Mardie Salt and Potash Project

GROUNDWATER MONITORING & MANAGEMENT PLAN

DOCUMENT CONTROL

Revision	Date	Description	Author	Checker	Approver
M	31-08-2024	Revised to respond to DCCEEW comments	Mardie Minerals	Karen Frehill	Shaun Meredith
L	30-04-2024	Revised to respond to DWER and DCCEEW comments	Mardie Minerals	Hamish Manzi	Shaun Meredith
K	19-03-2024	Revised to respond to DWER and DCCEEW comments	Mardie Minerals	Matt Spence	Shaun Meredith
J	21-12-2023	Revised to respond to DWER comments	Mardie Minerals	Matt Spence	Spencer Shute
I	21-11-2023	Revised to respond to DCCEEW comments	Mardie Minerals	Arron Minchin	David Boshoff
H	06-11-2023	Revised to respond to DCCEEW comments	Oscar Dalla Pria Bruce Harvey	Spencer Shute	Spencer Shute
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PROJECT SUMMARY

Action: To construct and operate the Mardie salt and sulphate of potash project, 80 km south-west of Karratha, Pilbara region, Western Australia.

Mardie Project Approvals: Ministerial Statement (MS) 1211 (replaces the superseded 1175) & EPBC 2018/8236

Optimised Mardie Project Approval: MS 1211, EPBC 2022/9169 (approval pending).

Proponent: Mardie Minerals Pty Ltd (ABN 50 152 574 457)

DECLARATION OF ACCURACY

In making this declaration, I am aware that sections 490 and 491 of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) make it an offence in certain circumstances to knowingly provide false or misleading information or documents. The offence is punishable on conviction by imprisonment or a fine, or both. I declare that all the information and documentation supporting this Monitoring Plan is true and correct in every particular. I am authorised to bind the approval holder to this declaration and that I have no knowledge of that authorisation being revoked at the time of making this declaration.

Signed:

Name:	Shaun Meredith
Position:	Head of Approvals and Government Relations
Organisation:	Mardie Minerals
ABN 50 152 574 457	

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1. EXECUTIVE SUMMARY

This Groundwater Monitoring and Management Plan (GMMP Rev M) is submitted by Mardie Minerals Pty Ltd (Mardie Minerals) in support of the Mardie Project (Ministerial Statement (MS) 1211, EPBC 2018/8236) and the assessment of the Optimised Mardie Project (EPBC 2019/9169). The GMMP has been developed to align with the Environmental Protection Authority (EPA) *Instructions and Templates for Part IV Environmental Management Plans* (EPA, 2021a) and the Commonwealth's *Environmental Management Plan Guidelines* (Commonwealth, 2014).

The GMMP has been prepared to address the specific approval condition requirements (Table 2) and to address comments from DWER and DCCEEW received over multiple revisions of this plan.

The purpose of the GMMP is to ensure that:

- Changes to the health, diversity, and extent of benthic communities and habitat (including subtidal macroalgae) as a result of changes to surface water, groundwater quality, groundwater regimes, and marine environmental quality associated with the proposal are detected as early as possible (MS1211, B1-3);
- The GMMP works together with the BCHMMPP to ensure overlapping and holistic impacts are managed and monitored (MS1211, B1-4);
- There are no adverse impact to water levels or water quality in Mardie Pool as a result of changes to groundwater regimes or groundwater quality (MS1211, B3-1);
- There are no changes to the health, extent or diversity of intertidal benthic communities and habitat, including mangrove, coastal samphire and algal mat as a result of changes to groundwater regimes or groundwater quality associated with the proposal (MS1211, B3-1);
- Impacts to protected matters are minimised from changes to groundwater (EPBC 2018/8236, 3 and EPBC 2022/9169).

Precautionary Approach

A key focus of the GMMP is to prevent unauthorised impacts to environmental matters and therefore the GMMP describes how these objectives will be met through a precautionary approach to risk and through adaptive management principles, for example in relation to mitigation and management actions, where there may be a level of residual uncertainty. To this end, key potential impact pathways relating to MNES are described in Section 2.9 of this report.

As part of this precautionary approach, Mardie Minerals is undertaking a staged filling of ponds 1-3 first, with an increased focus on the observation of pond integrity and groundwater conditions through the inclusion of a one-week pause period between each fill level. This GMMP will then be updated with data collected through that filling and submitted for reapproval by both the State and Commonwealth regulators prior to filling of ponds 4-9. This progressive approach will allow for the timely implementation of mitigation and management measures should there be changes to groundwater regimes as a result of filling.

Groundwater Modelling

AQ2 consultants have developed the Conceptual Groundwater Model for the project. This model builds on a range of technical inputs and studies and describes the predevelopment groundwater regime. The model describes groundwater in the vicinity of the project as characterised by a dominant hypersaline body of water under the tidal flats with predominantly vertical movement driven by tidal conditions and flooding. It also notes negligible lateral groundwater flow due to the flat groundwater gradients.

This is consistent with findings from a Department of Water and Environmental Regulation (DWER) review of the GMMP in late 2023 which stated that at the groundwater system around Mardie is likely dominated

by vertical groundwater flow, which would reduce the potential risks to the adjacent sensitive receptors to the west of the pond infrastructure (e.g. algal mat and mangrove habitats).

In 2024, AQ2 undertook 2D impact modelling across a number of Cross Sectional Transects under a number of modelled scenarios that would simulate conditions of leakage to groundwater.

Impact modelling for the Pond 1 transect predicted under a worst-case 'leaky pond' scenario that there would be a potential seasonal increase in groundwater level of up to 0.5m that would be observable 100m on the coastal side of the Pond wall, and a decrease of up to 0.1 m on the upstream side as a result of interrupted coastal inundation.

For the Pond 6 transect, tidal inundation downstream was predicted to continue and the model predicted groundwater level downstream would increase, albeit less than modelled under the predevelopment water level variation.

For Mardie Pool, under a worst-case 'leaky pond' scenario there may be short term leaks from the crystallisers however the impacts from these leaks are expected to be underneath and limited to the immediate vicinity.

At Pond 8/9, an operational scenario and a 'leaky pond' scenario have been modelled. These show that predicted salinity levels 100m from the pond walls are consistent with current background levels. Notwithstanding this, and because the approved design for Pond 8/9 walls are closest to mangrove and samphire BCH, the pond 8/9 walls have rebated so that they are 150m from mangroves to further minimise potential unforeseen impacts from pond leakage.

These impact modelling results provide Mardie Minerals with a range of potential impacts that are consistent with the sensitivity parameters of the proposed trigger and threshold detection methodology.

Mardie Minerals has engaged AQ2 to commence Regional Groundwater Modelling during Q2 2024 using ground-truthed information that will be collected during the progressive filling of the ponds. The GMMP will be reviewed and updated at the completion of that modelling and the concurrent groundwater data collection will inform the calibration and validation of the conceptual and impact modelling. Importantly, a full suite of mitigations have been proposed based on triggers and thresholds identified in this plan and in the inter-related Benthic Communities and Habitat Monitoring and Management Plan (BCHMMP) and Migratory Shorebird Monitoring and Management Plan (MSMMP) to ensure that any unexpected environmental impacts that are observed during this early progressive filling period are identified and managed appropriately.

Mardie Minerals has also committed to annual groundwater model updates every year for the first three years of the project, a time period which reflects achieving a steady operational state for the project.

Monitoring Groundwater Changes

Mardie Minerals groundwater monitoring network comprises 74 bores installed between 2021 and 2024. Pipeline bores have been in place from 2021, Terrestrial Bores from early 2022 and Coastal monitoring bores were installed from July/August 2023. This collective baseline data set, which now includes more than 12 months of data for some bores, has been used for the development of trigger and threshold criteria for the Coastal Monitoring bore network. Mardie Minerals has installed remote (telemetered) groundwater level and quality instrumentation which provides a more frequent data collection and ability to analyse for changes. This also provides more data security and reliability given the physical challenges in accessing these bores.

