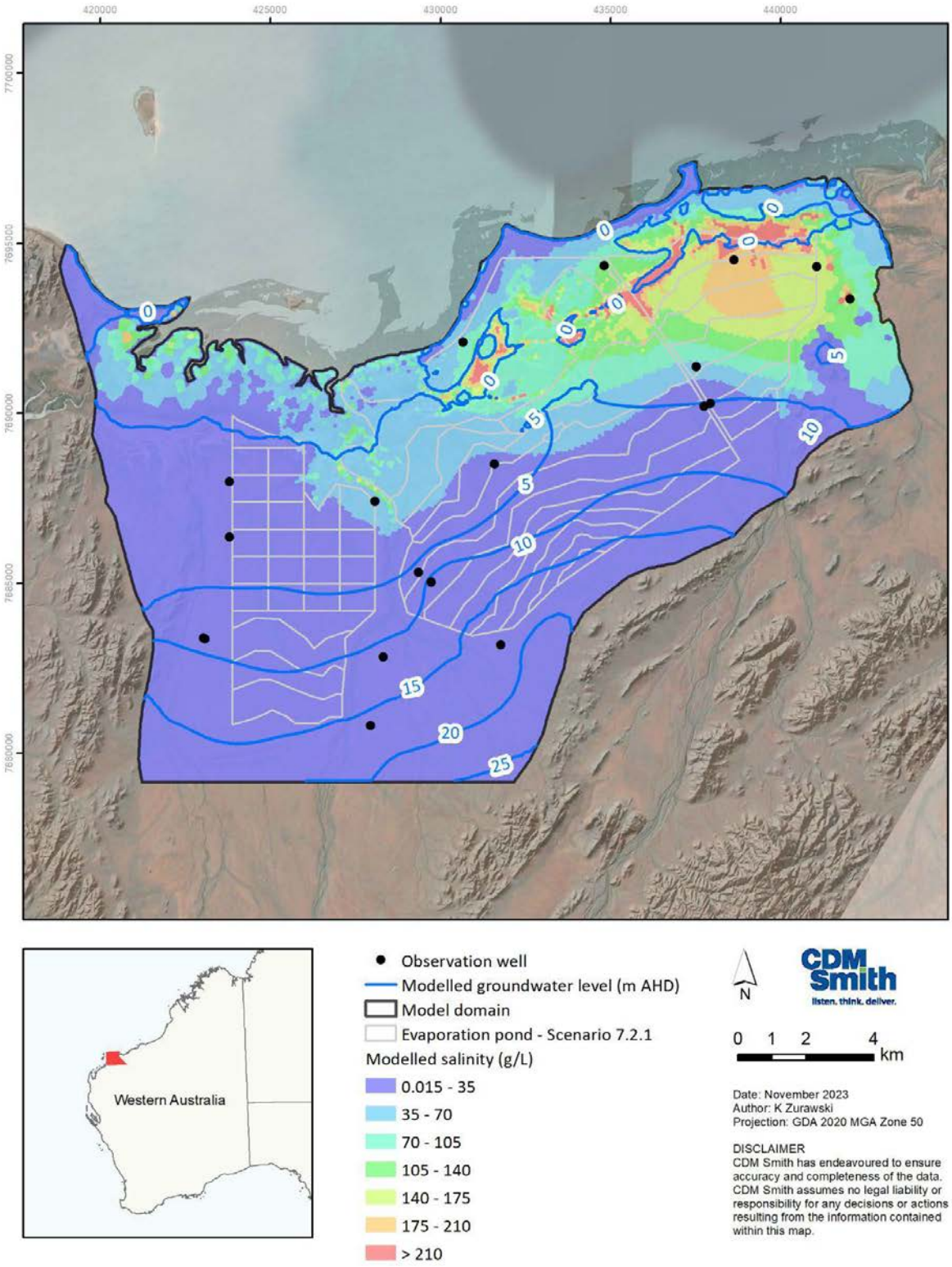


Figure 6-9: Modelled groundwater level contours from the calibrated model for current conditions

***Groundwater and Surface Water Interactions***

The most notable interaction between groundwater and surface water is expected to occur within the backwater areas adjacent to the coast, due to the low topography of the landform. Inflows are predicted to occur from a combination of:

i. The ocean;
ii. As upgradient flow further inland;
iii. Tidal flow; and
iv. Inundation from rainfall.

Outflows from this landform are predicted to occur via:

i. Evapotranspiration; and
ii. As minor outflows to the coast (depending on tidal movement and permeability of coastal aquifers).

Evapotranspiration within the backwater area forms a sabkha-like environment, where salts are precipitated above the saline water table hosted by lagoonal muds and marine sediments (CDM Smith, 2024). As shown in Figure 6-7, the result of these evaporative processes generates a hypersaline interface adjacent to the coast where concentrations currently exceed 100 g/L TDS and can reach as high as 240 g/L. This interpretation is generally consistent with the saline interface predicted by the CDM Smith's (2023) density dependent groundwater flow model albeit with some differences in salinity concentrations and extent of the saline interface inland. The development of hypersaline groundwater beneath this feature is likely to result in density-driven groundwater fluxes as salts infiltrate downwards into the underlying sediments. Although this area lacks deep drill holes to measure the change in salinity with depth, it is conceptualised salinity will increase with depth beneath and away from this feature. An increase of groundwater salinity with depth is observed at one nested monitoring site (MB33s and MB33d; Figure 6-2) where reported salinities vary by more than 16 g/L TDS between deep and shallow bores.

### 6.3.3 INLAND SURFACE WATER

***Catchment characteristics***

SWS (2025; Appendix 1.1) undertook a hydrologic assessment of the Proposal. The proposed ponds are located in three primary catchment areas: Eramurra Creek, McKay Creek, and Devil Creek (Figure 6-10). The total contributing catchment area of the three creeks is approximately 704 km$^2$. Catchment delineations and area tabulations are indicative only as there is some crossflow between the catchments that varies by flood event. In particular, there are some conjoined floodplains and anabranches connecting Eramurra Creek and McKay Creek.

Several creeks dissect this alluvial outwash plain. The creeks are generally small as the catchment is not large and the watershed is roughly coincidental with the position of the North West Coastal Highway. However, along the eastern edge of the site is a larger creek called Devil Creek which drains a larger inland area, as does Eramurra Creek that follows the western side of the proposed ponds. There is only one large named creek (McKay Creek) that flows through the middle of the ponds. This creek is locally incised down about 1 m in the creek bed or about 3 m of incision across the 200 m wide floodplain.

The central and eastern parts of the PIDE comprise a line of coastal beach ridges, dunes and cheniers forming a coastal barrier rising locally to over 12 m along the crest of the main dune. A backwater has formed behind the coastal barrier and this area is referred to as intertidal and supratidal flats. Several small (high tide) islands are present in the backwater and these provide evidence of former coastlines which are now partially buried beneath the lagoonal sediments associated with the backwater. Mangroves fringe the western aspect of this area and inland of intertidal and supratidal flats is an area of alluvial outwash. The land falls at a gradient of about 1 m in 300 m from the southeast towards the northwest.

The PIDE is located approximately 80 km from the nearest gauged catchments, which include several catchments with drainage areas approximately equal to the site catchments. Due to the elongated, linear shape of the Eramurra catchments, the Regional Flood Frequency Estimation (RFFE) results state that the applicability of the predicted peak flow rates may be limited.

Table 6-4 shows the RFFE results for Eramurra Creek, McKay Creek and Devil Creek. The RFFE results indicate substantial uncertainty with peak flow estimates from 5% and 95% confidence limits. As such, the results will be used for reference only, and more detailed rainfall-runoff modelling will be undertaken as the pond and drainage design progresses.

**Table 6-4: RFFE results for Eramurra Creek, McKay Creek and Devil Creek surface water catchments**

| Catchment | Area ($km^2$) | AEP | Discharge ($m^3/sec$) | Lower Confidence Limit (5%) ($m^3/sec$) | Upper Confidence Limit (95%) ($m^3/sec$) |
|---|---|---|---|---|---|
| **Eramurra Creek** | 151 | 50 | 27.0 | 5.30 | 138 |
| | | 20 | 77.5 | 15.3 | 397 |
| | | 10 | 126 | 24.9 | 647 |
| | | 5 | 184 | 36.2 | 942 |
| | | 2 | 267 | 52.6 | 1,370 |
| | | 1 | 333 | 65.6 | 1,710 |
| **McKay Creek** | 291 | 50 | 26.0 | 5.10 | 134 |
| | | 20 | 74.6 | 14.6 | 383 |
| | | 10 | 122 | 23.8 | 624 |
| | | 5 | 177 | 34.7 | 909 |
| | | 2 | 257 | 50.4 | 1,320 |
| | | 1 | 321 | 62.9 | 1,650 |
| **Devil Creek** | 262 | 50 | 33.8 | 6.70 | 171 |
| | | 20 | 96.9 | 19.2 | 490 |
| | | 10 | 158 | 31.3 | 798 |
| | | 5 | 230 | 45.6 | 1,160 |
| | | 2 | 334 | 66.3 | 1,690 |
| | | 1 | 417 | 82.7 | 2,110 |

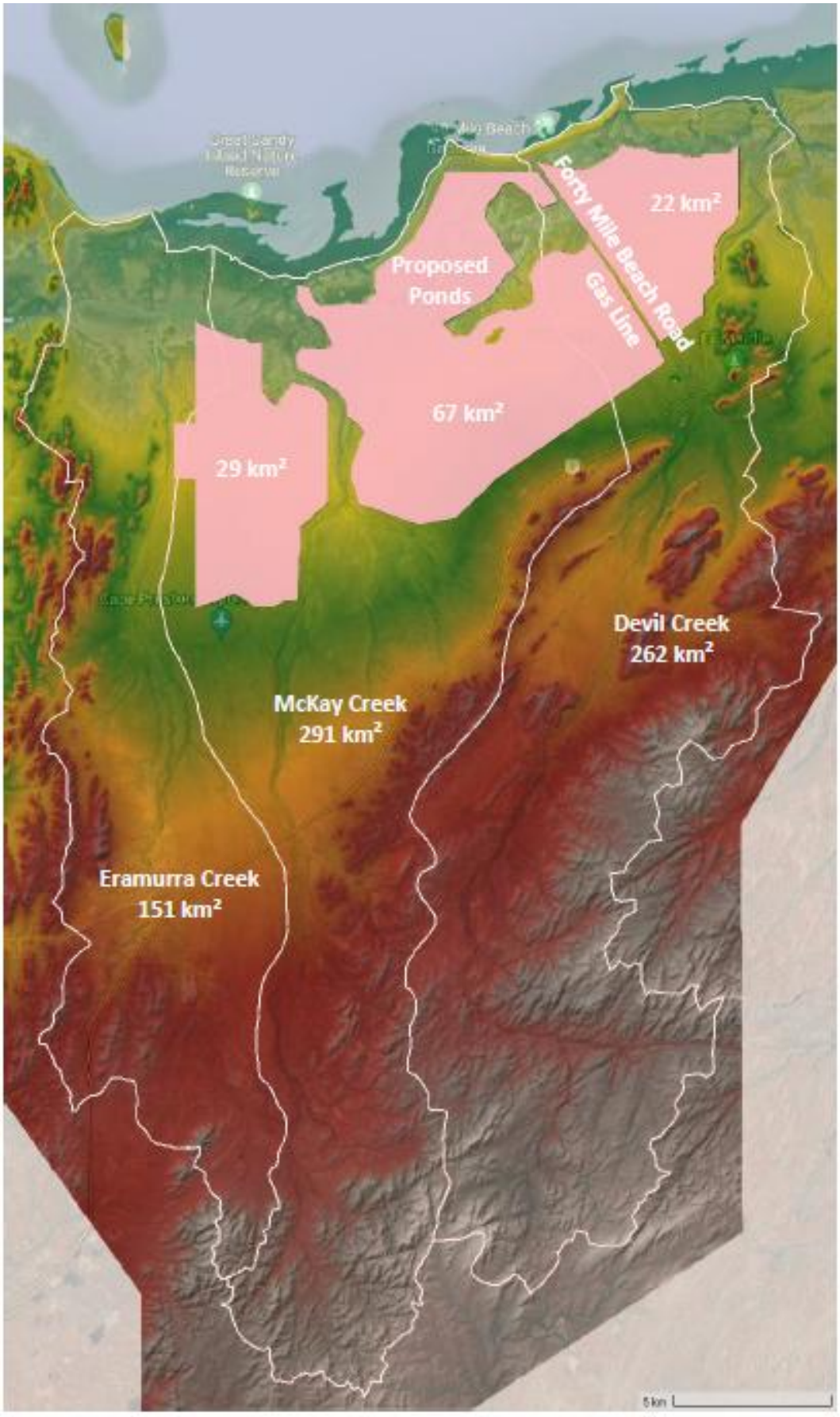


Figure 6-10: Pond layout and contributing catchment areas

A peer review was completed on a hydrologic assessment completed by LWC (2023) (Appendix 7.6). This report was replaced by the hydrologic assessment completed by SWS (2025) and comments provided in the peer review were addressed in this report. The peer review was conducted by Hydro Geo Enviro (2023a) which concluded that the hydrologic modelling has been undertaken using high-level industry standard techniques and is fit for purpose. It was recommended that hydrologic modelling be revisited again once more local flow gauging is available. LWC (2025) also underwent a peer review (Hydro Geo Enviro, 2023c), which identified that measurement procedures for both the manual values and logger data are suitable and follow relevant guidelines and standards.

***Key Surface Water Features***

Several creeks dissect the PIDE. The creeks are generally small as the catchment is not large and the watershed is roughly coincidental with the position of the North West Coastal Highway. As discussed in Section 6.3.3 Catchment Characteristics, Devil Creek drains a larger inland area, as does Eramurra Creek.

***Devils Pool***

Devils Pool is an ephemeral surface water feature located in an area of elevated basement geology characterised by underlying low permeability igneous rock. An indication of the permanence of surface water at Devils Pool is provided by the DEA Multi Year Water Observation Statistics from Landsat data. This a statistical summary that combines all years (2004 to near present) and plots the percentage of wet observations that were observed in the landscape. According to these data, Devils Pool holds water less than 2% of the time (Figure 6-11). This observation is supported by surface water monitoring in the area which indicates dry conditions within Devils Pool and Devil Creek for the majority of time since monitoring began in December 2021 (LWC, 2025). Images collected from monitoring in November 2023 are shown in Figure 6-12 with dry conditions observed at both Devils Pool surface water gauging point and Devil Creek surface water sampling point. Locations of these sampling points are shown in Figure 6-1 and Figure 6-2.

Monitoring data since January 2024 from the Devils Pool surface water logger is shown in Figure 6-13 with comparison made against Karratha rainfall data. Monitoring records indicate minor fluctuations over the period of record that lack correlation with rainfall data. The observed fluctuations are therefore most likely attributed to changes in atmospheric pressure as opposed to surface water flows.

Additional data to support the current understanding of Devils Pool has been obtained from recent groundwater drilling investigations undertaken in the vicinity of Devils Pool (CDM Smith, 2024). Drilling of MB21s, located around 150 m west of Devils Pool, encountered groundwater at around 10 m bgl. When viewing the recent groundwater levels (~8.5 m bgl) with respect to creek bed elevations, the observed depth to groundwater suggests groundwater discharge to Devil Creek and Pool is unlikely.

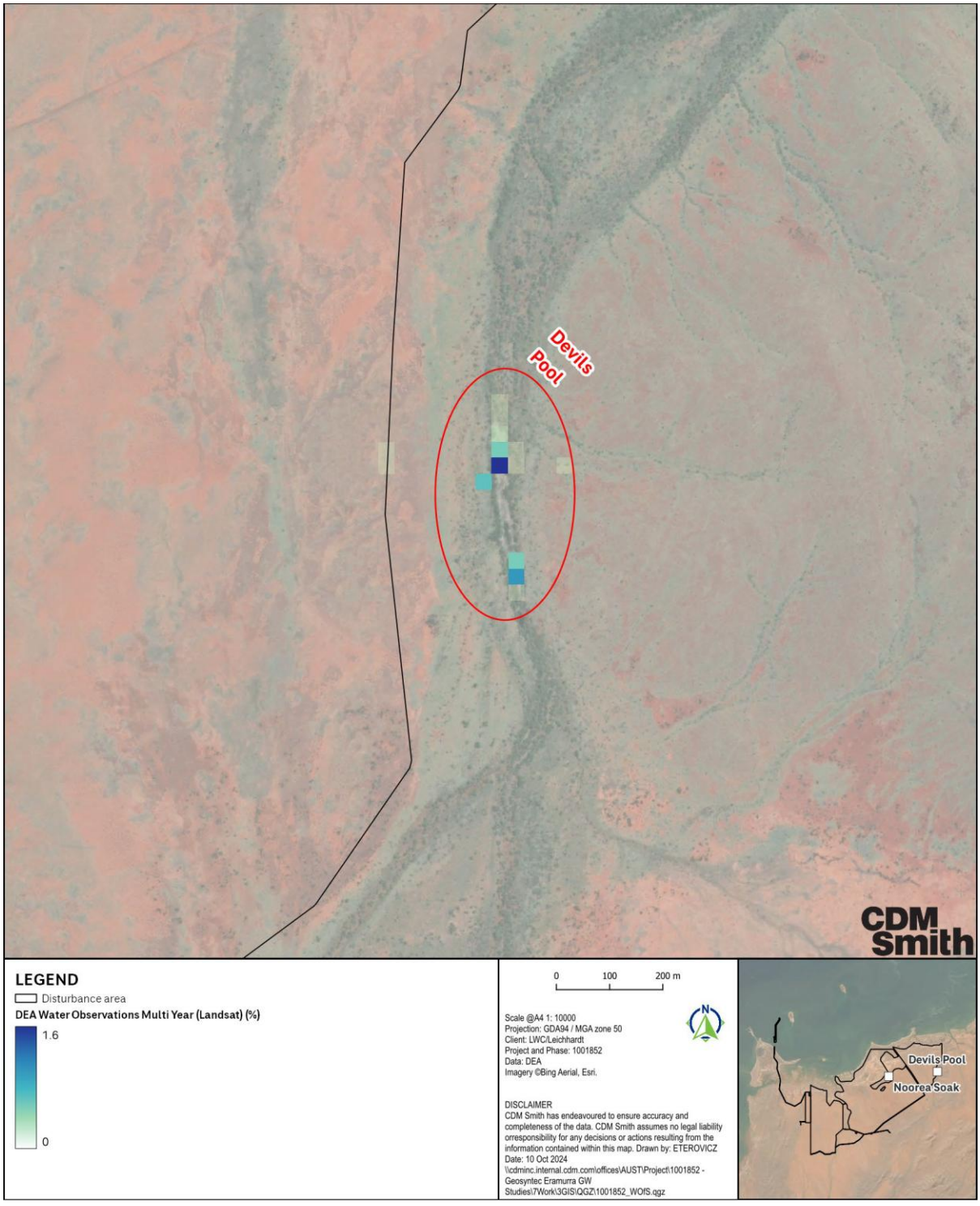


Figure 6-11: Percentage of Landsat observations in which water is detected



Figure 6-12: Devils pool surface water logger location (Y5850 - left) and Devils Pool surface water sampling location (SW11 – right)

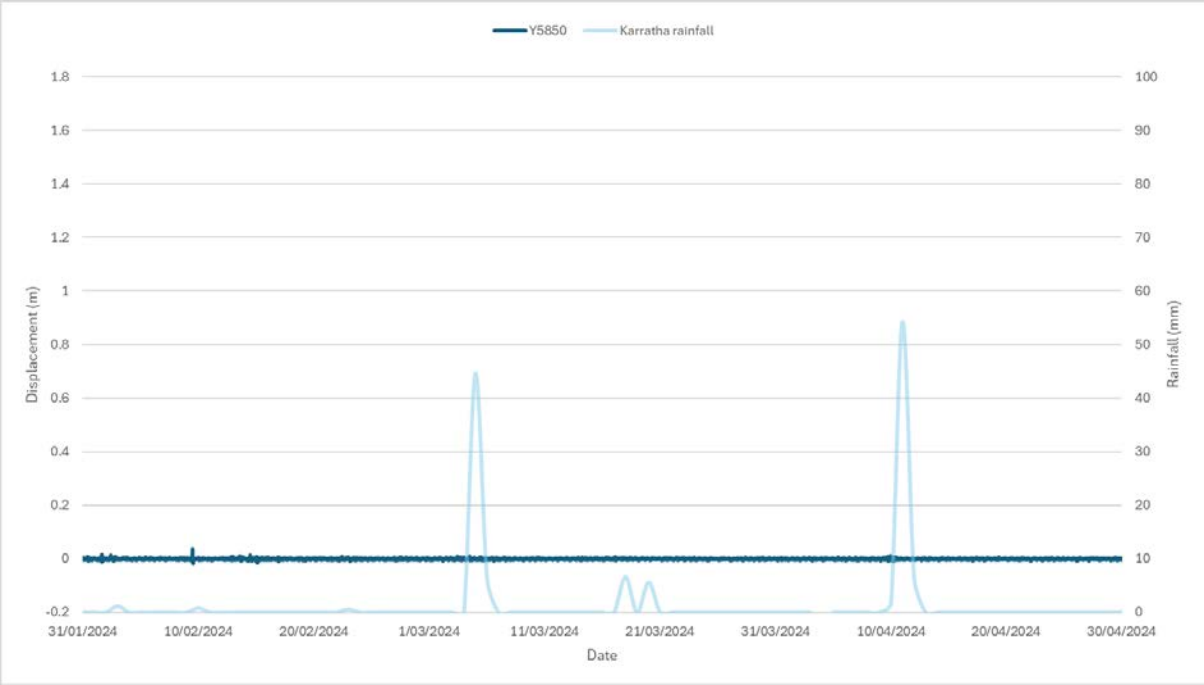


Figure 6-13: Devils Pool surface water logger (Y5850) records

### *Noorea Soak*

Noorea Soak is a depression located at the at the bottom of a catchment and collects water during rainfall and run off events (Figure 6-14). It is located within the central point of the PIDE in a topographical low point that is underlain by crystalline basement outcrop. Available information from both aerial imagery and remote sensing suggests Noorea Soak dries out on occasion and is not a permanent water feature. While groundwater contributions to this feature are possible, the depth to water at the nearest groundwater monitoring bores (MB06 at ~1 km and MB09d at ~1.5km) measured around 8.5 and 9 m below top of casing respectively.

Groundwater monitoring to date indicates little fluctuation (<1 m) of groundwater heads suggesting that discharge of groundwater to the Noorea Soak is unlikely to occur from seasonal fluctuations in groundwater elevation. CDM Smith (2023) predicted that groundwater heads would need to increase by more than 2 m for discharge to occur to this feature. Furthermore, granitic basement rock underlying the Noorea Soak is thought to be very low permeability (ranging between 1 x $10^{-5}$ to 1 x $10^{-4}$ m/d and very unlikely to support the storage and transmission of groundwater in large quantities. Due to the lack of permanent inundation, depth and fluctuation of groundwater in the surrounding areas, and permeability of the underlying basement stratigraphy, it is unlikely the soak currently receives substantial groundwater inflows and more likely the case this feature is driven by surficial pooling within the topographic low point it resides.

An additional monitoring bore is planned to be installed closer to Noorea Soak to obtain additional data to inform the conceptual understanding of this feature and guide future management.

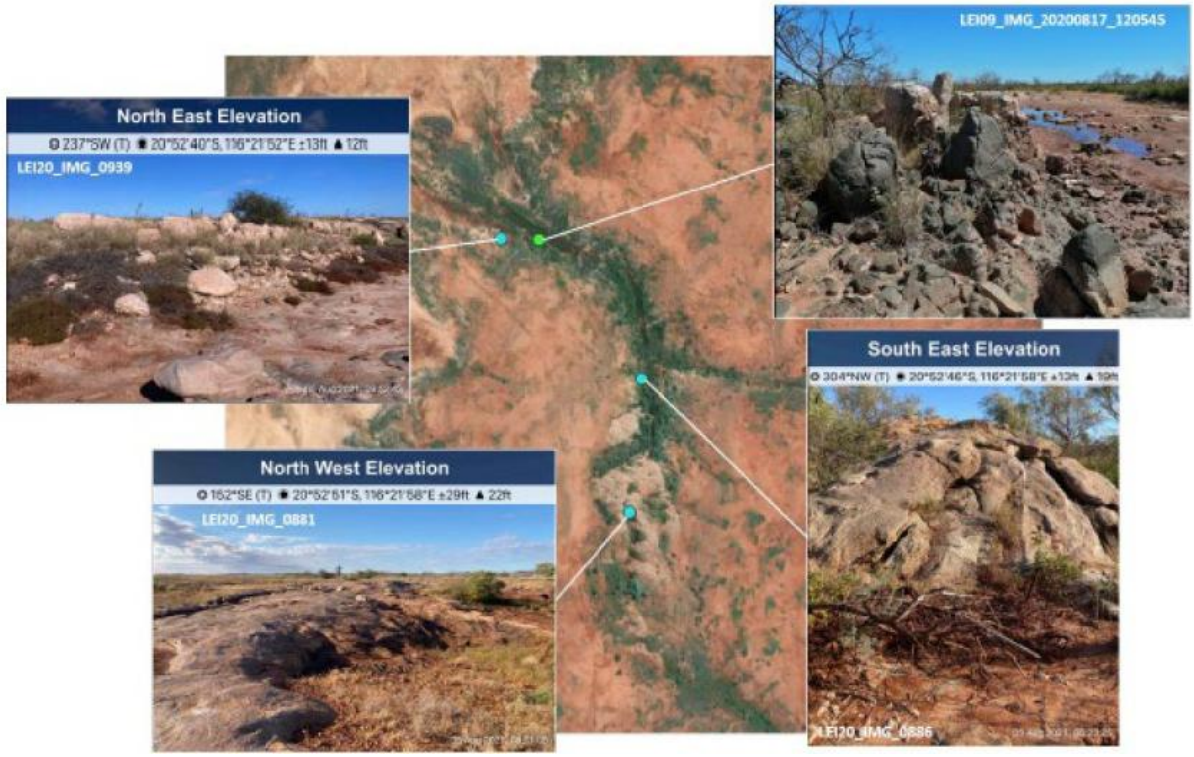


Figure 6-14: Field photographs of outcropping basement in the area of Noorea Soak

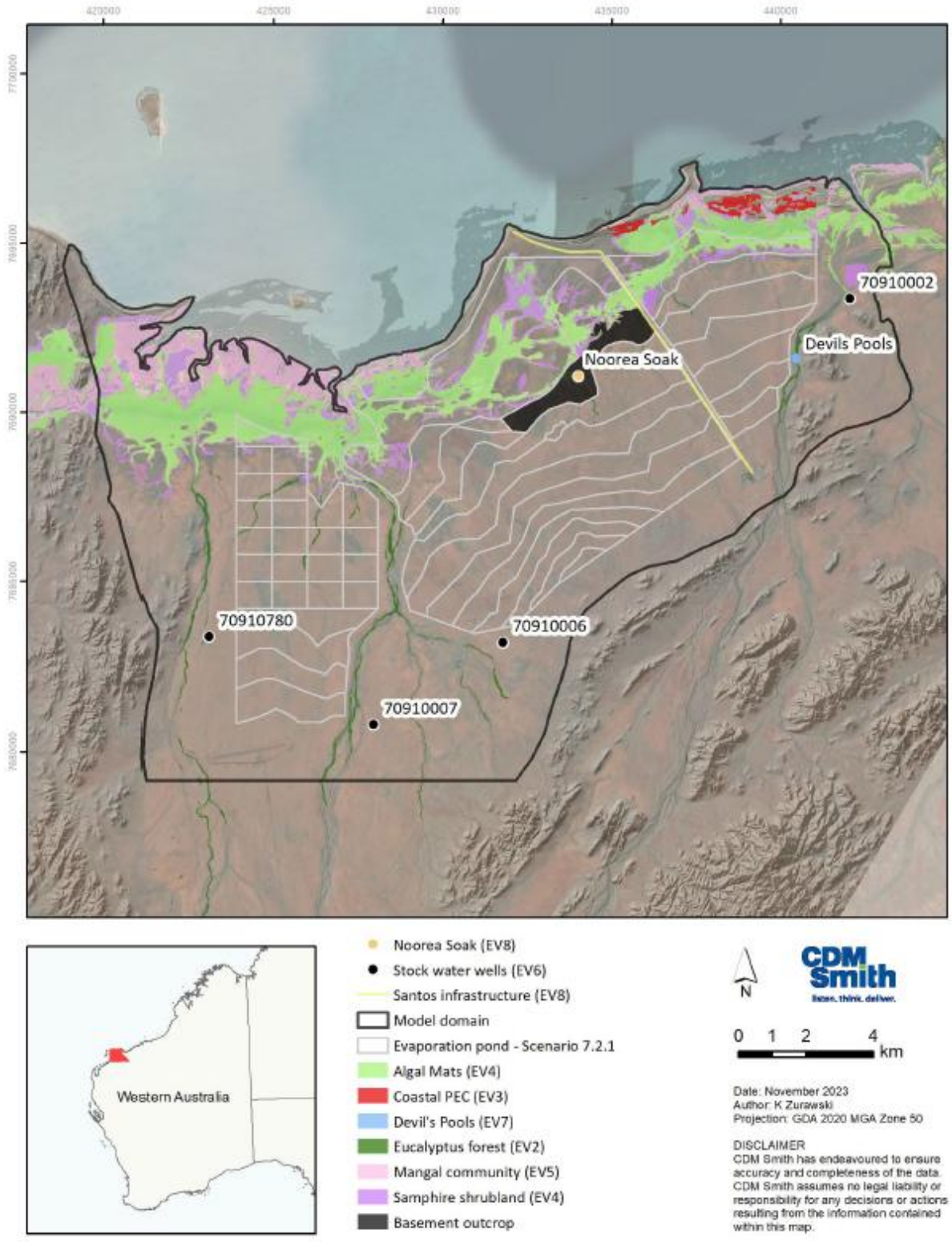


Figure 6-15: Key surface water features

### *Surface Water Quality*

The opportunity to collect surface water quality samples has been limited by extended periods of drought in the area. However, LWC (2025; Appendix 1.5) was engaged to undertake surface water monitoring in March, May and November 2022, June and November 2023 and July 2024 when sufficient run-off water was present. Surface water samples were collected from targeted locations and were analysed for key potential chemical substances of concern. Key findings of the monitoring events included the following:

1. The reported concentrations of pH, total dissolved solids, major cations/anions (calcium, chloride, sodium, sulfate and hardness), various metals/metalloids and nutrients were observed above the adopted guideline criteria for drinking water, recreation, freshwater, marine water, irrigation and/or livestock water use; and
2. The data quality assessment indicates that the chemical and physical hydrogeological data reported for the March, May and November 2022, June and November 2023 and July 2024 programs of work is suitable to inform the baseline hydrological assessment for the Proposal.

A summary of the field parameter ranges and hydro-geochemical conditions in surface water across the PIDE is provided in Table 6-5. The surface water monitoring network is shown in Figure 6-1.

Table 6-5: Summary of surface water monitoring results

| Field Parameter | Units | March 2022 | May 2022 | November 2022 | June 2023 | November 2023 | July 2024 | Comment |
|---|---|---|---|---|---|---|---|---|
| pH | pH units | 7.4 (SW01) – 8.9 (SW06) | 6.3 (SW11R) – 8.9 (SW04) | 5.99 (SW06) to 7.57 (SW01) | 5.07 (SW06) to 6.00 (SW05) | 7.97 (SW01) to 8.22 (SW02) | 6.85 (SW01) and 8.48 (SW14) | Slightly acidic to slightly alkaline conditions were observed in surface waters.<br>Field results were generally confirmed by the laboratory analytical results. |
| Electrical Conductivity (EC) | µS/cm | 256 (SW13) – 141,399 (SW06) | 81 (SW14) – 179,665 (SW06) | 61,698 (SW01) to 204,939 (SW02) | 215 (SW13) to 102,834 (SW06) | 65,772 (SW01) to 170,156 (SW06) | 1,050 (SW14) and 66,644 (SW01) | Higher salinities (i.e., TDS >1,000 mg/L) were reported for surface water sampled at SW01, SW02, SW06 and are all located near the marine/estuary environment.<br>Field results were generally confirmed by the laboratory analytical results, however, there were some variations between field and laboratory results higher salinities. |
| Total Dissolved Solids | mg/L | 167 (SW13) – 91,909 (SW06) | 53 (SW14) – 116,782 (SW06) | 40,103 (SW01) to 133,210 (SW02) | 140 (SW13) to 66,842 (SW06) | 42,752 (SW01) to 110,601 (SW06) | 683 (SW14) and 43,319 (SW01) | |
| Redox | mV | 19.1 (SW06) – 109.5 (SW02) | -4.7 (SW03R) – 349.4 (SW14) | -90.2 (SW01) to-70.4 (SW06) | 66.6 (SW05) to 99.5 (SW06) | -97.9 (SW01) to 69.4 (SW02) | 31.2 (SW01) and 52.0 (SW14) | Converting these values to the Standard Hydrogen Electrode (e.g., addition of 199 mV), positive oxidation-reduction potentials were observed at all locations. |
| Dissolved Oxygen | mg/L | 2.6 (SW01) – 5.3 (SW06) | 0.0 (SW06) – 6.2 (SW07) | 0.60 (SW06) to 5.10 (SW01) | 0.01 (SW01 & SW06) to 6.20 (SW05) | 3.14 (SW02) to 5.20 (SW01) | 1.60 (SW01) and 3.90 (SW14) | Dissolved oxygen levels were variable between locations. |
| Temperature | ºC | 26.9 (SW01) – 36.6 (SW13) | 22.0 (SW08) – 36.5 (SW06) | 23.9 (SW02) to 27.8 (SW06) | 14.4 (SW06) to 22.3 (SW05) | 22.4 (SW04) to 30.2 (SW06) | 13.5 (SW14) and 18.6 (SW01) | Temperatures were considered representative of atmospheric conditions at the time of sampling. |

### 6.3.4 TIDAL CHARACTERISTICS AND INFLUENCES

The text in this section has been sourced from O2 Metocean (2023b; Appendix 1.2) and Larcombe et al. (2025; Appendix 1.3), unless stated otherwise.

***Tidal Cycle***

The simulation period (24 March – 8 April 2021) encompassing some of the largest tidal ranges (in the measured data) was developed to allow for the comparison of tidal inundation processes during the full range of tides experienced at the site. The period was adopted for the inundation simulations based upon the availability of high quality validation data concurrently gathered at oceanographic data collection sites (UNS05, NCP05 and ERA05) and creeks (STR02, and SIC02) (Figure 6-16).




Figure 6-16: Metocean data collection sites

Figure 6-17 presents water levels available for water elevation validation of the O2 Metocean tidal inundation model. The high tide water levels during the selected period were between Mean High Water Springs (1.7 m mean sea level (MSL)) and Highest Astronomical Tide (HAT; 2.37 m MSL) for Cape Preston.

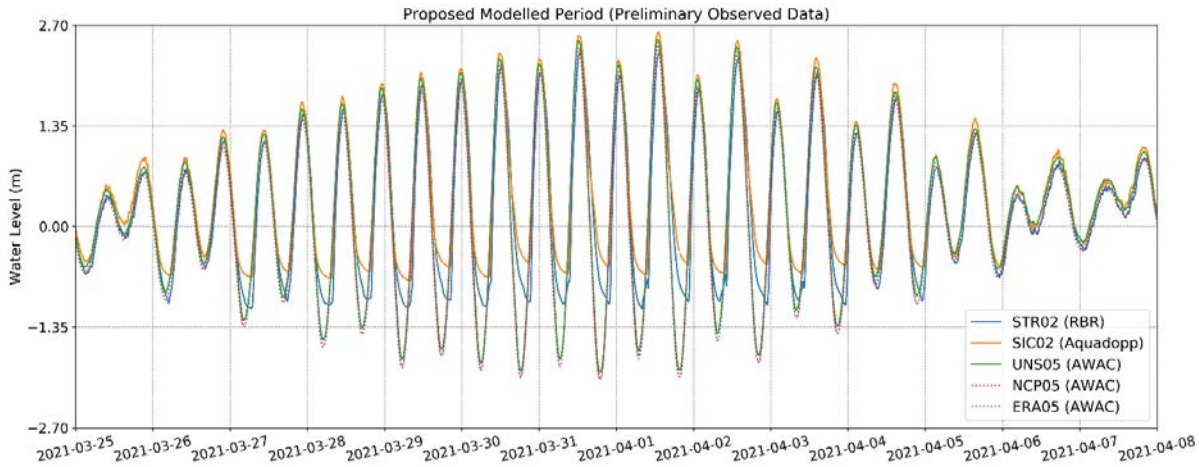


**Figure 6-17: Measured water level data**

The tidal inundation model domain extends from the western side of Cape Preston through to the coastline just prior to West Intercourse Island, covering approximately 50 km of coastline, centred at Regnard Bay. Depths range from approximately 25 m AHD near the offshore boundary through to heights of approximately 10 – 15 m AHD south of the ponds, allowing for full coverage of the intertidal regions. Substantial attention was made to optimise the geographic resolution of the complex intertidal regions, to best resolve the various creek systems surrounding the ponds and utilise high-resolution bathymetry data.

Figure 6-18 presents a map extending to the intertidal region of interest, illustrating the percentage of time wet for the existing bathymetry model simulation. The map demonstrates that there are two main intertidal creek systems which flood under normal spring high tide conditions but remain isolated from each other.

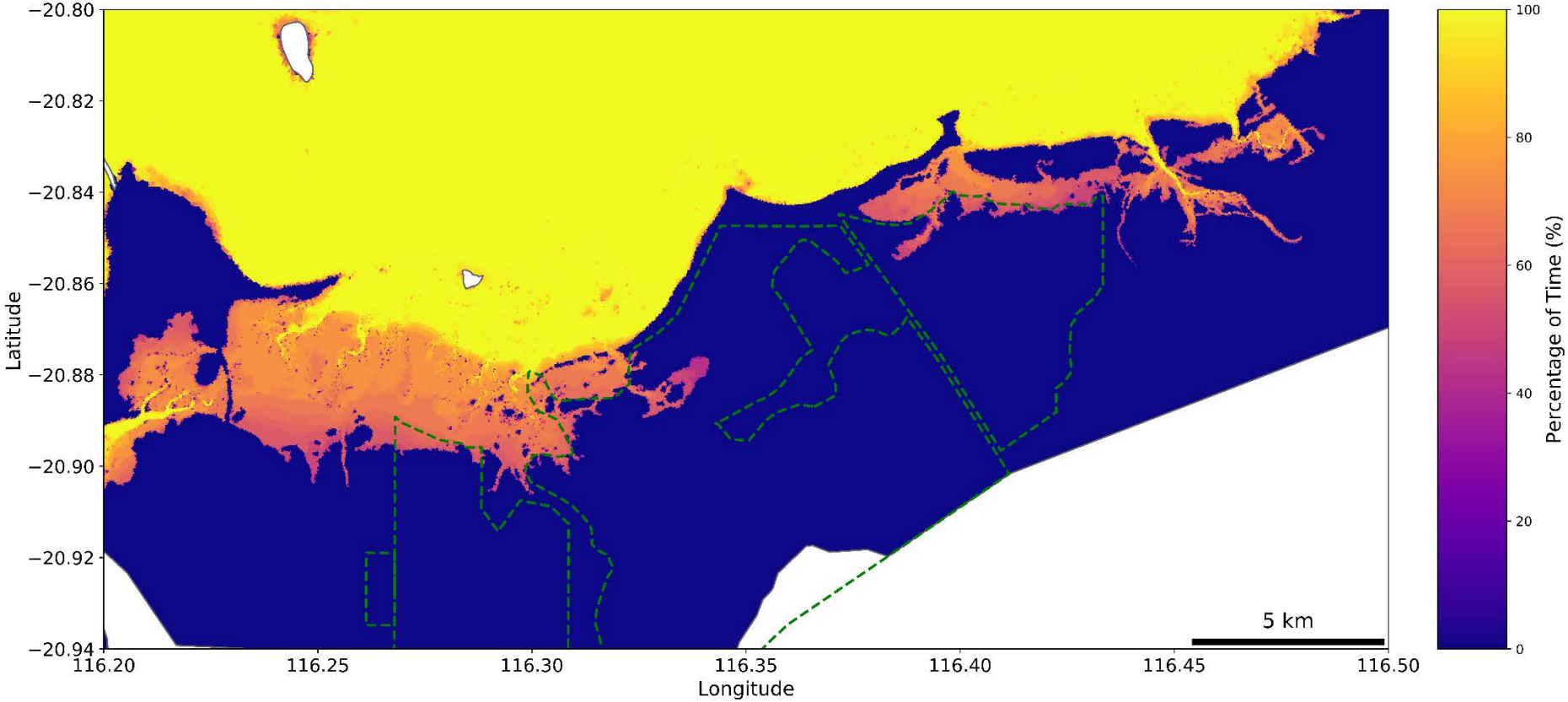


Figure 6-18: Percentage time 'wet' (pre-development)

### *Influence of Cyclones and Tropical Lows*

The region is exposed to tropical storms and cyclones during the wet season. The Karratha to Onslow coastline is the most cyclone-prone section of the Australian coast, with one cyclone making landfall on average every two years. Cyclones affecting the Pilbara typically form in the tropical waters between the Kimberley and the Timor Sea and intensify as they propagate westward and poleward, though tracks of significant cyclones impacting Cape Preston within the last 30 years are varied. In addition to tropical storms, troughs of low pressure also bring rain, strong winds, and sharp changes in wind direction.

Despite the presence of La Nina, cyclone impacts in the Pilbara Region were very mild during the 2020 – 2021 cyclone season. The only storms reaching cyclone classification were TC Marian (21 February – 9 March 2021), and the interacting systems TC Seroja (3 – 12 April 2021) and TC Odette (3 – 10 April 2021), although each of these reached full intensity far to the west of Cape Preston. In addition to these extreme events there were numerous other weaker tropical storms in the region (e.g., TL02U 6 – 12 December 2020; TL08U 15 – 23 January 2021, and; TL12U 28 January – 5 February 2021).

A total of 31 cyclonic events passed within 200 km of the site since the beginning of 1988. The track passage was categorised as a northwest passage (passing to the north and/or crossing land to the west), a southeast (crossing land east of the site) or a direct hit (passing within 20 km). Most (20 of 31) passed the site to the northwest, with most of those making landfall to the west. Cyclones travelling a northwest passage generate strong onshore winds and associated storm surges at the site. Cyclones travelling a southeast passage generate strong offshore winds that may reduce the associated storm surge. Cyclones that pass directly over the site generate a more complex (time-dependent) wind field at the site.

Cyclone associated rainfall was highly variable, as measured at the BoM Eramurra site which is 15 km inland and at 50 m elevation. Measured rainfall varied from 0 – 280 mm with an average of 85 mm (at Eramurra). Rainfall spatial distribution was highly variable, with large differences often measured between the weather station at Eramurra and stations at Karratha Airport (65 km northeast) and Mardie (33 km southwest).

### *Storm Surges*

A storm surge is a rise along a shore above the normal water level resulting from strong onshore winds and/or reduced atmospheric pressure. Storm surges accompany a tropical cyclone as it comes ashore. The combination of storm surge and normal (astronomical) tide is known as a 'storm tide' (BoM, 2018). The greatest impacts occur when the storm surge arrives on top of a high tide. Storm surge influences are often amplified by pounding waves generated by the powerful winds.

SWS (2025; Appendix 1.1) analysed available data to calculate storm surge and extreme water levels for the Proposal. The outcomes from that study indicated the following return period guidance:

- 100-year still water sea level is on average 3.19 m above 0.0 m AHD; and
- 10-year sea level is on average 2.69 m above 0.0 m AHD.

### *Tidal Creeks*

Tidal creeks are meandering and bifurcating drainage channels that connect the landward intertidal flat basins (claypans) with the ocean, through a series of banks and washes, and play an important role in the movement of water and sediment. Tidal creek systems and associated tidal flats display the majority of tide-driven coastal changes in the Pilbara, with rapid switching between erosion and accretion in response to changing metocean conditions (DPLH, 2013).

Freshwater inputs are virtually absent in tidal creeks and marine water is largely contained within channels on inundating adjacent mudflats during spring tides. These systems are dominated by high levels of tidal energy. Catchment derived sediments and nutrients are limited in tidal flats and creeks, with fine material only delivered by sheet runoff during rain events and coarser material during extreme storms. Marine sediments and nutrients dominate and are deposited in intertidal habitats, while strong tidal energy leads to erosion of finer sediments in subtidal habitats (Hadwen et al., 2012).

Tidal channels are frequently interconnected and flanked by large areas of low-gradient intertidal flats, mangroves, saltmarsh, and salt flat environments. The coastal mudflats that generally surround tidal creeks tend to be at or above the limit of high tide, and seawater is mainly confined to the tidal channel, except during spring tides (Ryan et al., 2003).

Evaporation is a significant process in tidal creeks due to the extensive intertidal area and extreme climatic conditions. Salt flats environments are inundated rarely (e.g., 3 – 4 days per month), resulting in hypersaline groundwater and often a saline crust on the surface. Ebb flows from these areas can cause tidal creeks to become hypersaline, but typically only for short periods of time, due to strong tidal flushing (Ryan et al., 2003).

The Proposal harbours a major tidal estuary, which contains tidal creeks of various forms and sizes, and within which are extensive areas of subtidal and intertidal flats, fringing and estuarine mangroves. The coastline north of the proposed ponds is about 18 km long, and contains a variety of coastal morphologies, inferred sediment transport regimes and sediment transport pathways. At the eastern margin of the ponds are located several tidal creeks, again of various forms and sizes. Further east are the wave-dominated deltas of some relatively small rivers - the Yanyare and Maitland – beyond which is the complex array of islands of the Dampier Archipelago.

### *Sea Level Rise*

Sea level rise data around the world are curated by the Permanent Service for Mean Sea Level, Liverpool, from whom data are available (PSMSL, 2022). Data for the last 50 years around Australia indicate an average rate of sea level rise of 2.1 mm/year. The Proposal is located between monitoring stations at Onslow to the southwest and Dampier to the east, for which data indicates high variability and a mean rate of sea level rise since 1985 of 2 – 4 mm/year.

### 6.3.5 Flood Level Joint Probability

The intertidal areas can be simultaneously flooded from the upstream catchment as well as coastal inundation from storm surges. Generally, both events are associated with cyclonic activity. However, a cyclone-related flood in the upstream catchment would occur sometime after any associated abnormal sea level (the height of which can vary greatly), as the cyclone tracked across the coast and moved inland. Hence significant storm surge and upstream flooding are not dependent, and generally do not occur simultaneously.

A common way of handling this joint probability between the two flood mechanisms is provided in the 'Flood Risk Management Guide' (New South Wales (NSW) Department of Environment, Climate Change and Water 2010/759, 2010). This approach adopts a probability ratio for the two flood mechanisms of 1:5, i.e., assuming 20-year ARI catchment flooding in conjunction with 100-year sea levels, or 100-year catchment flooding in conjunction with 20-year sea levels. The 'Karratha Coastal Vulnerability Study' (JDA, 2012) studied the joint probability between river flood levels and storm surge in the Karratha area and found no obvious correlation; that study therefore adopted the 100-year catchment flood flow in conjunction with the 20-year sea level (estimated as 3.9 mRL) as the downstream boundary condition.

### 6.3.6 Potential Acid Sulfate Soils

In order to select the number of sampling locations, a combination of targeted and grid-based sampling methods was adopted as detailed below:

- CMW investigated the western ponds area and algal mats along the coastal aspect of the Proposal, resulting in 464 test pit samples, 54 Cone Penetration Testing (CPT) samples and 63 surface samples in 2021;
- LWC investigated the following locations in March 2022;
    - Perimeter outside pond footprint, collecting 14 samples;
    - Access route area in northwestern corner of the Proposal, collecting four samples;
    - Monitoring well locations, collecting 11 samples;
    - Surface water sampling locations, collecting 14 samples; and
    - Infill sampling, collecting three samples.

All assessments were conducted in accordance with the 2015 *Guidelines for Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes* (DWER, 2015).

***ASS Risk Mapping***

The coastal soils at the site are described by LWC (2022) as possessing a high risk, moderate and low risk of containing acid sulfate soil within 3 m of current ground surface, each risk ranking is dependent on the soil/sediment type and depth to groundwater. The following criteria are used to interpret the field screening results:

- $pH_f \leq 3$;
- $pH_f - pH_{fox} = 3$ or more; and
- Strong to extreme reaction rating (values of 4 or above).

As per DWER (2015) Identification and investigation of acid sulfate soils and acidic landscapes, high Potential ASS (PASS) risk rating was assigned if the samples displayed all three criteria. Moderate PASS risk is assigned if two positive criteria are reported, and Low PASS risk is assigned if one criterion is positive.

The samples collected in 2021 were submitted for PASS screening analysis. Out of the 437 samples, 436 were given a low-risk rating (i.e., one or none of the three risk criteria were met). One sample (CPT052; Figure 6-19) was given a moderate risk rating, and no samples received a high-risk rating. Furthermore, no samples were considered to be Actual ASS.

CPT052 is located approximately 600 m outside the nearest proposed disturbance. Leichhardt considers that ASS poses a low risk to the Proposal with further investigations not required until there is a firm definition for bund alignments and borrow sites. All of these will be specifically assessed for ASS conditions at that stage. If ASS is identified, the first preference will be revising the design to avoid disturbing those locations, otherwise industry-standard treatment and management will be implemented.

***Assessment of Construction Materials***

In 2022, LWC undertook a baseline soil assessment of the PIDE including physical (i.e., particle size) and chemical (i.e., metals and hydrocarbons) characteristics (LWC, 2022; Appendix 1.4). The sampling locations are identified in Figure 6-19 and Figure 6-20.

The pH of surface soils at the Proposal were neutral to alkaline ranging from 6.9 – 13 (Figure 6-19). The highest pH is recorded in the coastal units ($pH_f$ SSA089) where evaporation is likely to be the greatest influence on pH. Sulfate and chloride concentrations generally correlate with soil Electrical Conductivity (EC) with the highest values reported in the coastal units. The coastal units also reported the highest Al, Mn, Ca, Na, K and Mg content (based on total and exchangeable concentrations).

The nutrient levels within soils are dominated by nitrogen, which is likely to be organic nitrogen, not nitrate. Organic carbon levels in the soil are generally below 1% C in the open playa areas, with concentrations increasing to a maximum of 10% C in areas close to creeks and in the coastal units. Phosphate concentrations displayed the opposite trend where concentrations are higher in the playa and alluvial outwash areas and lower in the coastal units.

ASS are unlikely to be present in the majority of the PIDE in the weathered residual soils and alluvial outwash. The soils outside of the coastal region are residual weathered soils derived from igneous rocks. Sulfides were not reported in these soils. However, one sample from the soils and sediments in the coastal units had some potential to be ASS. This sample was collected 1 km away from the Project boundary. The coastal units are described as occurring north of the alluvial outwash/residual surface within the playa (inter- and supra-tidal flats) and heading north towards the coastal dunes and including the sand islands (fringing dunes and deflated dunes, sand plains and sandy islands) interspersed within the inter- and supra-tidal flats and areas of mangrove and associated mangrove muds both along the coastline and within tidal creeks. Based on this, borrow areas proposed to be taken from the coastal units will be tested for ASS risk potential prior to disturbance.

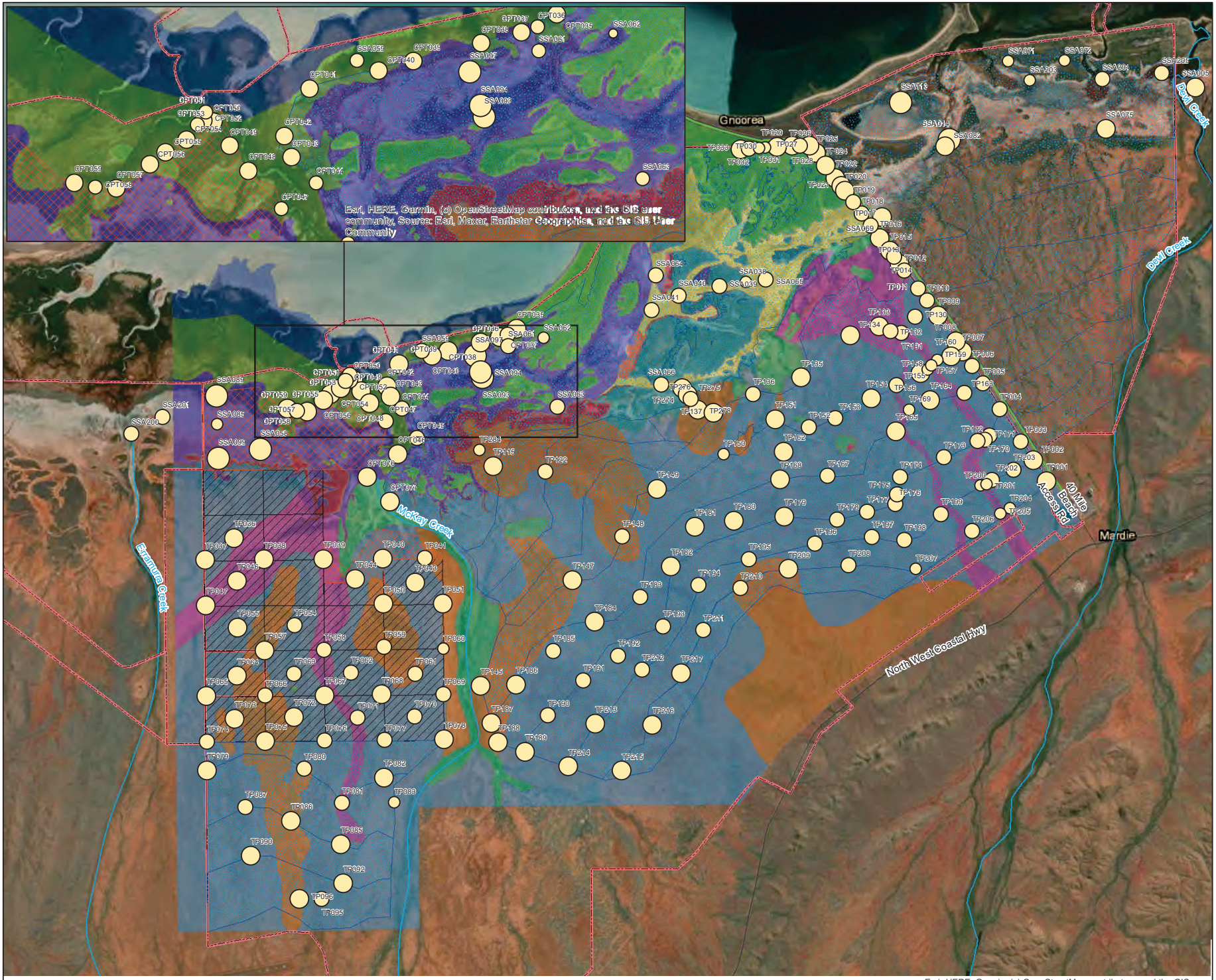


**Figure 6-19: Sampling locations and graduated concentration plots for pH field (note previous pond design shown)**

Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community, Source: Esri, the GIS User Community, Maxar, Earthstar Geographics. Source: Ersi

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Project:
Eramurra Salt Project
Soil and Sediment Phase 1 and 2

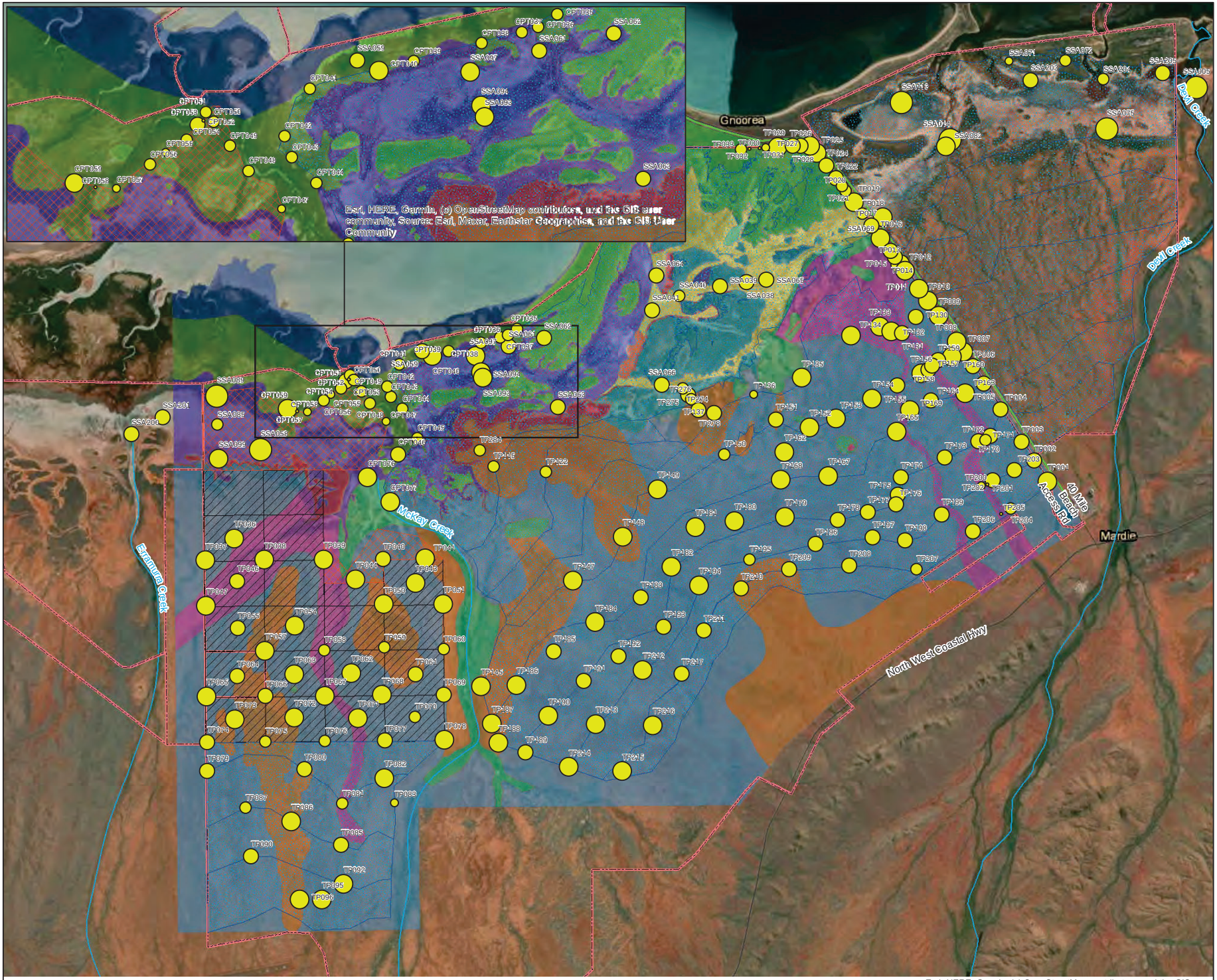
Figure Title:
Graduated Concentration Plots for pH Field

Date: July 2022
Projection: GDA94 Z50
Scale: See Plan
Figure in Set: 11 of 12

Site Address:
Mardie, Western Australia

Figure 11
Revision A

Drawing Reference AAAA




**Legend**

- Development Envelope
- Water Courses
- Gas Pipeline
- Roads

Pond Type

- Crystal
- Evaporation
- Recovery

Geology Description (CMW, 2022)

- Alluvial soil (sheetwash gravel over res. soil)
- Alluvial soils (braided channel gravels)
- Beach rock
- Calcarenite
- Calcarenite (inferred)
- Eolian sand (over calcarenite)
- Eolian sand (over granitoid/mafic rocks)
- Lagoonal mud
- Mangrove and Inter-tidal muds
- Mangrove mud
- Predominantly Doleritic dyke
- Predominantly Granitoid rocks
- Residual soil
- Thin Lagoonal Mud over Igneous Rock

pH Field Oxidised

- 3.1 - 6.3
- 6.3 - 7.4
- 7.4 - 8.4
- 8.4 - 9.1
- 9.1 - 10.0
- 10.0 - 12.0

0 440 880 1,760 2,640 3,520

Metres

N

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Project:
Eramurra Salt Project
Soil and Sediment Phase 1 and 2

Figure Title:
Graduated Concentration Plots for pH Field Oxidised

Date: July 2022 | Projection: GDA94 Z50

Scale: See Plan | Figure in Set: 12 of 12

Site Address:
Mardie, Western Australia

Figure 12 Revision A

Drawing Reference AAAA

**Figure 6-20: Sampling locations and graduated concentration plots for pH field oxidised (note previous pond design shown)**

Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community, Source: Esri, the GIS User Community, Maxar, Earthstar Geographics. Source: Ersi

### 6.3.7 Environmental Values

Based on the information provided in Section 6.3, the following environmental values were determined to require assessment for this factor:

- Groundwater beneath and surrounding the concentration ponds and crystalliser locations;
- Inland surface waters; and
- Intertidal zone.

## 6.4 Potential Impacts

Table 6-6 defines the potential impacts (direct, indirect and combined) on the environmental values for this factor in a local and regional context.

**Table 6-6: Potential impacts on inland waters environmental quality**

| Environmental value and current extent | Potential direct impact | Potential indirect impact | Impacts associated with other proposals | Total cumulative impact |
|---|---|---|---|---|
| **Groundwater**<br>Underlying groundwater varies from brackish to hypersaline and is relatively close to the surface in the vicinity of the concentration ponds and crystallisers. | No direct impact. Groundwater is not proposed to be abstracted for this Proposal and no direct discharges are proposed. | • Seepage and mounding from the concentration ponds and crystallisers may lead to changes in groundwater levels and flow paths;<br>• Seepage from ponds resulting in elevated salinity in underlying groundwater; and<br>• Changes in groundwater salinity regimes due to mounding. | • No other Proposals are predicted to be within the boundaries of the affected groundwater; and<br>• The Sino Iron Project dewatering zone is not expected to intersect with the predicted impacts of the Proposal (PSM, 2020). | • Changes in groundwater levels and flow paths due to seepage and mounding from the concentration ponds and crystallisers; and<br>• Changes in groundwater salinity due to seepage and mounding from the concentration ponds and crystallisers. |
| **Inland surface waters**<br>Several freshwater catchments intersect with the PIDE. | Intersection and diversion of drainage lines and floodwaters. | • Reduction in surface water flows due to the capture of rainfall within the ponds; and<br>• Surface water quality impacts associated with:<br>o Potential leaks or overflow of brine from the concentration ponds and crystallisers or pipelines;<br>o Sediment loss; and<br>o Hydrocarbon spills. | The North West Coastal Highway intersects across all three surface water catchments, however it is unlikely to have an effect on flow volumes and rates at the Proposal location. | • Changes to drainage and floodwater regimes due to the intersection and diversion of floodwaters and drainage lines, and the capture of rainfall within the ponds; and<br>• Indirect surface water quality impacts. |

| Environmental value and current extent | Potential direct impact | Potential indirect impact | Impacts associated with other proposals | Total cumulative impact |
|---|---|---|---|---|
| **Intertidal zone**<br>The intertidal system extends along the northern edge of the PIDE. | Maximum seawater abstraction rate of 31 $m^3/s$ from the tidal creek and never abstracting below 0.0 m AHD. | • Alteration of tidal regimes due to a reduction in intertidal zone;<br>• Erosion and accretion within tidal creeks due to changes in tidal inundation regimes;<br>• Surface water quality impacts associated with:<br>o Potential leaks or overflow of brine from concentration ponds and crystallisers or pipelines;<br>o Sediment loss; and<br>o Acidification of surface or groundwater as a result of the disturbance of ASS (if present).<br>• Restriction of inland movement of zone due to sea level rise. | There were minimal impacts to the inshore intertidal zone from Cape Preston Port and CPE Port, with the main impact being the causeway crossing between the mainland and Cape Preston, which is a bridge structure and therefore unlikely to affect intertidal flow regimes. | • Maximum seawater abstraction rate of 31 $m^3/s$ from the tidal creek and never abstracting below 0.0 m AHD;<br>• Alteration of tidal regimes due to a reduction in intertidal zone;<br>• Erosion and accretion within tidal creeks due to changes in tidal inundation regimes;<br>• Indirect surface water quality impacts; and<br>• Restriction of inland movement of zone due to sea level rise. |

# 6.5 Assessment of Impacts

## 6.5.1 Changes to Groundwater

Groundwater abstraction is not proposed as part of this Proposal. Impacts to groundwater from the Proposal are therefore restricted to those associated with seepage and mounding from the concentration ponds and crystallisers. CDM Smith (2023) developed a three-dimensional numerical groundwater model to determine the impacts of seepage and mounding, and these results are discussed below.

*Note that the potential impacts presented in this section are pre-mitigation, i.e., what could occur if groundwater was not monitored and managed appropriately.*

***Changes to Groundwater Levels***

The baseline model results show a high evaporation zone, (i.e., the area to the north of the main 0 m AHD contour in Figure 6-9) where groundwater evapotranspiration develops a depression in the water table and draws water from the south and the northern sea boundary.

Results from the mean sea level operation scenario suggest the concentration ponds and crystallisers will have a large influence on the surrounding and underlying groundwater levels. In particular, without mitigation, groundwater mounding beneath the concentration ponds and crystallisers could result in a steeper hydraulic gradient that causes more groundwater discharge to the sea. Under this scenario, the water table depression mentioned above in the northern part of the model domain (i.e., to the west of PL-N) is largely dissipated, which is expected as the current pond layout results in seepage recharge being directly applied to this area. In areas outside the concentration ponds and crystallisers (e.g., areas near AM-W and AM-E in Figure 6-21) the extent of high evaporation zone appears to remain largely similar to that of the baseline scenario (Figure 6-9).

Results from the operation scenario with sea level rise (SLR) are largely similar to the mean sea level operation scenario results, with the 0 m AHD contour along the coast (note this is different from the 0 m AHD contour near site AM-W) in the western part of the model domain being pushed towards the south due to the elevated sea level.

To assess the direct effects of water impoundment within the concentration ponds and crystallisers with respect to the location of the identified environmental values, predicted timeseries groundwater levels at selected locations were prepared and are shown in Figure 6-22 with positions outlined in Figure 6-21. Sites PL-S (Pipeline South) and PL-N (Pipeline North) have been selected to assess the direct effects of concentration pond operations on the Santos Gas Pipeline infrastructure. In particular, site PL-S is located at the Santos pumping station slightly upgradient (in terms of groundwater flow) of the concentration ponds, while site PL-N is located closer to the coast, in proximity to the concentration ponds and crystallisers, and the backwater area accommodating the algal mat communities. Sites, AM-W and AM-E, assess the direct effects to the algal mat and samphire communities, whereas site Devils Pool assesses the direct effects to Devils Pool and eucalypt species within Devil Creek. Similarly, sites PEC-E and PEC-W assess the direct effects to the Coastal PEC. The other locations (Mangroves, 70910002, 70910006, 70910007 and 70910780) have been positioned with respect to environmental values and named accordingly.

*EV3 – Coastal PEC*

Groundwater levels at sites PEC-E and PEC-W are predicted to increase only marginally (< 0.5 m). The predictive uncertainty analysis shows a relatively large range. The upper range is kept at approximately 2 m below the land surface at both sites throughout the simulation period, which is likely to be a result of groundwater evapotranspiration and therefore water logging is not predicted in the model. It should be noted that the mean of the 100 models indicates water level 3 - 4 m below the ground surface. The SLR scenario shows a slightly higher groundwater level at both sites, as a higher sea level reduces the hydraulic gradient towards the sea, slightly enhancing the groundwater mounding in the evaporation pond areas and the surroundings.

*EV4 and EV5 – Algal mats / samphire and mangroves*

Sites AM-E (Algal Mats East), AM-W (Algal Mats West) and Mangroves have been selected to assess the impact of evaporation pond operations on the algal mat and mangrove communities outside the evaporation ponds in the eastern and western parts of the model domain. The predicted groundwater levels at these sites are largely constant throughout the simulation period for all scenarios. This suggests groundwater evapotranspiration may be sufficient to buffer the impact from the pond operations and SLR at these sites despite their proximity to the ponds and the coast, with areas 'at risk' generally occurring close to the pond walls.

*EV6 – Stock water wells*

The predicted groundwater levels at the stock water wells varies considerably depending on the location. Groundwater levels within stock water wells 70910002 and 70910006 are predicted to rise only marginally (<0.5 m) whereas wells 70910007 and 70910780 are predicted to rise by between 1 - 3 m. This suggests the influence of water impoundment is relatively large near the western crystalliser ponds, consistent with Figure 6-21.

The predictions show little variation in groundwater levels over the long-term between the mean sea level scenario and SLR scenario, which is expected given the distance of these wells from the coast.

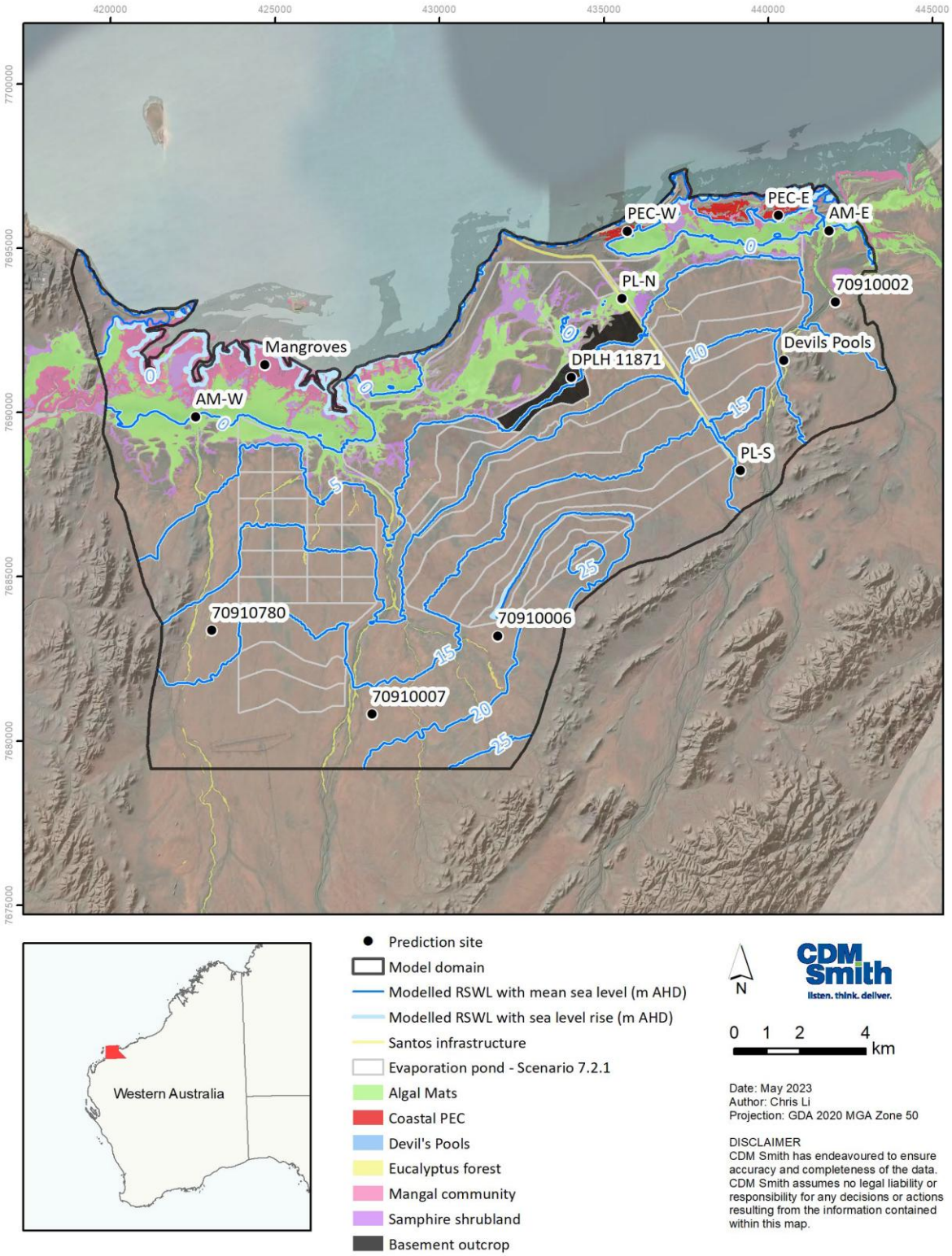



**Figure 6-21: Predicted groundwater level contours after 100 years of concentration pond and crystalliser operations**

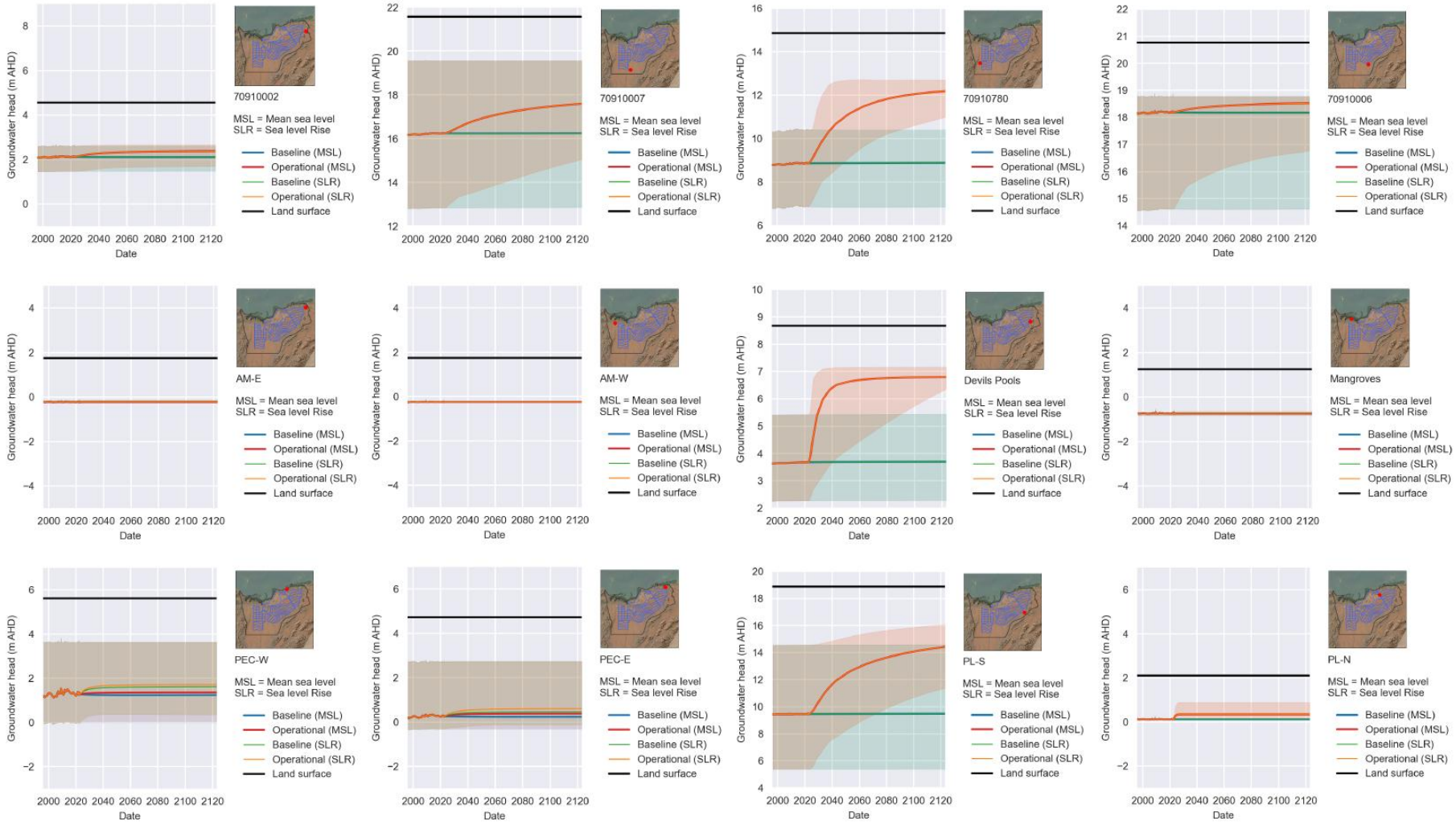



**Figure 6-22: Predicted groundwater level time series at selected locations (shading represents the range of prediction results from the 100 model realisations)**

*EV2 and EV7 – Terrestrial vegetation and Devils Pool*

The groundwater level within Devils Pool was similarly predicted to increase by around 3 m over both the mean sea level scenario and SLR scenario following Proposal development (however groundwater remains below the land surface throughout the simulation period). The results suggest water levels in this area would likely increase. Should this occur, Devils Pool and the groundwater dependent terrestrial vegetation located adjacent to the evaporation pond areas would likely be affected. This is because increased groundwater levels may cause waterlogging of the unsaturated root zone, impacting the reserve of fresher soil water used by the trees for transpiration. These species cannot draw water from completely saturated soil (below the water table).

*EV8 – Noorea Soak*

Within the vicinity of Noorea Soak the mean of the 100 calibrated model realisations shows no change in groundwater levels during the operational period. Similarly, there is no discernible increase associated with SLR at this EV, which is expected given the distance from the coast. The soak is located in an area of basement outcrop in the model and the very low hydraulic conductivity assigned to this unit is likely to be responsible for the limited change observed at the prediction point. The groundwater head is largely controlled by evapotranspiration, which keeps the water table at least 2 m below the surface.

*EV9 – Santos Gas Pipeline*

Under all scenarios, the groundwater level at site PL-S, despite being located upgradient of the concentration ponds and crystallisers, was predicted to rise considerably over time (increasing by 5 m at year 100) due to seepage recharge and groundwater mounding. The modelled groundwater level was however below the land surface throughout the simulation period. The impact of SLR on this site is minimal, which is expected given its distance from the coast.

The model results at site PL-N show a similar rise in groundwater levels. Given the relatively shallow groundwater level at this site, the impact of concentration pond seepage and the resulting groundwater mounding is believed to be dampened by groundwater evapotranspiration. As per site PL-S, the impact of SLR on this site is minimal.

***Salinity Changes***

The predicted groundwater salinity distribution for the top model layer after 100 years of concentration pond and crystalliser operations is shown in Figure 6-23 and Figure 6-24 for the mean sea level scenario and SLR scenario, respectively. To maintain readability, the vegetation receptors have been excluded from these figures and time series salinity changes to these environmental values are instead illustrated in Figure 6-25. Due to the limited salinity data available, the solute transport model has not been calibrated and therefore the salinity predictions contain a considerable level of uncertainty.

The mean sea level scenario results (Figure 6-23) suggest that without mitigation the concentration ponds and crystallisers would have a large influence on the salinity of the groundwater, particularly in areas beneath the concentration ponds and crystallisers, pond perimeters and creeks, where salinity is predicted to exceed 210 g/L.

These areas coincide with a shallow water table as a result of the groundwater mounding which in turn, increases the groundwater evapotranspiration and salinity. The salinity impact is predicted to be constrained within a zone of less than around 1 km surrounding the ponds although predicted to extend to 2 - 3 km to the west of the crystallisers. These results are consistent with the climate change scenario (Figure 6-24), where only minor salinity increases occur within the coastal areas to the north of the concentration ponds and crystallisers due to the influence of SLR and subsequent higher rates of groundwater evapotranspiration.

To assess the direct effects of water impoundment within the concentration ponds and crystallisers, with respect to the location of the identified environmental values, predicted timeseries salinographs (for the same locations outlined in Figure 6-21), have been prepared and are shown in Figure 6-25. Note, given the paucity of salinity data informing the solute transport and density components of the model considerable uncertainty exists in these results. Therefore, it was considered more appropriate to present the changes in concentrations rather than the predicted concentrations. This allows the direct effects to be assessed in a relative sense rather than an absolute sense where uncertainty exists.

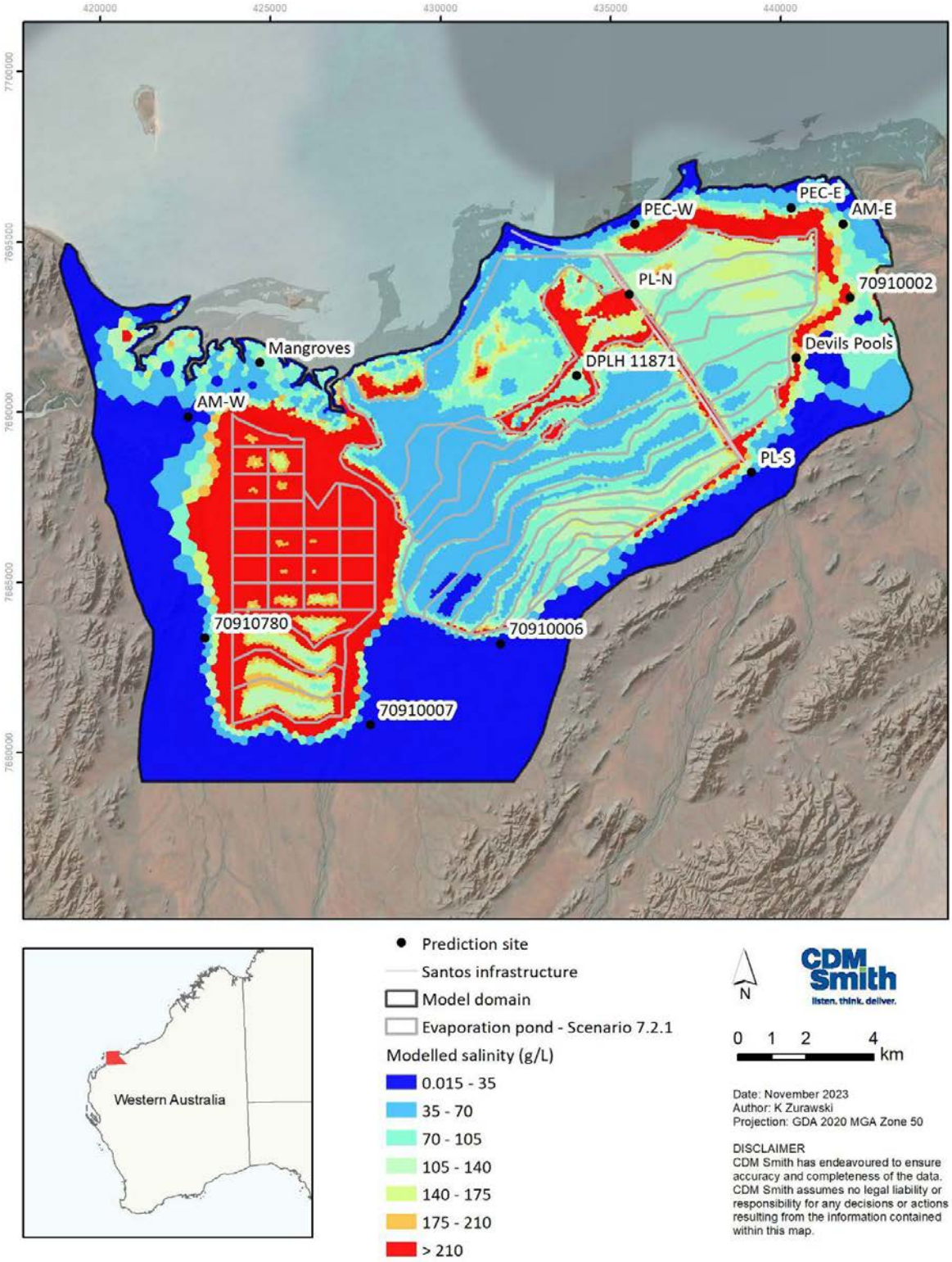



**Figure 6-23: Predicted salinity distribution for the operation scenario (mean sea level) 100 years after the concentration pond and crystalliser operations (without mitigation)**

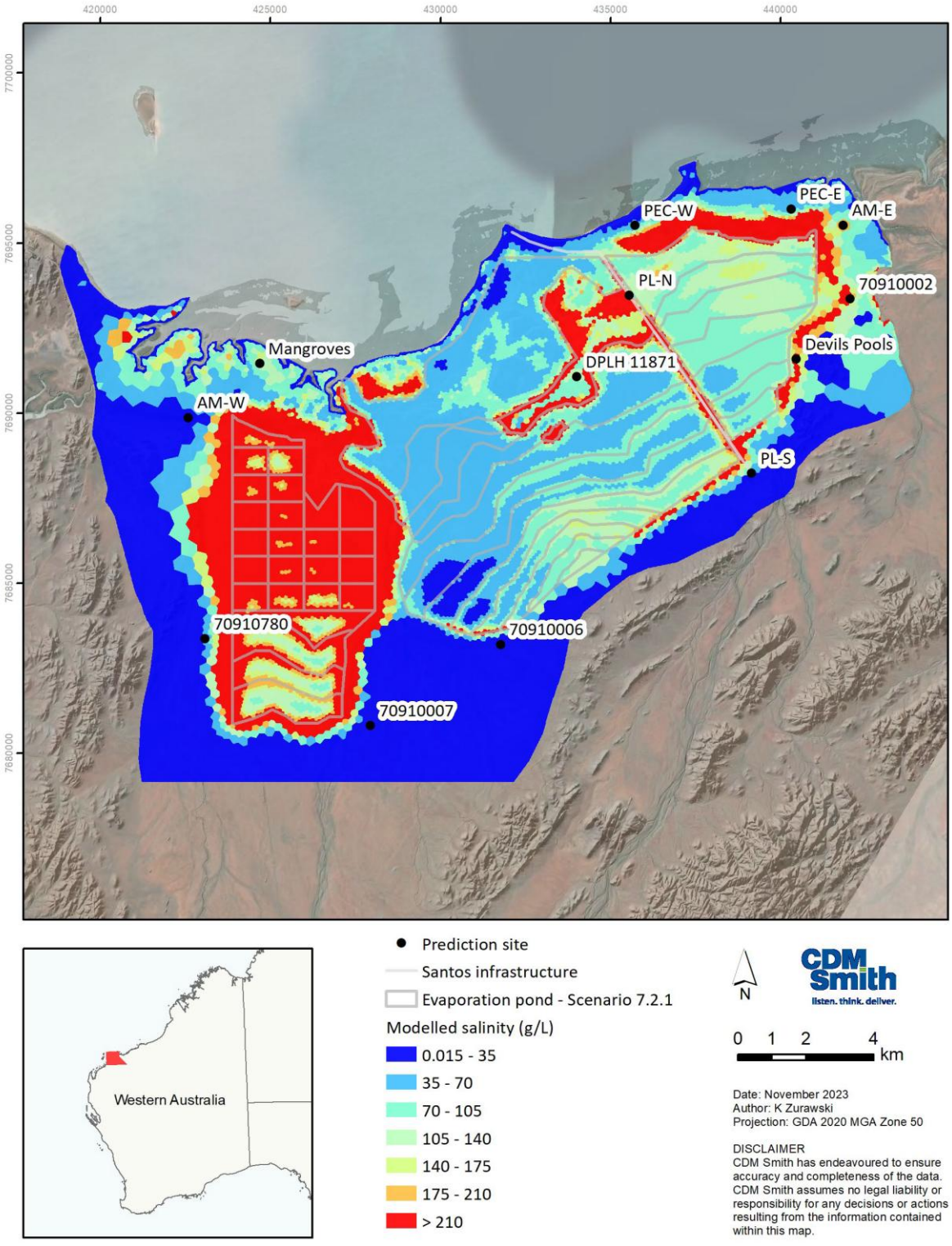



**Figure 6-24: Predicted salinity distribution for the operation scenario (SLR) 100 years after the concentration pond and crystalliser operations (without mitigation)**

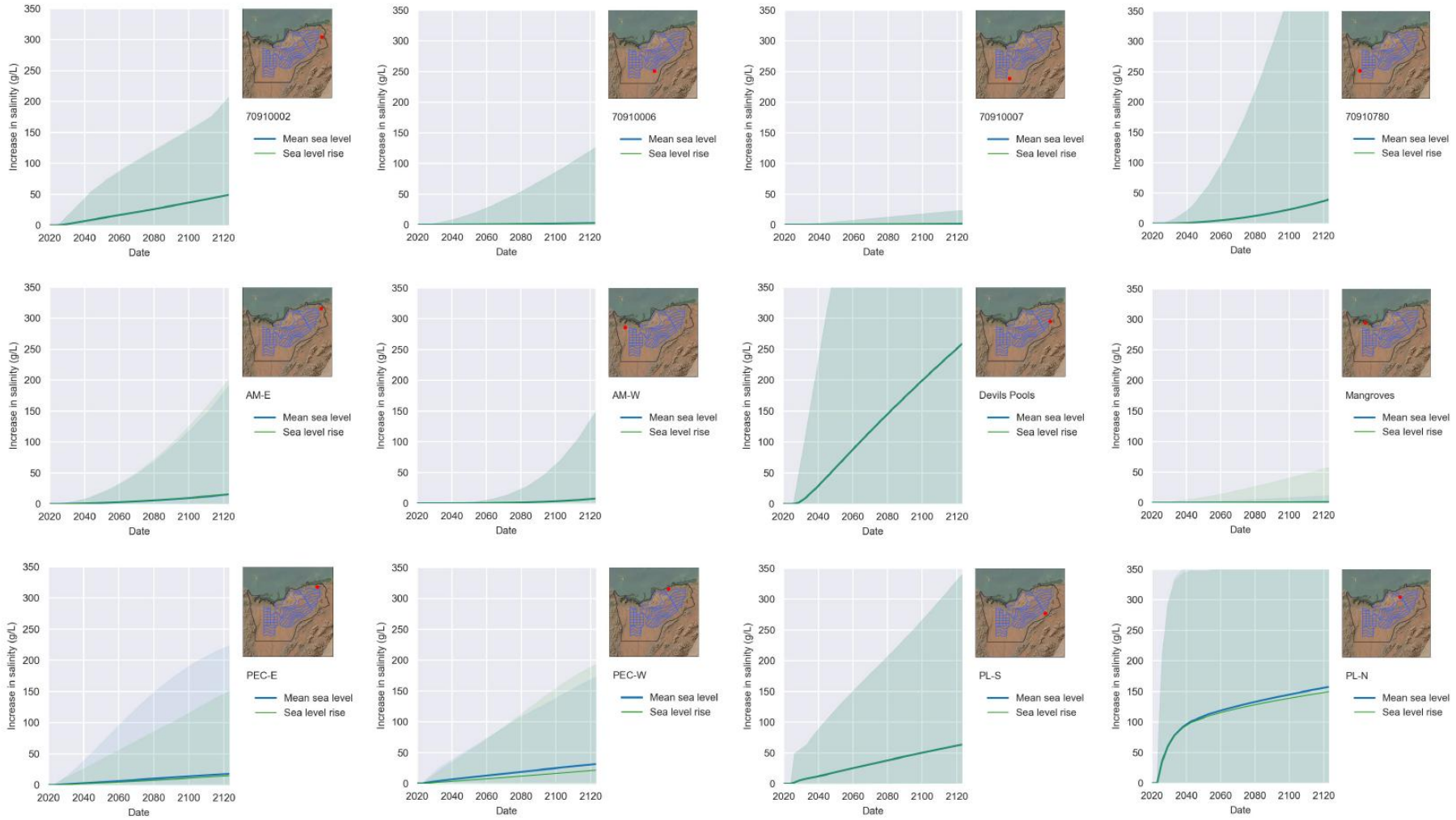



**Figure 6-25: Predicted groundwater salinity change time series at selected locations (without mitigation) (shading represents the range of prediction results from the 100 model realisations)**

*EV3 – Coastal PEC*

Groundwater salinity at PEC-E and PEC-W is predicted to increase gradually over time. Given their proximity to the ponds, the rate of increase is lower than expected, suggesting part of the saline inflow from the pond areas may be intercepted by groundwater evapotranspiration in the backwater areas before reaching PEC-E and PEC-W. The SLR scenario shows a lower salinity level at both sites due to its higher sea level (and hence a smaller hydraulic gradient towards the sea) compared to the mean sea level scenario. The uncertainty analysis suggests there is a potential for the saline inflow from the pond areas to reach PEC-E and PEC-W before being intercepted by groundwater evapotranspiration, which is likely to depend on the permeability in this area (i.e., the saline inflow will propagate more rapidly in a more permeable setting).

*EV4 and EV5 – Algal mats / samphire and mangroves*

The predicted groundwater salinity at AM-E and AM-W gradually increased over the simulation period for the mean sea level and SLR scenarios, which is expected given their proximity to the saline plume (Figure 6-23 and Figure 6-24). The salinity changes at these two sites were predicted to be approximately 30 g/L at AM-E and 100 g/L at AM-W over 100 years of operation. The predictive uncertainty analysis suggested that the saline plume has the potential to reach these two sites, causing groundwater salinity to increase substantially. Meanwhile, groundwater salinity at site 'Mangroves' was predicted to remain largely constant over time. However, the uncertainty analysis suggests the potential for evapo-concentration of inflow from the sea boundary, which may cause the salinity to increase notably over time at this site. This increase was found to be more profound for the SLR scenario. Note that this potential impact is likely to be a result of SLR, which is a natural process, instead of the evaporation pond operations.

*EV6 – Stock water wells*

The predicted groundwater salinity at the stock water wells varies considerably depending on the location. Groundwater salinity is predicted to increase notably (by around 50 g/L) at 70910002 and 70910780, possibly due to the lateral expansion (i.e., parallel to the coast) of the saline plume. In contrast, 70910006 and 70910007 show a minimal increase in groundwater salinity as they are located upgradient (in terms of groundwater flow fields) of the evaporation ponds.

The predictive uncertainty analysis indicates the modelled salinity at these sites contains a large uncertainty. The worst-case conditions (i.e., the upper bound of colour shades) suggest the salinity may increase substantially beyond the salt tolerance of cattle, which typically ranges between 4 and 5 g/L (ANZECC, 2000), potentially rendering these stock water wells inoperable. Alternate arrangements (new bores or supplementary water) would be provided if this was to occur.

*EV2 and EV7 – Terrestrial vegetation and Devils Pool*

Groundwater salinity within Devils Pool was predicted to increase substantially over time, which will likely impact the groundwater dependent terrestrial vegetation located adjacent to the evaporation pond areas including the eucalypt species residing within Devil Creek, Eramurra Creek, and McKay Creek as well as the pools themselves.

The predictive uncertainty analysis indicated the rate of salinity increase could be rapid, reaching almost 300 g/L within approximately 15 years of operation. No effect from SLR is observed at this site.

*EV8 – Noorea Soak*

Within the vicinity of Noorea Soak the mean of the 100 calibrated model realisations shows no change in salinity during the operational period in either the mean sea level or SLR operational scenarios. Similar to the direct effects predicted for groundwater level increases, these results are likely due to the very low permeability of the basement rock for which the soak is located (i.e., the saline plume cannot move quickly through the basement rock).

*EV9 – Santos Gas Pipeline*

Under both the mean sea level and the SLR scenarios, groundwater salinity at site PL-S was predicted to increase over time showing a mean increase of around 60 g/L. Conceptually this is understandable due to the distance of the site from the coast. However, the uncertainty analysis suggests the salinity at this site has the potential to increase to more than 300 g/L.

Groundwater salinity predictions at site PL-N show a larger rise in salinity (with a mean increase slightly above 150 g/L), possibly due to the evapo-concentration of the shallow saline plume in this area. The uncertainty analysis suggests the rate of increase in salinity could be very rapid, exceeding 300 g/L after a few years of operation. For most of the operational period, the impact of SLR is insignificant, although increases slightly over the later periods of operation likely due to the proximity to the coast.

***Predicted Mass Balance***

The impoundment of water within the evaporation ponds would alter recharge to the groundwater systems causing an increase in groundwater levels. The change in groundwater levels would alter the groundwater flow dynamics.

The baseline scenario suggests the major groundwater inflows are rainfall recharge and inflow from the sea, while the major groundwater outflow is groundwater evapotranspiration in low-lying areas. Under both scenarios (i.e., mean sea level scenario and SLR scenario) groundwater flow would be changed due to water impoundment within the evaporation ponds, although, to varying degrees.

For mean sea level conditions, the operation scenario indicates the major groundwater inflow would be seepage from the concentration ponds and crystallisers. Inflow from the sea only shows a slight reduction compared to the baseline scenario and occurs mostly in the western part of the model domain (see the 0 m AHD contour in Figure 6-21). The operation scenario shows a lower rainfall recharge than that of the baseline scenario as rainfall recharge is not applied in the evaporation pond areas.

The major groundwater outflow for the operation scenario would be groundwater evapotranspiration in areas adjacent to the concentration ponds and crystallisers where groundwater levels are elevated due to pond seepage. There would also be a notable outflow component attributed to groundwater discharge to the concentration ponds and crystallisers. This is due to the design pond layout that may induce a cascading effect on groundwater flow.

For instance, an upgradient pond at 20 m AHD could raise the underlying groundwater to a similar level (mounding), which will in turn induce groundwater discharge to the downgradient pond at 18 m AHD. The groundwater mounding would also have an impact on the hydraulic gradient, inducing more groundwater outflow to the sea, although to a lesser extent than the discharge mechanisms already described.

The SLR scenario shows a considerable increase in inflow from the sea, while the other inflow components are largely similar to the operation scenario. The increase in inflow from the sea is mostly offset by a similar increase in groundwater evapotranspiration in areas adjacent to the coast, suggesting groundwater evapotranspiration may buffer the impact from SLR.

The modelling shows a mean pond seepage (over 100 years of operations) of 25,652 kL/day, ranging between 16,052 – 41,038 kL/day across the 100 calibrated model realisations. With a total pond area of 11,872 ha, the pond seepage recharge translates to a mean of 79 mm/year. Note that the riverbed conductivity value was selected in a conservative manner.

The predicted increase in salt discharge to the sea, calculated as the difference between the operation and baseline scenarios, is shown in Figure 6-26 for the mean sea level and SLR scenarios. The increase in salt discharge is greater for the mean sea level scenario due to its lower sea level and hence a steeper hydraulic gradients towards the sea (compared to the SLR scenario).

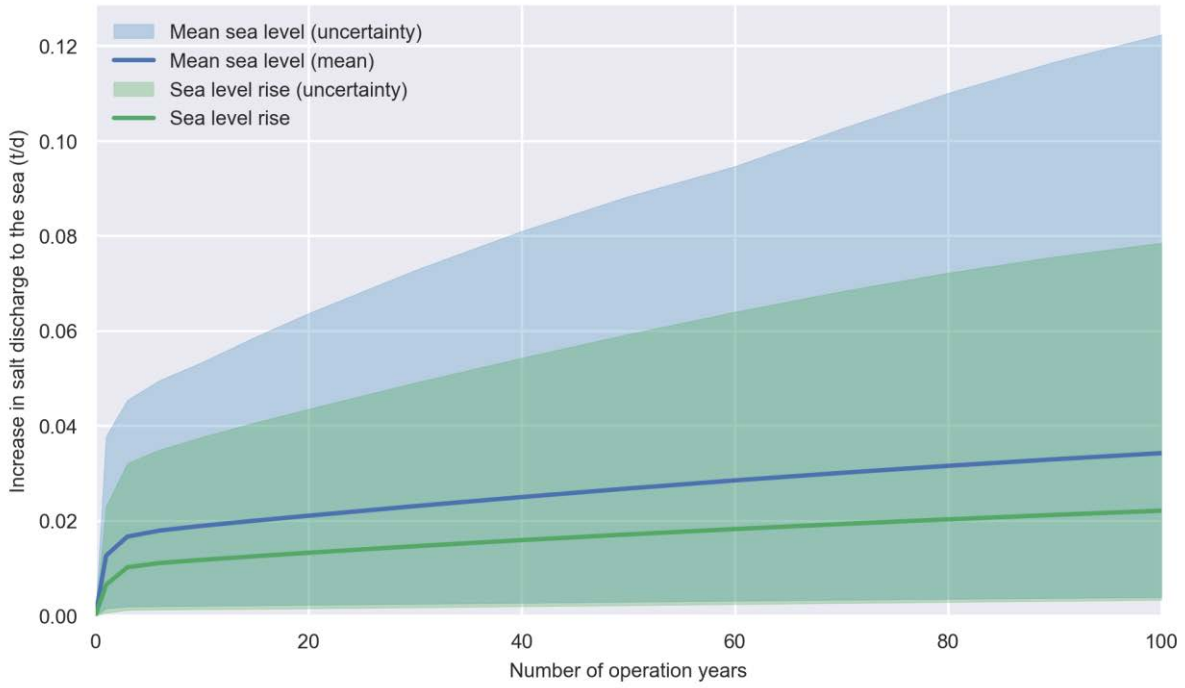



Figure 6-26: Predicted salt load (tonnes per day) to the sea

***Summary***

CDM Smith (2023) developed a density driven flow model that has been developed to investigate the potential for the Proposal to impact key environmental values within and in proximity to the Proposal. The assessment assumed an absence of mitigation and reached the following key conclusions:

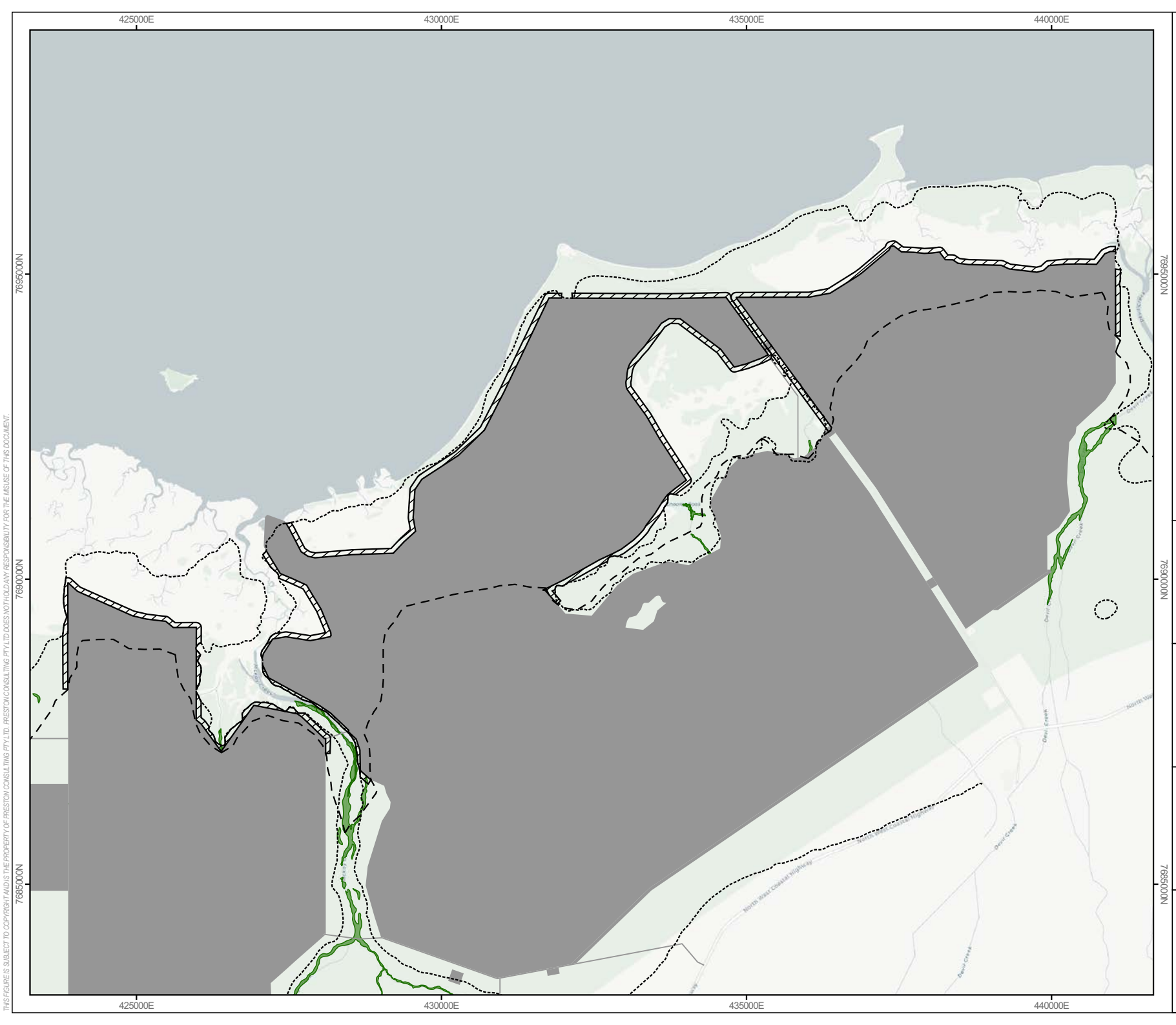
- The majority of groundwater inflow occurs from the sea and rainfall, while the groundwater outflow occurs mostly as groundwater evapotranspiration in low-lying areas (not discharged to the sea) under pre-operation (baseline) conditions;
- Without mitigation, seepage from the concentration ponds may lead to greater groundwater discharge to the sea. This impact will however likely be dampened by increased groundwater evapotranspiration in the low-lying areas as a result of additional infiltration from the concentration ponds;
- The impact of SLR is expected to be limited to the area immediately adjacent to the coast in the northwest of the PIDE, possibly due to the buffering of groundwater evapotranspiration within the backwater areas; and
- The long-term seepage recharge rate is estimated to range between 50 - 124 mm/year.

The assessment provided above describes the potential for impacts in some locations outside the Proposal disturbance footprint, in particular areas of shallow groundwater or Groundwater Dependent Ecosystems (GDE) that will experience large changes in groundwater salinity or height. To provide spatial reference for this assessment the following areas have been conservatively defined as being 'at risk' of impacts from seepage or mounding:

- Areas where the depth to groundwater is 5 m or less and the predicted change in groundwater level is 1 m or more; and
- Mapped GDEs where the predicted change in groundwater level is 1 m or more.

Mitigation measures are critical in these areas to minimise subsequent impacts on the surrounding environment. These measures are considered part of the planned standard operation of the Proposal and include extensive groundwater level and quality monitoring, as well as the installation of groundwater cut-off bores, and/or ponds if the monitoring indicates that groundwater seepage and mounding is extending outside the pond walls. Further details of the monitoring and management are provided in Section 6.6 and in the Groundwater Monitoring and Management Plan (GMMP) provided in Appendix 1.9. With the implementation of these controls, impacts from groundwater mounding and seepage are predicted to be contained within a 'management zone' that extends a maximum of 100 m from the external walls, with a smaller zone implemented in locations where GDEs are closer than 100 m to the pond walls (Figure 6-27). Note that some areas are not predicted to require management (as discussed above).

Ecological values could potentially be impacted within the 'management zone', including flora, vegetation, BCH and fauna habitat, and therefore ecological values within this zone are defined as being 'at risk' of impacts in those relevant sections of this ERD. The 100 m management zone however includes the 20 m construction disturbance footprint which is required to build the pond walls. Therefore, potential indirect impacts to ecological values within the 'management zone' from groundwater seepage and mounding have been calculated as being a maximum of 80 m within areas that are 'at risk' of groundwater mounding and seepage impacts.




## Legend

- Disturbance Footprint
- Seepage Risk Area
- Groundwater Dependent Ecosystems
- 1 m Change
- 5 m Contour

Imagery: Positron (retina)

N

0 1 2 km

GDA2020 / MGA zone 50

1:80,000

Project: LEI_0535_033
Date: 29/04/2025
Size: A4
Author: ASmithers (Preston Consulting Pty Ltd)

**Figure 6-27: Groundwater management zone**

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## 6.5.2 INLAND SURFACE WATERS

***Changes to Drainage and Floodwater Regimes***

SWS (2025) modelled and assessed the predicted drainage pre - and post-development in the Eramurra region, using the pond layout as solid barriers. Other infrastructures were not included in the model as the drainage for these areas are still being designed and will be incorporated into a future model run when available. Two portions of the assessment are considered to be of most relevance to this assessment:

1. Changes to the total volume of freshwater that reaches the marine environment (i.e., total discharge); and
2. Changes to the areas of freshwater inundation during frequent flood events (<10% AEP events).

SWS (2025) modelled the total discharge to the ocean from all three tributaries that intersect with the Proposal during a 10% AEP event and determined that:

- Initially the peak flow rate released to the ocean is reduced by approximately 5%. The total volume of flow released to the ocean during the 10% AEP event is reduced by approximately 14%. (Figure 6-28); and
- The total volume of freshwater delivered to the ocean is less under Proposal conditions because of a 17% reduction in catchment area resulting from rainfall capture within the ponds (Figure 6-29).

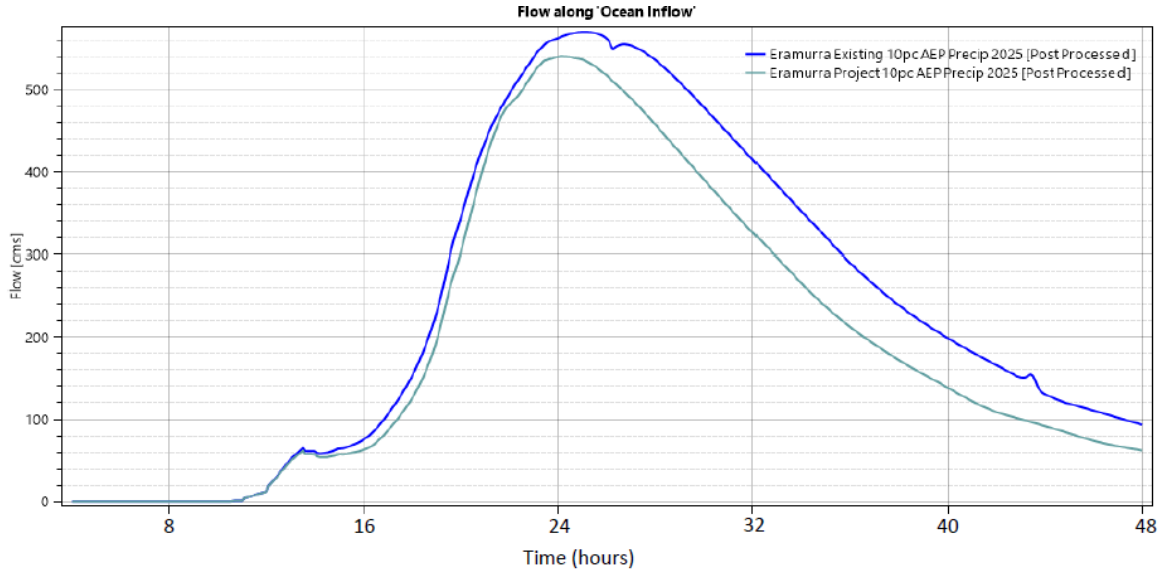



Figure 6-28: Changes to freshwater flow rates to the ocean during a 10% AEP event

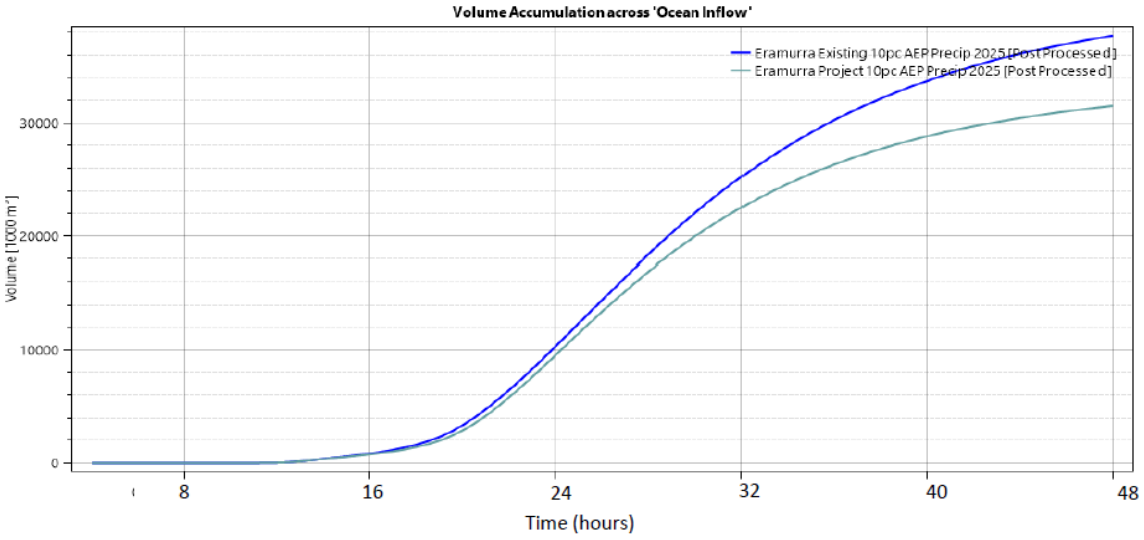



**Figure 6-29: Changes to freshwater cumulative volume discharged to the ocean during a 10% AEP event**

Figure 6-30 and Figure 6-31 show the predicted changes in inundation depths for a 1EY event and 10% AEP event respectively, comparing the current scenario with a development scenario with only the ponds in place. Figure 6-32 illustrates changes to flooding in a 1EY event. The figure shows the areas which were dry and are now wet, and vice versa, as a result of the Proposal. Maximum depth differences within Eramurra and McKay Creek are indiscernible between existing and Proposal conditions.

Maximum depth differences within Eramurra Creek are also indiscernible between existing and Proposal conditions for the 10% AEP event. Differences in McKay Creek during this event are limited to downstream areas, with the maximum difference being approximately 350 mm. Differences in Devil Creek are limited to downstream areas, with the maximum difference in the 10% AEP event being approximately 58 mm. In comparison to the 1EY event, areas downstream of the ponds are subject to greater reductions in maximum water surface elevation in a 10% AEP event. The area with a maximum depth reduction is located west of the McKay Creek outlet. The maximum reduction in the 10% AEP event is approximately 520 mm, extending approximately 1.5 km from the ponds to the ocean (Figure 6-31). Water surface elevation increases along the perimeter of the proposed ponds are limited to within approximately 500 m of the proposed pond embankments.

In some areas, the presence of the pond embankments block flow paths and impounds runoff. The construction of perimeter drains will facilitate runoff and prevent standing water around the external site perimeter. The current design prevents flood level increases along the Reindeer gas pipeline easement. The Proposal includes drains along the corridor to collect brine seepage and drain standing water from the corridor.

The differences in hydraulic characteristics between existing conditions and Proposal conditions within the main creek channels are not expected to significantly alter the sediment dynamics of the systems. The proposed ponds reduce the contributing catchment area draining freshwater runoff to the ocean by approximately 16%.

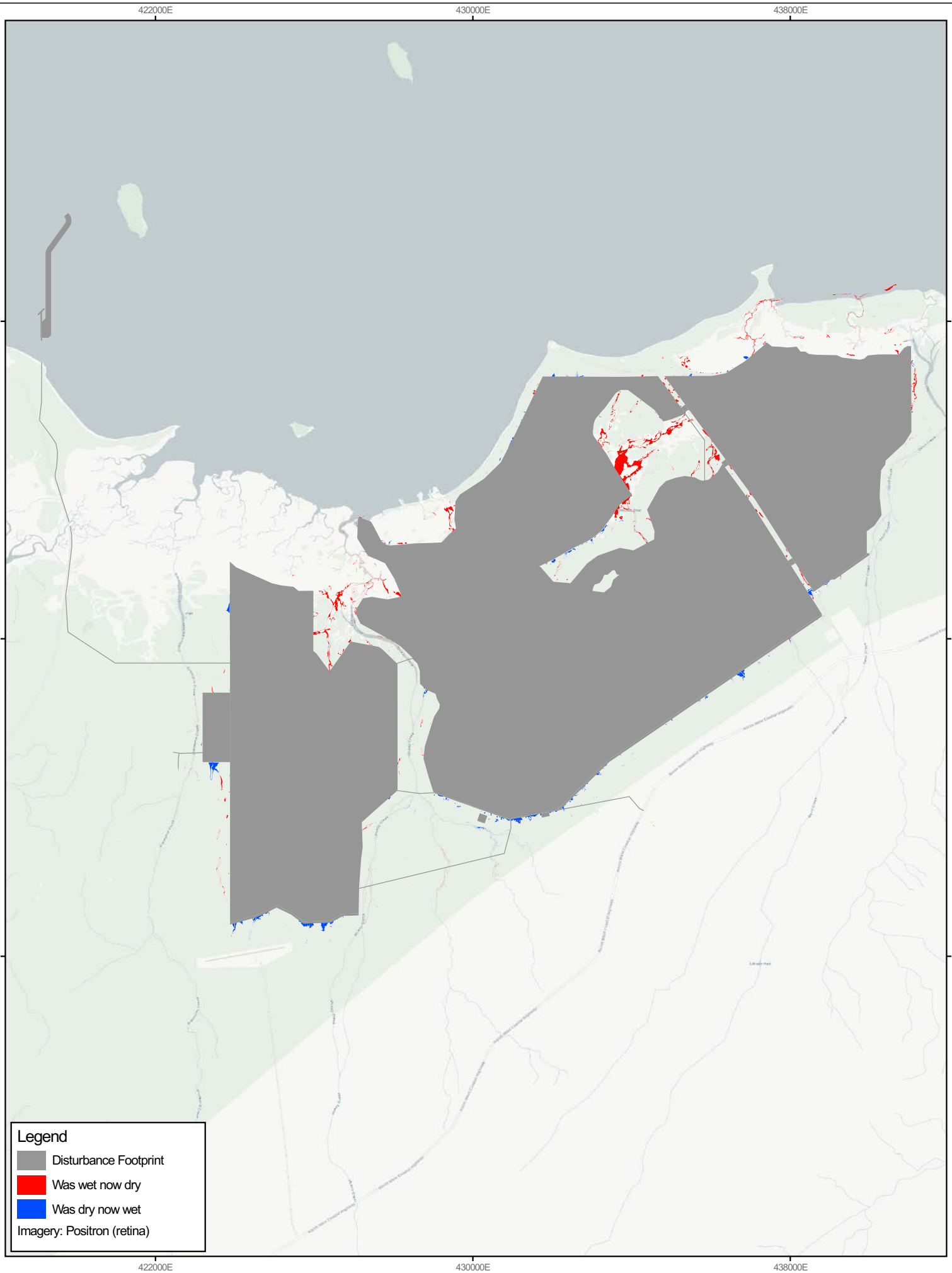
The results demonstrate that there will be some changes in freshwater discharge volumes and inundation as a result of the Proposal. These impacts may affect other factors, specifically BCH, Flora and Vegetation and Terrestrial Fauna, and the changes discussed in this Section have been assessed in the context of these other factors in Section 7.7, 8.7 and 11.7 respectively.




Figure 6-30: Changes to freshwater inundation depths (m) during a 1EY event




Figure 6-31: Changes to freshwater inundation depths (m) during a 10% AEP event

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0 2 4 km

GDA2020 / MGA zone 50

1:120,000

Project: LEI_0535_032
Date: 29/04/2025
Size: A4
Author: ASmithers (Preston Consulting Pty Ltd)

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**Figure 6-32: Changes to the flooding regime in a 1 EY event as a result of the Proposal**

### *Brine Spills*

A large spill or leak of brine from the ponds or pipelines, or product infrastructure washdown water could result in impacts to the marine environmental quality within adjacent tidal creeks. Brine is the primary resource for the Proposal and as such the concentration ponds, crystallisers and brine pipelines are designed to minimise the risk of leaks, overflows and wall breaches. Pipelines will utilise industry-standard materials to minimise the chance of leaks, and mitigation will be implemented to reduce this risk further (refer to Section 6.6). Ponds have been designed with adequate freeboard and overflow features to minimise the risk of unplanned overflows and wall breaches. The ponds include internal weirs to rebalance local excess brine levels and external emergency spillways into adjacent major creeks to avoid cascading internal bund failure leading to massive outflows.

There are drainage ditches along the base of all perimeter bunds primarily to intercept groundwater seepage and collect brine for recovery to the process ponds. These will also intercept and contain minor splashing and spillage events.

If a large external overflow was to occur, it is most likely to arise from a major rain event which raises all pond levels. In such events, McKay and Devil Creeks both flow at high levels. In this case the brine overflow will be rapidly mixed with fresh surface water flow and discharged to the ocean.

### *Erosion and Sediment Loss*

Sediment loss during the construction of the ponds and other infrastructure could result in increased turbidity within adjacent creeks and pools. The risk of sedimentation impacts within these areas is expected to be low given the following:

- Construction of the concentration ponds involves the construction of embankments only (i.e., the base of the ponds will not be disturbed except for borrow of construction material). There will not be large areas of disturbed ground that could release sediment. In addition, the construction sequence of the pond walls will result in runoff retention which will capture entrained sediment;
- Crystalliser development includes widespread cut/fill with large, exposed earth areas. The design also includes perimeter bunds which will be initiated early in the program to contain floor runoff from storm events;
- Construction areas remain dry most of the time, therefore there is little potential for flow paths between these areas and creeks and pools; and
- During significant flooding events, civil earthworks would likely need to pause until drier conditions permit resumption.

During operations, peak velocities in the 10% AEP flood are generally below 1.2 m/s, which falls below Austroads thresholds for rock protection for both the existing and Proposal modelling scenarios. The placement of coarser material such as Class A or B1 rock may, however, be beneficial in preventing erosion of the bunds and preventing adverse impacts, particularly along areas where the flow path has been constricted or where localised runoff concentrates on embankment slopes. Differences in velocity and water surface elevation related to the main creek channels are not expected to significantly alter the sediment dynamics of the creek systems (SWS, 2025).

***Leaks or spills of hydrocarbons or chemicals***

The Proposal does not include the storage or use of large volumes of hydrocarbons or chemicals. The implementation of industry-standard mitigation measures (Section 6.6) is expected to ensure that spills (if they occur) are controlled, contained and cleaned up to minimise impacts to inland waters.

### 6.5.3 INTERTIDAL ZONE

***Intake Creek***

Up to 31 $m^3/s$ of seawater is proposed to be abstracted from the tidal creek, never abstracting below 0.0 m AHD. The proposed intake is in a tidal zone just east of McKay Creek. Pumping is dependent on tidal windows with pumps sized to satisfy the demand associated with peak monthly evaporation. The seawater intake will operate when water levels are at or above 0.0 m AHD to ensure there is sufficient intake flow capacity from the ocean and the flow rate through the screen surrounding the enclosure does not exceed 0.15 m/s (to minimise marine fauna entrapment).

The peak abstraction rate will be around 25 $m^3/s$. While the tidal creek is fed from the ocean (almost infinite resource), the abstraction of large volumes of seawater has the potential to alter tidal flow volumes and rates, possibly inhibiting the upper reaches and surrounding areas from receiving tidal inflows in some circumstances.

The pump intake basin has a permanent seaward sill set 0.6 m below 0.0 m AHD. Pumping will only occur while the basin level is at 0.0 m AHD or above. The sill height of the intake pump basin is matched to the local bed level of the McKay Creek. The channel north of McKay Creek has a bed width of 80 m at a depth of 0.5 m below AHD and a length of 400 m. To determine if abstraction will have a material effect on the water levels within McKay Creek, an assessment was undertaken assuming a constant water depth over an extended approach.

Assuming the basin water level is exactly at 0.0 m AHD and the station is extracting its maximum flow (25 $m^3/s$) the topography of the approach channel can be defined by:

- Depth of 0.6 m;
- Width of 100 m (based on perimeter of the pump station sill); and
- Length of 400 m to significantly deeper and wider bathymetry.

Manning's equation is the method usually applied to estimate the flow for a channel given cross section and slope. In this case the solution is turned around to estimate the hydraulic slope from the flow and the cross section:

$$S = V^2 (n/k)^2 (P/A)^{4/3}$$

The channel dimensions and flow rate define an incoming nominal flow velocity of 0.4 m/s along the channel. The following parameters were used in Manning's equation:

- Cross section area A = width x depth = 60 $m^2$;
- Flow velocity V = 0.42 m/s;
- Channel wetted perimeter P = 100 m;
- Surface roughness 'n' = 0.025 (literature value for uneven sandy bed); and

- k = Scaling Constant (= 1.0 for SI units).

The slope calculates as 0.2 mm per metre, i.e., the estimated drawdown along the relevant distance is 8 - 9 cm, assuming all intake pumps are started when water reaches 0.0 m AHD. At 0.0 m AHD the tide rise rate averages around 60 cm/hr. At this stage there will be a considerable flow flooding past the pump station and continuing into McKay Creek.

The pump station will cause a delay in upstream flooding in the order of 8 - 10 minutes. As the tide rises higher, the approach channel becomes wider and deeper, and the effect of the pump station extraction becomes undetectably small.

***Alteration of Tidal Regimes***

O2 Metocean (2023b; Appendix 1.2) conducted an analysis of the spatial evaluation of the total water depth to determine the percentage of simulation time that each cell was 'wet' (total water depth greater than 0 m AHD). By comparing this parameter between the pre- and post-development, the impact of the Proposal around its footprint was able to be quantified.

There are two main intertidal creek systems which flood under normal spring high tide conditions but remain isolated from each other (Figure 6-18). Not shown is the agreement between the <50% 'wet' regions during typical spring tides with the areal coverage of the algal mats. The same map was replicated with the results from the post-project development model run (Figure 6-33), which shows how the pond walls block some of the flow south of the main creeks particularly near the proposed seawater intake area at McKay Creek. When compared to each other (Figure 6-34), minor-to-negligible changes in the tidal inundation regime outside the proposed pond walls footprint are seen. The percentage of time 'wet' in areas directly impacted by the Proposal development (e.g., inside the proposed pond walls) is not discussed.

Total water depth between the pre-project and post-development model simulations were compared on an hourly basis leading up to and returning from the highest tide during the simulated period. Comparisons are illustrated through spatial maps of the difference in total water depth between the two models, over this period (Figure 6-35 - Figure 6-37) at three selected points in time during the high spring tide.

During flood tides and up to peak spring tide (Figure 6-35 and Figure 6-36), the results show areas (in red) that will experience an increase in instantaneous water elevation in the order of 10 cm. These are mostly identified along the northward facing crystalliser pond walls, at the northern most concentration pond walls, and east of the proposed intake station site. Tidal flows that previously inundated the upper tidal catchment areas will be deviated or blocked by the proposed ponds. During ebb tides (Figure 6-37), the total water depth would be up to 10 cm lower in the north area of the crystallisers ponds because of a lower volume of water being trapped up the creeks that will be affected by the ponds. However, according to the tidal inundation modelling results, water would remain ponded for longer periods post-development compared to current conditions behind 40-Mile Beach (north of the ponds) and around the Barnard Creek mouth.

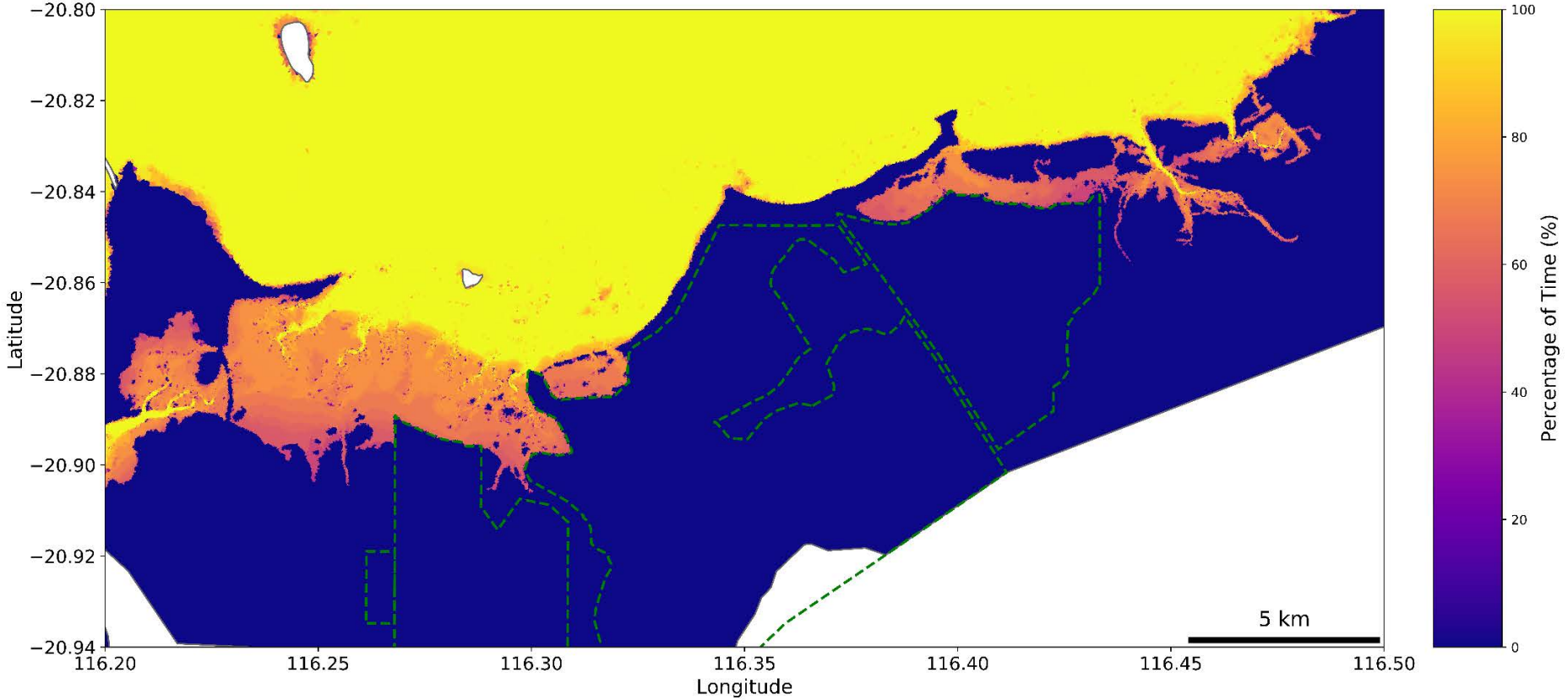


Figure 6-33: Percentage of time 'wet' (post-development)

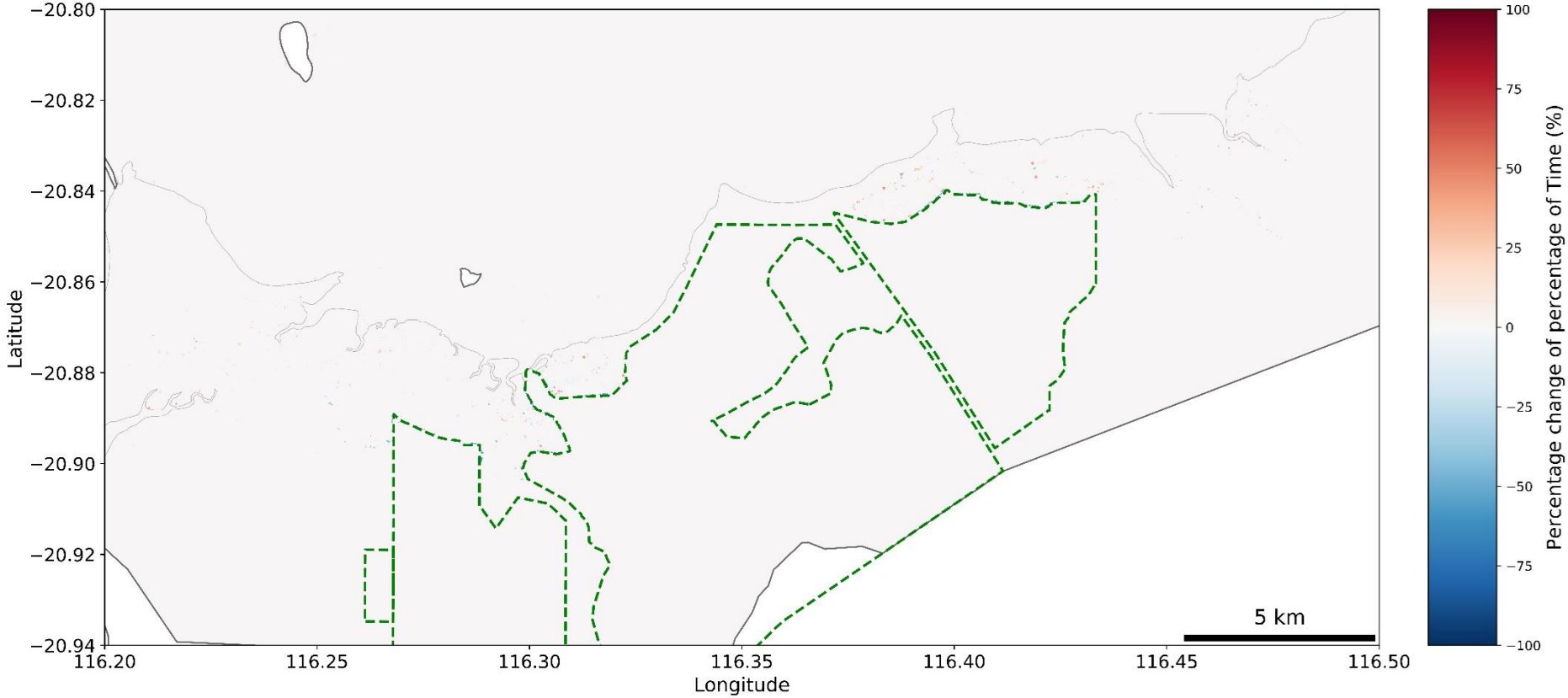


**Figure 6-34: Difference in percentage of time 'wet' between pre- and post-development (blue= reduction in percentage 'wet'; Red = increase) (adapted from O2 Metocean, 2023b)**

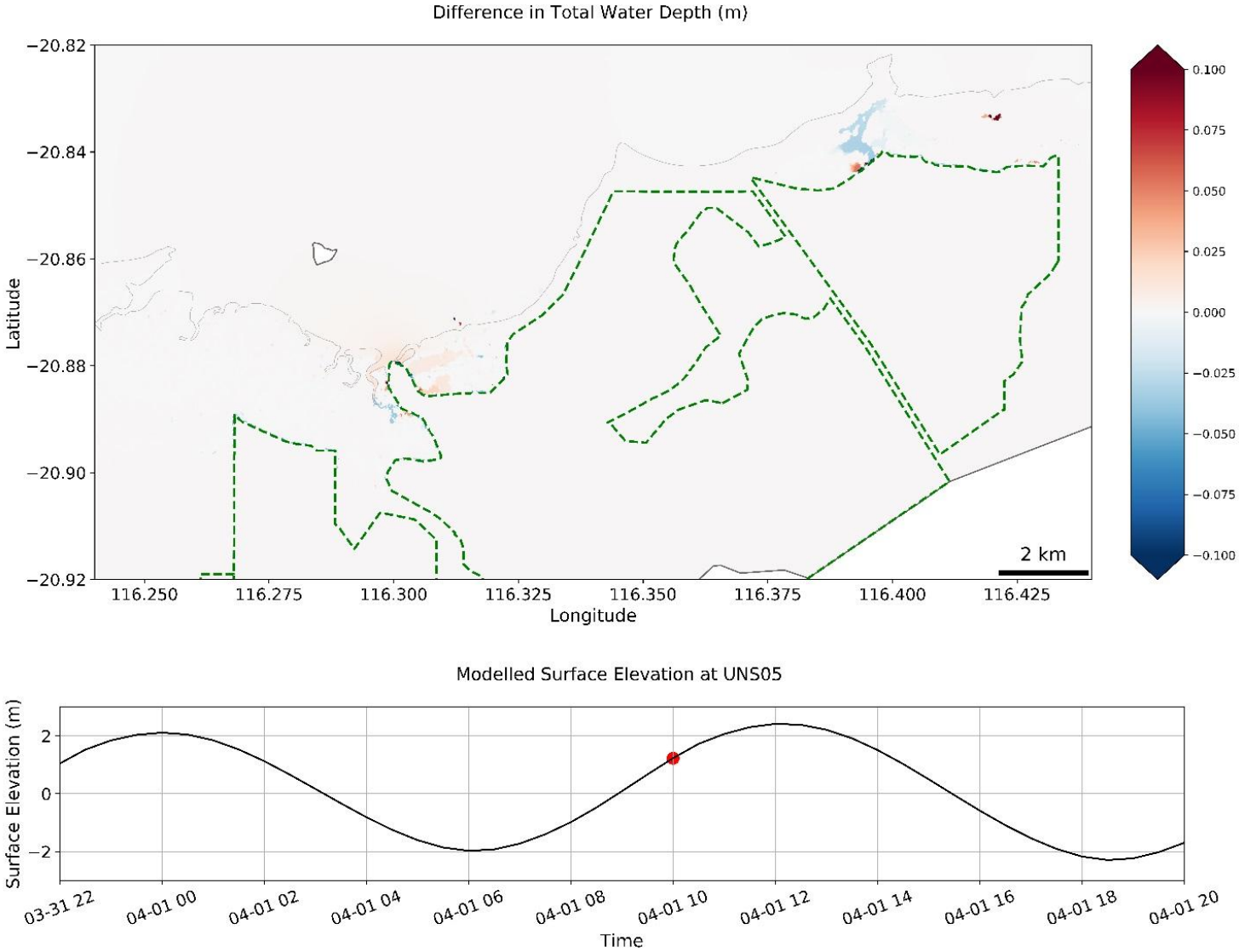


**Figure 6-35: Instantaneous difference in total water depth during peak of high spring tide on 01/04/2021 at 10:00 AWST (post-development vs existing)**

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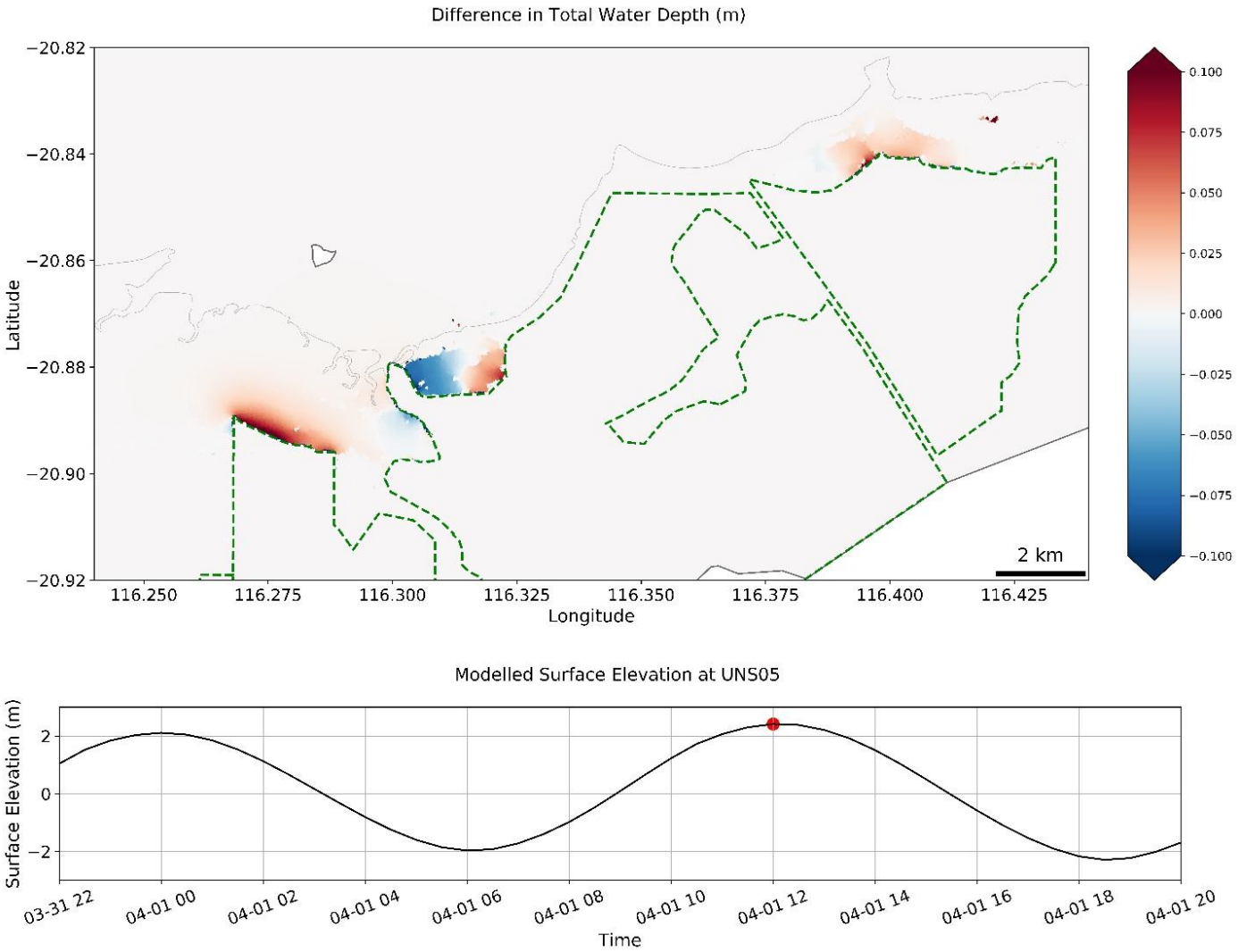



**Figure 6-36: Instantaneous difference in total water depth during peak of high spring tide on 1/04/2021 at 12:00 AWST (post-development vs existing)**

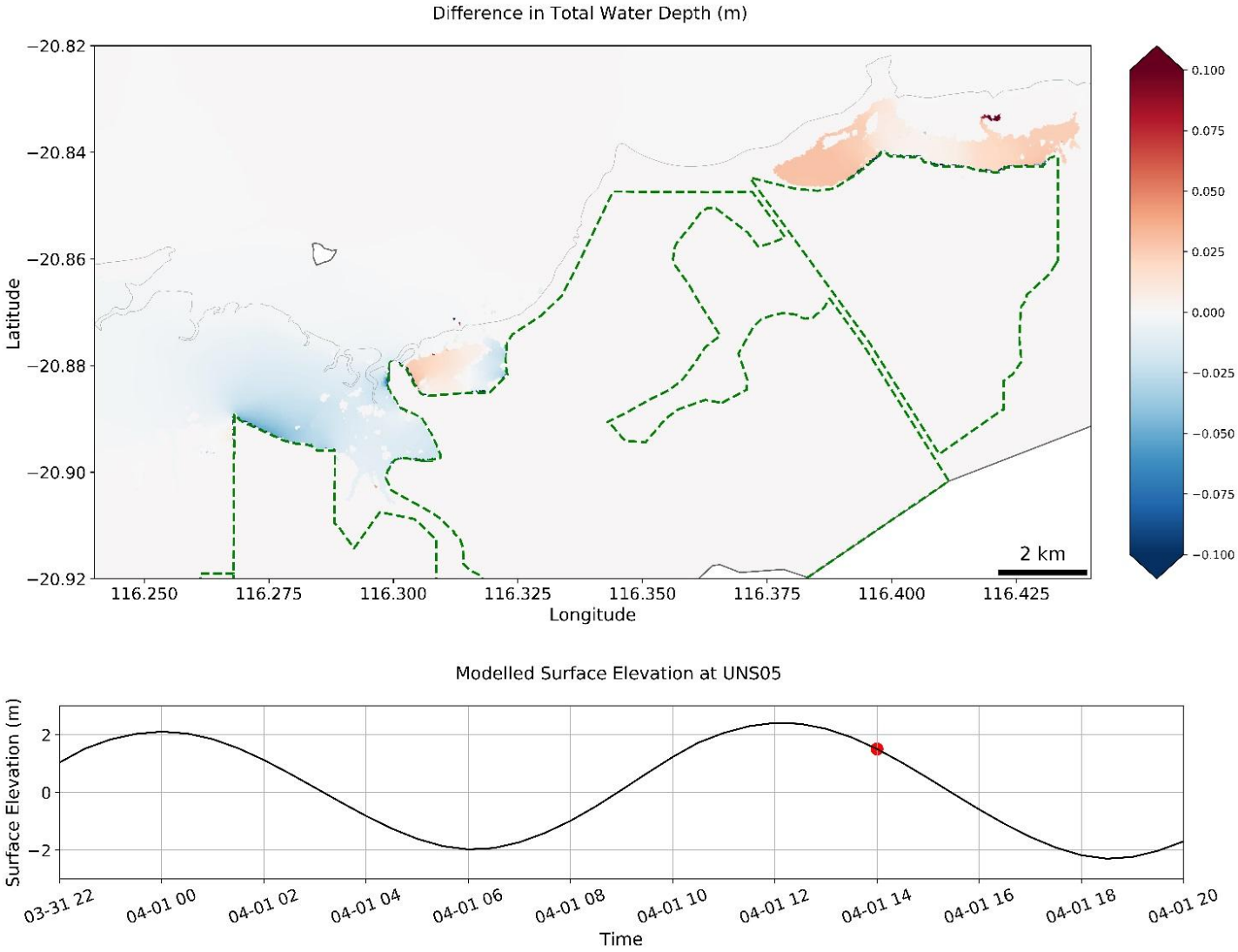



**Figure 6-37: Instantaneous difference in total water depth during peak of high spring tide on 01/04/2021 at 14:00 AWST (post-development vs existing)**

### *Changes to Tidal Creek Systems*

Information in this section is sourced from Larcombe et al., (2025; Appendix 1.3) unless stated otherwise.

Without the ponds, the interpretation of ebb tidal dominance for most tidal creek systems, especially regarding sand transport in the creek channels, is clear for arid weather conditions. With ponds emplaced, some catchments will experience some change in their tidal conditions, especially 40 Mile Road West and 40 Mile Road East. That said, for most affected catchments, the Vs:Vc ratio (ratio of water volumes in a creek system at different tidal elevations) remains 2.8 or more, only 10% below that for natural McKay Creek (ratio 3.1) for which flow measurements show that the tidal control on flow is strongly dominant. At this level of reduction in the Vs:Vc ratio, is not expected that tidal processes alone are likely to cause great physical change in these systems following implementation of the Proposal.

Where there are episodic or seasonal weather events such as floods or storm surges, the ponds could influence sediment transport, particularly during river flood events and the relaxation phase of high tidal surges that inundate above high tide level. The pond walls will divert water into some catchments, most notably McKay Creek, and potentially alter patterns of erosion, sediment throughput and accumulation.

It is notable that for all the creeks where the Vs:Vc is reduced by the ponds, the effects on tidal processes will be ameliorated to some degree by SLR, that will increase the frequency and magnitude of overbanks tides, i.e., increasing Vs and thus raising the Vs:Vc ration again.

### *Brine Spills*

Refer to Section 6.5.2.

### *Acid Sulfate Soils*

Some soils and sediments in the coastal units have potential to be ASS. Where these soils and sediments were sampled, testing has confirmed the presence of sulfides and the potential to generate acidic conditions should these soils or sediments be disturbed. Excavations in these areas are likely to be limited to distinct areas such as pump and intake locations, with material being brought in to construct the walls (i.e., material will not be taken adjacent to the wall location). The construction activities in soils and sediments within the coastal units will require a more detailed ASS investigation to be completed once detailed designs are available.

Leichhardt will collect and assess additional samples regularly for ASS during any excavations in the coastal units and treat ASS accordingly to ensure there are no impacts to intertidal waters (refer to Section 6.3.6).

### *Sea Level Rise*

The Proposal will require the placement of pond walls within the intertidal zone, which may alter the natural changes that would occur as a result of SLR. The Coastal Processes report (Larcombe et al., 2025) describes what would be likely to occur in the absence of the ponds and assumes a SLR of 0.9 m over the next century i.e., 10 mm/yr.

In general, the major changed factors as a result of the Proposal and SLR are:

- Changed tidal hydrodynamics;
- Change flow patterns during freshwater flood events, notably increased speeds near some pond walls and through areas of new constriction; and
- Reduced freshwater runoff and sediment availability and thus supply to coastal environments.

The resulting effects on coastal response are generally less where the affected areas have ample local sediment supply and the capacity to mobilise it, or at least plus some capacity for internal reworking of sediment. For the nascent mangroves, and perhaps more so for the McKay Creek catchment, the pond-associated response is somewhat dependent upon the age of the key sedimentary bodies involved, and especially of those unconsolidated sedimentary units of sufficient volume to potentially provide material to allow a coastal response to the changed drivers of sediment transport.

## 6.6 MITIGATION

Leichhardt has mitigated the potential impacts to this factor according to the mitigation hierarchy; avoid, minimise, rehabilitate, offset. Offsets are not expected to be required for this factor.

### 6.6.1 AVOID

The key avoidance mechanism implemented by Leichhardt was the iterative design of the development envelopes to avoid key environmental features. Leichhardt has conducted numerous ecological surveys and this information has been utilised to design the Proposal and its Indicative Disturbance Footprint to avoid the following:

- Blockages or diversions of McKay Creek and Eramurra Creek. The final Proposal design includes a significant exclusion to the pond footprint to ensure these creeks continue to flow through to the ocean; and
- Direct impacts to the majority of tidal creeks. The pond footprint was moved south to ensure the majority of tidal creeks are not intersected by the ponds. One exception is the intake creek where some direct impacts will be required.

In addition to the above, the following avoidance mitigation measures have been incorporated:

- Impacts associated with groundwater abstraction have been avoided by the use of seawater desalination and the use of third-party construction water supply as an interim measure.

### 6.6.2 MINIMISE

The following mitigation measures are proposed to ensure that direct and indirect impacts to inland waters are minimised:

1. **Obtain and comply with the following approvals**:
    a. Ministerial Statement to be issued under Part IV of the EP Act;
    b. Works Approval and Licence to be issued under Part V of the EP Act for solar salt manufacturing and;

c. MP to be approved under the Mining Act for activities on Mining Act tenure;
d. MCP to be approved under the Mining Act for activities on Mining Act tenure. The MCP will describe the rehabilitation and closure of the Proposal, and associated management and monitoring proposed during the closure phase;
e. Development Application to be approved under the *Port Authorities Act 1999* for activities within PPA-managed lands and waters;

2. **Implement the GMMP in Appendix 1.9**. The primary focus of the GMMP is to demonstrate how groundwater seepage and mounding will be monitored and managed to avoid and minimise impacts on surrounding environmental values. The key management controls described in the GMMP include:
    a. Installation of additional groundwater monitoring bores and collection of additional baseline data;
    b. Refinement of groundwater model using additional baseline data;
    c. Installation of sentinel wells extending from the pond walls to monitor groundwater physical parameters and levels. The information from these wells will trigger any active management at the Proposal;
    d. Development of pond floor which minimises the potential for seepage. The outcome will be a stable base which will act to limit seepage from each pond;
    e. Safe operation and maintenance of ponds for example, introduction of water to the ponds at such a rate as to minimise scour and maximise evaporation;
    f. If required for mitigation, installation of cut-off bores, sumps, and/or ponds which will be designed to capture and return saline water to the ponds;
    g. Bunding of areas where chemicals may be used;
    h. Suitable siting, design, and construction of waste storage facilities; and
    i. Appropriate spill management procedures;
3. **Drainage control structures will be designed with key stakeholders to accommodate agreed AEP values and may consist of:**
    a. Armoured bunding along either side of McKay Creek where it abuts the ponds;
    b. Diversion channels along the southern edge of the ponds, westward into McKay Creek and eastward into Devil Creek;
4. **Ensure erosion and sediment control is included in contractor management plans** for the construction phase, to ensure that erosion and sediment control strategies and measures are implemented consistent with industry best practice guidelines;
5. **Verify inundation modelling results after construction** to ensure potential indirect impacts to the tidal regimes of the intertidal zone are within predicted outcomes, and allow potential final drainage modifications if required. The verification monitoring will collect data from several points within the intertidal zone, including:
    a. Water levels;
    b. Inundation periods; and
    c. Flow rates (if relevant to the monitoring location);
6. **Concentration pond and crystallisers will be designed and constructed to be safe and stable,** according to DEMIRS requirements and in accordance with an approved MP issued under the Mining Act;
7. **Routinely inspect the condition and performance of pond walls, pipelines, containment systems and internal drainage structures,** to ensure they are in acceptable condition and/or operating appropriately;

8. **The following controls will be used to further reduce the risk of impact from unintentional brine pipeline spills**:
    a. External pipelines will be fitted with leak detection;
    b. Water flows will be shut off if leaks are detected;
    c. External pipeline routes will be inspected regularly;
    d. Pipelines will be located off access road surfaces;
    e. If pipelines cross access roads, they will be buried;
    f. Investigations will be conducted into the cause of any spills, and remedial actions will be taken to minimise the chance of re-occurrence; and
    g. Spill response training for site-based personnel to mitigate damage;
9. **Monitor erosion at the outlets of the surface water corridors after each significant flow event.** If significant erosion is noted, then install additional erosion controls to minimise further occurrences**;**
10. **Monitor the long-term erosion and accretion of the coastline during operations.** This information will be used to determine if drainage designs should be altered to increase or decrease velocities to better align with natural processes, in consideration of SLR**;**
11. **Comply with Water Quality Protection Guidelines and guidance notes,** particularly in relation to the storage and use of hydrocarbons and other harmful chemicals, the design and operation of vehicle maintenance areas and facilities, the siting and operation of wastewater treatment systems, and the handling and storage of other waste materials, including contaminated soils**;**
12. **Ensure fuel is stored within self-bunded tanks or within a bunded area;**
13. **Develop and implement a combined Proposal/CPE Port Oil Spill Response Plan** for marine activities (including the seawater intake). This Plan will be developed in consultation with PPA and will include:
    a. Refuelling procedures;
    b. Response equipment requirements;
    c. Response procedures and action plans for various spill scenarios; and
    d. Reporting and responsibilities;
14. **If required, develop an ASS Management Plan (ASSMP)** prior to any excavation works in the coastal zone. The ASSMP will be developed to align with current best-practice methods, once final excavation sites are identified (detailed design stage)**;**
15. **Embankment material will not be taken from ASS zones**; and
16. **Abstract seawater from the designated tidal creek only when tides are above 0.0 m AHD**. This will ensure that sufficient water volumes are available in the creek to minimise abstraction impacts.

### 6.6.3 REHABILITATE

At the completion of the Proposal the site will be rehabilitated to allow and encourage the natural establishment of vegetation and traditional values. This establishment will take some time in areas beneath the ponds where the soils have been saturated by saline water. An Interim MCP has been provided in Appendix 1.8. The MCP will be submitted to DEMIRS for assessment and approval prior to the construction of the Proposal and will be reviewed and revised every three years.

The key rehabilitation measures that relate to inland waters are summarised below:

1. Salts will be harvested from each crystalliser prior to closure;
2. Concentration pond walls will be flattened or opened up to allow tidal and overland flows to enter the ponds;
3. All above-ground infrastructure will be removed if not retained by Mardie Station or PPA; and
4. Crystallisers will be rehabilitated to an acceptable landform that allows free surface drainage.

## 6.7 PREDICTED OUTCOME

The EPA's environmental objective for this factor is to maintain hydrological regimes and quality of groundwater and surface water so that environmental values are protected (EPA, 2018a).

### 6.7.1 GROUNDWATER

The assessment in Section 6.5.1 identified that potentially significant impacts to groundwater EVs could occur as a result of seepage and mounding from the concentration ponds and crystallisers. These potential impacts will be monitored and mitigated as required to ensure that impacts are restricted to areas in the immediate vicinity of the pond walls, and do not extend into sensitive areas such as GDEs and BCH.

Given seepage and mounding affects are likely to be slow (years to decades), the proposed management approach of monitoring groundwater levels and chemistry near risk areas and recovering adversely affected groundwater (if required) is expected to be sufficient to prevent impacts to environmental values. This process is documented in the GMMP provided in Appendix 1.9. The GMMP will be further defined as more detailed baseline groundwater information becomes available, and specific outcomes managed by the GMMP are expected to be a condition of the Ministerial Statement if approved.

With regards to other potential impacts to groundwater quality, there is risk of ASS impacts, however in limited locations (managed, if necessary, by an ASSMP), and standard safeguards and responses for leaks and spills of hydrocarbons and other hazardous chemicals will be implemented across the Proposal. These risks will be regulated under Part V of the EP Act and under the Mining Act such that they are unlikely to be significant.

Based on the above, the predicted outcome for groundwater is highly dependent on the implementation of mitigation measures. With the implementation of these measures the predicted outcomes for groundwater are considered to be:

- No adverse impact to water levels or water quality in Devils Pool or Noorea Soak as a result of changes to groundwater regimes or groundwater quality from the Proposal;
- No change in the health, extent of coverage, or species diversity of intertidal BCH or Flora and Vegetation outside an area that extends 100 m from the pond walls as a result of changes to groundwater regimes or groundwater quality associated with the Proposal;
- No adverse impacts to GDEs outside an area that extends 50 m from the pond walls as a result of changes to groundwater regimes or groundwater quality associated with the Proposal.

These outcomes may contribute to impacts to other factors however they are not considered to be significant residual impacts to Inland Waters and therefore offsets are not proposed for this factor.

### 6.7.2 Surface Waters

The assessment in Section 6.5.2 identified that the Proposal would maintain the flow paths of Eramurra, McKay and Devil Creek. The presence of the ponds will however alter the size of the creek catchments, and require some diversion of broader floodwaters, resulting in changes in discharge volumes, water depths in these creeklines and areas downslope and upslope of the ponds. The predicted outcomes for inland surface waters are:

- No adverse impact to water levels or water quality in Devils Pool or Noorea Soak as a result of surface water flows associated with the Proposal;
- Decreased freshwater inundation attributable to the Proposal to no more than 84.2 ha of intertidal BCH; and
- No changes to the health, extent or diversity of intertidal BCH or Flora and Vegetation as a result of erosion, spills or ASS.

These outcomes may contribute to impacts to other factors however they are not considered to be significant residual impacts for this factor and therefore offsets are not proposed.

### 6.7.3 Summary

The presence of the concentration ponds and crystallisers will result in changes to hydrological regimes, both tidal and overland. Leichhardt has incorporated a number of levees, channels and culverts into the Proposal to ensure catchment flows are managed. This will constrain extreme flows resulting from tropical cyclones and storms and avoid flooding into the salt ponds, damage to pond walls and other infrastructure. Additionally, the final Proposal design includes a significant exclusion in the pond footprint to maintain the overall hydrological regimes of the drainage catchments. As a result, the Proposal is predicted to be able to be developed without significant impacts to hydrological regimes.

Potential impacts to inland water quality can be appropriately managed under Part V of the EP Act via a works approval and licence, as the Proposal will be considered under the 'solar salt manufacturing' category in Schedule 1 of the Environmental Protection Regulations 1987. A Mining Proposal issued under the Mining Act will also provide additional regulation for activities that are considered under that Act, such as pond wall geotechnical design and erosion.

The seawater intake is considered to be adequately managed under Part V of the EP Act via a works approval and licence however an abstraction condition (only at or above 0.0 m AHD) and an annual intake volume limit is expected to be required under Part IV of the EP Act to enforce the commitments made in Section 6.6.2.

The impacts of SLR are predicted to be relatively localised and mostly limited to the area immediately adjacent to the coast to the northwest of the PIDE.

Based on the above, the Proposal is expected to be able to be implemented in a way that maintains hydrological regimes and quality of groundwater and surface water so that environmental values are protected. The EPA objective for this factor is therefore able to be met.

# 7 MARINE ENVIRONMENTAL QUALITY

The Marine Environmental Quality factor was noted as being linked to several other key environmental factors such as BCH and Marine Fauna. As such, this section was moved ahead of these other factors to provide a logical flow to the ERD.

## 7.1 EPA OBJECTIVE

The EPA Objective for this key environmental factor is to maintain the quality of water, sediment and biota so that environmental values are protected.

## 7.2 POLICY AND GUIDANCE

Relevant EPA and Commonwealth Government Guidance Documents for Marine Environmental Quality are summarised in Table 7-1.

**Table 7-1: Policy and Guidance relevant to the Marine Environmental Quality key environmental factor**

| Policy and Guidance | How guidance has been considered |
|---|---|
| **WA Government** | |
| Key EPA documents | |
| EIA (Part IV Divisions 1 and 2) Procedures Manual (EPA, 2024a). | This document has been considered in planning for the Part IV approval process and has been used to inform the preparation of this ERD. |
| Statement of Environmental Principles, Factors, Objectives and Aims of EIA (EPA, 2023a). | This document was considered in the preparation of this ERD and to inform EIA. It was used identify the Key Environmental Factors likely to be impacted by the Proposal and the EPA's objective for each factor. |
| Statutory Guidelines for Mine Closure Plans (DEMIRS, 2020a). | This document has been considered in the design and planning of the Proposal, it has also been considered in the preparation of mitigation measures for the Proposal. |
| EIA (Part IV Divisions 1 and 2) Administrative Procedures (EPA, 2024d). | This document has been considered in planning for the Part IV approval process and has been used to inform the preparation of this ERD. |
| Instructions on how to prepare EP Act Part IV Environmental Management Plans (EPA, 2024e). | This document was used as guidance for development of the Marine Environment Quality Monitoring and Management Plan (MEQMMP; Appendix 2.1) and Dredging and Spoil Disposal Monitoring and Management Plan (DSDMMP; Appendix 2.2). |
| Relevant EPA Factor Guidelines | |
| Environmental Factor Guideline – Marine Environmental Quality (EPA, 2016a). | This document was considered in the preparation of this section (Section 7) of the ERD. |
| Relevant EPA Technical Guidance | |
| Technical Guidance – Protection of BCH (EPA, 2016b). | This document was considered in the preparation of this section (Section 7) of the ERD. |
| Technical Guidance – Protecting the Quality of WA's Marine Environment (EPA, 2016c). | This document was considered in the preparation of this section (Section 7) of the ERD. |
| Technical Guidance – EIA of Marine Dredging Proposals (EPA, 2021f). | This document was considered in the preparation of this section (Section 7) of the ERD. |

| Policy and Guidance | How guidance has been considered |
|---|---|
| Other Policy and Guidance | |
| Identification and investigation of acid sulfate soils and acidic landscapes (DoER, 2015a). | This document was considered for the Baseline Soils and Sediment Assessment (LWC, 2022). |
| Treatment and management of soil and water in acid Sauropus soil landscape (DoER, 2015b). | This document was considered for the Baseline Soils and Sediment Assessment (LWC, 2022). |
| Pilbara Coastal Water Quality Consultation Outcomes – Environmental Values and EQOs, DotE, Government of WA, Marine Series Report No. 1 (DotE, 2006). | This document was considered in the preparation of this section (Section 7) of the ERD. |
| Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018). | This document was considered in the preparation of this section (Section 7) of the ERD. |
| WA Environmental Offsets Policy (EPA, 2011). | This document was considered when determining whether offsets were expected to be required for the Marine Environmental Quality environmental factor. |
| WA Environmental Offsets Guidelines (EPA, 2014a). | This document was considered when determining whether offsets were expected to be required for the Marine Environmental Quality environmental factor. |
| WA Environmental Offsets Template (EPA, 2014b). | This document was considered when determining whether offsets were expected to be required for the Marine Environmental Quality environmental factor. |
| WA Environmental Offsets Metric and relevant guidance (DWER, 2021b). | This document was considered when determining whether offsets were likely to be required for the Marine Fauna environmental factor, and the adequacy of any proposed offsets. |
| **Commonwealth Government** | |
| Key Documents | |
| Generic guidelines for the content of a draft EPBC Act PER/EIS (including the objects and principles of the EPBC Act, 1999; DotEE, 2016). | These documents were considered in the preparation of this ERD and while undertaking EIA. |
| EPBC Act Environmental Offsets Policy (DSEWPaC, 2012a) – including the Offset Assessment guide. | This document was considered when determining whether offsets were expected to be required for the Marine environmental Quality environmental factor. |
| Environmental Management Plan Guidelines (DotE, 2014). | This document was used as guidance for development of the MEQMMP(Appendix 2.1) and DSDMMP(Appendix 2.2). |
| EPBC Act Condition Setting Policy (DAWE, 2020). | This document was used as guidance for the referral process and EIA of the Proposal. |
| EPBC Act Outcomes-based conditions policy (DotE, 2016a). | This document is used to assist in designing outcome-based Management Plans (MEQMMP and DSDMMP). |
| *Environment Protection (Sea Dumping) Act 1981.* | A Sea Dumping Permit will be required for the offshore disposal of dredge spoil material. Reference to this requirement is included in the mitigation section (Section 7.6) and in the DSDMMP. |
| National Assessment Guidelines for Dredging (DEWHA, 2009a). | This document was used during the development of the DSDMMP and the assessment of dredging impacts in this ERD. |
| Relevant EPBC Act listed species specific survey guidelines and protocols. | |
| Relevant EPBC Act listed species specific Recovery plans, Threat Abatement Plans, Approved Conservation Advice and other documents. | These documents were used as guidance to assess and manage EPBC listed species that may be impacted by impacts to marine environmental quality. |





| Policy and Guidance | How guidance has been considered |
|---|---|
| Marine bioregional plan for the North-west Marine Region (DSEWPaC, 2012b). | These documents were considered in the preparation of this section (Section 7) of the ERD. |
| Environmental best practice port development; an analysis of international approaches (GHD, 2013a). | This document was referred to during the review of the port design (noting that the CPE Port is not part of this Proposal). |

## 7.3 RECEIVING ENVIRONMENT

The information provided in this section has been sourced from the following reports:

- O2 Marine (2025a; Appendix 2.3) Eramurra Solar Salt Project – Sediment Analysis Report prepared for Leichhardt Salt Pty Ltd;
- O2 Marine (2022a; Appendix 2.4) Eramurra Solar Salt Project – Marine Water Quality Baseline Report;
- O2 Marine (2025d; Appendix 3.3) Eramurra Solar Salt Project – Subtidal Benthic Communities and Habitat;
- O2 Metocean (2025; Appendix 2.5) Eramurra Solar Salt Project – Dredge Plume Modelling Report. Report prepared for Leichhardt Salt Pty Ltd;
- O2 Metocean (2023a; Appendix 2.6) Eramurra Solar Salt Project – Bitterns Modelling. Report prepared for Leichhardt Salt Pty Ltd;
- Intertek (2024a; Appendix 2.7) Ecotoxicology Laboratory Test Report; and
- Intertek (2024b; Appendix 2.8) Ecotoxicology Laboratory: Technical Justification for the Selection of Bioassays For A Bitterns Direct Toxicity Assessment.

### 7.3.1 LEVELS OF ECOLOGICAL PROTECTION - BACKGROUND

The following text has been sourced from *Pilbara Coastal Water Quality Consultation Outcomes - Environmental Values and Environmental Quality Objectives* (DotE, 2006).

The EPA has developed an Environmental Quality Management Framework (EQMF) for the marine waters of WA. The EQMF was first implemented for Perth's coastal waters and then in greater detail for Cockburn Sound (EPA, 2000; Government of WA, 2005). The State Government has endorsed the progressive implementation of the EQMF for all of the State's marine waters on a priority basis (Government of WA, 2003). The key elements of the EQMF are Environmental Values (EVs), Environmental Quality Objectives (EQOs) and Environmental Quality Criteria (EQC). EVs are defined as "particular values or uses of the environment that are important for a healthy ecosystem or for public benefit, welfare, safety or health, and which require protection from the effects of pollution, waste discharges and deposits." (ANZECC and ARMCANZ, 2000). The EVs reflect the importance that the community places on the marine environment for its intrinsic biodiversity and ecosystem functions, its recreational and cultural attributes, and its commercial and industrial uses.

Five EVs are relevant to marine waters:

- Ecosystem Health (ecological value);
- Recreation and Aesthetics (social use value);
- Cultural and Spiritual (social use value);
- Fishing and Aquaculture (social use value); and
- Industrial Water Supply (social use value).

The ecosystem health value is fundamental and of most relevance to the Proposal because healthy ecosystems support and sustain life. The other four environmental values represent specific human benefits or uses that rely on a clean, healthy environment; collectively, they are referred to as social-use values.

For each EV, one or more EQOs may be defined. The EQOs are more specific than the EVs and represent management goals for maintaining environmental quality to protect particular aspects of the EVs from the effects of wastes. The EQO for maintenance of ecosystem integrity has four different levels of ecological protection (LEP), each representing a different environmental quality condition (described in Table 7-2). These LEPs are applied to each part of the ecosystem in such a way that the general integrity of the ecosystem is maintained. This allows for management of conservation values and multiple uses (some with localised effects) while still maintaining the broad structure and function of the ecosystem. Clearly, setting a Moderate or Low LEP over large areas would not protect ecosystem integrity overall. Conversely, it would be unreasonable to propose an area of Maximum LEP adjacent to major existing development or population nodes.

**Table 7-2: Requirements of various levels of ecological protection**

| LEP | Environmental quality condition (Limit of acceptable change) | |
|---|---|---|
| | Contaminant concentration indicators | Biological indicators |
| Maximum | No contaminants – pristine | No detectable change from natural variation |
| High | Very low levels of contaminant | No detectable change from natural variation |
| Moderate | Elevated level of contaminants | Moderate changes from natural variation |
| Low | High levels of contaminants | Large changes from natural variation |

In practice, the achievement of an EQO (or a LEP) will be judged from assessment of monitoring data. The environmental quality indicators selected for monitoring will relate to the EQOs/LEPs and to the pressures (e.g. types of waste inputs) that threaten their achievement. For each environmental indicator monitored, an EQC, either descriptive or quantitative, will be required as a benchmark against which the monitoring data can be compared to determine whether the EQO/LEP has been met. If the EQO/LEP is deemed not to be met, then this signals the need for remedial management action (e.g. reduction of waste discharge) in order to achieve the desired management goal.

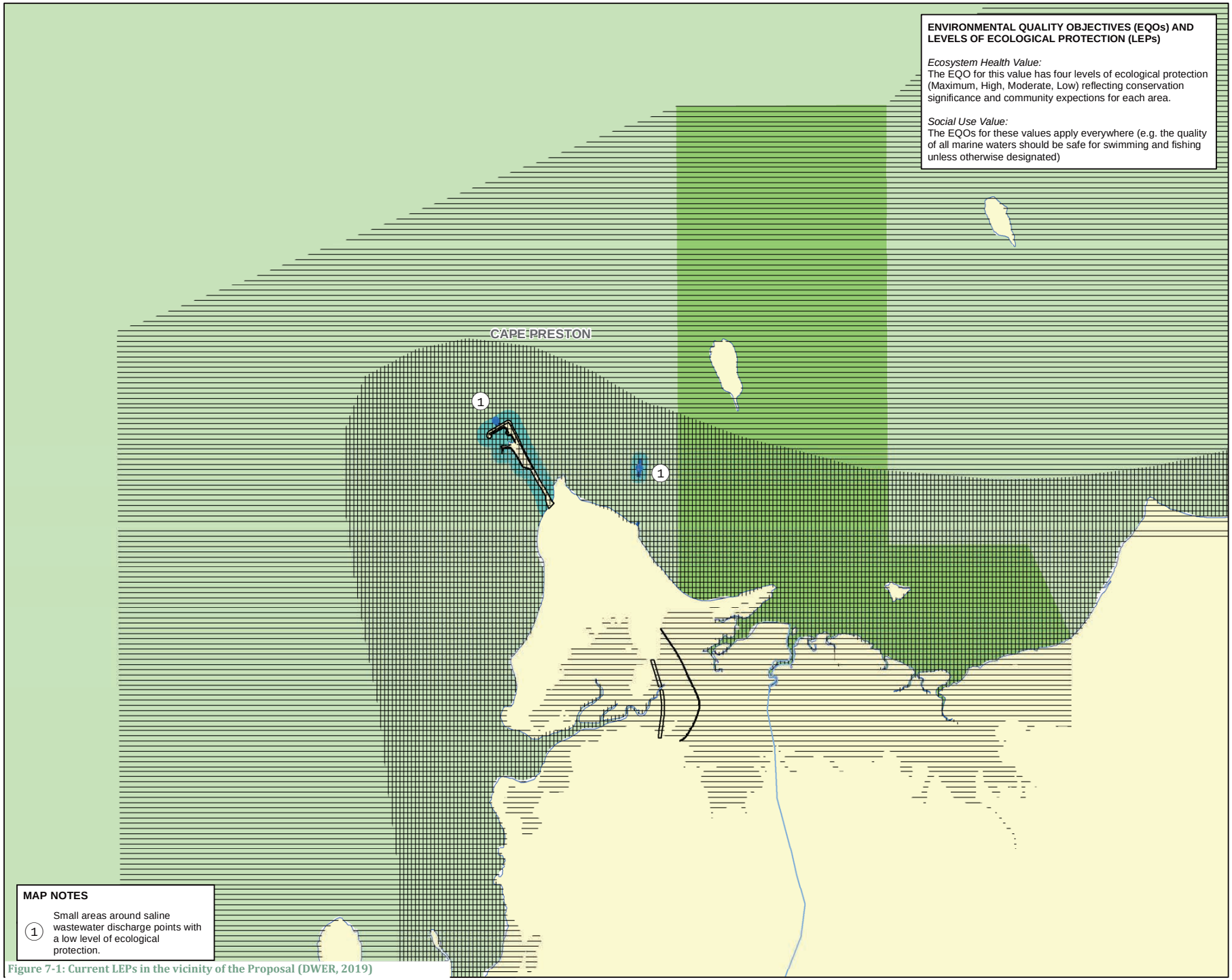
A comprehensive set of EQC has yet to be formally established by the EPA for the Pilbara coastal waters. The DCCEEW has recently conducted investigations of background water and sediment quality in the region for a range of potential contaminants. These regional background data are being used, together with the guidelines and approaches from the Australian and New Zealand Water Quality Guidelines (ANZECC & ARMCANZ, 2000), to develop water and sediment quality criteria appropriate to the region. The criteria will be used to assess and guide development of existing and future monitoring programs in the region.

### 7.3.2 Current Level of Ecological Protection

Marine waters adjacent to and within the Proposal have been assigned LEPs as part of the *Pilbara Coastal Waters Consultation Outcomes: Environmental Values and Environmental Quality Objectives* (DotE, 2006). A Maximum LEP has been assigned in coastal areas on the eastern side of Cape Preston and extends approximately 15 km from the coast, encompassing South West Regnard Island (Figure 7-1). The adjacent coastal waters are assigned a 'High' level of ecological protection. Two small areas (<100 m diameter) on the north and eastern sides of Cape Preston have been assigned a Low LEP, associated with approved desalination brine outfalls, and port areas at Cape Preston and CPE Ports have been assigned a Moderate LEP (Figure 7-1).

Regionally significant arid zone mangrove is present in coastal areas and the area has been nominated as a proposed marine conservation reserve. These classifications infer that the "environmental condition for this area are essentially pristine, with no detectable change from natural background conditions and no effects on marine life as a result of waste inputs or contamination" (DotE, 2006).

# Map 13: Cape Preston




**LEGEND**

- Major River
- Regionally Significant Arid Zone Mangrove Areas
- Proposed Marine Conservation Reserve

Level of Ecological Protection

- Maximum
- High
- Moderate
- Low

**ENVIRONMENTAL QUALITY OBJECTIVES (EQOs) AND LEVELS OF ECOLOGICAL PROTECTION (LEPs)**

*Ecosystem Health Value:*
The EQO for this value has four levels of ecological protection (Maximum, High, Moderate, Low) reflecting conservation significance and community expections for each area.

*Social Use Value:*
The EQOs for these values apply everywhere (e.g. the quality of all marine waters should be safe for swimming and fishing unless otherwise designated)

**MAP NOTES**

(1) Small areas around saline wastewater discharge points with a low level of ecological protection.

SOURCE DATA
DWER: Levels of Ecological Protection (2019), Regionally Significant Arid Zone Mangroves (2001)
Landgate: Towns, Rivers, Roads (2015)
Geoscience Australia: State Coastal Waters Limit (2016)
DoT, Pilbara Port Authority, DWER: Coastal Infrastructure, Areas (2016, 2017, 2018)
Proponents: Salt Works, Approved Ministerial Statements
DBCA: Proposed Marine Conservation Reserve (2005)

DWER GIS Section
Date: 30/01/2019, Map Version: 4

Disclaimer:
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GOVERNMENT OF WESTERN AUSTRALIA

N

0 1 2 4
Kilometres

Projection: Map Grid of Australia Zone 50
Datum: Geocentric Datum of Australia, 1994
Scale: 1:90,000 at A3

LOCALITY MAP




Figure 7-1: Current LEPs in the vicinity of the Proposal (DWER, 2019)

### 7.3.3 SEDIMENT QUALITY

O2 Marine (2025a; Appendix 2.3) undertook a sediment quality investigation to determine the characteristics and quality of the material to be dredged and disposed of offshore. The assessment included both preliminary and detailed site investigations in accordance with DWER's (2021a) *Guideline - Assessment and Management of Contaminated Sites*. Text from this section has been sourced from O2 Marine (2025a) unless stated otherwise.

***Preliminary Site Investigation***

The preliminary site investigation reviewed historical sediment investigations (i.e., SKM, 2013b) and sources of contaminants and identified that there are no known contaminants of potential concern (CoPC) within the proposed dredging area. Therefore, all areas were classified as being "uncontaminated." Outcomes of the preliminary site investigation provided a basis for determining the scope of the detailed site investigation, including defining the CoPC and identifying the number, depth and location of required sampling.

***Detailed Site Investigation***

A detailed site investigation of sediments from the proposed dredge footprint and the proposed offshore spoil disposal ground were undertaken in November 2020 and March 2023 respectively. Sediment samples were collected from 23 randomly distributed sampling sites on the 25 November 2020 through push coring (17) and vibracore (6) methods (Figure 7-2). Five sediment samples were collected from DSDDE 21 March 2023 (Figure 7-2).

Australian Diver Accreditation Scheme certified commercial divers were deployed with push corers at 17 of these locations. Observations and photographs were recorded for each sample. Samples were then placed into pre-labelled laboratory jars and stored in a chilled esky. Sediment corers and caps were washed using appropriate decontamination solution between samples. O2 Marine personnel undertook the following sample process/collection steps:

- Sieve the sediment through a 500 micrometre (µm) sieve using the saltwater deck wash to remove fine sediment; and
- Transfer all material retained on the sieve, such as coarse sediment and benthic infauna into two pre-labelled 2 kilos (kg) zip-lock bags and preserved with 95 - 100% ethanol solution.

The intention of the vibracoring method is to sample different sediment horizons to inform dredge design. This method involves the use of a 76.2 mm diameter stainless steel tube of 6 m length fastened to a custom-made bracket which used the flexible shaft of a small concrete vibrator to penetrate the tube into unconsolidated sediment. The tube was suspended from a davit arm over the side of the vessel and vibrated into unconsolidated sediment. A plastic liner was used inside the tube to collect the sample and a one-way core catcher was custom made for the tube to prevent losing the sample on recovery.

The tube was recovered using the deck winch, the actual core depth was recorded, and the core sample removed from the tube. The core sample initially hung vertically to settle sediments prior to being laid into the collection tube. Vibracore samples (V1 – V6) were sampled at different horizons to a maximum depth of 3 m (or until refusal).

The sample horizons which were meant to be sampled according to the Sampling and Analysis Plan (SAP) are: A (surface – 0.5 m), B (0.5 m – 1 m), C (1 m – 2 m) and D (2 m – 3 m). However, due to refusal only 'A' was collected. Replacement core liners were used for each core and core catchers were rinsed using appropriate decontamination solution (i.e., DECON) between samples.

Collected sediment samples were sent to a National Association of testing authorities (NATA) accredited laboratory for testing of:

- Particle size distribution (PSD);
- Total organic carbon (TOC);
- Metals;
- Total petroleum hydrocarbon (TPH), benzene, toluene, ethylbenzene, xylenes and Naphthalene (BTEXN) and Polyaromatic hydrocarbon (PAH);
- Organotins; and
- PASS.

Sediment samples for benthic infauna analysis were collected at six locations. Sediment recovery methods were the same as the recovery methods described above. Three individual diver cores were taken to provide the volume and statistical replication required for adequate analysis of benthic infauna. The following key findings were noted:

- There was no significant difference in species richness, diversity or composition across all the sites;
- The three most common taxa across all sites were Polychaeta and Cirratulidae (n=34), Ostracoda (n=32) and Tanaidacea and Pseudozeuxoidae (n=26);
- Polycharta was the most diverse class in terms of the number of morphological species identified (16); and
- The distribution and abundance of benthic infauna taxa across the six sample locations is heterogeneous.

The results did not identify any significant ecological importance and were generally comparable to similar infauna studies undertaken for the Mardie Project (O2 Marine, 2019a).

The following key findings were made during the detailed site investigation:

- All metal results (included the calculated 95% Upper Confidence Limits) recorded concentrations below the default guideline values (DGV) (ANZG, 2018) and Health Investigation Levels (HIL) (DEC, 2010);
- The majority of metal concentrations were below the background levels as stated in DEC (2006), with arsenic recording comparable concentrations, with one instance above the background level of 18 mg/kg (G7 – 20 mg/kg);
- Copper results within the offshore spoil disposal ground were above the background (Dec (2006) levels at all sites, but below relevant DGVs.
- All results for total recoverable hydrocarbons (TRH), PAH and organotins were below the laboratory Limit of Reporting (LoR) as well as the available screening levels (ANZG, 2018) and HILs (DEC, 2010). This indicates no contamination was present and is consistent with previous investigations (SKM, 2013b; DEC, 2006);

- All samples collected were assessed for PASS using the laboratory field screening test, however no reactions were recorded. It should be noted that the sample collection method did not test to the final dredge depth, as such a definitive conclusion on the presence of PASS to full dredge depth cannot be concluded from these results; and
- There was no presence of ASS.

O2 Marine (2025a) concluded that the surface sediment within the dredge corridor is uncontaminated. Deeper sediments could not be analysed due to coring refusal, however when considering the lack of anthropogenic impacts, and the results of previous coring studies in the study area (SKM, 2013b), it is likely that the deeper sediments are also uncontaminated and are environmentally acceptable for offshore disposal. Sediments within the proposed offshore spoil disposal ground were also found to be uncontaminated and have largely comparable characteristics as sediments within the dredge footprint.

### 7.3.4 Marine Water Quality

O2 Marine (2022a; Appendix 2.4) undertook a Baseline Marine Water Quality Investigation to characterise the existing water quality conditions in the Eramurra region. Text from this section has been sourced from O2 Marine (2022a) unless stated otherwise.

***Survey Effort***

*In-Situ Physico-Chemical Stations*

Marine water quality baseline monitoring was conducted from June 2020 to October 2021 from three monitoring locations outlined in Figure 7-3 (NCP05, UNS05 and SIC02). A range of instruments recorded in-situ physico-chemical parameters including:

- Temperature;
- Salinity and EC;
- Depth/Pressure;
- pH;
- Dissolved oxygen;
- Turbidity (Nephelometric Turbidity Units (NTU)); and
- Photosynthetically Active Radiation (PAR).

Water quality instruments were mounted on purpose-designed frames, alongside metocean data acquisition equipment. The purpose designed steel frames include mounting brackets to suit the various metocean and water quality instrumentation. The frames are designed to stand upright on the seabed, while maintaining the instruments at approximately 0.3 m above the seafloor and to reduce the likelihood of interaction of sensors with sediment, large rocks and rubble.

Instrument settings were configured to maximise data resolution for a four - six-week deployment period, as well as optimise battery performance. Retrieval, data download and instrument maintenance were carried out over a period of 12 months with field events occurring every four - six weeks (maintenance trips were weather-dependant).

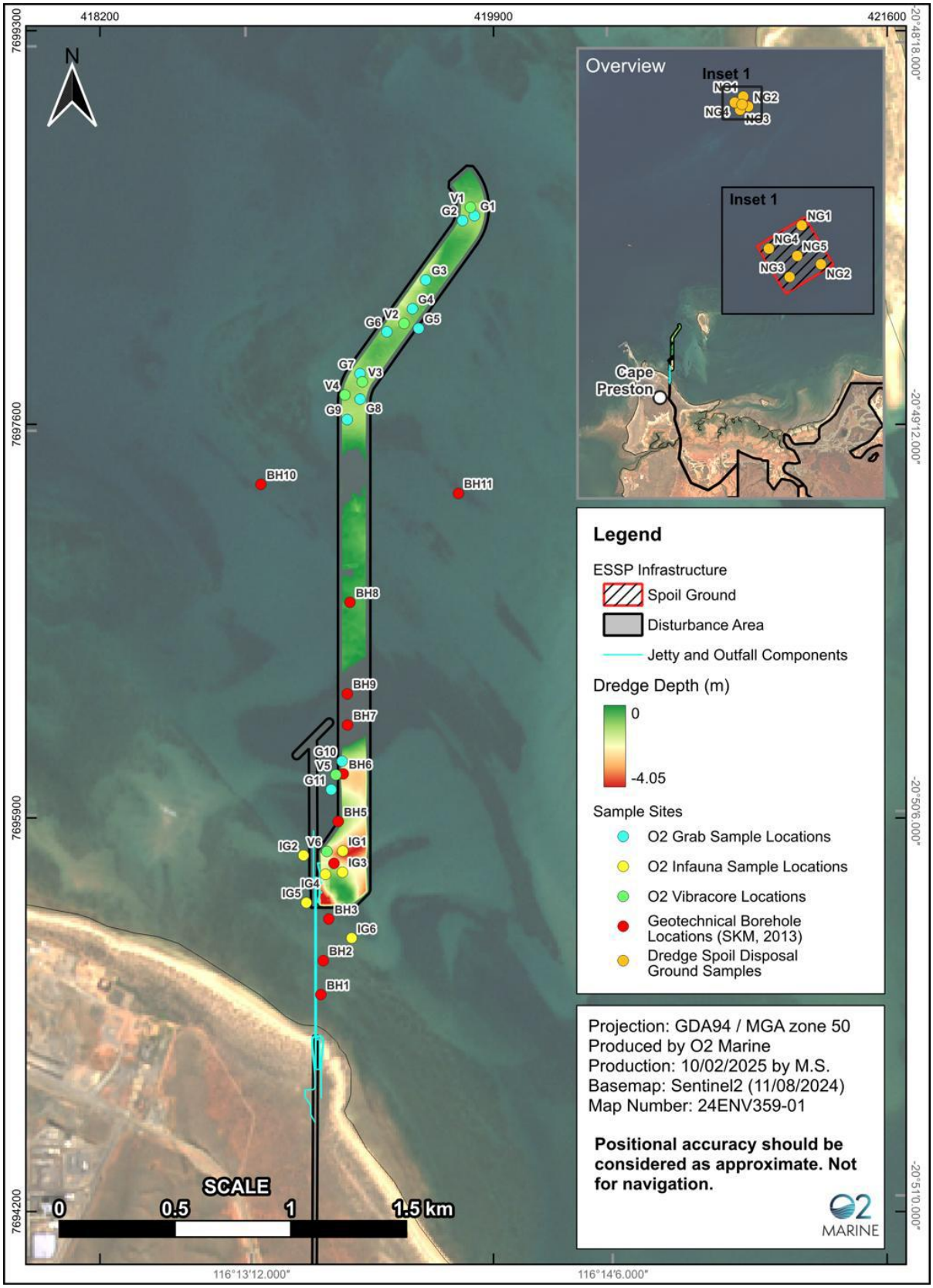



Figure 7-2: Sediment sampling locations (O2 Marine, 2025a)

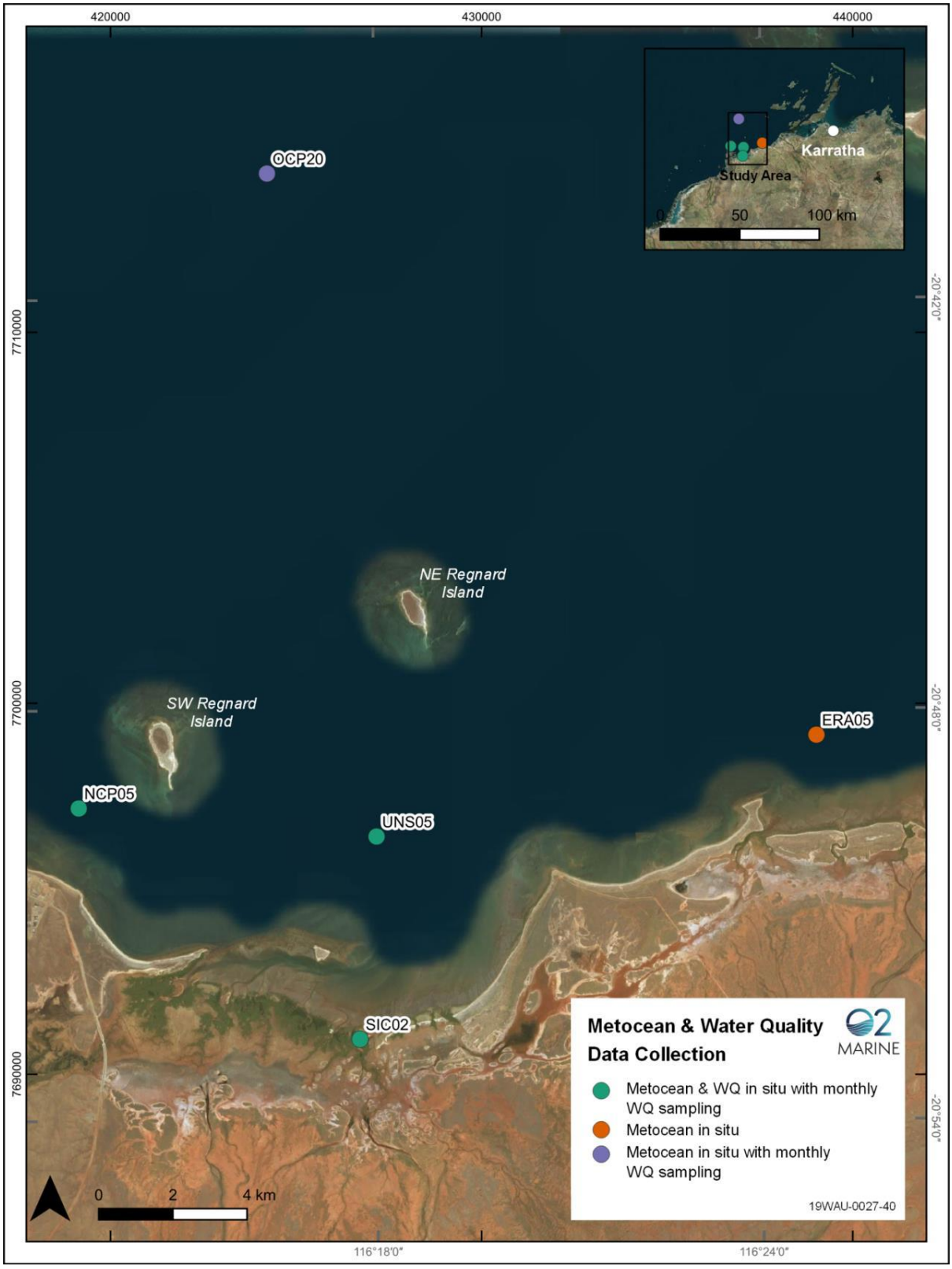



Figure 7-3: Water quality sampling locations (O2 Marine, 2022a)

### *Marine Water Sampling*

Marine water samples were collected during 12 marine water sampling events (four quarterly and eight monthly) from 15 July 2020 - 30 August 2021. The methods for these two regimes were the same, only the analytical suite differed.

Samples were sent to a NATA-accredited laboratory and analysed for the following;

- Alkalinity (monthly);
- Nutrients (monthly);
- Dissolved Metals (monthly);
- TOC (monthly);
- Dissolved Major Cations and Anions (monthly);
- Total metals (monthly);
- Total suspended solids (TSS) (monthly);
- Specific gravity (monthly);
- Microplastics (quarterly);
- BTEXN (quarterly); and
- TRH (quarterly).

Water sampling was conducted before retrieval of the water quality frame avoid disturbing benthic sediments and affect turbidity measurements. A weighted 12-volt water sampling pump and hose was lowered from the water surface to approximately 0.5 m above the seabed. Water was pumped to the topside and homogenised in a 10 L sampling container, before transferring the sample to laboratory supplied bottles and chilled on ice before being transferred to the Perth based laboratory via air freight. Samples were labelled with date, time and site name.

### *Additional Baseline Data*

The baseline data collected to date demonstrates that Eramurra marine waters are pristine and have had little anthropogenic impacts. The data collected to date is considered sufficient to inform the assessment of environmental impacts of the Proposal.

To derive site-specific EQC for monitoring and management, the EPA guidance (EPA, 2016b) recommends collection of two years of baseline data. Therefore, another 12 months of water quality sampling is proposed to inform dredge management and as part of the operational MEQMMP.

The following additional baseline data will be collected and incorporated into the MEQMMP:

- Compile all baseline data and derive site specific EQC using the methods outlined in ANZG (2018); and
- Consider inclusion of suitable reference monitoring location(s) for comparison against data collected at the proposed (outfall) location.

***Water temperature***

Overall, temperature ranged from 20.2 - 32.4°C (UNS05) and 20.1 - 32.5°C (NCP05), with mean temperatures of 26.6°C (UNS05) and 27.1°C (NCP05). The warmest waters were experienced during January, with only a slight decline until end of March, when water temperature declined more rapidly to the coolest months of June to August. No significant difference between temperature at each site was observed. Water temperatures at both sites were approximately 5°C warmer during the wet season than the dry season.

Both sites are located in shallow nearshore waters (~6 m) and are expected to show higher temperature variability than offshore waters, largely due to the influence of solar radiation (Pearce et al., 2003). The effect of solar radiation saw diurnal changes in water temperature at each site of around 0.8°C. Water temperature is seen to be highest during the mid-afternoon and lowest in the early morning, with a lag-time behind the daily solar cycle.

Several sharp (less than five days) decreases in water temperature (3 - 4°C) were observed simultaneously at both sites on 8 October 2020, 10 December 2020, 23 January 2021 and 5 March 2021. The latter three of these events coincided with tropical low-pressure systems, which are generally associated with a drop in air temperature and increased cloud cover.

***Salinity***

Overall, salinity ranged from 32.8 - 38.6 practical salinity units (psu) (UNS05) and 32.0 - 37.1 psu (NCP05), with mean salinities of 36.0 psu (UNS05) and 35.1 psu (NCP05). If seasonal trends were present, they were not consistent between sites. Higher salinities of approximately 2 psu were recorded at UNS05 than NCP05 during September and December 2020. The levels of salinity at NCP05 were more reflective of offshore Pilbara waters (ANZG, 2018) than UNS05 during that particular time period. A possible explanation is a greater influence of offshore waters due to regional current circulation at NCP05, while UNS05 may have experienced greater exchange with inshore evaporative tidal flats, where salinity can reach higher levels.

Summary statistics for salinity did not indicate significant differences between wet and dry seasons at either site. However, salinity levels were below 35 psu at both sites for several months from the beginning of December 2020, following a tropical low-pressure system which caused significant rainfall in the Eramurra area. This was followed by several other low-pressure systems over summer.

An excerpt of salinity data was examined to investigate short term (daily) changes in salinity. Daily variability showed correlation between sites for two of the seven days examined, while the other five days showed little to no correlation. The limited correlation may be related to tidal exchanges with inshore waters.

Overall, data recorded during the monitoring period were similar to the salinity range (i.e., 35.1 - 37.1 ppt) previously reported by the Department of Conservation and Land Management (2005) for the coastal Pilbara region, which is slightly lower than the range recorded at the Mardie Project (36.6 - 38.3 psu), 28 km southwest of the Proposal (O2 Marine, 2019b).

### *Turbidity/Suspended Sediment Concentration*

Turbidity data was recorded at UNS05 and NCP05 for 53 and 54 weeks respectively. To enable comparison of baseline turbidity data against the Jones et al. (2019) coral thresholds, turbidity data was converted to Suspended Sediment Concentration (SSC) using the surrogate correlation coefficient (i.e., 1 NTU: 1.1 mg/L SSC), that was derived via linear correlation of NTU and SSC from a recent dredging project offshore of Onslow (Fisher and Jones, 2019). Low turbidity (<3 NTU) occurred from July to December 2020 at both sites, with major high turbidity events occurring after 10 December 2020. Several high turbidity events were concentrated during the wet season. Turbidity ranged from 0.1 - 173.8 NTU (NCP05) and 0.0 - 105.4 NTU (UNS05). Median turbidity levels at both sites were 0.65 NTU.

The 24-hour rolling mean of turbidity at the monitoring sites UNS05 and NCP05 was generally below 3 NTU, with a number of sharp increases associated with intense weather events. As turbidity is a proxy for SSC, turbidity is expected to increase during events that lift benthic sediments into the water column. These events are associated with high period and larger sized waves, strong winds and increased current strength. These systems also commonly bring rainfall to the Pilbara. A brief analysis of low-pressure systems (including tropical cyclones) and rainfall events during the monitoring period was conducted with data provided by BoM (2022). Almost all high turbidity events (>5 NTU) were associated with significant rainfall. The entrainment of fine terrigenous sediment particles by freshwater runoff is a major source of suspended sediment to the nearshore marine areas, while strong winds and wave action associated with low-pressure systems resuspend benthic sediments causing high turbidity at the monitoring sites. This can cause elevated turbidity from days to weeks.

### *Light*

PAR sensors were added to the NCP05 and UNS05 in-situ frames during the October 2020 maintenance event, with data recorded from 9 November 2020 - 10 October 2021. PAR is used to calculate the Daily Light Integral (DLI), the recommended parameter used (along with turbidity or SSC) to assess possible and probable mortality thresholds for coral, seagrass and sponges (EPA, 2021f). Baseline DLI data is used to inform dredge plume modelling to determine spatial and temporal zones of impact (High, Moderate and Influence). The *Eramurra Solar Salt Project Dredge Plume Modelling Report* (O2 Metocean, 2025; Appendix 2.5) discusses in detail baseline DLI characteristics and delineates the zones of impact based on the current proposed dredge activities.

Natural DLI conditions at both NCP05 and UNS05 were regularly below the possible effects criteria during the 7, 14 and 28 day monitoring periods, particularly between February and July 2021. Both sites recorded several, brief periods where natural DLI conditions were below the probable effects criteria.

There was a demonstrated direct correlation between low DLI levels and the two tropical lows and one cyclone (Tropical Cyclone Odette) that had impacts on the marine environment around NCP05 and UNS05. During each of these occasions, DLI levels were seen to decline for brief periods of time, typically lasting for less than one week.

Guidance in EPA (2021g) suggests that possible and probable effect thresholds are best applied to offshore, clear water communities, and when applied to near-shore, turbid waters, the thresholds would be conservative and likely overestimate impacts. This guidance appears accurate for the DLI data recorded at the nearshore sites NCP05 and UNS05, where increased turbidity exists.

***pH***

pH data was recorded at NCP05 and UNS05 for 54 and 58 weeks respectively over the monitoring period. OzCoasts (2021) note that the pH of marine waters is close to 8.2, whereas most natural freshwaters have pH values in the range from 6.5 - 8.0. Water quality stations recorded mean baseline pH at NCP05 and UNS05 of 8.27 and 8.18 respectively. Both sites exhibited relatively stable pH levels throughout the monitoring period, with a slight decline in pH from April to June 2021. It is possible that this is related to a slight reduction in salinity during this period associated with freshwater input from rainfall and terrestrial runoff. The pH at NCP05 experienced sharp declines to ~7.5 around the times of two rainfall events on 10 December 2020 and 20 May 2021. UNS05 was more stable throughout the monitoring period and no trends were observed.

***Dissolved Oxygen***

Dissolved Oxygen (DO) concentration was recorded at NCP05 and UNS05 for 52 and 54 weeks respectively over the monitoring period. No significant long-term or seasonal trends were noted at either site. Overall, DO (% saturated) ranged from 65 to 103% (UNS05) and 61% to 105% (NCP05), with mean DO of 85% at both sites. DO concentration showed no trends and were not correlated between sites, indicating that factors influencing DO are likely to be localised and different at each site.

***Laboratory Results***

Most results reported by the NATA-certified laboratory were below the ANZG (2018) 99% species protection guidelines for all analytes with stated guideline values, and predominantly below the laboratory LoR.

***Thresholds***

WAMSI (Jones et al., 2019) SSC and DLI thresholds for possible and probable effects on coral were found to be unsuitable as criteria for monitoring dredging effects in the nearshore areas adjacent to Cape Preston, with natural baseline conditions exceeding the possible effects thresholds for corals on three occasions. It is noted that Jones et al. (2019) recognises these potential limitations of the thresholds and advises that WAMSI is in the process of developing thresholds for turbid water coral communities. Once these new turbid water thresholds are available, they should be evaluated against the baseline data collected in this program.

## 7.4 POTENTIAL IMPACTS

Table 7-3 defines the potential impacts (direct, indirect and combined) on the environmental values for this factor in a local and regional context. Cumulative impacts include impacts from the Sino Iron Project, but also consider broader-scale impacts from the Mardie Project and Dampier Salt's Dampier operation. A maximum LEP exists in the immediate vicinity to the east of the Proposal and relevant criteria will need to be met outside of impact areas.

**Table 7-3: Potential impacts on Marine Environmental Quality**

| Environmental value and current extent | Potential direct impact | Potential indirect impact | Impacts associated with other proposals | Combined local impact |
|---|---|---|---|---|
| **Marine waters surrounding port infrastructure and dredge material disposal area.**<br>Different LEP's have been previously assigned around the CPE Port to account for desalination discharges and port operations.<br>The marine waters surrounding dredge material disposal area are currently listed as having a 'high' LEP. | • Discharge of up to 5.9 GLpa of bitterns: and<br>• Disposal of up to 400,000 $m^3$ of dredged sediment through water column (construction only) | • Increased turbidity caused by dredging and the construction of the bitterns pipeline and diffuser; and<br>• Hydrocarbon spills from vessels. | • Discharge of desalination brine at Cape Preston (note that desalination brine will not be discharged at CPE Port if the Proposal is implemented);<br>• Increased turbidity caused by vessel movements (propeller churn) at Cape Preston and CPE Ports;<br>• Spills of magnetite ore, salt and other products during transfer to transhipment and ocean-going vessels at Cape Preston and CPE Ports and offshore; and<br>• Hydrocarbon spills from vessels. | • Discharge of up to 5.9 GLpa of bitterns in addition to the desalination brine discharge at Cape Preston Port;<br>• Turbidity caused by dredging activities and vessel movements at Cape Preston and CPE Ports (propeller churn);<br>• Spills of magnetite, salt and other products during transfer to transhipment and ocean-going vessels; and<br>• Hydrocarbon spills from vessels. |
| **Tidal Creeks.**<br>Several tidal creeks occur along the coastline to the north of the Proposal. These waters are currently listed as having either a 'maximum' or a 'high' LEP. | No direct impacts proposed. | • Hydrocarbon spills associated with the seawater intake;<br>• Increase in salinity due to leaks or spills of brine from ponds or pipelines; and<br>• Sedimentation due to runoff during construction of seawater intake. | • No other proposals occur within the tidal creek boundaries. | • Hydrocarbon spills associated with the seawater intake;<br>• Increase in salinity due to leaks or spills of brine from ponds or pipelines; and<br>• Sedimentation due to runoff during construction of seawater intake. |





# 7.5 ASSESSMENT OF IMPACTS

## 7.5.1 MARINE WATERS SURROUNDING PORT INFRASTRUCTURE

***Proposed Levels of Ecological Protection***

The EPA (2016a) provides a framework for protecting the quality of WA's marine environment via processes to spatially define, assess, and manage potential impacts of proposals on marine environmental quality. One of the relevant processes is the spatial designation of the area around the outfall into four LEPs:

1. Maximum;
2. High;
3. Moderate; and
4. Low.

O2 Metocean (a subsidiary of O2 Marine) was commissioned by Leichhardt to develop a hydrodynamic modelling program to support the Proposal, including modelling of the bitterns discharge to identify potential impacts to water quality and inform the preparation of a MEQMMP (Appendix 2.1). The EQO for the Proposal are to maintain specific LEPs within defined zones within proximity to Proposal infrastructure. The EPA's *Technical Guidance Protecting the Quality of Western Australia's Marine Environment* (2016c) provide the following guidance:

> *A moderate level of ecological protection may be applied to relatively small areas within inner ports and adjacent to heavy industrial premises where waste discharges and contamination from current and/or historical activities may have compromised a high level of ecological protection. It may also be used to accommodate any accumulation of contaminants from anti-foulant paints, typically extending up to 250 m from ship turning basins and berths.*

And:

> *A low level of ecological protection should only be considered around wastewater discharge where the need can be technically justified. They should be as small as possible and linked to the zone of initial dilution where reasonably practicable to do so, usually extending no more than 70 m from the diffuser. These areas should be located within moderate ecological protection areas where available.*

LEP are defined in terms of Species Protection Level (SPL) with low, moderate, and high ecological protection defined as 80%, 90% and 99% levels of species protection, respectively. The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG, 2018) provide default guideline values for many single toxicant triggers. They are defined as concentrations that should protect a percentage of species (i.e., an LEP) in the environment with 50% confidence. They are only intended for guidance, not an EQC applicable to all regions.

Direct toxicity assessment, termed whole effluent toxicity (WET), is applied to measure the overall toxicity of a mixture of compounds, such as bitterns. There are two overarching approaches to direct toxicity assessment, standard versus site-specific, summaries as follows:

- Standardised - good for assessing different effluents from similar industries, encouraging the generation of scientifically sound data, carried out using standard organisms, standard synthetic water, and standard test conditions (e.g., pH, temp, DO). Generally, not representative of the local environment; hence, have limited applicability to make conclusions about potential environmental effects.
- Site specific test protocols designed according to the environmental conditions of receiving waters. Limits possibility of comparisons with other effluents, different species, etc. Furthermore, the use of natural water as control and dilution water increases the complexity of the testing and presents further problems related to background effects, while treating and filtering natural waters may also alter the toxicity of contaminants.

***Bitterns Disposal***

The production process will produce a high-salinity bittern, that will be discharged through a diffuser located 600 m north from the end of the CPE Port trestle jetty. A seawater intake will be installed along the trestle jetty (outside the area influenced by the bitterns disposal) to allow the in-line dilution of bitterns at a ratio of at least one volume of seawater to one-part bitterns to reduce the initial salinity concentration of the discharged bitterns. The diluted bitterns will be discharged to marine waters via a 200 m diffuser with 21 nozzles.

The following key points are relevant to this assessment:

- The Proposal Content Document restricts the bitterns disposal to only occur within the Marine Development Envelope;
- The Proposal Content Document will restrict the total volume of undiluted bitterns discharge; and
- Revised LEPs will be required for the mixing zone (a revision of the boundaries of the Low and Moderate LEP areas approved for CPE Port).

*Effluent Testing*

An approach commonly applied to an operational discharge is to derive SPLs relevant to the direct toxicity of the effluent being discharged, which is termed Whole Effluent Toxicity (WET) testing. This process examines the cumulative effect of the contaminants within the discharge on locally relevant species to provide a concentration that the effluent needs to be diluted to in order to meet SPLs. This approach requires modelling only a single output to measure the number of dilutions of the effluent to determine the spatial extent of the low, moderate and high LEPs. Methods for toxicity testing are provided in ANZG (2018).

WET testing was conducted by EcoTox Services Australia to determine and describe the toxic effects of the bitterns' discharge and predict the number of dilutions required to meet the different LEPs surrounding the outfall (O2 Metocean, 2023a). In the absence of a bitterns product at the early assessment stage of a Proposal, an appropriate surrogate was used for WET testing to represent the predicted toxicity of the Proposal bitterns. WET testing was conducted for approval of the Mardie Project, another solar salt proposal in the Pilbara region, approximately 40 km southwest of the Proposal, using a surrogate bitterns collected from the solar salt processing facility at Onslow to conduct the analysis (O2 Metocean, 2023a). A summary of the chronic tests undertaken on relevant species and toxicity results are presented in Table 7-4. The results outline the proportion (%) of surrogate bitterns effluent which result in observed effect concentrations: none (No Observed Effect Concentration (NOEC)), Lowest Observed Effect

Concentration (LOEC), 50% (Effect Concentration (ECn)/Impact Concentration (IC) 50%) and 10% (ECn/IC 10%). The SPLs derived using the species sensitivity distribution curve and the required dilutions to achieve moderate (90%) or high (99%) levels of ecological protection are presented in Table 7-5. The surrogate sample applied to the WET testing comprised a total dissolved solids concentration of 420 g/L with density of 1.25 kg/L, equivalent to an absolute salinity of 336 ppt. To estimate the ecotoxicity of the Proposal bitterns from the WET test results of the surrogate sample, it was assumed that toxicity scales linearly with the salinity. Given the Proposal bitterns salinity of 410 ppt, a factor of 1.22 was applied to the dilutions derived by the surrogate sample. Refer to Table 7-5.

**Table 7-4: WET assessment results**

| Test | Type | NOEC | LOEC | ECn50/IC50 | ECn10/IC10 |
|---|---|---|---|---|---|
| 48-hr larval development test using the Milky oyster *Saccostrea echinata* | Sub-chronic | 0.31% | 0.63% | 0.70% | 0.41% |
| 8-day Sea anemone pedal lacerate development test using *Aiptasia pulchella* | Chronic | 0.31% | 0.63% | 0.70% | 0.43% |
| 72-hr sea urchin larval development test using *Heliocidaris tuberculata* | Chronic | 0.31% | 0.63% | 0.80% | 0.55% |
| 7-day fish imbalance toxicity test using barramundi *Lates calcarifer* | Chronic | 1.25% | 2.5% | 1.81% | 1.66% |
| 7-day fish biomass toxicity test using barramundi *Lates calcarifer* | Chronic | 0.63% | 1.25% | 1.70% | 0.9% |
| 72-hr marine algal growth test using *Nitzschia closterium* | Chronic | 0.63% | 1.25% | 1.56% | 0.73% |

**Table 7-5: Summary of dilution requirements**

| LEP | SPL (%) | Dilution requirements surrogate sample | Dilution factor adopted for Proposal bitterns |
|---|---|---|---|
| Moderate | 90 | 263 | 321 |
| High | 99 | 417 | 509 |

DPIRD recommended toxicity estimates based on local species of finfish such as blue spotted emperor, mangrove jack, gold spotted and black spotted cods; and invertebrates such as prawns and macroalgae (*Sargassum*). There are only two laboratories identified for accredited WET testing in Australia: Intertek, located in Perth, and Ecotox Services Australia (ESA) in Sydney. Each of the two laboratories offer an independent and limited range of accredited bioassays. Both Intertek and ESA advised there are currently no ecotoxicity bioassays commercially available for the fish species requested by DPIRD. Finfish bioassays are currently limited to Kingfish (Intertek) or barramundi (ESA). Intertek advised that the Kingfish (*Seriola lalandi*) larval development bioassay is commonly used for tropical and subtropical ecotoxicity testing, especially for the oil and gas industry. ESA do not offer a prawn bioassay, and Intertek advised they have moved away from acute (survival) testing with tiger prawn and focus on chronic testing. Intertek also advised that prawns are very tolerant so generally protected by standards established by more sensitive test species. Neither lab provide testing with *Sargassum*. Intertek advised closest option to be *Ecklonia radiata* zoospore germination test. *Ecklonia radiatat* has only sporadic distribution north of Kalbarri but is the best proxy available. ESA offers a macroalgal bioassays with Ecklonia radiata or *Hormosira banksia*.