Groundwater level data collected since 2021 shows significant temporal variation across multiple scales; varying by 0.6 to 1.16m per day in coastal bores, with a range of variability between 1.1m and 1.6m annually. This variability is driven by tidal influence, rainfall events and other (lesser) factors such as barometric pressure and wind direction and speed. This high natural variability precludes the 'normal' process of setting

fixed value groundwater level triggers and thresholds, so instead a methodology has been developed to better distinguish between natural environmental variability and any operationally attributed changes.

A modified M-BACI approach has been developed for the purpose of setting trigger and threshold criteria for groundwater level changes associated with the Coastal Bore Network adjacent to Benthic Communities and Habitats. The approach is consistent with the ANZG guidelines specifying that the triggers and thresholds should be set seasonally where seasonal variation exists. Tidal influence on individual bores has also been determined when considering selection of appropriate control and impact bores.

The statistical strength and sensitivity of this method (Auto Regressive Integrated Moving Average – ARIMA) enables Mardie Minerals to undertake daily analysis of groundwater changes and assesses these against 95th percentile triggers and thresholds. This frequency of analysis will provide a Mardie Minerals with rapid awareness of changes that exceed trigger or threshold criteria and will provide detailed information that will inform subsequent investigation, mitigation and management actions.

Mitigation and Management Measures

As above, impact modelling indicates that even under a worst-case 'leaky pond' scenario, the potential to impact environmental values, including to benthic communities and habitats is localised, and mitigation measures (e.g. rebating of pond walls) have been put in place to further minimise this potential. Notwithstanding this, a framework for assessing the cause and potential impacts of any trigger or threshold exceedance has been developed. This framework will be applied to the filling of the early ponds, and will be reviewed prior to resubmission of this GMMP after pond 3 has been filled. Regular and ongoing updates on water levels and any trigger or threshold exceedances will be provided to regulatory agencies. Any ongoing concerns will be addressed through clear and open communication.

The interaction of trigger and threshold exceedances outlined in this GMMP will also be assessed concurrently with information collected as part of the BCHMMP and MSMMP monitoring and also (where available) the research findings from the Research Offsets plan. This will ensure a holistic approach to the management of key flora and fauna. In situations where groundwater changes resulting from the project are having unsanctioned adverse impacts on benthic communities and habitats, mitigations which may include the cessation or reversal of pond filling will be actioned.

Conclusions

Mardie Minerals are strongly committed to the protection of the environment in which we plan to operate. We have sought clear and transparent advice from technical experts in their respective fields to help us demonstrate this commitment in this revision of the GMMP. In addition to the reporting and sharing of information proposed throughout this GMMP, we have also added a table in Section 3.5 of this revision to clarify our ongoing commitments for the project, particularly with regards to the review and update of the model and this GMMP. We would welcome ongoing feedback on these reporting and information sharing commitments such that they might be codified in subsequent scheduled revisions of this GMMP.

Proposal name	**Mardie Salt Project:** • **Original Project.** • **Optimised Project.**
Proponent name	Mardie Minerals Pty Ltd
Approval references	Original Proposal • Ministerial Statement 1211 (note that MS 1175 is superseded) • EPBC 2018/8236. Optimised Proposal • Ministerial Statement 1211. • EPBC 2022/9169 – approval pending.
Purpose of the Plan	Support the maintenance of the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.
Key environmental factor/s, outcome/s and objective/s	Key Environmental Factors: • **Inland Waters:** To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected. • **Benthic Communities and Habitats (BCH):** To protect benthic communities and habitats so that biological diversity and ecological integrity are maintained. Outcomes and Objectives: • **Key Environmental Objective:** No changes to the health, extent or diversity of intertidal benthic communities and habitat, including mangrove, coastal samphire and algal mat as a result of changes to groundwater regimes or groundwater quality associated with the proposal. • **Key Environmental Objective:** No adverse impact to water levels or water quality in Mardie Pool or Mt Salt Mound Spring because of changes to groundwater regimes or groundwater quality.
Condition clauses	Original Project • Ministerial Statement 1175 – Condition 3-3 (superseded). • Ministerial Statement 1211 – Conditions B3-1, B3-2, B3-3 and C1-1(3). • EPBC 2018/8236 – Conditions 4, 5, 6, 7. Optimised Project • Ministerial Statement 1211 – Conditions B3-1, B3-2, B3-3 and C1-1(3). • EPBC 2022/9169 – approval pending.
Key components in the Plan	• Groundwater monitoring network and baseline investigations.

	• Environmental objectives, indicators and triggers and thresholds for investigation and corrective action. • Conceptual and numerical groundwater modelling • Adaptive management, reporting and review
Proposed construction date	Construction of the Project commenced in February 2021
Key operations date	Refer to Section 2.3.3 of this Plan for timing and staging.
Plan required pre-construction?	No – the GMMP must be approved prior to starting transfer of seawater, brine or waste product into any evaporation or crystalliser pond.

2. CONTEXT, SCOPE AND RATIONALE

2.1 The Proposal

The Mardie Salt and Potash Project (the Project) currently being constructed by Mardie Minerals Pty Ltd (wholly owned by BCI Minerals) is located on the north-west coast of Western Australia in the Pilbara region, approximately 80 km south-west of Karratha (Figure 1). The Project involves development facilities to produce, process and export high purity industrial grade salt and fertiliser grade sulphate of potash (SOP) from seawater via solar evaporation, crystallisation, raw salt purification and SOP conversion.

2.2 GMMP Purpose

This GMMP outlines an approach to the monitoring and management of the potential impacts of the project on groundwater and associated potential impacts on the environment consistent with MS 1211, EPBC 2018/8236 and [draft] EPBC 2022/9169 conditions of approval.

The purpose of the GMMP is to ensure that:

- Changes to the health, diversity, and extent of benthic communities and habitat (including subtidal macroalgae) as a result of changes to surface water, groundwater quality, groundwater regimes, and marine environmental quality associated with the proposal are detected as early as possible (MS1211, B1-3);
- The GMMP works together with the BCHMMPP to ensure overlapping and holistic impacts are managed and monitored (MS1211, B1-4);
- There are no adverse impacts to water levels or water quality in Mardie Pool as a result of changes to groundwater regimes or groundwater quality (MS1211, B3-1);
- There are no changes to the health, extent or diversity of intertidal benthic communities and habitat, including mangrove, coastal samphire and algal mat as a result of changes to groundwater regimes or groundwater quality associated with the proposal (MS1211, B3-1);
- Impacts to protected matters are minimised from changes to groundwater (EPBC 2018/8236, and EPBC 2022/9169).

The implementation of the GMMP is a direct condition of EPBC 2018/8236 (Original Proposal); EPBC 2022/9169 (Optimised) and MS 1211 (Optimised Proposal). The GMMP has been prepared with reference to the *'Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans'* (EPA, 2021c) and the '*Environmental Management Plan Guidelines, Commonwealth of Australia 2014'* (DoE, 2014) in the context of the GMMP being submitted as part of the Approval conditions.

Figure 1 Mardie Project Regional Location

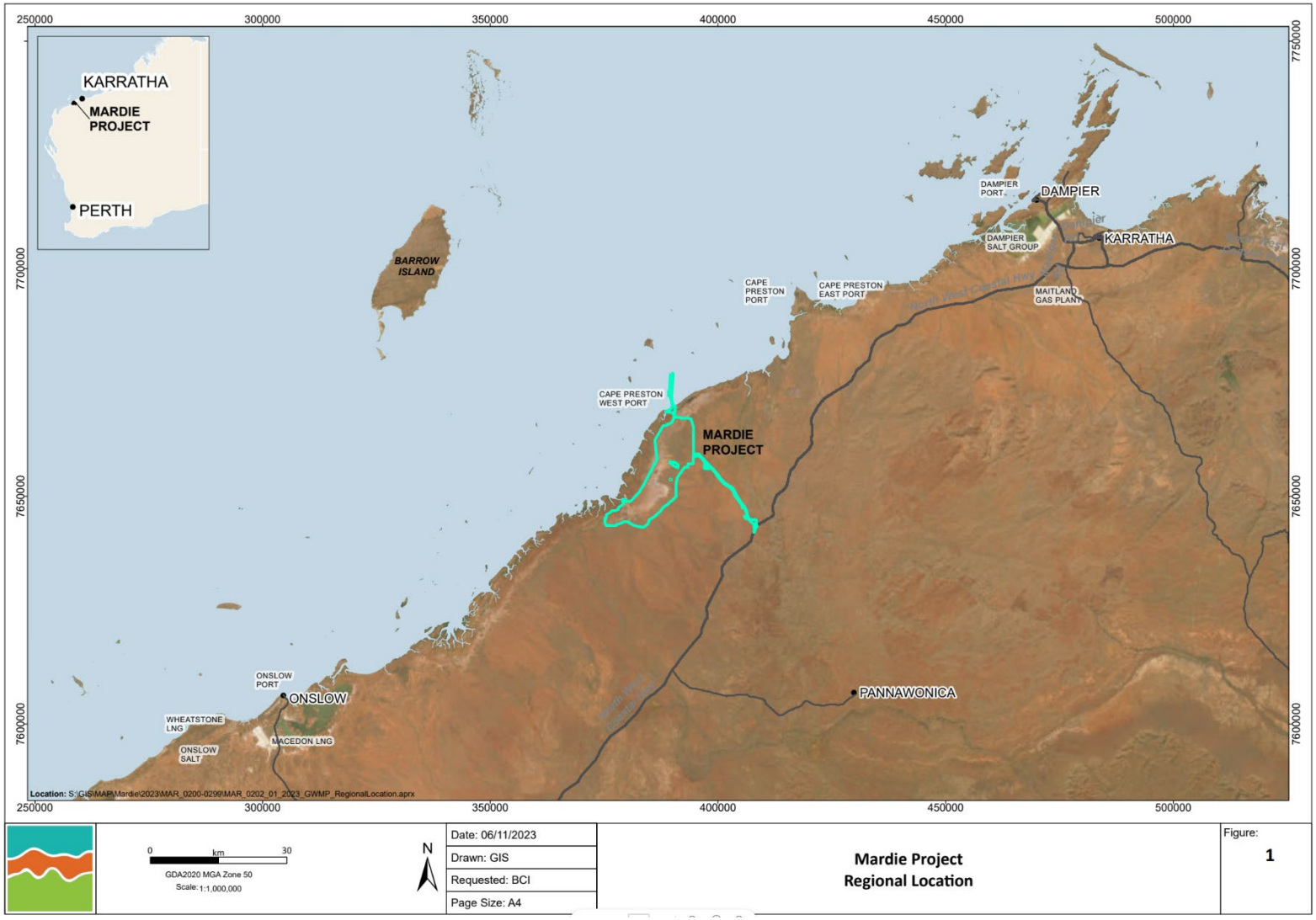


Figure 2 Mardie Project Layout – Original

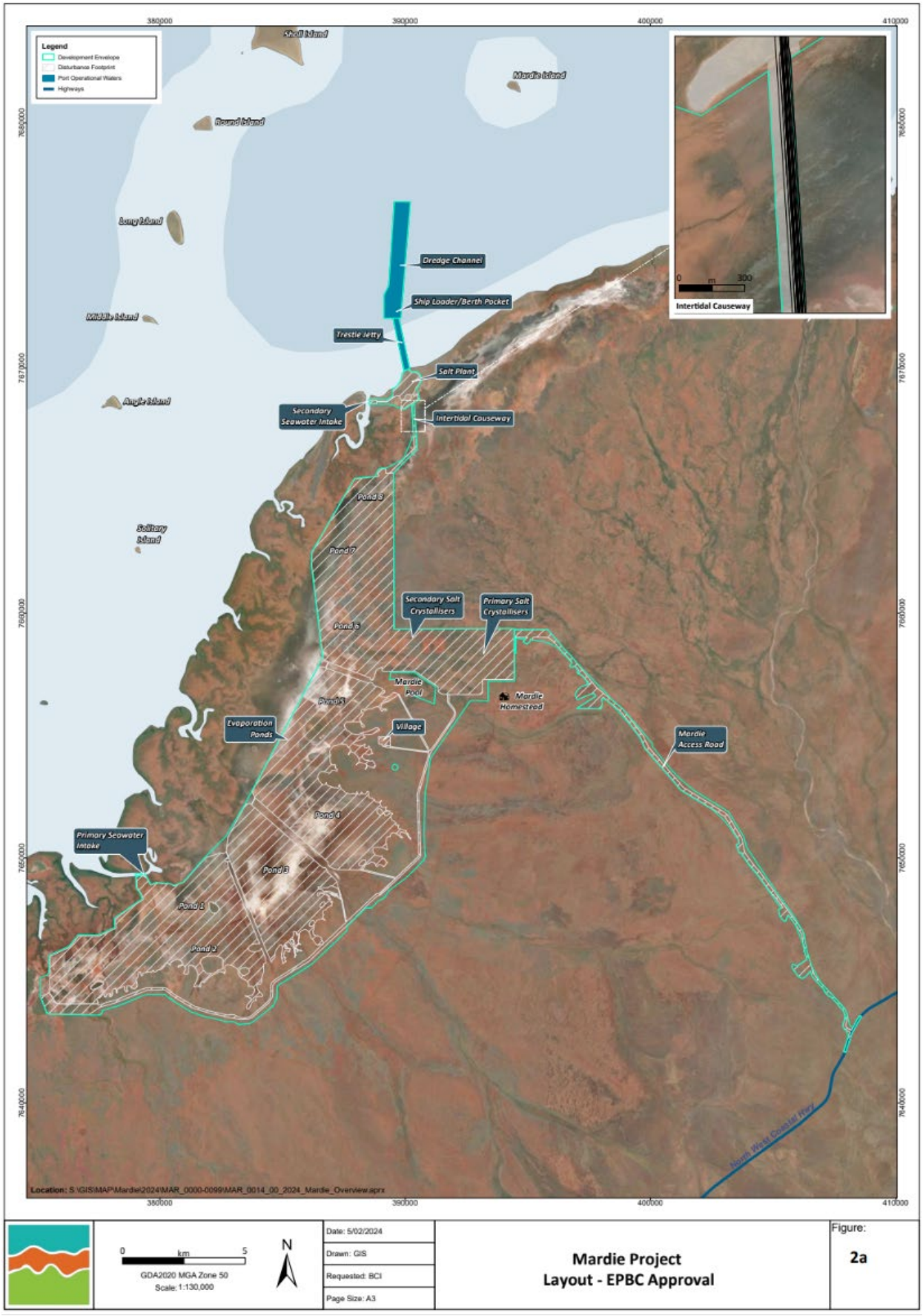


Figure 3 Mardie Project Layout – Optimised

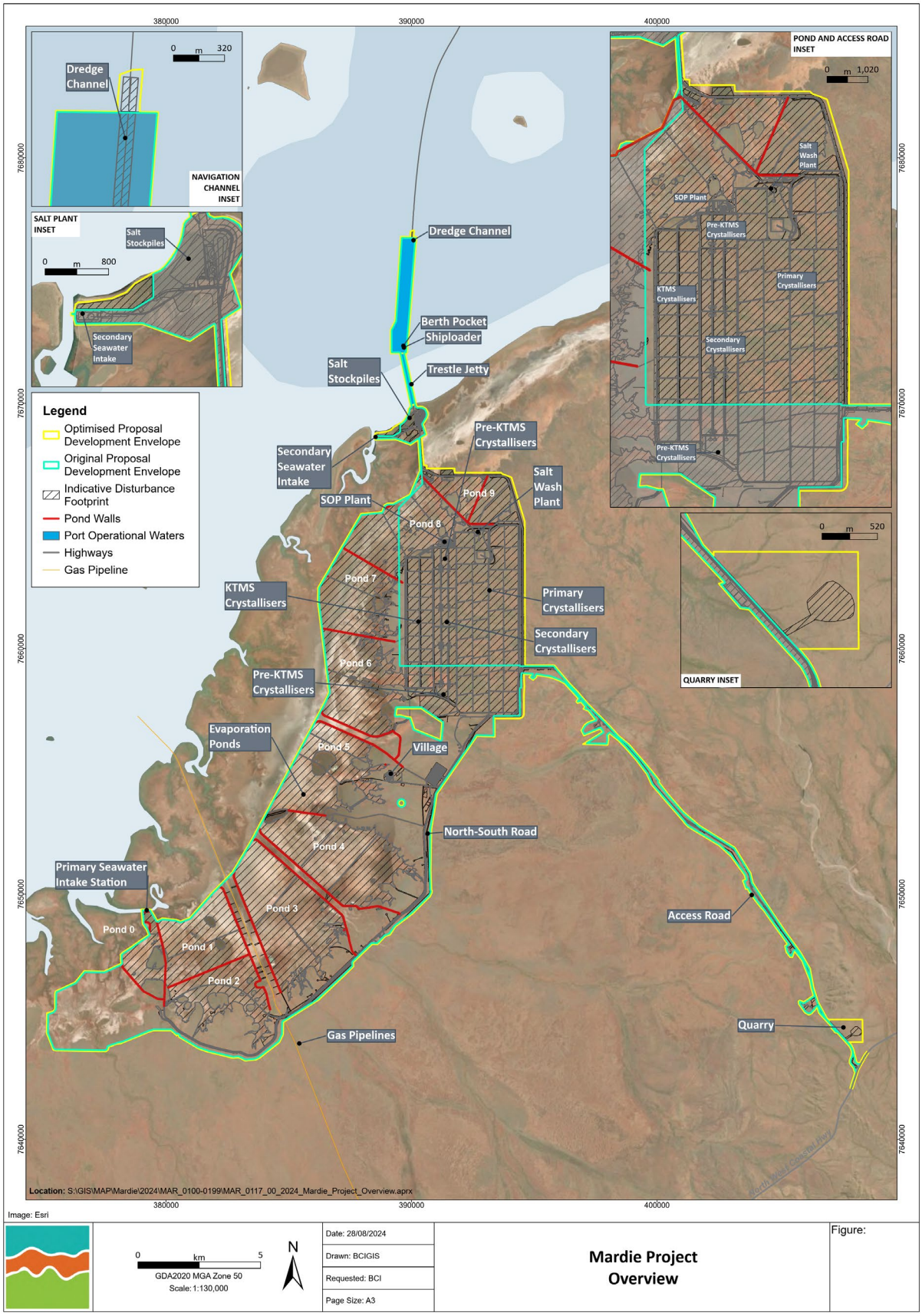
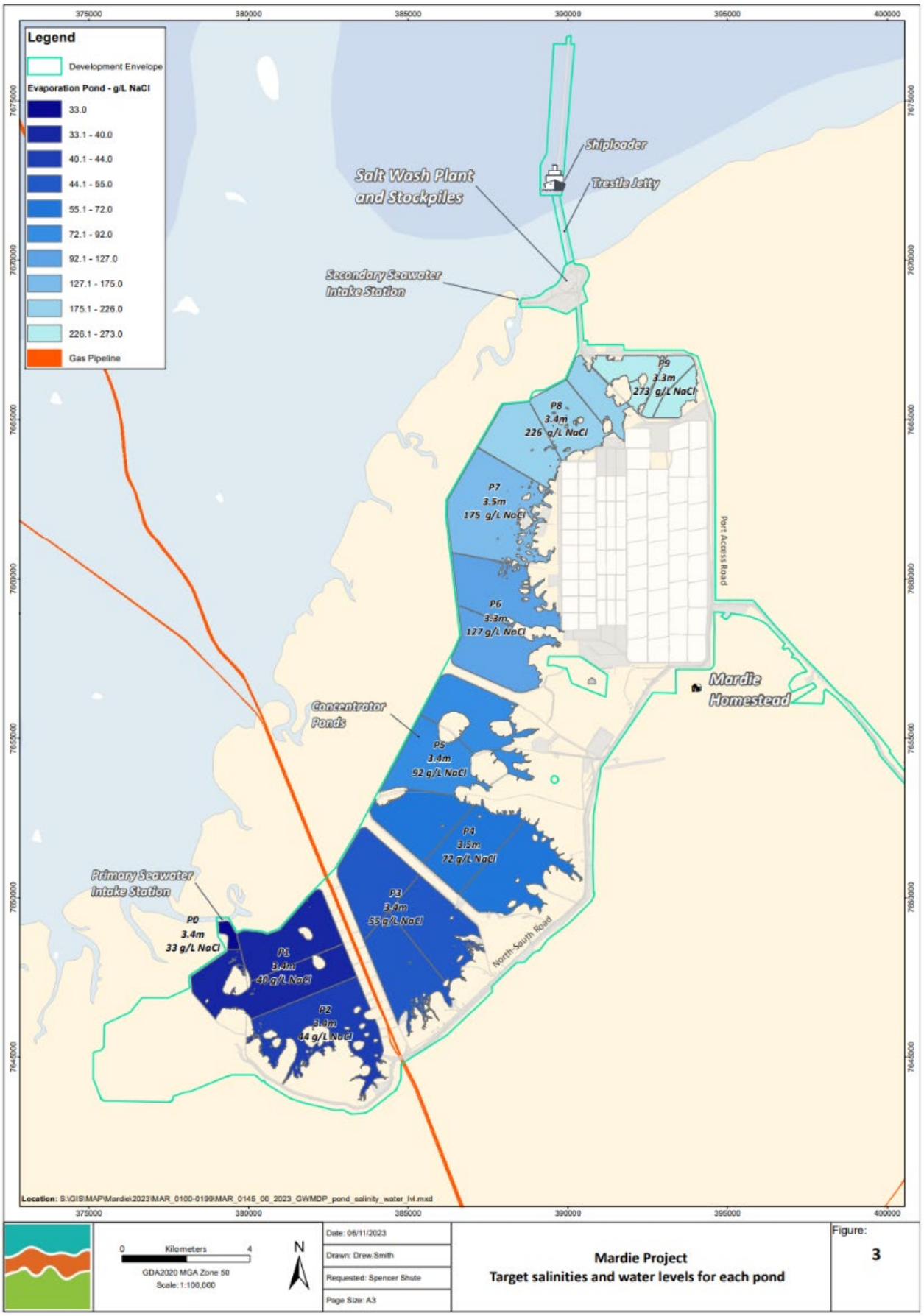


Figure 4 Pond Salinity and Depth



2.3 Rationale and Approach

2.3.1 Overview

Mardie Minerals has used this GMMP to describe the filling approach for the Original Project in accordance with both the State and Commonwealth approvals, and also to provide information on the Optimised Mardie Project to support an approval decision under the EPBC Act, noting that the Optimised Mardie Project has already received State Approval.

The key elements of the GMMP are:

- Environmental objectives and outcomes for State and Commonwealth matters;
- Supporting technical studies and baseline data (refer to Appendices);
- Proposed groundwater monitoring network;
- Conceptual hydrogeological model;
- Impact modelling;
- Management indicators and relevant trigger and threshold criteria;
- Linkages to other key management plans;
- Management, mitigation and remediation measures; and
- Review and reporting requirements.