Leichhardt commissioned Intertek to complete a toxicity test of a sample created by Leichhardt to represent the expected bitterns (Intertek, 2024a; Appendix 2.7). The results of the sample tested are presented in Table 7-6.

**Table 7-6: Intertek ecotoxicology results**

| Bioassay | $EC_{10}$ (%) | $EC_{50}$ (%) | NOEC (%) | LOEC (%) |
|---|---|---|---|---|
| Microtox Bioassay | 0.84 | 5.60 | 0.31 | 0.63 |
| Microalgal Growth Bioassay | 2.95 | 4.04 | 2.5 | 5.0 |
| Macroalgal Zoospore Germination Bioassay | 3.60 | 6.32 | 1.25 | 2.5 |
| Sea Urchin Larval Development Bioassay | 0.30 | 0.46 | 0.16 | 0.31 |
| Copepod Early Life Stage Bioassay [1] | 0.84 | 1.50 | 0.63 | 1.25 |
| Copepod Immobilisation Bioassay [1] | 0.82 (0.143) [4] | 1.43 | 0.63 | 1.25 |
| Mollusc Larval Development Bioassay [2] | 1.1 | 1.8 | 1.25 | 2.5 |
| Sea Urchin Fertilisation Bioassay [2] | 1.1 | 1.6 | 0.63 | 1.25 |
| Sea Anemone pedal lacerate development [2] | 0.9 | 1.4 | 0.63 | 1.25 |
| Fish Larval Development Bioassay | 0.44 | 1.02 | 0.31 | 0.63 |

Note [1] – Non-NATA Accredited Method
Note [2] – Subcontracted test to Ecotox Services Australia
Note [4] – The acute EC50 converted into a surrogate chronic endpoint using the default acute to chronic ratio (ACR) of 10 for use in the SSD following methodology in Warne et al. 2018
EC10 - The effective concentration where a 10% effect is observed compared to the control group.
EC50 - The effective concentration where a 50% effect is observed compared to the control group.
NOEC- No observed effect concentration
LOEC - Lowest observed effect concentration

Intertek were also commissioned to provide technical justification for the selection of bioassays (Intertek, 2024b; Appendix 2.8). The selected bioassay species encompass seven trophic groups (eight including Microtox) with a total of nine species used for the evaluation of the ecotoxicity of the bitterns sample and calculation of the species protection dilution factors. The species represent key species group that are found in the receiving environment. While a completely site-specific Direct Toxicity Assessment (DTA) was not completed, the best available local species were included. Where local species were not available, the most suitable surrogate species were used, either a related species or a species that is a sensitive indicator species. In addition, a variety of biological endpoints were used including growth, larval development, immobilisation, fertilisation, and germination.

A wide range of relevant species and biological endpoints were included in the DTA assessment, as well as the use of standard species. This has been shown to be conservative. In addition, as the species assessed are commercially available and not one-off tests, future assessments for this salt field bitterns will be able to repeat this DTA test suite which will allow for comparison of results from pre-commissioning, commissioning, as well as routine discharge monitoring over the lifecycle of the Proposal.

Leichhardt does not have information other than TDS to compare the Mardie/Onslow WET testing bitterns with the stream expected for the Proposal. The sample used in the 2024 WET testing specifically for the Proposal was an industry bitterns sample further evaporated to concentrations matching the estimated stream density from the Proposal process. Consequently, it inherently aligns to the expected future ionic concentrations as far as possible.

*Dispersion Modelling*

O2 Metocean (O2 Metocean, 2023a; Appendix 2.5) was engaged to undertake bitterns outfall modelling for the Proposal, using the required dilutions detailed above.

The bitterns discharge modelling was undertaken using a combination of near-field and far-field commercial hydrodynamic numerical models. A near-field model was used to estimate the number of bitterns dilutions and the distance from the proposed outfall structure where the near-field dispersion process transitions into far-field mixing. Both the dilution and distance to far-field mixing processes were used to inform the vertical and horizontal discretisation of the far-field numerical mesh. An iterative process was adopted where results from the near-field model informed far-field model set up, and results from the latter were used to adjust the near-field model configuration.

The far-field model was established to refine the outfall configuration (site, orientation, length, depth), discharge regime (flow rate, pre-discharge dilutions, discharge patterns). A range of outfall configurations were proposed by a panel of multi-disciplinary specialists including Environmental Engineers, Marine Scientists, Environmental Approval Specialists, Coastal Engineers, and Process Engineers during regular workshops organised to discuss model test runs. The far-field model was adjusted to represent these configurations and results from each of the simulations informed subsequent far-field model runs until the preferred configuration was identified. The objective of this iterative process was to optimise the diffuser configuration and discharge regime such that areal footprint of the bitterns and its impact to corals and seagrass was minimised, where possible.

Two far-field 'production' simulations, one for the summer/wet and the other for winter/dry seasons, were run for the preferred outfall configuration and discharge regime to derive dilution contours around the proposed outfall structure that meet the LEP of the waters surrounding the mixing zone.

*Results*

Leichhardt has investigated numerous discharge options for bitterns disposal in order to reduce the size of the impacted area. Preliminary design of the outfall structure started with a 50 m long diffuser extending from the jetty structure. This short diffuser aimed to maximise the distance from the diffuser extremes to a hypothetical target High Ecological Protection Area (HEPA) boundary 250 m away from the port infrastructure. Early simulations revealed, however, that this location and length of the diffuser would result in water quality impacts that were deemed to be unacceptable. An ocean outfall refinement phase was subsequently implemented.

The ocean outfall refinement phase was carried out using a local far field model nested into a regional, validated model of the Pilbara coast, combined with a near-field mixing model. Parameters investigated during this phase included:

- Predilution (no-predilution, 1:1, 1:5);
- Location (from the tip of the jetty extending north, and north of a bathymetric feature approximately 600 m north of the jetty);
- Diffuser length and nozzles (50 m long with five nozzles, and 200 m long with 21 nozzles);
- Diffuser orientation (north south aligning with the jetty alignment, and northeast to southeast perpendicular to main tidal currents); and

- Discharge regime (continuous and uniform discharge, intermittent during ebb-tides only, and intermittent when the water level exceeded a particular threshold).

Analysis of the far field modelling results were reviewed by the panel of specialists. As a result of this review the preferred outfall design was identified and adopted for the production runs. The final diffuser design consisted of the following design parameters:

- Located 600 m north of the CPE Port jetty head;
- Northeast to southwest orientation;
- 200 m in length;
- 21 nozzles;
- 6 – 8 m depth; and
- 1:1 pre-dilution with seawater.

The areal extent of the mixing zones associated with the target dilutions presented in Table 7-7 were derived as follows:

1. The minimum dilutions through the water column were identified at each timestep;
2. The percentage of time the target dilutions were exceeded was identified;
3. The mixing zone boundaries were drawn where results from point 2 were exceeded 5% of the time during the simulation.

As a result, the boundaries shown in this section enclose the area where a target SPL is not met or, in other words, the SPL are met outside the boundaries. A Low Ecological Protection Area (LEPA) is the area that does not meet the criteria for a Moderate SPL (the area immediately around the outfall), and a Moderate Ecological Protection Area (MEPA) is the area around the LEPA that does not meet the criteria for the surrounding High or Maximum SPL.

Figure 7-4 and Figure 7-5 present the 90% (LEPA) and 99% (MEPA) SPL boundaries for wet/summer and dry/winter, respectively, superimposed over the subtidal BCH (O2 Metocean, 2023a). The total areal extents enclosed within the LEPA and MEPA (90% and 99% SPL boundaries respectively) are shown in Table 7-7. The proposed LEPs based on the winter and summer scenarios are shown in Figure 7-6.

**Table 7-7: Areal extent of zones exceeding the dilution required to achieve the EQO**

| Season | LEPA (ha) | MEPA (ha) |
|---|---|---|
| Wet/Summer | 63 | 66 |
| Dry/Winter | 33 | 45 |

*Influence of the Dredge Channel*

The presence of a dredge channel greatly influences the boundaries of the LEPA and MEPA. In the modelling described above, the model assumed that at least 10 cm of dredging will be undertaken along the length of the dredge channel shown. As shown in Figure 7-4 and Figure 7-5, the presence of the dredge channel influences the spread of the plume, as it spreads along the channel north and south. If the channel is deeper than modelled, then more of the plume may be trapped in the channel, and the size of the plume may reduce. In this case it may be beneficial to move the diffuser into the channel to reduce the area of impact outside the already impacted channel.

If some areas are confirmed as being of sufficient depth already (i.e., require no dredging), then the plume may become more circular, rather than extending north and south along the channel.

The results shown in the section above therefore provides a reasonable estimation of the extent of the bitterns plume. This modelling will be re-run if more information becomes available about the final dredging locations and depths within the dredge channel.

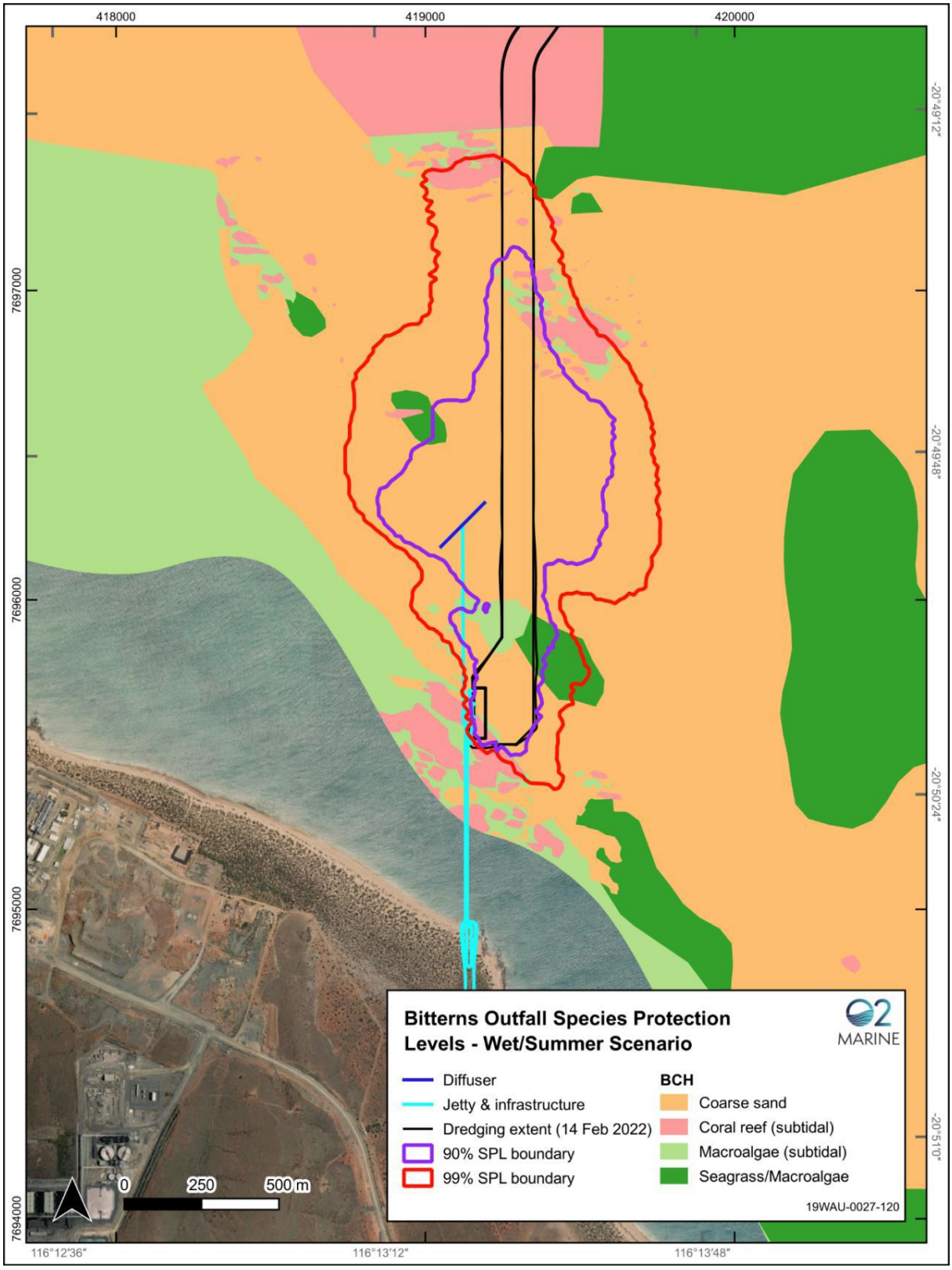



**Figure 7-4: LEPA (<90% SPL) and MEPA (90 - 99% SPL) boundaries intersection with subtidal BCH (wet/summer scenario) (O2 Metocean, 2023a)**

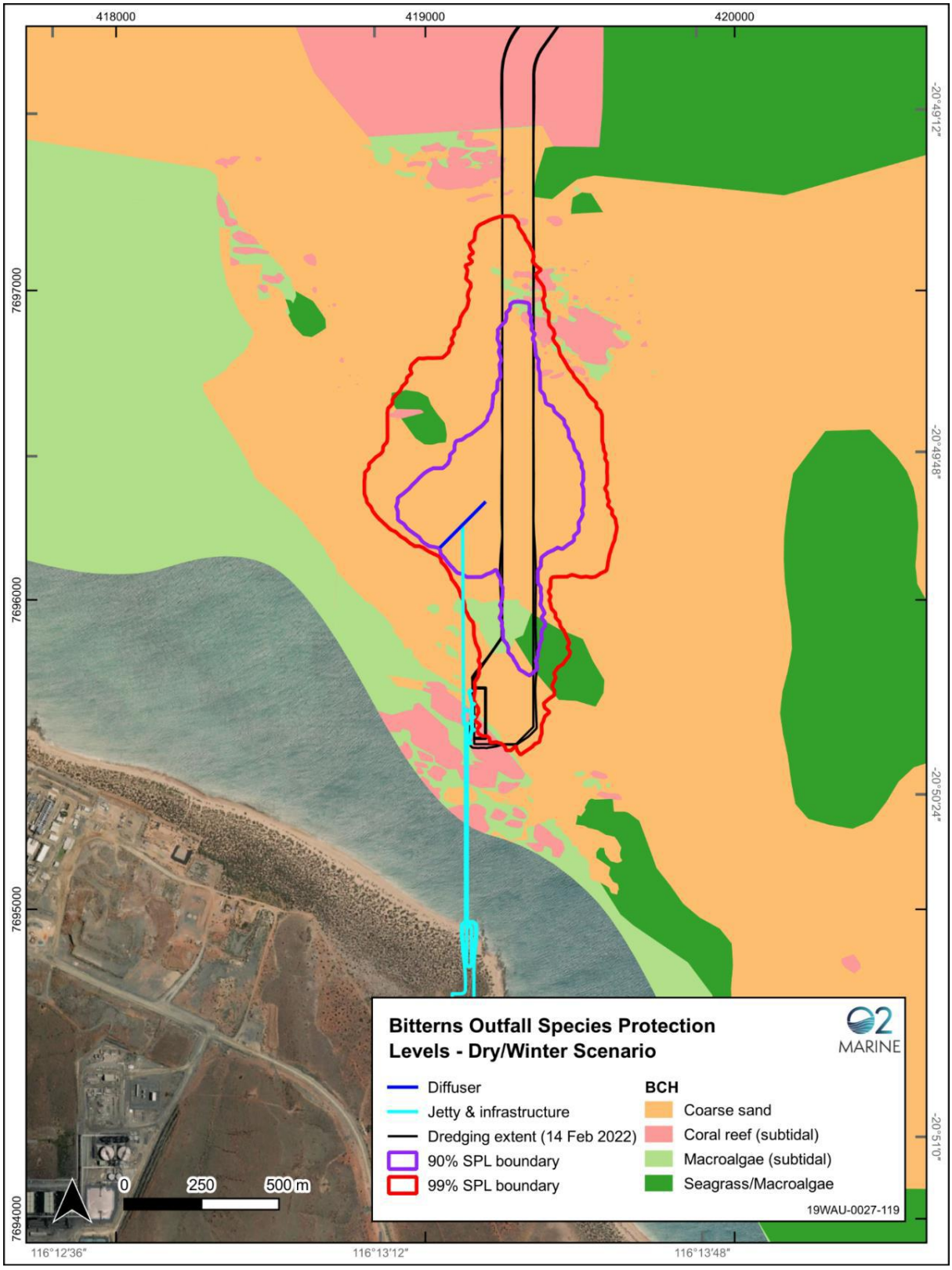



Figure 7-5: LEPA (<90% SPL) and MEPA (90 - 99% SPL) boundaries intersection with subtidal BCH (dry/winter scenario) (O2 Metocean, 2023a)

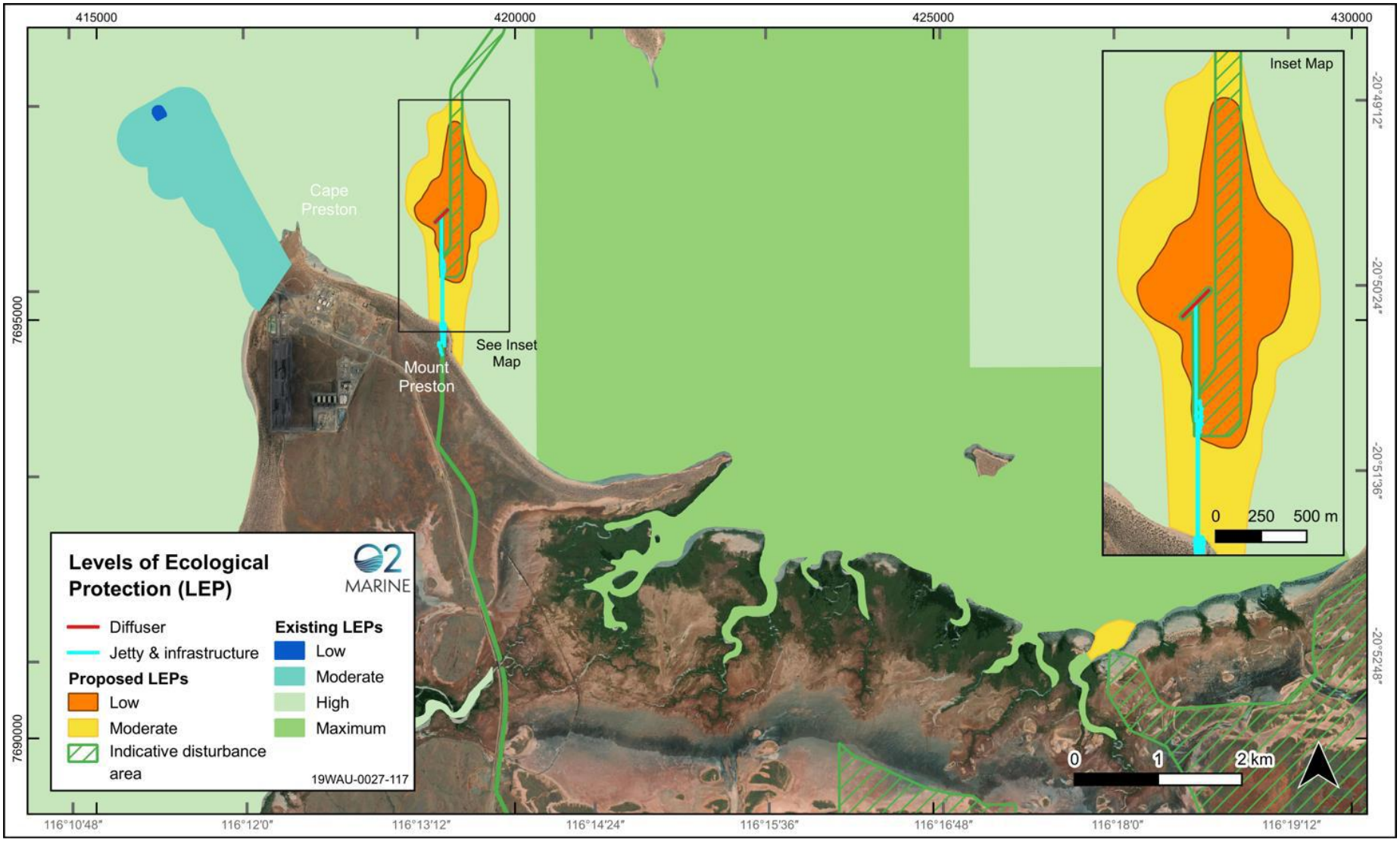



Figure 7-6: Proposed LEPs (O2 Metocean, 2023a)

*Assessment of Impact*

Leichhardt has investigated numerous discharge options for bitterns disposal in order to reduce the size of the impacted areas (LEPA and MEPA). The preferred discharge method was targeted on encouraging mixing as much as practicable to ensure the LEPA and MEPA are contained within as small an area as practicable. In addition, the LEPA and MEPA approved under MS 949 for the CPE Port are proposed to be replaced with the LEPA and MEPA boundaries provided in this document (i.e., the impacts presented in this ERD are not in addition to those approved impacts).

Section 5.3.4.1 of the bitterns dispersion modelling report (O2 Metocean, 2023a; Appendix 2.6) provides more details of how dispersion modelling results from screening tests were used to arrive at the selected configuration. Table 11 of Appendix 2.6 indicates the diffuser details varied in assessing the configuration. The most challenging condition is peak summer discharge with low (0.12 m/s) ambient current. Comparing 1:1 predilution and no dilution, 1:1 predilution achieves significantly more dilution at the end of the near field. A major factor is mixing energy which comes from the discharge velocity and the extra mass of the pre-diluted stream. Starting with 1:1 dilution ahead of discharge point also contributes significantly to the result. Dispersion modelling also trialled other pre-dilution rates (nil and 5 times). Neither of these achieved any improvement in the broader dispersion model.

The momentum-driven near field area is affected by the diffuser detail but extends less than 10 m from the diffuser alignment. This area is far smaller than the LEPA which is determined by further diffusion and mixing across that area. Conversely, the LEPA size is not influenced much by the details of the diffuser, within the general description of multiple outlet nozzles with velocities of 5-7 m/s for initial mixing. The key requirement is to disperse the bitterns along an extended line transverse to tidal currents, with 200 m being considered a practically achievable diffuser length. Figures 19 and 21 of Appendix 2.6 indicate how the immediate dispersion from the diffuser eventually translates to much larger LEPA and MEPA regions based on regional bathymetry and mixing effects

Bitterns discharge will result in localised impacts on water quality within the LEPA and MEPA. The bitterns discharge 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) (O2 Metocean, 2023a). Management of the discharge is therefore important, and a MEQMMP has been prepared to detail the monitoring and management measures proposed to ensure impacts are minimised (Section 7.6).

The bitterns discharge has the potential to impact BCH and marine fauna within the LEPA and MEPA and resultant impacts to these factors are assessed in Section 8.4 and 9.4 respectively.

Bitterns discharge was assessed on an annual basis and as a peak month (typically December in practice). The bitterns would have a stable SG of 1.29 all year round. Median annual bitterns production was estimated as 4.4 GL/a, with up to 5.9 GL/a given the best possible annual climate conditions (high evaporation, minimal rainfall). The peak monthly bitterns of 0.65 GL/m was similarly based on ideal weather for salt production.

Leichhardt has subsequently progressed understanding of the process, concluding that more of the salt content will be recovered as product before discharging the bitterns. Relative to the 2023 modelling the bitterns stream volume reduces by 8% and the concentration reduces around 12%, with overall bitterns salt discharge down by around 20%. This will lead to a LEPA/MEPA reduction which will be estimated via modelling when the process data is more firmly settled.

Table 7-8 outlines the changes from the data referred in 2023.

**Table 7-8: Revised characteristics of bitterns discharge**

| Factor | Units | As Referred | Revised 2025 |
|---|---|---|---|
| Density | kg/m$^3$ | 1,290 | 1,290 |
| Total dissolved salts | g/l | 520 | 460 |
| Absolute salinity | ppt | 410 | 360 |
| Maximum annual discharge | Gl/a | 5.9 | 5.4 |
| Peak summer | Gl/m | 0.65 | 0.59 |
| Mass of bitterns stream | | | |
| Peak summer | Mt/m | 0.84 | 0.76 |
| Mass of bitterns salt | | | |
| Peak summer | Mt/m | 0.34 | 0.27 |

### *Dredging and Disposal Program*

The total estimated volume required to be removed for the refined navigational channel, turning basin, and berth pocket design is 230,000 m$^3$. This volume is referred to as 'Base Case'. Design berth pocket and navigational channel dredge depths for the Base Case are 4.5 m CD and 6.7 m CD, respectively. Over-dredge and channel deepening or widening to accommodate for navigational safety recommendations may result in a larger dredge volume (approximately 400,000 m$^3$). Therefore, in this modelling exercise two dredge volumes were considered:

- Base Case: Leichhardt's best estimate of 230,000 m$^3$ considered the minimum dredge volume required to achieve the design;
- High Volume Case: Upper limit dredge volume of 398,000 m$^3$, which accounts for the Base Case and the following increments:
    - Channel widening at the channel bend location (58,000 m$^3$ );
    - Channel deepening by 0.3 m (54,000 m$^3$);
    - Berth pocket widening (9,000 m$^3$);
    - Expansion of turning area (18,000 m$^3$); and
    - Over dredging allowance of 0.3 m (29,000 m$^3$).

Dredging of the navigational channel, turning basin, and berth pocket is proposed to be undertaken with a CSD. The extents of each segment are shown in Figure 7-7.

Two dredge material disposal options were considered in the modelling:

- Disposal Option A: 100% of material disposed offshore to account for the possibility of onshore disposal location being technically unfeasible; or
- Disposal Option B: A combination of onshore and offshore dredge material disposal:

  - Southern channel and berth pocket: disposed onshore via pipeline; and
  - Northern channel: disposed offshore using hopper barges.

In summary, four dredging cases were considered:

- Base Case – Disposal Option A;
- Base Case – Disposal Option B;
- High Volume Case – Disposal Option A; and
- High Volume Case – Disposal Option B.

The program is scheduled to be completed within a 30-week period, inclusive of:

- Equipment mobilisation: four weeks;
- Setup of infrastructure (decant ponds, dredge spoil pipelines and pumps etc): six weeks; and
- Dredge and disposal operation: up to 20 weeks.

The selected dredge and disposal window (June to September) has been proposed and will ensure all works, including onshore disposal decanting, occurs outside of the cyclonic season, while also minimising impacts to marine fauna. The dredge and disposal operation will run 24 hours a day, 7-days a week, with one week intermission (no production) to allow for dredge equipment relocation to the northern channel extent (approximately mid-way through the dredging schedule). The production rate assumes 3 hours out of every 24 hours are lost due to daily maintenance or breakdowns, crew changes and sighting of marine fauna within the restrictied operation zone.

Key parameters pertaining to the proposed dredging programs are provided in Table 5 of Appendix 2.5.

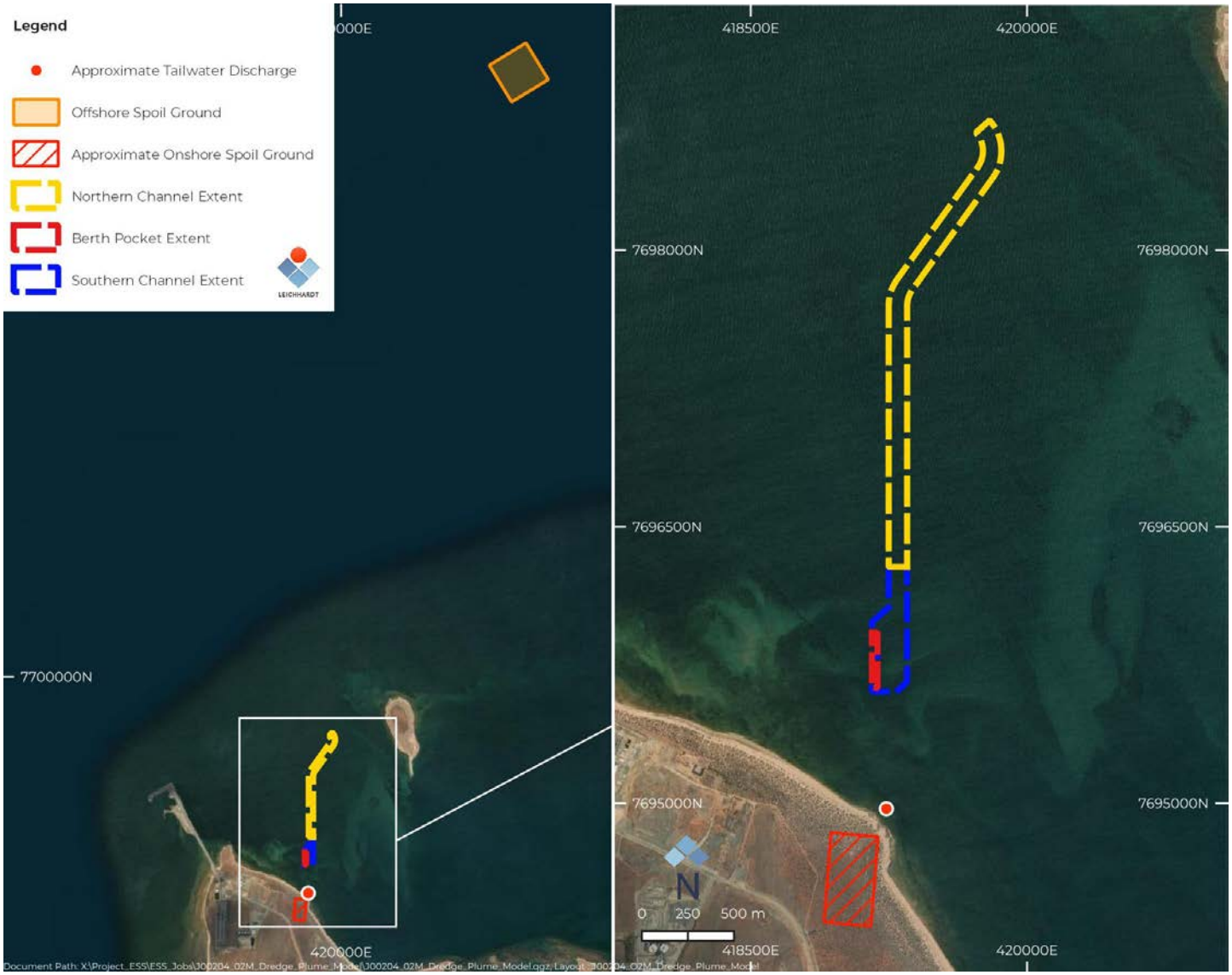



Figure 7-7: Offshore and indicative onshore spoil ground and tailwater discharge locations

*Modelling*

O2 Metocean (2025; Appendix 2.5) was engaged to undertake modelling to assess the extent of dredge plumes from the Proposal. The objectives of the modelling were to provide:

- An informed prediction of the potential fate of sediments mobilised during dredging and sea-dumping associated with the Proposal; and
- Provide data (zones of impact) to support the EIA for the Proposal (this ERD).

A nested approach was adopted for hydrodynamic modelling where boundary conditions to a local three-dimensional (3D) sediment transport model were extracted from a regional hydrodynamic model. Four types of sediment plume sources were considered: the spill at the dredging site, the hopper barge overflow during loading, the offshore disposal and erosion of disposed material. Assumptions related to source term definition closely follow the WAMSI guidelines for source term estimation (Sun et al., 2020, Becker et al., 2015 and Mills & Kemp, 2016).

The dredge footprint was split into three zones. The number of zones and boundary among them were evaluated by consideration of the available geotechnical information, the proposed dredge geometry, and proposed dredge methods. The need for precision was assessed against the relative importance of other known areas of uncertainty – a process requiring professional judgement. The three modelled zones (Figure 7-7) were:

- Zone 1: The southern channel extent;
- Zone 2: The berth pocket deepening; and
- Zone 3: The northern channel extent.

Vertical layering was not considered necessary for this level of assessment, owing to the relatively shallow target depth and uncertainty over the exact dredge sequencing.

The volume of material within each dredging zone varies between the Base Case and High-Volume Case, as defined in Table 7-9.

**Table 7-9: Dredging volume within each zone**

| Dredge Model Zone | Base Case | High Volume Case |
|---|---|---|
| Southern Channel Extent | 160,005 $m^3$ | 206,864 $m^3$ |
| Berth Pocket Deepening | 18,870 $m^3$ | 27,555 $m^3$ |
| Northern Channel Extent | 51,714 $m^3$ | 163,239 $m^3$ |

Several assumptions about the dredging pattern were made:

1. At any point in space, dredging will continue until the target depth is reached before the dredger moves on (i.e., single pass dredging);
2. The CSD was assumed to have a reach of up to 5 m to either side;
3. The order in which zones will be dredged is:
    a. Southern channel extent (onshore disposal);
    b. Berth pocket deepening (onshore disposal);
    c. Northern channel extent (offshore disposal);

4. For each zone, dredging will begin at the south west corner. The dredger will advance northward by alternating one west to east pass, followed by an east to west pass, and so forth; and
5. The CSD will dredge at a constant rate, thus it will progress more slowly in areas requiring more dredging (where the seabed is farther from target dredge depth).

For each dredge zone, the representative PSD was calculated as follows:

1. Determine what percentage of the material is located within each geological strata (e.g., 75% in sandy coastal deposit (SCD) and 25 % in calcrete);;.
2. Calculate an average PSD for each geological strata identified in (1), using only the samples that are within or neighbouring the zone (e.g. calculate a representative $PSD_{SCD}$ and $PSD_{calcrete}$); and
3. Calculate a weighted PSD using (1) and (2) above (e.g. $PSD_{zone} = 0.75*PSD_{SCD}+ 0.25*PSD_{calcrete}$.

The PSD for each zone was generated using the weighted average method.

Only the four fractions below 250 µm (clay, silt and fine sand fractions) were included as far-field source terms as other larger particles do not contribute to the dredge plume and settle near the source when released into the water column. Constant settling velocities of each modelled sediment fraction, a DHI MT module input, were estimated using Stoke's law (O2 Metocean, 2025). Neither flocculation nor hindered settling were considered.

The Zone of Moderate Impact (ZoMI) for coral was derived for the ambient condition (no-dredging) by applying the IMO (2022) light attenuation model to the naturally occurring SSC according to the assessment criteria for light reduction for corals. The derived ZoMI demarcates the zone where corals would be naturally impacted by light reduction and therefore unlikely to survive. Comparison of this naturally triggered ZoMI to the coral habitats identified in the subtidal BCH survey (O2 Marine, 2025d) is presented in The Zone of Moderate Impact (ZoMI) for coral was derived for the ambient condition (no-dredging) by applying the IMO (2022) light attenuation model to the naturally occurring SSC according to the assessment criteria for light reduction for corals. The derived ZoMI demarcates the zone where corals would be naturally impacted by light reduction and therefore unlikely to survive. Comparison of this naturally triggered ZoMI to the coral habitats identified in the subtidal BCH survey (O2 Marine, 2025d) is presented in Figure 7-8 for the period spanning the base scenario and high volume scenarios.

An agreement between the naturally occurring ZoMI boundary (approximately along the -10 m AHD isobath) derived using the IMO (2022) light attenuation model and the northern-most extent of the coral BCH patches is observed in Figure 12. This agreement qualitatively validates the light attenuation model adopted for this study, including:

- The selection of 0.47 mg/L ambient SSC for the model scenarios;
- The selection of the IMO (2022) light attenuation model as a function of depth and SSC;
- 'The 15% subsurface PAR reduction model; and
- The DLI thresholds.

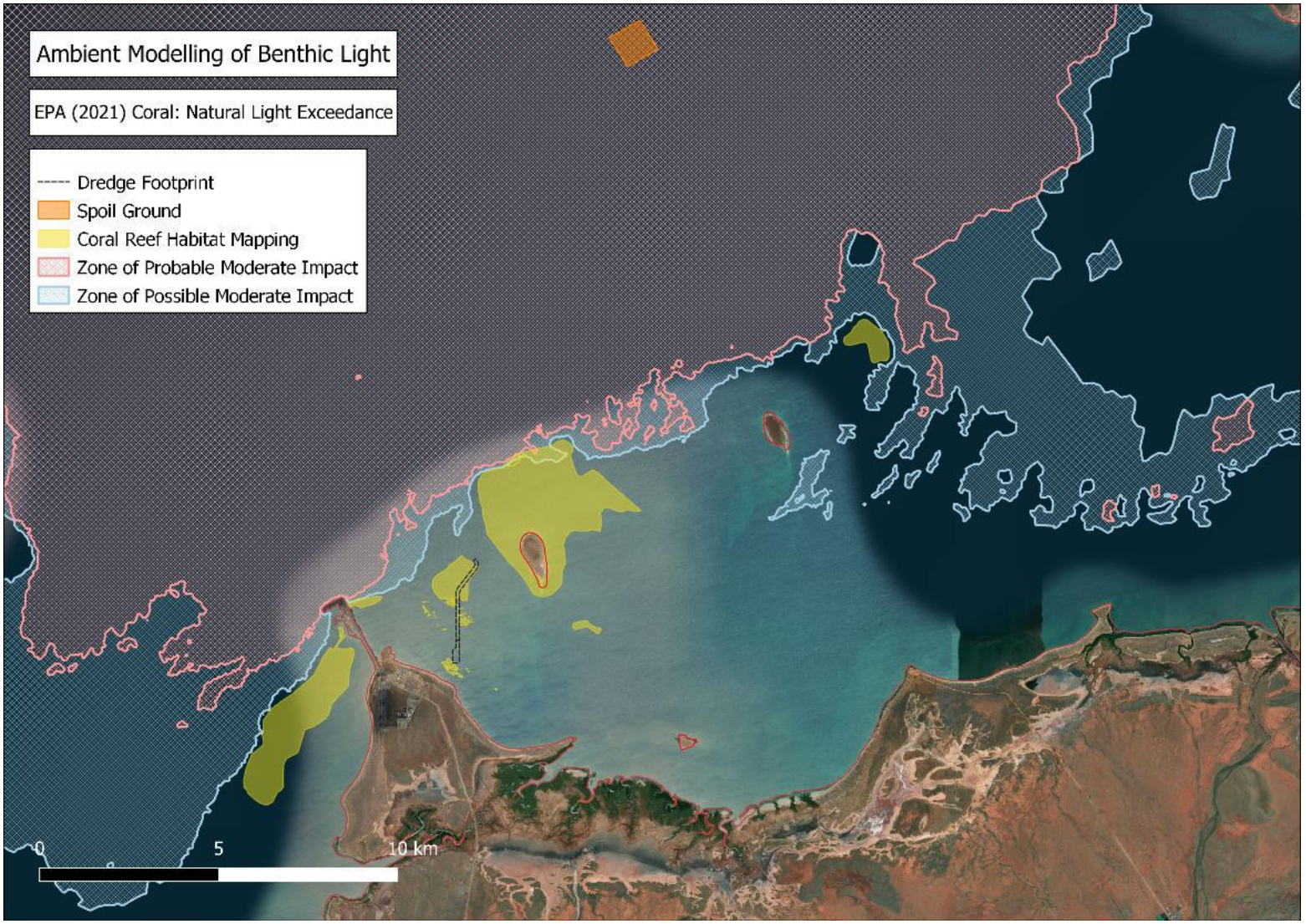



Figure 7-8: Natural ZoMI computed during the simulated dredging timeline (no dredge and disposal action) overlaying the subtidal coral BCH (O2 Metocean, 2025)

*Model Results*

The maximum suspended sediment (both in vertical layering and time) for each model cell was calculated and compiled together to produce the maximum SSC map for the Base Case and High-Volume Case. The maximum SSC maps do not reflect the extent of the sediment plume at any specific instant in time. Rather, they provide for a depiction of the scale, spread, and attenuation from discharge point of the sediment concentrations observed in each simulation.

Modelling results revealed a relatively low initial SSC at source and a rapid decrease in SSC with increasing distance from the dredging and disposal sites, driven by:

- The particle size of the discharged material, which contains a high proportion of fine sand that settles quickly and closer to the source compared to silt and clay;
- The type of dredger considered, since CSD releases material at its head near the seabed. Any material release near the seabed takes much shorter time to reach the seabed than when it is discharged at the surface layer, for example via split hopper barge overflow; and
- The type of disposal method, with a substantial reduction in generated SSC when onshore disposal is considered.

High 'above background' concentrations of >10 mg/L SSC were restricted to within or near the dredging footprint, which tended to oscillate along a north-westerly to south-easterly plane, in agreement with tidal currents. The low concentrations signal (<2 mg/L SSC) composed of the smaller particle fractions travelled further away, primarily aligning with wind driven current flows.

Owing to the very low fines content in the dredged material (typically <1% clay and <5 % silt, refer to Section 4.2.6), the extent and concentration of the modelled suspended sediment was similar for all four cases considered. Other notable observations are summarised as follows:

- Base Case:
    - Both disposal options led to similar size (areal extent) and severity (SSC) at the Offshore Spoil Ground C, which suggests that most of the material settles within 8-hours, the time spanning between two consecutive disposal events;
    - Barge overflow at the dredging site is the primary factor contributing to a broader spread of the sediment plume at the dredging site. Consequently, Disposal Option B, which assumes no overflow while dredging the southern channel and berth pocket, is expected to result in the smallest impact zones compared to Disposal Option A;
    - The tailwater discharge included in the Disposal Option B introduces an additional source of SSC south of the dredge footprint. Although this plume reaches >10 mg/L SSC, its contribution to the SSC footprint is relatively small and practically negligible;
- High Volume Case:
    - Key observations made earlier regarding the extent of the sediment plume when comparing the two disposal methods are also applicable to the High-Volume Case too; and
    - The sediment plume generated in the High Volume Case affects a larger areal extent compared to the Base Case.





*Assessment of Impact*

The EPA (2021g) has developed a spatially-based zonation scheme for proponents to use as a common basis to describe the predicted extent, severity and duration of impacts associated with their dredging proposals. The scheme consists of three zones that represent different levels of impact:

1. The Zone of High Impact (ZoHI) is the area where serious damage to BCH is predicted or where impacts are considered to be irreversible. The term serious damage means 'damage to benthic communities and/or their habitats that is effectively irreversible or where any recovery, if possible, would be unlikely to occur for at least five years.' Areas within and immediately adjacent to proposed dredge and disposal sites are typically ZoHI;
2. The ZoMI is the area within which predicted impacts on benthic organisms are sub-lethal, and/or the impacts are recoverable within a period of five years following completion of the dredging activities. This zone abuts, and lies immediately outside of, the ZoHI. EPA (2021g) states that proponents should clearly explain what would be protected and what would be impacted within this zone and present an appraisal of the potential implications for ecological integrity of the impacts over the timeframe from impact to recovery (e.g., through loss of productivity, food resources, shelter). Where recovery from the impact predicted in this zone is likely to result in an 'alternate state' compared with that present prior to development, then this outcome should be clearly stated in environmental assessment documents, along with justification as to why the predicted impacts should be included within this zone (rather than the ZoHI) and an appraisal of the potential consequences for ecological integrity. The outer boundary of this zone is coincident with the inner boundary of the next zone, the Zone of Influence (ZoI); and
3. The ZoI is the area within which detectable changes in environmental quality associated with dredge plumes are predicted and anticipated during the dredging operations, but where these changes would not result in a detectible impact on benthic biota (e.g., a reduction in biomass). These areas can be large, but at any point in time the dredge plumes are likely to be restricted to a relatively small portion of the ZoI. The outer boundary of the ZoI bounds the composite of all of the predicted maximum extents of dredge plumes and represents the point beyond which dredge-generated plumes should not be discernible from background conditions at any stage during the dredging campaign. Furthermore, this provides transparency for the public regarding where visible plumes may be present, albeit only occasionally, if the Proposal is implemented. Reference sites for monitoring natural variability would ideally be located outside of the ZoI.

The ZoHI, ZoMI and ZoI were determined by analysing model results as running mean values of SSC (including background SSC), their derived DLI, and the combined effects of SSC and DLI as recommended in *Technical Guidance – EIA of Marine Dredging Proposals* (EPA, 2021f), applied to corals and seagrass.

For both Disposal Option A and Disposal Option B:

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

The possible ZoMI for corals is shown in Figure 7-10 for Disposal Option A and B, respectively. The following comments apply to these zones of impact:

- The possible ZoMI associated with Disposal Option A (7.57 ha in area) is larger than those for Disposal Option B (0.12 ha in area). The relative increase in ZoMI area associated with Disposal Option A is attributable to the additional sediment spilled nearby the dredging site as a result of the CSD overflow/dewatering process;
- The possible ZoMI associated with Disposal Option A intersects with 0.03 ha of coral habitat; and
- The possible ZoMI associated with Disposal Option B does not intersect with any coral habitat.

Dredging will result in impacts on water quality in the vicinity of the dredging activities during dredging and for a short period afterwards. These impacts include increased turbidity and reduced benthic light (O2 Metocean, 2025). The dredging will be carefully managed to ensure these impacts are limited to the areas predicted (Section 7.6).

As discussed above, these water quality impacts will also have subsequent impacts to BCH and Marine Fauna. These impacts are discussed in more detail in Sections 8.5 and 9.5 respectively.

***Incidental Product Spills***

The Proposal does not include export operations at CPE Port such as the loading of salt onto transhipment barges, transhipment barge movements or OGV loading and movements. Nevertheless, the MEQMMP (Appendix 2.1) provides mitigation measures for reference, designed to minimise the likelihood of product spills entering the marine environment.

***Leaks or spills of hydrocarbons or chemicals***

As stated above, the Proposal does not include export operations at CPE Port such as the loading of salt onto transhipment barges, transhipment barge movements or OGV loading and movements. The key offshore hydrocarbon/chemical spill risks are therefore associated with the dredging program, and any construction vessels used for the construction of the bitterns dilution intake and bitterns discharge infrastructure.

There is a risk of hydrocarbon spill from these vessels as a result of vessel collisions or hydraulic hose leaks. With the implementation of standard industry safeguards and operating procedures (Section 7.6) any offshore spills are expected to be able to be contained and cleaned up such that they do not result in a significant ongoing impact to marine environmental quality.

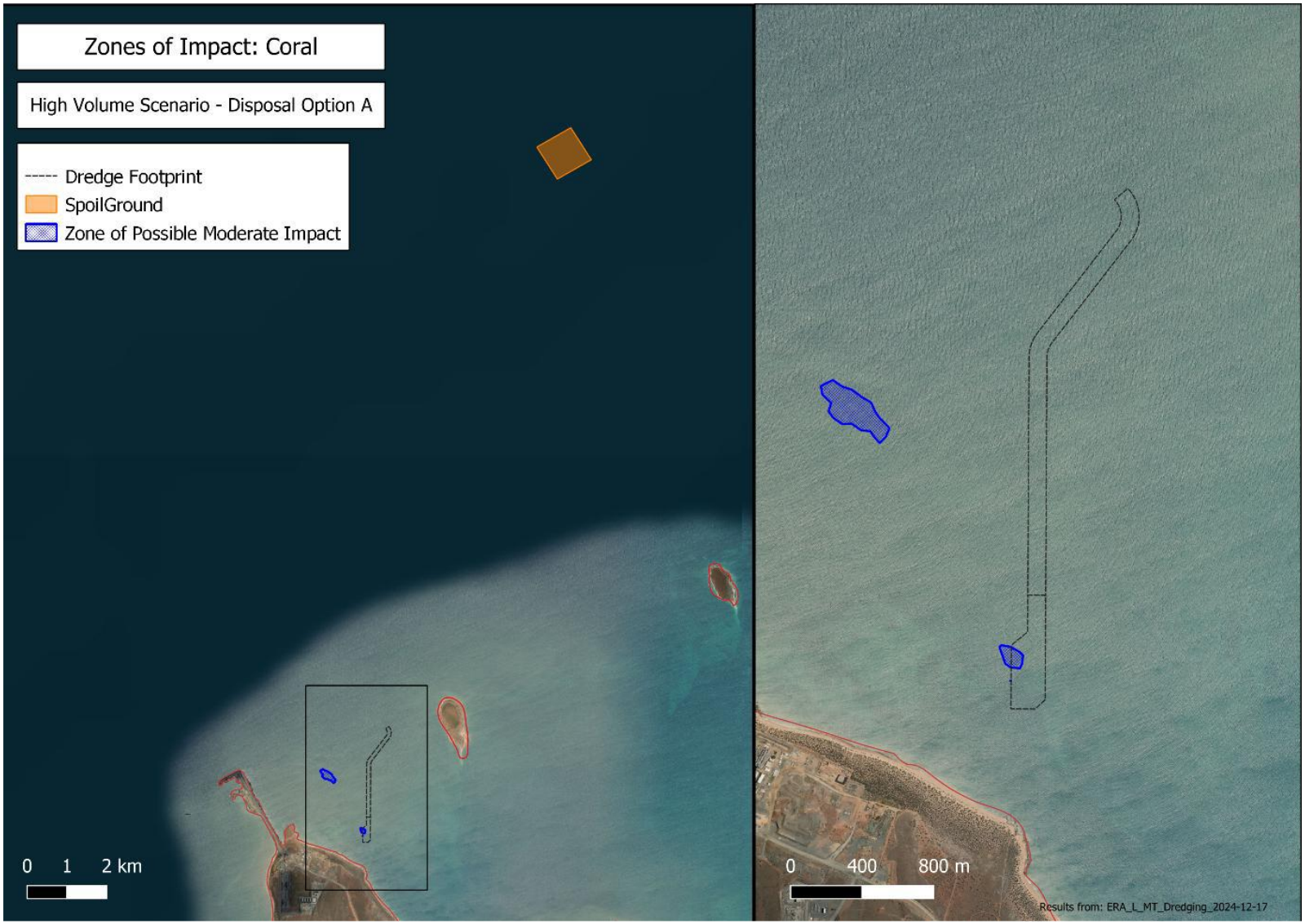



Figure 7-9: High volume case - disposal option A: Zones of Impact (Coral) (O2 Metocean, 2025)

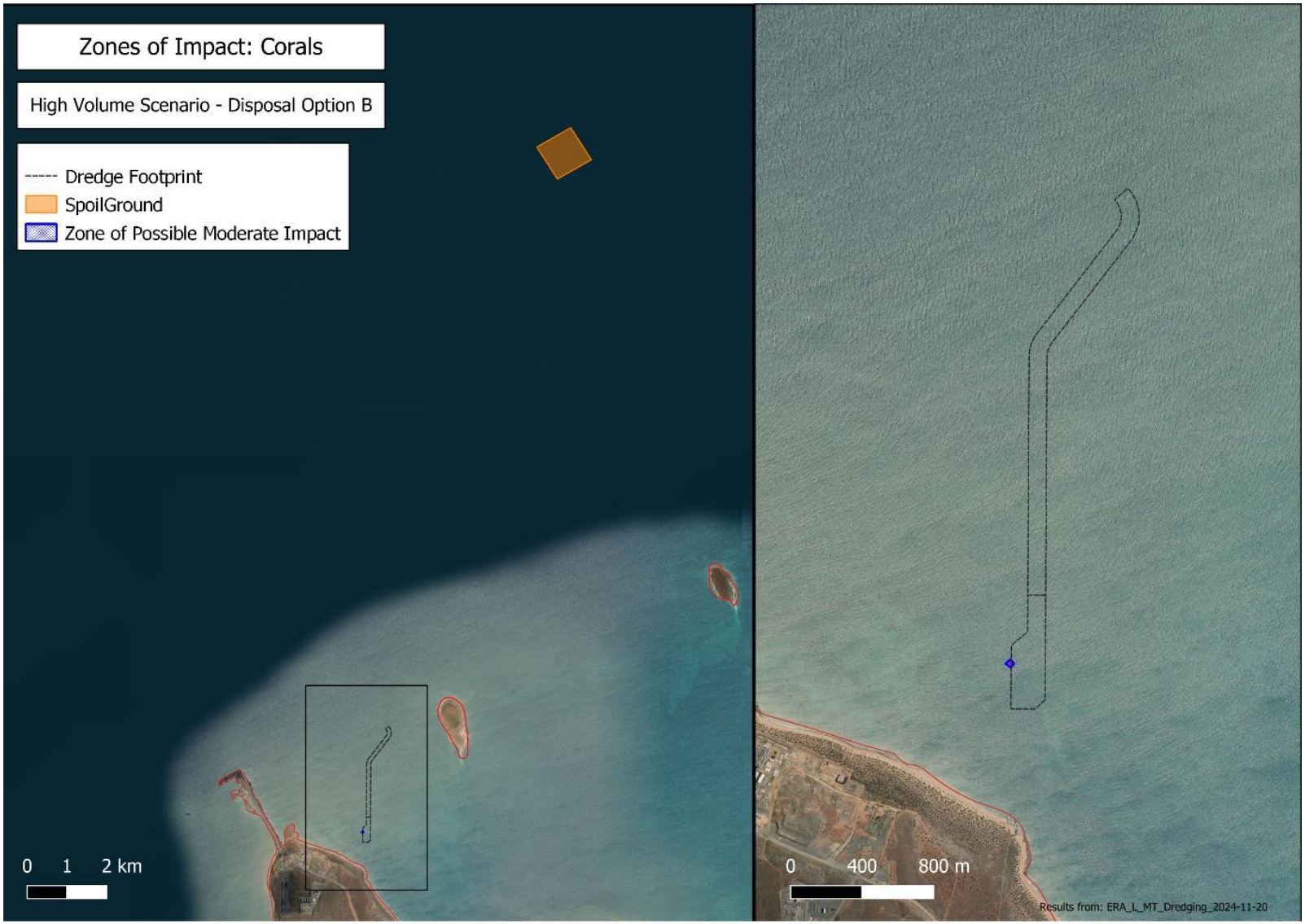



Figure 7-10: High volume case - disposal option B: Zones of Impact (Coral) (O2 Metocean, 2025)

***Cumulative Impacts***

The marine environmental quality of the waters surrounding the port infrastructure has the potential to be impacted by the operation of the Cape Preston Port and desalination plant, CPE Port (magnetite, salt and other product export) and minor impacts associated with vessels and waste from camping and recreational activities at 40-Mile Beach. The approved impacts associated with the proposed discharge of desalination brine from the CPE Port will be removed if this Proposal was to proceed, replaced by the discharge of bitterns from the Proposal.

The Proposal will result in a temporary reduction in marine environmental quality during dredging operations, and an ongoing reduction in marine environmental quality within the LEPA and MEPA boundaries during operations. This will create a broader zone of impact than what was approved for the CPE Port, however it will not extend into the MEPA for Cape Preston Port.

The cumulative impact of two marine discharge locations and two port operational areas in close proximity is predicted to have a significant impact on local marine water quality around these areas. However, outside these mixing zones the water quality is predicted to be similar to background levels. These impacts have been assessed as not significantly impacting BCH or marine fauna (refer to Section 8 and 9 respectively), therefore the quality of water, sediment and biota are predicted to be maintained outside the mixing zone such that that environmental values are protected.

A regional cumulative assessment of marine water quality impacts in the Pilbara is also provided in Section 18.

### 7.5.2 TIDAL CREEKS

***Hydrocarbon Spills***

The primary seawater intake is located within a tidal creek and will contain high-volume pumps that may temporarily be powered on diesel fuel. Generators will be located within a bunded area on the embankment. Any spills from these units will be captured by the bund which is designed to contain spills and prevent them reaching the tidal creek waters.

Refuelling of vehicles will occur on land, and not in proximity to the water's edge. Refuelling associated with construction and dredge operations will be conducted in accordance with refuelling procedures developed in consultation with PPA, and spill equipment will be maintained to ensure any spills are contained and cleaned up. Section 7.6 contains more detail about the mitigation measures proposed.

Based on the above, the likelihood of hydrocarbon spills impacting the marine environmental quality within tidal creeks is considered to be unlikely.

***Brine Spills***

A large spill or leak of brine from the ponds or pipelines, or product infrastructure washdown water could result in impacts to the marine environmental quality within adjacent tidal creeks. Brine is the primary resource for the Proposal and as such the concentration ponds, crystallisers and brine pipelines are designed to minimise the risk of leaks, overflows and wall breaches.

Pipelines will utilise industry-standard materials to minimise the chance of leaks and mitigation will be implemented to reduce this risk further (refer to Section 7.6). Ponds have been designed with adequate freeboard and overflow features to minimise the risk of unplanned overflows and wall breaches. The ponds include internal weirs to rebalance local excess brine levels and external emergency spillways into adjacent major creeks to avoid cascading internal bund failure leading to massive outflows.

There are drainage ditches along the base of all perimeter bunds primarily to intercept groundwater seepage and potentially collect brine for recovery to the process ponds. These will also intercept and contain minor splashing and spillage events.

If a large external overflow was to occur, it is most likely to arise from a major rain event which raises all pond levels. In such events, McKay and Devil Creeks both flow at high levels. In this case the brine overflow will be rapidly mixed with fresh surface water flow and discharged to the ocean.

***Sedimentation***

Sediment loss during the construction of the ponds and other infrastructure could result in increased turbidity within adjacent tidal creeks. The risk of sedimentation impacts within tidal creeks is expected to be low given the following:

- Construction of the concentration ponds involves the construction of embankments only (i.e., the base of these ponds will not be disturbed except for borrow of construction material). There will not be large areas of disturbed ground that could release sediment. In addition, the construction of the pond walls will result in runoff retention which will capture entrained sediment;
- Crystalliser development does include widespread cut/fill with large exposed earth areas. The design also includes perimeter bunds which will be initiated early in the program to contain floor runoff from storm events;
- Construction areas remain dry most of the time, so there is little potential for flow paths between these areas and tidal creeks; and
- During significant flooding events, civil earthworks would likely pause until drier conditions permit resumption.

Leichhardt has committed to mitigation measures to reduce the risk of sedimentation (refer to Section 7.6).

***Cumulative Impacts***

The cumulative impacts on the marine environmental quality of the tidal creeks surrounding the Proposal is relatively limited. The Cape Preston Port includes a bridge across the intertidal zone between the mainland and Cape Preston, however this is unlikely to contribute to any cumulative impacts to the marine environmental quality within local tidal creeks as it presents minimal pollutant risk. Other potential impacts to marine environmental quality within local tidal creeks are wastes associated with recreational activities in the tidal creeks east and west of the camping areas at 40-Mile Beach. These impacts are however also considered to be minor if they were to occur. Based on the above, cumulative impacts are unlikely to be a significant consideration for the assessment of marine environmental quality impacts for tidal creeks.

## 7.6 MITIGATION

Leichhardt has mitigated the potential impacts to this factor according to the mitigation hierarchy; avoid, minimise, rehabilitate, offset. Offsets are not expected to be required for this factor.

### 7.6.1 AVOID

There are limited opportunities to avoid impacts to marine environmental quality.

### 7.6.2 MINIMISE

The following mitigation measures are proposed to ensure that direct and indirect impacts to marine environmental quality are minimised:

1. **Obtain and comply with the following approvals:**
    a. Ministerial Statement to be issued under Part IV of the EP Act;
    b. Works Approval and Licence to be issued under Part V of the EP Act for solar salt manufacturing (including bitterns disposal) and bulk material loading (likely to be a separate approval for CPE Port);
    c. MP to be approved under the Mining Act for activities on Mining Act tenure;
    d. MCP to be approved under the Mining Act for activities on Mining Act tenure. The MCP will describe the rehabilitation and closure of the Proposal, and associated management and monitoring proposed during the closure phase;
    e. Development Application to be approved under the *Port Authorities Act 1999* for activities within PPA-managed lands and waters;
2. **The Proposal Content Document (Section 2.2.2) includes several limits that minimise impacts to marine environmental quality.** These include:
    a. A limit of up to 5.9 GLpa of bitterns discharge (prior to dilution); and
    b. A dredging limit of 400,000 $m^3$;
3. **Dilute the bitterns at least 1:1 with seawater prior to discharge;**
4. **Implement the MEQMMP (Appendix 2.1)**. The MEQMMP contains detailed information about the discharges, product spills, proposed management and monitoring, and contingency actions, including:
    a. Baseline monitoring requirements;
        i. The baseline water quality data collected from the site forms only a small portion of the baseline data available, with regional data able to be used to characterise conditions.
        ii. Two years is predicted to be sufficient to allow a comparison against regional data and determine the likelihood of an outlier. Specific measures such as trigger adjustments or additional monitoring could occur if this was determined to be the case.
    b. WET testing of initial bitterns and comparison against initial modelling input and outputs. Conduct remodelling if required to verify LEP boundaries;
    c. Model verification monitoring;
    d. Detailed design of the outfall diffuser;
    e. Ongoing bitterns quality monitoring;

   f. Develop and implement procedures and plans, including a Chemical Storage and Handling Procedure;
   g. Reporting requirements; and
   h. Contingency actions;
5. **Implement the DSDMMP (Appendix 2.2).** The DSDMMP includes key management actions to minimise impacts to marine environmental quality including:
   a. Dredging will be conducted using a cutter-suction vessel;
   b. Measures proposed to ensure the ZoHI and ZoMI remain within modelling predictions;
   c. Plume modelling and monitoring; and
   d. Contingency measures.
6. **Ensure fuel is stored within self-bunded tanks or within a bunded area;**
7. **Develop and implement an Oil Spill Response Plan** that incorporates the seawater intake. This Plan will be developed in consultation with PPA and will include:
   a. Refuelling procedures;
   b. Response equipment requirements;
   c. Response procedures and action plans for various spill scenarios; and
   d. Reporting and responsibilities.
8. **Generators are to be installed within a bunded area at the Primary Seawater Intake;**
9. **Concentration ponds and crystallisers will be designed and constructed to be safe and stable according to DEMIRS requirements;**
10. **The following controls will be used to minimise the risk of impact from unintentional brine pipeline spills**:
    a. Pipelines, external to the PIDE, will be fitted with leak detection;
    b. Flows will be shut off if leaks are detected;
    c. External pipe routes will be inspected to a schedule for issues of concern;
    d. Pipelines will mainly be located below ground;
    e. Where pipelines cross access roads they will be reinforced against traffic loading;
    f. Investigations will be conducted into the cause of any spills, and remedial actions will be taken to minimise the chance of recurrence.
    g. Spill response training to mitigate damage for site-based personnel;
11. **Monitor erosion at the outlets of the drainage corridors after significant flow events and upgrade erosion protection (i.e., rock baffles etc.) if required** (refer to Section 6);
12. **Contractually require silt curtains to be in place during the construction of the primary seawater intake**. The silt curtains will be removed when turbidity within the completed work areas is equivalent or lower than what is outside the silt curtain, based on a visual assessment.

### 7.6.3 REHABILITATE

The closure objective for this factor will be to remove all infrastructure and stabilise all altered lands such that there are no ongoing impacts to marine environmental quality. The marine components of the Proposal are relatively easy to rehabilitate, and the following measures will be taken:

- All marine infrastructure above the seabed including the seawater intakes and bitterns outlets will be removed and taken offsite; and

- The dredge channel will be left to gradually fill with sediment.

The remaining infrastructure will be rehabilitated and closed in accordance with a MCP approved under the Mining Act or as per PPA requirements.

## 7.7 PREDICTED OUTCOME

The EPA's environmental objective for this factor is to maintain the quality of water, sediment and biota so that environmental values are protected (EPA, 2016a).

The Proposal includes the offshore disposal of dredge material, which will result in impacts on water quality in the vicinity of the disposal site during dumping and for a short period afterwards. These impacts may result in increased turbidity and reduced benthic light in the vicinity of the dredging (O2 Metocean, 2025). The dredging will be carefully managed via a DSDMMP to ensure these impacts are limited to the areas predicted.

This Proposal also includes the discharge of up to 5.9 GLpa of bitterns into the marine environment, however recent detailed design work has identified that this discharge is unlikely to exceed 5.4 GLpa. The bitterns will be diluted at a 1:1 volume ratio prior to discharge by mixing with seawater taken from a seawater intake located on the jetty (but outside the area heavily influenced by the bitterns disposal to avoid drawing in bitterns) and discharged through a 200 m multi-port diffuser to promote mixing. This discharge will result in unavoidable significant water quality impacts in the waters surrounding the diffuser. The pre-dilution method proposed, the use of a diffuser and the siting and alignment of the diffuser have all been proposed to limit the size of the LEPA and MEPA boundaries as far as practicable, and ensure they are located such that areas of high-value BCH are not significantly impacted. Bitterns disposal will be regulated by a Licence issued under Part V of the EP Act and managed by DWER. The MEQMMP (Appendix 2.1) details the monitoring and management measures proposed to ensure the bitterns discharges meet appropriate criteria.

The primary seawater intake and general Proposal operations will increase the risk of water quality impacts (i.e., from oil or brine spills, product loss). The potential risks are however mitigated using a number of well-established measures, in this case it will be managed under a Works Approval and approvals under the Mining Act and the *Port Authorities Act 1999* (WA). A MEPA has been proposed around the LEPA and port operating areas as per other ports in the Pilbara and a High LEP around the primary seawater intake.

In summary, the resultant potential impacts to marine environmental quality are expected to be significant in the localised area around the bitterns diffuser and dredged/ dredge spoil areas, with limited impacts outside those impact zones given the mitigation measures are provided in the MEQMMP and DSDMMP.

It is expected that the Ministerial Statement will include the limits described in the Proposal Content Document. Solar salt manufacturing (including bitterns disposal) is a prescribed activity and therefore all associated emissions and discharges will be managed under Part V of the EP Act including bitterns, oil spills and brine spills.

The environmental outcomes for this factor are therefore predicted to be:

- Negligible ongoing impacts to water quality outside the LEPA and MEPA boundaries (monitored and managed by Part V of the EP Act and the MEQMMP);
- Negligible impacts to water quality outside the ZoI during dredging operations (monitored and managed by the DSDMMP and Sea Dumping Permit); and
- A remaining potential for rare localised short-term impacts associated with spill/pollutant incidents.

With the implementation of controls, the Proposal is able to be implemented while maintaining the quality of water, sediment and biota so that regional environmental values are protected. The Proposal is therefore able to meet the EPA's objective for this factor.

# 8 BENTHIC COMMUNITIES AND HABITATS

## 8.1 EPA OBJECTIVE

The EPA Objective for this key environmental factor is to protect BCH so that biological diversity and ecological integrity are maintained.

## 8.2 POLICY AND GUIDANCE

Relevant EPA and Commonwealth Government Guidance Documents for BCH are summarised in Table 8-1.

**Table 8-1: Policy and Guidance relevant to the Benthic Communities and Habitat key environmental factor**

| Policy and Guidance | How guidance has been considered |
|---|---|
| **WA Government** | |
| Key EPA documents | |
| EIA (Part IV Divisions 1 and 2) Procedures Manual (EPA, 2024a). | This document has been considered in planning for the Part IV approval process and has been used to inform the preparation of this ERD. |
| Statement of Environmental Principles, Factors, Objectives and Aims of EIA (EPA, 2023a). | This document was considered in the preparation of this ERD and to inform EIA. It was used identify the Key Environmental Factors likely to be impacted by the Proposal and the EPA's objective for each factor. |
| Statutory Guideline for Mine Closure Plans (DMIRS, 2020a). | This document has been considered in the design and planning of the Proposal; it has also been considered in the preparation of mitigation measures for the Proposal. |
| EIA (Part IV Divisions 1 and 2) Administrative Procedures (EPA, 2024d). | This document has been considered in planning for the Part IV approval process and has been used to inform the preparation of this ERD. |
| Instructions on how to prepare EP Act Part IV Environmental Management Plans (EPA, 2024e). | This document was considered during the preparation of environmental management plans to support this ERD. |
| Relevant EPA Factor Guidelines | |
| Environmental Factor Guideline – BCH (EPA, 2016d). | This document was considered in the preparation of this section (Section 8) of the ERD. |
| Relevant EPA Technical Guidance | |
| Technical Guidance – Protection of BCH (EPA, 2016b). | This document was considered in the preparation of this section (Section 8) of the ERD. |
| Technical Guidance – Protecting the Quality of Western Australia's Marine Environment (EPA, 2016c). | This document was considered in the preparation of this section (Section 8) of the ERD. |
| Technical Guidance – EIA of Marine Dredging Proposals (EPA, 2021f). | This document was considered in the preparation of this section (Section 8) of the ERD. |
| Guidance Statement No. 1 – Protection of Tropical Arid Zone Mangroves along the Pilbara Coastline (EPA, 2001). | This document was considered in the preparation of this section (Section 8) of the ERD. |
| Other Policy and Guidance | |

| Policy and Guidance | How guidance has been considered |
|---|---|
| Western Australian Prevention List for Introduced Marine Pests, Department of Fisheries (DPIRD, 2016). | This document was considered in the preparation of this section (Section 8) of the ERD. |
| Pilbara Coastal Water Quality Consultation Outcomes – Environmental Values and EQOs, DotE, Government of Western Australia, Marine Series Report No. 1 (DotE, 2006). | This document was considered in the preparation of this section (Section 8) of the ERD. |
| Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018). | This document was considered in the preparation of this section (Section 8) of the ERD. |
| WA Environmental Offsets Policy (EPA, 2011). | This document was considered when determining whether offsets were likely to be required for the BCH environmental factor, and the adequacy of any proposed offsets. |
| WA Environmental Offsets Guidelines (EPA, 2014a). | This document was considered when determining whether offsets were likely to be required for the BCH environmental factor, and the adequacy of any proposed offsets. |
| WA Environmental Offsets Template (EPA, 2014b). | This document was considered when determining whether offsets were expected to be required for the BCH environmental factor. |
| WA Environmental Offsets Metric and relevant guidance (DWER, 2021b). | This document was considered when determining whether offsets were likely to be required for the BCH environmental factor, and the adequacy of any proposed offsets. |
| **Commonwealth Government** | |
| Key Documents | |
| Generic guidelines for the content of a draft EPBC Act PER/EIS (including the objects and principles of the EPBC Act, 1999; DotEE, 2016). | These documents were considered in the preparation of this ERD and while undertaking EIA. |
| EPBC Act Environmental Offsets Policy (DSEWPaC, 2012a) – including the Offset Assessment guide. | This document was considered when determining whether offsets were likely to be required for the BCH environmental factor, and the adequacy of any proposed offsets. |
| Environmental Management Plan Guidelines (DotE, 2014). | This document was considered during the preparation of environmental management plans to support this ERD. |
| EPBC Act Condition Setting Policy (DAWE, 2020). | This document was used as guidance for the EIA and the development of mitigation measures and likely regulation of the Proposal. |
| EPBC Act Outcomes-based conditions policy (DotE, 2016a). | This document was used as guidance for the EIA and the development of mitigation measures and likely regulation of the Proposal. |
| Relevant Technical Guidance | |
| Relevant EPBC Act listed species-specific survey guidelines and protocols. | These documents were used as guidance when undertaking surveys of EPBC listed species and potential survey limitations. |
| Relevant EPBC Act listed species-specific Recovery plans, Threat Abatement Plans, Approved Conservation Advice and other documents. | These documents were used as guidance to assess and manage EPBC listed species that may be impacted by the Proposal. |
| Marine bioregional plan for the North-west Marine Region (DSEWPaC, 2012b). | This document was considered in the preparation of this ERD and while undertaking EIA. |
| National Assessment Guidelines for Dredging (DEWHA, 2009a). | This document was considered in the preparation of this ERD and while undertaking EIA. |
| Environmental best practice port development; an analysis of international approaches (GHD, 2013a). | This document was considered in the preparation of this ERD and while undertaking EIA. |

## 8.3 RECEIVING ENVIRONMENT

The information provided in this section has been sourced from the following reports:

- O2 Marine (2025b; Appendix 3.1) Eramurra Solar Salt Project – Benthic Communities and Habitat Cumulative Loss Assessment. Report prepared for Leichhardt Salt Pty Ltd;
- O2 Marine (2025c; Appendix 3.2) Eramurra Solar Salt Project – Intertidal Benthic Communities and Habitat. Report prepared for Leichhardt Salt Pty Ltd;
- O2 Marine (2025d; Appendix 3.3) Eramurra Solar Salt Project – Subtidal Benthic Communities and Habitat. Report prepared for Leichhardt Salt Pty Ltd;
- MScience (2022; Appendix 3.4) Eramurra Solar Salt Project Introduced Marine Pest Risk Assessment;
- EnSTaR (2025a; Appendix 3.5) Eramurra mapping: Mangrove – Remote Sensing;
- EnSTaR (2025b; Appendix 3.6) Eramurra mapping: Algal mat – Remote Sensing;
- Actis Consulting Pty Ltd (2023; Appendix 3.7) – Benthic Mat Study – Productivity Estimates of Local Assessment Units;
- Larcombe et al. (2024; Appendix 3.9) Effects of future sea-level rise and solar salt ponds on the coastline, Eramurra Solar Salt Project, with implications for benthic habitats; and
- Larcombe et al. (2025; Appendix 1.3) The past, present and future coastal dynamics relevant to the Eramurra Solar Salt Project, with implications for benthic habitats.

### 8.3.1 SURVEY EFFORT

***Intertidal Benthic Communities and Habitat***

Detailed intertidal BCH surveys were undertaken by O2 Marine between 2020 and 2024. The objectives of the assessment were to:

- Describe the current understanding of the ecological role and value of the intertidal BCH in the Local Assessment Units (LAUs);
- Prepare detailed intertidal BCH maps and description of the effort in the field to ground-truth and validate the predicted distributions; and
- Review any tenure, conservation, ecological or social values of the BCH that should be considered.

The assessment primarily focussed on the coastal zone extending from the existing Sino Iron causeway in the west and extending east along the northern shore to the Strelley River West in the east. This intertidal area has been assessed through four LAUs (Figure 8-1).

Part of O2 Marine's work included a comprehensive desktop review of the intertidal BCH in vicinity to the Proposal. The review focussed on surveys undertaken for previous coastal development projects in the Pilbara and relevant scientific journal literature on intertidal BCH in the Pilbara region.

O2 Marine undertook three field surveys during between May 2020 and October 2024 with the specific objectives of collecting detailed information to allow any data gaps identified in the desktop review to be sufficiently addressed. The surveys involved five primary tasks:

1. Collect information on mangrove tree health to enable an investigation into the functional ecological value and regional significance of mangrove communities throughout the LAUs;
2. Collect information on mangrove fauna abundance and biodiversity to enable an investigation into the functional ecological value and regional significance of mangrove communities throughout the LAUs;
3. Collect soil samples to determine any correlations between soil type and BCH associations;
4. Collect algal mat samples for taxonomic identification; and
5. Collect low-altitude geo-referenced imagery of mangrove and algal mat communities to validate satellite imagery.

The following locations (shown in Figure 8-1) were selected for the mangrove and algal intertidal assessment:

- May 2020:
  - Five mangrove assessment locations (M1-M3, R1 & R2);
  - Seven algae sampling locations (A1-A7);
  - Seven soil sampling locations (M2, M3, S1, S2, S6 & S10);
- June 2021:
  - Four mangrove assessment locations (M4-M7); and
  - Three algae sampling locations (A8-A10).

Locations were selected based upon a review of the preliminary BCH mapping. Mangrove survey locations were selected to ensure an assessment was conducted across each of the identified mangrove assemblage types (i.e., mixed communities or specific species), while sites at each location were selected to ensure the differences in mangrove canopy cover types were represented (i.e., landward edge, seaward edge etc.). The survey also included locations previously identified as regionally significant mangrove areas (RSMA) (EPA, 2001), which includes RSMA #9 – Cape Preston (R1 and R2), to provide further context for the study locations. Survey sites and RSMA's are presented in Figure 8-1.

Aerial drone photography was conducted in October 2024 to collect ground-truthing data for validating intertidal habitat mapping. Fifteen drone missions were undertaken across intertidal zones within LAU1 – LAU4 (Figure 8-2). A transect approach was identified as the most effective method for capturing imagery of different habitat types, with flight paths positioned perpendicular to the elevation contours. Imagery was collected across areas approximately 1,500 m in length and 200 m in width, ensuring adequate image overlap for orthomosaic generation.

Surveys were also designed by Actis Environmental Services and Actis Consulting Pty Ltd and undertaken by Leichhardt to investigate the productivity of benthic mats in the development envelopes and Indicative Disturbance Footprint and the broader LAUs (Appendix 3.7). The survey was conducted by taking subsamples of the mat in structure transects and at relatively specific sites of interest. Up to 197 samples were collected between December 2021 and May 2022 (Figure 8-3). Photos were taken of the mat environment and sample after a core had been extracted from the mat. Each sample was located with a GPS and the results entered into a GIS database. The samples were then freeze dried, weighed and homogenised.

The report by Actis Environmental Services also underwent a peer review by Eric Paling (MScience, 2023), provided as in Appendix 7.6. The peer review found that the report provides credible evidence that Chlorophyll-a biomass may be used as an effective indicator of relative productivity in the microbial mats that occur in the coastal environment within and around the Proposal. Thus, the use of microbial mat productivity, in relation to predicted seasonality and wetting, as a tool to both predict and reduce project impacts would seem appropriate in this setting.

Furthermore, it is considered that a reasonable degree of confidence can be attributed to the report's conclusion that the total productivity loss due to the construction of the salt field would be 25.2%.

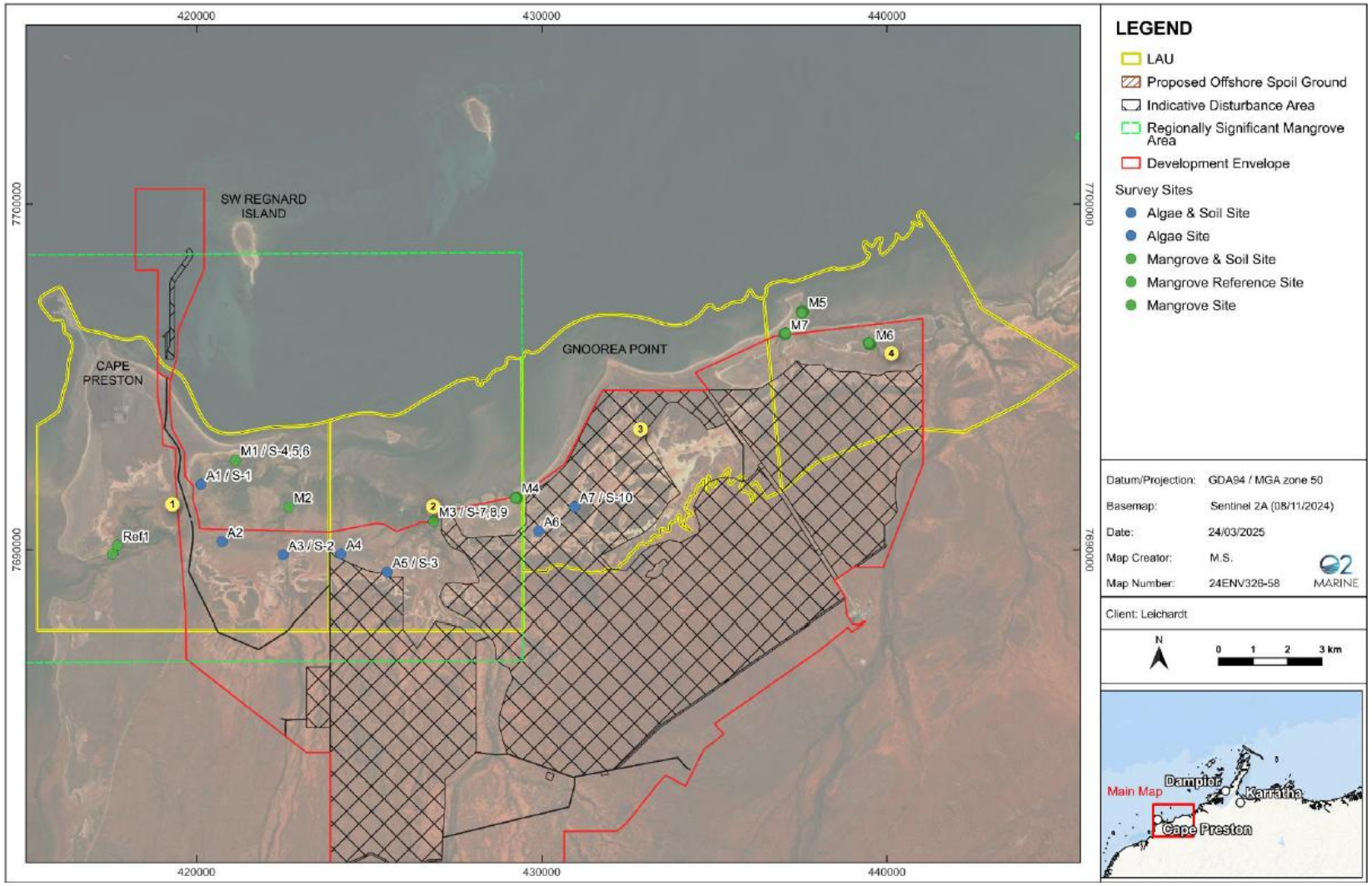



Figure 8-1: Intertidal BCH Study Area (LAU 1 - 4) and survey effort (O2 Marine, 2025c)

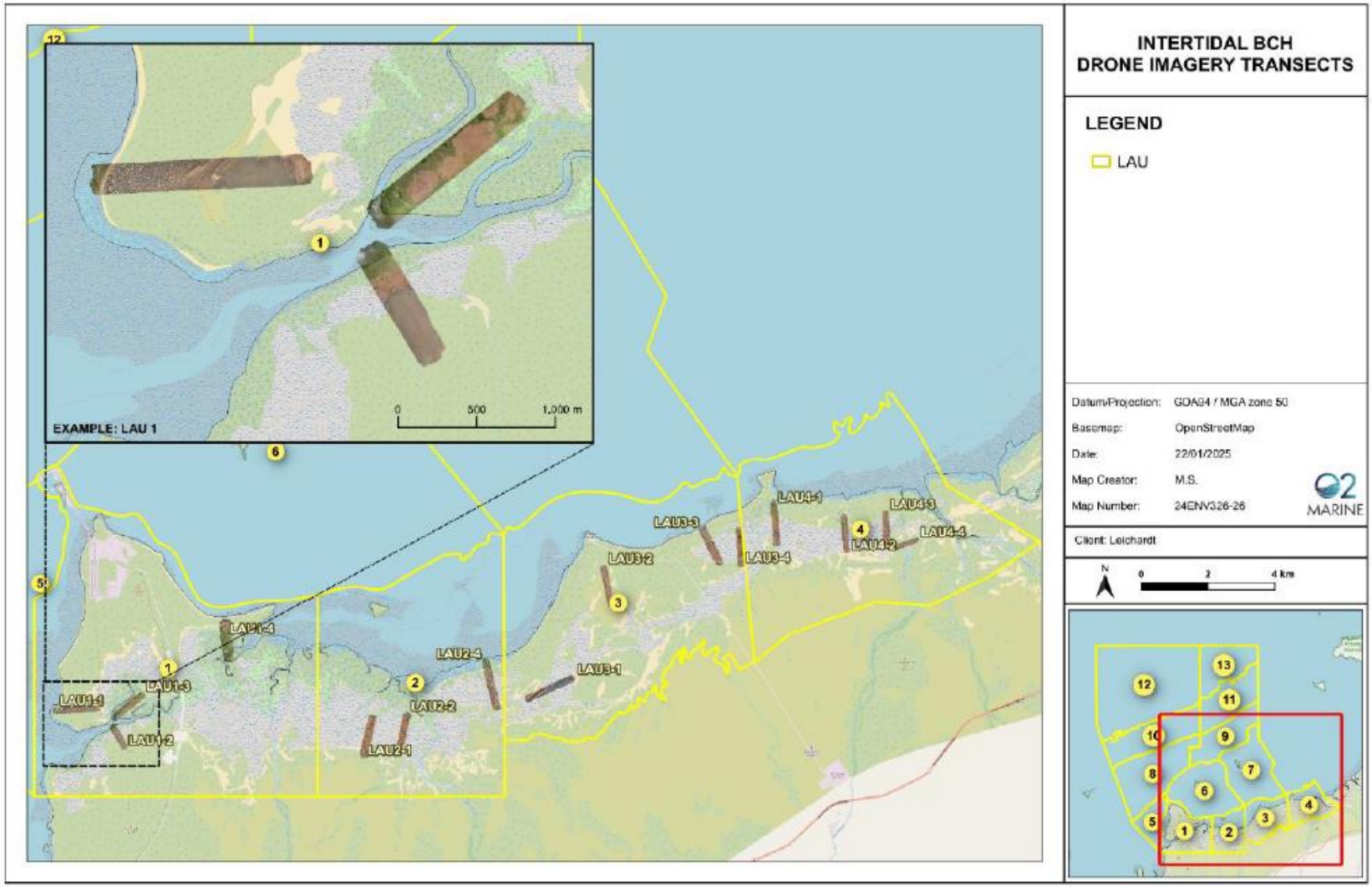



Figure 8-2: Drone survey effort over the study area (LAU1, LAU2, LAU3, LAU4) in October 2024 (O2 Marine, 2025c).




**Figure 8-3: Algal mat samples reported by Actis Consulting Pty Ltd.**

### *Subtidal Benthic Communities and Habitat*

O2 Marine (2025d) was commissioned to characterise and map the subtidal BCH within the proposed LAUs. This assessment of subtidal BCH primarily focused on the subtidal nearshore coastal zone surrounding the Proposal (Figure 8-4). The assessment also draws from surveys undertaken during pre-feasibility stages of the CPE Port, and from relevant information collected for wider regional nearby projects (within 100 km). The subtidal nearshore coastal zone is defined as extending from the intertidal foreshore mudflats of the Cape Preston East coast to the approximate 20 m bathymetric contour and includes several small coastal islands.

Guidance within EPA (2021g) encourages utilisation of available information to consolidate and improve knowledge of BCH. The desktop review identified that some existing maps have been generated that present the extent and distribution of subtidal BCH (Bancroft, 2000; Lyne et al., 2006; LeProvost, 2008; GHD, 2012). Bancroft (2000) and Lyne et al. (2006) provides shapefiles of broadscale low resolution mapping across a broader area of the Pilbara, while LeProvost (2008) and GHD (2012) maps were prepared for the Sino Iron Project and CPE Port respectively, which provided fine-scale detail more relevant to the LAUs.

The habitat classifications within the various maps were compiled into a standardised vocabulary of defined terms. The maps were overlaid in Quantum Geographic Information System (QGIS mapping software package) and layers were prioritised based on most recent and resolution.

All surveys were conducted by qualified and experienced marine scientists from O2 Marine. The field survey effort is summarised in Table 8-2 and presented in Figure 8-4.

**Table 8-2: Subtidal BCH field survey effort**

| BCH Survey | Survey Date | Number of Sites | Survey Objective |
|---|---|---|---|
| Survey 1 | 23-25 July 2018 | 125 camera tows | Pre-feasibility drop camera Investigative transects |
| Survey 2 | 2-7 March 2021 | 20 sidescan cameras<br>18 camera tows | Offshore drop camera sites and sidescan sonar transects. Broad scale habitat assessment using sparse transects. |
| Disposal Ground/Mooring Area Assessment | 19-22 March 2022 | 100 camera tows<br>3 spoil ground areas and 2 mooring | Spoil ground and mooring area sidescan sonar and drop camera work. Small scale habitat assessment of targeted locations.<br>Note: These disposal grounds are no longer being considered. |
| Coral Survey 1 | 14-18 July 2020 | 5 monitoring sites | First survey visiting previously established monitoring sites. |
| Coral Survey 2 | 3-6 June 2021 | 5 monitoring sites | Second survey visiting previously established monitoring sites. |
| Seagrass Survey 1 | 27-29 July 2020 | 7 monitoring sites | First survey during the dry season. |
| Seagrass Survey 2 | 22-25 March 2021 | 7 monitoring sites | Second (repeat) survey during the wet season. |
| Dredge Disposal Ground Assessment | 21-23 March 2023 | Complete sidescan coverage<br>15 camera tows | Revised spoil ground location. Sidescan sonar and drop camera work. Small scale habitat assessment of targeted locations. |
| Ground-truth survey acquisition | 20 October 2024 | Drone survey<br>10 transects | Obtain the primary ground-truth dataset |
| Ground-truth survey acquisition | 23-25 October 2024 | Towed video<br>75 transects | |

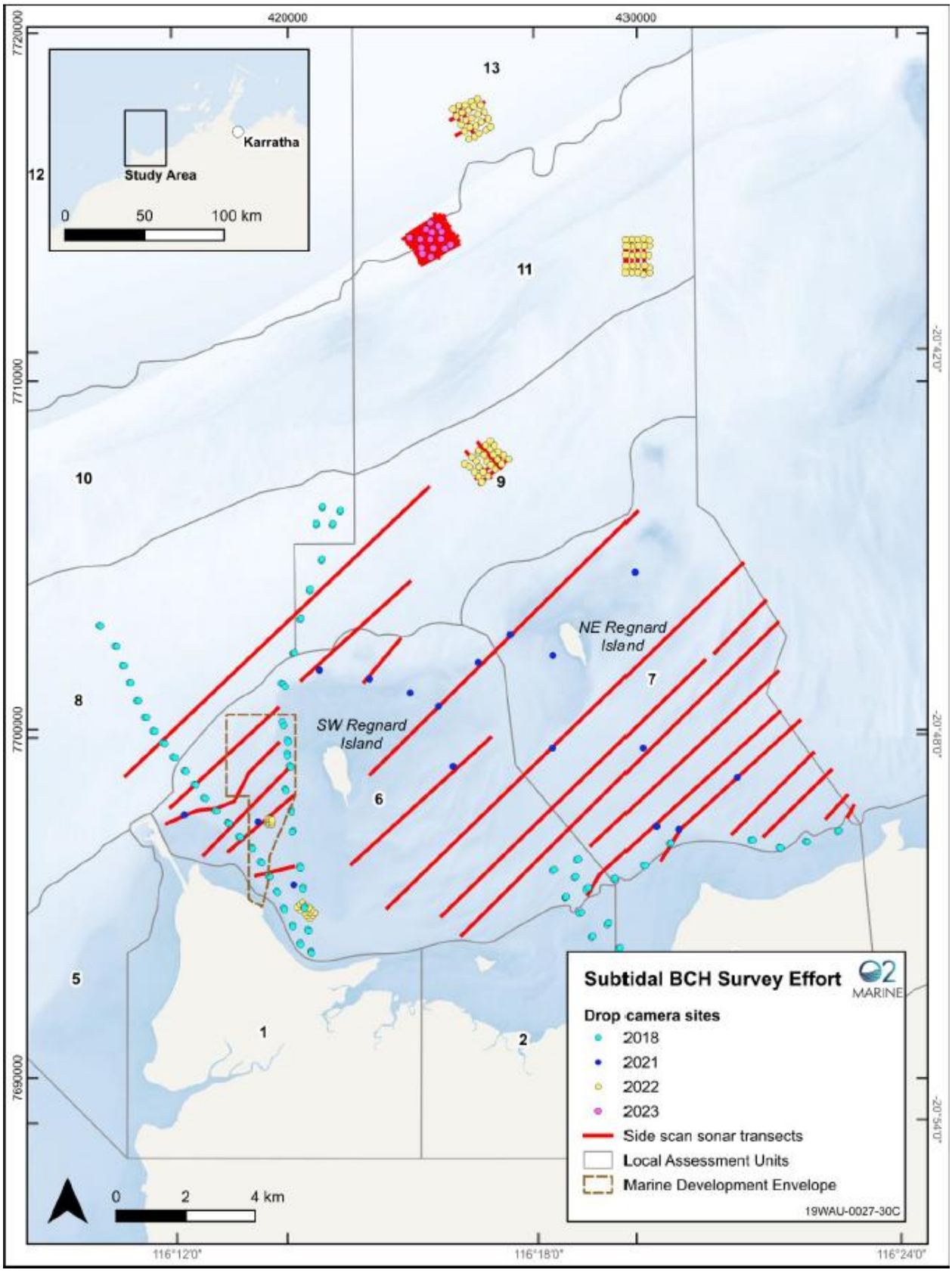



Figure 8-4: Subtidal LAUs and BCH side scan sonar and drop camera survey locations survey effort (O2 Marine, 2025d)

Field surveys were undertaken to validate and build upon the existing mapping of BCH within the LAUs to better describe the subtidal BCH in this area. The BCH mapping fieldwork involved two primary survey techniques:

- Sidescan Sonar to capture textural information over a series of broad swaths through the LAUs; and
- Drop Camera to determine in detail the type of BCH present, and 'ground truth' the sidescan data.

The broad-scale sidescan sonar survey was performed as a series of sparse transect lines, oriented northeast to southwest. Multiple parallel survey lines were completed, from the coastline moving offshore to the 20 m bathymetric contour, at a spacing of about 0.8 km. Sidescan data was also acquired (at 100% coverage) for five sites associated with potential management areas, consisting of two inshore management areas for mooring vessels and three offshore options for dredge spoil placement.

The primary towed video camera system used for the ground truth survey was a Spot X SQUID real-time subsea high definition video camera. The camera was flown at a depth of approximately 0.5 m above the seabed, with the operator recording between 30 seconds to a minute (30 - 60 m) of benthic video footage at each transect. Vessel speed ranged between 1-2 knots to allow for the acquisition of good-quality imagery. Diving/snorkelling was conducted to verify habitat in low visibility conditions at suspected seagrass and coral BCH locations. To ensure accurate BCH characterisation within potential impact areas, survey locations were generally targeted within and adjacent to the development envelopes. Additional targeted survey locations were identified based on review and analysis of the available sidescan imagery to achieve broad spatial coverage of BCH across the LAUs.

During each video survey, the observed BCH was assigned a preliminary classification based on the Collaborative and Automated Tools for Analysis of Marine Imagery (CATAMI) classification scheme for scoring marine biota and physical characteristics from underwater imagery.

***Regional Intertidal Study***

Regional intertidal mapping was undertaken by EnSTaR using satellite-based remote sensing (EnSTaR, 2025a & b; Appendix 3.5, 3.6). This mapping was undertaken to determine the regional extent of mangroves and algal mats and shows a representative distinction between high density and low density productive algal mats. Mangroves were predicted to have a regional extent of 33,706 ha and algal mats were predicted to have a regional extent of 41,574 ha over the west Pilbara coast (south of Exmouth Gulf to Dampier).

There are many approaches to mapping mangroves that use Light Detection and Ranging (LiDaR) and optical remote sensing data combined with machine learning or conventional targeted image-based processing. Conventional image-based mangrove identification is useful in identifying mangroves in a small region, but it is ineffective in large area of observations. The machine learning approaches have gained momentum in the last decade, such as Support Vector Machine (SVM) and Random Forest classification in mapping mangroves (Jiang et al., 2021).

The rapid adoption of machine learning approaches is mainly due to much improved access to large processing/computer power readily available via various cloud computing service providers such as Amazon Web Services and Google Earth Engine (Diniz et al., 2019) and increasing recognition that machine-learning approaches are efficient in mining and using spatial information (Dennis et al., 2012).

The SVM model for mangrove classification was used with aims to:

1. Study the feasibility of satellite remote sensing data from Sentinel-2 A/B in mapping mangrove extent; and
2. Develop a methodology, and assess limitations, to identify mangroves from Sentinel satellite data and generate a mangrove map to inform the extent of mangrove in the study region.

Algal mats are characterised by the presence of productive microbial communities at or near the surface of marine sediments, ranging from subtidal to supratidal environments. Sometimes the microbial concentration is obvious as colouration at the surface of the sediment, but sometimes the microbial concentration is active within the sediment profile, therefore not particularly apparent as sediment discolouration.

A conventional field-based survey in mapping algal mats is accurate and useful in identifying algal mats in a small, target region, but it is ineffective and cost prohibitive in a large area of observation. The aerial and satellite data provide an alternative to field-based surveillance in mapping algal mats for large spatial extents.

The SVM model for algal mat classification was used with aims to:

1. Study the feasibility of satellite remote sensing data from Sentinel-2A/B in mapping algal mats; and
2. Develop a methodology and consider limitations to identify algal mats from the satellite data and generate an algal mat map to inform the state of the algal mat in the study regions.

### 8.3.2 Local Assessment Units

Thirteen LAUs were established across the Study Area to provide a regional context for characterisation, mapping and assessment of impacts to BCH. The location and extent of the LAUs are shown on Figure 8-5. LAU 1 - 4 are focussed on the intertidal BCH areas, whilst LAU 5 - 13 focus on subtidal BCH areas. LAUs 5-13 were conservatively developed to spatially encompass all potential impacts. At the time of setting the LAUs, the dredge/disposal design was not finalised, thus, the total LAU area is larger than any Proposal-related impacts.

Consistent with the guidance provided by EPA (2016c), the 13 LAUs were established in consideration of the following key factors:

- BCH type, condition, extent and distribution;
- Management boundaries (i.e., RSMA);
- Bathymetry; and
- Coastal geomorphology.





The rationale for determination of LAU boundaries is summarised below.

- LAU1:
  - Intertidal BCH area (5,921 ha);
  - Existing LAU and RSMA #9 boundary;
  - LAU is characterised by a large river delta system in the lower western edge and two smaller river deltas in the northeast. 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 considered terrestrial vegetation, including coastal sand dunes and spinifex sandplains; and
  - BCH is characterised by mangrove communities along the main rivers and delta, which is 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:
  - Intertidal BCH area (3,790 ha);
  - Within RSMA #9 boundary;
  - 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 tidal delta system (McKay and Straight Creeks) occurring here;
  - BCH is characterised by mangrove communities along the main rivers and delta, supported by thin ribbons of samphire and surrounded by algal mats and mudflats/salt flats inland and an intertidal bay with extensive foreshore mudflats;
  - A series of terrestrial islands interspersed with the algal mats and mudflat/salt flats in the eastern central portion; and
  - Mangrove BCH typically declines with distance east.
- LAU3:
  - Intertidal BCH area (4,500 ha);
  - Southern border typically follows the southern extent of intertidal zone;
  - LAU characterised by a low-lying area of algal mats and mudflats/salt flats 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 northwestern facing shoreline up to Gnoorea Point; and
  - 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:
  - Intertidal BCH area (3,772 ha);
  - Southern boundary typically follows the southern extent of 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; and

  - The central portion of the LAU is characterized by extensive algal mats and mudflat/salt flats with some terrestrial islands in the western half and more of 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:
  - Subtidal BCH area (2,661 ha);
  - Nearshore LAU characterised by algae dominated limestone pavement and coral reefs in depth <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; and
  - Cape Preston significant geomorphological feature.
- LAU6:
  - Subtidal BCH area (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 waters boundary too close to edge of Marine Development Envelope, so eastern boundary extended to approximate predicted Zone of Moderate Impact area;
  - From LAT to 10 m depth contour; and
  - Cape Preston and South West Regnard Island significant geomorphological features.
- LAU7:
  - Subtidal BCH area (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; and
  - North East Regnard Island and small shoal ~6 km northeast on subtidal reef platform significant geological features.
- LAU8:
  - Subtidal BCH area (9,623 ha);
  - Mid-shelf LAU characterised by coarse sand;
  - Port of Cape Preston port waters boundary on east and west;
  - Bathymetry from 10 m to 15 m depth contours; and
  - Geomorphology relatively low gradient and featureless seabed.
- LAU9
  - Subtidal BCH area (5,353 ha);
  - Mid-shelf LAU characterised by coarse sand;
  - Port of Cape Preston port waters boundary on west;
  - Bathymetry from 10 -15 m depth; and
  - Geomorphology relatively low gradient and featureless seabed.

- LAU10:
  - Subtidal BCH area (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 easy and west;
  - 20 m depth contour forms northern boundary;
  - Bathymetry from 8 - 20 m depth; and
  - Geomorphology relatively low gradient and featureless seabed with occasional shoals and steep gradient from 10 - 20 m on outer shelf.
- LAU11:
  - Subtidal BCH area (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 - 20 m depth; and
  - Geomorphology relatively low gradient and featureless seabed with occasional shoals steep gradient from 10 -20 m on outer shelf.
- LAU12:
  - Subtidal BCH area (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; and
  - Geomorphology relatively low gradient and featureless seabed.
- LAU13:
  - Subtidal BCH area (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; and
  - Geomorphology relatively low gradient and featureless seabed.

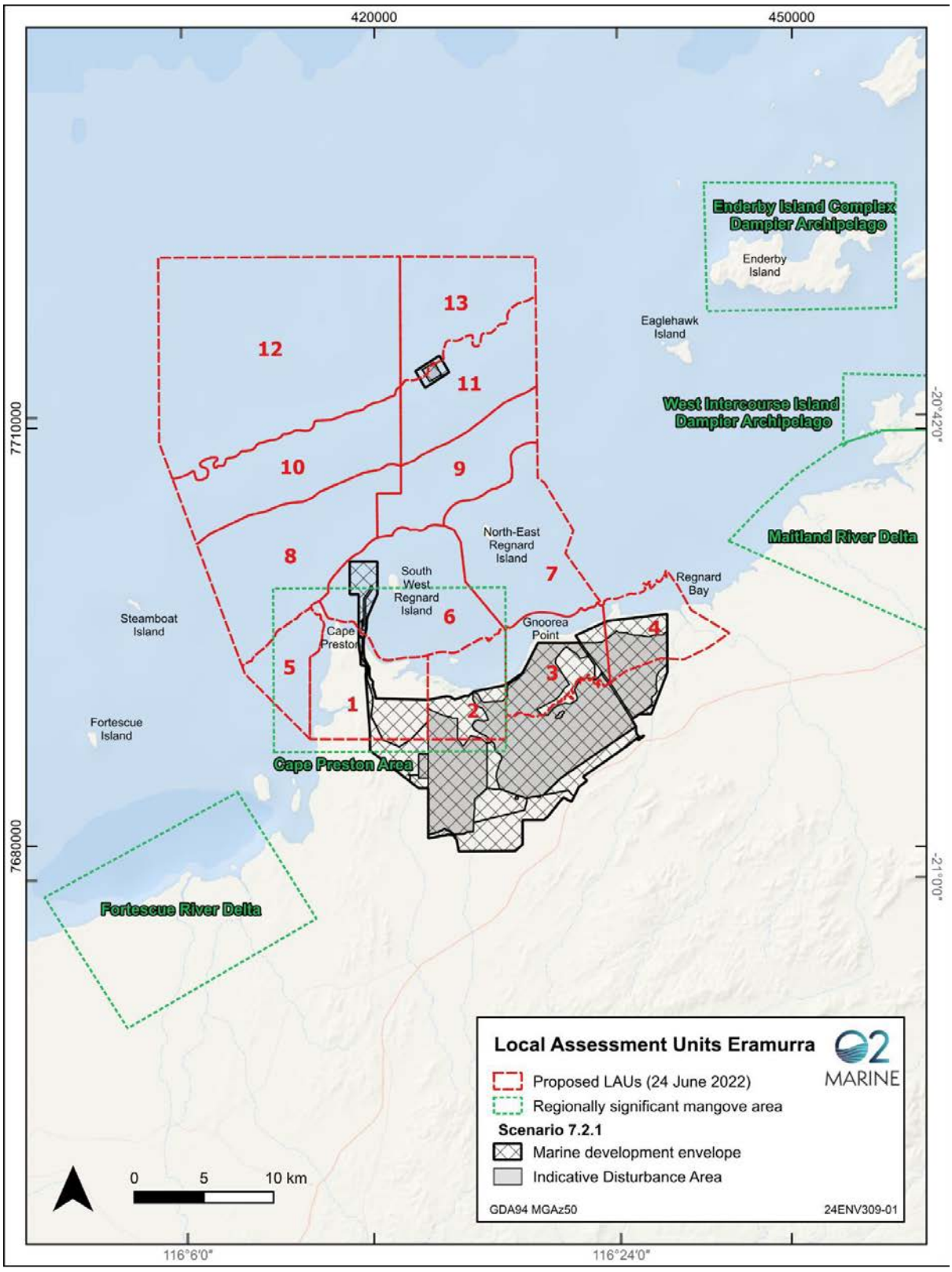



Figure 8-5: Local Assessment Units and Regionally Significant Mangrove Areas

### 8.3.3 INTERTIDAL BENTHIC COMMUNITIES AND HABITATS

Information in this section has been sourced from O2 Marine (2025c; Appendix 3.2) unless stated otherwise.

***Summary***

The term 'Study Area' in this section refers to the combined boundary of LAU 1 – 4. The distribution of each intertidal BCH habitat type within the Study Area and each LAU are presented in Table 8-3 and shown on Figure 8-6 - Figure 8-9. Table 8-4 also provides a description of each BCH category within the Study Area.

**Table 8-3: Area of the BCH within the intertidal LAUs**

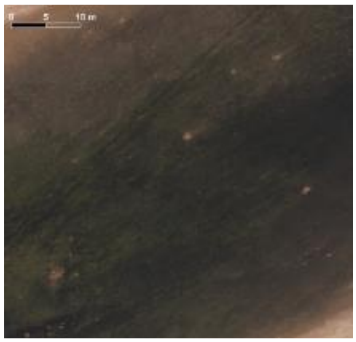
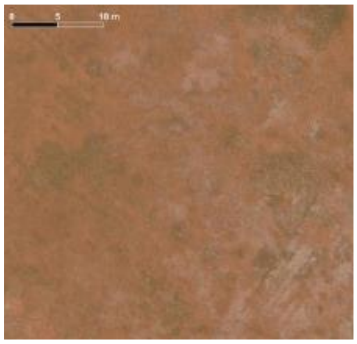
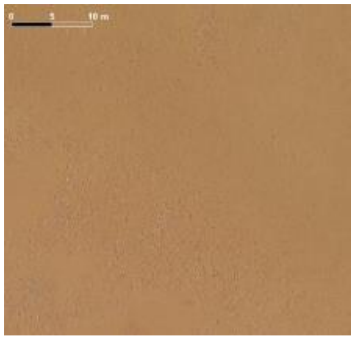
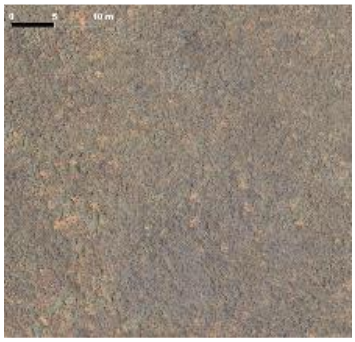
| BCH Class | LAU 1 | LAU 2 | LAU 3 | LAU 4 | TOTAL |
|---|---|---|---|---|---|
| | ha (%) | ha (%) | ha (%) | ha (%) | ha (%) |
| **Total area of LAU** | **5,921.7 (33%)** | **3,790.1 (21%)** | **4,500 (25%)** | **3,772.5 (21%)** | **17,984 (100%)** |
| **Intertidal** | | | | | |
| Bare, High Intertidal Salt Flat (HISF) | 102.2 (1.7%) | 67.6 (1.8%) | 54.6 (1.2%) | 36.9 (1%) | **261.3 (1.5%)** |
| *Avicennia marina* (Seaward edge) (Am1) | 105.4 (1.8%) | 72.3 (1.9%) | 8.5 (0.2%) | 50.5 (1.3%) | **236.6 (1.3%)** |
| *Avicennia marina* closed canopy (Landward edge) (Am2) | 211.6 (3.6%) | 119.6 (3.2%) | 0.2 (0.004%) | 26.1 (0.7%) | **357.5 (2%)** |
| *Avicennia marina* scattered (Am3) | 390.5 (6.6%) | 183.7 (4.8%) | 9.1 (0.2%) | 109.5 (2.9%) | **692.7 (3.9%)** |
| *Rhizophora stylosa / Avicennia marina* closed canopy mixed (Rs/Am) | 27.1 (0.5%) | 17.5 (0.5%) | 0.7 (0.01%) | 5.8 (0.2%) | **51.1 (0.3%)** |
| *Rhizophora stylosa* (Rs) | 22.2 (0.4%) | 19.7 (0.5%) | 0 | 1.5 (0.04%) | **43.4 (0.2%)** |
| HDAM | 275.2 (4.6%) | 167 (4.4%) | 127.6 (2.8%) | 127.4 (3.4%) | **697.3 (3.9%)** |
| Low density algal mat (LDAM) | 541.4 (9.1%) | 449.9 (11.9%) | 217.1 (4.8%) | 252 (6.7%) | **1460.4 (8.1%)** |
| Samphire including algal mat (sparse) | 240.1 (4.1%) | 194.2 (5.1%) | 372.4 (8.3%) | 208.6 (5.5%) | **1015.3 (5.6%)** |
| Samphire including algal mat (dense) | 71 (1.2%) | 33 (0.9%) | 14.7 (0.3%) | 63.4 (1.7%) | **182 (1%)** |
| Samphire shrubland (sparse) | 70 (1.2%) | 68.5 (1.8%) | 176.8 (3.9%) | 98.6 (2.6%) | **414.3 (2.3%)** |
| Samphire shrubland (dense) | 54.6 (0.9%) | 31.8 (0.8%) | 79.7 (1.8%) | 37.7 (1%) | **203.7 (1.1%)** |
| Grassland | 49.5 (0.8%) | 16.3 (0.4%) | 34 (0.8%) | 62.3 (1.7%) | **162.2 (0.9%)** |

| BCH Class | LAU 1 | LAU 2 | LAU 3 | LAU 4 | TOTAL |
|---|---|---|---|---|---|
| | ha (%) | ha (%) | ha (%) | ha (%) | ha (%) |
| Undecided - Mixed Habitat, no clear majority | 8.6 (0.1%) | 6 (0.2%) | 6.2 (0.1%) | 4.9 (0.1%) | **25.7 (0.1%)** |
| **Subtidal** | | | | | |
| Intertidal Sandy Muds | 395.4 (6.7%) | 198.8 (5.2%) | 125.5 (2.8%) | 126 (3.3%) | **845.6 (4.7%)** |
| Muddy sand, bare | 26.3 (0.4%) | 38.6 (1%) | 8.4 (0.2%) | 3.9 (0.1%) | **77.2 (0.4%)** |
| Coarse sand and shell fragments | 249.4 (4.2%) | 722.9 (19.1%) | 676.7 (15%) | 362 (9.6%) | **2011.1 (11.2%)** |
| Dense hard coral and macroalgae reef | 3.2 (0.1%) | 16.9 (0.4%) | 37.5 (0.8%) | 19.8 (0.5%) | **77.4 (0.4%)** |
| Dense macroalgae and hard coral reef | 4.9 (0.1%) | 0 | 10.1 (0.2%) | 15.1 (0.4%) | **30.2 (0.2%)** |
| Sand veneer with sparse mixed macroalgae and hard coral | 0.2 (0.003%) | 1.4 (0.04%) | 43.1 (1%) | 30.2 (0.8%) | **74.9 (0.4%)** |
| *Pinna bicolour* beds | 0.1 (0.002%) | 1 (0.03%) | 2.6 (0.1%) | 11.7 (0.3%) | **15.4 (0.1%)** |
| Sand veneer with filter feeders | 14.5 (0.2%) | 11.7 (0.3%) | 4.7 (0.1%) | 3.2 (0.1%) | **34 (0.2%)** |
| Sand with sparse filter feeders | 0 | 8.5 (0.2%) | 3.5 (0.1%) | 1.3 (0.04%) | **13.4 (0.1%)** |
| Sand veneer with mixed macroalgae | 471 (8%) | 236.7 (6.2%) | 335.7 (7.5%) | 268.5 (7.1%) | **1311.9 (7.3%)** |
| Sand with dense mixed macroalgae | 45.6 (0.8%) | 40.4 (1.1%) | 12.3 (0.3%) | 46.6 (1.2%) | **145 (0.8%)** |
| Sand with sparse mixed macroalgae | 4.1 (0.1%) | 0.4 (0.01%) | 0.3 (0.01%) | 0.4 (0.01%) | **5.2 (0.03%)** |
| Sand with dense ephemeral seagrass, sparse filter feeders | 93.5 (1.6%) | 145.8 (3.8%) | 34.6 (0.8%) | 31 (0.8%) | **304.9 (1.7%)** |
| Sand with dense perennial seagrass and mixed macroalgae | 0 | 2.1 (0.1%) | 1.3 (0.03%) | 0.3 (0.01%) | **3.7 (0.02%)** |
| Sand with sparse ephemeral seagrass and mixed macroalgae | 16 (0.3%) | 77.4 (2%) | 34 (0.8%) | 34.7 (0.9%) | **162.1 (0.9%)** |
| Sand with dense mixed macroalgae and sparse seagrass | 0.3 (0.01%) | 0 | 0.1 (0.003%) | 0 | **0.5 (0.003%)** |
| Undecided-Mixed Habitat, no clear majority | 38.3 (0.6%) | 61.5 (1.6%) | 40.6 (0.9%) | 34.8 (0.9%) | **175.2 (1%)** |
| **Other** | | | | | |
| Terrestrial | 2388.9 (40.3%) | 779 (20.6%) | 2027.6 (45.1%) | 1697.6 (45%) | **6893.1 (38.3%)** |

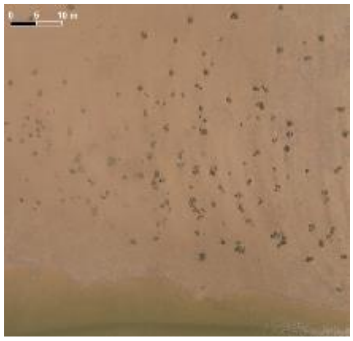
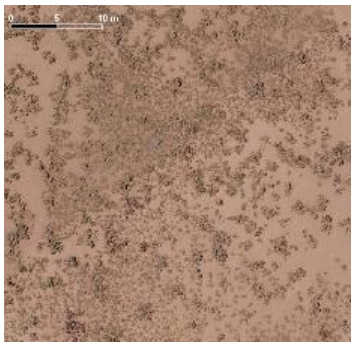
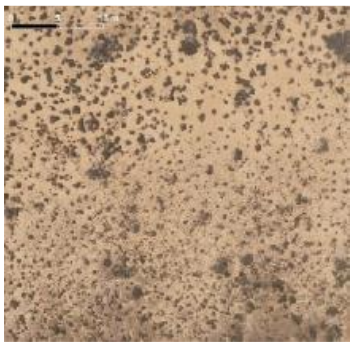




Table 8-4: Description of broad intertidal BCH classes mapped within the Study Area

| Group | Class | Description | Example Image |
|---|---|---|---|
| Algal Mat | HDAM | Area dominated by contiguous black, dark green or grey algal mat. |  |
| | LDAM | Algal mat with lighter colouring and/or fragmented mat features mixed with Bright Salt or with High Intertidal Salt Flat visible underneath. |  |
| Bare Intertidal Habitat | Bare/ HISF | Flat surfaces at lower elevations that are subject to inundation and exposure by tide. These areas are absent of algal mat or vegetation. |  |
| Terrestrial | Grassland | Grassland and dune vegetation e.g. spinifex, hummock/tussock grassland. |  |
| | Terrestrial (Unvegetated) | Terrestrial areas that are absent of vegetation. |  |

| Group | Class | Description | Example Image |
|---|---|---|---|
| Mangrove | Am1 | Typically closed canopy cover and usually large, spreading trees, often with limbs that bend down onto the substrate. This community is usually only a few 10's of metres wide and backed by *Rhizophora* (Rs either in a monospecific stand or mixed association with Am) or *Avicennia* (Landward edge). |  |
| | Rs | Typically closed canopy and dense, occurring either at the seaward edge in bands a few 10's of metres wide or behind Am1 as sprawling forests or as fingers extending into the landward Am where there are narrow shallow tidal channels. |  |
| | Rs/Am | This is usually a transition zone between the Rs monospecific stands and the monospecific stands of the landward edge Am 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. |  |
| | Am2 | Typically the largest area of mangrove association and comprises trees that show a decline in height moving from seaward to landward and often backed by the scattered Am3 association. |  |
| | Am3 | The point where Am landward edge displays canopy gaps and these gaps eventually become larger in total area than the surrounding Am. Individual scattered mangroves were excluded if tree density was approximately less than five trees per 100 $m^2$. |  |

| Group | Class | Description | Example Image |
|---|---|---|---|
| Samphire | Sam1 | Open samphire flats with sparse cover (<10%) inclusive of algal mats. These habitat classes occur in a transition area between algal mats and proper Samphire shrubland. A density gradient is evident, with increasing density of Samphire from Sam1 to Sam4. Sam1 and Sam2 are the only classifications that include algal mats. |  |
| | Sam2 | Open samphire flats with low cover (>10% <25%) inclusive of algal mats. These habitat classes occur in a transition area between algal mats and proper Samphire shrubland. A density gradient is evident, with increasing density of Samphire from Sam1 to Sam4. Sam1 and Sam2 are the only classifications that include algal mats. |  |
| | Sam3 | Samphire shrublands. Sparse level of cover (< 50%) |  |
| | Sam4 | Samphire shrublands.<br>Open samphire flats, including algal mats.<br>Dense level of cover (>50%). |  |

Regional characteristics from the seaward to landward zones of the intertidal area are quite variable between LAUs. Within LAU1 and LAU2, and to a lesser extent LAU4, the intertidal BCH is typified by foreshore mudflats/tidal creeks extending to the high-water mark where mangrove communities have become established as the dominant intertidal BCH type.

Thin bands of samphire communities occur on the landward extent of mangrove communities, where they often form overlapping boundaries with Scattered Canopy (SC) mangroves (these shared habitats are classified to the dominant BCH type and mapped as mangroves).

Behind samphires, mudflats/salt flats or algal mats typically occur up to the supratidal zone where terrestrial communities commence. The exception is the zonation observed in LAU3, and to a lesser extent LAU4, where the intertidal zone is typically restricted to algal mats and mudflats/salt flats occurring behind coastal sand dunes and interspersed by terrestrial islands.

### *Mangroves*

*Distribution*

Seven species of mangroves are known to occur within the Pilbara region (EPA, 2001). Of these, three species representing two families were identified. These included:

- *Avicennia marina* (Acanthaceae);
- *Ceriops australis* (Rhizophoraceae); and
- *Rhizophora stylosa* (Rhizophoraceae).

Mangrove habitat was mapped into dominant vegetation associations, which includes five classifications in accordance with Paling et al. (2003). Mangrove distributions and associations are presented in Figure 8-10 and Figure 8-13. The calculated areas for each association type occurring within the Study Area and the percentage of the total mapped area is presented in Table 8-5.

**Table 8-5: Total area of mapped mangrove associations within LAUs**

| Mangrove Association | LAU 1 (ha) | LAU 2 (ha) | LAU 3 (ha) | LAU 4 (ha) | Total Area (ha) |
|---|---|---|---|---|---|
| Am1 | 105.4 | 72.3 | 8.5 | 50.5 | **236.7** |
| Am2 | 211.6 | 119.6 | 0.2 | 21.6 | **357.5** |
| Am3 | 390.5 | 183.7 | 9.1 | 109.5 | **692.8** |
| Rs | 22.2 | 19.7 | 0.0 | 1.5 | **43.4** |
| Rs/Am | 27.1 | 17.5 | 0.7 | 5.8 | **51.1** |
| **Total** | **756.8** | **412.8** | **18.4** | **193.4** | **1,381.4** |

EnSTaR (2025a) conducted an assessment of satellite data to predict the regional extent of mangroves. Mangroves were predicted to have a regional extent of 33,706 ha (Figure 8-14).

Mangrove assemblages occur within all coastal LAUs. A. *marina* communities (Am1, Am2 and Am3) were associated with the greatest spatial extent covering over 1,286.9 ha or 93% of the mapped mangrove BCH area. The Am3 (Scattered) association dominates the landward fringe comprising 50.1% of the total area of mangroves, followed by 25.9% for Am2 (Landward) and 17.1% for Am1 (Seaward Edge). The mixed association comprising Rs/Am occupies 3.7% of the total area of mangroves and the mangroves dominated by Rs occupy 3.7% of all mangroves mapped. Approximately 84.7% of the total mapped mangrove habitat occurs within LAU1 (54.7%) and LAU2 (29.9%) which are located within the designated EPA RSMA #9 (EPA, 2001). Comparably, only 1.3% and 14% of mangrove habitats occur within LAU3 and LAU4, respectively. Key characteristics across the regional area from east to west identifies decreasing trends in the relative composition of Am1 (Seaward) and Am3 (Scattered) corresponding with increasing Am2 (landward), Rs (behind Am) and Mixed (Rs/Am). Not all associations are recorded in each LAU, with Am2, Rs and Rs/Am not present in LAU3.

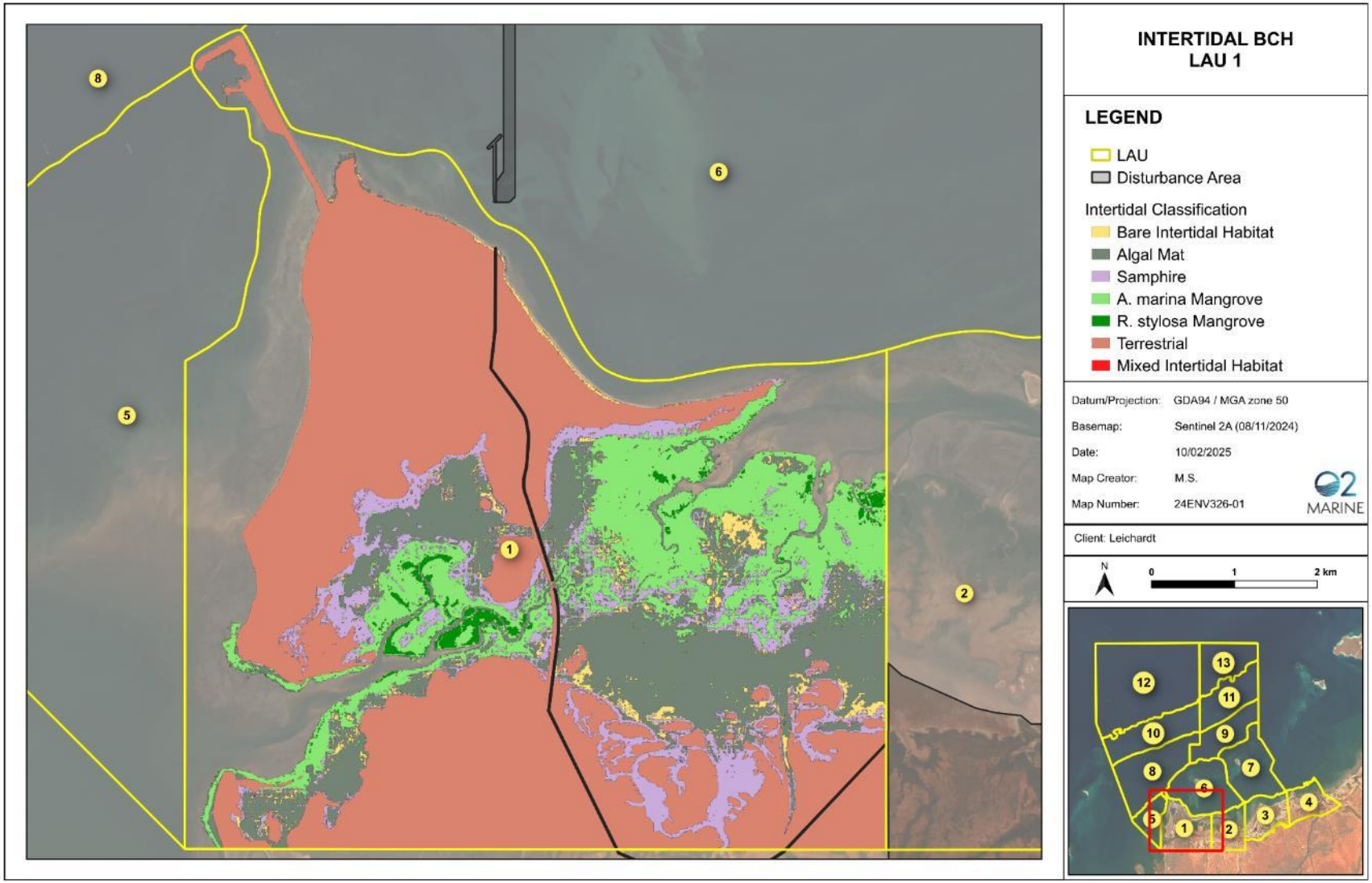



Figure 8-6: BCH and Terrestrial Vegetation identified in LAU1

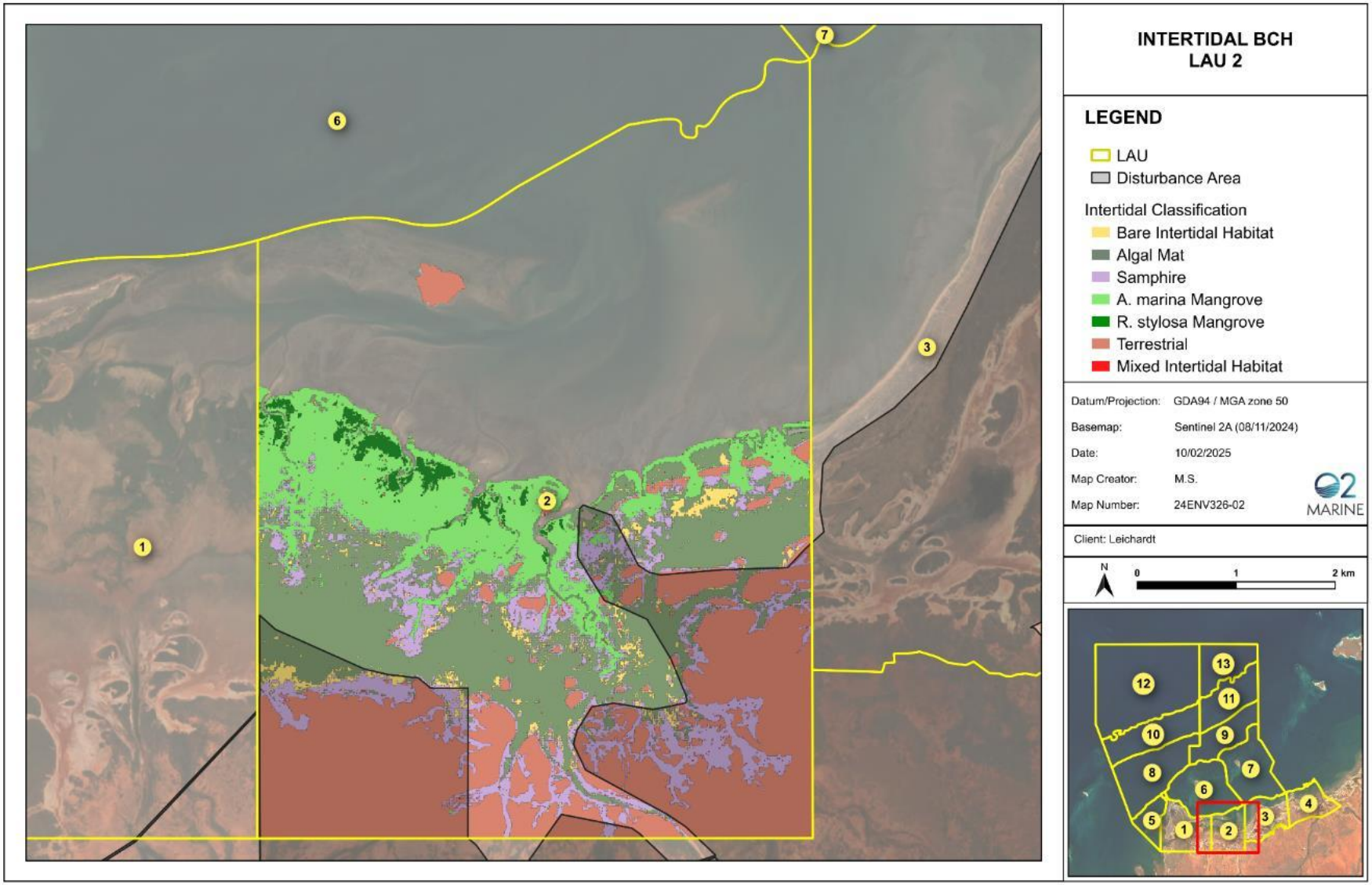



Figure 8-7: BCH and Terrestrial Vegetation identified in LAU2

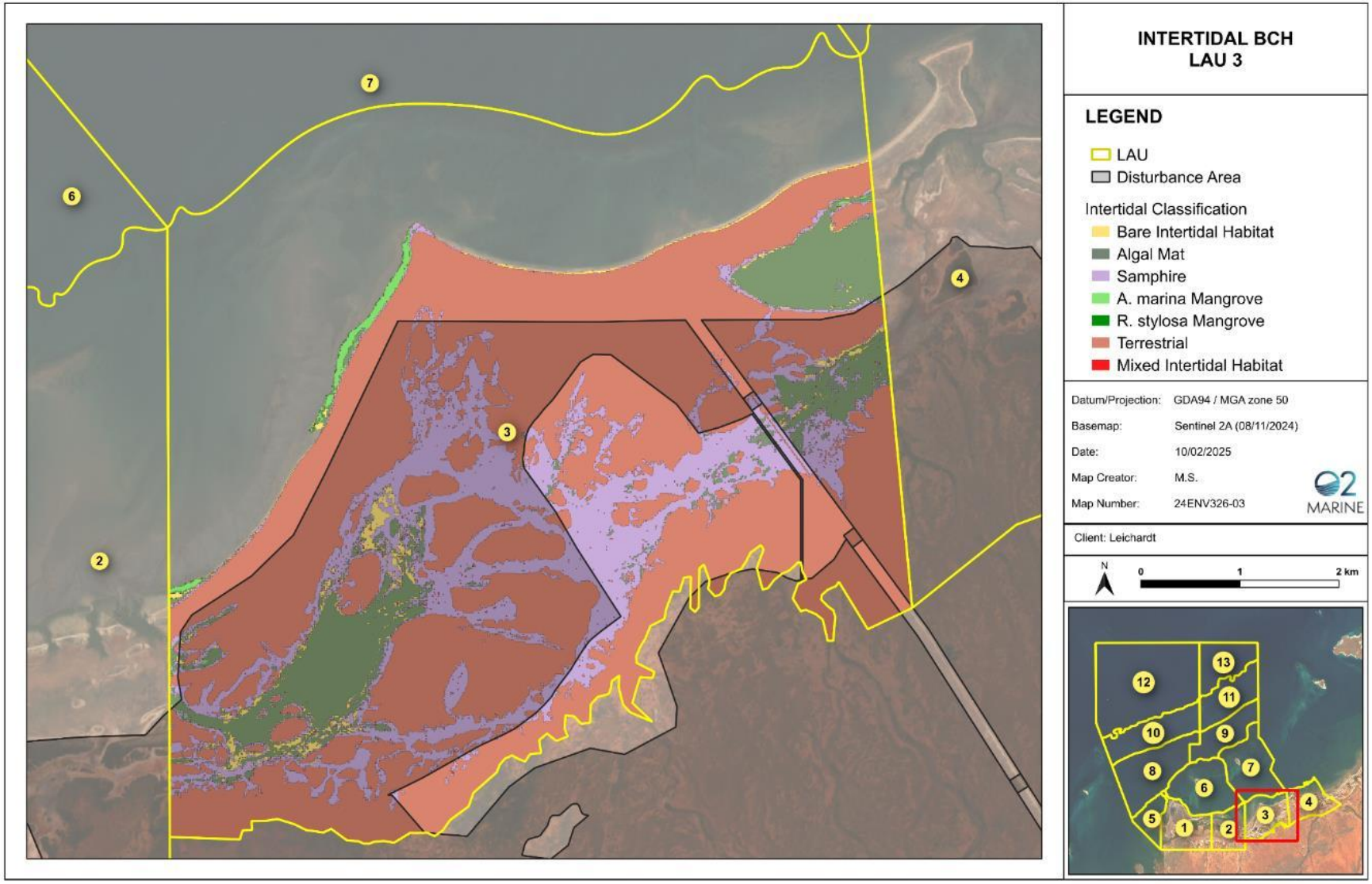



Figure 8-8: BCH and Terrestrial Vegetation identified in LAU3

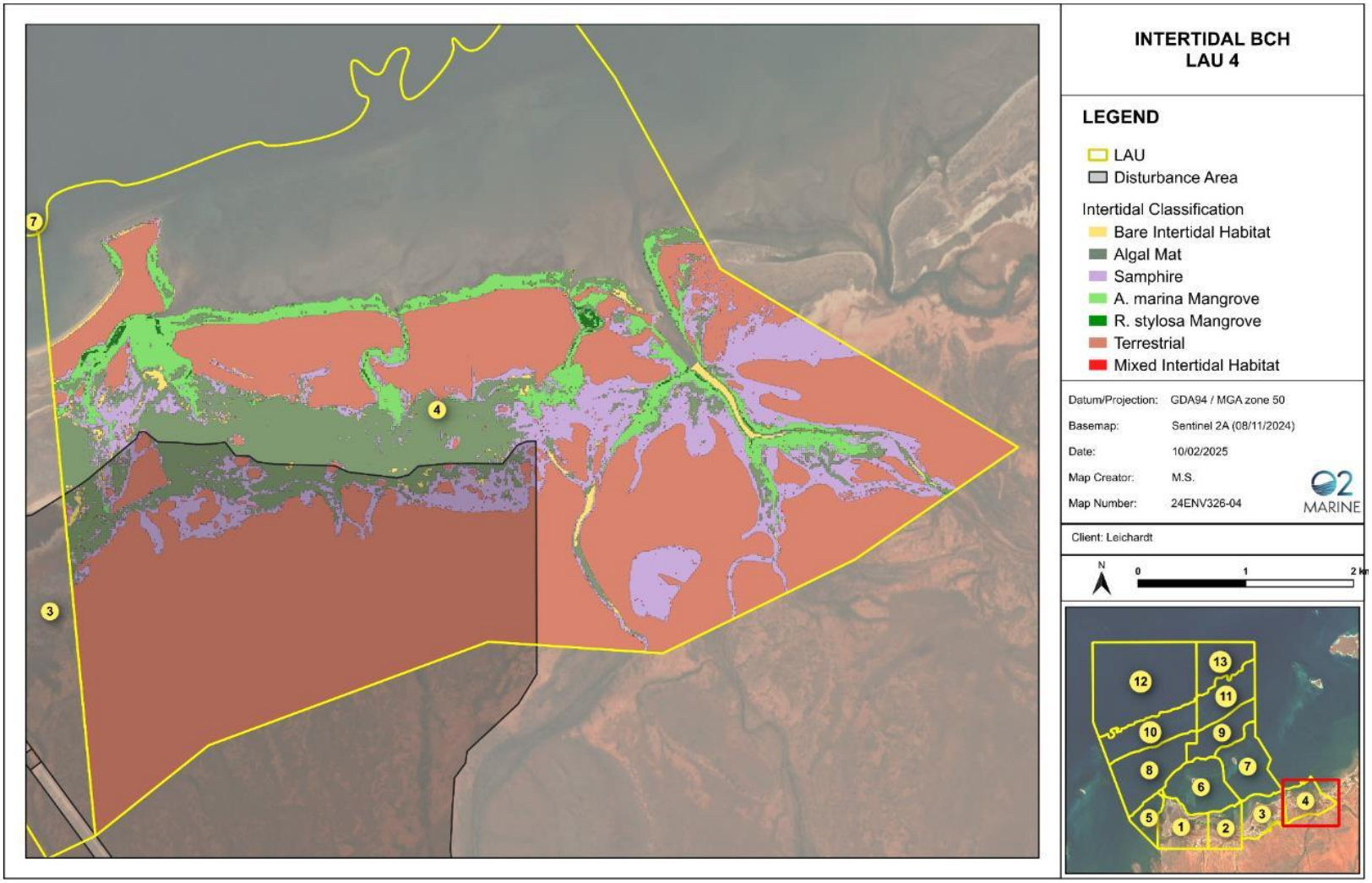



Figure 8-9: BCH and Terrestrial Vegetation identified in LAU4

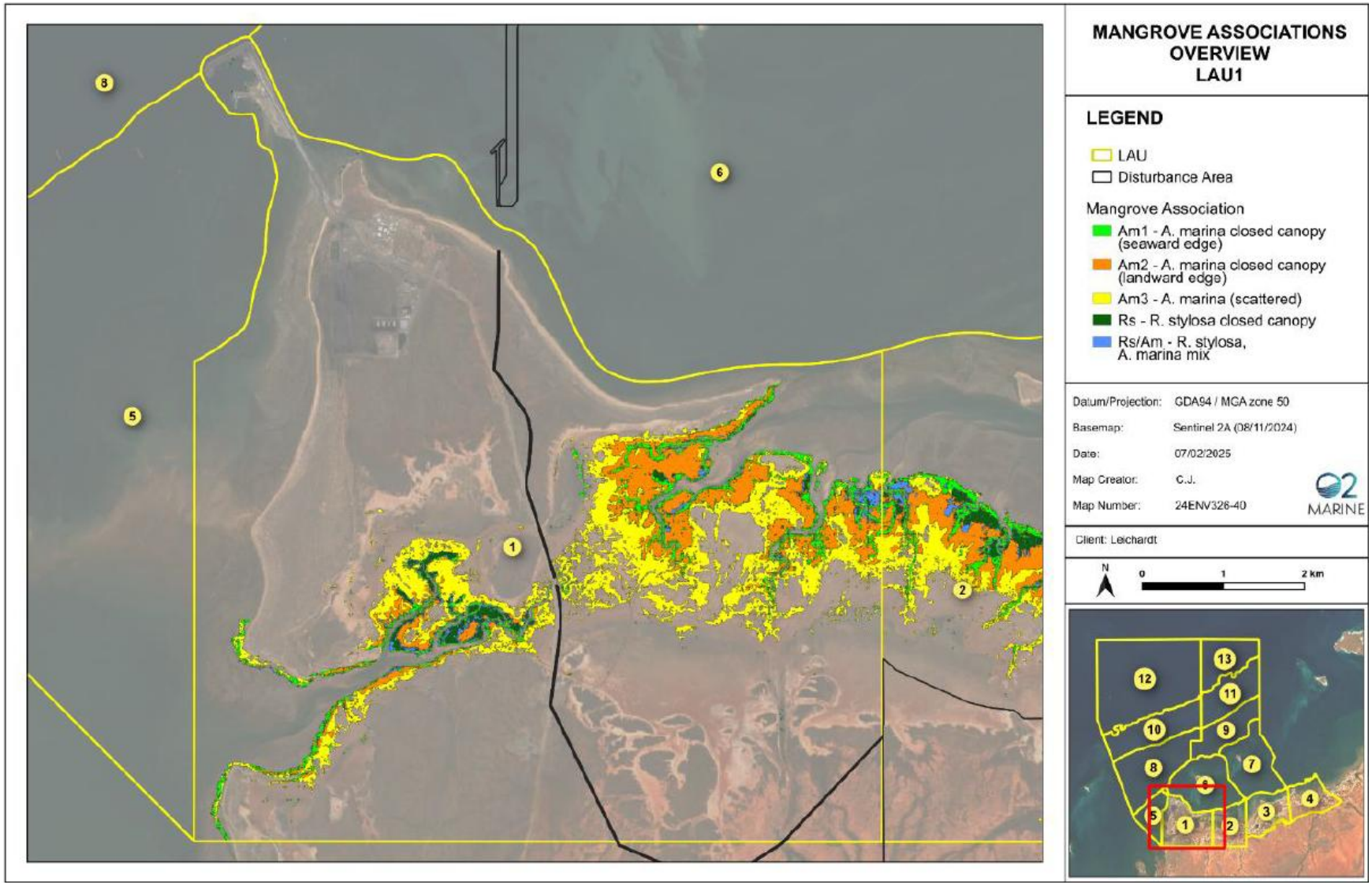



Figure 8-10: Mangrove associations LAU 1 (O2 Marine, 2025c).

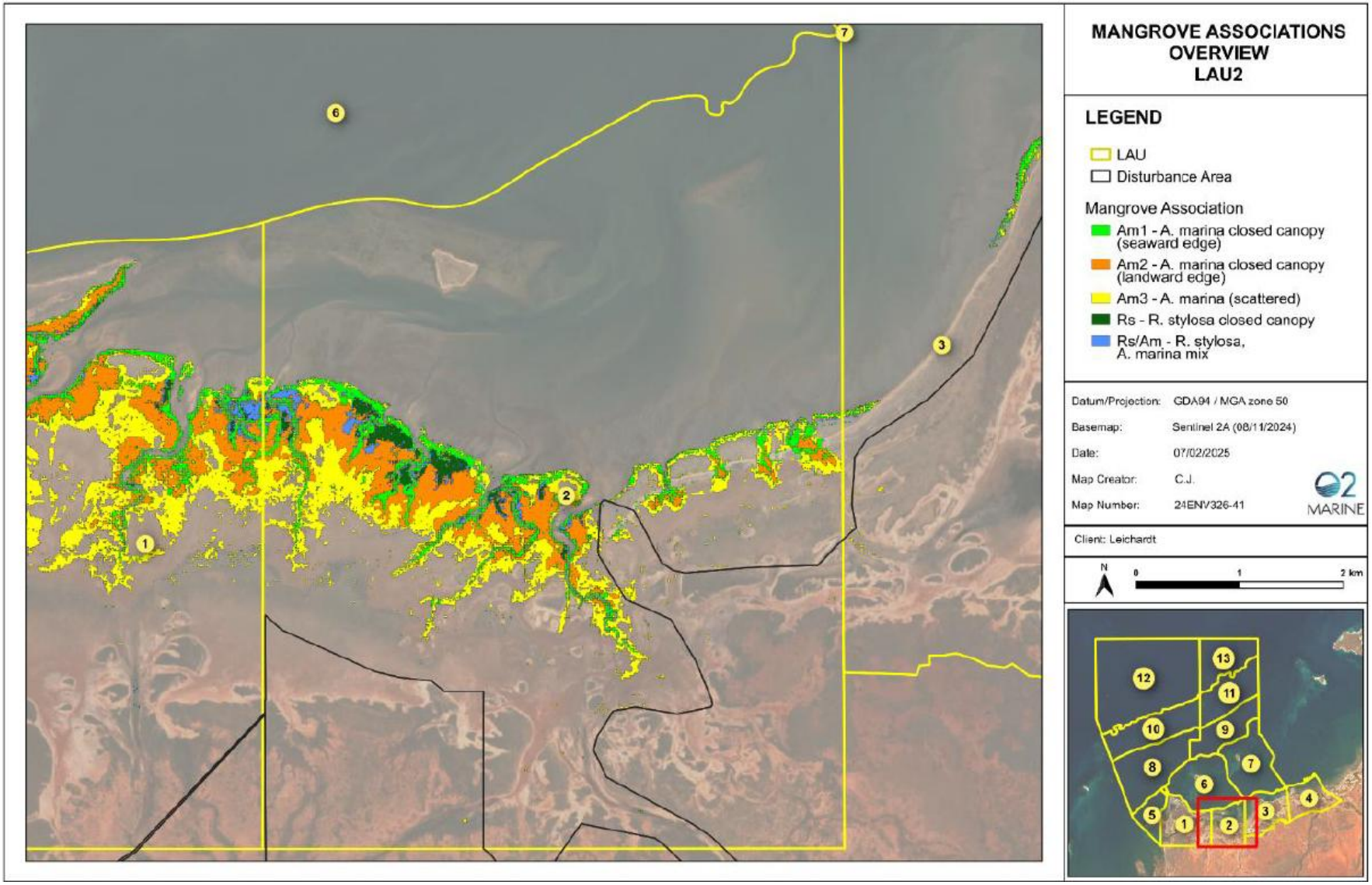



Figure 8-11: Mangrove associations LAU2 (O2 Marine, 2025c).

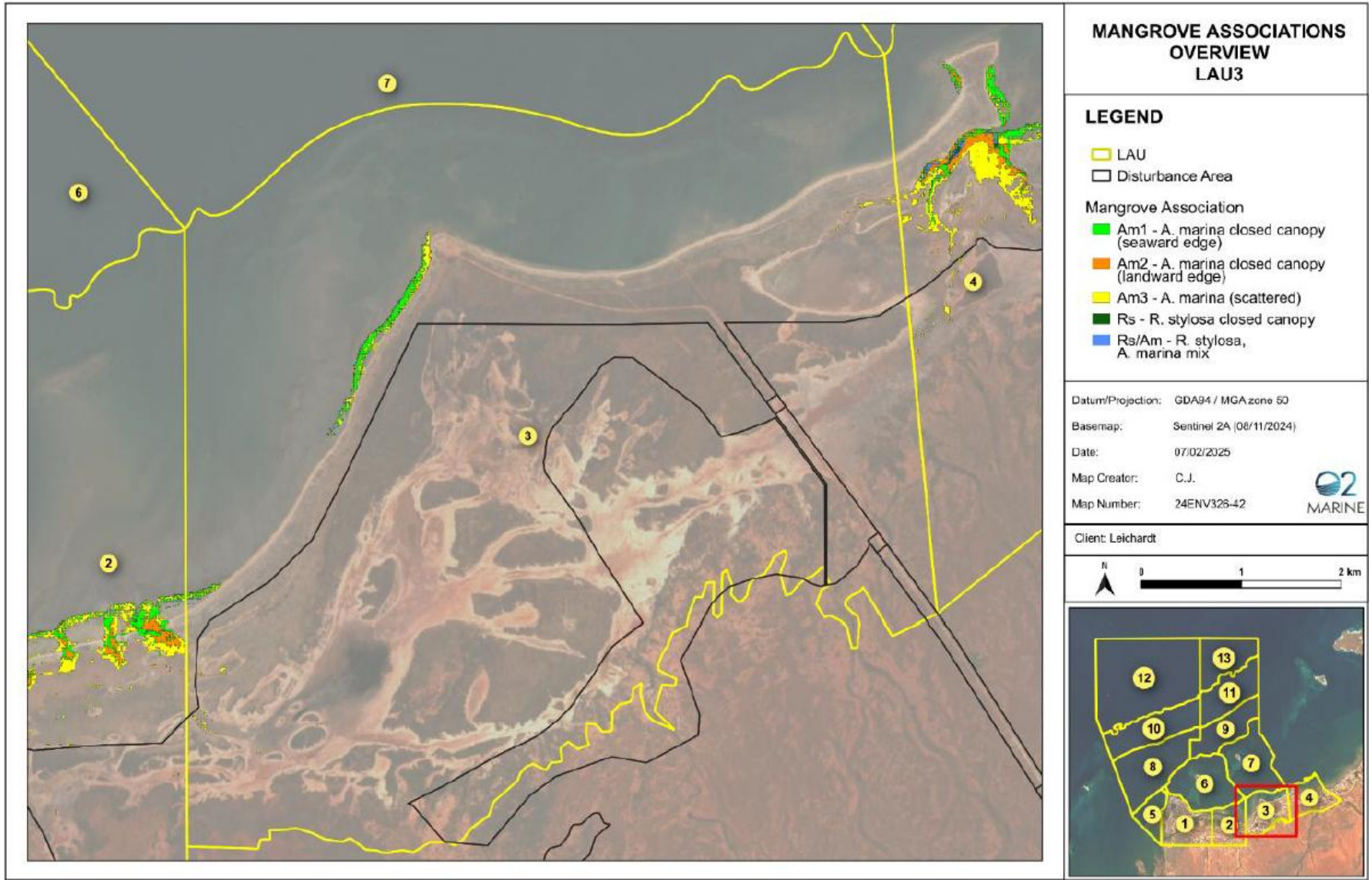



Figure 8-12: Mangrove associations LAU3 (O2 Marine, 2025c).

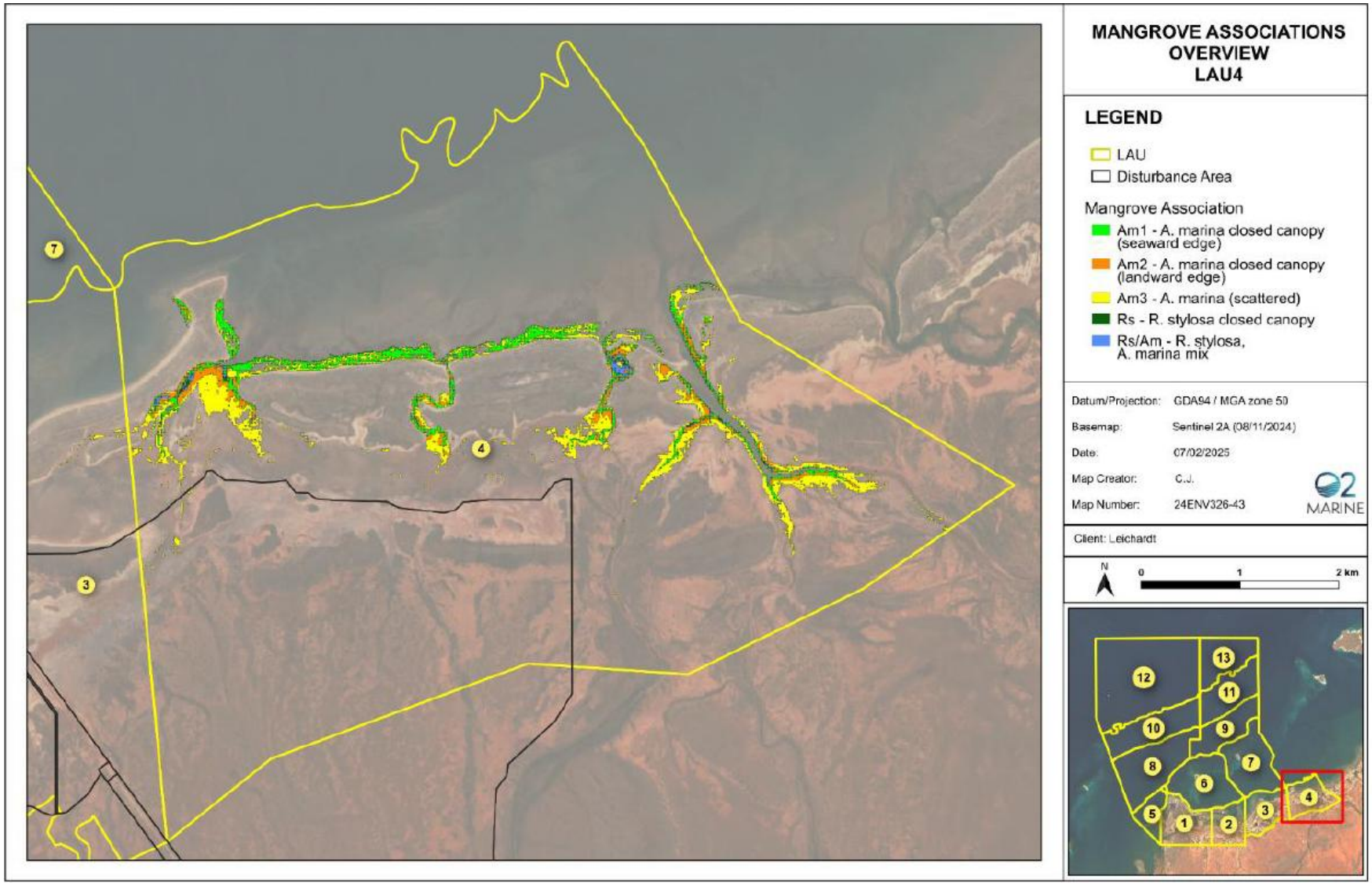
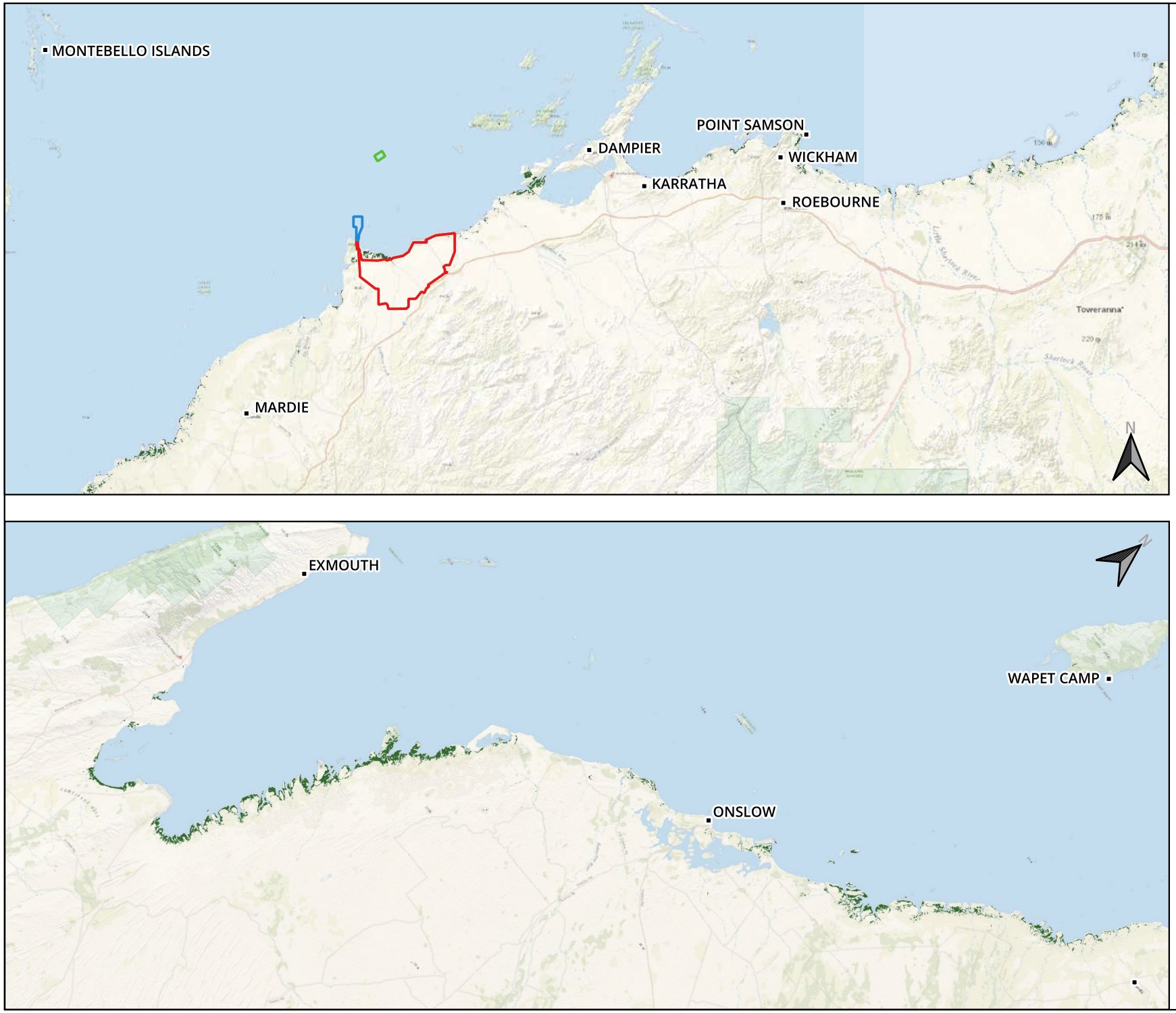



Figure 8-13: Mangrove associations for LAU4 (O2 Marine, 2025c)




Legend

Development Envelopes

DSDDE

Marine Development Envelope

PIDE

Mangroves

Imagery: NatGeo

Preston Consulting

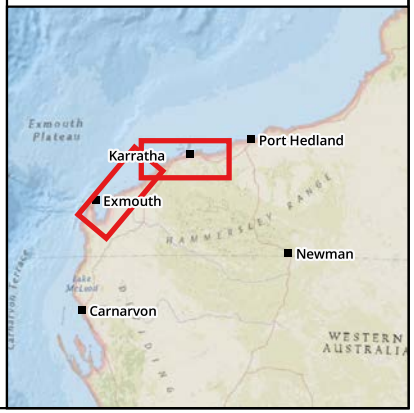
LEICHHARDT

**Figure 8-14: Regional distribution of mangroves (EnSTAR, 2025a)**

GDA 2020 / MGA Zone 50

0 10 20 30 40 km

1:1,150,000 (A4)

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05/07/2023

*Mangrove Biomass*

The positioning of the LAU2 eastern boundary was purposely aligned with the eastern edge of the RSMA #9 boundary. This allowed for the assessment of impacts to BCH within this specialised zone. LAU1 also sits wholly within the bounds of RSMA #9. Much of the mangrove biomass across the study area existed within LAU1 (54%) and LAU2 (30%), most of which was classified as CC mangroves (Table 8-6). Am3 (*A. marina*) dominated the study area, covering the most area within each of the four LAUs. During the field study, *A. marina* trees typically recorded thicker diameter breast height (DBH) readings compared to *R. stylosa*. Less variation was associated with the above-ground biomass recorded for *R. stylosa* trees throughout sites and the highest above-ground biomass was calculated for quadrats containing tall/thick diameter *A. marina* trees, of which LAU1 and LAU2 had the most abundance. *A. marina* trees within LAU4 were seen to be thicker (greater DBH) than the majority of those measured in LAU1 and LAU2 and recorded a higher biomass per hectare (5.3 t/ha). However, due to the notably reduced number of trees, the overall biomass remained well below that recorded in LAU 1 and 2.

Comparison of the functional groups identified in Table 8-6 shows LAU1, LAU2 and LAU4 each recorded a higher proportion of CC mangrove compared to SC mangrove, with 67%, 84% and 73% respectively within each LAU. Within LAU3, results indicated functional groups were reversed in comparison to the three other LAUs, whereby SC (57%) was higher than CC (43%). It is noted that these results may have a level of uncertainty due to the low number of mangroves identified in the LAU3.

**Table 8-6: Mean above ground biomass estimates (tonnes) and percentage for CC and SC mangrove functional groups**

| Mangrove functional group | LAU 1 (t) | LAU 2 (t) | LAU 3 (t) | LAU 4 (t) | Total biomass (t) |
|---|---|---|---|---|---|
| CC | 15,964 (67%) | 10,423 (84%) | 205 (43%) | 3,828 (73%) | **30,215 (73%)** |
| SC | 7,767 (33%) | 1,910 (16%) | 269 (57%) | 1,415 (27%) | **11,092 (27%)** |
| **Total** | **23,731 (58%)** | **12,333 (29%)** | **474 (1%)** | **5,243 (12%)** | **41,307 (100%)** |

*Factors Affecting Mangrove Distribution*

**Salinity Gradient**

The major contributing factor for mangrove distribution is the salinity gradient. Salinity gradients are established through the regularity of tidal inundation of seawater which alters depending upon tidal elevation of the land, typically resulting in lower soil and groundwater salinities at the lower tidal elevations due to increased levels of inundation. Several factors contribute to increasing landward salinities such as reduced tidal inundation (only the spring tides or tidal surges reach these areas), seasonal variation (hot days increase salinity through evapo-concentration), or rainfall (reduces salinity by flushing with freshwater). These salinity gradients are responsible for the variability in mangrove species distribution (a result of differing salt tolerances among species) and mangrove community structure. Of all the mangrove species within the Pilbara, *A. marina* has the widest salt tolerance range and can occur anywhere in the salinity gradient from normal seawater (~53 mS/m) to around 120 mS/m. However, for *A. marina* to thrive and develop into Am1, Am2 or mixed associations (like *R. stylosa*) they require salinities at the lower end of their range.

*R. Stylosa* typically requires salinities around 60 - 80 mS/m, hence they are commonly located within the study area at the seaward margins where regular tidal inundation occurs (often as thin bands along small drainage channels) or occurring with the larger structural forms of *A. marina* (as seen in LAU1).

**Surface and Groundwater Hydrology**

Groundwater or surface water flows can be important pathways for the removal of salt extruded through mangrove roots and the removal of wastes, such as sulphides, methane etc. During extended drought periods, freshwater flows are substantially reduced, resulting in increased salinities, particularly at the higher tidal elevations due to reduced tidal salinity regulation and increased evapo-concentration. The importance of freshwater inputs in maintaining mangrove systems typically decreases with increasing aridity. This is particularly relevant within the Pilbara region as rainfall is highly sporadic and often extended periods of drought are experienced. The Pilbara region is known to support the most arid mangrove assemblages within Australia.

Freshwater flows may also provide nutrient inputs, however this is highly dependent upon local climatology and season. A study within Exmouth Gulf concluded that the influence of freshwater inputs to the regulation of salinity, nutrient flows and removal of wastes was negligible due to the high evaporation rate, limited catchment area, low rainfall, and lack of perennial rainfall. The similarities between the study area and Exmouth Gulf in terms of mangrove associations, climate and catchment characteristics suggest that the maintenance of mangrove associations is similarly not reliant on substantial freshwater inputs unlike mangrove associations on coastlines further north in Australia, where seasonal rainfall is both higher and more reliable. The densest aggregation of drainage channels and associated tidal creeks were found in LAU1 and LAU2 (and to a lesser extent in LAU4) where episodic freshwater and tidal flows have carved a series of winding drainage channels, through which frequent tidal inundation occurs, ultimately providing a variety of habitats supporting the most ecologically significant mangroves within the study area.

*Ecological Significance*

The mangrove habitats assessed within the study area were found to be commonly distributed throughout the wider Pilbara region, with many having distributions either within the Australian tropics or internationally. Many species identified during the assessment are also typically found within a broader geographical distribution. Of particular significance within the study area are the regionally significant mangroves within LAU1 and LAU2 and as defined by RSMA #9 (EPA, 2001).

Intertidal BCH, primarily CC mangroves, are well understood to play key roles in primary and secondary productivity, and nutrient and carbon cycling in coastal environments. Intertidal BCH provide varying levels of organic matter in the form of vegetative litter and are active sinks for dissolved nitrogen, phosphorus, carbon and silicon. Detritus serves as an important nutrient source and forms the basis of an extensive coastal food web. In addition, 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, Above Ground Biomass (AGB) and their spatial distributions. This presents the case that the seaward BCH communities (i.e., CC and SC mangroves and seaward mudflats) present, by far, the most ecologically valuable

communities within the study area, particularly the CC mangroves within LAU1 and LAU2 which represent the most valuable BCH within the study area.

Of the nine known species of mangroves from the Pilbara region, this survey identified three of the well-known species distributed across the Pilbara region (*A. marina, R. stylosa* and *C. australis).* The dominant mangrove species *A. marina* is extremely common along the WA coast occurring across the greatest range. Despite being commonly distributed regionally and internationally, the mangroves recorded with LAU1 and LAU2 are classified as regionally significant (EPA, 2001). This classification was assigned largely because of the geographical location of where the mangroves occur.

### *Algal Mats*

*Species Diversity*

Field surveys conducted by O2 Marine (2025c) identified algal communities as either continuous or fragmented and varying in colour between green, to brown or grey depending upon hydration states. Algal mats were noted as being inundated, or recently inundated, during sample collection. Continuous algal mats were described as extensive, thicker (2 - 5 mm) and more cohesive, characterised by a smooth appearance. Several sites were observed where mats have a slightly filamentous appearance. Fragmented algal mats were thinner (1 - 3 mm) and patchier, often appearing pustular.

Laboratory analysis of algal mat samples collected from the study area identified six taxa, dominated by filamentous cyanobacteria *Lyngbya* sp. with *Coleofasciatus chthonoplastes* and *Schizothrix* spp. typically recorded as common. Comparable composition of taxa was identified between contiguous and fragmented communities, and little variation was evident among assemblages across the entire study area. Algal mats were typically associated with a fine clay material overlaying a dark anoxic layer.

Algal mats surveyed were considered representative of algal mat habitats assessed through studies in similar sites within the Pilbara region, including the Mardie coastline (O2 Marine, 2020a), Exmouth Gulf (Biota, 2005) and south of Onslow (Paling, 1990; URS, 2010). Algal mat colour, form and composition are consistent with similar regional Pilbara studies (Paling, 1990; Biota, 2005; URS, 2010; O2 Marine, 2020a). Similar smooth or folded thicker contiguous layers or thinner fragmented appearances were characteristic within algal mat communities studied within the Mardie Project, where recent inundation was observed (O2 Marine, 2020a).

Additional survey samples were examined by Actis Environmental Services (2023) and Actis Consulting Pty Ltd (2023) which found the composition of the mats did not vary from that reported elsewhere such as Exmouth, Dampier and Mardie and there was no evidence of endemic species. The filamentous cyanobacteria were the most dominant group in numbers and biomass. The common genera were *Oscillatoria*, *Coleofasciculus* and *Microcoleus*. Numerous other species were noted but in much lesser numbers. Algae in the form of diatoms were counted but only represented a minor component of the biomass.

*Distribution*

Benthic mats are typically found in intertidal areas protected from the sea by either dunes or mangroves (Actis Consulting Pty Ltd, 2023). The flats are usually made from alluvial soils formed by sea or terrestrial water flow, where material has become entrapped between the sea fringe and the land. They are typically flat and dry for most times, with occasional flooding from the tide or freshwater flow. The microbial mats are normally a darker colour due to an organic layer and can reach high temperatures (50 degrees Celsius plus) in summertime. Algal mat communities occur over 4,040 ha across LAUs 1 to 4. Algal mats were most abundant by area within LAU1 (1,335.9 ha). LAU2, LAU3 and LAU4 recorded less area of algal mat with 938.1 ha, 949.9 ha and 796.2 ha respectively. The two more active bands of productivity (very active and active) contribute to 52% of the productivity within the LAUs, while the four less active bands of productivity contribute to 48% of productivity within the LAUs. Overall, LAU1 has the highest nett productivity (548.8 t C $yr^{-1}$), followed LAU2 (406.1 t C $yr^{-1}$), LAU3 (305. 8 t C $yr^{-1}$) and LAU3 (192.4 t C $yr^{-1}$).

Microbial mats have a similar composition to biofilms and are made up primarily of species from the Kingdoms of Bacteria and Archaea but with the occasional species from the Kingdom of Protista (algae, mostly diatoms). All these organisms can be collectively described as microbes. Algae are not the dominant group in biomass or function.

Microbial mats are important areas for several reasons. They serve as areas for wading birds to feed and rest (particularly at high tide and stormy weather), biomass storage, biodiversity conservation, nutrient transfer between the land and ocean and to stabilise what would be mobile alluvial material if it were not covered by a mat.

EnSTaR (2025b) conducted an assessment of satellite data to predict the regional extent of algal mats (Figure 8-15). Algal mats were predicted to have a regional extent of 41,574 ha. The remote sensing included a representative distinction between high and low productivity.

*Factors Affecting Algal Mat Distribution*

The tidal movement of seawater is the main wetting event with the hydroperiod, or time that a site is flooded, being a major factor for the abundance of a benthic mat (Actis Consulting Pty Ltd, 2023). The two most obvious factors that may influence the location of the more active mats are location within the tidal range (AHD) and distance that the tidal water needs to transverse or de facto delay effect. The two key parameters for defining where a mat may be found was tidal height and distance from tidal creeks.

Mats with a high Chlorophyll-a were found over a very small range of 40 cm and this is comparable to other work in the Pilbara region. The relationship between Chlorophyll-a and AHD held, independent of wetting and desiccation, and only varied with magnitude of the amount of Chlorophyll-a per area. There were no significant microbial mats beyond 1,700 m from the nearest tidal creek (Actis Consulting Pty Ltd, 2023). Distance and elevation explained the majority, but not all, of the variation between algal mats and therefore it is likely that there are other contributing factors. Many of the high chlorophyll results were in shallow basins within the landscape particularly in scoured areas from runoff events. If these samples were removed from the analysis then the relationship of distance from mangroves and AHD was a better fit. These samples were captured at a later stage as manual corrections (basins) to the map.

The typical concentration of Chlorophyll-a was also very low at a distance less than 175 m and greater than 2,000 m from a tidal source. Anecdotally the low concentration of Chlorophyll-a near the tidal creeks is due to velocity of tidal water and ploughing activity of animals (fish and invertebrates) close to the creeks (Actis Consulting Pty Ltd, 2023).

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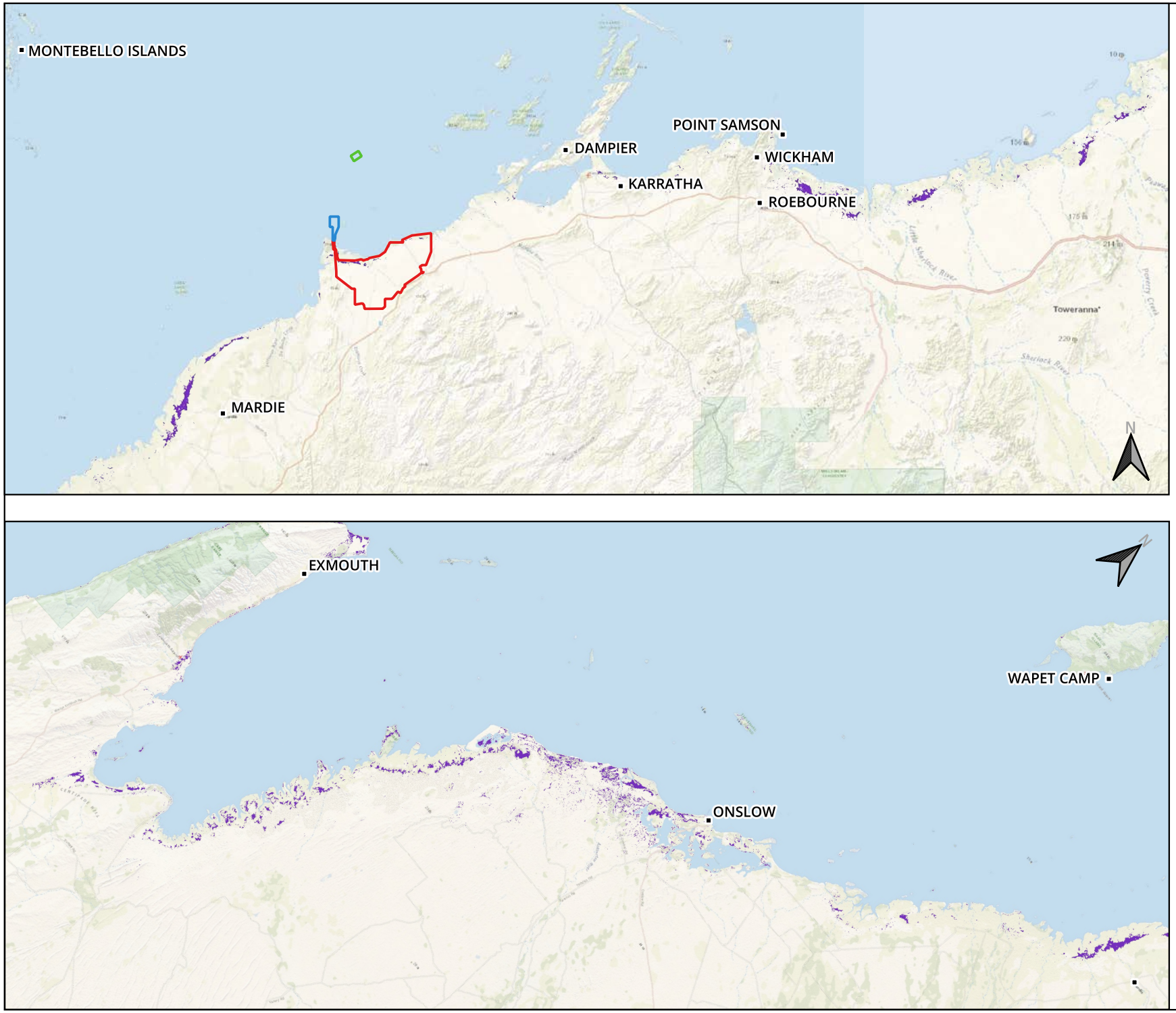


## Legend

Development Envelopes

- DSDDE
- Marine Development Envelope
- PIDE
- Algal Mat

Imagery: NatGeo

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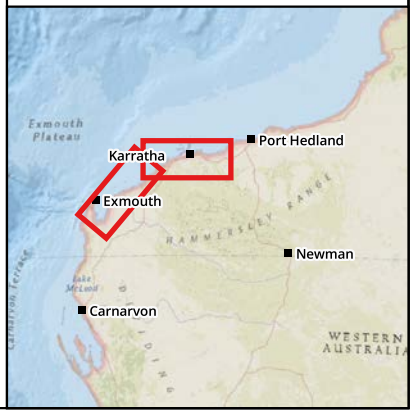
**Figure 8-15: Regional extent of algal mats**

GDA 2020 / MGA Zone 50

0 10 20 30 40 km

1:1,150,000 (A4)

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05/07/2023

***Mangrove and Algal Mat Productivity***

*Mangrove Communities*

Mangrove communities are recognised as highly productive ecosystems that provide large quantities of organic matter to adjacent coastal waters in the form of detritus and live animals. Recent research has identified primary productivity of tropical mangroves as rivalling those of tropical terrestrial forests. Mangrove leaves and wood consist mainly of lignocellulose components that are degradable by microorganisms. Degradation of fallen mangrove vegetation starts immediately after its colonisation by fungi and bacteria, and may last for 2 – 6 months, or more for degradation of the wood. The degradation of mangrove vegetative material produces detritus, which is rich in energy and contains a large active microbial population. As well as being an important food source, Boto & Bunt (1981) estimated that up to 46% of the primary productivity of an Australian mangrove ecosystem was exported to coastal waters through tidal movement as particulate organic matter.

The main sources of primary productivity are the seaward CC mangrove associations as these were calculated to have the greatest biomass per hectare of all habitat types within the study area, and therefore represent the highest ecologically valuable habitat within the study area.

Primary productivity within mangrove habitats is not just limited to the mangrove trees themselves. Many studies have also investigated the microbial activity of associated soils. Soils in which mangroves grow are typically composed of thick organic matter mixed with sediment, are anaerobic except for the sediment surface, and support highly productive microphytobenthos which fix significant amounts of nitrogen. The higher the AGB associated with the mangrove community, the higher the associated microbial activity. Therefore, with AGB related to nutrient export, the CC mangroves also support a far greater net primary productivity through associated microbial activity. Whilst the predominately cyanobacterial algal mat communities may form a higher standing biomass, the cyanobacterial communities associated with CC mangroves are likely to be higher in primary productivity (non-seasonal). Due to lower associated soil salinities, the cyanobacterial communities associated with CC mangroves also support significant secondary productivity (grazing by primary heterotrophs) and therefore play a more valuable ecological function within the system.

Other primary producer sources occurring within mangrove communities are epiflora and bacteria residing on vegetation or detritus and tidal phytoplankton imported from coastal waters. The magnitude of organic matter exported from mangrove areas depends on the biomass and extent of the mangrove ecosystem, the frequency and duration of tides, the size of the draining channel(s), the frequency and magnitude of rains, and the inflow of freshwater. In the Pilbara, the main export mechanisms are essentially tidal movements due to low rainfall.

*Nitrogen-fixing Cyanobacteria (Algal Mats)*

Generally, the algal mats provide a backwater where material is transferred from overland flows (rare in arid zones) and tidal flux (Actis Consulting Pty Ltd, 2023). The organisms in the mat accumulate biomass in situ and generate mass by fixing nitrogen and carbon dioxide. Of specific interest is the movement of nutrients from the algal mats into the near shore environment. Carbon and phosphate are readily available from the air and river flows respectively.

Although nitrogen makes up the bulk of air and is readily available as a gas, it is not readily available in a form useful for photosynthesising plants. Nitrogen needs to be 'fixed' into a more reactive form such as $NH_4^+$, $NO_2^-$ or $NO_3^-$. Once fixed it can then be incorporated into organic material (TOC) such as proteins.

The 'fixing' is nearly always done by microbes that commonly inhabit anerobic environments. More recently it has been shown that unicellular microbes can fix nitrogen in apparent aerobic environments but the opportunity and energy cycle restrictions suggest the more anaerobic layers would be more successful in fixing nitrogen. Algal mats are not the only marine environment that fixes nitrogen and others of note are deep oceans, sediments generally, but specifically seagrass meadows, and cyanobacteria plankton. Most marine sediments aerated by animals do not form a stable anerobic mud.

Paling (1986) speculated that loss of nutrients from the algal mats to other environments may occur when desiccated mat portions are carried by wind and by leaching and showed loss of nitrate from mat sections exposed to freshwater, indicating that rainfall may be significant in contributing to nutrient loss.

Paling & McComb (1994) found that small scale trials (leaching) with excised mats exported nutrients. However, in the trials with large scale enclosures and mats in situ, the export of nutrients still occurred but the variation was greater than net export. The average for five tidal cycles was slightly less than 15 $mg.^{m-2}$. Most of the N was in the form of organic N. It is not clear if it is water soluble organic nitrogen or insoluble organic nitrogen.

Joye & Paerl (1993) found that coastal intertidal mats had $N_2$ fixing rates of 3 mmol N $m^{-2}d^{-1}$ before runoff, using acetylene reduction to determine enzyme activity. After runoff occurred, they found that the $N_2$ fixing decreased and approached zero with denitrification increasing rapidly. Their model to explain the change was that organic carbon required for denitrification increased with runoff. There was no direct explanation of the decrease in nitrogen fixing other than there was a change in mat N cycling.

Adame et al. (2012) provide data for in situ nitrogen exchange from a microbial mat in Exmouth Gulf. They focussed on exchange of soluble nitrogen species (not organic N) in tidal creeks and isolation chambers. The tidal experiment was from brine above the benthic microbial mat during a spring tide. They showed that the mats were net removers of soluble nitrogen. In addition to the soluble nitrogen species, the mats fixed nitrogen (acetylene) and the nitrogen fixing was a significate part of the nitrogen cycle. The $N_2$ fixing accounted for 1.7 nmol N $cm^{-2}h^{-1}$ and the mat absorbed 3.2 nmol N $cm^{-2}h^{-1}$.

The evidence from the literature is that benthic microbial mats actively accumulate nitrogen from soluble N in the flood water and fix $N_2$ within the mat. The mats do not generally release soluble N to the near shore environment. There is evidence that organic N is exported but the variation over time is significant. Preliminary work at the Proposal is consistent with these findings of low soluble nitrogen exports from the tidal flats.

O2 Marine undertook a similar 'Nutrient Flux' study in 2021, with the purpose to obtain quantitative data to determine the ecological significance and regional importance of algal mats with respect to nutrient export into the intertidal and nearshore subtidal system at the Proposal (O2 Marine 2025g).

The difference was the assessment of change in relation to regular tidal inundation, rather than freshwater flow events as per Burford et al. (2012). Overall, the results were inconclusive, with no significant change in nutrient levels able to be associated solely to spring tidal exchange. The small changes that were recorded in nutrient levels, were on a tide to tide, and site to site basis, suggesting that the intra site variability in nutrients (temporal and spatial) may be greater than nutrient changes due to spring tides flowing over algal mats.

O2 Marine segregated water quality data by site, only presenting the results and statistical analysis for replicate samples at Site CA locations (CA1, CA2 and CA3, Figure 8-16)(O2 Marine, 2025g). Data collected from Site CA is most likely to record differences in nutrient concentrations as a result of tidal algal mat inundation (compared to Sites CB and CC). The analysis confirms that overall, there was no significant increase in nutrient concentration resulting from tidal algal mat inundation. Of the 27 significance tests, only one result indicated a significantly higher concentration during the spring ebb tide when compared to a neap ebb tide: Reactive P at location CA1. Results were variable among locations, tide direction and tide cycles, with no consistent patterns identified overall. This assessment reinforces the conclusion that the nutrient concentrations in the nearshore areas were not significantly higher following algal mat inundation, and thus did not contribute to nutrient cycling in nearshore waters and only small differences over tidal cycles. The nutrient flux study is included in Appendix D of O2 Marine (2025c).

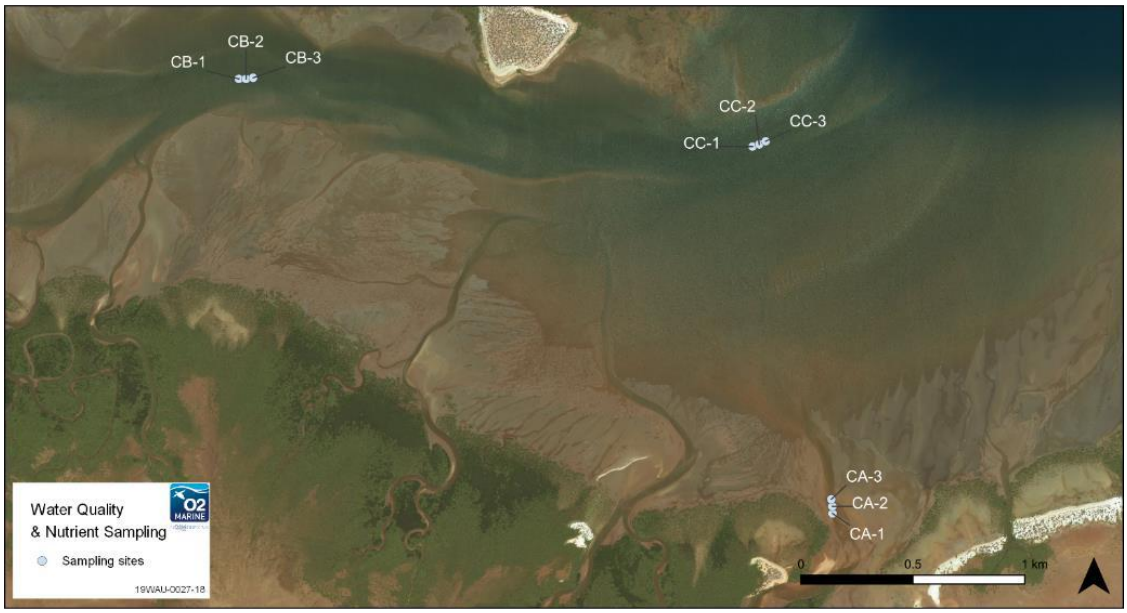



Figure 8-16: Tidal nutrient sampling locations

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.' In terms of supported heterotroph biomass, algal mats provide these opportunistic grazers with supplementary primary productivity sources and do not solely support them unlike the mangroves or samphire BCH. 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). However, attribution of the cyanobacterial 'mats' as the likely source of the cyanobacterial carbon is problematic (Penrose, 2011), 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 of the grazers, such as molluscs, crustaceans and especially polychaetes (osmoconformers) which have limited tolerances of high salinities. It appears that Penrose (2011) employs a much broader definition of cyanobacterial mats and includes areas much lower in the tidal zone which are classified by O2 Marine (2025c) as other habitat types.

*Nutrient Pathways*

Whilst primary productivity within mangroves is widely understood and investigated, there is limited understanding of the direct pathways between BCH and the primary productivity associated with algal mats. Some areas of the mudflat/algal mat setting of the study area have similar characteristics to that identified within the Mardie Project study area, located approximately 50 km to the southwest. Both areas have extensive mudflat/algal mat areas located in flat, low-lying depression areas behind the mangrove communities, however the extent of these depressions are greater at Mardie. During incoming tides (>1.2 m), oceanic water flows up through tidal creeks flooding the flat areas, with some water being retained for a period after the flooding. The areas of algal mats fill and drain in line with the tidal flows with some water remaining in depressions either evaporating, resulting in the high salinities which characterise this BCH, or migrating into the groundwater.

During heavy rainfall, associated with low-pressure systems, the surrounding catchments may fill and begin to flow through drainage channels into the study area. Depending upon which catchment, these flows are primarily directed straight through natural drainage channels and tidal creeks into coastal waters (Cooglegong Creek in LAU4), however small, localised catchments discharge across the flats where algal mats occur and may be retained in minor depressions .

Most of the mudflat falls towards the mangrove fringe and the depressions do not form a large part of the algal mats (Actis Consulting Pty Ltd, 2023). The portion of water trapped within these depressions (whether oceanic or fresh) is only able to exit via groundwater or evaporation and any associated dissolved nutrients remain in the system unless stormwater or storm surges are significant enough to promote mobilisation.

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.





*Biomass and Primary Productivity*

**Mangroves**

Across the study area, there is a dominant seaward to landward trend, whereby BCH with the highest AGB occurs along the seaward edge and typically decreases between BCH type, as the increasing stress of higher salinities support reducing AGB until the BCH becomes salt flats whereby no organisms are supported. AGB is directly related to productivity, and where there is higher AGB, net productivity is also at its highest, along with all the ancillary benefits these BCH provide such as erosion protection, shelter and refuge, food, nursery and breeding habitats.

Along the seaward edge, CC mangrove communities represent the highest AGB across all BCH types. These communities support complex communities and regulate nutrient and carbon cycles which support wider coastal food webs. CC communities are also the most structurally complex and robust, resulting in the delivery of a wide range of ecological functions that the remaining BCH types do not provide. CC mangroves support a range of marine invertebrate and vertebrate communities, which utilise the mangroves during high tides for breeding, feeding, shelter, hunting, or as nursery areas for juvenile stages. Mangrove communities are also known to support a wide range of terrestrial vertebrates, particularly shoreline birds, that lower biomass BCH types do not.

As the seaward communities become more scattered, less structurally complex and support lower AGB, the range of ecological functions they provide also reduces. The ecological functionality decreases from CC to SC mangroves. Samphire shrubland represent a further reduction in functional ecology, which continues the downward trend through mudflats, algal mats and finally the salt flats which support few or no organisms and/or provide negligible productivity to surrounding BCH.

**Algal Mats**

Chlorophyll-a has been identified as a useful indicator of primary production. Algal mat samples were tested for levels of chlorophyll-a to assess the distribution of productive algal mats within the LAUs (Actis Consulting Pty Ltd, 2023).

The most important aspect of a mat is its productivity and its potential to support the nutrient requirements of the near shore environment by exporting biomass. Productivity can only be measured in situ and the procedure limits the number of sites and times that it can be measured. Chlorophyll-a is a factor of productivity but it cannot be used as a direct measure. There are several other factors that will influence the productivity. These include available sunlight, nutrients and not being desiccated. However, if certain assumptions are made, it is possible to compare areas to make relative comparisons between potential productivity using only Chlorophyll-a. These assumptions include the same incidental light across the mat and relative efficiencies of converting light energy to productivity in the relative monoculture. This can be further refined by estimating time wet and not desiccated, and resting productivity.

Samples were categorised based on four different categories as outlined in Table 8-7. Samples in the nearshore environment were considered more important due to the greater potential to export biomass. The coverage of mats within the LAUs is outlined in Table 8-8 and shown in Figure 8-17.

Table 8-7: Algal mat types based on chlorophyll-a

| Algal Mat Type | Chlorophyll-a ($mg.m^{-2}$) |
|---|---|
| Very Active | >300 |
| Active | 151 - 300 |
| Limited Activity | 51 - 150 |
| Low Activity | 0 - 50 |

Table 8-8: Area (ha) within broad chlorophyll-a zones

| Category | Chlorophyll-a ($mg.m^{-2}$) | Description | LAU1 | LAU2 | LAU3 | LAU4 | Subtotal |
|---|---|---|---|---|---|---|---|
| 6 | > 300 | Very active mat 301+ $mg/m^2$ | 61.28 | 37.37 | 24.47 | 35.54 | 159 |
| 5 | 151-300 | Active mat 151-300 $mg/m^2$ | 225.27 | 227.43 | 53.45 | 116.44 | 623 |
| 4 | 51-150 | Limited activity far 51-150 $mg/m^2$ | 88.64 | 97.54 | 134.10 | 64.14 | 384 |
| 3 | 51-150 | Limited activity near 51-150 $mg/m^2$ | 91.57 | 78.43 | 10.18 | 57.49 | 238 |
| 2 | 0-50 | Low far 0-50 $mg/m^2$ | 331.63 | 207.65 | 703.46 | 227.35 | 1,470 |
| 1 | 0-50 | Low near 0-50 $mg/m^2$ | 557.51 | 289.72 | 24.24 | 295.22 | 1,167 |
| | | **Total** | **1,355.90** | **938.14** | **949.89** | **796.16** | **4,040** |

*Alignment with O2 Marine Mapping*

The algal mat mapping completed by O2 Marine (2025c) was completed at a much finer scale in comparison to the EnSTaR remote sensing mapping and therefore there are some noticeable differences in the mapped extents. In contrast, the Actis Environmental mapping was based on extensive ground truthing. However, the extent of higher productivity areas mapped by Actis Environmental (Categories 3 – 6) and EnSTaR (Active and Limited) generally align with the extent of the HDAM and LDAM mapped by O2 Marine (2025c; Figure 8-18 and Figure 8-19). Similarly, the extent of the lower productivity algal mats (Category 1 and 2) generally align with the samphire / algal mat areas mapped by O2 Marine (2025c; Figure 8-19).

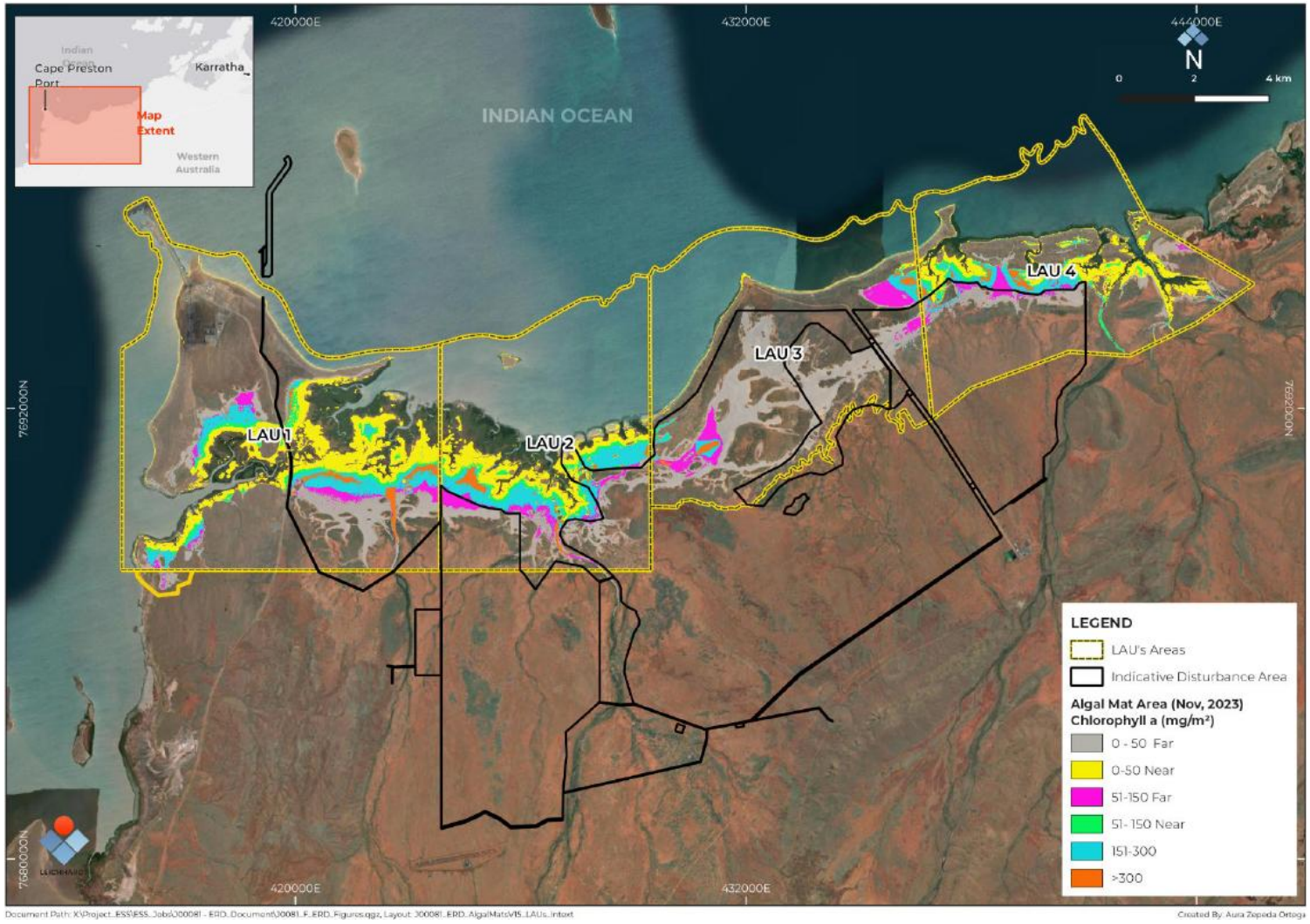
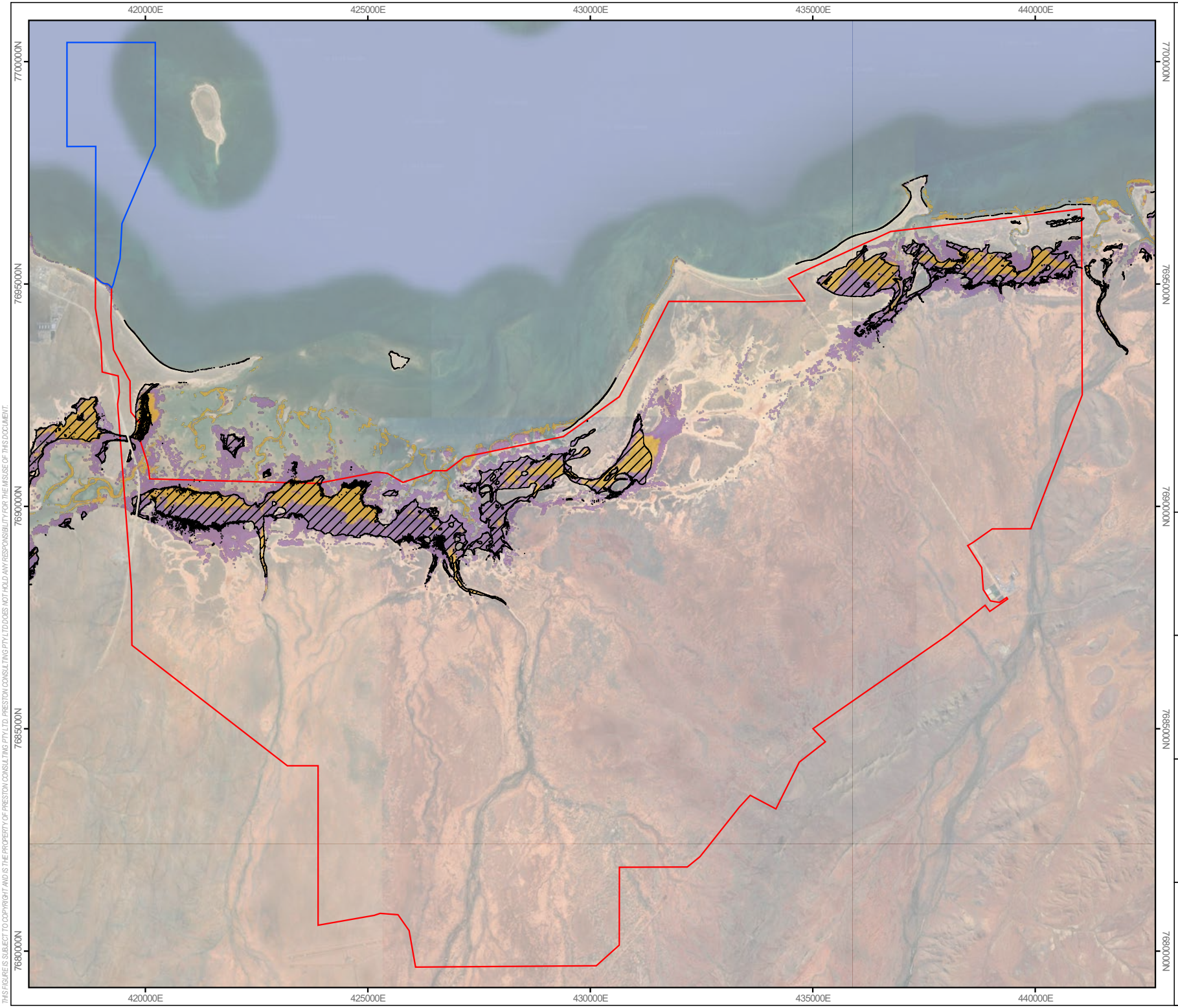



Figure 8-17: Algal mat distribution separated by productivity categories




## Legend

- Pond and Infrastructure Development Envelope
- Marine Development

Envelope Actis Consulting (2024)

- Productive Algal Mats

O2Marine (2025)

- HDAM
- LDAM

Imagery: Google Satellite

N

0 1 2 km

GDA2020 / MGA zone 50

1:110,000

Project: LEI_0535_022
Date: 14/03/2025
Size: A4
Author: ASmithers (Preston Consulting Pty Ltd)

**Figure 8-18: Comparison of high productivity algal mats (Category 3-6) (Actis Environmental) and HDAM/LDAM (O2 Marine, 2025c)**

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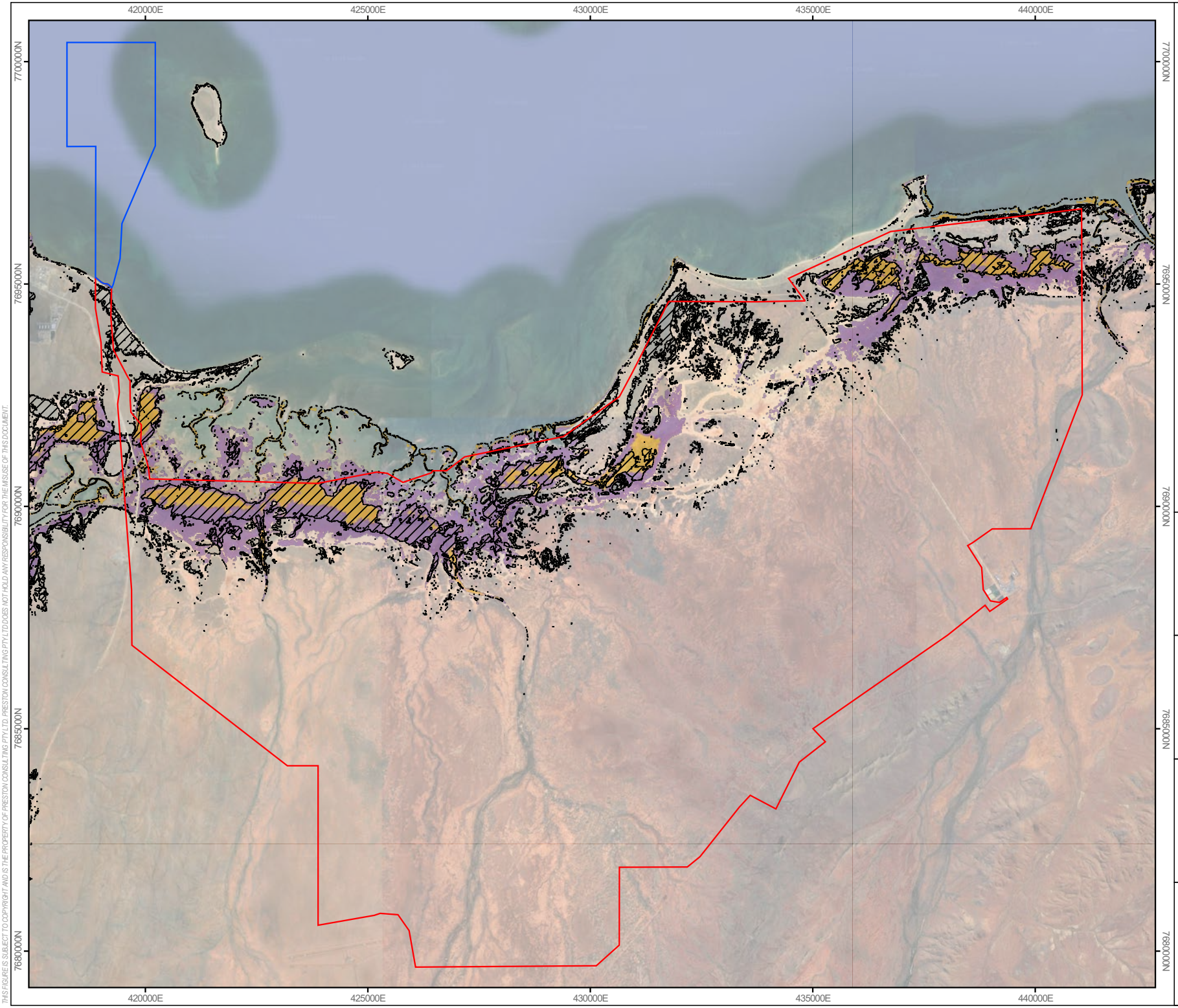


## Legend

- Pond and Infrastructure Development Envelope
- Marine Development Envelope

EnSTAR (2025)

- Productive Algal Mats (Remote Sensing)

O2Marine (2025)

- HDAM
- LDAM

Imagery: Google Satellite

N

0 1 2 km

GDA2020 / MGA zone 50

1:110,000

Project: LEI_0535_023
Date: 14/03/2025
Size: A4
Author: ASmithers (Preston Consulting Pty Ltd)

**Figure 8-19: Comparison of Active/limited activity algal mats (EnSTaR) and HDAM/ LDAM (O2 Marine, 2025c)**

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***Samphire Shrubland***

Samphire shrubland was distributed over 1,216 ha (6.8%) of the study area (O2 Marine, 2025c). This assumes that 50% of the 'samphire shrubland inclusive of algal mat habitat' BCH types are samphire shrubland. Samphire shrublands were generally found to be the most landward intertidal BCH, often found between inland mudflats and terrestrial vegetation. A portion LAU1 had samphire shrubland backing directly onto mangrove BCH.

The areas of samphire shrublands within LAU1, LAU2 and LAU4 were comparable, recording 280.6 ha, 213.9 ha and 272.3 ha respectively. LAU3 recorded slightly more with 450.1 ha. Notably, samphire shrublands were observed to be in close proximity to the upper creek branches in LAU4. Similar distributions were not observed in creeks located in LAU1 and LAU2. Further discussion on the functional ecology, regional significance, and species diversity of samphire shrubland is provided within Section 11.7 and Appendix 5.1 (Phoenix, 2025).

***Mudflats***

Mudflats across the study area ranged from the spring low tide mark, landward to the spring high tide mark. Mudflats were typically located immediately adjacent (both seaward and landward) of mangrove communities and generally have 'Terrestrial Vegetation' as the landward limit. A total of 2, 261.3 ha of mudflat was identified, making up 1.5% of the intertidal study area.

The most continuous and extensive mudflat areas within the study area exist seaward of mangrove or beach/foredunes, extending out towards the intertidal macroalgae/seagrass/rock platform communities. LAU1 contained the largest area of mudflat with 102.2 ha. Mudflat areas were notably lower within LAU3 and LAU4 with areas of 54.6 ha and 36.9 ha respectively. Large sections of the seaward mudflat areas have a regular exposed/inundated cycle as a result of daily tidal movement. These areas were generally classified as flat, fine sand with shell, and are predominantly devoid of biotic cover except for the occasional macroalgae and crab burrows.

Mudflats on the landward side of the mangrove BCH were found to contain less sand and have more clay properties, where shells and organic debris were commonly interspersed on the surface. These areas (particularly towards the Terrestrial Vegetation edge) have longer atmospheric exposure periods, with inundation only occurring at spring high tides.

### 8.3.4 Subtidal Benthic Communities and Habitats

Information in this section has been sourced from O2 Marine (2025d; Appendix 3.3) unless stated otherwise.

***Summary***

The subtidal BCH survey (O2 Marine, 2025d) identified six broad BCH classes, distinguished based on varying levels of benthic cover and dominant taxa. The BCH classes are described in detail in Table 8-9 and mapped in Figure 8-20.

Surveys were undertaken and a map of the distribution of key BCH was prepared. The Regnard Bay and CPE area forms a wide, shallow embayment bordered to the west by Cape Preston, and to the north by South West and North East Regnard Islands.

Due to tidal flow and minor platform reef development, the seabed of the bay has developed a complex topography, showing evidence of tidal scour, reef accumulation (around South West Regnard Island), and unstable tidal sand banks in the east.

The mapping undertaken as part of the O2 Marine (2025d) study has, in general, shown that the BCH of the CPE vicinity analogous to those found across the inner continental shelf of the Pilbara. The distribution of BCH is complex, due to the highly varied substrate that comprises areas of bare sediment, low relief limestone with sand veneer, and outcropping rocky structures and islands. In the CPE area, as is common elsewhere, bare sediment dominates, with patches of sessile organisms occurring where the geomorphic and oceanographic conditions allow.

**Table 8-9: Description of broad subtidal BCH classes mapped within Proposal LAUs**

| BCH Classification | | Description | Area (ha)/% of LAUs |
|---|---|---|---|
| Unvegetated Sediment | | Bare, undifferentiated sediment with no apparent structure or minor ripple features/ bioturbation. Sparse (<3%) to no biota. | 56,104.6/69.4% |
| Hard Coral Dominated Habitat | Coral and Macroalgae | Coral reef dominated substrate, with high structural complexity and live coral. High cover of red/brown/green algae of varied proportions. | 3,806.5/4.7% |
| Filter Feeders Dominated Habitat | Sparse Filter Feeders | Varied non-hard coral filter feeders on a sand/ silt substrate. Substrate is unconsolidated or semi-consolidated (pavement with veneer). Assemblages dominated by combinations of sponges, ascidians, bryozoans, soft corals or molluscs. | 15,484.7/19.2% |
| | Filter Feeders on Low Relief Reef | Varied non-hard coral filter feeders on a consolidated (low relief reef) or semi-consolidated (pavement with veneer) substrate. Assemblages dominated by combination sponges, ascidians, bryozoans and soft corals. Macroalgae is also prevalent. | |
| | *Pinna bicolor* beds | Benthic habitats dominated by the high density of the razor clam; *Pinna bicolor* on a sand/ silt substrate. Substrate is unconsolidated or semi consolidated (pavement with veneer). | |
| Macroalgae Dominated Habitat | | Macroalgae-dominated vegetation on sediment or pavement substrate. Including sparse assemblages of seagrass or filter feeders. | 2,066.5/2.6% |
| Habitat with Seagrass Present | Low Density Seagrass | Low (3-10%) to medium (10-25%) density of seagrass on a mostly sand or silty substrate, including potential minor ripple features/bioturbation. | 2,441.3/3.0% |
| Mixed Habitat | | Habitat with no dominant biota. May include varied compositions of filter feeders, macroalgae and seagrass. | 923.5/1.1% |

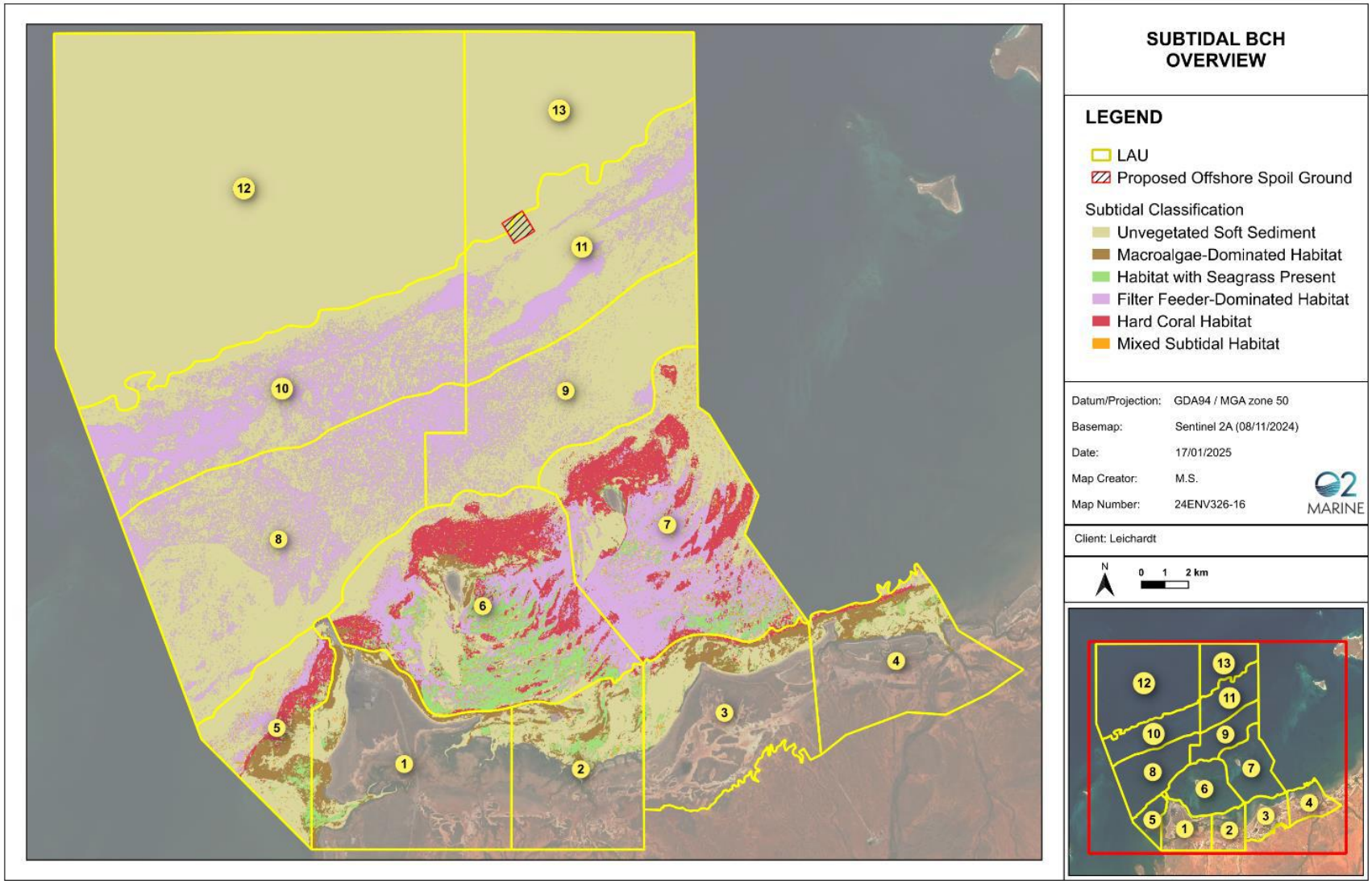



Figure 8-20: Subtidal BCH within the LAUs (O2 Marine, 2025d)

### *Bare Sand and Silt Habitat*

The dominant BCH that occurs in the Pilbara subtidal zone is bare sediment, typically dominated by coarse calcium carbonate silty sands. This habitat type has been identified as the most common type in the study area.

In this assessment, a gradual change was found from coarser sediments in the west through to finer silts in the east, which are associated with tidal sediment movement. Silty sands closer to the shore have previously been found to support a lower density of sessile invertebrates compared to coarser sands, although are typically more bioturbated, which is a trend noted elsewhere in the Pilbara. It is common for even the barest sandy areas in the Pilbara to harbour small patches of mixed filter feeders, some of which were identified in the disposal ground assessments.

There are three key sub-classifications of sediment types:

- Intertidal Sandy Muds, found in nearshore areas subject to tidal influences, supporting microphytobenthic algae and contributing to local productivity;
- Muddy sand, bare, predominantly in the eastern parts of the Proposal, associated with tidal sediment deposition and reduced hydrodynamic energy; and
- Coarse sand and shell fragments, dominating the mid-shelf and offshore zones, with minimal colonisation by sessile organisms due to high levels of sediment movement.

Bare sediment is typically afforded the lowest level of protection, given its prevalence in most marine environments and its limited contribution to primary production and three-dimensional structure on the seabed. This type of BCH does, however, support microphytobenthic algal communities and sometimes diverse benthic infauna depending on depth and other environmental variables. This environment, particularly where coarse well-sorted sediments dominate, is likely to experience high levels of disturbance due to wave, current and cyclone action, and therefore often does not provide good habitat for slower growing colonising sessile organisms.

### *Macroalgae*

As they require light for photosynthesis, macroalgal communities are restricted to areas where depth and turbidity levels are tolerable. Due to the shallow nature of the inshore Pilbara continental shelf, the limiting factor becomes turbidity and suspended sediment. Macroalgae also require a hard substrate on which to attach. In the Pilbara environment, this is less of a limitation due to the tendency for cementation of sediments and the prevalence of limestone reef/pavement which occur from the intertidal zone out to the continental shelf break.

Field data confirms the distribution of macroalgal habitats across LAUs 1 - 6, highlighting their association with rocky reef platforms and low-relief limestone substrates. Furthermore, ground truth data demonstrated that that dense macroalgae is dominated by brown algae (*Sargassum* spp.) in shallow, well-lit areas. Smaller components of green algae (*Caulerpa* sp., *Halimeda* sp.) and red algae (*Rhodophyta*) contribute to assemblage complexity, though their distribution and densities appear more limited.

Macroalgal habitats occur in distinct bands, particularly in shallow waters adjacent to 40-Mile Beach and between South West and North East Regnard Islands. These areas also appear to support sparse colonies of hard coral and filter feeder habitat.

Macroalgae contribute to the productivity of marine ecosystems as they are a photosynthetic primary producer that provide an important habitat for invertebrates, fish and birds, an important food source and a source of decomposition products. However, macroalgae differ from other marine plants such as seagrasses and mangroves in that macroalgae lack roots, leafy shoots, flowers, and vascular tissues. Additionally, some algae are important sediment producers (such as *Halimeda* and also contribute towards the cementation and binding of materials with calcium carbonate (e.g., the Rhodophyta), thereby creating habitats for other organisms.

***Seagrasses***

Seagrasses, comprising few species at relatively low coverage proportions, are mostly found in the protected inshore regions of Regnard Bay, occurring in three distinct subcategories based on density and associated biotic communities:

- Sand with dense ephemeral seagrass, sparse filter feeders, predominantly found in LAUs 1, 2, 5, and 6;
- Sand with dense mixed macroalgae and sparse seagrass, observed in LAUs 1, 2, and 5; and
- Sand with sparse ephemeral seagrass and mixed macroalgae, distributed more broadly across LAUs 1 to 6.

Seagrass habitats appear to be primarily concentrated in shallow waters less than 5 m below LAT, with notable coverage in LAU 6 (1,446 ha, 18%), followed by LAU 7 (399 ha, 5%) and LAU 2 (225 ha, 14%). Smaller patches are present in LAUs 3 and 4. Mapping highlights the presence of seagrass communities along the shoreline between Cape Preston and Gnoorea Point and between South West Regnard Island and Cape Preston.

The densities of seagrasses found in the current investigation are consistent with observations across the Pilbara. Coverage proportions rarely exceeded 5%, which aligns with regional trends (generally 10 - 15 %) where dense seagrass meadows are uncommon compared to southern Australian waters. No significant areas of seagrass were observed further offshore.

***Filter Feeders***

Marine habitats on the continental shelf of the Pilbara are often characterised by filter feeder communities dominated by a highly diverse assemblage of sponges, ascidians and other organisms. These communities create three-dimensional structure on the seabed that provides suitable habitat for a range of other organisms. Filter feeder communities dominate in areas where there is suitable substrate for attachment, and waters are too turbid or deep for significant competition from other communities (e.g., macroalgae). These habitats are often associated with limestone veneer and ancient shoreline deposits which can provide a great deal of hard substrate for attachment, however, can also occur in small patches. These substrates are ubiquitous in the Pilbara and therefore filter feeders can cover large tracts of marine habitats.

There are three specific subcategories within filter feeder habitats:

- *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;
- Sand veener with dense filter feeders: occurring where a thin layer of sand overlays hard substrates, supporting dense assemblages of sponges, ascidians, and other filter feeders; and
- Sand with sparse filter feeders: identified in areas with minimal substrate complexity, often transitional zones between bare sediment and more structured habitats.

Ecologically, filter feeders such as sponges can significantly influence water quality and substrate conditions and provide nutrition and vital habitat for many other organisms. Sponges are efficient filter feeders and play a critical role in linking the pelagic environment to the benthos through nutrient cycling and are increasingly recognised as key contributors to ecosystem services (O2 Marine, 2025d).

***Corals***

The coral habitats of Cape Preston and Regnard Bay appear distributed across multiple LAUs, with notable densities in LAUs 5, 6, 7, and 9 and additional occurrences in LAUs 1, 2, 3, and 4.

The mapping identifies three subcategories of coral habitat within the study area:

- Dense hard coral and macroalgae reef: found extensively in LAUs 6,7 and 9 with isolated patches also present in LAUs 2 and 3. These habitats are dominated by significant coral cover interspersed with macroalgae;
- Dense macroalgae and hard coral reef: appears concentrated in LAUs 6, 7 and parts of 9, with smaller areas in LAU 4. These habitats occur in transitional zones with a higher proportion of macroalgae relative to coral cover; and
- Rock veneer with sparse mixed macroalgae and hard coral: observed in LAUs 5, 6, 7 and 9, with smaller patched in LAUs 1, 2 and 4. These habitats feature sparse coral growth mixed with ephemeral biota such as macroalgae. They were commonly found on shallow rock outcrops and sand veneer, particularly in more turbid areas.

Corals were not found in muddier areas of the inner bay, with the exception of a narrow band of low-cover, inshore corals identified within LAU 7. The highest coral densities were observed on the reef platform surrounding South West Regnard Island, particularly in LAUs 6 and 7, as well as in isolated patch reefs in LAU 5. These areas exemplify developing coral reef platforms likely formed from slow-growing and sediment-tolerant species. As noted by WorleyParsons (2009a, b), such reefs showcase the resilience of coral species adapted to high sedimentation and low growth rates.

Smaller patches of coral habitat in LAUs 1, 2, 3, and 4 were found on nearshore limestone pavements, rocky substrates, and mixed communities. These habitats, though less extensive, enhance ecological connectivity and contribute to the overall biodiversity of the area.

***Benthic Community and Habitat Health***

*Status of seagrasses in Regnard Bay*

O2 Marine (2025d) recorded a general decrease of seagrass cover at most monitoring sites in the period between 2020 and 2021. This may be a reflection of seasonal changes in abundance. However, longer-term decline, or decline related to other environmental factors, cannot be ruled out.

A total of seven seagrass species have been described throughout the Pilbara, and subregional areas with five species previously considered as having relatively high species richness (e.g., Exmouth Gulf). Various species of seagrass were identified in the study area, including three species of *Halophila* (*decipiens*, *ovalis* and *spinulosa*), *Cymodocea* sp., *Halodule* sp., and *Syringodium* sp. As a comparison, only two species were identified in the Mardie Project area (*Halophila ovalis* and *Halodule* sp.) and one species was recorded at Cape Preston Island. Furthermore, other nearby studies have described seagrasses as being of low importance in the area. Due to the qualitative and low-resolution nature of many of the previous studies, it is highly likely that many of those studies did not capture the full range of species. This, and the ephemeral nature of seagrasses in the Pilbara, suggests that the seagrasses of Regnard Bay are probably representative of many other parts of the Pilbara coast.

*Status of Corals in Regnard Bay*

The proportion of hard corals across the five coral sites surveyed recorded cover ranging from 3.3 - 38.8%. Highest cover was recorded adjacent to South West Regnard Island. This proportion generally decreases moving inshore into more turbid waters. Previous studies have determined that over 50 coral species may be found in the vicinity of Cape Preston, with over 360 species known across the broader Pilbara bioregion (Campey & Gilmour, 2000). Each of the coral communities surveyed were distinctive among sites.

LeProvost (2008) identified three regionally significant coral communities in the vicinity of Cape Preston, with >50% cover and in parts up to 100% live coral cover, comprised primarily of large colonies of massive species such as *Porites*, *Favites*, *Lobophylia* and *Goniastrea*. These major reefs were located:

- Approximately 3 – 5 km to the southwest of Cape Preston;
- 4 km to the east-northeast of Cape Preston on the south-east end of South West Regnard Island; and
- 5 km east of Cape Preston.

A survey of five coral communities within the CPE area was undertaken by GHD in 2012 (GHD, 2013b), which included two regionally significant reefs to the east of Cape Preston. Repeat monitoring of these same survey sites in 2020 and 2021 within the O2 Marine (2025d) study indicated the reefs were largely dominated by the same coral types almost a decade later. However, the Faviid-dominated community recorded in 2012 at site three (close to South West Regnard Island) has increased in macroalgae cover, which is now also dominant. Additionally, the mixed 2012 community of site four (adjacent to the Cape Preston rock wall) was more recently seen to be dominated by Acroporidae. The proportion of hard coral was observed to decline from 2020 to 2021 at several sites. This was replaced by a relative increase in turf algal cover (as described above).

The reasons behind these changes are likely complex, although the observed trends are likely attributable to recent impacts from tropical cyclone Damien, which made landfall as a strong Category three severe tropical cyclone over the Dampier/Karratha region on 8 February 2020. In addition, marine heatwave conditions were also recorded in summer 2021 associated with a La Niña event which places thermal stress and causes bleaching of coral communities. Therefore, any reduction in health measures of the reefs since 2012 may be a function of shorter-term climatic conditions rather than permanent shift.

Campey & Gilmour (2000) identified an additional strip of coral reef with high cover and diversity on the steep slope that runs along the north side of Preston Island. This prompted conditions in MS 635 for the Sino Iron Project relevant to avoiding significant damage to this small community of coral reef. However, subsequent surveys undertaken by URS (2008) determined that this site had been wiped out by cyclone damage and no longer existed. The site was later buried beneath the causeway of the Cape Preston Port.

Most corals observed in the area were in a good health during surveys in 2020 and 2021, and no obvious indicators of coral stress were recorded (e.g., bleaching, sediment smothering, disease, predation, mucous production). This is probably attributable to the fact that many of the species present are sediment tolerant, and non-tolerant species were mostly absent.

### 8.3.5 Environmental Values

Based on the information provided in this section, the following environmental values were determined to require assessment for this factor:

- General intertidal BCH;
- Mangrove BCH;
- Algal mat BCH;
- Samphire shrublands habitat; and
- General subtidal BCH.

## 8.4 Potential Impacts

Table 8-10 defines the potential impacts (direct, indirect and combined) on the environmental values for this factor in a local and regional context. These impacts are informed by the results of detailed BCH studies described in Section 8.3 and provided in Appendix 3.1.

Table 8-10: Potential impacts on BCH

| Environmental value and current extent | Potential direct impact | Potential indirect impact | Local impacts associated with other proposals | Combined local impact (Proposal + others) |
|---|---|---|---|---|
| **General intertidal BCH**<br>Seven broad intertidal BCH classes recorded within LAU 1 – 4. | • Up to 1,175.1 ha of intertidal BCH to be irreversibly disturbed. | • Introduction of marine pests;<br>• Indirect impacts associated with changes to water quality, including:<br>o Increased sedimentation resulting in settlement and smothering of habitat;<br>o Alteration to surface water regimes;<br>o Changes to the dynamics of nutrient flows and budgets;<br>o Leaks or spills of hydrocarbons or chemicals;<br>o Leaks or spillages of hypersaline brine; and<br>o Potential movement of hypersaline groundwater as a result of hydrostatic pressure of the brine in the salt ponds. | The Cape Preston and CPE Ports occur within LAU1, resulting in 3.2 ha of intertidal BCH loss. | 1,178.3 ha of intertidal BCH loss.<br>Potential indirect impacts associated with changes to water quality and the risk of introducing marine pests. |
| **Mangrove BCH**<br>1,381 ha recorded across the LAUs, including:<br>• 756.8 ha in LAU 1;<br>• 412.8 ha in LAU 2;<br>• 18.4 ha in LAU 3; and<br>• 193.4 ha in LAU 4. | Up to 8.3 ha of disturbance. | As above. | No other proposals occur within the LAUs that have mangrove disturbance. | Up to 8.3 ha of total cumulative disturbance.<br>Some potential indirect impacts. |
| **Algal mat BCH**<br>3,354 ha recorded across the LAUs, including:<br>• 1,128 ha in LAU 1;<br>• 844 ha in LAU 2;<br>• 738 ha in LAU 3; and<br>• 651 ha in LAU 4. | Up to 611.0 ha (87.3 ha of which is HDAM) of disturbance, consisting of:<br>• 0 ha in LAU 1;<br>• 139.7 ha in LAU 2;<br>• 345.05 ha in LAU 3; and<br>• 126.0 ha in LAU 4. | As above. | No algal mat disturbance is known to occur from other proposals within LAU 1. | Up to 611.0 ha (87.3 ha of which is HDAM) of total cumulative disturbance including up to:<br>• 0ha in LAU 1;<br>• 139.7 ha in LAU 2;<br>• 345.05 ha in LAU 3; and<br>• 126.0 ha in LAU 4<br>Some potential indirect impacts. |





| Environmental value and current extent | Potential direct impact | Potential indirect impact | Local impacts associated with other proposals | Combined local impact (Proposal + others) |
|---|---|---|---|---|
| **Samphire shrublands BCH**<br>1,197 ha recorded across the LAUs, including:<br>• 311 ha in LAU 1;<br>• 227 ha in LAU 2;<br>• 387 ha in LAU 3; and<br>• 272 ha in LAU 4. | Up to 480.7 ha of disturbance, consisting of:<br>• 112.4 ha in LAU 2;<br>• 301.3 ha in LAU 3; and<br>• 67.0 ha in LAU 4. | As above. | No samphire shrublands disturbance is known to occur from other proposals within LAU 1. | Up to 480.7 ha of disturbance including up to:<br>• 112.4 ha in LAU 2;<br>• 301.3 ha in LAU 3; and<br>• 67.0 ha in LAU 4.<br>Some potential indirect impacts |
| **General subtidal BCH**<br>Includes:<br>23,799.1 ha of BCH mapped across LAUs 5-13 (excluding bare sediment) including:<br>• 15,484.7 ha of filter feeder dominated habitat;<br>• 3,806.5 ha of hard coral habitat;<br>• 2,066.5 ha of macroalgae-dominated habitat; and<br>• 2,441.3 ha of habitat with seagrass present. | Up to 47 ha of BCH disturbance consisting of:<br>• 26.5 ha of filter feeders dominated habitat;<br>• 12.5 ha of *Pinna bicolor* beds;<br>• 3.8 ha of hard coral habitat;<br>• 3.7 ha of seagrass with macroalgae;<br>• 0.4 ha of seagrass with filter feeders; and<br>• 0.1 ha of macroalgae-dominated habitat.<br>Up to 100 ha of bare 'unvegetated' substrate will also be directly impacted. | • Introduction of marine pests;<br>• Indirect impacts associated with changes to water quality, including:<br>o Increased sedimentation resulting in settlement and smothering of habitat;<br>o Leaks or spills of hydrocarbons or chemicals; and<br>o Bitterns disposal (salinity) at discharge location. | No other proposals occur within the sub-tidal LAUs. | Up to 47 ha of disturbance to vegetated habitats including up to:<br>• 26.5 ha of filter feeders dominated habitat;<br>• 12.5 ha of *Pinna bicolor* beds;<br>• 3.8 ha of hard coral habitat;<br>• 3.7 ha of seagrass with macroalgae;<br>• 0.4 ha of seagrass with filter feeders; and<br>• 0.1 ha of macroalgae-dominated habitat. |

# 8.5 ASSESSMENT OF IMPACTS

## 8.5.1 GENERAL INTERTIDAL BENTHIC COMMUNITIES AND HABITAT

### *Direct Disturbance*

The Proposal will result in the direct disturbance of up to 1,175.1 ha of intertidal BCH (Figure 8-21). There are several items of note during this assessment:

- The disturbance is to occur within a largely uncleared landscape as all intertidal BCH mapped during this assessment currently have at least 81% of their pre-European extent remaining (O2 Marine, 2025c); and





- The BCH generally represents widespread communities and is well represented with many having distributions either within the Australian tropics or internationally.

Table 8-11 shows the maximum amount of each intertidal BCH that is expected to be irreversibly disturbed to implement the Proposal, and the percentage of the total mapped across LAU 1-4.

**Table 8-11: Intertidal BCH irreversible disturbance**

| BCH Class | LAU 1 | LAU 2 | LAU 3 | LAU 4 | Total Disturbed | Percentage of total mapped |
|---|---|---|---|---|---|---|
| A.*marina* Mangrove | - | 6.4 ha (1.7%) | 0.8 ha (4.5%) | 1.1 ha (0.6%) | 8.3 ha | 0.6% |
| *R.stylosa* Mangrove | - | - | - | - | - | - |
| Bare Intertidal Habitat | 0.1 ha (0.1%) | 21.9 ha (32.4%) | 40.9 ha (74.9%) | 4.8 ha (13%) | 67.7 ha | 25.9% |
| Algal Mat | 0.2 ha (0.02%) | 93.6 ha (15.2%) | 221.2 ha (64.2%) | 100.5 ha (26.5%) | 415.5 ha | 19.6% |
| Mixed Intertidal | - | 1.8 ha (30.1%) | 4.7 ha (75.8%) | 1.0 ha (20.4%) | 7.5 ha | 29.2% |
| Samphire incl algal mat (sparse) | - | 80.9 ha (41.7%) | 237.5 ha (63.8%) | 48.5 ha (23.3%) | 366.9 ha | 36.4% |
| Samphire incl algal mat (dense) | - | 11.3 ha (34.2%) | 10.2 ha (69.4%) | 2.5 ha (3.9%) | 24.0 ha | 13.2% |
| Samphire shrublands (sparse) | - | 48.1 ha (70.2%) | 113.2 ha (64%) | 33.8 ha (34.3%) | 195.1 ha | 47.1% |
| Samphire shrublands (dense) | - | 18.2 ha (57.2%) | 64.2 ha (80.6%) | 7.7 ha (20.4%) | 90.1 ha | 13.2% |

Samphire shrublands (sparse) represent the greatest proportional direct loss with 47.1% of the total mapped within the study area to be disturbed. The second greatest loss is samphire shrublands (inclusive of algal mat, sparse) with a loss of 36.4%. Mixed intertidal represent the third greatest loss with an estimated 29.2% loss of the total mapped area. Zero to negligible losses are proposed to occur to *A. marina* and *R. stylosa* mangroves.

The direct loss of BCH has been assessed in context with the local cumulative indirect impacts described in the sections below. This local cumulative assessment is provided as a summary of impacts at the end of this section.

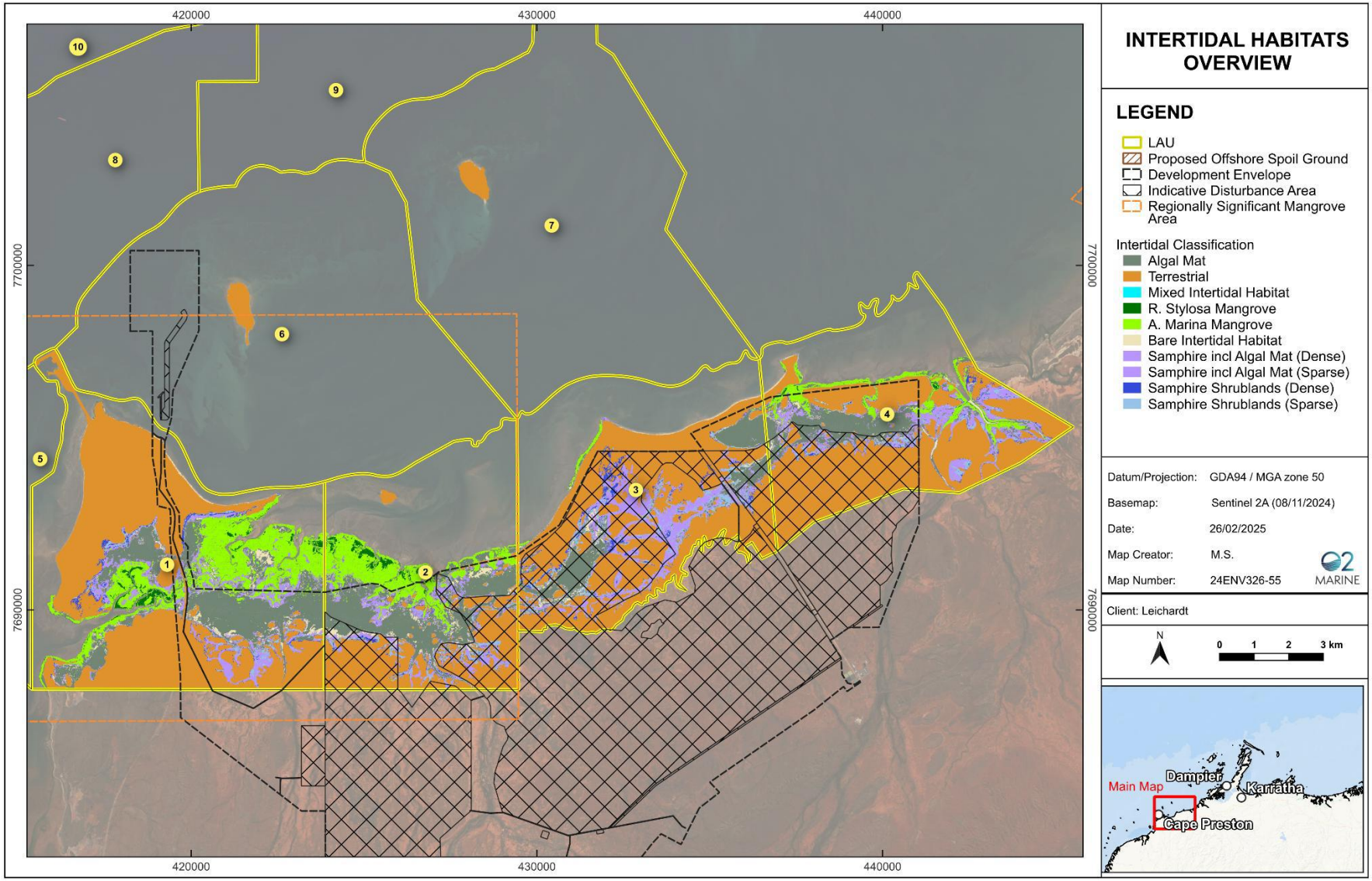



Figure 8-21: Direct impacts on BCH

### *Alteration to overland surface water regimes*

Section 6 describes that the overland flows will be largely diverted through drainage channels along the southern edge of the ponds westward into McKay Creek and eastward into Devil Creek. Any overflow of the drainage diversion channels will flow into the concentration ponds and crystallisers, where sufficient freeboard will be maintained to completely capture these inflow volumes. The Proposal will result in a maximum 17% reduction of freshwater runoff to the marine environment.

SWS concluded that in a 10% AEP event, a maximum depth reduction of 350 mm will be experienced approximately 1.5 km downstream of the ponds, with an overall area of 6.9 km$^2$ experiencing a surface water reduction of more than 10 cm (SWS, 2025). This reduction has the potential to adversely affect the intertidal samphire shrubland and algal mat BCH which occur downstream of the ponds if the BCH relies on this seasonal freshwater inundation and it is completely removed. However, the reliance of this BCH on surface water inundation is not well understood and so the severity of any impacts are unable to be accurately quantified.

Table 8-12 and Figure 8-22 outline the BCH remaining after construction that is at risk of indirect impacts associated with alterations to the surface water regimes. Up to 14.3 ha of the 'at risk' BCH in Table 8-12 is predicted to also be 'at risk' of impacts from groundwater seepage and mounding (detailed in the last column of Table 8-12).

**Table 8-12: Areas of BCH at risk of changes to surface water inundation**

| BCH Type | Was dry now wet (ha) | Was wet now dry (ha) | Total (ha) | Portion of total also 'at risk' from groundwater seepage / mounding (ha) |
|---|---|---|---|---|
| Mangroves | 0.1 | 4.6 | 4.7 | 0.2 |
| HDAM | 0.5 | 3.2 | 3.7 | 0.9 |
| LDAM | 0.3 | 14.1 | 14.4 | 1.6 |
| Samphire incl algal mat (sparse) | 1.1 | 35.0 | 36.1 | 7.6 |
| Samphire incl algal mat (dense) | - | 1.3 | 1.3 | 0.1 |
| Samphire shrublands (sparse) | 0.4 | 9.1 | 9.5 | 2.6 |
| Samphire shrublands (dense) | 0.2 | 1.9 | 2.1 | 0.1 |
| TOTAL | 2.6 | 69.2 | 71.8 | 14.3 |

Despite the limited area (i.e., 6.9 km$^2$) of BCH affected by a changed surface regime, the overall reduction in flow by up to 17% is likely to result in some changes to the overall health of the intertidal system. It is likely that with concentration of flow through McKay Creek that this area may see some improvement in ecosystem health of mangrove and samphire communities, whereas other areas where flow is reduced may see a decline in health of these communities.

However, there is a high degree of uncertainty surrounding the reliance of intertidal BCH on freshwater flows, particularly regarding how severe a change in surface water hydrology regime needs to be to affect the existing BCH. Nevertheless, given that the overall flow reduction (i.e., 17%) is within the natural variability range for rainfall in the area, it is considered likely that a decline in health would not be significant.

***Introduced Marine Pests***

Technical information in this section has been sourced from MScience (2022; Appendix 3.4) unless stated otherwise.

The Proposal will utilise vessels during dredging operations and marine construction activities that will be brought to Eramurra marine waters from other ports within Australia and overseas. These vessels have the potential to transport IMPs which can potentially impact intertidal BCH (MScience, 2022) if they:

- Out-compete, prey upon, or otherwise displace native species;
- Alter natural ecological and bio-physical processes;
- Act as vectors for pathogens which can impact upon ecological or human health;
- Degrade or cause the collapse of commercial fisheries and aquaculture enterprises, either through direct competition with target species or via the introduction of a pathogen; and
- Cause problems for industrial infrastructure and navigation aids, for example, by blocking seawater intakes/outlets, impairing the operation of undersea valves, or causing buoys to sink, resulting in increased costs associated with cleaning and maintenance.

Transport mechanisms (vectors) have facilitated the translocation of multiple marine pest species and often entire assemblages of tens to hundreds of species between disparate bioregions. Ballast water and biofouling have long been recognised as the vectors most likely to be responsible for marine species invasions. For dredge plant, sediment remaining from previous dredging represents a significant vector if not removed prior to port entry. Currently, DPIRD lists 83 marine species of concern which may be spread by biofouling or ballast water and become potential pests within the marine environment (DPIRD, 2016). The individual IMP(s) must attach to, or be taken in by, the vessel at the location of origin and then survive the journey as a 'passenger' (O2 Marine, 2020b). The survival and translocation risk of the IMP depends on several factors, including:

- Frequency and duration of vessel visits;
- Vessel operating speeds (e.g. stationary or slow- moving vessels in port areas allow fouling pests to attach, while transit times between ports will affect survivorship in ballast water);
- Type of vessel operations (direct contact with seabed brings higher risk);
- Origin location;
- Level of hull biofouling and prevention (anti-fouling coatings);
- Capacity and use of ballast water throughout journey;
- Voyage duration, the length of time species can survive in ballast water;
- Presence and size of internal vessel areas such as sea chests, anchor cable lockers, propeller shafts;
- Inspection of internal areas and treatment systems used; and
- Dry docking - duration since the last dry-docking or removal from the water.

Nodes are the locations from which a potential marine pest is transported. The conditions at the receiving environment are risk factors which can influence the likelihood of IMP's becoming established.

These factors include:

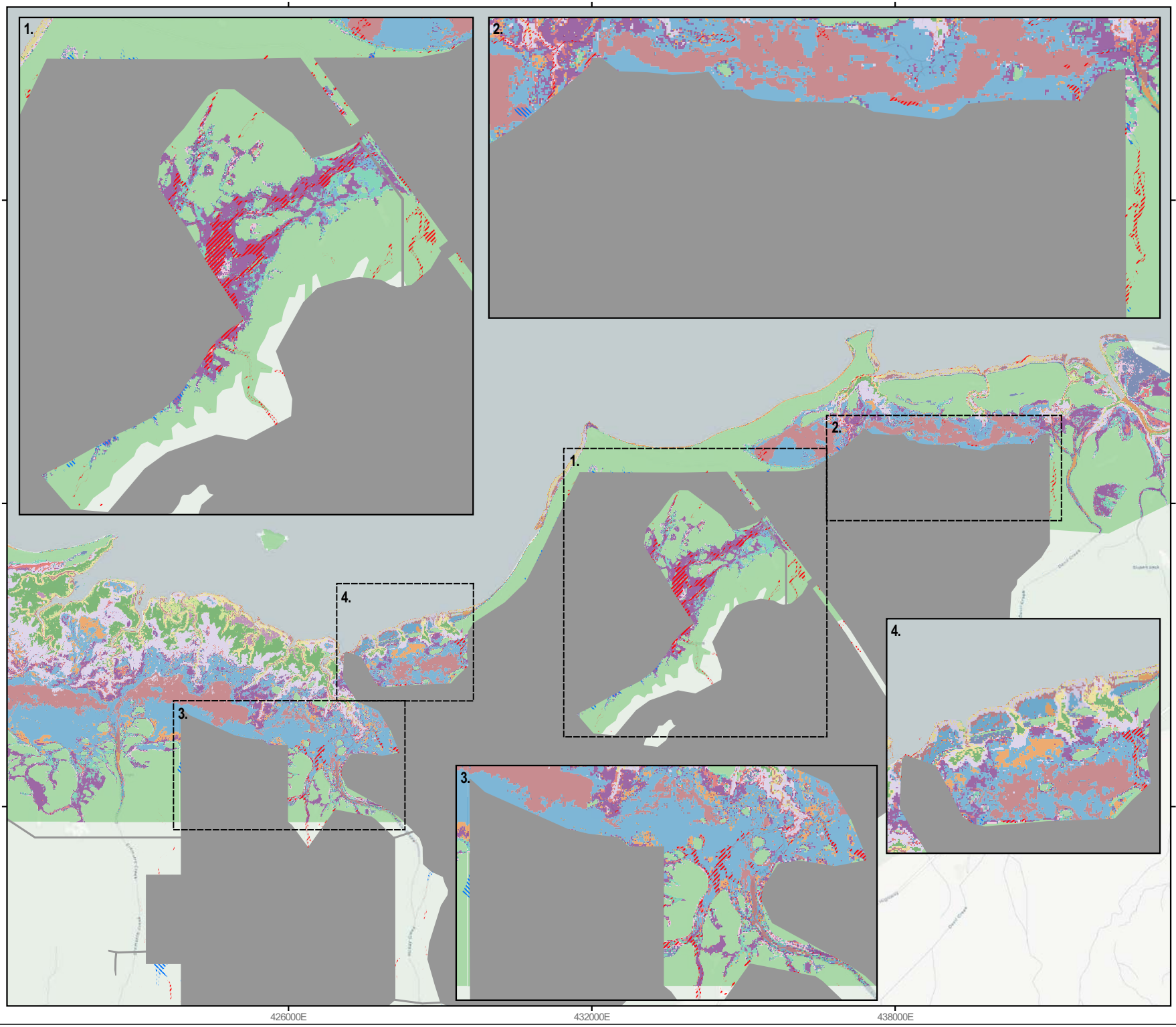
- Similarity of the receiving environment to the IMPs location of origin (habitat/substrate type, bioregional matching, physico-chemical conditions, temperature and salinity regimes);
- Availability of substrate/habitat;
- Availability of prey/food/nutrients;
- Presence of predators;
- Competition with local/native biota;
- Water quality (temperature and salinity regimes); and
- Distance to high-risk areas (ports, harbours, aquaculture facilities).

The risk factors described above are incorporated into several private sector and government-supplied risk assessments. Leichhardt engaged MScience (2022) to conduct an IMP risk assessment. There are two key inputs to the risk assessment; the risk of a vessel or equipment introducing a marine pest, and the risk of the IMP becoming established.

Using established risk determination methods (Bridgwood and McDonald, 2014), the Proposal-related vessel types were categorised into: (1) low risk, (2) moderate risk, and (3) high risk. The vessel types proposed for use were allocated relative risk ratings:

- CSD was given a risk rating of three (high risk);
- Barges/tugs were given a risk rating of two (medium risk); and
- Workboats/research vessels (i.e. hydrographic survey vessel) were given a risk rating of two (medium risk).

The dredging plant and other Proposal-related construction plant have not yet been contracted; thus, their port of origin is unknown. The dredge vessel and/or marine construction vessels may be sourced domestically or internationally. For MScience's (2022) assessment, internationally sourced vessels were assumed to be compliant with Australia's mandatory Ballast Water Management Requirements (Commonwealth of Australia, 2020) and had completed an inspection and cleaning, at a minimum. As such the risk associated with an internationally and domestically sourced vessel was considered the same. In addition, it has been assumed that marine construction/dredge plant will arrive and depart the Pilbara/Cape Preston area only once during construction. On this basis, the assessment focussed on the type and risk rating of Proposal-related construction vessels.




## Legend

- Disturbance Footprint
- Was dry now wet
- Was wet now dry

BCH

- Am1
- Am2
- Am3
- Bare, HISF
- Grassland
- HDCM
- LDCM
- Rs
- Rs/Am
- Sam1
- Sam2
- Sam3
- Sam4
- Terrestrial
- Undecided

Imagery: Positron (retina)

N

0 1 2 km

GDA2020 / MGA zone 50

1:100,000

Project: LEI_0535_040
Date: 27/03/2025
Size: A4
Author: ASmithers (Preston Consulting Pty Ltd)

**Figure 8-22: Areas of BCH at risk of impacts due to changes to surface water inundation**

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***Increased sedimentation resulting in settlement and smothering of habitat***

The majority of sedimentation resulting in disturbance to intertidal BCH is associated with the flooding of an existing landscape. Any sediment would be captured within the ponds during this activity. Sediment may be released during construction of the pond walls; however, the method and sequencing of construction of these walls will involve isolating working areas from interaction with water movements (including tidal flows) to ensure mobile sediments are not allowed to escape to the surrounding environment. The seaward toes of the walls will be rock armoured to further protect against erosion. Leichhardt has committed to mitigation measures to reduce the risk of sedimentation (refer to Section 7.6.2).

***Alteration to intertidal flow regime – pond walls***

As described in Section 6, an extensive tidal inundation study conducted by O2 Metocean (2023b) confirms that, during highest tides, the pond walls would affect the landward movement of seawater at the eastern and western ends of the PIDE, where the walls are closest to the ocean.

There are two main intertidal creek systems which flood under normal spring high tide conditions but remain isolated from each other. The same map was replicated with the results from the post-project development model run (Figure 6-33), which shows how the pond walls block some of the flow south of the main creeks particularly near the proposed seawater intake area at McKay Creek. When compared to each other (Figure 6-34), minor-to-negligible changes in the tidal inundation regime outside the proposed pond walls footprint are seen.

Water level (inundation) results between the pre-development and post-development simulations over the selected representative spring tide period were compared to derive an understanding of changes in inundation behaviour between the two scenarios to investigate the potential changes in local hydrodynamic processes associated with the construction of the salt ponds. Two types of comparison plots were used: percentage time 'wet' and 'change in total water depth'. The plots highlighted the importance of the system of interconnected creeks within the intertidal region and the areas that would be affected by the emplacement of the ponds and intake pumping station. The creeks which will be mostly affected by pond emplacement are McKay Creek, Straight Creek, and Barnard Creek. Though the percentage of time 'wet' before and after development differed little north of the crystallisers, changes in the total water depth of the order of 10 cm will be experienced at some locations during (possibly) every spring tide.

These predicted changes are minor and will affect relatively small areas of BCH, with changes generally in line with natural variation. Monitoring of BCH health and the verification of model predictions is proposed to verify this position (refer to Section 8.6). Section 6 (Inland Waters) provides more detail about the modelling and predicted results.

The potential impacts of these changes on mangrove, algal mats and samphire shrublands BCH are discussed in more detail in Section 8.5.2 - 8.5.4 respectively.

***Changes to the dynamics of nutrient flows and budgets***

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 ponds will result in loss of intertidal BCH, including mudflats, algal mats, samphire shrublands and mangroves. CC mangroves and their related ecosystems (especially cyanobacterial non-mat forming communities) are important contributors to the nutrient budget within the PIDE. The relative contribution of nutrients from other intertidal BCH to the nearshore marine environment is not well understood.

Many studies have inferred the importance of algal mats as a 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; 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.

The nutrient flux study (O2 Marine, 2025g) showed no nutrient exchange from algal mats to the nearshore marine environment during normal spring tidal cycles, suggesting that if nutrient exchange occurs from algal mats, it may be limited to significant freshwater inundation events. Where possible, alterations to surface water flows 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 extent of the predicted algal mat losses predicted (i.e., 19.6%) across the LAUs mean that these episodic surface water flows will no longer have the opportunity to collect as many nutrients during freshwater inundation over the algal mat areas. For that reason, Leichhardt completely redesigned the pond designs to reduce the area of algal mat impact from 1,537.5 ha to 87.3 ha of HDAM (refer to Section 4).

Nevertheless, 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 lower in comparison to the relative contribution of the more structurally complex BCH, such as CC mangroves.

***Leaks or spills of hydrocarbons or chemicals***

The Proposal does not include export operations at CPE Port such as the loading of salt onto transhipment barges, transhipment barge movements or ocean-going vessel loading and movements. The key offshore hydrocarbon/chemical spill risks are therefore associated with the dredging program, and any construction vessels used for the construction of the bitterns dilution intake and bitterns discharge infrastructure. There is a risk of hydrocarbon spill from these vessels as a result of vessel collisions or hydraulic hose leaks. With the implementation of standard industry safeguards and operating procedures (Section 8.6) any offshore spills are expected to be able to be contained and cleaned up such that they do not result in a significant ongoing impact to BCH.

### *Brine Spills*

A large spill or leak of brine from the ponds or pipelines, or product infrastructure washdown water could result in impacts to the marine environmental quality within adjacent tidal creeks. Brine is the primary resource for the Proposal and as such the concentration ponds, crystallisers and brine pipelines are designed to minimise the risk of leaks, overflows and wall breaches. Pipelines will utilise industry-standard materials to minimise the chance of leaks and mitigation will be implemented to reduce this risk further (refer to Section 8.6). Ponds have been designed with adequate freeboard and overflow features to minimise the risk of unplanned overflows and wall breaches. The ponds include internal weirs to rebalance local excess brine levels and external emergency spillways into adjacent major creeks to avoid cascading internal bund failure leading to massive outflows.

There are drainage ditches along the base of all perimeter bunds primarily to intercept groundwater seepage and collect brine for recovery to the process ponds. These will also intercept and contain minor splashing and spillage events.

If a large external overflow was to occur, it is most likely to arise from a major rain event which raises all pond levels. In such events, McKay and Devil Creeks both flow at high levels. In this case the brine overflow will be rapidly mixed with fresh surface water flow and discharged to the ocean.

### *Groundwater Seepage*

Modelling of the hydraulic influence of the proposed ponds on the underlying groundwater was conducted by CDM Smith (2024; Appendix 1.6), incorporating the results of laboratory testing of natural as well as screened and compacted soils from the proposed pond areas. The modelling indicated that:

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

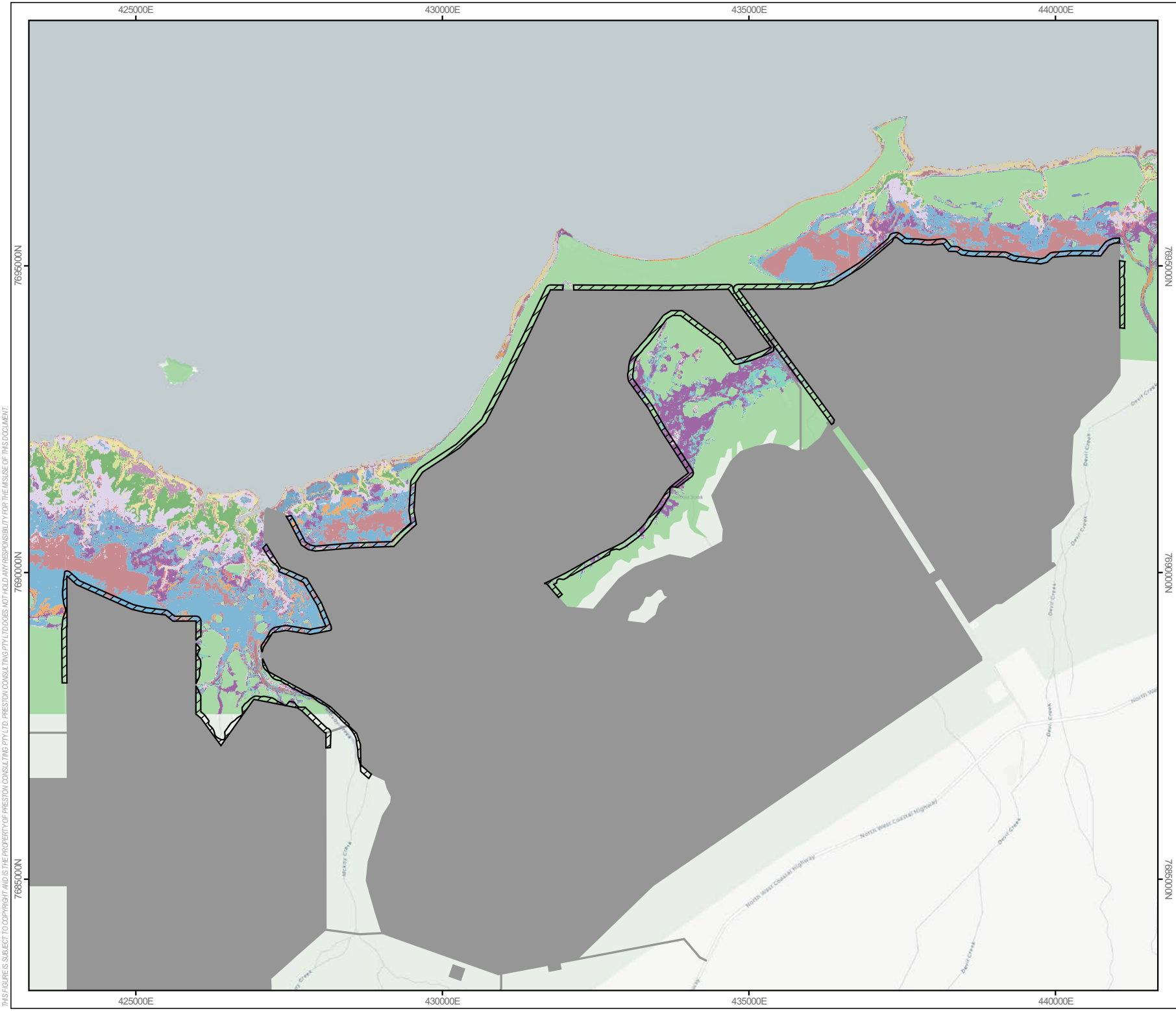
Groundwater seepage and mounding is proposed to be monitored and managed by implementing the GMMP in Appendix 1.9. The GMMP is intended to ensure that any seepage or mounding impacts can be contained to within 100 m of the external walls, by a series of cut-off bores, sumps or drains if required. The 100 m management zone includes a 20 m construction disturbance footprint which is required to build the pond walls. Therefore, indirect impacts to BCH have been calculated as being a maximum 80 m within areas that are 'at risk' of groundwater mounding and seepage impacts. These areas have been conservatively defined as being areas:

- Where the depth to groundwater is 5 m or less and the predicted change in groundwater level is 1 m or more; and
- Of mapped GDEs where the predicted change in groundwater level is 1 m or more (not relevant to BCH).

Table 8-13 and Figure 8-23 identifies the areas of BCH that are predicted to be 'at risk' of impacts from groundwater seepage and mounding. Up to14.3 ha of the 'at risk' BCH in Table 8-13 is predicted to also be 'at risk' of impacts from surface water changes (detailed in the last column of Table 8-13.

**Table 8-13: Areas of BCH at risk of groundwater seepage and mounding**

| BCH Type | Total area at risk of seepage and mounding (ha) | Portion of total also 'at risk' from surface water changes (ha) |
|---|---|---|
| Mangroves | 1.9 | 0.2 |
| HDAM | 12.9 | 0.9 |
| LDAM | 71.0 | 1.6 |
| Samphire incl algal mat (sparse) | 38.4 | 7.6 |
| Samphire incl algal mat (dense) | 2.4 | 0.1 |
| Samphire shrublands (sparse) | 14.5 | 2.6 |
| Samphire shrublands (dense) | 4.5 | 0.1 |
| TOTAL | 145.4 | 14.3 |




## Legend

- Disturbance Footprint
- Seepage Risk Area

BCH

- Am1
- Am2
- Am3
- Bare, HISF
- Grassland
- HDCM
- LDCM
- Rs
- Rs/Am
- Sam1
- Sam2
- Sam3
- Sam4
- Terrestrial
- Undecided

Imagery: Positron (retina)

N

0 1 2 km

GDA2020 / MGA zone 50

1:80,000

Project: LEI_0535_041
Date: 28/03/2025
Size: A4
Author: ASmithers (Preston Consulting Pty Ltd)

**Figure 8-23: Areas of BCH at risk of groundwater seepage impacts**

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***Sea Level Rise and Sedimentary Resilience***

Leichhardt commissioned a report to assess the impacts of sea-level rise on intertidal habitats and the potential response of mangroves, algal mats and samphire in the context of the Proposal (Larcombe et al., 2024; Appendix 3.9). The study included a thorough review of relevant past changes in the rise and fall of sea level, as these changes have influenced the locations and nature of key sedimentary processes, deposits, environments and mangrove, algal mats and samphire habitats. The main hydrodynamic drivers of change and projected future change are discussed along with the assessment and analysis of sea-level change in the context of the Proposal.

The key findings and conclusions in this report were accompanied by levels of confidence, each defined as the following:

- High confidence: the authors were very confident in the evidence supporting the conclusion and further research is very unlikely to change the estimates of change and impact;
- Moderate confidence: the authors were moderately confident in the evidence supporting the conclusion and further research could have an important impact, leading to a possible change in the estimates of change and impact;
- Low confidence: the authors had a low confidence in the evidence supporting the conclusions reached and further research is very likely to have an important impact, which is likely to change the estimates of change and impact; and
- Very low confidence: an estimate of change and impact is very uncertain. Further research would certainly have an important impact on estimates of change and impact.

The key findings made by Larcombe et al. (2024 & 2025) with regard to the sea level rise changes resulting from the Proposal, and their association with BCH are presented below:

- There have been a very large variety of historic coastal geomorphic changes and there is a high confidence that BCHs are well adapted to their dynamic environments;
- There is a degree of stability in the coastal geomorphic configurations in these locations because there is a moderate confidence that active breaching of the Gnoorea spit or barrier in front of the western PIDE region is unlikely;
- Assuming a SLR of 10 mm/yr, there is insufficient sediment available to raise bed elevations to match the rate of SLR and in general most of that change would come about by landward transport of mud and there will be arrange of effects of mobile bodies at the shoreline, affecting creek mouths and recovery from erosive events;
- Regarding SLR over the next century, there are two possible conclusions reached, each with different implications for the natural change that might occur over the next century, and the changes with the Proposal in place. Further information is required to rule out one of the options. These include:
    - Conclusion 1: Over the past 6,000 years, the shoreline has prograded (advanced towards the sea) 2 - 3 km in the estuary. The changes in natural processes and the extent of habitats over the next century are highly variable along the shoreline. If the conclusion is true, there is high confidence that the changes made to the coastal environment will not be of regional significance and there would be minimal change to coastal function. In the Proposal's context, there is moderate confidence that any possible changes to natural processes and habitats are only

locally significant and temporary, indicating the coastline has a degree of resilience to any changes caused by the Proposal;
    - Conclusion 2: The shoreline is dated at approximately 120,000 years. The changes in natural processes and the extent of habitats over the next century are highly variable along the shoreline. There may be some severe drowning of large areas of the coastal environment and some lesser drowning of high tidal area. If this conclusion is true, there is moderate confidence that the changes made to the coastal environment will not be of regional significance and there would be minimal change to coastal function. In the Proposal's context, there is high confidence that any possible changes to natural processes and habitat are locally significant and could be permanent, indicating the coastline has poor resilience against any changes caused by the Proposal;
- For the McKay Creek system (Figure 8-24), the effects of SLR without any development over 100 years include:
    - Mangroves possibly increasing in coverage by approximately 4% (moderate confidence);
    - Algal mats projected to decrease by 10% as mangroves advance across the tidal flats (low to moderate confidence);
- For the nascent mangrove systems, the effects of SLR without any development over 100 years include:
    - Little significant change to mangroves coverage (low to moderate confidence);
    - Algal mats projected to increase slightly by a total of 2% and samphire coverage decrease by 8% (moderate confidence);
- For the combined systems of 40-Mile Road East and Creeks 7 and 8 (Figure 8-24), the effect of SLR without any development over 100 years include:
    - Mangroves projected to increase coverage by 50% and 150% at 40-Mile Road East and Creek 8 respectively (low to moderate confidence);
    - Algal mats are projected to lose 10% - 33% of their original coverage (low to moderate confidence);
    - Samphire projected to be reduced to 33% of their original coverage (low to moderate confidence);
- For the McKay Creek system, the effect of the ponds over the next 100 years is:
    - Negligible-low upon mangroves (moderate confidence);
    - Large on samphire (low to moderate confidence);
    - Greatest on algal mats (low confidence);
- For the nascent mangrove system, which occurs at the mouth of the 40-Mile Road West catchment, the effect of the ponds over the next 100 years is:
    - Moderate on the mangroves (moderate to high confidence);
    - Very large on samphire (high confidence);
    - Greatest on algal mats (high confidence);
- For the combined systems of 40-Mile Road East, and Creeks 7 and 8, the effect of the ponds over the next 100 years is:
    - Very large on samphire (moderate to high confidence);
    - Moderate on mangroves (low to moderate confidence); and
    - Very large on algal mats (moderate confidence).

It is important to note that these numerical estimates based on available information and expert judgement, and numerical changes are well within the bounds of uncertainty.




Figure 8-24: Relevant creek catchments (watersheds) landward to just beyond the 5 m AHD contour

***Local Cumulative Loss Assessment***

Table 8-14 lists the predicted cumulative local loss across each BCH type within each LAU (from O2 Marine, 2025b). Unconfirmed indirect impacts associated with altered surface water regimes and groundwater seepage have not been included in the cumulative loss assessment. Table 8-14 identifies that:

- 39.4% of the total mapped Samphire shrublands BCH will be disturbed, with the disturbance primarily occurring within LAU 2, 3 and 4;
- 22.1% of the total mapped algal mat BCH will be disturbed, with the disturbance primarily occurring within LAU 2 - 4;
- Less than 1.5% of mangroves BCH will be disturbed, with the disturbance to occur primarily within LAU 3;
- BCH disturbance is greater in the higher elevation BCH (samphire shrublands).

Samphire shrublands are rarely inundated as they occur in areas that are higher in elevation. These BCH contain very little biomass and as such are expected to contribute very little to the intertidal ecosystem.

Intertidal habitats assessed within the study area were found to be commonly distributed throughout the wider Pilbara region, with many having distributions either within the Australian tropics or internationally. Many species identified during the assessment are also typically found within a broader geographical distribution. The coastal habitats within the study area have not been identified as containing significant ecological communities warranting protection through the introduction of marine or terrestrial reserves.

Whilst no formal reserves have been established, one area relevant to the Proposal has been identified by EPA (2001) as Cape Preston Regionally Significant Mangrove Area (RSMA#9). This area is a mangrove management area and direct impacts within this area have been minimised (discussed further in Section 8.5.2).

Numerous Proposal design iterations were developed to minimise impacts to significant BCH, and as a result the current Proposal has significantly lower impacts to mangrove BCH than previous design iterations (refer to Section 2.2.2). Overall, the Cumulative Loss Assessment (O2 Marine, 2025b) determined that the predicted losses of each intertidal BCH were unlikely to result in any risks of impacting biological diversity and ecosystem integrity.

A regional cumulative impact assessment has been provided in Section 18, which includes an assessment of intertidal BCH impacts.

Table 8-14: Intertidal cumulative BCH loss within each intertidal LAU

| LAU | Description | Area (ha) & % of Pre-European Extent | Intertidal BCH | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Algal Mat | Mixed Intertidal | *R. Stylosa* Mangrove | *A. Marina* Mangrove | Bare Intertidal Habitat | Samphire incl algal mat (sparse) | Samphire incl algal mat (dense) | Samphire shrubland (sparse) | Samphire shrubland (dense) |
| **LAU 1** | Pre-European Extent | ha | 825.2 | 8.6 | 49.3 | 708.9 | 102.2 | 243.7 | 71.0 | 70.4 | 54.6 |
| | Current Extent | ha | 816.7 | 8.6 | 49.3 | 707.5 | 102.2 | 240.1 | 71.0 | 70.4 | 54.6 |
| | | % | 99% | 100.0% | 100% | 99.8% | 100% | 98.5% | 100% | 100% | 100% |
| | Irreversible Loss | ha | 0.2 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| | | % | 0.0% | 0.0% | 0.0% | 0.0% | 0.1% | 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% |
| | Cumulative Loss | ha | 8.7 | 0.0 | 0.0 | 1.4 | 0.1 | 3.6 | 0.0 | 0.0 | 0.0 |
| | | % | 1.1% | 0.0% | 0.0% | 0.2% | 0.1% | 1.5% | 0.0% | 0.0% | 0.0% |
| **LAU 2** | Pre-European Extent | ha | 616.9 | 6.0 | 37.2 | 375.6 | 67.6 | 194.2 | 33.0 | 68.5 | 31.8 |
| | Current Extent | ha | 616.9 | 6.0 | 37.2 | 375.6 | 67.6 | 194.2 | 33.0 | 68.5 | 31.8 |
| | | % | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| | Irreversible Loss | ha | 93.6 | 1.8 | 0.0 | 6.4 | 21.9 | 80.9 | 11.3 | 48.1 | 18.2 |
| | | % | 15.2% | 30.1% | 0.0% | 1.7% | 32.4% | 41.7% | 34.2% | 70.2% | 57.2% |
| | 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% |

| LAU | Description | Area (ha) & % of Pre-European Extent | Intertidal BCH | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Algal Mat | Mixed Intertidal | *R. Stylosa* Mangrove | *A. Marina* Mangrove | Bare Intertidal Habitat | Samphire incl algal mat (sparse) | Samphire incl algal mat (dense) | Samphire shrubland (sparse) | Samphire shrubland (dense) |
| | Cumulative Loss | ha | 93.6 | 1.8 | 0.0 | 4.7 | 21.9 | 80.9 | 11.3 | 48.1 | 18.2 |
| | | % | 15.2% | 30.1% | 0.0% | 1.3% | 32.4% | 41.7% | 34.2% | 70.2% | 57.2% |
| **LAU 3** | Pre-European Extent | ha | 344.7 | 6.2 | 0.7 | 17.8 | 54.6 | 372.4 | 14.7 | 176.8 | 79.7 |
| | Current Extent | ha | 344.7 | 6.2 | 0.7 | 17.8 | 54.6 | 372.4 | 14.7 | 176.8 | 79.7 |
| | | % | 100% | 99.9% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| | Irreversible Loss | ha | 221.2 | 4.7 | 0.0 | 0.8 | 40.9 | 237.5 | 10.2 | 113.2 | 64.2 |
| | | % | 64.2% | 75.8% | 0.0% | 4.5% | 74.9 | 63.8% | 69.4% | 64% | 80.6% |
| | 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% |
| | Cumulative Loss | ha | 221.2 | 4.7 | 0.0 | 0.8 | 40.9 | 237.5 | 10.2 | 113.2 | 64.2 |
| | | % | 64.2% | 75.8% | 0.0% | 4.5% | 74.9 | 63.8% | 69.4% | 64% | 80.6% |
| **LAU 4** | Pre-European Extent | ha | 379.4 | 4.9 | 7.3 | 186.1 | 36.9 | 208.6 | 63.4 | 98.6 | 37.7 |
| | Current Extent | ha | 379.4 | 4.9 | 7.3 | 186.1 | 36.9 | 208.6 | 63.4 | 98.6 | 37.7 |
| | | % | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| | Irreversible Loss | ha | 100.5 | 1.0 | 0.0 | 1.1 | 4.8 | 48.5 | 2.5 | 33.8 | 7.7 |
| | | % | 26.5% | 20.4% | 0.0% | 0.6% | 13% | 23.3% | 3.9% | 34.3% | 20.4% |

| LAU | Description | Area (ha) & % of Pre-European Extent | Intertidal BCH | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Algal Mat | Mixed Intertidal | *R. Stylosa* Mangrove | *A. Marina* Mangrove | Bare Intertidal Habitat | Samphire incl algal mat (sparse) | Samphire incl algal mat (dense) | Samphire shrubland (sparse) | Samphire shrubland (dense) |
| | 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% |
| | Cumulative Loss | ha | 100.5 | 1.0 | 0.0 | 1.1 | 4.8 | 48.5 | 2.5 | 33.8 | 7.7 |
| | | % | 26.5% | 20.4% | 0.0% | 0.6% | 13% | 23.3% | 3.9% | 34.3% | 20.4% |
| **LAU 5** | Pre-European Extent | ha | - | - | - | - | - | - | - | | - |
| | Current Extent | ha | - | - | - | | - | - | - | | - |
| | | % | - | - | - | - | - | - | - | | - |
| | Irreversible Loss | ha | - | - | - | - | - | - | - | | - |
| | | % | - | - | - | - | - | - | - | | - |
| | Recoverable Impact | ha | - | - | - | - | - | - | - | | - |
| | | % | - | - | - | - | - | - | - | | - |
| | Cumulative Loss | ha | - | - | - | - | - | - | - | | - |
| | | % | - | - | - | - | - | - | - | | - |
| **LAU 6** | Pre-European Extent | ha | - | - | - | - | - | - | - | - | - |
| | Current Extent | ha | - | - | - | - | - | - | - | - | - |
| | | % | - | - | - | - | - | - | - | - | - |

| LAU | Description | Area (ha) & % of Pre-European Extent | Intertidal BCH | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Algal Mat | Mixed Intertidal | *R. Stylosa* Mangrove | *A. Marina* Mangrove | Bare Intertidal Habitat | Samphire incl algal mat (sparse) | Samphire incl algal mat (dense) | Samphire shrubland (sparse) | Samphire shrubland (dense) |
| | Irreversible Loss | ha | - | - | - | - | - | - | - | - | - |
| | | % | - | - | - | - | - | - | - | - | - |
| | Recoverable Impact | ha | - | - | - | - | - | - | - | - | - |
| | | % | - | - | - | - | - | - | - | - | - |
| | Cumulative Loss | ha | - | - | - | - | - | - | - | - | - |
| | | % | - | - | - | - | - | - | - | - | - |
| **LAU 7** | Pre-European Extent | ha | - | - | - | - | - | - | - | - | - |
| | Current Extent | ha | - | - | - | - | - | - | - | - | - |
| | | % | - | - | - | - | - | - | - | - | - |
| | Irreversible Loss | ha | - | - | - | - | - | - | - | - | - |
| | | % | - | - | - | - | - | - | - | - | - |
| | Recoverable Impact | ha | - | - | - | - | - | - | - | - | - |
| | | % | - | - | - | - | - | - | - | - | - |
| | Cumulative Loss | ha | - | - | - | - | - | - | - | - | - |
| | | % | - | - | - | - | - | - | - | - | - |
| **TOTALS** | **Pre-European Extent** | ha | 2166.2 | 25.7 | 94.5 | 1288.4 | 261.3 | 1018.9 | 182.1 | 414.3 | 203.8 |

| LAU | Description | Area (ha) & % of Pre-European Extent | Intertidal BCH | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Algal Mat | Mixed Intertidal | *R. Stylosa* Mangrove | *A. Marina* Mangrove | Bare Intertidal Habitat | Samphire incl algal mat (sparse) | Samphire incl algal mat (dense) | Samphire shrubland (sparse) | Samphire shrubland (dense) |
| | **Current Extent** | ha | 2157.7 | 25.7 | 94.5 | 1287.0 | 261.3 | 1015.3 | 182.1 | 414.3 | 203.8 |
| | | % | 99.6% | 100% | 100% | 99.9% | 100% | 99.6% | 100% | 100% | 100% |
| | **Irreversible Loss due to the Proposal** | ha | 415.5 | 7.5 | 0.0 | 8.3 | 67.7 | 366.9 | 24.0 | 195.1 | 90.1 |
| | | % | 19.3% | 29.2% | 0.0% | 0.6% | 25.9% | 36.1% | 13.2% | 47.1% | 44.2% |
| | **Recoverable Impact 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% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| | **Cumulative Loss since Pre-European Extent** | ha | 424.0 | 7.5 | 0.0 | 9.7 | 67.7 | 370.5 | 24.0 | 195.1 | 90.1 |
| | | % | 19.6% | 29.2% | 0.0% | 0.7% | 25.9% | 36.4% | 13.2% | 47.1% | 44.2% |

### 8.5.2 MANGROVE COMMUNITIES

The assessment conducted in Section 8.5.1 contains general information relevant to mangrove communities as they form part of the intertidal BCH within the LAUs. This section provides additional information specific to mangrove communities to ensure potential impacts on this important BCH type were assessed in sufficient detail.

The content of this section has been sourced from O2 Marine's Cumulative Loss Assessment (2025b; Appendix 3.1).

***Direct Loss***

For the assessment of the impacts of mangrove losses in the LAUs the CC assemblages *(A. marina)* have been combined into a single CC group reflecting the high level of heterogeneity within each of the assemblages. The SC (*R. stylosa*) mangrove assemblage has been treated separately as it is substantially different in terms of canopy height, AGB, primary productivity and associated fauna.

Direct loss calculations from the Proposal are presented in Table 8-14. Irreversible loss of 8.3 ha (0.6% across all LAUs) of *A. marina* mangroves none of *R. stylosa* mangroves are predicted to occur as a result of the Proposal (Figure 8-21). Mangroves within RSMA#9 are highest value mangroves within the Proposal, which aligns with LAU 1 and 2. The cumulative loss of mangroves in LAU1 is 0.2% and in LAU2 is 1.3%.

The highest amount of cumulative loss is within LAU3 which is 4.3 % for *A. marina* mangroves.

***Significance of Impacts***

None of the observed mangrove species were identified as having national or international significance and are typically widely distributed. The two most dominant mangrove species, *R. stylosa* and *A. marina* are broadly distributed throughout the Asia-Pacific region and the wider Indo-Pacific region, respectively.

O2 Marine (2025b) identified mangroves as being the highest ecologically important BCH within the LAUs, particularly CC mangroves, due to the range of ecological services in which they provide to adjacent BCH and coastal waters.

All efforts have been made during the Proposal design and engineering stages to maintain maximum mangrove extent and biomass. This has resulted in a maximum of 8.3 ha (0.004%) of mangroves being disturbed. Up to 7.3 ha of mangroves are predicted to be at risk of indirect impacts associated with hydrology. This includes:

- 5.4 ha associated with changes to surface water inundation;
- 1.7 ha associated with groundwater seepage; and
- 0.2 ha of overlapping surface water and groundwater impacts.

Approximately 1,373.2 ha of healthy and resilient mangrove habitat will remain within the LAUs, which equates to 99.5% of all mangroves that existed since pre-human disturbance. Approximately 33,697 ha of mangrove habitat will remain regionally, which equates to 99.9% of the pre-European regional extent.

The predicted irreversible impact to mangrove habitat and cumulative loss from the Proposal is proportionally low when compared to the local and regional extent of mangrove communities. However the high ecological value of mangroves, and the status of the mangroves within the RSMA #9, means that even small losses are considered significant. Significant residual impacts are proposed to be counterbalanced by offsets (discussed in Section 15).

### 8.5.3 Algal Mat

The assessment conducted in Section 8.5.1 contains general information relevant to algal mats as they form part of the intertidal BCH within the LAUs. This section provides additional information specific to algal mat BCH to ensure potential impacts on this BCH type were assessed in detail.

The content of this section has been sourced from O2 Marine's Cumulative Loss Assessment (2025b).

***Direct Loss***

A total of 3,254 ha of algal mats was identified in the study area during the survey, comprising 26.4% of the total area of the intertidal LAUs, although the bulk of the mats are in LAU 1. Algal mats were also identified alongside samphire (i.e., this means the assessed pixel contained both samphire and algal mat within it – however they do not overlap) within two BCH categories. For these categories the loss calculations assumed that 50% of the area would be algal mat and the other 50% would be samphire. Up to 1,197.4 ha was defined as samphire (inclusive of algal mat), and therefore 598.7 ha of this is considered to be algal mat. This includes BCH types dense samphire shrublands (inclusive of algal mat) and sparse samphire shrublands (inclusive of algal mat).

The maximum estimate of irreversible loss of algal mats is 611.0 ha or 22.1% of the total of this BCH type distributed across the intertidal LAUs. Most of the losses would be within LAU 3 (345.1 ha or 64.1% of the total extent of algal mat recorded in that LAU), LAU 2 (139.7 ha or 19.1% within that LAU) and LAU 4 (126.0 ha or 24.4% within that LAU) with negligible losses in LAU 1. These are the largest areas of habitat supporting intertidal BCH that will be lost due to the Proposal. Approximately 41,574 ha of algal mats were mapped regionally through remote sensing (EnSTaR, 2025b). Disturbance of up to 611.0 ha will result in approximately 1.5% reduction in the regional extent of algal mats (noting the density and health of the regional algal mats is unknown).

The reports on the distribution and composition of mats (Actis Environmental Services 2023; Actis Consulting Pty Ltd, 2023; O2 Marine, 2025c) 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 associated with algal communities found elsewhere in Australia and overseas. Although algal 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 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), therefore playing a more valuable ecological function within the intertidal ecosystem.

Mudflats and 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 LAUs (O2 Marine, 2025b).

***Significance of Impact***

Substantial percentages of the total area of algal mat BCH present within LAU 3 (64.1%), LAU 2 (19.1%) and LAU 4 (24.4%) will be lost, with the overall loss across all LAUs being 22.1% of the total present and 1.5% of the regional extent. While some of these loss percentages are high, the ecological impact of the losses is best assessed in the context of the high variation in ecological value within this BCH type. Up to 15.8 ha of HDAM are predicted to be at risk of indirect impacts associated with hydrology. This includes:

- 2.9 ha associated with changes to surface water inundation;
- 12.0 ha associated with groundwater seepage; and
- 0.9 ha of overlapping surface water and groundwater impacts.

The layout of the ponds was revised to minimise the impacts of the ponds on the algal mats and specifically, algal mats with higher density and higher levels of productivity (more active). Actis Environmental Services (2023) and Actis Consulting Pty Ltd (2023) completed an assessment of the productivity of the algal mats within the pond development area of the PIDE and within the LAUS, respectively. The presence of depressions within the algal mat topography was recognised and included in the analysis. Additionally, it was recognised that the flooding time of all categories should be adjusted to reflect different flood periods and therefore net productivity.

Table 8-15 outlines the different categories of algal mats and the distribution within the LAUs. The layout of the ponds was adjusted to minimise the impact on the algal mat productivity. As a result of this design change, the highest level of direct disturbance now occurs within the lower area of productivity furthest from the tidal influence (Table 8-16). Only 1.6% and 4.5% of the more productive algal mats within the LAUs will be impacted.

The Proposal disturbance is therefore predicted to reduce the overall productivity of algal mats within the LAUs by 11.2%.

**Table 8-15: Disturbance (ha) to broad chlorophyll-a zones**

| Chlorophyll-a (mg/m²) | Description | LAU1 | LAU2 | LAU3 | LAU4 | Subtotal |
|---|---|---|---|---|---|---|
| >300 | Very active mat 301+ mg/m² | 0.03 | 1.93 | 12.20 | 2.08 | 16.2 |
| 151-300 | Active mat 151-300 mg/m² | 0.06 | 13.50 | 21.72 | 11.80 | 47 |
| 51-150 | Limited activity far 51-150 mg/m² | 0.05 | 42.93 | 78.06 | 31.96 | 153 |
| 51-150 | Limited activity near 51-150 mg/m² | 0.11 | 7.12 | 4.05 | 3.31 | 14.6 |
| 0-50 | Low far 0-50 mg/m² | 0.04 | 140.05 | 508.24 | 124.57 | 773 |
| 0-50 | Low near 0-50 mg/m² | 0.87 | 22.78 | 0.00 | 6.54 | 30.2 |
| | **TOTAL** | **1.15** | **228.31** | **624.27** | **180.28** | **1,034** |

Table 8-16: Estimate of impacts to total net productivity (%)

| Chlorophyll-a (mg/m²) | Description | LAU1 | LAU2 | LAU3 | LAU4 |
|---|---|---|---|---|---|
| >300 | Very active mat 301+ mg/m² | 0.01 | 0.8 | 10.9 | 1.2 |
| 151-300 | Active mat 151-300 mg/m² | 0.01 | 2.5 | 8.6 | 2.9 |
| 51-150 | Limited activity far 51-150 mg/m² | 0.00 | 3.0 | 11.6 | 3.0 |
| 51-150 | Limited activity near 51-150 mg/m² | 0.01 | 0.5 | 0.6 | 0.3 |
| 0-50 | Low far 0-50 mg/m² | 0.00 | 2.9 | 22.5 | 3.5 |
| 0-50 | Low near 0-50 mg/m² | 0.05 | 1.9 | 0.0 | 0.7 |
| **TOTAL** | | **0.08** | **11.7** | **54.2** | **11.6** |

Leichhardt acknowledges that there is still a degree of uncertainty around the influence of algal mats on the nearshore environment, which is currently a subject of a research program being undertaken by WAMSI as part of the Mardie Offsets Program. Algal mats were also noted to be utilised by migratory shorebirds during higher tides. O2 Marine's HDAM mapping aligns with the higher productivity algal mats from Actis Consulting and therefore they present the highest value algal mats. The LDAM are generally higher in the landscape and have a lower productivity value and as such are unlikely to have significant foraging value for shorebirds.

In the absence of current information a conservative position has been taken that the predicted impacts to HDAM are locally significant and offsets are proposed to counterbalance these residual impacts (Section 15). This conservative position may change pending the results of the WAMSI research.

### 8.5.4 Samphire Shrublands

The assessment conducted in Section 8.5.1 contains general information relevant to samphire/samphire shrublands habitat as it forms part of the intertidal BCH within the LAUs.

The content of this section has been sourced from O2 Marine's Cumulative Loss Assessment (2025b).

***Direct Loss***

Samphire shrublands account for 618 ha (0.6%) of the LAUs. Up to 480.7 ha of samphire shrublands will be lost and this represents 39.4% of this habitat type present across all intertidal LAUs. Most of the losses are predicted within LAU 3 (301.3 ha, 66.9%), LAU 2 (112.4 ha, 52.5%) and in LAU 4 (67.0ha, 24.6%). Samphire shrublands were also identified alongside algal mats (i.e., this means the assessed pixel contained both samphire and algal mat within it – however they do not overlap) within two BCH categories. For these categories the loss calculations assumed that 50% of the area would be algal mat and the other 50% would be samphire.

***Significance of Impact***

When viewing this BCH type as a uniform habitat the losses of this habitat type are substantial in both LAU 2 and LAU 3 comprising around 53% and 67% of this habitat type present in those LAUs, respectively. Lesser amounts of this habitat type will be lost in LAU 4 (24.6%) which still represents a substantial loss in a local context. Up to 62.0 ha of samphire shrublands are predicted to be at risk of indirect impacts associated with hydrology. This includes:

- 22.6 ha associated with changes to surface water inundation;
- 31.8 ha associated with groundwater seepage; and
- 7.6 ha of overlapping surface water and groundwater impacts.

Losses of this BCH type will diminish the biomass of this specific BCH type present within each LAU. However, as the majority of the losses are within the sparse inland portion of this BCH type, this loss of biomass is likely to be low in the context of the overall LAU biomass. In addition, relative to adjoining mangrove habitats lower on the shore for example, samphire shrubland BCH in the LAUs (including the coastal habitats) are likely to comprise much lower AGB per hectare.

The biodiversity and abundance of in situ invertebrate fauna in those samphire shrublands BCH impacted by the Proposal is likely to be low – a consequence of the higher position on the shore with correspondingly higher soil salinities (SKM, 2013b). It is noted, however, that at high tide when the mudflats are inundated, the birds move into the intertidal area to forage in the inundated samphire shrublands and mangroves (refer to Section 12.5 for shorebird assessment).

Taking a precautionary approach in the absence of new data, the impacts to up to 39.4% of mapped samphire shrubland BCH would be considered locally significant and offsets are proposed to counterbalance the residual impact (Section 15).

### 8.5.5 Subtidal Benthic Communities and Habitat

A detailed assessment of the potential impacts on subtidal BCH from the Proposal is provided in O2 Marine (2025b; Appendix 3.1).

***Direct Disturbance***

The Proposal will result in the total disturbance of up to 47 ha of vegetated subtidal BCH within LAU 6 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; and
- 0.1 ha (<0.01%) of macroalgae-dominated habitat.

Up to 100 ha (0.18%) of Bare ‘unvegetated’ substrate (i.e., coarse sand) will also be directly impacted as a result of dredging and/or spoil disposal. This area will still be classified as bare substrate after the completion of dredging and spoil disposal (i.e., will not change) and so has not been considered further in this impact assessment.

Direct loss of subtidal BCH has been assessed in context with the indirect impacts described in Table 8-17. This cumulative assessment investigating other impacting projects is provided at the end of this section.

Table 8-17: Subtidal cumulative BCH loss within each LAU

| LAU | Description | Area (ha) & % of Pre-European Extent | Subtidal BCH | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 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 |
| LAU 1 | Pre-European Extent | ha | 686.8 | 38.3 | 520.8 | 36.3 | 93.5 | 16.3 | 0.1 | 14.5 |
| | Current Extent | ha | 671.1 | 38.3 | 520.8 | 8.3 | 93.5 | 16.3 | 0.1 | 14.5 |
| | | % | 97.7 | 100.0 | 100.0 | 22.9 | 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 | 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 |
| | Cumulative Loss | ha | 15.7 | 0.0 | 0.0 | 28.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | | % | 2.3 | 0.0 | 0.0 | 77.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| LAU 2 | Pre-European Extent | ha | 960.3 | 61.5 | 277.5 | 18.3 | 145.8 | 79.6 | 1.0 | 20.3 |
| | Current Extent | ha | 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 |
| | Irreversible Loss | ha | 1.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | | % | 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 |

| LAU | Description | Area (ha) & % of Pre-European Extent | Subtidal BCH | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 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 |
| | Cumulative Loss | ha | 1.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | | % | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **LAU 3** | Pre-European Extent | ha | 810.6 | 40.6 | 348.4 | 90.7 | 34.6 | 35.4 | 2.6 | 8.2 |
| | Current Extent | ha | 810.6 | 40.6 | 348.4 | 90.7 | 34.6 | 35.4 | 2.6 | 8.2 |
| | | % | 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 | 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 |
| | Cumulative Loss | 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 |
| **LAU 4** | Pre-European Extent | ha | 491.9 | 34.8 | 315.5 | 65.2 | 31.0 | 35.0 | 11.7 | 4.6 |
| | Current Extent | ha | 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 |
| | Irreversible Loss | 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 |
| | Recoverable Impact | ha | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |





| LAU | Description | Area (ha) & % of Pre-European Extent | Subtidal BCH | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 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 |
| | Cumulative Loss | 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 |
| **LAU 5** | Pre-European Extent | ha | 1472.6 | 100.9 | 363.3 | 301.3 | 40.8 | 84.2 | 46.3 | 252.4 |
| | Current Extent | ha | 1472.6 | 100.9 | 363.3 | 301.3 | 40.8 | 84.2 | 46.3 | 252.4 |
| | | % | 55.3 | 3.8 | 13.6 | 11.3 | 1.5 | 3.2 | 1.7 | 9.5 |
| | Irreversible Loss | 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 |
| | 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 |
| | Cumulative Loss | 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 |
| **LAU 6** | Pre-European Extent | ha | 2,215.0 | 332.3 | 223.1 | 1,750.2 | 358.9 | 1,086.8 | 758.8 | 1,337.9 |
| | Current Extent | ha | 2,215.0 | 332.3 | 223.1 | 1,750.2 | 358.9 | 1,086.8 | 758.8 | 1,337.9 |
| | | % | 27.2 | 4.1 | 2.7 | 21.5 | 4.4 | 13.4 | 9.3 | 16.4 |
| | Irreversible Loss | ha | 3.6 | 1.9 | 0.1 | 3.8 | 0.4 | 3.7 | 12.5 | 26.5 |
| | | % | 0.2 | 0.6 | 0.0 | 0.2 | 0.1 | 0.3 | 1.6 | 2.0 |





| LAU | Description | Area (ha) & % of Pre-European Extent | Subtidal BCH | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 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 |
| | Recoverable Impact | ha | 0.0 | 0.1 | 0.0 | 0.9 | 0.0 | 0.0 | 5.4 | 0.0 |
| | | % | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.7 | 0.0 |
| | Cumulative Loss | ha | 3.6 | 2.0 | 0.1 | 4.7 | 0.4 | 3.7 | 17.9 | 26.5 |
| | | % | 0.2 | 0.6 | 0.0 | 0.3 | 0.1 | 0.3 | 2.4 | 2.0 |
| **LAU 7** | Pre-European Extent | ha | 2,493.5 | 315.2 | 18.1 | 1,572.5 | 53.7 | 345.6 | 254.7 | 2,704.8 |
| | Current Extent | ha | 2,493.5 | 315.2 | 18.1 | 1,572.5 | 53.7 | 345.6 | 254.7 | 2,704.8 |
| | | % | 31.9 | 4.0 | 0.2 | 20.1 | 0.7 | 4.4 | 3.3 | 34.6 |
| | Irreversible Loss | 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 |
| | 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 |
| | Cumulative Loss | 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 |
| **LAU 8** | Pre-European Extent | ha | 6,161.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3,462.8 |
| | Current Extent | ha | 6,161.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3,462.8 |
| | | % | 64.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 36.0 |
| | Irreversible Loss | ha | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |





| LAU | Description | Area (ha) & % of Pre-European Extent | Subtidal BCH | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 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 |
| | 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 |
| | Cumulative Loss | 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 |
| **LAU 9** | Pre-European Extent | ha | 4,112.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1,240.5 |
| | Current Extent | ha | 4,112.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1,240.5 |
| | | % | 76.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 23.2 |
| | Irreversible Loss | 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 |
| | 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 |
| | Cumulative Loss | 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 |
| **LAU 10** | Pre-European Extent | ha | 3,868.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3,,741.5 |
| | Current Extent | ha | 3,868.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3,741.5 |





| LAU | Description | Area (ha) & % of Pre-European Extent | Subtidal BCH | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 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 |
| | | % | 50.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 49.2 |
| | Irreversible Loss | 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 |
| | 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 |
| | Cumulative Loss | 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 |
| **LAU 11** | Pre-European Extent | ha | 4,461.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1,622.4 |
| | Current Extent | ha | 4,,461.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1,622.4 |
| | | % | 73.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 26.7 |
| | Irreversible Loss | ha | 79.6 | 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 |
| | Cumulative Loss | ha | 79.6 | 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 |

| LAU | Description | Area (ha) & % of Pre-European Extent | Subtidal BCH | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 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 |
| LAU 12 | Pre-European Extent | ha | 22,495.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Current Extent | ha | 22,495.4 | 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 | 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 |
| | Cumulative Loss | 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 |
| LAU 13 | Pre-European Extent | ha | 5,890.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Current Extent | ha | 5,890.0 | 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 | 20.4 | 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 |





| LAU | Description | Area (ha) & % of Pre-European Extent | Subtidal BCH | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 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 |
| | Cumulative Loss | ha | 20.4 | 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 Extent** | ha | 56,120.0 | 923.6 | 2,066.7 | 3,834.5 | 758.3 | 1,682.9 | 1,075.2 | 14,409.9 |
| | **Current Extent** | ha | 56,104.3 | 923.6 | 2,066.7 | 3,806.5 | 758.3 | 1,682.9 | 1,075.2 | 14,409.9 |
| | | % | 100.0 | 100.0 | 100.0 | 99.3 | 100.0 | 100.0 | 100.0 | 100.0 |
| | **Irreversible Loss due to the Proposal** | ha | 105.2 | 1.9 | 0.1 | 3.8 | 0.4 | 3.7 | 12.5 | 26.5 |
| | | % | 0.2 | 0.2 | 0.0 | 0.1 | 0.1 | 0.2 | 1.2 | 0.2 |
| | **Recoverable Impact due to the Proposal** | ha | 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 | 0.5 | 0.0 |
| | **Cumulative Loss since Pre-European Extent** | ha | 120.9 | 1.9 | 0.1 | 31.8 | 0.4 | 3.7 | 12.5 | 26.5 |
| | | % | 0.2 | 0.2 | 0.0 | 0.8 | 0.1 | 0.2 | 1.2 | 0.2 |

***Introduced Marine Pests***

During dredging operations and marine construction activities, the Proposal will utilise vessels that will be brought to the marine waters in the vicinity of the Proposal from other ports within Australia and overseas. These vessels have the potential to transport IMPs which can potentially impact subtidal BCH (MScience, 2022). Refer to Section 8.5.1 for a detailed assessment of IMPs and potential impacts on subtidal BCH.

***Increased Sedimentation Resulting in Settlement and Smothering of Habitat***

Indirect impacts to subtidal BCH 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 (2021g), a dredge plume impact assessment was undertaken to develop predictions of the dredging ZoI, ZoMI and ZoHI for BCH in the vicinity of the dredging (O2 Metocean, 2025).

Within the Marine Development Envelope, the BCH at most 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). Indirect impacts to bare substrate are not predicted to occur as a result of dredging.

During baseline water quality monitoring in the Marine Development Envelope, the light and SSC conditions were found to naturally exceed the EPA (2021g) tolerance thresholds for coral and seagrass. However, the reported exceedances were generally confined to storm events when SSC is naturally elevated (O2 Marine, 2025b). Therefore, the EPA (2021g) thresholds for coral and seagrass were considered the most appropriate for impact assessment purposes. Furthermore, in the absence of published thresholds for macroalgae, the seagrass thresholds were considered to provide a conservative basis to evaluate potential impacts to macroalgae BCH, particularly as these communities are mixed across the majority of the Marine Development Envelope.

*Indirect Irreversible Loss*

Dredge plume modelling results for both coral and seagrass thresholds are shown in Figure 8-25. The results indicate that there will not be any indirect dredging ZoHI, and therefore there are no predicted indirect irreversible loss impacts for either coral or seagrass/macroalgae BCH. The ZoHI shown in Figure 8-25 is therefore limited to the direct disturbance footprint only.

It should be noted that due to the conservative nature of the threshold values used in the modelled predictions, the prediction of no indirect irreversible loss is considered to be conservative.

*Indirect Recoverable Impacts*

The worst case ZoMI for SSC was used to determine the extent of predicted recoverable impacts to subtidal BCH as a result of dredging. The area of recoverable impacts (i.e., ZoMI) for coral BCH is shown on Figure 8-25 Model results indicate that there are no impacts to seagrass/macroalgae. The estimated recoverable impacts to subtidal BCH as a result of indirect dredging effects are predicted to be 0.9 ha (0.1% of all LAUs) of coral reef BCH. It should be noted that due to the conservative nature of the threshold values used in the modelled predictions, these estimated recoverable impacts to subtidal BCH are considered to be conservative.

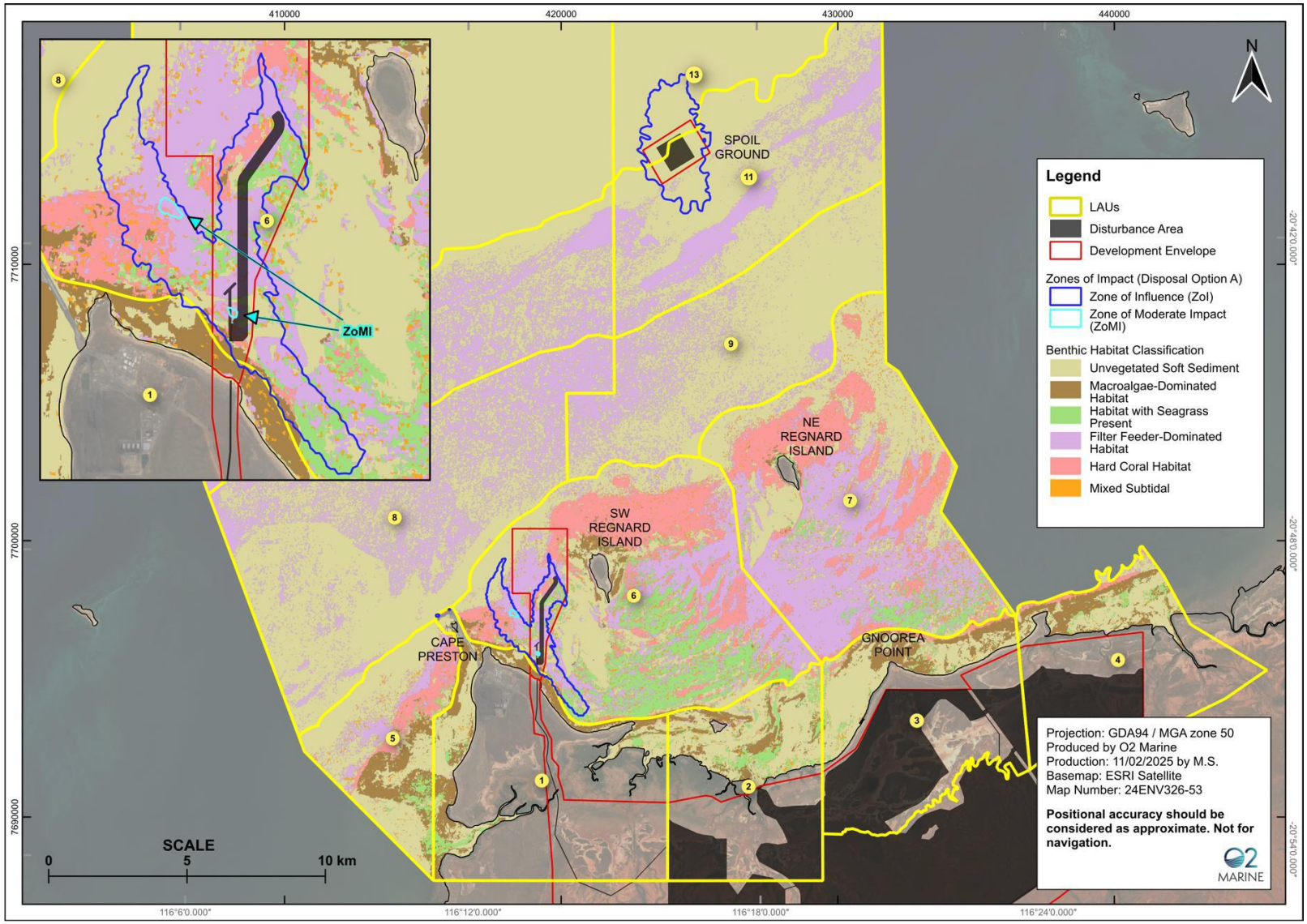



**Figure 8-25: Predicted area of direct and indirect impacts to BCH from dredging and dredge-related activities**

***Bitterns Disposal***

Indirect impacts to subtidal BCH will occur due to the discharge of hypersaline 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) (O2 Metocean, 2023a).

Following EPA guidance (2016d), bitterns outfall modelling (O2 Metocean, 2023a) was conducted based on previous WET testing (O2 Marine, 2019b). The modelling aimed to predict the spatial extent of the Low Ecological Protection Area (LEPA) and Moderate Ecological Protection Area (MEPA), based on achieving 80% and 90% SPL thresholds respectively, due to the water quality changes from the bitterns discharge. The LEP areas are presented within Figure 8-26. 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 original bitterns dispersion modelling basis. This will marginally reduce the LEPA and MEPA areas below those estimated in 2023, but that further modelling has not yet been undertaken.

Project-specific WET testing (Intertek, 2024a; Appendix 2.7) has been undertaken using a comparable bitterns solution further evaporated to match the predicted concentration for the Proposal. This testing arrived at results which were nominally equivalent to the previous estimates based on published data for the Mardie Project WET testing. Consequently there were no significant changes to LEPA and MEPA arising from this investigation.

Within the Marine Development Envelope, the BCH at most risk from indirect bitterns plume related impacts include coral, macroalgae, filter feeders and seagrass BCH. The impacts upon these BCH types will vary, being either plume toxicity impacts upon vulnerable life stages of certain species (in accordance with the specified SPL), or through alterations to the water quality through increased salinity or other physicochemical alterations (i.e., dissolved oxygen, pH etc.).

*Indirect Irreversible Loss*

Bitterns outfall modelling indicates that a 90% SPL will be achieved at the boundary between the LEPA and the MEPA. Discharge of hypersaline waste bitterns is predicted to result in an indirect irreversible loss of subtidal BCH that occurs within the LEPA.

The following estimated irreversible losses are predicted to subtidal BCH as a result of indirect effects of toxic bitterns (these losses are inclusive of the direct disturbance impacts (i.e., dredging) 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; and
- 1.9 ha (<0.1%) of subtidal area with no dominant habitat class.

*Indirect Recoverable Impacts*

No indirect impacts to subtidal BCH from bitterns discharge outside of the LEPA are predicted from the bitterns outfall modelling. Potential impacts in this area would primarily be due to changes in physicochemical water quality conditions caused by bitterns-induced vertical stratification leading to osmotic stress from elevated salt content or oxygen depletion and impacts to BCH. However, the bitterns outfall modelling does not predict vertical stratification occurring at known coral, seagrass or macroalgae communities.

***Leaks or Spills of Hydrocarbons or Chemicals***

A detailed assessment of leaks or spills of hydrocarbons or chemicals can be found in Section 8.5.1. To summarise this assessment, the risk of oil spills impacting subtidal BCH is not expected to be significant with the implementation of standard industry safeguards and operating procedures, as outlined in Section 1.3.

***Local Cumulative Loss Assessment – Coral Reef***

An irreversible loss of 3.8 ha (0.1%) of coral reef BCH is predicted to occur as a result of the Proposal across the total study area (all LAUs), resulting in a local cumulative loss of 31.8 ha (0.8%). O2 Marine (2025b) determined that the low-moderate coral predicted to be lost is well-represented throughout the LAUs and is 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 (O2 Marine, 2025d).

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

***Local Cumulative Loss Assessment – Filter Feeder/Macroalgae/Seagrass***

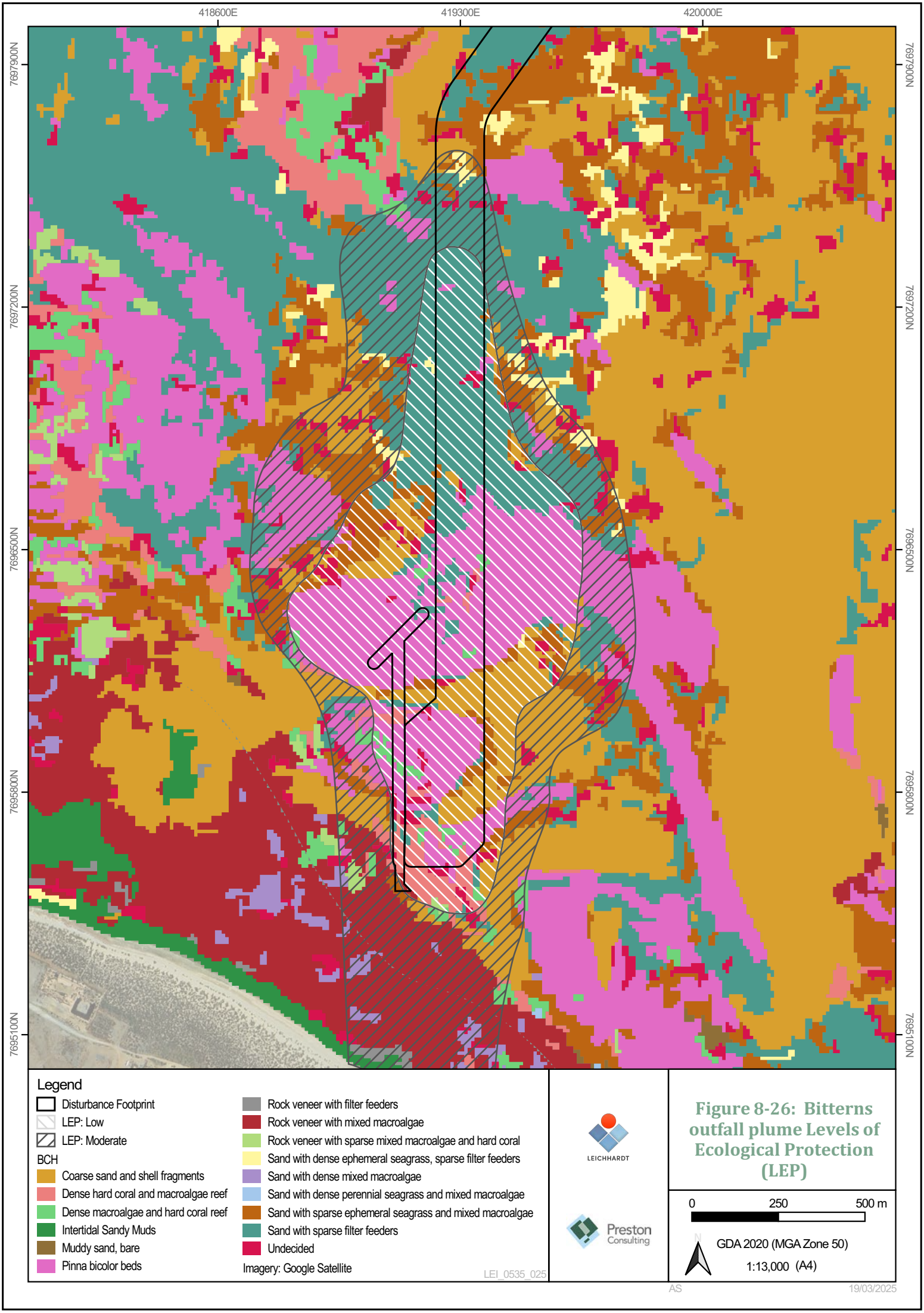
An irreversible loss of 12.5 ha (1.2%) of filter feeder BCH is predicted to occur as a result of the Proposal across all LAUs. The local cumulative loss is the same due to no historical loss. O2 Marine (2025d) determined that filter feeders are well-represented throughout the LAUs and are extensively well-represented throughout the region. Benthic filter feeder BCH in the vicinity of the Proposal is also comprised mostly of sparse communities. Although this BCH is also known to provide suitable habitat for a variety of marine fauna species, including commercially important species such as bluespotted emperor, the loss of 12.5 ha is not considered a significant risk to the ecological integrity and biological diversity in the LAUs.

An irreversible loss of 0.1 ha (<0.01%) of macroalgae-dominated BCH is predicted to occur as a result of the Proposal across the total study area (all LAUs). No irreversible loss of high cover (HC) macroalgae is predicted. Macroalgae is also 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%). O2 Marine (2025d) determined that the macroalgae BCH is well-represented throughout the LAU as well as 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 slopes of dredged areas). 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.

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 local cumulative loss of seagrass/macroalgae BCH is the same due to no historical loss. O2 Marine (2025d) determined that the seagrass/macroalgae BCH is well represented throughout the LAUs and the region generally. Seagrass BCH has been categorised into two distinct habitat types: 'Seagrass with Filter Feeders' and 'Seagrass with Macroalgae'. All of the 2,441.2 ha of seagrass mapped was identified as low to moderate benthic cover. This very small amount of local cumulative loss is well within the temporal range of abundance to this habitat type, 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 timeframes. 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. 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 type in the LAUs.


418600E
419300E
420000E
7697900N
7697200N
7696500N
7695800N
7695100N
Legend
Disturbance Footprint
LEP: Low
LEP: Moderate
BCH
Coarse sand and shell fragments
Dense hard coral and macroalgae reef
Dense macroalgae and hard coral reef
Intertidal Sandy Muds
Muddy sand, bare
Pinna bicolor beds
Rock veneer with filter feeders
Rock veneer with mixed macroalgae
Rock veneer with sparse mixed macroalgae and hard coral
Sand with dense ephemeral seagrass, sparse filter feeders
Sand with dense mixed macroalgae
Sand with dense perennial seagrass and mixed macroalgae
Sand with sparse ephemeral seagrass and mixed macroalgae
Sand with sparse filter feeders
Undecided
Imagery: Google Satellite
LEI_0535_025
LEICHHARDT
Preston Consulting
Figure 8-26: Bitterns outfall plume Levels of Ecological Protection (LEP)
0
250
500 m
N
GDA 2020 (MGA Zone 50)
1:13,000 (A4)
AS
19/03/2025

## 8.6 MITIGATION

Leichhardt has mitigated the potential impacts to this factor according to the mitigation hierarchy; avoid, minimise, rehabilitate, offset. Offsets are expected to be required for this factor, which is assessed in further detail in Section 15.

### 8.6.1 AVOID

The key avoidance mechanism implemented by Leichhardt was the design of the development envelopes to avoid key BCH where practicable. Leichhardt has conducted numerous ecological surveys and this information has been utilised to design the Proposal and its development envelope boundaries to avoid the following:

- Impacts to three dredge material disposal sites previously proposed, now just one in a new location with a smaller impact area(refer to Section 5);
- The majority of mangrove, higher productivity algal mats and tidal creek habitats (refer to Section 5); and
- The majority of the sandy beach north of the Proposal.

In addition to the above, impacts associated with large-scale dredging activities have been avoided by the use of a transhipment loading method.

### 8.6.2 MINIMISE

The following mitigation measures are proposed to ensure that direct and indirect impacts to BCH are minimised:

1. **Obtain and comply with the following approvals:**
    a. Ministerial Statement to be issued under Part IV of the EP Act;
    b. Works Approval and Licence to be issued under Part V of the EP Act for solar salt manufacturing (including bitterns disposal) and bulk material loading;
    c. MP to be approved under the Mining Act for activities on Mining Act tenure;
    d. MCP to be approved under the Mining Act for activities on Mining Act tenure. The MCP will describe the rehabilitation and closure of the Proposal, and associated management and monitoring proposed during the closure phase; and
    e. Development Application to be approved under the *Port Authorities Act 1999* for activities within PPA-managed lands and waters;
2. **The Key Proposal Characteristics (Section 2.3.2) provide several limits that were included to minimise impacts to BCH.** These include:
    a. Disturbance limits;
    b. Bitterns discharge limits;
    c. Dredging limits;
3. **Minimise disturbance within mangrove communities, with a particular focus on mangroves within the RSMA**;
4. **Implement the MEQMMP** (refer to Section 6 and Appendix 2.1);
5. **Implement the DSDMMP** (refer to Section 6 and Appendix 2.2);
6. **Implement the BCH Monitoring and Management Plan (BCHMMP; Appendix 3.8);**
7. **Implement an Hydrocarbon Spill Management Plan' (Appendix C of the MEQMMP)**. This Plan will be developed in consultation with PPA and will include:

   a. Refuelling procedures;
   b. Response equipment requirements;
   c. Response procedures and action plans for various spill scenarios;
   d. Reporting and responsibilities;
8. **The following controls will be used to minimise the risk of impact from unintentional brine pipeline spills**:
   a. Pipelines outside the pond footprints will be fitted with leak detection;
   b. Flows will be shut off if leaks are detected;
   c. Pipeline routes outside the pond footprints will be inspected regularly;
   d. Pipelines outside the pond footprints will mainly be located below ground;
   e. Where pipelines cross access roads they will be reinforced against traffic loading;
   f. Investigations will be conducted into the cause of any spills, and remedial actions will be taken to minimise the chance of reoccurrence;
   g. Spill response training to mitigate damage for site-based personnel;
9. **Ensure product infrastructure wash down water is captured and not released to the surrounding environment**;
10. **Minimise the risk of introducing marine pests by implementing the following measures**:
   a. All vessels should comply with Commonwealth Department of Agriculture and Water Resources – Biosecurity Requirements as well as all State legislation relating to management of introduced marine organisms;
   b. Any vessels visiting the Port of CPE from international or interstate waters are required to complete the WA DPIRD 'Vessel Check' risk assessment (https://www.vessel-check.com/);
11. **Maintain primary drainage corridors through or around the ponds** (refer to Section 6);
12. **Monitor erosion at the outlets of the drainage corridors after significant flow events and install erosion protection (i.e., rock baffles etc.) if required** (refer to Section 6);
13. **Verify inundation model within twelve months of the completion of the western pond walls to confirm indirect impact predictions associated with changes to tidal regimes** (refer to Section 6); and
14. **Implement GMMP, including monitoring of groundwater levels down-gradient of the concentration ponds and crystallisers to verify that the ponds will not result in the movement of hypersaline groundwater toward areas inhabited by mangrove communities** (refer to Section 6).

### 8.6.3 REHABILITATE

At the completion of the Proposal the site will be rehabilitated to reinstate BCH where appropriate. A MCP will be required to be enacted under the Mining Act. The key rehabilitation measures from the MCP that relate to BCH are summarised below:

1. Salts will be harvested from each crystalliser prior to closure;
2. Concentration pond walls will be flattened or opened up to allow tidal flows to enter the lower ponds;
3. All above-ground infrastructure will be removed if not retained by PPA or the landowner; and
4. All crystallisers will be rehabilitated to an acceptable landform.

An initial MCP is provided in Appendix 1.8. The MCP will be re-submitted to DEMIRS for assessment and approval prior to the construction of the Proposal and will be reviewed and revised every three years.

## 8.7 PREDICTED OUTCOME

The EPA's environmental objective for this factor is "to protect BCH so that biological diversity and ecological integrity are maintained". In the context of this objective "ecological integrity" is listed as the composition, structure, function and processes of ecosystems, and the natural range of variation of these elements (EPA, 2016d).

Intertidal BCH are important in primary and secondary productivity, as well as nutrient and carbon cycling in coastal environments. Given the scale and location of the Proposal, impacts to BCH are unavoidable. The Proposal will result in the loss of approximately 1,175.1 ha of intertidal BCH and 47 ha of subtidal BCH. The seaward BCH communities present, by far, the most ecologically valuable communities within the LAUs. The Proposal design was revised to avoid mangroves, resulting in only 8.3 ha of mangroves being disturbed.

The maximum estimate of irreversible loss of HDAM is 87.3 ha, or 12.5% of the total of this BCH type distributed across the intertidal LAUs. Algal mats are inferred to have the potential to act as important nutrient sources in the Pilbara intertidal BCH through their nitrogen-fixing properties in an otherwise nitrogen deficient system. The pond layout was revised to avoid large areas of algal mats, with a focus on conserving algal mats with higher productivity. As a result, the Proposal disturbance will reduce the overall productivity of algal mats within the LAUs by 11.2%.

Indirect impacts to BCH from dredging and bitterns disposal will be managed by a DSDMMP (Appendix 2.2) and MEQMMP (Appendix 2.1) respectively. It is anticipated that the requirement for a DSPMMP and MEQMMP will be a condition applied to the Proposal (if recommended for approval) and the plans will be updated to address comments through the assessment process.

With the implementation of controls, other indirect impacts to BCH are not predicted to be significant. Emissions from the construction and operation of the concentration ponds and crystallisers will be regulated under Part V of the EP Act (works approval and licence). Vessel hygiene (to prevent IMPs) is regulated by DPIRD.

At a local scale, and given the current uncertainty about algal mat significance, impacts to intertidal BCH are considered to be significant, even once mitigation measures are implemented. The Proposal is predicted to result in significant residual impacts to:

- Up to 8.3 ha of mangrove BCH, including losses within RSMA#9;
- Up to 87.3 ha of HDAM; and
- Up to 480.7 ha of samphire shrubland BCH.

Table 8-18 outlines how the ecological function, biological value and environmental quality of mangroves are maintained using the outcomes outlined in the Appeals Covenor Report to for the Optimised Mardie Project (Office of the Appeals Convenor, 2023).

Offsets are proposed to counterbalance the residual impact. These offsets are proposed in Section 15 and will be refined as further information and WAMSI research findings become available.

The environmental outcomes for this factor are therefore predicted to be:

- No adverse impact on the ecological function of the RSMA #9 or the maintenance of ecological processes which sustain mangrove habitats within RSMA #9;
- No adverse impacts on the broader ecological function of intertidal and subtidal benthic communities and habitats;
- No long-term (greater than five (5) years) net detectable loss of algal mat outside of the Proposal disturbance footprint from indirect impacts; and
- No loss of subtidal benthic communities and habitat (including subtidal algae) outside the LEPA and dredging Zones of Impact.

Based on the information provided in this assessment, and the Proposal is predicted to be able to meet the EPA's objective for this factor. The implementation of the proposed mitigation is expected to minimise the potential for significant residual impacts to BCH to a level where offsets are suitable and appropriate to counterbalance the residual impacts, as detailed in Section 15.

Table 8-18: Review of outcomes based on the Optimised Mardie Project Appeals Convenor Report

| Outcomes | Consideration | Avoidance Mitigation and Condition |
|---|---|---|
| Mangroves should not decline because of altered water flow or salinity (no significant alteration of tidal flow to mangroves with the key objective being to maintain existing tidal patterns) | The Proposal will result in alteration and reduction of tidal inundation due to the seawater intake and ponds | Avoidance measure:<br>• The final Proposal design includes a significant exclusion to the pond footprint to ensure these creeks continue to flow through to the ocean;<br>• The pond footprint was moved south to ensure the majority of tidal creeks are not intersected by the ponds. One exception is the intake creek where some direct impacts will be required.<br>Mitigation:<br>• There are no notable areas that will experience a significant change in tidal inundation duration as a result of the Proposal.<br>Condition:<br>• No change to extent of tidal inundation as a result of the ponds and sweater intake beyond predicted changes. |
| Existing groundwater flow, freshwater inflows and quality should be maintained in undisturbed mangrove areas | **Inland Waters**<br>• Risk from hypersaline seepage to groundwater; and<br>• Changed causeway design may change surface water /freshwater flooding for smaller intensity rainfall events.<br>**Benthic Communities and Habitats**<br>• Potential impacts to algal mats from changed freshwater flows (surface water and groundwater)<br>• Direct disturbance to samphire shrublands; significant residual impact to be offset<br>• Decrease in freshwater inundation to algal mat may require an offset in the future | Mitigation measures:<br>• Improved GMMP has developed preliminary triggers, thresholds and mitigation measures;<br>• More baseline groundwater data and modelling required to revise triggers and thresholds and develop mitigation measures;<br>• Potential mitigations are recovery bores to pump water away from impacted areas and reduce water or salinity levels.<br>Conditions:<br>• Adverse impacts to intertidal BCH limited to an area within 100 m of the ponds' walls;<br>• No development that would have an adverse impact on ecological function of BCH;<br>• Minimise impacts, detect early, contingency measures to address adverse impacts;<br>• Implement the BCHMMP;<br>• Implement GMMP and review within one year;<br>• Research offsets;<br>• BCHMMP (amongst other plans) to have contingency measures defined and implement if threshold or trigger criteria is met; and<br>• GMMP includes details and timing of hydrogeological investigations to provide detail of project's hydrological regime, inform monitoring and |

| Outcomes | Consideration | Avoidance Mitigation and Condition |
|---|---|---|
| | | management and mitigation actions and timing of bore installation and baseline data collection. |
| Mangrove decline should not occur as a result of wastewater, coolant water or runoff water discharge or irrigation, or from pollution | **Marine Environmental Quality**<br>• 400,000 m³ dredge volume;<br>• Increase turbidity, risk of spills from loading salt to port vessels; and<br>• Bitterns discharge of 5.9 GL/a. | Mitigation:<br>• Bitterns disposal, loading of product to be regulated under Part V of the EP Act; and<br>• Lower indirect sedimentation impacts on BCH from reduced size of zones of high impact and moderate impact from dredging.<br>Conditions:<br>• Define spatial locations for areas of low to high ecological protection for the bitterns disposal area; and<br>• Implement MEQMMP. |
| Sedimentation patterns should be maintained so that erosion and deposition within mangrove habitats is within natural variations | **Inland Waters**<br>• Risk of erosion and sedimentation as a result of constructed landforms | Avoidance measure:<br>• Ponds located largely outside of the intertidal zone.<br>Mitigation measures:<br>• Ponds to be designed to be safe and stable according to DEMIRS requirements under the Mining Act;<br>• Erosion and scouring of drainage and surface water diversion structures to also be regulated the Mining Act; and<br>• Monitoring of erosion by the proponent at outlets of southwest corridors after each significant flow event.<br>Conditions:<br>• Limit the volume and area subject to dredging; and<br>• Outcome condition that no changes health, extent or diversity of intertidal BCH (including mangrove, coastal samphire and algal mat) as a result of erosion. |
| There should be no significant loss of algal mats associated with mangrove areas | **Benthic Communities and Habitats**<br>• Up to 1,032.2 ha of disturbance to algal mats for the Proposal<br>• Indirect impact of reduction of freshwater flows<br>• Potential for changes to nutrient flows from groundwater changes due to pond seepage | Conditions:<br>• Limits direct impact to HDAM to an area of 87.3 ha<br>• Adverse impacts to intertidal BCH limited to an area within 100 m of the ponds walls;<br>• No development that would have an adverse impact on ecological function of BCH; and<br>• Minimise impacts, detect early, contingency measures to address adverse impacts. |

# 9 MARINE FAUNA

## 9.1 EPA OBJECTIVE

The EPA Objective for this key environmental factor is to protect marine fauna so that biological diversity and ecological integrity are maintained.

## 9.2 POLICY AND GUIDANCE

Relevant EPA and Commonwealth Government Guidance Documents for Marine Fauna are summarised in Table 9-1.

**Table 9-1: Policy and Guidance relevant to the Marine Fauna key environmental factor**

| Policy and Guidance | How guidance has been considered |
|---|---|
| **WA Government** | |
| Key EPA documents | |
| EIA (Part IV Divisions 1 and 2) Procedures Manual (EPA, 2024a). | This document has been considered in planning for the Part IV approval process and has been used to inform the preparation of this ERD. |
| Statement of Environmental Principles, Factors, Objectives and Aims of EIA (EPA, 2023a). | This document was considered in the preparation of this ERD and to inform EIA. It was used identify the Key Environmental Factors likely to be impacted by the Proposal and the EPA's objective for each factor. |
| Statutory Guideline for Mine Closure Plans (DMIRS, 2020a). | This document has been considered in the design and planning of the Proposal; it has also been considered in the preparation of mitigation measures for the Proposal. |
| EIA (Part IV Divisions 1 and 2) Administrative Procedures (EPA, 2024d). | This document has been considered in planning for the Part IV approval process and has been used to inform the preparation of this ERD. |
| Instructions on how to prepare EP Act Part IV Environmental Management Plans (EPA, 2024e). | This document was considered during the preparation of environmental management plans to support this ERD. |
| Relevant EPA Factor Guidelines | |
| Environmental Factor Guideline – Marine Fauna (EPA, 2016e). | This document was considered in the preparation of this section (Section 9) of the ERD. |
| Relevant EPA Technical Guidance | |
| Technical Guidance – Protection of BCH (EPA, 2016b). | This document was considered in the preparation of this section (Section 9) of the ERD. |
| Technical Guidance – Protecting the Quality of Western Australia's Marine Environment (EPA, 2016c). | This document was considered in the preparation of this section (Section 9) of the ERD. |
| Technical Guidance – EIA of Marine Dredging Proposals (EPA, 2021f). | This document was considered in the preparation of this section (Section 9) of the ERD. |
| National Light Pollution Guidelines for Wildlife (DCCEEW, 2023) | This document was considered in the preparation of this section (Section 9) of the ERD. |

| Policy and Guidance | How guidance has been considered |
|---|---|
| Environmental Assessment Guideline No. 5 – Protecting Marine Turtles from Light Impacts (EPA, 2010). | This document was considered in the preparation of this section (Section 9) of the ERD. |
| Other Policy and Guidance | |
| Status reports of the fisheries and aquatic resources of Western Australia 2020/21: State of the Fisheries (DPIRD, 2021a). | This document was considered in the preparation of this section (Section 9) of the ERD. |
| WA Environmental Offsets Policy (EPA, 2011). | This document was considered when determining whether offsets were likely to be required for the Marine Fauna environmental factor, and the adequacy of any proposed offsets. |
| WA Environmental Offsets Guidelines (EPA, 2014a). | This document was considered when determining whether offsets were likely to be required for the Marine Fauna environmental factor, and the adequacy of any proposed offsets. |
| WA Environmental Offsets Template (EPA, 2014b). | This document was considered when determining whether offsets were expected to be required for the Marine Fauna environmental factor. |
| WA Environmental Offsets Metric and relevant guidance (DWER, 2021b). | This document was considered when determining whether offsets were likely to be required for the Marine Fauna environmental factor, and the adequacy of any proposed offsets. |
| **Commonwealth Government** | |
| Key Documents | |
| Generic guidelines for the content of a draft EPBC Act PER/EIS (including the objects and principles of the EPBC Act, 1999; DotEE, 2016). | These documents were considered in the preparation of this ERD and while undertaking EIA. |
| EPBC Act Environmental Offsets Policy (DSEWPaC, 2012a) – including the Offset Assessment guide. | These documents were considered when determining whether offsets were likely to be required for the Marine Fauna environmental factor, and the adequacy of any proposed offsets. |
| Environmental Management Plan Guidelines (DotE, 2014). | This document was considered during the preparation of environmental management plans to support this ERD. |
| EPBC Act Condition Setting Policy (DAWE, 2020). | This document was used as guidance for the EIA and the development of mitigation measures and likely regulation of the Proposal. |
| EPBC Act Outcomes-based conditions policy (DotE, 2016a). | This document was used as guidance for the EIA and the development of mitigation measures and likely regulation of the Proposal. |
| National Assessment Guidelines for Dredging (DEWHA, 2009a). | This document was used during the development of the DSDMMP and the assessment of dredging impacts on marine fauna in this ERD. |
| Relevant Technical Guidance | |
| Relevant EPBC Act listed species specific survey guidelines and protocols. | These documents were used as guidance when undertaking surveys of EPBC listed species and potential survey limitations. |
| Relevant EPBC Act listed species specific Recovery plans, Threat Abatement Plans, Approved Conservation Advice and other documents. | These documents were used as guidance to assess and manage EPBC listed species that may be impacted by the Proposal. |
| Marine bioregional plan for the North-west Marine Region (DSEWPaC, 2012b). | This document was considered in the preparation of this section (Section 9) of the ERD. |
| National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (DotEE, 2017a). | This document was considered in the preparation of this section (Section 9) of the ERD. |

| Policy and Guidance | How guidance has been considered |
|---|---|
| Environmental best practice port development; an analysis of international approaches (GHD, 2013a). | This document was referred to during the review of the port design (noting that the CPE Port infrastructure is not part of this Proposal). |

## 9.3 RECEIVING ENVIRONMENT

The information in this section has been sourced from the following reports:

- Eramurra Solar Salt Project Introduced Marine Pest Risk Assessment (MScience, 2022; Appendix 3.4)
- Eramurra Solar Salt Project: Conservation Significant Marine Fauna Desktop Study (O2 Marine, 2025e; Appendix 4.1);
- Eramurra Solar Salt Project: Turtle Nesting Study Report (O2 Marine, 2022b; Appendix 4.2);
- Eramurra Solar Salt Project: Marine Turtle Monitoring 2022/23 (Pendoley Environmental Pty Ltd, 2023; Appendix 4.2);
- Eramurra Solar Salt Project: Marine Turtle Monitoring 2023/24(Pendoley Environmental Pty Ltd, 2024; Appendix 4.2);
- Technical Report Eramurra Solar Salt Project: Hatchling Orientation Monitoring and Nesting Habitat Assessment 2024/25 (Nocterra, 2025; Appendix 4.2);
- Eramurra Solar Salt Project: Benchmark Artificial Light Monitoring and Modelling (Pendoley Environmental Pty Ltd, 2022; Appendix 4.3);
- Eramurra Sawfish Risk Assessment Workshop Report (O2 Marine, 2022c; Appendix 4.4);
- Eramurra Sawfish Survey Field Report (O2 Marine, 2023a; Appendix 4.4);
- Eramurra Sawfish Survey (Morgan, D., 2025; Appendix 4.4);
- Fish and Fisheries Report Eramurra Solar Salt Project (O2 Marine, 2023b; Appendix 4.5);
- Eramurra Solar Salt Production: Identifying Potential Risks to Fisheries Values (Blueshift Consulting, 2025; Appendix 4.5); and
- Eramurra Solar Salt Project: Marine Fauna Underwater Noise and Shipping Risk Assessment (MScience, 2025; Appendix 4.6).

### 9.3.1 SURVEY EFFORT

***General Marine Fauna***

A comprehensive desktop review was undertaken by O2 Marine (2025e) to identify significant marine fauna species known or likely to occur. The desktop review included database searches as well as a comprehensive literature review. The literature review considered parameters aligned to the EPBC Act Significant Impact Criteria for Threatened and Migratory species (DotE, 2013) and the EPA's Environmental Factor Guideline for Marine Fauna (EPA, 2016e).

The results of the database searches and comprehensive literature review were used to conduct a likelihood of occurrence assessment (Section 9.3.4 and Table 6-4 in Appendix 4.1). This assessment identified that, based on its scale, location and marine habitat types, the Proposal posed a relatively low risk to marine fauna species other than turtles and sawfish (additional discussion on these species is provided below). A summary of key reports used to inform this desktop review is provided in Appendix C of the O2 Marine report (2025e).





Specific surveys targeting other marine fauna species were therefore not deemed to be warranted for this assessment.

***Marine Turtles***

Leichhardt commissioned O2 Marine to undertake a nesting beach survey using a remotely piloted aerial system (RPAS) between 2020 and 2022. The survey focused on defining which species were present and describing the nesting activity (O2 Marine, 2022b).

The survey area extended along the mainland, from east of Preston Island to the northeastern tip of 40-Mile Beach (Figure 9-1). Transects were placed on beaches likely to support turtle nesting which avoided mangroves and rocky inaccessible beaches through utilisation of satellite imagery. Survey flights were also conducted on South West Regnard Island and North East Regnard Island in 2022.

Five surveys were undertaken between December 2020 and January 2022 to capture peak nesting season for Green and Flatback turtles. The aim of each survey was to complete four flights of each beach within each survey. The survey dates were:

- 15 - 18 December 2020;
- 19 - 22 January 2021;
- 15 – 18 February 2021;
- 15 – 18 March 2021; and
- 18 – 21 January 2022.

Data captured during the survey included (refer to Figure 9-1 for locations):

- **Turtle Track Identification:** Each track is unique to individual turtle species and is therefore identifiable for abundance estimates and distribution estimates (Fossette et al., 2021). Turtles may also 'false crawl'. False crawls can be classified where an egg chamber is created but no eggs are laid or where turtles approach the beach to their potential nesting area regardless of whether any nest digging occurs. Evidence from these behaviours is defined as 'nesting activity'. Following Fossette et al. (2021) and associated DBCA methodologies, imagery was analysed by a single experienced and trained observer assessing each transect for the presence or absence of turtle tracks. Survey footage was reviewed using the software program QGIS, turtle tracks identified within a transect were marked as a feature and associated track information was recorded. Each track counted was assigned to a species and assessed for nest age and nesting outcome. Care was taken to avoid double counting duplicate images of the same track;
- **Species Presence:** Turtle species were identified from nesting tracks. This method is commonplace and considers a number of physical characteristics, including gait, track width, plastron drag, tail drag, and flipper mark characteristics (e.g., Fossette et al., 2021; Pendoley et al., 2016). When there was uncertainty in species identification (due to reduced track condition via weathering, or poor image quality), the track was defined as 'unknown';
- **Track Age:** Track age was categorised into fresh, recent and old, based on the position of the track in relation to the most recent high tide mark as well as the general condition of the track. Tracks were considered 'fresh' if they were made within the last 24 hours, 'recent' tracks were defined as made in the last 48 hours, any tracks older than that were listed as 'old';

- **Nesting Outcome:** Nesting outcome refers to the success of the nesting attempt and was determined by examining the apex of the track and assessing the activity and categorising the outcome into either false crawl, successful nest, or uncertain. False crawls were categorised by a turtle track with no digging, or what appeared to be unsuccessful digging (body pits), while a successful nest was recorded if a typical backfilled nest was evident. When a confident determination of nesting success could not be made, the outcome was classified as uncertain;
- **Beach Characteristics**: The observer noted characteristics for each beach which could affect nesting suitability, including human activity and beach topography. Beach width was determined in QGIS by measuring from the low tide line to start of the dune (indicated by scrub/vegetation line) observed from the georeferenced image taken at the time of survey. Four-wheel drive activity was recorded as a binomial presence/absence. Distance from light was measured from the nearest permanent light source by anthropogenic infrastructure in QGIS; and
- **Image Quality**: As part of quality control, and to inform an assessment of RPAs viability in data collection for turtle tracks, image quality was recorded post-processing. Transect images were rated as good, average or poor at the (experienced and trained) observer's discretion.

These initial surveys undertaken by O2 Marine were completed outside of the hawksbill turtle nesting window. Subsequently, Pendoley Environmental Pty Ltd (Pendoley Environmental) was commissioned to undertake additional and more comprehensive surveys in 2022/2023 and 2023/2024 that included the Hawksbill turtle nesting season. Six field surveys were undertaken at suitable nesting habitat on mainland and island beaches in October 2022 (Season (S) 1 Field Survey (FS) 1), January 2023 (S1/FS2), February 2023 (S1 FS3), October 2023 (S2 FS1), January 2024 (S2/FS2) and February 2024 (S2/FS3). The surveys were designed to target the peak nesting and hatching periods for Hawksbill (*Eretmochelys imbricata*), Flatback (*Natator depressus*), and Green Turtles (*Chelonia mydas*). All field surveys were a minimum of 14 days in duration, as per the recommendations of the National Light Pollution Guidelines for Wildlife (DCCEEW, 2023). For those surveys undertaken in October and January, the 14-day period represents the mean inter-nesting period for turtles in the North West Shelf Region, and nesting results can be used to estimate the relative annual index of marine turtle nester abundance for each species.

The Season 1 field surveys focused on four routine monitoring locations and four opportunistic monitoring locations (Figure 9-2). The routine monitoring locations included North East Regnard Island, South West Regnard Island, 40-Mile Beach, and CPE beach. Steamboat Island began as an opportunistic monitoring island in the October survey, however, became a routine monitoring location following identification of nesting activity from two days of opportunistic survey in October. The other opportunistic monitoring locations included Unnamed Island, Cape Preston West Beach, and Potter Island. A total of 45 survey days were undertaken for the 2022/23 nesting season.

The Season 2 field survey focused on four monitoring locations and two opportunistic locations (Figure 9-3). The routine monitoring locations included North East Regnard Island, South West Regnard Island and Steamboat Island. The opportunistic monitoring locations included 40-Mile Beach and CPE Beach. A total of 45 survey days were undertaken for the 2023/2024 nesting season.

Data captured during each survey included:

- **Track census:** Turtle tracks were located using an UAV that flew along preprogramed flight paths for FS1. Turtle tracks for FS2 and FS3 were largely located on foot at routine locations with the exception of 40-Mile Beach which was surveyed via UAV. Track census was completed entirely using an UAV during S2/FS1;
- **Turtle Species and Location:** A qualified marine scientist used track width, shape and orientation of flipper marks, tail drag marks, and displaced sand to identify the turtle species of each track;
- **Nesting Activity:** Nesting activity type was categorised as either:
    - Nest: The successful laying of a clutch of eggs;
    - Attempt female digging a nest but not laying eggs;
    - False Crawl;
    - Non-digging attempt and consequently non-clutch laying event by a female that crawled onto a beach before returning to sea;
    - Unknown: Nesting activity could not be determined from track characteristics; and
- **Hatchling orientation:** Hatchling fans were surveyed concurrently with on-foot track census for FS2 and FS3. Hatchling orientation was not assessed during S2/FS1. Species identification was ascertained using track characteristics including size and number of tracks as well as from the presence of hatchlings at the surface of nest cones.

Artificial light data was collected for Leichhardt in June 2022 at South West Regnard Island, North East Regnard Island, CPE and 40-Mile Beach (Pendoley Environmental, 2022; Appendix 4.3). An additional site was monitored during S1/FS2 (January 2023) at Steamboat Island. This was collected opportunistically after moderate turtle nesting activity was identified at Steamboat Island in S12/FS1, to form part of the benchmark light dataset for the Proposal.

In addition, Nocterra Pty Ltd completed a 15-day hatchling orientation survey in February and March 2025 which aligned with the peak hatching period for flatback turtles in the region and new moon period. Thus survey targeted the T3 section of mainland beach situated ~2 km to the southwest of 40-Mile Beach. This section, located west of 40-Mile Beach, had previously shown very low overnight nesting activity (one fresh track recorded over four days).

***Sawfish***

The likelihood of occurrence for sawfish species was informed by the sawfish risk assessment workshop (O2 Marine, 2022c), which involved subject matter experts from O2 Marine and Murdoch University. Emphasis was placed on species listed under the EPBC Act or BC Act. This was followed by a targeted sawfish survey designed and implemented by the Murdoch University Harry Butler Institute Freshwater Fish Group and Fish Health Unit and O2 Marine (2023a) in 2022. A further survey was designed and undertaken by the Murdoch University team in 2023 and 2024 (Morgan et.al., 2025; Appendix 4.4).

*Sawfish and prey species survey netting*

Fish sampling was undertaken from 23 - 25 August 2022, 7 – 10 October 2023 and 26 – 29 August 2024 using gill and seine nets from south of Cape Preston to Dampier Archipelago. Sampling included the setting of gill nets comprised of 150 mm monofilament stretched mesh.

Nets used were 50 - 60 m in length and with a depth of 2 m. Sawfish searches were also conducted by observers from the bow of the boat.

Netting for sawfish prey species was conducted by seine netting in shallow banks. Potential prey sampling utilised a combination of seine nets and composite gill nets. Gillnets were set perpendicular to the shoreline and checked at regular intervals or whenever evidence suggested that a fish had become entangled. Seine nets were deployed in a semicircle from the bank and pulled in immediately following deployment. Seine and cast netting occurred in the interval between the setting and retrieval of gill nets.

*Aerial surveys*

Visual surveys for sawfish were conducted using an UAV at the gill net locations as well as some opportunistic sites when travelling between the launch site and the tidal creeks (Morgan et.al., 2025). The majority of flights were conducted between 7:00am and 11:00am when windspeed was predicted to be lowest based on BoM data and to increase the likelihood of maximum visibility. If a sawfish was sighted, a video was then taken at ~5 m above sea level to determine if the sawfish had previously been tagged (a t-bar tag visible lateral to first dorsal fin), and to record any scarring or rostral teeth counts (for comparison to those individuals previously captured and tagged).

*Acoustic array*

An acoustic array of nine InnovaSea VR2W-69 kHz, single-channel receivers was installed prior to the fish sampling, to record sawfish that were tagged. They continuously monitor for and record tags emitting individual 'pings'. The array was distributed across the central Pilbara, from Mardie Creek in the south to west of Gnoorea Point (Figure 9-4), in areas likely to be utilised by sawfish. They were installed in shallow waters, avoiding depths that would be dry during low tide. An additional receiver was deployed (separate to Proposal surveys) in the mouth of the Fortescue River on 23 August 2022 and a light and temperature logger was attached to the mooring rope, immediately prior to this survey.

Two Green Sawfish were tagged with Innovasea V13TP acoustic tags, in the mouth of the nearby Fortescue River on 21 August 2022 (i.e., prior to the 2022 survey). Tags were inserted into the peritoneal cavity via a small incision on the ventral surface of the sawfish, anterior to the pelvic fins. Before deployment, each transmitter was tested using a VR2W acoustic receiver.




Figure 9-1: Location of marine turtle nesting monitoring sites (O2 Marine, 2022b)




Figure 9-2: Season 2 marine turtle nesting monitoring locations (Pendoley Environmental, 2024)

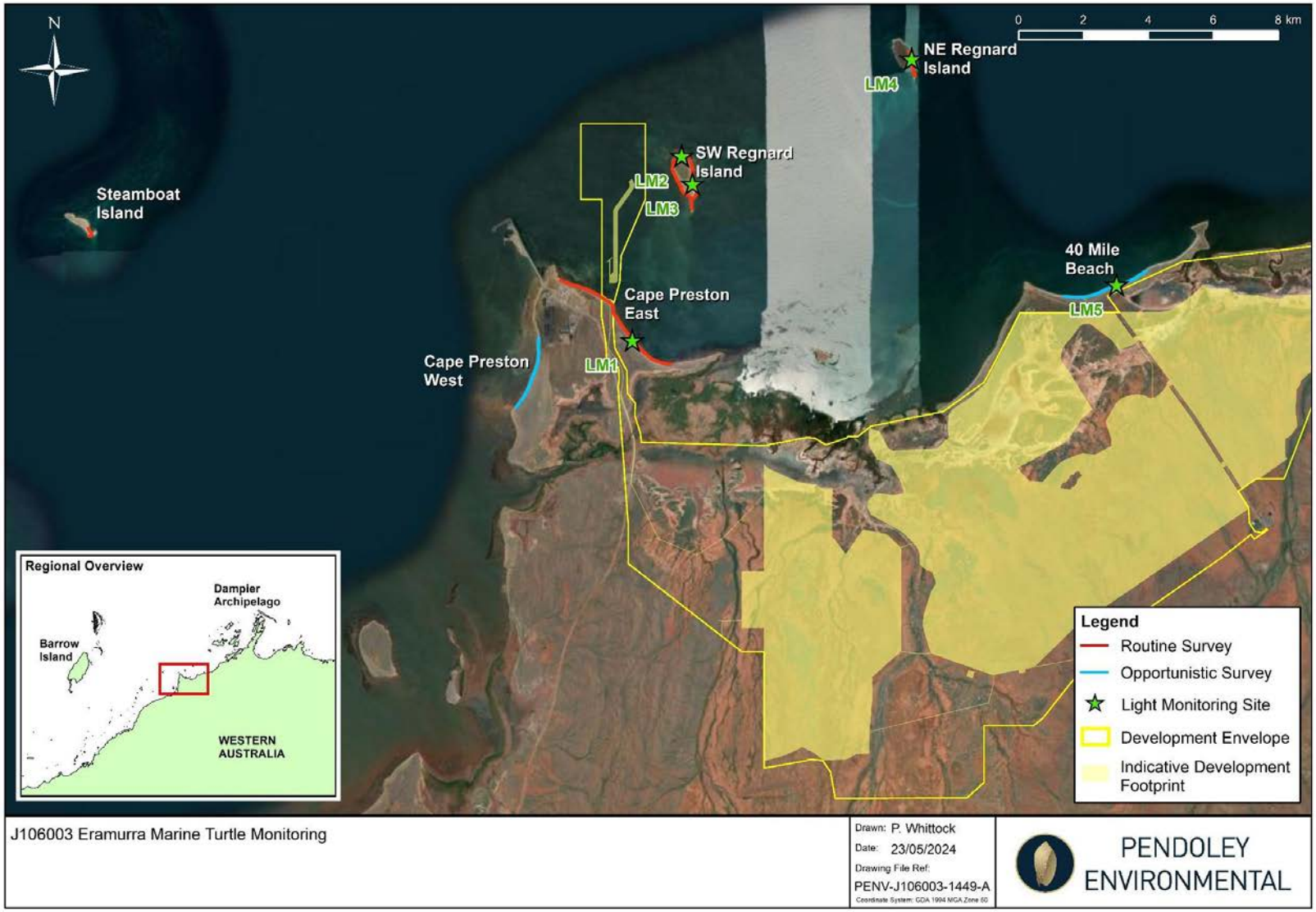
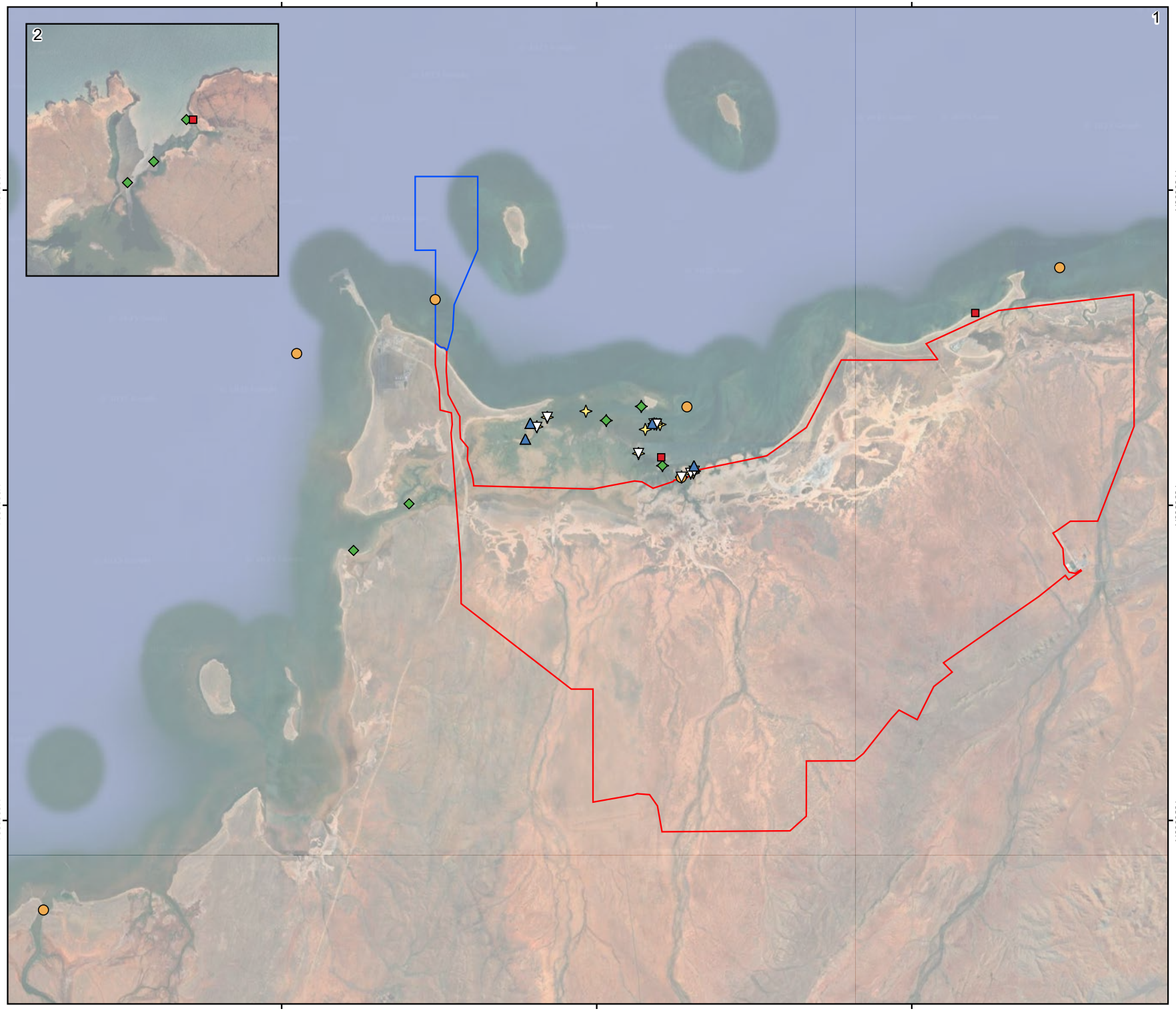


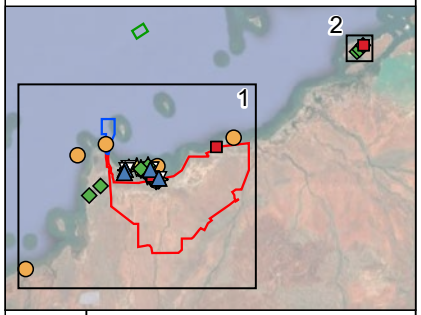

Figure 9-3: Season 2 marine turtle nesting monitoring locations (Pendoley Environmental, 2024)




## Legend

- Pond and Infrastructure Development Envelope
- Marine Development Envelope
- 2022 Seine Nets
- 2023 Seine Nets
- 2022 Gill Nets
- 2023 Gill Nets
- 2024 Gill Nets
- 2023 Acoustic Receivers

Imagery: Google Satellite




N

0 2 4 km

GDA2020 / MGA zone 50

1:160,000

Project: LEI_0535_024
Date: 17/03/2025
Size: A4
Author: ASmithers (Preston Consulting Pty Ltd)

**Figure 9-4: Sawfish survey locations**

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Preston Consulting

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### 9.3.2 HABITAT

A detailed description of the BCH present in proximity to the Proposal has been provided in Section 8.3.

BCH, such as seagrasses, macroalgae, coral reefs and filter feeders, support a high level of biodiversity, and these habitats are likely to attract higher order predators for foraging, such as coastal dolphins, turtles and sea snakes. A summary of the spatial overlap of Proposal elements and operations with local habitats is presented in Table 9-2, and an overview of marine fauna habitat in relation to associated BCH is presented in Table 9-3.

**Table 9-2: Spatial overlap between marine Proposal elements and operations, and habitats**

| Proposal Element / Aspect | Intertidal | Nearshore | Offshore | Islands |
|---|---|---|---|---|
| Seawater intake | Yes | Yes | No | No |
| Shipping channel | No | Yes | No | No |
| Bitterns | No | Yes | No | No |
| Spoil disposal ground | No | Yes | No | No |

**Table 9-3: Important marine fauna habitat associations (O2 Marine, 2025e)**

| Habitat type | Marine fauna |
|---|---|
| Seagrass beds | Dugongs and turtles are known to forage on seagrass beds. *Halodule* dominated seagrass meadows are known to support lactating female dugongs and their neonatal calves in the summer months. |
| Macroalgae | Macroalgae beds are an important component of the tropical subtidal ecosystem, contributing to the productivity of a system, and provides foraging and nursery habitat for commercially and ecologically important species. Macroalgae is consumed by herbivorous fishes, crabs, sea urchins, zooplankton and turtles.<br>Juvenile bluespotted emperor are directly associated with inshore (<10 m) macroalgae beds, along with seagrass, in the western Pilbara. |
| Tidal creeks and shallow intertidal zone | Sawfish and other elasmobranchs are known to forage in inshore marine waters, river mouths, embankments, and along sandy and muddy beaches. Further, creeks are known to provide pupping and nursery habitat for elasmobranchs. Shallow creeks and intertidal areas are known to provide refuge and foraging habitat for neonate and young juvenile green sawfish, the species almost exclusively uses shallow areas <1 m, often <20 cm. The Proposal's intake Creek appears to have high elasmobranch abundance. It is likely that this abundance is due to the high abundance of prey species (small teleosts) present within the creek. |
| Mangroves | Mangrove lined creeks are known to provide nursery habitat for juvenile green sawfish and juvenile green turtles. Green sawfish have a strong association with mangroves, providing shelter and foraging habitat. Juvenile green turtles are known to forage on mangroves and within mangrove lined creeks.<br>The mangroves communities in this area are of significant ecological and economic importance, supporting a large number of organisms such as snails, crabs, shrimps, oysters, barnacles, fish, and birds, and are highly productive nursery areas for many species, including fish, sawfish, marine turtles, and crustaceans. An assemblage of fishes and invertebrates utilise the food resources of mangals on a temporary basis. There are also some fish and invertebrate taxa whose adult populations are restricted to mangrove habitats, referred to as 'mangal obligates'. These mangrove habitats play a major role in supporting coastal food webs and nutrient cycles in the coastal zone and they are often an efficient sink for nitrogen, phosphorus, and silicon. |

| Habitat type | Marine fauna |
|---|---|
| Coral habitats | Short-nosed sea snakes primarily inhabit reef flats and shallow waters (<10 m depth) and leaf-scaled sea snakes are also a coral associated species. Coral trout are indirectly dependent on healthy, stable coral reef habitats. The Australian humpback dolphin is thought to predominantly occur within shallower coastal waters likely associated with foraging opportunities at coral reefs and shoals. |
| Sandy beaches | Sandy beaches, on the mainland and islands, in the Pilbara are known to provide nesting habitat for marine turtles. |
| Islands | In the waters surrounding the Proposal support a number of different islands, notably the Dampier Archipelago is located ~35 km from the Proposal. These islands are known to support a large diversity of marine fauna, including marine mammals, reptiles and elasmobranchs. |
| Nearshore waters | The Proposal is located within shallow nearshore waters, nearshore coastal waters are known to provide habitat for many coastal marine fauna species such as coastal dolphins, marine turtles, dugongs, elasmobranchs, sea snakes, and variety of fish, crustaceans, and invertebrates. |
| Offshore waters | The Proposal is located within shallow nearshore waters. There are no physical elements of the Proposal that overlap with the offshore subtidal environment. However, marine fauna species can be highly mobile and likely to move between offshore and nearshore subtidal environments, where operational vessels could potentially interact with mobile marine fauna. Adjacent to the Proposal the offshore waters are known to provide migration habitat for marine megafauna, namely the humpback whale, and the pygmy blue whale. |

The following sections describe the BCH that is considered important habitat for the relevant species.

### 9.3.3 Biologically Important Areas

Biologically Important Areas (BIAs) are spatially defined zones where aggregations of individuals of a species are known to display biologically important behaviours such as breeding, foraging, resting or migration (DCCEEW, 2022). A summary of marine fauna BIAs in proximity to the Proposal are presented in Table 9-4.

**Table 9-4: BIAs that spatially overlap the marine elements of the Proposal.**

| Species | Type | Marine Component |
|---|---|---|
| Humpback whale | Migration | Nearshore and offshore |
| Flatback turtle | Inter-nesting | Nearshore and offshore |
| Green turtle | Inter-nesting | Nearshore and offshore |
| Hawksbill turtle | Nesting | Offshore |

### 9.3.4 Marine Mammals

Information in this section has been sourced from O2 Marine (2025e) provided in Appendix 4.1.

An assessment was undertaken of the likelihood of occurrence for threatened marine mammal species identified through the desktop review. Threatened marine species are those listed under the EPBC Act, the BC Act and the International Union for Conservation of Nature (IUCN) Red List of Threatened Species. The results for the likelihood of occurrence assessment are presented in Table 9-5.

Table 9-5: Likelihood of occurrence for marine mammals

| Species | Distribution | Likelihood of occurrence |
|---|---|---|
| **Dugong (*Dugong dugon*)**<br>Marine, Migratory EPBC Act, Specially Protected BC Act, Vulnerable IUCN | Dugong range extends from East Africa to the western Pacific. Dugongs in Australia are the last great global stronghold. In Australia, dugong distribution and abundance vary along the northern coastline from Shark Bay in WA, into the Northern Territory and to Moreton Bay near Brisbane, Queensland. From satellite tracking of individuals and aerial surveys it appears that dugongs, like many other marine mammals, can move long distances, but the timing and length of movements vary individually. There has been a regional shift of dugongs from Exmouth Gulf and Ningaloo Reef to Shark Bay in response to large scale damage to seagrass meadows, from a tropical cyclone. | **High within nearshore waters**. No BIAs for dugongs overlap with the development envelopes, however they have been known to exist within the study area and throughout the Pilbara region. |
| **Australian Humpback Dolphin (*Sousa sahulensis*)**<br>Vulnerable, Migratory, Marine cetacean, EPBC Act, Priority 4 BC Act, Vulnerable IUCN | Australian Humpback Dolphins are found in shallow (<30 m deep) tropical/subtropical coastal waters of the Sahul Shelf including northern Australia and southern New Guinea. In the Pilbara, they have been recorded up to 50 km from the mainland, in areas associated with offshore islands. Australian Humpback Dolphins do not appear to undergo large-scale seasonal migrations, although seasonal shifts in abundance have been observed. The density of Australian Humpback Dolphins across North West Cape has been estimated at 0.09 - 1.09 individuals/km$^2$, which is higher than the density estimates for northern Australia of 0.1 - 0.19 individuals/km$^2$. | **High**. No BIAs have been recognised in the Pilbara for humpback dolphins, however, they are likely to move through the nearshore waters of the study area on occasions. Habitat suitability for the humpback dolphin was the highest for shallow intertidal waters, suggesting this could be important habitat for the species. |
| **Indo-Pacific Bottlenose Dolphin (*Tursiops aduncus*)**<br>- Cetacean EPBC Act, Near Threatened IUCN | Indo-Pacific Bottlenose Dolphins occur in tropical and sub-tropical, shallow waters from South Africa to the Red Sea and eastwards to the Arabian Gulf, India, China and Japan, southwards to Indonesia and New Guinea, and New Caledonia. Their shallow coastal habitats overlap with human activity and coastal development which exposes them to repeated and cumulative stressors that have potential to disrupt and displace individuals. Within Australia the species is restricted to inshore areas such as bays and estuaries, nearshore waters, open coast environments, and shallow offshore waters, around the whole Australian coast. Preliminary distribution models suggest that there could be habitat partitioning between Indo-Pacific Bottlenose and Humpback Dolphins. | **High**. This species been recorded throughout nearshore waters of the region, including the study area. Habitat suitability modelling for Bottlenose Dolphins was highest at greater depths further offshore. |
| **Humpback Whale (*Megaptera novaeangliae)***<br>Marine, Migratory EPBC Act, Conservation Dependent BC Act, Least Concern IUCN | The humpback whale migration route is generally within 200 km from shore. Important resting areas have been identified during the southern migration and include Augusta, Geographe Bay, Shark Bay, Exmouth Gulf and the southern Kimberley region:<br>Humpback whales have been recorded in high numbers throughout the area and surrounds. During their northern migration, the whales tend to remain further offshore (around 50 km offshore), than on their southern migration (around 35 km offshore). Humpback whale numbers during their northern migration peak offshore of the Dampier Archipelago, from the end of July to the beginning of August. Peak southern migration numbers occur from the end of August and the beginning of September. Data collected from satellite tagged whales found that | **High**. Humpback whales have been recorded in high numbers throughout the area and the humpback whale migration BIA overlaps with the development envelopes. Evidence for the expansion of the humpback whale calving grounds and resting behaviour of the whales observed in the Exmouth Gulf represent a proportion of the humpback whale population, with uncertainty of the humpback whale mother-calf behaviour at the study area. The assumption is that the whales |

| Species | Distribution | Likelihood of occurrence |
|---|---|---|
| | median distances from shore was less than 25 km and in shallow waters (<40 m water depth). During their southern migration, humpback whale cow-calf pairs travel close to the shore in shallow water depths (<30 m), likely to avoid attacks by sharks, killer whales, and threats from male humpback whales. Studies for the Wheatstone Proposal by the Centre for Whale Research recorded a substantial number of humpback whales further south of the Proposal area with highest numbers from mid-June onwards, the peak abundance being in August. | would display the same behaviours across the calving grounds. |
| **Pygmy Blue Whale (*Balaenoptera musculus brevicauda)*** - Endangered, Marine, Migratory, Cetacean EPBC Act, Endangered BC Act, Endangered IUCN | Blue whale sightings in Australian waters are widespread, and it is likely that the whales occur around the continent at various times of the year. Much of the Australian continental shelf and coastal waters have no particular significance to the whales and are used only for migration and opportunistic feeding. Pygmy Blue Whales are found off the coast of WA as they complete their northern and southern migrations. The highest densities of the Pygmy Blue Whales off the north--west WA coastline occurs between April and June during their northern migration and November-December during their southern migration. The Pygmy Blue Whale distribution BIA is large and extends from the coastline to far offshore. Studies in the Pilbara region and ecological knowledge from elsewhere suggests that pygmy blue whales are predominantly distributed in deep, offshore pelagic waters. During their northern migration they remain nearer to the coastline (~40-160 km) until they reach the North-West Cape, at which point they then move further offshore (~225-250 km) towards Indonesia. | **Low**. The pygmy blue whale distribution BIA is a broad area shown to overlap with the entire Pilbara coastal waters area. However, migrating whales are in fact much further offshore with data indicating a distance of some 250 km offshore. Tagging data showed that the whales have a preference for offshore waters, migrating along the coastal slope, with limited use of the continental shelf. During their northern migration the pygmy blue whales moved further offshore after they pass the North-West Cape. |

### *Whales*

The Marine Development Envelope and DSDDE overlap the Humpback Whale migration BIA. Humpback Whales of 'breeding stock D' migrate annually from Antarctic feeding grounds to the Kimberley coast for calving during the winter. Humpback whales are primarily a coastal species when migrating and the migration typically occurs within the 200 m bathymetry from the coastline. The migration route encompasses many different habitat types (e.g., seagrass, rocky seabed, sand). During their northern migration, the whales tend to remain further offshore (centred around 50 km), than the southern migration (centred around 35 km offshore).

### *Dugong*

Dugong (*Dugong dugong*) are found throughout the Pilbara region, particularly close to the coast or in the lee of reef-fringed islands and often in areas where seagrass has previously been recorded. Dugongs in Australia are an interconnected stock with a high level of gene flow, but with separate populations in the west and east coasts of Australia. Within WA, specific areas supporting Dugongs include Shark Bay, Ningaloo and Exmouth Gulf and the Pilbara coast. The largest Dugong population in WA is in Shark Bay, followed by the Exmouth Gulf, south of the Proposal.

They are relatively slow moving and can be difficult to detect which makes them susceptible to vessel strikes. In the Dampier Archipelago/Cape Preston region, small numbers of dugongs have been sighted in shallow, warm waters in bays and between islands, including East Lewis Island, Cape Preston, Regnard Bay, Nickol Bay and west of Keast Island. Drone surveys conducted around Regnard Island in May and November 2018 identified dugongs during each survey event (Said et al., 2025).

***Dolphins***

Humpback Dolphins inhabit shallow, coastal waters; typically, within 20 km of land and in water depths of less than 30 m. Australian humpback dolphins are generally found in small populations of 50 – 150 individuals. The Northwest Cape is thought to be an important habitat for the species with high levels of site fidelity and residence patterns observed. In WA they have been associated with coral reefs, with higher habitat suitability within intertidal areas. In the Pilbara, Australian Humpback Dolphins have been observed foraging in rivers, which could be an indication that rivers are an important habitat at a local scale and possibly used intermittently.

No studies have been undertaken for Bottlenose Dolphins at the Proposal, however, from opportunistic data collection during dugong aerial surveys undertaken for other Proposals, their numbers are likely to double those of Humpback Dolphins which is the pattern found elsewhere. Along the Northwest Cape, Indo-Pacific Bottlenose Dolphins have a density estimate of 2.4 - 2.8 individuals/km$^2$ and low site fidelity, suggesting the waters near the North West Cape are of high importance to the species (Haughey et al., 2020).

### 9.3.5 ELASMOBRANCH

Information in this section has been sourced from O2 Marine (2025e) and Murdoch University (Morgan et. al., 2025) provided in Appendix 4.1 and 4.4, respectively.

An assessment was undertaken of the likelihood of occurrence for Threatened elasmobranch species identified through the desktop review. The results for the likelihood of occurrence assessment are presented in Table 9-6.

**Table 9-6: Likelihood of occurrence for threatened elasmobranch**

| Species | Distribution | Likelihood of Occurrence |
|---|---|---|
| **Green Sawfish (*Pristis zijsron*)**<br>- Vulnerable EPBC Act, Migratory EPBC Act, Vulnerable BC Act, Critically Endangered IUCN | The known distribution of the Green Sawfish is from the Whitsundays in Queensland across northern Australian waters to Shark Bay in WA. They pup along the coast, from Shark Bay (at the mouth of Gascoyne River) and throughout the Kimberley to the Gulf of Carpentaria. However, their distribution is not clearly defined due to similar morphology causing confusion with other members of the genus who reside in similar habitats. They are known to primarily occur in inshore and offshore marine waters, or in shallow estuarine waters, however, they do not penetrate freshwater. They have a strong association with mangroves and mudflats. | **High**. Pupping is known to occur in the region for green sawfish, with the nearest known important pupping areas are at the Ashburton River delta. Pupping occurs after the wet season in northern WA, generally from late October to April. No BIAs have been identified for Green Sawfish around the Proposal.<br>A survey was undertaken in August 2022, October 2023 and August 2024 to identify the sawfish species present in the vicinity of the Proposal (O2 Marine, 2025e; Morgan et. al., |

| Species | Distribution | Likelihood of Occurrence |
|---|---|---|
| | | 2025). No sawfish were captured or tagged however one individual was detected during a UAV flight in the mouth of the intake creek in 2023. |
| **Narrow Sawfish (*Anoxypristis cuspidata*)**<br>- Migratory EPBC Act, Priority 1 BC Act, Endangered IUCN | Narrow Sawfish have been found from Onslow through to the northern Kimberley in Australia. Compared to other species, they are found in larger numbers offshore, preferring deeper waters. This is reflected in trawl fisheries bycatch in 50-200 m depth. However, they do occur in smaller numbers along the coast. | **Low**. Narrow Sawfish are found predominantly in offshore waters deeper than 40 m. Additionally, there are no identified BIAs for sawfish around the Proposal. |
| **Grey Nurse Shark (*Carcharias taurus*)** –<br>Vulnerable EPBC Act, Vulnerable BC Act, Vulnerable IUCN | The Grey Nurse Shark has a broad inshore distribution, primarily in cool temperate waters and southwest waters although they have been recorded as far north as the North West Shelf (NWS). Grey Nurse sightings collected from fisheries, divers, and charter boat operators, reported occasional sightings in the Exmouth/Muiron Islands, however sightings of the Grey Nurse Shark off the Navy Pier in Exmouth was the northernmost documentation of the western population of the Grey Nurse Shark. The study also indicated that the sharks have a temperature threshold of 24˚C, with sharks only being observed when the water temperature dropped below 24˚C. This is consistent with the east coast population, which spend 95% of their time in sea temperatures between 17 - 24 °C. | **Low**. The northern-most documented sighting of the species was in Exmouth, WA (which is 250 km southwest of the Proposal) and they are found to inhabit water temperatures that range from 17 - 24°C. The species temperature range is within the sea temperature range of the Proposal, which varies from 18 - 31.5°C. Grey Nurse Sharks may enter the development envelopes from time to time, but their occurrence is expected to be rare. |
| **Scalloped hammerhead shark (*Sphyrna lewini*)**<br>- Conservation Dependant EPBC Act, Critically Endangered IUCN | Scalloped Hammerhead Sharks occur globally in tropical and subtropical waters. In Australia, the species is found in NSW, QLD, the NT, and WA. Scalloped Hammerhead Shark distribution and populations are segregated by size and sex. In the waters off Australia the population is primarily small adult males and juveniles. Adult females are predominantly found in the waters off Indonesia and Papua New Guinea. This suggests a population structure where the female Scalloped Hammerhead Sharks migrate back to Australia to give birth in northern Australia nurseries. | **Low**. Similar to the grey nurse shark, the Scalloped Hammerhead may enter the development envelopes infrequently, but their occurrence is expected to be rare as this species is more likely to spend time foraging in adjacent deeper water areas where key ecological features (narrow shelf, canyons and the Exmouth plateau) facilitate upwelling and enhance local productivity. |
| **Whale Shark (*Rhincodon typus*)**<br>- Vulnerable, Marine, Migratory EPBC Act, Specially protected BC Act, Endangered IUCN | Globally, Whale Sharks are found throughout the three oceanic basins, including the Indian and Pacific oceans. The sharks form annual aggregations at Ningaloo with the peak occurring from March to July, coinciding with a pulse of coral spawning. Satellite tracking has revealed that whale sharks leaving Ningaloo remain relatively close to the coastline, showing a preference to warmer shallower waters, with a mean minimum distance of 1,667 km (±316 km) from Ningaloo. Reynolds et al. (2017) found that most of the tagged sharks travelled north or northeast from the Ningaloo marine park. The tagging results also showed homing movements of the Ningaloo whale sharks, with tagged sharks returning to the Ningaloo marine park. Of the 25 sharks tagged nine of the sharks returned to the northern end of the Ningaloo marine park after travelling more than 300 km, indicating high levels of site fidelity. These results suggested that the sharks are present all year round, not just during the seasonal aggregation. | **Low**. The approved CPE Port anchorage areas align with the inshore boundary of the Whale Sharks foraging BIA and is located approximately 50 km from the high-density foraging BIA of Ningaloo Reef. The shallow and flat bathymetric characteristics of the development envelopes do not represent preferred whale shark habitat. |

| Species | Distribution | Likelihood of Occurrence |
|---|---|---|
| **Giant Manta Ray (*Manta birostris*)** - Marine, Migratory EPBC Act, Marine, Migratory BC Act, Endangered IUCN | Giant Manta Rays are found throughout the Atlantic, Pacific and Indian Oceans, in tropical, subtropical, and temperate waters. Information on the global distribution of giant manta rays and their population sizes is lacking. | **Low**. Giant Manta Rays are rarely seen close to the coast due to their preference for offshore waters and have no BIAs or major population within close proximity to the Proposal. |
| **Reef Manta Ray (*Manta alfredi*)** - Marine, Migratory EPBC Act, Marine, Migratory BC Act, Vulnerable IUCN | Reef Manta Rays are distributed throughout the Pacific and the Indian Ocean. The Australian distribution is ~30°S on the east and west coast, with a continuous distribution north from Shark Bay (WA) (26°S) to the Solitary Island Marine Park (NSW) (26°S). The Ningaloo population exhibit a seasonal southernly shift in October. | **Medium**. Reef Manta Rays have no BIA or major populations within close proximity to the Proposal, however, due to their habitat preference being shallow waters in depths less than 20 m and their broadscale movements, is it possible for them to occur in the vicinity of the Proposal. |

### *Sharks*

Sharks are found in the nearshore environment where there is overlap of several Proposal elements such as the seawater intake, dredging areas, bitterns diffuser and spoil disposal ground. The Grey Nurse Shark, Scalloped Hammerhead Shark and the Whale Shark were identified as having a low likelihood of occurring in the development envelopes.

The WA population of the Grey Nurse Shark is genetically distinct from the east coast population. Prior to 1997 information from gillnet fisheries indicates that Grey Nurse Sharks were relatively abundant in temperate WA waters and that the population was stable. However, identification of Grey Nurse Shark aggregations in WA has been difficult and animals are encountered with low and indeterminate frequency making contemporary population estimates difficult.

No stock assessments are available for Scalloped Hammerhead Sharks in Australian waters or any of its regional neighbours. Given the limited stock structure data available there is a high likelihood, based on the available movement and tracking data, that the Scalloped Hammerhead Shark population in Australia is part of the same stock as occurs in other Oceanic nations.

Whale Sharks are abundant at Ningaloo reef with 300 - 500 resident individuals recorded through photo identifications (Meekan et al., 2006). The Indo-pacific Whale Shark population makes up 75% of the global population. The Ningaloo population is dominated by juvenile males, and there is mounting evidence that the WA whale shark aggregation site is a post-nursery site, where they visit to mature and forage.

### *Rays*

In Australia Giant Manta Rays are distributed on both the east and west coast. Their distribution is patchy, with majority of the Australian populations occurring at the Ningaloo Reef and Great Barrier Reef.

The global population of Reef Manta Rays can be found in tropical and subtropical waters through the Indian and Pacific Oceans, often in waters adjacent to islands and reefs. The Ningaloo population of Reef Manta Rays exhibit a seasonal southernly shift in October.





***Sawfish***

Five species of sawfish have been identified worldwide, four of these occur in Australian waters, including those of northern WA: Green Sawfish (*P. zijsron*), Narrow Sawfish (*A. cuspidate*), Dwarf Sawfish (*P. clavate*) and Largetooth Sawfish (previously known as the Freshwater Sawfish) (*P. pristis*).

The Largetooth Sawfish are generally found in the Kimberley, where the Fitzroy River is a globally important nursery. Adults are known to migrate down the whole Pilbara coast to the top of the Exmouth Gulf. Narrow Sawfish are found from Onslow up to the Northern Kimberley. They are commonly found offshore in deeper waters and are only occasionally present within the development envelopes. The Dwarf Sawfish are found within the Kimberley region (Morgan et al., 2021) and are not likely to be found south of Cape Keraudren, they have a very low potential to occur within the vicinity of the Proposal. The Green Sawfish has been identified by experts, Prof. David Morgan, and Dr. Karissa Lear, as having the highest likelihood of occurrence in the area.

*Green Sawfish (Pristis zijsron)*

There is limited information on current population sizes or trends in Australian waters for sawfish species, but there is evidence that all species have experienced recent population declines and some species are considered to have been extirpated from former parts of their range (DotE, 2015a). Green Sawfish populations in the Pilbara appear to be genetically distinct from other populations worldwide, with some clear morphological differences evident, including differing number and shape of rostral teeth. In the Pilbara, population studies exploring the connectivity for several sawfish species are ongoing, although it is hypothesised that for Pilbara Green Sawfish populations, the Dampier Archipelago may act as a natural barrier limiting genetic connectivity between western Pilbara and eastern Pilbara populations. The Ashburton River Delta is the only main pupping site known to be located coastally in the Pilbara, however it is suspected that the other large delta in the region, De Grey River Delta, may also be important. The Ashburton River Delta and surrounds are therefore critically important to the Green Sawfish population that may occur in the vicinity of the Proposal, and the recovery of the species globally.

There is significant uncertainty regarding the impact of existing Cape Preston Port infrastructure (as a barrier) on coastal sawfish movements and potential effect on Green Sawfish movements in each direction.

*Survey Results*

No sawfish were captured or tagged in 2022, 2023 or 2024. In 2022 over all creeks and net sets, 39.6 x 20 m net hours were fished (O2 Marine, 2023a). In comparison, a similar trip in October 2021 in the Onslow region averaged a Catch Per Unit Effort (CPUE) of 0.15 sawfish caught per 20 m of net per hour, equating to approximately six sawfish caught in the amount of gillnet effort conducted during the 2022 sawfish survey (O2 Marine, 2023a). The habitats surveyed included mangrove creeks and mudflats that appeared to be ideal sawfish habitat, similar to habitats where sawfish are found elsewhere in the region. The lack of sawfish recorded in the study indicates that the area may not be a major habitat or a pupping ground for any species of sawfish.

However, three Green Sawfish were captured immediately prior to the study at the mouth of the Fortescue River; two of which were tagged with acoustic tags and may enter the Eramurra acoustic array. These individuals, which were greater than 2 m total length, are of the size that have been shown to have a large home range (Morgan et al., 2017).

The sawfish pup captured at the mouth of the Fortescue River immediately prior to the survey suggests that there may be a slightly earlier pupping period there, in comparison to the Onslow population (generally October to December).

A single Green Sawfish (*Pristis zijsron*) was detected during the UAV flights in October 2023. This fish was observed feeding at the time during high tide. It was estimated to be of ~2.5 m total length and was identified as a Green Sawfish by the unique morphology of the rostrum. Following detection, it was observed for approximately 10 minutes. The last visual of the individual suggested that it swam upstream into the creek.

No sawfish were observed in 2024, however numerous other elasmobranchs were witnessed during the UAV flights. Although only one green sawfish was recorded in the surveys conducted between 2022 and 2024, the region between the south of Cape Preston and the Dampier Archipelago seem to meet the essential habitat requirements of this species. The area contains a wealth of shallow, estuarine and mangrove systems, which appear to be highly productive and therefore likely capable of supporting the critical life stages of the green sawfish (Morgan et.al., 2025). Furthermore, several other species of sharks and rays which are listed in threatened categories on the ICUN Red List of Threatened Species were also observed in this area The majority of encountered rays were observed in shallow waters with a depth of <50 cm, suggest that McKay Creek serves as an important habitat for sharks and rays (Morgan et.al., 2025).

### 9.3.6 Marine Reptiles

Information in this section has been sourced from O2 Marine (2025e) provided in Appendix 4.1.

An assessment was undertaken of the likelihood of occurrence for threatened marine reptile species identified through the desktop review. The results for the likelihood of occurrence assessment are presented in Table 9-7.

**Table 9-7: Likelihood of occurrence for threatened marine reptiles**

| Species | Distribution | Likelihood of Occurrence |
|---|---|---|
| **Flatback Turtle (*Natator depressus*)**<br>- Vulnerable, Migratory, Marine EPBC Act, Vulnerable BC Act | Flatback Turtles are distributed through tropical waters of northern Australia, Papua New Guinea, and Irian Jaya.<br>Nesting distribution of the Pilbara stock has been identified at the Montebello Islands, Mundabullangana Station, Barrow Island, Cemetery Beach, Dampier Archipelago (including Delambre Island and Huay Island), and coastal islands from Cape Preston to Locker Island. | **High** – Flatback, Hawksbill and Green turtles are the most likely to be present within the development envelopes and have been found to nest infrequently and in low density around the Proposal. |

| Species | Distribution | Likelihood of Occurrence |
|---|---|---|
| **Green Turtle (*Chelonia mydas*)**<br>- Vulnerable, Migratory, Marine EPBC Act, Vulnerable BC Act, Endangered IUCN | Green Turtles are distributed across tropical northern Australia waters. NWS stock Nesting distribution of the NWS stock has been identified at Adele Island, Maret Island, Cassini Island, Lacepede Islands, Barrow Island, Montebello Islands (all with sandy beaches), Serrurier Island, Dampier Archipelago, Thevenard Island, North West Cape, and the Ningaloo coast. | |
| **Hawksbill Turtle (*Eretmochelys imbricate*)**<br>- Vulnerable, Migratory, Marine EPBC Act, Vulnerable BC Act, Critically Endangered IUCN | Hawksbill Turtles are distributed globally in tropical, subtropical, and temperate waters. In Australia they are found in Queensland, the NT and WA.<br>Nesting distribution of the WA stock has been identified at the Dampier Archipelago (Including Rosemary Island and Delambre Island), Montebello Islands (including Ah Chong Island, Southeast Island and Trimouille Island), Lowendal Islands (including Varanus Island, Beacon Island and Bridled Island) and Sholl Island. | |
| **Loggerhead Turtle (*Caretta caretta*)**<br>- Endangered, Migratory, Marine EPBC Act, Endangered BC Act, Vulnerable IUCN | Loggerhead Turtles are distributed through tropical, sub-tropical and temperate waters throughout eastern, northern, and western Australia.<br>Nesting distribution of the WA Loggerhead Turtles has been identified at Dirk Hartog Island, Muiron Islands, Gnaraloo Bay and Ningaloo coast. | **Low**. They are infrequently spotted around the area during nesting with majority of their nesting occurring on South Pilbara beaches in Exmouth, WA. They migrate along the coast to their Kimberley foraging grounds and have no nesting BIA overlapping the development envelopes. |
| **Leatherback Turtle (*Dermochelys coriace*)**<br>- Endangered, Migratory, Marine EPBC Act, Vulnerable BC Act, Vulnerable IUCN | Throughout Australia the Leatherback Turtle utilises Australian coastal waters for foraging. Predominately found in central eastern Australia (Sunshine Coast to central NSW), southern-east Australia (Tasmania, Victoria, and eastern southern Australia) and southwestern WA. | **Low**. They have no known nesting sites within the Pilbara region, and no inter-nesting or foraging BIA within the development envelopes. Leatherback Turtles have occasionally been documented foraging in NWS waters but have rarely been observed in the Pilbara. Given the species wide geographical range they may occur from time to time. |
| **Short-nosed Sea snake (*Aipysurus apraefrontalis*)**<br>- Critically Endangered EPBC Act, Critically Endangered BC Act, Data Deficient IUCN | Short-nosed Sea Snakes are known to have a restricted range and have undergone a very severe reduction in numbers in the late 1990s and 2000s. They are rarely seen in locations other than Ashmore Reef and a few places in northwest Australian coastal waters. D'anastasi et al. (2016) completed extensive field surveys of coastal WA and Scott Reef. They captured five live Short-nosed Sea Snakes in the Exmouth Gulf and spotted a courting pair at Ningaloo Reef. Habitat suitability threshold modelling has identified a new potential distribution that extends from the Exmouth Gulf and around the Murion Island to the Montebello Islands Marine Park, suggesting that they could possibly occur on coral reefs adjacent to islands around the Proposal. | **Moderate**. Short-nosed Sea Snakes are rarely seen in locations other than Ashmore Reef, Exmouth Gulf and around Muiron Island to the Montebello Islands (D'anastasi et al., 2016). Habitat suitability is 50% in the waters surrounding the development envelopes. Therefore, there is a moderate likelihood of occurrence. |
| **Leaf-scaled Seasnake (*Aipysurus foliosquama*)**<br>- Critically Endangered EPBC Act, | Intensive field surveys, habitat data, and molecular genetic studies documented records of living Leaf-scaled Sea Snakes (n = 16) in coastal WA. There has been a significant increase in their known geographic range and habitats to include seagrass meadows in | **Moderate**. There have been low numbers of Leaf-scaled Sea Snakes recorded at Shark Bay, Ashmore Reef, and Barrow Island. However, the |

| Species | Distribution | Likelihood of Occurrence |
|---|---|---|
| Critically Endangered BC Act, Data deficient IUCN | subtropical Shark Bay (latitudes 24.5°S to 26.6°S). Morphological variation and mitochondrial sequencing was utilised to confirm that specimens of the sea snake found at Barrow Island were not vagrants as previously suspected but instead represent separate breeding populations (at Barrow Island). Habitat suitability threshold modelling has identified a new distribution within coastal regions of Shark Bay and Barrow Island, which suggests that they could possibly occur on coral reefs adjacent to islands around the Proposal. | species niche model (Udyawer et al. 2020) indicates a 50% or greater possibility of habitat suitability in the waters surrounding the Proposal and therefore there is a moderate likelihood of occurrence. |

### *Turtles*

The following information has been sourced from Pendoley Environmental (2023 & 2024) and O2 Marine (2025e).

It is acknowledged that, during O2 Marine's survey, there were survey effort limitations for Hawksbill Turtles and offshore islands, with surveys being undertaken outside of the Hawksbill nesting window. O2 Marine determined that South West Regnard Island, North East Regnard Island and beaches on the mainland could potentially represent nesting habitat for turtle species (Flatback, Green and Hawksbill Turtles).

*Monitoring Season 1 – 2022/2023*

Three field surveys subsequently undertaken by Pendoley Environmental between October 2022 and February 2023 on beaches on the mainland coast and islands offshore from the Proposal found that Hawksbill nesting activity accounted for the greatest number of tracks in the overall monitoring period (Figure 9-5). The highest density of nesting activity occurred on South West Regnard Island, particularly along the northern shoreline of the island. Overall nesting success (the number of successful nests as a percentage of the total number of overnight tracks) was low for Hawksbill Turtles in the first field survey at 15%, meaning the majority of Hawksbill tracks represented unsuccessful nesting attempts (53%) or false crawls (32%). Flatback and Green Turtle nesting was found to be present but marginal when combined for all routine monitoring beaches.

Track census results showed that Flatback and Green turtles only utilised the islands for nesting activity in January and were not found on the mainland beaches (40-Mile and CPE Beach) in close proximity to the Proposal. Low levels of Flatback turtle activity were identified at both Steamboat and South West Regnard Island during the January survey period. Green Turtle activity was also only noted during January however two nests were recorded, one at North East Regnard Island and one at Steamboat Island.

Nest fans indicated marine turtle hatchlings successfully oriented seaward after emergence at South West Regnard Island, North East Regnard Island, and CPE beach. At Steamboat Island, the majority of fans occurred on the southernmost spit, and as a result had much larger spread and offset angles. Emergence patterns on island spits are typically irregular, due to the presence of the ocean across multiple bearings to the nest cone, and the position of the nest further back on the beach. Despite this, the nest fans at Steamboat Island also indicated that hatchlings oriented seaward.





Steamboat Island was in the top three monitored locations for sky brightness, behind CPE (brightest) and equivalent to the eastern beach of South West Regnard Island. Sino Iron's export facility at Cape Preston was the largest contributor to visible artificial light at Steamboat Island.

*Monitoring Season 2 – 2023/2024*

Three field surveys have been commissioned for the 2023/2024 monitoring period. One field survey was undertaken in October 2023 with the remaining two surveys undertaken in January and February 2024 (Pendoley Environmental, 2024).

FS1 recorded 47 overnight Hawksbill Turtle tracks, including eight false crawls, 22 attempts, and 17 nests (Figure 9-5). The nesting success rate for this species during the peak of the nesting season was 36.2%. One track (false crawl) from an unknown species was also recorded on North East Regnard Island. No tracks from other marine turtle species were recorded.

FS2 recorded 11 overnight Hawksbill Turtletracks, including eight attempts and three false crawls, and no nests which was lower compared to 2022/23. Six Flatback Turtle tracks were recorded which included three nests, one attempt, and two false crawls, resulting in a nesting success rate of 16.7% which was lower compared to 2022/23 (28.5%). Three Green Turtle tracks were also recorded, consisting of two nests and one false crawl, making the nesting success rate 66.7% for this species.

FS3 recorded 12 overnight Hawksbill Turtle tracks, including one nest, eight attempts, and three false crawls, resulting in a nesting success rate of 8.3%. One Flatback Turtle nest was also recorded, with no other tracks, making the nesting success rate 100% for this species.

Hawksbill nesting activity accounted for the greatest number of tracks in the overall monitoring period. The highest density of nesting activity occurred on the south-east side of Steamboat Island. Overall nesting success was high for Hawksbill Turtles in FS1 at 36.2%, meaning the majority of Hawksbill Turtle tracks represented unsuccessful nesting attempts (47%) or false crawls (17%). Flatback and green turtle nesting was found to be present but marginal when combined for all routine monitoring beaches.

The results of the 2022/23 and 2023/24 monitoring seasons indicated that South West Regnard Island supports more Hawksbill Turtle nesting than the adjacent mainland at CPE and nearby North East Regnard Island.

Nest fans indicated marine turtle hatchlings successfully oriented seaward after emergence at South West Regnard Island, North East Regnard Island, and CPE. At Steamboat Island, several nest fans occurred on a sand spit, and as a result had much larger spread and offset angles. Emergence patterns on island spits are typically irregular, due to the presence of the ocean across multiple bearings to the nest cone, and the position of the nest further back on the beach. Despite this, the nest fans at Steamboat Island also indicated that hatchlings oriented seaward (Pendoley Environmental, 2024).

In addition, Nocterra Pty Ltd completed a 15-day hatchling orientation survey in February and March 2025 which aligned with the peak hatching period for flatback turtles in the region and new moon period. Thus survey targeted the T3 section of mainland beach situated ~2 km to the southwest of 40-Mile Beach. This section, located west of 40-Mile Beach, had previously shown

very low overnight nesting activity (one fresh track recorded over four days). The report prepared by Nocterra Pty Ltd (Nocterra, 2025; Appendix 4.2) advised that no turtle activity was recorded on the mainland beach referred to as 'T3'. There was also no evidence of adult turtle nesting activity, including the presences of historical nesting 'craters'. This is likely a combination of naturally low turtle usage in the area, unsuitable conditions for the successful incubation and hatching of any nests that may have been laid and inundation of existing nests from high seas following the close passage of Tropical Cyclone Sean in January. The result of the nesting habitat assessment indicate that much of the T3 beach is unlikely to provide suitable nesting habitat for flatback turtles (Nocterra, 2025).

Prior to the comprehensive surveys undertaken by Pendoley Environmental (2023 & 2024), O2 Marine (2022b) undertook some preliminary survey work predominantly focussed on the mainland. While outside of the Hawksbill peak nesting period, these drone surveys also noted that Flatback and Green turtles were found to infrequently nest in low densities on the mainland throughout the survey period.

Generally, Pilbara islands are recognised as being important for turtle nesting. At broad spatial and temporal scales, islands in the Pilbara have been found to be more important for nesting than the mainland. However, habitat characteristics, and therefore nesting importance, varies across islands.




Figure 9-5: Turtle nesting monitoring results (2022/2023 and 2023/2024)

***Sea Snakes***

The Short-nosed Sea Snake (*Aipysurus apraefrontalis*) is typically found in reef flats or shallow waters along the outer reef edge. The species has been observed during daylight hours, resting beneath small coral overhangs or coral heads in 1 - 2 m of water. Very few Short-nosed Sea Snakes moved even as far as 50 m away from the reef flat.

The Leaf-scaled Sea Snake occupies protected parts of reef flats, adjacent to coral and coral substrates, generally found in <10 m depths. They can be found in exposed tidal pools and are able to tolerate high water temperatures. The species have a restricted geographical range of <10 $km^2$.

The species niche model (Udyawer et al. 2020) indicates a 50% or greater possibility of habitat suitability for both species in the Proposal area. This is based on the habitat description and the mapped subtidal BCH types within the study area, (Figure 8-20). Given the species high conservation value and suitable habitat within the Proposal area, both species are considered to have a medium likelihood of occurrence. (relevant it could be present, it should be considered a key species

### 9.3.7 FISH

Information in this section has been sourced from O2 Marine (2023b) provided in Appendix 4.5.

The nearshore area of the North Coast Bioregion contains a low to moderate abundance of finfish, with species richness typically ranging from low nearshore to high further offshore. Marine species within the nearshore area are predominantly tropical and are short-lived with high productivity, resulting in life-history traits of high fecundity, high productivity and high input into reproduction during their relatively short life spans. Key fish species such as the southern bluefin tuna are found in the nearshore and offshore environment.

Southern Bluefin Tuna are migratory fish, crossing the Pacific, Atlantic and Indian Ocean during their annual migration. Southern Bluefin Tuna typically occur in waters between 30 – 50° S. Every year between September and April, adult Southern Bluefin Tuna (aged 11 - 12 years) migrate from southern feeding areas to their single identified spawning ground in the waters south of Indonesia. When migrating to their spawning grounds individuals are found close to the coastline, with approximately 84% of their time spent in the Australian Fishing Zone (Commonwealth waters, generally from three nautical miles to 200 nautical miles from the Australian coast).

Southern Bluefin Tuna have a 'low' likelihood of occurrence within waters of the development envelopes. They are deep ocean migratory fish species and unlikely to be nearshore. Spawning habitat does not exist in the development envelopes, and it is unlikely that foraging grounds are restricted to these areas.

Additional information about commercial fishery species is provided in Section 9.3.12.

### 9.3.8 INVERTEBRATES

A diverse range of marine invertebrate fauna exists in the Pilbara region, comprising of mostly tropical species associated with macroalgal communities. These macroalgal communities are supported by coral reefs, mangroves and subtidal sand and soft bottom habitats. Mangrove communities are known to support a range of invertebrate fauna.

The intertidal mud and sand flat burrowing invertebrate fauna are abundant and species-rich, which is extremely important as a food source for migratory birds. The benthic fauna is typical of the coastal habitats of the Northern Australian region with the suite of endemic coastal species well represented.

### 9.3.9 INTERTIDAL MARINE FAUNA COMMUNITY

The intertidal zone at the Proposal encompasses foreshore mudflats of the LAT level to the intertidal habitats of highest astronomical tidal level (HAT). Certain species of mobile marine fauna are known to move between these habitats and nearshore coastal waters. Shorelines are comprised of both rocky and sandy shores (O2 Metocean, 2023b).

The mangroves communities in this area are of significant ecological and economic importance, supporting a varied number of organisms such as snails, crabs, shrimps, oysters, barnacles, fish, and birds, and are highly productive nursery areas to many species including fish, sawfish, marine turtles and crustaceans (DBCA, 2020; DSEWPaC, 2012b).

Tidal creeks are considered critical feeding and reproduction habitats for marine species such as fish, crustaceans, turtles, rays and sawfish (DBCA, 2020). Tidal creeks form the base environment for mangrove communities and all the associated fauna that utilise this vegetated habitat (insects and birds etc.).

Algal mats were observed to typically occur adjacent to samphire shrublands and be centralised between mudflat areas on both the seaward and landward side; mudflats/samphire mudflats on the seaward edge and mudflat/salt flats on the landward edge. Algal mat analysis identified six taxa recorded across the study area, dominated by filamentous cyanobacteria *Lyngbya* sp. then *Coleofasciatus chthonoplastes* and *Schizothrix* sp.

Other studies from the Pilbara region have also concluded that, other than to support algal and bacterial communities, algal mats do not tend to support any particular marine fauna species that are solely reliant upon them, apart from opportunistic grazing on the seaward boundary by crabs and some fish species during high tides (Paling, 1990; Biota, 2005; URS, 2010).

### 9.3.10 SUBTIDAL MARINE FAUNA COMMUNITY

The subtidal nearshore zone extends from the intertidal foreshore mudflats of the CPE coast to approximately the 20 m isobath and includes several small coastal islands (O2 Marine, 2025d). The subtidal habitat classes include bare sand, coral reef, mixed filter feeders, subtidal macroalgae, seagrass and silt. The area represents migratory habitat for the Humpback Whale.

South West Regnard Island, North East Regnard Island and beaches on the mainland could potentially represent nesting habitat for turtle species (Flatback, Green and Hawksbill turtles).

Seagrasses and macroalgae provide essential habitat and food sources for Dugong, fish, turtles, and benthic invertebrates. In addition, with coral reefs and filter feeders, these BCH support a biodiversity of marine fauna that attract higher order predators for foraging such as significant coastal dolphins, turtles and sea snakes. Macroalgae habitat, such as the *Sargassum* dominated reefs, have also been suggested to form an important stage of the lifecycle for key commercial and recreational fishery species such as the bluespotted emperor (*Lethrinus hutchinsi*).

Macroalgae contribute to the productivity of marine ecosystems as they are a photosynthetic primary producer, which provide an important habitat for invertebrates, fish and birds, and an important source of food and of decomposition products (Olsen et al., 2019). However, macroalgae differ from other marine plants such as seagrasses and mangroves in that macroalgae lack differentiated tissues such as roots, leafy shoots, flowers, and vascular tissues. Additionally, some algae (such as *Halimeda* sp. and other Rhodophytes) are important sediment producers and contribute towards the cementation and binding of materials with calcium carbonate, thereby creating hard substrate habitats for other organisms (Jones & Desrochers, 1992).

Coral has a strong importance in adding complexity to BCH. Besides coral and seagrass communities, the shallow marine environments of the Pilbara harbour a diverse range of other benthic invertebrates, including ascidians, sponges, hydrozoans and soft corals, however little is known about their distribution and abundance.

### 9.3.11 INTRODUCED MARINE PESTS

This section has been sourced from MScience (2022, Appendix 3.4) unless stated otherwise.

Introduced Marine Species (IMS) are animals, plants, algae and other biota existing in a region beyond their natural geographical range, to which they have generally been translocated by human activity. Australia currently has over 250 known IMS, but only a small proportion have become Introduced Marine Pests (IMPs) (O2 Marine, 2020b). IMPs are IMS that harm the marine environment, social amenity or industries that use the marine environment, or have the potential to do so if they were to be introduced, established, or spread in Australia's marine environment.

In 2008, Huisman et al. reported on 102 marine and estuarine species that were known to be introduced and established in WA at the time. Sixty-six species were considered to have been introduced by anthropogenic activity. Most (37) were temperate species that have been found from areas south of Geraldton.

Seventeen IMP species have been recorded in the Pilbara. Despite extensive monitoring, the only IMP on the Australian National IMS list known to have established a self-sustaining population is the tunicate *Didemnum perlucidum* (Wells, 2018). Eight IMP alerts for WA were current at the time of the MScience (2022) report, including the Asian Green Mussel *Perna viridis*, reported during inspections of a dredge vessel and mobile platform, Asian Paddle Crab *Charybdis japonica*, Black Striped Mussel *Mytilopsis sallei*, European Green Crab *Carcinus maenas*, Japanese Kelp *Undaria pinnatifida*, Northern Pacific Seastar *Asterias amurensis,* Redclaw Crayfish *Cherax quadricarinatus* and Spangled Perch *Leiopotherapon unicolor*. None of these species are known to have established self-sustaining populations in the Pilbara but all represent a serious threat.

Wells (2018) conducted a review of IMS in the Pilbara (based on results of publicly available studies) and found that there are 24 IMPs most likely to survive in the Pilbara region. These IMPs were targeted in MScience's study for Cape Preston, assuming that the environmental tolerance ranges used by Wells (2018) for the Pilbara would be representative of Cape Preston.

To date, no IMS listed as species of concern on the National Introduced Marine Pests Coordination Group have been recorded at Cape Preston (GHD, 2013c; URS, 2009). The nearest introduced species known is *Didemnum perlucidum*, which has been recorded at Barrow Island, approximately 90 km to the northwest of the Proposal at Eramurra. This species is known to have established a self-sustaining population. This species presents some risk of impacting upon the marine environment, including risk to BCH which would adversely impact upon the marine fauna that rely on these areas for protection and as a food source. Another location where this species has been recorded is at the Port of Dampier.

### 9.3.12 COMMERCIAL FISHERIES

Information in this section has been sourced from O2 Marine (2023b; Appendix 4.5) unless stated otherwise.

Aquatic Resources encapsulate the commercial, recreational, and customary use of the species they manage across a geographical region. State aquatic resources, including the fisheries that they manage and the indicator fish species for each of these fisheries that are of relevance to the Proposal were identified through spatial analysis and desktop review of existing datasets and reports. Within each fishery, indicator species are selected to undertake assessments of the fishery stocks and to determine the status of the resource. Indicator species are selected based on their inherent vulnerability, management importance and overall risk to sustainability.

In WA, Aquatic Resources are grouped into their respective bioregions under an Ecosystem Based Fisheries Management (EBFM) approach. The Proposal is located within the North Coast Bioregion, which incorporates both the Pilbara and Kimberley regions. The principal commercial fisheries in the North Coast bio-region focus on tropical finfish, particularly the high-value emperors, snappers and cods that are taken by fisheries within the Northern Demersal Scalefish Resource. The typical catch is up to 3,000 - 4,000 tonnes annually, making these fisheries the most valuable finfish sector in WA, with an estimated annual value of more than $20 million (Newman et al., 2021). Invertebrate and Pearl Oyster fisheries make up a smaller proportion of the commercial fisheries in the bioregion. The prawn fisheries within the bio-region are relatively small compared to other parts of WA, however the Pearl Oyster fisheries are significant within this bioregion.

Table 9-8 identifies the aquatic resources that are related to or occur within the vicinity of the Proposal. Within each aquatic resource, the fisheries that utilise the resources have also been identified. Not all the commercial fisheries within the aquatic resource overlap with the Proposal, which are not described in detail.

Table 9-8: Aquatic resources related to the Proposal (Newman et al., 2021).

| Aquatic Resource | Fisheries | Key/Indicator species | Description |
|---|---|---|---|
| Northern Demersal Scalefish | • Commercial:<br>o Northern Demersal Scalefish Managed Fishery (NDSMF);<br>o Pilbara Demersal Scalefish Fisheries (PDSF):<br>- Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF);<br>- Pilbara Demersal Trap Managed Fishery (PTMF); and<br>- Pilbara Line Fishery (PLF).<br>• Recreational. | • Bluespotted Emperor;<br>• Rankin Cod;<br>• Red Emperor; and<br>• Goldband Snapper. | NDSMF operates in the Kimberley subregion, and the PDSF operated in the Pilbara subregion (Figure 9-6).<br>PDSF has three fisheries that occur in the vicinity of the Proposal. These fisheries provide sustainable commercial and recreational fishing value to the region, estimated to be in the order of $10 - 20 million. The fisheries are currently listed as adequate and sustainable. The Pilbara portion of the Aquatic Resource makes up a high percentage of the total catch, with 67% of the demersal catches occurring in the three Pilbara fisheries. The Pilbara commercial fisheries account for 90% of the total bluespotted Emperor commercially caught by the PDSF, 59% of the Red Emperor and 70% of the Rankin Cod.<br>Although NDSMF operates in the Kimberley subregion and does not overlap the Proposal, depletion of juvenile bluespotted Emperor in the Pilbara could impact the catch within the Kimberley, as the Pilbara is through to be the distribution point for the species into the Kimberley. |
| Northern Invertebrates | • Commercial:<br>o Onslow Prawn Managed Fishery (OPMF);<br>o Nickol Bay Prawn Managed Fishery;<br>o Broome Prawn Managed Fishery;<br>o Kimberley Managed Fishery; and<br>o Exmouth Gulf Prawn Managed Fishery (MSC*). | • Western King Prawn;<br>• Brown Tiger Prawn; and<br>• Banana Prawns | Only the OPMF overlaps with the development envelopes (Figure 9-7).The OPMF targets Western King Prawns (Penaeus latisulcatus), Brown Tiger Prawns (*Penaeus esculentus*), Blue Endeavour Prawns (*Metapenaeus endeavouri*) and Banana Prawns (*Penaeus merguiensis*). Minor species in the fishery include Moreton Bay bugs, squid, Blue Swimmer Crabs, cuttlefish, other prawn species (i.e., coral prawns), and some finfish species. |
| North Coast Crab | • Commercial:<br>o Pilbara Crab Managed Fishery (PCMF)<br>• Recreational. | • Blue Swimmer Crab. | The PCMF overlaps with the development envelopes and targets Blue Swimmer Crabs in the vicinity, both commercially and recreationally (Figure 9-8). This fishery is considered to be relatively small. |
| Statewide Large Pelagic Scalefish | • Commercial:<br>o Mackerel Managed Fishery (MMF).<br>• Recreational. | • Spanish Mackerel;<br>• Grey Mackerel; and | The Statewide Large Pelagic Scalefish Resource is of high commercial and recreational value within the vicinity of the Proposal. The MMF is separated into three areas; Kimberley, Pilbara and Gascoyne/West Coast. The MMF is highly reliant on its indicator species for both commercial and recreational value, especially the Spanish Mackerel. The Spanish Mackerel is the 5th highest |

| Aquatic Resource | Fisheries | Key/Indicator species | Description |
|---|---|---|---|
| | | • Samson Fish. | finfish species caught by recreational fishers and the 4th highest caught by tour and charter companies. The species is also of high economic value for the commercial fisheries, with an estimated value of $2.5 - 3 million. |
| Statewide Hand Collection | • Commercial:<br>o WA Sea Cucumber Fishery (WASCF) (MSC*).<br>• Customary. | • Sandfish; and<br>• RedFish. | Fishing occurs mostly in the northern half of the State, from Exmouth Gulf to the NT border, however Shark Bay was fished for the first time in 2020. Fishing mainly occurs within shallow, low energy environments sheltered by fringing reefs or within bays. The commercially viable WASCFs are located east of the Proposal area, however the target species known distribution overlaps with the Proposal area. This Fishery is thought to be minor in the area. |
| Statewide Marine Aquarium Fish and Hermit Crab | • Commercial:<br>o Marine Aquarium Fish Managed Fishery (MAFMF); and<br>o Hermit Crab Fishery (HCF). | • Syngathids;<br>• Invertebrates;<br>• Hard corals;<br>• Soft coral;<br>• Living rock and living sand;<br>• Sponges;<br>• Algae/Seagrasses; and<br>• Hermit Crabs. | The MAFMF and HCF supply the domestic and international markets with aquarium species, and the live pet trade. The MAFMF is State-wide, while the HCF is spread along the North Coast of WA. The HCF is one of only two-land based commercial fisheries in WA. This resource is thought to be minor in the area, however Customary fishing may occur. |
| Pearl Oyster (*Pinctada maxima*) | • Commercial:<br>o Pearl Oyster Wildstock Fishery (MSC*).<br>• Customary. | Silver Lipped Pearl Oyster. | The Pearl Oyster Wild Stock Fishery is the only remaining significant wild-stock fishery for pearl oysters in the world. The dive-based fishery is divided into three management zones, with the Proposal falling within Zone 1. This Fishery is thought to be minor in the area, however Customary fishing may occur.<br>Pearl Oyster shell is an important resource of cultural significance to the Indigenous people of Australia and has been harvested for at least 20,000 years. Aboriginal Australians of the West Kimberley harvested Pearl Oyster shells from shallow waters and had well established traditional trading networks that extended throughout Australia. The *P. maxima* pearling industry was initiated in 1861 through trade between early explorers and Aboriginal Australians. Pearl Oysters have been recognised under Native Title. The total customary catch for the Silver-lipped Pearl Oyster is unknown by DPIRD, as customary catch records are not maintained. |

| Aquatic Resource | Fisheries | Key/Indicator species | Description |
|---|---|---|---|
| Statewide Specimen Shell | • Commercial:<br>o Specimen Shell Managed Fishery (SSMF).<br>• Customary. | Nil. | The SSMF is based on the collection of individual shells for the purposes of display, collection, cataloguing, classification, and sale. This Fishery is thought to be minor in the area, however Customary fishing may occur. |
| Statewide Abalone | • Commercial:<br>o Abalone (Roe's) Managed Fishery; and<br>o Abalone (Greenlop/Brownlip) Managed Fishery (MSC*).<br>• Recreational. | • Roe's Abalone;<br>• Greenlip Abalone; and<br>• Brownlip Abalone. | These fisheries extend across the entire waters of WA, with abalone mostly occurring in the West Coast Bioregion and the South Coast Bioregion. The Proposal overlaps with the Statewide Abalone Resource fisheries management Area 4 (Busselton Jetty to NT/WA border). Management of Area 4 has no quota allocated and does not form part of the functional fishery. The Statewide Abalone Resource is not functional within the Proposal. |
| South Coast and West Coast Crustacean | • Commercial:<br>o West Coast Deep Sea Crustacean Managed Fishery (MSC*). | Crystal Crab. | The South Coast and West Coast Crustacean Resource manage the West Coast Deep Sea Crustacean Managed Fishery, which operate off the west coast of WA. The fishery is operational on the seaward side of the 150 m isobath and extends out to the Australian Exclusive Economic Zone (200 nm boundary). The fishery targets the Crystal Crab (deep-water species), occurring in water depths of 300 – 1,200 m. This fishery does not operate within the vicinity of the Proposal. |

*Some fisheries within the aquatic resources are also certified fisheries by the Marine Stewardship Council (MSC), which means the fisheries have been independenly certified as being sustainable.

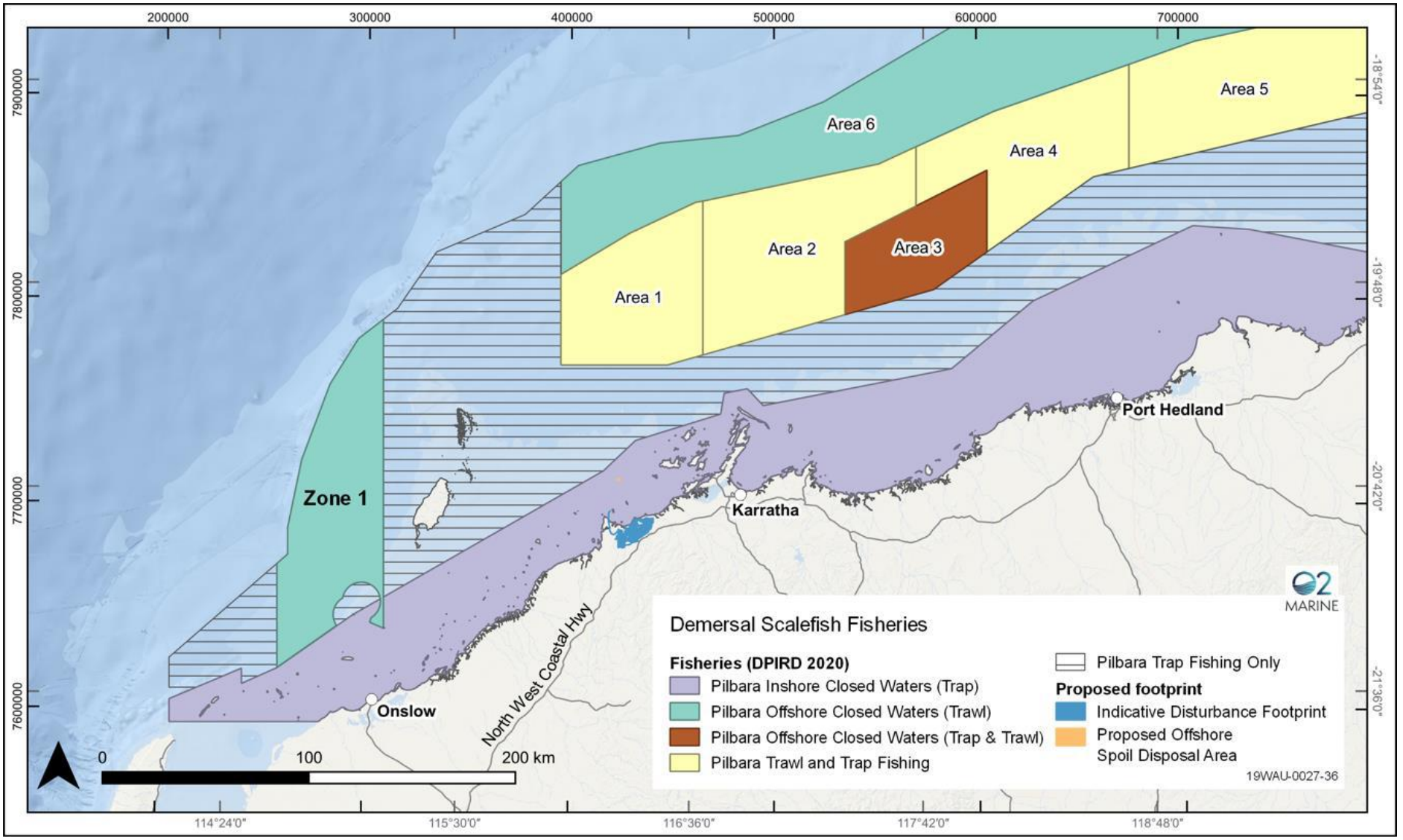



Figure 9-6: Northern Demersal Scalefish Resource fisheries zones in the Pilbara

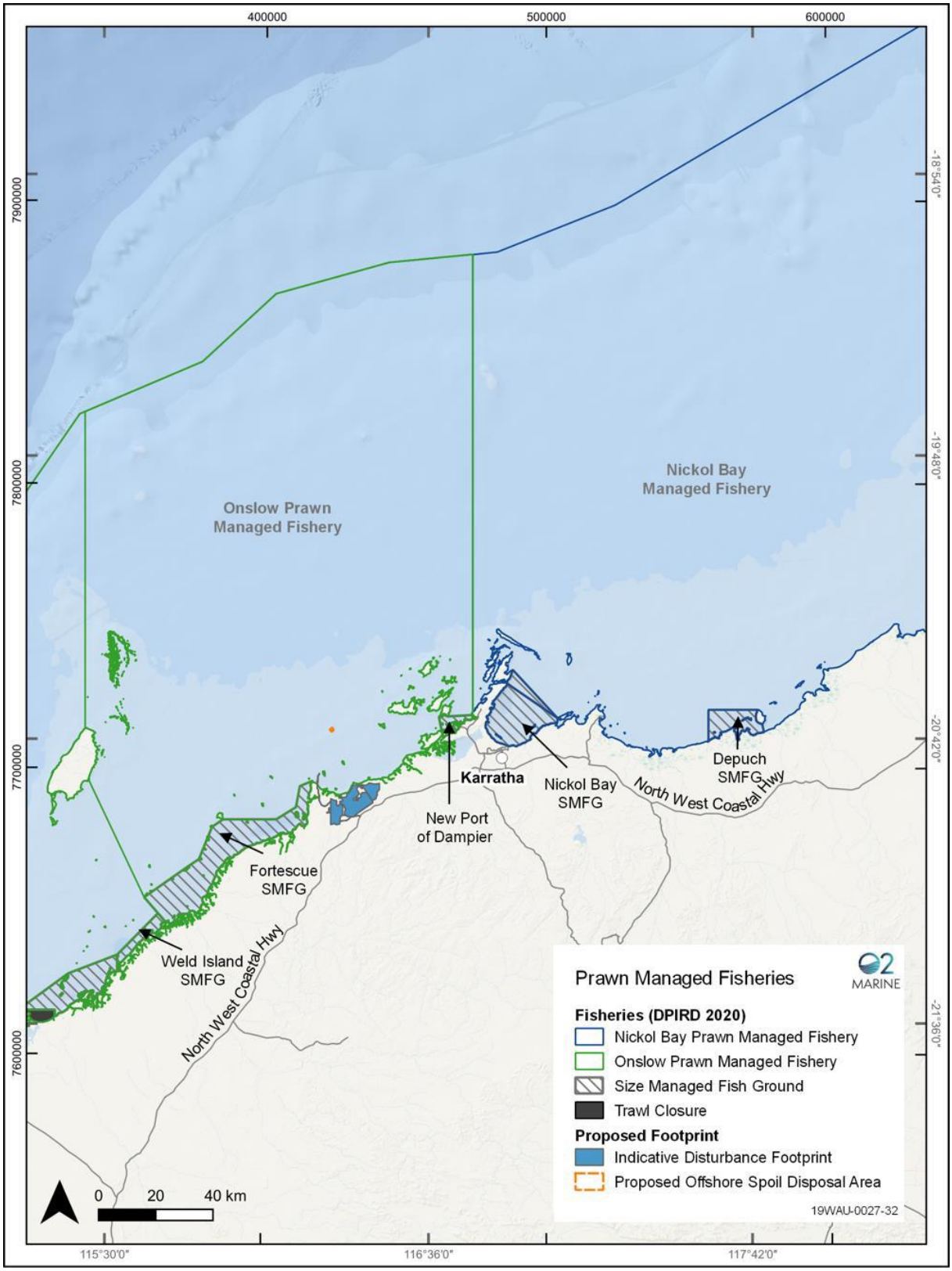



Figure 9-7: Prawn Managed Fisheries in the Pilbara

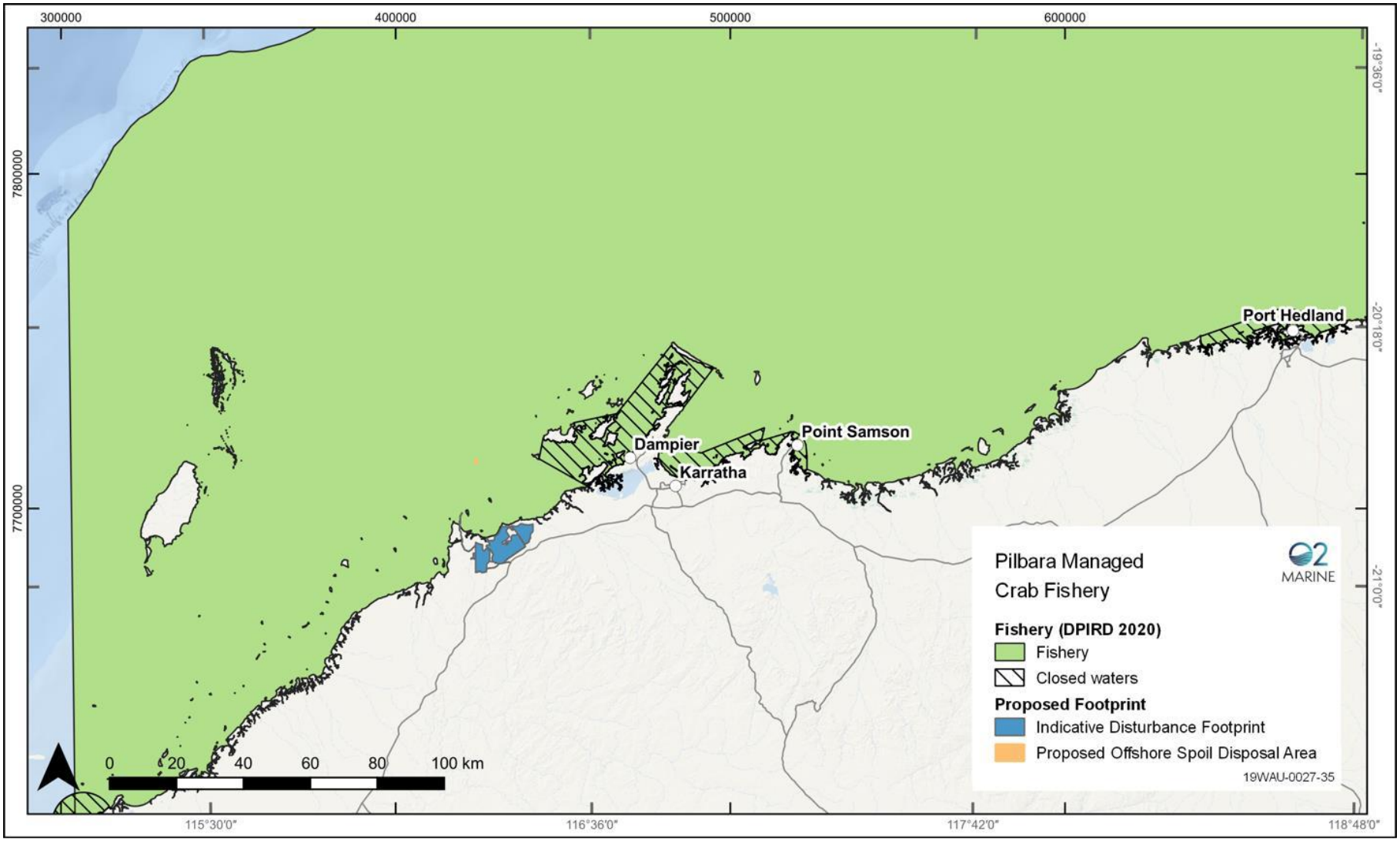



Figure 9-8: Pilbara Crab Managed Fishery zones and fishing areas

### *Commonwealth Fisheries*

The following Commonwealth-managed fisheries have fishing grounds (legally permitted to fish) in waters offshore from the Proposal. However, fishing effort is spread across a large area. The area offshore from the Proposal is not known to be particularly important for these fisheries, as these fisheries predominantly target species in the continental shelf waters out to 200 nautical miles offshore. The Commonwealth fisheries present in the broader area include:

- North West Slope Trawl Fishery;
- Western Skipjack Tuna Fishery;
- Southern Bluefin Tuna Fishery; and
- Western Tuna and Billfish Fishery.

### *Indicator and key species*

The indicator species present and relevant to the development envelopes as identified in Table 9-8 include;

- Bluespotted Emperor (*Lethrinus punctulatus);*
- Red Emperor (*Lutjanus sebae*);
- Rankin Cod (*Epinephelus multinotatus*);
- Narrow-barred Spanish Mackerel (*Scomberomorus commerson*);
- Grey Mackerel (*Scomberomorus semifasciatus*);
- Western King Prawn (*Penaeus latisulcatus*);
- Brown Tiger Prawn (*Penaeus esculentus*);
- Silver-lipped/South Sea Pearl Oyster (*Pinctada maxima*);
- Blue Swimmer Crab (*Portunus armatus*);
- Australian Land Hermit Crab (*Coenobita variabilis*);
- Sandfish (sea cucumber) (*Holothuria scabra*); and
- Redfish (sea cucumber) (*Actinopyga echinites*).

Of these, Bluespotted Emperor, Red Emperor, Spanish Mackerel and prawns have been identified as key socio-economically important species which have important habitats in proximity to the Proposal, most notably seagrass beds, macroalgal habitats and mangrove areas.

Macroalgae is a critically important nursery habitat for Bluespotted Emperors, with juveniles being reliant on nearshore macroalgae beds. Spawning and nursery areas are thought to be restricted to the west Pilbara. The western Pilbara region has the highest relative abundance of the Bluespotted Emperor and is the distribution point for the species across other regions.

Red Emperors are long-lived, slow growing species, and adults have restricted movements, which makes them inherently vulnerable to localised depletion. Juvenile Red Emperors are found inshore in turbid waters, while adults are found further offshore. The species is commercially important within the Pilbara fisheries but is also a key species for the Kimberley demersal fisheries and other parts of WA. As this species relies on broadcast spawning, depletion in one area may affect other fisheries elsewhere.

Various prawn species as well as Blue Swimmer Crabs typically show a high reliance on protected, muddy inshore areas, adjacent to either mangrove or dense seagrass beds (or both).

Other species of relevance include the Banana Prawn (*Penaeus merguiensis*). Although not a key species, it is known to be present in the area and has a lifecycle that includes a post-larval and juvenile phase, which is restricted to mangrove lined estuaries. Additionally, some lesser commercially caught demersal species such as Fingermark Bream, Estuarine Rockcod and Mangrove Jack are known to use the shallow nearshore waters of the Pilbara as nursery areas (Newman et al., 2004).

### 9.3.13 Recreational Fishing

Recreational fishing is popular in the Pilbara with six boat ramps located between Exmouth and Dampier, including one at Gnoorea Point abutting the Proposal. Fishers target snappers, Emperors and cod (particularly Coral trout) (Fishwell, 2023). The Bluespotted Emperor is also a popular species for recreational anglers.

Fish surveys in the vicinity of the Proposal identified fish important to recreational fishers, particularly Grass Emperor (*Lethrinus laticaudis*) and Stripey Snapper (*Lutjanus carponotatus*).

### 9.3.14 Environmental Windows

A summary of the environmental windows for significant species relevant to the Proposal are as follows:

- Humpback Whale (nearshore southern migration). The peak southern migration occurs in August to early September and represents the time when humpback whales and their calves have a higher potential to occur within the development envelopes, although 2 km from shore would represent the boundary limit of their nearshore distribution, typically occurring at an average of 36 km offshore;
- Dolphins generally are known to occur all year round, however higher abundances are around June – September;
- Turtle nesting season is typically October – March; and
- Sawfish pupping season is typically September – October.