2.3.2 Baseline Data

Collection

To date a significant concern from DWER and DCCEEW in relation to the commencement of pond filling has been the absence of 24 months of baseline groundwater dataset across all bores in the monitoring network. BCI has responded to this concern by:

a) installing a monitoring network of 74 groundwater bores

b) telemetering all 74 bores to enable ongoing measurement of groundwater levels and salinity.

In line with the existing approvals, the bore monitoring network needed to model and assess groundwater impacts on the environment has been fully installed. Further, and in consultation with the independent modelling consultants (AQ2) and data scientists (DAA), additional bores have been installed in Q2/3 2024 (Section 2.8) to guarantee that appropriate data is collected to inform a robust adaptive management program proposed under the sequential pond filling proposal.

Mardie Minerals have installed telemetry instrumentation across the monitoring bore network to measure groundwater level and electrical conductivity. Telemetry installation is now completed (Q3 2024). The status of installation is detailed in Table 4, Table 6 and Table 7. This now permits a greater frequency of data collection (hourly), data analysis (daily) and review (daily) against triggers and thresholds than a monthly or quarterly physical sampling approach would otherwise provide.

Figure 5 shows consolidated groundwater level baseline data collection for the area of Ponds 1 through Pond 8.

Quality

The long-term water level data from the gas pipeline corridor bores, as (Section 2.8.2) well as the more recent data from the coastal (Section 2.8.3) and terrestrial monitoring bore (Section 2.8.1) networks, shows significant temporal variation in response to tidal influence, significant rainfall events and likely other factors such as barometric pressure and wind direction and speed (the latter affect the flooding and persistence of marine waters across the tidal flat) (see refer to Section 3 in Appendix D).

Given this high temporal variability in groundwater levels, it is proposed, following an approach endorsed in ANZG (2018), that a modified Before/After Control Impact (M-BACI) methodology be used to identifying

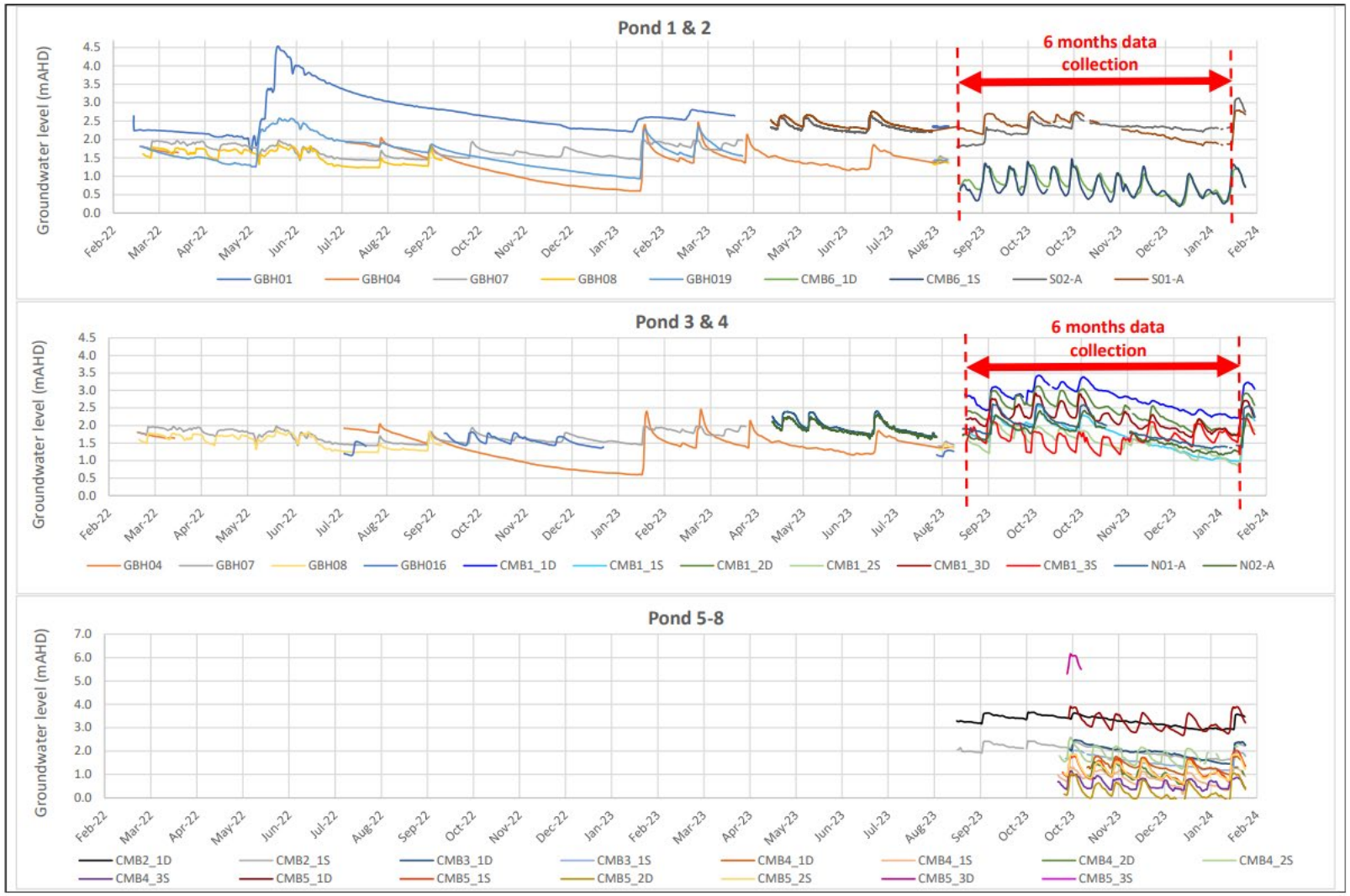
robust triggers and thresholds. The modified M-BACI design uses paired impact and multiple reference sites, accounting for natural or pre-existing differences between the sites, to estimate the difference between the reference and potentially impacted site(s). This approach involves:

- Visualisation and analysis of water level and salinity data to understand temporal variability at different temporal scales (daily / monthly / annual).
- Comparison of data from different bores to identify groups with similar patterns of temporal variation.
- Standardisation of water level data to determine how best to pair impact and reference sites.

Section 3.1 provides details of proposed indicators with triggers and threshold criteria.

Baseline EC profiling from monitoring bores installed on the western side of the proposed crystallisers to the east of the algal mat areas indicates that hypersaline water is present throughout the water column and that the saltwater interface is much further inland. The EC profiles were stable through five sampling events over 16 months. The recent ground-based Transient Electromagnetic survey also indicated that the hypersaline wedge generated by evaporation in the intertidal zone is 1 km or more inland from the eastern side of the salt flats.

Figure 5 Baseline Data



2.3.3 Progressive Filling Approach

Mardie Minerals is proposing a progressive filling approach for the initial filling of all ponds. This progressive approach will also allow for monitoring data to be carefully observed across the bore network as each pond is filled, and each fill level is conducted. This approach is consistent with the independent DWER review recommendations from late 2023.

The key benefit of this approach is that it provides for additional time between filling for groundwater observations and pond condition observations and if required, for the implementation of mitigation and management actions.

A detailed overview of this approach for Ponds 1 through 6 is provided in Appendix D of this GMMP. Appendix C provides a time-based schedule to accompany the proposed approach and covers all Ponds and Crystallisers.

The key aspects of the filling approach are:

1. To fill ponds 1-3 in incremental stages of approximately 0.3 m of seawater up to the operational depth and to ensure a minimum 1 week pause between each subsequent filling rise.
2. The 1 week pause allows for an observation of pond condition during filling, and concurrent review of groundwater data against the indicators and triggers and thresholds in this GMMP.
3. The 1 week pause allows for the implementation of mitigation and management measures should they be required in an effective and timely manner.
4. In line with expected Commonwealth conditioning of the Optimised Mardie Project, to then update and resubmit this GMMP, incorporating information outlined in the OMP conditions and addressing comments raised by the regulators regarding previous versions of the GMMP.
5. To fill ponds 4 to 9 and the crystallisers in a controlled and careful manner only after the updated GMMP (expected to be Rev N) is approved by both State and Commonwealth.

The staged filling activity is consistent with the description of filling that informed the State and Federal approvals for the project with regards to the infrastructure, pumping and depth of filling.

This approach will also facilitate the sharing of data with agencies through the filling of these ponds which is expected to take around 45 days to fill ponds 1-3. Any exceedances of trigger and threshold criteria during this period will be notified and investigated as described in Section 3.3 and Section 3.4.

Agreement amongst technical experts and supported by Conceptual Modelling is that filling Ponds 1 and 2 presents a low environmental risk, as water quality that develops within the first ponds is not materially different to that of seawater. Furthermore, Conceptual Hydrogeology and Coastal Transect Modelling detailed in Section 2.8.4, indicates that there is minimal lateral movement of groundwater from the sabkha to the ocean (or from the ocean inland), and negligible lateral movement of groundwater parallel to the coast, due to the very low permeability of the clay strata beneath the flats (AQ2, 2024). It is therefore expected that changes to the groundwater regime due to loading or seepage from ponds will not propagate far from the ponds (either towards or parallel to the coast).

The collection of operational data will inform the validation of the Conceptual Hydrogeological Model's performance, outcomes and proposed management approaches. Where there is an exceedance of a trigger and/or threshold criteria, the mitigation and adaptive management measures will be implemented to ensure the Groundwater Environmental Objective is achieved.

Fortnightly data provision to Agencies will occur through the Pond 1, 2 and 3 filling and any exceedances of trigger and threshold criteria will be notified and investigated as described in Section 3.3 and Section 3.4. An escalating hierarchy of mitigation and management has been included in Section 3.3.4 to respond to a threshold exceedance and to mitigate risks until additional investigations have identified actual environmental impacts and effective mitigations are clearly articulated.

2.3.4 Environmental outcomes / objective/s

The GMMP has been developed to meet the relevant State and Commonwealth approval objectives including:

- No impacts within the development envelope greater than that permitted (EPBC 2018/8236 and EPBC2022/9169)
- Minimising impacts to protected matters from changes to groundwater (EPBC 2018/8236 and EPBC2022/9169)
- Prevent impacts to the Mardie Pool, terrestrial, intertidal and subtidal protected matters and habitats (EPBC 2018/8236 and EPBC2022/9169)
- Identify further impacts that may result on protected matters within and/or outside the development envelope (EPBC 2018/8236 and EPBC2022/9169)
- No development that would have an adverse impact on the ecological function of intertidal and subtidal benthic communities and habitats (MS1211)
- No long-term (greater than five (5) years) net detectable loss of algal mat outside of the proposal footprint (MS1211)
- No loss of subtidal benthic communities and habitat (including subtidal algae) outside the Zones of impact authorised in condition A1-1 (MS1211)
- No adverse impact to water level or water quality in Mardie Pool as a result of changes to groundwater regimes or groundwater quality (MS1211)
- No changes to the health, extent or diversity of intertidal benthic communities and habitat, including mangrove, coastal samphire and algal mat as a result of changes to groundwater regimes or groundwater quality associated with the proposal (MS1211).

2.4 Key Environmental Factors

The key environmental factors considered in this GMMP are Inland Waters and Benthic Communities and Habitats (BCH).

The EPA objective for Inland Waters is “to maintain the hydrological regimes and quality of groundwater and surface water to ensure that environmental values are protected” (EPA, 2018).

The EPA objective for Benthic Communities and Habitat (BCH) is “to protect benthic communities and habitats so that biological diversity and ecological integrity are maintained” (EPA, 2018).

Secondary factors, which are dependent upon the outcomes to Inland Waters and BCH, are marine fauna and terrestrial fauna (including significant species).

Proposal activities that may affect these factors are described in Table 1.

Table 1 Potential impacts to Inland Waters and/or BCH

Key Environmental Factors: Inland Waters, BCH	
Proposal activities that may affect this factor.	• Evaporation Ponds • Crystalliser Ponds • Bitterns storage dams and pipelines.
Environmental values that may be affected by implementing the Proposal.	• Benthic communities and habitats (BCH), including mangrove, algal mat and samphire communities, as well as the biological systems that they support. • Water levels and/or water quality in Mardie pool as a result of changes to groundwater regimes or groundwater quality. • Protected matters and habitats associated with the Mardie Pool, terrestrial, intertidal and subtidal areas (EPBC 2018/8236 and EPBC2022/9169). • Livestock watering bores.

Key Environmental Factors: Inland Waters, BCH	
Ecosystem health condition / sensitive component of the key environmental factor.	• Groundwater salinity. • Groundwater levels.
Existing and/or potential uses.	• Pastoral Station (cattle).

2.5 Condition Requirements

The Original Mardie Salt Project was approved under the EP Act (Ministerial Statement 1175) in November 2021 and the EPBC Act in January 2022 (EPBC 2018/8236). The Optimised Mardie Project (which includes the Original Mardie Salt Project) was approved under the EP Act (Ministerial Statement 1211) in October 2023 (Ministerial Statement 1175 has now been superseded by MS 1211). EPBC Act approval for the additional project components in the Optimised Mardie Project EPBC 2022/9169 is pending.

The key conditions of EPBC 2018/8236; EPBC 2022/9169 and Ministerial Statement 1211 relevant to the Plan are shown in Table 2**.**

Table 2 Key Conditions of EPBC 2018/8236; EPBC 2022/9169 and MS 1211 (MS 1175) relevant to the GMMP (Revision M)