### 9.3.15 Environmental Values

Based on the information provided above, the following environmental values were determined to require assessment for this factor:

- General marine fauna;
- Marine turtles;
- Sea snakes;
- Marine mammals;
- Green Sawfish; and
- Fishery indicator and key species.

## 9.4 Potential Impacts

Table 9-9 defines the potential impacts (direct, indirect and combined) on the environmental values for this factor in a local and regional context. These impacts are informed by the results of detailed marine fauna studies described in Section 9.3 and provided in Appendix 3.1, 4.1 to 4.10

Table 9-9: Potential impacts on marine fauna

| Environmental value and current extent | Potential direct impact | Potential indirect impact | Local impacts associated with other proposals | Combined local impact (Proposal + others) |
|---|---|---|---|---|
| **General marine fauna**<br>Mangrove communities, tidal creeks and offshore islands were identified as key marine fauna habitat. | • Disturbance of up to 47.0 ha of vegetated subtidal marine fauna habitat;<br>• Disturbance of up to 8.3 ha of intertidal marine fauna habitat (mangroves); and<br>• Increased risk of death or injury as a result of vessel strike, dredging, dredging material disposal or entrapment in seawater intakes. | • Increased risk of introduction of marine pests by dredging vessels or other vessels used in construction and operations activities;<br>• Hearing or behavioural impacts as a result of construction-related noise (from dredging material disposal);<br>• Increased predation by aggregation of marine organisms around marine infrastructure;<br>• Changes in intertidal or freshwater inputs into the marine environment due to the presence of the ponds; and<br>• Indirect impacts to marine fauna habitat health from dredging, bitterns disposal or product / hydrocarbon spillages. | • Previous loss of 6.9 ha of coral reef within the LAUs associated with the Cape Preston Port;<br>• 0.7 ha of algal pavement/dense macroalgae and 0.7 ha of sparse/very sparse coral and macroalgae areas approved for CPE Port;<br>• Previous loss of 1.8 ha of beach habitat within the LAUs associated with the Cape Preston Port;<br>• Regional losses of BCH associated with the Cape Preston Port;<br>• Death or injury as a result of vessel strike or entrapment in seawater intakes associated with CPE Port and Cape Preston Port; and<br>• Potential indirect impacts associated with Cape Preston Desalination Plant, CPE Port and Cape Preston Port. | • Loss of up to 53.9 ha of sub-tidal marine fauna habitat and 9.7 ha of intertidal habitat;<br>• Death or injury as a result of vessel strike, dredging, dredging material disposal or entrapment in seawater intakes;<br>• Changes in nutrient flows into the marine environment from the intertidal zone due to the presence of the ponds; and<br>• Potential indirect impacts to habitat health. |
| **Marine turtles**:<br>Flatback, Hawksbill and Green Turtles likely to be present in the surrounding marine environment.<br>Turtle nesting has been recorded on the mainland beaches and offshore islands.<br>The nearshore and offshore areas represent BIAs for three marine turtle species. | • Disturbance of up to 47.0 ha of vegetated subtidal marine fauna habitat;<br>• Disturbance of up to 8.3 ha of intertidal marine fauna habitat (mangroves); and<br>• Increased risk of death or injury as a result of vessel strike, dredging, dredge material disposal | • Alterations to turtle and hatchling behaviour as a result of predation;<br>• Hearing or behavioural impacts as a result of construction-related noise (from dredging and dredging material disposal);<br>• Alterations to turtle and hatchling behaviour as a result of light emissions; and<br>• Indirect impacts to habitat health. | • Previous loss of 1.8 ha of beach habitat within the LAUs associated with the Cape Preston Port;<br>• Previous loss of 6.9 ha of coral reef within the LAUs;<br>• Approved direct disturbance of 1.0 ha of turtle nesting beach for CPE Port (not considered a key nesting beach, only used by a few individuals);<br>• Regional losses of BCH associated with the Cape Preston Port; | • Loss of up to 53.9 ha of subtidal habitat and 9.3 ha of intertidal habitat, including 1.8 ha of beach BCH;<br>• Death or injury as a result of vessel strike, dredging, dredging material disposal or entrapment in seawater intakes;<br>• Light spill impacts; and<br>• Potential indirect impacts to habitat health. |

| Environmental value and current extent | Potential direct impact | Potential indirect impact | Local impacts associated with other proposals | Combined local impact (Proposal + others) |
|---|---|---|---|---|
| | or entrapment in seawater intakes. | | • Death or injury as a result of vessel strike or entrapment in seawater intakes associated with CPE Port and Cape Preston Port; and<br>• Potential indirect impacts associated with Cape Preston Desalination Plant, CPE Port and Cape Preston Port (inc. light spill). | |
| **Sea snakes:**<br>Short-nosed sea snake and Leaf-scaled sea snake identified as potentially occurring within the vicinity of the Proposal. | Disturbance of up to 3.8 ha of coral reef BCH. | • Increased introduction of marine pests by dredging vessels or other vessels used in construction and operation activities; and<br>• Indirect impacts to habitat health. | • Previous loss of 6.9 ha of coral reef within LAUs;<br>• and<br>• Potential indirect impacts associated with Cape Preston Desalination Plant, CPE Port and Cape Preston Port (inc. light spill). | • Loss of up to 10.7 ha of coral reef habitat; and<br>• Potential indirect impacts to habitat health. |
| **Marine mammals**:<br>Humpback Whale, Australian Humpback Dolphin, Indo-pacific and Dugong identified as potentially occurring, predominantly offshore.<br>Potential to occur within both the nearshore and offshore waters of the Proposal.<br>The Humpback Whale migration BIA overlaps with the Proposal. | • Disturbance of up to 47.0 ha of vegetated subtidal marine fauna habitat; and<br>• Increased risk of death or injury as a result of vessel strike, dredging or dredging material disposal. | • Hearing or behavioural impacts as a result of construction related noise (from vessels, dredging or dredge material disposal); and<br>• Indirect impacts to habitat health. | • Previous loss of 6.9 ha of coral reef within the LAUs associated with the Cape Preston Port;<br>• Regional losses of BCH associated with the Cape Preston Port;<br>• Death or injury as a result of vessel strike or entrapment in seawater intakes associated with CPE Port and Cape Preston Port; and<br>• Potential indirect impacts associated with Cape Preston Desalination Plant, CPE Port and Cape Preston Port, including piling noise. | • Loss of up to 53.9 ha of subtidal marine fauna habitat;<br>• Death or injury as a result of vessel strike, dredging or dredging material disposal;<br>• Hearing or behavioural impacts as a result of construction-related noise and piling at CPE Port; and<br>• Potential indirect impacts. |
| **Green Sawfish**<br>A single Green Sawfish was recorded at the mouth of McKay Creek. | • Disturbance of up to 47.0 ha of vegetated subtidal marine fauna habitat; | • Hearing or behavioural impacts as a result of dredging;<br>• Presence of potential barriers to movement (pipelines, dredging); | • Previous loss of 6.9 ha of coral reef within the LAUs associated with the Cape Preston Port; | • Loss of up to 53.9 ha of subtidal marine fauna habitat and 9.7 ha of intertidal habitat; |

| Environmental value and current extent | Potential direct impact | Potential indirect impact | Local impacts associated with other proposals | Combined local impact (Proposal + others) |
|---|---|---|---|---|
| Pupping is known to occur in the region with the nearest important pupping site at the Ashburton River delta.<br>No BIAs have been identified for Green Sawfish around the Proposal. | • Disturbance of up to 8.3 ha of intertidal marine fauna habitat (mangroves and beach habitat);<br>• Increased risk of death or injury as a result of vessel strike, dredging or dredge material disposal. | • Indirect impacts to habitat health; and<br>• Long-term changes to coastal processes around tidal creek systems. | • 0.7 ha of algal pavement/dense macroalgae and 0.7 ha of sparse/very sparse coral and macro-algae areas approved for CPE Port;<br>• Regional losses of BCH associated with the CPE and Cape Preston Ports;<br>• Death or injury as a result of vessel strike associated with CPE Port and Cape Preston Port;<br>• Potential for the existing Cape Preston Port creating an artificial barrier to sawfish movement and possibility for a trapping or isolating effect between Cape Preston and the Dampier Archipelago; and<br>• Potential indirect impacts associated with Cape Preston Desalination Plant, CPE Port and Cape Preston Port. | • Death or injury as a result of vessel strike, dredging or dredging material disposal;<br>• Presence of potential barriers to movement;<br>• Potential indirect impacts to habitat health; and<br>• Long-term changes to coastal processes around tidal creek systems. |
| **Fishery indicator and key species**<br>Numerous indicator and key species were identified as being present and relevant to the development envelopes (Section 9.3 and O2 Marine (2023b). | Potential impacts sourced from O2 Marine (2023b):<br>• Pond design interacts with important BCH - loss of intertidal BCH, disturbance of important nursery areas;<br>• Dredging - direct loss of BCH; and<br>• Seawater intake - entrainment of larvae or juvenile marine fauna. | Potential impacts sourced from O2 Marine (2023b):<br>• Pond design alters hydrodynamics - altered tidal regime and surface water runoff patterns threatening intertidal BCH;<br>• Ponds alter groundwater quality - changes to groundwater salinity that result in impacts to BCH;<br>• Ponds change the coastal geomorphology and cause erosion of coastal BCH - changes to coastal and creek bank morphology may cause blockage of tidal creeks, resulting in loss | • Previous loss of 6.9 ha of coral reef within the LAUs associated with the Cape Preston Port;<br>• 0.7 ha of algal pavement/dense macroalgae and 0.7 ha of sparse/very sparse coral and macro-algae areas approved for CPE Port;<br>• Regional losses of BCH associated with the Cape Preston Port;<br>• Death or injury as a result of vessel strike or entrapment in seawater intakes associated with CPE Port and Cape Preston Port; and<br>• Potential indirect impacts associated with Cape Preston | • Loss of intertidal BCH, disturbance of important nursery areas;<br>• Dredging - direct loss of BCH;<br>• Seawater intake - entrainment of larvae or juvenile marine fauna.<br>• Altered tidal regime and surface water runoff patterns threatening intertidal BCH;<br>• Altered groundwater quality that result in impacts to BCH;<br>• Changes to coastal and creek bank morphology may cause blockage of tidal creeks, resulting in loss and access to important nursery areas; |

| Environmental value and current extent | Potential direct impact | Potential indirect impact | Local impacts associated with other proposals | Combined local impact (Proposal + others) |
|---|---|---|---|---|
| | | and access to important nursery areas;<br>• Dredging - generation of a turbid plume; turbidity and sedimentation caused from resuspension of dredged material during dredging and loading can restrict photosynthetic activity and end in mortality for BCH; and<br>• Bitterns discharge - increase in salinity at the discharge point can have detrimental effects on the surrounding BCH and marine fauna. | Desalination Plant, CPE Port and Cape Preston Port. | • Turbidity and sedimentation during dredging and loading can restrict photosynthetic activity; and<br>• Bitterns discharge - increase in salinity at the discharge point. |

# 9.5 ASSESSMENT OF IMPACTS

## 9.5.1 GENERAL MARINE FAUNA

***Direct Loss, Degradation or Modification of Marine Fauna Habitat***

*Intertidal Zone*

The Proposal occurs within the broader intertidal zone, however based on the species identified by O2 Marine (2025e), the parts of the intertidal zone of most significance to marine fauna (and in particular significant marine fauna) are the areas that are regularly inundated; the ocean side of the mangrove and rocky shore habitats, tidal creeks and the sand beach at the northern portion of the PIDE. Shorebirds are assessed as Terrestrial Fauna in this ERD (refer to Section 11.7).

The Proposal is predicted to result in the loss of up to 8.3 ha of mangrove BCH which are those most frequently utilised by marine fauna (generally most frequently inundated).
Disturbance in these areas is related to construction of the primary seawater intake, bitterns pipeline and associated works. Leichhardt has specifically designed the Proposal to ensure that more sensitive and high value intertidal BCH that could be utilised by marine fauna have been almost completely avoided, with very small losses of these BCH predicted. Section 8.5 assessed the significance of the loss of BCH, including cumulative impacts from the CPE and Cape Preston Ports and determined that there would be cumulative losses of mangrove BCH of 9.7 ha (8.3 ha of which is associated with the Proposal), which equates to 0.7% of all mangroves within the LAUs.

Based on the BCH assessment, it is considered likely that the disturbance of intertidal habitat would have negligible impact on general marine fauna populations that inhabit the area. Some of these BCH types are however important habitat for significant marine fauna species and have been discussed separately in the following sections.

*Subtidal Zone*

The Proposal will require the loss of 47 ha of subtidal marine fauna habitat associated with dredging, offshore disposal areas, seawater intakes, nearshore and offshore anchorages. An additional 6.4 ha is predicted to be subject to recoverable impacts from dredging and dredging material disposal.

Section 8.5 assessed the significance of the direct and indirect disturbance of subtidal BCH. The Proposal is predicted to result in:

- The loss of 26.5 ha of filter feeders dominated habitat;
- The loss of 12.5 ha and recoverable impacts to 5.5 ha of *Pinna bicolor* beds;
- The loss of 3.8 ha and recoverable impacts to 0.9 ha of hard coral habitat;
- The loss of 3.7 ha of seagrass with macroalgae BCH;
- The loss of 0.4 ha of seagrass with filter feeders BCH; and
- The loss of 0.1 ha of macroalgae-dominated habitat.

Leichhardt has specifically re-designed the Proposal to ensure that more sensitive and high value subtidal BCH that could be utilised by marine fauna have been avoided wherever practicable.

Section 8.5 assessed the significance of the loss of BCH, including cumulative impacts from the CPE and Cape Preston Ports and determined that:

- There would be a cumulative loss of hard coral habitat of 31.8 ha, and recoverable impacts to 0.9 ha, which equates to 0.8% and 0.0% of the extent within the LAUs respectively;
- There would be cumulative losses of filter feeders dominated habitats of 26.5 ha, which equates to 0.2% of the extent within the LAUs. No recoverable impacts are associated with this BCH;
- There would be a cumulative loss of *Pinna bicolor* beds BCH of 12.5 ha, and recoverable impacts to 5.5 ha, which equates to 1.2% and 0.5% of the extent within the LAUs respectively;
- There would be a cumulative loss of seagrass with filter feeders BCH of 0.4 ha which equates to 0.1% of the extent within the LAUs. No recoverable impacts associated are with this BCH;
- There would be a cumulative loss of seagrass with macroalgae-dominated habitat of 0.1 ha which equates to <0.1% of the extent within the LAUs. No recoverable impacts associated are with this BCH;
- There would be a cumulative loss of seagrass with macroalgae BCH of 3.7 ha which equates to 0.2% of the extent within the LAUs. No recoverable impacts associated are with this BCH; and
- There would be a cumulative loss of bare substrate BCH of 105.3 ha which equates to 0.18% of the extent within the LAUs. No recoverable impacts are associated with this BCH.

An assessment of the significance of these BCH impacts is provided in Section 8.5. Given the slightly higher proportion of impacts to coral reef, filter feeders and macroalgae BCH these impacts have been summarised below.

The low-moderate coral predicted to be lost is well represented throughout the LAUs and is well represented throughout the region. Although this BCH is also known to provide suitable habitat for a variety of marine fauna species, the cumulative loss of 47 ha is not considered a significant risk to the ecological integrity and biological diversity of this BCH (O2 Marine, 2025b).

General filter feeder BCH, *Pinna bicolor* beds and seagrass with filter feeders BCH are also well represented throughout the LAUs and are well represented throughout the region. Benthic filter feeder BCH in the vicinity of the Proposal is also comprised mostly of sparse communities. Although this BCH is also known to provide suitable habitat for a variety of marine fauna species, including commercially important species such as Bluespotted emperor, the loss of 39.4 ha is not considered a significant risk to the ecological integrity and biological diversity of this BCH (O2 Marine, 2025b).

Macroalgae BCH is also well represented throughout the LAUs and is well represented throughout the region. Due to varied methods of reproduction and regrowth potential of macroalgae some of the direct losses are 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.





Based on the BCH assessment, it is considered likely that the losses of subtidal BCH would have only minor impacts on general marine fauna populations that inhabit the area. Some of these BCH types however are part of broader habitat for significant marine fauna species and have been discussed separately in the following sections.

***Direct Injury or Death***

*Vessel Strike*

Vessel strikes associated with the export of salt product forms part of the approved CPE Port and are not part of the Proposal. Proposal-associated vessel strike risks are therefore limited to vessels associated with dredging and the construction and maintenance of the bitterns pipeline and seawater intakes. The likelihood of a vessel strike during these activities is considered low due to the small distances traversed by the vessels and their slow speed (8 knot speed limits will be imposed on construction vessels). Other vessel strike risks would also occur in the area from the Cape Preston and CPE Ports.

There is the potential for moving vessels associated with the Proposal, such as marine construction vessels (dredge, crew transfer, hydrographic survey, barge vessels) to collide with the marine fauna. Impacts specific to marine animal welfare as a consequence of a vessel collision incident can be divided into three types (Schoeman et al. 2020):

1. Direct – physical consequences that are the immediate result of a collision, which can be lethal on impact or occur several hours, days or weeks after the incident;
2. Long-term – a decrease in animal fitness over time e.g. locomotive impairments that effect foraging; and
3. Population consequences - such as a decrease in population growth rate due to high mortality or a decline in fertile animals.

MScience (2025) completed a vessel collision risk assessment for the Proposal and found that the residual risk to marine fauna was considered to be low but greater than negligible based on the following;

- Cape Preston is an existing facility which has been in operation since 2013. No incidents of marine fauna strike were found in the literature as a result of port operations in this time; and
- During operations the Proposal will increase existing vessel traffic, in the category which has the potential to significantly impact marine fauna, by just 12.5%.

The application of controls including observations, separation distances, reporting and vessel speed limitations reduces the likelihood and consequence of vessel strike for all species and complies with current marine fauna interaction guidelines (Part 8 of the Environment Protection And Biodiversity Conservation Regulations 2000 and the Biodiversity Conservation Regulations 2018. Therefore, after accounting for the low level of risk, the management actions for marine fauna disturbance identified in this assessment are comparable with the current practices used by other operators of export facilities in Australia.

The potential impacts from Proposal activities are unlikely to result in significant declines in the local or regional populations of species and their distribution, or reductions in the diversity of species. Dolphins are quick moving and would react quickly to avoid potential impact to vessels. Whales are expected to occur only rarely in the immediate dredging or material disposal areas during dredging, which is proposed to occur outside the peak southern Humpback Whale migration. Dugongs may be present however most areas of seagrass foraging habitat have been avoided.

Maintaining speed limits of 8 knots when undertaking Proposal works is a suitable measure to reduce marine fauna injury from vessel strike. Vessel strike risks are known to significantly increase above 8.6 knots (Vanderlaan & Taggart, 2006) and therefore 8 knot speed limits will be implemented for construction vessels at the Proposal to reduce this risk. In addition, vessel operators will be trained to observe and report the location of any sightings of large marine fauna (in particular marine turtles and mammals as sawfish would be difficult to identify on the seafloor) to other vessel operators in the area to allow them to be tracked (if visible) and avoided, and for minimum separation distances to be maintained between vessels and prescribed fauna as described in the BC Regulations.

The likelihood of vessel strike during dredging and construction activities remains low given that Leichhardt will align the timing of construction activities to avoid key environmental windows including whale migration, sawfish pupping, turtle nesting, and fish and coral spawning, in addition to the small distances traversed by the vessels, the slow speed of the vessels, the maintenance of separation distances, and the minor areas of foraging habitat in the vicinity of the dredge working areas.

*Dredging*

Dredging will be undertaken with a CSD and disposed of via split hopper barge transport or transported to shore for onshore disposal. During offshore disposal the dredged material will be transported to the disposal area and dumped directly to the seabed. Leichhardt will implement a soft start procedure prior to activating cutter operations and a dedicated marine fauna observer will be on board at all times to ensure marine fauna are monitored while dredging is occuring. The likelihood of injury or mortality to marine fauna as a result of dredging activity is considered low.

Dredging has the potential to impact upon marine fauna (migratory and non-migratory) through multiple pathways including (O2 Marine, 2025f):

- Continuous noise while dredging;
- Reduction of light levels (i.e. loss of BCH and reduce foraging capacity);
- Clogging of fauna feeding and respiratory structures by sediments;
- Displacement and/or relocation of animals elsewhere to seek alternative food sources;
- Avoidance of an area (from either noise, turbidity and/or loss of habitat);
- Injury or death from entrainment from cutter suction dredge;
- Direct or indirect loss of important habitats (e.g. foraging or breeding grounds) or prey displacement; and
- Mobilisation of nutrients and/or contaminants in dredging sediments.

The key concerns for migratory species are barriers to movement and reduced ability to access quality habitat and resources for important activities and life phases (e.g. movement, foraging, resting, pupping).

*Entrapment in Seawater Intakes*

O2 Marine (2025e) determined that marine fauna species could be present in the vicinity of the seawater intakes and therefore there was the potential for some small marine fauna to become trapped within the intakes.

The Proposal seawater intakes have been designed to ensure a flow rate of less than 0.15 m/s at the intake screen. An intake flow rate of less than 0.15 m/s is recommended by the US Environmental Protection Agency (2001) as it ensures the protection of 96% of fish species, and is lower than the swim speed of marine turtles (Bell & Richardson, 1978; Bustard & Limpus, 1970; Chung et al., 2009; de Silva, 1995; Frick, 1976; Hirth, 1971; Hughes, 1974; Papi et al., 1995; Prange, 1976; Salmon & Wyneken, 1987; Witherington, 1991; Wyneken 1997). This flow rate has been adopted at a number of seawater intakes in WA and around the world, including Anketell Port, The Wheatstone Development and Adelaide Desalination Plant, and is being implemented at the Mardie Project and also proposed at the Ashburton Salt Project.

The tidal creek intake pipes are to be located within a screened enclosure, in a tidal zone just east of Mckay Creek. The intake will draw in water through the perimeter screen when water depths are at or greater than 0.0 m AHD, resulting in an even flow rate at the screen of less than 0.15 m/s. This will ensure flow rates are low enough to allow most marine fauna to swim against the current and not become trapped against the enclosure screens.

Smaller marine fauna such as larvae will however be drawn through the screen, with many of these being drawn through the pumps into the first concentrator pond. These organisms are critical in maintaining the biology of the concentrator ponds, but they will remain isolated from the local ecosystem. In the absence of specific larvae quantitative data the following considerations are presented regarding the scale of impact associated with this loss of larvae:

- The intake will only pump water when water depths are at or greater than 0.0 m AHD, when total water volumes moving through the tidal zone are greater;
- The intake tidal zone is one of many similar areas near tidal creek mouths in the vicinity of the Proposal; and
- The flow of the nearby tidal creek will not be significantly altered, with the majority of flow still extending up into the tidal creeks (i.e., the intake volumes are able to be easily replenished by the ocean given the 100 m width of the tidal zone at that point).

***Introduced Marine Pests***

Technical information in this section has been sourced from MScience (2022; Appendix 3.4) unless stated otherwise.

The Proposal will utilise additional vessels during dredging operations and marine construction activities that will be brought to Eramurra marine waters from other ports within Australia and overseas. These vessels have the potential to transport IMPs which can potentially impact subtidal BCH (MScience, 2022):

- Out-compete, prey upon, or otherwise displace native species;

- Alter natural ecological and bio-physical processes;
- Act as vectors for pathogens which can impact upon ecological or human health;
- Degrade or cause the collapse of commercial fisheries and aquaculture enterprises, either through direct competition with target species or via the introduction of a pathogen; and
- Cause problems for industrial infrastructure and navigation aids, for example, by blocking seawater intakes/outlets, impairing the operation of undersea valves, or causing buoys to sink, resulting in increased costs associated with cleaning and maintenance.

The most common forms of vector for an IMP being biofouling on vessels, debris and submersible equipment, or in ballast water/sediment and seacocks/sea strainers (CSIRO, 1998). Nodes are the areas to which potential IMP translocation may occur. The risk factors described above are incorporated into several private sector and government-supplied risk assessments. Leichhardt engaged MScience (2022) to conduct an IMP risk assessment for the Proposal. There are two key inputs to the risk assessment; the risk of a vessel or equipment introducing a marine pest, and the risk of the IMP becoming established. Using established risk determination methods (Bridgwood and McDonald, 2014), the Proposal-related vessel types were categorised into: (1) low risk, (2) moderate risk, and (3) high risk. The vessel types proposed for use were allocated relative risk ratings:

- CSD was given a risk rating of three (high risk);
- Barges/tugs were given a risk rating of two (medium risk); and
- Workboats/research vessels (i.e. hydrographic survey vessel) were given a risk rating of two (medium risk).

The dredging plant and other Proposal-related construction plant have not yet been contracted; thus, their port of origin is unknown. The dredge vessel and/or marine construction vessels may be sourced domestically or internationally. Internationally sourced vessels were assumed to be compliant with Australia's mandatory Ballast Water Management Requirements (Commonwealth of Australia, 2020) and had completed an inspection and cleaning, at a minimum. As such the risk associated with an internationally and domestically sourced vessel was considered the same. In addition, it has been assumed that marine construction/dredge plant will arrive and depart the Pilbara/Cape Preston area only once during construction. On this basis, the assessment focussed on the type and risk rating of Proposal-related construction vessels.

Risk assessments conducted for dredging and construction have assumed that vessel and plant used for the Proposal will be subject to these management procedures. Risk assessments were based on the potential species identified as target IMPs for this area and used procedures recognised nationally for the categorisation of risk from dredging vessels. Risks were assessed as inherent risk (unmanaged) and residual risk (after management or mitigation). In all cases, once the probability of introduction had been lowered as a result of the barrier management measures, risks were assessed as low.

While dredging plant has been shown historically to contain a high probability of introducing IMPs, management measures to present barriers to such introductions have been greatly improved with new developments to the National Strategy arsenal. Implementation of those measures for this Proposal should result in a low risk of introducing marine species.

***Marine Noise***

Technical information in this section has been sourced from MScience (2025; Appendix 4.6) unless stated otherwise.

There are several terms relevant to this assessment:

- **Sound Pressure Level** (SPL) is the change in pressure as a sound or pressure wave passes. SPL is measured on a logarithmic scale in decibels (dB) relative to a standard reference pressure;
- **Peak Pressure ($P_{max}$)**is the maximum instantaneous SPL over the duration of the sound exposure. Measured in dB re 1 micropascal (µPa);
- **Sound Exposure Level** (SEL) is the time integral of sound pressures received over the duration of exposure, which reflects the total sound energy received during exposure. This measure recognises that the effects of sound are a function of exposure duration as well as maximum instantaneous peak pressure. SEL allows comparison of short exposures to high SPLs with longer exposures to lower pressure levels. SEL is referenced to both a reference pressure (1 µPa) and an exposure duration (1 s), and has units of dB re 1µPa$^2$s;
- **Permanent Threshold Shift** (PTS) refers to a permanent increase in the threshold sound level that is audible to an organism (permanent hearing loss). PTS may result from a single high-intensity exposure or from repeated exposures that produce less profound, temporary hearing loss; and
- **Temporary Threshold Shift** (TTS) refers to a temporary increase in the lower sound threshold of audibility, with hearing sensitivity later returning to pre-exposure levels. TTS results from fatigue of the auditory cells (Southall et al., 2007). TTS varies in severity (how much louder sound needs to be for an animal to hear it) and in duration, but the severity and duration of TTS are generally correlated. They depend on the sound level, the sound frequency in relation to the animal's hearing frequency range, and the duration, number, and timing of exposures. A threshold shift of 40 dB is likely to be permanent, at least in marine mammals (Southall et al., 2007). Measured recovery times vary from minutes to days, with recovery time typically increasing with the duration of exposure as well as the SPL.

There is wide agreement that $P_{max}$ and SEL are appropriate measures for assessment of sound impacts on marine fauna (Southall et al., 2007).

*Background*

Dredging and other anthropogenic sound sources can have a hierarchy of effects on marine fauna, which depend critically on the distance from the sound source, the sound frequency and intensity, and on the hearing, vocalisation, and other biological characteristics of the organism. For a given source, the effects diminish with range depending on sound attenuation and the organism's sensitivity. Figure 9-9 shows a simplified example of the potential impacts of marine noise on marine fauna as distances from the source increase.

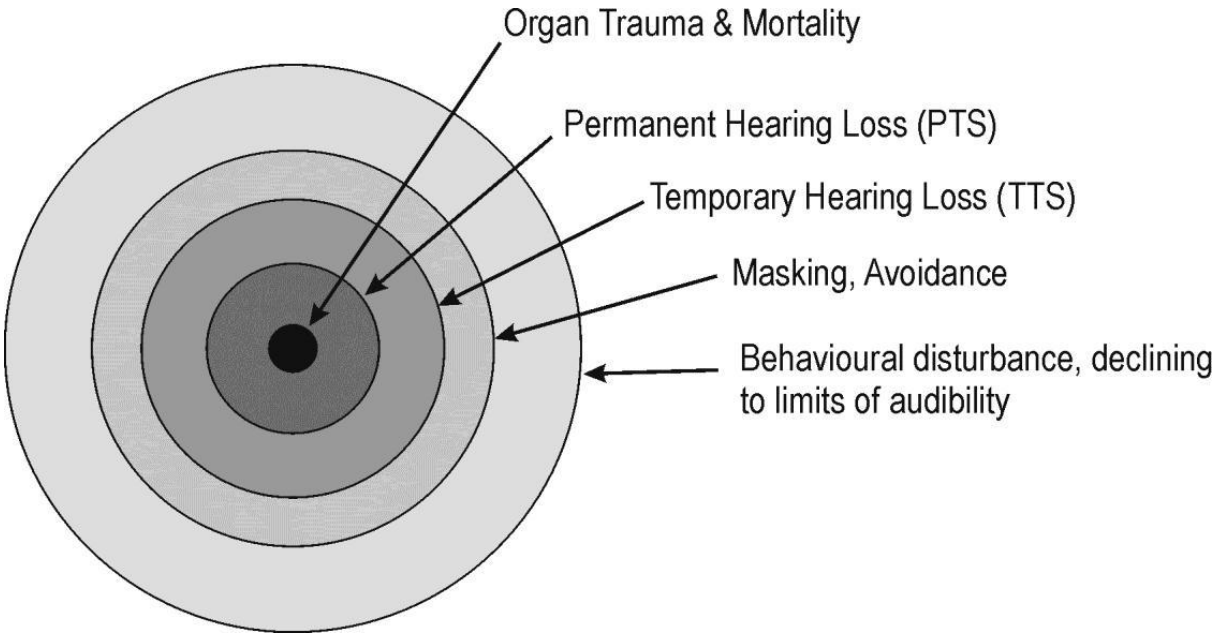



Figure 9-9: Potential effects of marine noise at increasing distances from the source (SKMa, 2013b)

Smaller organisms are more vulnerable to sound-induced injury. Fishes are therefore expected to be more vulnerable to injury from marine noise than turtles and marine mammals. Figure 9-10 provides an indication of mortality rates from marine noise in fish of various sizes.

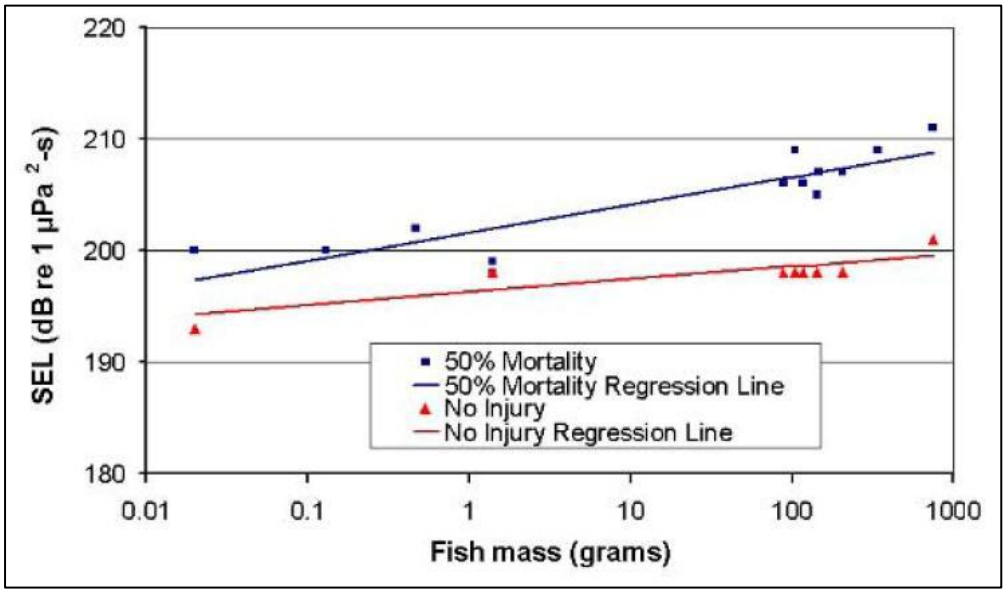



Figure 9-10: Estimated SEL resulting in 50% mortality and no mortality in fish (SKM, 2013b)

Marine fauna can use hearing for different purposes, including predator and prey detection, communications, the detection of objects in the environment through echolocation, and possibly navigation. Marine noise has the potential to affect all of these functions but is likely to be biologically significant at the population level if hearing loss is prolonged (National Research Centre, 2005).

Vulnerability to marine noise depends upon the sound frequency because PTS and TTS results from the same mechanism as hearing stimulation of auditory cells. Sound frequencies significantly above or below those at which the cells respond will not fatigue the cells or induce

PTS or TTS. Humpback and other baleen whales are thought to hear predominantly at low frequencies, as are fishes and turtles, though there is considerable variation among species (Nedwell & Howell, 2004). Dolphins and dugongs are thought to hear best primarily at higher frequencies above 5 - 10 kHz. Based on their high-frequency hearing and the predominantly low-frequency spectrum of piling noise, dolphins and dugongs are expected to be less vulnerable to piling-induced noise than Humpback Whales and fishes (SKM, 2013b).

Vulnerability to PTS and TTS depends not only on the frequency range of an animal's hearing, but also on how sensitive its hearing is within that range. Fishes have less-sensitive hearing than marine mammals (Nedwell & Howell., 2004), and therefore are expected to be less vulnerable to PTS or TTS than Humpback Whales. Therefore, sound exposure criteria for marine mammals that are used in marine fauna assessments are generally conservative with respect to fishes.

Lower marine noise levels may also result in behavioural impacts. Auditory masking occurs when an animal is unable to detect a biologically relevant sound signal against background noise (Richardson et al., 1995). Sounds that marine fauna use to detect predators and prey, communicate and echolocate, are all of much longer duration than a hammer blow due to piling, or in the case of echolocation, are frequently repeated over a longer duration. However, repeated noise emissions over a longer time can potentially interfere with marine fauna behaviour.

Observed responses to anthropogenic sound in marine fauna include avoidance of the sound source, altered swimming direction or speed including pronounced 'startle' reactions, increased dive times, and changes in vocalisation (National Research Centre, 2005). These responses are highly variable and depend on the ecological and behavioural context as well as an animal's experience. (National Research Centre, 2005; Richardson et al., 1995). Anthropogenic sound can also cause physiological reactions such as changes in heart or respiratory rates, and possibly longer-term physiological changes related to stress, but the effects of stress on marine fauna are poorly understood (National Research Centre, 2005).

*Proposal Marine Noise Sources*

The assessment of underwater noise impacts to marine fauna during construction and operation of the Proposal has been informed via an acoustic underwater noise modelling study undertaken by JASCO Applied Sciences (JASCO) (Appendix B of Appendix 4.6). The study assessed distances from Proposal-related underwater noise generating activities where underwater sound levels reached thresholds corresponding to a behavioural response and acoustic impairment relevant to the marine fauna of significance. The noise modelling study was conducted using the currently accepted methodology and standards for assessment of underwater noise impacts on marine fauna.

Quantification of the Proposal-related shipping identified the majority of marine shipping activity during construction to be associated with the dredging and transport of spoil material to the proposed disposal locations. It is anticipated that a single medium-sized CSD and two split hopper barges will be used, and approximately 315 movements of the split hopper barges are estimated to occur between the dredge and disposal grounds.

The potential impacts to marine fauna from underwater noise have been reviewed in detail. These can be broadly divided into behavioural impacts (displacement, attraction, avoidance, masking or interfering with biologically important sounds) and physiological impacts (stress, hearing damage and/or impairment). Physiological impacts can be temporary or permanent.

The assessment period for SEL accumulation has been defined as a 24-hour period over which sound energy may be integrated; the level is specified with the abbreviation SEL24h. SEL24h is a cumulative metric that reflects the dosimetric effect of noise levels within 24 hours, based on the assumption that a receiver (e.g., an animal) is consistently exposed to such noise levels at a fixed position. More realistically, marine mammals, fish, and marine turtles would not stay in the same location for 24 hours (especially in the absence of location-specific habitat) but rather a shorter period, depending on the animal's behaviour and the source's proximity and movements. Therefore, a reported radius for SEL24h criteria does not mean that marine fauna travelling within this radius of the source will be impaired, but rather that an animal could be exposed to the sound level associated with impairment (either PTS or TTS) if it remained in that location for 24 hours. Results are thus conservative.

*Marine Fauna and Associated Sound Criteria*

A likelihood of occurrence assessment was undertaken by O2 Marine (2025e) to identify key significant marine fauna species (excluding marine birds) that have the potential to occur within and/or adjacent to the Proposal location (with a 20 km buffer). These species are considered to be at most risk from underwater noise related impacts. The marine species with a high likelihood of occurrence include:

- Dugong (*Dugong dugon*);
- Turtles (Hawksbill Turtle (*Eretmochelys imbricata*), Green Turtle (*Chelonia mydas*), Flatback Turtle (*Natator depressus*);
- Humpback Whale (*Megaptera novaeangliae*);
- Australian Humpback Dolphin (*Sousa sahulensis*);
- Indo-Pacific Bottlenose Dolphin (*Tursiops aduncus*); and
- Green Sawfish (*Pristis zijsron*).

O2 Marine (2025e) noted that the Cape Preston area was not identified as a known important resting or nursing area for Humpback Whales. However, the Marine Development Envelope falls within a BIA for the migration of Humpback Whales, noting that calving grounds for the species occur between Camden Sound and North West Cape and uncertainty in the occurrence of Humpback Whale mother-calf behaviour within the development envelopes (O2 Marine, 2025e).

Popper et al. (2014) has established broadly applicable sound exposure guidelines for marine turtles and fishes based on the available scientific information, although the problems of assessing the impacts of noise upon fish are well known (Hawkins & Popper, 2017). Turtles tend to avoid areas of high noise, especially if it is sudden and prolonged, but the change in behaviour or reaction range is not well researched. Only impulsive noise (such as pile driving) exposure threshold values have been reported for impacts on turtles (potential mortal injury at a cumulative SEL of 210 dB re 1 $\mu Pa^2s$). Popper et al. (2014) recommends the use of subjective criteria for TTS from continuous noise sources. Similarly, it is recommended that potential for hearing effects, masking and behavioural disturbance to turtles be assessed qualitatively based on relative risk to the animal at varying distances from the noise source.

There is no evidence for PTS in fish and it may not occur in fishes since they can repair or replace sensory hair cells of the inner ear that have been lost or damaged (Popper & Hawkins, 2019). However, experiments conducted with (caged) Green and Loggerhead turtles using impulsive noise indicated active swimming when sound exceeded 166 dB re 1 $\mu Pa^2s$ and appeared in an agitated state at 175 dB re 1 $\mu Pa^2s$. Sound exposure criteria for fishes without a swim bladder are proposed to be the most appropriate for elasmobranchs (i.e. the green sawfish).

*Underwater Noise Screening Risk Assessment*

MScience (2025; Appendix 4.6) estimated marine noise impacts from dredging and operational noise of the seawater intake pump station at McKay Creek. On the basis of the underwater noise screening risk assessment, the following conclusions can be drawn regarding the risk of underwater noise impacts to marine fauna from the Proposal's activities:

- The inherent risk to the marine fauna of interest from dredging activities was considered moderate;
    - A marine mammal behavioural response was estimated to extend for 6.3 km from the dredging noise source;
    - Onset of TTS and PTS for the low frequency cetacean group, including humpback whales, using the worst case SEL24h criteria did not extend beyond 2.21 km and 330 m, respectively, from the dredging noise source;
    - Onset of TTS and PTS for the high frequency cetacean, including the Indo-Pacific bottlenose dolphin and Australian humpback dolphin, was estimated to extend for 240 m and 10 m, respectively, of the dredging noise source;
    - Onset of TTS in dugongs, using the worst case SEL24h criteria, extends for 50 m from the dredging noise source. Onset of PTS in dugongs was not predicted to occur during dredging activities;
    - Onset of TTS and PTS in marine turtles did not extend beyond 260 m and 10 m, respectively, from the dredging noise source; and
    - Dredging noise criteria thresholds for fish without a swim bladder (relevant to this assessment) were not reached;
- The inherent risk to the marine fauna of interest from operation of the seawater intake pump was considered low; and
    - The modelled intake pump noise was too quiet to reach any of the noise exposure threshold criteria for marine mammals, marine turtles or fish within the modelling resolution of 10 m.

***Barriers to Movement***

Bitterns discharge may result in direct effect of osmotic stress to marine fauna and indirect impacts to subtidal BCH because of increased salinity, osmotic stress, impairment, and ion toxicity. Further, bitterns discharge can also create an obstruction of marine fauna movements. Bitterns discharge can lead to disruptions of habitat important for foraging and breeding, especially for migratory marine fauna. Reduced oxygen levels from increased salt and chemicals can result in reduced oxygen which could create a barrier of unsuitable habitat which species may avoid or could create a physical barrier which species are unable to travel through. These potential impacts could cause avoidance, disorientation, altered migration movements or delays in migrations if the outfall is not appropriately managed.

The modelling of the bittern's outfall indicates that the impacts will be localised and concentrated to the nearshore environment. The MEPA does extend to the shore approximately 3 km offshore. The LEPA does not extend to the coastline and is approximately 1 km from the shore. However, the bittern's dispersion model (worst-case) indicates that both the 90% and 99% SPL do not extend to the shore. It is possible that the identified zones representing the LEPA and MEPA from the bittern's discharge could result in a barrier of movement. However, mobile marine fauna such as marine mammals, turtles, and sawfish may move through the low, moderate or high LEP zone from time to time, however the risk is considered low given the species ability to leave the zone if conditions are unfavourable. Less mobile marine fauna species are more susceptible to osmotic stress, such as juvenile prawns.

***Light***

Artificial light pollution is a threat to biodiversity, as it affects the natural behaviour of marine species such as turtles.

Pendoley Environmental (2022; Appendix 4.3) conducted benchmark light monitoring and light modelling for predicted lighting impacts from the Proposal.

Light modelling of Proposal facilities predicted that the greatest change in brightness will occur at the beach directly adjacent to CPE. The topography at this location provides minimal natural shielding of both direct light and sky glow from the port facilities, and the Proposal facilities and OGVs are also visible as sources of sky glow on the horizon.

Sites at South West Regnard Island will also experience a notable increase in brightness, but to a lesser degree than at CPE. At the northern end of South West Regnard Island the increase in brightness is primarily due to the OGV anchorages, (not part of the Proposal), which are visible as direct and unshielded sources of light from the beach. On the eastern beach of South West Regnard Island, the increase in brightness is attributed to sky glow from the Proposal and CPE facilities. At sites situated further from the Proposal, such as North East Regnard Island and 40-Mile Beach, the cumulative change in brightness resulting from Proposal lighting will be minimal and therefore the impact on marine fauna is also expected to be minimal. The impacts of lighting on marine turtles have been discussed in further detail in Section 9.5.2.

***Increased Predation***

Artificial structures installed in the marine environment often result in aggregations of marine fauna species, which can cause increases in predation. Many species of intertidal or subtidal animals and plants are limited in their distribution by the slope of the substratum (Whorff & Sweet, 1995). In addition, artificial intertidal vertical surfaces may crowd species into a limited area compared with the amount of intertidal habitat available on more gently sloping natural shores. Thus, densities may be abnormally increased, or species that do not usually come into contact can be forced to occupy the same area, potentially increasing the strength of interspecific interactions. Key ecological processes, such as recruitment (Glasby, 1999; Bulleri, 2005), foraging (Bulleri & Chapman, 2004), competition, predation (Kirk et al., 2007) or reproduction (Moreira et al., 2006) may differ between natural and artificial habitats.

The seawater intakes and bitterns diffusers are the only additional structures that will be installed in the marine environment above the seabed as part of the Proposal. Marine fauna would be expected to aggregate around these structures to some degree, however these structures are relatively small in scale and any increased predation is likely to be localised and not significantly impact the local or regional populations of species and their distribution or result in reductions in the diversity of species.

***Changes to Intertidal/Freshwater Inputs***

As discussed in Section 6, the Proposal is predicted to result in changes to the intertidal and freshwater inundation regimes, predominantly due to the presence of the pond footprint, and the capture of rainfall within the ponds. These changes may affect the amount of nutrients that are flushed into the marine environment, potentially altering subtidal BCH and indirectly the marine fauna that utilise those habitats.

This assessment is provided in the BCH section (Section 8.5) of this ERD. To summarise, O2 Marine (2025b) determined that:

- BCH impacted by altered surface water flows include algal mats and samphire shrublands;
- 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;
- The Proposal maintains the three major freshwater flow paths in the area; Eramurra Creek, McKay Creek and Devil Creek;
- It is well known that that mangroves and their related ecosystems (especially cyanobacterial non-mat forming communities) are the single most important contributor to the nutrient budget within the intertidal LAUs;
- The relative contribution of nutrients to the nearshore marine environment from other intertidal BCH is not as 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 & McComb, 1994; Biota, 2005; URS, 2010; 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 (O2 Marine, 2025g) for the Proposal showed no nutrient exchange from algal mats to the nearshore marine environment during normal spring tidal cycles, suggesting that nutrient exchange may be limited to significant freshwater inundation events (Paling, 1986);
- 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 mangroves; and

- The significant maximum losses of algal mats predicted across the LAUs mean that these episodic surface water flows will no longer have the opportunity to collect nutrients during freshwater inundation from algal mat areas. 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 therefore a conservative position has been taken.

The impact assessment determined that the losses of mangroves, algal mats and samphire shrubland BCH was likely to be locally significant and offsets were proposed to counterbalance that impact (Section 15).

***Other Indirect Impacts***

Marine fauna or their habitat may be indirectly impacted by the Proposal as a result of:

- Disposal of bitterns;
- Increased turbidity due to dredging or disposal of dredged material; and
- Leaks or spillages of product or hydrocarbons.

Indirect impacts to marine fauna habitat and water quality are discussed in detail in the BCH factor (Section 8.5) and Marine Environmental Quality factor (Section 7.5) respectively. This section focusses on how these impacts would specifically affect marine fauna.

Dredging will generate plumes of turbid water containing elevated levels of suspended sediments, which have the potential to impact marine fauna by reducing light availability for foraging, clogging feeding and respiratory structures; and mobilising nutrients and/or contaminants. The dredging volumes and duration are however relatively minor, meaning that sedimentation impacts to marine fauna are likely to be short-term (excluding habitat impacts discussed previously) and localised.

Bitterns disposal will result in a mixing zone with significantly reduced water quality, defined as the LEPA. This area has been assumed to result in a loss of BCH in the cumulative loss assessment conducted by O2 Marine (2025b; Appendix 3.1). It is therefore unlikely that there would be any resident marine fauna within the LEPA once that BCH has been lost. There will be significant stratification within parts of the LEPA for up to eight days at a time, with high salinity (and expected low dissolved oxygen) water in deeper areas and fresher and more oxygenated water closer to the surface. The majority of marine fauna that enter the high salinity stratified layer are however not expected stay for a long period, given the water density and salinity, low oxygen levels, and the lack of BCH within this area. Most marine fauna are therefore likely to pass through this layer, or avoid it completely, continuing their search for food, shelter or other habitat in the areas surrounding the LEPA. Bitterns discharge may result in the direct effect of osmotic stress to marine fauna and indirect impacts to subtidal BCH because of increased salinity, osmotic stress, impairment and ion toxicity. Reduced oxygen levels from increased salinity could create a barrier of unsuitable habitat which species may avoid or could create a physical barrier which species are unable to travel through. There is minimal suitable forging habitat within the outfall LEPA and MEPA. Further migration and movements of marine fauna are not restricted to shallow nearshore waters and therefore unlikely to result in restricted movements for dolphins, dugongs, turtles, sea snakes, and manta rays (O2 Marine, 2025f).

Product and hydrocarbon spill risks associated with the export of salt product forms part of the approved CPE Port and are not part of the Proposal. Proposal-associated risks are therefore limited to vessels associated with dredging and the construction and maintenance of the bitterns pipeline and seawater intakes. Specific management measures are proposed in the DSDMMP to address these risks, and these measures will also be utilised during construction and maintenance of the bitterns pipeline and seawater intakes.

### 9.5.2 Marine Turtles

This assessment applies to all marine turtles, but specifically the Flatback, Hawksbill and Green turtles, which were identified by Pendoley Environmental (2023 & 2024) as nesting in the vicinity of the Proposal. For completeness, any of the potential impacts described in the general assessment in Section 9.5 that are specifically relevant to marine turtles have been summarised or discussed further in this section.

***Habitat Disturbance***

The Recovery Plan for Marine Turtles in Australia 2017-2027 (DotEE, 2017c) identifies 'habitat critical to the survival' of marine turtle species as areas necessary:

- For activities such as foraging, breeding or dispersal;
- For the long-term maintenance of the species (including the maintenance of species essential to the survival of the species);
- To maintain genetic diversity and long-term evolutionary development; and
- For the reintroduction of populations or recovery of the species.

Hawksbill, Flatback and Green turtles were found to use the offshore islands and beaches north of the Proposal at low and varying levels. South West Regnard Island, North East Regnard Island, Steamboat Island and beaches on the mainland represent nesting habitat for these three species.

O2 Marine (2025e) found that the nearshore islands and tidal creeks (including mangroves) represent the most important feeding areas for turtles, with seagrasses and macroalgae BCH providing important feeding habitats (Gales et al., 2004).

Approximately 80 juvenile green turtles were sighted by researchers west of the intake creek and juveniles were also caught in gill net surveys in 2022 and 2023 ( Morgan et.al., 2025). Areas suitable for green turtle foraging include shallow reef that surround the offshore islands, and mangrove habitats close to the mainland, which are present at the Proposal. It is likely that juveniles will be present within the Intake Creek, other creek systems and the nearshore environment around the Proposal, and it is likely that the are represents foraging habitat for green turtles. Adult green turtles are likely to be present travelling, foraging, inter-nesting, and nesting in low abundance areas around the Proposal.

Losses of these habitats have been avoided or minimised at the Proposal, with 8.3 ha (0.6%) of mangroves and up to 3.7 ha (0.22%) of seagrass with macroalgae losses predicted of the mapped extent within the LAUs.

***Direct Injury or Death***

*Vessel Strike*

The likelihood of a vessel strike during dredging and construction activities is considered low due to the small distances traversed by the vessels, the short dredging duration, their slow speed and the minor areas of foraging habitat in the vicinity of the dredging, dredged material disposal areas and work areas. The consequence of vessel strike on marine turtles may result in injury or mortality, although given this is unlikely to occur except on rare occasions, potential impacts from Proposal activities are unlikely to result in significant declines in the local or regional populations of species and their distribution, or reductions in the diversity of species.

An 8-knot speed limit will be implemented for construction vessels at the Proposal to reduce the likelihood of injury or death of marine turtles. In addition, vessel operators will be trained to observe and report the location of any sightings of marine turtles to other vessel operators in the area to allow them to be tracked (if visible) and avoided.

*Dredging*

Dredging may result in injury or mortality or marine turtles, however the implementation of controls is predicted to significantly reduce the likelihood of this occurring. A DSDMMP (Appendix 2.2) has been developed which details the measures proposed, which align with other dredging programs in WA. A turtle exclusion device will be included if a cutter section dredge is used. With the implementation of controls, the likelihood of injury or mortality to marine turtles as a result of dredging activities, is considered low.

Dredging can increase sedimentation, reduce water quality and smother benthic habitats. The reduction in suitable benthic habitats can negatively impact marine turtles if the dredged area or sediment spoil ground is located in area that provides important foraging habitat. A study on turtles' response to dredging operations found that flatback turtles increased their use of dredging areas while active dredging operation were occurring; the cause of this is unknown. The increased use of dredge area during dredging operations did not result in concurrent injury or mortality of flatback turtles (Whittock et al., 2017). Further, there is the risk of injury or mortality to marine turtles, during dredging from entrainment, vessel strike or the effects of noise and vibration.

*Entrapment in Seawater Intakes*

O2 Marine (2025e) determined that marine turtles could be present in the vicinity of the seawater intakes and therefore there was the potential for them to become trapped against the intakes. The Proposal seawater intakes have been designed to ensure a flow rate of less than 0.15 m/s at the intake screen, which is lower than the swim speed of marine turtles. The screen size will also be small enough to prevent turtle hatchlings passing through the screen. Consequently, the risk of entrapment of marine turtles at the seawater intake is considered to be low.

***Increased Predation***

Turtle hatchling survival in the wild is heavily influenced by predation. The Proposal may result in an increase in shorebird numbers in the lower salinity pond areas closer to the coast as they have been recorded utilising salt ponds elsewhere in the Pilbara (Johnstone et al., 2013). The SBSA is already an internationally important wetland site as the area was found to regularly support >1% of the individuals in a population of one species or subspecies (DotEE, 2017a; Phoenix, 2023). Based on the recent survey undertaken by Phoenix (2023), the Proposal is likely to meet the international criteria for three migratory species. Therefore, the shorebird population is already well established in the area (i.e., ponds are not being introduced to an area that previously had no significant habitat). Increases in shorebird numbers close to turtle nesting beaches are therefore expected to be negligible and increases in marine turtle predation would be minimal given the distance to the key offshore nesting beaches.

***Marine Noise***

This section applies the findings of the marine noise assessment described in Section 9.5.1 to marine turtles and is sourced from MScience (2025). Turtles tend to avoid areas of high noise, especially if it is sudden and prolonged, but the change in behaviour or reaction range is not well researched. Only impulsive noise (such as pile driving) exposure threshold values have been reported for the impacts on turtles.

The threshold criteria from Finneran et al. (2017) were used to assess PTS and TTS for marine turtles. For the dredging scenario, the maximum distance to threshold were 260 m for TTS and 10 m for PTS.

To model impacts associated with the intake pump, the PTS and TTS threshold criteria from Finneran et al. (2017) were used. The modelled intake pump noise was too quiet to reach the noise exposure threshold criteria for turtles within the modelling resolution of 10 m.

***Light***

This section applies the findings of the light monitoring and modelling undertaken by Pendoley Environmental (2022 & 2023).

*Background*

Lighting is an important threat to marine turtles that can become significant if left unmitigated. Light pollution along, or adjacent to, nesting beaches or rookeries may cause alterations to critical nocturnal behaviours, particularly the selection of nesting sites and the passage of emerging turtle hatchlings from the beach to the sea. Potential impacts include a decrease in nesting success, beach avoidance by nesting females and disorientation resulting in increased mortality. Significant decreases in turtle nesting have been recorded in places like Florida (USA) and Queensland as development has resulted in the lighting of more and more turtle nesting beaches (Limpus, 1995; Rich & Longcore, 2006).

While turtles tend to prefer dark beaches, they do also nest in lit areas. When they do, however, the survival of their hatchlings is jeopardised (Witherington & Martin, 2000). As hatchlings emerge from nests they can be disoriented or mis-oriented by artificial lights. Artificial lighting may also deter mature turtles from emerging from the water to nest (Mortimer, 1982; Raymond, 1984; Witherington, 1991; Mattison et al., 1993). In particular, a female laying eggs for the first time in her life is more likely to avoid beaches affected by light. Witherington (1991) showed in field experiments that Loggerhead and Green turtles displayed a significant tendency to avoid brightly illuminated stretches of beach. In areas where glow from artificial lights is present behind the dunes, Loggerhead turtles have been shown to prefer to nest in the darker area shaded by tall buildings or dune vegetation (Salmon et al., 1995). Avoidance of lighted beaches may lead to a gradual decline in the number of turtles using a beach, with changes not evident for decades because of the long life cycles involved.

Hatchling turtles primarily rely on vision to find the sea by orienting towards the brightest direction (Salmon et al., 1992). Sea finding occurs when hatchlings orient away from dark, elevated horizons (Limpus, 1971; Salmon et al., 1992) towards the low, light horizon over the sea and make a frenzied dash for the water once they emerge from the nest. Under natural conditions, the brightest direction is almost always away from elevated horizons (e.g., dunes, vegetation) towards the horizon over the sea due to the reflection of celestial light off the water. Artificial lighting can disrupt this pattern (Tuxbury & Salmon, 2005). Turtles which are disoriented or mis-oriented by artificial lights often do not find the sea promptly and may die due to dehydration, predation or exhaustion (Witherington & Martin, 2000). Two hours of crawling towards a landward light source temporarily impairs the subsequent ability of loggerhead hatchlings to crawl seaward, by interfering with their ability to respond appropriately to the cues normally used to locate the ocean. Hatchlings may also waste part of the limited energy stored in the egg yolk, reducing their capacity to swim offshore away from coastal predators (Lorne & Salmon, 2007).

The impact of lighting on marine turtles is heavily influenced by wavelength (colour), intensity, glow, direction and elevation. In practical terms, bright light that has high directivity causes the greatest disruption. Broadly speaking, bright, highly directive white lights containing short (blue-green) wavelengths create the greatest problems for turtle hatchling orientation but even long wavelength lights (orange-red) that are intense enough and directive enough will disrupt hatchling orientation, especially in the absence of sun or moon light. As far as lighting design is concerned, the combination of intensity, colour, elevation and reflectivity of the surroundings appear to act together to influence turtle behaviour. Glow from an artificial light field reflected off overhead cloud is also problematic (EPA, 2010).

In summary, the effects of colour, intensity, proximity and direction of a light source combine to determine its attractiveness to a turtle hatchling. These factors, combined with the tendency to move away from dark horizons, determine the orientation adopted by a hatchling turtle (EPA, 2010).





*Proposal Lighting Impacts*

Pendoley Environmental (2022 & 2023) conducted benchmark light monitoring and light modelling respectively, for predicted lighting impacts from the Proposal. Information in this section is sourced from both of these reports.

Monitoring and modelling were undertaken at three island and two mainland locations outlined in Figure 9-11. CITIC Pacific's Sino Iron Facility at Cape Preston, situated adjacent to the proposed CPE Port facility, was the largest existing source of sky brightness on the horizon and was visible from all survey locations. Lighting from industry on the Burrup Peninsula, and the Karratha townsite were also visible from all survey locations, however the extent of sky glow visible from these sources was comparatively smaller due to the greater distance. Direct light from vessels anchored to the northwest of South West Regnard Island was also visible.

Light emissions from the approved CPE Port were also determined to be a significant light source at most monitoring locations if developed.

The Proposal was predicted to increase the horizon brightness at the monitoring locations by between 1% and 11% and include lighting that is directly visible from three of the five monitoring sites.

A risk assessment was undertaken to evaluate the potential for artificial light occurring in the vicinity of the Proposal to cause mis- or disorientation of hatchling sea turtles (Pendoley Environmental, 2023). The assessment was informed by the light modelling (Appendix 4.3) and considered other physical and biological factors that influence hatchling sea-finding behaviour, as well as the relative contribution of nesting females to the relevant genetic stocks. The assessment determined the inherent (unmitigated) risk to be Low at North East Regnard Island, South West Regnard Island and 40-Mile Beach, and Medium at CPE beach.

Overall low abundance was recorded for all three species within the vicinity of the Proposal and consequently impacts caused by light pollution are not expected to have significant impacts on respective genetic stocks. Nevertheless, it is acknowledged that any increase in light within proximity to turtle nesting areas should be minimised and therefore mitigation measures are proposed to minimise these light impacts (Section 9.6).

***Other Indirect Impacts***

Marine turtles or their habitat may be indirectly impacted by the Proposal as a result of:

- Disposal of bitterns;
- Increased turbidity due to dredging or disposal of dredged material; and
- Leaks or spillages of product or hydrocarbons.

Indirect impacts to marine turtle habitat types and water quality are discussed in detail in the BCH factor (Section 8.5) and Marine Environmental Quality factor (Section 7.5) respectively. The assessment in Section 9.5.1 predicted that indirect impacts from these sources would be localised and/or short-term.

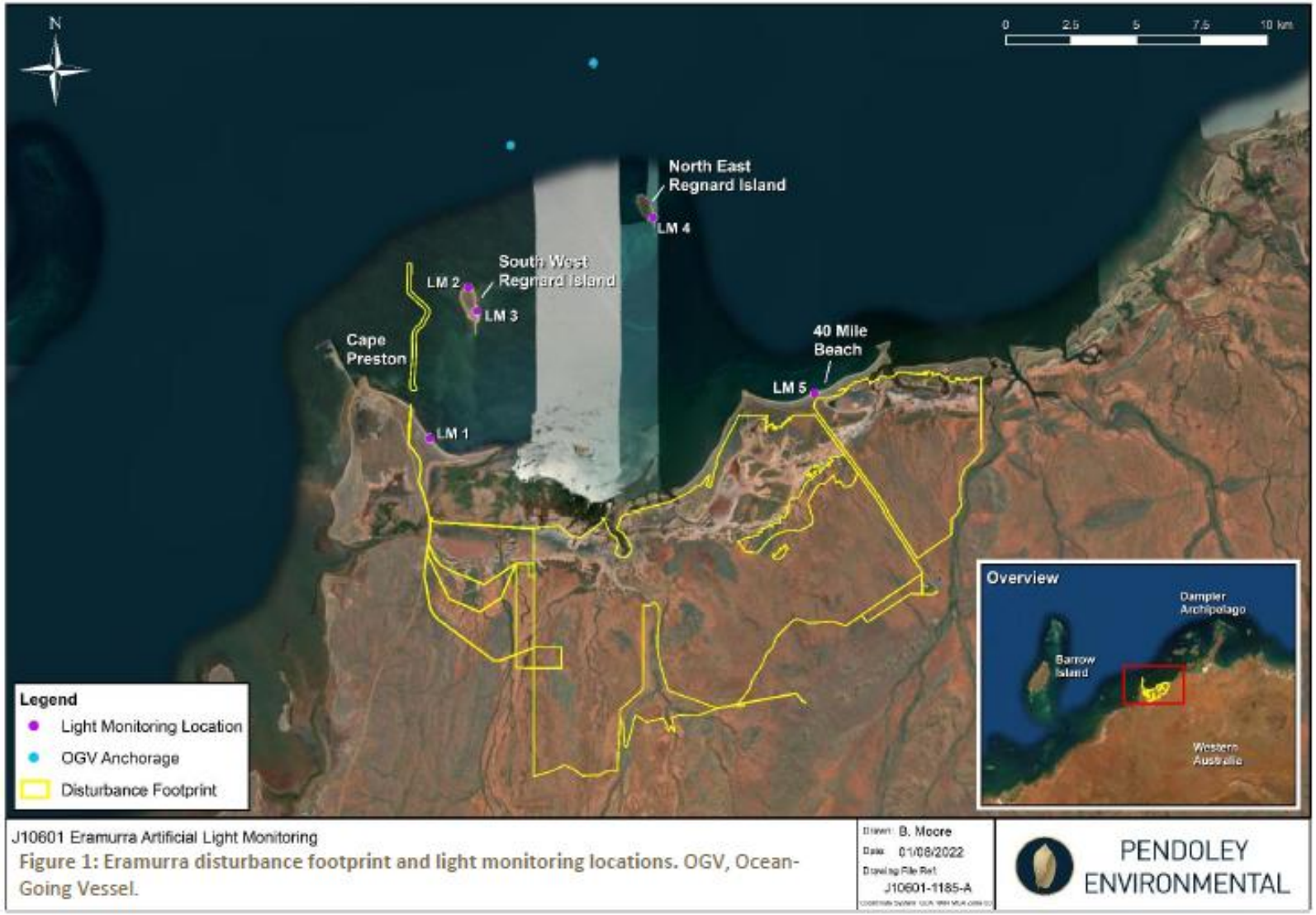



Figure 9-11: Light monitoring locations (note a previous version of the disturbance footprint is shown in this figure)

### 9.5.3 Sea Snakes

Information is provided in this section if it adds to the general assessment Section 9.5.1, i.e. if any of the potential impacts have more relevance to the short-nosed sea snake and the leaf-scaled sea snake then they have been discussed further in this section.

***Habitat Disturbance***

The short-nosed sea snake is a coral dependant species, found on the reef flats or in the shallow water of outer reefs. They have a restricted geographical range of <10km$^2$ and were previously mostly seen near Ashmore reef. Recent field surveys and habitat suitability threshold modelling, has identified new potential distribution that extends from the Exmouth Gulf and around Muiron Island to the Montebello Islands Marine Park, suggesting that they could occur on coral reefs around the Proposal (Udyawer et al., 2020). Only 3.8 ha (0.10%) of coral habitat is however proposed to be disturbed as a result of this Project.

The leaf-scaled sea snake occupies parts of reef flats which are adjacent to coral and coral substrates. A discovery of a population at Shark Bay WA indicated the species can also inhabit non-coral habitats, including seagrass habitats. Documented records and habitat suitability threshold modelling suggest this species could occur on coral reefs and seagrass meadows adjacent to islands around the Proposal (Udyawer et al., 2020). Only 3.8 ha (0.10%) of coral habitat and 4.1 ha (0.27%) of seagrass habitat is proposed to be disturbed as a result of this Project.

Given the high availability of habitats that will remain after the implementation of the Proposal, it is unlikely that the Proposal would result in significant impacts to these species.

### 9.5.4 Marine Mammals

This assessment applies to all marine mammals, however it focusses on the Humpback Whale, Australian Humpback Dolphin, Indo-Pacific Dolphin and Dugong as they are significant marine mammal species that were identified as potentially occurring in the area (predominantly offshore). For completeness, any of the potential impacts described in the general assessment in Section 9.5.1 that are specifically relevant to marine mammals have been summarised or discussed further in this section.

***Habitat Disturbance***

Section 9.5.1 provides an assessment of the potential impacts to marine fauna habitat, which is generally suitable to assess impacts to marine mammals given they are likely to range well outside the LAUs. Seagrass beds are however of specific interest to dugong as key foraging habitat, however only 4.1 ha, or 0.27% of the mapped extent within the LAUs was predicted to be lost as a result of the Proposal, which is unlikely to affect the local or regional population.

***Direct Injury or Death***

*Vessel Strike*

The likelihood of a vessel strike during dredging and construction activities is considered low due to the small distances traversed by the vessels, the short duration, their slow speed and the ability of marine mammals to avoid slow moving vessels. Dugongs are more susceptible to vessel strike however the majority of foraging habitat has been avoided (refer to section above) therefore this species is unlikely to be in proximity to the vessels in large numbers.

The consequence of vessel strike on marine mammals may result in injury or mortality, although given this is unlikely to occur except on rare occasions, potential impacts from Proposal activities are unlikely to result in significant declines in the local or regional populations of species and their distribution, or reductions in the diversity of species.

An 8-knot speed limit will be implemented for construction and dredging vessels at the Proposal to reduce the likelihood of injury or death of marine mammals. In addition, vessel operators will be trained to observe and report the location of any sightings of marine mammals to other vessel operators in the area to allow them to be tracked and avoided, and to allow minimum separation distances to be maintained between vessels and prescribed fauna as described in the BC Regulations.

*Dredging*

Dredging may result in injury or mortality or marine mammals, however the implementation of controls is predicted to significantly reduce the likelihood of this occurring. A DSDMMP has been developed which details the measures proposed, which aligns with other dredging programs in WA. With the implementation of controls, the likelihood of injury or mortality to marine mammals as a result of dredging activities is considered low.

Behavioural and masking response from underwater noise from dredging is the greatest potential impact to whales, especially during the resting and calving period of their annual migration (O2 Marine, 2025f). Masking is problematic when communication between animals (e.g. between mother-calf pairs) or the ability to detect predators is disrupted. Neonate humpback whale calves communicate at a low sources level and continuous noise from dredging could mask this. Behavioural responses to sound exposure can vary, including changes in swimming patters (speed and/or direction), diving (frequency and duration), breathing rates, vocalisation, foraging, mating, resting, socialising and defensive behaviours (Salgado Kent et al., 2016). Short-term behavioural responses including startling and avoidance of the noise can be advantageous in keeping individuals at a safe distance. This is not always the case because in some instances, behavioural responses can result in secondary organ or tissue damage (e.g. rapid rise from a dive) or result in the whales responding by moving directly in the path of other threats (Salgado Kent et al., 2016).

***Marine Noise***

This section applies the findings of the marine noise assessment described in Section 9.5.1 to marine mammals, specifically the Humpback Whale, Dugong, Indo-Pacific Bottlenose Dolphin and Australian Humpback Dolphin, given their high likelihood of occurrence.





The noise modelling predicted sound levels associated with dredging action via a CSD, movement of the CSD and two barges, either alongside the dredge under dynamic positioning, or transiting to the disposal area

The maximum distances to the NOAA (2024) marine mammal behavioural response criterion of 120 dB re 1 µPa (SPL) was 3.17 km from the TSV movement noise source and 6.30 km from the noise associated with dredging activities (Table 6-4). The furthest TTS and PTS ranges were associated with low-frequency (LF) cetaceans. Table 6-4 summarises the maximum horizontal distances to frequency-weighted TTS and PTS thresholds (NMFS, 2024) for each scenario.

Table 9-10 provides a summary of the noise modelling results and includes maximum ($R_{max}$) horizontal distances from dredging and vessel movements to the marine mammal behavioural response criterion of 120 dB re 1 µPa (SPL) and frequency-weighted TTS and PTS thresholds (with frequency-weighting in parentheses) based on NMFS (2024). Ensonified areas are also provided for TTS and PTS thresholds.

**Table 9-10: Marine mammal noise modelling results**

| Marine Mammal Behavioural Response – SPL $R_{max}$ (km) | Mammal | TTS – $SEL_{24h}$ | | PTS – $SEL_{24h}$ | |
|---|---|---|---|---|---|
| | | $R_{max}$ (km) | Area (km²) | $R_{max}$ (km) | Area (km²) |
| 6.30 | Humpback Whales | 2.21 | 9.61 | 0.33 | 0.32 |
| | Australian Humpback Dolphins and Indo-pacific Bottlenose Dolphin | 0.24 | 0.15 | 0.01 | / |
| | Dugong | 0.05 | 0.01 | - | / |

(-) indicates the level was not reached within the limits of the modelled resolution (10 m).
(/) indicates that the area is less than an area associated with the modelled resolution (0.0013 km²)

To model impacts associated with the intake pump, the thresholds used for assessing marine mammal behaviour included the 120 dB re 1 µPa (SPL) behavioural response threshold from NOAA (2024) and the frequency-weighted TTS and PTS thresholds from NMFS (2024).

The modelled intake pump noise was too quiet to reach the noise exposure threshold criteria for marine mammals within the modelling resolution of 10 m.

Mitigation measures are proposed in the DSDMMP (Appendix 2.2) to minimise behavioural impacts to marine mammals during the dredging program. Key measures include the timing of dredging to avoid key ecological windows and implementing dredging shutdown procedures when marine mammals move close to the dredging vessels or approach the dredging area.

With the implementation of suitable controls, the risk to marine mammals from marine noise is considered to be low.

### *Other Indirect Impacts*

Marine mammals or their habitat may be indirectly impacted by the Proposal as a result of:

- Disposal of bitterns;
- Increased turbidity due to dredging or dredged material disposal; and
- Leaks or spillages of product or hydrocarbons.

Indirect impacts to marine mammal habitat types and water quality are discussed in detail in the BCH factor (Section 8.5) and Marine Environmental Quality factor (Section 7.5) respectively. The assessment in Section 9.5.1 predicted that indirect impacts from these sources would be localised and/or short-term.

Humpback whales are unlikely to be in the waters where the impacts of the outfall are present, therefore no impact is to be expected. There is minimal suitable foraging habitat within the outfall LEPA and MEPA.

### 9.5.5 Green Sawfish

This assessment focusses on the Green Sawfish as a significant species that was identified as occurring in the LAUs. For completeness, any of the potential impacts described in the general assessment in Section 9.5.1 that are specifically relevant to the Green Sawfish have been summarised or discussed further in this section.

***Habitat Disturbance***

The habitats surveyed included mangrove creeks and coastal mudflats that appeared to be ideal sawfish habitat, similar to habitats where sawfish are found elsewhere in the region. Extreme shallows represent an important habitat for this species. Similar observations have been made in the Onslow area from tracked Green Sawfish, where neonates and young juveniles almost exclusively use shallow areas less than 1 m, and often less than 20 cm for both refuging and foraging areas (Morgan et.al., 2025). Availability of these extreme shallow areas is often limited to specific periods during the tidal cycle, and therefore maintaining access time to the shallow areas during high tides is particularly important. However, the low number of sawfish recorded in the sawfish surveys (O2 Marine, 2023a; Morgan et.al., 2025) indicates that the area is unlikely to be a major habitat or a pupping ground for any sawfish species. The assessment in Section 9.5.1 also identified that impacts to potential habitat is unlikely to be significant.

The occasional sightings of Green Sawfish (*Pristis zjisron*) in the general region and abundance of this species in nearby nursery habitats (e.g., Ashburton River, Fortescue) suggests that this area is likely an occasional foraging habitat along the migratory corridor for juvenile and sub-adult Green Sawfish. This species is known to reliably pup each year in October near the Ashburton River mouth, and juveniles and sub-adults (up to 3 m total length) migrate along the coastline to other tidal creeks during their development (Morgan et al., 2015, 2017).

The sawfish surveys conducted in 2023 recorded a notably low number of individuals, and the most recent survey in 2024 resulted in no sawfish being captured or observed. While a single sawfish was sighted at McKay Creek in 2023, it remains uncertain whether this individual emigrated from a nursery outside of the McKay Creek region. As sawfish mature into juveniles, their home range increases with size, and it has been documented that green sawfish are capable of travelling long distances (Morgan et.al., 2025). Consequently, a lack of encounters by sawfish is typical, as demonstrated by the surveys conducted.

***Direct Injury or Death***

*Vessel Strike*

The likelihood of a vessel strike during dredging and construction activities is considered low due to the small distances traversed by the vessels, their slow speed and the minimal areas of important habitat in the vicinity of the dredging, dredged material disposal areas and work areas. The consequence of vessel strike on sawfish may result in injury or mortality, although given this is unlikely to occur except on rare occasions, potential impacts from Proposal activities are unlikely to result in significant declines in the local or regional populations of sawfish species and their distribution.

An 8-knot speed limit will be implemented for construction vessels at the Proposal to reduce the likelihood of injury or death of sawfish. In addition, vessel operators will be trained to observe and report the location of any sightings of sawfish to other vessel operators in the area to allow them to be tracked (if visible) and avoided.

*Dredging*

Dredging may result in injury or mortality or sawfish, however there is minimal important habitat in the vicinity of the dredging, and controls are proposed to reduce the likelihood of this occurring. A DSDMMP has been developed which details the measures proposed, which align with other dredging programs in WA. With the implementation of controls, the likelihood of injury or mortality to sawfish as a result of dredging activities is considered low.

Suspended sediment plumes may reduce biological functioning by clogging feeding mechanisms or by smothering foraging habitats. Plumes of suspended sediments can impact marine fauna by reducing light penetration through the water column impairing visibility during foraging. This can potentially lead to reduced growth or death of light-dependent benthic habitats on which they feed on (O2 Marine, 2025f). Elasmobranchs rely on several senses while foraging, and it possible that increased turbidity could displace sawfish from foraging areas. Research on green sawfish movements at Ashburton River and Hooley Creek found green sawfish through acoustic detection when the creeks were highly turbid (flooding periods). It is thought that the rivers were avoided due to reduced feeding efficiency and increased predation risk (Morgan et al., 2017). However, the species is also known to inhabit clear to relatively turbid waters, therefore green sawfish are likely able to inhabit and successfully forage along the turbidity spectrum (O2 Marine, 2025f).

It is likely that the off-loading facility at Cape Preston has already impeded the sawfish movements between Fortescue River mouth and the Proposal area, with evidence that only larger individuals are likely to migrate between the area (>2.5 m in length) (Morgan et.al., 2025). Green sawfish migration movements are likely already impacted from the off-loading facility and pupping does not appear to occur within the creeks around the Proposal. It is likely that larger juveniles are foraging within nearby creeks, and the plume is not expected to enter the creeks or important pupping or foraging habitats.

***Marine Noise***

This section applies the findings of the marine noise assessment described in Section 9.5.1 to sawfish, in particular the Green Sawfish.

Sound produced by the modelled dredging reached the sound levels associated with recoverable injury and TTS for fish species with a swim bladder involved in hearing in close proximity to the sound sources. In order for the thresholds to be exceeded, the fish must remain within those distances for either 48 or 12 h, respectively. Sound levels associated with recoverable injury and TTS for fish species without a swim bladder (i.e. those relevant to this assessment) were not reached.

For the modelling of the intake pump, the thresholds used for fish species within the area was the recoverable injury and TTS thresholds from Popper et al. (2014). The modelled intake pump noise was too quiet to reach the noise exposure threshold criteria for fish within the modelling resolution of 10 m.

***Barriers to Movement***

It is likely that the coastal waters of the Proposal are part of the migratory corridor for juvenile-subadult Green Sawfish based on past studies and sightings. Previous research has suggested that juvenile sawfish do not readily migrate past solid barriers along the coastline, which would force them to swim into deeper water (D. Morgan & K. Lear, unpublished data).

The Proposal includes a bitterns pipeline from the coastline offshore, which could form a barrier for sawfish if not designed appropriately. Leichhardt intends to attach the pipeline to the CPE Port jetty structure, raising it off the seabed, and allowing sawfish to pass underneath, with a trench out to the diffuser. The trench will be back-filled after installation of pipeline, with only the diffuser nozzles protruding above the seabed. Neonates and older juvenile green sawfish are known to emigrate from the Ashburton River mouth during high periods of freshwater discharge, suggesting that the low salinity waters do not provide favourable conditions (Morgan et al., 2016). Closer to the Proposal area, green sawfish are known to occur within Fortescue River, which has a background salinity level that ranges from 36.4 ppt and 52.1 ppt (RPS, 2021), while juvenile sawfish have been identified in Urala Creek South, which has a background salinity of approximately 43 ppt. Given the ability of this species to inhabit saline environments, it is unlikely that bitterns discharge would act as a barrier to movement for green sawfish (O2 Marine, 2025e).

The dredged areas are generally shallow or high points along a defined transhipment vessel corridor, rather than dredging a defined channel, and will commence offshore rather than extending from the coast. The dredging is therefore unlikely to present a significant barrier to the movement of sawfish.

***Coastal Processes – Tidal Creeks***

The coastal processes assessment in Section 8.5 identified that the Proposal may result in increased sediment deposition within the various tidal creek mouths to the north of the ponds. This may gradually reduce the area of foraging habitat available to Green Sawfish. Leichhardt intends to monitor the long-term erosion and accretion of the coastline during operations as it may require the excavation of tidal creek mouths if required to maintain natural flushing processes.

***Other Indirect Impacts***

Green sawfish or their habitat may be indirectly impacted by the Proposal as a result of:

- Disposal of bitterns;
- Increased turbidity due to dredging or dredged material disposal; and
- Leaks or spillages of product or hydrocarbons.

Indirect impacts to Green Sawfish habitats and water quality are discussed in detail in the BCH factor (Section 8.5) and Marine Environmental Quality factor (Section 7.5) respectively. The assessment in Section 9.5.1 predicted that indirect impacts from these sources would be localised and/or short-term.

### 9.5.6 Fishery Indicator and Key Species

Information provided in this section is from Blueshift Consulting Pty Ltd (2025) Fisheries Review provided in Appendix 4.5. The assessment was informed by the Fish and Fisheries Report, described in Section 9.3.12 and attached as Appendix 4.5 (O2 Marine, 2023b). These documents have been prepared, based on available information.

The intent of the fisheries review was to:

- Highlight potential changes to the baseline condition of fisheries values as a result of the Proposal, individually and combined (i.e., multiple stressors);
- Consider cumulative impacts across the West Pilbara Coast by incorporating additional effects that may occur over time from other future projects;
- Evaluate the impact of the Proposal on fisheries values in the vicinity and broader region and compare this to other future projects.

Outcomes from the assessment were be used to identify potential mitigation strategies for the Proposal to address high-risk issues and minimise the contribution to any unacceptable cumulative impacts.

Relevant fisheries values were identified based on their potential vulnerability to the Proposal and their significance in the region, with species and/or fishing sectors likely to be directly or indirectly impacted by Proposal activities prioritised. This includes species and fisheries that are:

- Found or operating within or near the Proposal area and may be affected by Proposal activities, or Proposal activities in combination with other relevant future projects (cumulative impacts);
- Socially, economically, or culturally important, including indicator species used by DPIRD to monitor fisheries resources; recreationally or culturally important species; or important use/access areas;
- At risk of serious or irreversible harm, e.g., because they are particularly sensitive to habitat loss, water quality, or other potential impacts from the project; and
- To facilitate the assessment process, target species have been grouped into ecological suites, based on the general habitat and depth where they are commonly found and/or harvested. These suites are used by DPIRD to assess and manage fisheries resources.

Blueshift Consulting conducted a comprehensive issue identification and impact pathway analysis for the Proposal during construction and operational phases. The analysis focused on two primary metrics:

- Changes in fish species abundance, distribution or populations dynamics, as a key indicator for biodiversity values; and
- Impacts on social, cultural and economic values, as a key indicator for social surrounds.

Identified issues are provided in Table 9-11 and Table 9-12. Each identified 'issue' was assessed for key target species/group of species. Species were grouped where they displayed similar life history characteristics, habitat associations, or represented a range of species within a broader resource, e.g. the Pilbara Demersal Scalefish resource.

Table 9-11 Potential impacts on fisheries values (marine fauna and BCH) from Proposal construction and development activities (4 years).

| Activity | Potential Impact | Impact Pathway Description |
|---|---|---|
| **Pond and infrastructure development,** including pond/ crystalliser construction, processing plant, water supply, administration, and associated works (e.g. roads).<br>**Marine development** including installation of bitterns pipeline and outfall diffuser, channel dredging, and dredge spoil disposal. | (Direct) Physical injury, physiological stress, displacement, or mortality of fisheries species | Construction and development activities will directly impact fisheries species inhabiting habitats within the project footprint, resulting in potential physical injury, physiological stress, displacement, or mortality. These effects are acute and occur immediately within the construction area, primarily from habitat removal, dredging, and other construction-related disturbances. Immediate physical injury or mortality is expected to affect low mobility and habitat-dependent species, especially those within the dredging or construction zones.<br>Critical Habitats:<br>• PIDE: Includes mangroves, mudflats, and bare sediments, which are essential for fish and invertebrates during vulnerable life stages, such as breeding, foraging, and nurseries.<br>• MDE: Contains subtidal habitats, such as seagrasses, macroalgae, and coral reefs, which provide shelter, spawning, and feeding grounds for many species.<br>Direct and indirect disturbance will result in irreversible loss of habitat.<br>Construction and dredging operations also generate significant underwater noise and vibrations, causing acute physiological stress to species sensitive to sound. Prolonged exposure can interfere with communication, predator avoidance, and navigation, potentially leading to reduced reproductive success or displacement |
| | Indirect) Long-term habitat loss or fragmentation | Development and construction activities will modify or remove existing habitats, resulting in a loss of overall habitat area (extent) or habitat fragmentation, reducing the overall availability and connectivity of critical ecosystems required by fisheries species for essential life stages, including spawning, feeding, and shelter.<br>Some of these habitats, including mangroves, seagrass/macroalgae, and coral reefs, provide critical services for fisheries species and their removal can lead to an immediate loss of individuals (and associated population decline) that use these areas for spawning, feeding, or shelter. The ecological roles of other habitats, such a algal mats, is less understood and is currently being explored. Species with strong habitat dependence (e.g. sea cucumbers, syngnathids, certain scalefish species, and prawns) would be especially vulnerable to these impacts.<br>Additionally, altered habitat structure and function may disrupt ecosystem structure and function by changing nutrient cycling, sediment dynamics, or predator-prey relationships, leading to cascading ecological effects. Over time, these shifts may contribute to broader declines in biodiversity, resilience, and ecosystem productivity. |

| Activity | Potential Impact | Impact Pathway Description |
|---|---|---|
| | (Indirect) Altered hydrodynamics | The construction of ponds and related infrastructure will alter natural hydrodynamic processes, including surface runoff patterns or tidal flows, that sustain critical intertidal and coastal habitats.<br>Construction may divert natural runoff into adjacent intertidal flats or bypass key habitat areas, altering salinity, sediment composition, and nutrient inputs, while pond walls and drainage systems can impede or modify tidal flows, leading to reduced flushing, altered sediment deposition, and restricted water movement to critical habitats, such as mangroves and algal mats.<br>Altered sediment transport and reduced mixing can lead to sediment build-up or erosion, affecting coral reefs, seagrass beds, and other benthic habitats. The loss of regular tidal inundation can degrade or shift the composition of habitats (e.g. mangroves, mudflats, and algal mats), reducing their capacity to support fisheries species.<br>Altered salinity and temperature regimes can create conditions unfavourable for sensitive species, potentially leading to shifts in species composition and trophic interactions, and potentially reduce ecosystem productivity and resilience. |
| All construction and development activities combined | (Indirect) Combined ecological effects of multiple activities | The cumulative impacts of construction and development activities—including habitat loss, altered hydrodynamics, sedimentation, and changes to water quality—can lead to interconnected and long-term consequences for coastal and marine ecosystems.<br>These combined effects exacerbate individual impacts, undermining ecosystem health and the resilience of fisheries species.<br>Key combined stressors:<br>• Habitat Loss and Fragmentation: Direct destruction of critical intertidal and subtidal habitats (e.g. mangroves, seagrasses, coral reefs) is compounded by fragmentation, limiting species' ability to move between critical areas and reducing overall habitat functionality.<br>• Altered Hydrodynamics: Changes to natural tidal flows and surface water runoff disrupt sediment transport, nutrient cycling, and flushing processes, further degrading habitat quality and availability.<br>• Sedimentation and Turbidity: Construction activities increase suspended sediments and smother benthic habitats, reducing light penetration and primary productivity. This indirectly affects species reliant on these ecosystems for food or shelter.<br>• Water Quality Changes: Runoff, nutrient inputs, and pollutants from construction activities alter salinity and nutrient levels, potentially causing localised eutrophication and further stressing habitats and species. |

Table 9-12: Potential impacts on fisheries values (marine fauna and BCH) from Proposal operational activities

| Activity | Potential Impact | Impact Pathway Description |
|---|---|---|
| Seawater intake | (Direct) Larvae and juvenile entrainment and entrapment | The seawater intake system, drawing approximately 160 GL annually from nearshore waters around McKay Creek, has the potential to cause direct physical impacts on fisheries species, particularly during their early life stages.<br>Fish and invertebrate larvae can also become concentrated in nearshore waters, around the intake area, from local hydrodynamic processes (e.g. flood tides). Many fisheries species also have early life history states that depend on nearshore habitats like seagrass, mangroves and macroalgae, and are commonly found in these areas. The small size and proximity of larvae and juvenile individuals makes them vulnerable to being drawn into the seawater intake system.<br>Small fish and invertebrate larvae can be trapped against intake screens due to suction forces (known as entrapment). The Proposal will have an intake flow rate of 0.15 m/s, which is recognised to minimise impacts to 96 % of fish and invertebrate species (USEPA, 2014).<br>Larvae and juveniles small enough to pass through intake screens may be drawn into the system along with seawater, entering the concentrator pond system (known as entrainment).<br>Larvae and juveniles may also be directly drawn into intake pipes along with seawater, entering the concentrator pond system (known as entrainment).<br>Studies elsewhere in WA have shown that species like prawns, mud crabs, blue swimmer crabs and finfish are susceptible to these impacts (Molony & Parry, 2002). |
| | Indirect) Altered environmental flows, including sediment transport and nutrient distribution | The extraction of large volumes of seawater (160 GL per year) from McKay Creek and the surrounding nearshore environment has the potential to alter natural hydrodynamic processes, impacting the transport and distribution of nutrients, sediments, and organic matter. These disruptions could indirectly affect the structure and function of ecosystems that support fisheries species.<br>Seawater intake may reduce nutrient availability in nearshore waters by altering water circulation patterns and the supply of organic matter to benthic habitats. Reduced nutrient transport could also diminish primary productivity (e.g. seagrass and algae growth), indirectly affecting species dependent on these habitats for food and shelter.<br>Hydrodynamic changes might modify sediment deposition and erosion patterns, potentially increasing sedimentation in some areas and causing substrate instability in others. These changes could degrade critical habitats, such as seagrass beds, mangroves, and algal mats, leading to habitat loss or reduced habitat quality for fisheries species.<br>Such disruptions may affect fish recruitment, growth, and survival, particularly for species reliant on the productivity and stability of nearshore habitats. |

| Activity | Potential Impact | Impact Pathway Description |
|---|---|---|
| Salt concentration process | (Direct) Physical injury, physiological stress, displacement, or mortality of fisheries species from pond wall failure | Seawater is stored and moved through concentration ponds, progressively increasing the salt concentration, and into crystallisers to form precipitate (salt crystals).<br>If the pond walls fail, a large volume of concentrated seawater will be released into nearby waters. Marine species within the failure area may be directly harmed through toxic effects of hypersalinity.<br>The pond walls have been designed in accordance with international standards, with details of the wall design provided in CMW Geosciences (2023). The CMW Geosciences geotechnical review found that the pond wall design includes a significant safety factor, which sufficiently mitigates the risk of pond wall failure. |
| | (Indirect) Altered groundwater salinity from pond seepage | Seawater is stored and moved through concentration ponds, progressively increasing the salt concentration, and into crystallisers to form precipitate (salt crystals).<br>Seepage from salt ponds can increase groundwater salinity in surrounding areas, potentially altering the balance of freshwater and saltwater in coastal and nearshore ecosystems. These changes can affect the health and composition of benthic habitats, such as mangroves and algal mats, which provide critical habitats for fisheries species.<br>Over time, these habitat changes may indirectly impact fisheries species reliant on these ecosystems for shelter, foraging or breeding, leading to shifts in species abundance, distribution, or population dynamics. |
| Bitterns discharge | (Direct) Physical injury, physiological stress, displacement, or mortality of fisheries species | The salt production process will produce a high-salinity bittern (410 ppt salinity) that will discharge up to 5.9 GL of bitterns each year into the marine environment.<br>Bitterns contain a high concentration of salts, such as magnesium chloride, calcium chloride, potassium chloride and other minerals, which may have toxic effects on fisheries species.<br>Fish and invertebrates in the discharge area experience physiological stress or mortality due to the increased salinity and chemical exposure. Impacts are likely greater for sensitive life stages (e.g. larvae or juveniles) or species that cannot move away from the affected area. |
| | (Indirect) Long-term habitat loss around the discharge area | The salt production process will produce a high-salinity bittern (410 ppt salinity) that will discharge up to 5.9 GL of bitterns each year into the marine environment.<br>Hydrodynamic modelling indicates an irreversible loss of BCH in the bitterns discharge area (LEPA zone). These areas can provide critical habitat for fisheries species and their loss can lead to an immediate decline in populations that use these areas.<br>Ongoing bitterns discharge can lead to long-term habitat degradation and loss, reducing their suitability and availability for fisheries species that rely on these habitats. Over time, habitats can become fragmented, diminishing connectivity between critical areas and impeding the movement of species essential for completing life stages. |

| Activity | Potential Impact | Impact Pathway Description |
|---|---|---|
| | | Habitat changes can also disrupt key ecosystem processes, such as nutrient cycling, water quality, and trophic dynamics, leading to shifts in species distributions, predator-prey relationships, and community composition. Ultimately, such changes can decrease biodiversity, reduce ecosystem resilience, and lower productivity in the affected areas. |
| | (Indirect) Eutrophication | The operational activities of the project, particularly the discharge of high-salinity bitterns into the marine environment, present a potential risk of eutrophication due to nutrient inputs. While the bitterns primarily contain high concentrations of salts, they may also include organic matter or trace nutrients that could contribute to nutrient enrichment in receiving waters. Over time, the accumulation of these nutrients could lead to elevated primary productivity, algal blooms, and oxygen depletion in affected areas.<br>Nutrient loading from the project, combined with natural or anthropogenic sources (e.g. riverine inputs, upwelling events, agricultural runoff, or other developments), may exacerbate eutrophication risks. These combined impacts can disrupt ecosystem processes and dynamics, with cascading effects on fisheries species.<br>The spatial extent of eutrophication impacts is expected to be localized near the LEPA and MEPA discharge zones but could expand into adjacent habitats under certain conditions, such as weak tidal flushing or prolonged periods of discharge. Sensitive nearshore and benthic habitats, such as mangroves, seagrasses, and coral reefs, and the fisheries species they support are particularly vulnerable to these changes. |
| All operational activities combined | (Indirect) Combined ecological effects of multiple activities | The combined effects of operational activities, including chronic stress from seawater intake, bitterns discharge, pond wall failure, and altered groundwater salinity, have the potential to create cumulative and interconnected impacts on surrounding coastal and marine ecosystems. These activities may interact synergistically, amplifying the severity and persistence of ecological changes.<br>Key combined stressors:<br>• Seawater intake can disrupt nutrient flows and sediment transport, reducing productivity and connectivity between habitats critical for fisheries species.<br>• Bitterns discharge contributes to long-term habitat degradation, reducing the availability and quality of essential habitats for spawning, foraging, and shelter.<br>• Changes in groundwater salinity from pond seepage may disrupt the balance of freshwater and saline systems, potentially degrading intertidal habitats such as mangroves and algal mats.<br>Combined, these changes can shift community structures, disrupt predator-prey relationships, and lead to cascading effects through the ecosystem.<br>The cumulative nature of stressors, particularly for species whose populations are already depleted or under significant pressure (e.g. sandfish, red emperor, goldband snapper), may impair recruitment, growth, and survival, reducing recovery potential for these populations. |

Further risk assessment work will be undertaken following the results of the WAMSI algal mat research to further quantify the scale of impacts to fisheries.

## 9.6 MITIGATION

Leichhardt has mitigated the potential impacts to this factor according to the mitigation hierarchy; avoid, minimise, rehabilitate, offset. Offsets are not expected to be directly required for this factor however offsets are proposed in the BCH section that relate to this factor.

### 9.6.1 AVOID

The key avoidance mechanism implemented by Leichhardt was the re-design of the development envelopes to avoid key environmental features. Leichhardt has conducted numerous ecological surveys, and this information has been utilised to design the Proposal and its development envelope boundaries to avoid the following (refer to Section 5):

- Two dredged material disposal locations (removed from the scope of the Proposal);
- The majority of the sandy beach north of the Proposal; and
- The majority of mangrove habitats and higher productivity algal mats.

In addition to the above, the following avoidance mitigation measures have been incorporated:

- Impacts associated with large-scale dredging activities and ocean-going vessel movements close to shore have been avoided by the use of a transhipment loading method;
- Dredging will be conducted between the period of April to September to avoid key environmental windows including turtle nesting, sawfish pupping, whale migration, and spawning periods for coral and socio-economically important fish species; and
- Vessels will not be permitted to venture or operate outside of port waters unless conducting operational, monitoring, or rescue activities.

### 9.6.2 MINIMISE

The following mitigation measures are proposed to ensure that direct and indirect impacts to marine fauna are minimised:

1. **Implement the DSDMMP.** A DSDMMP has been provided in Appendix 2.2 and includes a comprehensive set of management actions and environmental performance measures related to marine fauna;
2. **Implement the MEQMMP.** A MEQMMP has been provided in Appendix 2.1 and includes a comprehensive set of management actions and environmental performance measures related to bitterns discharge and other water quality impacts;
3. **In addition to the measures proposed in the DSDMMP, minimise potential noise impacts to marine fauna for the duration of the marine operations by implementing the following controls:**
    a. Ensure all vessel equipment and machinery is in good condition and subject to regular maintenance while engaged on the Proposal;
    b. When in transit, all Proposal vessels will be operated in accordance with EPBC Regulations 2000 - Part 8 Division 8.1;

   c. Minimise the duration of run-time for vessel engines, thrusters and dredging plant by avoiding stand-by or running mode to the degree practical and consistent with safe operations;

4. **Minimise the risk of introducing marine pests by implementing the measures**:
   a. All vessels should comply with Commonwealth Department of Agriculture Fisheries and Forestry (DAFF) biosecurity requirements as well as all State legislation relating to management of introduced marine organisms; and
   b. Any vessels visiting Cape Preston from international or interstate waters are required to complete the WA DPIRD 'Vessel Check' risk assessment (https://vesselcheck.fish.wa.gov.au);
5. **Monitor the success of mitigation for entrapment and entrainment impacts of the seawater intake;**
6. **Minimise the risk of fatal vessel strikes to marine fauna**. Consistent with the DotE guidelines for reducing vessel strikes, Leichhardt will ensure that all Proposal vessel operators will be trained to observe and report the location of any sightings of large marine fauna (in particular marine turtles, mammals and sawfish) to other vessel operators in the area to allow them to be tracked (if visible) and avoided, and to allow minimum separation distances to be maintained between vessels and prescribed fauna as described in the BC Regulations. In addition, implementing an 8-knot speed limit for Proposal construction vessels will act to reduce marine fauna injury from vessel strike;
7. **Obtain and comply with a Works Approval and Licence under Part V of the EP Act** for solar salt manufacturing (which will include the bitterns disposal). These approvals will manage the pollution risks to marine fauna associated with bitterns disposal, product spills and other emissions associated with the salt production process;
8. **Seawater intakes are to be fitted with intake screens designed to reduce the likelihood of marine fauna being drawn into the intake, and designed such that intake speeds are limited to a maximum of 0.15 m/s**. This speed has been defined as slow enough to allow the majority of marine fauna to escape entrapment;
9. **Implement the ALMP (Appendix 4.7) for all lights within 15 km of a confirmed potential turtle nesting beach.**is
10. **Ensure key environmental windows (Section 9.3.14) are considered when planning construction activities**. Where practicable Leichhardt will align the timing of relevant construction activities to avoid these environmental windows; and
11. **Implement measures to minimise indirect impacts to marine fauna habitat (refer to Section 8.6)**.

### 9.6.3 REHABILITATE

The closure objective for this factor will be to remove all infrastructure and stabilise all altered lands such that there are no ongoing impacts to marine fauna or their habitats. The marine components of the Proposal are relatively easy to rehabilitate, and the following measures will be taken:

- All marine infrastructure above the seabed including the seawater intakes and bitterns outlets will be removed and taken offsite; and
- The dredged areas will be left to gradually fill with sediment if not required for ongoing use of the CPE Port.

## 9.7 PREDICTED OUTCOME

The EPA's environmental objective for this factor is "to protect marine fauna so that biological diversity and ecological integrity are maintained" (EPA, 2016e).

The assessment conducted in Section 9.5 determined that there were a number of potential impacts that required controls to ensure they were made acceptable:

- Vessel strike;
- Entrapment in seawater intakes;
- IMPs;
- Marine noise emissions, particularly during dredging activities; and
- Light impacts on marine turtles.

The mitigation measures for these potential impacts are well understood and established for marine projects (refer to Section 9.6).

Implementing an 8-knot speed limit for Proposal-related construction vessels will act to reduce marine fauna injury from vessel strike. While the probability of vessel strike is already low, reducing vessel speed has been shown to decrease the likelihood of fatal injury (to large whales) by 30% (Vanderlaan & Taggart, 2006). In addition, vessel operators will be required to report the location of any sightings of large marine fauna (in particular marine turtles, mammals and sawfish) to other vessel operators in the area to allow them to be tracked (if visible) and avoided, and to allow minimum separation distances to be maintained between vessels and prescribed fauna as described in the BC Regulations. Given the low numbers of vessels to be used at the Proposal and the implementation of controls the Proposal is expected to be able to be implemented without significant vessel strike impacts to marine fauna.

The Proposal will have two seawater intakes which could pose a risk of marine fauna entrapment if not designed and operated appropriately. Leichhardt has committed to two specific mitigation measures for these intakes; screens will be installed to prevent the majority of marine fauna from being drawn into the intake pipe, and the intake has been designed such that the intake velocity is maintained below 0.15 m/s. This velocity is recommended by the US Environmental Protection Agency (2001) as it ensures the protection of 96% of fish species, and is lower than the swim speed of marine turtles (Bell & Richardson, 1978; Bustard & Limpus, 1970; Chung et al., 2009; de Silva, 1995; Frick, 1976; Hirth, 1971; Hughes, 1974; Papi et al., 1995; Prange, 1976; Salmon & Wyneken, 1987; Witherington, 1991; Wyneken, 1997). With the implementation of these two controls the risk of marine fauna entrapment is expected to be lowered to an acceptable level.

With the application of regulated controls, the Proposal is considered to present a 'low risk' of introducing marine pests to Eramurra marine waters. Standard industry controls (enforced by DAFF) relating to ballast water and vessel hygiene provide a level of confidence that IMPs will not be introduced.

Estimated marine noise from dredging activities is not significant, and marine noise mitigation measures are now well established within the marine construction industry. With the application of these measures, it is expected that dredging will be able to be conducted without significant noise impacts on marine fauna.

Hawksbill, Flatback and Green turtles were found to use beaches near the Proposal at low and varying levels. The highest density of nesting activity occurred on South West Regnard Island and Steamboat Island. Given the presence of marine turtles in the area, light mitigation measures will be implemented (documented within an ALMP) to reduce the risk of light interfering with turtle navigation.

Water quality impacts from dredging and bitterns disposal (assessed in Section 7) were assessed as not being significant with the implementation of mitigation measures. Consequently, the impacts on marine fauna are subsequently not expected to be significant. Bitterns disposal and emissions from the salt production process will be managed under Part V of the EP Act via a works approval and licence.

Several significant fauna species listed under the BC Act and EPBC Act are known or expected to inhabit the waters surrounding the Proposal. Leichhardt considered these species when incorporating mitigation measures into the design and has proposed operational commitments to ensure that potential impacts on these species are not significant.

There may be some impacts to commercial and recreational fishery species, primarily associated with cumulative impacts across the extent of the fishery and the spatial range of the species that are being targeted. This is critical for some indicator species that may already be on the edge of triggering restrictions, where there is no buffer for additional cumulative impacts. Leichhardt will continue to liaise with industry experts and WAFIC and further quantify the impacts using the results of the WAMSI algal mat research (due in 2025).

The environmental outcomes for this factor are therefore predicted to be (in addition to associated BCH outcomes):

- No adverse impacts to marine fauna populations due to entrapment or entrainment within the seawater intake;
- No adverse impacts to marine megafauna from dredging and shipping movements;
- No introduction of IMPs; and
- No adverse impacts to marine turtle nesting and hatchling behaviour.

# 10 TERRESTRIAL ENVIRONMENTAL QUALITY

## 10.1 EPA OBJECTIVE

The EPA Objective for this key environmental factor is to maintain the quality of land and soils so that environmental values are protected.

## 10.2 POLICY AND GUIDANCE

Relevant EPA and Commonwealth Government guidance documents for Terrestrial Environmental Quality are summarised in Table 10-1.

**Table 10-1: Policy and guidance relevant to the Terrestrial Environmental Quality Key environmental factor**

| Policy and Guidance | How guidance has been considered |
|---|---|
| **WA Government** | |
| Key EPA documents | |
| EIA (Part IV Divisions 1 and 2) Procedures Manual (EPA, 2024a) | This document has been considered in planning for the Part IV approval process and has been used to inform the preparation of this ERD. |
| Statement of Environmental Principles, Factors, Objectives and Aims of EIA (EPA, 2023a) | This document was considered in the preparation of this ERD and to inform EIA. It was used identify the Key Environmental Factors likely to be impacted by the Proposal and the EPA's objective for each factor. |
| Statutory Guidelines for Mine Closure Plans (DMIRS, 2020a) | This document has been considered in the design and planning of the Proposal, it has also been considered in the preparation of mitigation measures for the Proposal. |
| EIA (Part IV Divisions 1 and 2) Administrative Procedures (EPA, 2024d) | This document has been considered in planning for the Part IV approval process and has been used to inform the preparation of this ERD. |
| Instructions on how to prepare EP Act Part IV Environmental Management Plans (EPA, 2024e) | This document will be used as guidance to develop the ASSMP, if required. |
| Relevant EPA Factor Guidelines | |
| Environmental Factor Guideline – Terrestrial Environmental Quality (EPA, 2016m) | This document was considered in the preparation of this section (Section 10) of the ERD. |
| Other Policy and Guidance | |
| Identification and investigation of acid sulfate soils and acidic landscapes (DER, 2015a) | This document was used as guidance for the EIA for the Proposal. |
| Treatment and management of soil and water in acid sulfate soil landscapes (DER, 2015b) | This document was used as guidance for the EIA for the Proposal. |
| Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Commonwealth of Australia, 2018) | These guidelines were used as guidance during EIA for Terrestrial Environment Quality and the preparation of the ASSMP for the Proposal. |
| WA Environmental Offsets Policy (EPA, 2011) | This document was considered during EIA for Terrestrial Environment Quality however it was determined not be relevant as offsets were not required. |

| Policy and Guidance | How guidance has been considered |
|---|---|
| WA Environmental Offsets Guidelines (EPA, 2014a) | This document was considered during EIA for Terrestrial Environment Quality however it was determined not relevant as offsets were not required. |
| WA Environmental Offsets Template (EPA, 2014b) | This document was considered during EIA for Terrestrial Environment Quality however it was determined not relevant as offsets were not required. |
| **Commonwealth Government** | |
| Key Documents | |
| Generic guidelines for the content of a draft EPBC Act PER/ EIS (including the objects and principles of the EPBC Act 1999) | This document was considered in the preparation of this ERD and while undertaking EIA. |
| EPBC Act Environmental Offsets Policy (DSEWPaC, 2012a) – including the Offset Assessment guide. | This document was considered when determining whether offsets were expected to be required for this factor. |
| Environmental Management Plan Guidelines (DotE, 2014) | This document will be used as guidance to develop the ASSMP, if required. |
| EPBC Act Condition Setting Policy (DAWE, 2020) | This document was used as guidance for the likely regulation of Proposal impacts. |
| EPBC Act Outcomes-based conditions policy (DotE, 2016a) | This document was used as guidance for the likely regulation of Proposal impacts. |
| *Relevant Technical Guidance* | |
| None identified. | |

## 10.3 RECEIVING ENVIRONMENT

### 10.3.1 STUDY EFFORT

Baseline data relevant to this section has been sourced from the following:

- Topographical data (land contours) was sourced from Landgate and subsequently corrected and expanded using on-ground and LiDAR aerial surveys;
- Soil samples were collected as part of ongoing geotechnical studies, with relevant samples being analysed for acid sulfate soil (ASS) indicators, and other soil samples tested for permeability (following compaction to field specification); and
- Groundwater samples were collected from a groundwater monitoring well network established in December 2021, comprising 11 groundwater wells.

The following data collected was used to calibrate a number of predictive models developed to inform Proposal design and this ERD:

- LWC completed baseline soil and sediment testing at the Proposal, additionally identifying any ASS that could potentially be disturbed (LWC, 2022; Appendix 1.4);
- LWC completed surface water monitoring of the Proposal (LWC, 2025 Appendix 1.5);
- CDM Smith provided a Groundwater Effects Assessment and Seepage Modelling report to LWC, addressing the Proposal's potential groundwater impacts (CDM Smith, 2023; Appendix 1.6); and
- CMW Geosciences conducted a geotechnical investigation of the Proposal area (CMW Geosciences, 2022; Appendix 7.5)

### 10.3.2 SOIL DESCRIPTION

***Geology***

The Proposal is located within the Pilbara Craton geological province which comprises Archean aged volcanic and sedimentary rocks of more than 3,600 Ma. The Pilbara Craton has been subject to a long history of tectonic and orogeny with various igneous intrusions occurring and deposition of shelf sediments such as the Hammersley Basin containing extensive banded iron-formation (BIF) deposits (CDM Smith, 2023).

A description of the geology encountered across the Proposal has been documented by CMW (2022) based on the observations from the August/September 2021 test pit, CPT and surface sampling (across the algal mats) soil investigations. The distribution of the interpreted geological units is presented as the base map for Figure 10-1. The geological units have been grouped into the two main geographical areas (geological and coastal units) where they are encountered. Unit names in italics below are the geomorphological units where the geological unit is commonly encountered:

- Units occurring within the *Alluvial Outwash/Residual Surface* north of the low-lying hills present immediately south of the North-west Coastal Highway, extending north through the crystalliser and concentrator ponds to the southern margin of the *Inter- and Supra-tidal flats*; and
- Coastal Units occurring north of the *Alluvial Outwash/Residual Surface* within the Playa (*Inter and Supra tidal flats*) and heading north towards the coastal dunes and including the sand islands (*Fringing Dunes and Deflated Dunes, Sand Plains and Sandy Islands*) interspersed within the *Inter- and Supra-tidal Flats* and areas of *Mangrove* and associated mangrove muds both along the coastline and within tidal creeks.

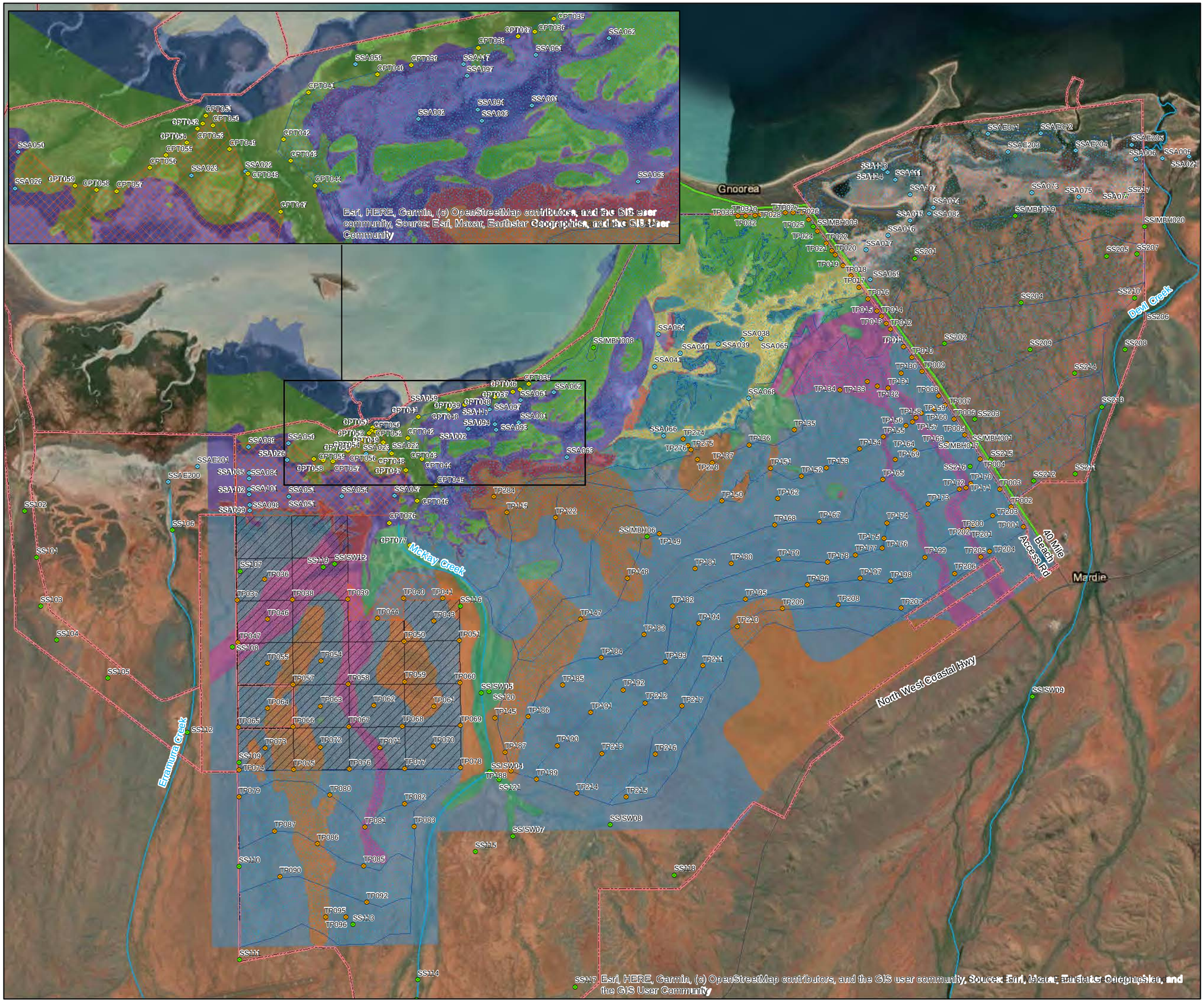
Geological units within the Alluvial Outwash/Residual Surface are described as:

- Alluvial sheetwash – surface deposits of predominantly sand with gravel or gravelly sand with cobbles;
- Residual soil – located at the surface throughout the *Alluvial Outwash/ Residual Surface* area and beneath the thin veneer of Alluvial Outwash described above. Main soil types include sandy clay and clay with sand;
- Alluvium – potential alluvium deposits were encountered within the *Alluvial Outwash/ Residual Surface* are generally associated with (in the vicinity of) existing creek beds and are considered to represent former channel courses (paleochannels). Main soil types included sandy clay and sandy gravel;
- Granite (Extremely Weathered) - this unit was encountered directly beneath the Residual Soil and although the parent rock has been weathered to such an extent that it is a soil, the mass structure, texture and fabric of the parent rock can be observed. The predominant soil types comprised coarse through to fine grained clay-sand-gravel mixtures;
- Dolerite (Extremely Weathered) - this unit was encountered directly beneath the Residual Soil. Weathering has produced a similar range of clay-sand-gravel mixtures as the Granite formation;
- Granite (Moderately Weathered) - the Archaean-age Dampier Granitoid Complex is present under most of the site and is exposed in outcrops as follows:

  - In the banks of incised creek bed channels and particularly towards the mouth of the creeks where they discharge into the Playa (Inter- and Supra-tidal flats);
  - At the southern margins of the Playa (Inter and Supra-tidal flats) sometimes as a coastal wave cut platform (shoreline surface);
  - As low relief, shallow outcrops across the Alluvial Outwash/Residual Soil surface area; and
- Metasediment (Highly to Moderately Weathered) - encountered along the western edge of the crystalliser ponds area close to the western boundary of the study area. The material was encountered below Residual Soil typically from around 1.00 - 1.50 m depth and recovered from the pit as a sandy gravel.

Coastal Units:

- Eolian Sand - these occur immediate north and north-east of the Intertidal and Supra-tidal Flats along the coast behind the beach areas. The material typically comprises orange silty sand;
- Residual Soil - description as above, encountered beneath the Eolian Sand at the southern edge of the Sand Plains. The material comprised sandy clay or clayey sand;
- Granite (Extremely Weathered) - description as above, encountered beneath the Eolian Sand at the southern edge of the *Sand Plains* adjoining the northern margin of the *Inter- and Supratidal Flats*;
- Dolerite (Extremely Weathered) - description as above, encountered beneath the Eolian Sand at the southern edge of the Sand Plains adjoining the northern margin of the *Alluvial Outwash/Residual Surface* and in the east of the sandy islands;
- Calcarenite (Extremely Weathered) - encountered beneath the Residual Soil beneath the majority of the *Deflated Dunes* and *Sand Plains* extending north from the margins of the *Alluvial Outwash/Residual Surface* and below the *Fringing Dunes*. The unit typically comprised sandy gravel and clayey gravelly sand;
- Calcarenite (Highly to Moderately Weathered) - encountered in the following geological settings:
  - Former coastal rock ledges exposed at the margins of the sandy islands and along the southern margin of the *Inter- and Supra-tidal Flats*;
  - Occasional cemented dune sands i.e., calcarenites exposed immediately to the south of the *Fringing Dunes* or around the edges of sand islands;
- Lagoonal Muds (Sediments) - soft sediments encountered in the Inter- and Supra-tidal Flats. These sediments occurred within the following geological settings:
  - Inter-tidal flats and creeks;
  - Within area of scattered mangrove;
  - Within area of Supra-tidal flats; and
- The lagoonal muds comprised Inter-laminated layers of clay, silt, sand and sandy clay (very soft to stiff) and clayey sand and sandy clay.




## Legend

- Development Envelope
- Roads
- Water Courses
- Gas Pipeline

Pond Type

- Crystal
- Evaporation
- Recovery

Geology Description (CMW, 2022)

- Alluvial soil (sheetwash gravel over res. soil)
- Alluvial soils (braided channel gravels)
- Beach rock
- Calcarenite
- Calcarenite (inferred)
- Eolian sand (over calcarenite)
- Eolian sand (over granitoid/mafic rocks)
- Lagoonal mud
- Mangrove and Inter-tidal muds
- Mangrove mud
- Predominantly Doleritic dyke
- Predominantly Granitoid rocks
- Residual soil
- Thin Lagoonal Mud over Igneous Rock
- CPT Locations
- SSA Locations
- Test Pit Locations
- Grab Sample Locations

0 462.5 925 1,850 2,775 3,700

Metres

Land & Water Consulting
Email: enquiries@lwconsulting.com.au
Web: www.lwconsulting.com.au

N

Project:
Eramurra Salt Project
Soil and Sediment Phase 1 and 2

Figure Title:
Soil Investigation Location Plan

Date: July 2022 | Projection: GDA94 Z50

Scale: See Plan | Figure in Set: x of x

Site Address:
Mardie, Western Australia

Figure 2 Revision A

Drawing Reference AAAA

Figure 10-1: Geology at the Proposal

### *Soil physical and chemical characteristics*

Soils and sediments were assessed for the following:

- pH and Electrical Conductivity (EC) of the 1:5 extract;
- Water soluble sulfate (1:5 extract);
- Total chloride (1:5 extract);
- Total nitrogen (TN), nitrate and Kjeldahl nitrogen;
- Total organic carbon (TOC);
- Total phosphorus (TP);
- Cation exchange capacity;
- Exchangeable cations Ca, Mg, Na and K;
- Metals iron (Fe), manganese (Mn), calcium (Ca), magnesium (Mg), sodium (Na) and potassium (K); and
- Particle size distribution (PSD) analysis (laser diffraction method).

Analytical results are presented in the Tables section of Appendix 1.4 (LWC, 2022). A statistical summary of findings is presented in Table 10-2 and described below:

**Table 10-2: Summary of analytical results**

| Parameter | Number (No.) of Samples Analysed | No. of Detections | Minimum Detected Concentration | Maximum Detected Concentration | Mean Detected Concentration |
|---|---|---|---|---|---|
| pH | 134 | 134 | 6.9 | 9.9 | 8.5 |
| EC | 134 | 133 | 20 | 25,000 | 5,699.7 |
| Sulfate (mg/kg as SO4) | 134 | 95 | 10 | 11,000 | 2,221.4 |
| Chloride (mg/kg) | 134 | 108 | 9.4 | 50,000 | 13,584.7 |
| TN (mg/kg) | 134 | 131 | 13 | 1,100 | 280.2 |
| Nitrate and Nitrite as N (mg/kg) | 134 | 56 | 1.1 | 39 | 7.5 |
| Kjeldahl Nitrogen as N (mg/kg) | 134 | 131 | 13 | 1,100 | 280.2 |
| Total Organic Carbon (mg/kg) | 134 | 123 | 0.1 | 10 | 0.9 |
| Total Phosphorus (mg/kg) | 134 | 126 | 9.3 | 1,900 | 179.5 |
| Cation Exchange Capacity (meq/100g) | 134 | 134 | 3 | 190 | 36.2 |
| Exchangeable cations (meq/100g) | | | | | |
| Ca | 52 | 52 | 1.7 | 34 | 16.9 |
| Mg | 52 | 52 | 0.6 | 47 | 5.4 |
| K | 52 | 47 | 0.2 | 4.4 | 1 |
| Na | 52 | 28 | 0.2 | 64 | 9 |

*pH*

Reported pH across the Proposal site indicates that the soil profile is generally more alkaline than acidic. In general, slightly lower pH (but still alkaline) were reported nearer the coastline.

*EC*

EC was observed to be highest near the coast, within the algal mat areas and within the Lagoonal Muds/ Eolian Sand coverage. As demonstrated on the bubble plots, EC throughout this area predominantly ranged from 7,500 - 25,000 µS/cm.

For the remainder of the Proposal (i.e., not within or adjacent the mapped algal mat areas), EC was generally less than 3,500 µS/cm with the majority of samples reporting EC less than 1,000 µS/cm.

*Sulfate*

Around 30% of the samples submitted for analysis reported concentrations of sulfate below laboratory detection limits. Similar to EC, sulfate was observed to be highest near the coast, within the algal mat areas and within the Lagoonal Muds/ Eolian Sand coverage.

For the remainder of the Site (i.e., not within/ adjacent the coastal algal mat area), concentrations of sulfate were generally less than 500 mg/kg.

*Chloride*

20% of samples reported chloride below laboratory detection limits. Chloride concentrations generally correlate with sulfate and EC distribution in the soils. Highest concentrations are within the algal mat areas and within the Lagoonal Muds/ Eolian Sand coverage.

*TN*

Concentrations of TN were variable across the Proposal and across areas of differing algal activity. The highest reported concentrations were as follows:

- SS/SW12 located at the surface within the water course near surface water sample location SW12, within the western portion of the Proposal Area in the Alluvial Soils coverage near the edge of the algal mat area – 1,100 mg/kg;
- TP58_0 located at the surface in the western portion of the Proposal Area within the Alluvial Soils coverage – 1,039 mg/kg; and
- SSA001_50-100 located in the central northern portion of the Proposal Area within the Lagoonal Muds/ Limited Algal Activity coverage – 950 mg/kg.

*Nitrate and Nitrite*

Concentrations of the sum of nitrate and nitrite were generally below 5 mg/kg, with 60% of samples reporting concentrations below the limits of laboratory detection. The highest reported concentration of 39 mg/kg was in TP058 at surface (0 - 0.5m).

*Kjeldahl Nitrogen*

Based on the data presented in Table 10-2, the majority of nitrogen in the soils is Kjeldahl nitrogen which is associated with organic nitrogen. The concentrations of Kjeldahl nitrogen therefore directly correlate to TN concentrations and distribution.

*Total Organic Carbon*

Concentrations of TOC were variable across the Proposal and across areas of differing algal activity. The highest reported concentrations were as follows:

- SSA200_50 located at the outlet of Eramurra Creek in the western portion of the Proposal (no geological coverage) – 10 % TP151_0 located at the surface in the central portion of the Site within the Residual Soil coverage – 5.6 %;
- SSA15_100-150 located within the north eastern portion of the Site (no geological coverage) – 4.2 %; and
- SSA058_100-150 located within the central northern portion of the Proposal Area within the Lagoonal Muds coverage - 4%.

Testing for TOC serves as a screen for the presence of hydrocarbons. Hydrocarbons are not expected as this area has not previously been developed. These concentrations of TOC do not indicate the presence of hydrocarbons. Groundwater well samples from the site have been analysed for hydrocarbons with no anomalous values identified, as reported in Appendix 1.5.

*Total Phosphorus*

The maximum concentration of phosphorus measured appears to be anomalously high as it is double the concentration of the next highest value 660 mg/kg. The presence of phosphorus correlates to TOC where concentrations of TOC are greater than 3 times the laboratory detection level of 0.1%.

*Cation Exchange Capacity and Exchangeable cations*

CEC was observed to be variable across the Proposal area. The highest reported CEC was reported at the north-eastern portion of the Proposal area near the coast–190 $m_{eq}$/100g.

The cation exchanging in these soils and sediments is predominantly Ca given the higher median concentration. However, it is noted that similar maximum concentrations were reported for Ca, Mg and Na. Thus, other cations are contributing to CEC at the site.

The data is too sparse at present to make a definitive association however, the higher CEC was always found in the silty clay soils (where soil type was recorded).

*Particle Size Distribution*

Particle size distribution analysis was undertaken across the Proposal area as summarised in Table 10-3.

Table 10-3: Summary of particle size distribution results (surface soils)

| Location in the Project Area | Interpreted Predominant Soil Type |
|---|---|
| Adjacent west of pipeline | Clayey Sandy Silt with minor gravels |
| Northern portion of PIDE near coast | Silty Sand with clay fines |
| Northern central portion of PIDE along coast | Sand with clay and silt fines |
| Adjacent east of pipeline | Sandy Clayey Silt with minor gravels |
| Eastern portion of PIDE near algal mats | Clayey Silty Sand with gravels |
| Eastern boundary of PIDE | Clayey Sandy Silt with minor gravels |
| Central portion of PIDE | Silty Sandy Clay with minor gravels |
| Southern portion of PIDE within McKay Creek | Gravelly Sand with trace clay and silt fines |
| Within McKay Creek | Gravelly Sand with silt and clay fines |
| Within McKay Creek | Gravelly Sand with trace silt and clay fines |
| Tributary of McKay Creek in south central portion of PIDE | Gravelly Sand with trace silt and clay fines |
| Tributary of McKay Creek in south central portion of PIDE | Silty Sand with gravels and clay fines |
| Devil Creek upgradient of PIDE | Gravelly Sand with trace silt and clay fines |
| Western portion of the PIDE in creek line/ near Algal May area | Clayey Silt with minor sand and gravels |
| Western portion of PIDE | Sandy Silt with clay fines |
| | Sandy Silt with clay fines and minor gravels |

*Other Attributes*

Surface soils and sediments were also assessed for their Al, Fe and Mn content. The highest Fe content (65,000 mg/kg) was reported in the alluvial soils in the central portion of the site. This did not correlate with other attributes of the sample such as Mn or EC, and thus it is likely that the distribution of Fe relates to the source rock of the alluvial material rather than any insitu weathering process or to surface water quality.

The highest Mn concentrations (maximum 2,300 mg/kg) were reported in the surface sediments of the coastal units. This is unsurprising given the common association of Mn with estuarine and coastal sediments.

The highest aluminium concentrations are found in the clay materials, particularly those in the coastal units. Clays are aluminium silicates, and thus the association with Al is expected.

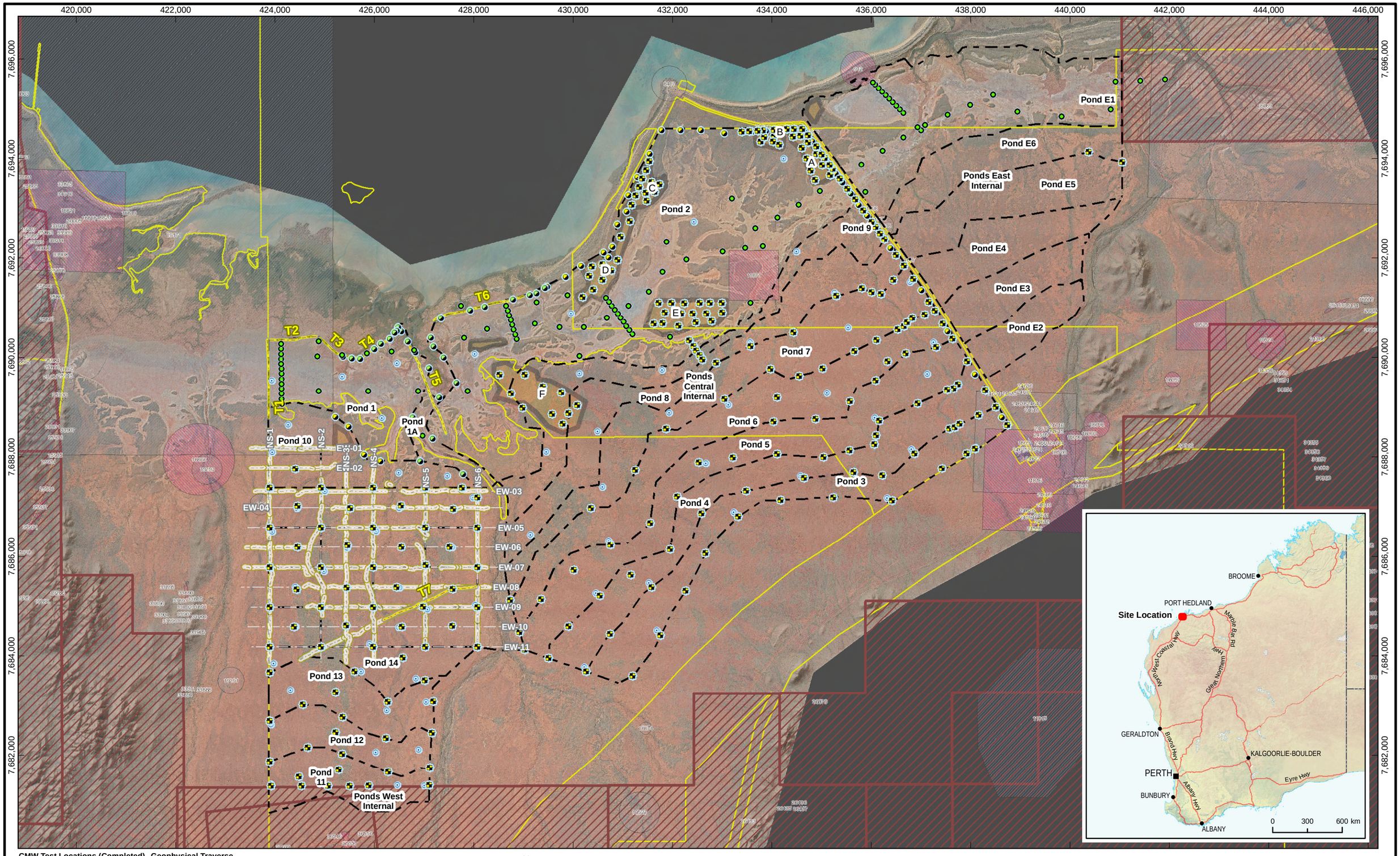
*Sub surface Soils Assessment*

Twenty-two (22) sub surface soils were collected during the groundwater monitoring well drilling program completed by LWC in December 2021. The soils were submitted to microanalysis for assessment of their crystalline mineral content via x-ray diffraction to assist with the geological description of these materials. Samples were collected above and below the water table with samples also collected within the screened interval of installed wells.

Generally, the sub-surface soils consist of a highly weathered residual soil. The majority of the samples consisted of clays kaolinite, palygorskite, illite and montmorillonite indicating the weathered nature of the materials sampled. The primary minerals remaining from the parent rock were silicates: quartz, feldspars (albite and microcline), amphibole, muscovite and chlorite (clinochlore), carbonates (dolomite and calcite) and iron oxides (hematite) with occasional sulfates (gypsum). Sulfides were not reported. The mineralogy is consistent with the geological description: residual soil.

The water table could not be distinguished based on the mineralogy, despite there being a distinct colour change from brown to cream or pale green at times. This colour change is likely due to leaching of iron from the surface of the minerals present, a process that can occur without altering the mineral crystal form.

The geotechnical survey across the Proposal (CMW Geosciences, 2022; Appendix 7.5) sampled soils from many test pits (Figure 10-2). Up to 25 samples were submitted for lab testing of Emerson Class Number which is the basis for assessing dispersivity. Up to 22 of the samples reported as Class 4, with one Class 3 and two Class 5. These results indicate soils with adequate resistance to surface erosion to be suitable for earthworks construction.




**CMW Test Locations (Completed)**

- CPT, Marooka
- Surface sample triaxial
- Algal sample
- Test pit
- CPT, Marsh Buggy

**Geophysical Traverse**

- MASW Refraction
- GPR
- Infrastructure Design
- Cadastral boundary
- Tenement
- Investigated borrow area

Aboriginal heritage site

- Registered Site
- Other Heritage Place

N

700 350 0 700 1,400 2,100 2,800 m

Coordinate System: GDA 1994 MGA Zone 50Transverse Mercator

CMW Geosciences

| | | | |
|---|---|---|---|
| CLIENT: LEICHHARDT INDUSTRIES | COMPILED: NR | PROJECT: PER2020-0143 |
| PROJECT: ERAMURRA SALT | CHECKED: MAT, RD | FIGURE: 1 - Layout |
| | REVISION: 0 | SCALE: 1:70,000 |
| TITLE: SITE INVESTIGATION PLAN | DATE: 11/02/2022 | SHEET: A3 L |

Figure 10-2: Geotechnical investigation sample sites

### 10.3.3 ACID SULFATE SOILS

Refer to Section 6.3.6.

### 10.3.4 GROUNDWATER ELEVATIONS AND SALINITY DISTRIBUTION

Equivalent freshwater head groundwater elevations measured in metres relative to Australian Height Datum (m AHD) across the well network ranged from 1.136 m AHD at MBH03 (in the north-western extent of the PIDE, closest to the coast) to 11.507 m AHD at MBH12 (in the south-eastern extent of the PIDE, furthest from the coast). For the deeper wells, the equivalent freshwater head groundwater elevations (salinity corrected) ranged from 2.32 m AHD at MB26D (in the north-western extent of the PIDE, closest to the coast, just west of MBH03) to 10.713 m AHD at MB33D (southern portion of site/ adjacent to the western side of McKay Creek).

Monitoring wells MB33S and MB33D are located adjacent each other and during the July 2024 GME, the groundwater elevation at MB33D (10.713 m AHD) was slightly higher than that recorded for MB33S (10.610 m AHD) indicating a possible upward hydraulic gradient between the groundwater in the deeper granodiorite basement unit and the shallower aquifer unit. Groundwater flow direction was determined to flow towards the coast in a westerly/ north-westerly direction for both the shallow and deep wells (Figure 6-1).

No non-aqueous phase liquids/hydrocarbon sheens were not observed in groundwater gauged at any monitoring well (Figure 6-9). A sulfurous odour was observed in groundwater sampled from MBH08 and MBH09.

A summary of comparing the results from July 2024 to those collected in November / June 2023 and November / March/ May 2022 is presented in LWC (2025; Appendix 1.5). Since the previous monitoring events, there appears to have been some rainfall in the area however, the groundwater elevations recorded in July 2024 appear to be slightly lower compared to the previous monitoring events at all locations with the exception MB33D, MB37D, MB38D, MB40D and possibly MBH13. It is noted that the previous water level recorded for MB33D was considered to be anomalous possibly due to insufficient well development upon construction. Future monitoring at these locations will confirm relationship with rainfall.

Groundwater quality is generally stable over the period of assessment but is variable across this site, with higher salinities present in the northwest of the site and near the downgradient extents of the watercourses/near the backwater zone (Figure 6-7). Exceedances of guideline concentrations for chemical substances in both groundwater and surface water were observed (LWC, 2025). Given the highly saline nature of both groundwater and surface water this is not unexpected and is not considered detrimental to the Proposal. The exceedances are reported for information purposes.

The area to the north of the main 0 m AHD contour (Figure 6-7) suggests the major groundwater discharge process may not be dominated by discharge to the sea as previously anticipated, but as groundwater evapotranspiration in low-lying areas. The land surface elevation in these areas is very close to or slightly below the 0.0 m AHD, where groundwater evapotranspiration develops a natural depression in the water table that draws water from the south and the northern sea boundary.

This conceptualisation is further supported by the groundwater salinity data collected by LWC (2025), which reports 150 g/L at MBH03, 170 g/L at MBH08, 175 g/L at MBH20 and 225 g/L at MCH19 (Figure 6-9). These salinity values are four to six times greater than the salinity of seawater (~35 g/L). These salinity measurements reflect the long-term impact of evapoconcentration.

Refer to Section 6 (Inland Waters) for further information.

### 10.3.5 Environmental Values

Based on the information provided in Section 10.3, the following environmental values were determined to require assessment for this factor:

- The ecosystem health values that the soils within the PIDE support, including biodiversity.

## 10.4 Potential Impacts

Table 10-4 defines the potential impacts (direct, indirect and combined) on the environmental values for this factor in a local and regional context.

**Table 10-4: Potential impacts on terrestrial environmental quality**

| Environmental value and current extent | Potential direct impact | Potential indirect impact | Local impacts associated with other proposals | Combined Local Impact (Proposal + others) |
|---|---|---|---|---|
| The ecosystem health values that the soils within the PIDE support, including biodiversity | • Disturbance of soil structure and integrity; and<br>• Release of acidic material into the environment through disturbance of ASS. | • Contamination of soil from increase of salinity due to seepage from the concentration ponds and crystallisers;<br>• Erosion from active structures spreads sediment into the terrestrial environment; and<br>• Leaks or spills of hydrocarbons or chemicals. | • Up to 153 ha of disturbance associated with Sino Iron Project and 40-Mile Beach Road. | • Disturbance of soil structure and integrity;<br>• Release of acidic material into the environment; and<br>• Soil contamination and erosion. |

## 10.5 Assessment of Impacts

### 10.5.1 Disturbance of Soil Structure and Quality, Erosion and Sedimentation

The Proposal will require the movement of soils in order to construct the pond embankments, drainage channels and other structures such as raised road corridors and pads. These structures have been designed to be geotechnically sound, with armouring used in high-risk areas to prevent erosion.

During operations, peak velocities in the 10% AEP flood are generally below 1.2 m/s, which falls below Austroads thresholds for rock protection for both the existing and Proposal modelling scenarios.

The placement of coarser material such as Class A or B1 rock may, however, be beneficial in preventing erosion of the bunds and preventing adverse impacts, particularly along areas where the flow path has been constricted or where localised runoff concentrates on embankment slopes (SWS, 2025).

The concentrator pond earthworks will be constructed from North to South. The lowest (intake) pond will be constructed first and seawater fill commenced. Further ponds will be constructed and filled in sequence up the slope of natural terrain. Surface water will be held up behind newly constructed bunds to evaporate, rather than draining downhill to dilute active brine ponds. This sequence inherently contains construction phase runoff (with or without sediment), within the ponds footprint.

The design of the structures will be assessed by DEMIRS and DWER as part of the Mining Proposal and Works Approval assessments respectively.

### 10.5.2 Disturbance of Acid Sulfate Soils

Some soils and sediments in the coastal units have potential to be ASS. Where these soils and sediments were sampled, testing has confirmed the presence of sulfides and the potential to generate acidic conditions should these soils or sediments be disturbed. Excavations in these areas are likely to be limited to distinct areas such as pump and intake locations, with material being brought in to construct the walls (i.e., material will not be taken adjacent to the wall location). The construction activities in soils and sediments within the coastal units will require a more detailed ASS investigation to be completed once detailed designs are available.

There are currently no specific locations for excavation sites. These sites will be finalised following further design and geotechnical work. It is yet to be shown that there is any Actual ASS to be encountered within the development envelopes and the first preference will be to avoid disturbance if such material is identified. Leichhardt will collect and assess additional samples regularly for ASS during any excavations in the coastal units and treat ASS accordingly to ensure there are no impacts to terrestrial environmental quality (refer to Section 6.3.6).

### 10.5.3 Salinity and Seepage from Ponds

As detailed in Section 6 (Inland Waters), there will be soils around the pond footprints that could be impacted by changes to the local groundwater levels or quality as a result of seepage and mounding from the ponds. The scale of these potential impacts to biological values was determined to be significant, and therefore mitigation is proposed under a GMMP to avoid these impacts as far as practicable. With the implementation of this mitigation, soil impacts associated with changes to the groundwater regime are predicted to be negligible, mostly limited to the construction zones around the pond walls. Monitoring and management of groundwater impacts as a result of the Proposal are outlined in the GMMP (Appendix 1.9). Section 6 (Inland Waters) provides more detail about this modelling, predicted results and proposed mitigation.

### 10.5.4 LEAKS OR SPILLS OF HYDROCARBONS OR CHEMICALS

The Proposal does not include the storage or use of large volumes of hydrocarbons or chemicals, and the implementation of industry-standard mitigation measures (Section 10.6) is expected to ensure that spills (if they occur) are controlled, contained and cleaned up to minimise impacts to terrestrial environmental quality.

## 10.6 MITIGATION

Leichhardt has mitigated the potential impacts to this factor according to the mitigation hierarchy; avoid, minimise, rehabilitate, offset. Offsets are generally not applied to this factor.

### 10.6.1 AVOID

The key avoidance mechanism implemented by Leichhardt was the iterative design of the development envelopes to avoid key environmental features. Leichhardt has conducted numerous ecological surveys and this information has been utilised to design the Proposal and its Indicative Disturbance Footprint to avoid additional clearing associated with the development of new port infrastructure (i.e., if CPE Port was not able to be used). Additionally, Leichhardt will avoid using dispersive/erosive soils and subsurface materials for the construction of ponds, crystallisers, embankments, and perimeter bunds.

In addition to the above, the development envelopes boundaries have been located to allow the use of existing tracks and port infrastructure wherever practicable.

### 10.6.2 MINIMISE

The following mitigation measures are proposed to ensure that direct and indirect impacts to terrestrial environmental quality are minimised:

1. **Obtain and comply with the following approvals**:
    a. Ministerial Statement to be issued under Part IV of the EP Act;
    b. Works Approval and Licence to be issued under Part V of the EP Act for solar salt manufacturing and bulk material loading (likely to be a separate approval for CPE Port);
    c. MP to be approved under the Mining Act for activities on Mining Act tenure;
    d. MCP to be approved under the Mining Act for activities on Mining Act tenure. The MCP will describe the rehabilitation and closure of the Proposal, and associated management and monitoring proposed during the closure phase;
    **e.** Development Application to be approved under the *Port Authorities Act 1999* for activities within PPA-managed lands and waters;
2. **If required, develop an ASSMP** for any excavation works in the coastal zone. If sampling of final excavation sites (once determined) identifies a risk of ASS, then a ASSMP will be developed to align with current best-practice methods (detailed design stage)**;**
3. **Embankment material will not be taken from ASS zones and will not be constructed using dispersive/erosive materials**;
4. **Implement the GMMP to minimise groundwater seepage and salinity impacts on terrestrial environment (Appendix 1.9)**;

5. **Ensure erosion and sediment control is included in contractor management plans** for the construction phase, to ensure that erosion and sediment control strategies and measures are implemented consistent with industry best practice guidelines;
6. **Monitor erosion at the outlets of the surface water corridors after each significant flow event.** If significant erosion is noted then install additional erosion controls to minimise further occurrences**;**
7. **Design and construct concentration ponds, crystallisers, and perimeter bunds to be safe and stable according to DEMIRS requirements, avoiding the use of dispersive/erosive materials in their construction**;
8. **Routinely inspect the condition and performance of pond walls, pipelines, containment systems and internal drainage structures,** to ensure they are in acceptable condition and/or operating appropriately;
9. **The following controls will be used to further reduce the risk of impact from unintentional brine pipeline spills**:
    a. Pipelines, outside the pond footprint, will be fitted with leak detection;
    b. Flows will be shut off if leaks are detected;
    c. Pipeline routes, outside the pond footprint, will be inspected to a schedule for issues of concern;
    d. Pipelines will be located off access road surfaces;
    e. If pipelines have to cross access roads then they will be buried;
    f. Investigations will be conducted into the cause of any spills, and remedial actions will be taken to minimise the chance of re-occurrence; and
    g. Spill response training to mitigate damage for site-based personnel;
10. **Comply with Guidelines and guidance notes related to the storage and use of hydrocarbons and other harmful chemicals**, the design and operation of vehicle maintenance areas and facilities, the siting and operation of wastewater treatment systems, and the handling and storage of other waste materials, including contaminated soils**;** and
11. **Ensure fuel is stored within self-bunded tanks or within a bunded area.**

### 10.6.3 REHABILITATE

At the completion of the Proposal the site will be rehabilitated to allow and encourage the natural establishment of vegetation and traditional values. This establishment will take some time in areas beneath the ponds where the soils have been saturated by saline water. An interim MCP has been provided in Appendix 1.8. The MCP will be submitted to DEMIRS for assessment and approval prior to the construction of the Proposal and will be reviewed and revised every three years.

The key rehabilitation measures that relate to terrestrial quality are summarised below:

1. Salts will be harvested from each crystalliser prior to closure;
2. Concentration pond walls will be flattened or opened up to allow tidal flows to enter the pond areas;
3. All above-ground infrastructure will be removed if not retained by Mardie Station or PPA; and
4. Crystallisers will be rehabilitated to an acceptable landform allowing free surface drainage.

## 10.7 PREDICTED OUTCOME

The EPA's environmental objective for this factor is to maintain the quality of land and soils so that environmental values are protected (EPA, 2016c). In the context of this objective: "terrestrial environmental quality" is defined as the chemical, physical, biological and aesthetic characteristics of soils (EPA, 2016c). The specific environmental values to be protected are the ecosystem health values that the soils support, including biodiversity.

The Proposal is not expected to significantly impact terrestrial environmental quality. Soil structure and quality parameters, including but not limited to pH, landform, nutrients and salinity will be monitored and managed through the implementation of mitigation measures. These parameters will also be managed through relevant secondary approvals and environmental management plans during pre-construction, construction, operation and closure of the Proposal.

The key risks to terrestrial environmental quality are the disturbance of ASS, seepage, and increased salinity from the evaporation ponds. The design and operation of all of these items will be regulated under Part V of the EP Act and the Mining Act.

The predicted outcome for terrestrial environmental quality is dependent on the implementation of mitigation measures. With the implementation of these measures the predicted outcomes for terrestrial environmental quality are considered to be:

- Negligible changes to soil salinity outside the area surrounding the pond walls; and
- A remaining potential for rare localised short-term impacts associated with spill/pollutant incidents.

The implementation of design and operation mitigation measures, and regulation under Part V of the EP Act and the Mining Act, are expected to ensure that the Proposal does not significantly impact this factor. The EPA objective for this factor is therefore able to be met.

# 11 FLORA AND VEGETATION

## 11.1 EPA OBJECTIVE

The EPA Objective for this key environmental factor is to protect flora and vegetation so that biological diversity and ecological integrity are maintained.

## 11.2 POLICY AND GUIDANCE

Relevant EPA and Commonwealth Government guidance documents for Flora and Vegetation are summarised in Table 11-1.

**Table 11-1: Policy and Guidance relevant to the Flora and Vegetation key environmental factor**

| Policy and Guidance | How guidance has been considered |
|---|---|
| **WA Government** | |
| Key EPA documents | |
| EIA (Part IV Divisions 1 and 2) Procedures Manual (EPA, 2024a). | This document has been considered in planning for the Part IV approval process and has been used to inform the preparation of this ERD. |
| Statement of Environmental Principles, Factors, Objectives and Aims of EIA (EPA, 2023a). | This document was considered in the preparation of this ERD and to inform EIA. It was used identify the Key Environmental Factors likely to be impacted by the Proposal and the EPA's objective for each factor. |
| Statutory Guideline for Mine Closure Plans (DMIRS, 2020a). | This document has been considered in the design and planning of the Proposal; it has also been considered in the preparation of mitigation measures for the Proposal. |
| EIA (Part IV Divisions 1 and 2) Administrative Procedures (EPA, 2024d). | This document has been considered in planning for the Part IV approval process and has been used to inform the preparation of this ERD. |
| Instructions on how to prepare EP Act Part IV Environmental Management Plans (EPA, 2024e). | This document was considered during the preparation of environmental management plans to support this ERD. |
| Relevant EPA Factor Guidelines | |
| Environmental Factor Guideline – Flora and Vegetation (EPA, 2016f). | This document was considered in the preparation of this section (Section 11) of the ERD. |
| Relevant EPA Technical Guidance | |
| Technical Guidance – Flora and Vegetation Surveys for EIA (EPA, 2016g). | This document was considered in the preparation of this section (Section 11) of the ERD. |
| Guidance Statement 6 – Rehabilitation of Terrestrial Ecosystems (EPA, 2006). | This document was considered in the preparation of this section (Section 11) of the ERD. |
| Environmental Protection Bulletin 20 – Protection of naturally vegetated areas through planning and development (EPA, 2013). | This document was considered in the preparation of this section (Section 11) of the ERD. |
| Checklist for documents submitted for EIA of proposals that have the potential to significantly impact of Sea and Land factors (EPA, 2016h). | This document was considered in the preparation of this section (Section 11) of the ERD. |

| Policy and Guidance | How guidance has been considered |
|---|---|
| Other Policy and Guidance | |
| *Biosecurity and Agriculture Management Act 2007.* | This document was considered in the preparation of this section (Section 11) of the ERD. |
| WA Environmental Offsets Policy (EPA, 2011). | This document was considered when determining whether offsets were likely to be required for the Flora and Vegetation environmental factor, and the adequacy of any proposed offsets. |
| WA Environmental Offsets Guidelines (EPA, 2014a). | This document was considered when determining whether offsets were likely to be required for the Flora and Vegetation environmental factor, and the adequacy of any proposed offsets. |
| WA Environmental Offsets Template (EPA, 2014b). | This document was considered when determining whether offsets were expected to be required for the Flora and Vegetation environmental factor. |
| WA Environmental Offsets Metric and relevant guidance (DWER, 2021b). | This document was considered when determining whether offsets were likely to be required for the Flora and Vegetation environmental factor, and the adequacy of any proposed offsets. |
| **Commonwealth Government** | |
| Key Documents | |
| Generic guidelines for the content of a draft EPBC Act PER/EIS (including the objects and principles of the EPBC Act, 1999; DotEE, 2016). | These documents were considered in the preparation of this ERD and while undertaking EIA. |
| EPBC Act Environmental Offsets Policy (DSEWPaC, 2012a) – including the Offset Assessment guide. | This document was considered when determining whether offsets were expected to be required for the Flora and Vegetation environmental factor. |
| Environmental Management Plan Guidelines (DotE, 2014). | This document was considered during the preparation of environmental management plans to support this ERD. |
| EPBC Act Condition Setting Policy (DAWE, 2020). | This document was used as guidance for the referral process and EIA of the Proposal. |
| EPBC Act Outcomes-based conditions policy (DotE, 2016a). | This document is used to assist in designing outcome-based Management Plans. |
| Relevant Technical Guidance | |
| Relevant EPBC Act listed species-specific survey guidelines and protocols. | These documents were used as guidance when undertaking surveys of EPBC listed species and potential survey limitations. |
| Relevant EPBC Act listed species-specific Recovery plans, Threat Abatement Plans, Approved Conservation Advice and other documents. | These documents were used as guidance to assess and manage EPBC listed species that may be impacted by the Proposal. |

## 11.3 RECEIVING ENVIRONMENT

This information has been sourced from the following reports:

- EnSTaR (2025a; Appendix 3.5) Eramurra mapping: Mangrove – Remote Sensing
- Phoenix (2025; Appendix 5.1) Detailed flora and vegetation survey for the Eramurra Solar Salt Project;
- EnSTaR (2025c; Appendix 5.2) Eramurra mapping: Horseflats PEC – Remote Sensing;
- Dillon et al. (2024; Appendix 5.3) Eramurra Solar Salt Project *Minuria tridens* resolution study; and

- Dr Kelly A. Shepherd and Dr Anže Žerdoner Čalasa (2024; Appendix 5.4) Eramurra Solar Salt Project: *Tecticornia* resolution study

### 11.3.1 BIOREGIONAL CONTEXT

The Proposal is almost completely situated within the Roebourne subregion (PIL4) of the Pilbara bioregion, with a small proportion (0.4%) falling within the Chichester subregion (PIL1). The Roebourne subregion is described by Kendrick and Stanley (2001) as:

> *Quaternary alluvial and older colluvial coastal and subcoastal plains with a grass savannah of mixed bunch and hummock grasses, and dwarf shrub-steppe of* Acacia stellaticeps *or* A. pyrifolia *and* A. inaequilatera*. Uplands are dominated by Triodia hummock grasslands. Ephemeral drainage lines support* Eucalyptus victrix *or* Corymbia hamersleyana *woodlands. Samphire,* Sporobolus *and mangal occur on marine alluvial flats and river deltas. Resistant linear ranges of basalts occur across the coastal plains, with minor exposures of granite. Islands are either Quaternary sand accumulations, or composed of basalt or limestone, or combinations of any of these three. The subregion experiences an arid (semi-desert) tropical climate with highly variable rainfall, often influenced by cyclonic activity in the northwest of WA and falling during summer. Subregional area is 2,008,983 ha.*

### 11.3.2 SURVEY EFFORT

Phoenix was commissioned to conduct a detailed flora and vegetation survey for the Proposal, consistent with the commitments provided in the ESD. Reconnaissance and detailed field surveys were conducted to verify and build on desktop reviews compiled using existing information of the Proposal and its surroundings. This field survey effort is summarised in Table 11-2.

**Table 11-2: Phoenix (2025) field survey dates**

| Survey type | Season | Dates |
|---|---|---|
| Detailed flora and vegetation survey, original study area, phase 1[1] | Summer | 13 February 2020 |
| Detailed flora and vegetation survey, original study area, phase 1 | Autumn | 15 – 23 April 2020 |
| Detailed flora and vegetation survey, original study area, phase 2 | Spring | 17 – 21 September 2020 |
| Detailed flora and vegetation survey, original study area, phase 1 | Autumn | 26 March – 01 April 2021 |
| Detailed flora and vegetation survey, expanded study area, phase 1 and original study area, phase 2 | Spring | 11 – 16 October 2021 |
| Detailed flora and vegetation survey, expanded study area, phase 2 and targeted survey | Autumn | 08 – 13 April 2022 |

[1] Survey abandoned due to weather-related access issues.

The surveys were completed over a defined 26,448.9 ha Study Area, which encompasses the Original Study Area (22,092.8 ha) and the Expanded Study Area (4,356.1 ha) (Figure 11-1), collectively referred to as the Study Area. The Study Area occurs in the Eremaean botanical province, covering a coastline extent of more than 22 km. The Study Area includes a total of 2,637.3 ha (10%) mapped as devoid of vegetation, either described as cleared or mudflats.

The detailed survey of the Study Area was conducted over two seasons (Table 11-3) in accordance with the recommendations in the EPA's Technical Guidance (EPA, 2016g) for the Eremaean botanical province.

The detailed surveys assessed 92 quadrats, 15 relevés and 21 transects (Figure 11-2). Targeted searches for significant flora, Declared Pests and Weeds of National Significance (WoNS) were also conducted, by searching for previous species records identified in the desktop review and suitable habitat encountered while traversing the Study Area. If a flora species was considered to potentially be a significant species, relevant characteristics were recorded for further analysis. At least three quadrats were sampled in all vegetation types, except those with very limited extent within the Study Area (discussed in more detail in Section 11.3.5).

Threatened Ecological Community (TEC) and PEC assessments were undertaken by:

- Comparing descriptions and locations provided in the DBCA TEC/PEC database search with observations made in the field; and
- Following statistical analysis of significant vegetation types to determine the presence/absence of the ecological communities reported in the DBCA database.

Targeted searches were undertaken for significant flora (Threatened and Priority), Declared Pests and WoNS. Initial searches focused on habitats considered likely to support significant flora (coastal dunes, creek systems), and species that had populations in close proximity to the study area. Targeted searches focused on previous recorded locations of significant flora and similar habitat within the vicinity of these records. If a flora species was considered to potentially be a significant species (i.e., similar floristic characteristics and occurring within suitable habitat) the following information was collected:

- GPS coordinates, including population boundary where applicable;
- Description of the habitat and floristic community in which the potential significant species was located;
- Population size estimate (i.e., estimated number of individual plants) where applicable;
- Specimen collection for taxonomic identification and lodgement at the WA Herbarium; and
- Photograph of live plant in situ and description of important details, such as flower colour, height of individual or average height of population.

Following the targeted field survey, the likelihood of occurrence for each significant flora species identified in the desktop review was assessed and assigned to one of three ratings:

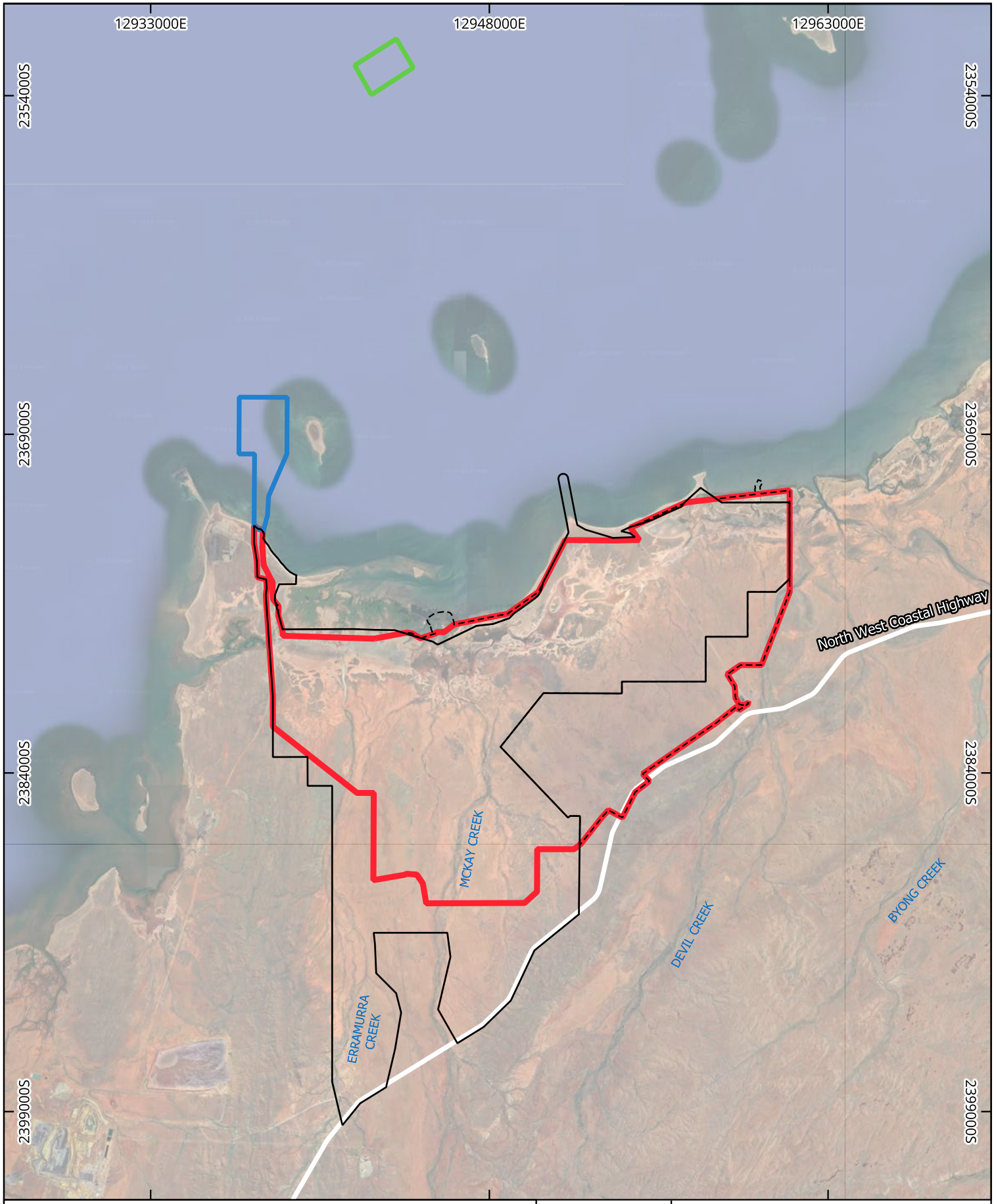
- Recorded – species recorded within the study area by previous or current survey;
- Possible – study area within known range of species; potential habitat within the Study Area, records within 5 km of Study Area and may not have been detectible during survey (e.g., survey conducted outside flowering period, annual plant survey conducted outside likely period of occurrence, small herbaceous plant in dense vegetation), or entire area of habitat not thoroughly searched;
- Unlikely – Study Area outside known range of species and/or no suitable habitat present in Study Area and/or suitable/potential habitat present but Study Area considered adequately searched for the species.

Dr Kelly Shepherd from the WA Herbarium and Dr Anže Žerdoner Čalasan from the Ludwig Maximilian University of Munich, were engaged to design and implement a survey for *Tecticornia* species and complete a taxonomic analysis (Shepherd & Žerdoner Čalasan, 2024; Appendix 5.4). Sampling of *Tecticornia* diversity was undertaken within the PIDE and to the north (Nickol Bay/Clearverville and Cossack/Point Sampson) and south (Onslow and Cape Preston) of the Proposal. Field work was undertaken between 4 – 7 December 2023, focusing on collecting specimens from the *Tecticornia halocnemoides* complex for DNA target enrichment sequencing. A total of 80 plants were sampled within the development envelopes (Figure 11-3). Some of these areas correspond to sites where sterile material was previously collected by Phoenix (2025). The remaining samples were collected south and north of the Proposal along the Pilbara coast (Figure 11-4).

Specimens collected in the Port Hedland area in 2009 by Dr. Shepherd were also assessed (Figure 11-5). Field photographs of habitat and close images of inflorescences and fruits were collated together for comparison along with detailed photomacroscope images of seeds, where available, as some samples had immature seed or were sterile.

Currently the WA Herbarium holds more than 550 specimens identified as belonging to the *Tecticornia halocnemoides* complex. These specimens were screened and a subset of 77 samples were selected for DNA sequencing, representing the morphological variation across the complex in WA (Figure 11-6). These specimens provided a comparison for the samples collected within the development envelope.

This assessment aimed to undertake targeted bait capture sequencing using custom baits ('SaliBaits'). These baits were designed specifically to discriminate between species within the Salicornioideae subfamily and preliminary analyses indicate they are useful in delimiting closely related species of *Tecticornia*.




Legend

Development Envelopes

- Dredge Spoil Disposal
- Marine
- Pond and Infrastructure

Study Areas

- Study Area Expansion
- Original Study Area

Imagery: Google Satellite

Preston Consulting

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**Figure 11-1: Flora and vegetation Study Area**

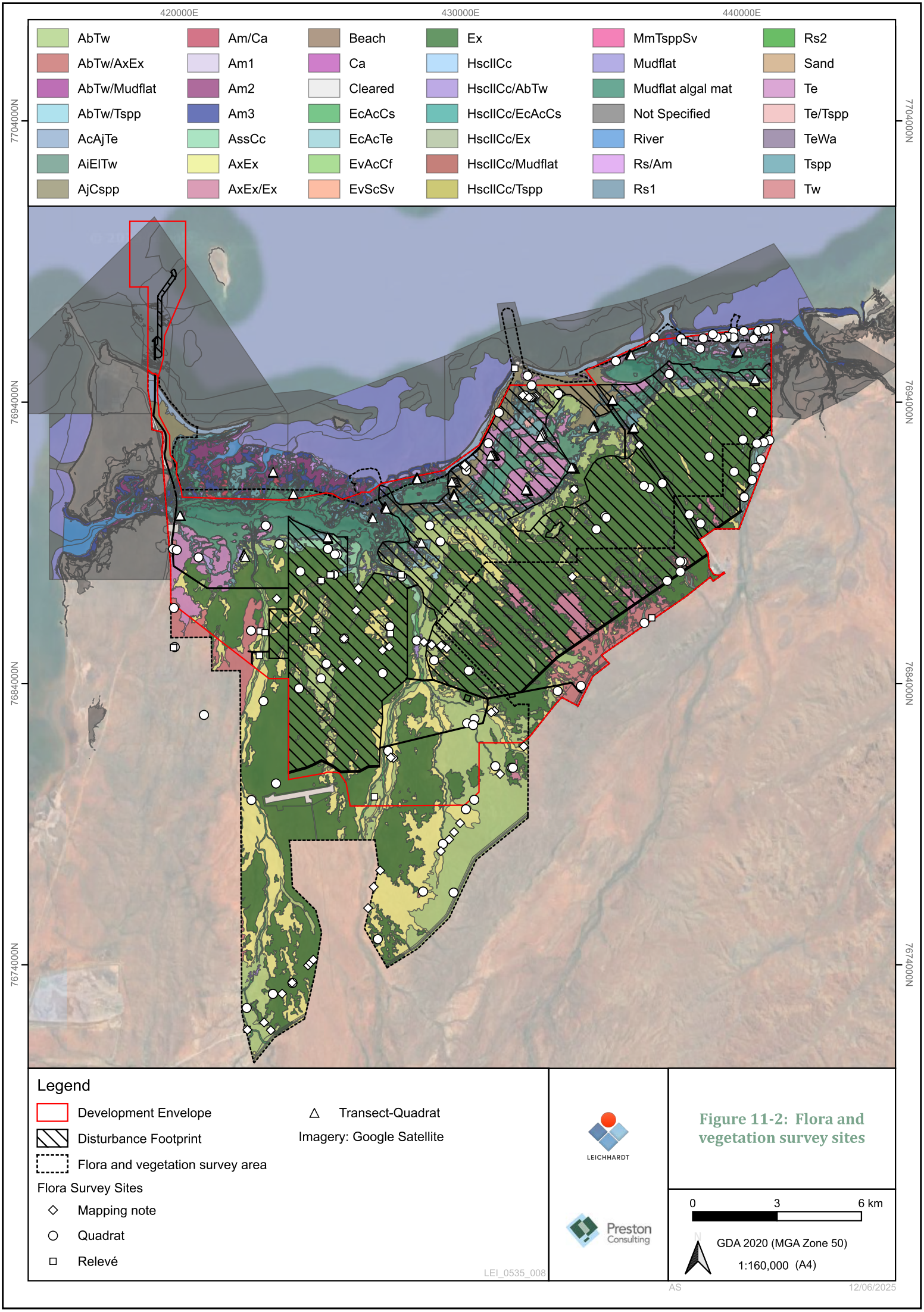
GDA 2020 / MGA Zone 50

0 2 4 6 8 km

1:220,000 (A4)

AS

27/06/2023


420000E
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AbTw
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AbTw/Tspp
AcAjTe
AiElTw
AjCspp
Am/Ca
Am1
Am2
Am3
AssCc
AxEx
AxEx/Ex
Beach
Ca
Cleared
EcAcCs
EcAcTe
EvAcCf
EvScSv
Ex
HsclICc
HsclICc/AbTw
HsclICc/EcAcCs
HsclICc/Ex
HsclICc/Mudflat
HsclICc/Tspp
MmTsppSv
Mudflat
Mudflat algal mat
Not Specified
River
Rs/Am
Rs1
Rs2
Sand
Te
Te/Tspp
TeWa
Tspp
Tw
Legend
Development Envelope
Disturbance Footprint
Flora and vegetation survey area
Flora Survey Sites
Mapping note
Quadrat
Relevé
Transect-Quadrat
Imagery: Google Satellite
LEICHHARDT
Preston Consulting
Figure 11-2: Flora and vegetation survey sites
0
3
6 km
N
GDA 2020 (MGA Zone 50)
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LEI_0535_008
AS
12/06/2025

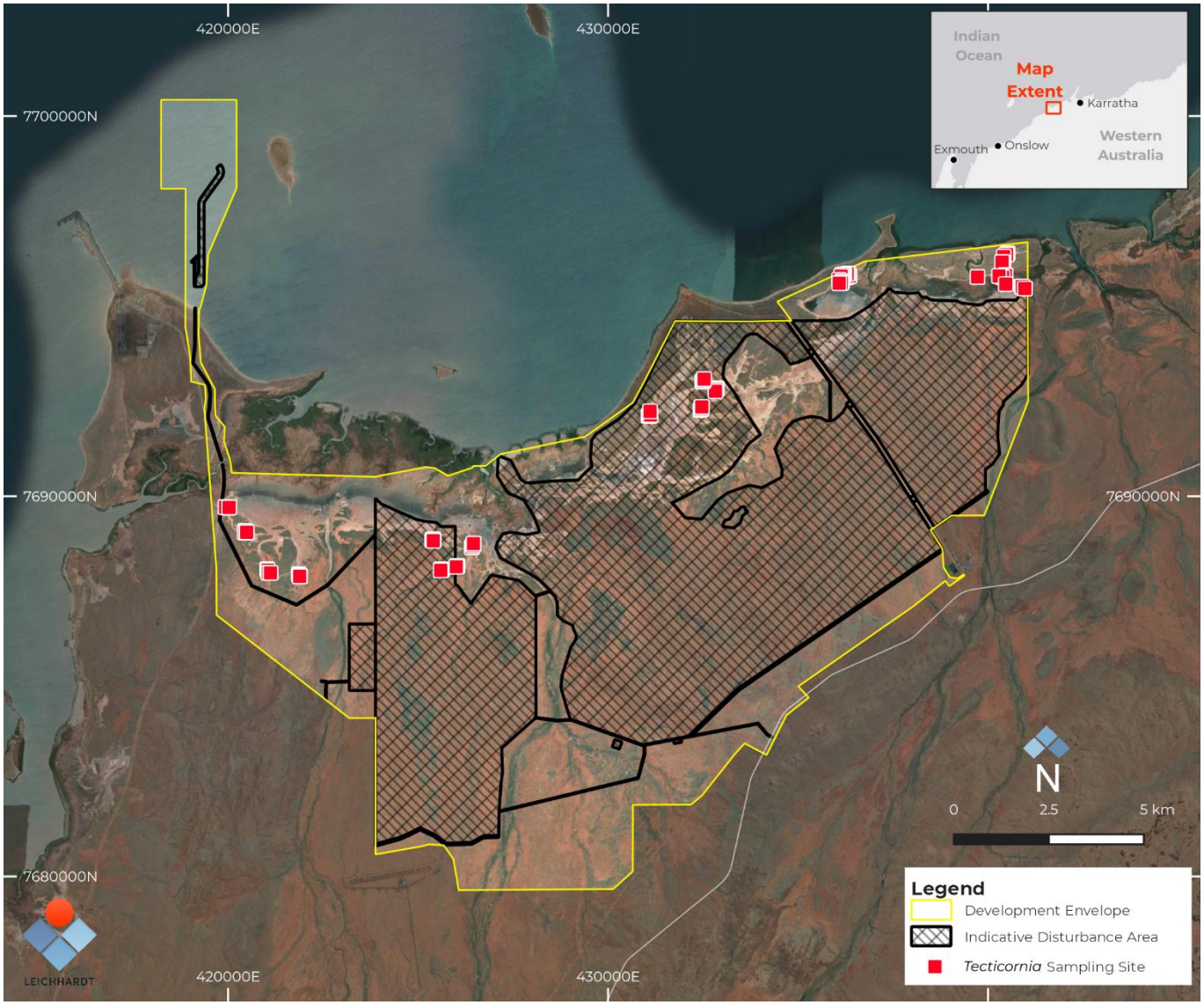



**Figure 11-3: *Tecticornia* sampling sites within the development envelopes**

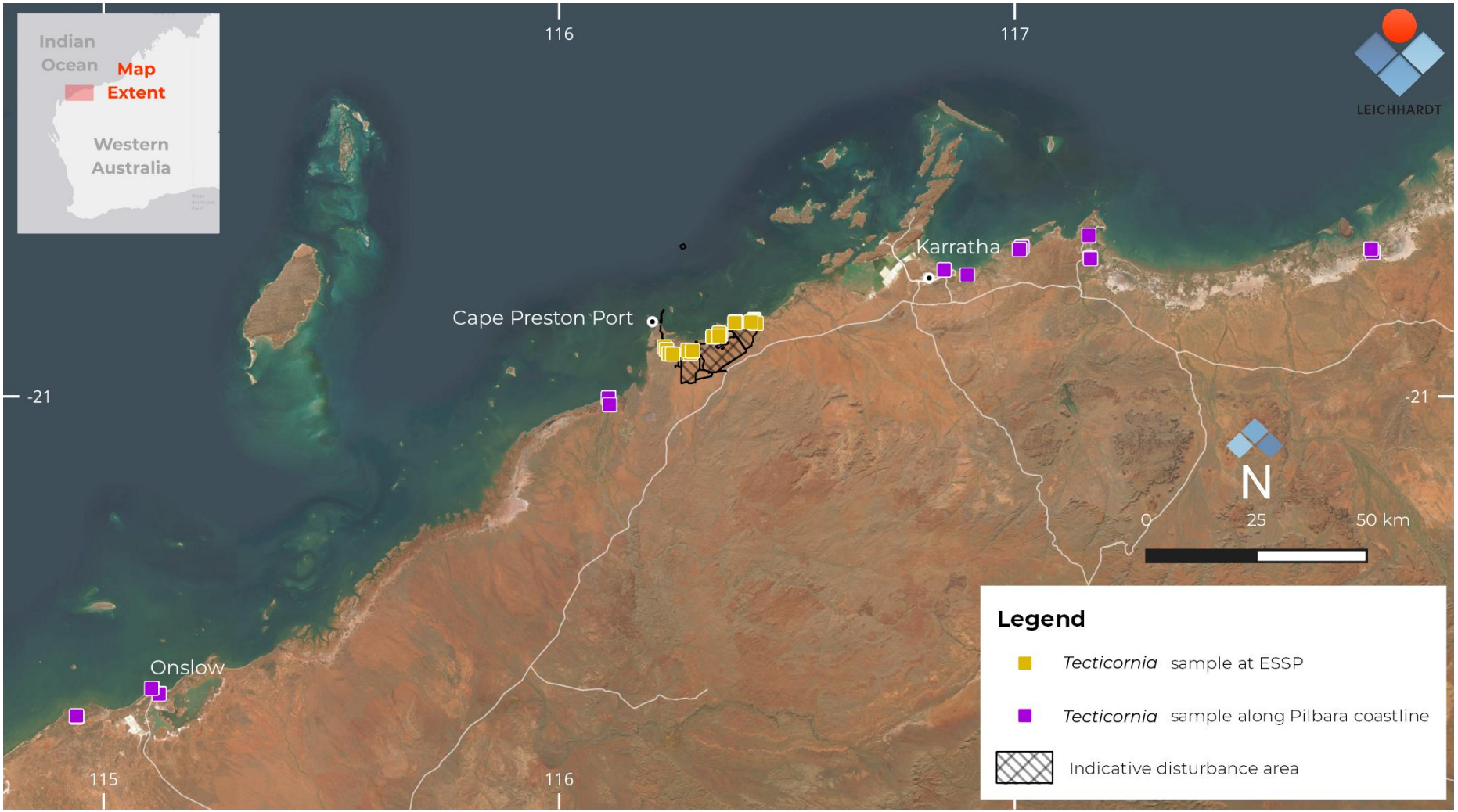



**Figure 11-4: *Tecticornia* samples within the development envelopes and along the Pilbara coastline**




**Figure 11-5: *Tecticornia* collections by Dr Kelly Shepherd in 2009**

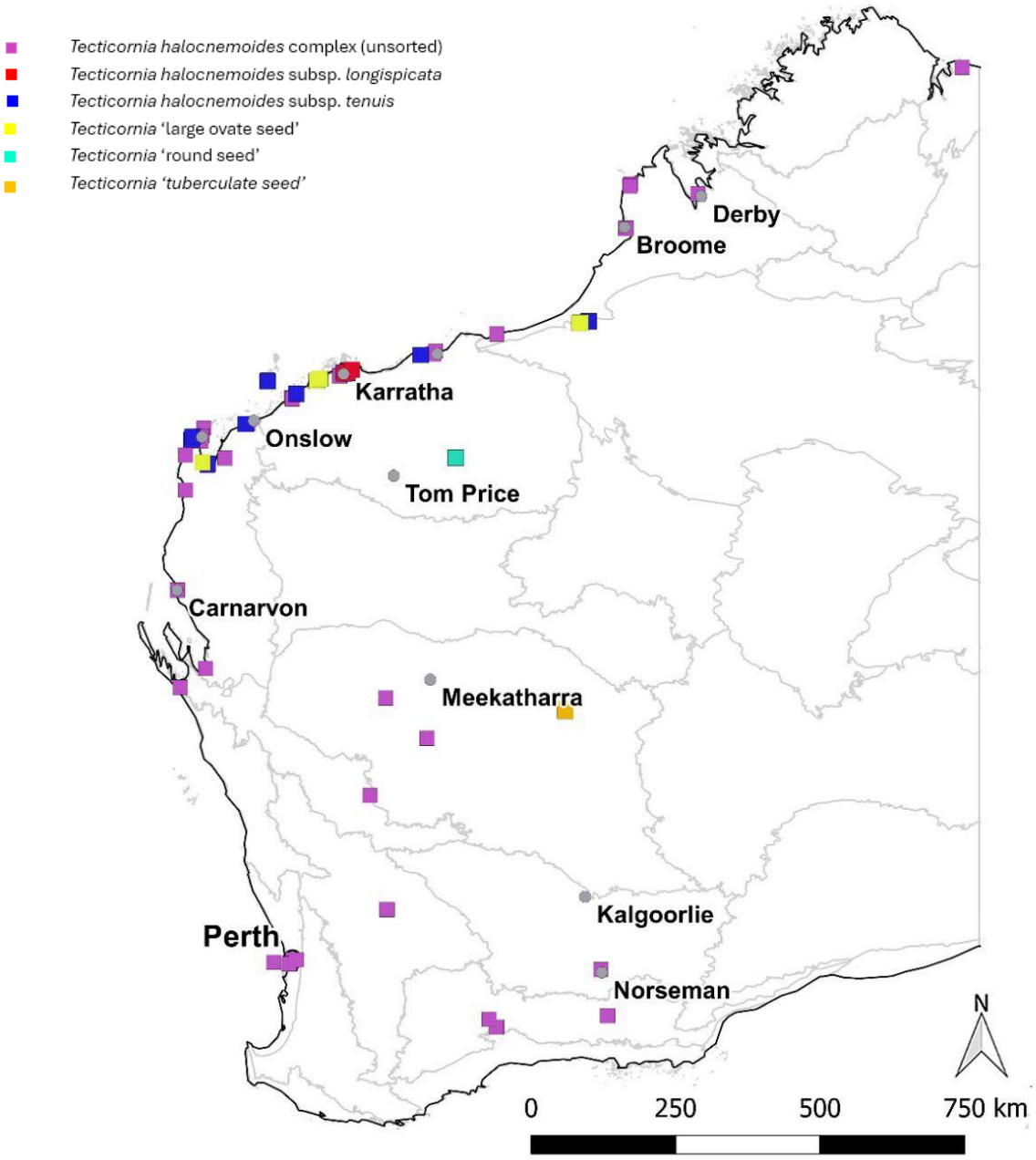



**Figure 11-6: *Tecticornia* specimens samples for sequencing currently lodged at the WA Herbarium ((Shepherd & Žerdoner Čalasan, 2024)**

### *Regional Priority Ecological Community Survey*

Additional regional Horseflat PEC mapping within the Horseflat Land System was undertaken by EnSTaR using satellite based remote sensing (EnSTaR, 2025c; Appendix 5.2). Remote sensing instruments measure the spectral reflectance, or colour, of land surfaces. Based on the descriptions of the PEC and adjacent land systems presented above, Horseflat PEC is predicted to be characterised by a generally bright red colour when vegetation cover is sparse (dry periods), but also displaying a high vegetation index cover for intermittent short periods where rainfall has enabled significant growth of vegetation. The regional Horseflat PEC mapping was undertaken across the Horseflat Land System of the Roebourne Plains.

To provide ground validation of the remote sensing model a flora and vegetation photography survey was undertaken at numerous locations within the mapped Horseflat PEC extent. The survey was implemented by Leichhardt and designed by Professor van Leeuwen (Curtin University), who nominated the PEC and is a member of the WA Threatened Ecological Communities Scientific Committee (Attachment 2 of Appendix 5.2; EnSTaR. 2025c). Figure 11-7 shows the photographic survey points specifically taken for the regional extent of the Horseflat PEC, which extends from Peedamulla to Balla Balla surrounding the towns of Karratha and Roebourne.

The collected photos were assessed by Professor van Leeuwen to determine whether the vegetation community was representative of the Horseflat PEC. This information was used to undertake further validation of the PEC mapping model. A total of 247 field photo validation points interpreted as PEC and 297 'Not PEC' were used, along with 794 validation data points collected prior to the photographic survey, representing surface types from regions surrounding the Horseflat Land System extent. These 'Not PEC' classes included diverse surface types such as mangrove and mudflat. The validation of the PEC model used for the mapping work returned a 94% accuracy of identifying PEC and an 87% accuracy of identifying 'Not PEC'. The model is conservative with a commission error of 38% for identifying Not-PEC as PEC and an omission error of 6% (PEC identified as not-PEC), with an overall total model accuracy of 88% (EnSTaR, 2025c).

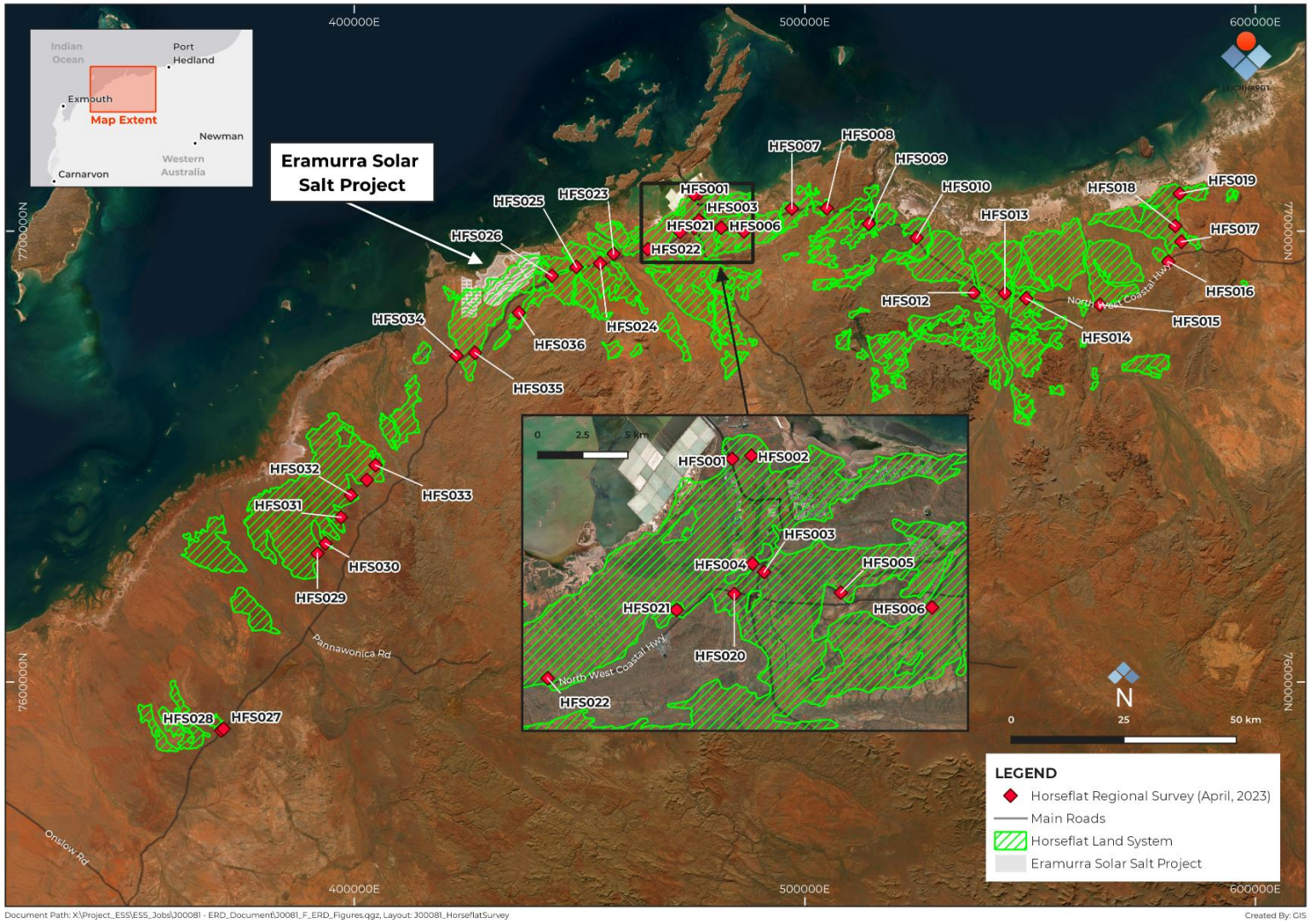



Figure 11-7: Photograph locations for validation of Horseflat PEC mapping

### *Alignment with Technical Guidance*

Phoenix (2025) conducted a review of the implemented survey methods against the relevant EPA technical guidance (EPA, 2016f). Overall, the survey methods aligned with the technical guidance, although the large size of the Study Area resulted in some challenges (Table 11-3). In accordance with the technical guidance, a minimum of three quadrats per vegetation type were installed, subject to available hectares of each vegetation type within the Study Area and avoidance of pseudo replication within single polygons.

**Table 11-3: Alignment of survey with EPA guidelines**

| Key points | Compliant? | Implications for EIA |
|---|---|---|
| **Preparation for survey**<br>Survey led by botanist with at least five years' experience in the bioregion<br>Survey conducted under flora collection licences and landowner permission obtained | Yes | None |
| **Desktop study**<br>Relevant databases searched at appropriate search extent<br>Description of regional setting (e.g., vegetation, land systems and soils) | Yes | None |
| **Survey**<br>Reconnaissance survey<br>To verify the information obtained from the desktop study, characterise the flora and delineate the vegetation units present | Yes | None |
| **Detailed survey**<br>Survey effort – multiple sampling events | Yes | None |
| **Sampling techniques appropriate**<br>i.e. site type, quadrat size, vegetation condition rating | Yes | None |
| **Survey design**<br>Survey area extent appropriate | Yes | None |
| Survey effort – adequate sampling of vegetation | Yes | None |
| Site selection | Yes, sites were selected from aerial imagery and from observations by helicopter and on the ground during the reconnaissance and Detailed surveys. | None |
| Survey timing appropriate | Yes, Surveys were conducted within the timeframes provided in the technical guidance (EPA, 2016f). | None |
| Flora population census | Significant flora searches not conducted over all suitable habitat due to very large size of Study Area. Extent of significant flora was not recorded for all significant species (in particular *Tecticornia*) as | The assessment has assumed that additional significant flora species may be present (i.e., the assessment is not limited to only recorded species). |

| Key points | Compliant? | Implications for EIA |
|---|---|---|
| | conditions were not adequate during the Targeted survey. | |
| **Flora**<br>Collection and identification of specimens<br>Vouchering<br>New species | Yes | None |
| **Vegetation**<br>Structural vegetation description<br>Floristic composition vegetation classification<br>Vegetation description<br>Defining TECs and PECs | Yes | None |
| **Mapping** | Yes | None |
| **Reporting** | Yes | None |

### 11.3.3 SURVEY LIMITATIONS

Table 11-4 describes the limitations encountered during the Phoenix (2025) survey and their implications to the assessment to vegetation and flora.

**Table 11-4: Phoenix (2025) survey limitations**

| Limitations | Limitations for this survey? | Comments | Implications for EIA |
|---|---|---|---|
| Availability of adequate contextual information at a regional and local scale | No | Previous reports were available combined with database searches to provide adequate background to the flora and vegetation survey. | None |
| Competency/experience of survey personnel, including taxonomy | No | The survey team possessed the required experience in the Pilbara region to satisfy the Technical Guidance. | None |
| Scope and completeness | No | A detailed level survey was appropriate for the Study Area and the proponent's proposed works. The scope of the survey adequately covered the requirements of a detailed survey and was completed. | None |
| Proportion of flora recorded and/or collected, any identification issues | No | Flattening of the accumulation curve demonstrates adequate number of sites to capture the flora of the Study Area. Due to the dry conditions for some field visits 26 flora specimens were unable to be identified completely but are unlikely to represent known significant flora identified in the desktop review. | None |
| Access within the Study Area | No | Access within the Study Area, including the use of helicopters, was adequate to allow full surveys of the Study Area. | None |
| Timing, rainfall, season | No | The surveys field visits were conducted at appropriate timing and seasons as per the requirements of Technical Guidance. | None |
| Disturbances which affected the results of the survey | No | There were no notable recent disturbances that may have impacted the results of the survey. | None |

### 11.3.4 FLORA

The field surveys recorded, and identified, to species level a total of 356 flora taxa, representing 51 families and 165 genera. Species richness between quadrats ranged from 6 – 75 species. The assemblage included 344 native species and 12 introduced species, including 253 perennial species, 93 annual or short-lived species and ten species that are considered both. The most prominent families recorded were Fabaceae (69 taxa), Poaceae (50 taxa), and Chenopodiaceae (38 taxa).

Phoenix (2025) reported that the number of species recorded in the current Study Area compares favourably to other surveys within close proximity to the Proposal.

***Threatened and Priority Flora***

Twenty-one significant flora species were identified in the desktop review as potentially occurring in or around the Study Area; 20 Priority flora listed under the BC Act and one novel species. One Priority flora species identified, *Minuria tridens,* is also listed as Threatened under the EPBC Act but has since been shown not to occur in WA. These records were visited by Phoenix and were not located. Pers. comms. with Professor Stephen van Leeuwen has identified that there is no suitable habitat for *Cucumis* sp. Barrow Island (D.W. Goodall 1264) as this species grows on limestone habitats on Barrow Island and Cape Range only. Therefore, the two historical records at Cape Preston East are likely to have been incorrectly identified and have not been considered further.

Targeted searches of the Study Area were undertaken for significant flora species identified in the desktop review. The searches focused on habitats considered likely to support such flora, in addition to previously recorded locations of significant plants or populations in close proximity to the Study Area.

No Threatened flora under the BC Act or EPBC Act were recorded during the field surveys. Three Priority 3 flora were recorded during the field survey; *Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479) (Priority 3), *Eremophila forrestii* subsp*. viridis* (Priority 3) and *Rostellularia adscendens* var*. latifolia* (Priority 3) (Figure 11-8). Leichhardt notes that *Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479) and *Eremophila forrestii* subsp*. viridis* remain taxonomically uncertain and their Priority flora status may change pending further taxonomic information. For the purposes of this assessment, they have been treated as Priority 3 flora species (i.e., their current status).

Nine other Priority flora species were identified by Phoenix (2025) as possibly occurring within the Study Area, following a conservative habitat assessment:

- *Minuria tridens* (P1);
- *Atriplex lindleyi* subsp. *conduplicate* (P3);
- *Euphorbia australis* var. *glabra* (P3);
- *Gomphrena cucullate* (P3);
- *Gomphrena leptophylla* (P3);
- *Gymnanthera cunninghamii* (P3);
- *Stackhousia clementii* (P3);
- *Terminalia supranitifolia* (P3); and

- *Goodenia nuda* (P4).

As above, it is now known that *Minuria tridens* does not occur in WA. Professor S. van Leeuwen (pers. comm., 2023) also noted that *Stackhousia clementii* (P3) and *Terminalia supranitifolia* (P3) were unlikely to occur based on a lack of suitable habitat. Table 11-5 lists the other Priority Flora that were assessed and considered unlikely to be present within the Study Area.

**Table 11-5: Likelihood of occurrence for significant flora in the Study Area (Phoenix, 2025)**

| Species | Status | Likelihood of occurrence |
|---|---|---|
| *Gomphrena axillaris* (R.W.Davis and J.Palmer) formally known as *Gomphrena* sp. Martins Well (K.F. Kenneally 6116) | P1 | Unlikely<br>Study Area outside of typical range. Closest record 31.1 km from Study Area. |
| *Corchorus congener* | P3 | Unlikely.<br>Study Area unlikely to contain typical habitat of offshore islands. |
| *Goodenia* sp. East Pilbara | P3 | Unlikely<br>Study Area outside of typical distribution and lack of suitable habitat. Closest Florabase record is 205.7 km however, it was recorded within several km (<5 km) from Study Area in Biota and Trudgen and Associates (2001). |
| *Owenia acidula* | P3 | Unlikely.<br>Study Area within typical range. Suitable habitat within the Study Area, however due the ease of detectability in the field and area of habitat searched, unlikely present. Closest record is 30.8 km from the Study Area. |
| *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) | P3 | Unlikely<br>Study Area outside of typical distribution and lack of suitable habitat present. Closest record is 36.3 km from the Study Area. |
| *Triodia pisoliticola* | P3 | Unlikely.<br>Study Area outside of typical distribution. Closest record is 28.6 km from Study Area. |
| *Vigna triodiophila* | P3 | Unlikely.<br>Study Area outside of typical distribution. Closest record is 39.7 km from Study Area. |
| *Rhynchosia bungarensis* | P4 | Unlikely.<br>Suitable habitat does not occur within the Study Area. Closest record is 1.2 km from the Study Area. |

*Minuria tridens*

Leichhardt commissioned DBCA to complete a resolution study for *Minuria tridens* following the likelihood of occurrence assessment completed by Phoenix (2025) (Dillon et al., 2024; Appendix 5.3). This species was identified as possibly occurring as suitable habitat occurs within the Study Area and the closest record was considered to be 28.2 km from the Study Area.

Taxonomic and molecular studies undertaken by DBCA/WA Herbarium (Dillon et al., 2024) for Leichhardt clearly demonstrate that *Minuria tridens* does not occur in WA. Results from the study conclusively demonstrate that the *Minuria* taxon on the west Pilbara coast is a new species which has been ascribed the phrase name *Minuria* sp. Onslow (A.J. Perkins & M. Henson AJP-WA167) by the WA Herbarium and is now incorporated into the WA Flora Census. It occurs in the mid-west and Pilbara ranging from Cape Preston to Northampton and inland to Mount Magnet. It is not a Priority species. As a result, this species has not been considered further.

***Potentially Significant Unidentified or Undescribed Flora***

Additional significant flora taxa identified during the Phoenix (2025) survey (Figure 11-8) include 12 unidentified /unknown species which include:

- *Polygala* aff. *galeocephala;*
- *Bonamia* aff. *media;*
- *Scaevola* aff. *pulchella*;
- *Tecticornia halocnemoides* 'ovate seed aggregate';
- *Tecticornia* sp. sterile 1;
- *Tecticornia* sp. sterile 2;
- *Tecticornia* sp. sterile 3;
- *Tecticornia* sp. sterile 4;
- *Tecticornia* sp. sterile 5;
- *Tecticornia* sp. sterile 6;
- *Tecticornia* sp. sterile 7; and
- *Tecticornia* sp. sterile 8.

The nine sterile *Tecticornia* species collected by Phoenix (2025) have unresolved taxonomy due to a lack of material.

While samphires (*Tecticornia* species) are easily recognised as a single vegetation type at the landscape level, ironically individual plants are extremely difficult to identify to species (Shepherd & Žerdoner Čalasan, 2024). This is due to their reduced morphology as they do not have true leaves (only succulent, bead-like stems), the flowers are tiny, and non-descriptive, and the seeds are very small (usually less than 1.5 mm long) A detailed study of samphire seeds using Electron Microscopy (Shepherd et al. 2005), determined that the shape, colour, and ornamentation of seeds are useful diagnostic characters and, in some cases, also the only reliable character for species identification, particularly among closely related taxa (species or subspecies). However, as samphire seeds are so small, these fine details are not as readily observed with the naked eye. Unfortunately, seed is also held only on some species with 'soft-fruits' for a period of weeks or months post-flowering before fruits fall, rendering them sterile and essentially unidentifiable for most of the year.

Samphires pose further taxonomic challenges due to the presence of unresolved species complexes with morphological intergrades, and potential hybrids among sympatric (co-occurring) species (Shepherd & Žerdoner Čalasan, 2024). Polyploids (taxa with multiple sets of chromosomes) have also been documented within some species of the genus and even among species in the same population.

Dr Kelly Shepherd from the WA Herbarium and Dr Anže Žerdoner Čalasan from the Ludwig Maximilian University of Munich were engaged to complete a taxonomic analysis of the *Tecticornia* species (Shepherd & Žerdoner Čalasan, 2024; Appendix 5.4). The results demonstrate that none of the currently known species of *Tecticornia* are restricted to the study area, confirming that all known species present within the Indicative Disturbance Footprint, also occur elsewhere. The large numbers of samples of the potentially new undescribed taxon *T.* sp. nov. 'large ovate seed' sequenced in this study confirm that this taxon is present at both the Proposal and elsewhere, having a widespread distribution along the coast from Carnarvon to Derby. Similarly, the genetically divergent subclade of *Tecticornia pterygosperma* subsp. *denticulata* includes a sample from the Proposal, which is genetically similar to samples with a widespread distribution from near Carnarvon to Point Sampson. If further research supports this subclade as morphologically distinct and warrants taxonomic recognition, it represents another potentially new, undescribed *Tecticornia*, which is present at both the Proposal and elsewhere.

### *Other Unidentified or Undescribed Species*

A total of 11 other taxa could not be identified to a species level (Table 11-6), mainly as a result of insufficient taxonomic characters, as plants were sterile or reproductive structures were too old/dry or damaged to be useful. The majority of the species possessed characters indicating that they were likely common species but lacked sufficient characters for confirmation of identity. Seven of the 11 unidentified flora have been ruled out as potential Priority species (Phoenix, 2025).

**Table 11-6: Unidentified taxa recorded during the field survey (Phoenix, 2025)**

| Taxon | Comments |
|---|---|
| *Boerhavia* sp. | Sterile.<br>No Priority *Boerhavia* are known in the Pilbara region. |
| *Frankenia* sp. | Sterile.<br>No Priority *Frankenia* are known in the Pilbara region. |
| *Goodeniaceae* sp. | Sterile. |
| *Hibiscus* sp. | Damaged reproductive structures.<br>No Priority *Hibiscus* are known in the Roebourne subregion. |
| Indeterminate | Damaged reproductive structures. |
| *Lamiaceae* sp. | Sterile.<br>No Priority *Lamiaceae* are known in the Roebourne subregion. |
| *Poaceae* sp. | Inflorescence old and dry. |
| *Sclerolaena* sp. | Damaged reproductive structures.<br>No Priority *Sclerolaena* are known in the Pilbara region. |
| *Sida* sp. | Old dry material, incomplete.<br>One Priority *Sida* (sp. Barlee Range (S. van Leeuwen 1642)) known in the Roebourne subregion, but not known within the local region and Study Area lacks suitable habitat. |
| *Tephrosia* sp. (E043) | Sterile.<br>One Priority *Tephrosia* (*rosea* var. Port Hedland (A.S. George 1114)) known in the Roebourne subregion, but not known within the local region. |
| *Triodia ?epactia* | Inflorescence old and dry. |

### *Range Extensions*

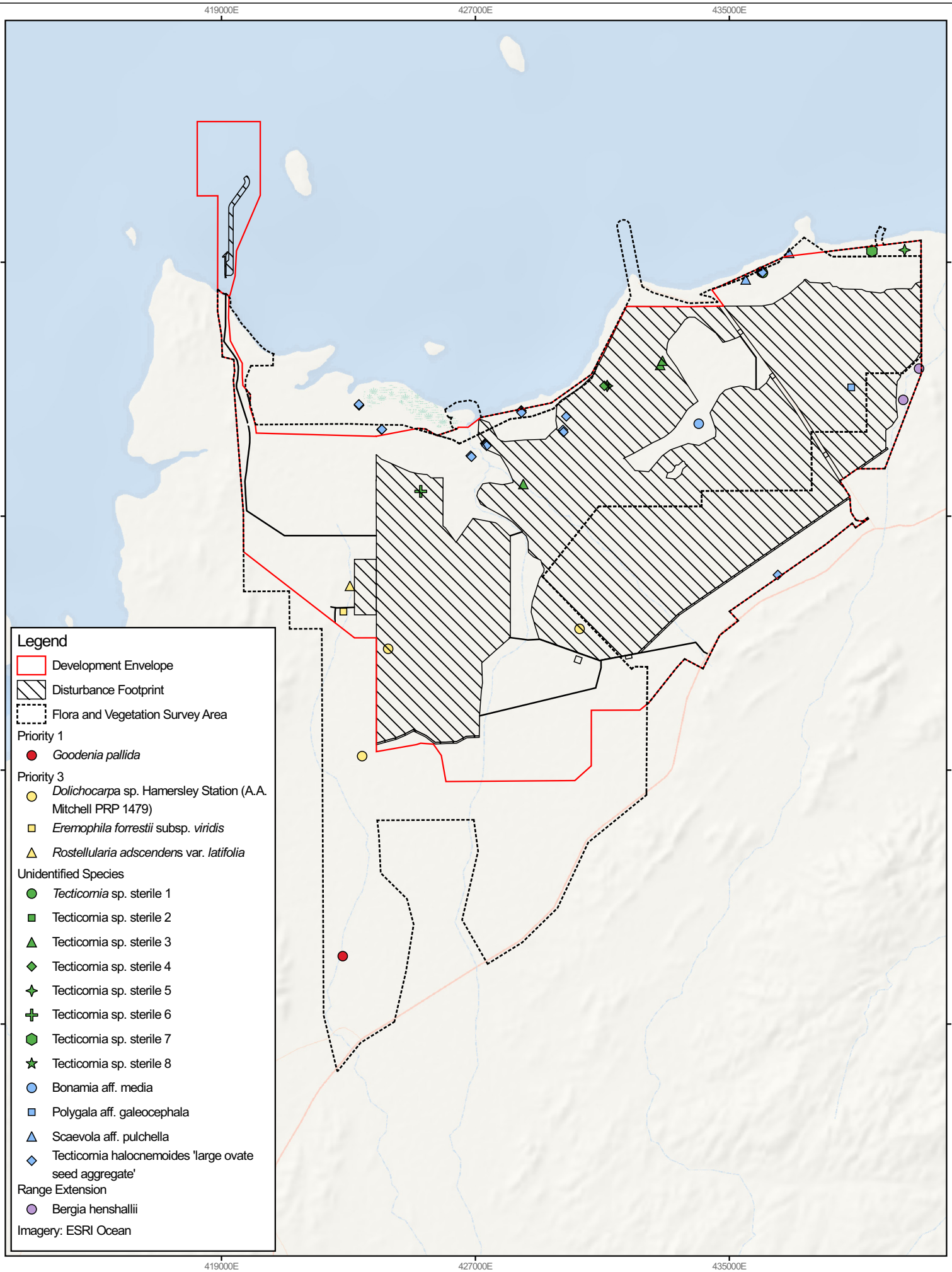
Two of the three Priority 3 species recorded within the Study Area are deemed range extensions, *Eremophila forrestii* subsp. *viridis* and *Rostellularia adscendens* var. *latifolia*. One additional species was also deemed as significant range extension. Details of flora species with significant range extensions are detailed in Table 11-7.

**Table 11-7 Details of flora species recorded during the field survey with range extensions**

| Species | Status | Distribution and ecology |
|---|---|---|
| *Eremophila forrestii* subsp. *viridis* | P3 (DBCA)<br>~147 km range extension | Recorded across the Carnarvon, Great Sandy Desert, Pilbara Bioregions and Roebourne subregion. Shrubland over hummock grassland, flats and hardpan. Rocky gullies. Five records in Florabase (WA Herbarium, 1998-). Further taxonomic work may be required to accurately determine distribution. |
| *Rostellularia adscendens* var. *latifolia* | P3 (DBCA)<br>~130 km range extension | Recorded across the Pilbara bioregion on ironstone soils near creeks and rocky hills. Florabase has 40 records with populations ranging from a few individuals to 50 plants (WA Herbarium, 1998-). |
| *Bergia henshallii* | ~239.8 km range extension | Recorded across the Dampierland, Gibson Desert, Great Sandy Desert, Ord Victorian Plain, Tanami, and Pilbara Bioregions, including the Roebourne subregion. Red clay, sand. Flats and dunes. 24 records in Florabase (WA Herbarium, 1998-). |

### *Introduced Flora*

Twelve introduced flora species were recorded during the survey. One of these species, *Prosopis glandulosa x velutina,* is listed as both a WoNS and Declared Pest. This species was recorded within one quadrat. This introduced species is allocated to the category 2 – eradication category (DPIRD, 2021). This identifies organisms which should be eradicated from part or all of WA, at the state-wide scale.




0 2 4 km

GDA2020 / MGA zone 50

1:150,000

Project: LEI_0535_026
Date: 29/04/2025
Size: A4
Author: ASmithers (Preston Consulting Pty Ltd)

LEICHHARDT

Preston Consulting

**Figure 11-8: Location of significant flora**

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## 11.3.5 VEGETATION

***Land Systems***

The Study Area covers eight land systems. However, it is dominated by two systems which together cover 82.9% of the Study Area (Figure 11-9):

- Horseflat System (~16,610.6 ha; 62.8%) – Gilgaied clay plains supporting Roebourne Plains grasslands and minor grassy snakewood shrublands; and
- Littoral (~5,321.0 ha; 20.1%) – Bare coastal mudflats (unvegetated), samphire flats, sandy islands, coastal dunes and beaches, supporting samphire low shrublands, sparse *Acacia* shrublands and mangrove forests.

***Vegetation Condition***

The condition of vegetation in the Study Area ranged from Completely Degraded to Excellent (Figure 11-10; Table 11-8); with the majority (76.8%) in Excellent condition. All areas rated as Completely Degraded comprised cleared areas only. Excellent condition ranks the vegetation as pristine or nearly so with no signs of damage caused by human activities since European settlement. Areas recorded as Good to Degraded were due to disturbances such as grazing and/or aggressive weeds. Weed species were a dominant factor within several vegetation types. Completely cleared areas (e.g., roads, tracks, paddocks) were excluded from condition ratings and mapped as 'cleared'.

**Table 11-8: Vegetation condition in the Study Area (Phoenix, 2025)**

| Condition rating | Area (ha) | % of Study Area |
|---|---|---|
| Excellent | 20,307.8 | 76.8 |
| Very Good | 1,253.8 | 4.7 |
| Good | 1,714.9 | 6.5 |
| Poor | 118.5 | 0.4 |
| Degraded | 3.7 | <0.1 |
| Completely Degraded | 148.0 | 0.6 |

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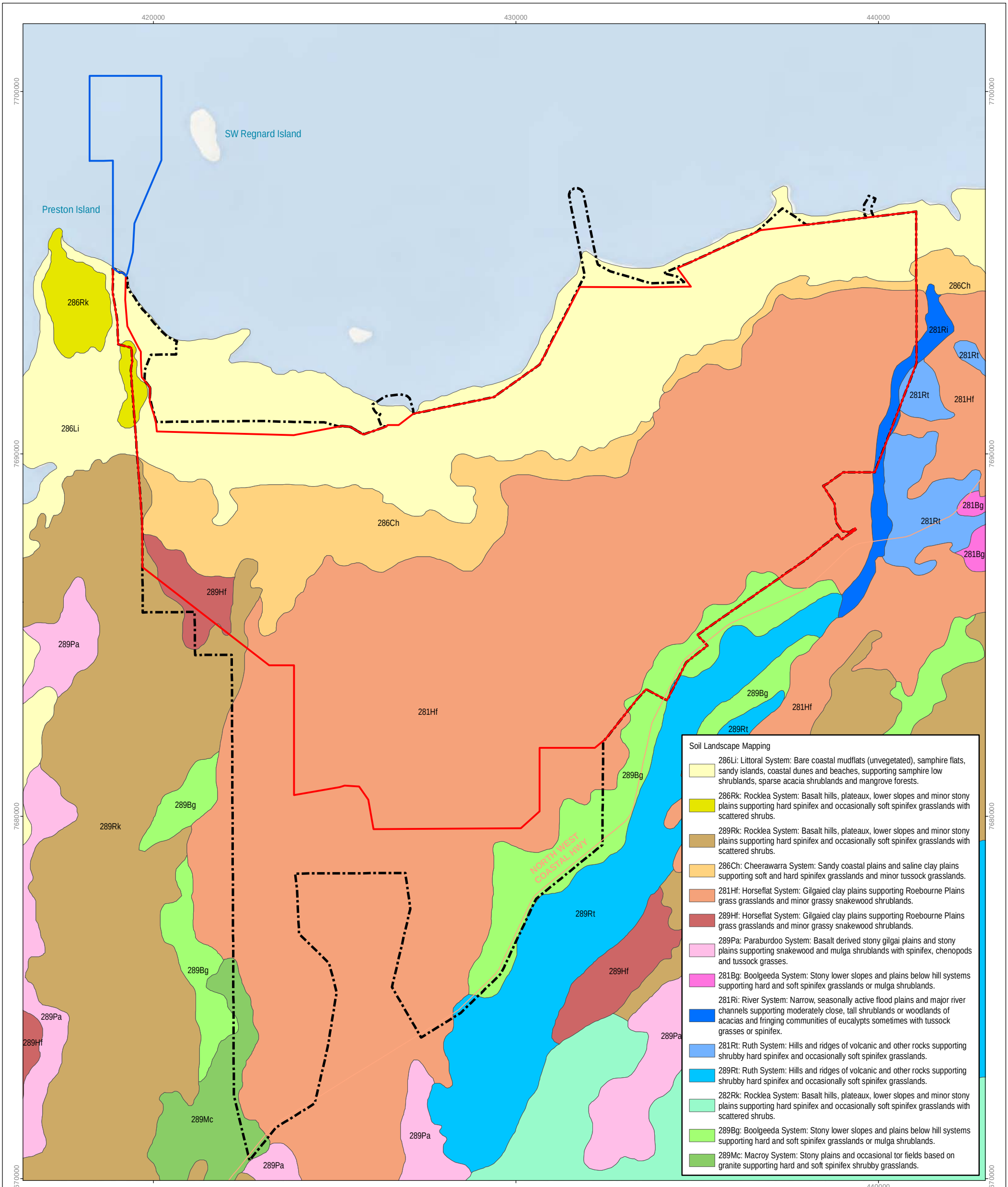


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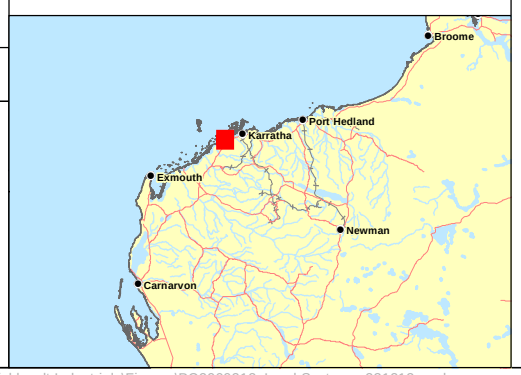
**Figure 11-9: Land systems**

0 0.75 1.5 3
km
Scale: 1:100,000 @ A3

N

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

**LOCALITY**




Legend
- Marine Development Envelope
- Pond and Infrastructure Development Envelope
- Flora and Vegetation Study Area

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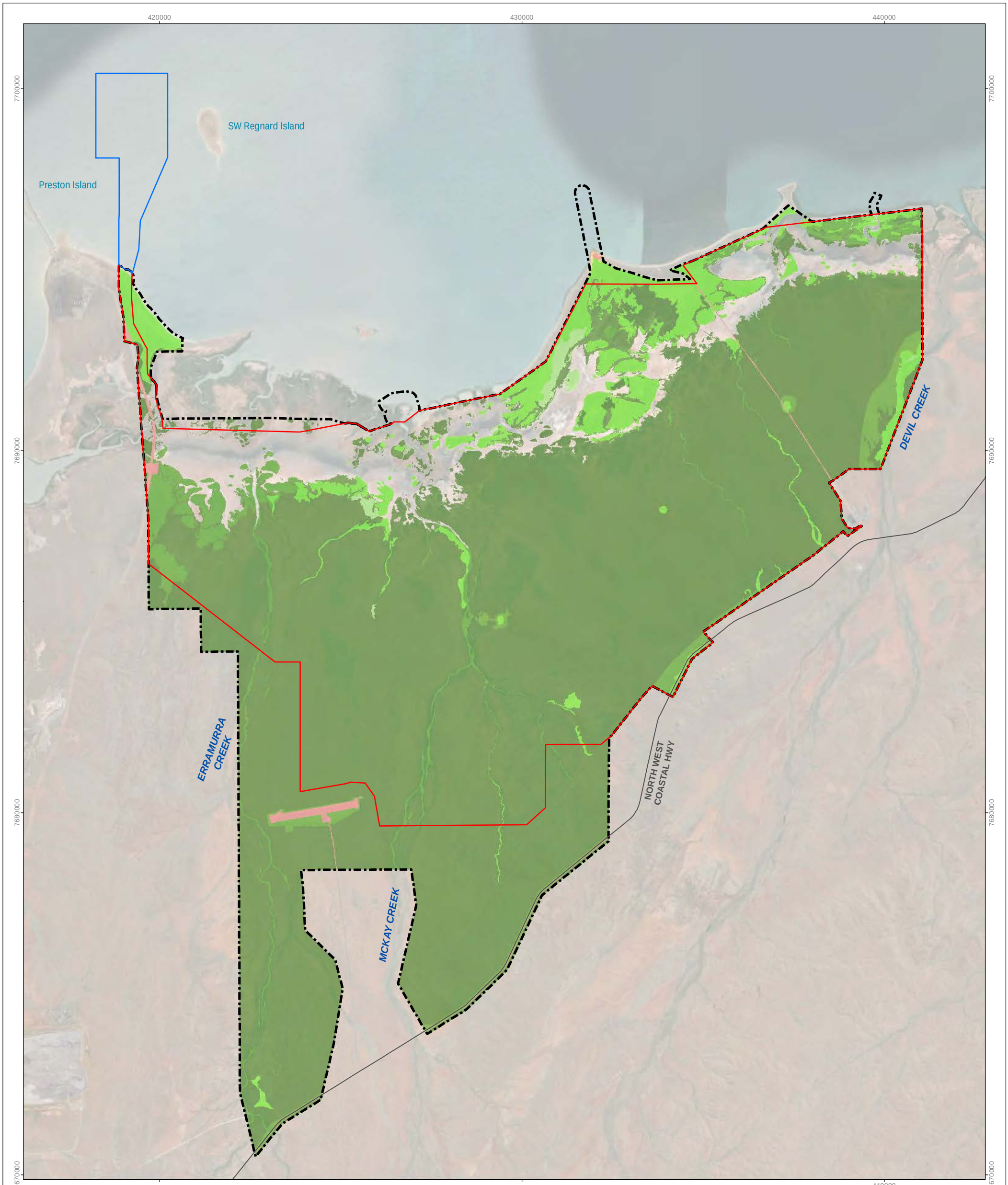


Figure 93: Vegetation condition

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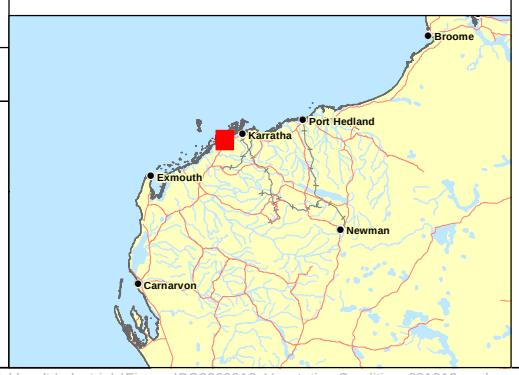
0 0.75 1.5 3
km
Scale: 1:100,000 @ A3

N

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

**LOCALITY**




Legend

- Marine Development Envelope
- Pond and Infrastructure Development Envelope
- Flora and Vegetation Study Area

Vegetation Condition

- Excellent
- Very Good
- Good
- Poor
- Degraded
- Completely Degraded

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### *Regional Native Vegetation Extent*

Native vegetation within 10, 50 and 100 km of the development envelopes was mapped using DPIRD's Native Vegetation Dataset and is shown in Table 11-9. The extent of native vegetation surrounding the development envelopes is shown in Figure 11-11. It is noted that the Mardie Project is currently under construction, which includes 7,299 ha of native vegetation disturbance (Preston Consulting, 2022c). All of this disturbance is located within the 100 km radius, with an estimated 3,650 ha within a 50 km radius.

**Table 11-9: Native vegetation surrounding the Proposal**

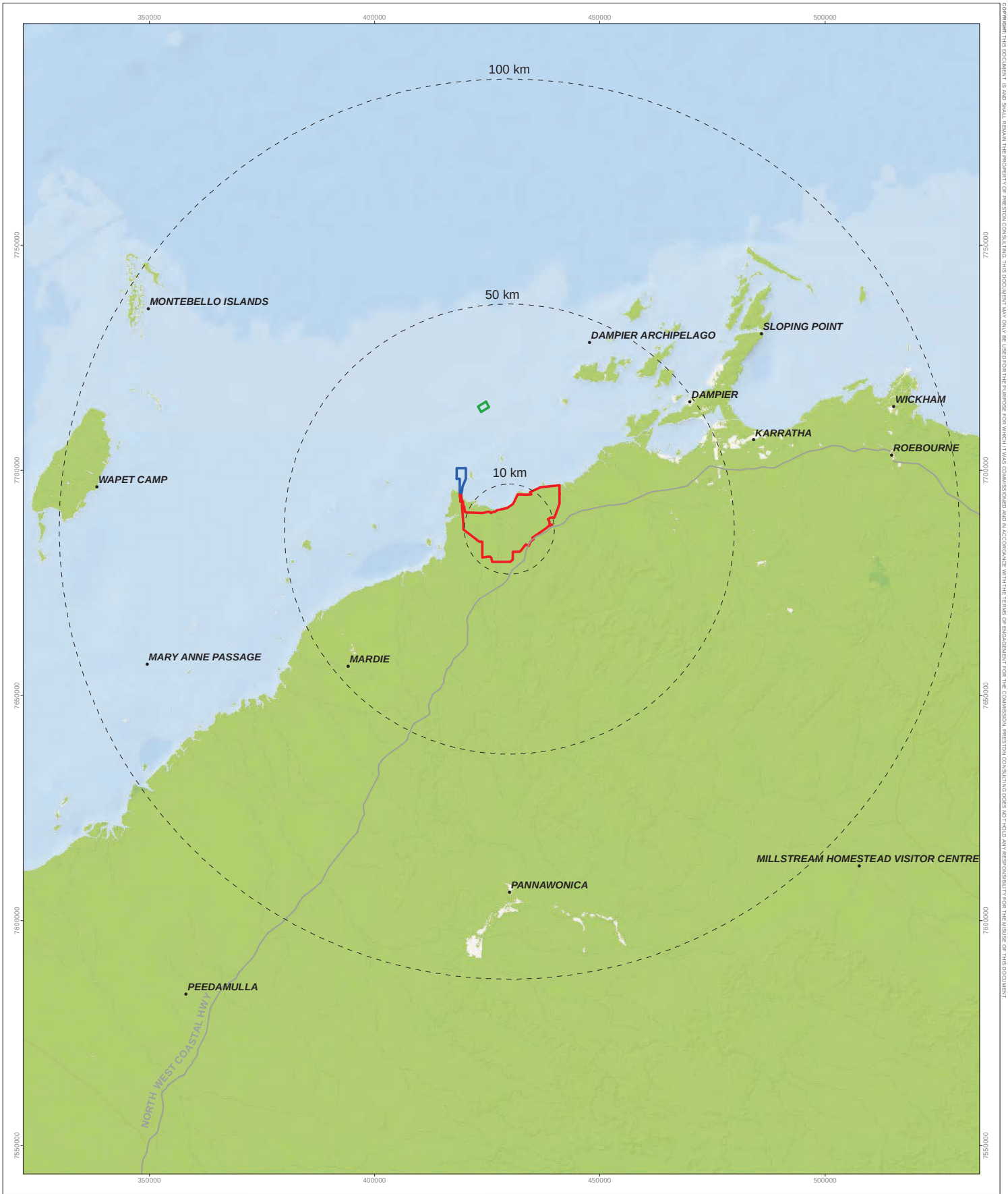
| Radius (km) | Area of native vegetation remaining (ha) |
|---|---|
| 10 | 27,291 |
| 50 | 437,204 |
| 100 | 1,563,132 |

### *Vegetation Associations*

Six vegetation associations are located within Study Area based on regional vegetation mapping by Shepherd et al. (2002) and Beard et al. (2013) (Table 11-10 and Figure 11-12). All vegetation associations are extensively represented in the Roebourne subregion and currently have over 84% pre-European extent remaining, and therefore have the status of 'Least Concern' (DPIRD, 2018). It is noted that the Mardie Project is currently under construction, which includes disturbance within 7,720 ha of the same vegetation associations. These values have been added to Table 11-10 for reference.

**Table 11-10: Vegetation associations within the development envelope**

| Vegetation association and description | Pre-European extent (ha) | Current extent (ha) | % Remaining | % of Study Area |
|---|---|---|---|---|
| **43**: Low Forest; mangroves (Kimberley) or thicket; mangroves (Pilbara) | 217,449.3 | 183,250.1 | 84.3 | 1.3 |
| **93**: Hummock grasslands, shrub steppe; kanji over soft spinifex | 3,044,309.5 | 3,040,641.0 | 99.9 | 7.4 |
| **117**: Hummock grasslands, grass steppe; soft spinifex | 919,517.0 | 886,005.8 (38 ha to be cleared at the Mardie Project) | 96.4 (inclusive of clearing at Mardie Project) | 4.6 |
| **127**: Bare areas; mudflats | 737,724.0 | 697,871.4 (7,682 ha to be cleared at the Mardie Project) | 93.6 (inclusive of clearing at Mardie Project) | 16.3 |
| **175**: Short bunch grassland – savanna/grass plain (Pilbara) | 526,957.9 | 524,640.2 | 99.6 | 70.3 |
| **587:** Mosaic: Hummock grasslands, open low tree-steppe; snappy gum over *Triodia wiseana*/Hummock grasslands, shrub-steppe; kanji over *Triodia pungens* | 580,728.6 | 580,697.0 | 100.0 | 0.1% |

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0 5 10 20
km
Scale: 1:800,000 @ A3

N

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

**LOCALITY**




Legend
- Dredge Spoil Disposal Development Envelope
- Marine Development Envelope
- Pond and Infrastructure Development Envelope
- Buffer (km)
- Native Vegetation

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Figure 11-11: Extent of native vegetation surrounding the Proposal (mapping dated 19/07/2023)

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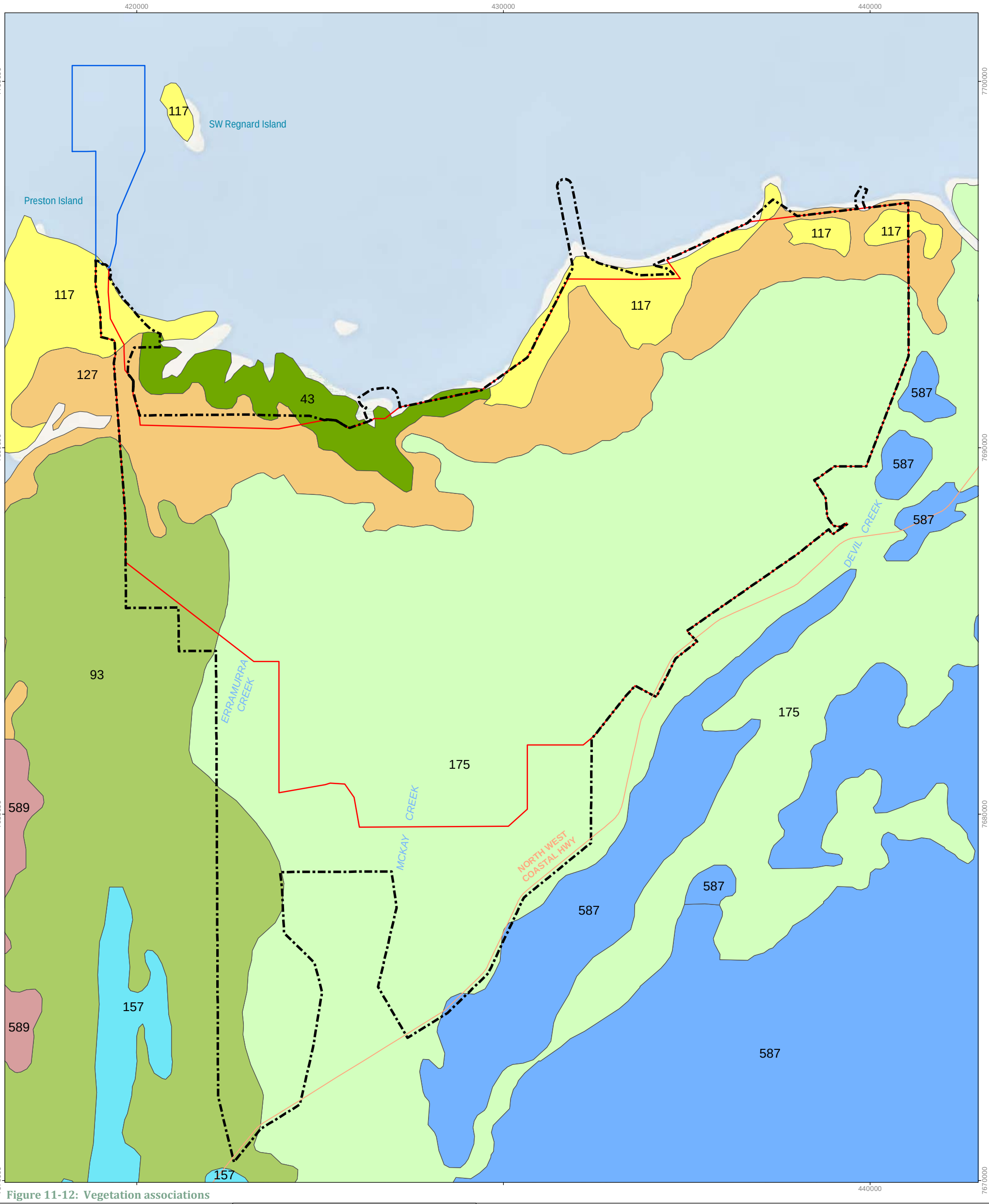


Figure 11-12: Vegetation associations

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|---|---|---|---|
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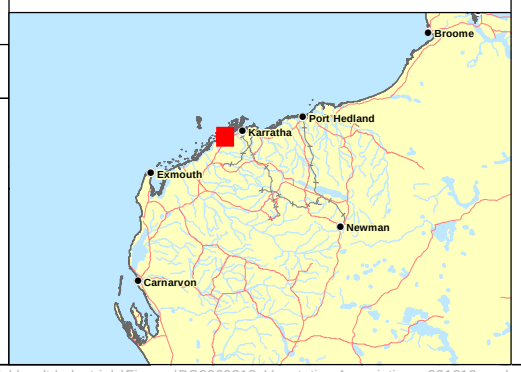
0 0.75 1.5 3
km
Scale: 1:100,000 @ A3

N

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

**LOCALITY**




Legend

- Marine Development Envelope
- Pond and Infrastructure Development Envelope
- Flora and Vegetation Study Area

Vegetation Association

- 43: Mangroves
- 117: Grass-steppe
- 127: Tidal mud flat
- 93: Shrub-steppe
- 589: Short bunch-grass savanna / Grass-steppe
- 157: Grass-steppe
- 175: Grasslands, short bunch-grass savanna
- 587: Sparse low tree-steppe / Sparse shrub-steppe

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### *Vegetation Types*

Seventeen vegetation types were mapped within the Study Area (Figure 11-13 – Figure 11-16). These vegetation types can be generalised into the following seven broad vegetation groups:

- Low isolated forbs over closed tussock grassland;
- *Acacia* shrubland over hummock grassland;
- *Acacia* shrubland over tussock grassland;
- Low open *Tecticornia* shrubland, occasionally over sparse tussock grassland;
- Low sparse to open shrubland of *Aerva javanica* over *Cenchrus* spp. Grassland;
- Drainage woodlands, variably composed of *Eucalyptus camaldulensis*, *E. victrix* and *Corymbia hamersleyana*; and
- Exposed granite areas containing isolated shrubs and forbs.

Vegetation type Ex is the dominant vegetation type, covering 44.3% of the Study Area. This vegetation type is described as low isolated forbs of *Sida fibulifera*, *Rhynchosia minima*, and *Indigofera trita*, over low tussock grassland to closed tussock grassland of *Eragrostis xerophila, Dichanthium sericeum* subsp*. humilius,* and *Sorghum plumosum*.

Vegetation type AbTw is the second largest covering 15.9% of the Study Area. This vegetation type is described as mid sparse to open shrubland of *Acacia bivenosa*, with occasional *A. stellaticeps* and *A. coriacea* (s.l.), over low hummock grassland of *Triodia wiseana*.

The remaining fifteen vegetation types mapped cover 26.8% of the Study Area, 1.5% was mapped as mosaic or complex vegetation types, and 10% was mapped as devoid of vegetation, either described as cleared or mudflats.

Four vegetation types (EcAcTe, EvScSv, HscIlCc and MmTsppSv) were noted as being restricted vegetation, each occupying less than 0.1% of the Study Area.

### *Threatened and Priority Ecological Communities*

No TECs listed under the BC Act or EPBC Act were recorded within the Study Area, however two PECs were recorded (Figure 11-17):

- Horseflat PEC (Priority 3), occupying 11,720.6 ha of the Study Area. This PEC is represented by vegetation type Ex; and
- Coastal Dune PEC (Priority 3), occupying 117.9 ha of the Study Area. This PEC is represented by vegetation type TeWa.

Additional regional mapping was undertaken by EnSTaR using remote sensing to further characterise the extent of the Horseflat PEC. Regional mapping indicated that the Horseflat PEC occupies a total area of 194,996.5 ha (Figure 11-18). Additional field verifications have been undertaken to determine the accuracy of these predictions (Section 11.3.2). The condition of the Horseflat PEC is likely to be variable throughout its extent, with none of this PEC represented in conservation reserve systems.

A minor proportion of the mapped vegetation consisted of a mosaic of complex vegetation types. Areas where the vegetation type (Ex) occurs as an element of the mosaic are considered as significant vegetation as a precaution.

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430000 440000 7700000 7690000

Ex Mudflat Mudflat Mudflat River Am3 TeWa Mudflat algal mat Mudflat algal mat Te AbTw AjCspp Tspp Ex Tw AxEx AxEx/Ex DEVIL CREEK NORTH WEST COASTAL HWY

Figure 11-13: Site vegetation types (northeast)

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0 0.5 1 2 km

Scale: 1:50,000 @ A3

N

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

**LOCALITY**




Legend

- Marine Development Envelope
- Pond and Infrastructure Development Envelope
- Flora and Vegetation Study

Vegetation Type

- AbTw
- AbTw/AxEx
- AbTw/Mudflat
- AbTw/Tspp
- AcAjTe
- AiElTw
- AjCspp
- AssCc
- AxEx
- AxEx/Ex
- EcAcCs
- EcAcTe
- EvAcCf
- EvScSv
- Ex
- HsclICc
- HsclICc/AbTw
- HsclICc/EcAcCs
- HsclICc/Ex
- HsclICc/Mudflat
- HsclICc/Tspp
- MmTsppSv
- Mudflat
- Te
- Te/Tspp
- TeWa
- Tspp
- Tw
- Cleared

Intertidal BCH

- Am/Ca
- Am1
- Am2
- Am3
- Beach
- Ca
- Mudflat algal mat
- Rs1
- Rs2
- Sand

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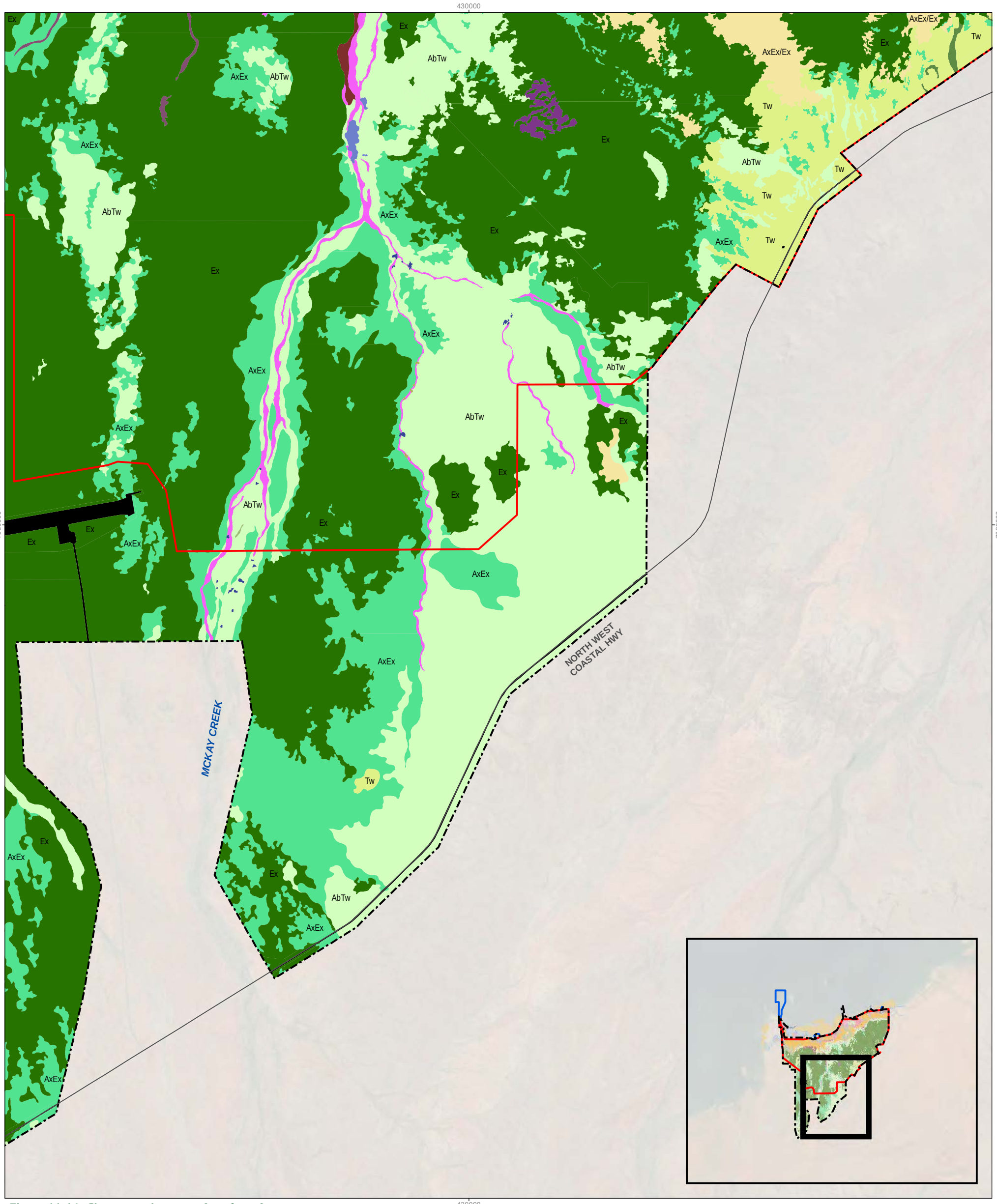
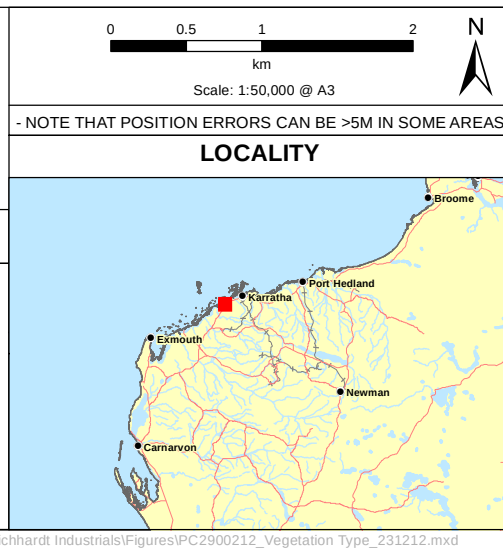



Figure 11-14: Site vegetation types (southeast)




Legend

- Marine Development Envelope
- Pond and Infrastructure Development Envelope
- Flora and Vegetation Study

Vegetation Type

- AbTw
- AbTw/AxEx
- AbTw/Mudflat
- AbTw/Tspp
- AcAjTe
- AiElTw
- AjCspp
- AssCc
- AxEx
- AxEx/Ex
- EcAcCs
- EcAcTe
- EvAcCf
- EvScSv
- Ex
- HscllCc
- HscllCc/AbTw
- HscllCc/EcAcCs
- HscllCc/Ex
- HscllCc/Mudflat
- HscllCc/Tspp
- MmTsppSv
- Mudflat
- Te
- Te/Tspp
- TeWa
- Tspp
- Tw
- Cleared

Intertidal BCH

- Am/Ca
- Am1
- Am2
- Am3
- Beach
- Ca
- Mudflat algal mat
- Rs1
- Rs2
- Sand

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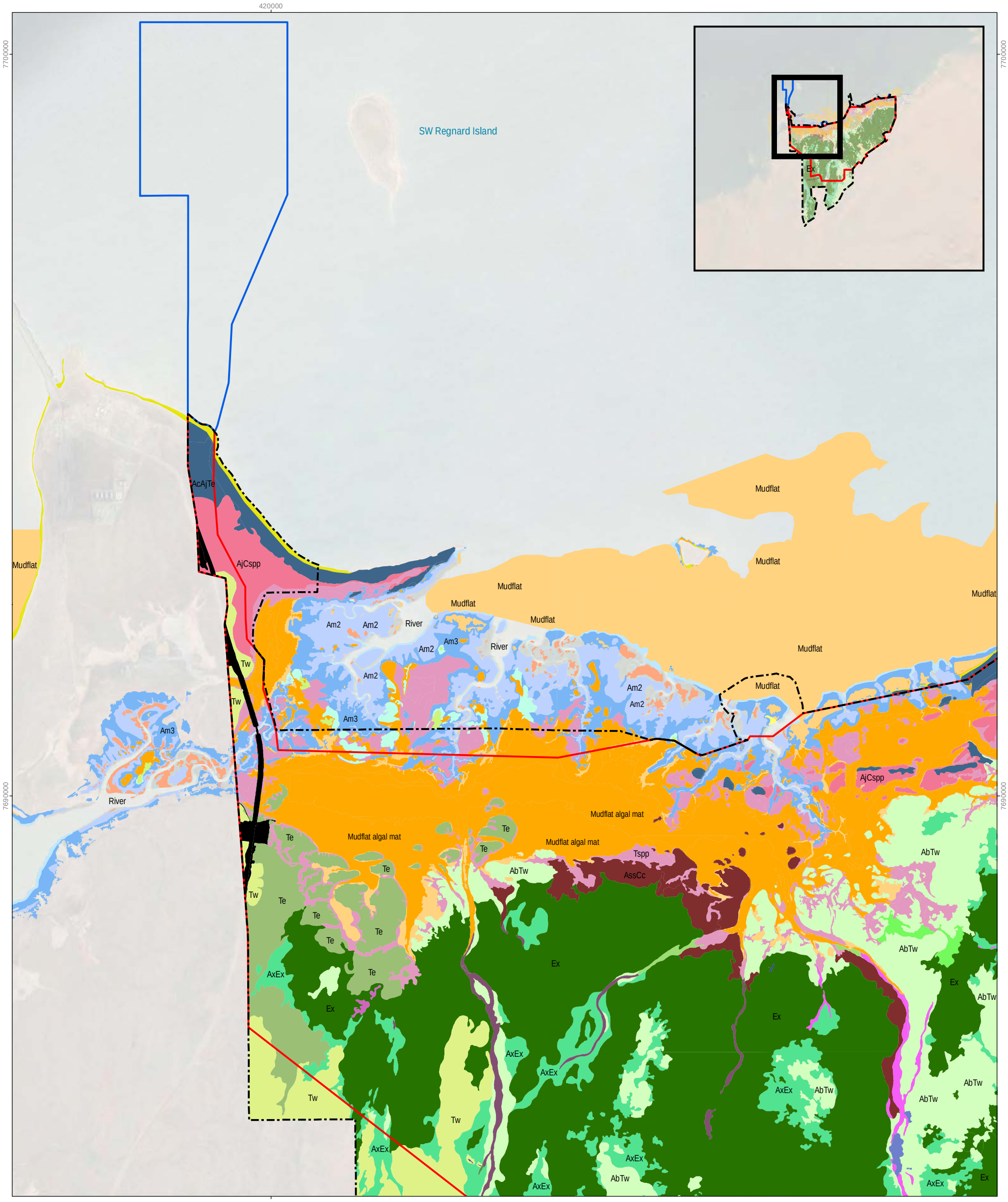


Figure 11-15: Site vegetation types (northwest)

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|---|---|---|---|
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0 0.5 1 2 km

Scale: 1:50,000 @ A3

N

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

**LOCALITY**




Legend

- Marine Development Envelope
- Pond and Infrastructure Development Envelope
- Flora and Vegetation Study

Vegetation Type

- AbTw
- AbTw/AxEx
- AbTw/Mudflat
- AbTw/Tspp
- AcAjTe
- AiElTw
- AjCspp
- AssCc
- AxEx
- AxEx/Ex
- EcAcCs
- EcAcTe
- EvAcCf
- EvScSv
- Ex
- HsclICc
- HsclICc/AbTw
- HsclICc/EcAcCs
- HsclICc/Ex
- HsclICc/Mudflat
- HsclICc/Tspp
- MmTsppSv
- Mudflat
- Te
- Te/Tspp
- TeWa
- Tspp
- Tw
- Cleared

Intertidal BCH

- Am/Ca
- Am1
- Am2
- Am3
- Beach
- Ca
- Mudflat algal mat
- Rs1
- Rs2
- Sand

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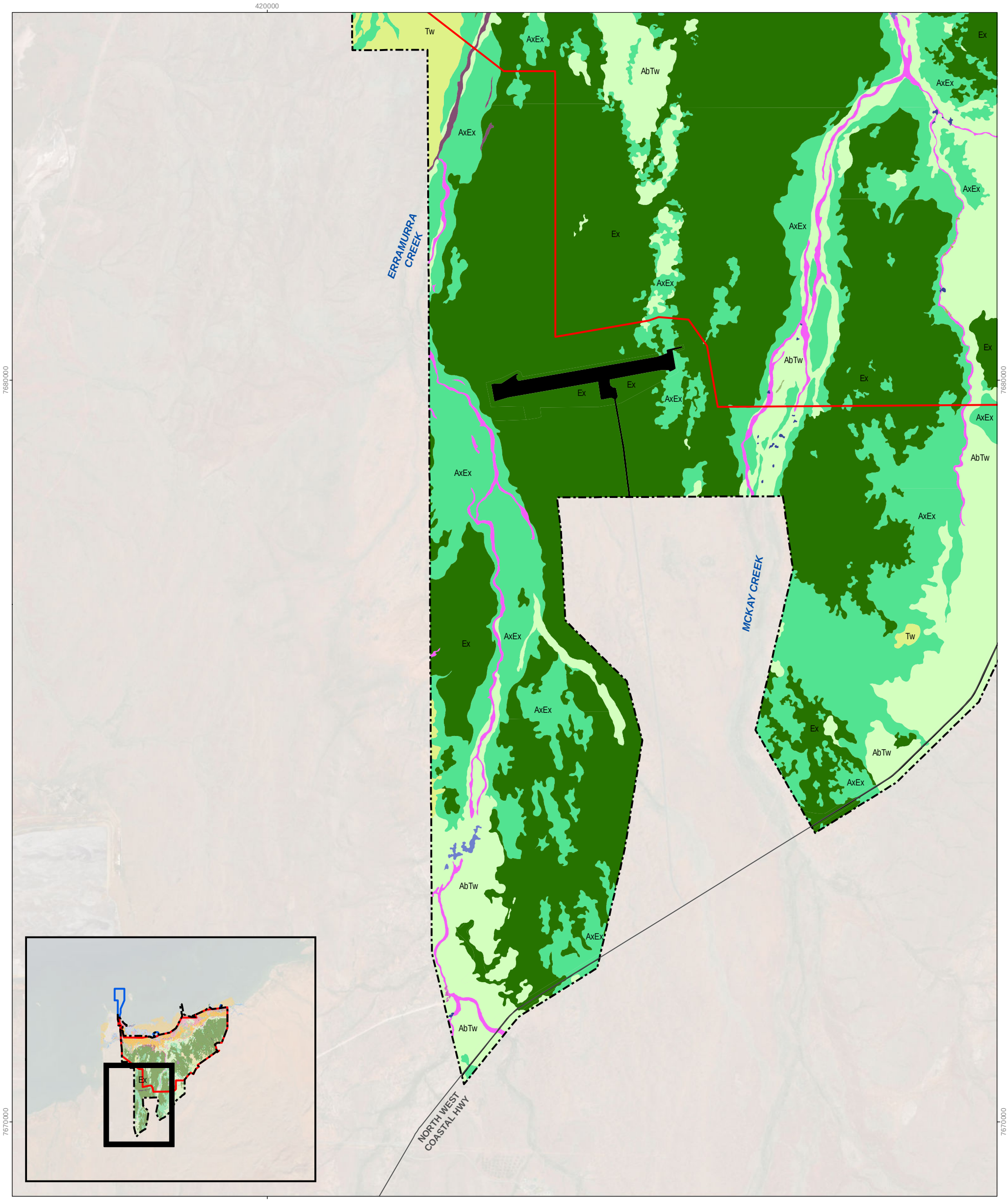


Figure 11-16: Site vegetation types (southwest)

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|---|---|---|---|
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0 0.5 1 2 km

Scale: 1:50,000 @ A3

N

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

**LOCALITY**




Legend

- Marine Development Envelope
- Pond and Infrastructure Development Envelope
- Flora and Vegetation Study

Vegetation Type

- AbTw
- AbTw/AxEx
- AbTw/Mudflat
- AbTw/Tspp
- AcAjTe
- AiElTw
- AjCspp
- AssCc
- AxEx
- AxEx/Ex
- EcAcCs
- EcAcTe
- EvAcCf
- EvScSv
- Ex
- HscIlCc
- HscIlCc/AbTw
- HscIlCc/EcAcCs
- HscIlCc/Ex
- HscIlCc/Mudflat
- HscIlCc/Tspp
- MmTsppSv
- Mudflat
- Te
- Te/Tspp
- TeWa
- Tspp
- Tw
- Cleared

Intertidal BCH

- Am/Ca
- Am1
- Am2
- Am3
- Beach
- Ca
- Mudflat algal mat
- Rs1
- Rs2
- Sand

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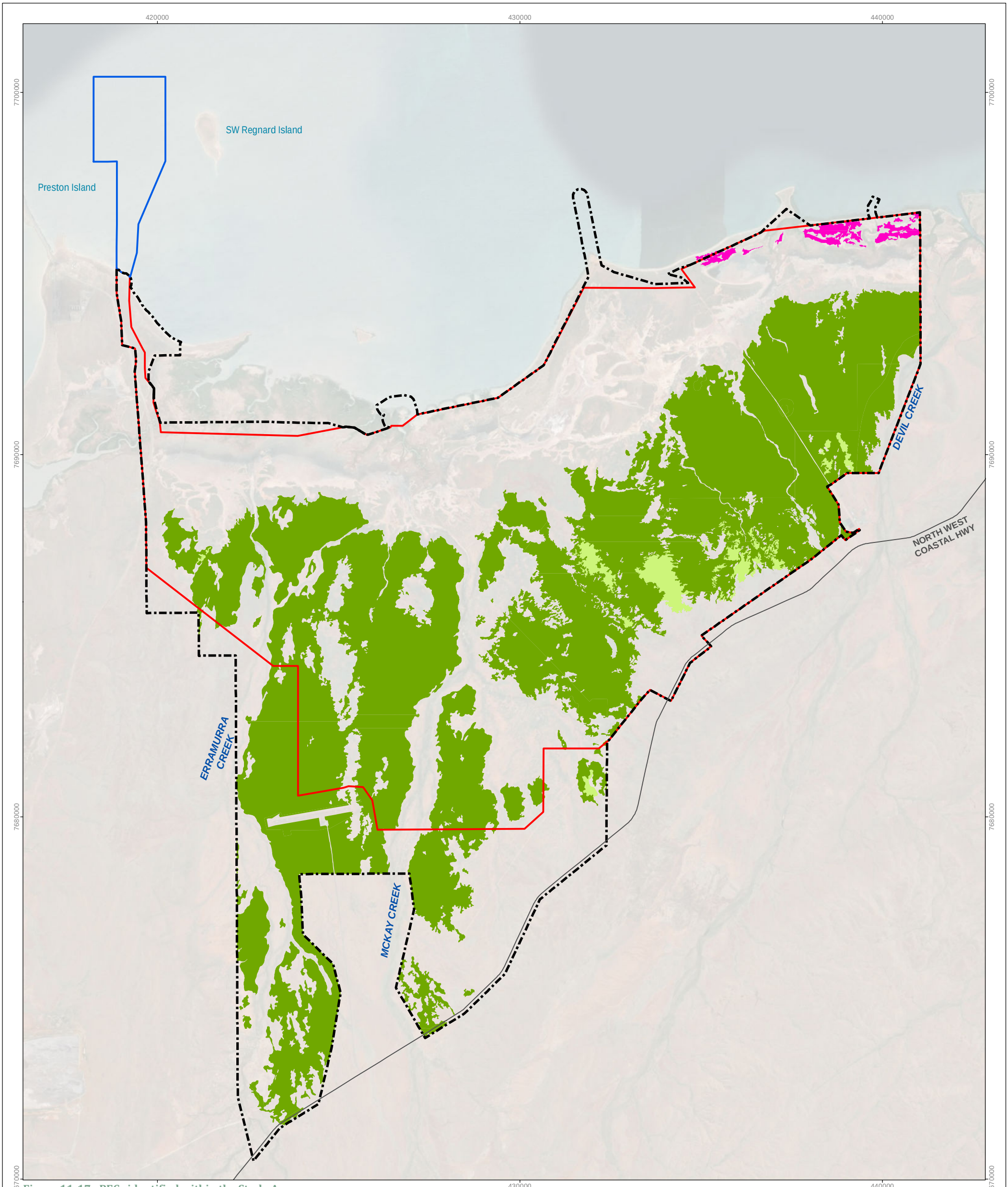


Figure 11-17: PECs identified within the Study Area

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0 0.75 1.5 3
km
Scale: 1:100,000 @ A3

N

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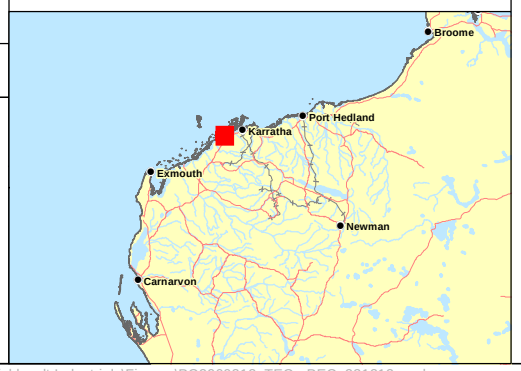
**LOCALITY**




Legend

- Marine Development Envelope
- Pond and Infrastructure Development Envelope
- Flora and Vegetation Study Area

Threatened and Priority Ecological Communities

- Priority 3: Coastal dune native tussock grassland dominated by *Whiteochloa airoides*
- Priority 3: Horseflat land system of the Roebourne Plains
- Priority 3: (PARTIALLY) Horseflat land system of the Roebourne Plains

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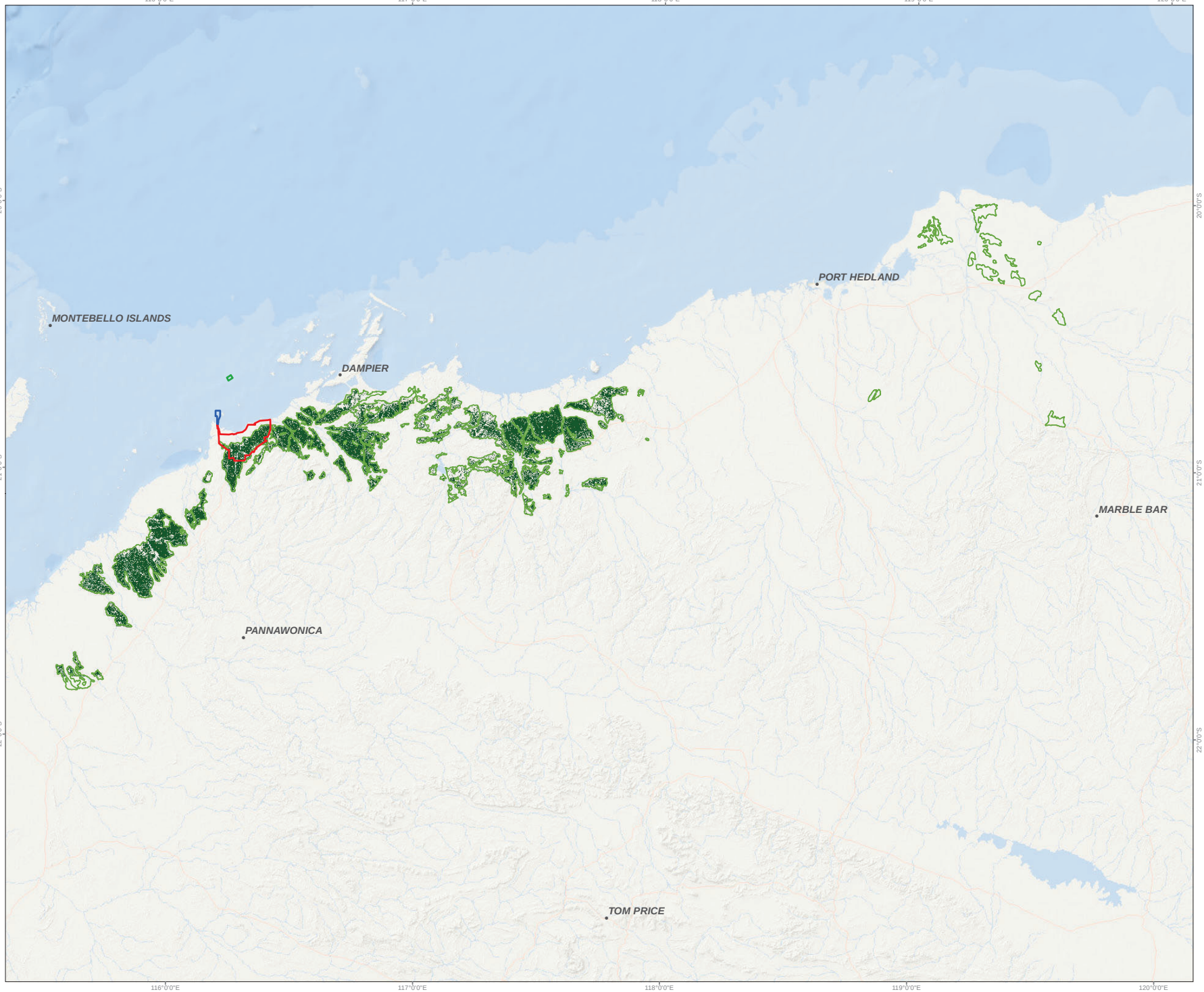


Legend

- Dredge Spoil Disposal Development Envelope
- Marine Development Envelope
- Pond and Infrastructure Development Envelope
- Horse Flat Land System
- Horseflat PEC

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

Preston Consulting

0 10 20 30 40 50
km

Scale: 1:1,500,000 @ A3

N

**LOCALITY MAP**




| CREATED BY | JOB | DATE | REVISION |
|---|---|---|---|
| ENVIRONMAPS | PC2900212 | 12/04/2023 | 0 |

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Figure 11-18: Regional extent of the Horseflat PEC

### *Significant Vegetation*

Thirteen vegetation types have been identified as being locally significant as they had restricted distributions within the Study Area and/or represented a refuge for flora species not recorded elsewhere in the Study Area. These vegetation codes and descriptions are listed in Table 11-11 and shown in Figure 11-19 and Figure 11-20. Table 11-11 also describes why each vegetation type was considered locally significant.

Vegetation type Tspp was originally identified by Phoenix as being locally significant as it represented habitat for sterile, and therefore potentially novel, *Tecticornia* sp. As none of the *Tecticornia* sp. were identified as being restricted to the development envelopes (Shepherd and Žerdoner Čalasan, 2024) this vegetation is no longer considered locally significant.

Vegetation type AbTw was not identified by Phoenix as being locally significant but has been included in Figure 11-19 and Table 11-11 as it represents habitat for Priority species *Goodenia pallida.* This species was not recorded by Phoenix but has previously been recorded in the Study Area.

**Table 11-11: Locally significant vegetation types within the Study Area**

| Vegetation type | Significance | Level of significance | Extent within Study Area (ha) |
|---|---|---|---|
| Ex | Represents the Horseflat PEC and habitat for:<br>• *Dolichocarpa* sp. Hamersley Station (P3)); and<br>• *Polygala* aff. *galeocephala* (sp. nov.). | Regionally and locally significant | 11,720.6 |
| TeWa | Represents the Coastal Dune PEC. | Regionally and locally significant | 117.9 |
| AxEx/Ex | Half of the mosaic represents the Horseflat PEC. | Locally significant | 300.9 |
| HscIlCc/Ex | Half of the mosaic represents the Horseflat PEC. | Locally significant | 4.0 |
| AcAjTe | Represents habitat for *Scaevola* aff. *pulchella* (sp. nov.). | Locally significant | 246.9 |
| AiElTw | Represents habitat for *Eremophila forrestii* subsp. *viridis* (P3). | Locally significant | 100.0 |
| EvAcCf | • Represents habitat for *Rostellularia adscendens* var. *latifolia* (P3); and<br>• Potential GDE. | Locally significant | 54.6 |
| AbTw | Represents habitat for *Goodenia pallida* (P1). | Locally significant | 4,196.4 |
| EvScSv | • Represents restricted vegetation community; and<br>• Potential GDE. | Locally significant | 7.7 |
| HscIlCc | • Represents restricted vegetation community; and<br>• Represents habitat for *Bonamia* aff. *media.* | Locally significant | 6.4 |
| MmTsppSv | Represents restricted vegetation community. | Locally significant | 3.8 |
| EcAcCs | Potential GDE. | Locally significant | 176.0 |
| EcAcTe | Potential GDE. | Locally significant | 25.7 |

*Groundwater Dependent Ecosystems*

There were four vegetation types within the Study Area that may represent GDE's due to the presence of either *Eucalyptus camaldulensis* or *E. victrix* that were associated with creek systems (Table 11-11; Figure 11-20) (Phoenix, 2025). The four vegetation types include EcAcCs, EvAcCf, EcAcTe and EvScSv. Combined, the four vegetation types represent only 1.1% of the Study Area.

Groundwater drilling completed between November 2023 and December 2024 (CDM Smith, 2024), found depth to water adjacent to many of the site drainages ranges between 10 and 12 m which is within the rooting depth of these species. Based on the interpreted groundwater levels for the site (Section 6.3.2) it is possible this vegetation accesses groundwater, however, the rooting depths and specific water use patterns of the local eucalypt species is not currently understood. This vegetation, in particular *Eucalypt* species, is known to be resilient to changes in water availability and utilise multiple water sources. Ev vegetation types consist of *E. vitrix* and/or *E. camaldulensis* and *E. vitrix* with occasional *E. camaldulensis*. However, *E. vitrix* is potentially a facultative GDE which may not always depend on groundwater and may be weakly phreatophytic or a vadophyte (independent of groundwater), as demonstrated by the University of WA (by Pauline Grierson and other researchers over multiple years throughout the Hamersley Range in the Pilbara for Rio Tinto).

It is also understood the presence of saline groundwater will limit its use for this vegetation.

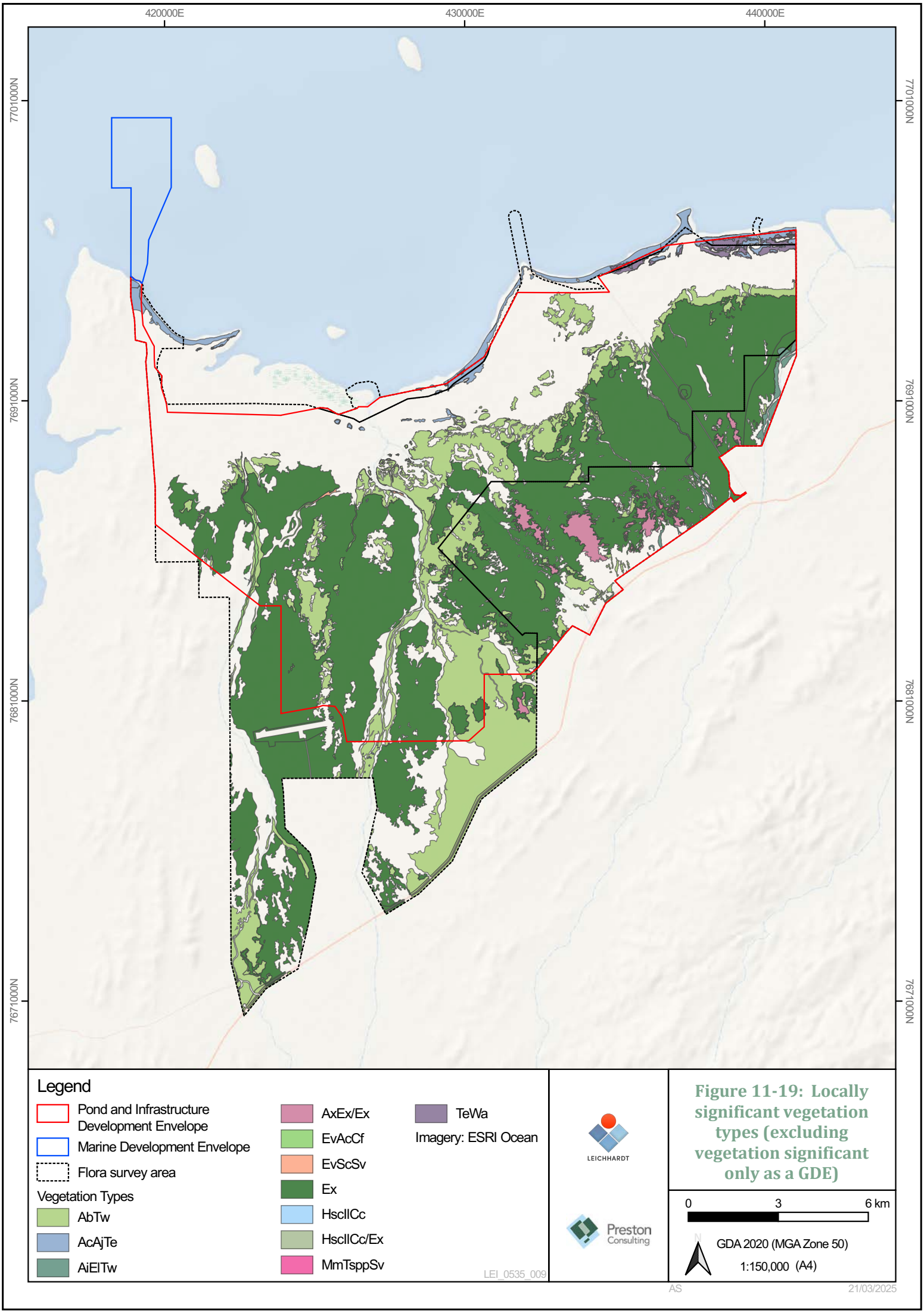
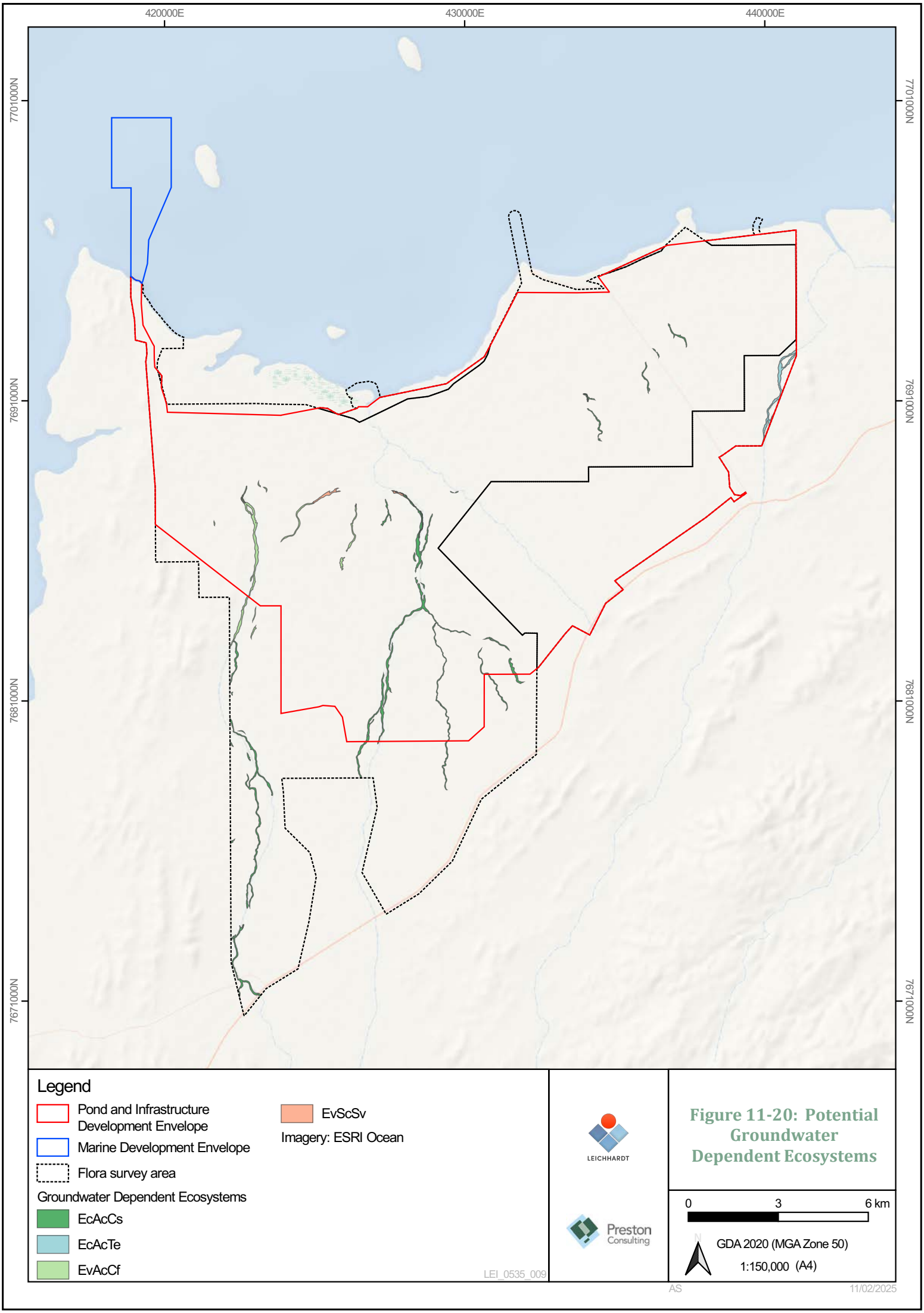



**Figure 11-19: Locally significant vegetation types (excluding vegetation significant only as a GDE)**


420000E
430000E
440000E
7701000N
7691000N
7681000N
7671000N
Legend
Pond and Infrastructure Development Envelope
Marine Development Envelope
Flora survey area
Groundwater Dependent Ecosystems
EcAcCs
EcAcTe
EvAcCf
EvScSv
Imagery: ESRI Ocean
LEICHHARDT
Preston Consulting
Figure 11-20: Potential Groundwater Dependent Ecosystems
0
3
6 km
N
GDA 2020 (MGA Zone 50)
1:150,000 (A4)
LEI_0535_009
AS
11/02/2025

### 11.3.6 ENVIRONMENTAL VALUES

Based on the information provided in Section 11.3, the following environmental values were determined to require assessment for this factor:

- General flora and vegetation, which covers all vegetation types listed in Phoenix (2025) that were not considered BCH, in order to assess broad local and regional impacts;
- Priority Flora, including:
    - *Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479) (Priority 3 Flora – BC Act) and its potential habitat (vegetation type Ex);
    - *Eremophila forrestii* subsp. *viridis* (Priority 3 Flora – BC Act) and its potential habitat (vegetation type AiElTw). Also a range extension flora;
    - *Rostellularia adscendens* var. *latifolia* (Priority 3 Flora – BC Act) and its potential habitat (vegetation type EvAcCf). Also a range extension flora;
    - Nine other potential Priority Flora species that were not recorded but could potentially occur;
- *Bergia henshallii* (range extensions flora)*;*
- Unidentified flora species;
- GDEs;
- The Horseflat PEC (Priority 3);
- The Coastal Dune PEC (Priority 3); and
- Restricted locally significant vegetation (other locally significant vegetation already addressed by the items above).

## 11.4 POTENTIAL IMPACTS

Table 11-12 defines the potential impacts (direct, indirect and combined) on the environmental values listed above in a local and regional context.

Table 11-12: Potential impacts on flora and vegetation

| Environmental value and current extent | Potential direct impact | Potential indirect impact | Impacts associated with other proposals | Combined local impact (Proposal + others) |
|---|---|---|---|---|
| **General terrestrial flora and vegetation** –<br>All vegetation associations have more than 84% of their pre-European extent remaining (Least Concern). | Up to 11,401.1 ha of disturbance to vegetation, 11,287.7 ha of which is in Good to Excellent Condition. | Reduction in vegetation health as a result of:<br>• Minor levels of dust settlement on vegetation during construction;<br>• Unintentional spillage or seepage of brine from concentration ponds, crystallisers or pipelines;<br>• Alteration of hydrological regimes;<br>• Introduction or spread of weed species which is a WoNS; and<br>• Reduced rehabilitation success due to high salinity. | Up to 153 ha of disturbance associated with Cape Preston Port, Sino Iron Project and 40-Mile Beach Road within the PIDE.<br>Regional disturbance associated with Cape Preston Port CPE Port and the Sino Iron Project. | Approximately 11,554.1 ha of direct disturbance of native vegetation with some potential indirect vegetation health impacts. |
| ***Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479)** (Priority 3 Flora – BC Act), recorded within the PIDE.<br>Ex vegetation type was identified as potential habitat. | Direct impact to two recorded locations of this species.<br>Up to 7,352.1 ha disturbance to Ex vegetation type. | As described in 'General terrestrial flora and vegetation'. | No other records are known to be impacted by other proposals in the Study Area or surrounds.<br>Up to 59.5 ha of disturbance to vegetation type Ex associated with Cape Preston Port, Sino Iron Project and 40-Mile Beach Road. | Two known records to be disturbed.<br>Up to 7,411.6 ha disturbance to potential habitat (63% of local extent, 4% of regional extent). |
| ***Eremophila forrestii* subsp. *viridis*** (Priority 3 Flora – BC Act), recorded within the PIDE.<br>AiElTw vegetation type was identified as potential habitat.<br>Also, a range extension flora. | No direct impact to any records.<br>Up to 16.9 ha of disturbance to AiElTw vegetation type. | As described in 'General terrestrial flora and vegetation'. | No other records are known to be impacted by other proposals in the Study Area.<br>The AiElTw vegetation type does not appear to have been disturbed as a result of Cape Preston Port, Sino Iron Project or 40-Mile Beach Road. | No known records to be disturbed.<br>Up to 16.9 ha of disturbance to potential habitat (17% of local extent). |
| ***Rostellularia adscendens* var. *latifolia*** (Priority 3 Flora – BC Act), recorded within the PIDE. | No direct impact to any records.<br>Up to 14.4 ha disturbance to EvAcCf vegetation type. | As described in 'General terrestrial flora and vegetation'. | No other records are known to be impacted by other proposals in the Study Area.<br>The EvAcCf vegetation type does not appear to have been | No known records to be disturbed.<br>Up to 14.4 ha of disturbance to potential |

| Environmental value and current extent | Potential direct impact | Potential indirect impact | Impacts associated with other proposals | Combined local impact (Proposal + others) |
|---|---|---|---|---|
| EvAcCf vegetation type was identified as potential habitat.<br>Also, a range extension flora. | | | disturbed Cape Preston Port, Sino Iron Project or 40-Mile Beach Road. | habitat (26% of local extent). |
| **Nine other potential Priority Flora species that were not recorded but could potentially occur.** | No direct impact to known records of these species as none were recorded in the Study Area.<br>Up to 11,401.1 ha of disturbance.<br>Disturbance to individuals or potential habitat is possible if a species is present. | As described in 'General terrestrial flora and vegetation'. | Up to 153 ha of disturbance associated with Cape Preston Port and 40-Mile Beach Road. | No known records to be disturbed.<br>Approximately 11,554.1 ha of direct disturbance to general flora habitat with some potential indirect vegetation health impacts. |
| ***Bergia henshallii,* Range Extensions Flora –** This species was deemed to be a significant range extension. | No direct impacts to known records.<br>Up to 11,401.1 ha of vegetation disturbance.<br>Disturbance to individuals or potential habitat is possible if a species is present. | As described in 'General terrestrial flora and vegetation'. | Up to 153 ha of disturbance associated with Cape Preston Port, Sino Iron Project and 40-Mile Beach Road. | No direct impacts.<br>Approximately 11,554.1 ha of direct disturbance to general flora habitat with some potential indirect vegetation health impacts. |
| **Unidentified and potentially undescribed species** –<br>Three potentially significant species were recorded within the development envelopes. | Direct impact to only one record of one unidentified species, *Polygala* aff. *galeocephala.* | Reduction in vegetation health as described above. | It is not possible to determine cumulative impacts on unidentified species. | Direct impacts to one record of one species<br>Some potential for indirect health impacts. |
| **GDEs** – 180.6 ha of this vegetation has been mapped within the development envelopes.<br>This vegetation is represented by vegetation types EcAcTe, EcAcTe, EvAcCf and EvScSv. | Up to 35.1 ha of disturbance. | As described in 'General terrestrial flora and vegetation'. | Up to 3 ha of disturbance associated with Cape Preston Port and 40-Mile Beach Road. | Approximately 38.1 ha of direct disturbance to GDEs with some potential indirect vegetation health impacts. |

| Environmental value and current extent | Potential direct impact | Potential indirect impact | Impacts associated with other proposals | Combined local impact (Proposal + others) |
|---|---|---|---|---|
| **Horseflat PEC –**9.633.5 ha of this PEC has been mapped within the development envelopes (6% of regional extent).<br>This PEC is represented by vegetation type Ex and partially by AxEx/Ex and HscllCc/Ex | Up to 7,614.1 ha of disturbance (4% of regional mapped extent). | As described in 'General terrestrial flora and vegetation'. | This PEC extends over a large area within the Pilbara and several other proposals occur within its total range.<br>Up to 59.5 ha of disturbance to vegetation type Ex associated with Cape Preston Port, Sino Iron Project and 40-Mile Beach Road.<br>Vegetation types AxEx/Ex and HscllCc/Ex do not appear to have been disturbed as a result of Cape Preston Port or 40-Mile Beach Road | Up to 7,673.6 ha disturbance to potential habitat (4% of regional extent) |
| **Coastal Dune PEC** – 117.9 ha of this PEC has been mapped within the development envelopes (40.3% of local extent) | No direct impacts. | Reduction in vegetation health as a result of:<br>• Minor levels of dust settlement on vegetation during construction;<br>• Unintentional spillage or seepage of brine from concentration ponds, crystallisers or pipelines;<br>• Alteration of hydrological regimes; and<br>• Introduction or spread of weed species which is a WoNS. | This vegetation type does not appear to have been disturbed as a result of Cape Preston Port or 40-Mile Beach Road. | No direct impacts.<br>Potential for indirect impacts. |
| **Locally significant vegetation type (EvScSv)**<br>Represents a restricted vegetation community.<br>7.7 ha has been mapped within the development envelopes (100% of local extent). | Up to 5.8 ha of disturbance (75% of the mapped extent). | As described in 'General terrestrial flora and vegetation'. | This vegetation type does not appear to have been disturbed as a result of Cape Preston Port, Sino Iron Project or 40-Mile Beach Road. | Up to 5.8 ha of disturbance (75% of the mapped extent).<br>Potential indirect impacts. |

| Environmental value and current extent | Potential direct impact | Potential indirect impact | Impacts associated with other proposals | Combined local impact (Proposal + others) |
|---|---|---|---|---|
| **Locally significant vegetation type (HscIlCc)**<br>Represents a restricted vegetation community.<br>5.0 ha has been mapped within the development envelopes (78.1% of local extent). | Up to 0.9 ha of disturbance (14% of the mapped extent). | As described in 'General terrestrial flora and vegetation'. | This vegetation type does not appear to have been disturbed as a result of Cape Preston Port, Sino Iron Project or 40-Mile Beach Road. | Up to 0.9 ha of disturbance (14% of the mapped extent).<br>Potential indirect impacts. |
| **Locally significant vegetation type (MmTsppSv)**<br>Represents a restricted vegetation community.<br>3.8 ha has been mapped within the development envelopes (100% of local extent). | No direct impacts proposed. | As described in 'General terrestrial flora and vegetation'. | This vegetation type does not appear to have been disturbed as a result of Cape Preston Port, Sino Iron Project or 40-Mile Beach Road. | No direct impacts proposed.<br>Potential indirect impacts. |





## 11.5 ASSESSMENT OF IMPACTS

The following sections assess the potential impacts on each environmental value identified in Section 11.3.6.

### 11.5.1 INTERACTION WITH BENTHIC COMMUNITIES AND HABITAT FACTOR

The development envelopes include areas of intertidal samphire vegetation that are rarely inundated and as such form a zone that could be assessed under the BCH factor and/or the flora and vegetation factor. This section assesses impacts on flora and vegetation within the context of the EPA objective for this factor, i.e., 'the protection of flora and vegetation so that biological diversity and ecological integrity are maintained'. This means that if significant flora is located within an area mapped as BCH, then the impacts have been assessed in this section in the context of the protection of that flora species. Some of the coastal vegetation types along the coast extend beyond the Study Area as a result of a combined mapping effort between O2 Marine (BCH) and Phoenix (vegetation). As a result, local extents refer to the entire area mapped not just that mapped within the Study Area. Vegetation types that were identified by Phoenix (2025) as being significant were also assessed in this section, even if they overlapped with the BCH mapping.

### 11.5.2 GENERAL TERRESTRIAL FLORA AND VEGETATION

Table 11-13 and Table 11-14 summarise the extent of the potential direct and indirect impacts on general flora and vegetation, respectively. Additional assessments are provided in the following sections. Note that the indicative disturbance footprint shapefile used to determine direct impacts is slightly smaller than the total requested disturbance described in Section 2.2.2. These values therefore reflect the maximum disturbance of each flora and vegetation value that Leichhardt could reasonably achieve if needed.

Potential indirect impacts relate to hydrological and hydrogeological changes and are discussed in the following section. Areas at risk of impact due to changes in flooding frequency have been referred to as 'potential indirect impacts.' These are areas that are predicted to experience inundation in a 1 EY rainfall event when they previously did not, or vice versa. Potential impacts associated with groundwater changes (seepage and mounding) have been identified as requiring mitigation through the implementation of a GMMP in order to ensure that there will be minimal impacts to flora and vegetation. The GMMP is intended to ensure that any seepage or mounding impacts can be contained within a management zone that extends a maximum of 100 m from the external walls, by a series of cut-off bores, sumps or drains if required. The 100 m management zone includes a 20 m construction disturbance footprint which is required to build the pond walls. Therefore, indirect impacts to fauna habitats have been calculated as being a maximum 80 m within areas that are 'at risk' of groundwater mounding and seepage impacts. These areas have been conservatively defined as being areas:

- Where the depth to groundwater is 5 m or less and the predicted change in groundwater level is 1 m or more; and
- Of mapped GDEs where the predicted change in groundwater level is 1 m or more (not relevant to BCH).

Table 11-13: Potential direct and indirect impacts on vegetation

| Vegetation/ Feature | Total known extent (ha) | Local extent (ha) | Extent in Development Envelope (ha) | Direct Impacts – Extent in Indicative Disturbance Footprint (ha) | Potential indirect impacts (ha) | Combined impacts (ha) (%C of known extent) |
|---|---|---|---|---|---|---|
| **Vegetation associations** | | | | | | |
| 43 | 217,449.3 | 456.2 | 439.2 | 27.5 | Negligible | 34,226.7 (15.7%) |
| 93 | 3,044,309.5 | 1,946.6 | 736.7 | 6.1 | Negligible | 3,674.6 (0.12%) |
| 117 | 919,517.0 | 1,220.9 | 1,100.8 | 457.8 | Negligible | 34,184.6 (3.7%) |
| 127 | 737,724.0 | 4,245.7 | 4,381.3 | 2,119.1 | Negligible | 41,971.7 (5.7%) |
| 175 | 526,957.9 | 18,364.9 | 14,984.5 | 10,484.6 | Negligible | 12,802.3 (2.4%) |
| **PECs** | | | | | | |
| Horseflat PEC (Priority 3) | 194,996.5 | 12,025.5 | 9,633.5 | 7,614.1 | 20.0 (mounding and seepage)<br>17.2 (increased inundation)<br>6.6 (reduced inundation)<br>No overlapping indirect impacts | 7,614.1 ha (3.9% of regional extent) with 37.2 ha (0.02%) indirect impacts |
| Coastal Dune PEC (Priority 3) | N/A | 122.3 | 117.9 | 0 | No indirect impacts expected | No impacts expected. |
| **Vegetation types** | | | | | | |
| Ex | 194,996.5 | 11,720.6 | 9,342.8 | 7,352.1 | 20.0 (mounding and seepage)<br>17.0 (increased inundation)<br>6.6 (reduced inundation)<br>0.3 (mounding, seepage and changed inundation) | 7,352.1 ha (3.8% of regional extent) with 43.9 ha (0.02%) indirect impacts |
| AbTw | N/A | 4,196.4 | 2,790.0 | 1,440.4 | 35.9 (mounding and seepage)<br>1.5 (increased inundation)<br>3.8 (reduced inundation)<br>1.5 (mounding, seepage and changed inundation) | 1,440.4 ha (34.4% of local extent) with 42.7 ha (1.0%) indirect impacts |

| Vegetation/ Feature | Total known extent (ha) | Local extent (ha) | Extent in Development Envelope (ha) | Direct Impacts – Extent in Indicative Disturbance Footprint (ha) | Potential indirect impacts (ha) | Combined impacts (ha) (%C of known extent) |
|---|---|---|---|---|---|---|
| AxEx | N/A | 2,927.3 | 1,406.1 | 750.0 | 0.8 (mounding and seepage)<br>3.3 (increased inundation)<br>0.6 (reduced inundation)<br>No overlapping indirect impacts | 750.0 ha (25.7% of local extent) with 4.7 ha (0.2%) indirect impacts |
| Te | N/A | 883.6 | 854.1 | 462.2 | 10.6 (mounding and seepage)<br>No indirect impacts associated with increased inundation<br>No indirect impacts associated with reduced inundation<br>0.1 (mounding, seepage and changes inundation) | 462.2 ha (52.3% of local extent) with 10.7 ha (1.2%) indirect impacts |
| Tspp | N/A | 865.4 | 820.5 | 452.7 | 25.5 (mounding and seepage)<br>0.1 (increased inundation)<br>7.2 (reduced inundation)<br>4.2 (mounding, seepage and changed inundation) | 452.7 ha (52.3% of local extent) with 37 ha (4.3%) indirect impacts |
| Tw | N/A | 805.7 | 590.9 | 63.5 | No indirect impacts associate with mounding and seepage<br>0.3 (increased inundation)<br>No indirect impacts associated with reduced inundation<br>No overlapping indirect impacts | 63.5 ha (7.9% of local extent) with 0.3 ha (0.04%) indirect impacts |
| AjCspp | N/A | 681.4 | 529.1 | 372.2 | 66.9 (mounding and seepage)<br>0.4 (increased inundation)<br>0.5 (reduced inundation)<br>2.0 (mounding, seepage and changed inundation) | 372.2 ha (54.6% of local extent) with 69.8 ha (10.2%) indirect impacts |

| Vegetation/ Feature | Total known extent (ha) | Local extent (ha) | Extent in Development Envelope (ha) | Direct Impacts – Extent in Indicative Disturbance Footprint (ha) | Potential indirect impacts (ha) | Combined impacts (ha) (%C of known extent) |
|---|---|---|---|---|---|---|
| AcAjTe | N/A | 246.9 | 188.4 | 34.6 | 14.3 (mounding and seepage)<br>No indirect impacts associated with increased inundation<br>No indirect impacts associated with reduced inundation<br>0.1 (mounding, seepage and changed inundation) | 34.6 ha (14% of local extent) with 14.4 ha (5.8%) indirect impacts |
| AssCc | N/A | 192.6 | 192.6 | 104.3 | 7.5 (mounding and seepage)<br>No indirect impacts associated with increased inundation<br>0.2 (reduced inundation)<br>1.0 (mounding, seepage and changed inundation) | 104.3 ha (54.2% of local extent) with 8.7 ha (4.5%) indirect impacts |
| EcAcCs | N/A | 176.0 | 104.0 | 14.9 | 0.2 (mounding and seepage)<br>0.2 (increased inundation)<br>0.9 ha (reduced inundation)<br>No overlapping indirect impacts | 14.9 ha (8.5% of local extent) with 1.3 ha (0.7%) indirect impacts |
| EcAcTe | N/A | 25.7 | 25.7 | 0 | No indirect impacts associated with mounding and seepage<br>0.2 (increased inundation)<br>No indirect impacts associated with reduced inundation<br>No overlapping indirect impacts | 0.2 ha (0.8%) indirect impacts |
| TeWa | N/A | 122.3 | 117.9 | 0 | No indirect impacts expected | No impacts expected. |
| AiElTw | N/A | 100.0 | 100.0 | 17.0 | 0.1 (increased inundation)<br>0.1 (reduced inundation) | 17.0 ha (17.0% of local extent) with 0.2 ha (0.2%) indirect impacts |

| Vegetation/ Feature | Total known extent (ha) | Local extent (ha) | Extent in Development Envelope (ha) | Direct Impacts – Extent in Indicative Disturbance Footprint (ha) | Potential indirect impacts (ha) | Combined impacts (ha) (%C of known extent) |
|---|---|---|---|---|---|---|
| EvAcCf | N/A | 54.6 | 43.2 | 14.4 | 0.1 (mounding and seepage)<br>No indirect impacts associated with increased inundation<br>0.4 (reduced inundation)<br>0.1 (mounding, seepage and inundation) | 14.4 ha (26.1% of local extent) with 0.6 ha (1.1%) indirect impacts |
| EvScSv | N/A | 7.7 | 7.7 | 5.8 | No indirect impacts expected | 5.8 ha (75.3% of local extent) with no indirect impacts expected |
| HscIlCc | N/A | 6.4 | 5.0 | 0.9 | 0.1 (mounding and seepage)<br>No indirect impacts associated with increased inundation<br>No indirect impacts associated with reduced inundation<br>No overlapping indirect impacts | 0.9 ha (14% of local extent) with 0.1 (1.6%) indirect impacts |
| MmTsppSv | N/A | 3.8 | 3.8 | 0 | No indirect impacts expected | No impacts expected. |
| **Mosaic/complex vegetation types** | | | | | | |
| AxEx/Ex | N/A | 300.9 | 287.3 | 261.8 | No indirect impacts associated with mounding and seepage<br>0.2 (increased inundation)<br>No indirect impacts associated with reduced inundation<br>No overlapping indirect impacts | 261.8 ha (87.0% of local extent) with 0.2 (0.1%) indirect impacts |
| AbTw/AxEx | N/A | 23.7 | 23.7 | 23.7 | No indirect impacts expected | 23.7 ha (100% of local extent) |
| HscIlCc/AbTw | N/A | 19.3 | 14.5 | 1.0 | 0.1 (mounding and seepage) | 1.0 ha (5.2% local extent) with 1.5 ha |

| Vegetation/ Feature | Total known extent (ha) | Local extent (ha) | Extent in Development Envelope (ha) | Direct Impacts – Extent in Indicative Disturbance Footprint (ha) | Potential indirect impacts (ha) | Combined impacts (ha) (%C of known extent) |
|---|---|---|---|---|---|---|
| | | | | | No indirect impacts associated with increased inundation<br>1.4 (reduced inundation)<br>No overlapping indirect impacts | (7.8%) indirect impacts |
| AbTw/Tspp | N/A | 19.9 | 19.9 | 19.9 | No indirect impacts expected | 19.9 ha (100% of local extent). |
| Te/Tspp | N/A | 9.9 | 9.9 | 9.9 | No indirect impacts expected | 9.9 ha (100% of local extent). |
| HscIlCc/Ex | N/A | 4.0 | 3.4 | 0.2 | No indirect impacts expected | 0.2 ha (5.0% of local extent). |
| HscIlCc/Tspp | N/A | 3.9 | 3.9 | 0 | No indirect impacts expected | No impacts expected. |
| AbTw/Mudflat | N/A | 2.1 | 2.1 | 1.2 | 0.9 (mounding and seepage)<br>No indirect impacts associated with increased inundation<br>No indirect impacts associated with reduced inundation<br>No overlapping indirect impacts | 1.2 ha (57.1% of local extent)with 0.9 ha(42.9%) indirect impacts. |
| HscIlCc/EcAcCs | N/A | 1.9 | 1.9 | 0.1 | No indirect impacts associated with mounding and seepage<br>Noi indirect impacts associated with increased inundation<br>0.2 (reduced inundation)<br>No overlapping indirect impacts | 0.1 ha (5.3% of local extent) with 0.2 ha (10.5%) indirect impacts |
| HscIlCc/Mudflat | N/A | 1.2 | 1.2 | 0 | No indirect impacts expected | No impacts expected |

Table 11-14: Potential direct and indirect impacts on flora records

| Flora | Total known extent | Local extent | Extent in Development Envelope | Direct Impacts – Extent in Indicative Disturbance Footprint | Potential indirect impacts | Combined impacts (% of known extent) |
|---|---|---|---|---|---|---|
| **Priority Flora** | | | | | | |
| *Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479) (Priority 3) | 31 records | 3 records | 2 records | 2 records | No indirect impacts expected | 2 records (6.5% of regional records, 67% of local records) |
| *Eremophila forrestii* subsp. *viridis* (Priority 3) | 5 records | 1 record | 1 record | 0 records | No indirect impacts expected | 0 |
| *Rostellularia adscendens* var. *latifolia* (Priority 3) | 40 records | 1 record | 1 record | 0 records | No indirect impacts expected | 0 |
| **Unidentified Species** | | | | | | |
| *Scaevola* aff. *pulchella* | N/A | 2 records | 1 record | 0 records | No indirect impacts expected | 0 |
| *Polygala* aff. *galeocephala* | N/A | 1 record | 1 record | 1 record | N/A | 1 record (100%) |
| *Bonamia* aff. *media* | N/A | 1 record | 1 record | 0 records | No indirect impacts expected | 0 |
| **Other range extensions flora** | | | | | | |
| *Bergia henshallii* | 24 records | 2 records | 2 records | 0 records | No indirect impacts expected | 0 |

***Direct Disturbance***

The Proposal will result in the direct disturbance of up to 11,401.1 ha of vegetation within the PIDE. There are several items of note during this assessment:

- The disturbance is to occur within a largely uncleared landscape as all vegetation associations currently have at least 84% of their pre-European extent remaining (Shephard et al., 2002);
- The vegetation generally represents widespread communities and is well represented at a regional level (based on regional mapping);
- Up to 3,572.6 ha and 2,360.6 ha of disturbance will occur with the ex-Karratha and ex-Mardie DBCA Lands of Interest, respectively;
- The PIDE does not contain any recorded Threatened Flora, however four Priority flora have been recorded; and
- There has been minimal clearing in the Study Area, limited to that required for CPE Port and 40-Mile Beach Road. Surrounding the Study Area however there is clearing associated with the Sino Iron Project, Cape Preston Port, and Devil Creek Gas Plant.

When assessing the disturbance associated with the Proposal at a regional scale, the majority of the disturbance will occur within two vegetation associations; '175: Short bunch grassland – savanna/grass plain (Pilbara)', and '127: Bare areas, mudflats' (Figure 11-21).

The current extent of vegetation association '175: Short bunch grassland – savanna/grass plan (Pilbara)' is 524,640.2 ha (99.6% of its pre-European extent). Approximately 13,927 ha of the PIDE intersects the mapped boundary of this vegetation association, however, only 10,488.0 ha is predicted to be disturbed. Projects not considered in the current extent of vegetation association 175 (disturbance not accounted for as clearing had not occurred when data was collected in 2018) include:

- Up to 8,956 ha of disturbance associated with the Brockman Syncline Proposal;
- Up to 3,218 ha of disturbance associated with the Sino Iron Mine Continuation;
- Up to 2,964 ha of disturbance associated with the Mulga Downs Iron Ore Mine;
- 378 ha of disturbance associated with the Eliwana Railway Project; and
- 215 ha of disturbance associated with Mulga Downs Hubb and Rail Spur.

This equates to a total of 15,731 ha which reduces the current State-wide extent to 509,909 ha and Roebourne sub-region extent to 98,553 ha (97% and 86% of their pre-European extent respectively). When combined with the Proposal this equates to a final State-wide extent of 495,982 ha and Roebourne sub-region extent of 84,626 ha, or a cumulative loss of 29,658 ha if all proposals were to proceed. This equates to 94% of the State-wide pre-European extent remaining and 74% of the Roebourne sub-region extent remaining.

The current extent of vegetation association '127: Bare areas, mudflats' is 697,871.4 ha, 94.6% of its pre-European extent. The Proposal targets the bare mudflat areas in order to minimise vegetation clearing, and 4,381.3 ha of the PIDE intersects with the mapped boundary of this vegetation association, however, only 2,119.1ha is predicted to be disturbed (Figure 11-21). This vegetation association also extends over a large length of the Pilbara coast, including a portion of the area approved for the Mardie Project. Disturbance associated with other proposals in the vicinity include:

- 7,700 ha of disturbance associated with the Ashburton Salt Project;

- 7,682 ha of disturbance associated with the Mardie Project;
- 2,240 ha of disturbance associated with the Sino Iron Mine Continuation; and
- Other miscellaneous proposed disturbance may amount to approximately 200 ha.

This equates to a total of 17,822 ha which reduces the current State-wide extent to 680,049 ha and Roebourne sub-region extent to 141,202 (92% and 80% of their pre-European extent respectively). When combined with the Proposal this equates to a final State-wide extent of 677,930 ha and Roebourne sub-region extent of 139,083 ha, or a cumulative loss of 19,941 ha if all proposals were to proceed. This equates to 91% of the State-wide pre-European extent remaining, which is still well within the category of 'Least Concern' (Shepherd, 2002).

The Proposal will result in direct disturbance of approximately 11,287.7 ha of vegetation in Good to Excellent condition. The EPA considers that the clearing of native vegetation and impacts on other associated environmental values in the Pilbara IBRA bioregion is significant where the cumulative impact may reach critical levels if not managed. Leichhardt has assessed the vegetation loss in a similar manner, with the loss of Good to Excellent vegetation considered to be a significant residual impact. Offsets are proposed to counterbalance those impacts. (Section 15).

An assessment has been provided below of the impacts of the direct disturbance of the vegetation types that were identified as environmental values in Section 11.3.6 (Figure 11-22 and Figure 11-23). Where more detail is warranted, it has been provided in subsequent sections:

- **Ex** – 7,352.1 ha of this vegetation type is proposed to be disturbed. This equates to 62.7% of the of the local extent and 3.8% of the regional extent. This vegetation type was assessed as regionally and locally significant by Phoenix (2025) as it represents the Horseflat PEC. A detailed assessment of impacts to this vegetation type has therefore been provided in Section 11.5.7;
- **AxEx/Ex** –261.8 ha of this vegetation type is proposed to be disturbed. This equates to 87.0% of the of the local extent. This vegetation type was assessed as regionally and locally significant by Phoenix (2025) as half of this vegetation type represents the Horseflat PEC. A detailed assessment of impacts to this vegetation type has therefore been provided in Section 11.5.7;
- **HscIlCc/Ex –** 0.2 ha of this vegetation type is proposed to be disturbed. This equates to 5.0% of the of the local extent. This vegetation type was assessed as regionally and locally significant by Phoenix (2025) as half of this vegetation type represents the Horseflat PEC. A detailed assessment of impacts to this vegetation type has therefore been provided in Section 11.5.7;
- **AiElTw –** 17.0 ha of this vegetation type is proposed to be disturbed. This equates to 17.0% of the local extent. This vegetation type was identified as being locally significant by Phoenix (2025) as it provides habitat for *Eremophila forrestii* subsp. *viridis* (Priority 3). A detailed assessment of impacts to this vegetation type is provided in Section 11.5.3;
- **AcAjTe –** 34.6 ha of this vegetation type is proposed to be disturbed. This equates to 14.0% of the local extent. This vegetation type was identified as being locally significant by Phoenix (2025) as it provides habitat for *Scaevola* aff. *pulchella* (sp. nov.). A detailed assessment of impacts to this vegetation type is provided in Section 11.5.5;

- **EvScSv** – 5.8 ha of this vegetation type is proposed to be disturbed. This equates to 75.3% of the local extent. This vegetation type was assessed as locally significant by Phoenix (2025) as it represents a restricted vegetation community and a potential GDE. A detailed assessment of impacts to this vegetation type is provided in Section 11.5.6 and 11.5.9;
- **HscIlCc** - 0.9 ha of this vegetation type is proposed to be disturbed. This equates to 14% of the local extent. This vegetation type was assessed as locally significant by Phoenix (2025) as it represents a restricted vegetation community. A detailed assessment of impacts to this vegetation type is provided in Section 11.5.9;
- **EvAcCf –** 14.4 ha of this vegetation type is proposed to be disturbed. This equates to 26.1% of the local extent. This vegetation type was assessed as locally significant by Phoenix (2025) as it represents habitat for *Rostellularia adscendens* var*. latifolia* and is a potential GDE. A detailed assessment of impacts to this vegetation type is provided in Section 11.5.3 and 11.5.6;
- **EcAcCs -** 14.9 ha of this vegetation type is proposed to be disturbed. This equates to 8.5% of the local extent. This vegetation type was assessed as locally significant by Phoenix (2025) as it represents a potential GDE. A detailed assessment of impacts to this vegetation type is provided in 11.5.6;
- **AbTw** – 1,440.4 ha of this vegetation type is proposed to be disturbed. This equates to 34.4% of the local extent. This vegetation type was identified as being locally significant by Phoenix (2025) as it provides habitat for *Goodenia pallida* (Priority 1 – BC Act). A detailed assessment of impacts to this vegetation type is provided in Section 11.5.3; and

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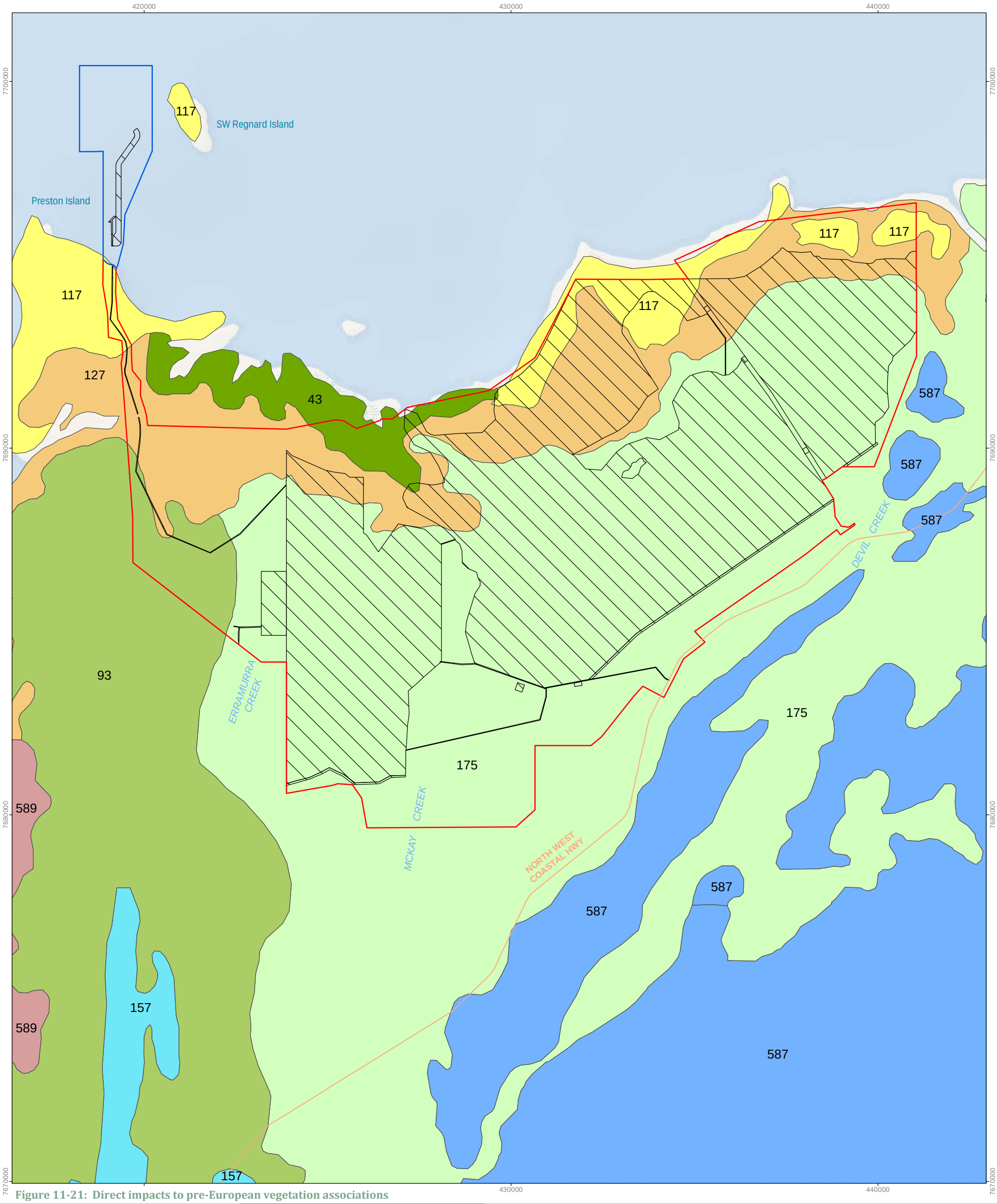


Figure 11-21: Direct impacts to pre-European vegetation associations

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km
Scale: 1:100,000 @ A3

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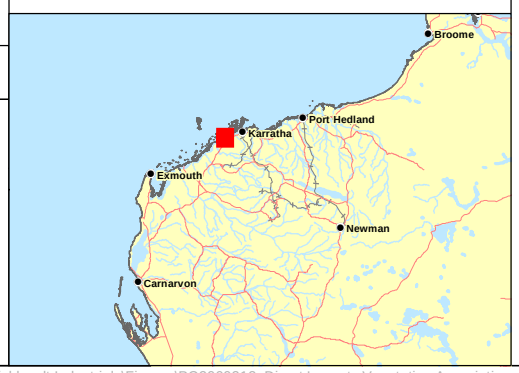
- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

**LOCALITY**




Legend

- Marine Development Envelope
- Pond and Infrastructure Development Envelope
- Revised Disturbance Footprint

Vegetation Association

- 43: Mangroves
- 117: Grass-steppe
- 127: Tidal mud flat
- 93: Shrub-steppe
- 589: Short bunch-grass savanna / Grass-steppe
- 157: Grass-steppe
- 175: Grasslands, short bunch-grass savanna
- 587: Sparse low tree-steppe / Sparse shrub-steppe

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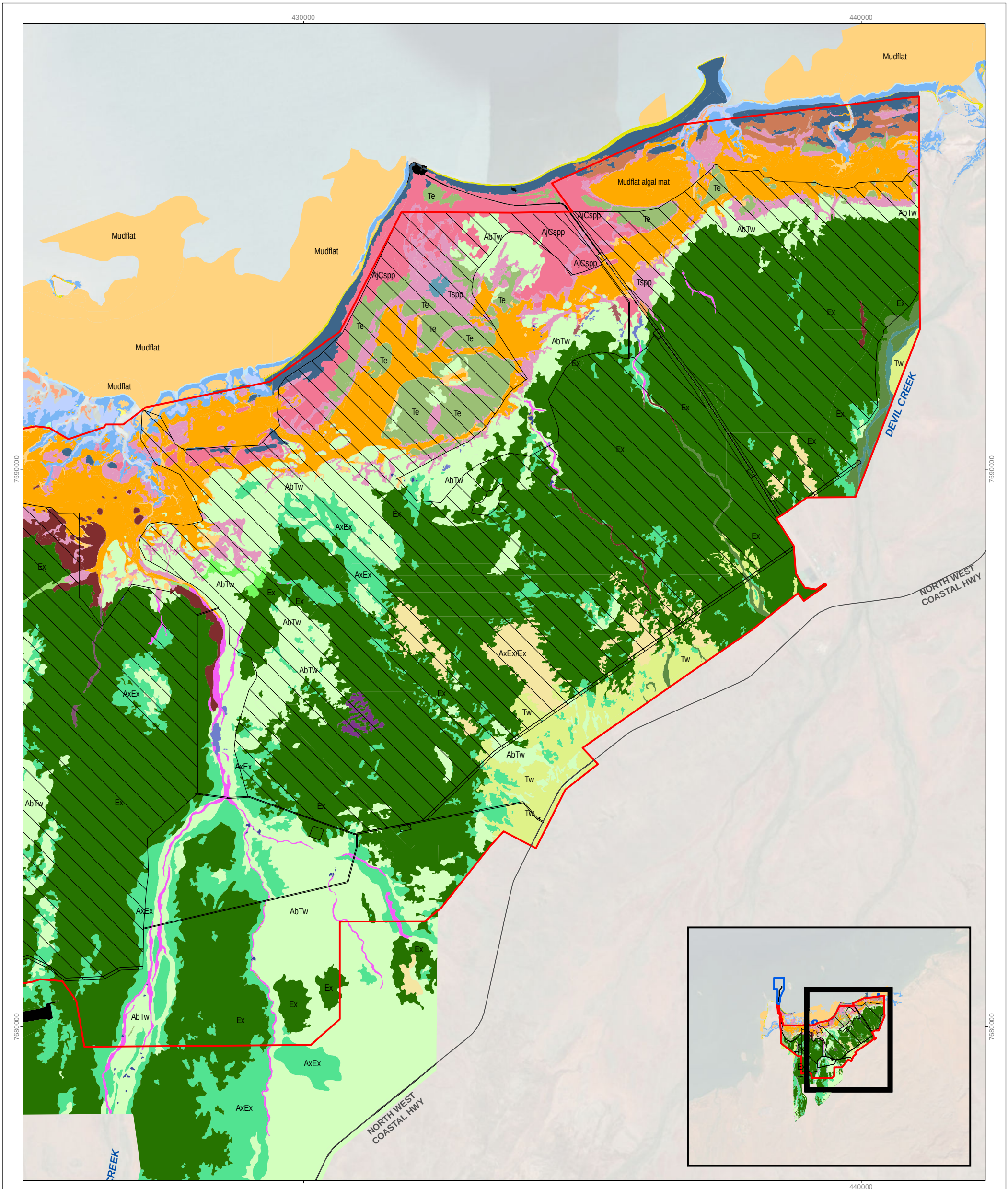


Figure 11-22: Direct disturbance to vegetation communities (east)

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Scale: 1:65,000 @ A3

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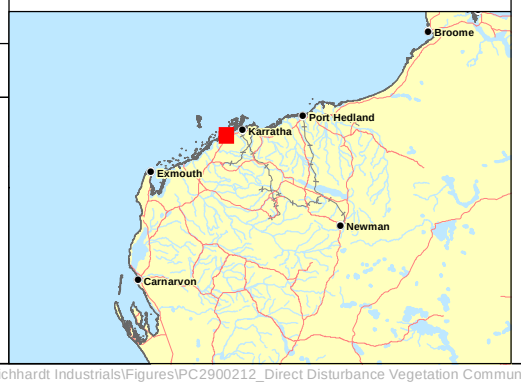
- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

**LOCALITY**




Legend

- Marine Development Envelope
- Pond and Infrastructure Development Envelope
- Revised Disturbance Footprint

Vegetation Type

- AbTw
- AbTw/AxEx
- AbTw/Mudflat
- AbTw/Tspp
- AcAjTe
- AiElTw
- AjCspp
- AssCc
- AxEx
- AxEx/Ex
- EcAcCs
- EcAcTe
- EvAcCf
- EvScSv
- Ex
- HsclICc
- HsclICc/AbTw
- HsclICc/EcAcCs
- HsclICc/Ex
- HsclICc/Mudflat
- HsclICc/Tspp
- MmTsppSv
- Mudflat
- Te
- Te/Tspp
- TeWa
- Tspp
- Tw
- Cleared

Intertidal BCH

- Am/Ca
- Am1
- Am2
- Am3
- Beach
- Ca
- Mudflat algal mat
- Rs1
- Rs2
- Sand

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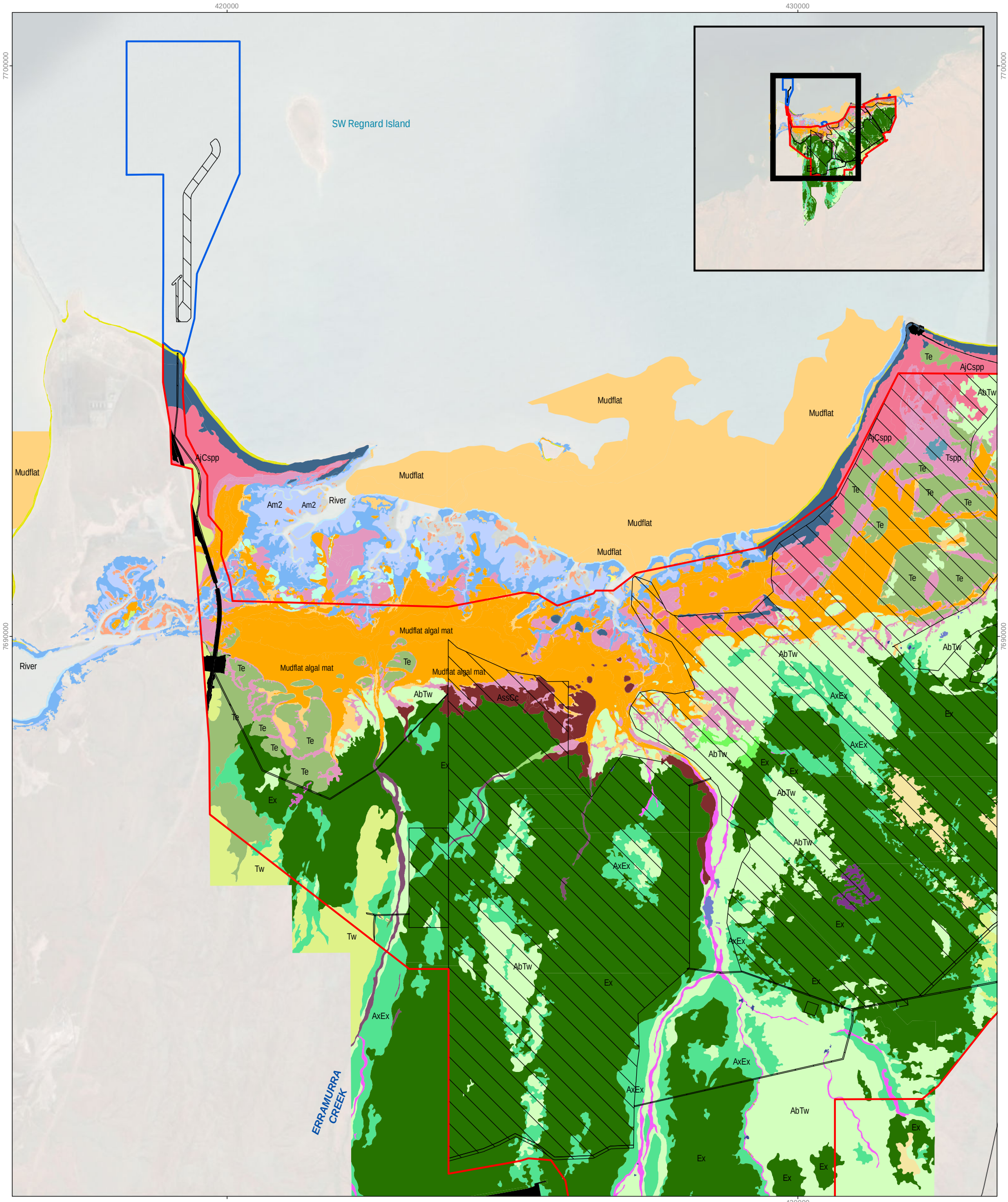


Figure 11-23: Direct disturbance to vegetation communities (west)

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***Changes to Surface Water Regimes***

As detailed in Table 11-13 and Section 6 (Inland Waters), there will be some vegetation that will be subject to changes to the local surface water regimes. There are three ways that changes to overland flows caused by the Proposal could potentially indirectly impact vegetation:

1. Less freshwater reaches the vegetation downstream of the ponds if freshwater flows are blocked by Proposal infrastructure or diverted away from these areas;
2. Increased freshwater inundation occurs within vegetation if the vegetation is within or near creeklines or are close to the creek outlets; and
3. Increased freshwater inundation occurs within vegetation upstream of the ponds if freshwater flows pool against the embankment.

SWS (2025; Appendix 1.1) modelled the potential changes to the overland freshwater flows due to the presence of the ponds and determined that there would be some moderate changes to the flow regime as a result of the Proposal. Section 6 (Inland Waters) provides more detail about this modelling and predicted results. Figure 11-24 and Figure 11-25 shows the vegetation at risk from indirect impacts associated with changes to the surface water regime as a result of the Proposal, noting that some impacted areas lie just outside the survey boundary. Total affected areas of each vegetation type where mapped are provided in Table 11-13. Only two terrestrial vegetation types were predicted to experience changes to surface water flows more than 10% of their local extent: HscllCc/EcAcCs and EvScSv.

***Changes to Groundwater Regimes and Quality***

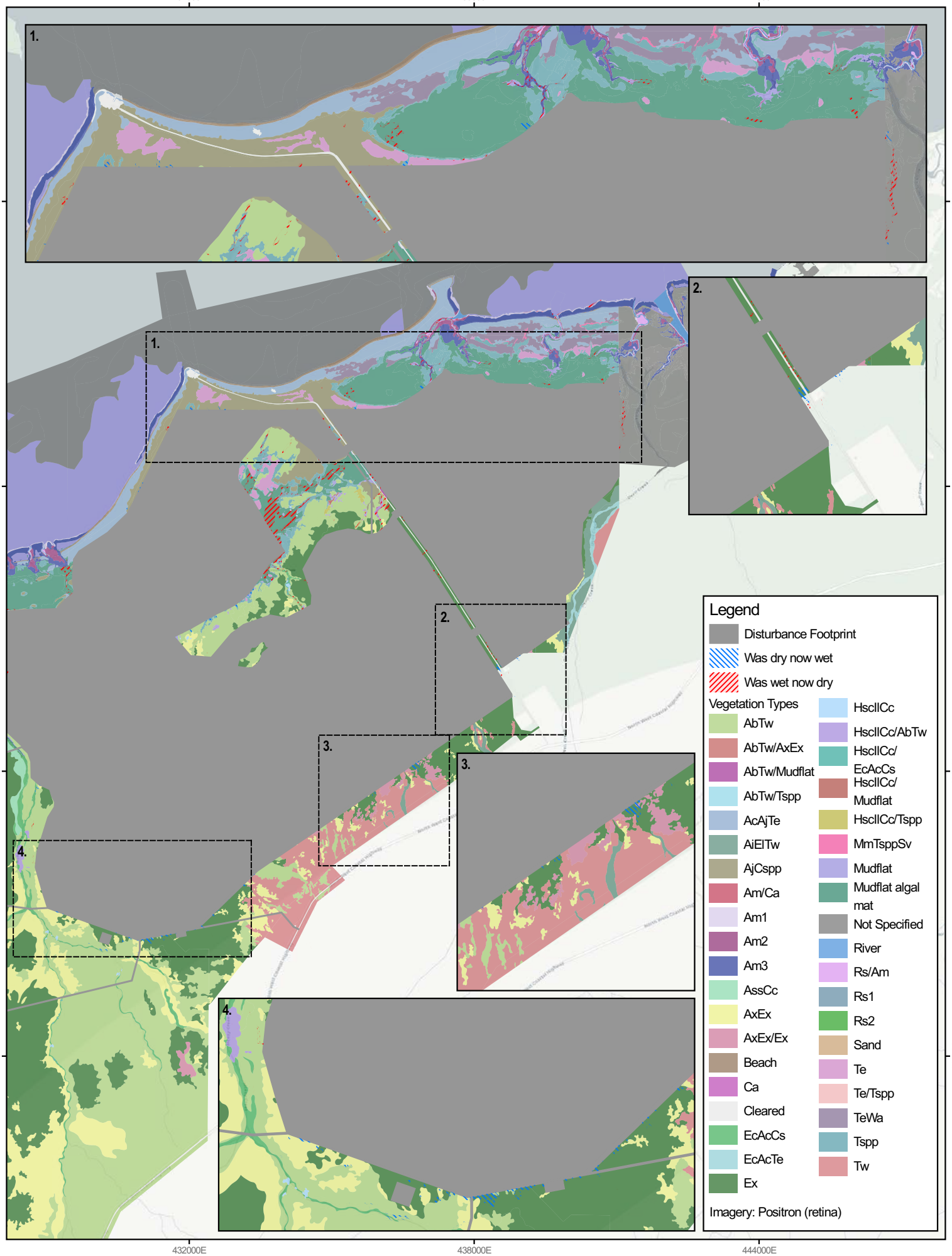
As detailed in Table 11-13and Section 6 (Inland Waters), there will be vegetation around the pond footprints that could be impacted by changes to the local groundwater levels or quality as a result of seepage from the ponds. The scale of these impacts were determined to be significant, and therefore mitigation is proposed under the GMMP (Appendix 1.9).

The GMMP is intended to ensure that any seepage or mounding impacts can be contained within a management zone that extends a maximum of 100 m from the external walls, by a series of cut-off bores, sumps or drains if required. The 100 m management zone includes a 20 m construction disturbance footprint which is required to build the pond walls. Therefore, indirect impacts to BCH have been calculated as being a maximum 80 m within areas that are 'at risk' of groundwater mounding and seepage impacts. These areas have been conservatively defined as being areas:

- Where the depth to groundwater is 5 m or less and the predicted change in groundwater level is 1 m or more; and
- Of mapped GDEs where the predicted change in groundwater level is 1 m or more (not relevant to BCH).

Figure 11-26 shows the vegetation at risk from indirect impacts associated with changes to the surface water regime as a result of the Proposal, noting that some impacted areas lie just outside the survey boundary.

With the implementation of this mitigation, impacts associated with changes to the groundwater regime are predicted to be, limited to the construction zones around the pond walls. Monitoring and management of groundwater impacts as a result of the Proposal are outlined in the GMMP in Appendix 1.9. Section 6 (Inland Waters) provides more detail about this modelling, predicted results and proposed mitigation.

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GDA2020 / MGA zone 50

1:100,000

Project: LEI_0535_037
Date: 27/03/2025
Size: A4
Author: ASmithers (Preston Consulting Pty Ltd)

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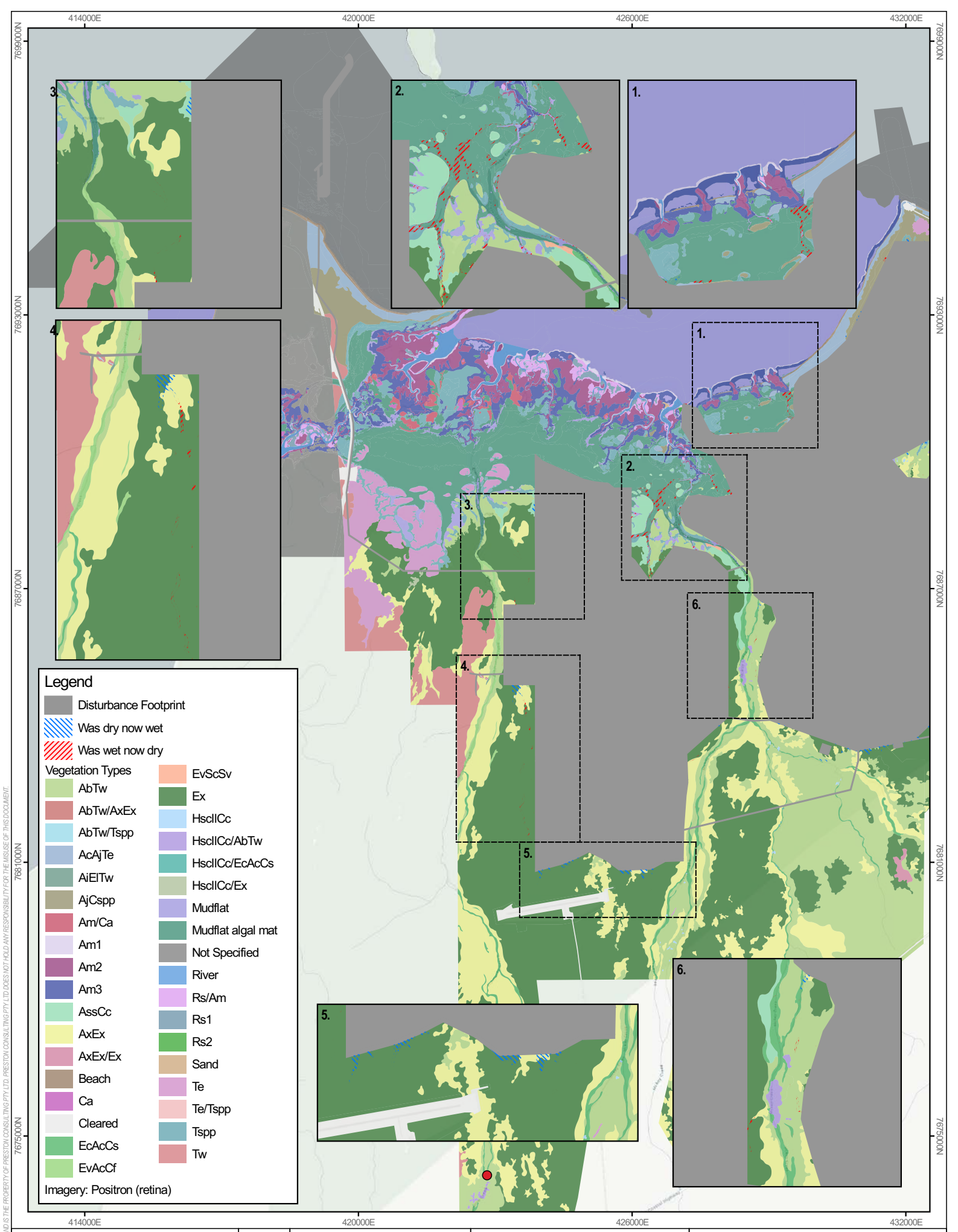
**Figure 11-24: Vegetation types (east) at risk from indirect impacts associated with changes to the surface water regime**

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GDA2020 / MGA zone 50

1:100,000

Project: LEI_0535_038
Date: 27/03/2025
Size: A4
Author: ASmithers (Preston Consulting Pty Ltd)

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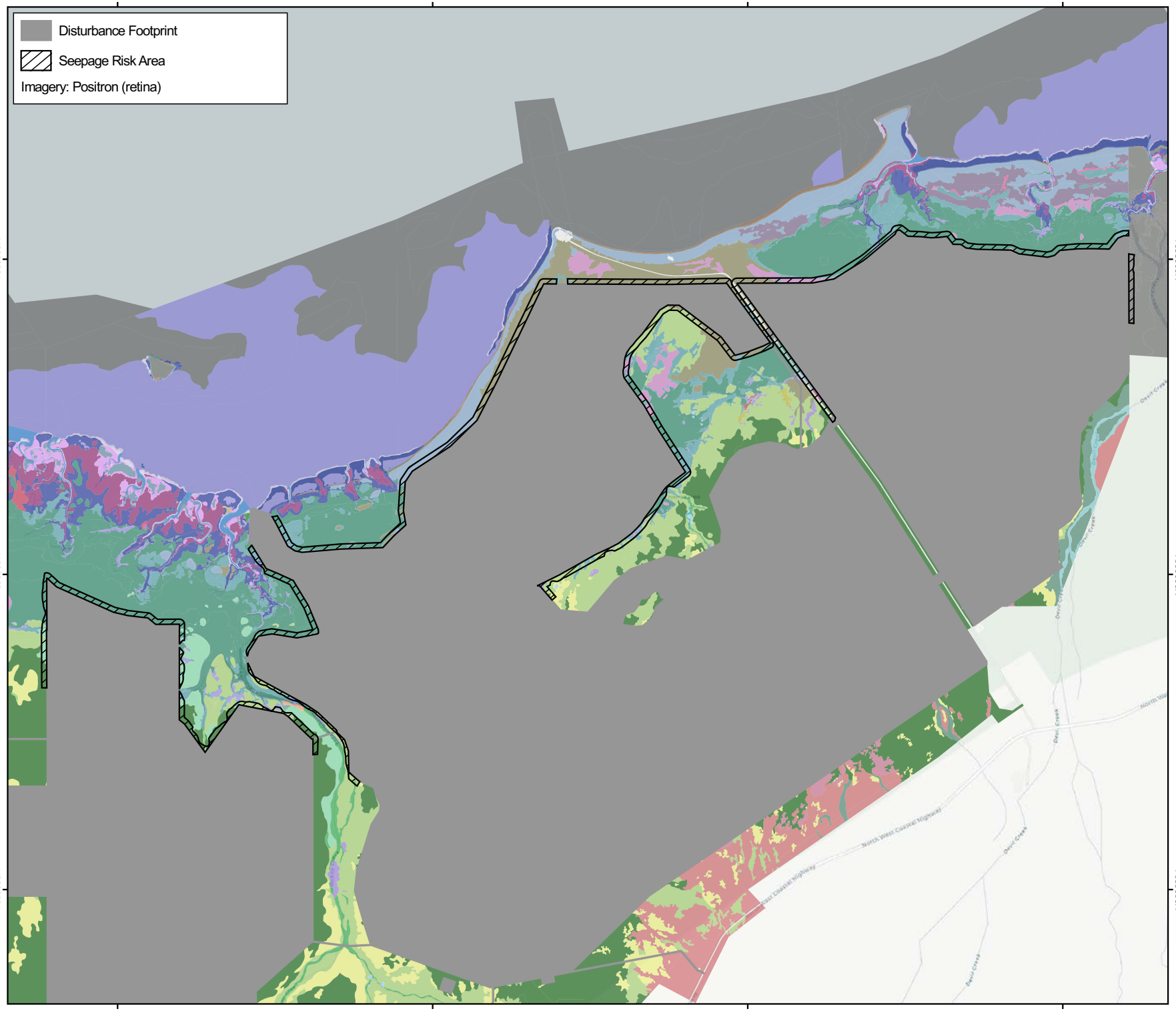
**Figure 11-25: Vegetation types (west) at risk from indirect impacts associated with changes to the surface water regime**




## Legend

**Vegetation Types**

- AbTw
- AbTw/AxEx
- AbTw/Mudflat
- AbTw/Tspp
- AcAjTe
- AiElTw
- AjCspp
- Am/Ca
- Am1
- Am2
- Am3
- AssCc
- AxEx
- AxEx/Ex
- Beach
- Ca
- Cleared
- EcAcCs
- EcAcTe
- EvAcCf
- EvScSv
- Ex
- HsclICc
- HsclICc/AbTw
- HsclICc/EcAcCs
- HsclICc/Mudflat
- HsclICc/Tspp
- MmTsppSv
- Mudflat
- Mudflat algal mat
- Not Specified
- River
- Rs/Am
- Rs1
- Rs2
- Sand
- Te
- Te/Tspp
- TeWa
- Tspp
- Tw

N

0 1 2 km

GDA2020 / MGA zone 50

1:80,000

Project: LEI_0535_039
Date: 28/03/2025
Size: A4
Author: ASmithers (Preston Consulting Pty Ltd)

**Figure 11-26: Vegetation types at risk from indirect impacts associated with groundwater seepage and mounding**

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***Brine Leaks and Spills***

A large spill or leak of brine from the ponds or pipelines, or product infrastructure washdown water could result in impacts to the health of the surrounding vegetation. Brine is the primary resource for the Proposal and as such the concentration ponds, crystallisers and brine pipelines are designed to minimise the risk of leaks, overflows and wall breaches. Pipelines will utilise industry-standard materials to minimise the chance of leaks, and mitigation will be implemented to reduce this risk further (refer to Section 11.5.7). Ponds have been designed with adequate freeboard and overflow features to minimise the risk of unplanned overflows and wall breaches. The ponds include internal weirs to re-balance local excess brine levels and external emergency spillways into adjacent major creeks to avoid cascading internal bund failure leading to massive outflows.

There are drainage ditches along the base of all perimeter bunds primarily to intercept groundwater seepage and collect brine for recovery to the process ponds. These will also intercept and contain minor splashing and spillage events.

If a large external overflow was to occur, it is most likely to arise from a major rain event which raises all pond levels. In such events, McKay and Devil Creeks both flow at high levels. In this case the brine overflow will be rapidly mixed with fresh surface water flow and discharged to the ocean.

The mitigation measures proposed to safeguard against such potential impacts are described in Section 11.5.7.

***Weeds***

Weeds have the potential to be introduced to the area or spread as a result of the Proposal, with the greatest risks associated with earthmoving during the construction period. The Declared Pest and WoNS, *Prosopsis glandulose x velutina* was recorded within one quadrat. The control of the spread of this species will require management (refer to Section 11.5.7).

***Dust Emissions***

Dust emissions may occur during construction, however excessive dust emissions will be managed using industry-standard dust control measures and given that the local vegetation is well adapted to dusty conditions, the Proposal is unlikely to impact vegetation health outside the PIDE during this period. During operations the potential for dust emissions is expected to be minimal.

***Rehabilitation and Closure***

The change to the Proposal will result in additional large areas of ponds that contain salts or brine and as such revegetation may be impeded by the presence of salt post-closure. Precipitate composition and volumes will vary across different stages of the ponds. Prior to closure, the volumes and composition of these deposits will be measured to enable effective planning for remediation. It is expected that by breaching walls and flushing the concentration ponds with surface runoff from rainfall events, soluble salts will be dissolved and returned to the surrounding intertidal area with no significant impacts.





Crystallisers have a smaller surface area than the concentration ponds and are located well above the intertidal zone. Post-closure, the pond floors will be hypersaline. After the removal of harvestable salts the crystallisers will be flushed with seawater for further salt removal. Pond embankments will be initially breached to re-establish overland flooding regimes. Remaining embankments will be pushed down to return the area to a gently graded landform sloped northwards toward the intertidal area.

### 11.5.3 PRIORITY FLORA

***Dolichocarpa sp. Hamersley Station (A.A. Mitchell PRP 1479)***

*Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479) (Priority 3 Flora – BC Act) was recorded across three quadrats within vegetation type Ex. Two of these records are predicted to be directly impacted by the Proposal. This species is not endemic to the Study Area and has previously been recorded 31 times with a distribution that extends throughout the Pilbara bioregion (Figure 11-27). Vegetation type Ex was considered locally and regionally significant because it provides habitat to *Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479) and because it represents the Horseflat PEC. This vegetation type covers 11,720.6 ha within the Study Area, with an additional 152.5 ha present in mosaic vegetation types (AxEx/Ex and HscllCc/Ex). Up to 7,483 ha of this vegetation type (63.0% of local extent and 3.7% of regional extent) is predicted to be directly impacted by the Proposal. Impacts to this vegetation type are discussed in further detail in Section 11.5.7 as part of the Horseflat PEC environmental value assessment.

As described in Section 11.5.1, there is the potential for some indirect impacts associated with altered surface water hydrology (Table 11-13), however this is not predicted to impact the remaining record as it lies outside the area of potential impact.

*Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479) has been recorded 31 times across multiple locations in the Pilbara bioregion and only two records are proposed to be impacted by the Proposal. Given this wide range, the areas of habitat predicted to be lost as a result of the Proposal are considered unlikely to result in significant impacts to this species.




**Figure 11-27: Current distribution of *Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479) (Priority 3) (from Florabase, accessed February 2025)**

***Eremophila forrestii subsp. viridis***

*Eremophila forrestii* subsp. *viridis* (Priority 3 Flora – BC Act) was recorded in one quadrat within vegetation type AiElTw. The one record is not predicted to be directly impacted by the Proposal. This species is not endemic to the Study Area and has previously been recorded five times across the Carnarvon, Great Sandy Desert, Great Victoria Desert and Pilbara bioregions.

Vegetation type AiElTw was considered locally significant as it provides habitat to *Eremophila forrestii* subsp. *viridis*. This vegetation type covers 100 ha within the Study Area all of which occurs within the PIDE. However only 17.0% (17.0 ha) is predicted to be disturbed for the Proposal.

As described in Section 11.5.1, there is the potential for some indirect impacts, however these are not expected to have a significant impact on the AiElTw vegetation type (0.1 ha; Table 11-13) and will not impact the recorded specimen.

Given that no records will be directly impacted by the Proposal, the species occurs across multiple bioregions and 83% of the local habitat is predicted to remain, impacts to this species are not expected to be significant.

***Rostellularia adscendens* var. *latifolia***

*Rostellularia adscendens* var. *latifolia* (Priority 3 Flora – BC Act) was recorded in one quadrat within vegetation type EvAcCf. This record is not predicted to be directly impacted by the Proposal. This species has previously been recorded 40 times across the Pilbara bioregion with populations ranging for a few individuals to 50 plants (WA Herbarium, 1998).

Vegetation type EvAcCf was considered locally significant as it provides habitat to *Rostellularia adscendens* var. *latifolia*. This vegetation type covers 54.6 ha within the Study Area with 79.1% (43.2 ha) of the mapped extent occurring within the PIDE (of which 14.4 ha is predicted to be disturbed for the Proposal).

As described in Section 10.5.1, there is the potential for some indirect impacts, however these are not expected to have a significant impact on the EvAcCf vegetation type (0.6 ha; Table 11-13) and will not impact the recorded specimen.

Given that no records will be directly or indirectly impacted by the Proposal, the species has multiple records across the Pilbara bioregion and 72.3% of the local habitat will remain, impacts to this species are not expected to be significant.

***Other Potential Priority Flora***

*Goodenia pallida* (P1) has previously been recorded within the Study Area, south of the PIDE. This species was not recorded in Phoenix's (2025) survey and the record is not proposed to be disturbed for the Proposal.

Suitable habitat for *Goodenia pallida* occurs within vegetation type AbTw, which has been identified as locally significant due to its role in supporting this species.). Approximately 1,440.4 ha of AbTw vegetation type is proposed to be disturbed for the Proposal, equating to 34.4% of the mapped extent within the Study Area.

Given that no records of *Goodenia pallida* were identified within the development envelopes, the one previous record of this species will not be disturbed for the Proposal and 66% of habitat will remain, the likelihood of the Proposal having a significant impact on this species is considered to be low.

Six other Priority Flora species were noted by Phoenix (2025) as potentially occurring within the Study Area (refer to Section 10.3.2). This excludes those identified by Professor van Leeuwen as not having suitable habitat and *Minuria tridens* which has been redetermined to be *Minuria* sp. Onslow (A.J. Perkins & M. Henson AJP-WA167) and is not a Priority species.

- *Atriplex lindleyi* subsp. *conduplicate* (P3);
- *Euphorbia australis* var. *glabra* (P3);
- *Gomphrena cucullata* (P3);
- *Gomphrena leptophylla* (P3);
- *Gymnanthera cunninghamii* (P3); and
- *Goodenia nuda* (P4).

These species were not recorded during the surveys, however suitable habitat is present within the Study Area. The assessment below has sourced records from Florabase (DBCA, 2021), accessed in 2021.

As discussed in Section 11.3.4, the WA species identified as *Minuria tridens* are now considered to be a new taxon. The WA specimens previously identified as *M. tridens* have now been redetermined to be *Minuria* sp. Onslow (A.J. Perkins & M. Henson AJP-WA167) or *Minuria* sp. Little Sandy Desert (S. van Leeuwen 4919). The *Minuria* on the west Pilbara coast in known from 26 locations and is not a Priority species. *Minuria* tridens does not occur in WA (Dillon et al., 2024).

The remaining Priority 3 and 4 Flora species have widespread and numerous records throughout the Pilbara region, all found across more than one IBRA region and are unlikely to be significantly impacted as a result of the Proposal, even if isolated records were present.

Based on the above, and the surveys completed to-date, the likelihood of the Proposal having a significant impact on any of these Priority Flora species is considered low.

### 11.5.4 RANGE EXTENSIONS FLORA

One species was recorded within the Study Area and identified to be significant range extension. It was recorded in the PIDE but outside of the Indicative Disturbance Footprint.

*Bergia henshallii* was recorded twice during the survey, both records were identified within the PIDE but outside of the Indicative Disturbance Footprint. This record represents a 239.8 km range extension for the species. The species has previously been recorded 24 times across the Dampierland, Gibson Desert, Great Sandy Desert, Ord Victorian Plain, Tanami, and Pilbara bioregions. The two records are not expected to be at risk from surface water inundation changes. As no records will be impacted it is likely that a local population of this species will be maintained.

### 11.5.5 UNIDENTIFIED FLORA SPECIES

***Undescribed and Unidentified Tecticornia Species***

As described in Section , nine *Tecticornia* species were recorded within the Study Area that were unable to be identified to species level. However, all of these species have been confirmed as being represented elsewhere along the Pilbara coastline, with none restricted to the PIDE. These species were therefore not considered to be significant environmental values requiring further assessment.

***Other Unidentified Species***

Three other species were recorded within the Study Area which were unable to be identified to a species level. Only one of these three species has records outside of the PIDE.

*Scaevola* aff. *pulchella* was recorded twice within the Study Area and once within the PIDE. No records are predicted to be impacted by direct disturbance or indirectly impacted as a result of changes to hydrology.

*Polygala* aff. *galeocephala* was recorded once, within the Indicative Disturbance Footprint. This species was recorded in vegetation type Ex associated with Horseflat PEC. It is highly likely this is either a misidentification or a mistake in the flora database. The *Polygala* sp. that occurs in the area is *Polygala glaucifolia* which is common in the PIDE and was recorded in the footprint of other developments and on a Pilbara Biological Survey site in the vicinity. Leichhardt will undertake further taxonomic work on the specimen to determine if this is the case. If further investigations reveal that the species is significant then Leichhardt will undertake a targeted survey prior to construction in search of records outside of the indicative disturbance footprint, following suitable rainfall.

*Bonamia* aff. *media* was recorded once within the PIDE. This record is not predicted to be impacted by direct disturbance or indirectly impacted as a result of changes to hydrology.

The proposed mitigation measures are predicted to ensure that impacts to these species are minimised such that they are not considered significant.

### 11.5.6 GROUNDWATER DEPENDENT ECOSYSTEMS

Four vegetation types were identified as potential GDEs; EcAcCs, EvAcCf, EcAcTe and EvScSv (Phoenix, 2025). Up to 338.3 ha of GDEs were recorded with up to 35.1 ha (10.4% of local extent) proposed to be disturbed as a result of the Proposal (Figure 11-28). No disturbance to vegetation type EcAcTe is proposed.

Given the relatively shallow interception of groundwater near surface water drainages (generally between 10 - 12 m), it is possible the eucalypt species within creek lines are to some extent groundwater dependent and are contributing to groundwater discharge through evapotranspiration (CDM Smith, 2024).

The potential GDEs have the potential to be impacted by increased recharge, increased salinity and increased groundwater levels (CDM Smith, 2024). In the absence of mitigation, groundwater levels are predicted to increase by around 3 m within the creeks and drainages within the PIDE, notably Devil Creek to the east and McKay Creek situated between the ponds in the centre of the PIDE. This may cause waterlogging of the unsaturated root zone, impacting the reserve of fresher soil water used by the trees for transpiration, as these species cannot draw water from completely saturated soil (below the water table).

Eucalypts are found to occur in a wide range of geological settings and are well adapted and resilient to extreme conditions having the ability to access multiple sources of soil moisture (both shallow and deep) due to their dimorphic root structure (CDM Smith, 2024). When eucalypts become waterlogged, they are known to form 'adventitious roots' at or just above the water table as an avoidance mechanism to rising water levels (Clements et al., 1978). This suggests the ability of eucalypts to resist waterlogging is reflective of their ability to source adventitious roots as a means to avoid stresses rather than tolerate them. Should groundwater levels rise as predicted (i.e., around 2 to 3 m m within creeks and drainages) this will result in a reduced unsaturated zone that will require the vegetation to adapt their water sourcing. The consequence of a permanent rise by this magnitude will likely result in some stresses to the vegetation (which these species are resilient to) such as reduced canopy growth, reduced root development of the deeper root systems and production of adventitious roots.

Permanent loss of vegetation is not expected provided an unsaturated zone remains (i.e., the eucalypts are not exposed to permanent inundation) (CDM Smith, 2024). The modelling predicts an unsaturated zone will remain. It should be noted that the changes to groundwater level and salinity are expected to occur relatively quickly (within a few years) and therefore a temporary, short-term loss of condition (such as leaf loss) may occur as the plants adapt to a loss of deeper roots while the adventitious roots establish and the canopy rebounds.

Eucalypt species also have the potential to be impacted by increases in groundwater salinity, should these species access groundwater for periods of time (CDM Smith, 2024). Eucalypts are highly resilient to changes in weather patterns and adaptable in terms of their water sourcing (i.e., soil water vs groundwater, or both) and therefore, will likely be able to exist without a groundwater supply for sustained periods, unless unanticipated waterlogging occurs. However, salinity increases to the groundwater at the predicted concentrations will likely affect the vadose zone and impact the water (groundwater) uptake during dry periods when fresher waters supplies are diminished. Eucalypt species are documented to viably use groundwater with salinity of less than around 13 g/L, while they have also been shown to use groundwater between 7 - 21 g/L (CDM Smith, 2021). These tolerance ranges are far below the predicted salinity increases at the creeks, for which increases of almost 350 g/L could occur in some locations (in the absence of mitigation). The consequence of such a direct effect is increased tree stress during dry periods and potential permanent loss of vegetation.

Increased groundwater levels may also threaten eucalypts should this change the groundwater – surface water interactions (CDM Smith, 2024). Shallower groundwater levels will extend the periods of surface water inundation within creeks from the baseline condition. This effect alone generally will not result in an adverse effect unless it induces a prolonged period of waterlogging that entirely inundates the unsaturated zone or combines with direct effects associated with salinity increases, for example if the surface water becomes saline as a result of groundwater interactions, or groundwater from beneath the evaporation ponds seep to within these drainages. The consequence of such a direct effect is increased tree stress during dry periods, reduction of the number and frequency of emergent saplings and potential permanent loss of vegetation.

The assessment above identifies that there is a high risk of impacts to GDE's if mitigation measures are not implemented to prevent groundwater seepage and mounding reaching the area of GDEs. Details of the proposed mitigation measures are discussed in Section 11.6 and the GMMP provided in Appendix 1.9.

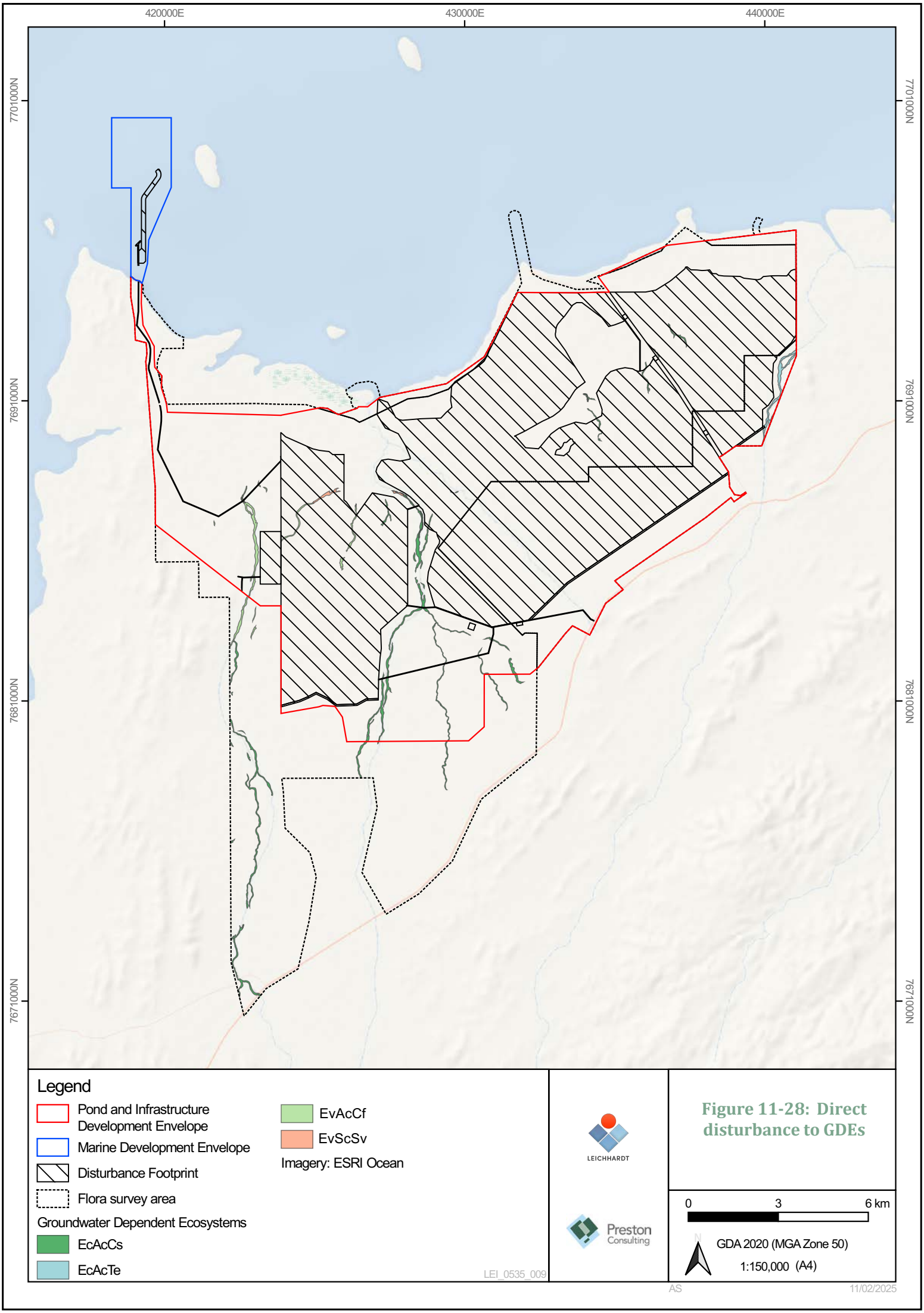



**Figure 11-28: Direct disturbance to GDEs**

### 11.5.7 HORSEFLAT LAND SYSTEM OF THE ROEBOURNE PLAINS PEC

This PEC has been recorded within the Study Area with 9,633.5 ha occurring within the PIDE. Up to 7,614.1 ha (63% of local extent) is predicted to be disturbed for the Proposal. An additional 79.0 ha of this PEC (0.7%) may experience indirect impacts associated with changes to surface water hydrology.

Regional mapping and field verifications conducted by EnSTaR predicted that this PEC covers an area of 194,996.5 ha (refer to Section 11.3.5), and as such only 3.9% of the regional extent of this PEC is predicted to be impacted by the Proposal. However, the regional mapping assessment does not include any assessment of the condition of the Horseflat PEC, which is likely to be variable throughout its extent. None of this PEC is currently represented in conservation reserve systems.

Given the widespread nature of this PEC, there are numerous cumulative pressures along the coastline, including at the Sino Iron Project, Mardie Project, Woodside Solar Project and Balla Balla Export Facilities (refer to Section 18). Given this, the variable condition of the regional extent, and the priority status of the ecological community, the predicted disturbance to this PEC is considered significant in a local and regional context and therefore offsets have been proposed in Section 15 to counterbalance these impacts.

### 11.5.8 COASTAL DUNE NATIVE TUSSOCK GRASSLAND PEC

This PEC has been recorded within the Study Area with 117.9 ha occurring within the PIDE. Records of this PEC are restricted within the local region of the Study Area occurring mainly on the nearby offshore islands (i.e., Barrow Island) and coastal dunes to the east. Given its restricted extent this PEC has been completely avoided during the pond re-design (refer to Section 5).

No indirect impacts are predicted to affect this PEC.

### 11.5.9 RESTRICTED LOCALLY SIGNIFICANT VEGETATION

Twelve vegetation types were identified as being locally significant within the Study Area (Figure 11-29). Several of these vegetation types have already been assessed as their significance is associated with another environmental value:

- Ex, AxEx/Ex and HscllCc/Ex were assessed as part of the Horseflat PEC environmental value (Section 11.5.7);
- AiElTw was assessed as part of the *Eremophila forrestii* subsp. *viridis* environmental value (Section 11.5.3);
- EcAcCs was assessed as part of the GDE environmental value (Section 11.5.3 and 11.5.6);
- EvAcCf was assessed as part of the *Rostellularia adscendens* var. *latifolia* and GDEs environmental value (Section 11.5.3 and 11.5.6); and
- AbTw was assessed as part of the *Goodenia pallida* environmental value (Section 11.5.5).

Vegetation type AcAjTe and HscllCc will not be significantly impacted (more than 70% of its extent will be retained). These vegetation types are considered adequately assessed in Section 11.5.2. The potential impacts to the remaining locally significant vegetation types are assessed below.

***EvScSv***

Vegetation type EvScSv was considered locally significant because it occupied a small area (7.7 ha); less than 0.1% of the Study Area. This vegetation type occurs in two narrow strips in the northwest corner of the PIDE (Figure 11-15). This vegetation type was only recorded within the PIDE and up to 5.8 ha (75.3%) is predicted to be disturbed for the Proposal.

This vegetation type is not predicted to be at risk from indirect impacts associated with groundwater mounding or changes to surface water hydrology.

Leichhardt is confident that with the implementation of mitigation measures (Section 11.6) that at least a 25% portion of this vegetation type will be maintained within the Study Area.

***MmTsppSv***

Vegetation type MmTsppSv was considered locally significant because it occupied a small area (3.8 ha); less than 0.1% of the Study Area. This vegetation type occurs in narrow strips in the northeast corner of the PIDE. The entire extent of this vegetation type occurs within the PIDE however it will not be disturbed by the Proposal.

This vegetation type is also not predicted to be at risk from indirect impacts associated with groundwater mounding, increased salinity or change to surface water hydrology.

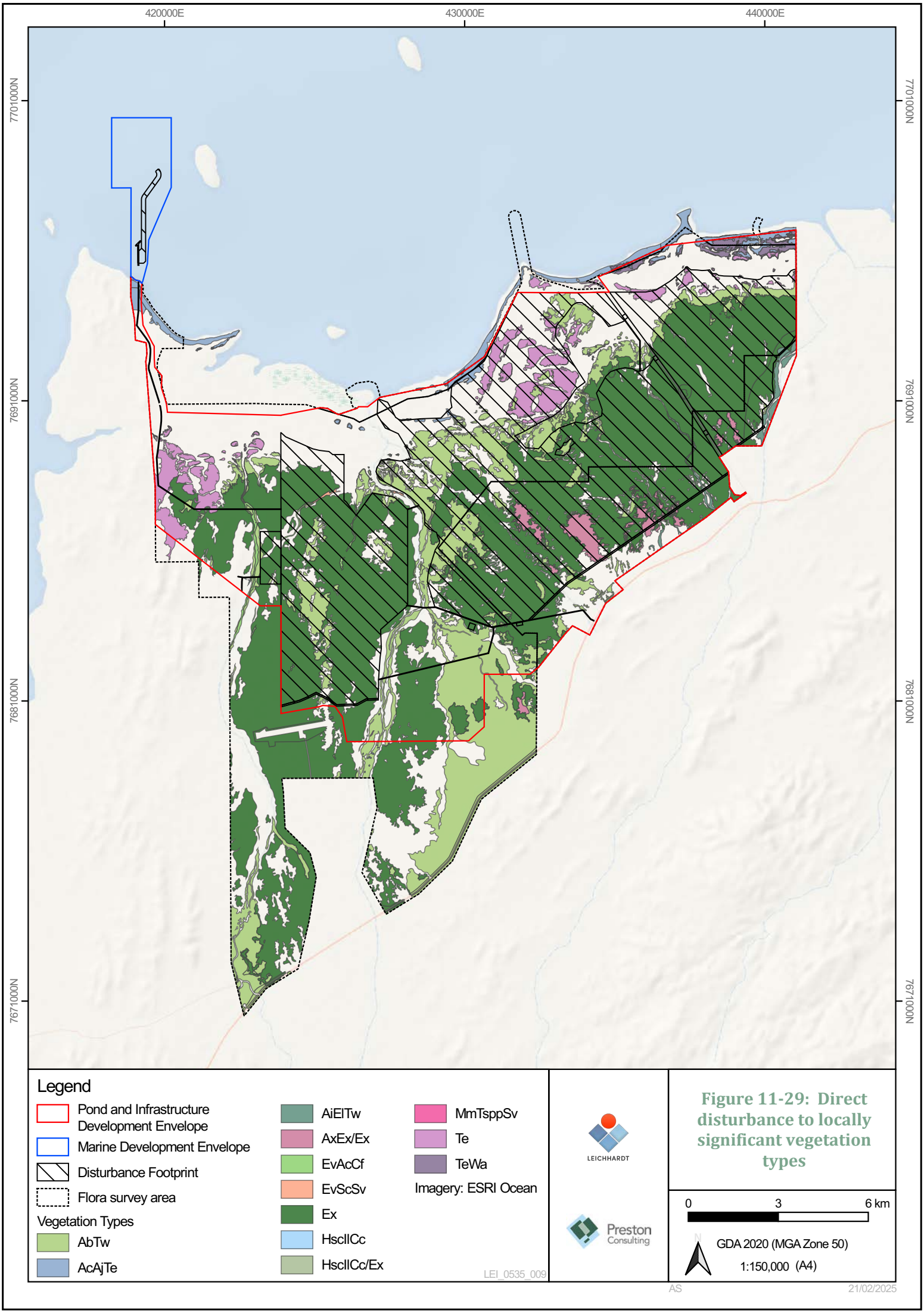



**Figure 11-29: Direct disturbance to locally significant vegetation types**

## 11.6 MITIGATION

Leichhardt has mitigated the potential impacts to this factor according to the mitigation hierarchy; avoid, minimise, rehabilitate, offset.

### 11.6.1 AVOID

The key avoidance outcome achieved by Leichhardt was the iterative design of the development envelopes to avoid key environmental features. Leichhardt has conducted numerous ecological surveys, and this information has been utilised to design the Proposal and its development envelope boundaries to avoid the following:

- The majority of riparian vegetation along Eramurra, McKay and Devil Creeks;
- The Coastal Dune PEC;
  Vegetation types EcAcTe, TeWa, MmTsppSv, HscllCc/Tspp and HscllCc/Mudflat; and
- Additional clearing associated with the development of new port infrastructure (i.e., if CPE Port was not able to be used).

### 11.6.2 MINIMISE

The following mitigation measures are proposed to ensure that direct and indirect impacts to flora and vegetation are minimised:

1. **Implement industry best-practice management measures for flora and vegetation, including**:
    a. Vegetation clearing will be managed through internal ground disturbance procedures;
    b. Boundaries of areas to be cleared or disturbed will be identified by GPS coordinates and real time on-screen mapping will be provided to equipment operators;
    c. Progressive clearing will be undertaken;
    d. The disturbance footprint will be developed to the minimum required to ensure safe and adequate construction and operation, and compliance with approved limits;
    e. Water or dust suppressants will be applied to disturbed areas and product transfer/storage areas as required to minimise dust generation;
    f. Emergency response capabilities will be maintained to control fire outbreaks;
    g. Weed hygiene and management measures/procedures will be implemented to prevent spread of weeds and the introduction of new weed species as a result of construction and operation;
2. **Obtain and comply with the following approvals**:
    a. Ministerial Statement to be issued under Part IV of the EP Act;
    b. MP to be approved under the Mining Act;
    c. MCP to be approved under the Mining Act. The MCP will describe the rehabilitation and closure of the Proposal, and associated management and monitoring proposed during the closure phase. An interim MCP has been provided in Appendix 1.8;
    d. Works Approval and Licence to be issued under Part V of the EP Act for solar salt manufacturing;

3. **Conduct additional targeted surveys for unidentified *Polygala* aff. *galeocephala* .** The targeted surveys will be to ensure that no potentially novel species occur only within the disturbance area**;**
4. **Develop the final Proposal design with the consideration of minimising impacts to known locations of:**
    a. Priority Flora;
    b. Potentially new restricted flora species;
    c. Range extension flora;
5. **Implement the GMMP in Appendix 1.9** to reduce impacts to vegetation surrounding the ponds, including GDEs. The primary focus of the GMMP is to demonstrate how groundwater seepage and mounding will be monitored and managed to avoid and minimise impacts on surrounding environmental values. The management controls that have been considered during the design of the proposed monitoring network described in the GMMP include:
    a. Development of pond floor which minimises the potential for seepage. The outcome will be a stable base which will act to limit seepage from each pond;
    b. Installation of sentinel wells at/in the pond walls to monitor groundwater physical parameters and levels. The information from these wells will trigger any active management at the Proposal;
    c. Bunding of areas where chemicals may be used;
    d. Suitable siting, design, and construction of waste storage facilities;
    e. Safe operation and maintenance of ponds for example, introduction of water to the ponds at such a rate as to minimise scour and maximise evaporation;
    f. Appropriate spill management procedures;
6. **Monitor the potential changes to tidal and surface water inundation regimes as discussed in Section 6 (Inland Waters).** This monitoring will be conducted to verify the model and associated indirect impact assessments;
7. **Design and construct concentration ponds and crystallisers to be safe and stable according to DEMIRS requirements**;
8. **Implement the following controls to further reduce the risk of impact from unintentional brine pipeline spills**:
    a. Pipelines outside the pond footprints will be fitted with leak detection;
    b. Flows will be shut off if leaks are detected;
    c. Pipeline routes outside the pond footprints, will be inspected to a schedule for issues of concern;
    d. Pipelines will mainly be located below ground;
    e. Where pipelines cross access roads they will be reinforced against traffic loading;
    f. Investigations will be conducted into the cause of any spills, and remedial actions will be taken to minimise the chance of reoccurrence; and
    g. Spills response training for site-based personnel.

### 11.6.3 REHABILITATE

At the completion of the Proposal the site will be rehabilitated to allow and encourage the natural establishment of vegetation and traditional values. A MCP will be required under the Mining Act and an initial MCP has been provided in Appendix 1.8. The key rehabilitation measures from the MCP that relate to flora and vegetation are summarised below:

- Salts will be harvested and washed from each crystalliser prior to closure;
- Concentration pond walls will be flattened or opened up to allow tidal flows to enter the ponds, and surface drainage through higher areas;
- Above ground infrastructure will be removed if not retained by PPA or the landowner; and
- Crystallisers will be rehabilitated to an acceptable landform.

The MCP will be assessed by DEMIRS prior to the construction of the Proposal and will be reviewed and revised every three years.

## 11.7 PREDICTED OUTCOME

The EPA's environmental objective for this factor is "to protect flora and vegetation so that biological diversity and ecological integrity are maintained". In the context of this objective: "ecological integrity" is listed as the composition, structure, function and processes of ecosystems, and the natural range of variation of these elements (EPA, 2016g).

Leichhardt has incorporated extensive avoidance and minimisation measures into the Proposal design and operational processes, and this section presents the predicted outcomes after those measures have been incorporated.

The Proposal will result in direct impacts to flora and vegetation that are unavoidable. All vegetation associations to be disturbed will have more than 84% of their pre-European extent remaining, even once cumulative disturbance associated with the Proposal and others such as CPE Port, Sino Iron Project, Mardie Project and 40-Mile Beach Road have been deducted. This means that all of the vegetation associations will remain in the 'Least Concern' category (Phoenix, 2025).

Impacts to Priority Flora records have almost completely been avoided, with only two records of *Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479) (Priority 3) predicted to be disturbed. Leichhardt notes that *Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479) remains taxonomically uncertain and its Priority flora status may change pending further taxonomic information. For the purposes of this assessment, it has, nevertheless, been treated as Priority 3 flora species (i.e., current status). Given that this species has been recorded 31 times across multiple locations in the Pilbara bioregion and only two records are proposed to be disturbed for the Proposal, significant impacts to this species are unlikely.

Impacts to potentially new species and species with range extensions are proposed to be mitigated such that they are not considered significant. Leichhardt is proposing to undertake a targeted survey for *Polygala* aff. *galeocephala* prior to construction if further taxonomic investigations identify that the specimen is significant. Additional regional surveys will be undertaken if needed to achieve this outcome.

The Proposal includes large areas of ponds that contain salts or brine and as such revegetation will be impeded for some time post-closure. The Proposal is a long-life project with an infinite resource (seawater and solar energy), so consideration of altered ocean hydrodynamics and climate change will be necessary. Closure planning will continue through the life of the Proposal (with the MCP being revised every three years), with the purpose of refining the closure strategies already identified in the Interim MCP (Appendix 1.8), including:

- The concentration pond walls will be flattened or opened up to allow tidal flows to reinstate within the former pond areas. Over time this is expected to return the area to a state where salt-tolerant species can revegetate those pond areas; and
- Salts will be recovered from the crystallisers, which are to be located on terrestrial vegetation.

To summarise the above, with the implementation of mitigation measures (primarily the avoidance, minimisation of disturbance and further survey), the residual impacts to the following values are not considered significant:

- Priority flora and associated habitat;
- Potentially new flora; and
- Locally significant vegetation.

Some impacts were deemed to remain significant after the implementation of mitigation measures. The Proposal is predicted to result in residual impacts to up to 11,287.7 ha of Good to Excellent condition native vegetation which includes habitat for significant flora and the Horseflat PEC. The EPA considers that the clearing of native vegetation and impacts on other associated environmental values in the Pilbara IBRA bioregion is significant where the cumulative impact may reach critical levels if not managed. Leichhardt has assessed the vegetation loss in a similar manner, with the loss of Good to Excellent vegetation considered to be a significant residual impact. Offsets are proposed to counterbalance those impacts (Section 15).

The residual impacts to Good to Excellent condition vegetation includes residual impacts to up to 7,614.1 ha of Horseflat PEC (3.9% of regional extent). This residual impact is considered significant and additional offsets have been proposed to counterbalance the residual impact.

The environmental outcomes for this factor are therefore predicted to be:

- No more than 11,287.7 ha of Good to Excellent quality native vegetation to be cleared as a result of the Proposal, including no more than 7,614.1 ha of Horseflat PEC;
- No losses of Priority Flora that would significantly affect the viability of the species;
- No disturbance associated with the Proposal to more than 76% of the mapped extent of restricted locally significant vegetation EvScSv;
- No disturbance associated with the Proposal to the mapped extent of restricted locally significant vegetation MmTsppSv;
- No indirect impacts from the introduction or spread of weeds compared with pre-construction condition; and
- No permanent impacts associated with spill/pollutant incidents.

With the implementation of mitigation measures, and offsets detailed in Section 11.6, Leichhardt considers that the EPA objective for this factor can be met.

# 12 TERRESTRIAL FAUNA

## 12.1 EPA OBJECTIVE

The EPA Objective for this key environmental factor is to protect terrestrial fauna so that biological diversity and ecological integrity are maintained.

## 12.2 POLICY AND GUIDANCE

Relevant EPA and Commonwealth Government Guidance Documents for Terrestrial Fauna are summarised in Table 12-1.

**Table 12-1: Policy and Guidance relevant to the Terrestrial Fauna key environmental factor**

| Policy and Guidance | How guidance has been considered |
|---|---|
| **WA Government** | |
| Key EPA documents | |
| EIA (Part IV Divisions 1 and 2) Procedures Manual (EPA, 2024a). | This document has been considered in planning for the Part IV approval process and has been used to inform the preparation of this ERD. |
| Statement of Environmental Principles, Factors, Objectives and Aims of EIA (EPA, 2023a). | This document was considered in the preparation of this ERD and to inform EIA. It was used identify the Key Environmental Factors likely to be impacted by the Proposal and the EPA's objective for each factor. |
| Statutory Guideline for Mine Closure Plans (DMIRS, 2020a). | This document has been considered in the design and planning of the Proposal; it has also been considered in the preparation of mitigation measures for the Proposal. |
| EIA (Part IV Divisions 1 and 2) Administrative Procedures (EPA, 2024d). | This document has been considered in planning for the Part IV approval process and has been used to inform the preparation of this ERD. |
| Instructions on how to prepare EP Act Part IV Environmental Management Plans (EPA, 2024e). | This document was considered during the preparation of environmental management plans to support this ERD. |
| Relevant EPA Factor Guidelines | |
| Environmental Factor Guideline – Terrestrial Fauna (EPA, 2016i). | This document was considered in the preparation of this section (Section 12) of the ERD. |
| Relevant EPA Technical Guidance | |
| Technical Guidance – Sampling methods for terrestrial vertebrate fauna (EPA, 2016j). | This document was considered in the preparation of this section (Section 12) of the ERD. |
| Technical Guidance – Terrestrial fauna surveys (EPA, 2020). | This document was considered in the preparation of this section (Section 12) of the ERD. |
| Technical Guidance – Sampling of short range endemic invertebrate fauna (EPA, 2016k). | This document was considered in the preparation of this section (Section 12) of the ERD. |
| Other Policy and Guidance | |
| WA Environmental Offsets Policy (EPA, 2011). | This document was considered when determining whether offsets were likely to be required for the Terrestrial Fauna environmental factor, and the adequacy of any proposed offsets. |

| Policy and Guidance | How guidance has been considered |
|---|---|
| WA Environmental Offsets Guidelines (EPA, 2014a). | This document was considered when determining whether offsets were likely to be required for the Terrestrial Fauna environmental factor, and the adequacy of any proposed offsets. |
| WA Environmental Offsets Template (EPA, 2014b). | This document was considered when determining whether offsets were expected to be required for the Terrestrial Fauna environmental factor. |
| WA Environmental Offsets Metric and relevant guidance (DWER, 2021b). | This document was considered when determining whether offsets were likely to be required for the Terrestrial Fauna environmental factor, and the adequacy of any proposed offsets. |
| **Commonwealth Government** | |
| Key Documents | |
| Generic guidelines for the content of a draft EPBC Act PER/EIS (including the objects and principles of the EPBC Act, 1999; DotEE, 2016). | These documents were considered in the preparation of this ERD and while undertaking EIA. |
| EPBC Act Environmental Offsets Policy (DSEWPaC, 2012a) – including the Offset Assessment guide. | This document was considered when determining whether offsets were expected to be required for the Terrestrial Fauna environmental factor. |
| Environmental Management Plan Guidelines (DotE, 2014). | This document was considered during the preparation of environmental management plans to support this ERD. |
| EPBC Act Condition Setting Policy (DAWE, 2020). | This document was used as guidance for the referral process and EIA of the Proposal. |
| EPBC Act Outcomes-based conditions policy (DotE, 2016a). | This document was used as guidance for the EIA and the development of mitigation measures and likely regulation of the Proposal. |
| Relevant Technical Guidance | |
| Relevant EPBC Act listed species-specific survey guidelines and protocols. | These documents were used as guidance when undertaking surveys of EPBC listed species and potential survey limitations. |
| Relevant EPBC Act listed species-specific Recovery plans, Threat Abatement Plans, Approved Conservation Advice and other documents. | These documents were used as guidance to assess and manage EPBC listed species that may be impacted by the Proposal. |

## 12.3 RECEIVING ENVIRONMENT

This information has been sourced from the following reports:

- Phoenix (2023; Appendix 6.1) Detailed terrestrial fauna and Migratory shorebird surveys for the Eramurra Solar Salt Project;
- Adaptive NRM (Leseberg, 2025; Appendix 6.2) Eramurra Solar Salt Project: Results of revised acoustic surveys for the Night Parrot (*Pezoporus occidentalis*);
- Curtin University (Cowan, 2023; Appendix 6.3) Review of Northern Quolls within Detailed Terrestrial Fauna and Migratory Shorebird Surveys for the Eramurra Solar Salt Project;
- Curtin University (Cowan, 2024; Appendix 6.3) Survey for the Presence of Northern Quolls (*Dasyurus hallucatus*) within Eramurra Solar Salt Project Footprint; and
- Danks et.al., (2025; Appendix 6.4) Urodacus, Acanthodillo, and Conothele from the Eramurra Solar Salt Project area: A comparison with Pilbara congeners.

### 12.3.1 SURVEY EFFORT

A desktop review and numerous field surveys have been conducted by Phoenix (2023) to inform this ERD.

***Study Areas***

Two study areas were defined:

1. The 'Terrestrial Fauna Study Area (TFSA)' which is 19,133 ha in size (Figure 12-1); and
2. The 'Migratory Shorebird Study Area (SBSA)' which is 12,591 ha in size and overlaps the TFSA. The SBSA has a maximum width east to west of approximately 29.5 km, ending typically less than 1 km offshore to the north (but up to 3 km) and typically extending approximately 4 km inland from the coast (Figure 12-2).

The SBSA has been determined to be a 'shorebird area' as per EPBC Act Policy Statement 3.21–-*Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed Migratory shorebird species* (DotEE, 2017b), which is described as:

> "The geographic area used by the same group of shorebirds over the main non-breeding period, effectively the home range of the local population when present. Shorebird areas may include multiple roosting and feeding habitats. While most Migratory shorebird areas will represent contiguous habitat, non-contiguous habitats may be included as part of the same area where there is evidence of regular bird movement between them."

***Desktop Review***

A desktop review of several biological databases was undertaken to identify and prepare lists of significant fauna that may occur within the study areas. A literature search was conducted for accessible reports for biological surveys conducted either within 50 km of the study areas, or up to 200 km on the coastal plain, to build on the lists developed from the database.

***Field Survey Summary***

Initial habitat characterisation was undertaken using various remote geographical tools, including aerial photography (Google Earth®), land system maps and topographic maps. Habitats with the potential to support significant terrestrial fauna species were identified based on known habitats of such species within the Pilbara bioregion. Tentative sites were selected for the terrestrial fauna survey to represent all habitat types. Final survey site selection was conducted after ground-truthing of site characteristics.

At the broadest scale, site selection considered aspect, topography, and land systems. At the finer scale, consideration was given to the proximity of water bodies (drainage lines and creeks), vegetation complexes and condition and soil type. Sites were primarily chosen to represent the best example of distinct habitats within the broader habitat associations of the study area with a focus on significant fauna species identified in the desktop review.

Field methods for the terrestrial fauna survey are summarised as follows:

- Habitat assessment;
- Systematic trapping;

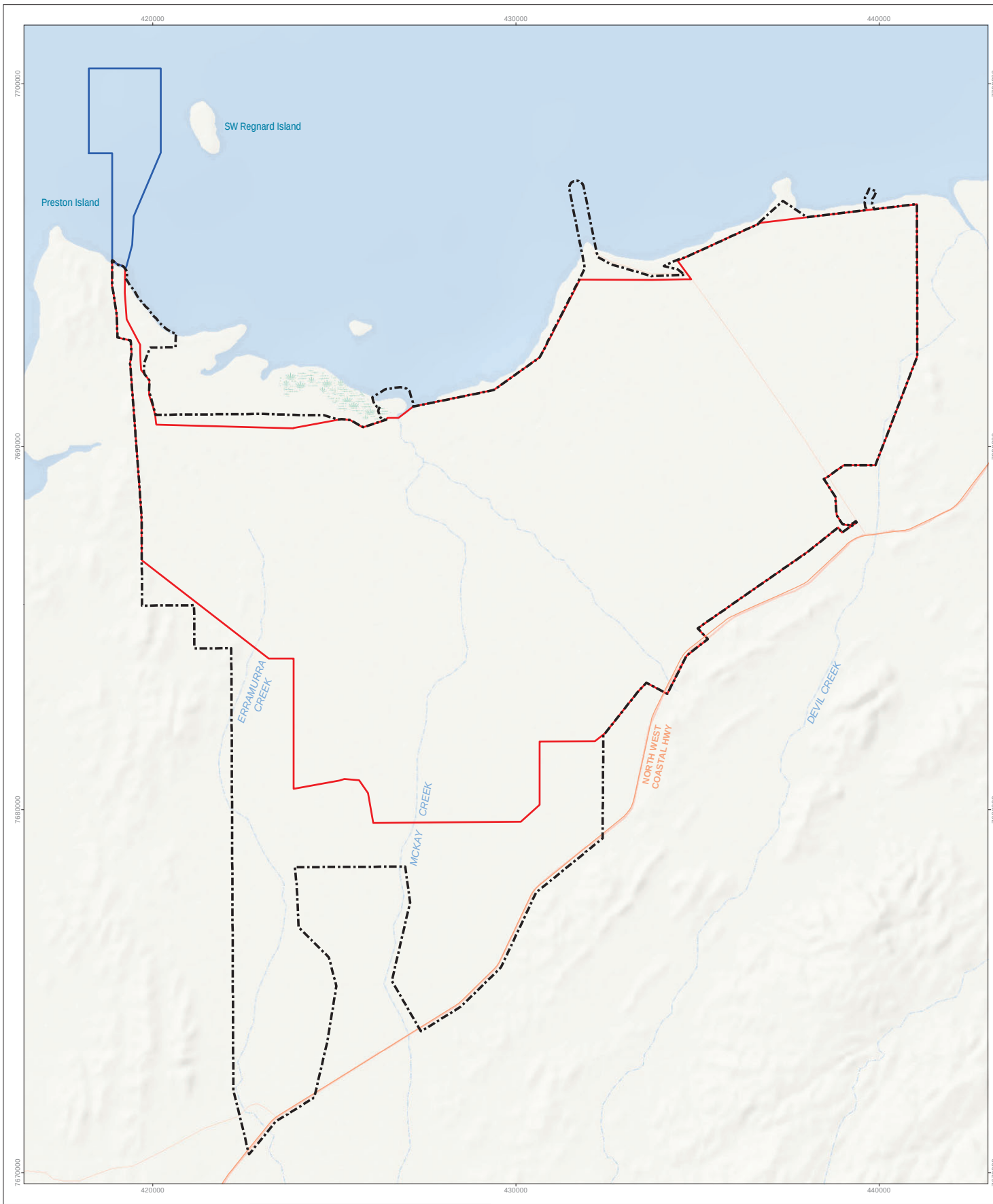
- Active diurnal and nocturnal searches;
- Avifauna surveys;
- Bat echolocation recordings;
- Camera trapping;
- Night Parrot audio recordings;
- Migratory shorebird surveys; and
- SRE invertebrate sampling.

The timing of the field survey work was as follows:

- Shorebird helicopter survey over five periods from:
  - 9 – 11 December 2019 (Phase 1);
  - 13 – 18 January 2020 (Phase 2);
  - 2 – 5 February 2020 (Phase 3);
  - 10 – 12 February 2020 (Phase 4);
  - 6 – 8 July 2020;
- Terrestrial fauna survey, including vertebrate fauna and SRE invertebrates from 15 – 27 April 2020;
- Targeted night parrot survey from December 2019 – February 2020 and November-October 2024;
- Northern Quoll monitoring (camera trapping) from February 2024 – April 2025;
- Targeted SRE survey from 24–- 27 April 2021 for trap installation and foraging, and from 24–- 26 May 2021 for trap pickup; and
- Basic/targeted fauna survey from 29 November – 7 December 2021.

The locations of TFSA survey sites in relation to fauna the disturbance footprint and fauna habitats are shown in Figure 12-3 and Figure 12-4.

O2 Marine were commissioned to undertake two preliminary assessments of BCH in 2021 (O2 Marine, 2025c & d). This work included mapping of the mangroves, algal mats and samphire shrublands along the coastline. This survey also provided regional context for fauna habitats.

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- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

**LOCALITY**




Legend

- Marine Development Envelope
- Pond and Infrastructure Development Envelope
- Terrestrial Fauna Study Area

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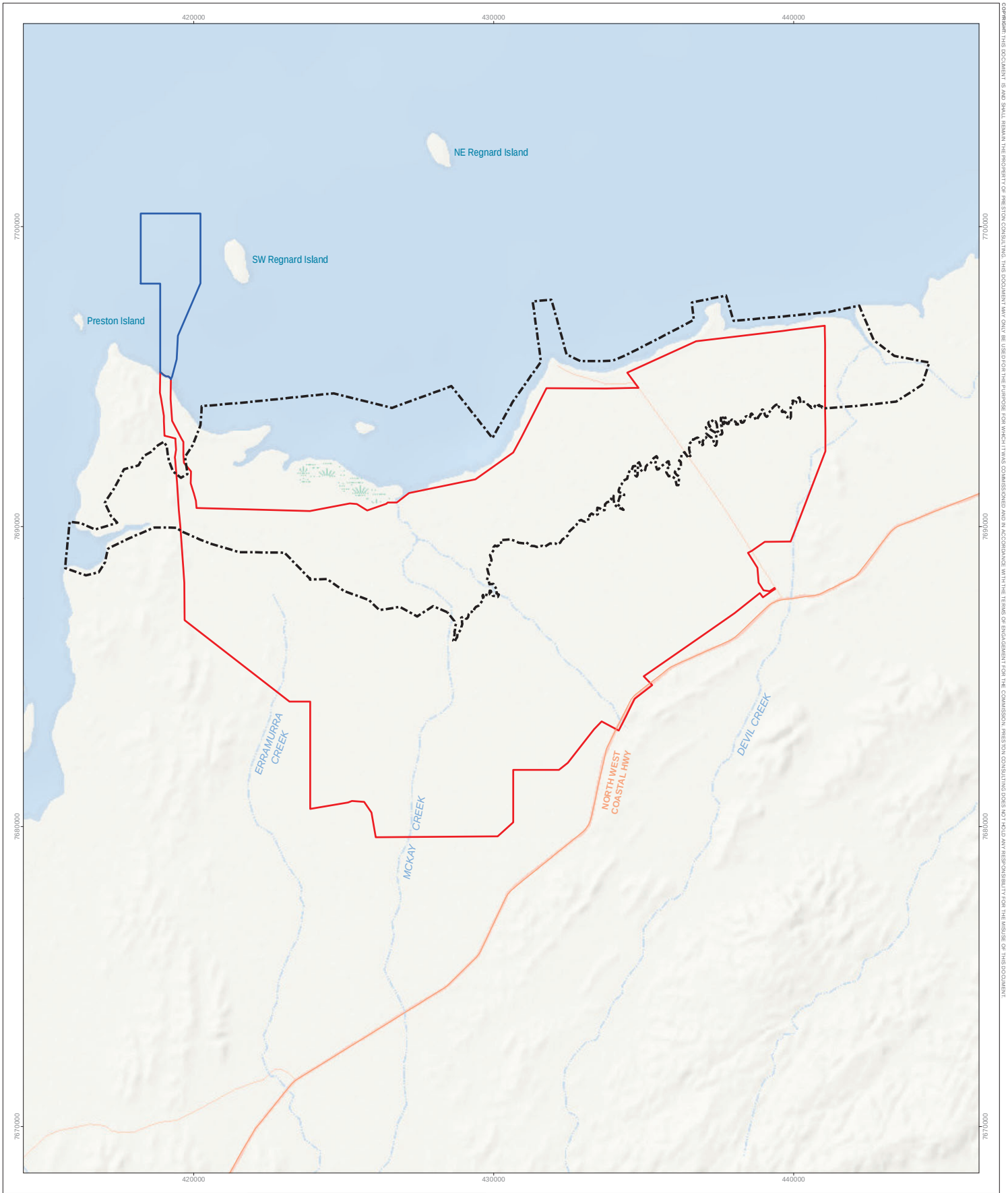
Figure 12-1: Terrestrial Fauna Study Area (TFSA)

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- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

**LOCALITY**




Legend

- Marine Development Envelope
- Pond and Infrastructure Development Envelope
- Shorebird Bird Study Area

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**Figure 12-2: Migratory Shorebird Study Area (SBSA)**

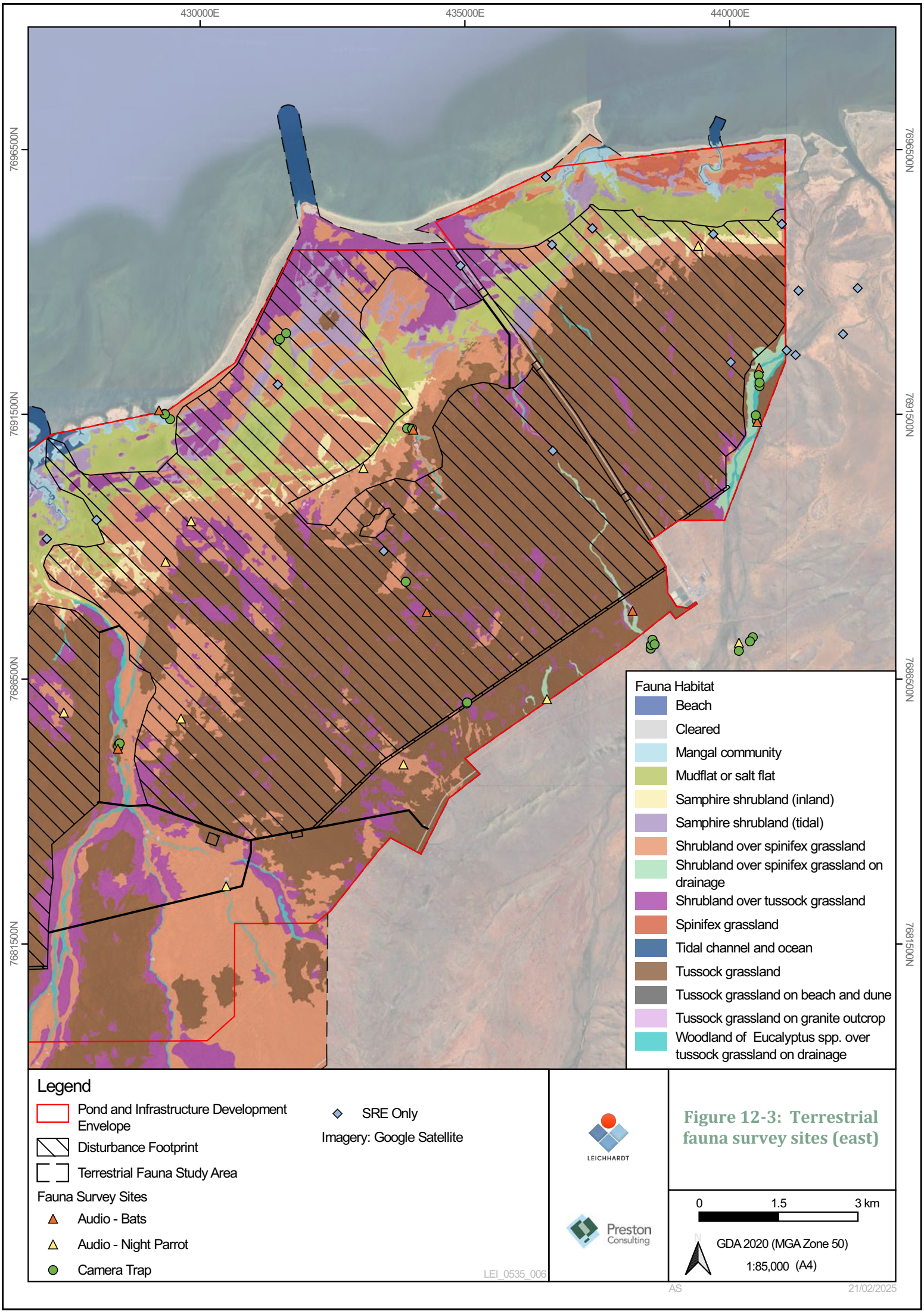



**Figure 12-3: Terrestrial fauna survey sites (east)**

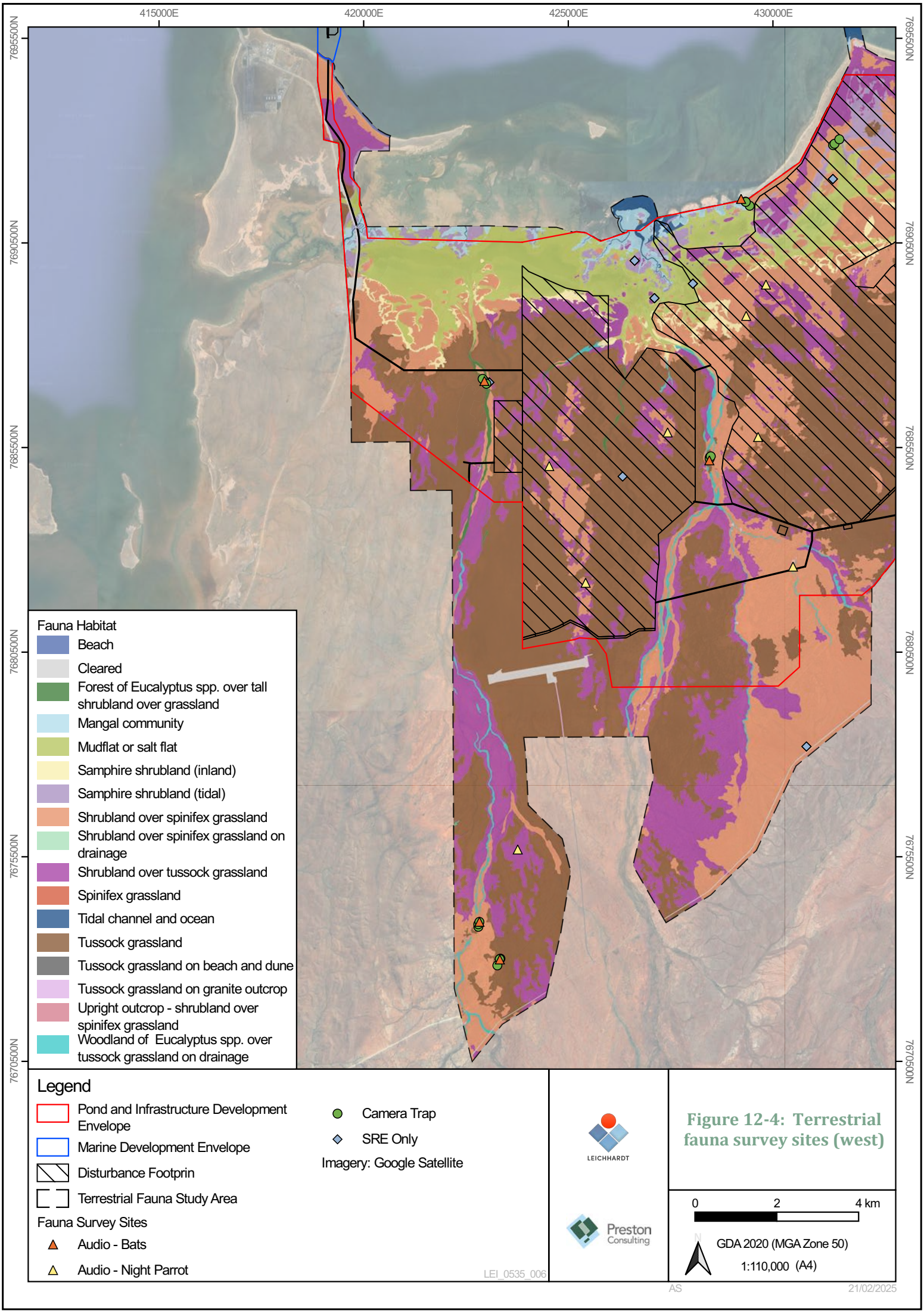



**Figure 12-4: Terrestrial fauna survey sites (west)**

***Migratory Shorebirds***

Migratory shorebird surveys were conducted over five phases (four summer, one winter) by personnel from Phoenix and Ornithological Technical Services, a specialist avifauna consultancy. Habitats sampled included tidal channels, beaches, mangrove areas, intertidal sand/mudflats, and supratidal mudflats.

DotEE (2017b) acknowledges that in large study areas and areas where many birds may occur, it may be impossible to achieve a complete ('instantaneous') survey of shorebirds. The Program for Regional and International Shorebird Monitoring (PRISM, 2018) details survey methods for monitoring non-breeding shorebirds. They recommend sampling be undertaken wherever possible within discrete, manageable spatial units, such that an instantaneous sample can be achieved, preferably within 2 – 3 hours, centred around tidal movements (as the area of available habitat changes with time and being aligned with peak tides means the most 'stable' area of habitat availability is surveyed) and thereby reducing the risk of observer fatigue.

The SBSA was large and thus the methodology was designed to achieve as close to an instantaneous survey as possible and was based on experience gained assessing an almost identical project (Mardie Project) just 30 km to the west-southwest (Phoenix, 2020).

Aerial (R44 helicopter) counts were the main method employed but ground counts were also completed in areas of high density/activity. An R44 helicopter was considered the most effective method to access such a large area of coastline and associated habitat. The alternative survey craft were boat and fixed-wing plane which were determined to be unviable. Boats were not considered suitable as they would likely have resulted in a very limited and/or biased dataset, due to the following reasons:

- Survey by boat would have taken much longer in each phase to achieve coverage meaning a 'snap-shot' could not be attained as significant numbers of birds could move in and out of the area in any survey period;
- Mangrove roosting birds are difficult to flush, identify and count (DotEE, 2017b);
- Large parts of the SBSA were not accessible by boat, particularly landward roosting and feeding grounds which would not have even been identified without aerial support; and
- Flocks could not be reliably tracked and therefore the risk of double-counting was considered too high.

The limitations of surveying with a fixed-wing plane include the inability to rapidly respond to bird movements, slow down or stop, which would have resulted in large numbers being missed or double-counted on return. In addition, no ground counts could be achieved.

Survey from helicopter was therefore chosen as the most viable method for shorebird surveys, capable of overcoming the above limitations. It was particularly effective at detecting birds active in the extensive mangroves of the SBSA (a habitat unit where assessment is often inadequate; DotEE, 2017b) as the helicopter was able to fly along both seaward and landward faces, or over the top of mangroves, as necessary.

Aerial transects were typically three hours in duration, centred on the peak low and high tide each day. A total of 21 survey events were completed (including one incomplete survey interrupted due to a mechanical issue with the aircraft) equating to 54.5 hours of aerial survey time. The survey program methods therefore largely met the considerations detailed in PRISM (2018).

Each sample transect commenced in the east and tracked west, then returned east and then west and east again. On high tides, they commenced on the landward side of the SBSA and on low tides they commenced on the coast over the exposed tidal mudflats, reefs, and near-shore islands, finishing over the inland mudflats.

Where large congregations were encountered, the helicopter hovered or slowly circled so that the full complement of a flock could be identified and counted. Care was taken to track flocks so as not to double-count birds. The helicopter was also landed so that ground counts could be completed at certain areas, e.g., in areas of high foraging/roosting density/activity. Care was always taken to avoid disturbance of feeding or roosting activity, primarily by flying low and slow towards any congregations identified. It was apparent that this typically resulted in the birds taking to the wing for short periods of time before landing back in the same location. There were no observed events of congregations permanently departing an area due to disturbance by the helicopter observations.

While conducting the surveys, a primary observer was positioned in the front of the helicopter who called out species names and numbers to the be recorded by a secondary observer who also made other observations, identified, and tracked flocks, as required.

It was estimated during the surveys that identifications could be reliably made on average 150 m either side of the helicopter. Based on this, an area of 11,902.8 ha was reliably surveyed in total, including 10,086.9 ha within the SBSA, which represents over 80% of the SBSA over the course of the 21 transects completed.

A 'site' comprised both single and multiple species records, as required. In total, 5,288 site point-locations were marked during the five survey phases in the 54.5 hours of aerial and ground count surveys. These comprised 4,752 within the SBSA and 536 outside.

The data gathered on migratory shorebirds was assessed against the criteria for determining nationally and internationally important habitats in Australia, including total abundance for each sample event and for individual species records against the most recent published East Asian-Australasian Flyway (EAAF) population estimates for 37 species of shorebird (Hansen et al., 2016), where the total abundance of a species in each of the sample events was calculated.

To determine the estimated abundance for each species across the SBSA, it was necessary to multiply the maximum recorded abundance by the extrapolation factor for the survey component area. While shorebirds are highly mobile and not always evenly distributed, this was considered the most reliable and accurate method available for estimating the total abundance for a species within the SBSA, particularly given that the recorded abundance for a species in any given sample event is likely an underestimate of the actual resident numbers as the entire area could not be reliably surveyed.

The analysis of total shorebird population considered only the 37 species listed under *EPBC Act Policy Statement 3.21* (DotEE, 2017b) with the total abundance in each sample event again calculated. Other 'shorebird' species listed as migratory under the BC Act only, such as the gull-billed tern, were not considered in these calculations.

### *Northern Quoll*

Curtin University was commissioned to undertake a detailed camera trapping program within identified potential Northern Quoll habitat to determine presence (Cowan, 2024).

Based on a review of spatial information provided by Phoenix (2023), 20 cameras were deployed on 16 February 2024 to sample the three areas identified as important to Northern Quolls. Eight cameras were placed in the area identified as critical habitat, seven along the area identified as dispersal/foraging habitat and five in the part of Devil Creek (outside the indicative disturbance footprint) (Figure 12-5). Cameras were placed at locations to ensure comprehensive coverage of the habitat available within each of the three target areas. The total number of camera trap nights without lures was 2,000 (as at October 2024) with 800 in the critical habitat, 700 in the foraging/dispersal habitat, and 500 in the Devil Creek area. The number of trap nights with lures was 1,060: 424 in the critical habitat, 371 in the foraging/dispersal habitat, and 265 in Devil Creek. Combined, this resulted in a total of 3,060 camera trap nights: 1,224 in the critical habitat, 1,071 in the foraging/dispersal habitat, and 765 in Devil Creek (Cowan, 2024).

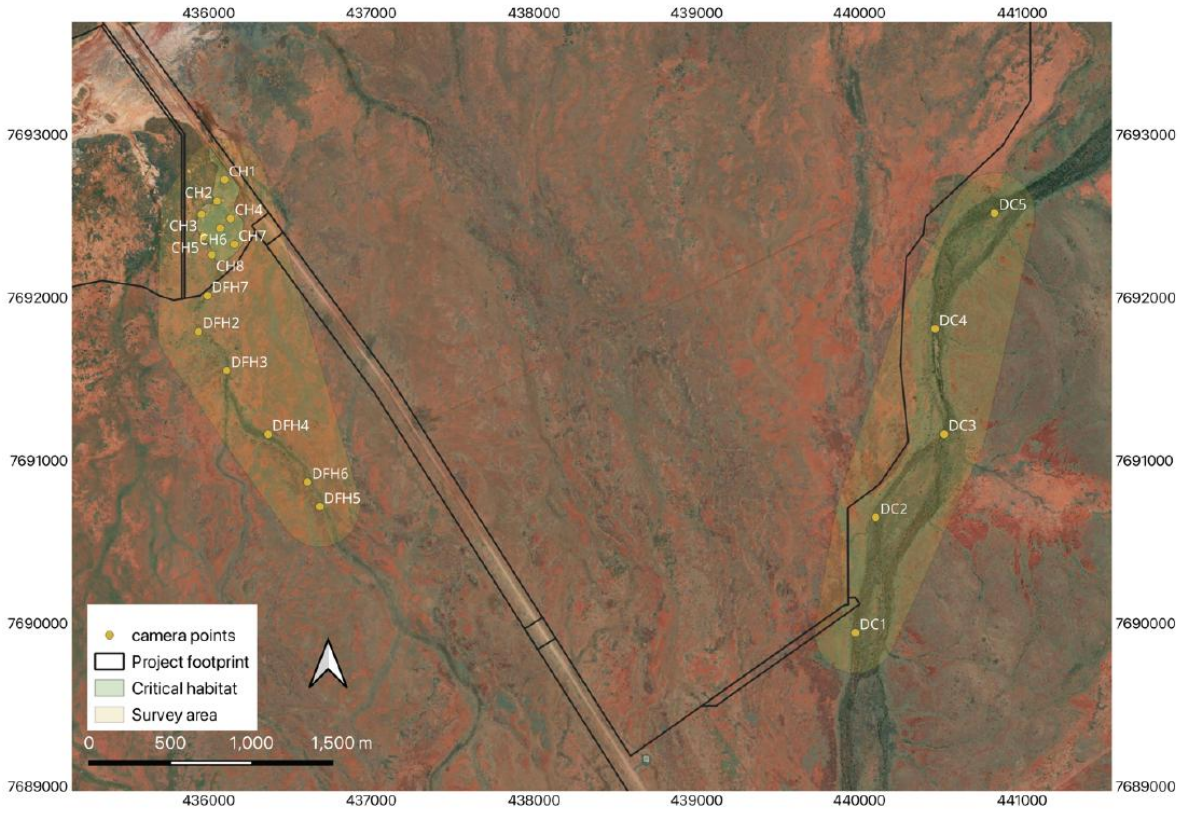



Figure 12-5: Northern Quoll camera placements

### *Night Parrot*

Automated Recording Units (ARUs) targeting night parrot were deployed at 14 sites within the TFSA (Figure 12-3) using SongMeter units in areas considered the most prospective habitat (i.e., areas of relatively large, old spinifex hummocks).

Four devices were deployed during the December 2019 survey, which were moved to new sites in January 2020 and retrieved in February 2020. Three devices were deployed during November 2021 and moved after six nights to a further two locations for two nights.

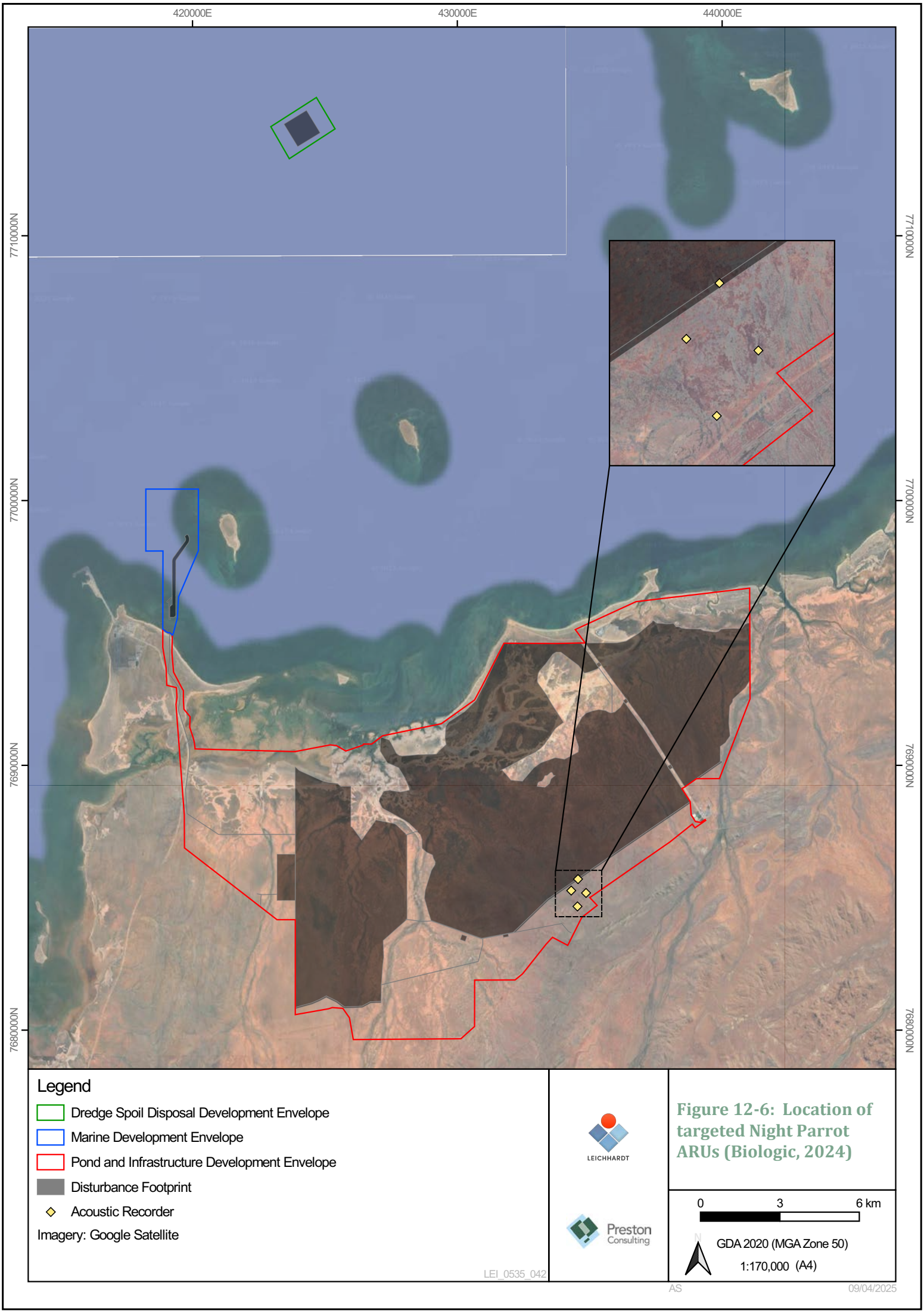
Acoustic data gathered to determine the presence of the Night Parrot and the resultant recordings were analysed by Phoenix and Robert Bullen (Bat Call WA Pty Ltd) independently, with results communicated by email.

Recordings were subsequently analysed by Nick Leseberg at Adaptive NRM (Leseberg, 2022; Appendix 6.2; Appendix 6.2) to provide a specialist opinion on the recordings and confirm if any may be associated with the Night Parrot. Adaptive NRM was provided with data from ten of the 14 survey sites by Phoenix. Of these ten sites, it was found that seven sites had enough data to allow robust conclusions around Night Parrot presence in the immediate vicinity of those sites. The duration of recorded data was insufficient for NP07, NP13 and NP14, and data was not provided for NP05, NP06 and NP11. Due to insufficient labelling, two recordings may be ascribed to NP09, NP10 or NP12.

In 2024 a revised desktop assessment of potential Night Parrot habitat was therefore conducted with the explicit purpose of identifying any Night Parrot habitat that exists within the PIDE (Leseberg, 2024; Appendix 6.2). This report concluded that although there are significant amounts of possible foraging habitat available, there is only very limited potential roosting habitat. A revised acoustic sampling program was designed by Adaptive NRM to survey this roosting habitat and determine whether Night Parrots occur at that site. This sampling program was implemented by Biologic (2024) in October and November 2024 with survey details provided in Table 12-2 and shown in Figure 12-6.

**Table 12-2: Night Parrot acoustic recording details**

| Site name | Recording start date (PM) | Recording end date (AM) | Total recording nights |
|---|---|---|---|
| VENP-001 | 19-Oct-24 | 6-Nov-24 | 18 |
| VENP-002 | 19-Oct-24 | 6-Nov-24 | 18 |
| VENP-003 | 19-Oct-24 | 28-Oct-24 | 9 |
| VENP-004 | 19-Oct-24 | 27-Oct-24 | 8 |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Marine Development Envelope
Pond and Infrastructure Development Envelope
Disturbance Footprint
Acoustic Recorder
Imagery: Google Satellite
LEICHHARDT
Preston Consulting
Figure 12-6: Location of targeted Night Parrot ARUs (Biologic, 2024)
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3
6 km
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GDA 2020 (MGA Zone 50)
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***Bat Acoustic Data Analysis***

Ultrasonic acoustic data gathered to determine the diversity and presence of bats within the TFSA (Figure 12-3) were analysed by Dr. Kyle Armstrong and Yuki Konishi (Specialised Zoological) and Mr Bob Bullen (Bat Call WA Pty Ltd).

### 12.3.2 REVIEW AGAINST RELEVANT SURVEY GUIDELINES

The methods, timing and techniques appropriate for each component (i.e., terrestrial fauna or migratory shorebirds) or particular species were reviewed against relevant State and Commonwealth survey guidelines (Table 12-3). The review has concluded that all survey methods complied with relevant State and Commonwealth legislation.

**Table 12-3: Review of survey methods against relevant State and Commonwealth guidelines**

| Component/species | Relevant guideline | Survey level/effort | Compliance |
|---|---|---|---|
| Terrestrial fauna surveys | Technical Guidance: Terrestrial fauna surveys for EIA (EPA, 2020)<br>Environmental Factor Guideline: Terrestrial fauna (EPA, 2016i). | Targeted/detailed survey – see multiple techniques, seasons and species targeted below. | **Compliant**<br>Multiple methods employed across multiple seasons, targeting species considered likely to occur based on the desktop review and as further knowledge of site gained. |
| SREs | Technical Guidance: Sampling of short range endemic invertebrate fauna (EPA, 2016k). | Detailed survey. | **Compliant**<br>Habitat mapping completed during field surveys followed by active foraging in the season following annual rainfall peak, in the most prospective habitats of the survey area.<br>Some areas of low prospectivity were not sampled however this is not considered to have affected the findings and impact assessment. |
| 37 EAAF Migratory shorebirds | EPBC Act Policy Statement 3.21—Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species (DotEE, 2017b). | 5 survey phases encompassing:<br>• 20 sample events (16 in summer, four in winter);<br>• Summer and winter periods;<br>• Aerial and ground counts;<br>• ~11,903 ha surveyed; and<br>• 54.5 hours of aerial survey completed. | **Compliant**<br>DotEE (2017b) states that "Ideally, survey effort should be comprised of a minimum of:<br>• Four surveys for roosting shorebirds- One survey in December, two surveys in January and one survey in February;<br>• Four surveys for foraging shorebirds, including two surveys at spring low tide and two surveys at neap low tide".<br>While it is noted that only a single January survey 'phase' was completed, the minimum effort was clearly met because in each phase, four transects (surveys) were completed at low and high tide, over consecutive days. An additional survey phase was also undertaken for a total of five |

| Component/species | Relevant guideline | Survey level/effort | Compliance |
|---|---|---|---|
| | | | survey phases and 20 surveys. Indeed, on this basis the minimum effort was exceeded. |
| Night Parrot | Interim guideline for preliminary surveys of Night Parrot (Pezoporus occidentalis) in Western Australia (DPaW, 2017). | • 18 ARU sites;<br>• Operated 18 nights on average; and<br>• Completed over multiple seasons, during good conditions. | **Compliant** |
| Olive python / reptiles | Survey guidelines for Australia's threatened reptiles. Guidelines for detecting reptiles listed as threatened under the EPBC Act (DSEWPaC, 2011c). | Nocturnal searches in most prospective area, during ideal conditions. | **Compliant** |
| Bats | Survey guidelines for Australia's threatened bats: Guidelines for detecting bats listed as threatened under the EPBC Act (DEWHA, 2010a). | • 6 echolocation sites;<br>• 5 nights recording at each site; and<br>• Sites located across the terrestrial and intertidal (mangrove) components of the TFSA. | **Compliant** |

### 12.3.3 SURVEY LIMITATIONS

The limitations of the terrestrial fauna surveys (Phoenix, 2023) have been considered (Table 12-4) in accordance with Technical Guidance: Terrestrial fauna surveys (EPA, 2020).

**Table 12-4: Phoenix (2023) survey limitations**

| Limitations | Survey limitation? | Comments |
|---|---|---|
| Availability of contextual information at a regional and local scale | No | There was ample information concerning species and habitats in the vicinity of the study area from nearby surveys and research. |
| Competency/experience of the team carrying out the survey | No | All members of the survey team have had appropriate training and experience in terrestrial fauna surveys within the Pilbara region, with specialised zoologists engaged where appropriate, e.g., ornithologists with experience in shorebird surveys from ornithological technical services (OTS). |
| Scope and completeness-- were all target groups sampled, were all planned survey methods implemented successfully, was the Study Area fully surveyed? | No | All faunal groups were sampled using systematic methods. Substantial targeted search efforts were made to assess the presence of significant fauna species thought most likely to occur based on desktop records. |

| Limitations | Survey limitation? | Comments |
|---|---|---|
| Proportion of fauna identified, recorded and/or collected, any identification issues. | No | Approximately 44% of the species identified in the desktop review were recorded in the field surveys, including 49% of significant species, and including a number of important range extensions being documented. No difficulties were encountered in identifying targeted fauna species when encountered.<br>Refer to text below regarding species accumulation curves. |
| Access within the study area | No | Adequate access to all parts of the study area. |
| Timing, rainfall, season | No | The study areas were sampled over multiple years, seasons, and conditions between 2019 and 2021. Shorebird surveys were conducted at both spring and neap low tides, in summer and winter, and were replicated well above the minimum expectations of the recommended survey effort detailed by the DotEE (2017b). SRE sampling was conducted within the optimal survey period (November to April). |

Characterising the vertebrate fauna assemblage is much more difficult than guidance implies and may best be achieved through database review and landscape interpretation.

Complete documentation of the vertebrate assemblage cannot be achieved with the levels of sampling suggested in guidance as the sampling used only detects a proportion of the fauna (pers. comms. Mike Bamford). The species accumulation curves provided by Phoenix (2023) are typical of most similar projects, and the predicted assemblage size will be very inadequate as the traps used sample only a proportion of the reptile assemblage.

The information below has been provided by Mike Bamford as a pers. comms. Mike Bamford was consulted regarding the concerns with the assumption that sampling as per guidance is critical to effective EIA. His concerns with the assumption include:

- The sampling considers vertebrates and only a very small suite of invertebrates. Therefore, it is addressing probably <5% of the actual fauna assemblage;
- There is considerable annual variation in the fauna assemblage in terms of abundance and even presence. This is particularly the case in arid and semi-arid regions;
- Standard sampling methods are highly biased. Bamford and Calver (2015) outlines how extremely biased pitfall traps are in the sampling of reptiles, with some of the most abundant species in the assemblage being extremely under-represented in pitfall samples;
- Sampling methods are not very efficient. In a review of seven level 2 ('detailed') surveys, 15 - 47% of the reptile assemblage was not found by trapping. These were species found only by searching and opportunistic sightings. These cannot be factored into species accumulation curves. The average was 31%, almost a third of the reptile assemblage was undetected by recommended trapping methods. In one of these studies (in the Pilbara), the number of reptile species recorded only by trapping (i.e., species that were detected by any other means) was determined: just nine (21%) species in a recorded assemblage of 43 reptiles were found only by trapping. Therefore, 79% of the reptile assemblage were confirmed without resorting to trapping;

- Biodiversity is high even within one vegetation type, which means that replicate sampling sites in the same 'habitat' will not record the same assemblage even when a true asymptote in the species assemblage is reached. As an example, in a >30 year sampling program, two transects of pitfalls 400 m apart and in the same vegetation, species accumulation (reptiles) reached an asymptote at 24 or 26 years, but with different numbers of species (42 on one transect, 47 on the other), but 49 species were recorded overall. Therefore, the transect with 42 species lacked seven species found on the other transect, and the transect with 47 species lacked two species found on the other. There were also another seven species recorded within 500 m of the transects, which were not recorded. There is so much biodiversity in these sorts of assemblages that even where absolute species accumulation data are available, the species accumulation is relevant only to a particular site;
- The absolute (i.e., real data; not a model) species accumulation indicate it takes over two decades of near-annual sampling to reach a species asymptote. Interestingly, the application of recommended species accumulation models to these data suggest that the recorded species assemblage remains incomplete even after 24 - 26 years. The modelled assemblage for the transect that recorded 42 species was 45 - 52 species, and that for the transect with 47 species was 52 - 61 species. This apparent incompleteness may be explained by species turnover within the data (there were some species recorded in the programme that either disappeared after a few years, or were not detected until after 15 years of sampling). The known reptile assemblage from all sampling in the area was 58 species. It clearly takes an extensive survey effort, over many years, just to confirm the majority of reptile species in an area. Species accumulation curves, as suggested by guidance, are likely to be highly inaccurate when applied to small datasets of very incomplete samples; and
- Measuring the number of species and the 'completeness' of the survey is not effective. Recording common species, or conducting extensive surveys to detect species that may only rarely occur in an area is not useful to EIA. EIA should instead focus on processes, ecological interactions/impacts and species of significance.

### 12.3.4 FAUNA HABITAT

A total of 16 fauna habitat types were identified in the TFSA which can be classified into eight broad groupings based on vegetation and landform:

- Tussock grasslands on beaches and dunes;
- Mangal forests;
- Eucalypt forests and woodlands (typically on drainage lines);
- Samphire shrublands (tidal and inland) which are indistinguishable floristically;
- Tussock grasslands, with varying degrees of shrub cover/dominance;
- Spinifex grasslands;
- Tidal creeks and ocean; and
- Mudflats and salt flats.

Descriptions and mapped extent of the habitats are provided in Table 12-5 and shown in Figure 12-7 and Figure 12-8.

Table 12-5: Fauna habitats of the TFSA

| Habitat | Vegetation descriptions | Mapped extent within TFSA (ha) | Percentage of TFSA |
|---|---|---|---|
| Beach | Beach. | 16.4 | 0.1 |
| Cleared | Cleared, no native vegetation. | 142.1 | 0.5 |
| Forest of *Eucalyptus* spp. over tall shrubland over grassland | Variably present open forest of *Eucalyptus victrix* and/or *E. camaldulensis* (s.l.), over tall variably present open shrubland of *Acacia coriacea* (s.l.), over mid grassland to closed grassland of *Chrysopogon fallax*, *Eriachne flaccida*, and *Cenchrus* spp. (EvAcCf). | 54.6 | 0.2 |
| Mangal community | Mangrove forests and thickets. | 285.1 | 1.1 |
| Mudflat or salt flat | Bare, unvegetated mudflats and salt flats. | 2,419.7 | 9.1 |
| Samphire shrubland (tidal) | Low open shrubland to shrubland of *Tecticornia* sp., variably with *Surreya diandra* and *Frankenia pauciflora*, over variably present isolated tussock grasses to tussock grassland of *Eragrostis falcata* and *Xerochloa laniflora* (Tspp). | 593.7 | 2.2 |
| Samphire shrubland (inland) | Low open shrubland to shrubland of *Tecticornia* spp., variably with *Surreya diandra* and *Frankenia pauciflora*, over variably present isolated tussock grasses to tussock grassland of *Eragrostis falcata* and *Xerochloa laniflora* (Tspp). | 295.1 | 1.1 |
| Shrubland over spinifex grassland | Mid sparse to open shrubland of *Acacia bivenosa*, with occasional *A. stellaticeps* and *A. coriacea* (s.l.), over low hummock grassland of *Triodia wiseana* (AbTw).<br>Variably present mid isolated shrubs of *Acacia coriacea* (s.l.) and *A. bivenosa*, over mid isolated forbs of *Evolvulus alsinoides* var. *villosicalyx*, *Arivela viscosa*, and *Rhynchosia minima*, over mid open to closed hummock grassland of *Triodia epactia* and *Cenchrus *ciliaris* (Te).<br>Tall sparse shrubland to shrubland of *Acacia coriacea* (s.l.), *A. ligulata*, and/or *A. sclerosperma* subsp. *sclerosperma*, over low isolated shrubs to open shrubland of **Aerva javanica*, *Corchorus walcottii*, and *Rhagodia eremaea*, over low sparse hummock grassland to hummock grassland of *Triodia epactia* with **Cenchrus ciliaris* and *Whiteochloa airoides* (AcAjTe). | 5,326.5 | 20.1 |
| Shrubland over tussock grassland | Variably present tall sparse shrubland to shrubland of *Acacia sclerosperma* subsp. *sclerosperma, A. coriacea* (s.l.), and *A. inaequilatera*, over low sparse grassland to closed grassland of **Cenchrus ciliaris*, *Dactyloctenium radulans*, and **C. setiger* (AssCc).<br>Low sparse to open shrubland of **Aerva javanica* and *Solanum lasiophyllum*, over low sparse grassland to grassland of **Cenchrus* spp. with *Whiteochloa airoides* and/or *Sorghum plumosum* (AjCspp).<br>Mid sparse shrubland to open shrubland of *Acacia xiphophylla*, over low isolated forbs of *Sida fibulifera, Ptilotus exaltatus,* and *Rhynchosia minima,* over low sparse to open tussock grassland of *Eragrostis xerophila, Dichanthium sericeum* subsp. *humilius,* and *Aristida contorta* (AxEx) | 3,805.2 | 14.4 |

| Habitat | Vegetation descriptions | Mapped extent within TFSA (ha) | Percentage of TFSA |
|---|---|---|---|
| | Mid to tall open shrubland to shrubland of *Myoporum montanum*, *Acacia ampliceps*, and *Rhagodia eremaea*, over low isolated chenopod shrubs of *Tecticornia* spp. and *Threlkeldia diffusa*, over mid tussock grassland of *Sporobolus virginicus* with occasional **Cenchrus ciliaris* and *Triodia epactia* (MmTsppSv). | | |
| Shrubland over spinifex grassland on drainage | Tall sparse shrubland of *Acacia inaequilatera*, with occasional *Ipomoea costata* and *A. coriacea* (s.l.), over mid sparse shrubland of *Eremophila longifolia*, with occasional *Acacia pyrifolia* var. *pyrifolia* and *A. bivenosa*, over low open hummock grassland to hummock grassland of *Triodia wiseana* with **Cenchrus ciliaris* and occasional *T. epactia* (AiElTw). | 100.0 | 0.4 |
| Spinifex grassland | Low isolated shrubs of **Aerva javanica, Corchorus walcottii*, and *Indigofera linnaei*, over mid open to closed hummock grassland of *Triodia epactia*, co-dominant with *Whiteochloa airoides* and some presence of **Cenchrus ciliaris* (TeWA). | 120.5 | 0.5 |
| Tidal channel and ocean | Tidal channel and ocean | 155.9 | 0.6 |
| Tussock grassland | Isolated low shrubs of *Abutilon lepidum*, *Indigofera monophylla*, and *Triumfetta clementii*, over isolated forbs of *Trichodesma zeylanicum* var. *zeylanicum*, *Ptilotus auriculifolius* or *P. clementii*, and *Evolvulus alsinoides* var. *villosicalyx*, over low hummock grassland of *Triodia wiseana* (Tw).<br>Hybrid or mosaic of two vegetation types.<br>Low isolated forbs of *Sida fibulifera*, *Rhynchosia minima*, and *Indigofera trita*, over low tussock grassland to closed tussock grassland of *Eragrostis xerophila, Dichanthium sericeum* subsp. *humilius,* and *Sorghum plumosum* (Ex). | 12,914.6 | 48.8 |
| Tussock grassland on beach and dune | Not mapped | 0.03 | <0.1 |
| Tussock grassland on granite outcrop | Exposed granite areas containing low isolated shrubs of *Hibiscus sturtii* var. *campylochlamys*, over isolated forbs of *Indigofera linifolia*, *Arivela viscosa*, and *Boerhavia coccinea*, over low isolated grasses of **Cenchrus ciliaris*, *Enneapogon caerulescens*, and *Sporobolus australasicus* (HscIlCc). | 9.5 | <0.1 |
| Upright outcrop-- shrubland over spinifex grassland | Mid sparse to open shrubland of *Acacia bivenosa*, with occasional *A. stellaticeps* and *A. coriacea* (s.l.), over low hummock grassland of *Triodia wiseana* (AbTw). | 0.5 | <0.1 |
| Woodland of *Eucalyptus* spp. over tussock grassland on drainage | Mid open woodland to woodland variably composed of *Eucalyptus camaldulensis* (s.l.), *E. victrix*, and *Corymbia hamersleyana*, over tall sparse shrubland to shrubland of *Acacia coriacea* (s.l.) and *A. trachycarpa* with occasional stands of *Melaleuca glomerata*, over mid sparse grassland to grassland of **Cenchrus setiger, Dactyloctenium radulans*, and **C. ciliaris* (EcAcCs).<br>Mid open woodland to woodland of *Eucalyptus victrix* and occasional *E. camaldulensis* (s.l.), over mid to tall open shrubland composed variably of *Sesbania cannabina*, *Acacia sericophylla*, or *A. coriacea* (s.l.), over low open tussock grassland to grassland of *Sporobolus virginicus* (EvScSv). | 209.4 | 0.8 |

| Habitat | Vegetation descriptions | Mapped extent within TFSA (ha) | Percentage of TFSA |
|---|---|---|---|
| | Low woodland of *Eucalyptus camaldulensis* (s.l.), over tall open shrubland of *Acacia coriacea* (s.l.), *Melaleuca linophylla*, and *M. glomerata*, over mid open hummock grassland of *Triodia epactia* with **Cenchrus ciliaris* and *Eulalia aurea* (EcAcTe). | | |
| | **Total** | **26,448.8** | **100.0%** |

- Introduced flora species are indicated with an asterisk (*).

***Tussock Grasslands***

Tussock grasslands is the most dominant fauna habitat within the TFSA comprising approximately 60% of the total area. Tussock grasslands recorded a single significant species, the North-Western Free-tailed Bat (P1). The record here is associated with a drainage line and is consistent with other survey records in the region (Phoenix, 2013 and 2020), where the species was recorded several kilometres inland from its coastal roosting sites.

***Mangal Communities***

Mangal communities support North-Western Free-tailed Bat which was recorded from four locations and occurs extensively within mangal communities of the region. This habitat also supports foraging and roosting of numerous migratory shorebirds, such as Whimbrel (Migratory; EPBC Act, BC Act), and the Shining Flycatcher which was recorded as a range extension.