Cond. #	Condition Requirement	How/Where addressed in GMMP
EPBC 2022/9169		
29	To avoid and mitigate harm to protected matters as a result of groundwater changes associated with the Action, the approval holder must comply with conditions B3-1, B3-2, B3-3, C3-1 and C4-1 of the WA Approval, to the extent that the WA Approval conditions relate to protected matters.	This GMMP (Revision M), and subsequent revisions as approved by the Delegate, has been prepared to address these conditions through its implementation – see below for further detail
30	The approval holder must document and maintain records that demonstrate a detailed understanding of the hydrological regimes and processes to the extent that it demonstrates the potential for impact to protected matters, validates the monitoring approach and management measures in the Groundwater Monitoring and Management Plan required by condition 56, and in line with the Australian and New Zealand guidelines for fresh and marine water quality (2018).	Section 2.7 details the relevant technical studies completed to demonstrate and detail the understanding of the hydrological regimes and processes to the extent.
39	To detect changes to groundwater regimes, groundwater quality, and groundwater levels associated with the Action, prior to commencement of operations, the approval holder must:	-
	gggg. establish a network of groundwater monitoring bores across the development envelope that is able to detect changes in groundwater regimes, groundwater levels, and groundwater quality.	Section 2.8 (Groundwater Monitoring Bore Network) details the extent of the groundwater monitoring bore network that has been installed across the Development Envelope.
	hhhh. assign and calibrate all reference bores and impact bores, installed to comply with condition 38a.	Section 3.1.2 (Impact and Reference Bores) and Appendix E1 (DAA 2024a) details the use of three reference bores for each impact bore improved forecast accuracy and trigger detection as well as being consistent with guidelines.
	iiii. complete the development and deployment of all software, equipment and monitoring protocols required to monitor and determine whether a change in groundwater regimes, groundwater levels, and groundwater quality has occurred.	Section 2.8 (Groundwater Monitoring Bore Network) and Table 4, Table 6 and Table 7 details the deployment dates for all telemetry for the groundwater monitoring bores located across the Development Envelope.
40	The approval holder must maintain and ensure the working order of all groundwater monitoring bores, reference bores and impact bores within the development envelope until the expiry date of this approval. The approval holder must, until the expiry date of this approval, undertake monitoring at least monthly, capable of:	Noted. Section 3.3 (Monitoring Schedule), and Table 18 details the parameters and monitoring frequency for the groundwater monitoring bores that have been installed across the Development Envelope.
	jjjj. Demonstrating compliance with conditions C3-1 and C4-1 of the WA Approval,	In relation to WA Approval C3-1, Section 3.3 (Monitoring Schedule), and Table 18 details the parameters and monitoring frequency for the groundwater monitoring bores that have been installed across the Development Envelope. In relation to WA Approval C4-1, Section 2.6 (Association with other Management Plans) and Table 19 in Section 3.5 (Commitments Register) details BCI's commitment to this reporting requirement.
	kkkk. detecting if any of the trigger value and thresholds specified in these conditions, including plans, are exceeded and determine if the exceedance is a result of the Action	Section 3.2 (Outcome-based Provisions) and Table 16 and Table 17, details the trigger value and thresholds.
	llll. Detecting incremental change over time to groundwater regimes, groundwater level, and groundwater quality as a result of the Action	Section 3.1.2 (Environmental and Incremental Change Detection) and Appendix E1 and Appendix E2 (DAA 2022a, 2024b) details the methodology for detecting incremental change over time to groundwater regimes, levels and quality.
41	After two years from the commencement of operations provide a report that documents compliance with conditions 36 and 37. The report should include assessment of the whether the outcomes of trigger and thresholds exceedance investigations were scientifically validated and justified. The report should also assess whether the trigger and threshold exceedance investigations were	N/A as the Proposal has not yet commenced. However, Section 3.4 (Reporting) details the compliance and regulatory reporting requirements.

Cond. #	Condition Requirement	How/Where addressed in GMMP
	conducted in accordance with commitments in the GMMP and that management responses were conducted in accordance with the GMMP.	
42	To minimise impacts to protected matters and their habitats that include the Mardie Pool, open riparian woodlands vegetation and Benthic Communities and Habitat, the approval holder must, at least once per week, monitor the evaporation pond walls for surface expressions of seepage, brine spill and structural integrity.	Section 2.9 (Impacts to Matters of National Environmental Significance) outlines the potential impacts to protected matters and their habitats that include the Mardie Pool, open riparian woodlands vegetation and Benthic Communities and Habitat. While Table 16 and Table 17 in Section 3.2 (Outcome base Provisions) details the commitment to monitor the evaporation pond walls for surface expressions of seepage, brine spill and structural integrity
43	In the event of seepage and/or brine spill at the evaporation pond walls, the approval holder must:	-
	mmmm. Report the event to the department in writing within 5 business days of the event.:	Noted. Table 19 in Section 3.5 (Commitments Register) details BCI's commitment to this reporting requirement. Additionally, Section 3.3.2 (Groundwater Management Response Plan Framework) outlines the management framework to be followed for investigations if triggers and thresholds are breached.
	The findings of the seepage and/pr brine spill event investigation	
	Details of corrective measures implemented	
	An evaluation of the effectiveness of the corrective measures implemented.	
	Measures to prevent another seepage and/or brie spill event occurring in the future.	
60	The approval holder must implement the Groundwater Monitoring and Management Plan (GMMP) to avoid and mitigate harm to protected matters as a result of groundwater changes associated with the Action. The GMMP must be implemented for the life of the project.	Noted. This GMMP (Revision M) and subsequent revisions, as approved by the Delegate, has been prepared to address these conditions through its implementation.
61	By implementing the GMMP, the approval holder must achieve the following environmental outcome:	-
	eeeeee. Prevent any harm to protected matters and their habitats within and outside the development envelope as a result of changes to groundwater regimes, groundwater quality, and groundwater levels associated with the Action.	Noted. Section 2.9 (Impacts to Matters of National Environmental Significance) and Appendix H outline the potential pathways for the
62	The approval holder must review the approved GMMP at the conclusion of filling evaporation ponds 1 through 3.	Noted. Table 19 in Section 3.5 (Commitments Register) details BCI's commitment to this reporting requirement.
63	At the conclusion of filling evaporation ponds 1 through 3 the approval holder must undertake the following investigations:	-
	ffffff. All groundwater monitoring data collected to date and throughout the staged filling to be included in the groundwater model and an automatic model calibration process applied for the successively growing calibration period (e.g., using PEST-IES, White et al., 2020), which will allow for model uncertainty to be quantified as a by-product of the model calibration. The model uncertainty must then be considered in the predictive model simulations.	Noted. Table 19 in Section 3.5 (Commitments Register) details BCI's commitment to this reporting requirement. BCI will resubmit an updated GMMP (Rev N) at the conclusion of filing evaporation ponds 1 through 3 which will detail the outcomes of the investigations detailed against Condition 63.
	gggggg. Model predictions must be undertaken for the entire project lifetime to consider the full impact of the project, including the more slowly occurring impact of salinity changes.	
	hhhhhh. Determine approximate aquifer residence times by collecting environmental tracer data (groundwater age tracers) to provide greater evidence supporting the proposed "slow" groundwater flow.	
	iiiiii. Independent review of the modified Before/After Control Impact approach proposed by Data Analysis Australia.	

Cond. #	Condition Requirement	How/Where addressed in GMMP
	jjjjjj. A regional groundwater model that demonstrates an understanding of, and supports the ability to predict, the potential impacts of the proposed action on the regional groundwater system and nearby receptors. This must include groundwater hydrology in areas upstream of the evaporation ponds, for input into the groundwater modelling.	
64	The approval holder must within 3 months of the conclusion of the filling of evaporation ponds 1 through 3, submit a revised GMMP to the department for approval by the Minister. The approval holder must not undertake any further filling of the ponds until the revised GMMP is approved in writing by the Minister. At the completion of filling evaporation pond 3, the GMMP must be updated with sufficient information and data to address the above requirements and be resubmitted to and approved by the Minister and DWER in writing prior to filling any other ponds.	Noted. Table 19 in Section 3.5 (Commitments Register) details BCI's commitment to this reporting requirement. BCI will resubmit an updated GMMP (Rev N) at the conclusion of filing evaporation ponds 1 through 3 which will detail the outcomes of the investigations detailed against Condition 63.
65	The revision required by condition 62 must be revised based on the conclusions of the investigations required by condition 63. All commitments in the revised GMMP, including environmental outcomes, management measures, corrective measures, trigger values, thresholds and performance indicators must be SMART and based on referenced or included evidence of effectiveness. The GMMP must be consistent with the Environmental Management Plan Guidelines, and must include:	Noted. Table 19 in Section 3.5 (Commitments Register) details BCI's commitment to the reporting requirements and requirements to update the GMMP based on the requirements of Condition 65. BCI will resubmit an updated GMMP (Rev N) at the conclusion of filling evaporation ponds 1 through 3 which will detail the outcomes of the investigations detailed against Condition 63.
	kkkkkk. a table of commitments made in the plan to achieve the environmental outcome, and a reference to exactly where these commitments are detailed in the plan,	
	llllll. details of the data collection and modelling undertaken to inform the GMMP,	
	mmmmmm. impact avoidance, mitigation and/or repair measures, and the timing of those measures,	
	nnnnnn. commitments capable of ensuring that the environmental outcomes are achieved,	
	oooooo. a monitoring program, which must include:	
	The early warning trigger values for groundwater regimes, groundwater quality, and groundwater levels that will trigger the implementation of management and/or contingency actions to prevent non-compliance with conditions B3-1 of the WA Approval,	
	the thresholds for groundwater regimes, groundwater quality, and groundwater levels to demonstrate compliance with condition B3-1 of the WA Approval,	
	the final design of monitoring that will meet the requirement of condition B3-1 of the WA Approval, including the timing and frequency of monitoring, ensuring monitoring is capable of detecting trigger values and thresholds,	
	corrective measures which must be implemented in response to trigger value exceedances,	
	corrective measures which must be implemented in response to threshold exceedances,	
	proposed corrective measures if trigger values are reached, and	
	details of how trigger value and threshold exceedances will be assessed to determine if the exceedance is a result of the Action,	