Additional regional mangal community mapping was undertaken by EnSTaR using satellite based remote sensing (EnSTaR, 2025a; Appendix 3.5). Leichhardt then used this mapping to estimate the total area of mangroves for the broader region and identified a total of 33,706 ha (Figure 8-14).

***Eucalypt forests and woodlands (typically on drainage lines)***

A number of drainage lines carry water from the south and east towards the coast and these typically support narrow strips of riparian eucalypt open woodlands and woodlands. Here, where the inland alluvial, more porous soils meet the marine-deposited soils of the mudflats above the current tide line, fresher groundwater is forced to the surface over the denser marine groundwater and pools. Further, if granite outcropping occurs, surface water persistence is often extended (mainly in the northeast). These habitats are typically heavily impacted by cattle and have likely suffered significant changes to the vegetation structure and composition. Despite the impacts, these habitat areas support Northern Quoll (EN; EPBC Act, BC Act) dispersal down the drainage lines from the hills to the south and shelter/denning opportunities where granite outcropping occurs. This habitat also recorded the Common Brushtail Possum, which Phoenix (2023) noted as a range extension. The Pilbara form of the Brushtail possum (Northern or Common) is however taxonomically unresolved (Middleton et al., 2022). Some experts consider it to be the Common Brushtail Possum whereas others ascribe to the Northern Brushtail Possum. Given this taxonomic uncertainty the Pilbara population of the Common Brushtail Possum has previously been referred to at the species level (360 Environmental, 2021). Six records of Brushtail Possums are known from the Roebourne subregion (Anderson et al., in prep) and it has been recorded at Miaree Pool (Professor Stephen van Leeuwen pers comm. July 2023), approximately 19 km from the nearest record at the Proposal.

The occurrence of persistent surface water in this habitat is also an important water source for most species of bird and mammal through the dry season.

### *Samphire Shrublands*

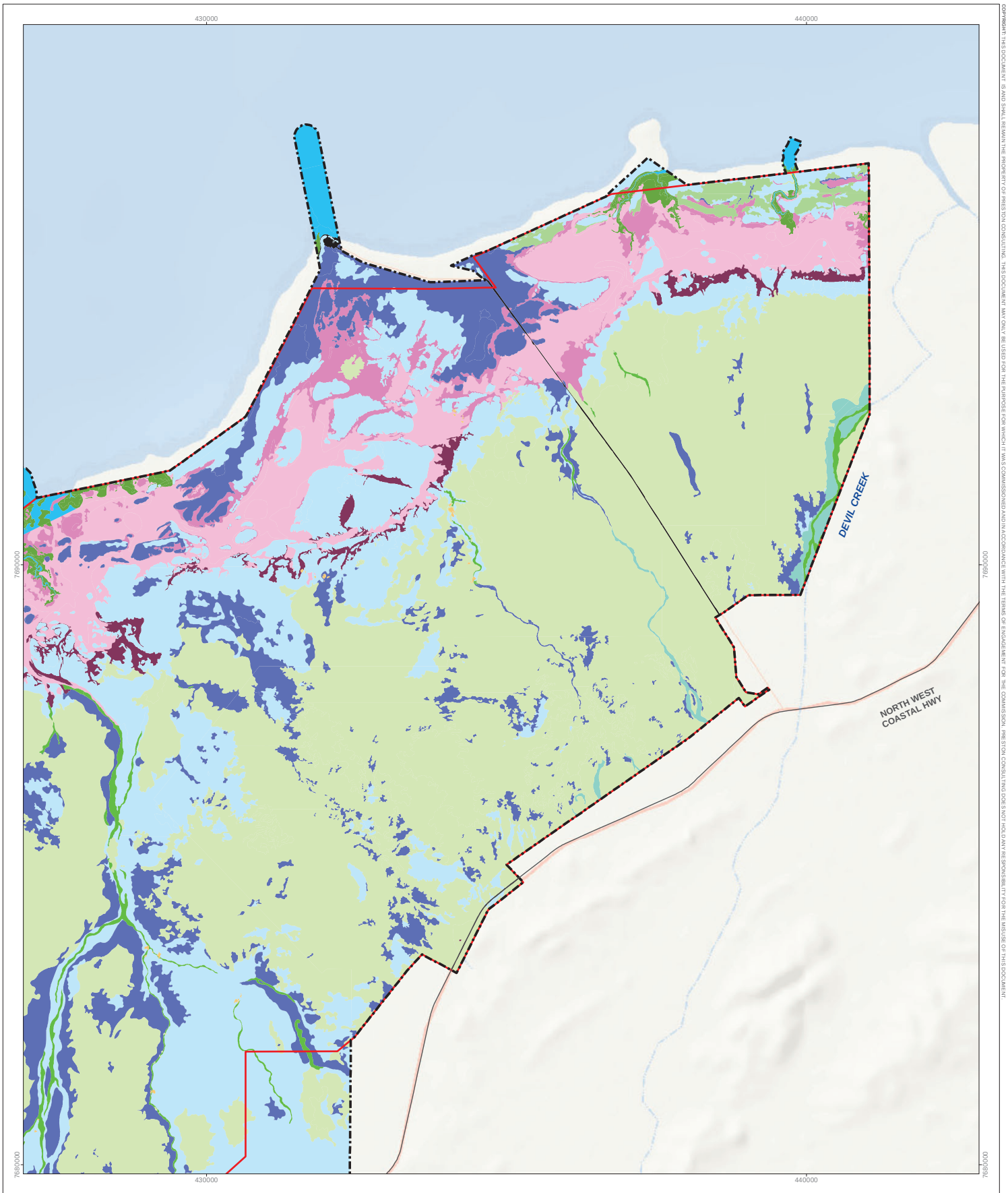
Within the tidal samphire habitat, 16 migratory bird species were recorded while conducting aerial shorebird transects. A Northern Quoll scat was also recorded in this habitat, just 790 m from the coast, and isolated from other Northern Quoll habitat features typically targeted when attempting to determine presence/absence of the species. Tidal samphire shrublands predominantly support foraging by the diverse and abundant shorebird assemblage recorded; of which 31 species were present (including six Threatened species) often in nationally significant numbers and occasionally in internationally significant numbers.

### *Spinifex Grasslands*

Spinifex grasslands is the second most dominant fauna habitat within the TFSA comprising approximately 21% of the total area. Spinifex grassland habitats were found to directly support four significant species, the Grey Falcon (VU; EPBC and BC Act), Northern Quoll, North-Western Free-tailed Bat, Pilbara Leaf-nosed Bat (VU; EPBC Act, BC Act) and the Lined Soil-crevice Skink (P4).

### *Mudflats and Salt flats*

A total of 24 Migratory bird species were associated with mudflat and salt flat habitat while conducting aerial shorebird transects.

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| CREATED BY | JOB | DATE | REVISION |
|---|---|---|---|
| ENVIRONMAPS | PC2900212 | 27/04/2023 | 0 |

**Leichhardt Salt Pty Ltd**

0 0.5 1 2
km

Scale: 1:60,000 @ A3

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- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

**LOCALITY**




Legend

- Marine Development Envelope
- Pond and Infrastructure Development Envelope
- Terrestrial Fauna Study Area

Fauna Habitat

- Beach
- Mangal community
- Tidal channel and ocean
- Mudflat or salt flat
- Samphire shrubland (tidal)
- Samphire shrubland (inland)
- Forest of Eucalyptus spp. over tall shrubland over grassland
- Shrubland over spinifex grassland
- Shrubland over spinifex grassland on drainage
- Shrubland over tussock grassland
- Spinifex grassland
- Tussock grassland on beach and dune
- Tussock grassland on granite outcrop
- Upright outcrop - shrubland over spinifex grassland
- Woodland of Eucalyptus spp. over tussock grassland on drainage
- Tussock grassland
- Cleared

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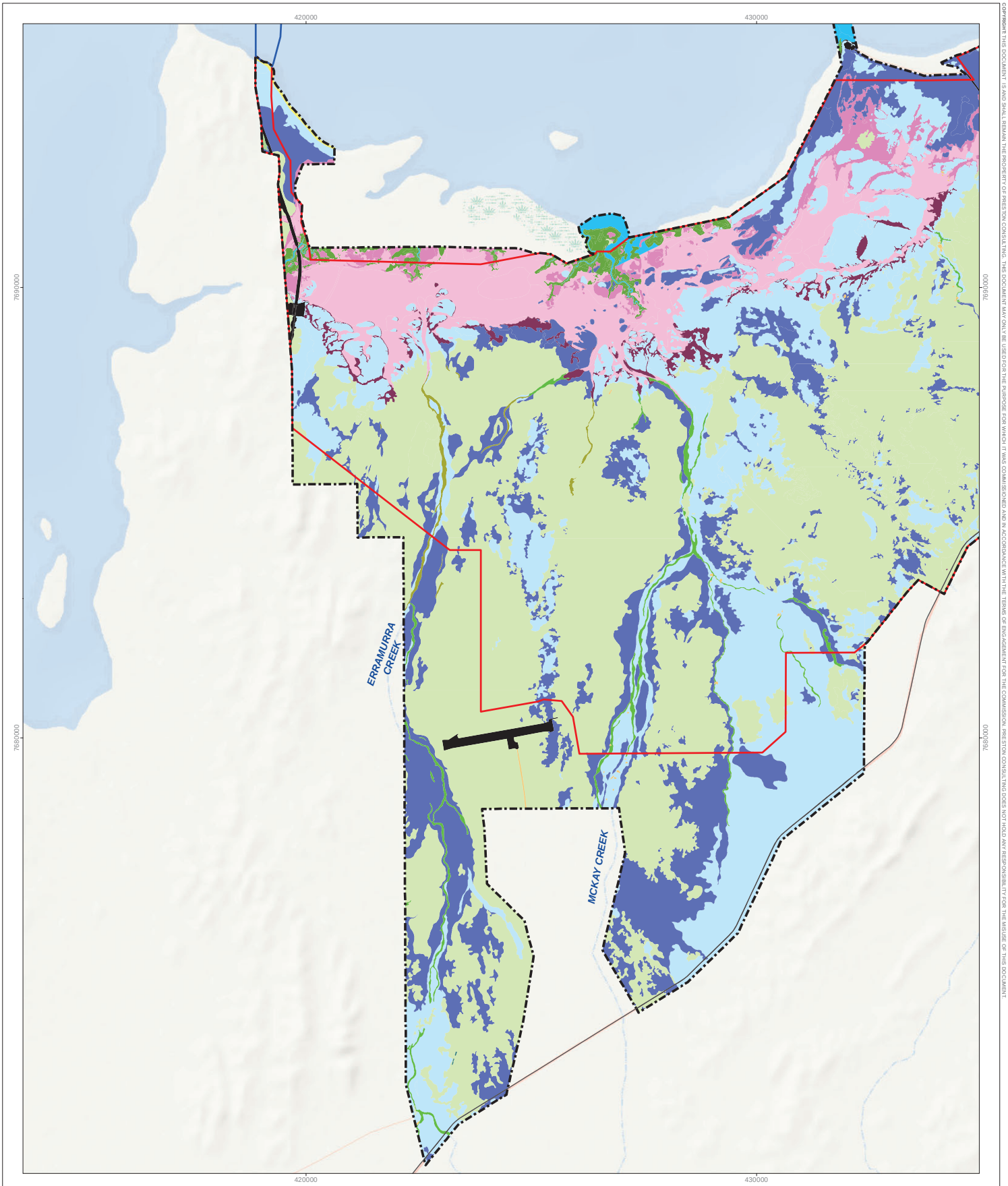
**Figure 12-7: Fauna habitats recorded within the TFSA (East)**

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**Leichhardt Salt Pty Ltd**

0 0.75 1.5 3
km
Scale: 1:80,000 @ A3

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- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

**LOCALITY**




Legend

- Marine Development Envelope
- Pond and Infrastructure Development Envelope
- Terrestrial Fauna Study Area

Fauna Habitat

- Beach
- Mangal community
- Tidal channel and ocean
- Mudflat or salt flat
- Samphire shrubland (tidal)
- Samphire shrubland (inland)
- Forest of Eucalyptus spp. over tall shrubland over grassland
- Shrubland over spinifex grassland
- Shrubland over spinifex grassland on drainage
- Shrubland over tussock grassland
- Spinifex grassland
- Tussock grassland on beach and dune
- Tussock grassland on granite outcrop
- Upright outcrop - shrubland over spinifex grassland
- Woodland of Eucalyptus spp. over tussock grassland on drainage
- Tussock grassland
- Cleared

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Figure 12-8: Fauna habitats recorded within the TFSA (West)

### 12.3.5 General Fauna

A total of 201 species were recorded in the TFSA and SBSA during the field surveys undertaken between December 2019 and December 2021, including two amphibians, 48 reptiles, 128 birds and 23 mammals (20 native and three introduced). This represents 44% of the species that were identified as potentially occurring in the desktop review. In addition monitoring for Northern Quolls completed by Cowan (2024) identified the most widespread and frequently recorded species were red kangaroos, present in every habitat and at every camera location.

Birds were the most diverse Class of vertebrates recorded, which is consistent with the findings of the desktop review. This is to be expected where the largest proportion of the survey effort has focused on birds, principally migratory shorebirds.

### 12.3.6 Significant Fauna

For the purposes of this assessment the term 'significant fauna' refers to:

- Fauna species listed under the EPBC Act or BC Act that were recorded or considered likely to occur within the study areas, as well as the Night Parrot;
- Species with restricted distribution;
- Species with a degree of historical impact from threatening processes; and
- Species that provide an important function required to maintain the ecological integrity of a significant ecosystem.

A total of 60 significant terrestrial fauna (noting that turtles are excluded as they are considered marine fauna) were recorded or considered likely to occur within the survey areas, including seven mammals, two reptiles and 51 birds (Table 12-6).

The significant fauna species that were recorded during the field surveys are shown in Figure 12-9 and outlined in Table 12-6. Migratory shorebirds are excluded from Figure 12-9, which only displays bird species listed under the EPBC Act or BC Act.

**Table 12-6: Significant fauna recorded or considered likely or possible to occur within the study areas**

| Species | Common name | Conservation status | Likelihood of occurrence |
|---|---|---|---|
| Mammals | | | |
| *Dasyurus hallucatus* | Northern Quoll | EN (EPBC Act; BC Act) | Recorded |
| *Macroderma gigas* | Ghost Bat | VU (EPBC Act; BC Act) | Likely |
| *Rhinonicteris aurantia* (Pilbara) | Pilbara Leaf-nosed Bat | VU (EPBC Act; BC Act) | Recorded |
| *Mormopterus cobourgianus* | North-Western Free-tailed Bat | P1 (DBCA) | Recorded |
| *Hydromys chrysogaster* | Rakali, Water Rat | P4 (DBCA) | Likely |
| *Leggadina lakedownensis* | Northern Short-tailed Mouse | P4 (DBCA) | Likely |
| *Pseudomys chapmani* | Western Pebble-mound Mouse | P4 (DBCA) | Likely |

| Species | Common name | Conservation status | Likelihood of occurrence |
|---|---|---|---|
| Reptiles | | | |
| *Notoscincus butleri* | Lined Soil-crevice Skink | P4 (DBCA) | Recorded |
| *Liasis olivaceus barroni* | Pilbara Olive Python | VU (EPBC Act; BC Act) | Likely |
| *Ctenotus angusticeps* | Airlie Island *Ctenotus* | P3 (DBCA) | Possible |
| Birds | | | |
| *Calidris ferruginea* | Curlew Sandpiper | CR/Mig. (EPBC Act; BC Act) | Recorded |
| *Calidris tenuirostris* | Great Knot | CR/Mig. (EPBC Act; BC Act) | Recorded |
| *Limosa lapponica menzbieri* | Bar-tailed Godwit (northern Siberian) | CR/Mig. (EPBC Act; BC Act); | Recorded |
| *Numenius madagascariensis* | Eastern Curlew | CR/Mig. (EPBC Act; BC Act) | Recorded |
| *Calidris canutus* | Red Knot | EN/Mig. (EPBC Act; BC Act) | Recorded |
| *Charadrius mongolus* | Lesser Sand Plover | EN/Mig. (EPBC Act; BC Act) | Recorded |
| *Puffinus huttoni* | Hutton's Shearwater | EN (BC Act) | Likely |
| *Charadrius leschenaultii* | Greater Sand Plover | VU/Mig. (EPBC Act; BC Act) | Recorded |
| *Sterna nereis nereis* | Australian Fairy Tern | VU (BC Act) | Recorded |
| *Falco hypoleucos* | Grey Falcon | VU (EPBC Act; BC Act) | Likely |
| *Oxyura australis* | Blue-billed Duck | P4 DBCA | Likely |
| *Tringa brevipes* | Grey-tailed Tattler | P4 (DBCA) Mig. (EPBC Act; BC Act) | Recorded |
| *Falco peregrinus* | Peregrine Falcon | OS (BC Act) | Likely |
| *Actitis hypoleucos* | Common Sandpiper | Mig. (EPBC Act; BC Act) | Recorded |
| *Arenaria interpres* | Ruddy Turnstone | Mig. (EPBC Act; BC Act) | Recorded |
| *Apus pacificus* | Fork-tailed Swift | Mig. (EPBC Act; BC Act) | Recorded |
| *Calidris acuminata* | Sharp-tailed Sandpiper | Mig. (EPBC Act; BC Act) | Recorded |
| *Calidris alba* | Sanderling | Mig. (EPBC Act; BC Act) | Recorded |
| *Calidris melanotos* | Pectoral Sandpiper | Mig. (EPBC Act; BC Act) | Recorded |
| *Calidris ruficollis* | Red-necked Stint | Mig. (EPBC Act; BC Act) | Recorded |
| *Charadrius veredus* | Oriental Plover | Mig. (EPBC Act; BC Act) | Recorded |
| *Chlidonias leucopterus* | White-winged Black Tern | Mig. (EPBC Act; BC Act) | Recorded |
| *Glareola maldivarum* | Oriental Pratincole | Mig. (EPBC Act; BC Act) | Recorded |
| *Limosa limosa* | Black-tailed Godwit | Mig. (EPBC Act; BC Act) | Recorded |
| *Numenius minutus* | Little Curlew | Mig. (EPBC Act; BC Act) | Recorded |
| *Numenius phaeopus* | Whimbrel | Mig. (EPBC Act; BC Act) | Recorded |
| *Pandion cristatus* | Osprey | Mig. (EPBC Act; BC Act) | Recorded |
| *Pluvialis fulva* | Pacific Golden Plover | Mig. (EPBC Act; BC Act) | Recorded |





| Species | Common name | Conservation status | Likelihood of occurrence |
|---|---|---|---|
| *Pluvialis squatarola* | Grey Plover | Mig. (EPBC Act; BC Act) | Recorded |
| *Sternula albifrons* | White-shafted Little Tern, Little Tern | Mig. (EPBC Act; BC Act) | Recorded |
| *Sterna bergii* | Crested Tern | Mig. (EPBC Act; BC Act) | Recorded |
| *Sterna caspia* | Caspian Tern | Mig. (EPBC Act; BC Act) | Recorded |
| *Sterna dougallii* | Roseate Tern | Mig. (EPBC Act; BC Act) | Recorded |
| *Sterna hirundo* | Common Tern | Mig. (EPBC Act; BC Act) | Recorded |
| *Sterna nilotica* | Gull-billed Tern | Mig. (EPBC Act; BC Act) | Recorded |
| *Tringa nebularia* | Common Greenshank | Mig. (EPBC Act; BC Act) | Recorded |
| *Xenus cinereus* | Terek Sandpiper | Mig. (EPBC Act; BC Act) | Recorded |
| *Ardenna pacifica* | Wedge-tailed Shearwater | Mig. (EPBC Act; BC Act) | Likely |
| *Calidris subminuta* | Long-toed Stint | Mig. (EPBC Act; BC Act) | Likely |
| *Fregata ariel* | Lesser Frigatebird | Mig. (EPBC Act; BC Act) | Likely |
| *Gallinago stenura* | Pin-tailed snipe | Mig. (EPBC Act; BC Act) | Likely |
| *Hirundo rustica* | Barn Swallow | Mig. (EPBC Act; BC Act) | Likely |
| *Limicola falcinellus* | Broad-billed sandpiper | Mig. (EPBC Act; BC Act) | Likely |
| *Oceanites oceanicus* | Wilson's Storm Petrel | Mig. (EPBC Act; BC Act) | Likely |
| *Plegadis falcinellus* | Glossy Ibis | Mig. (EPBC Act; BC Act) | Likely |
| *Sula leucogaster* | Brown Booby | Mig. (EPBC Act; BC Act) | Likely |
| *Tringa stagnatilis* | Marsh Sandpiper | Mig. (EPBC Act; BC Act) | Likely |
| *Tringa totanus* | Common Redshank | Mig. (EPBC Act; BC Act) | Likely |
| *Ardenna carneipes* | Flesh-footed Shearwater | Mig. (EPBC Act; BC Act),VU (BC Act) | Possible |
| *Calonectris leucomelas* | Streaked Shearwater | Mig. (EPBC Act; BC Act) | Possible |
| *Macronectes giganteus* | Southern Giant Petrel | EN (EPBC Act), Mig. (EPBC Act; BC Act) | Possible |
| *Limosa lapponica baueri* | Bar-tailed Godwit (western Alaskan) | VU, Mig (EPBC and BC Act) | Possible |
| *Phalaropus lobatus* | Red-necked Phalarope | Mig. (EPBC Act; BC Act) | Possible |
| *Tringa glareola* | Wood Sandpiper | Mig. (EPBC Act; BC Act) | Possible |
| *Motacilla flava* | Yellow Wagtail | Mig. (EPBC Act; BC Act) | Possible |

### *Mammals*

The field surveys identified three mammals that were considered to be 'significant fauna'. An additional four mammal species were identified during the desktop review as likely to occur: the Ghost Bat (*Macroderma gigas*), the Rakali (or Water Rat) (*Hydromys chysogaster*), the Northern Short-tailed Mouse (*Leggadina lakedoenensis*) and the Western Pebble-mound Mouse (*Pseudomys chapmani*).

The Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) is listed as Vulnerable under both the EPBC Act and the BC Act and was identified from a single detection. The Pilbara Leaf-nosed Bat is not a resident as no geological formations are present to form suitable roost caves. The record of a single detection in April suggests a post-maternity, dispersing individual. Pilbara Leaf-nosed Bats roost in warm and humid caves. At night, individuals disperse outside of their caves to forage in the open, often over open water. In the Pilbara, this habitat is almost exclusively present in large creek beds and gorges. Pilbara Leaf-nosed Bats also forage over *Triodia* grasslands, usually flying close to the ground up to 3 m high. Only certain diurnal roost sites are considered critical habitat for the Pilbara Leaf-nosed bat (Bat Call WA Pty Ltd, 2021b). No suitable roost sites (critical habitat) were recorded within the TFSA.

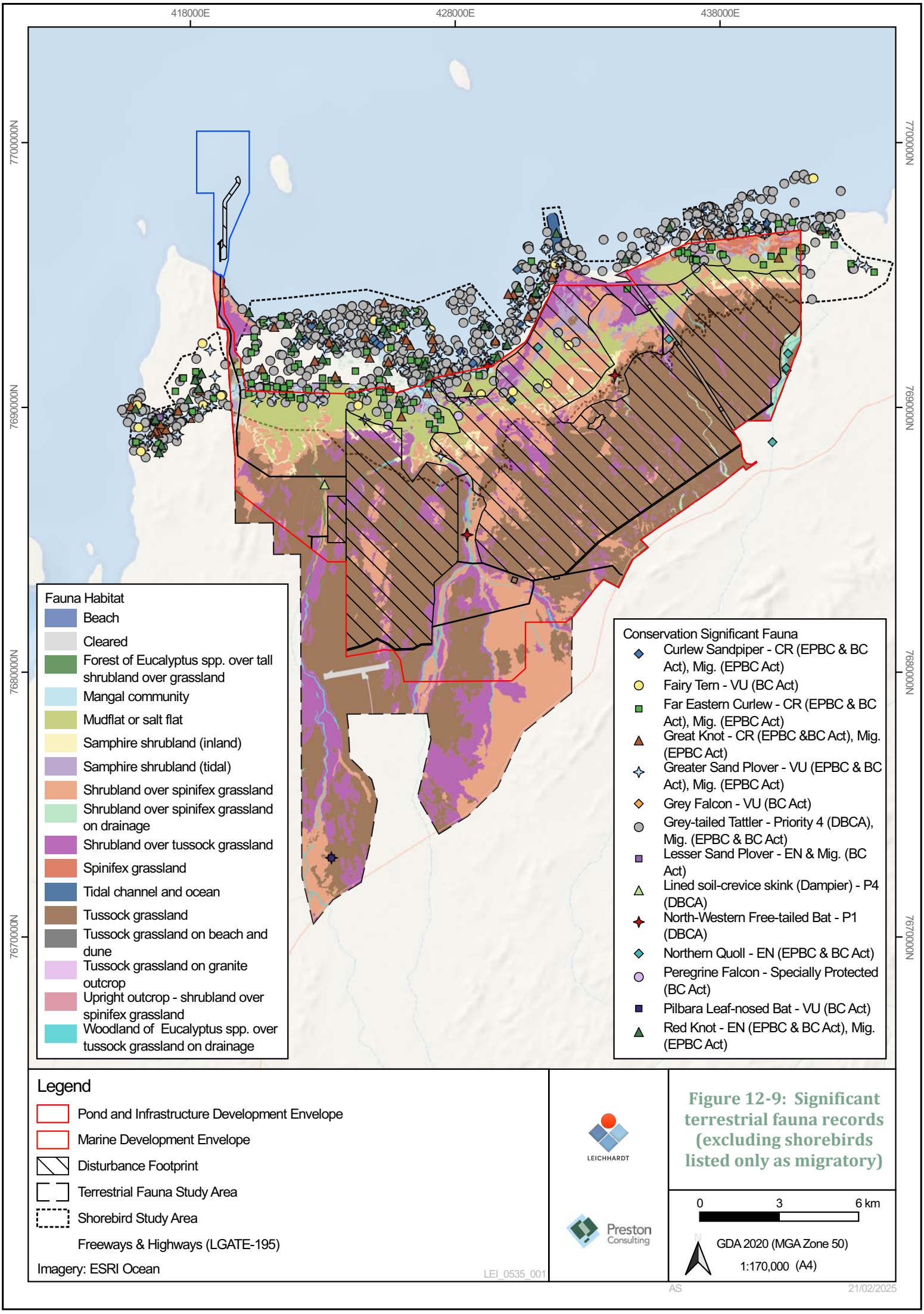
The North-Western Free-tailed Bat (*Mormopterus cobourgianus*) is listed by DBCA as a Priority 1 fauna and was identified from four locations and occurs extensively within the mangal communities of the region. The mangal habitat is considered critical roosting habitat for this species (Figure 12-10). Devil Creek and McKay Creek also support foraging for North-Western Free-tailed Bat that roosts in mangroves. Creeklines represent important feeding grounds as riparian habitat tends to support more flowering/fruiting and associated insect activity, compared with surrounding shrubland and grassland.

The Ghost Bat (*Macroderma gigas*) is listed as Vulnerable under both the EPBC Act and the BC Act and was considered likely to occur within the TFSA but was not recorded during the field surveys. Only certain diurnal roost sites are considered critical habitat for the Ghost Bat (Bat Call WA Pty Ltd, 2021b). No suitable roosts (critical habitat) were recorded within the TFSA. The riparian vegetation along the creeklines represent potential foraging habitat for the Ghost Bat.

The Rakali or Water Rat (*Hydromys chrysogaster*) is listed by DBCA as Priority 4 fauna and was considered likely to occur within the TFSA in the eucalypt woodland, samphire shrubland and/or mangal forest habitat, but was not recorded during the field surveys.

The Short-tailed Mouse (*Leggadina lakedownensis*) is listed by DBCA as a Priority 4 fauna and was considered likely to occur within the TFSA, but was not recorded during the field surveys. This species occupies a variety of habitat types including hummock and tussock grasslands, tropical woodlands, samphire, sedgelands and stony ranges, and suitable habitat was recorded in the TFSA.

The Western Pebble-mound Mouse (*Pseudomys chapmani*) is listed by DBCA as a Priority 4 fauna and was considered likely to occur within the TFSA, but was not recorded during the field surveys. The species has previously been recorded 5 km to the west of the southwest corner of the TFSA. Suitable spinifex grasslands and eucalypt woodland habitat is present within the TFSA.




# Figure 12-9: Significant terrestrial fauna records (excluding shorebirds listed only as migratory)

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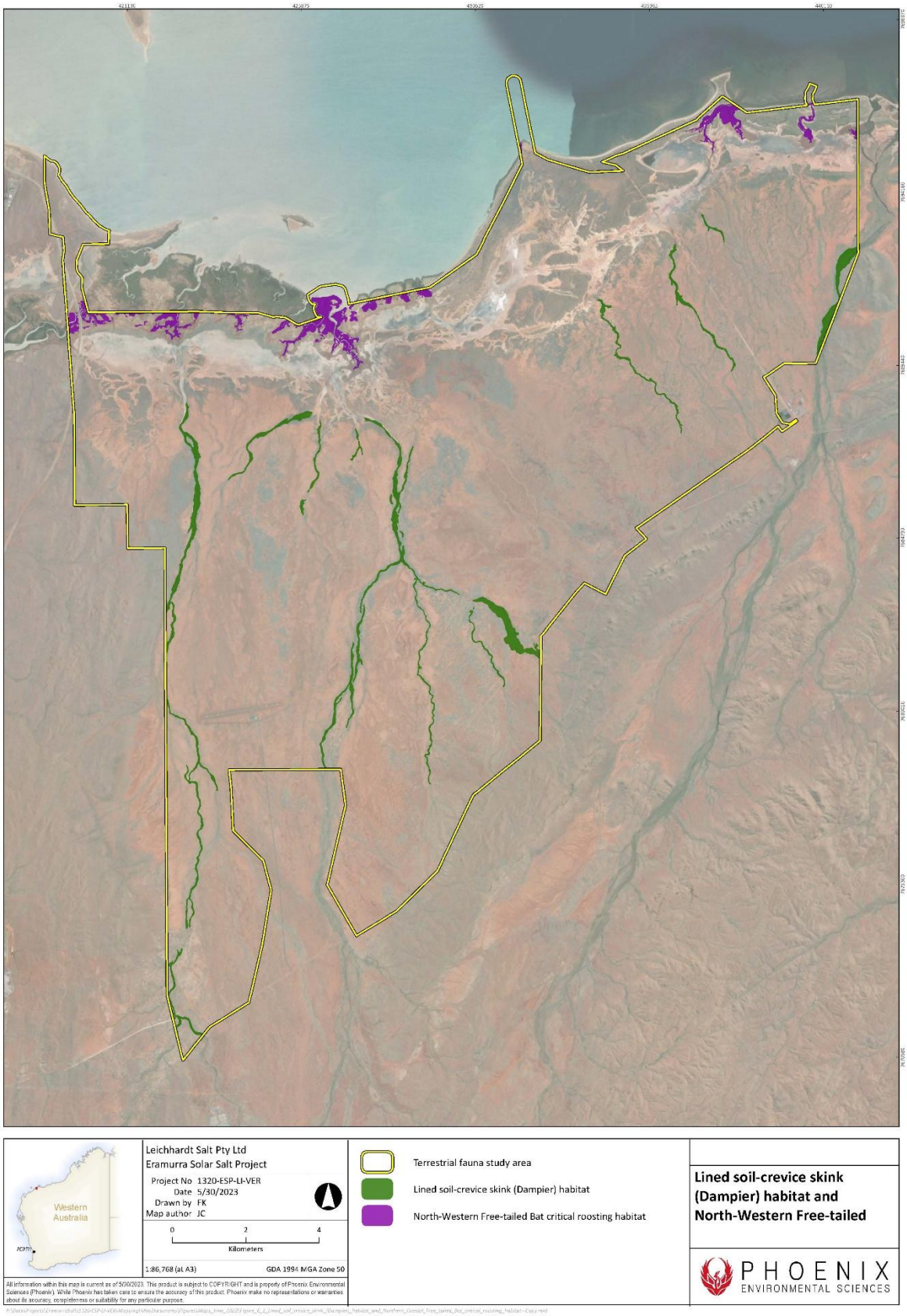



Figure 12-10: Lined Soil-crevice Skink and North-Western Free-tailed Bat habitat

*Northern Quoll*

The Northern Quoll (*Dasyurus hallucatus*) is listed as Endangered under both the EPBC Act and the BC Act and was recorded at six sites including from tidal samphire shrubland, approximately 800 m from the coast. Curtin University (Cowan, 2023; Appendix 6.3) completed a review of the Northern Quoll conclusions of Phoenix (2023) and determined that there was little to support suggestions that the Northern Quoll was a resident of the broader TFSA. This is primarily because four of the six sites where the Northern Quoll was recorded were on the eastern periphery of the TFSA, with the other two sites not representative of the Proposal area and with only secondary evidence.

The Northern Quoll camera trapping monitoring program conducted by Curtin University (Cowan, 2024), only recorded Northern Quoll at a single location within Devil Creek (foraging/dispersal habitat) between 13 March and 17 May 2024 on a total of six nights (Figure 12-11). No Northern Quolls were detected in the 'critical habitat' identified by Phoenix (2023). Cats were detected on a total of 14 independent occasions with the highest frequency, nine occasions, in the area identified as critical habitat (Figure 12-12).

Northern quolls were detected at relatively regular intervals from a single camera in the Devil Creek area, yet no detections occurred with even higher camera density and numbers in the 'critical habitat'. It is possible that the relatively close proximity to known populations of Northern Quolls at both the Devil Creek mining camp and within Devil Creek could result in occasional animals, primarily males undertaking large traverses during the breeding season, encountering this area. However, the lack of a clear pathway and the shallow, exposed drainage tracts suggest such occurrences would be rare, if they occur at all. Additionally, the small size and limited rock complexity of the area would provide inadequate thermal protection under extreme Pilbara conditions, further reducing its suitability for Northern Quolls. This study concluded there is no evidence of Northern Quolls either being resident or utilising areas identified as critical or foraging/dispersal habitat within the disturbance footprint.

The camera traps were reviewed again for the period between 24 July and 18 October 2024 and there were again no detections of Northern Quolls within the so-called 'critical habitat'. There were a few detections at the same sites where they were previously recorded in Devil Creek. Cats remained common and widespread.

Based on the monitoring work completed by Curtin University (Cowan, 2024), habitat identified by Phoenix (2023) as being potential denning and foraging habitat is no longer considered to be habitat and is not discussed further.

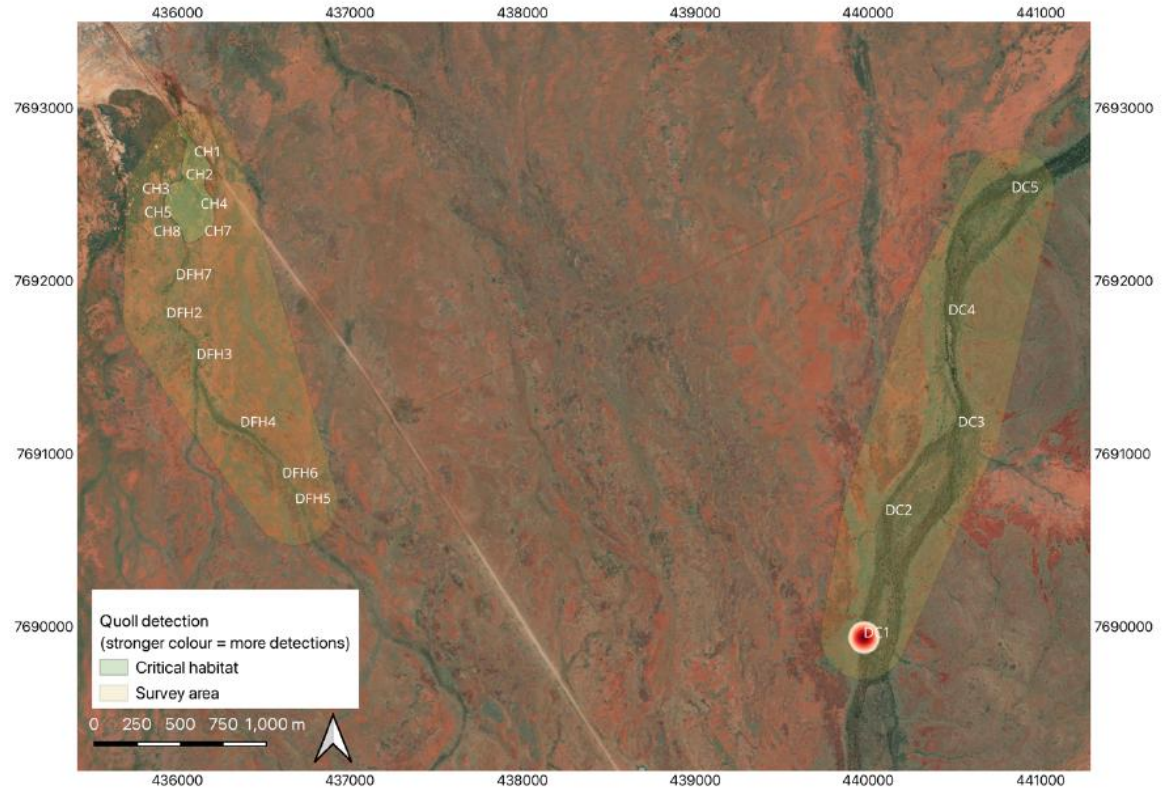



Figure 12-11: Northern Quoll detections




Figure 12-12: Cat detections

### *Reptiles*

One significant reptile species, the Lined Soil-crevice Skink (*Notoscincus butleri*), was recorded during the field surveys. The skink is listed by DBCA as Priority 4 fauna and was recorded within the shrubland over spinifex grassland habitat. The site is associated with a drainage line which occurs 80 m to the east. The skink is thought to be largely confined to creeklines and therefore significant creeklines in the TFSA are mapped as important habitat for this species (Figure 12-10).

One additional reptile species was identified during the desktop review as likely to occur; the Pilbara Olive Python (*Liasis olivaceus barroni*). The Pilbara Olive Python is listed as Vulnerable under both the EPBC Act and the BC Act and is commonly found in rocky areas in association with watercourses and pools. The species is also found in areas of permanent pooling water near rocky habitats, such as gullies, gorges and rocky ranges or boulder sites. This species was not recorded during searches but creekline habitat is present in the TFSA. Critical habitat has not been defined for the Pilbara Olive Python.

### *Night Parrot*

Historical records of the Night Parrot and of the habitat suggests it is unlikely Night Parrots occur within the PIDE (Leseberg, 2024). There are no high veracity historical records of Night Parrot from the region, and although this does not mean Night Parrots never occurred in the area, it is possible the area was never a stronghold for the species.

Adaptive NRM (Leseberg, 2025) completed acoustic surveys for Night Parrot in the identified potential habitat. A total of 59,443 Kaleidoscope detections were manually assessed for Night Parrot vocalisations. No calls attributable to Night Parrots were detected during the analysis and no other significant fauna species were detected.

All sites where Night Parrots have been found in the last decade are notable for the availability of significant amounts of suitable roosting and foraging habitat at the landscape scale. Although there are significant amounts of foraging habitat available, an analysis of potential roosting habitat suggests it is of very limited extent within the PIDE. It is unlikely this small area of roosting habitat is critical to supporting a population of Night Parrots at the landscape scale. The acoustic surveys have confirmed that there are unlikely to be Night Parrots currently residing in that small area of potential roosting habitat.

If a population of Night Parrots does exist in the wider landscape, it is possible that the foraging habitat within the PIDE is used occasionally by this population. Previous examination of available imagery suggests that similar foraging habitat that occurs within the PIDE is widespread at the landscape scale, and that the expected disturbance of such habitat will not significantly impact the availability of foraging habitat at this scale.

The results of all work to determine whether Night Parrots could occur within the PIDE suggest that the PIDE does not support a population of Night Parrots, and that any disturbance within this area is unlikely to adversely affect any population of Night Parrots that may occur within the wider landscape (Leseberg, 2025).

### *Migratory Shorebirds*

The field surveys identified 31 birds that are considered to be significant fauna species, and 11 additional significant bird species were identified during the desktop review as likely to occur within the TFSA (Table 12-6). The abundance of shorebirds is r shown in Figure 12-13 to Figure 12-15.

*Recorded and Potential Species*

The EAAF migratory shorebird survey recorded 21 of the 37 species listed under EPBC Act Policy Statement 3.21 (DotEE, 2017b). Of these, 14 were recorded in nationally and internationally significant numbers.

*Habitat Assessment*

Under the EPBC Act, 'important habitat' is a key concept for migratory species (DotEE, 2017b). Important habitats in Australia for migratory shorebirds under the EPBC Act include those recognised as nationally or internationally important. The accepted and applied approach to identifying internationally important shorebird habitat has been through the use of criteria adopted under the Ramsar Convention on Wetlands (DotEE, 2017b).

According to that approach, wetland habitat should be considered:

- Internationally important if it regularly supports:
  - 1% of the individuals in a population of one species or subspecies of waterbird; or
  - A total abundance of at least 20,000 waterbirds.
- Nationally important if it regularly supports:
  - 0.1% of the flyway population of a single species of Migratory shorebird;
  - A total abundance of at least 2,000 Migratory shorebirds; or
  - At least 15 Migratory shorebird species.

As assessment of the findings of the surveys within the SBSA against the above criteria is provided in Table 12-7.

**Table 12-7: Assessment of migratory shorebird habitat within the SBSA**

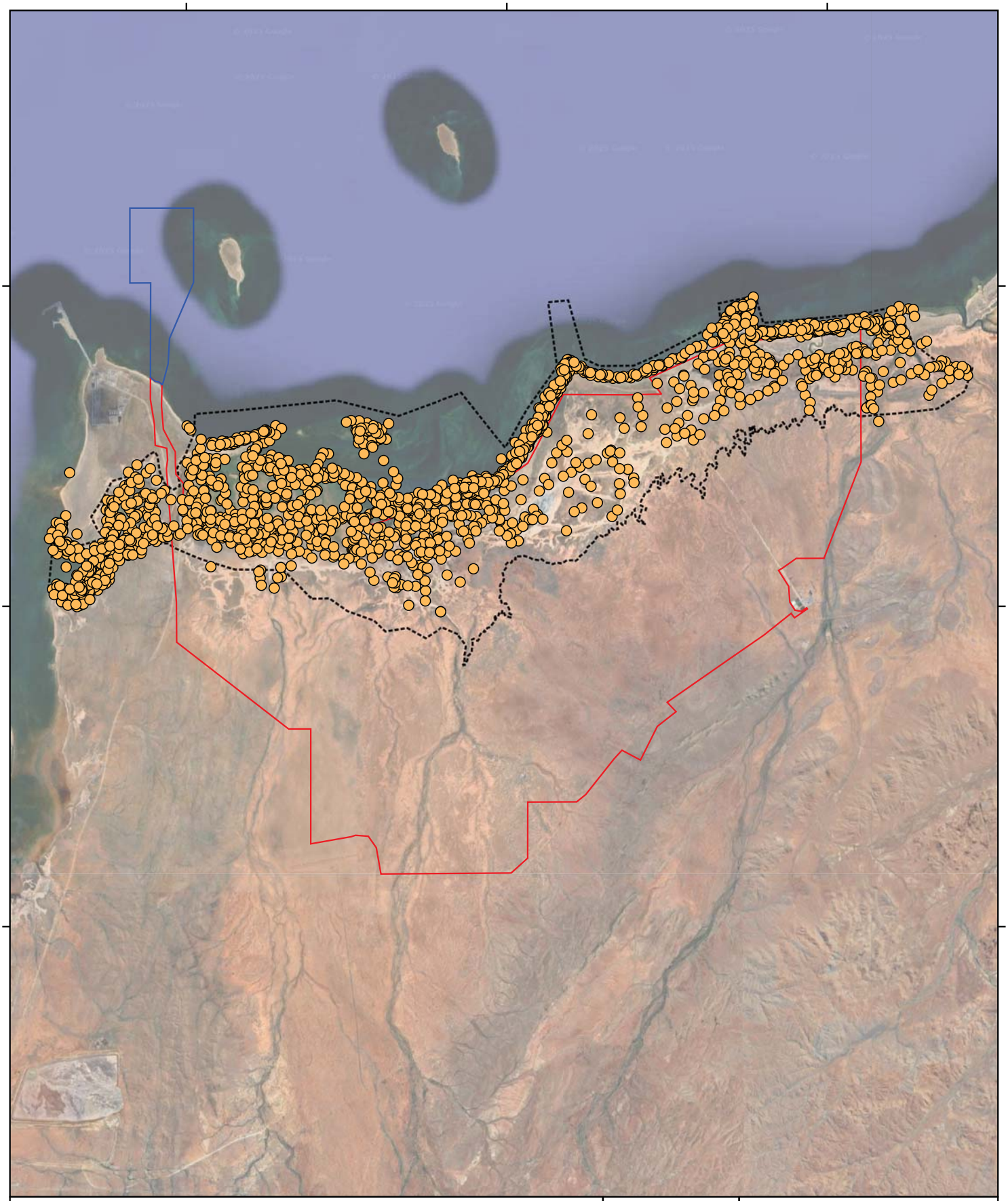
| International Criteria | SBSA Characteristics |
|---|---|
| Regularly supports 1% of the individuals in a population of one species or subspecies of waterbird | Likely to meet criterion. Three species were expected to meet this criterion once data was extrapolated across the SBSA:<br>• Oriental Pratincole;<br>• Ruddy Turnstone; and<br>• Grey-tailed Tattler. |
| Regularly supports a total abundance of at least 20,000 waterbirds | Unlikely to meet criterion. The data does not suggest the SBSA supports more than 20,000 waterbirds. |
| **National Criteria** | **SBSA Characteristics** |
| Regularly supports 0.1% of the flyway population of a single species of migratory shorebird | Meets criterion. 14 species were recorded that meet this criterion:<br>• Greater Sand Plover (also Vulnerable, EPBC Act);<br>• Oriental Pratincole;<br>• Ruddy Turnstone;<br>• Sharp-tailed Sandpiper;<br>• Sanderling; |

| International Criteria | SBSA Characteristics |
|---|---|
| | • Red Knot (also Critically Endangered, EPBC Act; Vulnerable, BC Act);<br>• Curlew Sandpiper (also Critically Endangered, EPBC Act; Vulnerable, BC Act);<br>• Red-necked Stint;<br>• Bar-tailed Godwit;<br>• Eastern Curlew (also Critically Endangered, EPBC Act; Vulnerable, BC Act);<br>• Whimbrel;<br>• Grey-tailed Tattler;<br>• Common Greenshank; and<br>• Terek Sandpiper. |
| Regularly supports a total abundance of at least 2,000 Migratory shorebirds | Meets criterion. More than 2,000 migratory shorebirds were regularly recorded in a single transect. |
| Regularly supports at least 15 Migratory shorebird species | Meets criterion. The surveys recorded 21 of the EAAF Migratory species. |

Higher numbers of birds were observed in January and February compared to July. Abundance in summer was always greater for high tide events, suggesting more feeding opportunities are presented in the tidal samphire shrublands than on the exposed mudflats.

The area appears to be particularly important to the larger 'wetland species' (within the context of the Pilbara), Whimbrel, Curlew Sandpiper and Eastern Curlew, which is likely a reflection of the large extent of uninterrupted mangrove tidal creeks and associated intertidal samphire wetlands sitting immediately inland of large expanses of mudflats and sand banks that are exposed at low tides.

Most foraging habitat is clearly to the seaward side of the coast (ie tidal mudflats) and will not be impacted. Likewise, most key aggregations at high tides will be of roosting birds and are on the coast; these locations will not be impacted. The specific activity of the shorebirds was not recorded but this can be assumed by the location and stated tide level (i.e., most inland records at high tide will be roosting birds). However, it is evident from the recorded locations, and more importantly the heat maps (Figure 12-16 - Figure 12-19) that on low tide when the intertidal mudflats are exposed the shorebirds move out of the SBSA and are highly concentrated in the bay and island immediately north of the Proposal, and in the 'delta' south of Cape Preston, to the west of the Proposal. At high tide when the mudflats are inundated, the birds move back into the SBSA to forage in the tidal samphire shrublands and mangroves, and on exposed sand bars in the tidal channels, but are more diffuse. However, important aggregations (roosting) still occur on high tide on the beaches west of 40-Mile Beach, on the unnamed island (407) (DBCA, 2020) offshore and also at the delta south of Cape Preston. The same pattern is evident in winter, but there are far fewer birds in the area at that time.




Legend

- Pond and Infrastructure Development Envelope
- Marine Development Envelope
- Shorebird Records at High Tide

Imagery: Google Satellite

LEICHHARDT

Preston Consulting

# Figure 12-13: Shorebird records - high tides

0 3 6 km

N

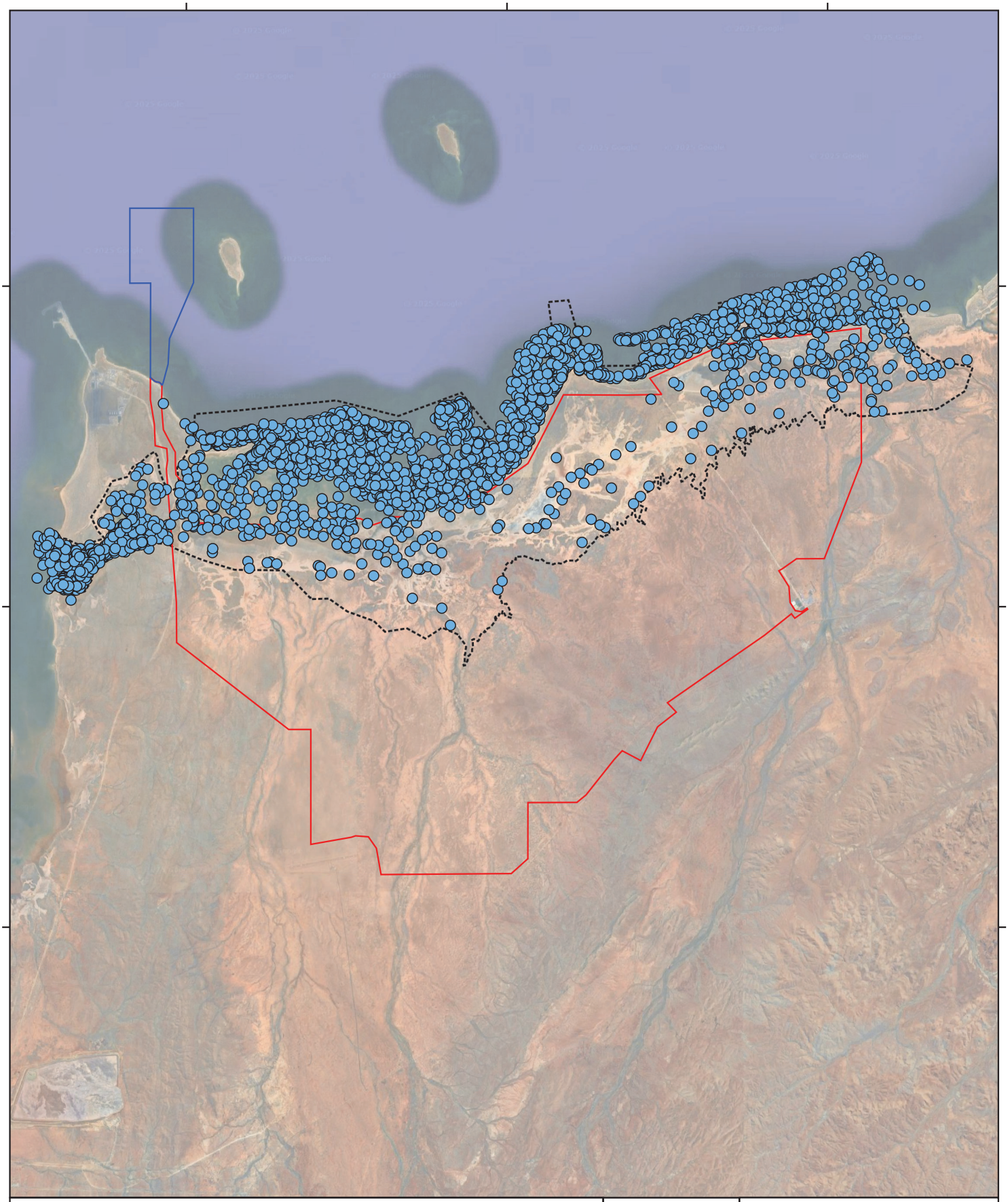
GDA 2020 (MGA Zone 50)

1:160,000 (A4)

LEI_0535_013

AS

12/02/2025




## Legend

- Pond and Infrastructure Development Envelope
- Marine Development Envelope
- Shorebird Records at Low Tide

Imagery: Google Satellite

LEICHHARDT

Preston Consulting

# Figure 12-14: Shorebird Records - Low tides

0 3 6 km

N

GDA 2020 (MGA Zone 50)

1:160,000 (A4)

LEI_0535_015

AS

12/02/2025




## Legend

- Pond and Infrastructure Development Envelope
- Marine Development Envelope
- Shorebird Records

Imagery: Google Satellite

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Preston Consulting

# Figure 12-15: Shorebird Records - all tides

0 3 6 km

N

GDA 2020 (MGA Zone 50)

1:160,000 (A4)

LEI_0535_013

AS

12/02/2025

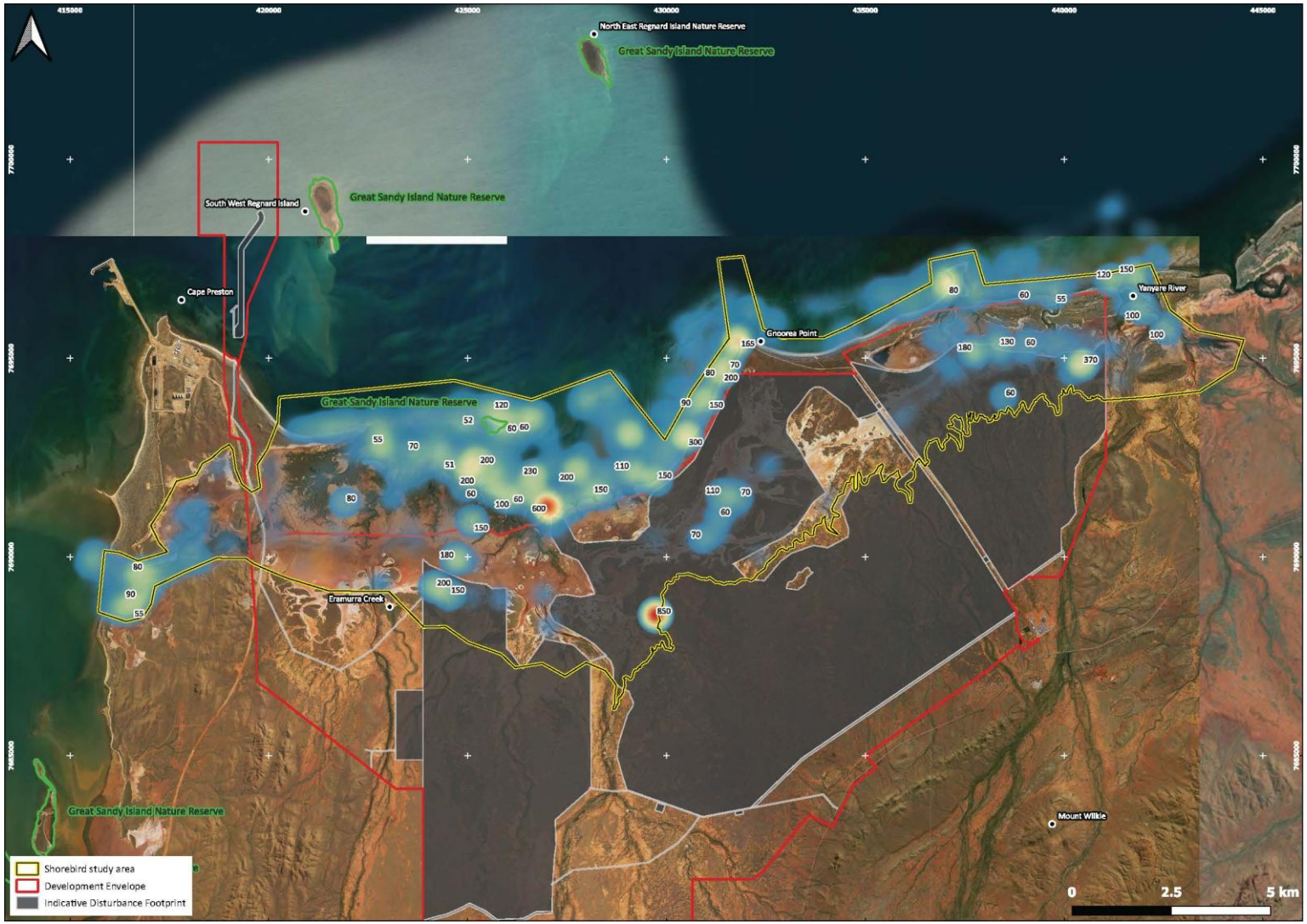



Figure 12-16: Summer low tide heat map for all birds recorded during shorebird transects

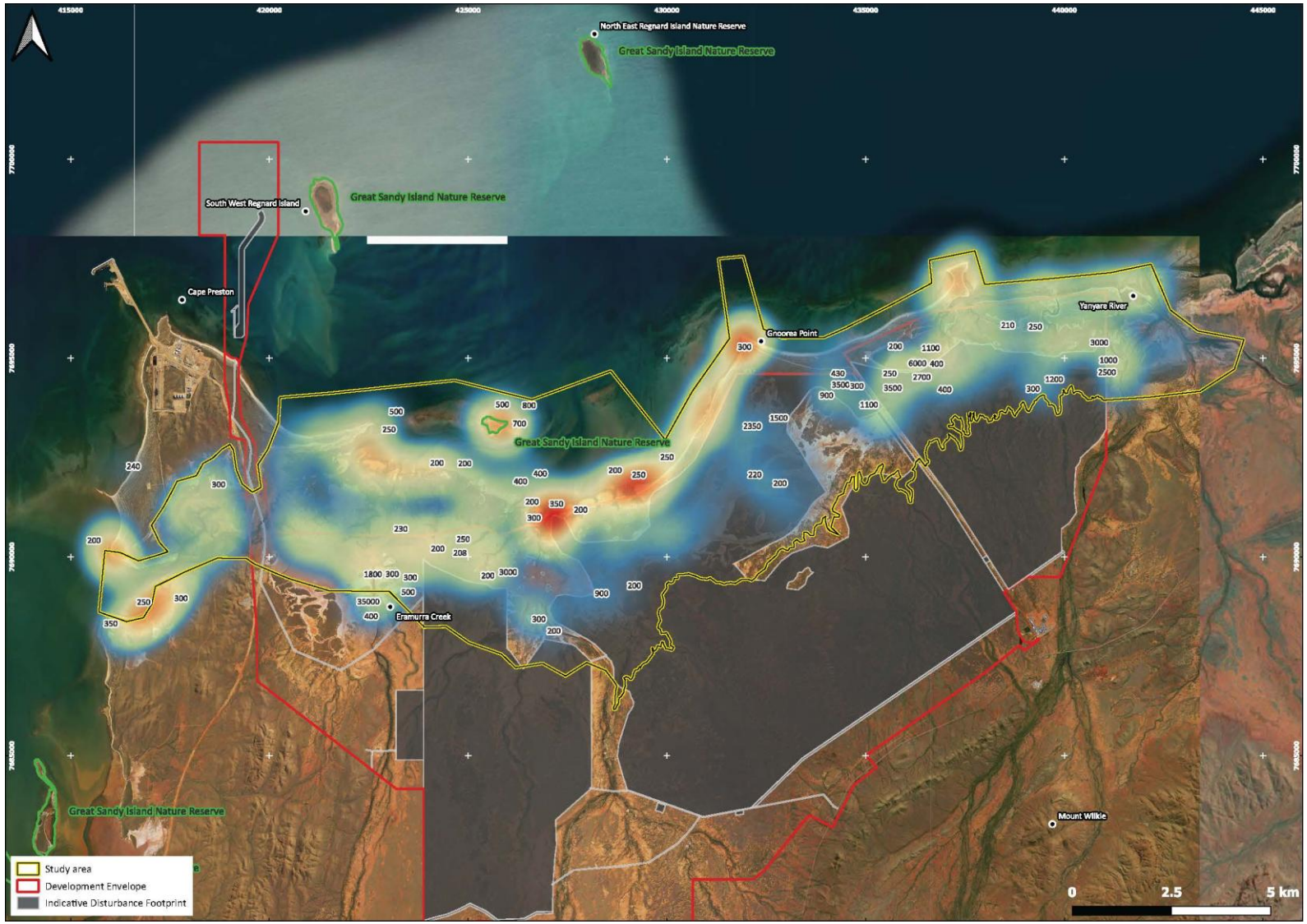



Figure 12-17: Summer high tide heat map for all birds recorded during shorebird transects

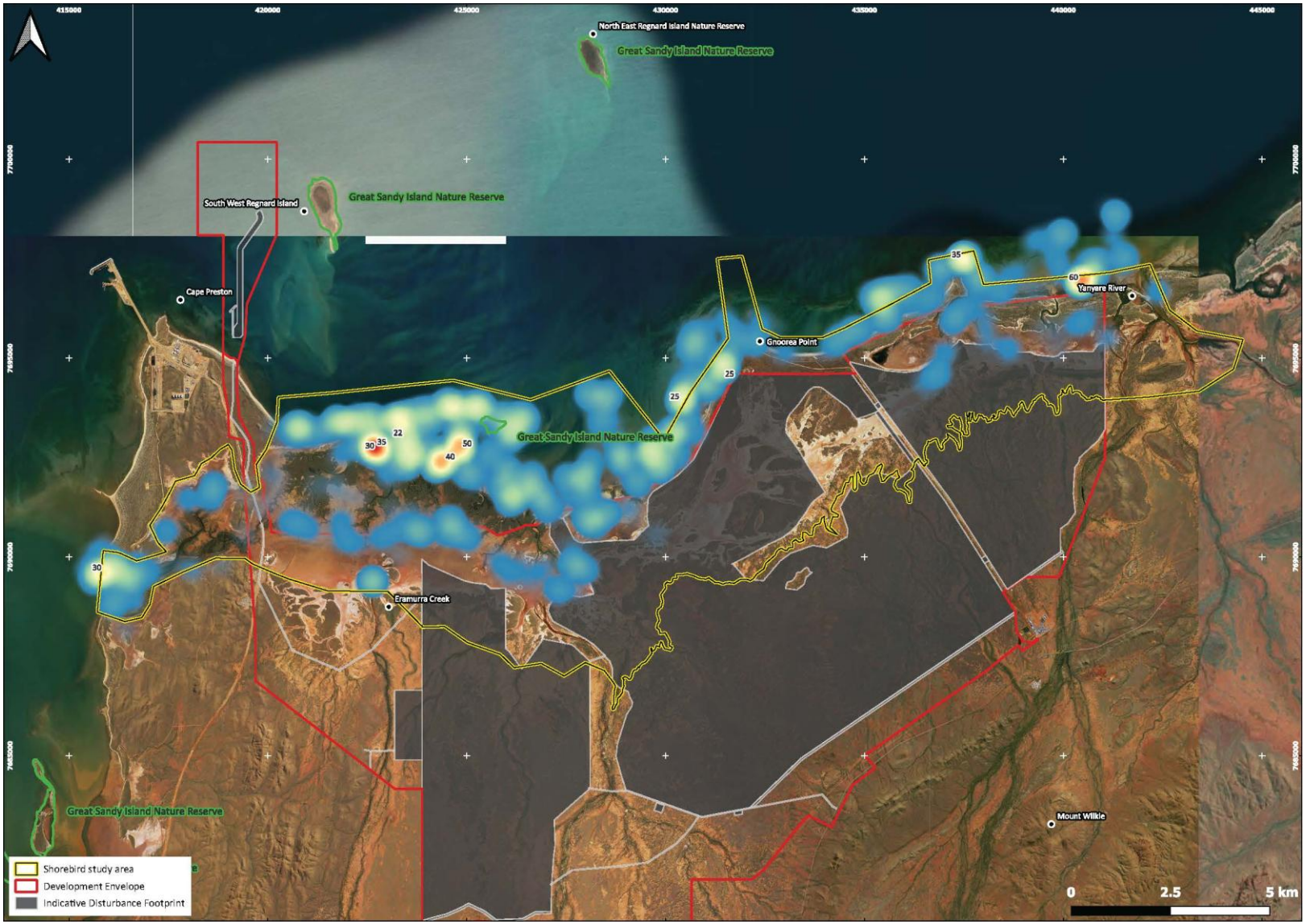



Figure 12-18: Winter low tide heat map for all birds recorded during shorebird transects




Figure 12-19: Winter high tide heat map for all birds recorded during shorebird transects

### 12.3.7 SIGNIFICANT FAUNA HABITAT

A total of 16 fauna habitat types were identified in the TFSA which were classified into eight broad groupings based on vegetation and landforms, as described in Section 12.3.4. Table 12-8 outlines significant fauna recorded or identified as likely or possible to occur within the study areas and the habitat associated with that species.

**Table 12-8: Significant fauna and associated habitat within the TFSA**

| Species | Status | Likelihood of occurrence | Terrestrial habitats | | | | | | Intertidal habitats | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Tussock grasslands | Spinifex grassland | Eucalypt woodland | Tussock grasslands on beaches and dunes | Samphire shrublands | Mudflats and salt flats | Mangal forests | Tidal creeks and ocean |
| **Reptiles** | | | | | | | | | | |
| *Ctenotus angusticeps*<br>Airlie Island *Ctenotus* | P3 (DBCA) | **Possible**, previous uncertain record in study area | ✓ | ✓ | | ✓ | ✓ | | ✓ | |
| *Notoscincus butleri*<br>Lined Soil-crevice Skink | P4 (DBCA) | **Recorded** | ✓ | ✓ | ✓ | | | | | |
| *Liasis olivaceus barroni*<br>Pilbara Olive Python | VU (EPBC Act, BC Act) | **Likely**, suitable habitat present | | | ✓ | | | | | |
| **Birds** | | | | | | | | | | |
| *Oxyura australis*<br>Blue-billed Duck | P4 (DBCA) | **Likely** as occasional visitor | | | ✓ | | | | | |
| *Oceanites oceanicus*<br>Wilson's Storm Petrel | Mig (EPBC Act, BC Act) | **Likely** as occasional visitor, but will not nest within the SBSA | | | | ✓ | | | ✓ | ✓ |
| *Ardenna carneipes*<br>Flesh-footed Shearwater | Mig (EPBC Act, BC Act), VU (BC Act) | **Possible** as occasional visitor, but will not nest within the SBSA | | | | ✓ | | | ✓ | ✓ |

| Species | Status | Likelihood of occurrence | Terrestrial habitats | | | | | | Intertidal habitats | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Tussock grasslands | Spinifex grassland | Eucalypt woodland | Tussock grasslands on beaches and dunes | Samphire shrublands | Mudflats and salt flats | Mangal forests | Tidal creeks and ocean |
| *Ardenna pacifica* Wedge-tailed Shearwater | Mig (EPBC Act, BC Act) | **Likely occasional visitor,** but will not nest within the SBSA | | | | ✓ | | | ✓ | ✓ |
| *Calonectris leucomelas* Streaked Shearwater | Mig (EPBC Act, BC Act) | **Possible** as occasional visitor, but will not nest within the SBSA | | | | ✓ | | | ✓ | ✓ |
| *Macronectes giganteus* Southern Giant Petrel | EN (EPBC Act), Mig (EPBC Act, BC Act) | **Possible** as occasional visitor, but will not nest within the SBSA | | | | ✓ | | | ✓ | ✓ |
| *Puffinus huttoni* Hutton's Shearwater | EN (BC Act) | **Likely** as occasional visitor, but will not nest within the SBSA | | | | ✓ | | | ✓ | ✓ |
| *Plegadis falcinellus* Glossy Ibis | Mig (EPBC Act, BC Act) | **Likely** as occasional visitor, but will not nest within the SBSA | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Fregata ariel* Lesser Frigatebird | Mig (EPBC Act, BC Act) | **Likely** as occasional visitor, but will not nest within the SBSA | | | | ✓ | | | ✓ | ✓ |
| *Sula leucogaster* Brown Booby | Mig (EPBC Act, BC Act) | **Likely** as occasional visitor, but will not nest within the SBSA | | | | ✓ | | | ✓ | ✓ |
| *Pandion cristatus* Osprey | Mig (EPBC Act, BC Act) | **Recorded**, breeding resident | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Charadrius leschenaultii* Greater Sand Plover | VU, Mig (EPBC Act, BC Act) | **Recorded**, migrant | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Charadrius mongolus* Lesser Sand Plover | EN, Mig (EPBC Act, BC Act) | **Recorded in nationally significant numbers** twice in February, migrant | | | | ✓ | ✓ | ✓ | ✓ | ✓ |

| Species | Status | Likelihood of occurrence | Terrestrial habitats | | | | | | Intertidal habitats | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Tussock grasslands | Spinifex grassland | Eucalypt woodland | Tussock grasslands on beaches and dunes | Samphire shrublands | Mudflats and salt flats | Mangal forests | Tidal creeks and ocean |
| *Charadrius veredus*<br>Oriental Plover | Mig (EPBC Act, BC Act) | **Recorded in internationally significant numbers**, migrant | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Pluvialis fulva*<br>Pacific Golden Plover | Mig (EPBC Act, BC Act) | **Recorded**, migrant | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Pluvialis squatarola*<br>Grey Plover | Mig (EPBC Act, BC Act) | **Recorded**, migrant | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Actitis hypoleucos*<br>Common Sandpiper | Mig (EPBC Act, BC Act) | **Recorded**, migrant | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Arenaria interpres*<br>Ruddy Turnstone | Mig (EPBC Act, BC Act) | **Recorded in internationally significant numbers** in January 2020, migrant | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Calidris acuminata*<br>Sharp-tailed Sandpiper | Mig (EPBC Act, BC Act) | **Recorded in nationally significant numbers** in 30% of summer transects, migrant | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Calidris alba*<br>Sanderling | Mig (EPBC Act, BC Act) | **Recorded in nationally significant numbers** once in December 2019, migrant | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Calidris canutus*<br>Red Knot | EN, Mig (EPBC Act, BC Act) | **Recorded in nationally significant numbers** once in February 2020, migrant | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Calidris ferruginea*<br>Curlew Sandpiper | CR, Mig (EPBC Act, BC Act) | **Recorded in nationally significant numbers** once in February 2020, migrant | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Calidris melanotos*<br>Pectoral Sandpiper | Mig (EPBC Act, BC Act) | **Recorded** (previously) | | | | ✓ | ✓ | ✓ | ✓ | ✓ |

| Species | Status | Likelihood of occurrence | Terrestrial habitats | | | | | | Intertidal habitats | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Tussock grasslands | Spinifex grassland | Eucalypt woodland | Tussock grasslands on beaches and dunes | Samphire shrublands | Mudflats and salt flats | Mangal forests | Tidal creeks and ocean |
| *Calidris ruficollis* Red-necked Stint | Mig (EPBC Act, BC Act) | **Recorded in nationally significant numbers** in 35% of summer transects | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Calidris subminuta* Long-toed Stint | Mig (EPBC Act, BC Act) | **Likely** as occasional visitor | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Calidris tenuirostris* Great Knot | CR, Mig (EPBC Act, BC Act) | **Recorded** | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Gallinago stenura* Pin-tailed Snipe | Mig (EPBC Act, BC Act) | **Likely** as occasional visitor | | | ✓ | | | | | |
| *Limicola falcinellus* Broad-billed Sandpiper | Mig (EPBC Act, BC Act) | **Likely** as occasional visitor | | | | ✓ | ✓ | | | |
| *Limosa lapponica baueri* Bar-tailed Godwit (western Alaskan) | VU, Mig (EPBC Act, BC Act) | **Possible** as occasional visitor | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Limosa lapponica menzbieri* Bar-tailed Godwit (northern Siberian) | CR, Mig (EPBC Act, BC Act) | **Recorded in nationally significant numbers** once in January and twice in February | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Limosa limosa* Black-tailed Godwit | Mig (EPBC Act, BC Act) | **Recorded** | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Numenius madagascariensis* Eastern Curlew | CR, Mig (EPBC Act, BC Act) | **Recorded in nationally significant numbers** twice in February. | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Numenius minutus* Little Curlew | Mig (EPBC Act, BC Act) | **Recorded** (previously) | | | | ✓ | ✓ | ✓ | ✓ | ✓ |

| Species | Status | Likelihood of occurrence | Terrestrial habitats | | | | | | Intertidal habitats | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Tussock grasslands | Spinifex grassland | Eucalypt woodland | Tussock grasslands on beaches and dunes | Samphire shrublands | Mudflats and salt flats | Mangal forests | Tidal creeks and ocean |
| *Numenius phaeopus* Whimbrel | Mig (EPBC Act, BC Act) | **Recorded in nationally significant numbers** in 53% of summer transects | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Phalaropus lobatus* Red-necked Phalarope | Mig (EPBC Act, BC Act) | **Possible** as occasional visitor | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Tringa brevipes* Grey-tailed Tattler | Mig (EPBC Act, BC Act), P4 (DBCA) | **Recorded in internationally significant numbers –** area supports a large number of this species throughout summer | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Tringa glareola* Wood Sandpiper | Mig (EPBC Act, BC Act) | **Possible** occasional visitor | | | ✓ | ✓ | ✓ | | | |
| *Tringa nebularia* Common Greenshank | Mig (EPBC Act, BC Act) | **Recorded in nationally significant numbers twice in December and twice in February** | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Tringa stagnatilis* Marsh Sandpiper | Mig (EPBC Act, BC Act) | **Likely** as occasional visitor | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Tringa totanus* Common Redshank | Mig (EPBC Act, BC Act) | **Likely** as occasional visitor in very small numbers | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Xenus cinereus* Terek Sandpiper | Mig (EPBC Act, BC Act) | **Recorded in nationally significant numbers twice in February** | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Glareola maldivarum* Oriental Pratincole | Mig (EPBC Act, BC Act) | **Recorded in internationally significant numbers** – to 75,377 individuals recorded in the air, in a single transect in February 2020, which represents 2.6% of the world's population | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ |

| Species | Status | Likelihood of occurrence | Terrestrial habitats | | | | | | Intertidal habitats | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Tussock grasslands | Spinifex grassland | Eucalypt woodland | Tussock grasslands on beaches and dunes | Samphire shrublands | Mudflats and salt flats | Mangal forests | Tidal creeks and ocean |
| *Chlidonias leucopterus*<br>White-winged Black Tern | Mig (EPBC Act, BC Act) | **Recorded** | | | | ✓ | ✓ | | ✓ | ✓ |
| *Sterna albifrons*<br>Little Tern (or *Sternula*) | Mig (EPBC Act, BC Act) | **Recorded** | | | | ✓ | ✓ | | ✓ | ✓ |
| *Sterna bergii*<br>Crested Tern | Mig (EPBC Act, BC Act) | **Recorded** | | | | ✓ | ✓ | | ✓ | ✓ |
| *Sterna caspia*<br>Caspian Tern | Mig (EPBC Act, BC Act) | **Recorded** | | | | ✓ | ✓ | | ✓ | ✓ |
| *Sterna dougallii*<br>Roseate Tern | Mig (EPBC Act, BC Act) | **Recorded** | | | | ✓ | ✓ | | ✓ | ✓ |
| *Sterna hirundo*<br>Common Tern | Mig (EPBC Act, BC Act) | **Recorded** | | | | ✓ | ✓ | | ✓ | ✓ |
| *Sterna nereis nereis*<br>Fairy Tern (or *Sternula*) | VU (BC Act) | **Recorded** | | | | ✓ | ✓ | | ✓ | ✓ |
| *Sterna nilotica*<br>Gull-billed Tern (or *Gelochelidon*) | Mig (EPBC Act, BC Act) | **Recorded** | | | | ✓ | ✓ | | ✓ | ✓ |
| *Apus pacificus*<br>Fork-tailed Swift | Mig (EPBC Act, BC Act) | **Recorded** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Falco hypoleucos*<br>Grey Falcon | VU (EPBC Act, BC Act) | **Likely** (nest 6 km E) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |

| Species | Status | Likelihood of occurrence | Terrestrial habitats | | | | | | Intertidal habitats | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Tussock grasslands | Spinifex grassland | Eucalypt woodland | Tussock grasslands on beaches and dunes | Samphire shrublands | Mudflats and salt flats | Mangal forests | Tidal creeks and ocean |
| *Falco peregrinus*<br>Peregrine Falcon | OS (BC Act) | **Likely** as occasional visitor | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| *Hirundo rustica*<br>Barn Swallow | Mig (EPBC Act, BC Act) | **Likely** as occasional visitor | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| *Motacilla flava*<br>Yellow Wagtail | Mig (EPBC Act, BC Act) | **Possible** as occasional visitor | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| **Mammals** | | | | | | | | | | |
| *Dasyurus hallucatus*<br>Northern Quoll | EN (EPBC and BC Acts) | **Recorded** | | | ✓ | | | | | |
| *Macroderma gigas*<br>Ghost Bat | VU (EPBC and BC Acts) | **Likely** (foraging only, no roost sites present) | ✓ | ✓ | ✓ | | | | | |
| *Rhinonicteris aurantia* (Pilbara)<br>Pilbara Leaf-nosed Bat | VU (EPBC and BC Acts) | **Recorded** – foraging only, no roost sites present | ✓ | ✓ | ✓ | | | | | |
| *Mormopterus cobourgianus*<br>North-Western Free-tailed Bat | P1 (DBCA) | **Recorded--** roosting in mangroves, foraging elsewhere | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| *Hydromys chrysogaster*<br>Rakali, Water-rat | P4 (DBCA) | **Likely** | | | ✓ | | ✓ | | ✓ | |
| *Leggadina lakedownensis*<br>Northern Short-tailed Mouse | P4 (DBCA) | **Likely** | ✓ | ✓ | ✓ | | | | | |
| *Pseudomys chapmani*<br>Western Pebble-mound Mouse | P4 (DBCA) | **Likely** | | ✓ | ✓ | | | | | |

### 12.3.8 SHORT-RANGE ENDEMIC FAUNA

A total of 40 taxa from SRE groups were collected from the field surveys of the TFSA and the regional targeted survey area to the east, comprising 20 taxa in the TFSA and 23 taxa from the regional targeted survey (three taxa species in both). The locations of these records are identified in Figure 12-20–- Figure 12-23.

Within the TFSA 12 taxa are considered Potential SREs and eight are widespread species or indeterminate (Uncertain) taxa. The 12 Potential SRE taxa included five isopods, four scorpions and three mygalomorph spiders. The habitat within the TFSA is comprised entirely of low potential SRE habitats which extend beyond the TFSA and are dominated by three similar types comprised of landforms and vegetation types that are unlikely to restrict the dispersal of SRE fauna.

Generally, the SREs within the TFSA appear to have an affinity with the SRE fauna of nearby mainland coastal areas. Of significance, three taxa collected during the field surveys were previously known only from Barrow Island, which is located approximately 85 km to the west of the TFSA. These comprise one mygalomorph spider (*Aname* 'MYG593'), one scorpion (*Isometroides* 'SCO051/barrow'), and one isopod (*Buddelundia* '32'). These records have significantly increased the known range of these taxa. An additional two taxa are known from both Barrow Island and the mainland: one mygalomorph spider (*Synothele* 'MYG335') and one scorpion (*Lychas* 'SCO051/glauerti').

All but five of the 20 species recorded within the TFSA are already known from other areas indicating there is habitat connectivity outside the TFSA. Further to this, the paucity of systematic SRE surveys undertaken within general mainland coastal areas (as opposed to nearby islands of the Dampier Archipelago, and Barrow Island, which have been extensively surveyed for invertebrates, particularly land snails) is likely to be the reason these taxa have not been recorded before. The range extensions documented for three taxa previously known only from Barrow Island is further evidence that many species in the area are more widespread than currently known.

Of the five species currently known only from the TFSA, four were recorded in the field survey, and one is known from the desktop review. They comprise one mygalomorph spider, one scorpion, three isopods (slaters) and one land snail:

- Mygalomorph spider:
  - *Conothele* 'MYG726';
- Scorpion:
  - *Urodacus* 'erramurra';
- Isopods (slaters):
  - *Acanthodillo* sp. B (erramurra);
  - *Buddelundiinae* 'erramurra'; and
- Land snail:
  - *Rhagada* 'cape preston'.

Within the regional targeted survey 16 Potential SREs were recorded. These included five isopods, three pseudoscorpions, three land snails, three *Antichiropus* millipedes, two *Cryptops* centipedes, and one scorpion. The remaining seven taxa collected from the regional targeted survey are widespread species or indeterminate taxa.

None of the recorded potential SRE species were considered likely to be restricted to the TFSA:

- *Conothele* 'MYG726' was sighted during SRE foraging at site FAU06 within the TFSA. This record was from the most widespread, unrestricted habitat within the TFSA, tussock grassland, and it is likely this species can occur throughout the coastal tussock grasslands;
- *Urodacus* 'erramurra' was collected in a wet pitfall trap at site SRE04 in shrubland over spinifex grassland habitat which is widespread in the TFSA and surrounds;
- *Acanthodillo* sp. *B* (erramurra) was collected from two sites (SRE003 and SRE04), both within shrubland over spinifex grassland habitat and approximately 800 m apart from each other. The *A.* sp. A (erramurra) specimens were collected from seven sites, including SRE003 and SRE004 from shrubland over tussock grassland and shrubland over spinifex grassland habitats respectively. *A.* sp. A (erramurra) and *A.* sp. B (erramurra) are considered likely to have similar broad distributions;
- *Buddelundiinae* 'erramurra' was represented by a single specimen collected from a wet pitfall trap from one site (SRE07), within the TFSA. This specimen was collected from the widely occurring shrubland over spinifex grassland habitat; and
- *Rhagada* 'cape preston' is a record from the desktop review, being collected from a previous survey in the area (circa 2007) (WAM, 2020). The collection site was in the widespread tussock grassland habitat. As no molecular information is available for this specimen, it is possible this species is synonymous with another undescribed taxon such as *R.* 'Phoenix0070', *R.* 'Phoenix0071', and *R.* 'Phoenix0087', all of which were recorded 21.5 km to the east (200–- 1,200 m apart from each other along a creekline) in the regional survey. These new records may represent specimens that have originated upstream or downstream rather than from the habitat they were recorded from.

Leichhardt commissioned a project with Curtin University and the WA Museum to undertake a review of the taxonomic status of the *Conothele* 'MYG726', *Urodacus* 'erramurra' and *Acanthodillo* sp. B specimens to determine the relationships to others recorded in the general vicinity of the Proposal (Danks et al., 2025; Appendix 6.4). The taxonomic review found that all three specimens are unique and represent new, undescribed species. The scorpion fauna of the Pilbara is poorly known and all Western Australian species of *Conothele* are short-range endemics, all of which represent new and undescribed species (Danks et al., 2025).

The lack of regional records of these species is considered an artefact of the paucity of regional detailed SRE surveys. The habitats within the TFSA are neither restricted, nor contain geographical features that would limit the dispersal of SREs and therefore, implementation of the Proposal would appear to present little risk to these four taxa (Phoenix, 2023).

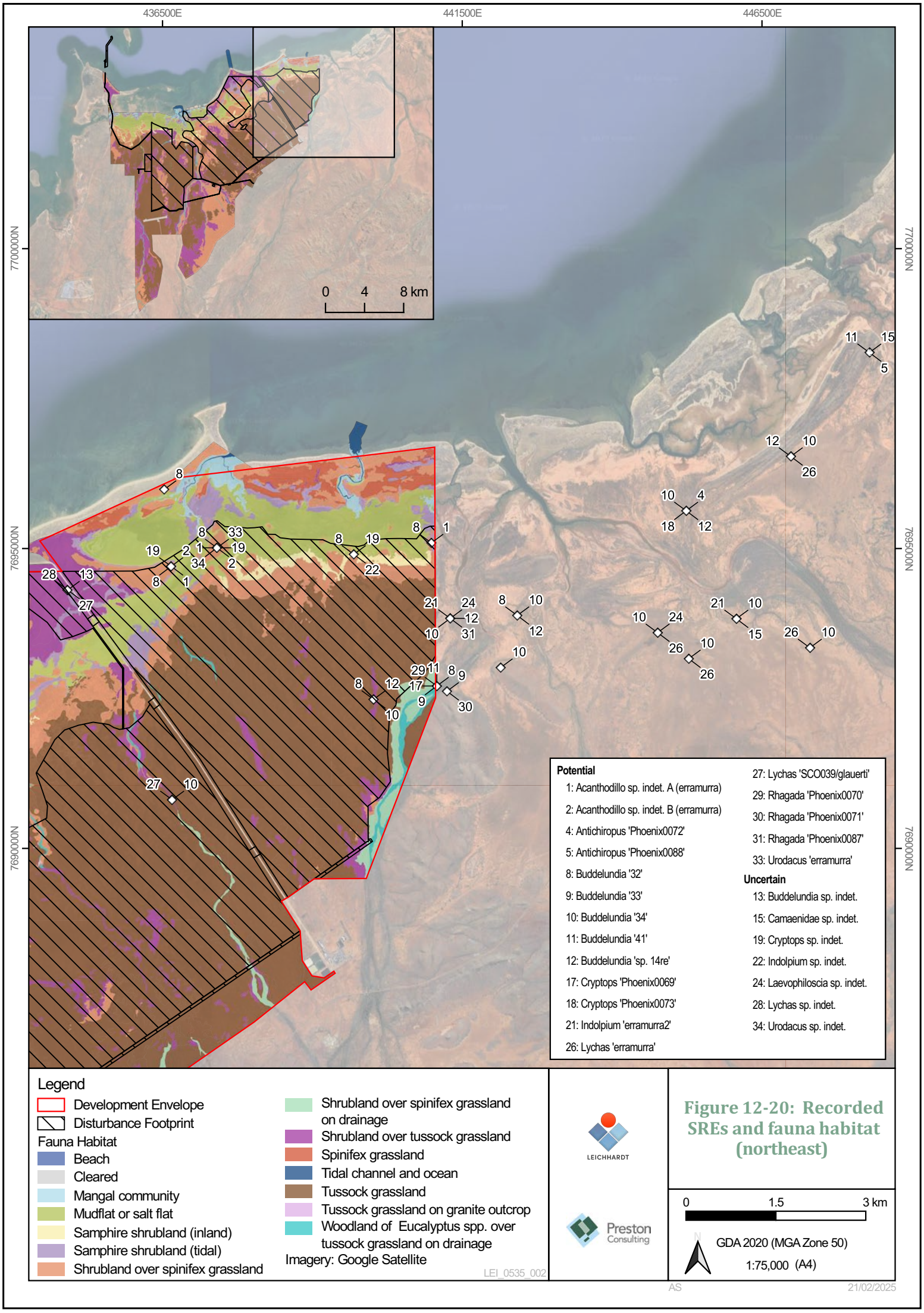
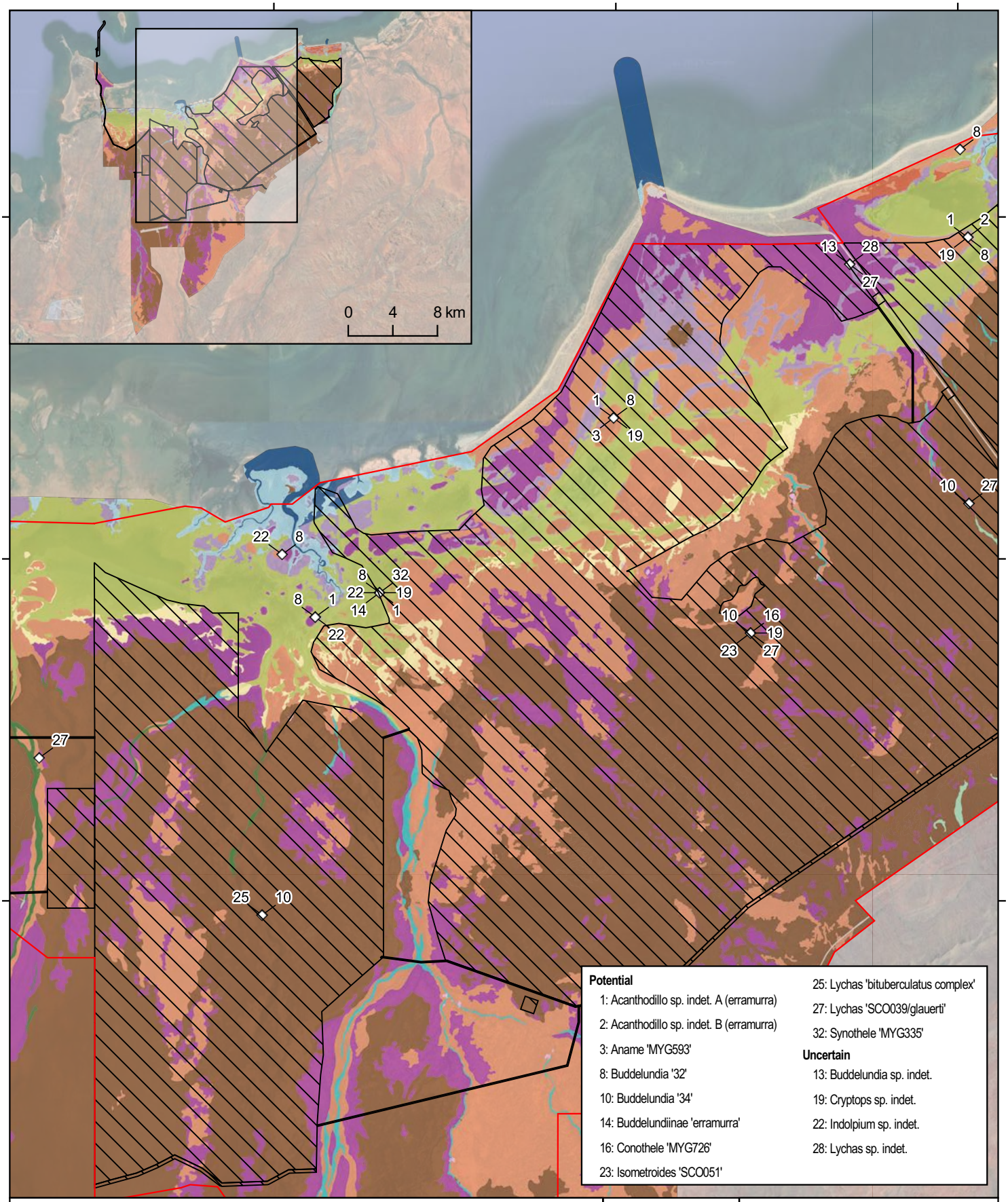



**Figure 12-20: Recorded SREs and fauna habitat (northeast)**




## Legend

- Development Envelope
- Disturbance Footprint

Fauna Habitat

- Cleared
- Forest of Eucalyptus spp. over tall shrubland over grassland
- Mangal community
- Mudflat or salt flat
- Samphire shrubland (inland)
- Samphire shrubland (tidal)
- Shrubland over spinifex grassland
- Shrubland over spinifex grassland on drainage
- Shrubland over tussock grassland
- Spinifex grassland
- Tidal channel and ocean
- Tussock grassland
- Tussock grassland on beach and dune
- Tussock grassland on granite outcrop
- Woodland of Eucalyptus spp. over tussock grassland on drainage

Imagery: Google Satellite

LEI_0535_002

LEICHHARDT

Preston Consulting

**Figure 12-21: Recorded SREs and fauna habitat (north)**

0 1.5 3 km

N

GDA 2020 (MGA Zone 50)

1:75,000 (A4)

AS

21/02/2025

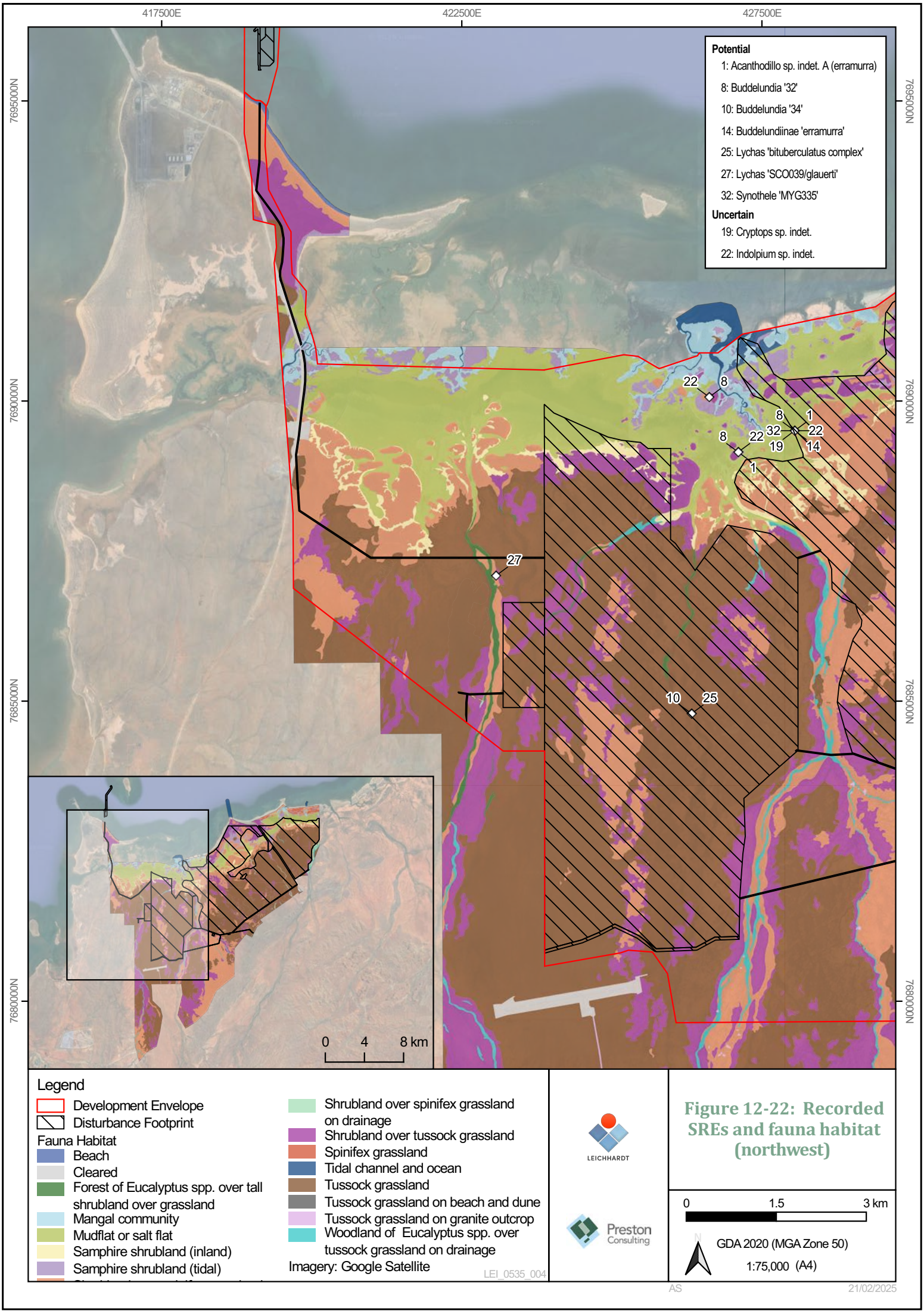



**Figure 12-22: Recorded SREs and fauna habitat (northwest)**

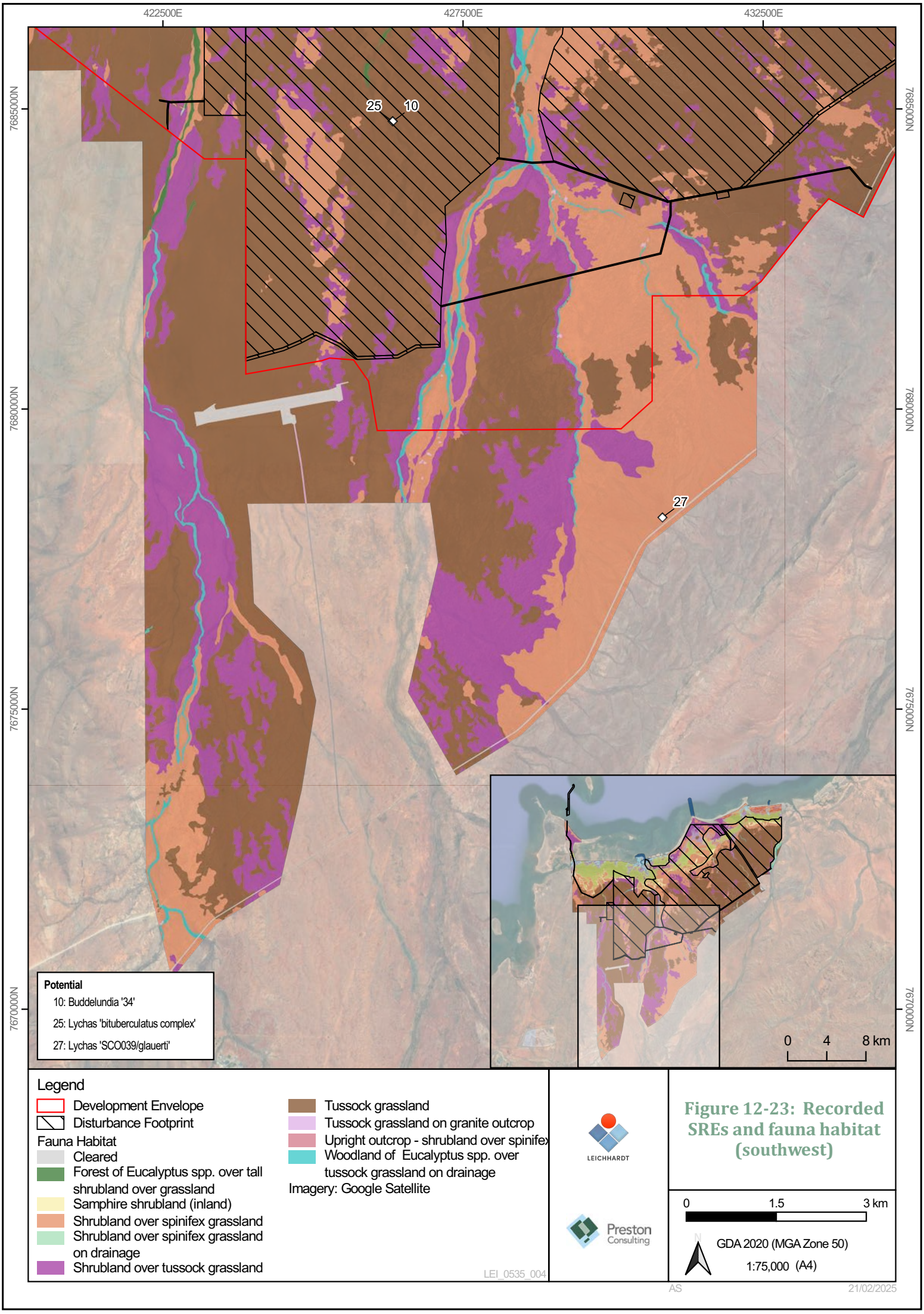



**Figure 12-23: Recorded SREs and fauna habitat (southwest)**

### 12.3.9 INTRODUCED FAUNA

Evidence of introduced animal presence was common in the TFSA, including agricultural species (cattle) and pest species (feral cats and dogs). Over two thirds of land in the Roebourne subregion is used for grazing native vegetation. Both grazing pressure and the presence of feral cats and dogs as key introduced predator species, are likely to have substantively influenced the distribution and abundance of native fauna species in the TFSA.

### 12.3.10 ENVIRONMENTAL VALUES

The information provided in Section 12.3.4 – 12.3.9 was utilised to determine the environmental values that require assessment for this factor. Values were included for assessment based on the following parameters, taken from the Environmental Factor Guideline; Terrestrial Fauna (EPA, 2016i):

- Fauna species listed under the EPBC Act or BC Act that were recorded or considered likely to occur within the study areas;
- Species with restricted distribution;
- Species with a degree of historical impact from threatening processes;
- Species that provide an important function required to maintain the ecological integrity of a significant ecosystem; and
- Habitat types that are important to the life history of a significant species, i.e. breeding, feeding and roosting or aggregation areas, or where they are unique or isolate habitats in the landscape or region.

Table 12-9 assesses each habitat type against the significance criteria.

**Table 12-9: Significant fauna habitats of the study areas**

| Habitat | Habitat type that is important to the life history of a significant species | Unique or isolated habitats |
|---|---|---|
| Beach | Yes, provides habitat for migratory shorebirds. | Yes |
| Cleared | No | No |
| Forest of *Eucalyptus* spp. over tall shrubland over grassland | Possible – may provide potential habitat/foraging habitat for Pilbara Leaf-nosed Bat, Ghost Bat, North-Western Free-tailed Bat and Grey Falcon. | No |
| Mangal community | Yes – provides potential habitat/foraging habitat for North-Western Free-tailed Bat, Grey Falcon and migratory shorebirds. | Yes – isolated to coastal fringe |
| Mudflat or salt flat | Possible – may provide potential low value habitat/foraging habitat for migratory shorebirds, North-Western Free-tailed Bat and Grey Falcon. | No |
| Samphire shrubland (tidal) | Yes – provides potential habitat/foraging habitat for North-Western Free-tailed Bat, Grey Falcon and migratory shorebirds. | No |
| Samphire shrubland (inland) | Possible – may provide potential broad foraging habitat for North-Western Free-tailed Bat, Grey Falcon and migratory shorebirds. | No |

| Habitat | Habitat type that is important to the life history of a significant species | Unique or isolated habitats |
|---|---|---|
| Shrubland over spinifex grassland | Possible – may provide broad potential foraging habitat for Pilbara Leaf-nosed Bat Ghost Bat, North-Western Free-tailed Bat and Grey Falcon. | No |
| Shrubland over tussock grassland | Possible – may provide potential broad foraging habitat for Pilbara Leaf-nosed Bat, Ghost bat, North-Western Free-tailed Bat and Grey Falcon. | No |
| Shrubland over spinifex grassland on drainage | Yes – provides potential habitat/foraging habitat for Pilbara Leaf-nosed Bat, Ghost Bat, Grey Falcon, North-Western Free-tailed Bat and the Lined Soil-crevice Skink, particularly during flow events. | Yes – constrained to creeklines |
| Spinifex grassland | Possible – may provide potential broad foraging habitat for Pilbara Leaf-nosed Bat, Ghost Bat, North-Western Free-tailed Bat and Grey Falcon. | No |
| Tidal channel and ocean | N/A – not specifically a terrestrial fauna habitat | |
| Tussock grassland | Possible – may provide potential broad foraging habitat for Pilbara Leaf-nosed Bat, Ghost Bat, North-Western Free-tailed Bat and Grey Falcon. | No |
| Tussock grassland on beach and dune | Possible – may provide potential habitat/foraging habitat for Grey Falcon and migratory shorebirds. | No |
| Tussock grassland on granite outcrop | Possible – provides potential habitat/foraging habitat for Pilbara Leaf-nosed Bat, Ghost Bat, North-Western Free-tailed Bat and Grey Falcon | No |
| Upright outcrop-– shrubland over spinifex grassland | Yes – provides foraging habitat for Pilbara Leaf-nosed Bat. | No |
| Woodland of *Eucalyptus* spp. over tussock grassland on drainage | Yes – provides habitat/foraging habitat for Pilbara Leaf-nosed Bat, Ghost Bat, Grey Falcon, Pilbara Olive Python, North-Western Free-tailed Bat and the Lined Soil-crevice Skink. | Yes – constrained to creeklines |

The following environmental values were therefore determined to require assessment for this factor:

- General fauna species and habitat (provides a general assessment of fauna assemblages and habitat);
- Ghost Bat and Pilbara Leaf-nosed Bat;
- North-Western Free-tailed Bat;
- Pilbara Olive Python;
- Grey Falcon; and
- Migratory birds, including those protected under the EPBC Act.

Potential impacts on tidal channel and ocean, mangal communities and beach and dune habitats have previously been assessed in detail in Section 7.7 (BCH) and therefore has not been re-assessed in this section.





The previous assessment is however referred to when assessing potential impacts on specific species that utilise this habitat (i.e., migratory birds, North-Western Free-tailed Bat).

## 12.4 POTENTIAL IMPACTS

Table 12-10 defines the potential impacts (direct, indirect and combined) on the environmental values for this factor in a local and regional context.

**Table 12-10: Potential impacts on terrestrial fauna**

| Environmental value and current extent | Potential direct impact | Potential indirect impact | Impacts associated with other local proposals | Combined local impact (Proposal + others) |
|---|---|---|---|---|
| **General fauna species and habitat.**<br>Current habitats are relatively undisturbed, all vegetation associations have more than 84% of their pre-European extent remaining (Least Concern). | Up to 12,174 ha disturbance<br>Injury or death from vehicle strike | Alteration of habitat characteristics as a result of changes to surface water regimes.<br>Predation or competition from an increased risk of introduced fauna.<br>Concentration ponds and crystallisers attracting fauna and potential fauna entrapment.<br>Alteration of behaviour as a result of noise or light emissions.<br>Ponds result in a barrier to fauna movement.<br>Reduction in habitat health as a result of:<br>• Groundwater seepage;<br>• Increased sedimentation during construction;<br>• Leaks or spillages of hypersaline brine, hydrocarbons or chemicals; and<br>• Introduction or spread of weed species | Up to 153 ha of disturbance associated with Sino Iron Project and 40-Mile Beach Road. | Up to approximately 12,327 ha of direct disturbance of fauna habitat.<br>Potential indirect habitat health impacts. |
| **Pilbara Leaf-nosed Bat and Ghost Bat**<br>Spinifex grasslands, tussock grasslands and eucalypt forest / woodland may provide foraging habitat. 22,540.8 ha mapped within the TFSA. | Up to 10,950.3 ha disturbance of foraging habitat.<br>Injury or death from vehicle strike | Alteration of behaviour as a result of noise or light emissions.<br>Predation or competition, or reduction in habitat health as described in 'general species and habitat'. | Up to 111 ha of disturbance to foraging habitat associated with Sino Iron Project and 40-Mile Beach Road. | Up to 11,031.3 ha of direct disturbance of foraging habitat.<br>Potential indirect habitat health impacts. |
| **North-Western Free-tailed Bat.**<br>Mangal community habitat is considered to be critical roosting habitat. | Up to 8.3 ha disturbance of critical habitat.<br>Up to 12,145.2 ha of disturbance of | Alteration of behaviour as a result of noise or light emissions.<br>Predation or competition, or reduction in habitat health as described in 'general species and habitat'. | Up to 119 ha of disturbance to foraging habitat associated with Sino Iron Project and | Up to approximately 8.3 ha of direct disturbance of critical roosting habitat. |

| Environmental value and current extent | Potential direct impact | Potential indirect impact | Impacts associated with other local proposals | Combined local impact (Proposal + others) |
|---|---|---|---|---|
| 1,310.5 ha of critical habitat mapped within the LAUs.<br>Spinifex grassland, tussock grassland, eucalypt forest, mudflats or salt flats and samphire shrubland provide potential foraging habitat. 25,848.8 ha mapped within the TFSA. | foraging habitat.<br>Injury or death from vehicle strike. | | 40-Mile Beach Road. | Up to approximately 12,264.2 ha of direct disturbance of foraging habitat.<br>Potential indirect habitat health impacts. |
| **Pilbara Olive Python**<br>Eucalypt woodland on drainage may provide potential foraging habitat. 209.4 ha of potential habitat mapped within the TFSA. | Up to 20.8 ha of disturbance of potential foraging habitat.<br>Injury or death of individuals due to vehicle strike. | Increased competition from introduced fauna.<br>Alteration of behaviour as a result of noise or light emissions.<br>Reduction in habitat health as described in 'general species and habitat'. | Up to 111 ha of disturbance to foraging habitat associated with Sino Iron Project and 40-Mile Beach Road. | Up to approximately 20.8 ha of direct disturbance of potential foraging habitat.<br>Potential indirect habitat health impacts. |
| **Grey Falcon**<br>Well known nesting site recorded immediately east of the Proposal. Spinifex grassland within the Proposal would be used for foraging.<br>5,547.0 ha of the TFSA could be considered suitable foraging habitat. | Up to 1,954.4 ha of disturbance of potential foraging habitat. | Alteration of behaviour as a result of noise or light emissions.<br>Predation or competition, or reduction in habitat health as described in 'general species and habitat'. | Up to 15.1 ha of disturbance associated with Sino Iron Project and 40-Mile Beach Road. | Up to approximately 1,969.5 ha of direct disturbance of fauna habitat.<br>Potential indirect habitat health impacts. |
| **Migratory birds**<br>Potential foraging and roosting habitat was recorded within the LAUs, including tidal samphire shrubland, mudflat or salt flat, tidal channel and ocean, algal mat and mangal communities.<br>6,952.4 ha of the LAUs could be considered suitable habitat. An additional 3,517.4 ha was identified as being potential habitat for the Oriental Pratincole, inclusive of spinifex grassland and tussock grassland habitat types. | Up to 576.3 ha of disturbance of migratory shorebird significant habitat.<br>Up to 2,392.2 ha of additional disturbance of Oriental Pratincole foraging habitat. | Alteration of behaviour as a result of noise or light emissions.<br>Attraction and use of concentration ponds and crystallisers.<br>Predation or competition, or reduction in habitat health as described in 'general species and habitat'. | Up to 8.2 ha of disturbance to migratory shorebird foraging habitat associated with Sino Iron Project and 40-Mile Beach Road.<br>Up to 111 ha of disturbance to Oriental Pratincole foraging habitat associated with Sino Iron Project and | Up to approximately 1,239.2 ha of direct disturbance of migratory bird habitat.<br>Up to approximately 2,503.2 ha of direct disturbance of Oriental Pratincole habitat.<br>Potential indirect habitat health impacts. |





| Environmental value and current extent | Potential direct impact | Potential indirect impact | Impacts associated with other local proposals | Combined local impact (Proposal + others) |
|---|---|---|---|---|
| Therefore, a total of 6,866.6 ha of the SBSA could be considered suitable habitat for this species. | | | 40-Mile Beach Road. | |

# 12.5 ASSESSMENT OF IMPACTS

The following sections assess the potential impacts on each environmental value identified in Section 12.3.9.

## 12.5.1 GENERAL FAUNA SPECIES AND HABITAT

***Direct Disturbance***

The Proposal will result in the direct disturbance of up to 12,174 ha of terrestrial fauna habitat. There are several items of note during this assessment:

- The disturbance is to occur within a largely uncleared landscape as all vegetation associations currently have at least 84% of their pre-European extent remaining (Shephard et al., 2002; Beard et al., 2013); and
- There has been minimal clearing in the local area, limited to that required for the construction of 40-Mile Beach Road and campsites, Sino Iron Project (including Cape Preston Port), and Devil Creek gas plant.

When assessing the disturbance associated with the Proposal at a regional scale, the majority of the disturbance will occur within two vegetation associations; '175: Short bunch grassland – savanna/grassland (Pilbara)' and '127: Bare areas, mudflats.' For a detailed description of these vegetation associations, refer to Section 11.5.2.

Table 12-11 lists out the potential direct and indirect impacts to fauna habitats mapped during the surveys. Regional extent has been included if similar habitat types were mapped over the broader region.

Potential indirect impacts to habitat referred to in Table 12-11 relate to hydrological and hydrogeological changes and are discussed in the following sections. Areas at risk of impact due to changes in flooding frequency have been referred to as 'potential indirect impacts.' These are areas that are predicted to experience inundation in a 1EY rainfall event when they previously did not, or vice versa. Potential impacts associated with groundwater changes (seepage and mounding) have been identified as requiring mitigation through the implementation of a GMMP (Appendix 1.9) in order to ensure that there will be minimal impacts to fauna habitat. These mitigation measures are predicted to be able to contain impacts to a 100 m buffer around the pond walls (refer to Section 6). Therefore as a conservative approach all fauna habitats within 100 m of the pond walls have been included as being potentially indirectly impacted by groundwater mounding and seepage.





Table 12-11: Potential direct and indirect impacts to fauna habitats

| Fauna habitat types | Regional extent (ha/numbers) | Extent in TFSA (ha) | Extent in Development Envelopes (ha) | Direct Impacts- Extent in Disturbance Footprint (ha) | Indirect impacts (ha) | Combined Proposal impact |
|---|---|---|---|---|---|---|
| Beach | Not available | 16.4 | 3.7 | 0.1 | No indirect impacts expected | 0.1 ha (0.6% of TFSA extent) |
| Forest of *Eucalyptus* spp. over tall shrubland over grassland | Not available | 54.6 | 43.2 | 14.4 | 0.1 (mounding and seepage)<br>No indirect impacts associated with increased inundation<br>0.4 (reduced inundation)<br>0.1 (mounding. seepage and changed inundation) | 14.4 ha (26.9% of TFSA extent) with 0.6 (1.1%) indirect impacts |
| Mangal community | 33,706 | 285.1 | 194.0 | 6.2 | 0.7 (mounding and seepage)<br>No indirect impacts associated with increased inundation<br>4.1 (reduced inundation)<br>0.1 (mounding, seepage and changed inundation) | 6.2 ha (2.2% of TFSA extent, 0.03% of regional extent) with 4.9 ha (1.7% of TFFA extent) indirect impacts |
| Mudflat or salt flat | Not available | 2,419.7 | 2,349.7 | 742.9 | 108.8 (seepage)<br>0.3 (increased inundation)<br>47.3 (reduced inundation)<br>11.0 (seepage and changed inundation) | 742.9 ha (30.7% of TFSA extent) with 167.4 ha (6.9%) indirect impacts |
| Samphire shrubland (tidal) | Not available | 593.7 | 536.0 | 262.7 | 17.2 (mopunding and seepage)<br>No indirect impacts associated with increased inundation<br>5.1 (reduced inundation)<br>1.8 (seepage and changed inundation) | 262.7 ha (44.1% of TFSA extent) with 24.1 ha (4.1%) indirect impacts |
| Samphire shrubland (inland) | Not available | 295.1 | 295.1 | 189.5 | 8.3 (seepage)<br>0.1 (increased inundation)<br>2.2 (reduced inundation) | 189.5 ha (64.2% of TFSA extent) with |

| Fauna habitat types | Regional extent (ha/numbers) | Extent in TFSA (ha) | Extent in Development Envelopes (ha) | Direct Impacts- Extent in Disturbance Footprint (ha) | Indirect impacts (ha) | Combined Proposal impact |
|---|---|---|---|---|---|---|
| | | | | | 2.4 (seepage and changed inundation) | 13 ha (4.4%) indirect impacts |
| Shrubland over spinifex grassland | Not available | 5,326.5 | 3,831.8 | 1,937.4 | 60.5 (mounding and seepage)<br>1.5 (increased inundation)<br>3.8 (reduced inundation)<br>1.8 (mounding, seepage and changed inundation) | 1,937.4 ha (36.4% of TFSA extent) with 67.6 ha (1.3%) indirect impacts |
| Shrubland over tussock grassland | Not available | 3,805.2 | 2,131.8 | 1,226.3 | 65.9 (mounding and seepage)<br>3.6 (increased inundation)<br>1.2 (reduced inundation)<br>2.8 (mounding, seepage and change inundation) | 1,226.3 ha (32.2% of TFSA extent) with 73.5 ha (1.9%) indirect impacts |
| Shrubland over spinifex grassland on drainage | Not available | 100.0 | 100.0 | 17.0 | No indirect impacts associated with mounding and seepage<br>0.1 (increased inundation)<br>(0.1) reduced inundation<br>No overlapping indirect impacts | 17.0 ha (17.0% of TFSA extent) with 0.2 (0.2%) of indirect impacts |
| Spinifex grassland | Not available | 120.5 | 120.4 | 0 | No indirect impacts expected | No impacts expected |
| Tidal channel and ocean | Not available | 155.9 | 30.8 | 8.1 | 1.1 (mounding and seepage)<br>No indirect impacts associated with increased inundation<br>(0.8) reduced inundation<br>No overlapping indirect impacts | 8.1 ha (5.2% of TFSA extent) with 1.9 (1.2%) indirect impacts |
| Tussock grassland | Not available | 12,914.6 | 10,303.5 | 7,733.4 | 21.1 (mounding and seepage)<br>17.5 (increased inundation)<br>8.1 (reduced inundation) | 7,733.4 ha (59.9% of TFSA extent) with 47 ha (0.4%) indirect impacts |

| Fauna habitat types | Regional extent (ha/numbers) | Extent in TFSA (ha) | Extent in Development Envelopes (ha) | Direct Impacts- Extent in Disturbance Footprint (ha) | Indirect impacts (ha) | Combined Proposal impact |
|---|---|---|---|---|---|---|
| | | | | | 0.3 (mounding, seepage and changed inundation) | |
| Tussock grassland on beach and dune | Not available | 0.03 | 0.02 | 0 | No indirect impacts expected | No impacts expected |
| Tussock grassland on granite outcrop | Not available | 9.5 | 5.0 | 0.9 | 0.1 (mounding and seepage)<br>No indirect impacts associated with increased inundation<br>No indirect impacts associated with reduced inundation<br>No overlapping indirect impacts | 0.9 ha (9.5% of TFSA extent) with 0.1 ha (1.1%) indirect impacts. |
| Woodland of *Eucalyptus* spp. over tussock grassland on drainage | Not available | 209.4 | 137.4 | 20.8 | 0.2 (mounding and seepage)<br>0.4 (increased inundation)<br>1.0 (reduced inundation)<br>No overlapping indirect impacts | 20.8 ha (9.9% of TFSA extent) with 1.6 (0.8%) indirect impacts |

An assessment of the impacts of the direct disturbance of fauna habitat has been provided below and is shown in Figure 12-24 and Figure 12-25. Where more detail is warranted, it has been provided in subsequent sections:

- **Beach** – 0.1 ha of this habitat type is proposed to be disturbed. This equates to 0.6% of the extent within the TFSA. There are minimal impacts to this habitat, which are therefore not considered significant from a terrestrial fauna perspective;
- **Forest of *Eucalyptus* spp. over tall shrubland over grassland** – 14.4 ha of this habitat type is proposed to be disturbed, mostly by the development of concentration ponds and crystallisers. This equates to 26.9% of the mapped extent within the TFSA. Up to 0.6 ha (1.1%) of this habitat type is predicted to be at risk of indirect impacts associated with hydrology. This includes 0.1 ha associated with groundwater seepage, 0.4 ha associated with changes to surface water inundation and 0.1 ha of overlapping surface water and groundwater impacts. This habitat type holds value as foraging habitat for multiple significant fauna species, including the the Ghost Bat, the Pilbara Leaf-nosed Bat, and the North-Western Free-tailed Bat. As such, this habitat type will be discussed in further detail in Sections 12.5.2, 12.5.3 and 12.5.4;
- **Woodland of *Eucalyptus* spp. over tussock grassland on drainage** – 20.8 ha of this habitat type is proposed to be disturbed, mostly by the development of concentration ponds and crystallisers. This equates to 9.9% of the mapped extent within the TFSA. Up to 1.6 ha (0.8%) of this habitat type is predicted to be at risk of indirect impacts associated with hydrology. This includes 0.2 ha associated with groundwater seepage, 1.4 ha associated with changes to surface water inundation and no overlapping surface water and groundwater impacts. This habitat type holds value as important habitat for multiple significant species, including the Pilbara Olive Python, the Ghost Bat, the Oriental Pratincole, the Pilbara Leaf-nosed Bat, and the North-Western Free-tailed Bat. As such, this habitat type will be discussed in further detail in Sections 12.5.2, 12.5.3, 12.5.4 and 12.5.6;
- **Mangal community** – 6.2 ha of this habitat type is proposed to be disturbed, mostly by the development of the seawater intake, concentration ponds and crystallisers. This equates to 2.2% of the mapped extent within the TFSA. Up to 4.9 ha (1.7%) of this habitat type is predicted to be at risk of indirect impacts associated with hydrology. This includes 0.7 ha associated with groundwater seepage, 4.1 ha associated with changes to surface water inundation and 0.1 ha of overlapping surface water and groundwater impacts. This habitat type holds value as important habitat for multiple significant species, including migratory shorebirds and the North-Western Free-tailed Bat. As such, this habitat type will be discussed in further detail in Sections 12.5.3 and 12.5.6;
- **Mudflat or salt flat** – A large proportion of disturbance is proposed to occur within this habitat type. 742.9 ha of this habitat is proposed to be disturbed, mostly by the development of concentration ponds and crystallisers. This equates to 30.7% of the mapped extent within the TFSA. Up to 167.4 ha (6.9%) of this habitat type is predicted to be at risk of indirect impacts associated with hydrology. This includes 108.8 ha associated with groundwater seepage, 47.6 ha associated with changes to surface water inundation and 11 ha of overlapping surface water and groundwater impacts. This habitat type holds value as occasional foraging habitat for multiple significant species, including migratory shorebirds and the North-Western Free-tailed Bat. As such, this habitat type will be discussed in further detail in Sections 12.5.3 and 12.5.5;

- **Tidal channel and ocean** – 8.1 ha of this habitat type is proposed to be disturbed, mostly within the marine development envelope. This equates to 5.2% of the extent within the mapped TFSA. Up to 1.9 ha (1.2%) of this habitat type is predicted to be at risk of indirect impacts associated with hydrology. This includes 1.1 ha associated with groundwater seepage, 0.8 ha associated with changes to surface water inundation and no overlapping surface water and groundwater impacts. This habitat type holds value as habitat for migratory shorebirds, and as such, this habitat type has been discussed in further detail in Section 12.5.6;
- **Samphire shrubland (tidal) –** 262.7 ha of this habitat is proposed to be disturbed, mostly by the development of concentration ponds and crystallisers. This equates to 44.1% of the extent within the mapped TFSA. Up to 24.1 ha (4.1%) of this habitat type is predicted to be at risk of indirect impacts associated with hydrology. This includes 17.2 ha associated with groundwater seepage, 5.1 ha associated with changes to surface water inundation and 1.8 ha of overlapping surface water and groundwater impacts. Indirect impacts are predicted to be minimal, as samphire communities have a high tolerance of hypersaline conditions. This habitat type holds value as important habitat for multiple significant species, including migratory shorebirds and the North-Western Free-tailed Bat. As such, this habitat type will be discussed in further detail in Sections 12.5.3 and 12.5.6;
- **Samphire shrubland (inland) –** 189.5 ha of this habitat is proposed to be disturbed, mostly by the development of concentration ponds and crystallisers. This equates to 64.2% of the extent within the mapped TFSA. Up to 13 ha (4.4%) of this habitat type is predicted to be at risk of indirect impacts associated with hydrology. This includes 8.3 ha associated with groundwater seepage, 2.3 ha associated with changes to surface water inundation and 2.4 ha of overlapping surface water and groundwater impacts. This habitat type holds value as important habitat for multiple significant species, including the North-Western Free-tailed Bat. As such, this habitat type has been discussed in further detail in Section 12.5.3;
- **Shrubland over spinifex grassland** – 1,937.4 ha of this habitat is proposed to be disturbed, mostly by the development of concentration ponds and crystallisers. This equates to 36.4% of the extent within the mapped TFSA. Up to 67.6 ha (1.3%) of this habitat type is predicted to be at risk of indirect impacts associated with hydrology. This includes 60.5 ha associated with groundwater seepage, 5.3 ha associated with changes to surface water inundation and 1.8 ha of overlapping surface water and groundwater impacts. This habitat type holds value as important habitat for multiple significant species, including the Pilbara Leaf-nosed Bat, Ghost Bat, North-Western Free-tailed Bat, Grey Falcon and migratory shorebirds. This habitat type will be further assessed in Sections 12.5.2, 12.5.3, 12.5.4, 12.5.5 and 12.5.6;
- **Shrubland over spinifex grassland on drainage** – 17.0 ha of this habitat is proposed to be disturbed, mostly by the development of the concentration ponds and crystallisers. This equates to 17% of the extent within the mapped TFSA. This habitat type holds value as important habitat for multiple significant species including the Pilbara Leaf-nosed Bat, Ghost Bat, North-Western Free-tailed Bat, Grey Falcon and migratory shorebirds. Up to 0.2 ha (0.2%) of this habitat type is predicted to be at risk of indirect impacts associated with hydrology. This includes 0.2 ha associated with changes to surface water inundation and no impacts associated with groundwater seepage or the overlap between surface

water and groundwater impacts. This habitat type will be further assessed in Sections 12.5.2, 12.5.3, 12.5.4, 12.5.5 and 12.5.6;

- **Tussock grassland** – Tussock grassland comprised a majority of the TFSA at almost 60%. 7,733.4 ha of this habitat type is proposed to be disturbed, primarily by the development of concentration ponds and crystallisers. This equates to 59.9% of the extent within the mapped TFSA. Up to 47 ha (0.4%) of this habitat type is predicted to be at risk of indirect impacts associated with hydrology. This includes 21.1 ha associated with groundwater seepage, 25.6 ha associated with changes to surface water inundation and 0.3 ha of overlapping surface water and groundwater impacts. This habitat type holds value as habitat for multiple significant species, including the Ghost Bat, Oriental Pratincole, the Pilbara Leaf-nosed Bat, and the North-Western Free-tailed Bat. As such, this habitat type and associated Tussock grassland habitat types listed below will be discussed in further detail in Sections 12.5.2, 12.5.3, 12.5.4 and 12.5.6;
- **Tussock grassland on granite outcrop** – 0.9 ha of this habitat type is proposed to be disturbed, mostly by the development of concentration ponds and crystallisers. This equates to 9.5% of the extent within the mapped TFSA. There are no predicted indirect impacts. This habitat type holds value for multiple significant species including the Pilbara Leaf-nosed Bat, Ghost Bat, North-Western Free-tailed Bat and the Oriental Pratincole. As mentioned above, this habitat type will be further assessed in Sections 12.5.2, 12.5.3, 12.5.4 and 12.5.6; and
- **Shrubland over tussock grassland** – 1,226.3 ha of this habitat is proposed to be disturbed, mostly by the development of concentration ponds and crystallisers. This equates to 32.7% of the extent within the mapped TFSA. Up to 73.5 ha (1.9%) of this habitat type is predicted to be at risk of indirect impacts associated with hydrology. This includes 65.9 ha associated with groundwater seepage, 4.8 ha associated with changes to surface water inundation and 2.8 ha of overlapping surface water and groundwater impacts. This habitat type holds value for multiple significant species including the Pilbara Leaf-nosed Bat, Ghost Bat, North-Western Free-tailed Bat and migratory shorebirds. As mentioned above, this habitat type will be further assessed in Sections 12.5.2, 12.5.3, 12.5.4 and 12.5.6.

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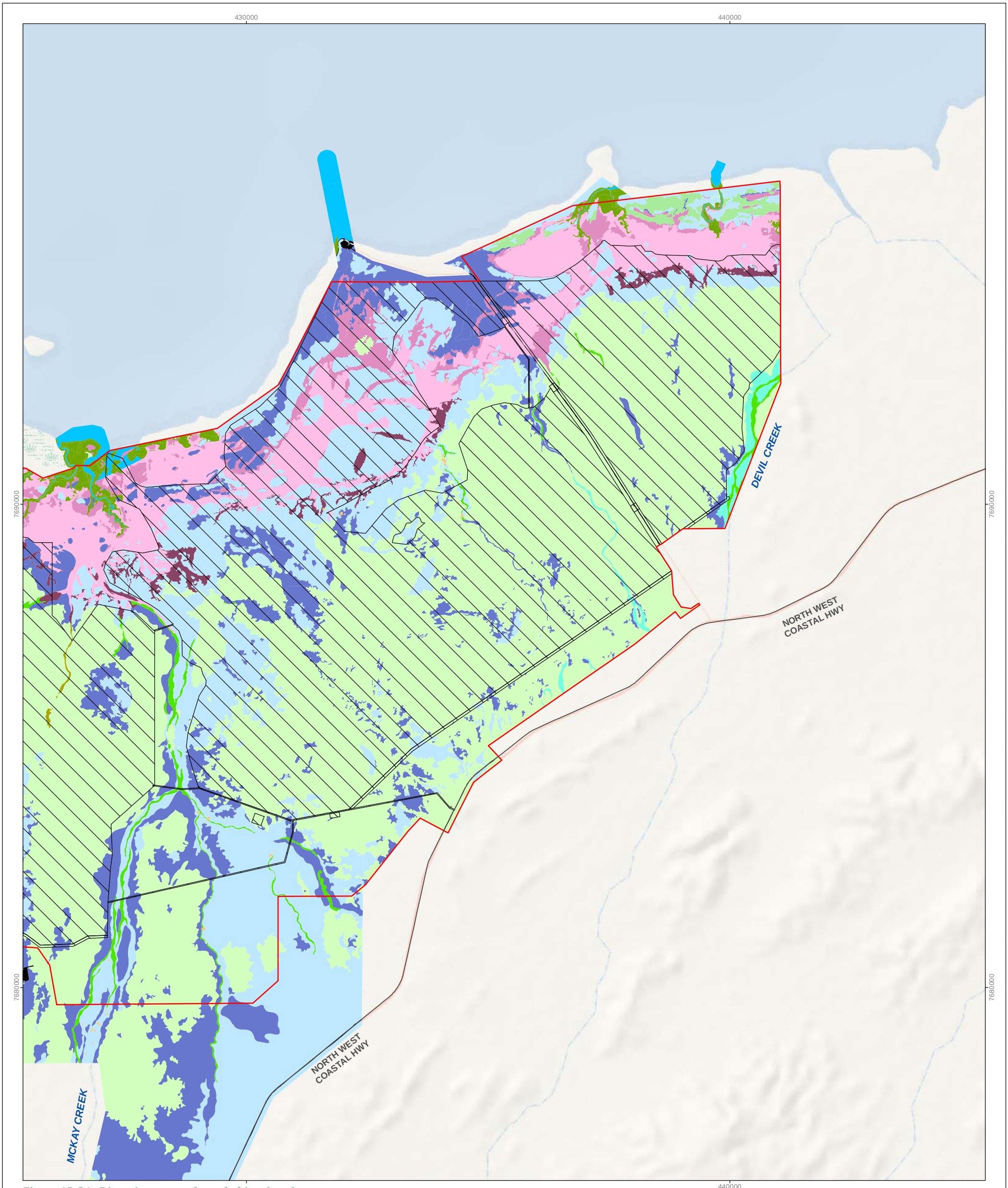


Figure 12-24: Direct impacts to fauna habitat (east)

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**Leichhardt Salt Pty Ltd**

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Scale: 1:75,000 @ A3

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- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

**LOCALITY**




Legend

- Marine Development Envelope
- Pond and Infrastructure Development Envelope
- Revised Disturbance Footprint

Fauna Habitat

- Beach
- Mangal community
- Tidal channel and ocean
- Mudflat or salt flat
- Samphire shrubland (tidal)
- Samphire shrubland (inland)
- Forest of Eucalyptus spp. over tall shrubland over grassland
- Shrubland over spinifex grassland
- Shrubland over spinifex grassland on drainage
- Shrubland over tussock grassland
- Spinifex grassland
- Tussock grassland on beach and dune
- Tussock grassland on granite outcrop
- Upright outcrop - shrubland over spinifex grassland
- Woodland of Eucalyptus spp. over tussock grassland on drainage
- Tussock grassland
- Cleared

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SW Regnard Island
Preston Island
ERRAMURRA CREEK
NORTH WEST COASTAL HWY

Figure 12-25: Direct impacts to fauna habitat (west)

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| CREATED BY | JOB | DATE | REVISION |
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| ENVIRONMAPS | PC2900212 | 28/11/2023 | 0 |

**Leichhardt Salt Pty Ltd**

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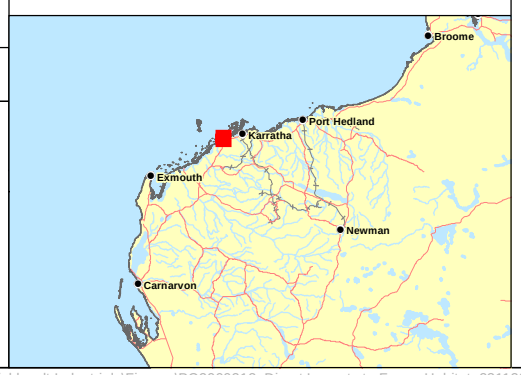
- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

**LOCALITY**




Legend

- Marine Development Envelope
- Pond and Infrastructure Development Envelope
- Revised Disturbance Footprint

Fauna Habitat

- Beach
- Mangal community
- Tidal channel and ocean
- Mudflat or salt flat
- Samphire shrubland (tidal)
- Samphire shrubland (inland)
- Forest of Eucalyptus spp. over tall shrubland over grassland
- Shrubland over spinifex grassland
- Shrubland over spinifex grassland on drainage
- Shrubland over tussock grassland
- Spinifex grassland
- Tussock grassland on beach and dune
- Tussock grassland on granite outcrop
- Upright outcrop - shrubland over spinifex grassland
- Woodland of Eucalyptus spp. over tussock grassland on drainage
- Tussock grassland
- Cleared

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***Fauna Vehicle Strike***

The number of vehicles required for the Proposal is relatively low, with access to the accommodation camp close to the North West Coastal Highway (i.e., short travel distance), which will reduce the risk of the death or injury of fauna individuals due to vehicle strike. Mitigation measures have been proposed in Section 12.6 to reduce this risk as far as practicable.

***Changes to Surface Water Regimes***

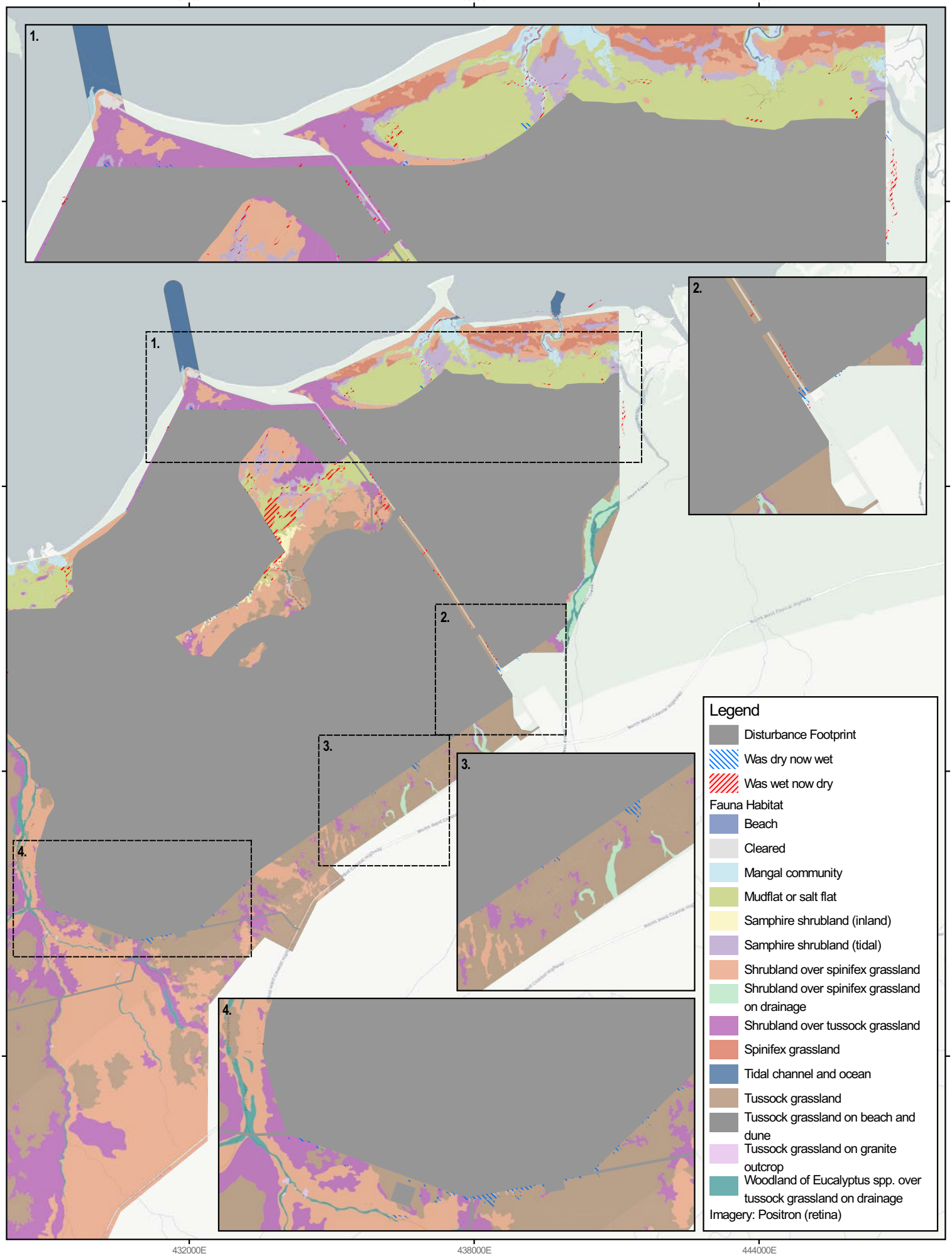
As detailed in Table 12-11 and Section 6 (Inland Waters), there will be some terrestrial fauna habitats that will be subject to changes to the local surface water regimes. There are four ways that changes to overland flows caused by the Proposal could potentially indirectly impact fauna habitats:

1. Less freshwater reaches the fauna habitats downstream of the ponds if freshwater flows are diverted away from these areas or blocked by the ponds;
2. Less freshwater reaches the habitat upstream of the ponds if freshwater flows are diverted around the area;
3. Increased freshwater inundation occurs within vegetation downstream of the ponds if the habitats are within the creeklines or close to the diversion channel outlets; and
4. Increased freshwater inundation occurs within vegetation upstream of the ponds if freshwater flows flow into and temporarily expand the ponds.

The Proposal will maintain the flow paths of Eramurra, McKay and Devil Creek. The presence of the ponds will however alter the size of the creek catchments, and require some diversion of broader floodwaters, resulting in changes in water depths in these creeklines and areas downslope of the ponds. Section 6 (Inland Waters) provides more detail about this modelling and predicted results. Figure 12-26 and Figure 12-27 shows the fauna habitat at risk from indirect impacts associated with changes to the surface water regime as a result of the Proposal. The total affected area of each habitat is provided in Table 12-12. No fauna habitats were predicted to experience changes to surface water flows of more than 5% of their local extent.

In the context of fauna habitat, the influence of the overland freshwater flow changes can be summarised below and shown in Figure 12-26 and Figure 12-27:

- 74.1 ha of fauna habitat would not experience flooding in a 1EY flood event (was wet, now dry) as a result of the Proposal; and
- 23.5 ha of fauna habitat would experience flooding in a 1EY flood event (was dry, now wet) as a result of the Proposal.

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Project: LEI_0535_034
Date: 27/03/2025
Size: A4
Author: ASmithers (Preston Consulting Pty Ltd)

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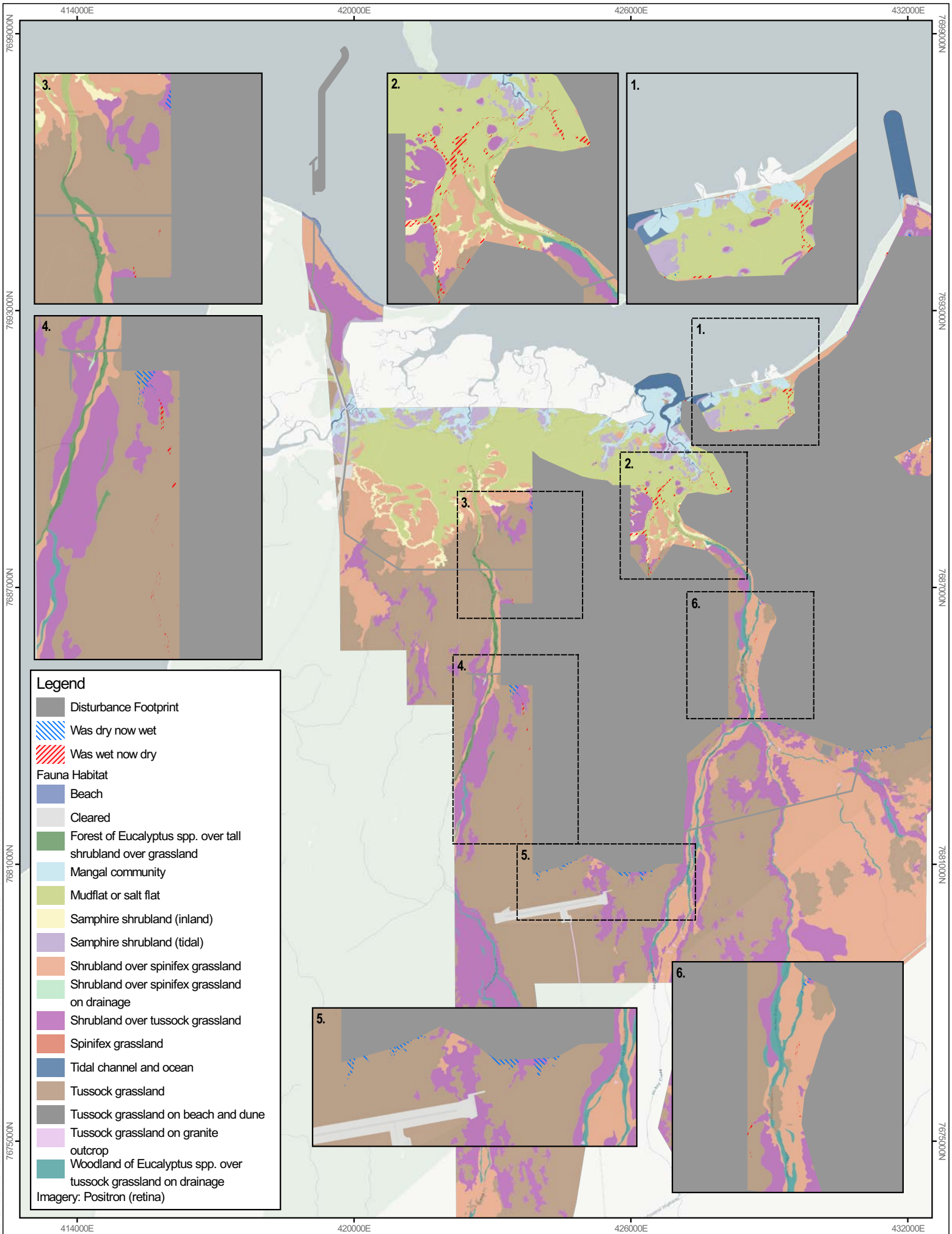
**Figure 12-26: Fauna habitat (East) at risk of indirect impacts associated with changes to the surface water regime**

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Project: LEI_0535_035
Date: 27/03/2025
Size: A4
Author: ASmithers (Preston Consulting Pty Ltd)

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**Figure 12-27: Fauna habitat (West) at risk of indirect impacts associated with changes to the surface water regime**

***Changes to Groundwater Regimes and Quality***

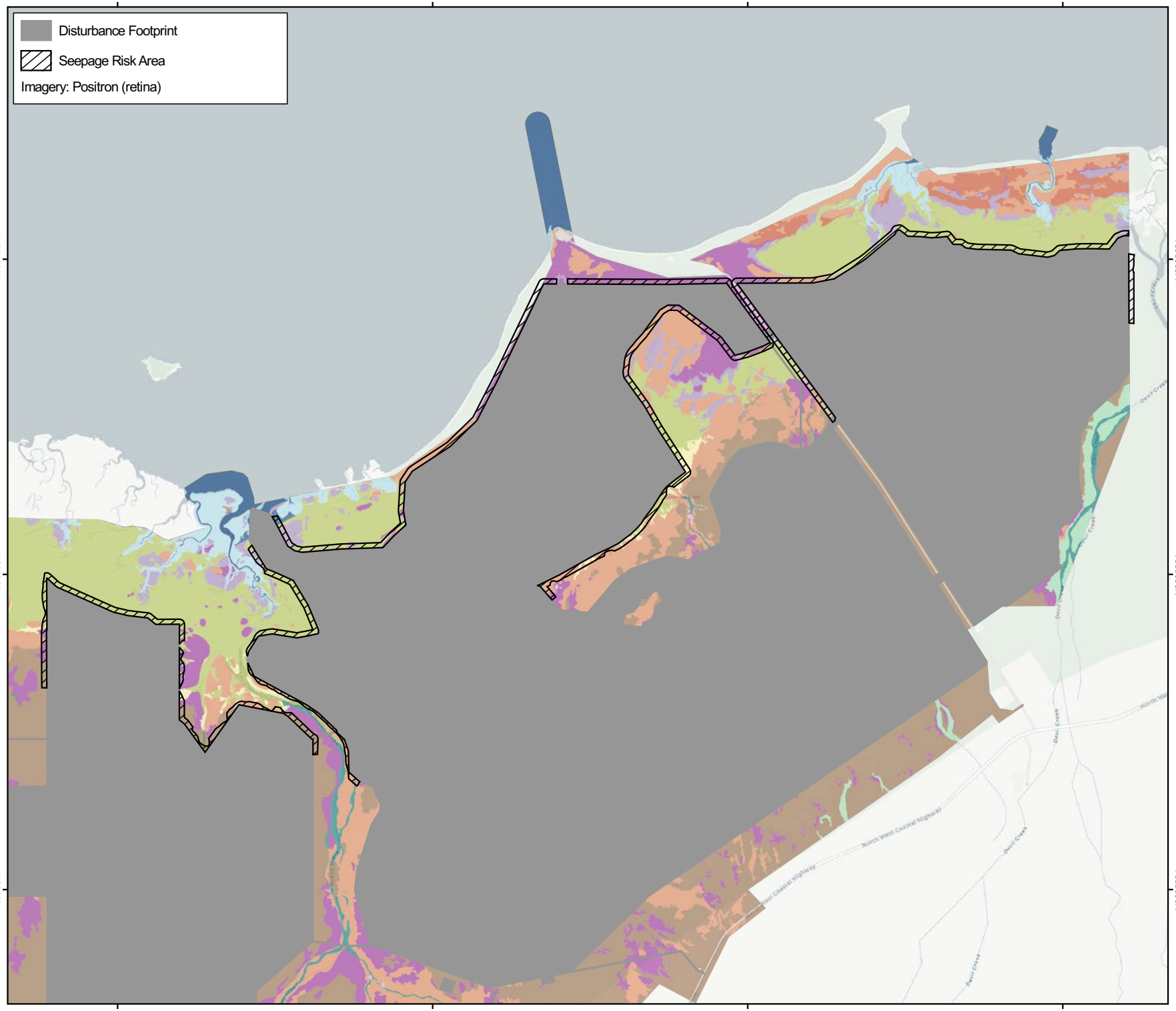
As detailed in Section 6 (Inland Waters), there will be fauna habitat around the pond footprints that could be impacted by changes to the local groundwater levels or quality as a result of seepage and mounding from the ponds. The scale of these potential impacts was determined to be significant, and therefore mitigation is proposed under a GMMP to minimise these impacts as far as practicable (Appendix 1.9). With the implementation of this mitigation, impacts associated with changes to the groundwater regime are predicted to be able to be restricted to a 100 m zone around the pond walls. Monitoring and management of groundwater impacts as a result of the Proposal are outlined in the GMMP. The 100 m management zone includes a 20 m construction disturbance footprint which is required to build the pond walls. Therefore, indirect impacts to BCH have been calculated as being a maximum 80 m within areas that are 'at risk' of groundwater mounding and seepage impacts. These areas have been conservatively defined as being areas:

- Where the depth to groundwater is 5 m or less and the predicted change in groundwater level is 1 m or more; and
- Of mapped GDEs where the predicted change in groundwater level is 1 m or more (not relevant to BCH).

Areas of fauna habitat at risk of seepage and mounding are outlined in Table 12-11 and shown in Figure 12-28.

Section 6 (Inland Waters) provides more detail about this modelling, predicted results and proposed mitigation.

With the implementation of controls, it is predicted that groundwater seepage impacts to fauna habitat could be contained to within 100 m of the walls (generally within the construction disturbance footprint). Potential impacts from this source to each fauna habitat type is provided in Table 12-11. Not all of the fauna habitats in this zone will be impacted, however the calculations provide a conservative estimate of the fauna habitat that could be at risk of impacts.




## Legend

Fauna Habitat

- Beach
- Cleared
- Forest of Eucalyptus spp. over tall shrubland over grassland
- Mangal community
- Mudflat or salt flat
- Samphire shrubland (inland)
- Samphire shrubland (tidal)
- Shrubland over spinifex grassland
- Shrubland over spinifex grassland on drainage
- Shrubland over tussock grassland
- Spinifex grassland
- Tidal channel and ocean
- Tussock grassland
- Tussock grassland on beach and dune
- Tussock grassland on granite outcrop
- Woodland of Eucalyptus spp. over tussock grassland on drainage

N

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GDA2020 / MGA zone 50

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Project: LEI_0535_036
Date: 28/03/2025
Size: A4
Author: ASmithers (Preston Consulting Pty Ltd)

**Figure 12-28: Fauna habitat at risk of seepage and mounding impacts**

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### *Introduced Fauna*

Three introduced fauna were recorded within the TFSA: cattle, dogs and cats (Phoenix, 2023; Cowan, 2024). The Proposal does not provide any significant vectors for increases in introduced fauna species. There are no other Proposal activities that would either attract introduced fauna species or aid their survival in the area. With the implementation of mitigation measures, the Proposal is not expected to result in additional feral species being introduced and may result in a reduction in the local feral animal population as a result of eradication programs (refer to Section 12.6.2).

### *Pond Fauna Attraction*

The concentration ponds and crystallisers will contain saline and hypersaline water, and as such they will not provide a freshwater source for terrestrial fauna. Nevertheless, shorebirds and other terrestrial fauna may be attracted and utilise the lower salinity concentration ponds. Shorebirds have been observed to use salt ponds as nesting, foraging and roosting nesting habitat, often preferring the ponds over nearby mudflats and occurring in great densities (Masero & Pérez-Hurtado, 2001; Rufino, 1984; Sadoul, 1998; Sampath & Krishnamurthy, 1989; Takekawa et al., 2001; Velasquez, 1992, 1993; Warnock & PRBO Conservation Science, 2005). Indeed, in the Pilbara, the Port Hedland Dampier Saltworks are listed as Important Bird and Biodiversity Areas (IBAs) (Birdlife Australia, no date), and Houston et al. (2012) concluded after studying two salt fields associated with the Fitzroy River estuary, Queensland, that saltfields are "an integral component of the ecology of the landscape, providing complementary resources to that of the natural wetlands."

### *Pond Fauna Entrapment*

The concentration ponds and crystallisers will have embankments with low wall slopes so fauna that enter the ponds are expected to be able to climb out. Mitigation measures are proposed to minimise entrapment (refer to Section 12.6.2).

### *Noise and Light Emissions*

Construction of the Proposal will result in relatively low levels of noise and minimal night works are expected during pond construction.

The operation of the Proposal will result in low noise and light emissions overall as it relies on solar evaporation for the majority of the process (Herring Storer Acoustics, 2022). Noise and light emissions from the ponds are therefore unlikely to be significant enough to affect the behaviour of terrestrial fauna species.

The main source of noise and light emissions will be from the processing plant, which covers only several hectares and is located away from the coastline. Lighting controls are proposed as part of the Proposal to minimise impacts to turtle nesting and migratory birds (refer to Section 12.6.2), these controls will also minimise light impacts on other terrestrial fauna.

### *Erosion and Sedimentation of Terrestrial Habitat*

The majority of the disturbance for the Proposal is associated with the flooding of landscape that is currently inundated to varying degrees by frequent tidal pulses, periodic intense tropical storms and occasional significant catchment discharges. Receiving environments (mangal and samphire habitats) are therefore adept at accommodating changes to local hydrodynamics and sedimentation.

Excessive erosion at sections with direct coastal exposure will be prevented by the installation of rock armouring to stabilise the structures. Further inland, the walls will be constructed to limit permeability between adjacent ponds with some rip-rap protection against wave erosion.

Sediment may be released during construction of the pond walls, particularly during flood and heavy rain events. The wall material is generally high in clay content and will be compacted and rock armoured to ensure sediment losses are minimal. Leichhardt has committed to mitigation measures to reduce the risk of sedimentation (refer to Section 12.6.2).

### *Barriers to Fauna Movement*

With the exception of drainage corridors, the TFSA generally contains two 'zones' of fauna habitat; the coastal zone, which is generally associated with coastal and migratory bird species, and the inland zone, used by terrestrial fauna. In between these zones is large areas of bare mudflats and algal mats, which are generally not utilised or crossed by ground-dwelling fauna species. These mudflats therefore present an existing barrier to fauna movement, other than for birds. As the ponds are generally located on top of the inland edge of these mudflats, the ponds are unlikely to present a new barrier to fauna movement that does not currently exist. The preservation of drainage line corridors will still allow for fauna movement through the pond areas where needed.

### *Brine Seepage and Spills*

A large spill or leak of brine from the ponds or pipelines, or product infrastructure washdown water could result in impacts to the health of the surrounding fauna habitat. Brine is the primary resource for the Proposal and as such the concentration ponds, crystallisers and brine pipelines are designed to minimise the risk of leaks, overflows and wall breaches. Pipelines will utilise industry-standard materials to minimise the chance of leaks and mitigation will be implemented to reduce this risk further (refer to Section 12.6). Ponds have been designed with adequate freeboard and overflow features to minimise the risk of unplanned overflows and wall breaches. The ponds include internal weirs to rebalance local excess brine levels and external emergency spillways into adjacent major creeks to avoid cascading internal bund failure leading to massive outflows.

There are drainage ditches along the base of all perimeter bunds primarily to intercept groundwater seepage and collect brine for recovery to the process ponds. These will also intercept and contain minor splashing and spillage events.

If a large external overflow was to occur, it is most likely to arise from a major rain event which raises all pond levels. In such events, McKay and Devil Creeks both flow at high levels. In this case the brine overflow will be rapidly mixed with fresh surface water flow and discharged to the ocean.

***Weeds***

Weeds have the potential to be introduced to the area or spread as a result of the Proposal, with the greatest risks associated with earthmoving during the construction period. Phoenix (2025) identified the presence of *Prosopis glandulosa x velutina* from one quadrat within the study area. The control of the spread of *Prosopis glandulosa x velutina* will require significant controls (refer to Section 12.6).

***Rehabilitation and Closure***

The Proposal will result in large areas of ponds that contain salts or brine and as such the rehabilitation of fauna habitat may be impeded by the presence of salt post-closure.

Many of the impurities such as calcium carbonate and calcium sulfate will precipitate on the concentration pond floors as the brine salinity (and density) increases. Precipitate composition and volumes will vary across different stages of the ponds. Prior to closure, the composition and volumes of these deposits will be measured to enable effective planning for remediation. It is expected that by breaching walls and flushing the concentration ponds with surface runoff from rainfall events, soluble salts will be dissolved and returned to the surrounding intertidal area with no significant impacts.

Crystallisers have a smaller surface area than the concentration ponds and are located above the intertidal zone. Post-closure, the pond floors will likely be hypersaline. Even with the removal of the halite salts it will be necessary to flush the crystallisers with seawater to reduce residual salt. Pond embankments will be pushed down to allow re-establishment of overland flooding regimes.

### 12.5.2 PILBARA LEAF-NOSED BAT AND GHOST BAT

The Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) is listed as Vulnerable under the EPBC Act and BC Act. The Pilbara Leaf-nosed Bat is normally restricted to caves and mine adits (horizontal shafts) with stable, warm and humid microclimates, but temporary roosts such as crevices and tree hollows may be used in warm and humid conditions, allowing greater dispersal during the wet season. Their roosting site is often at depth in mines; in small crevices within caves, usually those ascending between sedimentary rock layers; and with associated groundwater seeps. Simple vertical shafts are not used by this species, and shallow caves beneath mesa bluffs are also unlikely roost sites. Pilbara Leaf-nosed Bat foraging has been observed in the following habitats: *Triodia* hummock grasslands covering low rolling hills and shallow gullies, with scattered *Eucalyptus camaldulensis*: over small watercourses amongst granite boulder terrain and around nearby koppies; over pools and low shrubs in ironstone gorges; and above low shrubs and around pools in gravelly watercourses with *Melaleuca leucodendron*, such as in Barlee Range Nature Reserve.

The Pilbara Leaf-nosed Bat was recorded foraging in an upright outcrop. This single detection suggests a post-maternity, dispersing individual. The Pilbara Leaf-nosed Bat is not a resident to the area and was not recorded within the PIDE, as no geological formations are present to form suitable roost caves within the development envelopes. Habitat of value to this species is therefore limited to broad-ranging foraging habitat and water sources.

The Ghost Bat (*Macroderma gigas*) is listed as Vulnerable under the EPBC Act and BC Act. The survival of the Ghost Bat is critically dependent on natural roosts in caves, crevices, deep overhangs, and artificial roosts such as abandoned mine adits; the most suitable roosting locations in the Pilbara occur in the Marra Mamba Iron Formation. Ghost Bats were not recorded in the TFSA, however they are still likely to occur in the development envelopes for foraging.

For both the Pilbara Leaf-nosed Bat and the Ghost Bat, three habitat types within the development envelopes are considered potential (or recorded) foraging habitats:

- Spinifex grasslands;
- Tussock grasslands; and
- Eucalypt forests and woodland.

22,540.8 ha of potential Pilbara leaf-nosed bat and Ghost Bat broad foraging habitat was recorded within the TFSA. Up to 10,950.3 ha (49%) may be disturbed, and 190.6 ha is predicted to be at risk of indirect impacts associated with hydrology. This includes:

- 37.7 ha associated with changes to surface water inundation;
- 147.9 ha associated with groundwater seepage; and
- 5.0 ha of overlapping surface water and groundwater impacts.

The nearby pools and creeks are likely to be regularly used as a water source or foraging by both species, however McKay Creek and Devil Creek are both outside the disturbance footprint and will not be significantly impacted by the Proposal.

Based on the above assessment, the Proposal is predicted to result in direct impacts to 10,950.3 ha of broad foraging habitat. While these habitats are wide-ranging in the area, these impacts to the Pilbara Leaf-nosed Bat and Ghost Bat are nevertheless considered significant, and therefore offsets are proposed under the PEOF to counterbalance the impacts to these species in Section 15.

### 12.5.3 NORTH-WESTERN FREE-TAILED BAT

The North-Western Free-tailed Bat (*Mormopterus cobourgianus*) is listed as a Priority 1 species. They are a mangrove-obligate species that occurs in rainforest, monsoon forest riparian zones and mangrove communities. It is known to roost in mangrove mosaics along the coastline. The mangal habitat is considered critical roosting habitat for this species.

This species was recorded within spinifex grassland, as well as tussock grasslands, which was associated with a drainage line and is consistent with other survey records in the region. The North-Western Free-tailed Bat, which was recorded foraging from four locations in mangal community habitat, is known to occur extensively within mangal communities of the region. Devil Creek and McKay Creek are also likely to support foraging for North-Western Free-tailed Bat that roosts in the mangroves. The Proposal has however been designed to avoid impact to these creeks which will continue to flow to the coast.

In total, six habitat types within the PIDE are considered were identified as critical or potential foraging habitats:

- Mangal community (critical);
- Spinifex grasslands (foraging);
- Tussock grasslands (foraging);
- Eucalypt forests and woodland (foraging);
- Mudflat or salt flat (foraging); and
- Samphire shrubland (foraging).

Mangal community habitat was considered of most importance, given its status as critical habitat. Eucalypt forest, spinifex grassland, tussock grassland, mudflats or salt flats and samphire shrubland are considered below as broad foraging habitat. O2 Marine conducted a detailed assessment of BCH which included the mangal community. O2 Marine's survey extended beyond the area surveyed by Phoenix and therefore disturbance estimates have taken from O2 Marine's (2025b) cumulative loss assessment (see Section 8.5).

1,381.5 ha of mangrove was recorded in the LAUs. Potential impacts to mangrove BCH can be summarised as a maximum loss of 8.3 ha (0.6%). Up to 7.3 ha of mangrove BCH is predicted to be at risk of indirect impacts associated with hydrology. This includes:

- 5.4 ha associated with changes to surface water inundation;
- 1.7 ha associated with groundwater seepage; and
- 0.2 ha of overlapping surface water and groundwater impacts.

25,848.8 ha of potential foraging habitat was recorded within the TFSA. Up to 12,145.2 ha (47%) may be disturbed. Up to 394.9 ha (1.5%) of foraging habitat is predicted to be at risk of indirect impacts associated with changes to surface water or groundwater. This includes:

- 92.6 ha associated with changes to surface water inundation;
- 282.2 ha associated with groundwater seepage; and
- 20.2 ha of overlapping surface water and groundwater impacts.

The nearby pools and creeks are likely to be regularly used as a water source or foraging however McKay Creek and Devil Creek are both outside the disturbance footprint and will not be significantly impacted by the Proposal.

Based on the above assessment, the Proposal is predicted to result in direct impacts to up to 8.3 ha of critical habitat (BCH Mangroves), and 12,145.2 ha of broad foraging habitat. The predicted disturbance to the North-Western Free-tailed Bat critical habitat is considered significant, and therefore offsets are proposed under the PEOF to counterbalance the impacts to this species in Section 15.

### 12.5.4 PILBARA OLIVE PYTHON

The Pilbara Olive Python (*Liasis olivaceus barroni*) is listed as Vulnerable under the EPBC Act and BC Act. They reside near rocky creeks, gorges, outcrops and cliffs, usually near permanent water. The Pilbara Olive Python was not recorded during the Phoenix (2023) survey within the TFSA, however it was considered likely to occur within the development envelopes.

Phoenix (2023) identified woodland of *Eucalyptus* spp. over tussock grassland on drainage habitat as significant Pilbara Olive Python habitat. However, to be significant habitat for the Pilbara Olive Python, riparian ecosystems need to have water holes and be associated with significant areas of rocky habitat and this is not available within the PIDE. If riparian ecosystems are considered significant habitat for Pilbara Olive Python in the Pilbara then there would be several tens of thousands of hectares of such habitat (if not hundreds of thousands) in which case the current Threatened status of the Pilbara Olive Python would probably not fulfil the requirements of it being listed as a Vulnerable species under IUCN criteria and thus the listing criteria applied by DBCA and DCCEEW (Professor Stephen van Leeuwen pers comms.). Based on this, woodland of *Eucalyptus* spp. over tussock grassland on drainage has been considered as potential foraging habitat for the Pilbara Olive Python, instead of significant habitat.

209.4 ha of potential foraging habitat was recorded within the TFSA Up to 20.8 ha (9.9%) may be disturbed as a result of direct impacts. An additional 1.4 ha (<1%) is predicted to be at risk of indirect impacts associated with changes to the surface water regime, and 0.2 ha (0.1%) at risk of indirect impacts from groundwater mounding and seepage. There are not predicted overlapping surface water and groundwater impacts of eucalypt woodland on drainage habitat.

Based on the above assessment, the Proposal is predicted to result in direct impacts to 20.8 ha of potential foraging habitat for the Pilbara Olive Python. The predicted disturbance is considered to be a significant residual impact, and therefore offsets are proposed under the PEOF to counterbalance the impacts to this species in Section 15.

### 12.5.5 GREY FALCON

The Grey Falcon (*Falco hypoleucos*) is listed as Vulnerable under the EPBC Act and BC Act. This species was not recorded within the TFSA, but was recorded immediately to the east of the TFSA as a known nest site on a communications tower on the North West Coastal Highway. This species has a large foraging range, and will therefore forage within the TFSA. Spinifex grasslands is a known habitat type for the Grey Falcon, which is where the nest was recorded.

The Grey Falcon is only restricted by habitat in relation to roosting sites (inland drainage lines, grasslands, sparse wooded lowlands, often using old nests and communication towers etc.) and its foraging range is widespread due to its prey mainly being other birds. The tussock grassland habitat is used widely for hunting by the Grey Falcon (Garnett & Crowley, 2000). In the Pilbara, the Grey Falcon is mostly recorded from the coastal plain between the de Grey and Ashburton Rivers. The preferred habitat of this species comprises lightly wooded coastal and riverine plains.

Given the wide-ranging nature of this species, seven habitat types within the development envelopes are considered potential foraging habitats:

- Spinifex grasslands;
- Tussock grasslands;
- Tussock grassland on beach and dune;
- Mudflats and salt flats
- Eucalypt forests and woodland;
- Mangal community; and
- Samphire shrubland.

Of the above habitat types, spinifex grassland was considered to be most important given this habitat type supports this species immediately south of the TFSA, as well as contributing to potential foraging habitat within the TFSA.

5,547 ha of spinifex grassland habitat occurs within the TFSA, and up to 1,954.4 ha (35%) is predicted to be disturbed. An additional 5.5 ha (<1%) is predicted to be at risk of indirect impacts associated with changes to the surface water regime and 60.5 ha (1.1%) at risk of groundwater impacts. An additional 2.8 ha (0.1%) is at risk of both surface water and groundwater impacts.

Leichhardt considers that the disturbance to Grey Falcon habitat is conservative as it is based on disturbance across the entire development envelope. However, based on the draft Pilbara Bioregion EPBC Act Policy Statement (DCCEEW, 2024) only suitable areas containing key foraging habitats for the Grey Falcon within 10 km of the breeding structure should be avoided within the development envelope. Vegetation within 10 km of suitable breeding structures has been outlined in Figure 12-29 to Figure 12-31. There will be no disturbance within 500m of a structure where the Grey Falcon has been sighted.

Given the scale of disturbance, the impacts to the Grey Falcon are considered significant, and therefore offsets are proposed under the PEOF to counterbalance the impacts to these species in Section 15.

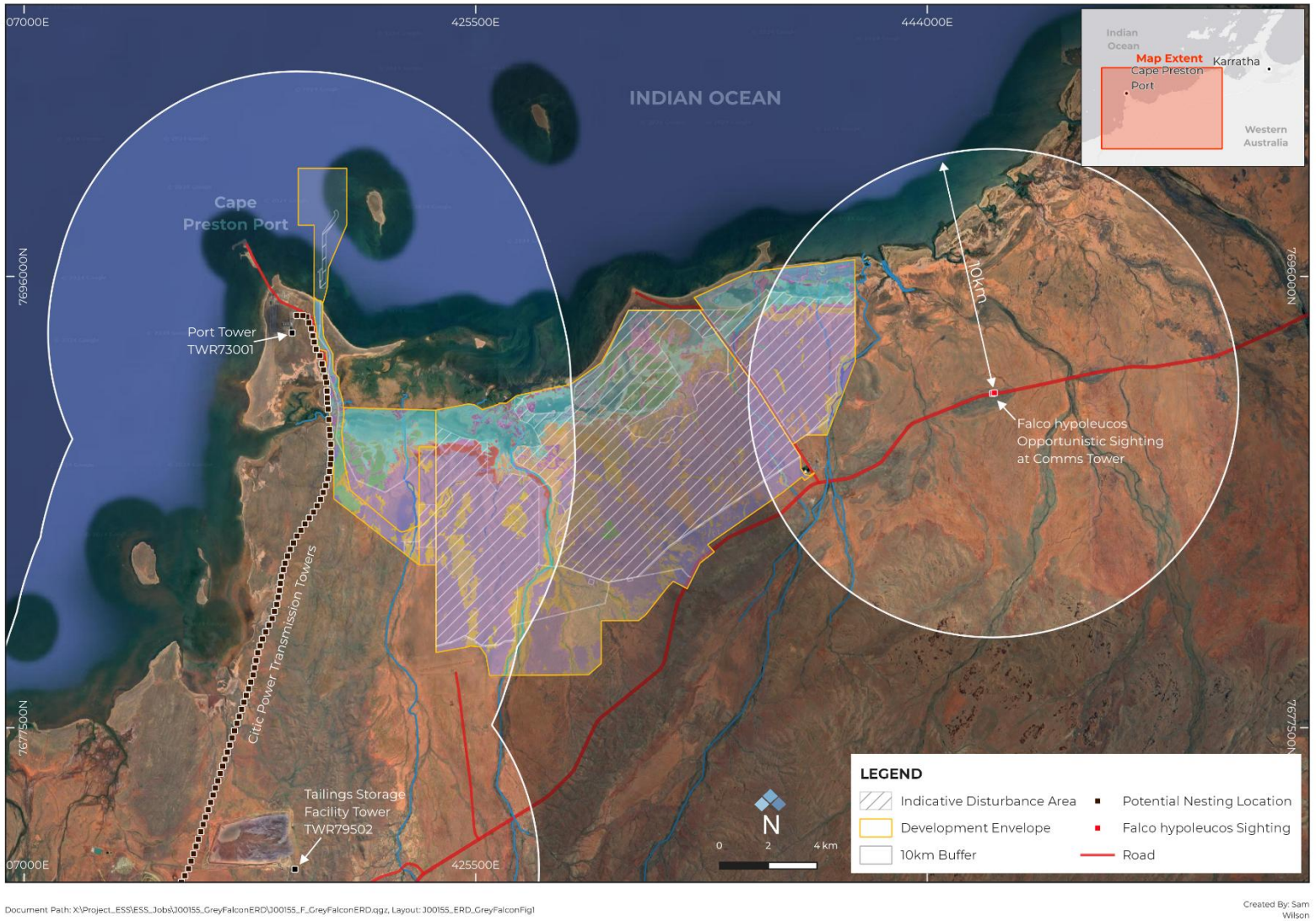



**Figure 12-29: Grey Falcon record and potential nesting locations**

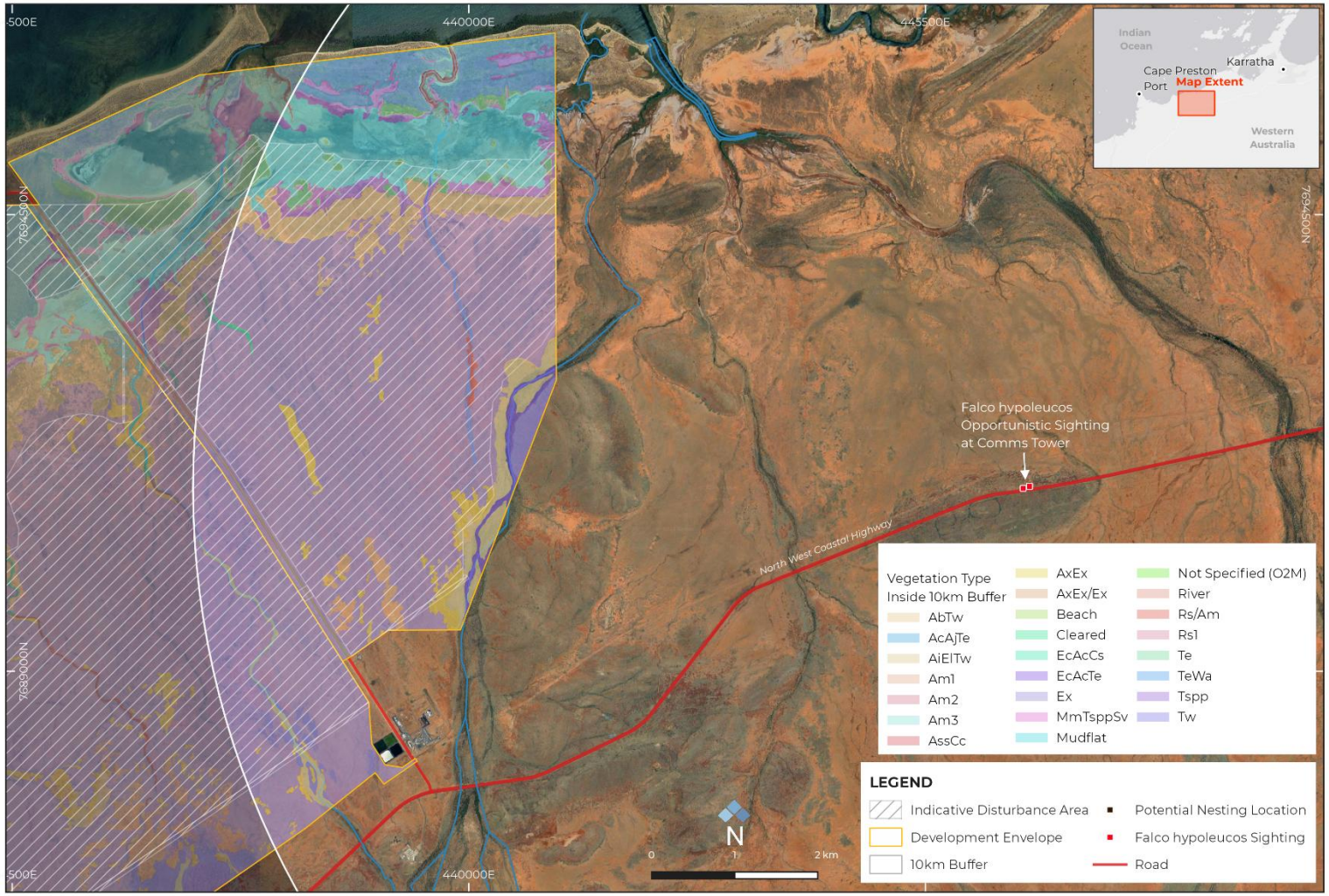



**Figure 12-30: Disturbed vegetation within 10 km of Grey Falcon sighting**

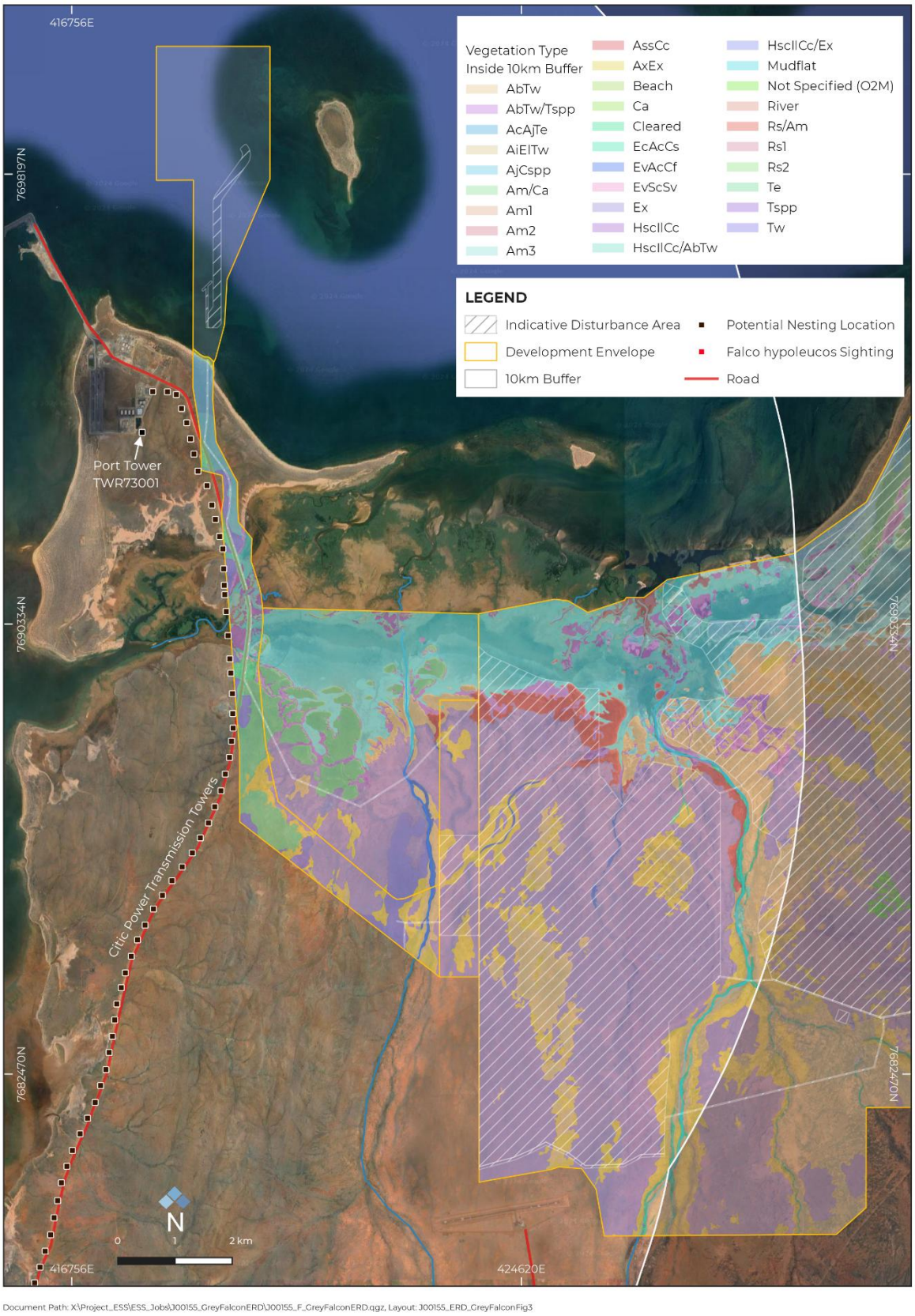



**Figure 12-31: Disturbed vegetation within 10 km of potential nesting trees for Grey Falcon**

### 12.5.6 MIGRATORY SHOREBIRDS

The SBSA is 12,591.1 ha in size, overlapping the TFSA. The SBSA was designed with consideration of DotEE (2017b), whereby it is expected that a minimum survey coverage should include all of the habitat thought to be used by the same population of shorebirds and the entire area of contiguous habitat where shorebirds may occur. As such, the SBSA extends further east to include Devil Creek and its delta, and west to include the tidal channel that creates Cape Preston. The SBSA has a maximum width east to west of approximately 29.5 km, ending typically <1 km offshore to the north (but up to 3 km) and typically extending approximately 4 km inland from the coast, where it took in vast areas of unvegetated mudflat.

The SBSA intersects five land systems and is dominated by the Littoral System (63.2%). A small portion of coastward locations within the TFSA and SBSA (0.4% and 16.1% respectively) are represented by no land system. The SBSA intersects six geological formations and is dominated by estuarine and delta deposits (63.3%) and water (18.5%).

The majority of the recorded significant species are migratory birds, and shorebirds in particular. A total of 31 bird species listed as Migratory were recorded, including Osprey, which is not a shorebird. 21 of the 37 Migratory Shorebird species listed under *EPBC Act Policy Statement 3.21* were recorded (DotEE 2017b). A total of 14 species were recorded in nationally significant numbers and three in internationally significant numbers (Oriental Pratincole, Ruddy Turnstone and Grey-tailed Tattler). Accordingly, the shorebird habitat within and adjacent to the development envelopes is considered nationally important wetland habitat on the following basis:

- 14 species were recorded in nationally significant numbers (threshold is one species);
- >2,000 Migratory shorebirds were regularly recorded in a single transect; and
- 21 Migratory shorebird species were recorded in total (criterion is 15 species).

The Proposal is also considered an internationally important wetland for three migratory species. The three species include the Oriental Pratincole, Ruddy Turnstone, Grey-tailed Tattler. Of the two international criteria, the Proposal meets one for all three species in that it regularly supports 1% of the individuals in a population.

Of the 21 Migratory Shorebirds recorded, six are listed as Threatened Migratory species, including three Critically Endangered species (Curlew Sandpiper, Eastern Curlew and Great Knot), two Endangered species (Lesser Sand Plover and Red Knot) and one Vulnerable species (Greater Sand Plover). Eastern Curlew was recorded in nationally significant numbers, as well as the DBCA Priority four species, the Grey-tailed Tattler.

The majority of Proposal disturbance within the PIDE is to occur within tussock grassland, which was only important for one species of shorebird within the SBSA. However, the development envelopes contain portions of the five migratory shorebird habitats identified and mapped by Phoenix (2023) within the SBSA:

- Samphire shrubland (tidal);
- Mudflat or salt flat;
- Tussock grassland on beach and dune;
- Tidal channel and Ocean; and
- Mangal communities.

O2 Marine conducted a detailed assessment of BCH which included the samphire shrublands, mangroves, mudflats and algal mats. Algal mats were not included in Phoenix's assessment but are considered an important foraging habitat for migratory birds. O2 Marine's survey for these BCH types extended beyond the area surveyed by Phoenix and therefore disturbance estimates have taken from O2 Marine's (2025b) cumulative loss assessment (see Section 8.5).

5,354.7 ha of potential migratory shorebird habitat occurs within the LAUs which includes samphire shrublands, HDAM and mangroves. and up to 576.3 ha (10.8%) is subject to disturbance. An additional 57.0 ha (1.1%) is predicted to be at risk of indirect impacts associated with changes to the surface water regime and 131.1 ha (2.4%) at risk of groundwater impacts. An additional 14.3 ha (0.3%) is at risk of both surface water and groundwater impacts.

In addition, the Oriental Pratincole, which was found in internationally significant numbers, has the potential to forage within spinifex grassland and tussock grassland habitat types, as well as the potential habitat listed above. It is assumed that the Oriental Pratincole is unlikely to travel significant distances inland, and as such spinifex grassland and tussock grassland within the SBSA is considered to be the additional habitat primarily utilised by this species. Up to 2,392.2 ha of additional potential Oriental Pratincole habitat is expected to be disturbed.

As discussed in Section 12.3.6, most foraging habitat is clearly to the seaward side of the coast (i.e., tidal mudflats) and will not be impacted. Likewise, most key aggregations at high tides will be of roosting birds and are on the coast; these locations will not be impacted. Additionally, there is nothing to suggest that migratory patterns will be affected, as the loss of habitat is highly localised and mostly limited to roosting areas used by proportionally small numbers of birds (Mike Bamford pers. Comms.). No delays in departure time, migratory pathways or length of foraging times are in any way indicated by the loss (or alteration) of habitat.

There is significant flexibility in the number of birds that might use a roost site. Shorebird roosting patterns are dynamic with the tide and season; while it is correct that there are favoured roost sites, these do not have strict boundaries and birds will roost opportunistically. A favoured roost may support 500 birds on a high but neap tide, and 5,000 birds on a high spring tide. The carrying capacity of roost sites would be impossible to assess as shorebird roosting patterns are so dynamic with the tide and season (M. Bamford, pers. Comms.). While it is correct that there are favoured roost sites, these do not have strict boundaries and birds will roost opportunistically. A favoured roost may support 500 birds on a high but neap tide, and 5,000 birds on a high spring tide. Carrying capacity would only be a concern at the Proposal if a very large proportion of key roost sites were to be impacted (which is not the case). Birds may continue to roost on bunds and raised earth areas within the Proposal, as is observed at other similar facilities. There will also be islands within the concentration ponds which may be attractive to roosting shorebirds (Bamford pers. comm. 2025).

Table 12-12 assesses migratory shorebirds in further detail, based upon potential impacts to species.

Table 12-12: Assessment of potential impacts on migratory bird species

| Species | Recorded within PIDE? | Occurrence and significance of habitat |
|---|---|---|
| Bar-tailed Godwit (*Limosa lapponica)*– Migratory EPBC Act and BC Act | Yes | Only the Siberian subspecies is a regular migrant to Australia, occurring on the Pilbara coastline in all months but mostly from September-April; forages on tidal mudflats, beaches, and low-salinity saltwork ponds (Johnstone et al., 2013). This species is a regular migrant to Australia from the northern hemisphere, mainly between September to April. Following the southward migration, some birds remain in Australia and do not migrate northward, but this species does not breed in Australia. It occurs throughout the Pilbara coast and several offshore islands (Phoenix, 2020).<br>The Bar-tailed Godwit was recorded within the SBSA in nationally significant numbers once in January and twice in February. As many as 45 individuals were recorded during the overwintering surveys, suggesting that the SBSA represents important overwinter grounds for the species.<br>The predicted impacts represent a worst-case scenario under which impacts to this species are considered significant. |
| Black-tailed Godwit (*Limosa limosa*)- Migratory EPBC Act and BC Act | No | In Australia, the Black-tailed Godwit has a primarily coastal habitat environment. The species is commonly found in sheltered bays, estuaries and lagoons with large intertidal mudflats or sandflats, or spits and banks of mud, sand or shell-grit; occasionally recorded on rocky coasts or coral islets. The use of habitat often depends on the stage of the tide. It is also found in shallow and sparsely vegetated, near-coastal wetlands; such as saltmarsh, salt flats, river pools, swamps, lagoons and floodplains. There are a few inland records, around shallow, freshwater and saline lakes, swamps, dams and bore-overflows. They also use lagoons in sewage farms and salt works (Phoenix, 2020). Regular but uncommon migrant present on Pilbara coast August to April, not known to overwinter there; mainly at low-salinity saltwork ponds but also rocky and muddy coasts, and may roost/loaf on sandy beaches (Johnstone et al., 2013).<br>Only five Black-tailed Godwit individuals were recorded throughout the whole survey program, therefore this species is considered unlikely to utilise the development envelopes in large numbers and impacts are unlikely to be significant. |
| Common Greenshank (*Tringa nebularia*)- Migratory EPBC Act and BC Act | Yes | The Common Greenshank is present in summer across all Australian States, mostly on the coast but sometimes inland. Small groups can sometimes be seen when roosting at high-tide. They prefer coastal open mudflats (Phoenix, 2020) and are found in a wide variety of inland wetlands and sheltered coastal habitats of varying salinity, including coastal mudflats, saltmarsh and mangroves. The Common Greenshank occurs in Pilbara August-June (DotEE, 2019; Johnstone et al., 2013).<br>Common Greenshank were in every sample event and were recorded in nationally significant numbers twice in December and twice in February. 632 summer records and one winter record of this species was within the development envelopes, however the majority were reported in the SBSA.<br>The predicted disturbance represents a worst-case scenario under which impacts to this species are considered significant. |
| Common Sandpiper (*Actitis hypoleucos*)- Migratory EPBC Act and BC Act | Yes | The Common Sandpiper utilises a wide range of coastal wetlands and some inland wetlands, with varying levels of salinity, and is mostly found around muddy margins or rocky shores and rarely on mudflats. The Common Sandpiper has been recorded in estuaries and deltas of streams, as well as on banks farther upstream; around lakes, pools, billabongs, reservoirs, dams and claypans, and occasionally piers and jetties. The muddy margins utilised by the species are often narrow and may be steep. The species is often associated with mangroves, and sometimes found in areas of mud littered with rocks or snags (Phoenix, 2020). Breeds in temperate Eurasia during the northern hemisphere summer. A small population winters in Australia (3,000 individuals). They are found across a wide range of wetlands, mostly coastal with some inland records (Geering et al., 2007). |

| Species | Recorded within PIDE? | Occurrence and significance of habitat |
|---|---|---|
| | | The Common Sandpiper was recorded within the SBSA, but was not recorded at significant numbers, with four records within the development envelopes, therefore this species is considered unlikely to utilise the development envelopes in large numbers and impacts are unlikely to be significant. |
| Curlew Sandpiper (*Calidris ferruginea*)- Critically Endangered/Migratory EPBC Act, Vulnerable/Migratory BC Act | Yes | The Curlew Sandpiper is migratory from the northern hemisphere, arriving in Australia in late August–September and does not breed in Australia. The species is more abundant on the northeast Pilbara coast and Kimberley than further south (Phoenix, 2020). Johnstone et al. (2013) reported peak numbers at the Port Hedland Saltworks (25,000) and further north at Eighty Mile Beach in the Kimberley (60,000; representing two thirds of the flyway population), with numbers decreasing rapidly southwest of Port Hedland (Phoenix, 2020).<br>The Curlew Sandpiper was recorded in nationally significant numbers within the SBSA once in February. Four individuals were recorded within the development envelopes. The predicted disturbance represents a worst-case scenario under which impacts to this species are considered significant, given the conservation status of this species. |
| Eastern Curlew (*Numenius madagascariensis*)- Critically Endangered/Migratory EPBC Act, Vulnerable/Migratory BC Act | Yes | The Eastern Curlew is a moderately common visitor between October and February from the northern hemisphere, although some birds remain in Australia. It does not breed in Australia. They have a continuous distribution from Barrow Island and Dampier Archipelago northwards around the north of Australia. The species mainly forages on soft sheltered intertidal sandflats/mudflats that are open and without vegetation or covered with seagrass, often near mangroves, on salt flats and in saltmarsh, rock pools and amongst rubble on coral reefs, and on ocean beaches near the tideline. The species roosts on sandy spits, sandbars and islets during high-tide and amongst coastal vegetation including low saltmarsh or mangroves (Phoenix, 2020).<br>The Eastern Curlew was recorded in nationally significant numbers twice in February within the SBSA. Whilst important habitats for the species occur in the SBSA, only five individuals were recorded within the development envelopes.<br>The predicted disturbance represents a worst-case scenario under which impacts to this species are considered significant, given the conservation status of this species. |
| Great Knot (*Calidris tenuirostris*)- Critically Endangered/Migratory EPBC Act, Vulnerable/Migratory BC Act | Yes | The Great Knot is a common northern hemisphere visitor mainly from August to May, especially to northeastern parts of the Pilbara coast. It does not breed in Australia. Most of the EAAF population overwinters in Australia with greatest numbers found in northern WA and the NT. Larger counts of the species have been recorded at Barrow Island, the eastern side of Exmouth Gulf and Forestier Bay (Phoenix, 2020). Preferred habitat in Australia is sheltered coastal habitats with large intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons.<br>The Great Knot was not recorded i" nat'onally significant numbers. The maximum sample event count was 94 individuals, recorded at low tide in summer within SBSA. 87 records occurred within the development envelopes.<br>The predicted disturbance represents a worst-case scenario under which impacts to this species are considered significant |
| Greater Sand Plover (*Charadrius leschenaultia*)- Vulnerable/Migratory EPBC Act and BC Act | Yes | In Australia, the Greater Sand Plover occurs in coastal areas in all states, though the greatest numbers occur in northern Australia, especially the northwest. Migrating birds arrive in Australia from August and depart by March. Some, mostly first year birds, remain in Australia but the species does not breed in Australia. Most (nearly three quarters) of the EAAF population is in Australia during the non-breeding period. Greater Sand Plover occurs throughout the coastal Pilbara, including several offshore islands; however, Eighty Mile Beach and Roebuck Bay in the Kimberley are |





| Species | Recorded within PIDE? | Occurrence and significance of habitat |
|---|---|---|
| | | by far the most important non-breeding area for the species, supporting 90% of the Australian population (~60,000 birds). Much larger counts have been recorded at other Pilbara sites, for example 1,036 on the eastern side of Exmouth Gulf, 1,158 on Barrow Island, 323 at Forestier Bay and 303 in the Port Hedland area (Phoenix, 2020).<br>The Greater Sand Plover was recorded in nationally significant numbers twice in February within the SBSA. 93 records occurred within the development envelopes.<br>The predicted disturbance represents a worst-case scenario under which impacts to this species are considered significant. |
| Grey Plover (*Pluvialis squatarola*)- Migratory EPBC Act and BC Act | Yes | In Australia, Grey Plovers occur almost entirely in coastal areas, where they usually inhabit sheltered embayments, estuaries and lagoons with mudflats and sandflats, and occasionally on rocky coasts with wave-cut platforms or reef-flats, or on reefs within muddy lagoons. They also occur around terrestrial wetlands such as near-coastal lakes and swamps, or salt-lakes. The species is also very occasionally recorded further inland, where they occur around wetlands or salt-lakes.<br>This species was identified within the SBSA in small numbers, with four individuals identified within the development envelopes. This species is therefore considered unlikely to utilise the development envelopes in large numbers and impacts are unlikely to be significant. |
| Grey-tailed Tattler (*Tringa brevipes*)- Migratory EPBC Act and BC Act, P4 DBCA | Yes | Migrating Grey-tailed Tattler arrive from August and depart by April; however, some birds remain in non-breeding grounds in Australia. There is a marked seasonal variation between breeding and non-breeding adults. The species is moderately common and occurs throughout the coastal Pilbara, including offshore islands. Formally recognised internationally important areas for the species include Barrow Island and Eighty Mile Beach (Phoenix, 2020). Tidal mudflats, reef flats, mangrove creeks, sandy beaches, saltwork ponds, sewage ponds and brackish lagoons (Johnstone et al., 2013).<br>The Grey-tailed Tattler was recorded in nationally significant numbers throughout January and the first half of February, after which it increased to internationally significant numbers. The area supports a large number of this species throughout summer, with as much as 3.15% of the world's population being recorded in a single transect. Nationally significant numbers of the Grey-tailed Tattler were also recorded at SBSA in winter. Furthermore, nationally significant numbers were found in the development envelopes during summer.<br>The predicted disturbance represents a worst-case scenario under which impacts to this species are considered significant. |
| Lesser Sand Plover (*Charadrius mongolus*) – Vulnerable/Migratory EPBC Act and BC Act | No | The Lesser Sand Plover is an uncommon to moderately common visitor to the Pilbara from the northern hemisphere (July–late May) with occasional birds overwintering. It does not breed in Australia. It occurs throughout the Pilbara coast (Yardie Creek to Madora) and offshore islands. Important Pilbara sites include Barrow Island and Port Hedland Saltworks. The species mainly feeds in freshly-exposed areas of intertidal sandflats and mudflats in estuaries or beaches, or in shallow ponds in saltworks. It roosts near foraging areas, on beaches, banks, spits and banks of sand or shells and occasionally on rocky spits, islets or reefs (Phoenix, 2020).<br>Only two individuals of Lesser Sand Plover were identified within the SBSA, and none were found within the development envelopes. This suggests the SBSA does not represent critical habitat for this species. This species is therefore considered unlikely to utilise the development envelopes in large numbers and impacts are unlikely to be significant. |
| Oriental Plover (*Charadrius veredus*) – | Yes | The Oriental Plover is a non-breeding visitor to Australia, being widely distributed, but most records are along the northwestern coast between |





| Species | Recorded within PIDE? | Occurrence and significance of habitat |
|---|---|---|
| Migratory EPBC Act and BC Act | | Exmouth Gulf and Derby. Inland habitats occupied by the species include sparsely vegetated plains or recently burnt open areas (DotEE, 2019).<br>The Oriental Plover was recorded in five sample events, generally in low numbers, but 197 individuals were recorded in a high tide summer sample event. The predicted disturbance represents a worst-case scenario under which impacts to this species are considered significant. |
| Oriental Pratincole (*Glareola maldivarum)* – Migratory EPBC Act and BC Act | Yes | The Oriental Pratincole breeds in southern, southeastern, and eastern Asia, most of the global population overwintering in northern Australia (October-April); occurs in small groups to very large flocks on the Pilbara coast (and more dispersed inland), usually over open plains with short grassland, samphire, or bare ground, feeding mostly aerially on insects. Large flocks are often associated with thundery and cyclonic storms, as well as pre-departure aggregations (DotEE, 2019; Johnston et al., 2013). They often occur near terrestrial wetlands, such as billabongs, lakes or creeks, and artificial wetlands such as reservoirs, saltworks and sewage farms, especially around the margins. The species also occurs along the coast, inhabiting beaches, mudflats and islands, or around coastal lagoons (Phoenix, 2020).<br>The species was recorded in natio"ally'and internationally significant numbers, with up to 75,377 individuals recorded in a single transect in February 2020, which represents 2.6% of the world's population. The species was recorded in nationally significant numbers twice in February. As many as 75,377 Oriental Pratincoles were recorded in a single transect, but the median aggregate abundance was 389, highlighting how extreme the changes in abundance can be in time and space. It was recorded from 13 of 17 summer transects and was not recorded overwintering. It is worth noting that the large flocks of Oriental Pratincole recorded on 11 February 2020 were not observed using the SBSA but were encountered in the air (and on that day close to 3% of the EAAF population of Oriental Pratincole was recorded). Thus, while the areas where the concentration ponds are proposed to be located were observed to be utilised by an array of shorebird species, the numbers were far lower than further north in the tidal samphire shrublands and associated mangrove habitat. This is evident from the heat maps also, where it can be seen that the numbers were far more diffuse within the development envelopes.<br>The predicted disturbance represents a worst-case scenario under which impacts to this species are considered significant. |
| Pacific Golden Plover (*Pluvialis fulva*)- Migratory EPBC Act and BC Act | No | This large Charadriidae is a strict migrant in Australia where it can be found in small flocks across the coastal shoreline of every state. During the northern hemisphere summer they breed in Siberia and Western Alaska. Numbers in Australia are small (less than 10,000 individuals) and no recent data concerning population trends are available, however in Alaska the species is declining. They can be found feeding singly or in flocks in open mudflats, saltmarshes and rocky shores (Phoenix, 2020). Most Australian sightings occur on coastal beaches, rocky shorelines and saltmarshes, also with some inland records that are mostly on major river systems (Marchant and Higgins, 1990).<br>This species was recorded on two separate occasions, but not within the development envelopes. This suggests the SBSA does not represent critical habitat for this species. Nevertheless, the predicted disturbance represents a worst-case scenario under which impacts to this species potential habitat are considered significant. |
| Red-necked Stint (*Calidris ruficollis*)- Migratory EPBC Act and BC Act | Yes | The Red-necked Stint occurs in great numbers along the East Asian – Australasian Flyway: 325,000 total individuals overall, 270.000 in Australia (Geering et al., 2007). Very common visitor on the Pilbara coast, present all months but mainly August-April (Johnstone et al., 2013). In Australasia, the Red-necked Stint is mostly found in coastal areas, including in sheltered inlets, bays, lagoons and estuaries with intertidal mudflats, often near spits, islets and banks and, sometimes, on protected sandy or coralline shores. |





| Species | Recorded within PIDE? | Occurrence and significance of habitat |
|---|---|---|
| | | Occasionally they have been recorded on exposed or ocean beaches, and sometimes on stony or rocky shores, reefs or shoals. They also occur in saltworks and sewage farms; saltmarsh; ephemeral or permanent shallow wetlands near the coast or inland, including lagoons, lakes, swamps, riverbanks, waterholes, bore drains, dams, soaks and pools in salt flats. They sometimes use flooded paddocks or damp grasslands. They have occasionally been recorded on dry gibber plains, with little or no perennial vegetation (Phoenix, 2020).<br>The Red-necked Stint was recorded in nationally significant numbers in 35% of summer transects, which included within the development envelopes. This species was typically the most abundant species within the SBSA at high tide and was recorded in numbers approaching 3,500 in one transect, but was typically recorded (median) at approximately 900 individuals on a given high tide transect. In comparison, at low tide the median aggregate abundance was closer to 100 individuals.<br>The predicted disturbance represents a worst-case scenario under which impacts to this species are considered significant. |
| Red Knot (*Calidris canutus*) – Endangered/Migratory EPBC Act, Migratory BC Act | Yes | The Red Knot migrates from northern breeding grounds arriving in Australia from August, departing by April. It does not breed in Australia. The species is common in its main habitats around the coast of Australia. In the Pilbara, it mostly occurs along the coast from Mandora southwest to the Ashburton estuary, and also Barrow Island (Phoenix, 2020). Internationally important sites for the species in northwestern Australia include Eighty Mile Beach and Roebuck Bay.<br>The Red Knot was recorded in nationally significant numbers once in February 2020. The predicted disturbance represents a worst-case scenario under which impacts to this species are considered significant. |
| Ruddy Turnstone (*Arenaria interpres*)- Migratory EPBC Act and BC Act | Yes | Non-breeding migrant, common on the Pilbara coast mainly from late August – April, but may be present year-round as juvenile birds overwinter here (Johnstone et al., 2013). The Ruddy Turnstone occurs throughout the Pilbara coast, including many offshore islands. There are several internationally important non-breeding sites in Australia, mostly in northwestern Australia, i.e. Barrow Island, Eighty Mile Beach, Ashmore Reef, Roebuck Bay and Lacepede Islands. Preferred habitats are coastal regions with exposed rock coast lines, coral reefs or tidal mudflats as well as saltworks ponds. It mainly forages between lower supralittoral and lower littoral zones of foreshores, from strandline to wave-zone, including amongst banks of stranded seaweed, but are also known to forage on exposed rocky platforms, coral reefs and mudflat. It has been observed to roost on beaches above the tideline, rocky islets amongst grassy tussocks, and on mudflats and sandflats (Phoenix, 2020).<br>The abundance of Ruddy Turnstone "ecor'ed in January 2020 (513 individuals) represents 1.7% of the world's population. It was recorded in nationally significant numbers in every transect in January and February. On two occasions, this species was recorded in internationally significant numbers.<br>The predicted disturbance represents a worst-case scenario under which impacts to this species are considered significant. |
| Sanderling (*Calidris alba*)- Migratory EPBC Act and BC Act | Yes | The Sanderling occur in coastal areas around Australia; in the Pilbara they are present along most of the coast from Mandora to Point Cloates, as well as some islands. Breeding birds migrate from the northern hemisphere arriving in Australia from September and departing by April; non-breeding birds are present all year. They inhabit mostly on open sandy beaches exposed to open sea swell, exposed sandbars and spits, shingle banks, and less often on more sheltered sandy shorelines of estuaries, inlets and harbours (Phoenix, 2020). |

| Species | Recorded within PIDE? | Occurrence and significance of habitat |
|---|---|---|
| | | The Sanderling was recorded in nationally important numbers once in December 2019. The predicted disturbance represents a worst-case scenario under which impacts to this species are considered significant. |
| Terek Sandpiper (*Xenus cinereus*)- Migratory EPBC Act and BC Act | Yes | Uncommon to scarce summer visitor to Australian coasts (rarely found inland) with no overwintering records in the Pilbara, found on tidal mudflats and low-salinity saltwork ponds (DotEE, 2019; Johnstone et al., 2013). The Terek Sandpiper is a shorebird that inhabits coastal mudflats, sheltered estuaries and lagoons. In Australia, it has a primarily coastal distribution, with occasional records inland.<br>Terek Sandpiper was recorded in nationally significant numbers twice in February, however only five individuals were recorded within the development envelopes. Nevertheless, the predicted disturbance represents a worst-case scenario under which impacts to this species are considered significant. |
| Whimbrel (*Numenius phaeopus*)- Migratory EPBC Act and BC Act | Yes | The Whimbrel migrates from breeding grounds to several coastal areas around Australia, although it is more common in the north. It is common and widespread in WA from Carnarvon north to the northeast Kimberley, and is present in all months due to overwintering of non-breeding birds, but mainly August-April. In the Pilbara it occurs along the mainland coast and several islands. This species inhabits mainly tidal mudflats and less frequently sandy beaches and saltworks ponds (but not hypersaline ponds) in the Pilbara. It regularly roosts in mangroves and other structures flooded at high-tide.<br>This species was recorded in nationally significant numbers in 53% of summer transects. It was also found in nationally significant numbers within the development envelopes. The potential impacts to this species are considered significant. The predicted disturbance represents a worst-case scenario under which impacts to this species are considered significant. |
| Sharp-tailed Sandpiper (*Calidris acuminata*)-- Migratory EPBC Act and BC Act | Yes | The Sharp-tailed Sandpiper occurs in mainly coastal areas, occasionally on large inland wetlands after significant rainfall. Their numbers in the northeastern Pilbara are highest from September-November, moving further south for summer feeding, and are not known to overwinter here (Johnstone et al., 2013).<br>This species was recorded in nationally significant numbers in 30% of summer transects. However, it was recorded in relatively low numbers within the development envelopes. Nevertheless, the predicted disturbance represents a worst-case scenario under which impacts to this species are considered significant. |
| White-winged Black Tern (*Chlidonias leucopterus*) Migratory EPBC Act and BC Act | Yes | Non-breeding migrant in Australia (September-May), usually inhabiting coastal wetlands of varying salinity and vegetation types (DotEE, 2019; Johnstone et al., 2013).<br>This species was recorded within the development envelopes and SBSA, with a maximum of 60 individuals recorded in the summer period within the SBSA. The predicted disturbance represents a worst-case scenario under which impacts to this species are considered significant. |
| Little Tern (*Sternula albifrons*) (formerly *Sterna*)-- Migratory EPBC Act and BC Act | Yes | The Little Tern is an uncommon to moderately common visitor to Pilbara coast, derived from two populations breeding in eastern Asia and the Kimberley respectively. Their preferred habitat of this species comprises sheltered seas, estuaries, and mangrove creeks. It is mainly a non-breeding visitor (all months, mostly September-June) (DotEE, 2019; Johnstone et al., 2013).<br>The Little Tern was recorded in low numbers within the SBSA and the development envelopes. This species is therefore considered unlikely to utilise the development envelopes in large numbers and impacts are unlikely to be significant. |

| Species | Recorded within PIDE? | Occurrence and significance of habitat |
|---|---|---|
| Crested Tern (*Sterna bergii*)- Migratory EPBC Act and BC Act | Yes | The Crested Tern mainly resides in the Pilbara region, breeding on islands (March-May) but may also include migrants from Asia or southern areas. This species favours sheltered seas, estuaries and saltwork ponds, only rarely inland after storms (DotEE, 2019; Johnstone et al., 2013).<br>The Crested Tern was recorded in SBSA, as well as the development envelopes. As many as 330 individuals were recorded. The predicted disturbance represents a worst-case scenario under which impacts to this species are considered significant. |
| Caspian Tern (*Sterna caspia*)- Migratory EPBC Act and BC Act | Yes | Caspian Terns are a moderately common breeding resident, nesting on low islands, mainland beaches (including at Cape Preston) and terrestrial wetlands. They forage in open wetlands including shallow margins of lakes and rivers, but also in open coastal waters (DotEE, 2019; Johnstone et al., 2013).<br>The Caspian Tern was recorded in low numbers in the SBSA and the development envelopes during the summer period. This species is therefore considered unlikely to utilise the development envelopes in large numbers and impacts are unlikely to be significant. |
| Roseate Tern (*Sterna dougallii*)- Migratory EPBC Act and BC Act | Yes | The Roseate Tern occurs in coastal and marine areas in subtropical and tropical seas, usually associated with coral reefs and blue water; resident subspecies *S. dougallii gracilis* breeding on offshore islands including in the Pilbara region (reported May-June and October), some non-breeding individuals of northern subspecies *bangsi* may also occur (DotEE, 2019; Johnstone et al., 2013).<br>The Roseate Tern was recorded in low numbers in the SBSA and the development envelopes during the summer period. This species is therefore considered unlikely to utilise the development envelopes in large numbers and impacts are unlikely to be significant. |
| Common Tern (*Sterna hirundo*)- Migratory EPBC Act and BC Act | Yes | The Common Tern is a regular non-breeding summer visitor to Pilbara coast and islands (August-April) and are sometimes locally common in inshore areas including the intertidal zone, estuaries, beaches, saltworks and sewage ponds. They also forage in terrestrial wetlands. Mostly the east-Asian subspecies *S. hirundo longipennis* occurs in Australia, but occasional records of individuals from more westerly populations (subspecies) occur (DotEE, 2019; Johnstone et al., 2013).<br>The Common Tern was recorded in SBSA and the development envelopes during the summer period. The predicted disturbance represents a worst-case scenario under which impacts to this species are considered significant. |
| Gull-billed Tern (*Gelochelidon nilotica*) (Formerly *Sterna*)- Migratory EPBC Act and BC Act | Yes | At least two distinct populations occur in the region, an endemic Australian subspecies *S. nilotica macrotarsa* (regular visitor to coast, coastal plains, and islands of the Pilbara and occasionally at Fortescue Marsh inland, sometimes breeding) and the Asian *S. nilotica affinis* (regularly occurs at Broome and recorded in the northeastern Pilbara). These populations inhabit shallow wetlands of coasts and inland areas and are rarely found over the ocean (BirdLife Australia, 2018; DotEE, 2019; Johnstone et al., 2013).<br>The Gull-billed Tern was recorded in SBSA, the development envelopes and Indicative Disturbance Footprint in summer and winter, with as many as 135 individuals recorded in SBSA during summer. The predicted disturbance represents a worst-case scenario under which impacts to this species are considered significant. |
| Brown Booby (*Sula leucogaster*)- Migratory EPBC Act and BC Act | No | Mainly found in tropical waters, often staying close to breeding islands, but approaches mainland coastlines more than other boobies; has been recorded in coastal waters, harbours, and estuaries and near offshore islands but seldom flying over land. Off northwest WA, Brown Boobies are most abundant 18–36 km from land (Abbott, 1979; Marchant and Higgins ,1990). |

| Species | Recorded within PIDE? | Occurrence and significance of habitat |
|---|---|---|
| | | Three individuals were identified within high tide during summer. This suggests the SBSA does not represent critical habitat for this species. This species is therefore considered unlikely to utilise the development envelopes in large numbers and impacts are unlikely to be significant. |

Dampier Salt Ltd has operated salt facilities at three sitesin WA including Dampier, Port Hedland and Lake MacLeod. The three operations are listed as IBAs by Birdlife Australia and are recognised as globally important habitats for shorebirds (ECU, 2015). The operations represent important and high-quality feeding grounds for small to medium-size migratory shorebirds both post and pre-migration (ECU, 2015). Roost selection appears to be related to several factors, such as predation risk; visibility; presence of water; and distance to feeding grounds with large unvegetated low islands surrounded by water (to help with thermoregulation and avoid predators and disturbance) considered appropriate to promote shorebird roosting in saltworks (Estrella & Davis, 2020). Leichhardt has designed the ponds to have islands in order to create roosting habitat which may be of use to migratory birds and other waterbirds. The Curlew Sandpiper, Greater Sand Plover and Red-necked Stint (recorded in nationally significant numbers) along with the Grey Plover and Pacific Golden Plover have a high likelihood of roosting on islands (Bamford, 2021), with large migratory species consistently using saltworks to roost (Estrella & Davis, 2020). Estrella and Davis (2020) recommended roost areas are created on the section closest to the coast to reduce the traveling energy cost from where large shorebird species will feed. All natural islands in the ponds closest the coast created from the water level at 4 m AHD, will be left undisturbed as potential roosting habitat (Figure 12-32). Within the first concentration pond, 124 ha of islands are estimated with a maximum potential height above the pond water level of 1.7 m AHD (Figure 12-33). An additional 3 ha is also estimated in the eastern concentration pond closest to the coast, with a maximum potential height above water of 1.1 m AHD. The highest slope of these areas is 15 degrees with 19 ha between 5 cm and 10 cm above the 4 m water depth, which may be attractive for roosting (M. Bamford pers comm. 2023), and a gentle slope of less than three degrees (Figure 12-34). Some of the elevated land areas that are contiguous with the pond shoreline will be modified to support salt production. It is expected that a further minimum of 60 ha of fringing elevated land above the 4 m pond water level (out of 237 ha) will remain within the final design for these ponds.

Salt projects have also been shown to provide foraging habitat for migratory birds in areas of shallow depth that overlie a substrate supporting macroinvertebrates, with the smaller species feeding in shallow water (≤3 cm) and larger species feeding at a greater range of water depths (Estrella & Davis, 2020). Leichhardt has taken this into consideration to create areas of suitable depth for potential foraging by migratory birds. While wind dependent, it is estimated that in the first concentration pond there will be 38 ha surrounding the islands at a depth of 5 cm or less, 76 ha at 10 cm and 109 ha at 15 cm. In addition, in the eastern concentration pond closest to the coast,2 ha surrounding the islands are estimated to be at a depth of 5 cm or less, 5 ha at 10 cm and 8 ha at 15 cm. Many sections of the pond embankments are located along natural contours which approximate the level of the adjacent pond surface, i.e., the brine nominally meets the toe of the bund. In this situation, the pond design will develop a gently sloping beach, in the order of 1:20. This will be graded to provide a few metres of dry land at the bund toe potentially for roosting, and a similar wetted floor area for wading and foraging. The bund walls at 2.8 m high along the south side of the coastal ponds will also provide shelter from the strong SE winds

experienced in cooler months. It is expected that around 20 km of graded shore will be created inside the concentration ponds closest to the coast, in addition to the island shorelines.

Significant Proposal design changes have been made to reduce the impacts to migratory shorebird habitat (refer to Section 4). This has reduced the extent of habitat disturbance (algal mats, mudflats, samphire shrublands and mangroves) from 2,272.9 ha to 576.3 ha, an overall reduction of 75%. Additionally, Leichhardt is proposing to prepare and implement a shorebird management plan which will monitor and manage impacts of the Proposal on shorebirds to ensure they are minimised. Nevertheless, given the extent of the predicted remaining disturbance, the potential local impacts to migratory shorebirds remain and are considered locally significant. Offsets have been proposed to counterbalance these impacts in Section 15.

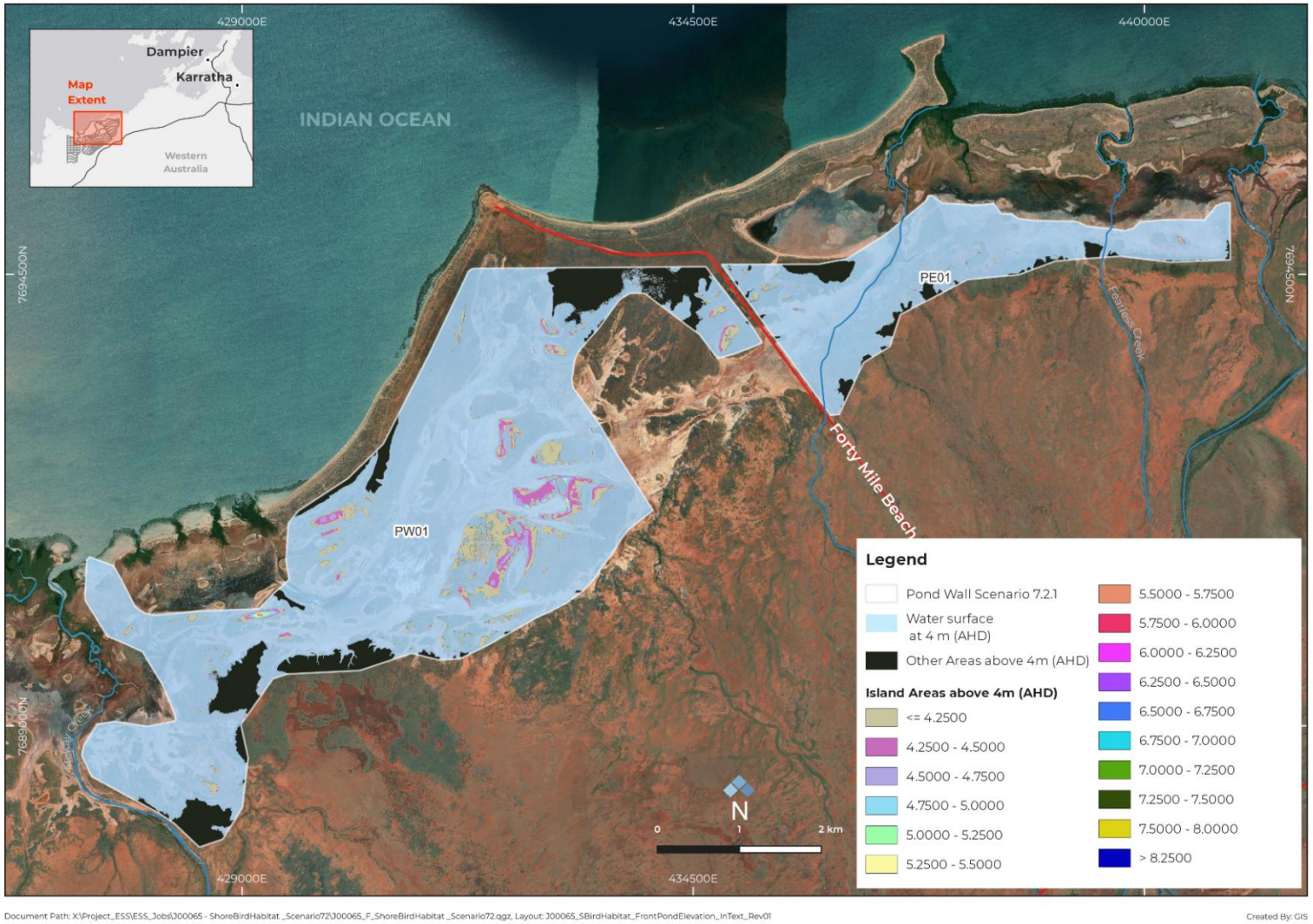



Figure 12-32: Bird habitat pond elevation

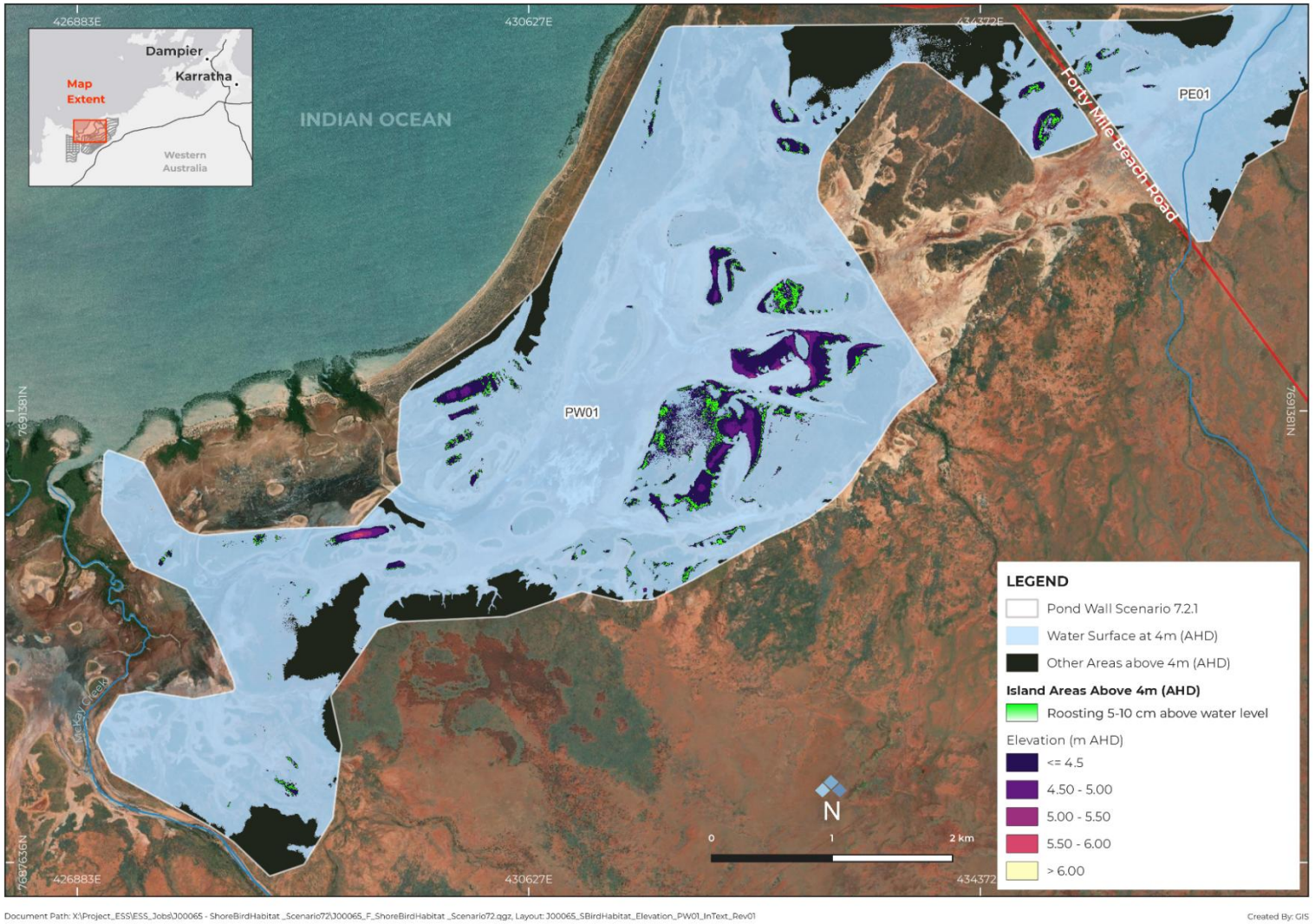



Figure 12-33: Roosting elevation

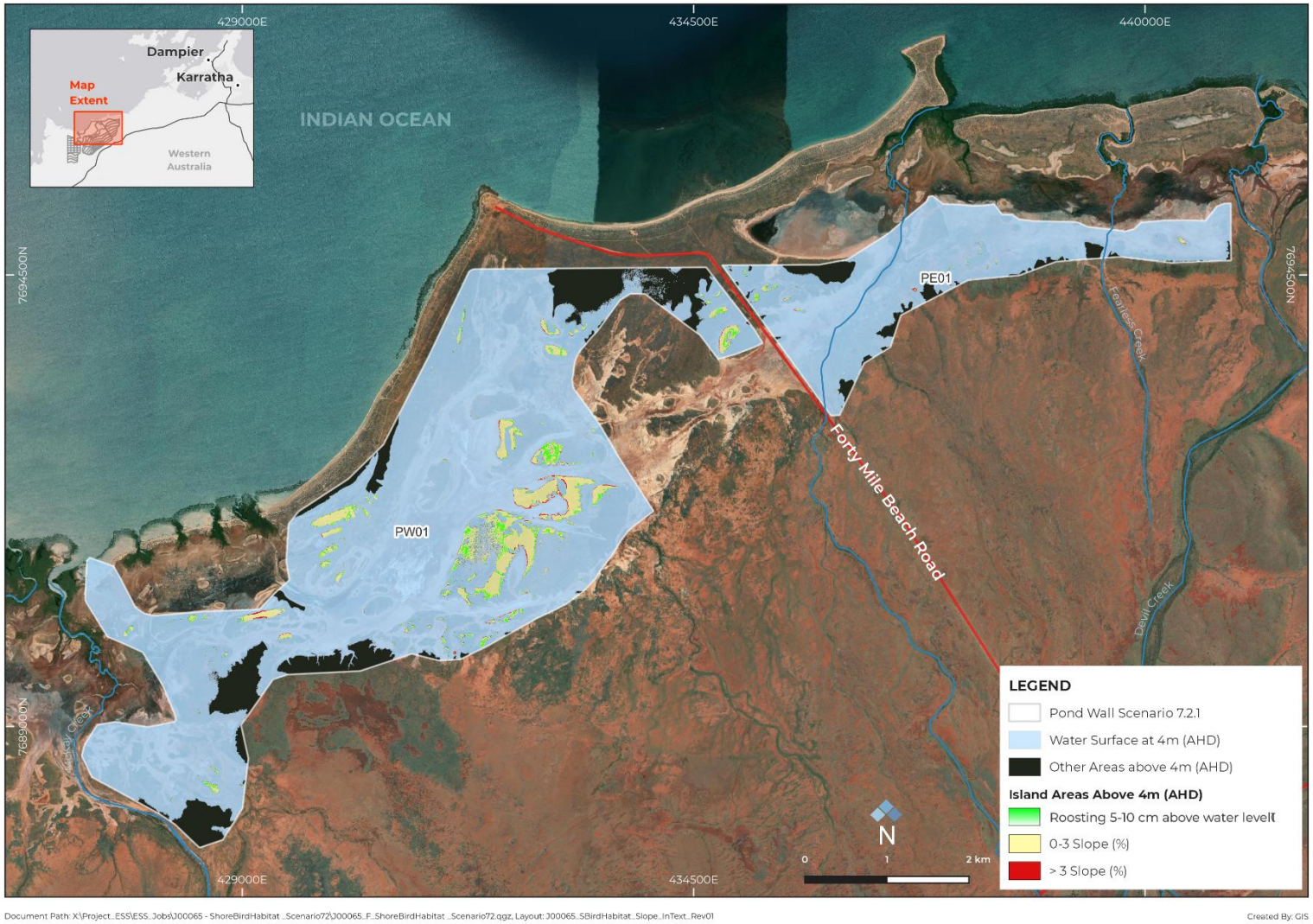



Figure 12-34: Roosting slope

## 12.6 MITIGATION

Leichhardt has mitigated the potential impacts to this factor according to the mitigation hierarchy; avoid, minimise, rehabilitate, offset. Offsets have been proposed for this factor, which is assessed in further detail in Section 15.

### 12.6.1 AVOID

The key avoidance outcomes achieved by Leichhardt was the iterative design of the development envelopes to avoid key environmental features, informed by engagement with ECU and expert consultants. Leichhardt has conducted numerous ecological surveys and this information has been utilised to significantly change the design the Proposal to avoid the majority of coastal habitats as these were identified as having a higher ecological value, including higher productivity algal mats (refer to Section 5). In addition, the following avoidance mitigation measures have been incorporated:

- The development envelope boundaries have been located to allow the use of existing tracks and port infrastructure wherever practicable; and
- No above-ground power lines in coastal areas.

### 12.6.2 MINIMISE

The following mitigation measures are proposed to ensure that direct and indirect impacts to terrestrial fauna are minimised:

1. **Implement industry best-practice management measures for fauna**:
    a. Vegetation clearing will be managed through internal ground disturbance procedures;
    b. Boundaries of areas to be cleared or disturbed will be identified by GPS coordinates and real-time on-screen mapping will be provided to plant operators;
    c. Progressive clearing will be undertaken;
    d. The disturbance footprint will be developed to the minimum required to ensure safe and adequate construction and operation;
    e. Water or dust suppressants will be applied to disturbed areas and product transfer/storage areas as required to minimise dust generation;
    f. Emergency response capabilities will be maintained to prevent fire outbreaks where possible;
    g. Weed hygiene and management measures/procedures will be implemented to prevent spread of weeds and the introduction of new weed species as a result of construction and operation;
    h. Pets will not be brought to site;
    i. Pipeline trenches will be progressively opened and closed;
    j. Fauna egress mechanisms will be installed at all pipeline trenches and turkeys nests;
    k. The open portions of pipeline trenches will be inspected less than two hours after sunrise for the presence of trapped fauna;

l. Introduced fauna will be controlled around camps and other work areas and training will be provided to ensure that native or introduced fauna are not fed by site personnel;
m. Food wastes will be stored in bins that are not easily accessible to fauna;
n. All incidents resulting in fauna injury or death will be reported internally;
o. Vehicle speed limits will be set and enforced;

2. **Obtain and comply with the following approvals**:
   a. Ministerial Statement to be issued under Part IV of the EP Act;
   b. Works Approval and Licence to be issued under Part V of the EP Act for solar salt manufacturing and bulk material loading;
   c. MP to be approved under the Mining Act; and
   d. MCP to be approved under the Mining Act. The MCP will describe the rehabilitation and closure of the Proposal, and associated management and monitoring proposed during the closure phase;
   e. Approval under Section 40 of the BC Act if threatened fauna is required to be taken or disturbed (as defined in the BC Act);
3. **Limit total and specific fauna habitat disturbance in the Proposal Content Document**;
4. **Implement a GMMP and BCHMMP (Appendix 1.9 and 3.9).** The monitoring and management is to be conducted over the life of the Proposal;
5. **Verify inundation modelling results after construction to ensure potential indirect impacts to coastal habitats are within predicted outcomes** (refer to Section 6.6);
6. **Monitor erosion at the outlets of the surface water corridors after each significant flow event** (refer to Section 6.6)**;**
7. **Incorporate features into the Proposal pond design to promote shorebird foraging and roosting** (refer to Section 12.5.6);
   a. **Preparation of a long-term shorebird management plan** – the management plan will outline monitoring and mitigation strategies to ensure the Proposal does not significantly impact shorebirds. The plan will include a requirement to conduct annual migratory shorebird surveys within the SBSA for a minimum of eight years to capture construction and post-construction phases. The annual surveys will be conducted in a similar manner to the targeted survey conducted by Phoenix (2023) and will provide information regarding long-term changes in the numbers, species and distributions of migratory shorebirds utilising the SBSA. If suitable these surveys may be incorporated into the surveys conducted at the Mardie Project to provide regional results;
8. **Note the usage of the concentration ponds by fauna species.** Incorporate these areas into the annual migratory shorebird survey if shorebird species are noted to utilise the ponds;
9. **Record any fauna entrapment within the ponds as an incident and review whether additional egress mechanisms should be installed;**
10. **Concentration ponds and crystallisers will be designed and constructed to be safe and stable according to DEMIRS requirements**;
11. **Minimise lighting as described in Section 12.5.1 and the ALMP in Appendix 4.7;**
12. **The following controls will be used to further reduce the risk of impact from unintentional brine pipeline spills**:
    a. Pipelines routed outside the pond footprints, will be fitted with leak detection;

b. Flows will be shut off if leaks are detected;
c. Pipe routes will be inspected to a schedule for issues of concern;
d. Pipelines outside the pond footprints will mainly be located below ground;
e. Where pipelines cross access roads they will be reinforced against traffic loading;
f. Investigations will be conducted into the cause of any spills, and remedial actions will be taken to minimise the chance of reoccurrence; and
g. Spills response training to mitigate damage for site-based personnel.

### 12.6.3 REHABILITATE

At the completion of the Proposal the site will be rehabilitated to reinstate fauna habitat. A MCP will be required under the Mining Act and the key rehabilitation measures that relate to terrestrial fauna are summarised below:

1. Salts will be harvested and washed from the crystallisers prior to closure;
2. Concentration ponds walls will be flattened or opened up to allow tidal flows to enter the lower ponds, and surface drainage through higher areas;
3. Above ground infrastructure will be removed if not retained by PPA or the landowner; and
4. Crystallisers will be rehabilitated to an acceptable landform.

The MCP will be submitted to DEMIRS for assessment and approval prior to the construction of the Proposal, and will be reviewed and revised every three years.

## 12.7 PREDICTED OUTCOME

The EPA's environmental objective for this factor is to "protect terrestrial fauna so that biological diversity and ecological integrity are maintained". In the context of this objective: "ecological integrity" is listed as the composition, structure, function and processes of ecosystems, and the natural range of variation of these elements (EPA, 2016i).

Leichhardt has incorporated avoidance and minimisation measures into the Proposal design and operational processes, and this section presents the predicted outcomes after those measures have been incorporated.

The Proposal will result in direct impacts to fauna habitats that are unavoidable. At a regional scale, all vegetation associations to be disturbed will have more than 84% of their pre-European extent remaining, even once cumulative disturbance associated with the Proposal and others such as CPE Port, Sino Iron Project, Mardie Project and 40-Mile Beach Road have been deducted. This means that all of the vegetation associations will remain in the 'Least Concern' category (Phoenix, 2025).

The Proposal includes large areas of ponds that contain salts or brine and as such revegetation will be impeded for some time post-closure. The Proposal is a long-life project with an infinite resource (seawater and solar energy), so consideration of altered ocean hydrodynamics and climate change will be necessary. Closure planning will continue through the life of the Proposal (with the MCP being revised every three years), with the purpose of refining the closure strategies already identified in the MCP (Appendix 1.8), including:

- The concentration pond walls will be flattened or opened up to allow tidal and overland drainage flows to reinstate within the former pond areas. Over time this is expected to return the area to a state where salt-tolerant species can revegetate the pond areas; and
- Salts will be recovered from the crystallisers, which are to be located on terrestrial vegetation, and the landform re-established to facilitate surface drainage from rainfall events.

At a local scale, impacts to numerous listed fauna species are considered to be significant, even after the extensive design changes and detailed mitigation measures are implemented. The Proposal is predicted to result in significant residual direct and indirect impacts to:

- 10,966.7 ha of foraging habitat for the Pilbara Leaf-nosed Bat and Ghost Bat;
- 12.3 ha of critical mangal community habitat and 12,238.4 ha of foraging habitat for the North-Western Free-tailed Bat;
- 20.8 ha of potential foraging habitat for the Pilbara Olive Python;
- 1,960.2 ha of spinifex grassland foraging habitat for the Grey Falcon; and
- Up to 1,315.0 ha of disturbance to habitat for Migratory Shorebirds and 2,392.2 ha of additional disturbance to Oriental Pratincole habitat. Cumulative impacts are also considered in more detail in Section 18.

Offsets are proposed in Section 15 to counterbalance these impacts.

The environmental outcomes for this factor are therefore predicted to be:

- No reduction in the abundance and diversity of migratory shorebirds utilising coastal habitats;
- No losses of fauna habitat that would significantly affect the viability of any significant fauna species;
- Losses of Good to Excellent quality habitat for significant fauna;
- A remaining potential for localised impacts associated with weeds and feral fauna; and
- A remaining potential for rare localised short-term impacts associated with spill / pollutant incidents.

Based on the above the Proposal is expected to meet the EPA's objective for this factor. The implementation of the proposed mitigation is expected to minimise the potential for significant residual impacts to terrestrial fauna or their habitats, and where these residual impacts remain significant, offsets are proposed and deemed to be appropriate, as detailed in Section 15.

# 13 SOCIAL SURROUNDINGS

## 13.1 EPA OBJECTIVE

The EPA Objective for this key environmental factor is 'to protect social surroundings from significant harm'.

## 13.2 POLICY AND GUIDANCE

Relevant EPA and Commonwealth Government Guidance Documents for Social Surroundings are summarised in Table 13-1.

**Table 13-1: Policy and Guidance relevant to the Social Surroundings key environmental factor**

| Policy and Guidance | How guidance has been considered |
|---|---|
| **WA Government** | |
| Key EPA documents | |
| EIA (Part IV Divisions 1 and 2) Procedures Manual (EPA, 2024a). | This document has been considered in planning for the Part IV approval process and has been used to inform the preparation of this ERD. |
| Statement of Environmental Principles, Factors, Objectives and Aims (EPA, 2023a). | This document was considered in the preparation of this ERD and to inform EIA. It was used identify the Key Environmental Factors likely to be impacted by the Proposal and the EPA's objective for each factor. |
| Guidelines for Preparing Mine Closure Plans (DMIRS, 2020a). | This document has been considered in the design and planning of the Proposal, it has also been considered in the preparation of mitigation measures for the Proposal. |
| EIA (Part IV Divisions 1 and 2) Administrative Procedures (EPA, 2024d). | This document has been considered in planning for the Part IV approval process and has been used to inform the preparation of this ERD. |
| Instructions on how to prepare EP Act Part IV Environmental Management Plans (EPA, 2024e). | This document was considered during the preparation of the Social, Cultural Heritage Management Plan (SCHMP). |
| Relevant EPA Factor Guidelines | |
| Environmental Factor Guideline – Social Surroundings (EPA, 2023b). | This document was considered in the preparation of this section (Section 13) of the ERD. |
| Interim Technical Guidance – Environmental Impact Assessment of Social Surroundings – Aboriginal Cultural Heritage (EPA, 2023c) | This document was considered in the preparation of this section (Section 13) of the ERD. |
| Relevant EPA Technical Guidance | |
| Guidance Statement 41 – Assessment of Aboriginal Heritage (EPA, 2004). | This document was considered in the preparation of this section (Section 13) of the ERD. |
| **Commonwealth Government** | |
| Key Documents | |
| Generic guidelines for the content of a draft EPBC Act PER/ EIS (including the objects and principles of the EPBC Act, 1999; DotEE, 2016). | These documents were considered in the preparation of this ERD and while undertaking EIA. |

| Policy and Guidance | How guidance has been considered |
|---|---|
| EPBC Act Condition Setting Policy (DAWE, 2020). | This document was used as guidance for the EIA and the development of mitigation measures and likely regulation of the Proposal. |
| EPBC Act Outcomes-based conditions policy (DotE, 2016a). | This document was used as guidance for the EIA and the development of mitigation measures and likely regulation of the Proposal. |
| Relevant Technical Guidance | |
| Engage Early – Guidance for proponents on best practice Indigenous engagement for environmental assessments under the EPBC Act (DotE, 2016b). | This document was considered in the preparation of this ERD and while assessing social impacts. |

# 13.3 RECEIVING ENVIRONMENT

## 13.3.1 ABORIGINAL HERITAGE AND CULTURAL VALUES

The information in this section was provided by Leichhardt's Aboriginal Heritage consultant.

***Native Title/Traditional Owners***

Native Title rights and interests comprise either the exclusive right to possession, occupation, use and enjoyment of the relevant land or a set of non-exclusive rights which include, among others, the right to maintain and protect places of significance.

The Mardudhunera People are the Traditional Owners and determined Native Title holders for the land that underlies the Proposal. The Native Title Determination Area covers an area of 9,927 km$^2$ (Figure 13-1). The WAC RNTBC is the registered prescribed body corporate that holds on trust the Native Title rights and interests for the Mardudhunera People. The Proposal is located 55 km west of Karratha, which is where many of the Traditional Owners currently reside.

***Aboriginal Heritage***

The Aboriginal Heritage values within the development envelopes have been identified through cultural heritage surveys with Mardudhunera People and ongoing consultation with the WAC. Approximately 15,500 ha (almost all of the development envelopes), has been surveyed for previously unknown and unrecorded Aboriginal Heritage sites and other areas of potential cultural interest (Figure 13-2). Leichhardt has agreed with WAC to survey the unsurveyed areas, including the port corridor, prior to any development. This commitment will be contained within the SCHMP. The extensive heritage survey work has allowed Leichhardt to gain a thorough understanding of the cultural landscape, Aboriginal Heritage sites and their importance to the Traditional Owners.

Prior to the completion of the cultural heritage surveys, Leichhardt commissioned a desktop study from Horizon Heritage Management, WAC's heritage consultant. The key finding of this report was that there had been no Aboriginal Heritage surveys previously undertaken within the Survey Area, which is generally aligned with the boundaries of the PIDE. One registered site, Noorea Soak (ID 11871), was identified within the Survey Area through the Aboriginal Heritage Inquiry System (AHIS). This site was recorded in 1975 as a freshwater soak with an engraving.

The six other sites listed on the AHIS within the Survey Area have either been assessed by the Aboriginal Cultural Material Committee as being sites to which section 5 of the AH Act does not apply, or the sites are in fact outside of the Survey Area.

Eight surveys were conducted over 58 survey days between September 2021 and September 2023, with 76 Mardudhunera People participating in the surveys. A total of 304 new Aboriginal sites were identified. A breakdown of the site types is provided in Table 13-2 and depicted in Figure 13-3.

**Table 13-2: Newly recorded site types in the Survey Areas**

| Site Type | Number recorded | Percentage (%) of total |
|---|---|---|
| Grinding Patches | 80 | 27 |
| Artefacts inc. Quarries and Camps | 188 | 62 |
| Rock Engravings | 22 | 7 |
| Fish Traps | 7 | 2 |
| Stone Arrangements | 4 | 1 |
| Freshwater Soaks | 1 | <1 |
| Mythological (Water Pool) | 2 | <1 |
| **Total** | **304** | **100** |

The key finding from the surveys is that there are pockets of land in the Survey Areas rich in Aboriginal cultural heritage sites and areas of cultural interest. The Mardudhunera People have noted that the area within the Survey Areas used to be a 'food bowl' due to the proximity to the ocean, rich in food types and close to freshwater creeks. The granite and dolerite rock outcrops that occur throughout the Survey Areas have been used for grinding seeds and carving rock engravings. Some of the engraving figures depict domestic messages such as the presence of native fauna and some engravings have been described by the Mardudhunera People during the surveys as depicting ceremonies. The Mardudhunera People attribute a particular significance to these types of rock engravings and have requested that Leichhardt avoid these places and ensure access is maintained.

The predominant site type present in the Survey Areas is artefact/camp/grinding stones sites representing 188 sites (62% of the total). These sites include portable grinding stones, artefact scatters, quarries, and camping areas. The grinding patch sites have also been found in high numbers accounting for 80 sites (27%). These sites are found on the large dolerite rock outcrops and granite domes.

It should be noted that many sites contain more than one cultural feature. For example, many of the grinding sites also included artefacts. The large grinding sites are in proximity to the several freshwater creeks including Eramurra Creek, McKay Creek and Devil Creek. These creeks feed numerous ephemeral creek lines throughout the PIDE. These environmental factors created a bountiful food production area during the wet season when water and native grass seed were available. The area of land is also a transitional zone between the inland hills and the coastal zone. The presence of the large number of grinding sites indicates the intensive use of the area by generations of Mardudhunera People.

There are 22 new rock engraving sites that have been identified in the Survey Areas representing 7% of the new sites recorded. The engravings feature both religious depictions of Aboriginal culture and more mundane motifs indicating the presence of animals. Most of the rock engravings are situated on large rock outcrops. The rock engravings were assessed by the Mardudhunera People and WAC as being highly significant in Aboriginal tradition.

Fish traps and stone arrangements were identified during the heritage surveys in the coastal tidal flats. These cultural features are considered rare and highly significant by the Mardudhunera People. The Mardudhunera People requested that these features be preserved for future generations.

Devil's Pool was identified as a mythological place associated with a Dreamtime story. The pool is significant because of these mythical associations and WAC has requested that the pool remain undisturbed, and access maintained.

The numerous artefact sites including camps and quarries confirms the intensive use of the area by generations of Aboriginal people. The cultural features of these sites range from a few artefacts in a location to hundreds of artefacts indicating intensive quarrying of suitable stone resources for different purposes.

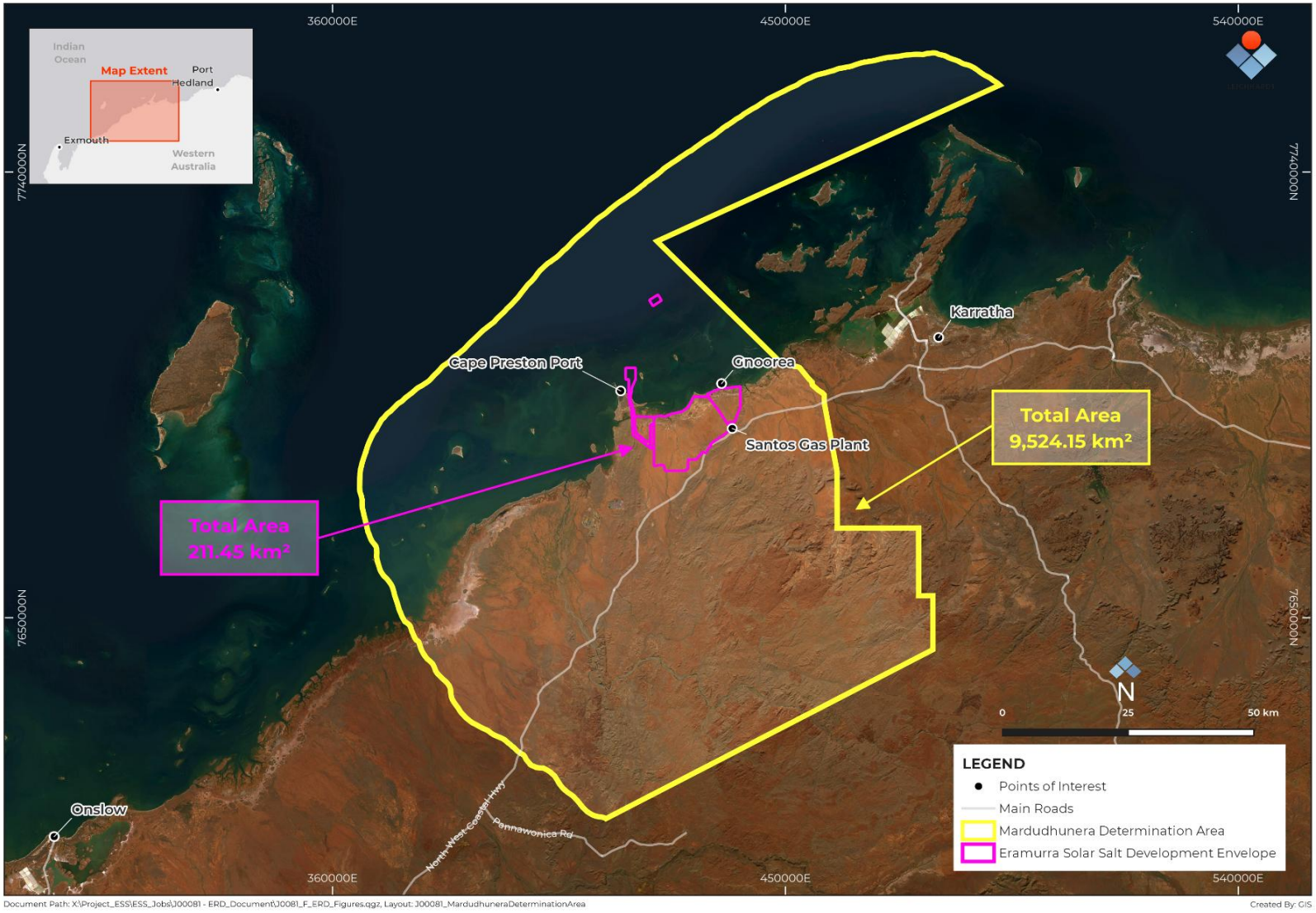



Figure 13-1: Mardudhunera Determination Area and development envelopes

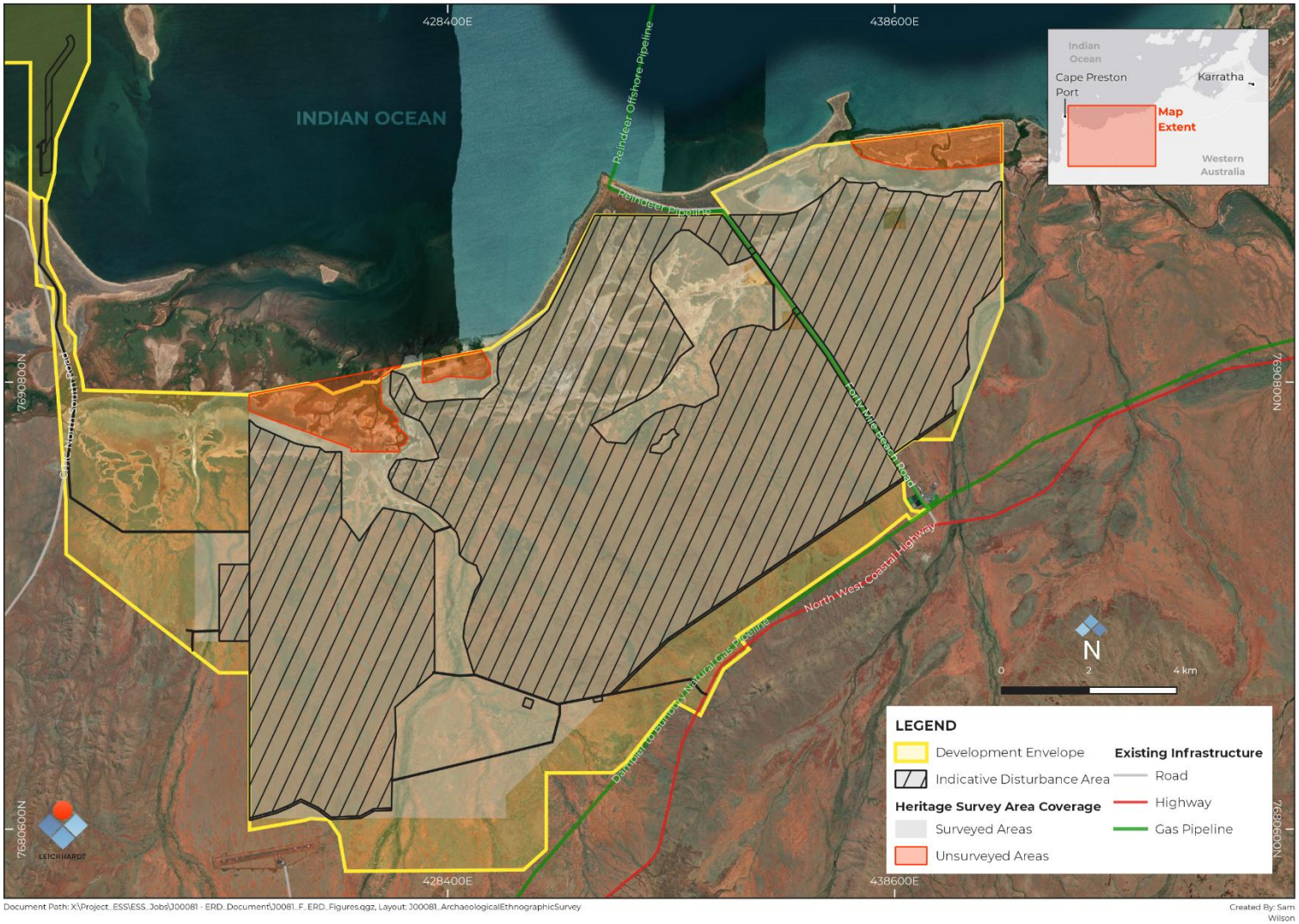



Figure 13-2: Archaeological and Ethnographic Survey Coverage

**This figure has been removed as it contains culturally sensitive information. Please contact Leichhardt Salt Pty Ltd for further information**

Figure 13-3: Recorded Sites in Survey Areas

### *Engagement with the Mardudhunera People*

Leichhardt finalised the negotiation of a Heritage Protection Agreement with the determined native title holders the Mardudhunera People through WAC in May 2021 and a SCHMP in April 2023. The SCHMP addresses the impacts of the Proposal on both Aboriginal heritage and other cultural values and key aspects of the relevant social surroundings.

Leichhardt is finalising a Land Access Agreement for the Proposal which Leichhardt has been negotiating with WAC since 2019. The agreement sets out Leichhardt's obligations in relation to the identification, protection, and management of the social environment where the Proposal is located. These obligations require Leichhardt to conduct its operations in a way that avoids or minimises disturbance to cultural values and respects Mardudhunera cultural heritage. This philosophy informs Leichhardt's approach to all its land uses.

Under the Heritage Protection Agreement, Leichhardt and WAC have conducted seven Aboriginal ethnographic and archaeological heritage surveys to determine the presence of Aboriginal cultural sites and the areas that the Mardudhunera People would like preserved and managed. Ethnobotanical consultation was also undertaken to understand the important cultural flora present in the Survey Areas and to identify areas that continue to be used by the Native Title holders for social recreation and cultural purposes. Several site visits have also taken place with Mardudhunera Elders for Leichhardt to understand the importance of particular areas of the country where the Proposal is located.

A series of meetings and workshops have been held between Leichhardt and WAC to develop the management responses in the SCHMP for areas identified by WAC during the field work processes. Table 13-3 details the engagement and outcomes agreed.

**Table 13-3: SCHMP Consultation**

| Date | Engagement | Outcomes |
|---|---|---|
| 21 May 2021 | Meeting with eight WAC Board Members | Agreed process for developing SCHMP. Agreed to on-country meeting with WAC elders as soon as possible.<br>Agreed to initiate Aboriginal heritage surveys for entire Proposal. Heritage Agreement approved by the parties. |
| 29 & 30 May 2021 | On-Country Meeting with eight WAC Members | Leichhardt commitment to fully heritage survey the land before committing to final Proposal design. Leichhardt commits to avoid culturally significant sites. |
| 13 & 14 April 2022 | Meeting with the eight WAC Board Members | Leichhardt commits to avoiding rock engraving sites. |
| 10 & 11 May 2022 | SCHMP Development Workshop with eight WAC Board Members | Agreement on a range of management measures. Agreement for further heritage surveys to be undertaken. Agreement to hold further workshops and produce a Factsheet about the Proposal to be sent to all members. |
| 1 June 2022 | SCHMP Development Workshop with 12 WAC Members | Further SCHMP measures agreed to.<br>Leichhardt committed to completing visual impact assessment at key locations determined by WAC and providing viewshed material at next SCHMP Workshop of larger group of WAC members. |
| 22 June 2022 | Publication of Factsheet to all WAC Members | Information to WAC members. |

| Date | Engagement | Outcomes |
|---|---|---|
| 11 July 2022 | SCHMP Development Workshop with 23 WAC Board Members | Further amendments agreed to the SCHMP.<br>Leichhardt commit to assist with funding the WAC Ranger Program to assist with the implementation of the SCHMP. |
| 14 September 2022 | Leichhardt and WAC Meeting about Mining Agreement and SCHMP | Further changes to the SCHMP including agreeing a Keeping Place for the storage of artefacts, site recording methodology, review process. Further engagements agreed to. |
| 6 October 2022 | Leichhardt and WAC Elders field | Elder's visit to area of cultural significance resulted in further changes to the Proposal design to allow greater protection of sites and greater access for Mardudhunera People. |
| 14 October 2022 | Leichhardt and WAC | Further amendments to the Proposal design were agreed following feedback from WAC.<br>SCHMP amendments. |

### 13.3.2 TRADITIONAL USES OF THE LAND

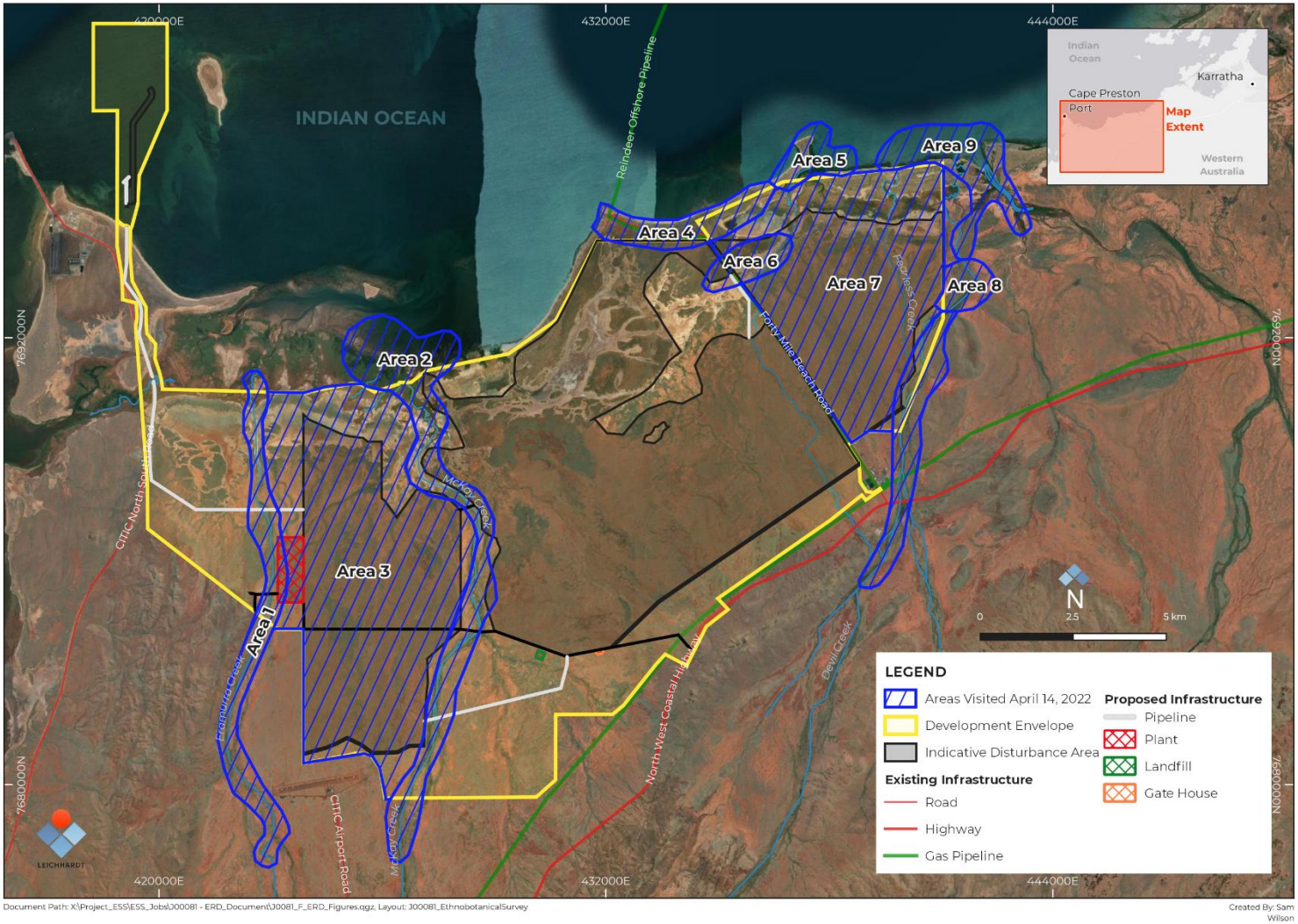
Leichhardt consulted with the Mardudhunera People via WAC about the traditional uses of the land and conducted a field visit within the Survey Areas with ethnobotanist Vicki Long and several Mardudhunera Elders (Figure 13-4). Numerous bush tucker species were identified during the field visit and findings from previous ethnobotanical work undertaken by Vicki Long and the Mardudhunera People has also been considered as part of this assessment.

The flora species list from the Phoenix (2025) flora and vegetation survey was assessed against the results of field visits and findings from previous ethnobotanical work, to obtain a view of the extent of bush tucker and medicine species across the development envelopes. Figure 13-6 shows the range of these records, noting some specific concentrations around creeklines and intertidal areas. In total, 48 culturally significant flora species were identified of which 36 were recorded by Phoenix during field surveys. Ten species were considered to be of most importance (Table 13-4), and eight of these were recorded during the field surveys.

**Table 13-4: Culturally significant flora species of most importance**

| Traditional name | Species/Common name | Habitat | Use | Recorded by Phoenix |
|---|---|---|---|---|
| Garama (Kanji Bush) | *Acacia pyrifolia*/Kanji Bush | Plains, outer creek banks, likes fire | Food | Yes |
| Miniritchie | *Acacia trachycarpa*/Miniritchie | Various | Artefacts, ceremony | Yes |
| Marruwa, Pukarti | *Acacia xiphophylla*/Snakewood | Stony gibber plains edge of Devil Creek | Culture, food | Yes |
| Waggala or Palyarringu | *Corymbia hamersleyana*/Pilbara Bloodwood or Bloodwood | Various | Medicine, food | Yes |
| Warnanykura | *Eucalyptus victrix*/Smooth bark coolabah | Creek banks and bed | Medicine, food, artefacts, other | Yes |
| Warthawa | *Gossypium robinsonii*/Wild cotton | Various | Medicine, ceremony | No |
| Jinngu/Pithangara | *Grevillea pyramidalis*/Caustic bush | Plains | Men's and women's business | Yes |
| Bidangarra | *Sesbania formosa*/White Dragon Tree | Various | Medicine, Ceremony | No |

| Traditional name | Species/Common name | Habitat | Use | Recorded by Phoenix |
|---|---|---|---|---|
| Minyjarra/Jami | *Stemodia grossa*/Vicks Plant | Devil Creek and all riverbeds | Medicine | Yes |
| Mirna | *Triodia epactia*/Gummy Spinifex | Landward of coastal dunes, coastal plain, rocky areas | Artefacts, spiritual, ceremony | Yes |


420000E
432000E
444000E
INDIAN OCEAN
Reindeer Offshore Pipeline
Indian Ocean
Karratha
Cape Preston
Port
Map Extent
Western Australia
Area 1
Area 2
Area 3
Area 4
Area 5
Area 6
Area 7
Area 8
Area 9
7692000N
7680000N
Fortescue Creek
Fortescue Creek
Fortescue Creek

***Demarcated Areas***

There are five demarcated recreational areas identified by WAC during consultation meetings and fieldwork. These areas continue to be used by Mardudhunera People today. 40-Mile Beach is used by many Mardudhunera People and the general public who visit the area to camp and fish. Mardudhunera People also have a strong cultural association with the 40-Mile Beach Area.

Concerns were raised by WAC during the consultation engagements about continued access to the five areas, particularly 40-Mile Beach. Access to 40-Mile Beach is via 40-Mile Beach Road, a public road maintained by the City of Karratha. This road will not be impacted by the Proposal and access to 40-Mile Beach will remain unrestricted. The demarcated areas are shown in Figure 13-5 and discussed below.

*Eramurra Creek*

Eramurra Creek was identified as a key place of recreation where Mardudhunera People continue to gather for social purposes. It is also a place where the current cohort of elders used to visit with their parents and recreate. It is a place that people stopped off at when visiting Balmoral Station travelling on horseback and when carrying out mustering on Karratha Station. Several ethnobotanical features were identified along the creek including bush tomato, bush potato and Vicks bush.

The Mardudhunera elders requested that a further ethnobotanical survey be undertaken after heavy summer rainfall to identify culturally significant flora species in the Eramurra Creek area. They also identified this area as potentially suitable for a Keeping Place for displaced cultural artefacts that will be salvaged prior to construction of the Proposal.

*McKay Creek*

The area in and around McKay Creek was identified as a place where numerous bush tucker species can be identified following summer rainfall. The Mardudhunera elders observed numerous portable grinding stones and concluded that the area would have been heavily used by their ancestors. The Mardudhunera elders were interested to find out what species of seeds were processed on the grinding stones next to McKay Creek. Their recommendations included limiting the disturbance of the area and conducting residue analysis on the grinding stones to determine what species were used and if they still occur in the area today.

*Gnoorea Point – 40-Mile Beach*

The Mardudhunera elders observed that the dune vegetation at Gnoorea Point is easy to access from Karratha for any current usage requirements. They requested that the dunes not be impacted by the Proposal and remain as they are. Access to this coastal area is very important to maintain so Mardudhunera People can continue to use the coastal resources, camp and continue to practice their culture.

The Mardudhunera elders noted that this is an area they want to officially manage through a Ranger Program to reduce the environmental impacts of tourism. Leichhardt has committed to assist WAC in this objective, including through the provision of funding and facilitating discussions with the City of Karratha, who currently manage the camp sites.

*Pelican Point*

This area is characterised as a sheltered mangrove lined creek which continues to be a very popular fishing spot for the Mardudhunera People who have been coming to this area for generations. Concerns were raised about potential indirect impacts to the mangroves and water levels, and concerns were raised that the Proposal may change the nature of the area. It was observed that bush onions (*Cyperus bulbosus*) are abundant in this area. This place was also observed to have a spiritual importance as it is a place where the Mardudhunera People 'sing in the whales.'

*Bills Mill*

This place has historical significance for some Mardudhunera People who used to live and work on Karratha Station. It is still frequented today as it has been for several generations. The area is characterised by Devil Creek changing from being tree lined with dense riparian vegetation to treeless on the saline plain. The Mardudhunera People are keen to ensure that no impacts occur to this place.

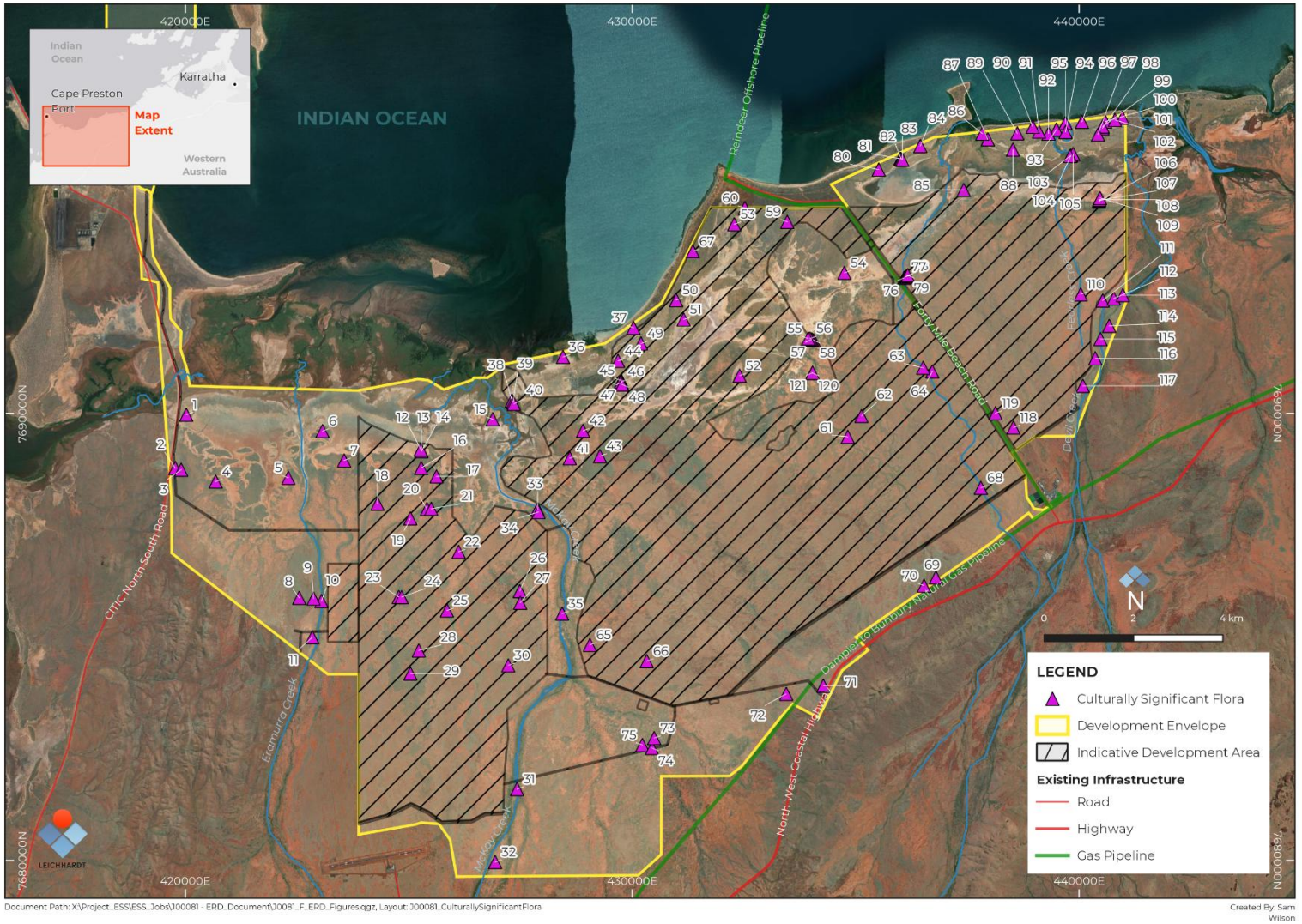



Figure 13-5: Location of bush tucker and medicine species

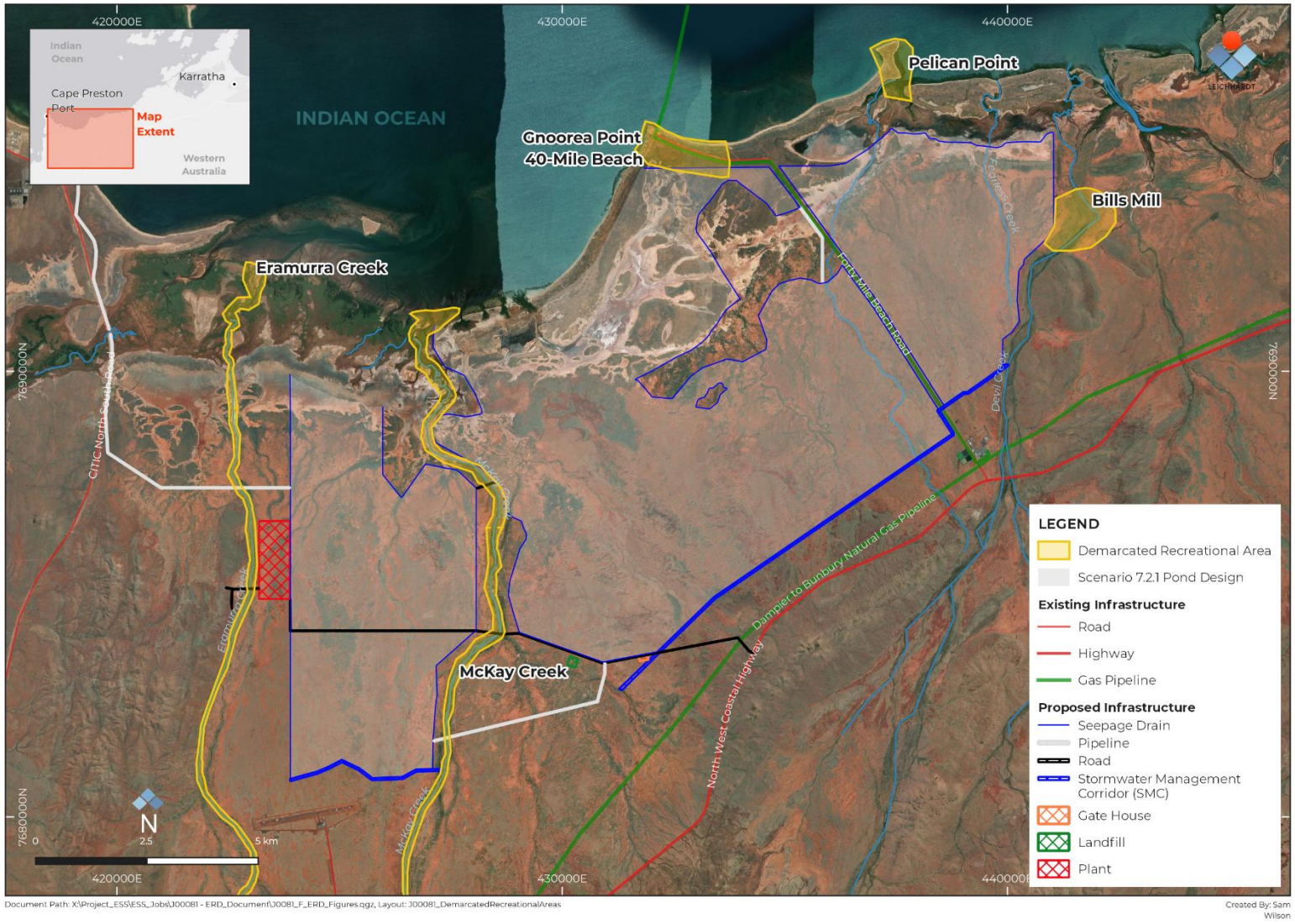



Figure 13-6: Demarcated recreational areas

### 13.3.3 RECREATIONAL/COMMUNITY USE

Leichhardt commissioned Preston Consulting (2025) to undertake a desktop and field survey of recreational activities in proximity to the Proposal to inform the environmental approval process under Part IV of the EP Act. An online survey is also being undertaken to capture a higher number of responses. This survey was available from July 2023 and will remain open for submissions for the next three months.

The Study Area for the survey ranged from the northeast reaches of 40-Mile Beach through to McKay Creek located south-southwest of Gnoorea Point (Figure 13-7). The Study Area was separated into five zones, selected based upon their recreational usage type and locality to the Proposal. Zone three is a designated camping region at Gnoorea Point, with a boat ramp and basic facilities. Zone four features an extension of campsites that sprawl along the coastline. Zone two includes a secondary main campsite, with several other individual locations available for camping. Zones one and five are not allocated camping locations, and therefore feature little to no camping activity.




Figure 13-7: Recreational Survey Study Area

### *Desktop Study*

A desktop assessment was undertaken to determine the historical recreational uses of the Study Area. Data on recreational activities dating back to August 2000 were obtained through aerial imagery sourced from publicly accessible databases Landgate and Google Earth.

There was no recreational activity recorded during the summer months of 2013 and spring 2001, 2004 and 2015. There is a significant increase in recreational use during the cooler months, when average maximum temperatures are lower, between 25–- 30°C. A maximum of 71 individual campsites were identified during August 2013. In the months where average maximum temperatures surpassed 30°C, recreational use decreased, with little to no activity identified at these times through imagery investigations.

August returned the highest levels of activity (average of 50 vehicles), and zone three (Gnoorea Point) always contained the greatest number of visitors.

### *Field Reconnaissance Surveys*

Three field surveys were conducted by environmental consultants, with survey details and dates outlined in Table 13-5.

**Table 13-5: Field survey dates and personnel**

| Survey | Season | Dates |
|---|---|---|
| One day site reconnaissance across five zones at three timeframes (morning, midday, and afternoon) | Winter | 24 June 2021 |
| Two-day site reconnaissance across five zones at three timeframes (morning, midday and afternoon) | Winter | 10 July – 11 July 2021 |
| One day single site reconnaissance across five zones, one day visitor questionnaire | Spring | 3 October 2022 |

In line with the desktop assessment, zone three recorded the highest level of recreational activity across all field surveys, with the remaining four zones recording significantly less activity (Table 13-6). Zone three is a designated camping area, with a boat ramp and basic facilities and camping sites were almost at full capacity throughout the duration of survey two. As survey three was during the off season, significantly less vehicles were recorded than the previous two surveys.

**Table 13-6: Average number of vehicles recorded in each zone**

| Survey | Zone 1 | Zone 2 | Zone 3 | Zone 4 | Zone 5 |
|---|---|---|---|---|---|
| Survey One (June 2021) | 2 | 5 | 45 | 12 | 2 |
| Survey Two (July 2021) | 5 | 9 | 89 | 32 | 17 |
| Survey 3 (October 2022) | 0 | 3 | 19 | 4 | 2 |

During the field survey, key activities, site characteristics and other general observations were recorded for each site as detailed in Table 13-7.

Table 13-7: Observation summary

| Zone | Observations | Main Activities |
|---|---|---|
| Zone 1 | - Multiple pedestrian access points to mangroves for fishing or visual activities<br>- Individuals walking onto reef platform from Pelican Point | Swimming, general exploration and fishing |
| Zone 2 | - Individuals walking onto reef platform from 40-Mile Beach<br>- Vehicle access to 40-Mile Beach<br>- Good visual of beach from access tracks<br>- Campsite area<br>- Toilet and waste disposal facilities | Beach access, swimming, general exploration, fishing and boating |
| Zone3 | - Main camping area<br>- Boat ramp<br>- Toilet and waste disposal facilities | Camping, boating (boat access) |
| Zone 4 | - Dispersed campsites<br>- Shallow waters and mangroves present limiting suitability for swimming, fishing and boating | Camping and general exploration |
| Zone 5 | - Minimal use of salt pans or mangrove areas recorded<br>- Scattered campsites | Salt pans, general exploration |

***Visitor Questionnaire Survey***

An in person intercept questionnaire was undertaken on 3 October 2022, during survey three, between 9 am and 3:30 pm. Campers and visitors were approached and asked if they would like to participate in a questionnaire related to their experience and thoughts of the 40-Mile Beach area and the potential impacts of the Proposal on those experiences. All identified and occupied camp locations throughout zones 1–- 5 were surveyed. The visitor survey was also made available online with campers able to scan a QR code which would take them to an online platform. The QR code was available at various locations at the camping ground. The online survey was available from 11 July 2023 and will be available until August 2025. Visitors were provided with a series of real and computer-generated images, featuring pre- and post-Proposal development conditions from different viewpoints around Gnoorea Point, 40-Mile Beach and surrounding roads. Survey participants were asked to express their thoughts and general considerations about these images. General demographic and site visit details were collected, including length of stay, number of visits, recreational activity participation and locations visited.

Fifteen visitor groups were approached to participate in the questionnaire. Visitor groups were defined as the group of people that were present at each camping site or recreational location and varied from one to six adults. Eight visitor groups declined to participate, resulting in a total of seven complete in-person questionnaires. The visitors that were not interested in participating provided the following reasoning:

- Indifference to the Proposal;
- Not interested as they were interstate travellers; or
- Opposed to the Proposal.

An additional ten responses were received through the online platform as of 30 November 2023, four of the surveys were completed, four were partially completed and two were started but no answers were provided.

Camping, fishing, four-wheel driving and swimming were the most popular activities among those who took part in the surveys, with the most regularly visited locations being Gnoorea Point and 40-Mile Beach. The eastern tidal creek was also considered a popular fishing area for visitors. The low response rate to boating was likely due to many of the visitors who participate in boating being out on the water and unavailable during the questionnaire period. A summary of the responses to the general visitation information questionnaire is provided in Table 13-8.

**Table 13-8: General visitation information**

| General Information | | Response Rate |
|---|---|---|
| Number of times visited<br>Number of responses (N)=21 | First visit | 4 |
| | 2–- 4 | 5 |
| | 5–- 9 | 1 |
| | 10-14 | 3 |
| | 15-19 | 3 |
| | 20 or more | 5 |
| Duration of current visit<br>N=7<br>(in-person questionnaire only) | Day visit | 1 |
| | 2 – 7 days | 5 |
| | More than a month | 1 |
| Regular camping location/s<br>(participants could select more than one answer)<br>(not provided in revised online questionnaire)<br>N=15 | Gnoorea Point | 8 |
| | Coastline West of Gnoorea Point | 6 |
| | Small Eastern Campsite | 3 |
| | Other | 1 |
| Regularly visited location/s<br>(participants could select more than one answer)<br>N=21 | Gnoorea Point | 15 |
| | 40-Mile Beach | 14 |
| | Coastline west of Gnoorea Point | 14 |
| | Tidal creek and point east of 40-Mile Beach | 11 |
| | Inland mudflats | 3 |
| | Offshore | 5 |
| Activities participated in during visit<br>(participants could select more than one answer)<br>N=21 | Camping | 21 |
| | Fishing | 18 |
| | Swimming | 15 |
| | Wildlife/nature appreciation | 15 |
| | Photography | 8 |
| | Four-wheel driving | 12 |
| | Boating | 9 |
| | Other | 3 |
| Location of boating activities<br>N=9 | Inshore of the Islands | 4 |
| | West of Cape Preston | 2 |
| | Around or offshore of the islands | 4 |





### 13.3.4 European Heritage and Cultural Values

A search of WA databases identified no European heritage sites in the development envelopes. The De Grey – Mullewa Stock Route (No. 8701) traverses through Woodenooka and Tallering Peak north from Mullewa. The site is located to the south of the Proposal and generally aligns with North West Coastal Highway south of the Proposal. Leichhardt's tenement E47/4301 has the largest intersection with the stock route and must comply with Condition 18 of the tenement conditions which states that "No exploration activities being carried out on De Grey Mullewa Stock Route Reserve 9701 which restrict the use of the reserve."

Enderby Island (No. 8668), located in the Dampier Archipelago heritage area, contains at least one historic burial and one shipwreck. The heritage area of the Archipelago follows the 40-Mile Beach coastline, encompassing the Dampier Archipelago and the Burrup Peninsula to the west. No shipwreck sites or maritime heritage sites have been identified or recorded within the development envelopes from video surveillance survey methods.

### 13.3.5 Social Values

Based on the information provided above, the following social values were determined to require assessment for this factor:

- Recreational and community uses;
- Aboriginal Heritage sites;
- Demarcated Recreational Areas; and
- Land used for traditional purposes.

## 13.4 Potential Impacts

Table 13-9 defines the potential impacts (direct, indirect and combined) on the social values for this factor in a local and regional context. These impacts are informed by the results of studies and surveys described in Sections 13.3 and 6 –12.

**Table 13-9: Potential** impacts on social surroundings

| Social value and current extent | Potential direct impact | Potential indirect impact | Impacts associated with other proposals | Combined impact (Proposal + others) |
|---|---|---|---|---|
| **Recreational and community uses.**<br>Generally seasonal use for camping, swimming, fishing, boating, exploration. | Loss of areas previously accessed for recreational activities. | Access restrictions to marine environment and coastal areas during some construction activities.<br>Decline in amenity (visual, noise, light, dust) due to construction and operation of ponds and other infrastructure. | The CPE and Cape Preston Ports include/will include the removal of marine and coastal habitat, and present access restrictions around operational port areas. | Loss of areas previously accessed for recreational activities, in addition to areas associated with the CPE and Cape Preston Ports.<br>Temporary restriction of access to marine environment and coastal area during some construction activities. |

| Social value and current extent | Potential direct impact | Potential indirect impact | Impacts associated with other proposals | Combined impact (Proposal + others) |
|---|---|---|---|---|
| **Aboriginal Heritage sites**<br>304 Aboriginal sites have been identified in the Ponds and Infrastructure Development Envelope, including one Registered Site. | Disturbance of 114 sites.<br>Disturbance within the DPLH boundary to Registered Aboriginal Heritage Site 11871. | Impacts to sites due to changes to the hydrological regimes or the quality of water. | Additional disturbance to heritage values as a result of the CPE and Cape Preston Ports. | Disturbance of 114 sites as a result of the Proposal and additional impacts associated with the CPE and Cape Preston Ports.<br>Disturbance within the DPLH boundary to Registered Aboriginal Heritage Site 11871.<br>Impacts to sites due to changes to the hydrological regimes or the quality of water. |
| **Demarcated Recreational Areas**<br>Five demarcated areas were recorded within the PIDE | No direct impacts. | Decline in amenity (visual, noise, light, dust).<br>Access restrictions. | No other proposals are currently impacting the Demarcated Recreational Areas. | Decline in the amenity (visual, noise, dust) of the areas due to construction and operation of ponds and other infrastructure. |
| **Land used for traditional purposes**<br>34 culturally significant flora species were identified in the PIDE. | 1,222 ha disturbance of coastal and marine habitat (intertidal and subtidal)<br>Up to 11,401 ha disturbance of terrestrial vegetation.<br>Up to 28 culturally significant flora species occur within the indicative disturbance footprint. | Changes to vegetation health as a result of changes to hydrological and hydrogeological processes or quality, weed infestation.<br>Decline in amenity (visual, noise, light, dust).<br>Access restrictions. | There are several other proposals/operations within the Mardudhunera NTA. The closest is Santos' Devil Creek gas plant to the south and comprises up to 120 ha of disturbance. | 1,222 ha disturbance of coastal and marine habitat (intertidal and subtidal)<br>Up to 11,521 ha disturbance of terrestrial vegetation.<br>Changes to vegetation health as a result of changes to hydrological and hydrogeological processes or quality, weed infestation.<br>Access restrictions.<br>Disturbance of up to 28 culturally significant flora species. |

# 13.5 ASSESSMENT OF IMPACTS

## 13.5.1 REGISTERED AND OTHER ABORIGINAL HERITAGE SITES

***Disturbance of Aboriginal Heritage Sites***

The information in this section was provided by Leichhardt's Aboriginal Heritage consultant.

Seven Aboriginal ethnographic and archaeological heritage surveys have been undertaken identifying 304 Aboriginal sites. The development of the Proposal will directly impact 114 of these sites. The impacts will occur during the clearing of land for pond walls or infrastructure, or when the ponds are flooded with seawater. Submerged sites cannot be meaningfully used by the

Mardudhunera People and are therefore considered to be 'disturbed'. Table 13-10 shows the overall impacts to site by category.

**Table 13-10: Aboriginal Heritage site impacts**

| Site type | Category | Total number of sites | Number of sites preserved | Number of sites impacted (% of total of site type) |
|---|---|---|---|---|
| Mythological – Devil's Pool & Eramurra Pool | No direct impacts (wholly avoid) | 2 | 2 | 0 (0%) |
| Fish Traps | | 7 | 7 | 0 (0%) |
| Soak | Impacted–- Salvage and Storage (to be recorded and catalogued prior to construction) | 1 | 0 | 1 (100%) |
| Stone Arrangement | | 4 | 2 | 2 (50%) |
| Engraving | | 22 | 20 | 2 (9%) |
| Artefacts, Grinding Stones and Camp Sites | | 188 | 108 | 80 (42%) |
| Grinding Patches | Impacts by Flooding (to be recorded and catalogued) | 80 | 51 | 29 (38%) |
| **Total** | | **304** | **190** | **114** |

Eighty of the 114 sites being impacted are artefact sites, representing 70% of the impacted sites. Two engraving sites and two stone arrangements will also be directly impacted. Leichhardt and WAC have agreed that all of these sites will be relocated through cultural salvage by the Mardudhunera People to a Keeping Place prior to construction of the Proposal.

The 29 Grinding Patch sites and the one freshwater soak will be impacted by water inundation. Given the size of the grinding patch sites it is not possible to effectively salvage them.

Significance assessments have not been undertaken on each of the 304 heritage sites however the Mardudhunera People have advised that the engraving and fish trap sites are important and significant in Aboriginal tradition. These sites would meet with definition of a site under section 5 of the AH Act and an Aboriginal Place under the ACH Act. The two engraving sites agreed to be salvaged are both single motifs carved on small portable dolerite rocks. Some of the 20 engraving sites that will not be impacted include tens of carved motifs on large dolerite outcrops.

Leichhardt has agreed to develop a Keeping Place facility led and managed by WAC to store relocated cultural artefacts. The Keeping Place will be located on Leichhardt tenure held under the Mining Act.

*Cumulative Impacts*

There is a methodological difficulty in predicting the cumulative impacts on Mardudhunera heritage sites that arise from the Proposal. This is because no accurate data exists for Mardudhunera heritage sites and locations within the determination area. The best (imperfect) indicator is the AHIS, which provides a list of heritage sites that have been reported to the DPLH in the Mardudhunera determination area. The AHIS is not a census of all Aboriginal sites in the determination area, and it is reasonable to assume that there are many more sites that are yet to be recorded and reported on. An analysis of the AHIS data shows that large parts of the

determination have not been subject to heritage surveys (Figure 13-8) and the distribution of heritage sites are within areas that have been subject to heritage surveys (Figure 13-9).

By contrast, the PIDE has been extensively surveyed for Aboriginal sites and consequently the Aboriginal heritage profile of the land is very well known and understood (Figure 13-2). A direct comparison of these two datasets artificially inflates the predicated cumulative impact arising from the Proposal.

There are 1,273 Aboriginal sites listed on AHIS, but several hundred sites include more than one cultural feature. For example, there are 152 engraving sites listed on the AHIS but several of these sites also include artefact scatters and/or a water source. In addition to the 282 new sites recorded during the seven Leichhardt and WAC surveys, there are a total of 1,555 Aboriginal sites recorded in the Mardudhunera determination area. Aboriginal sites at the Proposal make up 18% of all recorded sites in the Mardudhunera determination area.

Implementation of the Proposal will cause impacts to 114 Aboriginal sites, with 84 of these sites being salvaged and 30 being impacted by water inundation. This represents a predicted cumulative impact of 7.3% of all Mardudhunera recorded sites. Eighty of these sites are artefact scatters, which is the most common site type at the Proposal (167) and the Mardudhunera determination area (1,096). Using these data, the cumulative impacts to artefact scatters in the determination area is 7%. For engraving sites, the cumulative impact is 1%. Cumulative impacts are calculated in Table 13-11.

**Table 13-11: Cumulative Impacts to Mardudhunera Cultural Heritage Sites**

| Cultural Features | No. of sites within Determination Area | No. within Proposal Survey Areas | Cumulative Impact Determination Area – impacted sites |
|---|---|---|---|
| Artefacts/Quarry Site | 1,096 | 188 | 80 (7.3%) |
| Engraving/Painting | 174 | 22 | 2 (1.1%) |
| Fish Traps/Man-Made Structures/Stone Arrangements | 23 | 11 | 2 (8.7%) |
| Grinding Patches | 205 | 80 | 29 (14.6%) |
| Mythological | 32 | 1 | 0 |
| Water | 25 | 2 | 1 (4%) |
| **Totals** | **1,555** | **304 (18%)** | **114 (7.3%)** |

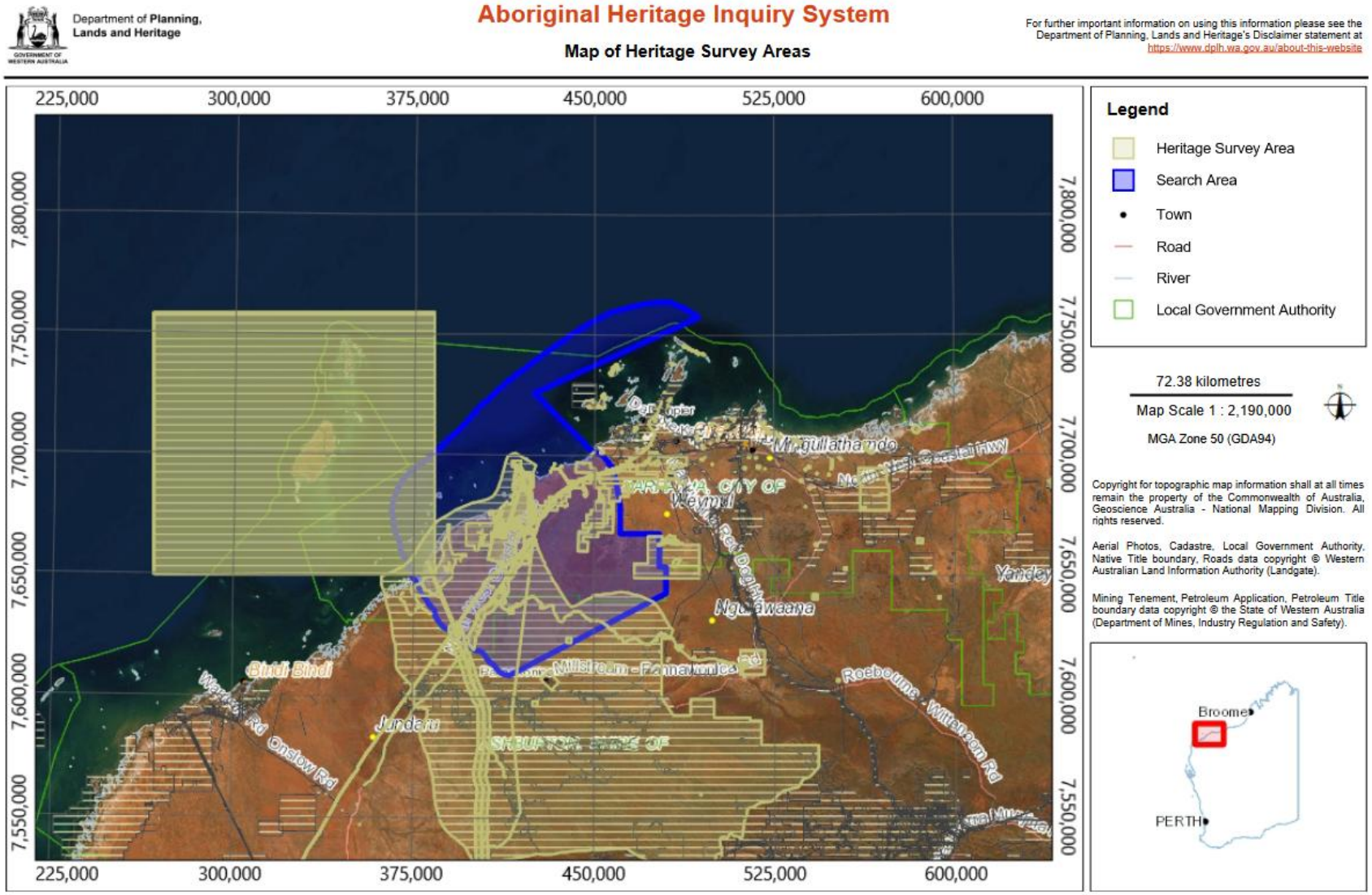



Figure 13-8: AHIS Aboriginal Heritage Surveys in the Mardudhunera Determination Area

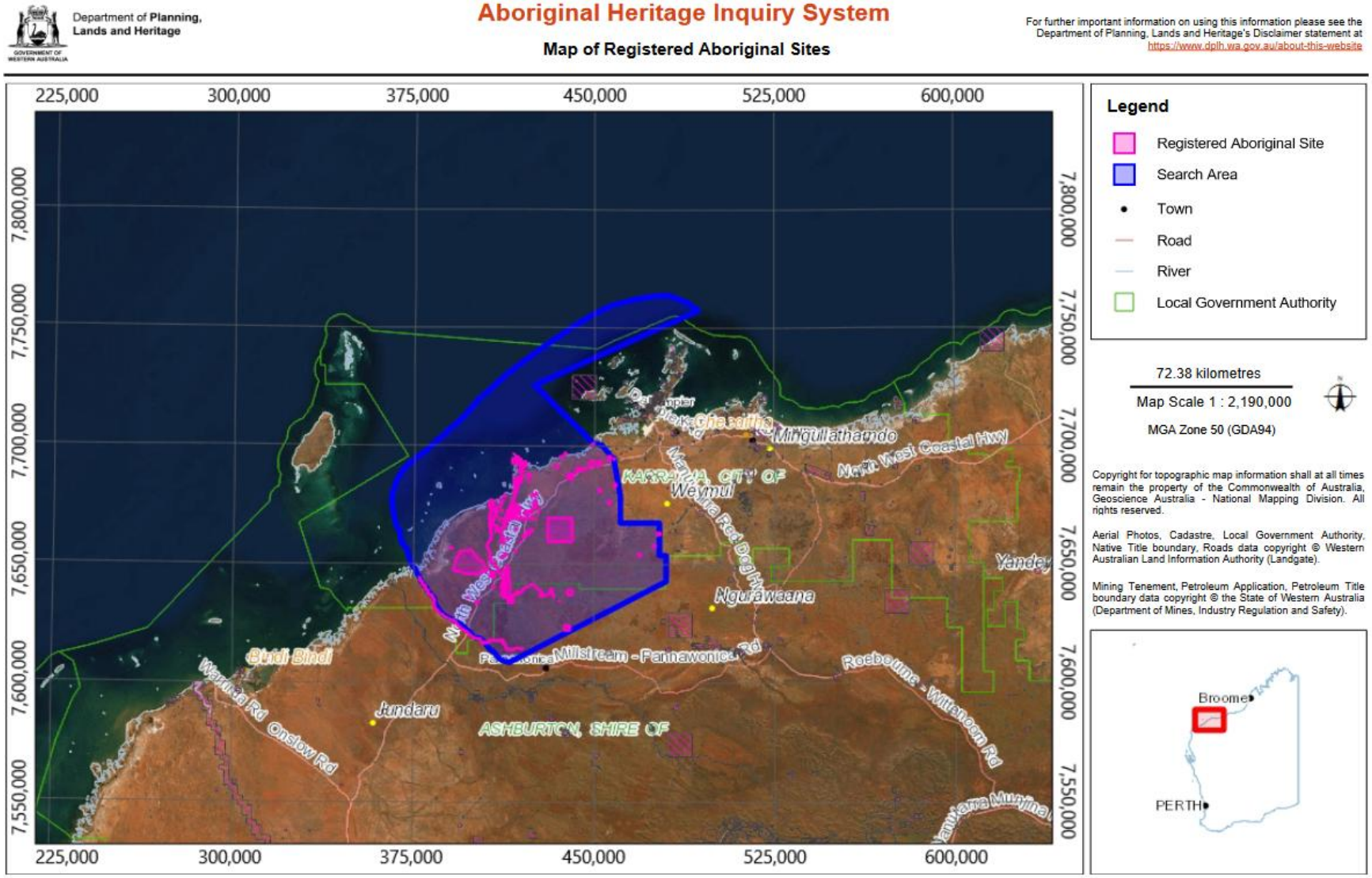



Figure 13-9: AHIS Registered Sites in the Mardudhunera Determination Area

***Hydrological Changes***

As described in Section 6, the Proposal will result in changes to groundwater and surface water flow regimes and quality. Mitigation measures are proposed to minimise groundwater impacts beyond areas immediately surrounding the pond walls, and these measures will also apply to any Aboriginal Heritage sites that may lie within the area of potential impact. Groundwater impacts to Aboriginal Heritage sites is therefore likely to be minimal provided mitigation measures are implemented.

Surface water flows are variable in the Pilbara region and the Proposal is not predicted to result in significant changes to flow regimes during common flood events (refer to Section 6).

***Summary***

The Proposal will result in unavoidable impacts to 114 Aboriginal Heritage sites, which includes 80 artefact sites, two engraving sites, two stone arrangements, 29 grinding patch sites and one freshwater soak. The impacts will occur during the clearing of land for pond walls or infrastructure, or when the ponds are flooded with seawater. Submerged sites cannot be meaningfully used by the Mardudhunera People and are therefore considered to be 'disturbed'.

Leichhardt and WAC have agreed that all of the artefact, engraving and stone arrangement sites will be relocated through cultural salvage by the Mardudhunera People to a Keeping Place prior to construction of the Proposal.

The 29 Grinding Patch sites and the one freshwater soak will be impacted by water inundation. Given the size of the grinding patch sites it is not possible to effectively salvage them. This has been agreed to by the Mardudhunera People.

Leichhardt continues to consult with the Mardudhunera People regarding these impacts, as well as the preservation and salvage of other sites, through the SCHMP. The SCHMP measures have been agreed to by the WAC Board on behalf of the Mardudhunera People and is awaiting endorsement by the wider WAC membership.

### 13.5.2 DEMARCATED RECREATIONAL AREAS

All five Demarcated Recreational Areas are excluded from the Proposal footprint and access to each place will be preserved. No direct impacts to any of these places will occur. WAC have confirmed that they support this approach.

During the workshops WAC raised concerns about potential visual impacts at 40-Mile Beach during both the construction and operational phases of the Proposal. Specific measures have been included in the SCHMP as well as setting back the Proposal footprint from 40-Mile Beach. The visual impact assessment presented to the WAC confirmed the visual impacts are limited because the infrastructure such as pond walls are no more than 4.5 m high. The impacts to the vista are minimal and WAC is comfortable with the proposed setback. As detailed in Section 13.5.4, other potential amenity impacts from dust, noise and light are unlikely to be significant.

Both Eramurra Creek and McKay Creek are important in Mardudhunera traditions. A consistent theme during the SCHMP consultation was the importance of maintaining the flow of water in the creeks. In response to this Leichhardt has amended its plans to remove the use of drainage barriers to manage the water flows in the creeks. No artificial barriers will be used to manage creek flows and the Proposal footprint has been set back from the creeks to ensure access to all areas of main channels of the creeks is maintained.

### 13.5.3 Land Used for Traditional Purposes

The assessment of potential impacts on land used for traditional purposes is closely linked to the assessment of impacts on mangrove communities (Section 8.5) and flora and vegetation (Section 11.5). Numerous bush tucker species were identified during the field visits and findings from previous ethnobotanical work. The Proposal will require disturbance to 11,401.1 ha of terrestrial vegetation. This vegetation generally represents widespread communities and is well presented at a regional level (Phoenix, 2025). Indirect impacts are not expected to be significant given the application of controls. The Proposal is therefore unlikely to significantly impact the surrounding area to the extent that it affects its utilisation for traditional purposes. The Proposal will require disturbance within savanna/grass plain vegetation and within bare areas and mudflats, however this disturbance is minimal in the context of the current extent of vegetation available in the area, with all vegetation associations currently having at least 84% of their pre-European extent remaining. The current extent of vegetation association '175: Short bunch grassland – savanna/grass plain (Pilbara) is 524,640.2 ha, 99.6% of its pre-European extent and the current extent of vegetation association '127: Bare areas, mudflats' is 697,871.4 ha, 94.6% of its pre-European extent. The Declared Pest and WoNS, *Prosopsis glandulose x velutina* was recorded within one quadrat and may subsequently decrease the land use values to the Traditional Owners.

The flora species list from the Phoenix (2025) flora and vegetation survey was assessed against the results of field visits and findings from previous ethnobotanical work, to obtain a view of the extent of bush tucker and medicine species across the development envelopes. Figure 13-5 shows the range of these records, noting some specific concentrations around creeklines and intertidal areas.

A total of 34 culturally significant flora species were recorded within the PIDE, and 28 of these occur within the indicative disturbance footprint. Six of the ten species considered to be of most importance occur within the indicative disturbance footprint:

- Garama (Kanji Bush; *Acacia pyrifolia*);
- Marruwa, Pukarti (*Acacia xiphophylla*);
- Warnanykura (*Eucalyptus victrix*);
- Jinngu/Pithangara (*Grevillea pyramidalis*);
- Minyjarra/Jami (*Stemodia grossa*); and
- Mirna (*Triodia epactia*).

It is unlikely that all species will be able to be avoided, given the widespread extent of many of them. However, Leichhardt is committed to minimising impacts to these species where practicable.

Further ethnobotanical surveys have been committed to in order to gain a better understanding of the extent and populations of bush tucker and medicine species, and inform further avoidance and minimisation measures, including maintaining access to the locations of these species where practicable. The results will also be used to inform rehabilitation.

Leichhardt continues to consult with the Mardudhunera People regarding these impacts, as well as the preservation and salvage of other bush tucker and medicine species, through the SCHMP. The SCHMP measures have been agreed to by the WAC Board on behalf of the Mardudhunera People and is awaiting endorsement by the wider WAC membership.

### 13.5.4 RECREATIONAL/COMMUNITY USE

Recreational use of the local marine environment and coastal area was assessed by Preston Consulting (2025). The wider marine environment and coastal area along 40-Mile Beach is used for recreational purposes such as four-wheel driving, camping, fishing, boating and exploration, however Gnoorea Point, a designated camping and boat loading location, was the area with the greatest recreational use.

During the visitor questionnaire survey in October 2022, Preston Consulting (2025) approached all campsites to participate in a questionnaire where visitors were provided with a series of real and computer-generated images featuring pre- and post-Proposal development conditions from different viewpoints around the Proposal. Additionally, general demographic and site visit details were collected including length of stay, number of visits, recreational activity participation and locations visited. The visitor survey was also made available online with campers able to scan a QR code which would take them to an online platform. The QR code was available at various locations at the camping ground. The online survey was available from 11 July 2023 and is still available.

During implementation of the in-person questionnaires, any questions and concerns raised by respondents were also recorded. Some of these concerns and queries are listed below:

- Distance of the ponds from the campsite, and safety with children. The distances were generally deemed to be acceptable once discussed (>500 m);
- Noise. Recent modelling results were discussed that predicted minimal detectable noise at the camping areas;
- Concerns about the environmental impacts from the Proposal;
- Fencing around the ponds;
- Fishing and potential bird life in the ponds;
- Similarity to the Dampier Salt Operations;
- The possibility of cooler conditions as a result of the ponds; and
- The possibility of large trucks and/or a large number of workers in the camping area as a result of the new workforce required for Proposal development.

During the online questionnaires, respondents were asked to provide any additional comments regarding the Proposal and how it might affect their experience. These concerns are summarised below:

- Difficult to distinguish the full extent of the Proposal and how it would impact campers;
- Disrupt vehicle and boating accessibility to creeks in the area via land and sea;
- Negative visual impacts;

- Queries of truck movements on the access road and maintenance;
- Impacts to tidal water via flooding;
- Safety of the levy banks near access road;
- Cultural significance of the area;
- Noise, lighting and operations impacting 'nature based' camping and nearby flora and fauna;
- Environmental impacts from the Proposal; and
- Preference to not develop the Proposal (i.e. leave natural, don't build another salt mine, etc.).

Respondents were also asked if there were any facilities that could be improved. Of the eight suggestions outlined in the questionnaires, four amenity improvements were identified to be particularly popular among respondents:

- Improved access to drinking water (eight responses);
- Improved toilet facilities (including sullage) (seven responses);
- Improved phone coverage (seven responses); and
- Informative signage (six responses).

The remaining four suggestions outlined in the questionnaires included access road upgrades and maintenance (five responses), more picnic tables and associated infrastructure (three responses), allocated campsites (one response), and improved rubbish collection (three responses).

Respondents were presented the option to include personal suggestions for improvements, which included:

- Retaining the 'natural' campsite aesthetic;
- Maintain and develop some secluded campsites; and
- Development of another camp site away from the Proposal if it was to go ahead.

Respondents were also asked if they had further comments regarding how their experience at Gnoorea campsite and 40-Mile Beach could be improved in the future (note: this was not included within the revised 2024 online questionnaire). Four comments were received:

- Improve the online campsite booking system;
- Don't build the ponds;
- Concerns over people not visiting due to Proposal becoming too big; and
- Already know what is going to happen, suggest no change.

***Loss of Recreational Areas***

The Proposal does not include the disturbance of any land within the coastal dune and beach system that includes Gnoorea Point, 40-Mile Beach and other coastal areas accessible from 40-Mile Beach Road. Disturbance will occur inland of these coastal areas.

Impacts to these areas were discussed with recreational users as part of the Preston Consulting (2025) survey. None of the survey participants stated that they conducted any recreational activities in the inland mudflat areas, however given the timing of this portion of the survey (early-October), only limited numbers of surveys were able to be completed.





The results should therefore be assumed to be only a 'snapshot' of the views of recreational users rather than a comprehensive assessment. The reconnaissance surveys did record four-wheel motorbike tracks within these inland mudflat areas, however only a limited number of tracks were evident.

The Proposal will remove a large portion of the areas available for four-wheel motorbiking, however some areas will remain and the region around Karratha contains many similar tidal mudflat areas, therefore it is likely that those riding the four-wheel motorbikes did not come to the Gnoorea Point/40-Mile Beach area for this activity alone.

***Access Restrictions***

The Proposal does not involve any temporary or permanent closures of 40-Mile Beach Road or any of the coastal camping and recreational areas at Gnoorea Point and 40-Mile Beach. As discussed above, there may be some access restrictions inland of these areas while construction is underway on the pond walls and other infrastructure. Once operational these access restrictions will generally be removed (apart from some key infrastructure).

The Proposal will not present any new permanent marine access restrictions that are not already planned or in place around the operating port areas at CPE and Cape Preston. There will be some short-term restrictions around the dredge vessels when dredging but this will be in a relatively small area and is unlikely to cause significant inconvenience to recreational vessels.

***Visual Amenity***

The ponds and embankments will be visible from various positions accessible to the public, including North West Coastal Highway, 40-Mile Beach Road, Gnoorea Point and other elevated locations around Gnoorea Point and 40-Mile Beach.

BG&E prepared a number of computer-generated visualisations to demonstrate what the inland view would be from a number of different locations. These visualisations are provided in Preston Consulting (2025), and the view from Gnoorea Point and the northern end of 40-Mile Beach Road is provided as examples in Figure 13-10 and Figure 13-11 respectively.




Figure 13-10: Predicted view of Proposal ponds from Gnoorea Point (View 1)

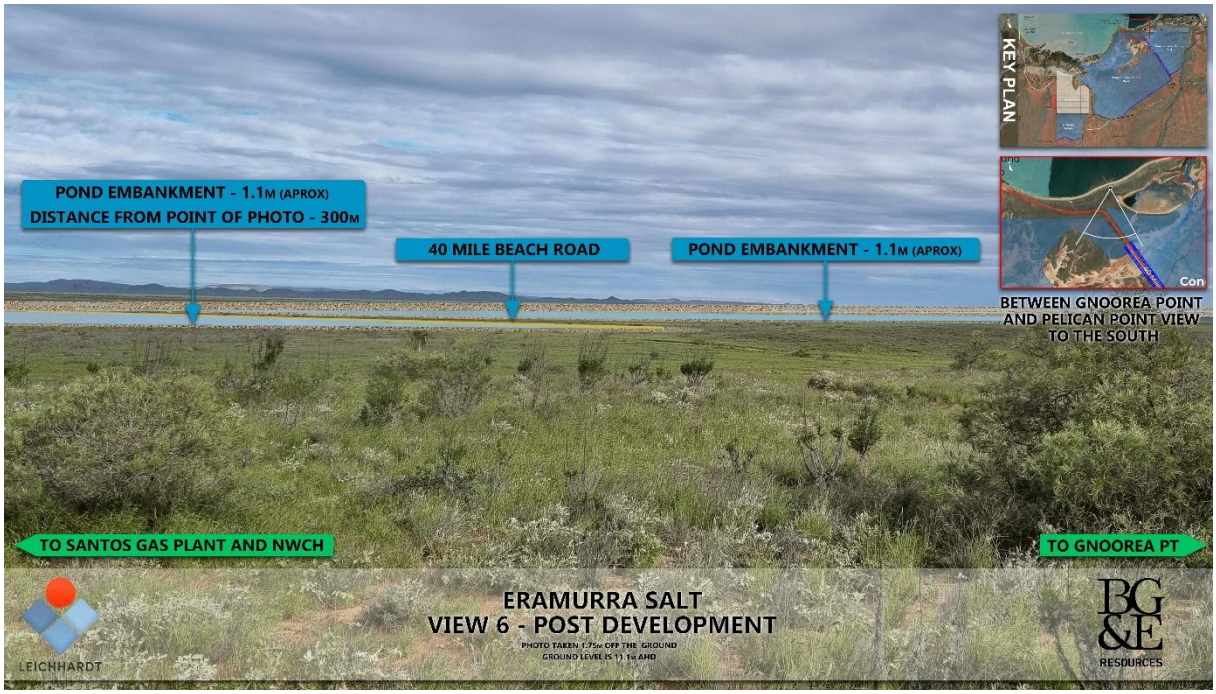



Figure 13-11: Predicted view of Proposal ponds from near the northern end of 40-Mile Beach Road (View 6)

Impacts to visual amenity was discussed with recreational users as part of the Preston Consulting (2025) survey, using images of the previous Proposal design, with ponds much closer to viewing areas. Respondents were asked to rate on a scale of one to five (scale listed in Table 13-12) how the view from post-development compares to pre-development. Five visualisations were presented, with the most common response being 'About the same' for both visual quality and experience-based questions (blue cells in Table 13-12).

Table 13-12: Visitor response to five viewpoints of the Proposal

| Response | View 1 (N=14) (N=25)* | View 2 (N=5) (N=16)* | View 5 (N=7) | View 6 (N=11) (N=21)* | View 8 (N=11) | View 9 (N=11) |
|---|---|---|---|---|---|---|
| **Visual Quality – "How would you say the post development view compares to current view?"** | | | | | | |
| Much worse (1) | 1 | 0 | 1 | 1 | 1 | 1 |
| Somewhat worse (2) | 2 | 3 | 0 | 2 | 1 | 2 |
| About the same (3) | 10 | 2 | 6 | 7 | 9 | 8 |
| Somewhat better (4) | 1 | 0 | 0 | 0 | 0 | 0 |
| Much better (5) | 0 | 0 | 0 | 1 | 0 | 0 |
| **Experience quality-- "How would the change in view change your experience?"** | | | | | | |
| Much worse (1) | 8 | 8 | 1 | 8 | 1 | 1 |
| Somewhat worse (2) | 4 | 3 | 1 | 2 | 0 | 1 |
| About the same (3) | 12 | 5 | 5 | 10 | 10 | 9 |
| Somewhat better (4) | 1 | 0 | 0 | 0 | 0 | 0 |
| Much better (5) | 0 | 0 | 0 | 1 | 0 | 0 |

**Applies to Experience Quality questions only – The revised online questionnaire did not include Visual Quality questions.*

Given the limited numbers of surveys that have been completed to-date the results should be assumed to be only a 'snapshot' of the views of recreational users rather than a comprehensive assessment. The survey results however showed that the majority of participants did not have major concerns about impacts to visual amenity, responding with "About the same" when comparing the visual quality and experience quality of the Proposal pre- and post-implementation.

### *Noise*

Leichhardt commissioned Herring Storer Acoustics (2022; Appendix 7.1) to carry out an acoustic study of noise emissions for the Proposal, using the previous Proposal design. Recreational users at the Gnoorea Point/40-Mile Beach areas were noted as being the nearest noise sensitive receptors.

The modelling determined that the noise sensitive receptors at the Gnoorea Point/40-Mile Beach areas were located 12 – 16 km from the processing plant, and 2.5 – 3.5 km from the nearest Proposal noise source (pumps), based off the previous larger Proposal design (i.e., results would be conservative). Given this distance, the Proposal was predicted to result in maximum noise levels at the Gnoorea Point/40-Mile Beach areas of only 22 dB(A), much lower than the assigned noise level of 35 dB(A) in the Environmental Protection (Noise) Regulations 1987. This noise level is defined as faint, or similar to the soft rustling of leaves, and quieter than a whisper at a 1 m distance. This means that noise from the Proposal is unlikely to be detectable above normal background noise on almost all occasions.

***Light***

The Proposal will not require permanent lighting in proximity to the recreational areas, with accommodation, workshop areas and processing areas all located several kilometres inland. Pendoley (2022) modelled the light impacts from the Proposal (previous larger design) in the context of the existing and approved (i.e., including CPE Port) light environment. The modelling determined that the Proposal would contribute to an increase in horizon brightness of less than 11% at each of the monitoring location. This level of light is not predicted to result in significant amenity issues for the recreational users of the Gnoorea Point/40-Mile Beach area.

***Dust***

The works in proximity to the Gnoorea Point/40-Mile Beach area will be limited to pond wall construction, which will be moving work fronts located more than 250 m from areas where the public would be present. The construction materials will generally be damp clay and any dust emissions are likely to be short-term and localised around the areas where material is being placed. If dust emissions are unexpectedly noted over extended distances during the construction of initial walls, then Leichhardt may undertake construction closer to the Gnoorea Point/40-Mile Beach area during non-peak periods to avoid impacts to recreational users.

## 13.6 MITIGATION

Leichhardt has mitigated the potential impacts to this factor according to the mitigation hierarchy; avoid, minimise, rehabilitate. The mitigation strategies and measures have been developed in consultation and with the agreement of WAC and contained in detail in the SCHMP. The SCHMP details the management measures for each of the 304 recorded Aboriginal sites.

### 13.6.1 AVOID

Leichhardt's primary objective is to avoid Aboriginal sites and other places of cultural significance. Leichhardt has carried out numerous cultural heritage surveys, on-country consultations with Mardudhunera People, and held numerous workshops to understand the places that the WAC would like preserved. This consultation has also involved re-designing the Proposal disturbance footprint to avoid key features relevant to this factor, including:

- 268 Aboriginal Heritage sites, including 20 engraving places, Devils Pool, and seven fish traps;
- Five Demarcated Recreational and Cultural areas including setting back the Proposal from 40-Mile Beach; and
- The majority of the coastal zone.

Figure 13-3 shows areas that have been removed from the disturbance footprint. These areas will continue to be accessible via 40-Mile Beach Road and the proposed access road.

To reduce the risk of inadvertent incursions into these areas Leichhardt and WAC has agreed to the following management measures:

- GPS recording of heritage values and establishment of a GIS database;
- Physical demarcation of sites will be implemented where WAC considers it necessary;
- Information on sites of cultural significance is provided as part of the site induction; and

- Approval must be obtained from the General Manager Operations prior to any land clearing taking place.

### 13.6.2 MINIMISE

The following mitigation measures are proposed to ensure that direct and indirect impacts to social surroundings are minimised:

1. **Finalise and implement the SCHMP that has been co-developed with WAC.** The SCHMP includes best-practice management measures for Aboriginal Heritage:
    a. Establish Implementation Committee of WAC and Leichhardt representatives to oversee the Proposal construction and operations to ensure the management measures are effective;
    b. Complete targeted ethnobotanical surveys of remaining areas of land with Mardudhunera People;
    c. Monitor potential impacts caused by noise, dust and vibration and consult with WAC to define suitable trigger levels for further investigation and actions at key locations during the construction phase if required;
    d. Vegetation clearing will be managed through internal ground disturbance procedures;
    e. Boundaries of areas to be cleared or disturbed will be identified by GPS coordinates and maps of boundaries will be provided to dozer operator;
    f. Erect signage at cultural heritage areas identified by WAC;
    g. Monitor impact of construction activities twice per year and report to the Implementation Committee;
    h. Cultural awareness training will be included in site inductions, to ensure all personnel are made aware of their obligations in the SCHMP and under the ACH Act;
    i. In consultation with Mardudhunera People, carry out water monitoring regime at Noorea Soak, Devil Creek, McKay Creek and Eramurra Creek to ensure water quality and levels are not compromised;
    j. If human remains, skeletal materials that may be human or materials that may be a human grave are uncovered, then Leichhardt and its contractors will stop work immediately and the materials and the area will be left undisturbed. The Mardudhunera People will be informed immediately and managed in accordance with Aboriginal custom; and
    k. Carry out periodic formal evaluation and review of the SCHMP.
2. **Ensure the 84 Aboriginal cultural material sites are properly recorded, documented, and appropriately salvaged and relocated to the Keeping Place prior to disturbance;**
3. **Minimise clearing and access restrictions within areas used for traditional purposes;**
4. **Maintain or improve Traditional Owners' access to land for traditional uses;**
5. **Undertake additional community surveys of recreational users of the 40-Mile Campground throughout the 2025 peak season.** The additional survey information will be used to plan and implement measures designed to minimise impacts on recreational uses of the area;

6. **Implement a complaint/incident register that allows recreational users to notify Leichhardt of any amenity concerns that may arise during the implementation of the Proposal;**
7. **Liaise with the City of Karratha regarding ongoing support for the management of Gnoorea Point/40-Mile Beach areas and the potential for Traditional Owner collaboration;**
8. **Ensure Proposal vehicles and workforce personnel do not access the Gnoorea Point/40-Mile Beach areas during work shifts;**
9. **Minimise Proposal-related traffic on 40-Mile Beach Road;**
10. **Implement low-noise equipment to minimise noise emissions;** and
11. **Minimise light sources in proximity to recreational areas.**

### 13.6.3 REHABILITATE

Leichhardt acknowledge the important role that the Traditional Owners have to play in rehabilitation from designing final landforms that reflect cultural values and participating in the physical rehabilitation of the land generating economic opportunities through contracting.

At the completion of the Proposal the site will be rehabilitated to allow and encourage the natural establishment of vegetation and traditional values. This establishment may take some time in areas where the soils have been saturated by saline water, such as beneath the ponds. An Interim MCP has been prepared and is provided as Appendix 1.8. The MCP will be required under the Mining Act and the key rehabilitation measures that relate to social surroundings are summarised below:

1. Salts will be harvested from each crystalliser pond prior to closure;
2. Leichhardt will examine inundated demarcation sites and remediate to the satisfaction of the Mardudhunera People;
3. Concentration pond walls will be flattened or opened up to allow tidal flows to enter the ponds;
4. All infrastructure will be removed if not retained by Mardie Station, City of Karratha or PPA; and
5. All crystallisers will be rehabilitated to an acceptable landform.

Mardudhunera People will be included as a key MCP stakeholder. The MCP will be submitted to DEMIRS for assessment and approval prior to the construction of the Proposal and will be reviewed and revised every three years.

## 13.7 PREDICTED OUTCOME

The EPA's environmental objective for this factor is to "protect social surroundings from significant harm" (EPA, 2023b).

Leichhardt's approach has been to collect thorough and robust Aboriginal cultural information about the Proposal Survey Areas through heritage surveys and consultation with WAC. The feedback provided by the Mardudhunera People has been carefully considered and used when designing the Proposal, to avoid causing impacts to places of high cultural value.

The revisions to the original disturbance footprint will result in the preservation of more than 160 Aboriginal sites of significance and will ensure that the five areas (Figure 13-9) where Mardudhunera People continue to recreate and practice culture are not directly impacted. However, the development of the Proposal will directly impact 114 sites. The impacts will occur during the clearing of land for pond walls or infrastructure, or when the ponds are flooded with seawater. Submerged sites cannot be meaningfully used by the Mardudhunera People and are therefore considered to be 'disturbed'. Leichhardt will salvage 84 sites however 29 Grinding Patch sites and the one freshwater soak will be impacted by water inundation and given the size of the grinding patch sites it is not possible to effectively salvage them. This has been agreed to by the Mardudhunera People.

Leichhardt continues to consult with the Mardudhunera People regarding these impacts, as well as the preservation and salvage of other sites, through the SCHMP. The SCHMP measures have been agreed to by the WAC Board on behalf of the Mardudhunera People and is awaiting endorsement by the wider WAC membership.

The Proposal disturbance footprint will continue to be co-designed by Leichhardt and WAC. The SCHMP and Land Access Agreement between Leichhardt and WAC provides the ongoing legal management framework to ensure places that are important to the Native Title holders continue to be preserved and are accessible.

The Proposal avoids the majority of the coastal zone and creeklines, which were considered to be a traditional food source for Traditional Owners. Terrestrial vegetation will not be significantly impacted in a regional context. Leichhardt has also committed to maintaining access to land for the Mardudhunera People, and minimising disturbance within the areas noted to be used for traditional purposes. As a result of the above, the Proposal is not expected to significantly impact the traditional uses of the land.

The Proposal will have unavoidable access and visual amenity impacts on the recreational users of the Gnoorea Point/40-Mile Beach area. These impacts are unlikely to be significant based on the evidence and survey data gathered to-date, with very limited usage of the pond areas being recorded, and general neutral feedback about visual impacts. It is acknowledged however that the survey questionnaires present a 'snapshot' only. The online survey will remain open to allow Leichhardt to plan and implement measures designed to further minimise impacts on recreational uses of the area.

The outcomes for this factor are therefore predicted to be:

- The preservation of more than 160 Aboriginal sites of significance;
- No direct impacts to the five areas (Figure 13-9) where Mardudhunera People continue to recreate and practice culture;
- The SCHMP will provide the ongoing legal management framework to ensure places that are important to the Native Title holders continue to be preserved and are accessible;
- No impact to the accessibility of camping areas at Gnoorea Point; and
- Negligible amenity impacts to the campers and recreational users of Gnoorea Point and surrounds.

Based on the above the Proposal is expected to meet the EPA's objective for this factor. The implementation of the proposed mitigation is expected to ensure that there are no significant residual impacts to social surroundings.

# 14 OTHER ENVIRONMENTAL FACTORS

Leichhardt has reviewed the impact of the Proposal and determined that it is unlikely to significantly impact on the following Key Environmental Factors:

- Coastal Processes;
- Landforms;
- Subterranean Fauna;
- Air Quality;
- Greenhouse Gas (GHG) Emissions; and
- Human Health.

Justification for this determination is provided below. The assessment of the Proposal's impacts on the Coastal Processes factor was determined to require more detailed justification which is provided in Table 14-1.

**Landforms:** The Proposal does not contain any significant landforms and therefore the Landforms factor is not considered relevant to the Proposal.

**Subterranean Fauna**: No significant excavations or groundwater abstraction are part of the Proposal. Impacts to subterranean fauna habitat are therefore likely to be limited to saturation of troglofauna habitat or changes to the salinity of stygofauna habitat as a result of seepage and mounding from ponds.

A desktop assessment was undertaken by Bennelongia Pty Ltd to assess whether prospective habitat for subterranean fauna is likely to occur in and around the Proposal (Bennelongia, 2022, Appendix 7.3). The desktop assessment returned 157 species of subterranean fauna in the search area, including 119 species of stygofauna and 38 species of troglofauna. There are no records of troglofauna occurring inside the PIDE, however there are 11 records of stygofauna species. These species present linear distributions that extend beyond the Proposal.

Based on local and regional geological and hydrogeological profiles, the Proposal and surroundings may contain prospective habitat for stygofauna, particularly in the extensive alluvial plain. The desktop review however shows that the geologies in the PIDE that are prospective for subterranean fauna also extend to the surrounding areas, and no restricted subterranean fauna species have been previously recorded within the PIDE.

Unsaturated subterranean spaces are likely to be limited except possibly in areas where depth to water table is greatest. As a result, if present, any troglofauna community that may occur in the PIDE is likely to be very depauperate.

Based on the above, the potential impacts resulting from the Proposal are unlikely to have a significant impact on the likely survival of local subterranean fauna communities.

**Air Quality**: During the construction phase there will be large-scale civil earthworks within the disturbance areas. This will require suitable dust control via moisture addition and other surface treatments.

Dust will be minimal in the project operation phase due to limited machine movement and wet process conditions. Any emissions are to occur into an airshed that is currently influenced by large emission sources at the Sino Iron Project and the Proposal is unlikely to result in any significant changes to air quality impacts at any sensitive receptors. As a result, this factor is unlikely to be a Key Environmental Factor for the Proposal.

**Greenhouse Gas Emissions:** Elemental Consulting Services Pty Ltd (ECS) was commissioned by Leichhardt to estimate the operational GHG emissions from the Proposal (ECS, 2024; Appendix 7.2). The anticipated worse-case annual steady-state GHG emissions from activities subject to the Proposal are estimated at 29,000 $tCO_2e$ per year, based on a combination of electricity and diesel power generation. The GHG emissions intensity for the Proposal compares favourably with other salt projects operating or soon to be under construction in WA and is about one-third that of one of the world's largest international salt producers. Industrial salt is produced from either the underground mining of rock salt deposits or the vacuum or solar evaporation of seawater or naturally occurring underground brine deposits. Of these methods, the solar evaporation of seawater is likely to be the most sustainable and least emissions intensive method.

Based on the limited data available, the Proposal's anticipated GHG emissions intensity sits mid-way between the established Dampier Salt operations and the estimates for the Mardie Project (ECS, 2024).

There are increasing expectations that projects will recognise the undesirability of GHG emissions) and will adopt directions which limit GHG in the short term and identify reductions for future years as targets become tighter and improved technologies arise. Leichhardt plan to achieve a net zero-carbon footprint in the future.

The most probable path to further reduce Proposal GHG emissions is increased renewables generation, most likely from installing wind turbines, and/or increased battery/solar capacity. The use of a conveyor for product movement from the wash plant to port is one clear option for a step down in diesel usage. This change would most logically combine with powering the entire Port area from the Proposal's hybrid power generation which may well be above 30% renewable at that stage.

**Human Health**: The Proposal does not pose any foreseeable risks to Human Health.

Table 14-1: Assessment of Coastal Processes factor

| Coastal Processes | |
|---|---|
| **EPA Objective** | To maintain the geophysical processes that shape coastal morphology so that the environmental values of the coast are protected. |
| **Policy and Guidance** | Relevant EPA and Commonwealth Government guidance documents for coastal processes are listed below:<br>**Western Australian Government**<br>**Key EPA Documents**<br>• EIA (Part IV Divisions 1 and 2) Procedures Manual (EPA, 2021a);<br>• Statement of Environmental Principles, Factors, Objectives and Aims of EIA (EPA, 2023a);<br>• EIA (Part IV Divisions 1 and 2) Administrative Procedures 2021 (EPA, 2021d); and<br>• Instructions on how to prepare EP Act Part IV Environmental Management Plans (EPA, 2021e).<br>**Relevant EPA Factor Guidelines**<br>• Environmental Factor Guideline – Coastal Processes (EPA, 2016l).<br>**Relevant EPA Technical Guidance**<br>• Technical Guidance – Protection of BCH (EPA, 2016b).<br>**Other Policy and Guidance**<br>• WA Environmental Offsets Policy (EPA, 2011);<br>• WA Environmental Offsets Guidelines (EPA, 2014a); and<br>• WA Offsets Template (EPA, 2014b).<br>**Commonwealth Government**<br>**Key Documents**<br>• Generic guidelines for the content of a draft EPBC Act PER/EIS (including the objects and principles of the EPBC Act, 1999) (DotEE, 2016);<br>• Other Minister of the Environment (Cth) approval decision making considerations;<br>• Environmental Management Plan Guidelines (DotE, 2014);<br>• EPBC Act Condition-Setting Policy (DAWE, 2020);<br>• EPBC Act Outcomes-based conditions policy (DotE, 2016a); and<br>• EPBC Act Environmental Offsets Policy (DSEWPaC, 2012a) – including the Offset Assessment guide.<br>**Relevant Technical Guidance**<br>• Relevant EPBC listed species specific survey guidelines and protocols;<br>• Relevant EPBC listed species specific Recovery plans, Threat Abatement Plans, Approved Conservation Advices and other documents;<br>• Marine bioregional plan for the North-west Marine Region (DSEWPaC, 2012b); and<br>• Environmental best practice port development: an analysis of international approaches (GHD, 2013a). |
| **Potential Impacts** | **Presence of infrastructure within the coastal and intertidal zone, potentially resulting in:**<br>• Changes to tidal flows and sedimentation;<br>• Impacts to surface sedimentary processes that maintain the tidal creek environment; and<br>• Changed flows and sediment transport and therefore an increased risk of erosion. |
| **Mitigation** | Leichhardt has mitigated the potential impacts to this factor according to the mitigation hierarchy: avoid, minimise, rehabilitate, offset. Offsets are not expected to be required for this factor. Mitigations associated with BCH and Marine Fauna have been described in Section 8.6 and 9.6, respectively.<br>**Avoid**<br>The key avoidance mechanism implemented by Leichhardt was the iterative design of the development envelopes to avoid key coastal processes features such as sandy beaches and tidal creek mouths. Of relevance to this factor is that the design avoids almost all disturbance on the coastal fringe, maintaining the nearshore processes.<br>**Minimise** |

| | |
|---|---|
| | The following mitigation measures are proposed to ensure that direct and indirect impacts to coastal processes are minimised:<br>1. **Obtain and comply with the following approvals:**<br>a. Works Approval and Licence to be issued under Part V of the EP Act for solar salt manufacturing;<br>b. MP to be approved under the Mining Act for activities on Mining Act tenure;<br>c. MCP to be approved under the Mining Act for activities on Mining Act tenure. The MCP will describe the rehabilitation and closure of the Proposal, and associated management and monitoring proposed during the closure phase; and<br>d. Development Application to be approved under the *Port Authorities Act 1999* (WA) for activities within PPA-managed lands and waters.<br>2. **The Proposal Content description (Section 2.2.3) contain several criteria that were included to minimise impacts to coastal processes.** These include:<br>a. Positioning of the seawater intake to minimise environmental impacts such as erosion and scour;<br>b. Abstraction of seawater from the designated tidal creek only when tides are at or above 0.0 m AHD (to ensure that sufficient water volumes are available in the creek to minimise abstraction impacts); and<br>c. Pumps are sized to satisfy the demand associated with peak monthly evaporation.<br>3. **Excavate the seawater intake tidal creek if sediment build-up is identified during operations**; and<br>4. **Monitor erosion at the outlets of the surface water corridors after each significant flow event.** If erosion is noted then install additional erosion controls to minimise further erosion.<br>**Rehabilitate**<br>At the completion of the Proposal the site will be rehabilitated to reinstate tidal and inland water regimes. All marine infrastructure above the seabed including the seawater intakes and bitterns outlets will be removed and taken offsite. The remaining infrastructure will be closed in accordance with a MCP approved under the Mining Act. The MCP will be submitted to DEMIRS for assessment and approval prior to the construction of the Proposal and will be reviewed and revised every three years.<br>The key rehabilitation measures that relate to inland waters are summarised below:<br>1. Salts will be harvested from each pond prior to closure;<br>2. Concentration pond walls will be flattened or opened up to allow tidal flows to enter the ponds;<br>3. All infrastructure will be removed if not retained by Mardie Station or PPA; and<br>4. All crystallisers will be rehabilitated to an acceptable landform. |
| **Outcomes** | The Proposal includes marine/coastal infrastructure such as the seawater intakes, diffusers and ponds which have the potential to cause alterations to coastal processes. Beaches and other coastal habitat types in the CPE area are known to support nesting, interesting and foraging behaviours of marine turtles, and provide habitat for other significant fauna taxa including dugongs, cetaceans and migratory shore and seabirds. These habitats may be impacted by this Proposal through the alteration of coastal processes during construction and operation of marine/coastal infrastructure. Impacts associated with BCH and marine fauna have been addressed in Section 8.5 and Section 9.5, respectively.<br>Leichhardt commissioned a report to complete a coastal processes assessment in the context of the Proposal (Larcombe et al.(2025; Appendix 1.3)). The text below summarises the outcomes of that assessment.<br>It should be noted that the key findings and conclusions in this report are accompanied by levels of confidence, the definitions of which can be found in Section 8.5.1 of Appendix 1.3.<br>*The past and present*<br>• There have been a very large variety of coastal geomorphic changes and there is a high confidence that BCH are well adapted to their dynamic environments; and<br>• There is a degree of stability in the coastal geomorphic configurations in these locations because there is a moderate confidence that active breaching of the Gnoorea spit or barrier in front of the western Proposal region is unlikely.<br>*The future- SLR over the next century*<br>• Regarding SLR over the next century, there are two possible conclusions reached, each with different implications for the natural change that might occur over the next century, |

and the changes with the Proposal development in place. Further information is required to rule out one of the options. The options include:

- Conclusion 1: Over the past 6,000 years, the shoreline has prograded 2-3 km in the estuary. The changes in natural processes and the extent of habitats over the next century are highly variable along the Proposal's shoreline. If the conclusion is true, there is high confidence that the changes made to the coastal environment will not be of regional significance and there would be minimal change to coastal function. In the Proposal's context, there is moderate confidence that any possible changes to natural processes and habitats are only locally significant and temporary, indicating the coastline has a degree of resilience to any changes caused by this Proposal;
- Conclusion 2: The shoreline is dated at approximately 120,000 years. The changes in natural processes and the extent of habitats over the next century are highly variable along the Proposal's shoreline. There may be some severe drowning of large areas of the coastal environment and some lesser drowning of high tidal area. If this conclusion is true, there is moderate confidence that the changes made to the coastal environment will not be of regional significance and there would be minimal change to coastal function. In the Proposal's context, there is high confidence that any possible changes to natural processes and habitat are locally significant and could be permanent, indicating the coastline has poor resilience against any changes caused by this Proposal;

- There is high confidence that over the next 10-30 years, projected SLR and corresponding changes to shore sediment transport will involve increased beach scraping and the reduction of potential length of beach optimal for turtle nesting.

*Influences of the Proposal development*

- There is moderate confidence that any possible changes to natural processes and habitats are only locally significant and temporary, indicating the coastline has a degree of resilience to any changes caused by this Proposal;
- There is high confidence that any possible changes to natural processes and habitat are locally significant and could be permanent, indicating the coastline has poor resilience against any changes caused by this Proposal;
- There is high confidence that coastal erosion will likely be influenced by major river floods and tropical cyclones, however these impacts will be substantially unaffected by the ponds;
- The influence of episodic events may be especially significant to the nascent mangroves along the eastern Proposal region (high confidence);
- There is a high confidence that while episodic events will influence coastal erosion, the likely influence on the habitats of the ponds will not be greatly affected over the next century;
- Regarding habitats for green sawfish and sympatric species, there is high confidence that SLR will not have any significant natural changes in the availability of habitat;
- There is moderate confidence that over the next century, some potential turtle foraging habitat at the east of McKay Creek may be reduced in area as a result of the Proposal ponds;
- Over the future century, the effects of the ponds on for the McKay Creek system are:
  - Negligible-low upon mangroves (moderate confidence);
  - Large on samphire (low to moderate confidence); and
  - Greatest on algal mats (low confidence).
- Over the future century, the effects of the ponds on for the nascent mangrove system are:
  - Moderate on the mangroves (moderate to high confidence);
  - Very large on samphire (moderate to high confidence); and
  - Greatest on algal mats (high confidence).
- Over the future century, the effects of the ponds on for the combined systems of 40-Mile Road East, and Creeks 7 and 8 are:
  - Moderate on the mangroves (low to moderate confidence);
  - Very large on samphire (moderate to high confidence); and
  - Very large on algal mats (moderate confidence).

# 15 OFFSETS

Environmental offsets are actions that provide environmental benefits which counterbalance the significant residual impacts of a proposal. The EPA may apply environmental offsets where it determines that the residual impacts of a proposal are significant, after avoidance, minimisation and rehabilitation have been pursued. Consistent with the WA Environmental Offsets Guidelines (EPA, 2014a), the EPA will consider whether offsets can counterbalance, and are appropriate for, the Proposal's residual impacts.

Offsets are the last of the four steps in the mitigation hierarchy (Avoid, Minimise, Rehabilitate and Offset). They are only applied to counterbalance residual significant impacts when the other steps have already been applied to a Proposal.

Leichhardt has commissioned numerous environmental surveys and studies for the Proposal. The surveys determined that there were key environmental values that required protection including, significant BCH, marine and terrestrial fauna habitat, flora and vegetation, and areas of Aboriginal cultural value. Changes to the Proposal design have been made to avoid and minimise significant impacts to the key environmental factors during Proposal construction and operations.

## 15.1 SUMMARY OF SIGNIFICANT RESIDUAL IMPACTS

The WA Environmental Offsets Guidelines (EPA, 2014a) states:

> "*In general, significant residual impacts include those that affect rare and endangered plants and animals (such as declared rare flora and threatened species that are protected by statute), areas within the formal conservation reserve system, important environmental systems and species that are protected under international agreements (such as Ramsar listed wetlands) and areas that are already defined as being critically impacted in a cumulative context. Impacts may also be significant if, for example, they could cause plants or animals to become rare or endangered, or they affect vegetation which provides important ecological functions*".

The assessments conducted in Sections 6 –13 have utilised the findings of the numerous surveys and studies completed for the Proposal. Leichhardt has assessed the residual impacts of the Proposal against the residual impact significance model provided in the WA Environmental Offsets Guidelines (EPA, 2014a). As described in the preceding sections of this ERD, the Proposal's predicted significant residual impacts on the environmental values are summarised in Table 15-1 and the MNES listed in Table 15-2. There is also some uncertainty regarding the likelihood of some potential indirect impacts associated with sea level rise, groundwater seepage / mounding and altered hydrology. These impacts could be considered significant residual impacts if predicted worst-case scenarios occur.

Table 15-1: Summary of significant residual impacts – Part IV EP Act Environmental Values

| Environmental value | Other associated values | Residual Impacts |
|---|---|---|
| 'Good' to 'Excellent' condition native vegetation | Horseflat PEC, Pilbara Olive Python, Pilbara Leaf-nosed Bat, Ghost Bat and Grey Falcon | Clearing of up to 11,287.7 ha of good to excellent condition native vegetation, including:<br>• 7,614.1 ha (3.9% of regional extent) of the Horseflat PEC;<br>• 20.8 ha of potential foraging habitat for Pilbara Olive Python;<br>• 10,950.3 ha of broad foraging habitat for the Pilbara Leaf-nosed Bat and Ghost Bat; and<br>• 1,954.4 ha of broad foraging habitat for the Grey Falcon.<br>Potential indirect impacts to up to 181.1 ha of good to excellent vegetation as a result of groundwater mounding and seepage, including up to:<br>• 20.3 ha of Horseflat PEC;<br>• 1.2 ha of potential foraging habitat for the Pilbara Olive Python;<br>• 150.9 ha of broad foraging habitat for the Pilbara Leaf-nosed Bat and Ghost Bat; and<br>• 151.0 ha of broad foraging habitat for the Grey Falcon.<br>Potential indirect impacts to up to 27.0 ha of good to excellent vegetation as a result of a reduction in surface water inundation, including:<br>• 6.9 ha of Horseflat PEC;<br>• 0.4 ha of potential foraging habitat for the Pilbara Olive Python;<br>• 16.9 ha of broad foraging habitat for the Pilbara Leaf-nosed Bat and Ghost Bat; and<br>• 17.0 ha of broad foraging habitat for the Grey Falcon<br>Up to 20.3 ha of the groundwater and surface water indirect impacts described above, overlap. |
| Intertidal BCH, in particular mangroves, algal mats, and samphire shrubland | Migratory shorebirds (all listed BCH), marine turtles, green sawfish, North-Western Free-tailed Bat (mangroves) | Loss of up to:<br>• 87.3 ha of HDAM;<br>• 480.7 ha of samphire shrubland BCH; and<br>• 8.3 ha of mangroves.<br>Potential indirect impacts that are uncertain and subject to monitoring, described below.<br>Potential indirect impacts as a result of groundwater mounding and seepage, up to:<br>• 12.0 ha of HDAM;<br>• 15.5 ha of samphire shrublands; and<br>• 1.8 ha of mangroves.<br>Potential indirect impacts as a result of a reduction in surface water inundation, including up to:<br>• 2.9 ha of HDAM;<br>• 8.0 ha of samphire shrublands; and<br>• 2.4 ha of mangroves<br>Potential for a reduction in available habitat for BCH migration due to sea level rise. |

Table 15-2: Summary of significant residual impacts – MNES

| Relevant MNES | Residual Impacts |
|---|---|
| **Listed threatened species and communities (Sections 18 & 18A)** | |
| Migratory Shorebirds | Clearing of foraging habitat including:<br>• Up to 87.3 ha of HDAM;<br>• Up to 480.7 ha of samphire shrubland BCH; and<br>• Up to 8.3 ha of mangroves.<br>Potential indirect impacts as a result of groundwater mounding and seepage, up to:<br>• 12.0 ha of HDAM;<br>• 15.5 ha of samphire shrublands; and<br>• 1.8 ha of mangroves.<br>Potential indirect impacts as a result of a reduction in surface water inundation, including up to:<br>• 2.9 ha of HDAM;<br>• 8.0 ha of samphire shrublands; and<br>• 2.4 ha of mangroves |
| Pilbara Olive Python (*Liasus olivaceaus barroni*) | Clearing of up to 20.8 ha of potential foraging habitat.<br>There will be an additional 0.2 ha and 1.0 ha of potential foraging habitat at risk of indirect impacts associated with groundwater mounding and seepage and reduced surface water inundation respectively. |
| Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) and Ghost Bat (*Macroderma gigas*) | Clearing of up to 10,950.3 ha of broad foraging habitat.<br>There will be an additional 150.9 ha and 16.9 ha of broad foraging habitat at risk of indirect impacts associated with groundwater mounding and seepage and change to surface water inundation respectively. |
| Grey Falcon (*Falco hypoleucos*) | Clearing of up to 1,954.4 ha of broad foraging habitat.<br>There will be an additional 151.0 ha and 17.0 ha of broad foraging habitat at risk of indirect impacts associated with groundwater mounding and seepage and change to surface water inundation respectively. |
| **Listed migratory species (Sections 20 & 20A)** | |
| Migratory Shorebirds | Clearing of foraging habitat including:<br>• Up to 87.3 ha of HDAM;<br>• Up to 480.7 ha of samphire shrubland BCH; and<br>• Up to 8.3 ha of mangroves<br>Potential indirect impacts as a result of groundwater mounding and seepage, up to:<br>• 12.0 ha of HDAM;<br>• 15.5 ha of samphire shrublands; and<br>• 1.8 ha of mangroves.<br>Potential indirect impacts as a result of a reduction in surface water inundation, including up to:<br>• 2.9 ha of HDAM;<br>• 8.0 ha of samphire shrublands; and<br>• 2.4 ha of mangroves |

Leichhardt has assessed the residual impacts of the Proposal against the residual impact significance model provided in the WA Environmental Offsets Guidelines (EPA, 2014a). The findings of this assessment are provided in Table 15-3.

Table 15-3: Assessment against residual impact significance model

| **Part IV Environmental Factors** | Vegetation and Flora | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | Benthic Habitat and Communities | | |
| | | | | Terrestrial Fauna | | | |
| **Part V Clearing Principles** | **C--** Rare flora | **D--** TECs | **E--** Remnant vegetation | **F--** Wetlands and waterways | **H--** Conservation areas | **A--** High biological diversity | **B--** Habitat for fauna |
| **Residual impact that is environmentally unacceptable and cannot be offset** | No residual impacts are considered to meet this criterion | | | | | | |
| **Significant residual impacts that will require an offset** – *all significant residual impacts to species and ecosystems are protected by statute or where the cumulative impact is already at a critical level* | No residual impacts are considered to meet this criterion:<br>• No Threatened Flora records are located within the development envelopes;<br>• No significant Priority Flora impacts;<br>• Undescribed flora species are proposed to be mitigated such that they are not considered significant; and<br>• No significant residual impacts to novel species or species with significant range extensions. | No TECS recorded within the development envelopes.<br>Residual impacts to Horseflat PEC are likely to meet this criterion. Up to 7,614.1 ha of disturbance (3.9% of regional extent). | Residual impacts to vegetation in 'good' to 'excellent' condition are likely to meet this criterion: Up to 11,287.7 ha of good to excellent condition native vegetation, including potential habitat for significant flora and fauna. | No residual impacts are considered to meet this criterion as no wetlands or waterways that are protected by statute lie within the development envelopes. | Some significant residual impacts to mangroves within the RSMA. The Proposal will result in up to 8.3 ha of mangroves within this area. | Some significant residual impacts to mangroves which are considered areas of high biological diversity. The Proposal will result in the loss of up to 8.3 ha of mangroves. | Some significant residual impacts to migratory bird species. Up to 576.3 ha of disturbance is to migratory shorebird habitat is predicted which includes:<br>• Mangroves;<br>• Samphire shrublands; and<br>• HDAM.<br>Some significant residual impacts associated with terrestrial fauna habitat including:<br>• Up to 20.8 ha of disturbance to potential foraging habitat for Pilbara Olive Python<br>• Up to 8.3 ha of disturbance to critical habitat for North-Western Free-tailed Bat;<br>• Up to 10,950.3 ha of disturbance to potential foraging habitat for the Ghost Bat and Pilbara Leaf-nosed Bat; and<br>• 1,954.4 ha of disturbance to potential foraging habitat for the Grey Falcon. |
| **Significant residual impacts that may require an offset** – *any significant residual impacts to potentially threatened species and ecosystems, areas of high environmental value or where the cumulative impact may reach critical levels if not managed* | No other residual impacts are considered to meet this criterion – refer above. | Potential indirect impacts to the Horseflat PEC associated with reductions in surface water inundation and groundwater seepage and mounding may occur, although the extent of impact is uncertain. If these impacts result in the loss of Horseflat PEC then this would be considered a significant residual impact that requires an offset. | Potential indirect impacts to good to excellent quality vegetation associated with reductions in surface water inundation and groundwater seepage and mounding may occur, although the extent of impact is uncertain. If these impacts result in the loss of good to excellent quality vegetation then this would be considered a significant residual impact that requires an offset. | No residual impacts are considered to meet this criterion: refer above. | Potential indirect impacts to mangroves within the RSMA associated with reductions in surface water inundation and groundwater seepage and mounding may occur, although the extent of impact is uncertain. There is also uncertainty about the impacts of sea level rise on the mangroves in the RSMA. In a worst-case scenario the Proposal could reduce the area available for the migration of mangroves inland.<br>If these potential impacts occur and result in the loss of mangroves within the RSMA then this would be considered a significant residual impact that requires an offset. | Impacts to coral reefs may meet this criterion if dredging and bitterns disposal are not managed appropriately.<br>Potential indirect impacts to mangroves associated with reductions in surface water inundation and groundwater seepage and mounding may occur, although the extent of impact is uncertain. There is also uncertainty about the impacts of sea level rise on the mangroves. In a worst-case scenario the Proposal could reduce the area available for the migration of mangroves inland.<br>If these potential impacts occur and result in the loss of mangroves then this would be considered a | No other residual impacts are considered to meet this criterion – refer above.<br>Potential indirect impacts to migratory species and terrestrial fauna associated with reductions in surface water inundation and groundwater seepage and mounding may occur, although the extent of impact is uncertain. There is also uncertainty about the impacts of sea level rise on BCH habitat. In a worst-case scenario the Proposal could reduce the area available for the migration of BCH inland. |

| **Part IV Environmental Factors** | Vegetation and Flora | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | Benthic Habitat and Communities | | |
| | | | | Terrestrial Fauna | | | |
| **Part V Clearing Principles** | **C--** Rare flora | **D--** TECs | **E--** Remnant vegetation | **F--** Wetlands and waterways | **H--** Conservation areas | **A--** High biological diversity | **B--** Habitat for fauna |
| | | | | | | significant residual impact that requires an offset. | |
| **Residual impacts that are not significant** | No known Threatened Flora listed under the EPBC Act or BC Act will be disturbed.<br>Priority flora species were recorded within the development envelopes. Based on the assessments of these species in Section 11.5, the Proposal is unlikely to significantly impact the local or regional extent of these species. | No other residual impacts are considered to meet this criterion – refer above. | Clearing of vegetation that is in poor or degraded condition will occur as a result of the Proposal however this is not considered to be a significant residual impact. | No other residual impacts are considered to meet this criterion – refer above. | No other residual impacts are considered to meet this criterion – refer above. | With the exception of the above, the Proposal avoids areas of high biological diversity. | Clearing of fauna habitat that is in poor or degraded condition will occur as a result of the Proposal however this is not considered to be a significant residual impact. |

## 15.2 DETAILS OF PROPOSED OFFSETS

Table 15-4 describes the measures proposed to offset the additional residual impacts associated with the Proposal. These measures are subject to refinement as the Proposal assessment progresses, and pending discussions with influencing parties such as DBCA.

PEOF funding will be maintained through indexation to the Perth CPI.

**Table 15-4: Proposed offsets**

| Offset | Type | Details | Relevant values/MNES |
|---|---|---|---|
| **Offsets for known significant residual impacts** | | | |
| Contribution to the PEOF ('higher rate') for direct impacts to critical habitat for North-Western Free-tailed Bat | PEOF: Direct-- preservation of existing habitat and management | As above. | North-Western Free-tailed Bat |
| Contribution to the PEOF ('higher rate') for direct impacts to Horseflat PEC *not already offset by the measures above* | PEOF: Direct-- preservation of existing habitat and management | As above. | Horseflat PEC |
| Contribution to the PEOF ('base rate') for direct impacts to 'Good' to 'Excellent' condition native vegetation *not already offset by the measures above.* This vegetation includes broad foraging habitat for Pilbara Olive Python, Pilbara Leaf-nosed Bat, Ghost Bat and Grey Falcon. | PEOF: Direct-- preservation of existing habitat and management | As above. | Pilbara Olive Python<br>Pilbara Leaf-nosed Bat<br>Ghost Bat<br>Grey Falcon<br>Good to Excellent quality vegetation |
| Contribution of funds to a relevant intertidal BCH conservation and management program established for the Proposal. Funds are to be paid at a rate of $2,102 per hectare of mangroves, samphire shrublands and HDAM lost as a result of the Proposal (estimated value of $1.2 million), based on 2023 Perth CPI index.<br>The proposed offsets will be developed after the relevant results of the Mardie Project offset program are released, with the information used to develop suitable management measures to protect the ecological roles, values and functions of intertidal BCH. | Direct (management)-- contribution for the purpose of management | The Proposal is predicted to have a significant residual impact on several intertidal BCH types. Leichhardt is aware that research programs are underway as part of the offsets for the Mardie Project:<br>Project A-- Mapping of the original and current extent of samphire and algal mat on the west Pilbara coast.<br>Project B-- Identify and quantify the potential effects of sea level rise on mangroves, samphire and algal mat on the west Pilbara coast.<br>Project C (i)-- Identify the ecological roles, values and functions of algal mat on the west Pilbara coast.<br>Funding could include a postdoctoral or similar study on *Tecticornia* spp., on a per hectare brate, to resolve their taxonomy and provide a genomic library and taxonomic key to their identification along the west Pilbara | Migratory shorebirds<br>Mangroves<br>Samphire shrublands<br>Algal mats<br>Commercial fish stocks<br>Nearshore marine fauna |

| Offset | Type | Details | Relevant values/MNES |
|---|---|---|---|
| | | coast. This research to address this uncertainty will provide environmental and nature resource management regulators with greater confidence when assessing project developments that impact samphire habitats. Furthermore, this research also provides greater certainty (de-risking) to development proponents and project operators, especially in respect to the mitigation of impacts to samphire species and the communities they form, and the application of regulatory frameworks designed to limit and offset impacts. The details of the study have been drafted with Curtin University and DBCA (Appendix 7.7).<br>It is likely that the findings of the Mardie offset research listed above will be available in 2025, well before the implementation of the Proposal. Leichhardt intends to assess the findings and develop further appropriate conservation and management offsets in consultation with DBCA, DCCEEW, WAMSI and DWER that provide the best environmental outcome for these BCH types across the western Pilbara coast.<br>Leichhardt will ensure that the real funding for the conservation and management projects will be maintained through indexation to the Perth CPI. | |
| **Contingency offsets for potential indirect significant residual impacts**<br>Contingency offsets will be implemented if monitoring identifies that there are additional impacts associated with indirect impacts such as SLR and altered hydrology and hydrogeology. | | | |
| Contribution to the PEOF ('higher rate') for confirmed indirect impacts to critical habitat for North-Western Free-tailed Bat | PEOF: Direct-- preservation of existing habitat and management | Potential indirect impacts to critical habitat for North-Western Free-tailed Bat associated with reductions in surface water inundation and groundwater seepage and mounding may occur, although the extent of impact is uncertain. There is also uncertainty about the impacts of sea level rise on mangrove habitat. In a worst-case scenario the Proposal could reduce the area available for the migration of mangroves inland.<br>If these potential impacts occur and result in the loss of critical habitat for North-Western Free-tailed Bat (i.e., confirmed by monitoring) then this would be considered a significant residual impact that requires an offset.<br>Refer above for a description of the PEOF. | North-Western Free-tailed Bat |
| Contribution to the PEOF ('higher rate') for confirmed | PEOF: Direct-- preservation of existing | Potential indirect impacts to Horseflat PEC associated with reductions in | Horseflat PEC |

| Offset | Type | Details | Relevant values/MNES |
|---|---|---|---|
| indirect impacts to Horseflat PEC *not already offset by the measures above* | habitat and management | surface water inundation and groundwater seepage and mounding may occur, although the extent of impact is uncertain.<br>If these potential impacts occur and result in the loss of Horseflat PEC (i.e., confirmed by monitoring) then this would be considered a significant residual impact that requires an offset.<br>Refer above for a description of the PEOF. | |
| Contribution to the PEOF ('base rate') for confirmed indirect impacts to 'Good' to 'Excellent' condition native vegetation *not already offset by the measures above.* This vegetation includes broad foraging habitat for Pilbara Olive Python, Pilbara Leaf-nosed Bat, Ghost Bat and Grey Falcon. | PEOF: Direct-- preservation of existing habitat and management | Potential indirect impacts to 'Good' to 'Excellent' condition native vegetation associated with reductions in surface water inundation and groundwater seepage and mounding may occur, although the extent of impact is uncertain.<br>If these potential impacts occur and result in the loss of 'Good' to 'Excellent' condition native vegetation (i.e., confirmed by monitoring) then this would be considered a significant residual impact that requires an offset.<br>Refer above for a description of the PEOF. | Pilbara Olive Python<br>Pilbara Leaf-nosed Bat<br>Ghost Bat<br>Grey Falcon<br>Good to Excellent quality vegetation |
| Contribution of funds to a relevant intertidal BCH conservation and management program established for the Proposal. Funds are to be paid at a rate of $2,102 per hectare of mangroves, samphire shrublands and HDAM confirmed to be indirectly impacted as a result of the Proposal, based on 2023 Perth CPI index.<br>The contingency offsets will be in addition to the BCH offsets described above, to protect the ecological roles, values and functions of intertidal BCH. | Direct (management)-- contribution for the purpose of management | Potential indirect impacts to intertidal BCH associated with reductions in surface water inundation and groundwater seepage and mounding may occur, although the extent of impact is uncertain. There is also uncertainty about the impacts of sea level rise on intertidal BCH. In a worst-case scenario the Proposal could reduce the area available for the migration of BCH inland.<br>Leichhardt is aware that research programs are underway as part of the offsets for the Mardie Project:<br>Project A-- Mapping of the original and current extent of samphire and algal mat on the west Pilbara coast.<br>Project B-- Identify and quantify the potential effects of sea level rise on mangroves, samphire and algal mat on the west Pilbara coast.<br>Project C (i)-- Identify the ecological roles, values and functions of algal mat on the west Pilbara coast.<br>It is likely that the findings of the Mardie offset research listed above will be available in 2025, well before the implementation of the Proposal or the requirement for contingency offsets. Leichhardt intends to assess the findings and develop further appropriate conservation and management offsets in consultation | Migratory shorebirds<br>Mangroves<br>Samphire shrublands<br>Algal mats<br>Commercial fish stocks<br>Nearshore marine fauna |

| Offset | Type | Details | Relevant values/MNES |
|---|---|---|---|
| | | with DBCA, DCCEEW, WAMSI and DWER that provide the best environmental outcome for these BCH types across the western Pilbara coast.<br>Leichhardt will ensure that the real funding for the conservation and management projects will be maintained through indexation to the Perth CPI. | |

## 15.3 ASSESSMENT OF OFFSETS–- WA

Leichhardt has completed a WA Offsets Template as per the requirements of the WA Environmental Offsets Guideline (EPA, 2014a), provided in Table 15-5.

Table 15-5: WA offsets policy template

| Existing Environment/Impact | Mitigation | | | Significant Residual Impact | Offset Calculation Methodology | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Avoid and Minimise | Rehabilitation Type | Likely Rehab Success | | Type | Risk | Likely Offset Success | Time Lag | Offset Quantification |
| **North-Western Free-tailed Bat** – clearing of up to 8.3 ha of critical roosting habitat. | **Avoid:**<br>The ponds have been re-designed to avoid the majority of critical habitat (mangroves).<br>**Minimise**:<br>• Minimise clearing within good to excellent habitat<br>• Industry standard clearing controls<br>• Compliance with Part IV EP Act approval, Part V EP Act Works Approval and Licence, and Mining Act. | • Decommission and remove infrastructure;<br>• Remove excess salt and brine from crystallisers<br>• Pond embankments will be breached to allow re-establishment of tidal inundation and flooding regimes; and<br>• Crystallisers will be rehabilitated to an acceptable landform. | Can the environmental values be rehabilitated/Evidence?<br>Likely, Pilbara rehabilitation methods are well established and while rehabilitation of a salt project has not yet been undertaken, additional scientific information is likely to be available at closure given the long life of the Proposal.<br>Operator experience in undertaking rehabilitation?<br>Leichhardt will source experienced rehabilitation operators at closure.<br>What is the type of vegetation being rehabilitated?<br>Various<br>Time lag?<br>Up to several decades for vegetation to fully re-establish.<br>Credibility of the rehabilitation proposed (evidence of demonstrated success)<br>Credible, Pilbara rehabilitation methods are well established and while success has been varied, additional scientific information is likely to be available at closure given the long life of the Proposal. | Yes | Critical habitat:<br>Refer to 'Intertidal BCH' item below. | Critical habitat:<br>Unknown – offset programs are to be determined at the completion of the Mardie offsets research program | Can the values be defined and measured?<br>Yes – value to species can be measured<br>Operator experience/Evidence?<br>PEOF managers will manage the offset<br>What is the type of vegetation being revegetated?<br>N/A | Minimal--manages this species soon after payment. | Offset would protect/improve/maintain the quality of significant habitat for this environmental value. |
| **Horseflat PEC** – Clearing of up to 7,614.1 ha of Horseflat PEC. | **Avoid:**<br>N/A<br>**Minimise**:<br>• Minimise clearing within good to excellent vegetation<br>• Industry standard clearing controls<br>• Compliance with Part IV EP Act approval, Part V EP Act Works Approval and Licence, and Mining Act | • Decommission and remove infrastructure;<br>• Remove excess salt and brine from crystallisers;<br>• Pond embankments will be breached to allow re-establishment of tidal inundation and flooding regimes; and<br>• Crystallisers will be rehabilitated to an acceptable landform. | Can the environmental values be rehabilitated/Evidence?<br>Likely, Pilbara rehabilitation methods are well established and while rehabilitation of a salt project has not yet been undertaken, additional scientific information is likely to be available at closure given the long life of the Proposal.<br>Operator experience in undertaking rehabilitation?<br>Leichhardt will source experienced rehabilitation operators at closure.<br>What is the type of vegetation being rehabilitated?<br>Various<br>Time lag?<br>Up to several decades for vegetation to fully re-establish.<br>Credibility of the rehabilitation proposed (evidence of demonstrated success)<br>Credible, Pilbara rehabilitation methods are well established and while success has been varied, additional scientific information is likely to be available at closure given the long life of the Proposal. | Yes | Contribution to the PEOF at the 'Roebourne--higher' rate for direct or indirect impacts (predicted and additional impacts identified during monitoring) to Good to Excellent quality habitat | Low – PEOF well-established for offsets in the Pilbara | Can the values be defined and measured?<br>Likely – value to ecosystem should be able to be measured<br>Yes – value to PEC can be measured<br>Operator experience/Evidence?<br>PEOF managers will manage the offset<br>What is the type of vegetation being revegetated?<br>N/A | Minimal--manages PEC soon after payment. | Offset would protect/improve/maintain the quality of significant areas of this environmental value. |
| **Good to Excellent Condition native vegetation** – clearing of up to 11,287.7 ha of good to excellent condition native vegetation, including potential habitat for significant flora and fauna species. | **Avoid:**<br>The Coastal Dunes PEC has been completely avoided.<br>**Minimise**:<br>• Minimise clearing within good to excellent vegetation<br>• Industry standard clearing controls | • Decommission and remove infrastructure;<br>• Remove excess salt and brine from crystallisers. | Can the environmental values be rehabilitated/Evidence?<br>Likely, Pilbara rehabilitation methods are well established and while rehabilitation of a salt project has not yet been undertaken, additional scientific information is likely to be available at closure given the long life of the Proposal.<br>Operator experience in undertaking rehabilitation? | Yes | Contribution to the PEOF at the 'Roebourne – base' rate for direct or indirect impacts (predicted and additional impacts | Low – PEOF well-established for offsets in the Pilbara | Can the values be defined and measured?<br>Yes – value to ecosystem can be measured<br>Operator experience/Evidence? | Minimal--manages vegetation and affected species soon after payment. | Offset would protect/improve/maintain the quality of significant areas of these environmental values. |

| Existing Environment/Impact | Mitigation | | | Significant Residual Impact | Offset Calculation Methodology | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Avoid and Minimise | Rehabilitation Type | Likely Rehab Success | | Type | Risk | Likely Offset Success | Time Lag | Offset Quantification |
| **Pilbara Olive Python**– clearing of up to 20.8 ha of potential foraging habitat.<br>**Pilbara Leaf-nosed Bat and Ghost Bat** – clearing of up to 10,950.3 ha of potential foraging habitat.<br>**Grey Falcon** – 1,954.4 ha of potential foraging habitat. | • Compliance with Part IV EP Act approval, Part V EP Act Works Approval and Licence, and Mining Act. | • Pond embankments will be breached to allow re-establishment of tidal inundation and flooding regimes; and<br>• Crystallisers will be rehabilitated to an acceptable landform. | Leichhardt will source experienced rehabilitation operators at closure.<br>What is the type of vegetation being rehabilitated?<br>Various<br>Time lag?<br>Up to several decades for vegetation to fully re-establish.<br>Credibility of the rehabilitation proposed (evidence of demonstrated success)<br>Credible, Pilbara rehabilitation methods are well established and while success has been varied, additional scientific information is likely to be available at closure given the long life of the Proposal. | | identified during monitoring) to Good to Excellent quality vegetation / habitat | | PEOF managers will manage the offset<br>What is the type of vegetation being revegetated?<br>N/A<br>Is there evidence the environmental values can be re-created (evidence of demonstrated success)?<br>N/A | | |
| **Intertidal BCH**– loss of up to:<br>• 480.7 ha of samphire shrubland BCH<br>• 8.3 ha of mangroves<br>• 87.3 ha of HDAM.<br>BCH above is also considered migratory shorebird habitat, and mangroves are considered North-Western Free-tailed Bat habitat. | **Avoid**:<br>• Marine disturbance footprint avoids impacts to known high value BCH areas such as dense cover coral and seagrass;<br>• Pond disturbance footprint avoids impacts to almost all of the structurally complex (i.e., CC) mangrove BCH; and<br>• Pond design avoids impacts to surface water flows within McKay Creek.<br>**Minimise**:<br>• Mangrove disturbance limits;<br>• Ensure low noise and light emissions;<br>• Industry standard clearing controls; and<br>• Compliance with Part IV EP Act approval, Part V EP Act Works Approval and Licence, and Mining Act approvals. | • All buildings and structures on land will be removed from the site and the pond areas may be selectively reconnected to the existing tidal flat system, with consideration of the ponds becoming fauna habitat for shore birds;<br>• Remove excess salt and brine from crystallisers; and<br>• Pond embankments will be breached to allow re-establishment of tidal inundation and flooding regimes. | Can the environmental values be rehabilitated/Evidence?<br>Yes, natural processes are expected to gradually reinstate the remaining BCH, although some boundaries may be altered due to sea level rise. BCH are relatively dynamic due to cyclone events.<br>Operator experience in undertaking rehabilitation?<br>None required, rehabilitation will occur via natural processes.<br>What is the type of vegetation being rehabilitated?<br>Algal mat, mudflat or salt flat, samphire shrubland BCH and some mangrove BCH.<br>Time lag?<br>Up to two years to remove salts depending on rainfall events, then several decades for BCH to re-establish.<br>Credibility of the rehabilitation proposed (evidence of demonstrated success)<br>Credible, intertidal processes are dynamic and will flush the area and allow BCH to spread across the area over time. There is evidence in the Pilbara of mangroves growing on man-made structures. | Yes | Contribution to a relevant management program established for the Proposal. The management program is intended to be developed after the results of the Mardie Project offset program are released, with the information used to develop suitable management measures to protect the ecological roles, values and functions of intertidal BCH.<br>Funding will be maintained through indexation to the Perth CPI. | Unknown but predicted to be low, as offset would be based on recent detailed research | Can the values be defined and measured?<br>Likely – value to regional BCH should be able to be measured<br>Operator experience/Evidence?<br>Land managers will manage the offset (DBCA or contractor)<br>What is the type of vegetation being revegetated?<br>N/A<br>Is there evidence the environmental values can be re-created (evidence of demonstrated success)?<br>There is evidence in the Pilbara of mangroves growing on man-made structures. | Minimal – funding will be provided to a management program established specifically for the Proposal. | Offset program would be based on recent research to best manage this environmental value. |

## 15.4 OFFSET PRINCIPLES

Six principles support the assessment and decision-making process undertaken by the WA Government in relation to the use of environmental offsets. These principles are set out in the Environmental Offsets Policy (EPA, 2011). The Proposal and proposed offsets have been assessed against each of these principles, as provided in Table 15-6.

**Table 15-6: Assessment of the proposed offsets against the six principles**

| Number | Principle | Consideration |
|---|---|---|
| 1 | Environmental offsets will only be considered after avoidance and mitigation options have been pursued. | Leichhardt has applied the mitigation hierarchy by identifying measures to avoid, minimise and rehabilitate. The primary action taken to meet this policy's requirements was site selection and design, which avoided and minimised impacts to key environmental features, and reduced the development envelope and required disturbance to the smallest size possible. |
| 2 | Environmental offsets are not appropriate for all projects. | It is acknowledged that offsets are not appropriate for all projects. Numerous pond designs were assessed to ensure the impacts are at a scale of significance where offsets are appropriate. As the Proposal may result in significant residual impacts to BCH, fauna habitat and vegetation, an offset is considered to be appropriate. |
| 3 | Environmental offsets will be cost-effective, as well as relevant and proportionate to the significance of the environmental value being impacted. | Leichhardt will contribute funding into the PEOF for residual impacts to terrestrial fauna habitats, Horseflat PEC and good to excellent condition vegetation. In area where these values overlap, the higher rate will be selected. The PEOF has been developed to be cost-effective for potential significant residual impacts in the Pilbara and is relevant and proportionate to the Proposal's potential significant residual impacts.<br>Leichhardt also intends to contribute funding for conservation and management programs to offset the residual impacts to intertidal BCH. These offsets will be designed based on the findings of intertidal BCH research currently be undertaken by WAMSI and due to be completed in 2025. Funding could include a postdoctoral or similar study on *Tecticornia* spp., on a per hectare rate, to resolve their taxonomy and provide a genomic library and taxonomic key to their identification along the west Pilbara coast. This research to address this uncertainty will provide environmental and nature resource management regulators with greater confidence when assessing project developments that impact samphire habitats. Furthermore, this research also provides greater certainty (de-risking) to development proponents and project operators, especially in respect to the mitigation of impacts to samphire species and the communities they form, and the application of regulatory frameworks designed to limit and offset impacts. The details of the study have been drafted with Curtin University and DBCA (Appendix 7.7).<br>This will ensure the offsets are cost-effective for the management of these BCH types and are relevant and proportionate to the Proposal's potential significant residual impacts (funding has been based on a review of offset costs for the Mardie Project). Contingency offsets will be implemented if monitoring identifies that there are additional impacts associated with indirect impacts such as SLR and altered hydrology or hydrogeology. Contingency offsets will include additional funding for management, potentially resulting in an extension or expansion of the original program. Leichhardt understands that additional detail is required and intends to refine the scope of these offsets once the Mardie research program in complete (completion expected in 2025). |

| Number | Principle | Consideration |
|---|---|---|
| 4 | Environmental offsets will be based on sound environmental information and knowledge. | PEOF is managed and implemented by DWER with advice from the fund's advisory group. It is expected that PEOF meets this principle.<br>The proposed management and conservation programs will be designed to ensure the offsets are based on sound environmental information and knowledge. |
| 5 | Environmental offsets will be applied within a framework of adaptive management. | PEOF is adaptively managed to adjust its delivery over time as more information and opportunities become available.<br>The proposed management and conservation programs will be developed to include a review and revision component to ensure it utilises the most up-to-date information and research measures. |
| 6 | Environmental offsets will be focused on longer term strategic outcomes. | PEOF investment will target areas with a high density of both state and Commonwealth environmental values, and where land tenure enables legal access and longevity for offset outcomes.<br>The proposed management and conservation programs will be designed to be focused on longer term strategic outcomes. |

# 15.5 Assessment of Proposed Offsets – EPBC Act

## 15.5.1 Commonwealth Environmental Offsets Guidelines

Offsets are defined as measures that compensate for the residual adverse impacts of an action on the environment. Where appropriate, offsets are considered during the assessment phase of an EIA under the EPBC Act.

The EPBC Act Environmental Offsets Policy (DSEWPaC, 2012a) states:

> "*The term 'environmental offsets' refers to measures that compensate for the residual adverse impacts of an action on the environment. Offsets provide environmental benefits to counterbalance the impacts that remain after avoidance and mitigation measures. These remaining, unavoidable impacts are termed 'residual impacts.' For assessments under the EPBC Act, offsets are only required if residual impacts are significant.*
>
> *Offsets can help to achieve long-term environmental outcomes for matters protected under the EPBC Act, while providing flexibility for proponents seeking to undertake an action that will have residual impacts on those protected matters*."

## 15.5.2 Offset Principles

Table 15-7 provides the overarching principles that are applied in determining the suitability of offsets. In assessing the suitability of an offset, government decision-making will be informed by scientifically robust information and incorporate the precautionary principle in the absence of scientific certainty and conducted in a consistent and transparent manner.

**Table 15-7: EPBC Act overarching principles applied in determining the suitability of offsets**

| No. | Principle | Offset suitability |
|---|---|---|
| 1 | Offsets must deliver an overall conservation outcome that improves or maintains | The PEOF has been developed to deliver overall conservation outcomes that improve or maintain the viability of MNES. |

| No. | Principle | Offset suitability |
|---|---|---|
| | the viability of the protected matter | The intertidal management and conservation programs proposed as offsets will be directly related to the impacts. Management projects can add significant value through strategic protection and the management of the environmental values being impacted. The outcomes of the research projects being conducted by WAMSI are intended to inform the management programs to achieve the objectives above. For this Proposal, conservation and management offsets for impacts to algal mat, samphire shrubland BCH and mangroves are appropriate due to the lack of available options for direct land acquisition offsets to be undertaken. The research projects being conducted by WAMSI will provide new science to develop better mitigation measures for impacts to mangroves and algal mats and provide valuable scientific knowledge to inform regional and strategic protection of these values.<br>Management measures will be refined after priority knowledge gaps have been filled by the WAMSI research programs, leading to positive conservation outcomes based on current and relevant science. |
| 2 | Offsets must be built around direct offsets but may include other compensatory measures | The PEOF has been developed to primarily deliver management offsets but may include land acquisition and compensatory measures.<br>There are currently limited opportunities for direct land acquisition offsets in the Pilbara given the lack of freehold land, and there are no Pilbara strategic conservation initiatives that are undertaking actions that would be relevant to marine and intertidal values. The WA EPA identified a lack of scientific knowledge about the extent, ecological roles, values and functions of intertidal BCH on the west Pilbara coast. Research offsets were therefore deemed appropriate for the Mardie Project to offset their residual impacts as the research would result in positive conservation outcomes, address priority knowledge gaps and provide critical information to improve environmental assessment of future projects. These offsets proposed for this Proposal are intended to build on the Mardie Project offsets, utilising the information gathered to conserve and manage high-value sites. |
| 3 | Offsets must be in proportion to the level of statutory protection that applies to the protected matter | Leichhardt acknowledge the various levels of statutory protection that apply to the protected matters. This was considered when assessing the significance of the residual impacts. The scale of the proposed offsets takes these considerations into account. |
| 4 | Offsets must be of a size and scale proportionate to the residual impacts on the protected matter | The proposed offsets will be significant in size and scale, proportionate to the predicted residual impacts. The information gathered during the WAMSI research will inform Leichhardt's proposed management offsets, providing valuable scientific knowledge to inform regional and strategic protection of these values. |
| 5 | Offsets must effectively account for and manage the risks of the offset not succeeding | An Interim Offset Strategy has been provided that will continue to be revised to include detailed information about each management program, its management and governance, and the outcomes. This strategy will be revised to become a detailed Offset Management Plan prior to implementation, in consultation with relevant stakeholders to ensure that there is minimal risk of the offset not succeeding. |
| 6 | Offsets must be additional to what is already required, determined by law or planning regulations, or agreed to under other schemes or programs | The proposed offsets are in addition to that which is already required, determined by law or planning regulations, or agreed to under other schemes or programs. |
| 7 | Offsets must be efficient, effective, timely, transparent, scientifically robust and reasonable | The Interim Offset Strategy includes information about timeframes and transparency of information, which will be further detailed as the management programs are developed. The management programs will be developed in consultation with relevant stakeholders to ensure that they are effective, scientifically robust and reasonable. |

| No. | Principle | Offset suitability |
|---|---|---|
| 8 | Offsets must have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced | The Interim Offset Strategy provides information about the transparent governance proposed to be implemented during the development and implementation of the management programs. The management programs will be designed to ensure they can be readily measured, monitored, audited and enforced. |

# 16 MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

## 16.1 CONTROLLED ACTION PROVISIONS

The Proposal was referred to the Minister for Environment and Water under the EPBC Act on 13 September 2021. The Minister determined that the Proposal was a Controlled Action under Section 75 of the EPBC Act (EPBC 2021/9027), with an accredited assessment to be conducted.

The controlling provisions for the Proposal are:

- Listed threatened species and communities (Sections 18 and 18A of the EPBC Act);
- Listed migratory species (Sections 20 and 20A); and
- Commonwealth marine areas (Sections 23 and 24A).

Based on the studies conducted and the information provided in Sections 6 –12 of this ERD, the species in Table 16-1 were considered to be potentially impacted by the Proposal and require assessment under the EPBC Act.

**Table 16-1: MNES that may be impacted by the Proposal**

| Common Name | Species Name | Conservation Status | Recorded |
|---|---|---|---|
| **Mammals** | | | |
| Northern Quoll | *Dasyurus hallucatus* | Endangered | Yes |
| Pilbara Leaf-nosed Bat | *Rhinonicteris aurantia* (Pilbara) | Vulnerable | Yes |
| Ghost Bat | *Macroderma gigas* | Vulnerable | No |
| Australian Humpback Dolphin | *Sousa sahulensis* | Vulnerable, Migratory, Cetacean | No |
| Indo-Pacific Bottlenose Dolphin | *Tursiops aduncus* | Vulnerable, Migratory, Cetacean | No |
| Humpback Whale | *Megaptera novae* | Migratory, Cetacean | No |
| Dugong | *Dugong dugon* | Migratory | No |
| **Reptiles** | | | |
| Pilbara Olive Python | *Liasis olivaceus barroni* | Vulnerable | No |
| Flatback Turtle | *Natator depressus* | Vulnerable, Migratory, Marine | Yes |
| Hawksbill Turtle | *Eretmochelys imbricate* | Vulnerable, Migratory, Marine | Yes |
| Green Turtle | *Chelonia mydas* | Vulnerable, Migratory, Marine | Yes |
| Short-nosed Sea Snake | *Aipysurus apraefrontalis* | Critically Endangered | No |
| Leaf-scaled Sea Snake | *Aipysurus foliosquama* | Critically Endangered | No |
| **Elasmobranch** | | | |





| Common Name | Species Name | Conservation Status | Recorded |
|---|---|---|---|
| Green Sawfish | *Pristis clavata* | Vulnerable, Migratory, Marine | Yes |
| Reef Manta Ray | *Mobula alfredi* | Migratory | No |
| **Birds** | | | |
| Red Knot | *Calidris canutus* | Endangered, Migratory | Yes |
| Curlew Sandpiper | *Calidris ferruginea* | Critically Endangered, Migratory | Yes |
| Great Knot | *Calidris tenuirostris* | Critically Endangered, Migratory | Yes |
| Eastern Curlew | *Numenius madagascariensis* | Critically Endangered, Migratory | Yes |
| Greater Sand Plover | *Charadrius leschenaultii* | Vulnerable, Migratory | Yes |
| Lesser Sand Plover | *Charadrius mongolus* | Vulnerable, Migratory | Yes |
| Grey Falcon | *Falco hypoleucos* | Vulnerable | Yes |
| Common Sandpiper | *Actitis hypoleucos* | Migratory | Yes |
| Fork-tailed Swift | *Apus pacificus* | Migratory | Yes |
| Ruddy Turnstone | *Arenaria interpres* | Migratory | Yes |
| Sharp-tailed Sandpiper | *Calidris acuminata* | Migratory | Yes |
| Sanderling | *Calidris alba* | Migratory | Yes |
| Pectoral Sandpiper | *Calidris melanotos* | Migratory | Yes |
| Red-necked Stint | *Calidris ruficollis* | Migratory | Yes |
| Oriental Plover | *Charadrius veredu* | Migratory | Yes |
| White-winged Black Tern | *Chlidonias leucopteru* | Migratory | Yes |
| Oriental Pratincole | *Glareola maldivarum* | Migratory | Yes |
| Black-tailed Godwit | *Limosa limosa* | Migratory | Yes |
| Little Curlew | *Numenius phaeopus* | Migratory | Yes |
| Whimbrel | *Numenius phaeopus* | Migratory | Yes |
| Osprey | *Pandion cristatus (haliaetus)* | Migratory | Yes |
| Pacific Golden Plover | *Pluvialis fulva* | Migratory | Yes |
| Grey Plover | *Pluvialis squatarola* | Migratory | Yes |
| Crested Tern | *Sterna bergii* | Migratory | Yes |
| Roseate Tern | *Sterna dougallii* | Migratory | Yes |
| Common Tern | *Sterna hirundo* | Migratory | Yes |
| Gull-billed Tern | *Sterna nilotica* | Migratory | Yes |
| White-shafted Little Tern, Little Tern | *Sternula albifrons* | Migratory | Yes |
| Grey-tailed Tattler | *Tringa brevipes* | Migratory | Yes |
| Common Greenshank | *Tringa nebularia* | Migratory | Yes |

| Common Name | Species Name | Conservation Status | Recorded |
|---|---|---|---|
| Terek Sandpiper | *Xenus cinereus* | Migratory | Yes |

## 16.2 POLICY AND GUIDANCE

The relevant policy and guidance for MNES includes:

- Generic guidelines for the content of a draft EPBC Act PER/EIS (including the objects and principles of the EPBC Act) (DotEE, 2016);
- Other Minister of the Environment (Cth) approval decision making considerations;
- Environmental Management Plan Guidelines (DotE, 2014);
- EPBC Act Condition Setting Policy (DAWE, 2020);
- EPBC Act Outcomes-based conditions policy (DotE, 2016a);
- EPBC Act Environmental Offsets Policy (DSEWPaC, 2012a) – including the Offset Assessment guide;
- *Environment Protection (Sea Dumping) Act 1981*;
- Marine bioregional plan for the North-west Marine Region (DSEWPaC, 2012b);
- National Assessment Guidelines for Dredging (DEWHA, 2009a);
- Environmental best practice port development: an analysis of international approaches (GHD, 2013a);
- Significant Impact Guidelines: 1.1 – Matters of National Environmental Significance (DotE, 2013);
- Recovery Plan for Marine Turtles in Australia (DotEE, 2017c);
- Sawfish and River Sharks Multispecies Recovery Plan (DotE, 2015a);
- Approved Conservation Advice for *Dermochelys coriacea* (Leatherback Turtle) (DEWHA, 2008a);
- Approved Conservation Advice for *Liasis olivaceus barroni* (Olive Python – Pilbara subspecies) (DEWHA, 2008b);
- Approved Conservation Advice for Green Sawfish (DEWHA, 2008c);
- Approved Conservation Advice for the Short-nosed Sea Snake (DSEWPaC, 2011a);
- Approved Conservation Advice for the Leaf-scaled Sea Snake (DSEWPaC, 2011b);
- Conservation Advice *Numenius madagascariensis* Eastern Curlew (DotE, 2015b);
- Conservation Advice *Calidris ferruginea* Curlew Sandpiper (DotE, 2015c);
- Conservation Advice *Rhinonicteris aurantia* (Pilbara form) (Pilbara Leaf-nosed Bat) (TSSC, 2016a);
- Conservation Advice *Falco hypoleucos* Grey Falcon (TSSC, 2020);
- Conservation Advice *Calidris canutus* Red Knot (TSSC, 2016b);
- Conservation Advice *Calidris tenuirostris* Great Knot (TSSC, 2016c);
- Conservation Advice *Charadrius mongolus* Lesser Sand Plover (TSSC, 2016d);
- Approved Conservation Advice *Charadrius leschenaultia* Greater sand plover (TSSC, 2016e);
- Conservation Advice *Megaptera novaeangliae* (Humpback Whale) (TSSC, 2015);
- Conservation Advice for *Sousa sahulensis* (Australian humpback dolphin) (DCCEEW, 2025);

- Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species (DotEE, 2017b);
- Survey guidelines for Australia's threatened bats (DEWHA, 2010a);
- Survey guidelines for Australia's threatened birds (DEWHA, 2010b);
- Survey guidelines for Australia's threatened fish (DSEWPaC, 2011a);
- Survey guidelines for Australia's threatened mammals (DSEWPaC, 2011b);
- Survey guidelines for Australia's threatened reptiles (DSEWPaC, 2011c);
- EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales (DEWHA, 2008d);
- National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (DotEE, 2017a);
- National Light Pollution Guidelines for Wildlife including marine turtles, seabirds and migratory shorebirds (DCCEEW, 2023);
- Threat abatement plan for predation by the European red fox (DEWHA, 2008e);
- Threat abatement plan for predation by feral cats (DotE, 2015d);
- Threat abatement plan to reduce the impacts of exotic rodents on biodiversity on Australian offshore islands of less than 100,000 ha (DEWHA, 2009b);
- Threat Abatement Plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans (DotEE, 2018);
- Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads (DSEWPaC, 2011d);
- Commonwealth Listing Advice on Northern Quoll (*Dasyurus hallucatus*) (TSSC, 2005);
- EPBC Act referral guideline for the endangered northern quoll *Dasyurus hallucatus* (DotE, 2016c);
- Threat abatement plan to reduce the impacts on northern Australia's biodiversity by the five listed grasses (DSEWPaC, 2012c);
- The Action Plan for Australian Bats (Duncan et al., 1999);
- Conservation Advice for *Macroderma gigas* Ghost Bat (TSSC, 2016f);
- A review of Pilbara Leaf-nosed Bat ecology, threats and survey requirements (Bat Call WA Pty Ltd, 2021a);
- A review of Ghost Bat ecology, threats and survey requirements (Bat Call WA Pty Ltd, 2021b); and
- Sea turtles and the environmental management of industrial activities in north-west Western Australia (Pendoley, 2005).

## 16.3 DESCRIPTION OF THE ENVIRONMENT

A summary of surveys conducted to date and a detailed description of survey findings relevant to each of the MNES species and their respective habitats is provided in Section 9 (Marine) and Section 12 (Terrestrial Fauna). A summary of the findings is provided below.

### 16.3.1 SURVEY EFFORT

***Marine Turtles***

Leichhardt commissioned O2 Marine to undertake a nesting beach survey using RPAS between 2020 and 2022 (O2 Marine, 2022b). The survey focused on defining which species were present and describing the nesting activity (O2 Marine, 2022b). The survey area is described in Section 9.3.1 and shown in Figure 9-1. Field surveys were undertaken between December 2020 and January 2022.

Pendoley Environmental was commissioned to undertake additional surveys in the 2022/23 and 2023/24 summers targeting the peak nesting and hatching periods for Hawksbill, Flatback, and Green Turtles (Pendoley Environmental, 2023 & 2024). This survey is also described in Section 9.3.1.

In addition, Nocterra Pty Ltd completed a 15-day hatchling orientation survey in February and March 2025 which aligned with the peak hatching period for flatback turtles in the region and new moon period. This survey targeted the T3 section of mainland beach situated ~2 km to the southwest of 40-Mile Beach. This section, located west of 40-Mile Beach, had previously shown very low overnight nesting activity (one fresh track recorded over four days).

***Other Marine Fauna***

A comprehensive desktop review was undertaken by O2 Marine (2025e) to identify significant marine fauna species known or likely to occur. The desktop review included database searches as well as a comprehensive literature review. The literature review considered parameters aligned to the EPBC Act Significant Impact Criteria for Threatened and Migratory species (DotE, 2013), and the EPA's Environmental Factor Guideline for Marine Fauna (EPA, 2016e).

The results of the database searches and comprehensive literature review were used to conduct a likelihood of occurrence assessment (Section 9.3.4 and Table 6-4 in O2 Marine, 2025e). This assessment identified that, based on its scale, location and marine habitat types, the Proposal posed a relatively low risk to marine fauna species other than turtles and sawfish (additional discussion on these species is provided below). Specific surveys targeting other marine fauna species were therefore not deemed to be warranted for this assessment.

O2 Marine (2025c) was commissioned to undertake a preliminary assessment of BCH communities in 2021 and 2024. This work included mapping of the mangroves, algal mats and samphire shrublands along the coastline (Appendix 3.2). This survey also provided regional context for fauna habitats.

Additional algal mat mapping was also undertaken by Actis Environmental Services (2023) and Actis Consulting Pty Ltd (2023) to characterise the distribution and productivity of algal mats within and around the development envelopes and LAU's (Appendix 3.7).

A desktop review and numerous field surveys have been conducted to inform this ERD, as listed in Section 9.3.

### *Terrestrial Fauna*

Phoenix (2023) defined two study areas, detailed in Section 12.3.1, the TFSA and SBSA comprising 19,133 ha (Figure 12-1) and 12,591 ha (Figure 12-2) respectively. Phoenix (2023) determined the SBSA to be a 'shorebird area' as define by DotEE (2017b).

Desktop reviews consisted of review of biological databases and literature searches of biological surveys conducted within 50 km of the study area or within 200 km of the coastal plain. Field surveys for terrestrial fauna were undertaken by Phoenix (2022) between December 2019 and December 2021 and were conducted in accordance with '*Technical Guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment*' (EPA, 2020). The location of TFSA survey sites is shown in Figure 12-1. Additional surveys for Northern Quoll and Night Parrot were undertaken between 2024 and 2025

### *Migratory Shorebirds*

Migratory shorebird surveys were conducted over five phases (four summer, one winter) by personnel from Phoenix and Ornithological Technical Services, a specialist avifauna consultancy. Habitats sampled included tidal channels, beaches, mangrove areas, intertidal sand/mudflats, and supratidal mudflats.

The SBSA, described above, was surveyed in accordance with the Program for Regional and International Shorebird Monitoring (PRISM, 2018). The large (19,133 ha) survey area required aerial (R44 helicopter) counts whereby aerial transects were flown for a duration of typically three hours. Aerial surveys provided the most effective results when compared to surveying from boats or a fixed wing plane, as discussed in Section 12.3.1. Sampling was undertaken wherever possible, usually centred around tidal movements when shorebirds are likely to be active. A total of 21 survey events were completed by Phoenix (2023), equating to 54.5 hours of aerial survey time. Phoenix (2023) reported no observed events of congregations permanently departing an area due to disturbance by the helicopter observations.

It was estimated by Phoenix (2023) during the surveys that identifications could reliably made on average 150 m either side of the helicopter. Based on this, an area of 11,902.8 ha was reliably surveyed in total, including 10,086.9 ha within the SBSA, which represents over 80% of the SBSA over the course of the 21 transects completed.

The data gathered on migratory shorebirds was assessed against the criteria for determining nationally and internationally important habitats in Australia, including total abundance for each sample event and for individual species records against the most recent published EAAF population estimates for 37 species of shorebird (Hansen et al., 2016), where the total abundance of a species in each of the sample events was calculated. Phoenix (2023) calculated the estimated total abundance of each species across the SBSA and assessed recorded and expected populations with values listed by DotEE (2017b) to determine whether the species was recorded in nationally or internationally significant numbers. The survey effort is wholly described in Section 12.3.1.

***Northern Quoll***

Curtin University was commissioned to undertake a detailed camera trapping program within identified potential Northern Quoll habitat to determine presence within critical and foraging/dispersal habitat (Cowan, 2024).

Based on a review of spatial information provided by Phoenix (2023), 20 cameras were deployed on 16 February 2024 to sample the three areas identified as important to Northern Quolls. Eight cameras were placed in the area identified as critical habitat, seven along the area identified as dispersal/foraging habitat and five in the part of Devil Creek adjacent to the indicative disturbance footprint (Figure 12-5). Cameras were placed at locations to ensure comprehensive coverage of the habitat available within each of the three target areas. The total number of camera trap nights without lures was 2,000 (as at October 2024): 800 in the critical habitat, 700 in the foraging/dispersal habitat, and 500 in the Devil Creek area (outside the indicative disturbance footprint). The number of trap nights with lures was 1,060: 424 in the critical habitat, 371 in the foraging/dispersal habitat, and 265 in Devil Creek. Combined, this resulted in a total of 3,060 camera trap nights: 1,224 in the critical habitat, 1,071 in the foraging/dispersal habitat, and 765 in Devil Creek (Cowan, 2024).

***Night Parrot Survey Effort***

ARUs targeting night parrot were deployed at 13 sites within the TFSA (Figure 12-3). Survey details are provided in Section 12.3.1.

Recordings were analysed by Nick Leseberg at Adaptive NRM (Leseberg, 2022; Appendix 6.2) to provide a specialist opinion on the recordings and confirm if any may be associated with the Night Parrot. Adaptive NRM were provided with data from ten of the 14 survey sites by Phoenix. Of these ten sites, seven sites had enough data to allow robust conclusions around Night Parrot presence in the immediate vicinity of those sites. The duration of recorded data was insufficient for NP07, NP13 and NP14, and data was not provided for NP05, NP06 and NP11. Due to insufficient labelling, two recordings may be ascribed to NP09, NP10 or NP12.

In 2024 a revised desktop assessment of potential Night Parrot habitat was conducted with the explicit purpose of identifying any Night Parrot habitat that exists within the PIDE (Leseberg, 2024). This report concluded that although there are significant amounts of possible foraging habitat available, there is only very limited potential roosting habitat. A revised acoustic sampling program was developed to survey this roosting habitat to determine whether Night Parrots occur at that site. This sampling program was conducted in October and November 2024 with survey details provided in Table 12-2 and shown in Figure 12-6.

***Bat Acoustic Data Analysis***

Identification of bat ultrasonic acoustic records from within the TFSA (Figure 12-3) was undertaken by specialised personnel, detailed in Section 12.3.1.

## 16.3.2 RECORDED OR LIKELY SPECIES

The MNES species identified in Table 16-2 have either been recorded during studies or they were considered likely to occur given the presence of suitable habitat in the development envelopes or

surrounding areas. The location of the Threatened species that were recorded are shown in Figure 12-9. The location of all Migratory Bird records are provided in Figure 12-13 ton Figure 12-15.

The following sections provide more detail on the species recorded.

### *Marine Mammals*

An assessment was undertaken of the likelihood of occurrence for threatened marine mammal species identified through the desktop review. Threatened marine species are those listed under the EPBC Act. The results for the fauna likelihood of occurrence assessment are presented in Table 16-2. Listed threatened marine mammals with high potential to occur in the area (on occasion) include the Dugong (*Dugong dugong*), Australian humpback dolphin (*Sousa sahulensis*), Indo-Pacific Bottlenose Dolphin (*Tursiops aduncus*) and Humpback whale (*Megaptera novaeangliae*).

**Table 16-2: Likelihood of occurrence for marine mammals (from O2 Marine, 2025e; Appendix 4.1)**

| Species | Distribution | Likelihood of occurrence |
|---|---|---|
| **Dugong (*Dugong dugon*)**<br>Marine, Migratory EPBC Act, Specially Protected BC Act, Vulnerable IUCN | Dugong range extends from East Africa to the western Pacific. Dugongs in Australia are the last great global stronghold. In Australia, dugong distribution and abundance vary along the northern coastline from Shark Bay in WA, into the Northern Territory and to Moreton Bay near Brisbane, Queensland. From satellite tracking of individuals and aerial surveys it appears that dugongs, like many other marine mammals, can move long distances, but the timing and length of movements vary individually. There has been a regional shift of dugongs from Exmouth Gulf and Ningaloo Reef to Shark Bay in response to large scale damage to seagrass meadows, from a tropical cyclone. | **High within nearshore waters**. No BIAs for dugongs overlap with the development envelopes, however they have been known to exist within the study area and throughout the Pilbara region. |
| **Australian Humpback Dolphin (*Sousa sahulensis*)**<br>Vulnerable, Migratory, Marine cetacean, EPBC Act, Priority 4 BC Act, Vulnerable IUCN | Australian Humpback Dolphins are found in shallow (<30 m deep) tropical/subtropical coastal waters of the Sahul Shelf including northern Australia and southern New Guinea. In the Pilbara, they have been recorded up to 50 km from the mainland, in areas associated with offshore islands. Australian Humpback Dolphins do not appear to undergo large-scale seasonal migrations, although seasonal shifts in abundance have been observed. The density of Australian Humpback Dolphins across North West Cape has been estimated at 0.09 - 1.09 individuals/km$^2$, which is higher than the density estimates for northern Australia of 0.1 - 0.19 individuals/km$^2$. | **High**. No BIAs have been recognised in the Pilbara for humpback dolphins, however, they are likely to move through the nearshore waters of the study area on occasions. Habitat suitability for the humpback dolphin was the highest for shallow intertidal waters, suggesting this could be important habitat for the species. |
| **Indo-Pacific Bottlenose Dolphin (*Tursiops aduncus*)**<br>- Cetacean EPBC Act, Near Threatened IUCN | Indo-Pacific Bottlenose Dolphins occur in tropical and sub-tropical, shallow waters from South Africa to the Red Sea and eastwards to the Arabian Gulf, India, China and Japan, southwards to Indonesia and New Guinea, and New Caledonia. Their shallow coastal habitats overlap with human activity and coastal development which exposes them to repeated and cumulative stressors that have potential to disrupt and displace individuals. Within Australia the species is restricted to inshore areas such as bays and estuaries, nearshore waters, open coast environments, and shallow offshore waters, around | **High**. This species been recorded throughout nearshore waters of the region, including the study area. Habitat suitability modelling for Bottlenose Dolphins was highest at greater depths further offshore. |

| Species | Distribution | Likelihood of occurrence |
|---|---|---|
| | the whole Australian coast. Preliminary distribution models suggest that there could be habitat partitioning between Indo-Pacific Bottlenose and Humpback Dolphins. | |
| **Humpback Whale (*Megaptera novaeangliae)***<br>Marine, Migratory EPBC Act, Conservation Dependent BC Act, Least Concern IUCN | The humpback whale migration route is generally within 200 km from shore. Important resting areas have been identified during the southern migration and include Augusta, Geographe Bay, Shark Bay, Exmouth Gulf and the southern Kimberley region:<br>Humpback whales have been recorded in high numbers throughout the area and surrounds. During their northern migration, the whales tend to remain further offshore (around 50 km offshore), than on their southern migration (around 35 km offshore). Humpback whale numbers during their northern migration peak offshore of the Dampier Archipelago, from the end of July to the beginning of August. Peak southern migration numbers occur from the end of August and the beginning of September. Data collected from satellite tagged whales found that median distances from shore was less than 25 km and in shallow waters (<40 m water depth). During their southern migration, humpback whale cow-calf pairs travel close to the shore in shallow water depths (<30 m), likely to avoid attacks by sharks, killer whales, and threats from male humpback whales. Studies for the Wheatstone Proposal by the Centre for Whale Research recorded a substantial number of humpback whales further south of the Proposal area with highest numbers from mid-June onwards, the peak abundance being in August. | **High**. Humpback whales have been recorded in high numbers throughout the area and the humpback whale migration BIA overlaps with the development envelopes. Evidence for the expansion of the humpback whale calving grounds and resting behaviour of the whales observed in the Exmouth Gulf represent a proportion of the humpback whale population, with uncertainty of the humpback whale mother-calf behaviour at the study area. The assumption is that the whales would display the same behaviours across the calving grounds. |
| **Pygmy Blue Whale (*Balaenoptera musculus brevicauda)***<br>- Endangered, Marine, Migratory, Cetacean EPBC Act, Endangered BC Act, Endangered IUCN | Blue whale sightings in Australian waters are widespread, and it is likely that the whales occur around the continent at various times of the year. Much of the Australian continental shelf and coastal waters have no particular significance to the whales and are used only for migration and opportunistic feeding. Pygmy Blue Whales are found off the coast of WA as they complete their northern and southern migrations. The highest densities of the Pygmy Blue Whales off the northwest WA coastline occurs between April and June during their northern migration and November-December during their southern migration. The Pygmy Blue Whale distribution BIA is large and extends from the coastline to far offshore. Studies in the Pilbara region and ecological knowledge from elsewhere suggests that pygmy blue whales are predominantly distributed in deep, offshore pelagic waters. During their northern migration they remain nearer to the coastline (~40-160 km) until they reach the North-West Cape, at which point they then move further offshore (~225-250 km) towards Indonesia. | **Low**. The pygmy blue whale distribution BIA is a broad area shown to overlap with the entire Pilbara coastal waters area. However, migrating whales are in fact much further offshore with data indicating a distance of some 250 km offshore. Tagging data showed that the whales have a preference for offshore waters, migrating along the coastal slope, with limited use of the continental shelf. During their northern migration the pygmy blue whales moved further offshore after they pass the North-West Cape. |

### *Whales*

The Marine Development Envelope and DSDDE overlap the Humpback Whale migration BIA. Humpback Whales of breeding stock 'D' migrate annually from Antarctic feeding grounds to the Kimberley coast for calving during the winter. Humpback whales are primarily a coastal species when migrating and the migration typically occurs within the 200 m bathymetry from the

coastline. The migration route encompasses many different habitat types (e.g., seagrass, rocky seabed, sand). During their northern migration, the whales tend to remain further offshore (centred around 50 km), than the southern migration (centred around 35 km offshore).

### *Dugong*

Dugong (*Dugong dugong*) are found throughout the Pilbara region, particularly close to the coast or in the lee of reef-fringed islands and often in areas where seagrass has previously been recorded. Dugongs in Australia are an interconnected stock with a high level of gene flow, but with separate populations in the west and east coasts of Australia. Within WA, specific areas supporting dugongs include Shark Bay, Ningaloo and Exmouth Gulf and the Pilbara coast. The largest dugong population in WA is in Shark Bay, followed by the Exmouth Gulf, south of the Proposal.

They are relatively slow moving and can be difficult to detect which makes them susceptible to vessel strikes. In the Dampier Archipelago/Cape Preston region, small numbers of dugongs have been sighted in shallow, warm waters in bays and between islands, including East Lewis Island, Cape Preston, Regnard Bay, Nickol Bay and west of Keast Island.

### *Dolphins*

Humpback dolphins inhabit shallow, coastal waters; typically, within 20 km of land and in water depths of less than 30 m. Australian humpback dolphins are generally found in small populations of 50 – 150 individuals. The North-West Cape is thought to be an important habitat for the species with high levels of site fidelity and residence patterns observed. In WA they have been associated with coral reefs, with higher habitat suitability within intertidal areas. In the Pilbara, Australian humpback dolphins have been observed foraging in rivers, which could be an indication that rivers are an important habitat at a local scale and possibly used intermittently.

No studies have been undertaken for bottlenose dolphins at the Proposal, however, from opportunistic data collection during dugong aerial surveys undertaken for other Proposals, their numbers are likely to double those of humpback dolphins which is the pattern found elsewhere. Along the Northwest Cape, Indo-Pacific bottlenose dolphins have a density estimate of 2.4 - 2.8 individuals/km$^2$ and low site fidelity, suggesting the waters near the North West Cape are of high importance to the species (Haughey et al., 2020).

### *Elasmobranch*

An assessment was undertaken of the likelihood of occurrence for Threatened elasmobranch species identified through the desktop review. The results for the likelihood of occurrence assessment are presented in Table 16-3.

**Table 16-3: Likelihood of occurrence for threatened elasmobranch (O2 Marine, 2025e)**

| Species | Distribution | Likelihood of Occurrence |
|---|---|---|
| **Green Sawfish (*Pristis zijsron*)**<br>- Vulnerable EPBC Act, Migratory EPBC Act, Vulnerable BC Act, | The known distribution of the green sawfish is from the Whitsundays in Queensland across northern Australian waters to Shark Bay in WA. They pup along the coast, from Shark Bay (at the mouth of Gascoyne River) and throughout the Kimberley to the Gulf of Carpentaria. However, their distribution is not clearly defined due to | **High**. Pupping is known to occur in the region for green sawfish, with the nearest known important pupping areas are at the Ashburton River delta. Pupping occurs after the wet |

| Species | Distribution | Likelihood of Occurrence |
|---|---|---|
| Critically Endangered IUCN | similar morphology causing confusion with other members of the genus who reside in similar habitats. They are known to primarily occur in inshore and offshore marine waters, or in shallow estuarine waters, however, they do not penetrate freshwater. They have a strong association with mangroves and mudflats. | season in northern WA, generally from late October to April. No BIAs have been identified for green sawfish around the Proposal.<br>A survey was undertaken in August 2022, October 2023 and August 2024 to identify the sawfish species present in the vicinity of the Proposal (O2 Marine, 2023a, Morgan et.al., 2025). No sawfish were captured or tagged however one individual was detected during a UAV flight in the mouth of the intake creek. |
| **Narrow Sawfish (*Anoxypristis cuspidata*)**<br>- Migratory EPBC Act, Priority 1 BC Act, Endangered IUCN | Narrow sawfish have been found from Onslow through to the northern Kimberley in Australia. Compared to other species, they are found in larger numbers offshore, preferring deeper waters. This is reflected in trawl fisheries bycatch in 50-200 m depth. However, they do occur in smaller numbers along the coast. | **Low**. Narrow sawfish are found predominantly in offshore waters deeper than 40 m. Additionally, there are no identified BIAs for sawfish around the Proposal. |
| **Grey Nurse Shark (*Carcharias taurus*)** –<br>Vulnerable EPBC Act, Vulnerable BC Act, Vulnerable IUCN | The grey nurse shark has a broad inshore distribution, primarily in cool temperate waters and southwest waters although they have been recorded as far north as the NWS. Grey nurse sightings collected from fisheries, divers, and charter boat operators, reported occasional sightings in the Exmouth/Muiron Islands, however sightings of the grey nurse shark off the Navy Pier in Exmouth was the northernmost documentation of the western population of the grey nurse shark. The study also indicated that the sharks have a temperature threshold of 24˚C, with sharks only being observed when the water temperature dropped below 24˚C. This is consistent with the east coast population, which spend 95% of their time in sea temperatures between 17 - 24 °C. | **Low**. The northern-most documented sighting of the species was in Exmouth, WA (which is 250 km southwest of the Proposal) and they are found to inhabit water temperatures that range from 17 - 24. The species temperature range is within the sea temperature range of the Proposal, which varies from 18 °C - 31.5 °C. Grey nurse sharks may enter the development envelopes from time to time, but their occurrence is expected to be rare. |
| **Scalloped hammerhead shark (*Sphyrna lewini*)**<br>- Conservation Dependant EPBC Act, Eritically Endangered IUCN | Scalloped hammerhead sharks occur globally in tropical and subtropical waters. In Australia, the species is found in NSW, QLD, the NT, and WA. Scalloped hammerhead shark distribution and populations are segregated by size and sex. In the waters off Australia the population is primarily small adult males and juveniles. Adult females are predominantly found in the waters off Indonesia and Papua New Guinea. This suggests a population structure where the female scalloped hammerhead sharks migrate back to Australia to give birth in northern Australia nurseries. | **Low**. Similar to the grey nurse shark, the scalloped hammerhead may enter the development envelopes infrequently, but their occurrence is expected to be rare as this species is more likely to spend time foraging in adjacent deeper water areas where key ecological features (narrow shelf, canyons and the Exmouth plateau) facilitate upwelling and enhance local productivity. |
| **Whale Shark (*Rhincodon typus*)**<br>- Vulnerable, Marine, Migratory EPBC Act, Specially protected BC Act, Endangered IUCN | Globally whale sharks are found throughout the three oceanic basins, including the Indian and Pacific oceans. The sharks form annual aggregations at Ningaloo with the peak occurring from March to July, coinciding with a pulse of coral spawning. Satellite tracking has revealed that whale sharks leaving Ningaloo remain relatively close to the coastline, showing a preference to warmer shallower waters, with a mean minimum distance of 1,667 km (±316 km) from Ningaloo. Reynolds et al. (2017) found that most of the tagged sharks travelled north or north-east from the Ningaloo marine park. The tagging results also showed homing | **Low**. The approved CPE Port anchorage areas align with the inshore boundary of the whale sharks foraging BIA and is located approximately 50 km from the high-density foraging BIA of Ningaloo Reef. The shallow and flat bathymetric characteristics of the development envelopes do not represent preferred whale shark habitat. |

| Species | Distribution | Likelihood of Occurrence |
|---|---|---|
| | movements of the Ningaloo whale sharks, with tagged sharks returning to the Ningaloo marine park. Of the 25 sharks tagged 9 of the sharks returned to the northern end of the Ningaloo marine park after travelling more than 300 km, indicating high levels of site fidelity. These results suggested that the sharks are present all year round, not just during the seasonal aggregation. | |
| **Giant Manta Ray (*Manta birostris*)** - Marine, Migratory EPBC Act, Marine, Migratory BC Act, endangered IUCN | Giant manta rays are found throughout the Atlantic, Pacific and Indian Oceans, in tropical, subtropical, and temperate waters. Information on the global distribution of giant manta rays and their population sizes is lacking. | **Low**. Giant manta rays are rarely seen close to the coast due to their preference for offshore waters and have no BIAs or major population within close proximity to the Proposal. |
| **Reef Manta Ray (*Manta alfredi*)** - Marine, Migratory EPBC Act, Marine, Migratory BC Act, Vulnerable IUCN | Reef manta rays are distributed throughout the Pacific and the Indian Ocean. The Australian distribution is ~30°S on the east and west coast, with a continuous distribution north from Shark Bay (WA) (26°S) to the Solitary Island Marine Park (NSW) (26°S). The Ningaloo population exhibit a seasonal southernly shift in October. | **Medium**. Reef manta rays have no BIA or major populations within close proximity to the Proposal, however, due to their habitat preference being shallow waters in depths less than 20 m and their broadscale movements, is it possible for them to occur in the vicinity of the Proposal. |

*Sharks*

Sharks are found in the nearshore environment where there is overlap of several Proposal elements such as the seawater intake, dredging areas, bitterns diffuser and spoil disposal ground. The Grey Nurse Shark, Scalloped Hammerhead Shark and the Whale shark were identified as having a low likelihood of occurring in the development envelopes.

The WA population of the grey nurse shark is genetically distinct from the east coast population. Prior to 1997 information from gillnet fisheries indicates that grey nurse sharks were relatively abundant in temperate WA waters and that the population was stable. However, identification of grey nurse shark aggregations in WA has been difficult and animals are encountered with low and indeterminate frequency making contemporary population estimates difficult.

No stock assessments are available for scalloped hammerhead sharks in Australian waters or any of its regional neighbours. Given the limited stock structure data available there is a high likelihood, based on the available movement and tracking data, that the scalloped hammerhead shark population in Australia is part of the same stock as occurs in other Oceanic nations.

Whale sharks are abundant at Ningaloo reef with 300-500 resident individuals recorded through photo identifications (Meekan et al., 2006). The Indo-pacific whale shark population makes up 75% of the global population. The Ningaloo population is dominated by juvenile males, and there is mounting evidence that the WA whale shark aggregation site is a post-nursery site, where they visit to mature and forage.

*Rays*

In Australia the giant manta rays are distributed on both the east and west coast. Their distribution is patchy, with majority of the Australian populations occurring at the Ningaloo Reef and Great Barrier Reef.

The global population of reef manta rays can be found in tropical and subtropical waters through the Indian and Pacific Oceans, often in waters adjacent to islands and reefs. The Ningaloo population of reef manta rays exhibit a seasonal southernly shift in October.

*Sawfish*

Five species of sawfish have been identified worldwide, four of these occur in Australian waters, including those of northern WA: green sawfish (*P. zijsron*), narrow sawfish (*A. cuspidate*), dwarf sawfish (*P. clavate*) and largetooth sawfish (previously known as the freshwater sawfish) (*P. pristis*).

The largetooth sawfish are generally found in the Kimberley, where the Fitzroy River is a globally important nursery. Adults are known to migrate down the whole Pilbara coast to the top of the Exmouth Gulf. Narrow sawfish are found from Onslow up to the Northern Kimberley. They are commonly found offshore in deeper waters and are only occasionally present within the development envelopes. The dwarf sawfish are found within the Kimberley region (Morgan et al., 2021) and are not likely to be found south of Cape Keraudren, they have a very low potential to occur within the vicinity of the Proposal. The green sawfish has been identified by experts, Prof. David Morgan, and Dr. Karissa Lear, as having the highest likelihood of occurrence in the area.

**Green Sawfish (*Pristis zijsron*)**

There is limited information on current population sizes or trends in Australian waters for sawfish species, but there is evidence that all species have experienced recent population declines and some species are considered to have been extirpated from former parts of their range (DotE, 2015a). Green sawfish populations in the Pilbara appear to be genetically distinct from other populations worldwide, with some clear morphological differences evident, including differing number and shape of rostral teeth. In the Pilbara, population studies exploring the connectivity for several sawfish species are ongoing, although it is hypothesised that for Pilbara green sawfish populations, the Dampier Archipelago may act as a natural barrier limiting genetic connectivity between western Pilbara and eastern Pilbara populations. The Ashburton River delta is the only main pupping site known to be located coastally in the Pilbara, however, it is suspected that the other large delta in the region, De Grey River delta, may also be important. The Ashburton River delta and surrounds are therefore critically important to the green sawfish population that may occur in the vicinity of the Proposal, and the recovery of the species globally. A survey was undertaken in August 2022, October 2023 and August 2024 to identify the sawfish species present in the vicinity of the Proposal (O2 Marine, 2023a; Morgan et.al., 2025). No sawfish were captured or tagged over the survey period, however a Green Sawfish was detected during a UAV flight in the mouth of the intake creek (Morgan et.al., 2025). The occasional sightings of Green Sawfish in the general region and abundance of this species in nearby nursery habitats (e.g., Ashburton River and Fortescue River) suggests that the Cape Preston area is likely an occasional foraging habitat along the migratory corridor for juvenile and sub-adult Green Sawfish.

There is significant uncertainty, however, regarding the impact of existing Cape Preston Port infrastructure (as a barrier) on coastal sawfish movements and potential effect on green sawfish movements in each direction.

### *Marine Reptiles*

An assessment was undertaken of the likelihood of occurrence for threatened marine reptile species identified through the desktop review. The results for the likelihood of occurrence assessment are presented in Table 16-4.

**Table 16-4: Likelihood of occurrence for threatened marine reptiles (from O2 Marine, 2025e; Appendix 4.1)**

| Species | Distribution | Likelihood of Occurrence |
|---|---|---|
| **Flatback Turtle (*Natator depressus*)**<br>- Vulnerable, Migratory, Marine EPBC Act, Vulnerable BC Act | Flatback Turtles are distributed through tropical waters of northern Australia, Papua New Guinea, and Irian Jaya.<br>Nesting distribution of the Pilbara stock has been identified at the Montebello Islands, Mundabullangana Station, Barrow Island, Cemetery Beach, Dampier Archipelago (including Delambre Island and Huay Island), and coastal islands from Cape Preston to Locker Island. | **High** – Flatback, Hawksbill and Green turtles are the most likely to be present within the development envelopes and have been found to nest infrequently and in low density around the Proposal. |
| **Green Turtle (*Chelonia mydas*)**<br>- Vulnerable, Migratory, Marine EPBC Act, Vulnerable BC Act, Endangered IUCN | Green Turtles are distributed across tropical northern Australia waters. NWS stock Nesting distribution of the NWS stock has been identified at Adele Island, Maret Island, Cassini Island, Lacepede Islands, Barrow Island, Montebello Islands (all with sandy beaches), Serrurier Island, Dampier Archipelago, Thevenard Island, North West Cape, and the Ningaloo coast. | |
| **Hawksbill Turtle (*Eretmochelys imbricata*)**<br>- Vulnerable, Migratory, Marine EPBC Act, Vulnerable BC Act, Critically Endangered IUCN | Hawksbill Turtles are distributed globally in tropical, subtropical, and temperate waters. In Australia they are found in Queensland, the NT and WA.<br>Nesting distribution of the WA stock has been identified at the Dampier Archipelago (Including Rosemary Island and Delambre Island), Montebello Islands (including Ah Chong Island, Southeast Island and Trimouille Island), Lowendal Islands (including Varanus Island, Beacon Island and Bridled Island) and Sholl Island. | |
| **Loggerhead Turtle (*Caretta caretta*)**<br>- Endangered, Migratory, Marine EPBC Act, Endangered BC Act, Vulnerable IUCN | Loggerhead Turtles are distributed through tropical, sub-tropical and temperate waters throughout eastern, northern, and western Australia.<br>Nesting distribution of the WA Loggerhead Turtles has been identified at Dirk Hartog Island, Muiron Islands, Gnaraloo Bay and Ningaloo coast. | **Low**. They are infrequently spotted around the area during nesting with majority of their nesting occurring on South Pilbara beaches in Exmouth, WA. They migrate along the coast to their Kimberley foraging grounds and have no nesting BIA overlapping the development envelopes. |
| **Leatherback Turtle (*Dermochelys coriace*)**<br>- Endangered, Migratory, Marine EPBC Act, Vulnerable BC Act, Vulnerable IUCN | Throughout Australia the Leatherback Turtle utilises Australian coastal waters for foraging. Predominately found in central eastern Australia (Sunshine Coast to central NSW), southern-east Australia (Tasmania, Victoria, and eastern southern Australia) and southwestern WA. | **Low**. They have no known nesting sites within the Pilbara region, and no inter-nesting or foraging BIA within the development envelopes. Leatherback Turtles have occasionally been documented foraging in NWS |

| Species | Distribution | Likelihood of Occurrence |
|---|---|---|
| | | waters but have rarely been observed in the Pilbara. Given the species wide geographical range they may occur from time to time. |
| **Short-nosed Sea snake (*Aipysurus apraefrontalis*)**<br>- Critically Endangered EPBC Act, Critically Endangered BC Act, Data Deficient IUCN | Short-nosed Sea Snakes are known to have a restricted range and have undergone a very severe reduction in numbers in the late 1990s and 2000s. They are rarely seen in locations other than Ashmore Reef and a few places in northwest Australian coastal waters. D'anastasi et al. (2016) completed extensive field surveys of coastal WA and Scott Reef. They captured five live Short-nosed Sea Snakes in the Exmouth Gulf and spotted a courting pair at Ningaloo Reef. Habitat suitability threshold modelling has identified a new potential distribution that extends from the Exmouth Gulf and around the Murion Island to the Montebello Islands Marine Park, suggesting that they could possibly occur on coral reefs adjacent to islands around the Proposal. | **Moderate**. Short-nosed Sea Snakes are rarely seen in locations other than Ashmore Reef, Exmouth Gulf and around Muiron Island to the Montebello Islands (D'anastasi et al., 2016). However, the species niche model (Udyawer et al. 2020) indicates a 50% or greater possibility of habitat suitability in the waters surrounding the Proposal and therefore there is a moderate likelihood of occurrence. |
| **Leaf-scaled Sea snake (*Aipysurus foliosquama*)**<br>- Critically Endangered EPBC Act, Critically Endangered BC Act, Data deficient IUCN | Intensive field surveys, habitat data, and molecular genetic studies documented records of living Leaf-scaled Sea Snakes (n = 16) in coastal WA. There has been a significant increase in their known geographic range and habitats to include seagrass meadows in subtropical Shark Bay (latitudes 24.5°S to 26.6°S). Morphological variation and mitochondrial sequencing was utilised to confirm that specimens of the sea snake found at Barrow Island were not vagrants as previously suspected but instead represent separate breeding populations (at Barrow Island). Habitat suitability threshold modelling has identified a new distribution within coastal regions of Shark Bay and Barrow Island, which suggests that they could possibly occur on coral reefs adjacent to islands around the Proposal. | **Moderate**. There have been low numbers of Leaf-scaled Sea Snakes recorded at Shark Bay, Ashmore Reef, and Barrow Island. However, the species niche model (Udyawer et al. 2020) indicates a 50% or greater possibility of habitat suitability in the waters surrounding the Proposal and therefore there is a moderate likelihood of occurrence. |

*Turtles*

The following information has been sourced from Pendoley Environmental (2023 & 2024), Nocterra Pty Ltd (2025) and O2 Marine (2025e). It is acknowledged that, during O2 Marine's survey, there were survey effort limitations for Hawksbill Turtles and offshore islands, with surveys being undertaken outside of the Hawksbill nesting window. O2 Marine determined that South West Regnard Island, North East Regnard Island and beaches on the mainland could potentially represent nesting habitat for turtle species (Flatback, Green and Hawksbill turtles).

**Monitoring Season 1 – 2022/2023**

Three field surveys subsequently undertaken by Pendoley Environmental between October 2022 and February 2023 on beaches on the mainland coast and islands offshore from the Proposal found that Hawksbill nesting activity accounted for the greatest number of tracks in the overall monitoring period. The highest density of nesting activity occurred on South West Regnard Island, particularly along the northern shoreline of the island. Overall nesting success (the number of successful nests as a percentage of the total number of overnight tracks) was low for

Hawksbill Turtles in the first field survey at 15%, meaning the majority of Hawksbill tracks represented unsuccessful nesting attempts (53%) or false crawls (32%). Flatback and Green Turtle nesting was found to be present but marginal when combined for all routine monitoring beaches.

Track census results showed that Flatback and Green turtles only utilised the islands for nesting activity in January 2023 and were not found on the mainland beaches (40-Mile and CPE Beach) in close proximity to the Proposal. Low levels of Flatback turtle activity were identified at both Steamboat and South West Regnard Island during the January survey period. Green Turtle activity was also only noted during January however two nests were recorded, one at North East Regnard Island and one at Steamboat Island.

Nest fans indicated marine turtle hatchlings successfully oriented seaward after emergence at South West Regnard Island, North East Regnard Island, and CPE beach. At Steamboat Island, the majority of fans occurred on the southernmost spit, and as a result had much larger spread and offset angles. Emergence patterns on island spits are typically irregular, due to the presence of the ocean across multiple bearings to the nest cone, and the position of the nest further back on the beach. Despite this, the nest fans at Steamboat Island also indicated that hatchlings oriented seaward.

Steamboat Island was in the top three monitored locations for sky brightness, behind CPE (brightest) and equivalent to the eastern beach of South West Regnard Island. Sino Iron's export facility at Cape Preston was the largest contributor to visible artificial light at Steamboat Island.

**Monitoring Season 2 – 2023/2024**

Three field surveys have been commissioned for the 2023/2024 monitoring period. One field survey was undertaken in October 2023 with the remaining two surveys undertaken in January and February 2024 (Pendoley Environmental, 2024).

FS1 recorded 47 overnight Hawksbill Turtle tracks, including eight false crawls, 22 attempts, and 17 nests. The nesting success rate for this species during the peak of the nesting season was 36.2 %. One track (false crawl) from an unknown species was also recorded on North East Regnard Island. No tracks from other marine turtle species were recorded.

FS2 recorded 11 overnight Hawksbill Turtletracks, including eight attempts and three false crawls, and no nests which was lower compared to 2022/23. Six Flatback Turtle tracks were recorded which included three nests, one attempt, and two false crawls, resulting in a nesting success rate of 16.7% which was lower compared to 2022/23 (28.5%). Three Green Turtle tracks were also recorded, consisting of two nests and one false crawl, making the nesting success rate 66.7% for this species.

FS3 recorded 12 overnight Hawksbill Turtle tracks, including one nest, eight attempts, and three false crawls, resulting in a nesting success rate of 8.3%. One Flatback Turtle nest was also recorded, with no other tracks, making the nesting success rate 100% for this species.

Hawksbill nesting activity accounted for the greatest number of tracks in the overall monitoring period. The highest density of nesting activity occurred on the south-east side of Steamboat Island. Overall nesting success was high for Hawksbill Turtles in FS1 at 36.2%, meaning the majority of Hawksbill Turtle tracks represented unsuccessful nesting attempts (47%) or false crawls (17%). Flatback and green turtle nesting was found to be present but marginal when combined for all routine monitoring beaches.

The results of the 2022/23 and 2023/24 monitoring seasons indicated that South West Regnard Island supports more Hawksbill Turtle nesting than the adjacent mainland at CPE and nearby North East Regnard Island.

Nest fans indicated marine turtle hatchlings successfully oriented seaward after emergence at South West Regnard Island, North East Regnard Island, and CPE. At Steamboat Island, several nest fans occurred on a sand spit, and as a result had much larger spread and offset angles. Emergence patterns on island spits are typically irregular, due to the presence of the ocean across multiple bearings to the nest cone, and the position of the nest further back on the beach. Despite this, the nest fans at Steamboat Island also indicated that hatchlings oriented seaward (Pendoley Environmental, 2024).

In addition, Nocterra Pty Ltd completed a 15-day hatchling orientation survey in February and March 2025 which aligned with the peak hatching period for flatback turtles in the region and new moon period. Thus survey targeted the T3 section of mainland beach situated ~2 km to the southwest of 40-Mile Beach. This section, located west of 40-Mile Beach, had previously shown very low overnight nesting activity (one fresh track recorded over four days). The report prepared by Nocterra Pty Ltd (Nocterra, 2025) advised that no turtle activity was recorded on the mainland beach referred to as 'T3'. There was also no evidence of adult turtle nesting activity, including the presences of historical nesting ‘craters’. This is likely a combination of naturally low turtle usage in the area, unsuitable conditions for the successful incubation and hatching of any nests that may have been laid and inundation of existing nests from high seas following the close passage of Tropical Cyclone Sean in January. The result of the nesting habitat assessment indicate that much of the T3 beach is unlikely to provide suitable nesting habitat for flatback turtles (Nocterra, 2025).

Prior to the comprehensive surveys undertaken by Pendoley Environmental (2023 & 2024), O2 Marine (2022b) undertook some preliminary survey work predominantly focussed on the mainland. While outside of the Hawksbill peak nesting period, these drone surveys also noted that Flatback and Green turtles were found to infrequently nest in low densities on the mainland throughout the survey period within the Proposal site.

Generally, Pilbara islands are recognised as being important for turtle nesting. At broad spatial and temporal scales, islands in the Pilbara have been found to be more important for nesting than the mainland. However, habitat characteristics, and therefore nesting importance, varies across islands.

*Sea Snakes*

The Short-nosed Sea Snake (*Aipysurus apraefrontalis*) is typically found in reef flats or shallow waters along the outer reef edge. The species has been observed during daylight hours, resting beneath small coral overhangs or coral heads in 1 - 2 m of water. Very few Short-nosed Sea Snakes moved even as far as 50 m away from the reef flat.

The Leaf-scaled Sea Snake occupies protected parts of reef flats, adjacent to coral and coral substrates, generally found in <10 m depths. They can be found in exposed tidal pools and are able to tolerate high water temperatures. The species have a restricted geographical range of <10 $km^2$.

The species niche model (Udyawer et al. 2020) indicates a 50% or greater possibility of habitat suitability for both species in and around the Proposal development envelopes. This is based on the habitat description and the mapped subtidal BCH types within the study area. Given the species high conservation value and suitable habitat within the Proposal area, both species are considered to have a medium likelihood of occurrence. (relevant it could be present, it should be considered a key species

*Fish*

Information in this section has been sourced from O2 Marine (2025e) provided in Appendix 4.1.

The nearshore area of the North Coast Bioregion contains a low to moderate abundance of finfish, with species richness typically ranging from low nearshore to high further offshore. Marine species within the nearshore area are predominantly tropical and are short-lived with high productivity, resulting in life-history traits of high fecundity, high productivity and high input into reproduction during their relatively short life spans. Key fish species such as the southern bluefin tuna are found in the nearshore and offshore environment.

Southern bluefin tuna are migratory fish, crossing the Pacific, Atlantic and Indian Ocean during their annual migration. Southern bluefin tuna typically occur in waters between 30 – 50° S. Every year between September and April, adult southern bluefin tuna (aged 11 - 12 years) migrate from southern feeding areas to their single identified spawning ground in the waters south of Indonesia. When migrating to their spawning grounds individuals are found close to the coastline, with approximately 84% of their time spent in the Australian Fishing Zone (Commonwealth waters, generally from three nautical miles to 200 nautical miles from the Australian coast).

Southern bluefin tuna have a 'low' likelihood of occurrence within waters of the development envelopes. They are deep ocean migratory fish species and unlikely to be nearshore. Spawning habitat does not exist in the development envelopes, and it is unlikely that foraging grounds are restricted to these areas.

Additional information about commercial fishery species is provided in Section 9.3.12.

### *Threatened Flora*

No Threatened Flora species listed under the EPBC Act were recorded during the field surveys. *Minuria tridens* was identified in the desktop review as potentially occurring however this was based on the records found at the Mardie Project, which have since been determined to be a new *Minuria* species and not the Threatened *Minuria tridens* (Dillon et al., 2025).

### *Terrestrial Mammals*

The Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) is listed as Vulnerable under the EPBC Act and was identified from a single detection. The Pilbara Leaf-nosed Bat is not a resident as no geological formations are present to form suitable roost caves. The record of a single detection in April suggests a post-maternity, dispersing individual. Pilbara Leaf-nosed Bats roost in warm and humid caves. At night, individuals disperse outside of their caves to forage in the open, often over open water.

In the Pilbara, this habitat is almost exclusively present in large creek beds and gorges. Pilbara Leaf-nosed Bats also forage over *Triodia* grasslands, usually flying close to the ground up to 3 m high.

The Ghost Bat (*Macroderma gigas*) is listed as Vulnerable under the EPBC Act and was considered likely to occur within the TFSA but was not recorded during the field surveys. The riparian vegetation along the creeklines represent potential foraging habitat for the Ghost Bat.

The Northern Quoll (*Dasyurus hallucatus*) is listed as Endangered under both the EPBC Act and the BC Act and was recorded at six sites including from tidal samphire shrubland, approximately 800 m from the coast (Phoenix, 2022). Curtin University (Cowan, 2023; Appendix 6.3) completed a review of the Northern Quoll conclusions of Phoenix (2023) and determined that there was little to support suggestions that the Northern Quoll was a resident of the broader TFSA. This is primarily because four of the six sites where the Northern Quoll was recorded were on the eastern periphery of the TFSA, with the other two sites not representative of the Proposal area and with only secondary evidence.

The Northern Quoll camera trapping monitoring program conducted by Curtin University (Cowan, 2024), only recorded Northern Quoll at a single location within Devil Creek (foraging/dispersal habitat) between 13 March and 17 May 2024 on a total of six nights (Figure 12-11). No Northern Quolls were detected in the 'critical habitat' identified by Phoenix (2023). Cats were detected on a total of 14 independent occasions with the highest frequency, nine occasions, in the area identified as critical habitat (Figure 12-12).

Northern quolls were detected at relatively regular intervals from a single camera in the Devil Creek area, yet no detections occurred with even higher camera density and numbers in the 'critical habitat'. It is possible that the relatively close proximity to known populations of Northern Quolls at both the Devil Creek mining camp and within Devil Creek could result in occasional animals, primarily males undertaking large traverses during the breeding season, encountering this area. However, the lack of a clear pathway and the shallow, exposed drainage tracts suggest such occurrences would be rare, if they occur at all. Additionally, the small size and limited rock complexity of the area would provide inadequate thermal protection under extreme Pilbara conditions, further reducing its suitability for Northern Quolls.

This study concluded that there is no evidence of Northern Quolls either being resident or utilising areas identified as critical or foraging/dispersal habitat within the disturbance footprint.

The camera traps were reviewed again for the period between 24 July and 18 October 2024 and there were again no detections of Northern Quolls within the so-called 'critical habitat'. There were a few detections at the same sites where they were previously recorded in Devil Creek. Cats remained common and widespread.

Based on the monitoring work completed by Curtin University (Cowan, 2024), habitat identified by Phoenix (2023) as being potential denning and foraging habitat is no longer considered to be habitat and is not discussed further.

***Night Parrot***

Historical records of the Night Parrot and of the habitat suggests it is unlikely Night Parrots occur within the PIDE (Leseberg, 2024). There are no high veracity historical records of Night Parrot from the region, and although this does not mean Night Parrots never occurred in the area, it is possible the area was never a stronghold for the species. All sites where Night Parrots have been found in the last decade are notable for the availability of suitable roosting and foraging habitat at the landscape scale. Although there are significant amounts of foraging habitat available, an analysis of potential roosting habitat suggests it is of limited extent within the PIDE.

Adaptive NRM (Leseberg, 2025) completed acoustic surveys for Night Parrot in the identified potential habitat. A total of 59,443 Kaleidoscope detections were manually assessed for Night Parrot vocalisations. No calls attributable to Night Parrots were detected during the analysis and no other significant fauna species were detected.

All sites where Night Parrots have been found in the last decade are notable for the availability of significant amounts of suitable roosting and foraging habitat at the landscape scale. Although there are significant amounts of foraging habitat available, an analysis of potential roosting habitat suggests it is of very limited extent within the PIDE. It is unlikely this small area of roosting habitat is critical to supporting a population of Night Parrots at the landscape scale. The acoustic surveys have confirmed that there are unlikely to be Night Parrots currently residing in that small area of potential roosting habitat.

If a population of Night Parrots does exist in the wider landscape, it is possible that the foraging habitat within the PIDE is used occasionally by this population. Previous examination of available imagery suggests that similar foraging habitat occurring within the PIDE is widespread at the landscape scale, and that the expected disturbance of such habitat will not significantly impact the availability of foraging habitat at this scale.

The results of all work to determine whether Night Parrots could occur within the PIDE suggest that the PIDE does not support a population of Night Parrots, and that any disturbance within this area is unlikely to adversely affect any population of Night Parrots that may occur within the wider landscape (Leseberg, 2025).

### *Terrestrial Reptiles*

No terrestrial reptile species listed under the EPBC Act were recorded during the field surveys. One species was however identified as likely to occur within the TFSA; the Pilbara Olive Python (*Liasis olivaceus barroni*).

### *Grey Falcon*

The Grey Falcon (*Falco hypoleucos*) is listed as Vulnerable under the BC Act. This species was not recorded within the TFSA, but was recorded immediately to the east of the TFSA as a known nest site on a communications tower on the North West Coastal Highway.

### *Migratory Shorebirds*

The EAAF migratory shorebird survey recorded 21 of the 37 species listed under the EPBC Act Policy Statement 3.21 (DotEE, 2017b). Of these, 14 were recorded in nationally and internationally in significant numbers. All 21 species were recorded in the summer sampling events, and eight were recorded overwintering; no new species were confined to the overwintering survey.

The recorded species are listed in Table 16-5 and the collated locations of Migratory bird records are shown in Figure 12-13 to Figure 12-15.

**Table 16-5: Migratory bird species recorded within the SBSA**

| Species | EPBC Act | Records (no. of individuals) |
|---|---|---|
| Common Sandpiper (*Actitis hypoleucos*) | Migratory | 198 |
| Ruddy Turnstone (*Arenaria interpres*) | Migratory | 2,260 |
| Sharp-tailed Sandpiper (*Calidris acuminata*) | Migratory | 1,452 |
| Sanderling (*Calidris alba*) | Migratory | 373 |
| Red Knot (*Calidris canutus*) | Endangered, Migratory | 390 |
| Curlew Sandpiper (*Calidris ferruginea*) | Critically Endangered, Migratory | 148 |
| Red-necked Stint (*Calidris ruficollis*) | Migratory | 10,682 |
| Great Knot (*Calidris tenuirostris*) | Critically Endangered, Migratory | 338 |
| Greater Sand Plover (*Charadrius leschenaultii*) | Vulnerable, Migratory | 1,428 |
| Lesser Sand Plover (*Charadrius mongolus Atrifrons*) | Endangered, Migratory | 3 |
| Oriental Plover (*Charadrius veredus*) | Migratory | 252 |
| Oriental Pratincole (*Glareola maldivarum*) | Migratory | 91,447 |
| Bar-tailed Godwit (*Limosa lapponica*) | Migratory | 4,077 |
| Black-tailed Godwit (*Limosa limosa*) | Migratory | 7 |
| Eastern Curlew (*Numenius madagascariensis*) | Critically Endangered, Migratory | 301 |
| Whimbrel (*Numenius phaeopus*) | Migratory | 1,709 |
| Pacific Golden Plover (*Pluvialis fulva*) | Migratory | 62 |
| Grey Plover (*Pluvialis squatarola*) | Migratory | 146 |
| Grey-tailed Tattler (*Tringa brevipes*) | Migratory | 9,519 |

| Species | EPBC Act | Records (no. of individuals) |
|---|---|---|
| Common Greenshank (*Tringa nebularia*) | Migratory | 2,470 |
| Terek Sandpiper (*Xenus cinereus*) | Migratory | 426 |

### 16.3.3 HABITAT SUITABILITY FOR MNES

The Short-nosed Sea Snake (*Aipysurus apraefrontalis*) is typically found in reef flats or shallow waters along the outer reef edge. The species has been observed during daylight hours, resting beneath small coral overhangs or coral heads in 1 - 2 m of water. Very few short-nosed sea snakes moved even as far as 50 m away from the reef flat.

Based on the above habitat description and the mapped subtidal BCH types within the Study Area suitable habitat for the short-nosed sea snake is unlikely to occur in proximity to the development envelopes.

The Leaf-scaled Sea Snake occupy protected parts of reef flats, adjacent to coral and coral substrates, generally found in <10 m depths. They can be found in exposed tidal pools and are able to tolerate high water temperatures. The species have a restricted geographical range of <10 km$^2$. Low habitat suitability makes it is unlikely the species would be in vicinity of the Proposal.

***Fish***

Information in this Section has been sourced from O2 Marine (2025e) provided in Appendix 4.1.

The nearshore area of the North Coast Bioregion contains a low to moderate abundance of finfish, with species richness typically ranging from low nearshore to high further offshore. Marine species within the nearshore area are predominantly tropical and are short-lived with high productivity, resulting in life-history traits of high fecundity, high productivity and high input into reproduction during their relatively short life spans. Key fish species such as the southern bluefin tuna are found in the nearshore and offshore environment.

Southern Bluefin Tuna have a 'low' likelihood of occurrence within waters of the development envelopes. They are deep ocean migratory fish species and unlikely to be nearshore. Spawning habitat does not exist in the development envelopes, and it is unlikely that foraging grounds are restricted to these areas. Additional information about commercial fishery species is provided in Section 9.3.12.

***Terrestrial Mammals***

The Pilbara Leaf-nosed Bat was identified from a single detection southwest of the PIDE. Only certain diurnal roost sites are considered critical habitat for the Pilbara Leaf-nosed bat (Bat Call WA Pty Ltd, 2021a). No suitable roost sites (critical habitat) were recorded within the TFSA. Pilbara Leaf-nosed Bats forage over *Triodia* grasslands, usually flying close to the ground up to 3 m high. Extensive foraging habitat is present across the PIDE.





The Ghost Bat was considered likely to occur within the TFSA but was not recorded during the field surveys. Only certain diurnal roost sites are considered critical habitat for the Ghost Bat (Bat Call WA Pty Ltd, 2021b). No suitable roosts (critical habitat) were recorded within the TFSA. The riparian vegetation along the creeklines represent potential foraging habitat for the Ghost Bat.

***Terrestrial Reptiles***

The Pilbara Olive Python is listed as Vulnerable under the EPBC Act and is commonly found in rocky areas in association with watercourses and pools. The species is also found in areas of permanent pooling water near rocky habitats, such as gullies, gorges and rocky ranges or boulder sites. This species was not recorded during searches but suitable habitat is present in the spinifex and tussock grasslands as well as the creeklines. Critical habitat has not been defined for the Pilbara Olive Python.

***Grey Falcon***

This species has a large foraging range and will therefore forage within the TFSA. Spinifex grasslands is a known habitat type for the Grey Falcon, which is where the nest was recorded.

***Migratory Shorebirds***

Under the EPBC Act, 'important habitat' is a key concept for migratory species (DotEE, 2017b). Important habitats in Australia for migratory shorebirds under the EPBC Act include those recognised as nationally or internationally important. The accepted and applied approach to identifying internationally important shorebird habitat has been through the use of criteria adopted under the Ramsar Convention on Wetlands (DotEE, 2017b).

It is evident from the heat maps (Figure 12-16 to Figure 12-19) that on low tide when the intertidal mudflats are exposed the shorebirds move out of the SBSA and are highly concentrated in the bay and island immediately north of the Proposal, and in the 'delta' south of Cape Preston, to the west of the Proposal. At high tide when the mudflats are inundated, the birds move back into the SBSA to forage in the tidal samphire shrublands and mangroves, and on exposed sand bars in the tidal channels, but are more diffuse. However, important aggregations (roosting) still occur on high tide on the beaches west of 40-Mile Beach, on the island offshore and also at the delta south of Cape Preston. The same pattern is evident in winter, but there are far fewer birds in the area at that time.

## 16.4 RELEVANT IMPACTS

Sections 6 - 12 of this ERD have assessed the potential impacts on MNES in detail. To avoid repetition, Table 16-6 summarises the findings of those assessments as applicable to MNES.

Table 16-6: Potential Impacts to MNES

| Potential Impact | Relevant MNES | Assessment of Impacts |
|---|---|---|
| **Direct disturbance/loss of habitat** | | |
| Disturbance of up to 10,950.3 ha of foraging habitat. | Pilbara Leaf-nosed Bat<br>Ghost Bat | **Nature and extent of impact:**<br>Approximately 10,950.3 ha of potential foraging habitat including spinifex grasslands, tussock grasslands and eucalypt woodland.<br>**Unknown, unpredictable or irreversible impacts:**<br>Irreversible impact of disturbance to 10,950.3 ha of potential foraging habitat.<br>No unknown or unpredictable impacts are predicted from disturbance of Pilbara Leaf-nosed Bat and Ghost Bat foraging habitat.<br>**Significance of impacts:**<br>Of the 22,540.8 ha potential Pilbara Leaf-nosed bat and Ghost Bat foraging habitat within the TFSA, up to 10,950.3 ha (49%) is subject to disturbance. The nearby pools and creeks are likely to be regularly used as a water source or foraging by both species, however McKay Creek and Devil Creek will not be significantly impacted by the Proposal.<br>Based on the above assessment, the majority of the predicted disturbance impacting the Pilbara Leaf-nosed Bat and Ghost Bat is unavoidable. The predicted disturbance to the Pilbara Leaf-nosed Bat and Ghost Bat is considered significant, and therefore offsets are proposed under the PEOF to counterbalance the impacts to these species in Section 15.<br>**Additional technical data:**<br>• Section 12.3.6 provides details on likelihood of occurrence and habitat assessment within the TFSA;<br>• Section 12.5.2 provides further detail regarding the assessment of significance of the potential impacts; and<br>• Phoenix (2023; Appendix 6.1) provides further technical information on bat species potentially occurring within the TFSA. |
| Disturbance of up to 20.8 ha of potential foraging habitat | Pilbara Olive Python | **Nature and extent of impact:**<br>Disturbance up to approximately 20.8 ha of potential foraging habitat to allow the development of Proposal infrastructure. Potential habitat comprises spinifex grasslands, tussock grasslands and eucalypt woodland.<br>**Unknown, unpredictable or irreversible impacts:**<br>20.8 ha of irreversible disturbance to potential foraging habitat.<br>No unknown or unpredictable impacts are predicted from disturbance of potential Pilbara Olive Python habitat.<br>**Significance of impacts:**<br>The Pilbara Olive Python was not recorded during surveys of the TFSA however it is considered likely to occur within the PIDE. Of the 209.4 ha of potential foraging habitat within the PIDE, up to 20.8 ha (9.9%) is subject to disturbance.<br>The predicted disturbance to the Pilbara Olive Python is considered significant, and therefore offsets are proposed under the PEOF to counterbalance the impacts to these species in Section 15.<br>**Additional technical data:**<br>• Section 12.3.6 provides details on likelihood of occurrence and habitat assessment within the TFSA;<br>• Section 12.5.4 provides further detail regarding the assessment of significance of the potential impacts; and |

| Potential Impact | Relevant MNES | Assessment of Impacts |
|---|---|---|
| | | • Phoenix (2023; Appendix 6.1) provides further technical information on the Pilbara Olive Python potentially occurring within the TFSA. |
| Disturbance of up to 1,954.4 ha of potential foraging habitat | Grey Falcon | **Nature and extent of impact:**<br>Disturbance of up to 1,954.4 ha of potential foraging habitat to allow the development of the Proposal. Spinifex grasslands, tussock grasslands, mudflats and salt flats, eucalypt forests and woodlands, mangal and samphire shrubland habitat may provide foraging habitat within the development envelopes.<br>**Unknown, unpredictable or irreversible impacts:**<br>1,954.4 ha of potential foraging habitat is unavoidable.<br>No unknown or unpredictable impacts are predicted from disturbance of habitat.<br>**Significance of impacts:**<br>The Grey Falcon was not recorded during surveys of the TFSA however it is considered likely to occur within the PIDE. Of the 5,547.0 ha of broad foraging habitat within the TFSA, up to 1,954.4 ha (35.2%) is subject to disturbance.<br>The predicted disturbance to the Grey Falcon is considered significant, and therefore offsets are proposed under the PEOF to counterbalance the impacts to these species in Section 15.<br>**Additional technical data:**<br>• Section 12.3.6 provides details on likelihood of occurrence and habitat assessment within the TFSA;<br>• Section 12.5.5 provides further detail regarding the assessment of significance of the potential impacts; and<br>• Phoenix (2023; Appendix 6.1) provides further technical information. |
| Disturbance of up to 576.3 ha of potential habitat and an additional 2,392.2 ha of Oriental Pratincole habitat. | Migratory Birds | **Nature and extent of impact:**<br>3,295.6 ha of potential foraging and roosting habitat recorded within the LAUs and up to 576.3 ha (10.8%) is subject to disturbance. Potential habitat includes samphire shrubland, mudflats, algal mats and mangroves. 2,392.2 ha of additional potential Oriental Pratincole habitat is expected to be disturbed, up to a total of 3,623.2 ha for this species.<br>**Unknown, unpredictable or irreversible impacts:**<br>576.3 ha of potential habitat is unavoidable. Up to 2,407.3 ha of additional potential Oriental Pratincole habitat is expected to be disturbed, up to a total of 2,983.6 ha for this species.<br>No unknown or unpredictable impacts are predicted from this disturbance of habitat.<br>**Significance of impacts:**<br>Of the 3,295.6 ha potential migratory shorebird habitat within the LAUs, up to 576.3ha (10.8%) is subject to disturbance.<br>In addition, the Oriental Pratincole, which was found in internationally significant numbers, has the potential to forage within spinifex grassland and tussock grassland habitat types, as well as the potential habitat listed above. It is assumed that the Oriental Pratincole is unlikely to travel significant distances inland, and as such spinifex grassland and tussock grassland is considered to be the additional habitat primarily utilised by this species. Up to 2,392.2 ha of additional potential Oriental Pratincole habitat is expected to be disturbed, up to a total of 2,983.6 ha for this species.<br>**Additional technical data:**<br>• Section 12.3.6 provides details on likelihood of occurrence and habitat assessment; |

| Potential Impact | Relevant MNES | Assessment of Impacts |
|---|---|---|
| | | • Section 12.5.6 provides further detail regarding the assessment of significance of the potential impacts; and<br>• Phoenix (2023; Appendix 6.1) provides further technical information on Migratory bird species potentially occurring within the LAUs. |
| Disturbance of up to 47.0 ha of subtidal and 8.3 ha of intertidal marine fauna habitat.<br>Vessel/propeller strike | Flatback Turtle<br>Hawksbill Turtle<br>Green Turtle<br>Short-nosed sea snake<br>Leaf-scaled sea snake<br>Humpback Whale<br>Australian Humpback Dolphin<br>Indo-Pacific Bottlenose Dolphin<br>Dugong<br>Green Sawfish | **Nature and extent of impact:**<br>Disturbance of up to 47.0 ha of subtidal marine fauna habitat and up to 8.3 ha of intertidal marine fauna habitat to allow development of the seawater intake and concentration ponds and crystallisers.<br>O2 Marine (2025e) found that the nearshore islands and tidal creeks (including mangroves) represent the most important feeding areas for turtles, with seagrasses and macroalgae BCH comprising those important feeding habitats. Disturbance comprises 8.3 ha of mangroves,. Disturbance in these areas is related to the construction of concentration ponds, primary seawater intake, bitterns pipeline and associated works.<br>Increased risk of death or injury as a result of vessel strike, dredging or disposal of dredged material.<br>**Unknown, unpredictable or irreversible impacts**:<br>Cumulative losses of 8.3 ha (0.65%) of BCH mangroves from the Proposal.<br>No unknown impacts are predicted from this direct disturbance of habitat.<br>The growth of new mangrove communities on built structures (i.e., pond walls are difficult to predict.)<br>**Significance of impacts**:<br>Losses to marine fauna habitats have been minimised at the Proposal, with seagrass/macroalgae losses (including seagrass with filter feeders and seagrass with macroalgae) of 4.1 ha, approximately 0.2% of the mapped extent within the LAUs. Losses of macroalgae is predicted to be lower, at 0.1 ha, which equates to only 0.005% of the mapped extent within the LAUs.<br>Hawksbill, Flatback and Green Turtles were found to use beaches north of the Proposal at low and varying levels. South West Regnard Island, North East Regnard Island, Steamboat Island and beaches on the mainland represent nesting habitat for turtle species (Flatback, Green and Hawksbill turtles).<br>The short-nosed sea snake and leaf-scaled sea snake were found to use reef flats or shallow waters along the outer reef edge and seagrass meadows. Losses of habitat for these species are not predicted to be significant given they are likely to range well outside the LAUs. Seagrass beds and coral reef are of specific interest to sea snakes as key habitat, however only 4.1 ha and 3.8 ha, or 0.2% and 0.1%, respectively, of the mapped extent within the LAUs is predicted to be lost as a result of the Proposal, which is unlikely to affect the local or regional population.<br>Losses of habitat for marine mammals including Humpback Whale, Australian Humpback Dolphin, Indo-Pacific Bottlenose Dolphin and Dugong, are not predicted to be significant given marine mammals are likely to range well outside the LAUs. Seagrass beds are however of specific interest to Dugong as key foraging habitat, however only 4.1 ha, or 0.2% of the mapped extent within the LAUs was predicted to be lost as a result of the Proposal, which is unlikely to affect the local or regional population.<br>The habitats surveyed included mangrove creeks and coastal mudflats that appeared to be ideal sawfish habitat, similar to habitats where sawfish are found elsewhere in the region. Extreme shallows represent an important habitat for these elasmobranchs. Similar observations have been made in the Onslow area from tracked Green Sawfish, where neonates and young juveniles almost exclusively use shallow areas less than 1 m, and often less than 20 cm for both refuging and foraging areas (Morgan et al. 2023). Availability of these extreme shallow areas is often limited to specific periods during the tidal cycle, and therefore maintaining access time to the shallow areas during high tides is particularly important (Morgan et.al., 2025). However, only one Green Sawfish was detected during a UAV flight in October 2023 (Morgan et.al., 2025) despite extensive survey effort whereby a comparable trip in the region saw six sawfish caught during said survey by O2 Marine (2023a). This |

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| | | indicates that the area is unlikely to be a major habitat or a pupping ground for any sawfish species. The assessment in Section 9.5.5 also identified that impacts to potential habitat are unlikely to be significant.<br>Cumulative losses mangroves within the study area were calculated to be 0.6% of the total mangrove area and less than 1% for mangrove biomass. Within LAU2 (which intersects RSMA#9) cumulative losses will be incurred at 1.7 ha. There are no predicted additional losses for mangroves in LAU1 which also intersects with RSMA#9.<br>The likelihood of vessel strike during dredging and construction activities remains low given that Leichhardt will align the timing of construction activities to avoid key environmental windows such as whale migration, sawfish pupping, turtle nesting and fish and coral spawning, in addition to the small distances traversed by the vessels, the slow speed of the vessels and the minor areas of foraging habitat in the vicinity of the dredge working areas. Minimum separation distances will be maintained between vessels and prescribed fauna as described in the BC Regulations. The consequence of vessel strike on marine turtles, marine mammals, sawfish, and reef manta rays may result in injury or mortality, although given this is unlikely to occur except on rare occasions. Potential impacts from Proposal activities are unlikely to result in significant declines in the local or regional populations of species and their distribution, or reductions in the diversity of species.<br>**Additional technical data:**<br>• Sections 8.3.3– 8.3.4 provide detail regarding LAUs, intertidal BCH and subtidal BCH, respectively;<br>• Section 9.3.3 provides detail regarding BIAs that overlap the marine elements of the Proposal;<br>• Sections 9.3.4 – 9.3.6 provides detail regarding the distribution and likelihood of occurrence of marine mammals, elasmobranch species and marine reptiles, respectively;<br>• Sections 9.5.2– 9.5.5 provides detail regarding assessment of significance of the potential impacts of marine turtles, marine mammals and green sawfish, respectively; and<br>• O2 Marine (2025e; Appendix 4.1) provides further technical information regarding marine fauna within the study area. |
| Entrapment in seawater intakes | Flatback Turtle<br>Hawksbill Turtle<br>Green Turtle | **Nature and extent of impact:**<br>A seawater intake is required for the Proposal. The seawater intake located in McKay creek and used as an intake for the concentration ponds and crystallisers (Figure 2-2; Section 2.2.3). O2 Marine (2025e; Appendix 4.1) determined that turtles and fish species are likely to be present in the vicinity of the proposed seawater intakes and therefore there was the potential for marine fauna to become trapped within the intakes.<br>An intake flow rate of less than 0.15 m/s is recommended by the US Environmental Protection Agency (2001) as it ensures the protection of 96% of fish species, and is lower than the swim speed of marine turtles. This flow rate has been adopted at a number of seawater intakes in WA including Anketell Port, the Mardie Project, The Wheatstone Development, the Cape Preston Desalination Plant and Adelaide Desalination Plant.<br>The tidal creek intake pipes are to be located within a screened enclosure. Water within the enclosure rises and falls with the tide, and the intake pumps are to be operated when water depths are equal to or greater than 0.0 m AHD. The intakes will draw in water through all sides of the perimeter screen, resulting in an even flow rate around the perimeter of less than 0.15 m/s.<br>The seawater intake will draw in up to 31 $m^3$/s, never abstracting below 0.0 m AHD. Extraction will be over 2 x 6-hour tidal periods per day with the abstraction rate up to 30$m^3$/second at high tide. A similar screened enclosure (albeit a smaller size) will be installed at the jetty pump station to again ensure an even flow rate of less than 0.15 m/s around the perimeter of the screen.<br>This will ensure flow rates are low enough to allow marine turtles to swim against the current and not become trapped against the enclosure screens. Consequently, the risk of entrapment of marine turtles at the seawater intakes is considered to be low.<br>**Unknown, unpredictable or irreversible impacts**: |

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| | | Entrapment impacts were able to be predicted given the proposed flow rate and known swim speed of marine turtle hatchlings.<br>No irreversible impacts are predicted from this indirect impact.<br>**Significance of impacts**:<br>The Proposal will have two seawater intake stations with multiple pumps, posing a risk of marine fauna entrapment if not designed and operated appropriately. Leichhardt has committed to two specific mitigation measures for these intakes; screens will be installed to prevent marine turtles from being drawn into the intake pipe, and the intake has been designed such that the intake velocity is maintained below 0.15 m/s at all times. This velocity is recommended by the US Environmental Protection Agency (2001) as it ensures the protection of 96% of fish species, and is lower than the swim speed of marine turtles. With the implementation of these two controls the risk of marine turtle entrapment is expected to be lowered to an acceptable level.<br>**Additional technical data**:<br>• Section 9.3.6 provides detail regarding marine turtles and their habitat identified within the study area;<br>• Section 9.5.2 provides further detail regarding the assessment of significance of the potential impacts;<br>• Pendoley Environmental (2023 & 2024, Appendix 4.2), Nocterra (2025; Appendix 4.2) and O2 Marine (2022b; Appendix 4.2) provides further technical information regarding turtle nesting; and<br>• O2 Marine (2025e; Appendix 4.1) provides further technical information regarding significant marine fauna. |
| As described in the mangrove assessment in Section 8 – BCH | Migratory Birds | **Nature and extent of impact:**<br>Irreversible loss of 8.3 ha of mangroves are predicted to occur as a result of the Proposal. This amounts to loss of 0.6% of all mangroves within the LAUs and 0.01% of the mapped regional extent. The mangroves within RSMA#9 are the highest value mangroves, which aligns with LAU 1-3. The cumulative loss of mangroves in LAU1 is 0.2%, in LAU2 is 1.7% and LAU3 is 4.5%.<br>**Unknown, unpredictable, or irreversible impacts:**<br>Irreversible disturbance to potential foraging habitat which includes:<br>• Up to 480.7 ha of samphire shrubland BCH;<br>• Up to 8.3 ha of mangroves; and<br>• Up to 87.3 ha of HDAM.<br>No unknown or unpredictable impacts are predicted from disturbance of BCH.<br>**Significance of impacts:**<br>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. However, the losses of mangroves (i.e., 8.3 ha or 0.6% of LAUs) is considered to be a significant reduction in mangrove habitat within RSMA #9. This loss is therefore considered to compromise the EPA (2001) objective for Guideline 3.<br>**Additional technical data:**<br>• O2 Marine (2025b; Appendix 3.1) provides technical information on benthic communities and habitat cumulative loss assessment of the Proposal;<br>• O2 Marine (2025c; Appendix 3.2) provides technical information on the intertidal BCH of the Proposal; and |

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| | | • O2 Marine (2025d; Appendix 3.3) provides technical information on the subtidal BCH of the Proposal. |
| **Indirect Impacts** | | |
| Light spill to the Marine Environment | Flatback Turtle<br>Hawksbill Turtle<br>Green Turtle | **Nature and extent of impact:**<br>The Proposal will require lighting on infrastructure close to the coast. Lighting within these coastal areas will be limited to lighting of the operational areas, in addition to on-demand lights at the seawater intake<br>**Unknown, unpredictable or irreversible impacts**:<br>No irreversible impacts are predicted from this indirect impact.<br>**Significance of impacts**:<br>While exact light emissions are unable to be predicted, it is understood that the Proposal will require relatively low amounts of permanent lighting, particularly close to the coast. Most lighting will be able to be turned off when not required, which will reduce the extent of the lighting impact.<br>The Proposal was predicted to increase the horizon brightness at the Pendoley Environmental (2022; Appendix 4.3) monitoring locations by between 1% and 11% and include lighting that is directly visible from three of the five monitoring sites. While these increases are not significant, any increase in light should be avoided and therefore mitigation measures are proposed to minimise these light impacts (Section 9.6).<br>South West Regnard Island, North East Regnard Island, Steamboat Island and beaches on the mainland represent nesting habitat for turtle species (Flatback, Green and Hawksbill turtles).<br>A risk assessment was undertaken to evaluate the potential for artificial light occurring in the vicinity of the Proposal to cause mis- or disorientation of hatchling sea turtles (Pendoley Environmental, 2023 & 2024). The assessment determined the inherent (unmitigated) risk to be Low at North East Regnard Island, South West Regnard Island and 40-Mile Beach, and Medium at CPE beach.<br>Nevertheless, lighting for all infrastructure will consider design recommendations provided by DotEE (2020) in order to ensure that lighting impacts are as low as practicable.<br>**Additional technical data**:<br>• Section 9.3.6 provides detail regarding marine turtles and their habitat identified within the study area;<br>• Section 9.5.2 provides further detail regarding the assessment of significance of the potential impacts;<br>• Pendoley Environmental (2023, 2024; Appendix 4.2), Nocterra (2025; Appendix 4.2) and O2 Marine (2022b; Appendix 4.2) provide further technical information regarding marine turtle species and use of the mainland coast within the study area; and<br>• Pendoley Environmental (2023, 2024; Appendix 4.2) and Nocterra (2025; Appendix 4.2) provides information regarding turtle nesting and hatchling orientation on the mainland coast and surrounding islands. |
| Marine Noise | Flatback Turtle<br>Hawksbill Turtle<br>Green Turtle<br>Dugong<br>Humpback Whale | **Nature and extent of impact:**<br>Quantification of the Proposal-related shipping identified the majority of marine shipping activity during construction to be the dredging and transport of spoil material to the proposed disposal locations. Dredging is required to develop the proposed berth pocket, TSV channel and anchorages, and the bitterns pipeline channel. The current Proposal design does not require any dredging along the selected channel route for the OGVs. It is anticipated up to 400,000 $m^3$ of material (in situ volume) will be dredged for the Proposal, utilising a single medium sized CSD and two split hopper barges (each with a capacity of ~1,500 $m^3$). Approximately 315 movements of the split hopper barges are estimated to occur between the dredge and disposal grounds. During operations, Panamax sized OGVs, TSVs and a pilot/work vessel will be utilised. |

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| | Australian Humpback Dolphin<br>Green Sawfish<br>Reef Manta Ray | Approximately 990 operational vessel movements per year are anticipated, an increase to the existing vessel traffic at Cape Preston of ~46% (MScience, 2025).<br>On the basis of the underwater noise screening risk assessment, the following conclusions can be drawn regarding the risk of underwater noise impacts to marine fauna from the Proposal's dredging and shipping activities:<br>• The inherent risk to the marine fauna of interest from dredging activities was considered moderate;<br>  o A marine mammal behavioural response was estimated to extend for 6.3 km from the dredging noise source;<br>  o Onset of TTS and PTS for the low frequency cetacean group, including humpback whales, using the worst case SEL24h criteria did not extend beyond 2.21 km and 330 m, respectively, from the dredging noise source;<br>  o Onset of TTS and PTS for the high frequency cetacean, including the Indo-Pacific bottlenose dolphin and Australian humpback dolphin, was estimated to extend for 240 m and 10 m, respectively, of the dredging noise source;<br>  o Onset of TTS in dugongs, using the worst case SEL24h criteria, extends for 50 m from the dredging noise source. Onset of PTS in dugongs was not predicted to occur during dredging activities;<br>  o Onset of TTS and PTS in marine turtles did not extend beyond 260 m and 10 m, respectively, from the dredging noise source; and<br>  o Dredging noise criteria thresholds for fish without a swim bladder (relevant to this assessment) were not reached;<br>• The inherent risk to the marine fauna of interest from operation of the seawater intake pump was considered low; and<br>• The modelled intake pump noise was too quiet to reach any of the noise exposure threshold criteria for marine mammals, marine turtles or fish within the modelling resolution of 10 m.<br>**Unknown, unpredictable or irreversible impacts**:<br>There are unknowns surrounding turtle behaviour following turtles experiencing high noise situations, especially if it is sudden and prolonged.<br>Unknowns and data gaps remain in understanding marine mammal hearing characteristics, as outlined in Section 9.5.1.<br>Marine noise impacts from the Proposal are known and were able to be predicted.<br>No irreversible impacts are predicted from this indirect impact.<br>**Significance of impacts**:<br>Section 9.5.1 describes the underwater noise risk to marine fauna. The inherent risk to marine fauna from dredging activities and the seawater intake pump was considered to be moderate and low, respectively. A marine mammal behavioural response was estimated to extend for 6.3 km from the dredging noise source. Onset of TTS and PTS in marine turtles did not extend beyond 260 m and 10 m, respectively, from the dredging noise source.<br>Modelling of dredging noise approximated that received noise levels may attenuate to below 120 dB re 1 $\mu Pa^2s$ (i.e., the behavioural response level) within 2,000 m and 250 m from the noise source for humpback whales and Indo-pacific and humpback dolphins, respectively.<br>Noise impacts and the density will be greatest during construction activity. Such activity is limited in time, rather than extending over years and is predominantly in inshore areas which minimises impacts on more offshore marine fauna.<br>There is a low probability of marine megafauna being within the vicinity of active construction operations for a sufficient time period to accumulate the requisite length of exposure to noise at damaging levels. The mitigating potential of the proposed management measures further reduces this risk. Overall, risks for noise generating activities and vessel collision impacts were assessed as low.<br>**Additional technical data**:<br>• Section 9.3.6 provides detail regarding marine turtles and mammals and their habitat identified within the study area; |

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| | | • Section 9.5.1 provides more detail about the source and extent of the marine noise and risk pathways for marine fauna;<br>• Section 9.5 provides further detail regarding the assessment of significance of the potential impacts; and<br>• MScience (2025; Appendix 4.6) provides further technical information regarding the underwater noise screening risk assessment. |
| Noise and light spill to the terrestrial environment | Pilbara Leaf-nosed Bat<br>Ghost Bat<br>Pilbara Olive Python<br>Grey Falcon<br>Migratory Birds | **Nature and extent of impact:**<br>Minimal night works are expected during pond construction.<br>The operation of the Proposal will result in low noise and light emissions overall as it relies on solar evaporation for the majority of the process. Noise and light emissions from the ponds are therefore unlikely to be significant enough to affect the behaviour of terrestrial fauna species.<br>Herring Storer Acoustics (2022; Appendix 7.1) completed an acoustic noise study of the noise emissions for the Proposal. The acoustic assessment shows that in the worst case, that noise received at a premise is below the assigned noise level. Thus, noise emissions from the Proposal would be deemed to comply with the requirements of the Regulations.<br>The main source of noise and light emissions will be from the processing plant, which covers only several hectares and is located away from the coastline, and the salt wash plant and stockyard. Lighting controls are proposed as part of the Proposal to minimise impacts to turtle nesting, these controls will also minimise light impacts on terrestrial fauna.<br>**Unknown, unpredictable or irreversible impacts**:<br>No irreversible impacts are predicted from this indirect impact.<br>**Significance of impacts**:<br>While exact light emissions are unable to be predicted, it is understood that the Proposal will require relatively low amounts of permanent lighting, particularly close to the coast. Most lighting will be able to be turned off when not required, which will reduce the extent of the lighting impact.<br>The Proposal was predicted to increase the horizon brightness at the Pendoley Environmental (2022; Appendix 4.3) monitoring locations by between 1% and 11% and include lighting that is directly visible from three of the five monitoring sites. While these increases are not significant, any increase in light should be avoided and therefore mitigation measures are proposed to minimise these light impacts (Section 12.5).<br>**Additional technical data**:<br>• Section 12.3.6 provides details on likelihood of occurrence and habitat assessment;<br>• Section 12.5 provides further detail regarding the assessment of significance of the potential impacts; and<br>• Phoenix (2023; Appendix 6.1) provides further technical information on terrestrial fauna species potentially occurring within the TFSA. |
| Indirect impacts to habitat health | Flatback Turtle<br>Hawksbill Turtle<br>Green Turtle<br>Short-nosed sea snake<br>Leaf-scaled sea snake | **Nature and extent of impact:**<br>Other indirect impacts to habitat health with potential to impact marine reptiles, marine mammals, sawfish and rays include:<br>• Discharge of bitterns;<br>• Increased turbidity due to dredging or disposal of dredged material; and/or<br>• Leaks and spillages of product of hydrocarbons.<br>**Unknown, unpredictable or irreversible impacts**:<br>There are unknown and unpredictable variables around leaks and spillages of product or hydrocarbons as all discharges are expected to be accidental. |

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| | Dugong<br>Humpback Whale<br>Australian Humpback Dolphin<br>Green Sawfish<br>Reef Manta Ray | The Proposal will result in up to 5.9 GL of bitterns discharge to a localised portion of the marine environment per year.<br>No irreversible impacts are predicted from this indirect impact.<br>**Significance of impacts**:<br>While exact product or hydrocarbon emissions are unable to be predicted, it is understood that the Proposal will implement safety measures to prevent and minimise the impact of accidental discharges. Leichhardt will implement standard industry safeguards and operating procedures (Section 7.6) to ensure any offshore spills are expected to be able to be contained and cleaned up such that they do not result in a significant ongoing impact to the marine environment.<br>Bitterns discharge will result in localised impacts on water quality within the LEPA and MEPA. The bitterns discharge 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) (O2 Marine, 2025b). Bitterns disposal will result in indirect irreversible loss to BCH and indirect recoverable impacts to BCH. Irreversible losses include:<br>• 0.1 ha (<0.1% of LAU6) of macroalgae-dominated habitat;<br>• 3.8 ha (<0.1% of LAU6) of hard coral habitat; and<br>• 4.1 ha (<0.1% of LAU6) of seagrass with macroalgae.<br>No indirect recoverable impacts are predicted.<br>Management of the discharge is therefore important, and a MEQMMP has been prepared to detail the monitoring and management measures proposed to ensure impacts are minimised (Appendix 2.1).<br>Dredging will result in impacts on water quality in the vicinity of the dredging activities during dredging and for a short period afterwards. These impacts include increased turbidity and reduced benthic light (O2 Metocean, 2025). The dredging will be carefully managed under the DSDMMP to ensure these impacts are limited to the areas predicted.<br>**Additional technical data**:<br>• Section 7.5.1 and 8.5.1 provides details on bitterns disposal, dredging activities and incidental product or hydrocarbon spills within the Marine Development Envelope.<br>• O2 Marine (2025e; Appendix 4.1) provides further technical information regarding marine fauna species.<br>• O2 Marine (2025c & d; Appendix 3.2 and 3.3) provides further technical information regarding intertidal and subtidal BCH. |
| Alterations to turtle and hatchling behaviours as a result of predation | Flatback Turtle<br>Hawksbill Turtle<br>Green Turtle | **Nature and extent of impact:**<br>Turtle hatchling survival in the wild is heavily influenced by predation. The Proposal may result in an increase in shorebird numbers in the lower salinity pond areas closer to the coast as they have been recorded utilising salt ponds elsewhere in the Pilbara (Johnstone et al., 2013).<br>**Unknown, unpredictable or irreversible impacts**:<br>No impacts would be considered unknown. The presence of shorebird population is known as a result of fauna surveys.<br>No irreversible impacts are predicted.<br>**Significance of impacts**:<br>The SBSA is however already an internationally important wetland site, as the area was found to regularly support >1% of the individuals in a population of one species or subspecies. Therefore, the shorebird population is already well established in the area (i.e., ponds are not being |

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| | | introduced to an area that previously had no significant habitat). Increases in shorebird numbers close to turtle nesting beaches are therefore expected to be negligible and increases in marine turtle predation would be minimal given the distance to the key offshore nesting beaches.<br>**Additional technical data**:<br>• Section 9.3.6 provides detail regarding marine turtles and their habitat identified within the study area;<br>• Section 9.5.2 provides further detail regarding the assessment of significance of the potential impacts; and<br>• Phoenix (2023; Appendix 6.1) provides further technical information on Migratory bird species potentially occurring within the SBSA. |
| Presence of potential barriers to movement (pipelines, dredging) | Sawfish | **Nature and extent of impact:**<br>It is likely that the coastal waters of the Proposal are part of the migratory corridor for juvenile-subadult Green Sawfish based on past studies and sightings. Previous research has suggested that juvenile sawfish do not readily migrate past solid barriers along the coastline, which would force them to swim into deeper water.<br>The Proposal includes a bitterns pipeline from the coastline offshore, which could form a barrier for sawfish if not designed appropriately.<br>The Proposal also includes dredging which could present a potential barrier to sawfish migration. Dredged channels or increased depths in coastal areas could also restrict movement, particularly of juveniles which are limited to shallow areas.<br>**Unknown, unpredictable or irreversible impacts**:<br>There is uncertainty regarding the impact of a non-physical barriers on sawfish movement.<br>No irreversible impacts are predicted.<br>**Significance of impacts**:<br>Leichhardt intends to attach the pipeline to the CPE Port jetty structure, raising it off the seabed, and allowing sawfish to pass underneath. Further from the jetty, the pipeline will reside in a trench to allow sawfish to pass over and therefore not creating a barrier to movement.<br>The dredged areas are generally high points along a defined transhipment vessel corridor, rather than dredging a defined channel, and will commence offshore, rather than extending from the shore. The dredging is therefore unlikely to present a significant barrier to the movement of sawfish.<br>**Additional technical data**:<br>• Section 9.3.5 provides detail regarding sawfish and their habitat identified within the study area;<br>• Section 9.5.5 provides further detail regarding the assessment of significance of the potential impacts; and<br>• Morgan et. al. (2025) and O2 Marine (2023a & 2022c) provides further technical information on the potential impacts to sawfish as a result of the Proposal. |
| Long-term changes to coastal processes around tidal creek systems | Sawfish<br>Marine Turtles | **Nature and extent of impact:**<br>The coastal processes assessment in Section 14 identified that the Proposal will likely modify the creek erosion-recovery cycles. Localised increases in current speed and bed shear stress post-ponds development could also lead to limited loss of mangrove and creek habitats and increased sedimentation east of McKay Creek.<br>**Unknown, unpredictable or irreversible impacts**:<br>There is a level of uncertainty associated with coastal evolution around the Proposal.<br>No irreversible impacts are predicted. |

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| | | **Significance of impacts**:<br>This is likely to gradually reduce the area of foraging habitat available to Green Sawfish and marine turtles. A survey was undertaken in August 2022, October 2023 and 2024 to identify the sawfish species present in the vicinity of the Proposal (O2 Marine, 2023a; Morgan et.al., 2025). No sawfish were captured or tagged, however one Green Sawfish was detected on a UAV flight in the mouth of the intake creek in October 2023 (Morgan et.al., 2025). The occasional sightings of Green Sawfish in the general region and abundance of this species in nearby nursery habitats (e.g., Ashburton River and Fortescue River) suggests that the Cape Preston area is likely an occasional foraging habitat along the migratory corridor for juvenile and sub-adult Green Sawfish. Leichhardt intends to monitor the erosion and accretion of the coastline during operations as it may require the excavation of the tidal creek mouth near the seawater intake. If required, Leichhardt may be able to excavate the openings of other tidal creek mouths to maintain suitable foraging habitat, if recommended by relevant experts and DBCA.<br>**Additional technical data**:<br>• Section 14 provides detail regarding impact of the Proposal on coastal processes;<br>• Larcombe et al. (2025) provides further technical information on coastal processes;<br>• Section 9.3.5 provides detail regarding sawfish and their habitat identified within the study area;<br>• Section 9.5.5 provides further detail regarding the assessment of significance of the potential impacts; and<br>• Morgan et. al. (2025) and O2 Marine (2023a and 2022c) provides further technical information on the potential impacts to sawfish as a result of the Proposal. |
| Introduction or spread of weed species. | Pilbara Leaf-nosed Bat<br>Ghost Bat<br>Pilbara Olive Python | **Nature and extent of impact:**<br>Weeds have the potential to be introduced to the area or spread as a result of the Proposal, with the greatest risks associated with earthmoving during the construction period. Phoenix (2025) identified the presence of *Prosopis glandulosa x velutina* from one quadrat within the study area. The control of the spread of *Prosopis glandulosa x velutina* will require significant controls. If managed correctly, the Proposal may also reduce the current extent of *Prosopis glandulosa x velutina* infestations.<br>**Unknown, unpredictable, or irreversible impacts**:<br>No impacts would be considered unknown. The presence of weed species is known as a result of flora and vegetation survey.<br>No irreversible impacts are predicted.<br>**Significance of impacts**:<br>Leichhardt will implement weed hygiene and management measures and procedures to prevent the spread of weeds and the introduction of new weed species resulting from construction activities and during operations. As a results, impacts associated with the introduction and spread of weeds are not considered to be significant.<br>**Additional technical data**:<br>Phoenix (2025; Appendix 5.1) provides further technical information regarding weed species. |
| Introduced Fauna | Pilbara Olive Python<br>Grey Falcon<br>Migratory Birds | **Nature and extent of impact:**<br>Increased competition from introduced fauna poses an indirect risk to Pilbara Olive Python and Grey Falcon and increased predation or competition from introduced fauna poses an indirect risk to Migratory birds.<br>Three introduced animals were recorded within the TFSA, including dogs, cattle and cats (Phoenix, 2023; Appendix 6.1). The Proposal does not provide any significant vectors for increases in introduced fauna species; the accommodation camp will be relatively small and only in use |

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| | | during construction of the Proposal, and there are no other Proposal activities that would either attract introduced fauna species or aid their survival in the area.<br>**Unknown, unpredictable, or irreversible impacts**:<br>No impacts would be considered unknown. The presence of introduced species is known as a result of fauna surveys.<br>No irreversible impacts are predicted.<br>**Significance of impacts**:<br>With the implementation of mitigation measures the Proposal is not expected to result in additional feral species being introduced and may result in a reduction in the local feral animal population as a result of eradication programs (refer to Section 12.6.2).<br>**Additional technical data**:<br>Phoenix (2023; Appendix 6.1) provides further technical information regarding introduced species. |
| Leaks or spillages | Pilbara Leaf-nosed Bat<br>Ghost Bat<br>Pilbara Olive Python<br>Grey Falcon<br>Migratory Birds | **Nature and extent of impact:**<br>A large spill or leak of brine from the ponds or pipelines, or product infrastructure washdown water could result in impacts to the fauna habitat within adjacent tidal creeks. Brine is the primary resource for the Proposal and as such the concentration ponds, crystallisers and brine pipelines are designed to minimise the risk of leaks, overflows and wall breaches. Pipelines will utilise industry-standard materials to minimise the chance of leaks and mitigation will be implemented to reduce this risk further (refer to Section 12.6). Ponds have been designed with adequate freeboard and overflow features to minimise the risk of unplanned overflows and wall breaches. The ponds include internal weirs to rebalance local excess brine levels and external emergency spillways into adjacent major creeks to avoid cascading internal bund failure leading to massive outflows.<br>There are drainage ditches along the base of all perimeter bunds primarily to intercept groundwater seepage and collect brine for recovery to the process ponds. These will also intercept and contain minor splashing and spillage events.<br>**Unknown, unpredictable, or irreversible impacts:**<br>Brine spills or leaks or washdown water contamination events are expected to be incidental and are therefore unable to be quantified.<br>Chemical characteristics of brine in ponds and pipelines is measured and recorded for operational use.<br>It is not expected that the potential impact would be irreversible.<br>**Significance of impacts:**<br>It is not expected that spills, leaks or washdown water contamination would cause irreversible impacts to the surrounding environment. If a large external overflow was to occur, it is most likely to arise from a major rain event which raises all pond levels. In such events, McKay and Devil Creeks both flow at high levels. In this case the brine overflow will be rapidly mixed with fresh surface water flow and discharged to the ocean. (as outlined in Section 6; Inland Waters).<br>The provision of downslope drainage control such as catch pits has been considered, but not adopted based on the additional clearing that would be required to manage the unlikely risk.<br>**Additional technical data:**<br>• Section 2.2.3 provides detail on brine, pond and drainage characteristics of the Proposal.<br>• O2 Metocean (2023a; Appendix 2.6) provides technical information of bitterns dispersion modelling of the Proposal. |

| Potential Impact | Relevant MNES | Assessment of Impacts |
|---|---|---|
| Vehicle strike | Pilbara Olive Python | **Nature and extent of impact:**<br>The number of vehicles using the access roads will increase due to the Proposal, which will increase the risk of death or injury to fauna individuals due to vehicle strike.<br>**Unknown, unpredictable, or irreversible impacts:**<br>No impacts would be considered unknown.<br>No irreversible impacts are predicted.<br>**Significance of impacts:**<br>Leichhardt will set and enforce vehicle speed limits.<br>General fauna management measures (i.e., rubbish management) will be implemented, as described in Section 11.6. As a result, impacts associated with vehicle strikes are not expected to be significant.<br>**Additional technical data:**<br>Section 12.5 provides further details on the impact of vehicle strikes on significant fauna. |
| Sedimentation | Pilbara Leaf-nosed Bat<br>Pilbara Olive Python<br>Ghost Bat<br>Grey Falcon<br>Migratory Birds | **Nature and extent of impact:**<br>The majority of the disturbance for the Proposal is associated with the flooding of landscape that is inundated to varying degrees by frequent tidal pulses, periodic intense tropical storms and occasional significant catchment discharges. Receiving environments (mangal and samphire habitats) are therefore adept at accommodating changes to local hydrodynamics and sedimentation.<br>Excessive erosion at sections with direct coastal exposure will be prevented by the installation of rock armouring to stabilise the channel structures and reduce water velocity. Further inland, the walls will be constructed to limit permeability between adjacent ponds with some rip-rap protection against wave erosion.<br>Sediment may be released during construction of the pond walls, particularly during flood and heavy rain events. The wall material is generally high in clay content and will be compacted to ensure sediment losses will are minimal. Leichhardt has committed to mitigation measures to reduce the risk of sedimentation (refer to Section 6.6).<br>**Unknown, unpredictable, or irreversible impacts:**<br>No impacts would be considered unknown.<br>No irreversible impacts are predicted.<br>**Significance of impacts:**<br>Implementation of mitigation measures outlined in Section 12.6 is predicted to reduce the impacts of sedimentation such that they are not considered to be significant,<br>**Additional technical data:**<br>Section 12.5.1 provides further detail on the impacts of sedimentation on terrestrial fauna. |
| Alteration of surface water regimes affecting | Pilbara Leaf-nosed Bat<br>Ghost Bat | **Nature and extent of impact:**<br>Changes to the surface water regime |

| Potential Impact | Relevant MNES | Assessment of Impacts |
|---|---|---|
| downstream habitats | Pilbara Olive Python<br>Grey Falcon<br>Migratory Birds | The alteration of surface water regimes (overland and intertidal) has the potential to indirectly impact the health of habitats utilised by these species. There are four potential ways that changes to overland flows caused by implementation of the Proposal could potentially indirectly impact fauna habitats:<br>1. Less freshwater reaches the fauna habitats downstream of the ponds if freshwater flows are diverted away from these areas;<br>2. Less freshwater reaches the vegetation upstream of the ponds if freshwater flows are diverted around the area;<br>3. Increased freshwater inundation occurs within vegetation downstream of the ponds if the habitats are close to the diversion channel outlets; and<br>4. Increased freshwater inundation occurs within vegetation upstream of the ponds if freshwater flows pool against the embankment.<br>The Proposal will maintain the flow paths of Eramurra, McKay and Devil Creek. The presence of the ponds will however alter the size of the creek catchments, and require some diversion of broader floodwaters, resulting in changes in water depths in these creeklines and areas downslope of the ponds. Section 6 (Inland Waters) provides more detail about this modelling and predicted results.<br><u>Groundwater Seepage</u><br>With the implementation of controls, it is predicted that groundwater seepage impacts to fauna habitat could be contained to within 100 m of the walls (generally within the construction disturbance footprint). Potential impacts from this source to each fauna habitat type is provided in Table 12-11. Not all of the fauna habitats in this zone will be impacted, however the calculations provide a conservative estimate of the fauna habitat that could be at risk of impacts.<br>**Unknown, unpredictable or irreversible impacts**:<br>Altered surface water regimes and groundwater mounding and seepage have the potential to impact the following fauna habitat:<br>• Up to 190.6 ha of foraging habitat for the Pilbara Leaf-nosed Bat and Ghost Bat;<br>• Up to 1.6 ha of potential foraging habitat for the Pilbara Olive Python; and<br>• Up to 68.8 ha of foraging habitat for the Grey Falcon.<br>No impacts would be considered unknown as all have been assessed and modelled if required. The changes to flow volumes and rates of overland and intertidal flows have been modelled based on adequate available information, however there will remain some unpredictable elements until further monitoring is conducted and the model can be verified.<br>**Significance of impacts**:<br>Impacts to fauna habitat associated with changes to the surface water regime are not significant when considered in isolation of direct impacts. However, when considered holistically, impacts to fauna habitat (direct and indirect) are considered significant. As a result, offsets have been proposed and are outlined in Section 15.<br>**Additional technical data**:<br>• Section 6.3.3 provides detail regarding the surface water regime of the Proposal;<br>• Section 12.3.4 provides detail regarding the MNES habitats that may be affected;<br>• Section 6.5.2 provides further detail regarding the assessment of significance of the potential impacts to inland surface waters;<br>• Section 12.5.2, 12.5.4, 12.5.5 and 12.5.6 provides detail regarding assessment of significance of the potential impacts to these species;<br>• SWS (2025; Appendix 1.1) provides technical information around storm surge and potential flood flows from inland catchments;<br>• O2 Metocean (2023b; Appendix 1.2) provides technical information on tidal characteristics of the Proposal; and<br>• LWC (2025; Appendix 1.5) provides technical information on groundwater and surface water monitoring of the Proposal. |

| Potential Impact | Relevant MNES | Assessment of Impacts |
|---|---|---|
| | | |
| Attraction and use of concentration and crystallisers | Migratory Birds | **Nature and extent of impact:**<br>The concentration ponds and crystallisers will contain saline and hypersaline water, and as such they will not provide a freshwater source for terrestrial fauna. Nevertheless, shorebirds may be attracted and utilise the shoreline. Shorebirds have been observed to use salt ponds as nesting, foraging and roosting habitats at similar projects where the areas have been classified as IBAs.<br>**Unknown, unpredictable or irreversible impacts**:<br>No impacts would be considered unknown.<br>No irreversible impacts are predicted from indirect impacts if mitigation measures are implemented.<br>**Significance of impacts**:<br>The pond walls will have low embankments with shallow walls and therefore any fauna that enter the ponds are expected to be able to climb out. The proposed mitigation measures (Section 12.6) are expected to minimise fauna entrapment within the ponds and therefore not expected to be a significant impact from the implementation of the Proposal.<br>**Additional technical data**:<br>• Section 12.3.6 provides details on likelihood of occurrence and habitat assessment;<br>• Section 12.5 provides further detail regarding the assessment of significance of the potential impacts; and<br>• Phoenix (2023; Appendix 6.1) provides further technical information on terrestrial fauna species potentially occurring within the TFSA. |

## 16.5 PROPOSED SAFEGUARDS AND MITIGATION MEASURES

The proposed safeguards and mitigation measures are outlined in Table 16-7.

**Table 16-7: Proposed safeguards and mitigation measures**

| Mitigation/ Safeguard Number | Key Mitigation/Safeguard | Detail | Species Affected | Timing | Location | Residual Impact |
|---|---|---|---|---|---|---|
| **Hydrological/Water Quality** | | | | | | |
| 1. | Monitor, where present, groundwater levels and quality down-gradient of the concentration ponds and crystallisers. This is detailed in the GMMP (Appendix 1.9). | A groundwater monitoring well network was established in December 2021 and comprises a total of 11 groundwater wells. As of January 2024, an additional 10 groundwater monitoring wells were installed across the Proposal, providing a total of 21 groundwater wells within the monitoring well network. The current well network is considered suitable to establish both a baseline understanding of the system and ongoing monitoring assessments during operations. The monitoring wells have been installed down-gradient of each bank of crystallisers, along the concentration pond walls. The monitoring information will be used to determine whether any impacts to groundwater are occurring. Reference bores will also be monitored to allow an appropriate comparison. | Terrestrial and intertidal species | Operation | Ponds | No significant residual impact expected if mitigation is implemented effectively. |
| 2. | Design and implementation of a hydraulic testing programme. This is in the GMMP (Appendix 1.9). | Hydraulic testing programme to determine the in-situ permeability and potential for transportation of hypersaline seepage from the ponds to inland waters. | Terrestrial and intertidal species | Operation | Ponds | No significant residual impact expected if mitigation is implemented effectively. Seepage is predicted to be a slow process whereby groundwater near risk areas will be monitored and disposed of within the ponds if required. |
| 3. | Modelling to inform the design and placement of | Complete 3D density-dependent flow modelling to inform and confirm the design | Terrestrial and | Operation | Ponds | No significant residual impact expected as modelling will be used to |

| Mitigation/ Safeguard Number | Key Mitigation/Safeguard | Detail | Species Affected | Timing | Location | Residual Impact |
|---|---|---|---|---|---|---|
| | groundwater monitoring wells. This is detailed in the GMMP (Appendix 1.9). | and placement of groundwater monitoring wells, estimate the worse-case seepage rates, and test the efficacy of proposed management responses. | intertidal species | | | inform design details of monitoring wells. |
| 4. | Collecting baseline environmental data. This is detailed in the GMMP (Appendix 1.9). | Collect water quality data for surface water bodies before and during operations to monitor for natural variation and for impacts which may potentially arise from the Proposal. | Terrestrial and intertidal species | Construction<br>Operation | Ponds | N/A – collection of baseline data will not result in any residual impacts. |
| 5. | Install cut-off bores, sumps and pump the water to the appropriate salinity pond. This is detailed in the GMMP (Appendix 1.9). | Install cut-off bores, sumps and pump the water to the appropriate salinity pond if the monitoring described in Mitigation 1 either:<br>a. Identifies sustained mounding that is encroaching on mangrove or algal mat habitat or is leaching water on the surface; or<br>b. Identifies seepage of high salinity brine that is above the natural groundwater range and likely to significantly impact on environmental values. | Terrestrial and intertidal species | Operation | Ponds | N/A – refer to Hydrological/Water Quality Mitigation/Safeguard Number 1. |
| 6. | Incorporate and install drainage control structures as required to maintain freshwater creek flows. | Drainage control structures will be designed with key stakeholders to accommodate agreed AEP values and may consist of:<br>a. Armoured bunding along the ponds either side of McKay Creek; and<br>b. Diversion channels along the southern edge of the ponds, westward into McKay Creek and eastward into Devil Creek. | Terrestrial and intertidal species | Construction | Ponds at McKay Creek<br>Devil Creek | No significant residual impacts expected. |
| 7. | Ensure erosion and sediment control is included in contractor management plans. | Erosion and sediment controls will be implemented for the construction phase to ensure that erosion and sediment control strategies and measures and implemented consistent with industry best practice guidelines. | Intertidal species | Construction | Concentration Ponds | No significant residual impact expected. Sediment controls are predicted to contain sedimentation and prevent impacts to the surrounding environment. |

| Mitigation/ Safeguard Number | Key Mitigation/Safeguard | Detail | Species Affected | Timing | Location | Residual Impact |
|---|---|---|---|---|---|---|
| 8. | Verify inundation modelling results after construction to ensure potential indirect impacts to the tidal regimes of the intertidal zone are within predicted outcomes. | The verification monitoring will collect data from several points within the intertidal zone, including:<br>a. Water levels;<br>b. Inundation periods; and<br>c. Flow rates (if relevant to the monitoring location). | Intertidal species | Construction | Ponds | No significant residual impact expected. This mitigation is to verify that the impacts of the ponds are within modelled predictions (Section 6.6) as not having a significant residual impact. |
| 9. | Concentration ponds and crystallisers will be designed and constructed to be safe and stable. | Concentration ponds and crystallisers will be designed and constructed to be safe and stable according to DEMIRS (WA) requirements and in accordance with an approved Mining Proposal issued under the Mining Act. | Terrestrial and intertidal species | Construction | Ponds | No significant residual impact expected. DEMIRS regulation of pond construction will ensure this mitigation measure is suitable. |
| 10. | Routine inspections of infrastructure. | Routinely inspect the condition and performance of pond walls, pipelines, containment systems and internal drainage structures, to ensure they are in acceptable condition and/or operating appropriately. | Terrestrial and intertidal species | Operation | Ponds<br>Pipelines | No significant residual impact expected. Regular inspections are expected to ensure structures do not pose a risk of significant impact. |
| 11. | Additional controls will be used to further reduce the risk of impact from unintentional brine pipeline spills. | Controls include:<br>a. Pipelines, external to the PIDE, will be fitted with leak detection;<br>b. Flows will be shut off if leaks are detected;<br>c. External pipe routes will be inspected to a schedule for issues of concern;<br>d. Pipelines will mainly be located below ground;<br>e. Where pipelines cross access roads they will be reinforced against traffic loading;<br>f. Investigations will be conducted into the cause of any spills, and remedial actions will be taken to minimise the chance of reoccurrence; and<br>g. Spill response training to mitigate damage for site-based personnel. | Terrestrial and intertidal species | Construction<br>Operation | Ponds<br>Process Plant<br>Pipelines | Spill prevention measures are considered appropriate to ensure that there are no significant residual impacts. |
| 12. | Monitor erosion at the outlets of the surface water | If erosion is noted, then install additional erosion controls to minimise further erosion. | Intertidal species | Construction<br>Operation | Pond drainage channels | Corrective measures are considered appropriate to ensure that there are no significant residual impacts. |





| Mitigation/ Safeguard Number | Key Mitigation/Safeguard | Detail | Species Affected | Timing | Location | Residual Impact |
|---|---|---|---|---|---|---|
| | corridors after each significant flow event. | | | | | |
| 13. | Comply with WA Water Quality Protection Guidelines and guidance notes. | Particularly in relation to the storage and use of hydrocarbons and other harmful chemicals, the design and operation of vehicle maintenance areas and facilities, the siting and operation of wastewater treatment systems, and the handling and storage of other waste materials, including contaminated soils. | All species | Construction<br>Operation<br>Closure | All infrastructure | Containment, clean-up, and corrective measures are considered appropriate to ensure that there are no significant residual impacts. |
| 14. | Ensure fuel is stored with secondary containment. | Ensure fuel is stored within self-bunded tanks or within a bunded area. | Terrestrial species | Construction<br>Operation | Fuel storage facilities | Containment measures are considered appropriate to ensure that there are no significant residual impacts. |
| 15. | Develop and implement a combined Proposal/CPE Port Oil Spill Response Plan prior to shipping operations and submit to PPA. | This Plan will be for marine activities (including the seawater intake). This Plan will be developed in consultation with PPA and will include:<br>a. Refuelling procedures;<br>b. Response equipment requirements;<br>c. Response procedures and action plans for various spill scenarios; and<br>d. Reporting and responsibilities. | Marine and intertidal species | Construction<br>Operation | All intertidal or marine facilities | Containment, clean-up and corrective measures are considered appropriate to ensure that there are no significant residual impacts. |
| 16. | If required, develop and implement an ASSMP for any excavation works in the coastal zone. | The ASSMP will be developed to align with current best-practice methods, once final excavation sites are identified (detailed design stage). The ASSMP will collect and assess additional soil samples regularly for ASS during construction of the pond walls , and during dredging.<br>To ensure the ongoing reliability of the original assessments. Leichhardt will conduct detailed assessment and treat soils in accordance with an ASSMP if ASS are detected. | All species | Construction | Ponds<br>Dredging | Corrective measures are considered appropriate to ensure that there are no significant residual impacts. |





| Mitigation/ Safeguard Number | Key Mitigation/Safeguard | Detail | Species Affected | Timing | Location | Residual Impact |
|---|---|---|---|---|---|---|
| 17. | Embankment material will not be taken from the coastal zone without testing for PASS. | To ensure any soil with a moderate PASS risk rating is not used as embankment material. | All species | Construction | Ponds | Corrective measures are considered appropriate to ensure that there are no significant residual impacts. |
| 18. | Abstract seawater from the designated tidal creek only when tides are at or above 0.0 m AHD. | This will ensure that sufficient water volumes are available in the creek to minimise abstraction impacts. | Marine species | Operations | Seawater intake | No significant residual impact expected. The impacts of this abstraction timing has been assessed (Section 6.5) and a limit is effective in mitigating associated impacts. |
| 19. | Implement the MEQMMP (Appendix 2.1). | The MEQMMP contains detailed information about the discharges, proposed management and monitoring, and contingency actions, including:<br>a. Baseline monitoring requirements;<br>b. Implementation of a Marine Environmental Quality Monitoring Program;<br>c. WET testing of initial bitterns and comparison against initial modelling input and outputs. Conduct remodelling if required to verify LEP boundaries;<br>d. Model verification monitoring<br>e. Detailed design of the outfall diffuser;<br>f. Ongoing bitterns quality monitoring;<br>g. Develop and implement procedures and plans, including a Hydrocarbon Spill Management Plan and Product Spill Management Plan (Appendix B and C of Appendix 2.1);<br>h. ; and<br>i. Contingency actions. | Marine species | Operations | Bitterns outfall | This mitigation measure will ensure that significant reduction in water quality is restricted to a dedicated offshore mixing zone within the Marine Development Envelope for bitterns. |
| 20. | Implement the DSDMMP (Appendix 2.2) | The DSDMMP includes key management actions to minimise impacts to marine environmental quality including:<br>a. Dredging will be conducted using a cutter-suction vessel; | Marine species | Construction | Dredge Corridor | This mitigation measure will ensure that losses of subtidal BCH is limited to 47.0 ha (including 3.8 ha of hard coral habitat, 4.1 ha of seagrass habitat, 12.5 ha of *Pinna bicolor* beds, |





| Mitigation/ Safeguard Number | Key Mitigation/Safeguard | Detail | Species Affected | Timing | Location | Residual Impact |
|---|---|---|---|---|---|---|
| | | b. Measures proposed to ensure the ZoHI and ZoMI remain within modelling predictions;<br>c. Plume modelling and monitoring; and<br>d. Contingency measures. | | | | 26.5 ha of filter feeder dominated habitat and 0.1 ha of macroalgae dominated habitat, which is not considered to be a significant residual impact |
| 21. | Visually monitor sediment plumes during the construction of the seawater intake. | If plumes are evident that are not dissipating quickly then install curtains. | Marine species | Construction | Seawater intake | Impact will be short-term and containment measures (if required) are considered appropriate to ensure that there are no significant residual impacts. |
| 22. | Ensure product infrastructure washdown water is captured and not released to the surrounding environment. | Product wash down water will be captured within catchment basins and not released to the surrounding environment. | Intertidal species | Operation | Process Plant | Containment measures are considered appropriate to ensure that there are no significant residual impacts. |
| 23. | Limit bitterns discharge and dilute prior to discharge. | Bitterns discharge will be limited to up to 5.9 GLpa. Bitterns is to be diluted with seawater prior to discharge. | Marine species | Operations | Bitterns diffuser | This mitigation measure (in connection with the MEQMMP) will ensure that significant reduction in water quality is restricted to a dedicated offshore mixing zone within the Marine Development Envelope. |
| 24. | Limit total dredging volumes. | Dredging will be limited to 400,000 $m^3$. | Marine species | Operations | Dredge corridor | This mitigation measure (in connection with the DSDMMP) will ensure that losses of subtidal BCH is limited to ensure there are no irreversible impacts to coral, seagrass of macroalgae subtidal BCH. Up to 6.4 ha of disturbance to subtidal BCH as of result of dredge plumes is predicted to be recoverable. |
| **Benthic Communities and Habitats** | | | | | | |
| 1. | Limit disturbance of mangroves | Mangrove disturbance will be limited to 8.3 ha | Intertidal species | Construction | Ponds | This mitigation measure will ensure that no more than 8.3 ha of |

| Mitigation/ Safeguard Number | Key Mitigation/Safeguard | Detail | Species Affected | Timing | Location | Residual Impact |
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| | | | | | | mangroves are disturbed by the Proposal. This is however considered to be a significant residual impact. |
| 2. | Minimise disturbance within mangrove, algal mat and samphire communities | Disturbance of these habitats will be considered during detailed design to ensure the disturbance is the minimum practicable. Disturbance of these habitat will be limited to:<br>• 8.3 ha of mangroves;<br>• 1,091.7 ha of algal mats/samphire | Intertidal species | Construction | Ponds | This mitigation measure will ensure that the disturbance of these habitats is less than predicted in this ERD. This is however considered to be a significant residual impact. |
| 3. | Implement the MEQMMP and DSDMMP (refer to item 20 and 21 above). | Refer to item 20 and 21 above. | Marine and intertidal species | Construction<br>Operation<br>Closure | Intertidal zone.<br>Dredge corridor and disposal zone. | These mitigation measures will ensure that the impacts to MEQ and impacts from dredging is aligned with the predictions in this ERD, resulting in no significant residual impacts. |
| 4. | Minimise the risk of introducing marine pests by implementing the following measures | a. All vessels should comply with Commonwealth DAFF – Biosecurity Requirements as well as all State legislation relating to management of introduced marine organisms; and<br>b. Any vessels visiting the CPE Port from international or interstate waters are required to complete the WA DoF 'Vessel Check' risk assessment (https://www.vessel-check.com/). | Marine species | Construction<br>Operations<br>Closure | Offshore activities | IMP mitigation measures are well-established and are considered appropriate to ensure that there are no significant residual impacts. |
| **Fauna** | | | | | | |
| 1. | Minimise potential noise impacts that will impact marine fauna. | Potential noise impacts to marine fauna for the direction of the marine operations will be minimised by implementing the following controls:<br>a. Ensure all vessel equipment and machinery is in good condition and subject to regular maintenance while engaged on the Proposal; | Marine species | Construction<br>Operation | Port | Estimated marine noise from dredging activities is not significant, and marine noise mitigation measures are now well established within the marine construction industry. With the application of these measures it is expected that dredging will be able to be conducted |

| Mitigation/ Safeguard Number | Key Mitigation/Safeguard | Detail | Species Affected | Timing | Location | Residual Impact |
|---|---|---|---|---|---|---|
| | | b. When in transit, all Proposal vessels will be operated in accordance with EPBC Regulations 2000 - Part 8 Division 8.1; and<br>c. Minimise the duration of run-time for vessel engines, thrusters and dredging plant by avoiding stand-by or running mode to the degree practical and consistent with safe operations. | | | | without significant noise impacts on marine fauna. |
| 2. | Minimise the risk of introducing marine pests. | The following measures will be implemented to minimise the risk of introducing marine pests to the Proposal:<br>a. All vessels should comply with DAFF biosecurity requirements as well as all State legislation relating to management of introduced marine organisms; and<br>b. Any vessels visiting the CPE Port from international or interstate waters are required to complete the WA DPIRD 'Vessel Check' risk assessment (https://vessel-check.com). | Marine species | Operation | Port | The application of regulated controls reduces the risk of introducing marine pests to marine waters to a 'low risk'. Standard industry controls relating to ballast water and vessel hygiene provide a level of confidence that pests will not be introduced. |
| 3. | Minimise the risk of fatal vessel strikes to marine fauna. | Consistent with the DCCEEW guidelines for reducing vessel strikes, Leichhardt will ensure that all Proposal vessel operators will be trained to observe and report the location of any sightings of large marine fauna (in particular marine turtles, mammals and sawfish) to other vessel operators in the area to allow them to be tracked (if visible) and avoided. In addition, implementing an 8-knot speed limit for Proposal construction vessels will act to reduce marine fauna injury from vessel strike. Minimum separation distances will be maintained between vessels and prescribed fauna as described in the BC Regulations. | Marine species | Construction<br>Operation<br>Closure | Port | While the probability of vessel strike is already low, restricting vessel speed has been shown to decrease the likelihood of fatal injury (to large whales) (Vanderlaan and Taggart, 2006. |





| Mitigation/ Safeguard Number | Key Mitigation/Safeguard | Detail | Species Affected | Timing | Location | Residual Impact |
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| 4. | Seawater intakes are to be fitted with intake screens designed to prevent marine fauna from being drawn into the intake, and designed such that intake speeds are limited to a maximum of 0.15 m/s. | This speed has been defined as slow enough to allow marine fauna to escape entrapment. Specially designed intake screen enclosures are proposed to be installed around intakes to ensure flow rates at the screen do not exceed 0.15 m/s. | Marine species | Operation | Seawater intakes | This mitigation measure is expected to prevent any significant residual impacts to marine fauna. An intake flow rate of less than 0.15 m/s is recommended by the US Environmental Protection Agency (2001) as it ensures the protection of 96% of fish species, and is lower than the swim speed of marine turtles (Bell and Richardson, 1978; Bustard and Limpus, 1970; Chung et al., 2009; de Silva, 1995; Frick, 1976; Hirth, 1971; Hughes, 1974; Papi et al., 1995; Prange, 1976; Salmon and Wyneken, 1987; Witherington, 1991; Wyneken 1997). This flow rate has been adopted at a number of seawater intakes in Australia including Anketell port, M Project, Ashburton Salt Project, the Wheatstone Development and Adelaide Desalination Plant. |
| 5. | Implement the ALMP (Appendix 4.7) for coastal and marine infrastructure. | The ALMP includes key management actions to minimise impacts to marine fauna. Each light source has been described in terms of its purpose, location, footprint, intensity and spectral composition. The plan will ensure that appropriate lighting is installed that minimises impacts to marine turtles. Marine and coastal construction and operational activities will be conducted in accordance with design recommendations provided in EPA (2010) and DCCEEW (2023). Key mitigation includes the application of the following principles (from DCCEEW, 2023):<br>a. Start with natural darkness and only add light for specific purposes; | Marine turtles | Construction<br>Operation | Pond lighting<br>Accommodation Camp<br>Process Plant | The application of measures within EPA (2010) and DCCEEW (2023) are shown to be successful in minimising light impacts on marine turtles. Some light spill will be unavoidable however mitigation is expected to be able to minimise these impacts such that they are not considered significant residual impacts. |

| Mitigation/ Safeguard Number | Key Mitigation/Safeguard | Detail | Species Affected | Timing | Location | Residual Impact |
|---|---|---|---|---|---|---|
| | | b. Use adaptive light controls to manage light timing, intensity and colour;<br>c. Light only the object or area intended – keep lights close to the ground, directed, and shielded to avoid light spill;<br>d. Use the lowest intensity lighting appropriate for the task; and<br>e. Use lights with reduced or filtered blue, violet and ultraviolet wavelengths.<br>An as-built audit will be conducted to verify that lighting impacts on the turtle nesting beach are minimal. Further actions will be taken to reduce lighting impacts if the audit determines that the Proposal lights are illuminating the nesting beaches.<br>A marine turtle hatchling survey will be conducted within 12 months of the completion of construction to determine if there is any evidence of mis-orientation or disorientation of turtle hatchlings that could be attributed to the Proposal. If evidence is found then lighting to be reviewed to reduce impacts further. | | | | |
| 6. | Ensure key environmental windows (Section 9.3.12) are considered when planning construction activities. | Where practicable Leichhardt will align the timing of relevant construction activities to avoid these environmental windows. | Marine species | Construction | Dredging areas | This mitigation measure (in connection with others in this table) is expected to prevent any significant residual impacts to marine fauna. |
| 7. | Implement best-practice general management measures for fauna. | Management measures include:<br>a. Vegetation clearing will be managed through internal ground disturbance procedures;<br>b. Boundaries of areas to be cleared or disturbed will be identified by GPS coordinates and on-line maps of boundaries will be provided to construction plant operators;<br>c. Progressive clearing will be undertaken; | Terrestrial and intertidal species | Construction<br>Operation<br>Closure | All onshore areas | These mitigation measures (in connection with others in this table) are expected to prevent any significant residual impacts to terrestrial and intertidal fauna. |





| Mitigation/ Safeguard Number | Key Mitigation/Safeguard | Detail | Species Affected | Timing | Location | Residual Impact |
|---|---|---|---|---|---|---|
| | | d. Raised blade disturbance will be conducted where practicable on temporary tracks to minimise vegetation removal;<br>e. The disturbance footprint will be developed to the minimum required to ensure safe and adequate construction and operation;<br>f. Water or dust suppressants will be applied to disturbed areas and product transfer/storage areas as required to minimise dust generation;<br>g. Emergency response capabilities will be maintained to prevent fire outbreaks where possible;<br>h. Weed hygiene and management measures/procedures will be implemented to prevent spread of weeds and the introduction of new weed species as a result of construction and operation;<br>i. Feral animal controls will be implemented;<br>j. Pets will not be brought to site;<br>k. Pipeline trenches (if required) will be progressively opened and closed;<br>l. Fauna egress mechanisms will be installed at open pipeline trenches and turkeys nests ;<br>m. The open portions of pipeline trenches will be inspected less than two hours after sunrise for the presence of trapped fauna;<br>n. Introduced fauna will be controlled around camps and other work areas and training will be provided to ensure that native or introduced fauna are not fed by site personnel;<br>o. Food wastes will be stored in bins that are not easily accessible to fauna; | | | | |





| Mitigation/ Safeguard Number | Key Mitigation/Safeguard | Detail | Species Affected | Timing | Location | Residual Impact |
|---|---|---|---|---|---|---|
| | | p. All incidents resulting in fauna injury or death will be reported internally; and<br>q. Vehicle speed limits will be set and enforced. | | | | |
| 8. | Limit total and specific fauna habitat disturbance in the PCD. | DCCEEW is expected to include relevant limits in the conditions of the EPBC Act approval (if approved). | All fauna species | Construction<br>Operation | Entire disturbance footprint | Regardless of mitigation, significant impacts resulting from disturbance of fauna habitat are expected as detailed in Section 12.4. Offsets are proposed to counterbalance the impacts, detailed in Section 15. |
| 9. | Implementation of the GMMP and BCHMMP as described in Section 6 and 8. | Monitoring and management is expected to be conducted over the life of the Proposal. | Marine Fauna<br>Terrestrial and intertidal species. | Construction<br>Operation | Tidal areas<br>Ponds | These mitigation measures will ensure that the impacts to fauna align with the predictions in this ERD, resulting in no significant residual impacts. |
| 10. | Verify inundation modelling results after construction to ensure potential indirect impacts to the tidal regimes of the intertidal zone are within predicted outcomes. | The verification monitoring will collect data from several points within the intertidal zone, including:<br>a. Water levels;<br>b. Inundation periods; and<br>c. Flow rates (if relevant to the monitoring location). | Intertidal species. | Construction | Ponds | Refer to Hydrological/Water Quality Mitigation/Safeguard Number 8 |
| 11. | Monitor erosion at the outlets of the surface water corridors after each significant flow event. | If erosion is noted, then install additional erosion controls to minimise further erosion. | Intertidal species | Construction<br>Operation | Pond drainage channels | Refer to Hydrological/Water Quality Mitigation/Safeguard Number 12. |
| 12. | Conduct annual migratory shorebird surveys within the SBSA to capture construction and post-construction phases. | The annual surveys will be conducted in a similar manner to the targeted survey conducted by Phoenix (2023) and will provide information regarding long-term changes in the numbers, species and distributions of migratory shorebirds utilising the SBSA. If suitable these surveys can be incorporated into | Shorebird species | Construction<br>Operation<br>Closure | Ponds<br>SBSA | N/A – monitoring only |

| Mitigation/ Safeguard Number | Key Mitigation/Safeguard | Detail | Species Affected | Timing | Location | Residual Impact |
|---|---|---|---|---|---|---|
| | | the surveys conducted at the Mardie Project to provide regional results. | | | | |
| 13. | Monitoring of shorebird fauna use of ponds. | Record the usage of the concentration ponds and crystallisers by fauna species. Incorporate these areas into the annual migratory shorebird survey if shorebird species are noted to utilise the ponds. | Shorebird species | Operation | Concentration ponds and crystallisers | N/A – monitoring only |
| 14. | Monitoring of fauna entrapment within ponds. | Record any fauna entrapment within the ponds as an incident and review whether additional egress mechanisms should be installed. | Shorebird species, terrestrial fauna | Operation | Ponds | N/A – monitoring and incident reporting only. |
| 15. | Controls will be used to further reduce the risk of impact from unintentional brine pipeline spills. | Controls include:<br>a. Pipelines, external to the PIDE, will be fitted with leak detection;<br>b. Flows will be shut off if leaks are detected;<br>c. Pipe routes will be inspected to a schedule for issues of concern;<br>d. Pipelines will mainly be located below ground;<br>e. Where pipelines cross access roads they will be reinforced against traffic loading;<br>f. Investigations will be conducted into the cause of any spills, and remedial actions will be taken to minimise the chance of reoccurrence; and<br>g. Spills response training to mitigate damage for site-based personnel. | Terrestrial and intertidal species. | Construction<br>Operation | All infrastructure | Refer to Hydrological/Water Quality Mitigation/Safeguard Number 10. |
| 16. | Vessels will not be permitted to venture or operate outside of port operational waters unless conducting operations, monitoring or rescue activities. | Restricting vessels to port operational waters is proposed to limit the spatial extent of vessel strike risks | Marine species | Operation | Port | This mitigation measure (in connection with other vessel strike measures) is predicted to be effective in minimising the likelihood of a vessel strike that results in injury or death of marine fauna. |
| 17. | Implement the DSDMMP. | A DSDMMP has been provided in Appendix 2.2 and includes a comprehensive set of management actions and environmental | Marine species | Construction<br>Operation | Marine environment | Potential impacts from offshore disposal of dredge material may result in impacts to water quality in |





| Mitigation/ Safeguard Number | Key Mitigation/Safeguard | Detail | Species Affected | Timing | Location | Residual Impact |
|---|---|---|---|---|---|---|
| | | performance measures related to risks to marine fauna from dredging and the construction and maintenance of the bitterns pipeline and seawater intakes. | | | | the vicinity of the disposal site during dumping for a short period afterwards. Water quality potential impacts include increased turbidity and reduced benthic light. Dredging and construction and maintenance of the bitterns pipeline and seawater intake is expected to manage potential impacts to ensure they are limited to the areas predicted. |
| 18. | Implement the MEQMMP. | A MEQMMP has been provided in Appendix 2.1 and includes a comprehensive set of management actions and environmental performance measures related to marine environmental quality. | Marine species. | Construction<br>Operation | Marine Environment | Refer to Hydrological/Water Quality Mitigation/Safeguard Number 19. |
| **Rehabilitation** | | | | | | |
| 1. | Salts will be harvested from each crystalliser prior to closure. | Seawater will cease being pumped into Pond 1, and then the remaining saline water will be pumped out to each subsequent pond until a final product is created. The civil works will be breached locally to drain any remaining brine from the lower salinity initial ponds to the ocean. Crystallisers will have the water evaporated. These salts will be harvested prior to closure, with seawater wash to reduce residual salts. Refer to the Interim MCP in Appendix 1.8 for more information. | Marine and intertidal species | Closure | Ponds | This mitigation measure is expected to result in no residual impacts once the salts have been removed and the pond footprint flushed with surface drainage or tidal waters (refer below). |
| 2. | Concentration pond walls will be opened up to allow tidal flows to enter the ponds. | The pond walls will be flattened or opened up to allow tidal flows to reinstate within the tidal pond areas, and stormwater drainage over the higher land.<br>Over time this is expected to return the area to a state where salt-tolerant species can revegetate portions of the pond areas.<br>The ponds will be rehabilitated and closed in accordance with a MCP approved under the | Marine and intertidal species | Closure | Ponds | This mitigation measure is expected to result in no residual impacts once the pond footprint has been adequately flushed with tidal waters and rainfall/runoff. |

| Mitigation/ Safeguard Number | Key Mitigation/Safeguard | Detail | Species Affected | Timing | Location | Residual Impact |
|---|---|---|---|---|---|---|
| | | Mining Act. An interim MCP has been developed and provided in Appendix 1.8 which contains detail about the proposed rehabilitation of the Proposal. The MCP will be submitted to DEMIRS for assessment and approval prior to the construction of the Proposal, and will be reviewed and revised every three years or in accordance with DEMIRS guidelines. | | | | |
| 3. | Key surface water drainage systems will be reinstated. | The pond drainage system will be reshaped to reinstate key drainage systems (i.e., those listed in Section 6.3). | Terrestrial and intertidal species | Closure | Pond drainage infrastructure | This mitigation measure is expected to result in no residual impacts as key drainage lines will be fully reinstated. |

## 16.6 SUMMARY OF MNES IMPACTS

Table 16-8 summarises the key impacts to MNES.

**Table 16-8: Summary of MNES impacts**

| Listed threatened species and communities (sections 18 and 18A) | Recovery Plan | Threat Abatement Plan | Approved Conservation Advice (ACA) | Listing advice | Bioregional Plan | Survey Guidelines | Other references | References | Adequate survey/abundance | Impact | Avoidance | Mitigation | Residual | Offset |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pilbara Leaf-nosed bat** (*Rhinonicteris aurantia* (Pilbara form)) | None | None | TSSC (2016a) | Within ACA | N/A | DEWHA (2010a) | Duncan et al. (1999) | Phoenix (2023; Appendix 6.1) | Survey conducted in accordance with guidelines.<br>Single detection in April suggests a post-maternity, dispersing individual. | Up to 10,950.3 ha disturbance of broad foraging habitat.<br>Injury or death from vehicle strike. | N/A – habitat cannot be avoided. | Minimise disturbance within suitable habitat.<br>Monitor groundwater levels and quality down-gradient and install cut-off sumps if required.<br>Routinely inspect the condition and performance of pond walls.<br>Ponds will be constructed in accordance with DEMIRS requirements.<br>Controls for pipeline spills implemented.<br>Wash-down water is captured and not released to the surrounding environment. | Up to 10,950.3 ha of broad foraging habitat. | Contribution to the PEOF ($1,653/ha) for direct and indirect impacts to 'Good' to 'Excellent' condition habitat *not already offset by the measures above.* This vegetation includes broad foraging habitat for Pilbara Olive Python, Pilbara Leaf-nosed Bat, Ghost Bat and Grey Falcon. |
| **Ghost Bat** (*Macroderma – igas*) - Vulnerable | None | Fox | TSSC (2016f) | Within ACA | N/A | Bat Call WA (2022) | - | Phoenix (2023; Appendix 6.1) | Nocturnal and bat echolocation recording methods deemed adequate sampling techniques.<br>No records of this species but suitable habitat is present in Eucalypt woodland. | | | | | |
| **Pilbara Olive Python** (*Liasis olivaceus ba–roni*) - Vulnerable | None | Cats | DEWHA (2008b) | Within ACA | N/A | DSEWPAC (2011c) | - | Phoenix (2023; Appendix 6.1) | No records of this species from 15.4 hours of nocturnal searches but suitable habitat is present at the Proposal (Eucalypt woodland on drainage). | Up to 20.8 ha disturbance to potential foraging habitat.<br>Injury or death from vehicle strike. | N/A - habitat cannot be avoided. | | Up to 20.8 ha disturbance to potential foraging habitat. | |
| **Grey Falcon** (*Falco hypleucos)* - Vulnerable | None | None | TSSC (2020) | Within ACA | N/A | N/A | - | Phoenix (2023; Appendix 6.1) | No records of this species within the TFSA but was recorded immediately east of the TFSA in a known nest site on a communications tower on North West Costal Highway. | Up to 1,954.4 ha disturbance to broad foraging habitat. | N/A- habitat cannot be avoided. | | Up to 1,954.4 ha disturbance to broad foraging habitat. | |
| **Australian Humpback Dolphin** (*Sousa sahulensis*) – Vulnerable, Cetacean, Migratory | None | None | DCCEEW (2025) | None | DSEWPAC (2012b) North-west Marine | None | - | O2 Marine (2025e; Appendix 4.1) | Not recorded during various marine surveys but high potential to occur. The species has been recorded in the region (desktop searches) and suitable habitat is present in the study area. | Loss of up to 47.0 ha of subtidal marine fauna habitat.<br>Increased risk of death or injury as a result of vessel strike, dredging or dredged material disposal.<br>Hearing or behavioural impacts as a result of construction related noise.<br>Introduction of marine pests. | Impacts associated with significant dredging activities and ocean-going vessel movements close to shore has been avoided by the use of a transhipment loading method.<br>Dredging will be limited to avoid sensitive ecological windows.<br>Vessels will not be permitted to venture or operate outside of port operational waters unless conducting monitoring or rescue | Limit bitterns discharge, dilute prior to discharge and discharge to designated mixing zone.<br>Limit dredging volumes and visually monitor sediment plumes.<br>Implement MEQMMP, DSDMMP, ASSMP, BCHMMP and Oil Spill Response Plan.<br>Construction and dredge vessel speed limits.<br>Report large marine fauna sightings to vessels. | Irreversible loss of 47.0 ha of vegetated subtidal habitat. Not considered a significant residual impact. | None proposed |
| **Indo-Pacific Bottlenose Dolphin** (*Tursiops aduncus*) | None | None | None | None | DSEWPAC (2012b) North- west Marine | None | - | O2 Marine (2025e; Appendix 4.1) | Not recorded during various marine surveys but high potential to occur. The species has been recorded in the region (desktop searches) and suitable habitat is present in the | | | | | |

| Listed threatened species and communities (sections 18 and 18A) | Recovery Plan | Threat Abatement Plan | Approved Conservation Advice (ACA) | Listing advice | Bioregional Plan | Survey Guidelines | Other references | References | Adequate survey/abundance | Impact | Avoidance | Mitigation | Residual | Offset |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | study area. | | operations.<br>Bitterns disposal to be contained within a dedicated mixing zone. | Introduced marine pest controls.<br>Construction activities to consider key environmental windows.<br>Brine pipeline spill controls. | | |
| **Humpback Whale** (*Megaptera novaeangliae*) –Migratory | None | Marine debris | TSSC (2015) | DAWE, (2022) | DSEWPAC (2012b) North-west Marine | DEWHA (2008d) | - | O2 Marine (2025e; Appendix 4.1) | Not recorded during various marine surveys but high potential to occur.<br>The species has been recorded in the region (desktop searches). Typically occur further offshore (>35 km) during migratory routes, although some whales recorded in <10 m water during southern migration (i.e. September). | | | | | |
| **Dugong** (*Dugong dugon*) - Marine, Migratory | None | Marine debris | None | None | DSEWPAC, (2012b) North-west Marine | None | - | O2 Marine (2025e; Appendix 4.1) | Not recorded during various marine surveys but high likelihood of occurrence. | As above, plus 4.1 ha of seagrass beds. | As above | As above | As above, which includes 4.1 ha of seagrass beds, representing 0.2% of the mapped extent within the LAUs. | None proposed |
| **Hawksbill Turtle** (*Eretmochelys imbricata*) – Vulnerable, Migratory<br>**Green Turtle** (*Chelonia mydas*) – Vulnerable, Migratory<br>**Flatback Turtle** (*Natator depressus*) – Vulnerable, Migratory | DotEE (2017c) | Pigs, Marine debris.<br>Cats (Hawksbill only).<br>Fox (Green and Flatback) | None | None | DSEWPAC, (2012b) North-west Marine | Pendoley (2005) | Wilson et al., 2018 | O2 Marine (2025e; Appendix 4.1)<br>Pendoley Environmental (2023 & 2024, Appendix 4.2)<br>Nocterra (2025; Appendix 4.2) | Surveys from December 2020 to February 2023 in accordance with guidelines.<br>Hawksbill, Flatback and Green Turtles were found to use beaches north of the Proposal at low and varying levels.<br>South West Regnard Island, North East Regnard Island and beaches on the mainland represent nesting habitat for turtle species (Flatback, Green and Hawksbill turtles). | Disturbance of up to 47.0 ha of subtidal marine fauna habitat.<br>Disturbance of up to 8.3 ha of intertidal marine fauna habitat (mangroves).<br>Increased risk of death or injury as a result of vessel strike, dredging, dredged material disposal or entrapment in seawater intakes. | As above.<br>Tidal creek BCH has been completely avoided.<br>The majority of mangrove and beach habitats has been avoided. | As above.<br>Seawater intake speeds limited to <0.15 m/s.<br>Seawater intakes to be fitted with intake screens.<br>Develop an ALMP. | Loss of 47.0 ha of subtidal marine fauna habitat and 8.3 ha of intertidal marine fauna habitat.<br>Given the survey findings, the direct impacts are unlikely to significantly impact local marine turtle populations.<br>Impacts to mangrove BCH is considered to be a significant residual impact. | Contribution to a relevant management program established for the Proposal. The management program is intended to be developed after the results of the Mardie Project offset program are released (expected in 2025), with the information used to develop suitable management measures to protect the ecological roles, values and functions of intertidal BCH.<br>Proposed funding values will be maintained through indexation to the Perth CPI. |
| **Short-nosed Sea Snake** (*Aipysurus apraefrontalis*) – Critically Endangered<br>**Leaf-nosed Sea Snake** (*Aipysurus foliosquama*) – | None | None | DSEWPaC (2011a)<br>DSEWPaC (2011b) | TSSC (2011a)<br>TSSC (2011a) | DSEWPAC, (2012b) North-west Marine | None | - | O2 Marine (2025e; Appendix 4.1) | Not recorded during various marine surveys but moderate potential to occur. The species has been recorded in the region | Loss of up to 47.0 ha of subtidal marine fauna habitat.<br>Increased risk of death or injury as a result of vessel strike, | Impacts associated with significant dredging activities and OGV movements close to shore has been avoided by the use of a | Limit bitterns discharge, dilute prior to discharge and discharge to designated mixing zone.<br>Limit dredging volumes and visually monitor | Irreversible loss of 47.0 ha of vegetated subtidal habitat. Not considered a significant residual | None proposed |

| Listed threatened species and communities (sections 18 and 18A) | Recovery Plan | Threat Abatement Plan | Approved Conservation Advice (ACA) | Listing advice | Bioregional Plan | Survey Guidelines | Other references | References | Adequate survey/abundance | Impact | Avoidance | Mitigation | Residual | Offset |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Critically Endangered | | | | | | | | | and suitable habitat is present in the study area. | dredging or dredged material disposal.<br>Introduction of marine pests. | transhipment loading method.<br>Dredging will be limited to avoid sensitive ecological windows.<br>Vessels will not be permitted to venture or operate outside of port operational waters unless conducting monitoring or rescue operations.<br>Bitterns disposal to be contained within a dedicated mixing zone. | sediment plumes.<br>Implement MEQMMP, DSDMMP, ASSMP, BCHMMP and Oil Spill Response Plan.<br>Construction and dredge vessel speed limits.<br>Introduced marine pest controls.<br>Construction activities to consider key environmental windows.<br>Brine pipeline spill controls. | impact. | |
| **Green Sawfish** (*Pristis zijsron*) – Vulnerable, Migratory | DotE (2015a) | None | DEWHA (2008c) | TSSC, (2008) | DSEWPAC (2012b) North-west Marine | Kyne & Pillans (2014) | - | O2 Marine (2025d; Appendix 4.1, 2023d; Appendix 4.4, 2023a; Appendix 4.4, Morgan et.al., 2025; Appendix 4.4) | One Green Sawfish was detected during a UAV flight near the mouth of the intake creek. The species is known in the region by the nearby pupping area of the Ashburton River delta. No BIAs for the Green Sawfish have been identified within around the Proposal although suitable habitat is present. | Loss of up to 47.0 ha of subtidal marine fauna habitat.<br>Increased risk of death or injury as a result of vessel strike, dredging or dredged material disposal.<br>Indirect impacts include from marine noise, potential barriers, bitterns disposal (habitat health) and changing coastal processes. | Impacts associated with significant dredging activities and OGV movements close to shore has been avoided by the use of a transhipment loading method.<br>Dredging will be limited to avoid sensitive ecological windows.<br>Vessels will not be permitted to venture or operate outside of port operational waters unless conducting monitoring or rescue operations.<br>Bitterns disposal to be contained within a dedicated mixing zone. | As above. | Loss of 47.0 ha of subtidal marine fauna habitat.<br>Not considered a significant residual impact. | None proposed. |
| **Reef Manta Ray** (*Mobula a–fredi*) - Migratory | None | None | None | None | None | N/A | N/A | O2 Marine (2025e; Appendix 4.1) | Not recorded during various marine surveys but medium likelihood of occurrence within the Proposal area. No BIA or major populations within close proximity to the Proposal, however, due to their habitat preference being shallow waters and their broadscale movements, it is possible for them to occur in the vicinity of the Proposal. | Disturbance of up to 47.0 ha of vegetated subtidal marine fauna habitat.<br>Increased risk of death or injury as a result of vessel strike, dredging, dredged material disposal or entrapment in seawater intakes. | As above. | As above. | Up to 47.0 ha of disturbance to vegetated subtidal marine fauna habitat and 8.0 ha of intertidal marine fauna habitat.<br>No significant residual impacts predicted. | None proposed. |
| **Red Knot** (*Calidris canutus*) – Endangered, Migratory | See ACA | None | TSSC (2016b) | Within ACA | DSEWPaC (2012b) North-west Marine | DotEE (2017b) | Bamford et al. (2008)<br>Hansen et | Phoenix (2023; Appendix 6.1)<br>O2 Marine (2025c; | Surveys conducted in accordance with guidelines.<br>390 records within the | Up to 576.3 ha of disturbance to habitat for migratory shorebirds, including | Development envelope boundaries have been designed to utilise existing tracks and port | Implement best practice management measures for fauna.<br>Implement a GMMP and | 5,368.2 ha of potential migratory shorebird habitat | Contribution to a relevant management program |

| Listed threatened species and communities (sections 18 and 18A) | Recovery Plan | Threat Abatement Plan | Approved Conservation Advice (ACA) | Listing advice | Bioregional Plan | Survey Guidelines | Other references | References | Adequate survey/abundance | Impact | Avoidance | Mitigation | Residual | Offset |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | al. (2016)<br>DotE (2015e) | Appendix 3.2) | SBSA.<br>Meets national criteria: 0.1% of flyway population (110 individuals) | samphire shrublands, HDAM and mangroves.<br>Noise and light emissions altering behaviour.<br>Attraction and use of concentration ponds and crystallisers. | infrastructure wherever practicable.<br>Extensive habitat will remain within the LAUs. | BCHMMP.<br>Verify inundation modelling results.<br>Migratory shorebird surveys every five years.<br>Monitor shorebird fauna use of ponds.<br>Monitor groundwater levels and quality and install cut-off sumps if required.<br>Inspect the condition and performance of pond walls<br>Ponds comply with DEMIRS requirements.<br>Limit mangrove disturbance to 8.3 ha. | occurs within the LAUs, and up to 1,100 ha (20.5%) is subject to disturbance, including samphire shrublands, HDAM and mangroves.<br>These impacts are considered to be significant residual impacts. | established for the Proposal. The management program is intended to be developed after the results of the Mardie Project offset program are released (expected in 2025), with the information used to develop suitable management measures to protect the ecological roles, values and functions of intertidal BCH used by these species.<br>Proposed funding values will be maintained through indexation to the Perth CPI. |
| **Curlew Sandpiper** (*Calidris ferruginea*) – Critically Endangered, Migratory | See ACA | None | DotE (2015b) | Within ACA | DSEWPaC (2012b) North-west Marine | DotEE (2017b) | Bamford et al. (2008)<br>Hansen et al. (2016)<br>DotE (2015e) | Phoenix (2023; Appendix 6.1)<br>O2 Marine (2025c; Appendix 3.2) | 148 records within the SBSA.<br>Meets national criteria: 0.1% of flyway population (90 individuals). | | | | | |
| **Great Knot** (*Calidris tenuirostris*) – Critically Endangered, Migratory | See ACA | None | TSSC (2016d) | Within ACA | DSEWPaC (2012b) North-west Marine | DotEE (2017b) | Bamford et al. (2008)<br>Hansen et al. (2016)<br>DotE (2015e) | Phoenix (2023; Appendix 6.1)<br>O2 Marine (2025c; Appendix 3.2) | 338 records within the SBSA.<br>Not expected to meet national criteria: 0.1% of flyway population is 425 individuals. | | | | | |
| **Eastern Curlew** (*Numenius madagascariensis*) – Critically Endangered, Migratory | See ACA | None | DotE (2015b) | Within ACA | None | DotEE (2017b) | Bamford et al. (2008)<br>Hansen et al. (2016)<br>DotE (2015e) | Phoenix (2023; Appendix 6.1)<br>O2 Marine (2025c; Appendix 3.2) | 301 records within the SBSA.<br>Meets national criteria: 0.1% of flyway population (35 individuals) | | | | | |
| **Greater Sand Plover** (*Charadrius leschenaultii*) – Vulnerable, Migratory | See ACA | None | TSSC (2016e) | Within ACA | DSEWPaC (2012b) North-west Marine | DotEE (2017b) | Bamford et al. (2008)<br>Hansen et al. (2016)<br>DotE (2015e) | Phoenix (2023; Appendix 6.1)<br>O2 Marine (2025c; Appendix 3.2) | 1,428 records within the SBSA.<br>Meets national criteria: 0.1% of flyway population once extrapolated (200 individuals) | | | | | |
| **Lesser Sand Plover** (*Charadrius mongolus*) – Endangered, Migratory | See ACA | Fox | TSSC (2016d) | Within ACA | None | DotEE (2017b) | Bamford et al. (2008)<br>Hansen et al (2016)<br>DotE (2015e) | Phoenix (2023; Appendix 6.1)<br>O2 Marine (2025c; Appendix 3.2) | 3 records within the SBSA.<br>Not expected to meet national criteria: 0.1% of flyway population is 180 individuals. | | | | | |
| **Other Migratory Birds**<br>26 Migratory bird species were recorded within the SBSA (Section 16.3.2). | See ACA | None | - | None | DSEWPaC (2012b) North-west Marine | DotEE (2017b) | DotE (2015e) | Phoenix (2023; Appendix 6.1)<br>O2 Marine (2025c; Appendix 3.2) | Recorded within SBSA.<br>The SBSA was deemed to represent or contain important habitat for 14 species (Phoenix, 2023):<br>• Common Sandpiper;<br>• Ruddy Turnstone;<br>• Sharp-tailed Sandpiper;<br>• Sanderling;<br>• Red-necked Stint;<br>• Oriental Plover;<br>• Bar-tailed Godwit;<br>• Black-tailed Godwit;<br>• Whimbrel;<br>• Pacific Golden Plover;<br>• Grey Plover; | As above | As above | As above | As above | As above. |

| Listed threatened species and communities (sections 18 and 18A) | Recovery Plan | Threat Abatement Plan | Approved Conservation Advice (ACA) | Listing advice | Bioregional Plan | Survey Guidelines | Other references | References | Adequate survey/abundance | Impact | Avoidance | Mitigation | Residual | Offset |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | • Grey-tailed Tattler;<br>• Common Greenshank; and<br>• Terek Sandpiper. | | | | | |
| **Oriental Pratincole** (*Glareola maldivarum*) - Migraory | None | None | None | None | None | DotEE (2017b) | Bamford et al. (2008)<br>Hansen et al. (2016)<br>DotE (2015e) | Phoenix (2023; Appendix 6.1) | Surveys conducted in accordance with guidelines.<br>91,447 records within the SBSA, representing 2.6% of the world's population.<br>Meets international criteria: 1% of flyway populations. | As above and an additional 2,392.2 ha of potential Oriental Pratincole habitat is expected to be disturbed. | As above | As above.<br>Best practice management measures for clearing. | As above. | As above. |

# 16.7 RESIDUAL SIGNIFICANT IMPACTS FOR LISTED THREATENED SPECIES AND ECOLOGICAL COMMUNITIES

## 16.7.1 MARINE MNES SPECIES

The assessment conducted in Section 9.5 determined that there were a number of potential impacts that required controls to ensure they were made acceptable:

- Vessel strike;
- Entrapment in seawater intakes;
- IMPs;
- Marine noise emissions, particularly during dredging activities; and
- Light impacts on marine turtles.

The mitigation measures for these potential impacts are well understood and established for marine projects (refer to Section 9.6). Implementing an 8-knot speed limit for Proposal-related construction vessels will act to reduce marine fauna injury from vessel strike. While the probability of vessel strike is already low, reducing vessel speed has been shown to decrease the likelihood of fatal injury (to large whales) by 30% (Vanderlaan & Taggart, 2006). In addition, vessel operators will be required to report the location of any sightings of large marine fauna (in particular marine turtles, mammals and sawfish) to other vessel operators in the area to allow them to be tracked (if visible) and avoided, and to allow minimum separation distances to be maintained between vessels and prescribed fauna as described in the BC Regulations. Given the low numbers of vessels to be used at the Proposal and the implementation of controls the Proposal is expected to be able to be implemented without significant vessel strike impacts to marine fauna.

The Proposal will have two seawater intakes and they could pose a risk of marine fauna entrapment if not designed and operated appropriately. Leichhardt has committed to two specific mitigation measures for these intakes; screens will be installed to prevent the majority of marine fauna from being drawn into the intake pipe, and the intake has been designed such that the intake velocity is maintained below 0.15 m/s at all times. This velocity is recommended by the US Environmental Protection Agency (2001) as it ensures the protection of 96% of fish species, and is lower than the swim speed of marine turtles (Bell & Richardson, 1978; Bustard & Limpus, 1970; Chung et al., 2009; de Silva, 1995; Frick, 1976; Hirth, 1971; Hughes, 1974; Papi et al., 1995; Prange, 1976; Salmon & Wyneken, 1987; Witherington, 1991; Wyneken 1997). With the implementation of these two controls the risk of marine fauna entrapment is expected to be lowered to an acceptable level.

With the application of regulated controls, the Proposal is considered to present a 'low risk' of introducing marine pests to the marine waters of the Proposal. Standard industry controls (enforced by DAFF) relating to ballast water and vessel hygiene provide a level of confidence that IMPs will not be introduced.





Estimated marine noise from dredging activities is not significant, and marine noise mitigation measures are now well established within the marine construction industry. With the application of these measures, it is expected that dredging will be able to be conducted without significant noise impacts on marine fauna.

O2 Marine (2022b) determined that South West Regnard Island, North East Regnard Island, Steamboat Island and beaches on the mainland could potentially represent nesting habitat for turtle species (Flatback, Green and Hawksbill Turtles).

A risk assessment was undertaken to evaluate the potential for artificial light occurring in the vicinity of the Proposal to cause mis- or disorientation of hatchling sea turtles (Pendoley Environmental, 2023 & 2024). The assessment determined the inherent (unmitigated) risk to be low at North East Regnard Island, South West Regnard Island and 40-Mile Beach, and medium at CPE beach. Light mitigation measures will be implemented to reduce the risk of light interfering with hatchling orientations.

Water quality impacts from dredging and bitterns disposal (assessed in Section 6) were assessed as not being significant with the implementation of mitigation measures. Consequently, the impacts on marine fauna are subsequently not expected to be significant. Bitterns disposal and emissions from the salt production process will be managed under Part V of the EP Act via a works approval and licence.

Several MNES fauna species are known or expected to inhabit the waters surrounding the Proposal. Leichhardt considered these species when incorporating mitigation measures into the design and has proposed operational commitments to ensure that potential impacts on these species are not significant. As a result, no residual significant impacts to marine MNES species are predicted.

### 16.7.2 TERRESTRIAL MNES SPECIES

At a local scale, impacts to numerous EPBC-listed terrestrial fauna species are considered to be significant, even once mitigation measures are implemented. The Proposal is predicted to result in residual significant impacts to:

- Up to 10,950.3 ha of foraging habitat for the Pilbara Leaf-nosed Bat and Ghost Bat;
- Up to 20.8 ha of Eucalypt woodland on drainage habitat for the Pilbara Olive Python, potential foraging habitat;
- Up to 1,954.4 ha of 'spinifex grassland foraging habitat for the Grey Falcon; and
- Up to 1,100.0 ha of disturbance to Threatened Migratory Shorebirds habitat.

## 16.8 RESIDUAL SIGNIFICANT IMPACTS FOR LISTED MIGRATORY SPECIES

A total of 37 species listed as migratory under the EPBC Act have been recorded or are considered likely to occur in the vicinity of the Proposal based on an assessment of habitat requirements (Section 16.3.2). Detailed information about these species, their distribution and potential impacts from the Proposal is provided in Section 9.3 and Section 12.3.

### 16.8.1 MIGRATORY MARINE SPECIES

Several migratory marine MNES fauna species are known or expected to inhabit the waters surrounding the Proposal. Leichhardt considered these species when incorporating mitigation measures into the design and has proposed operational commitments to ensure that potential impacts on these species are not significant. The assessment conducted in Section 16.7.1 determined that there would be no residual significant impacts to threatened marine fauna species, and this assessment would also apply to migratory marine species.

### 16.8.2 TERRESTRIAL MNES SPECIES

Significant Proposal design changes have been made to reduce the impacts to migratory shorebird habitat (refer to Section 4). This has reduced the extent of disturbance from 2,272.9 ha to 576.3 ha, an overall reduction of 75%. This habitat consists of samphire shrublands, algal mats and mangroves. Nevertheless, given the extent of the predicted remaining disturbance, the local impacts to migratory shorebirds are considered locally significant. Assessment of Impacts to Commonwealth Marine Areas

## 16.9 ASSESSMENT OF IMPACTS TO COMMONWEALTH MARINE AREAS

The Proposal and associated activities are to be contained completely within State Waters, and indirect impacts are not predicted to extend into Commonwealth Marine Areas.

# 17 HOLISTIC IMPACT ASSESSMENT

Leichhardt has revised the pond layout several times since referral, specifically to avoid and minimise environmental impacts. The latest revised pond layout has focused on reducing impacts to BCH, vegetation and fauna habitats that were deemed to be most significant (refer to Section 4). As a result, the following reductions in environmental impacts were achieved (in comparison with the design assessed in 2022):

- An 79% reduction in mangrove losses;
- A 60% reduction in algal mat losses;
- A 26% reduction in bitterns discharge volume;
- A 60% reduction in dredging spoil volume;
- Reduction in indirect impacts to BCH from tidal inundation, coastal processes, sea level rise and groundwater seepage/mounding;
- Complete avoidance of the Coastal Dune PEC; and
- An avoidance of significant Aboriginal Heritage Areas.

For each relevant Key Environmental Factor, the ERD provides a detailed assessment of the potential impacts associated with the Proposal, application of the mitigation hierarchy and the management strategies proposed. The Key Environmental Factors relevant to the Proposal include:

- Inland Waters;
- Marine Environmental Quality;
- BCH;
- Marine Fauna;
- Terrestrial Environmental Quality;
- Flora and Vegetation;
- Terrestrial Fauna; and
- Social Surroundings.

Each relevant Key Environmental Factor has been assessed separately in Sections 6 – 13. Linkages of varying strengths exist between the relevant Key Environmental Factors. The potential impacts of the Proposal have been considered in a holistic context and a conceptual model demonstrating links between key environmental factors is provided in Figure 17-1. A linkage is considered to be present if any two Key Environmental Factors share the same impact. The strength of the links is based on the significance of the impact and the interconnectivity of each Key Environmental Factor with another. Linkages are represented by lines, strong linkages are shown as solid black lines and weaker linkages are represented by dotted lines.

Potential overarching impacts relevant to each Key Environmental Factor have been summarised in Table 17-1. While many potential impacts are shared between multiple factors, key impacts (those which have been identified as creating a strong linkage) have been identified with red ticks.

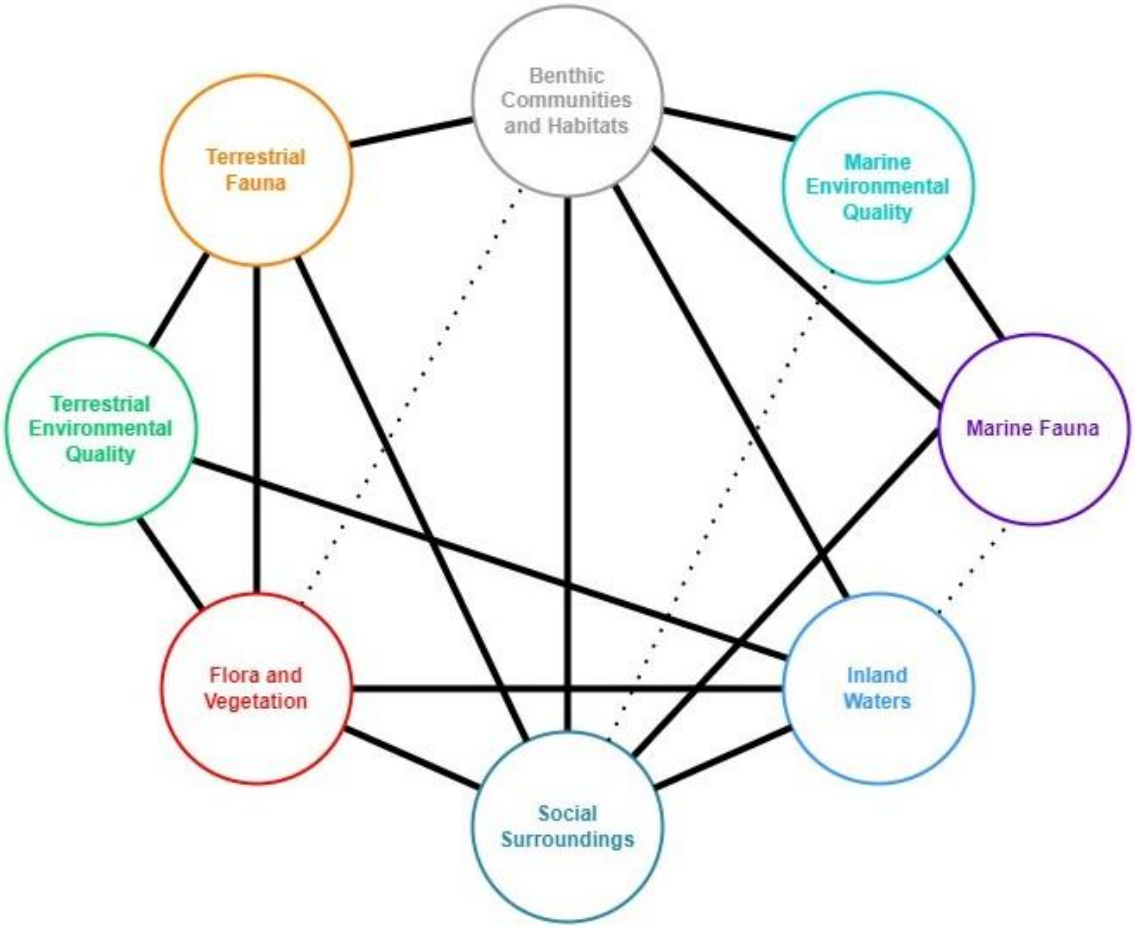



Figure 17-1: Conceptual model of linkages between Key Environmental Factors

Table 17-1 Potential impacts shared by key environmental factors

| Key Environmental Factor | Relevant Potential Impacts | | | | | | |
|---|---|---|---|---|---|---|---|
| | Ground disturbance | Dredging | Bitterns disposal | Surface water changes | Groundwater Seepage | Contamination | Amenity (visual, noise, light) |
| Inland Waters | ✓ | | | ✓ | ✓ | ✓ | |
| Marine Environmental Quality | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| BCH | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Marine Fauna | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| Terrestrial Environmental Quality | ✓ | | | ✓ | ✓ | ✓ | |
| Flora and Vegetation | ✓ | | | ✓ | ✓ | ✓ | |
| Terrestrial Fauna | ✓ | | | ✓ | ✓ | ✓ | ✓ |
| Social Surroundings | ✓ | | | ✓ | ✓ | ✓ | ✓ |

The Proposal relies on solar evaporation to produce product and as such the large-scale inundation of habitats is unavoidable. Ground disturbance, including the clearing and inundation of native vegetation and BCH is identified as a key impact as it will directly impact eight key environmental factors. Ground disturbance will impact the Flora and Vegetation and Terrestrial Fauna key environmental factors by removing or disturbing flora species, significant ecological communities and significant fauna habitat. It will also impact the Social Surroundings factor by reducing the quality and availability of vegetation that may otherwise be used by the Traditional Owners for bush tucker or bush medicine, and affect the amenity of recreational users of the 40-Mile beach area. Leichhardt also acknowledges that native vegetation values are related to the availability of faunal and botanical resources and represents a connection to Country.

Impacts to the marine environment as a whole are predicted to be localised, with short-term dredging, limited vessel movements, and a dedicated mixing zone for the bitterns.

Changes to the quality and flow regimes of surface water has the potential to affect all of the Key Environmental Factors and groundwater seepage affects all but one. Mitigation will be critical in ensuring the impacts are minimised to an acceptable level.

Other Proposal impacts (contamination and amenity impacts) provide linkages between the other key environmental factors however these impacts are unlikely to be significant and therefore linkages are not considered to be as strong as the others mentioned above. All linkages have been considered in the design of the Proposal, application of the mitigation hierarchy and proposed management measures.

There are some potential impacts that require management and monitoring to ensure that the impacts are not significant. Many of these potential impacts are adequately regulated under other legislation:

- Bitterns discharge, brine spills and leaks, and sewage will be regulated under Part V of the EP Act;
- General environmental management will be regulated through a Mining Proposal assessed under the Mining Act or a Development Application and Construction Approval under the *Port Authorities Act 1999*; and
- Closure and rehabilitation on Mining Act tenure will be regulated through a MCP assessed under the Mining Act.

There are some potential impacts however that are expected to require limits or conditions in the Ministerial Statement, including:

- Limits on total disturbance within each development envelope;
- Limits on total bitterns discharge and dredging volumes;
- The implementation of a DSDMMP to regulate dredging;
- The implementation of a MEQMMP to outline marine environmental quality boundaries, and management and monitoring requirements for bitterns discharge;
- The implementation of a GMMP to monitor and manage impacts to groundwater; and
- The implementation of a BCHMMP to monitor and manage impacts to BCH.

With the application of the avoidance mechanisms in the Proposal design and operations, and the limits and regulation of potential impacts discussed above, Leichhardt considers that many of the potential impacts to key environmental values are able to be reduced to an acceptable level with appropriate management. However, despite the outcomes and mitigation listed in this ERD, the unavoidable large-scale inundation of habitats will result in the following significant residual impacts:

- 11,287.7 ha of disturbance of Good to Excellent vegetation, a portion of which is the Horseflat PEC and foraging habitat for several significant fauna species; and
- 1,175.1 ha of disturbance of intertidal BCH, which also provides foraging habitat for Migratory birds.

These significant residual impacts are proposed to be counterbalanced by:

- Contributions to the PEOF, to counterbalance the disturbance of Good to Excellent vegetation and significant fauna habitat; and
- The development and implementation of intertidal research and conservation and management programs, informed by the findings and recommendations of intertidal research programs listed in MS 1211 for the Mardie Project, to counterbalance the disturbance of intertidal BCH.

With the application of the mitigation hierarchy (avoid, minimise, rehabilitation and offsets), Leichhardt considers that potential impacts to key environmental values can be reduced to a level that ensures the EPA's objectives can be met.

# 18 CUMULATIVE IMPACT ASSESSMENT

Leichhardt has conducted an assessment of the potential and residual environmental impacts for each Key Environmental Factor relevant to the Proposal. A cumulative environmental impact assessment was included to assess the successive, incremental and interactive impacts of the Proposal on the environment in addition to impacts from past, present and reasonably foreseeable future activities. The results of this assessment are summarised in the following sections.

## 18.1 INLAND WATERS

The Proposal will not affect any creeklines and the majority of surface water flow through to the marine environment will be maintained. There are no other major regional impacts on surface water flow or groundwater in the vicinity of the Proposal. Impacts associated with inland waters are expected to be localised and therefore there are no cumulative impacts associated with the Proposal.

## 18.2 MARINE ENVIRONMENTAL QUALITY

Five existing and planned solar salt operations and multiple desalination plants, at various stages of development, have been identified along west Pilbara Coast. The solar salt operations, listed in order of location west to east along the coast, are Ashburton Salt, Onslow Salt, Optimised Mardie Project, the Proposal and Dampier Salt. The desalination plants support various mining, industrial and municipal infrastructure along the coast. Two of the desalination plants operate through independent infrastructure, while multiple were identified to utilise combined infrastructure and discharge through the Multi-User Brine Return Line on the Burrup. The current and planned desalination plants accounted for in the Burrup Hub include Water Corporation Burrup Peninsula Desalination, Yara Pilbara Fertiliser, Yuri Renewable Hydrogen Project, and Perdaman's Karratha Urea Plant.

Figure 18-1 lists the seawater processing operations and their operating capacities and Figure 18-2 shows the various discharge locations.

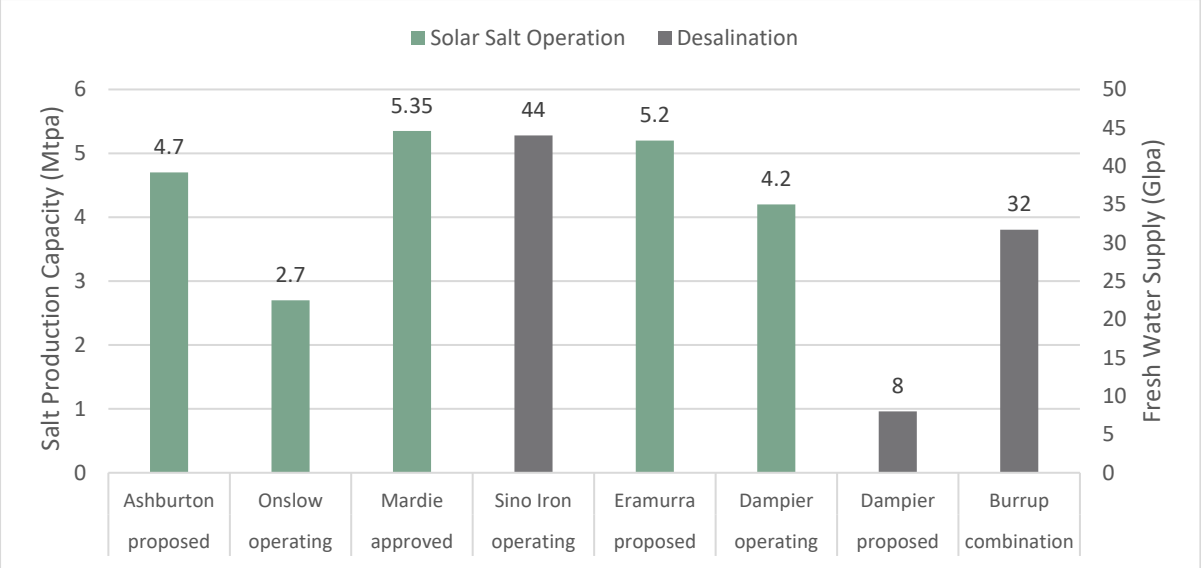



**Figure 18-1: Seawater Processing Operations, West Pilbara Coast**

The Proposal will result in up to 5.9 GLpa of bitterns discharge. A number of the above desalination plants and solar salt projects in the vicinity of the Proposal have an approved annual bitterns / brine discharge (Figure 18-3 and Figure 18-4) rate and others identified in DoE (2006), including approved limits of:

- 64 GLpa associated with the Sino Iron Project Desalination Plant and Bulk Loading Facility;
- 6.0 GLpa associated with Onslow Salt;
- 13 GLpa associated with Dampier Seawater Desalination Plant;
- 5.5 GLpa associated with the Optimised Mardie Project; and
- 10 GLpa associated with the Ashburton Salt Project.

The publicly available information on the Dampier Salt operation indicates 4.2 Mtpa production. With conservative assumptions for weather variability and non-recycled losses, Leichhardt has estimated an average of 4.8 GLpa of bitterns discharge.

Nearly all the salt taken into desalination plants goes back to ocean in the discharge. Solar salt operations rely on the evaporation of water to atmosphere to concentrate the seawater and assist in the extraction of salt to product, prior to discharge of the concentrated stream. Salt operations apply various degrees of salt concentration and salt extraction prior to discharge. Traditional salt operations extract 55-70% of the original salt (including 70-90% of the sodium chloride). A potash producing salt operation (e.g., Mardie) will extract close to 80% of the original salt (targeting 100% recovery of the sodium chloride and potassium). The bitterns waste stream from salt operations is a relatively small volume however at a very high salts concentration.

The cumulative discharge from the solar salt and desalination operations identified is estimated to contain up to 22 Mtpa of salt. Figure 18-5 depicts the estimated maximum salt loads from the operations on the west Pilbara Coast in Mtpa.

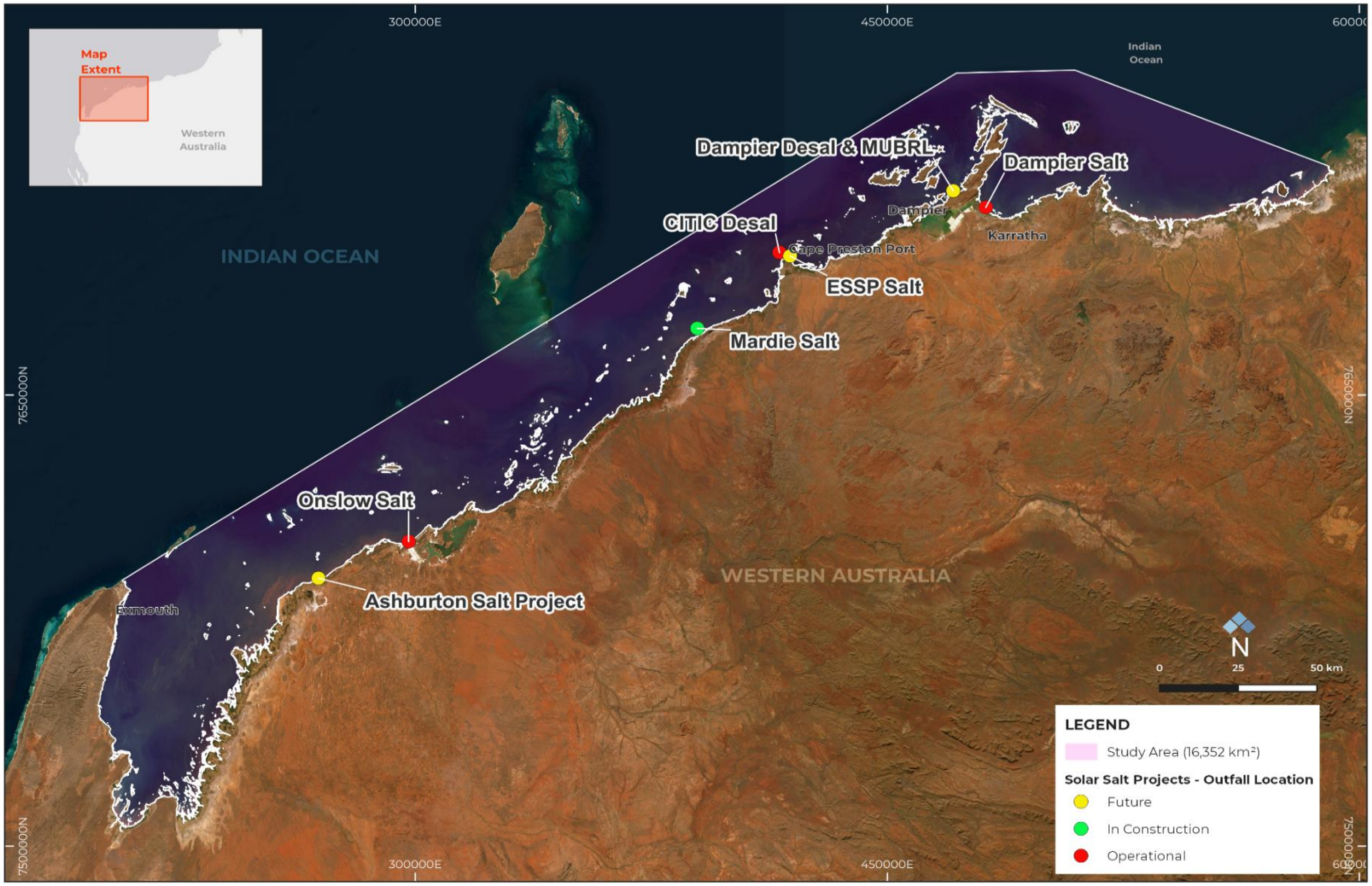
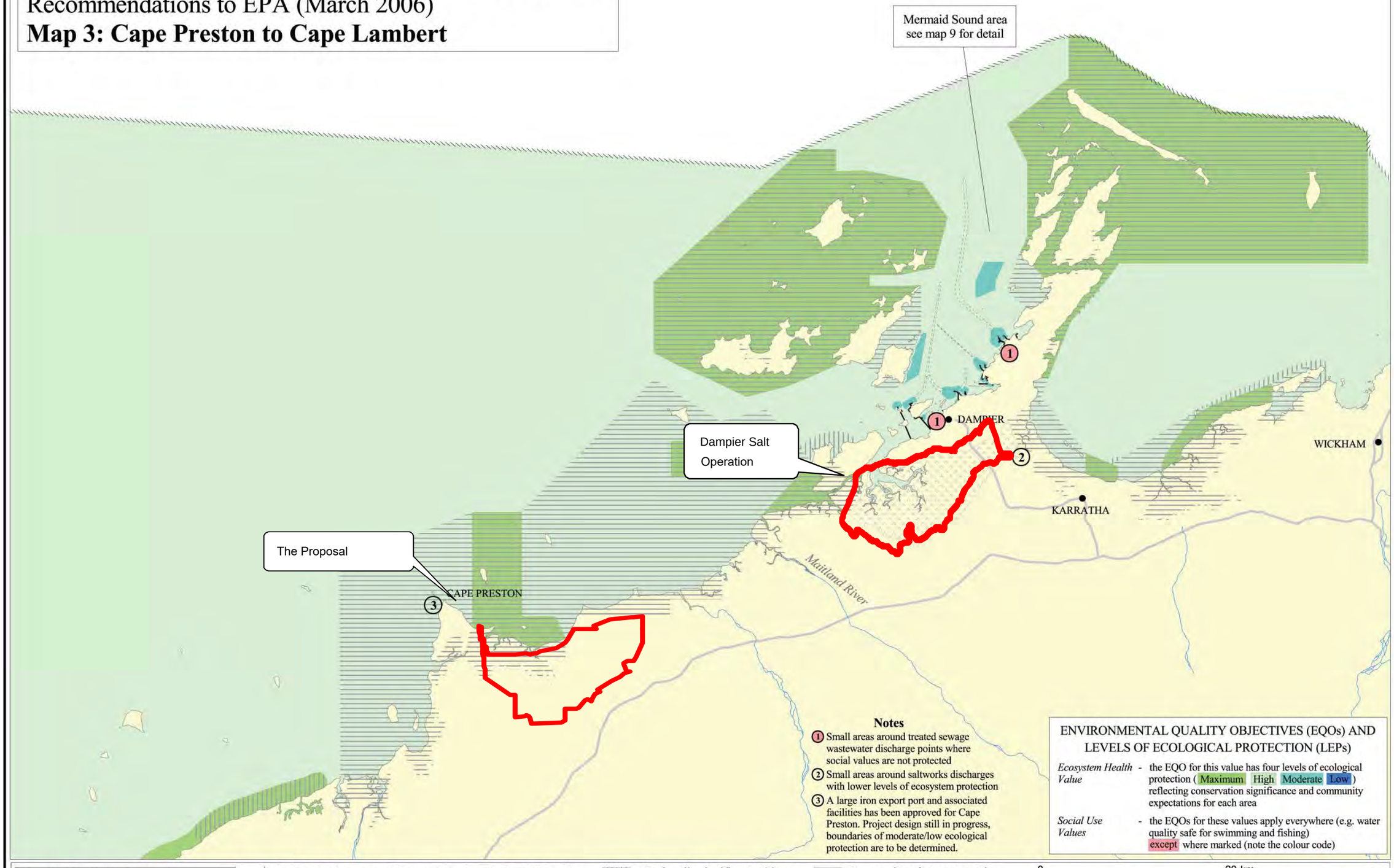



Figure 18-2: Seawater processing projects - discharge locations

Pilbara Coastal Water Quality Consultation Outcomes
Recommendations to EPA (March 2006)
**Map 3: Cape Preston to Cape Lambert**




**Notes**

1. Small areas around treated sewage wastewater discharge points where social values are not protected
2. Small areas around saltworks discharges with lower levels of ecosystem protection
3. A large iron export port and associated facilities has been approved for Cape Preston. Project design still in progress, boundaries of moderate/low ecological protection are to be determined.

ENVIRONMENTAL QUALITY OBJECTIVES (EQOs) AND LEVELS OF ECOLOGICAL PROTECTION (LEPs)

*Ecosystem Health Value* - the EQO for this value has four levels of ecological protection ( Maximum High Moderate Low ) reflecting conservation significance and community expectations for each area

*Social Use Values* - the EQOs for these values apply everywhere (e.g. water quality safe for swimming and fishing) except where marked (note the colour code)

Levels of Ecological Protection
Maximum Moderate
High Low

Limit of state coastal waters
Salt Works
Dredge Spoil Dump Area
Dredged Channel
Coastal Infrastructure
Regionally significant arid zone mangrove areas (EPA, 2001)
Worthy of consideration for marine reserve (CALM, 1994)
Proposed marine conservation reserve as per Indicative Management Plan (CALM, 2005)

0 20 km

The information on this map should not be relied upon for navigational purposes

Map Produced: March 2006

Natural Heritage Trust



**Figure 18-3: LEP zones in the region – Cape Preston to Cape Lambert**

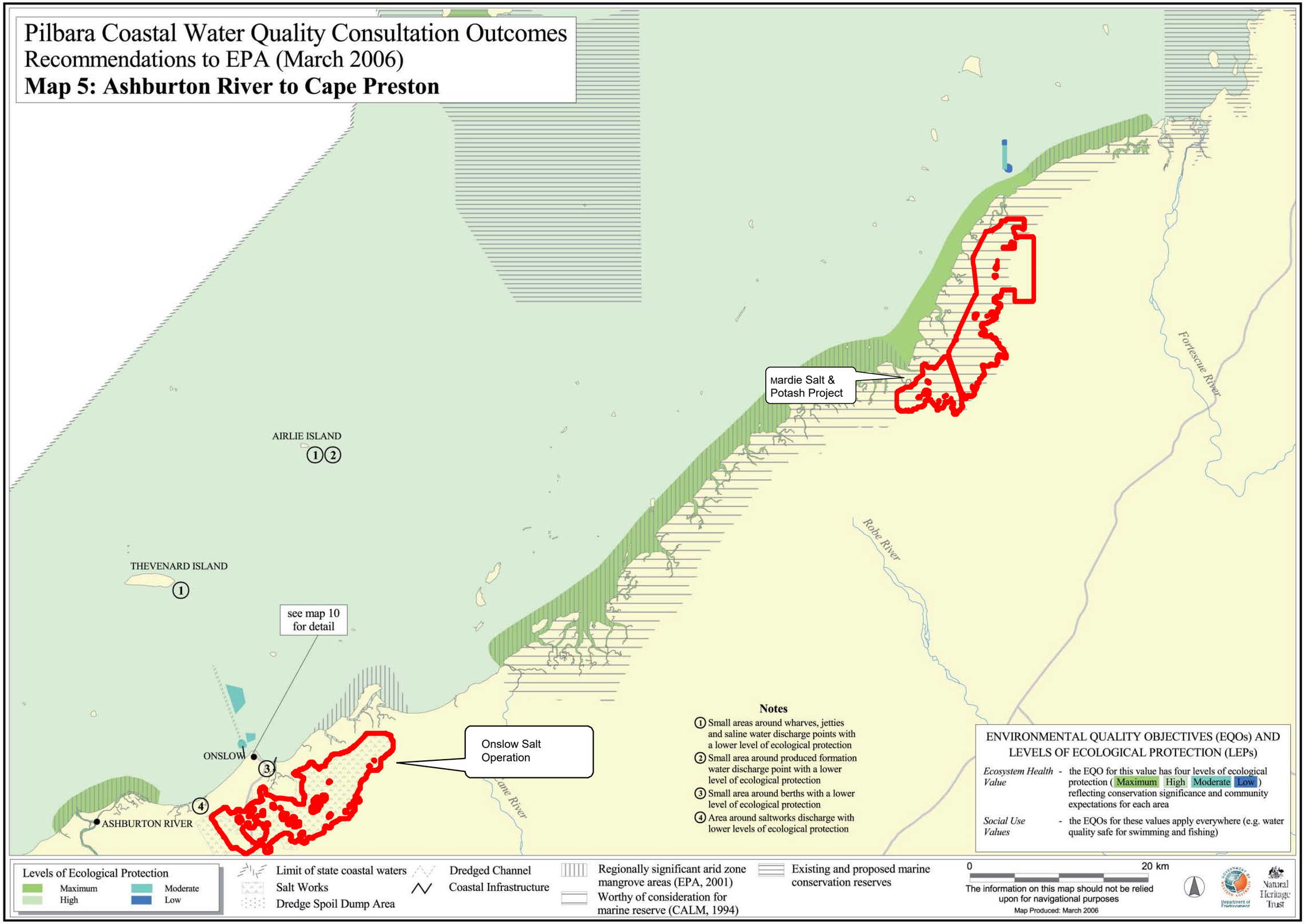





**Figure 18-4: LEP zones in the region - Ashburton to Cape Preston**

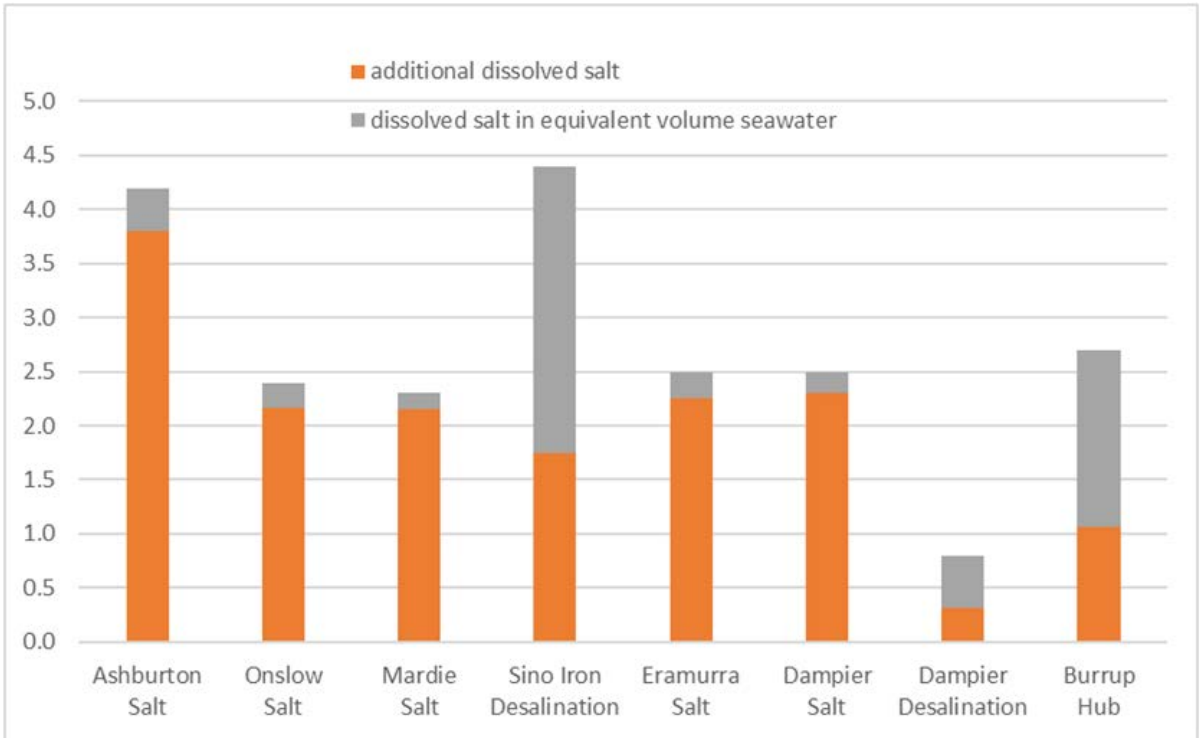



Figure 18-5: Salt Loads in Undiluted Discharges (Mtpa)

The depicted salt loads were estimated on the following basis:

Solar salt operations:

- All specified salt production capacities plus a factor of +30% to account for maximum annual salt growth associated with weather variation;
- Undiluted discharge volumes and concentrations estimated based on the applied process and the mass of salt extracted from seawater into product. The applied process refers to the degree of salt extraction expected from the concentrated seawater stream: Ashburton and Onslow applying the lowest recovery, Eramurra and Dampier with similar secondary recovery, and Mardie recovering through to precipitation of potassium; and
- Aside from product to sales, the only loss of salt accounted for is precipitation of all calcium salts within the salt ponds.

Desalination:

- Concentrate stream based on annual fresh water supply capacity and 40% recovery;
- No net loss of salt; and
- Any wastewater produced by use of the desalinated water supply is excluded from the calculations.

The first-order impact of each brine outfall may be considered by conceptually separating the process discharge stream into an equivalent volume of seawater, plus a further quantity of salts based on the excess salinity (above seawater) within that stream. Brine outfalls may include local seawater injection to pre-dilute the flow, but this does not affect the far field and such dilutions are not relevant to large scale impact assessment. This provides a simple basis for high level assessment of impacts from desalination and solar salt production.

This approach only considers total salts. Desalination plants simply return a more concentrated seawater, but salt production bitterns have a changed ionic composition due to the extraction of 55%-80% of the original salt content. Leichhardt has assessed the current and proposed major projects along the West Pilbara Coast in this manner and estimates an "excess salt" discharge of around 17 Mtpa from the eight tabled desalination and solar salt projects between North-West Cape and Dampier.

### 18.2.1 BASELINE OCEAN SALINITY CONDITIONS – ERAMURRA LOCATION

The Proposal has undertaken a baseline ocean condition measurement program (O2 Marine, 2022a). This comments on features of the coastal salinity:

*In general, nearshore waters are more saline than those found on the outer shelf (Condie et al., 2006). Water quality studies of the nearshore Pilbara regions have shown surface water salinities to range from 35.1 to 37.1 ppt (CALM, 2005).*

*Variable salinity is common in nearshore waters of the west Pilbara (Pearce et al., 2003). During the summer monsoonal season, salinity may be impacted by freshwater outflows from tidal creeks that connect the coast with large inland flats.*

The Proposal water measurement program included a series of salinity measurements at three locations relevant to this study:

- OCP20 – approximately 21 km offshore, in the proposed anchorage area for product cargo ships;
- NCP05 – 1.5 km offshore, approximating the proposed location for the bitterns outfall diffuser; and
- UNS05 – around 4.5 km out from the mouth of McKay Creek, within a shallow bay area.

Salinity probes were deployed at NCP05 and UNS05 for 52 and 59 weeks, respectively, and finishing up in June 2021. The logged salinity values at NCP05 and UNS05 varied from 32.0 - 38.6 psu, with respective mean values of 35.1 and 36.0 psu (O2 Marine, 2022a). It is proposed that NCP05 is more influenced by mixing with water from offshore, while UNS05 accrues higher salinity from evaporation across the shallow tidal flats. Water samples were collected for laboratory analysis from the three locations over 12 monthly events, with final samples collected September 2021. All three locations experienced similar maximum salinities up to 42 ppt while the minimum and mean salinities increase closer to shore and within the shallow bay area. Mean salinities were 37, 38 and 39 ppt for OCP20, NCP05 and UNS05, respectively and minimum salinities at 34, 35, and 36 ppt.

In summary, studies (CALM, 2005) suggests that nearshore Pilbara salinities can vary by 6% on a 36 ppt mean; while the 1-year salinity monitoring program on Proposal site measured salinity variations near 20% on means of 35 in psu and 37 ppt. The mean nearshore salinities increased 3-5% from mean offshore salinity, with seasonal influences leading to the more significant variation.

### 18.2.2 BITTERNS DISPERSION MODELLING

The basis and results of modelling bitterns dispersion for the Proposal is reported by O2 Metocean (2023a). The applied dilution factor of 509 yields a salinity increase of less than 1 ppt above background at the high LEP (> 99% SPL) boundary. This is similar to the existing mean salinity difference between NCP05 and UNS05.

Two separate bitterns dispersion scenarios were modelled:

1. The peak rate of discharge that would ever occur during summer months: and
2. The annual average rate of bitterns discharge, modelled under winter conditions.

The dispersion model was run over a simulated period of two months operation by which time it was evident that salinity levels throughout were steady and the extent of the Moderate LEP zone had stabilised at 1.29 $km^2$. Within that MEPA, the input of salts with bitterns was being fully balanced by its removal from the zone via mixing and convection processes. An additional check was undertaken that further reaches of the 655 $km^2$ model domain had also reached steady state.

### 18.2.3 ORDER-OF-MAGNITUDE ASSESSMENT

This section aims to provide simple order of magnitude perspectives on the potential for cumulative impact from these operations based on the combination of their discharge streams.

For conceptual assessment, an offshore polygon was drawn along the West Pilbara coast (refer Figure 18-2) showing both current and proposed brine discharge sites. This boundary encloses a sea area of around 16,350 $km^2$ with an average extent of about 36 km from the coast. By comparison the average distance between brine discharge sources is in the order of 40 km. Although the polygon was somewhat arbitrary, an adequate offshore distance must be considered when assessing the potential for project discharges up to 100 km apart to link up for a larger-scale effect. The volume of seawater enclosed within this area was estimated via GIS based on North West Shelf bathymetry to be 2.1 x $10^{11}$ $m^3$.

The analysis takes a high-level approach of assuming the west Pilbara coast water body is in long term steady state with seawater processing facilities as the only applied change.

***Seawater Processing Impact as Equivalent Evaporation***

The total concentration of salts in coastal Pilbara seawater is nominally 36 ppt or 35 g/L, 73% of the salt content being sodium chloride. Restating the near-shore concentration as 0.035 $t/m^3$, the 17 Mtpa of discharged excess salt corresponds to the equivalent removal by those projects of 490 GLpa of fresh water. The following assesses indicative impact on seawater salinity within this coastal region.

***Comparison with Natural Evaporation Process***

The net evaporation (Class A pan less mean rainfall) considered for the Proposal and similar projects is in the order of 3.0 m/annum. After discounting by 40% for the reduced evaporation across large wet surface areas, the expected offshore evaporation is in the order of 1.8 m/annum.

For the offshore polygon area, the natural evaporative water loss is in the order of:
16,350 x $10^6$ x 1.8 i.e., 2.9 x $10^4$ GLpa

That is around 59 times the equivalent water removal estimated for the eight west Pilbara coastal locations considered. Consequently, natural evaporation will be the dominant driver of concentration. It has been noted above there is a small increase of salinity towards the shoreline. The surface evaporation is primarily balanced by seawater inflow from the open ocean. The small salinity gradient near the shore is continuously limited by mixing with less saline offshore water driven by wind, tides, currents and diffusion. The large natural evaporation within this coastal area poses no issue in respect of seawater concentration, with the concentration rise capped by mixing processes on a vast scale.

***Comparison with Coastal Waters Salt Inventory***

Based on North West Shelf bathymetry, the water volume within the selected water envelope has been estimated via GIS assessment to be around 0.21 x $10^{12}$ $m^3$. Using a lesser salt concentration of 35 g/L TDS (36 ppt salinity), the corresponding contained quantity of salts is around 7,400 Mt. That is, the 17 Mt of annual "excess salt" contributed by these projects is around 0.23% of the baseline salt content of the referenced water volume. In the absence of any other processes, this would move the concentration of that seawater volume by just 0.23% per year. As noted above, the routine salinity variation over one year of site monitoring showed 20% seasonal variation and up to 5% variation between nearshore and offshore mean salinities.

### 18.2.4 CONCLUSION

In summary, each of the discharges identified has a relatively localised impact area around the discharge point with the cumulative discharge likely to only impact a small proportion of the coastal waters. The prospect that these distributed salt emissions can combine to create a substantial impact appears most unlikely due to the wide geographic spread of the salt discharge sources. This makes the impact of these salt emissions on a regional scale very small compared to the magnitude of natural processes and quantities within the relevant coastal zone. The total salinity impact of these coastal projects is a small fraction of the proximal natural processes, which are not themselves considered of any concern.

## 18.3 BENTHIC COMMUNITIES AND HABITAT

Leichhardt has assessed cumulative impacts on intertidal BCH by incorporating the findings of impact assessments and regional mapping undertaken for the Mardie Project and by Leichhardt. Impacts have been considered for the western Pilbara coastline, including built, approved and planned salt and port projects.

The extent of the indirect sedimentation impacts as a result of dredging has been modelled (O2 Metocean, 2025; Appendix 2.5). The modelling indicated that there will be no irreversible indirect impacts to BCH as a result of the dredging. Hence, there are no cumulative impacts associated with dredging.

The regional extent of mangroves is predicted to be 33,706 ha and up to 8.3 ha of this BCH type is proposed to be disturbed to implement the Proposal. Cumulative impacts from projects in the surrounding area is shown in Figure 18-6.

In general, cumulative pressures in the area are relatively low compared to the total extent, with 17 ha approved at the Mardie Project and less than 5 ha proposed to be disturbed at the Ashburton Salt Project. It is likely that the Dampier Salt Project would have the most extensive historic mangrove losses however this cannot be determined given the lack of pre-development data. Some other minor losses would have occurred during port developments. Mangroves remain at high pre-European extents throughout the Pilbara and are expected to remain at high levels given their level of protection through the EIA process.

The regional extent of algal mats is predicted to be 41,574 ha and up to 611.0 ha of this BCH type (only 87.3 is considered HDAM) is proposed to be disturbed as a result of the Proposal. Cumulative impacts from projects in the surrounding area is shown in Figure 18-7. The Mardie Project is the only other recent or proposed project in the region that is likely to have a significant impact on algal mats, with almost 900 ha of disturbance approved. The Dampier Salt Project may also have resulted in significant losses of algal mats however cannot be determined given the lack of pre-development data. The Ashburton Salt Project includes negligible losses of algal mats. Cumulative impacts are therefore likely to be in the order of 5 – 10% loss, depending on the historic losses associated with the Dampier Salt Project. It is also noted that WAMSI is currently conducting detailed cumulative impact research on algal mats on the west Pilbara coastline which is planned to be completed in 2025.




**Figure 18-6: Cumulative impact on mangroves**

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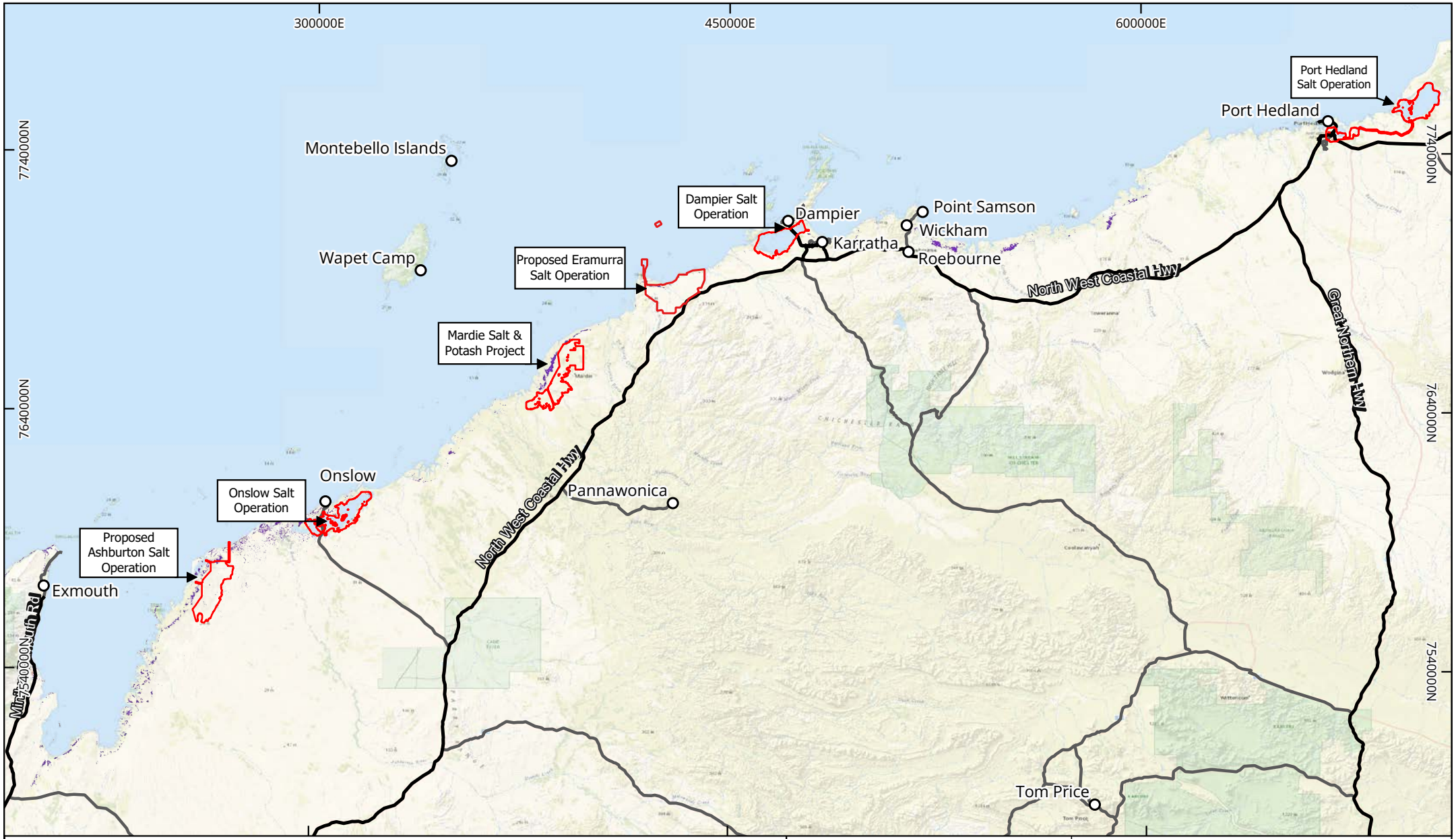


**Figure 18-7: Cumulative impact on algal mats**

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## 18.4 MARINE FAUNA

The potential cumulative impacts to marine fauna are associated with dredging; bitterns discharge; vessel movements; entrapment and entrainment; and changes to light spill.

The method of dredging proposed includes the use of a CSD. Dredging will be conducted in accordance with the DSDMMP provided in Appendix 2.2 and mitigation measures implemented to ensure that impacts to marine fauna are minimised as much as practicable, including avoidance of environmental windows and use of fauna spotters. Given the above, the cumulative impacts associated with dredging are likely to be minimal.

Two seawater intakes are proposed as part of the Proposal, located within the PIDE and Marine Development Envelope. O2 Marine (2025e; Appendix 4.1) determined that turtles and fish species are likely to be present in the vicinity of the proposed seawater intake and therefore there was the potential for marine fauna to become trapped and/or entrained within the intakes. An intake flow rate of less than 0.15 m/s will be applied to the intakes, which ensures the protection of 96% of fish species, and is lower than the swim speed of marine turtles (Bell & Richardson, 1978). Other intakes are located at each of the current and proposed salt projects shown Figure 18-1. These other intakes and the seawater intakes proposed as part of the Proposal may result in localised reductions to some marine fauna, however, these reductions are unlikely to represent a significant cumulative loss when considered in the context of regional Pilbara waters.

Lighting within coastal areas will be limited to operational areas. While exact light emissions are unable to be predicted until the detailed design stage, it is understood that the Proposal will require relatively low amounts of permanent lighting, with minimal lighting close to the coast. Pendoley (2022 & 2023) assessed the cumulative light impacts in the area, and the influence of the Proposal (refer to Section 9.5). The Proposal is predicted to contribute moderate increases (<11%) in the predicted horizon brightness in the local area, given the scale of light emissions from the large-scale coastal ports at Cape Preston and CPE. Lighting for coastal facilities will consider design recommendations provided in DCCEEW (2023) in order to ensure that lighting impacts are as low as practicable. An ALMP for marine and terrestrial fauna has been developed, which incorporates the requirements of EPA (2010) and DCCEEW (2023) guidance. With the implementation of this plan the local light emissions are not expected to be significantly increased and therefore cumulative light impacts in the area will also not be significantly increased.

The Proposal will result in cumulative loss of the following critical fish habitat over the entire Proposal (i.e., including all LAUs; O2 Marine, 2025b):

- Mangroves: 8.3 ha of 1,381.5 ha (0.6%);
- Macroalgae: 0.1 ha of 2,066.7 ha (0.005%);
- Seagrass: 4.1 ha of 2,441.2 ha (0.2%); and
- Coral reef: 3.8 ha of 3,806.5 ha (0.1%).

Overall, this cumulative loss assessment indicated that the impacts to critical fish habitat, whilst measurable, were unlikely to result in any significant risk of impacting biological diversity and ecosystem integrity (O2 Marine, 2025b).

All efforts have been made during the Proposal design and engineering stages to maintain maximum mangrove extent and biomass in recognition of its importance as critical fish habitat.

This has resulted in a reduced disturbance to the ecologically important mangroves (8.3 ha) as a result of direct removal. Approximately 1,373.23 ha of healthy and resilient mangrove habitat will remain within the local area, which equates to 99.9% of all mangroves within the LAUs 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 to aquatic resources that overlap with the Proposal.

Although the impacts (individual and cumulative) to critical fish habitat and fisheries from this Proposal are considered acceptable, combined there are potentially broader and more significant cumulative impacts to fisheries and critical fish habitat with the numerous other proposed solar salt farms across the west Pilbara. Following recent assessment of a new salt field 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.

There may be some impacts to commercial and recreational fishery species that become more significant due to the cumulative pressures across the extent of the fishery and the spatial range of the species that are being targeted. This is critical for some indicator species that may already be on the edge of triggering restrictions, where there is no buffer for additional cumulative impacts. Leichhardt will continue to liaise with EPA and WAFIC regarding the most appropriate method to accurately quantify these impacts and mitigate them as far as practicable.

Leichhardt will be contributing appropriate funding to a coordinated conservation and management program to protect and maintain the ecological value of these expansive intertidal habitats and the potential services they provide to the broader west Pilbara marine environment such as primary productivity, nutrient cycling and other ecosystem maintenance functions (Section 15).

## 18.5 TERRESTRIAL ENVIRONMENTAL QUALITY

The potential cumulative environmental impacts to terrestrial environmental quality are associated with disturbance of ASS, hydrocarbon spills and other soil contamination. Impacts to terrestrial environmental quality from the Proposal is expected to be minimal and managed appropriately under Part V Licence under the EP Act. Impacts associated with terrestrial environmental quality are expected to be localised and therefore there are no cumulative impacts to this factor associated with the Proposal.

## 18.6 FLORA AND VEGETATION

Section 11.5.2 assessed the predicted cumulative impacts to regional vegetation associations, which can be used at a high level to assess cumulative impacts to vegetation. When assessing the disturbance associated with the Proposal at a regional scale, disturbance mainly occurs within two vegetation associations; '175: Short bunch grassland – savanna/grass plain' and '127: Bare areas, mud flats'.

Disturbance within the remaining associations 93, 43, and 117 is relatively minor with impacts unlikely to affect the overall distribution of these associations.

The current state-wide extent of vegetation association '127: Bare areas, mud flats' is 697,871 ha, 94.6% of its pre-European extent (DPIRD, 2018). The current extent of this vegetation association is 159,595 ha (89.8% of pre-European extent) and 159,024 ha (89.7%) within the Pilbara IBRA region and Roebourne sub-region respectively. Up to 2,119 ha of this vegetation association intersects the Indicative Disturbance Footprint, which equates to 0.3% of its State-wide pre-European extent, and 1.2% within the Roebourne sub-region. Proposals in the vicinity of the Proposal which also intersect vegetation association 127 are shown in Figure 18-8. Projects not considered in the current extent of vegetation association 127 (disturbance may not have been accounted for as clearing had not occurred when data was collected in 2018) include:

- 7,700 ha of disturbance associated with the Ashburton Salt Project;
- 7,682 ha of disturbance associated with the Mardie Project;
- 2,240 ha of disturbance associated with the Sino Iron Mine Continuation; and
- Other miscellaneous proposed disturbance that may amount to approximately 200 ha.

This equates to a total of 17,822 ha which reduces the current State-wide extent to 680,049 ha and Roebourne sub-region extent to 141,202 (92% and 80% of their pre-European extent respectively). When combined with the Proposal this equates to a final State-wide extent of 677,930 ha and Roebourne sub-region extent of 139,083 ha, or a cumulative loss of 19,941 ha if all proposals were to proceed. This equates to 91% of the State-wide pre-European extent remaining, and 78% of the Roebourne sub-region extent remaining.

The current state-wide extent of vegetation association '175: Short bunch grassland – savanna/grass plain' is 524,640 ha, 99.6% of its pre-European extent (DPIRD, 2018). The current extent of this vegetation association is 507,567 ha (99.9% of pre-European extent) and 114,284 ha (99.97%) within the Pilbara IBRA region and Roebourne sub-region respectively. Approximately 13,927 ha of the PIDE intersects the mapped boundary of this vegetation association, and 10,488.0 ha is predicted to be disturbed, which equates to 2.0% of its State-wide pre-European extent, and 9.2% within the Roebourne sub-region. Proposals in the vicinity of the Proposal which also intersect vegetation association 175 are shown in Figure 18-9. Projects not considered in the current extent of vegetation association 175 (disturbance not accounted for as clearing had not occurred when data was collected in 2018) include:

- Up to 8,956 ha of disturbance associated with the Brockman Syncline Proposal;
- Up to 3,218 ha of disturbance associated with the Sino Iron Mine Continuation;
- Up to 2,964 ha of disturbance associated with the Mulga Downs Iron Ore Mine;
- 378 ha of disturbance associated with the Eliwana Railway Project; and
- 215 ha of disturbance associated with Mulga Downs Hubb and Rail Spur.

This equates to a total of 15,731 ha which reduces the current State-wide extent to 509,909 ha and Roebourne sub-region extent to 98,553 ha (97% and 86% of their pre-European extent respectively). When combined with the Proposal this equates to a final State-wide extent of 495,982 ha and Roebourne sub-region extent of 84,626 ha, or a cumulative loss of 29,658 ha if all proposals were to proceed. This equates to 94% of the State-wide pre-European extent remaining and 74% of the Roebourne sub-region extent remaining.

The BHP Pilbara Expansion Strategic Proposal also intersects vegetation association 175 (Figure 18-9), however actual disturbance areas for this vegetation association have not been calculated and therefore could not be included in the cumulative disturbance.

Leichhardt also assessed the impacts of the Proposal against potential and existing cumulative clearing impacts. Leichhardt determined that the cumulative native vegetation clearing across the Proposal is estimated to be 11,401.1 ha, representing:

- 41.9% of the remaining native vegetation extent within 10 km of the Proposal;
- 2.6% of the remaining native vegetation extent within 50 km of the Proposal; and
- 0.7% of the remaining native vegetation extent within 100 km of the Proposal.

Cumulative impacts from projects in the surrounding area is shown in Figure 18-10. Other large Proposals within these distances include the Mardie Project and Sino Iron Project, and historic disturbances associated with the Dampier Salt operations.

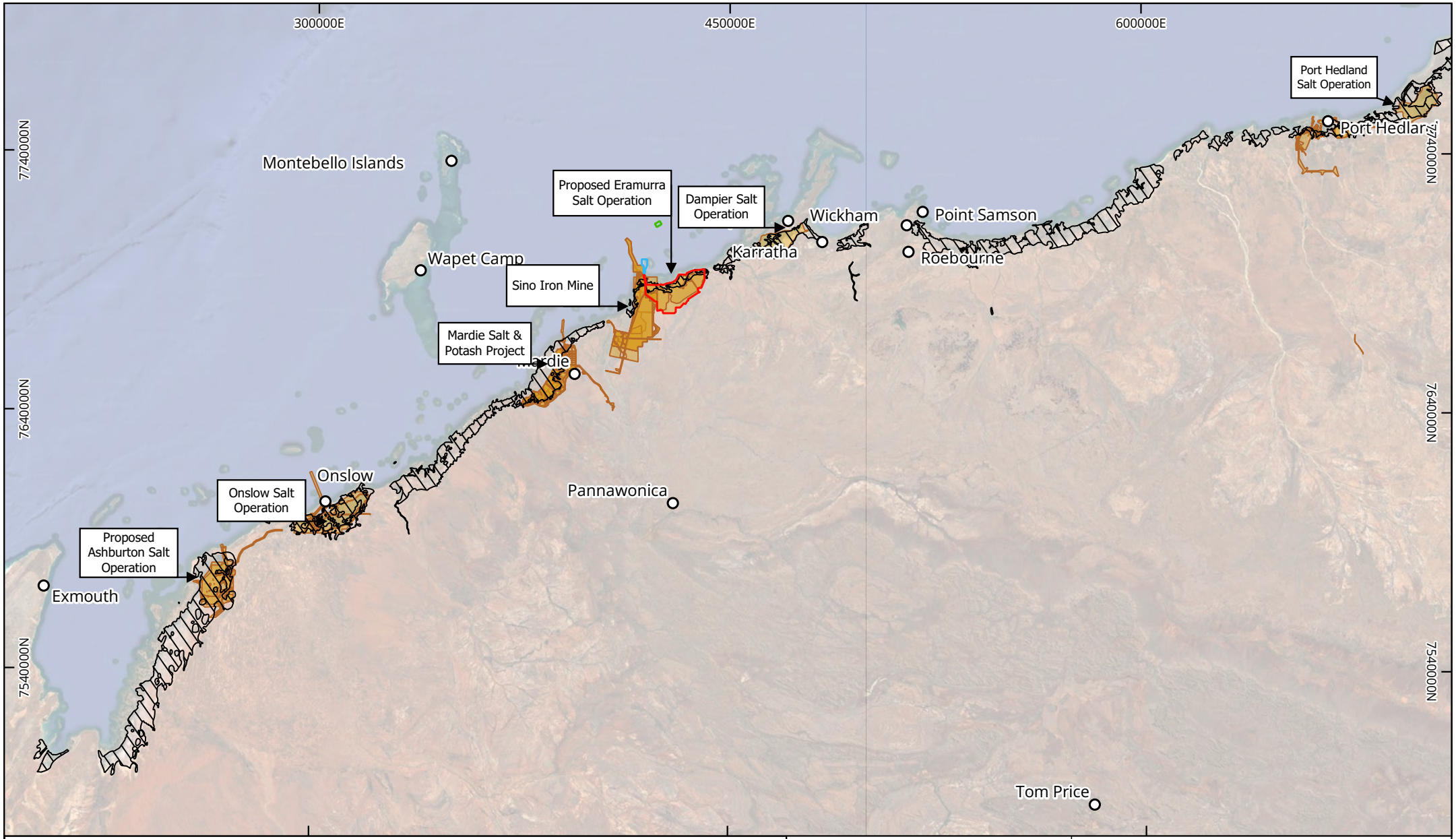
The predicted regional extent of Horseflat PEC is 194,996 ha, and 7,614.1 ha of this is proposed to be disturbed as a result of the Proposal. Cumulative impacts from projects in the surrounding area are shown in Figure 18-11. The existing/proposed projects with the greatest disturbance to Horseflat PEC include:

- 2,006 ha of disturbance associated with the West Pilbara Infrastructure Project - Rail;
- 1,515 ha of disturbance associated with the Balla Balla Magnetite Project;
- 690 ha of disturbance associated with the Balmoral South Iron Ore Project;
- 527 ha of disturbance associated with the Woodside Solar Facility;
- 145 ha of disturbance associated with the Sino Mine Continuation; and
- 145 ha of disturbance associated with the Mardie Project.

Approximately 13,037 ha is therefore proposed to be disturbed, resulting in an estimated cumulative impact of 6.7%.

Leichhardt acknowledges the EPA's position that the clearing of native vegetation, fauna habitat and impacts on other associated environmental values in the Pilbara IBRA bioregion is significant where the cumulative impact may reach critical levels if not managed. In its advice on the cumulative impacts in the Pilbara (EPA, 2014a), the EPA considered that without intervention, in the increasing cumulative impacts of development and land use in the Pilbara region will significantly impact on biodiversity and environmental values.

The Proposal will result in direct disturbance of approximately 11,287.7 ha of vegetation in Good to Excellent vegetation. Leichhardt has assessed the vegetation loss in a similar manner, with the loss of Good to Excellent vegetation considered to be a significant residual impact. Offsets are proposed to counterbalance those impacts (Section 15).




Legend

Development Envelope
- DSDDE
- Marine Development Envelope
- PIDE

Nearby referred significant proposals

Pre-European Vegetation (DPIRD-006)
- 127

Imagery: Google Satellite

Preston Consulting

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Extent of Vegetation Association 127: Tidal Mud Flat

GDA 2020 / MGA Zone 50

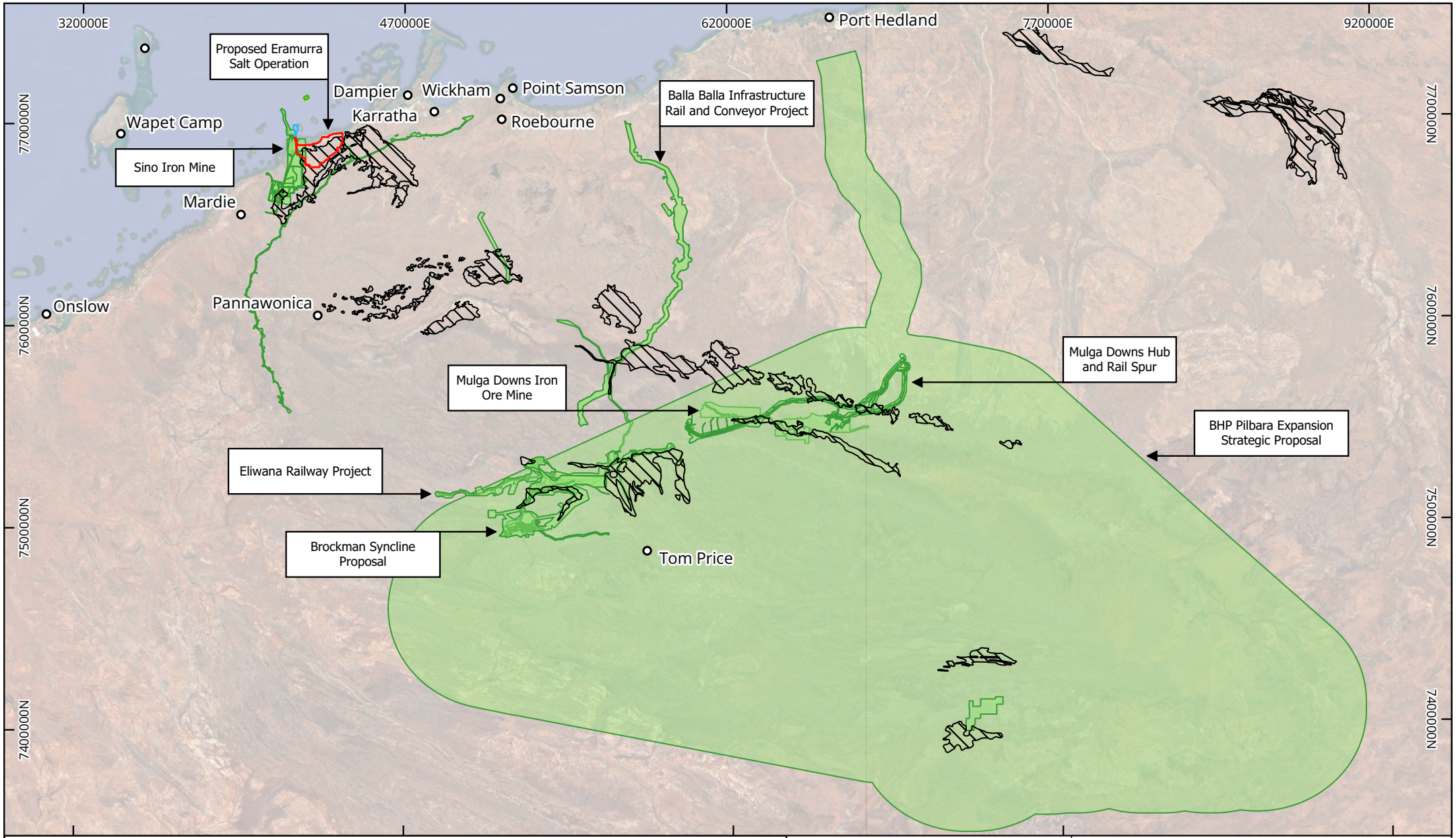
0 20 40 60 80 km

1:1,500,000 (A4)

Figure 18-8: Cumulative impact on vegetation association 127

AS

03./07/2023




Legend

Development Envelope
- DSDDE
- Marine Development Envelope
- PIDE

Nearby referred significant proposals

Pre-European Vegetation (DPIRD_006)
- 175

Imagery: Google Satellite

Preston Consulting

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# Extent of Vegetation Association 175: Grasslands, short bunch-grass savanna

GDA 2020 / MGA Zone 50

0 20 40 60 80 km

1:1,900,000 (A4)

**Figure 18-9: Cumulative impacts on vegetation association 175**

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03./07/2023

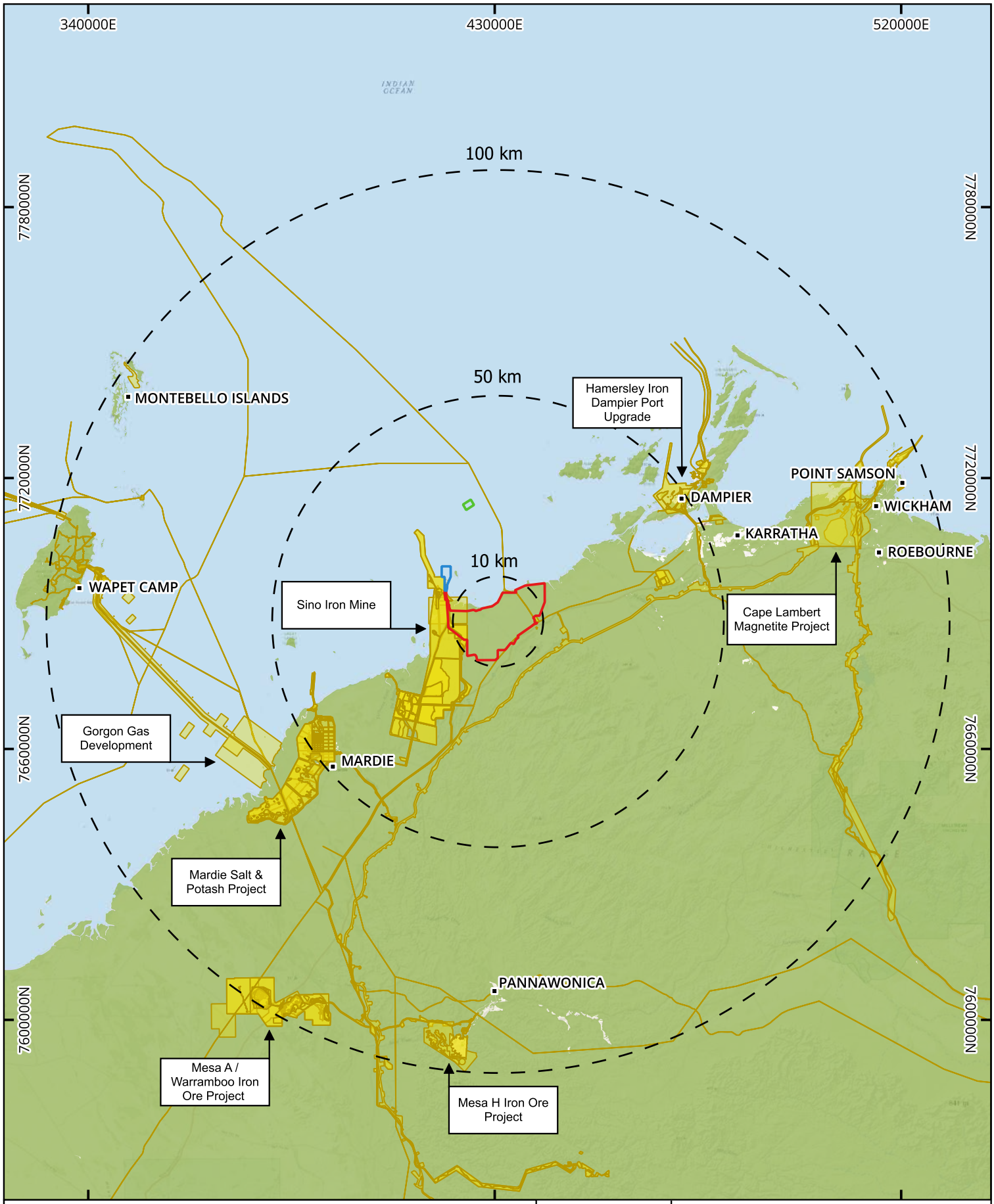


Figure 18-10: Cumulative impacts on remaining native vegetation

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05/07/2023

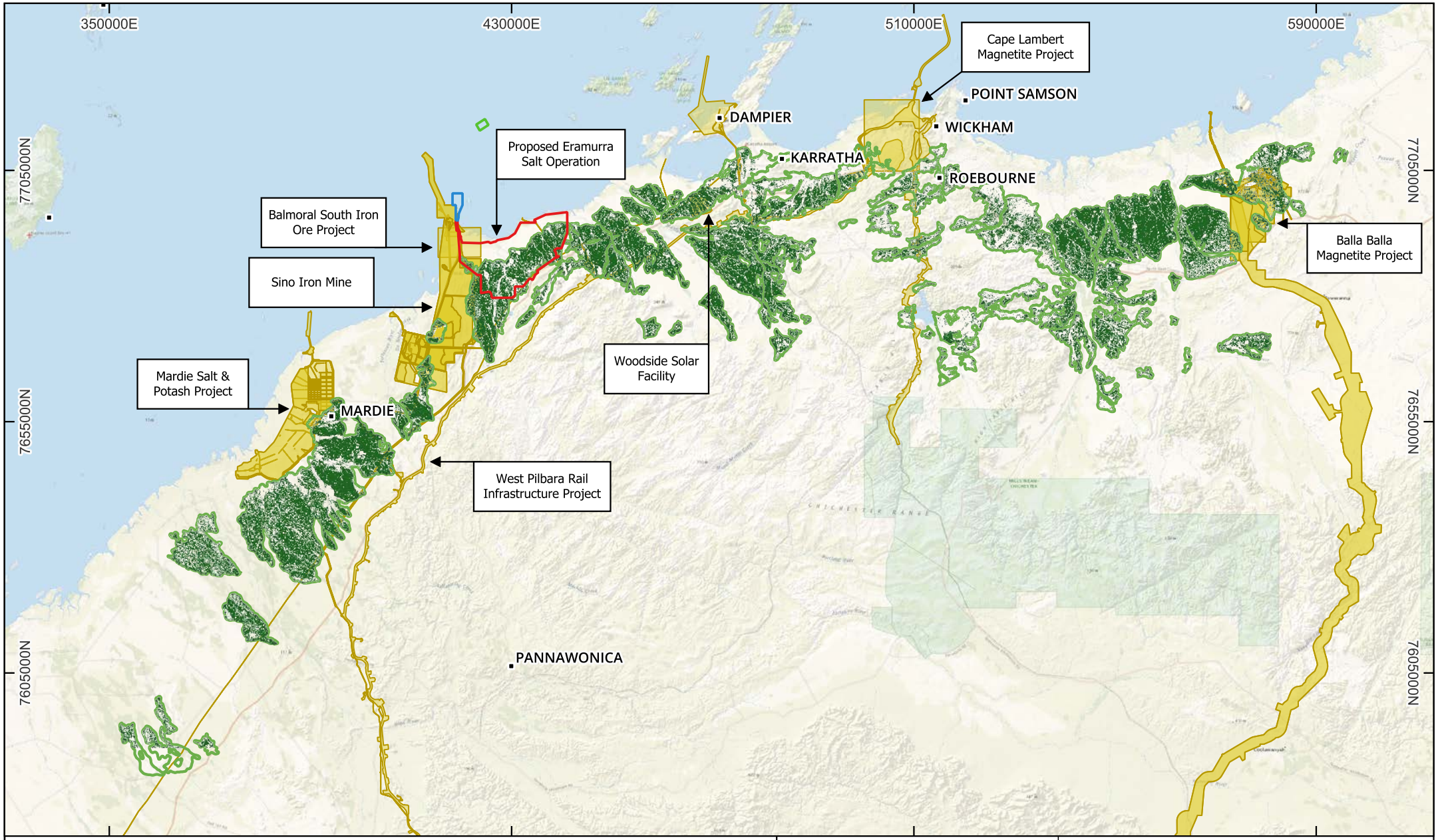


**Figure 18-11: Cumulative impact on Horseflat PEC**

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05/07/2023

## 18.7 TERRESTRIAL FAUNA

The majority of fauna species recorded have wide ranging foraging habitat and therefore cumulative impacts to general fauna habitat can be assessed at a high-level in terms of total remaining native vegetation, discussed in Section 18.6. Leichhardt determined that the cumulative native vegetation clearing across the Proposal is estimated to be 11,401.1 ha, representing:

- 41.9% of the remaining native vegetation extent within 10 km of the Proposal;
- 2.6% of the remaining native vegetation extent within 50 km of the Proposal; and
- 0.7% of the remaining native vegetation extent within 100 km of the Proposal.

Cumulative impacts from projects in the surrounding area is shown in Figure 18-10. Other large Proposals within these distances include the Mardie Project and Sino Iron Project, and historic disturbances associated with the Dampier Salt operations. The Proposal will result in direct disturbance of approximately 11,287.7 ha of vegetation in Good to Excellent vegetation which includes:

- 20.8 ha of potential foraging habitat for Pilbara Olive Python;
- 10,950.3 ha of broad foraging habitat for the Pilbara Leaf-nosed Bat and Ghost Bat; and
- 1,954.4 ha of broad foraging habitat for the Grey Falcon.

Leichhardt has assessed the vegetation loss and considers the residual impact to be significant. Offsets are proposed to counterbalance those impacts.

Shorebirds generally occur within coastal areas and therefore cumulative impacts can be assessed by reviewing existing and proposed projects along the coast. Johnstone et, al. (2013) identified the coast between Port Hedland and Eighty Mile Beach as an internationally important area for waterbirds. Habitat from Port Hedland to Exmouth, where the Proposal is located, is considered to provide lower value habitat for shorebirds, however it still contains areas of national and international significance for some species. Figure 18-12 outlines referred significant coastal proposals from Exmouth to Eighty Mile Beach. There are a total of 83 proposals which occur within this area, two of which intersect in part with the Internationally Important Area (Asia Renewable Energy Hub and the Ridley Magnetite Project). There are 81 proposals which occur south of Port Hedland which impact shorebird habitat. The key projects impacting this habitat include:

- Ashburton Salt Project;
- Onslow Solar Salt Project;
- Optimised Mardie Project;
- Cape Lambert Magnetite Project; and
- Dampier Heavy Load Out Facility Berth and Swing Basin Expansion.

Impacts from these projects are best assessed in the context of intertidal BCH, described in Section 18.3. The findings of that assessment imply that cumulative losses of shorebird habitat on the Western Pilbara coastline are in the order of 5 – 10%.

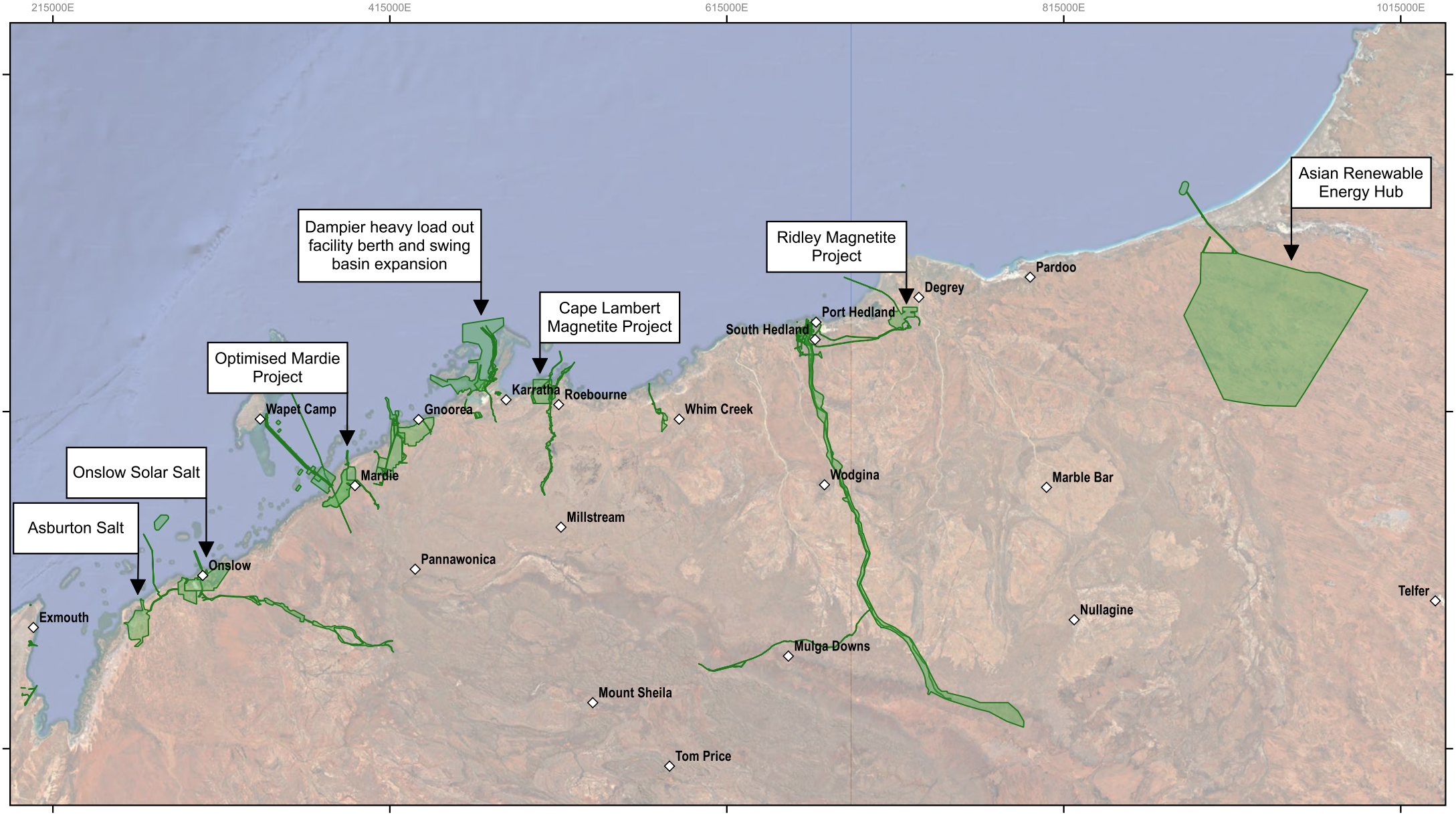


**Figure 18-12: EPA referred significant coastal proposals**

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06/12/2023

## 18.8 SOCIAL SURROUNDINGS

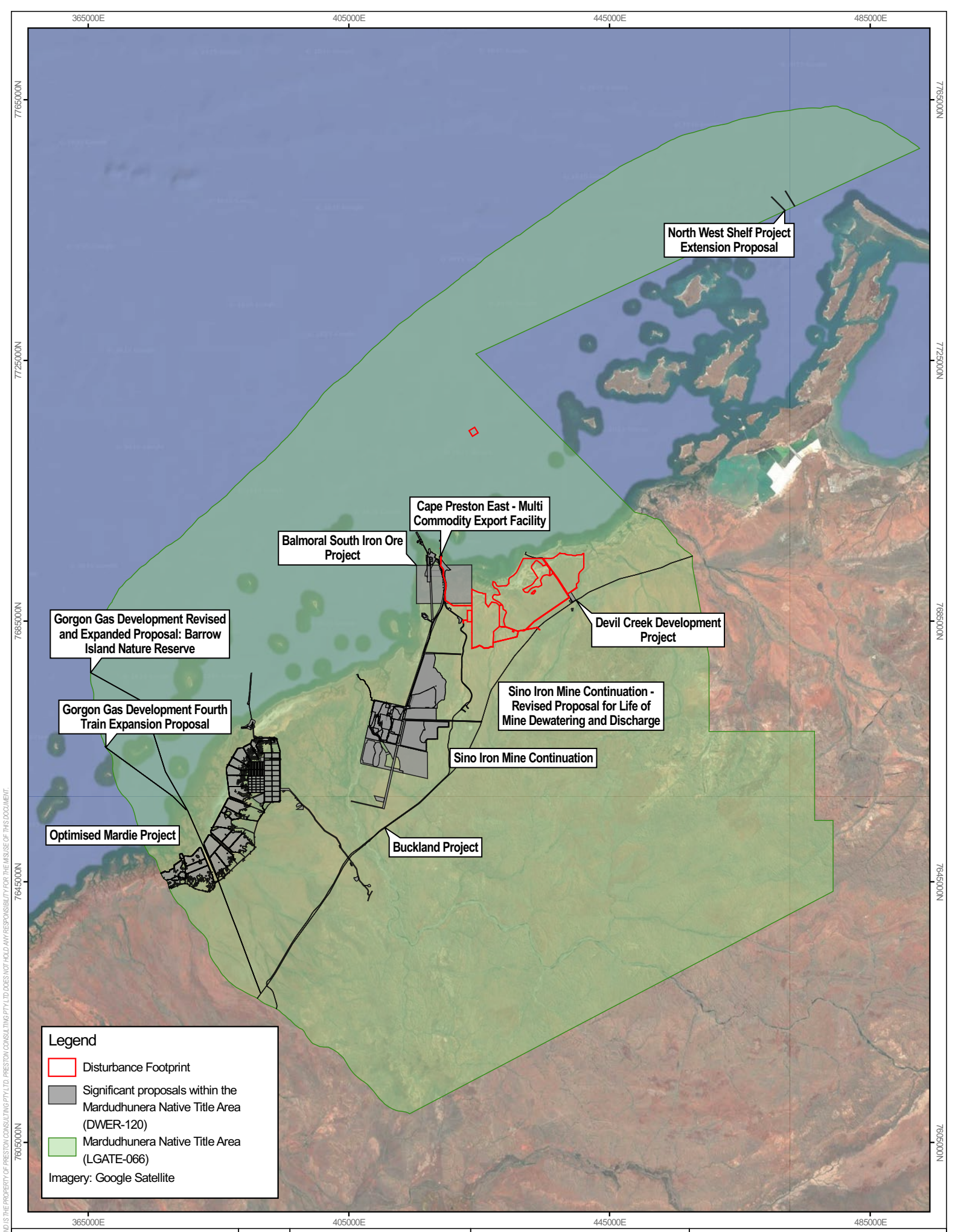
The Proposal avoids a large proportion of heritage values identified in Section 13. There are a number of EPA Significant Proposals which occur within the Mardudhunera Native Title Determination Area including:

- Balmoral South Iron Ore Project;
- Buckland Project;
- CPE Multi Commodity Export Facility;
- Devil Creek Development Project;
- Gorgon Gas Development;
- Optimised Mardie Project; and
- Sino Iron Mine Continuation

Figure 18-13 illustrates the disturbance footprints of EPA Significant Proposals located within the Mardudhunera Native Title Determination Area. There is limited public information on disturbance to heritage values associated with other Projects however it is acknowledged that the implementation of some of these projects will result in the loss of heritage values in addition the 114 sites proposed to be disturbed for the Proposal.

The Proposal will result in some impacts to visual amenity as discussed in Section 13.5.4. There are only a few projects in the vicinity of the Proposal which may result in additional visual impacts including Cape Preston Port, CPE Port and the Devil Creek Development Project.

There will be no significant impacts to recreational activity and access around the Proposal. Access to campsite and four wheel drive areas will be maintained. There are no other projects in the vicinity of the Proposal which may also impact on the recreational use of the area. As such, there are no cumulative impacts to recreational activity as a result of the Proposal.

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0 10 20 km

GDA2020 / MGA zone 50

1:700,000

Project: LEI_0535_044
Date: 08/05/2025
Size: A4
Author: ASmithers (Preston Consulting Pty Ltd)

LEICHHARDT

Preston Consulting

**Figure 18-13: EPA significant Proposals within the Mardudhunera Native title Determination Area**

# GLOSSARY

| Term | Meaning |
|---|---|
| µm | Micrometre |
| µPa | Micro-Pascal |
| ACA | Approved Conservation Advice |
| ACH Act | *Aboriginal Cultural Heritage Act 2021* |
| AEP | Annual Exceedance Probability |
| AGB | Above ground biomass |
| AH Act | *Aboriginal Heritage Act 1972* |
| AHD | Australian Height Datum |
| AHIS | Aboriginal Heritage Inquiry Systems |
| ALMP | Artificial Light Management Plan |
| Am1 | *A. marina* (Seaward edge) mangroves |
| Am2 | *A. marina* closed canopy (Landward edge) mangroves |
| Am3 | *A. marina* scattered mangroves |
| AM-E | Algal Mat East |
| AM-W | Algal Mat West |
| ANZECC | Australian and New Zealand Environment and Conservation Council |
| ANZG | Australian and New Zealand Guidelines for Fresh and Marine Water Quality |
| ARI | Average rainfall intensity |
| ARMCANZ | Agriculture and Resource Management Council of Australia and New Zealand |
| ARU | Automated Recording Units |
| ASS | Acid Sulfate Soil |
| ASSMP | Acid Sulfate Soil Management Plan |
| BC Act | *Biodiversity Conservation Act 2016* (WA) |
| BCH | Benthic Communities and Habitats |
| BCHMMP | Benthic Communities and Habitat Monitoring and Management Plan |
| BIA | Biologically important area |
| BIF | Banded iron formation |
| BoM | Bureau of Meteorology |
| BTEXN | Benzene, toluene, ethylbenzene, xylenes and naphthalene |
| CALM | Department of Conservation and Land Management |
| CALM Act | *Conservation and Land Management Act 1984* |
| CATAMI | Collaborative and Automated Tools for Analysis of Marine Imager |
| CC mangroves | Closed canopy mangroves |
| cm | centimetre |
| $CO_2e$ | Carbon dioxide equivalent |

| Term | Meaning |
|---|---|
| Coastal Dune PEC | The Coastal dune native tussock grassland dominated by *Whiteochloa airoides* (Priority 3) |
| CoPC | Contaminants of potential concern |
| CPE | Cape Preston East |
| CPI | Consumer Price Index |
| CPT | Cone Penetration Testing |
| CPUE | Catch Pet Unit Effort |
| CR | Critically Endangered |
| CSD | Cutter Suction Dredge |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation |
| Cth | Commonwealth |
| DAFF | Department of Agriculture, Fisheries and Forestry |
| DAWE | Department of Agriculture, Water and the Environment (Commonwealth), now DCCEEW |
| dB | Decibel |
| DBCA | Department of Biodiversity, Conservation and Attractions |
| DBH | Diameter Breast Height |
| DCCEEW | Department of Climate Change, Energy, the Environment and Water |
| DEH | Department of Environment and Heritage |
| DG | Dangerous Goods |
| DG Act | *Dangerous Goods Safety Act 2004* (WA) |
| DGV | Default guideline values |
| DJTSI | Department of Jobs, Tourism, Science and Innovation (WA) |
| DLI | Daily Light Integral |
| DMA | Decision Making Authority |
| DEMIRS | Department of Energy, Mines, Industry Regulation and Safety (WA) |
| DO | Dissolved Oxygen |
| DoER | Department of Environmental Regulation |
| DoT | Department of Transport |
| DotE | Department of the Environment |
| DotEE | Department of the Environment and Energy (Commonwealth) |
| DoW | Department of Water (WA), now DWER |
| DPIRD | Department of Primary Industries and Regional Development (WA) |
| DPLH | Department of Planning Lands and Heritage |
| DSD | Department of State Development |
| DSDDE | Dredge Spoil Disposal Development Envelope |
| DSDMMP | Dredging and Spoil Disposal Monitoring and Management Plan |
| DSEWPaC | Department of Sustainability, Environment, Water, Population and Communities (Commonwealth), now DCCEEW |
| DTA | Direct Toxicity Assesment |
| DWER | Department of Water and Environmental Regulation |

| Term | Meaning |
|---|---|
| dwt | Deadweight tonnage |
| E | Exploration Licence |
| EAAF | East Asian-Australasian Flyway Partnership |
| EBFM | Ecosystem Based Fisheries Management |
| EC | Electrical Conductivity |
| ECn | Effect Concentration |
| ECS | Elemental Consulting Services Pty Ltd |
| ECU | Edith Cowan University |
| EIA | Environmental Impact Assessment |
| EIS | Environmental Impact Statement |
| EN | Endangered |
| EP Act | *Environmental Protection Act 1986* (WA) |
| EPA | Environmental Protection Authority (WA) |
| EPBC Act | *Environment Protection and Biodiversity Conservation Act 1999* (Cth) |
| EQC | Environmental Quality Criteria |
| EQMF | Environmental Quality Management Framework |
| EQO | Environmental Quality Objectives |
| ERD | Environmental Review Document |
| ESD | Environmental Scoping Document |
| EV | Environmental Values |
| EY | Average number of exceedances per year |
| GHG | Greenhouse Gas |
| GIS | Geographic Information System |
| GL | Gigalitre |
| GLpa | Gigalitres per annum |
| GMMP | Groundwater Monitoring and Management Plan |
| GPS | Global Positioning System |
| ha | Hectares |
| HC | High Cover |
| HCF | Hermit Crab Fishery |
| HDAM | High Density Algal Mat |
| HEPA | High Ecological Protection Area |
| HF | High frequency |
| HISF | High Intertidal Salt Flats |
| HIL | Health Investigation Levels |
| Horseflat PEC | Horseflat Land System of the Roebourne Plains Priority Ecological Community (Priority 3) |
| IBA | Important Bird and Biodiversity Area |
| IBRA | Interim Biogeographic Regionalisation for Australia |
| IBSA | Index of Biodiversity Surveys for Assessments |

| Term | Meaning |
|---|---|
| IC | Impact Concentration |
| IFD | Intensity-Frequency-Duration |
| IMCRA | Integrated Marine and Coastal Regionalisation of Australia |
| IMP | Introduced Marine Pests |
| IMS | Introduced Marine Species |
| IPCC | Intergovernmental Panel on Climate Change |
| IUCN | International Union for Conservation of Nature |
| kg | Kilogram |
| km | Kilometres |
| LAT | Lowest Astronomical Tide |
| LAU | Local Assessment Unit |
| LDAM | Low Density Algal Mat |
| Leichhardt | Leichhardt Salt Pty Ltd |
| LEP | Level of ecological protection |
| LEPA | Low Ecological Protection Area |
| LF | Low Frequency |
| LiDaR | Light Detection and Ranging |
| LNG | Liquefied Natural Gas |
| LOEC | Lowest Observed Effect Concentration |
| LoR | Limit of Reporting |
| LV's | Light Vehicles |
| LWC | Land & Water Consulting |
| m | Metres |
| M | Mining Lease |
| m/s | Metres per second |
| $m^3$/sec | Cubic metres per second |
| mAHD | Metres relative to Australian Height Datum |
| MAFMF | Marine Aquarium Fish Managed Fishery |
| MCA | Multi-criteria Analysis |
| MCP | Mine Closure Plan |
| MEPA | Moderate Ecological Protection Area |
| MEQ | Marine Environmental Quality |
| MEQMMP | Marine Environmental Quality Monitoring and Management Plan |
| mg/kg | Milligrams per Kilogram |
| mg/L | Milligrams per litre |
| Mig | Migratory |
| Mining Act | *Mining Act 1978* (WA) |
| MLA | Mining Lease Application |
| mm | Millimetre |

| Term | Meaning |
|---|---|
| MMF | Mackerel Managed Fishery |
| MNES | Matters of National Environmental Significance |
| MP | Mining Proposal |
| MRF | Mine Rehabilitation Fund |
| mRL | Metres Relative Level |
| MS | Ministerial Statement |
| MS 1449 | Ministerial Statement 1449 |
| MS 949 | Ministerial Statement 949 |
| MSC | Exmouth Gulf Prawn Managed Fishery |
| MSL | Mean sea level |
| Mtpa | Million tonnes per annum |
| MW | Megawatt |
| N/A | Not Applicable |
| NaCl | Sodium Chloride |
| NAIF | Northern Australia Infrastructure Fund |
| NATA | National Association of Testing Authorities |
| NDSMF | Northern Demersal Scalefish Managed Fishery |
| nm | Nanometres |
| NOEC | No Observed Effect Concentration |
| NPI | Non-process infrastructure |
| NSW | New South Wales |
| NT | Northern Territory |
| NTU | Nephelometric Turbidity Units |
| NWS | North West shelf |
| OGV | Ocean-going vessel |
| OPMF | Onslow Prawn Managed Fishery |
| OS | Specially Protected |
| OTS | Ornithological technical services |
| P | Priority |
| PAH | Polyaromatic hydrocarbon |
| PAR | Photosynthetically Active Radiation |
| PASS | Potential acid sulfate soils |
| PCD | Proposal Content Document |
| PCMF | Pilbara Crab Managed Fishery |
| PDSF | Pilbara Demersal Scalefish Fisheries |
| PEC | Priority Ecological Communities – plant communities listed as being potentially threatened under the *Biodiversity Conservation Act 2016* |
| PEOF | Pilbara Environmental Offsets Fund |
| PER | Public Environment Report |
| PFTIMF | Pilbara Fish Trawl (Interim) Managed Fishery |

| Term | Meaning |
|---|---|
| $pH_F$ | Field pH |
| PIDE | Ponds and Infrastructure Development Envelope |
| PIL1 | Chichester; of the IBRA subregions |
| PIL4 | Roebourne; of the IBRA subregions |
| PLF | Pilbara Line Fishery |
| $P_{max}$ | Peak Pressure |
| PL-N | Pipeline North |
| PL-S | Pipeline South |
| PoW | Programme of works |
| PPA | Pilbara Ports Authority |
| ppt | Parts per thousand |
| Proponent | Leichhardt Salt Pty Ltd |
| PSD | Particle size distribution |
| PSMSL | Permanent Service for Mean Sea Level |
| psu | Practical salinity units |
| PTMF | Pilbara Trap Managed Fishery |
| PTS | Permanent Threshold Shift |
| QA/QC | Quality Assurance/Quality Control |
| QGIS | Quantum Geographic Information System |
| QLD | Queensland |
| RFFE | Regional Flood Frequency Estimation |
| RNTBC | Registered Native Title Body Corporate |
| RPAS | Remotely Piloted Aerial System |
| RSMA | Regionally significant mangrove areas |
| SAP | Sampling and Analysis Plan |
| SBSA | Shorebird Study Area |
| SC mangroves | Scattered Canopy mangroves |
| SCD | Sandy Coastal Deposit |
| SCHMP | Social Cultural Heritage Management Plan |
| SEL | Sound Exposure Level |
| SI Units | International System of Units |
| SKM | Sinclair Knight Merz Consultants |
| SLR | Sea Level Rise |
| SoP | Sulfate of Potash |
| SPL | Species Protection Level |
| SPL | Sound Pressure Level |
| SPT | Standard Penetration Test |
| SRE | Short-range Endemic |
| SSC | Suspended Sediment Concentration |

| Term | Meaning |
|---|---|
| SSMF | Specimen Shell Managed Fishery |
| SVM | Support Vector Machine |
| t | Tonnes |
| t/day | Tonnes per day |
| TACC | Technical Advisory and Consultative Committee |
| TDS | Total Dissolved Solids |
| TEC | Threatened Ecological Communities – plant communities listed as being threatened and legally protected under the *Biodiversity Conservation Act 2016* and/or the *Environment Protection and Biodiversity Conservation Act 1999* |
| TEQ | Terrestrial Environmental Quality |
| TFSA | Terrestrial Fauna Study Area |
| the Proposal | Eramurra Solar Salt Project |
| TN | Total Nitrogen |
| TOC | Total organic carbon |
| TP | Total Phosphorus |
| tph | Tonnes per hour |
| TPH | Total petroleum hydrocarbons |
| TRH | Total Recoverable Hydrocarbons |
| TSS | Total suspended solids |
| TSSC | Threatened Species Scientific Committee |
| TSV | Transhipment vessel |
| TTS | Temporary Threshold Shift |
| UAV | Unmanned Aerial Vehicles |
| VU | Vulnerable |
| WA | Western Australia |
| WAC | Wirrawandi Aboriginal Corporation |
| WAFIC | WA Fishing Industry Council |
| WAMSI | Western Australia Marine Science Institute |
| WASCF | Western Australian Sea Cucumber Fishery |
| WET | Whole Effluent Toxicity |
| WoNS | Weeds of National Significance |
| YACMAC | Yaburara and Coastal Mardudhunera Aboriginal Corporation |
| yr | Year |
| ZoHI | Zone of High Impact |
| ZoI | Zone of Influence |
| ZoMI | Zone of Moderate Impact |





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