Cond. #	Condition Requirement	How/Where addressed in GMMP
	The approval holder must provide written justification in the form of a report as an appendix to the GMMP, for the proposed triggers, limits triggers and indicators as they relates to the protection of MNES habitat by providing analysis of baseline data (from relevant locations in the receiving environment) and comparison with Australian and New Zealand guidelines for fresh and marine water quality (2018), or default guideline values for high conservation/ecological value systems.	
	pppppp. details of seepage recovery measures that will be implemented where seepage from evaporation ponds to groundwater is detected,	
	qqqqqq. an assessment of the effectiveness and reliability of the proposed monitoring system, including:	
	demonstrate if and how the monitoring system will be able to detect changes to groundwater regimes, groundwater quality, and groundwater levels until at least the anticipated completion of the Action, and	
	demonstrate if and how the monitoring system will be able to determine if exceedances are attributable to the Action,	
	rrrrrr. reporting and review mechanisms to demonstrate compliance with the commitments made in the plan and the requirement specified in condition B3-1 of the WA Approval, including a commitment to review the GMMP at least once every 5 years,	
	ssssss. an assessment of risks relating to achieving the environmental outcomes and risk management strategies and/or mitigation measures that will be applied to address identified risks, and	
	tttttt. references to other relevant plans or conditions of approval (including state approval conditions).	
66	If the revised GMMP required in condition 62 is not approved within 12 months of the date of evaporation ponds 1 to 3 being filled, the approval holder must undertake the following:	Noted. Table 1 in 9Section 3.5 (Commitments Register) details BCI's commitment to the requirements detailed in Condition 66.
	Empty evaporative ponds 1 to 3. Contents of evaporative ponds is to be disposed in a manner approved in writing by the department.	
67	The approval holder must review the GMMP after 2 years of commencement of the Action. The approval holder must submit the findings of each review to the department. The review must be completed by a reviewer, or reviewers approved by the department and must include detailed reviews of the:	Noted. Table 19 in Section 3.5 (Commitments Register) details BCI's commitment to the requirements detailed in Condition 67.
	Monitoring required by the approved GMMP, including monitoring bore network, monitoring methodology, monitoring frequency, and trigger and thresholds.	
	Implementation of the GMMP,	
	Effectiveness of the GMMP regarding the achievement of its environmental objective.	
	Capacity to measure incremental impacts at the conclusion of the Ramp period	
	Assessment of whether the GMMP requires revision at this time.	
68	The GMMP must be revised in line with the recommendations of the review required by condition 67 and submitted to the department for approval by the Minister. The revised GMMP must include:	Noted. Table 19 in Section 3.5 (Commitments Register) details BCI's commitment to the requirements detailed in Condition 68.

Cond. #	Condition Requirement	How/Where addressed in GMMP
	Revised modelling that includes all data collected to date	
	Revised monitoring and management measures in accordance with recommendations of the review undertaken in condition 67	
69	The approval holder must review the approved GMMP at least once within every subsequent 5 year period following the approval of the GMMP. The approval holder must submit the findings of each review to the department. The review must be completed by a reviewer or reviewers approved by the department and must include detailed reviews of the:	Noted. Table 19 in Section 3.5 (Commitments Register) details BCI's commitment to the requirements detailed in Condition 69.
	Monitoring required by the approved GMMP, including monitoring bore network, monitoring methodology, monitoring frequency, and trigger and thresholds.	
	Implementation of the GMMP,	
	Effectiveness of the GMMP regarding the achievement of its environmental objective.	
70	The GMMP must be revised in line with the recommendations of the review required by condition 67 and submitted to the department for approval by the Minister. The revised GMMP must include:	Noted. Table 19 in Section 3.5 (Commitments Register) details BCI's commitment to the requirements detailed in Condition 70.
	Revised modelling that includes all data collected to date	
	Revised monitoring and management measures in accordance with recommendations of the review undertaken in condition 67.	
71	For any revision of the GMMP, all commitments in the GMMP, including environmental outcomes, management measures, corrective measures, trigger values, thresholds and performance indicators must be SMART and based on referenced or included evidence of effectiveness and in accordance with condition 65. The GMMP must be consistent with the Environmental Management Plan Guidelines, and must include: [note: this is an incomplete sentence in the draft conditions]	Noted. Table 19 in Section 3.5 (Commitments Register) details BCI's commitment to the requirements detailed in Condition 71.
EPBC 2018/8236		
3	To minimise **impacts** to **protected matters** from changes to groundwater (the Groundwater Objective), the approval holder must comply with conditions 3-1 to 3-9 of **MS 1211.**	This GMMP (Revision M), and subsequent revisions as approved by the Delegate, has been prepared to address these conditions through its implementation – see below for further detail
4	The approval holder must submit a Groundwater Monitoring and Management Plan (GMMP) to the Minister for approval. The approval holder must not commence operations until the GMMP has been approved by the Minister in writing. The approval holder must implement the approved GMMP. The GMMP must:	Noted. This GMMP (Revision M) and subsequent revisions, as approved by the Delegate, has been prepared to address these conditions through its implementation
	a. be consistent with the Environmental Management Plan Guidelines.	This GMMP (Revision M) for the Mardie Project adheres to the guidance provided under Chapter 4 of Australia's national environment law, the *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) for the preparation of a suitable environmental management plan. This GMMP (Revision M) has been prepared to be consistent with the Environmental Management Plan Guidelines, Commonwealth of Australia 2014
	b. include the outcomes of the Mardie Project Groundwater Memo that is to be implemented, which specifies the locations for the monitoring bores and specifies the modelling to be undertaken to inform the GMMP in order to prevent impacts to the Mardie Pool, terrestrial, intertidal and subtidal protected matters and habitats	See Appendix Q of the GMMP. Final technical studies are currently underway for the remainder of the modelling and outcomes prescribed in Mardie Project Groundwater Memo. Timing for the completion of technical studies is provided in Section 3.5, Table 19. Studies completed are described in Section 2.7

Cond. #	Condition Requirement	How/Where addressed in GMMP
	(the Groundwater Objective). The outcomes of the modelling proposed in the Mardie Project Groundwater Memo must be included as an Appendix to the GMMP.	The progressive filling approach described in this GMMP supersedes the approach outlined in the memo.
	c. include the information required under condition 3-4 of the WA Approval and how the Groundwater Objective will be met.	See Section 2.2 of this version of the Mardie Project GMMP. When implemented, this GMMP will satisfy WA Conditions 3-1(1) and 3-1(4) of Ministerial Statement 1175 noting that Condition 3-4 has been superseded by MS 1211 conditions (described below). Relevant WA Approval Conditions including implementation of the Plan are described below. The GMMP has been prepared to address these conditions through its implementation.
	d. present additional measures based on the outcomes of the modelling undertaken as part of the Mardie Project Groundwater Memo that identify further impacts that may result on protected matters within and/or outside the development envelope.	See Section Appendix Q of the GMMP. AQ2 Mardie Project Conceptual Groundwater System and Modelling Assessment report prepared for Mardie Minerals dated January 2024 has been provided in **Appendix A** Section 2.9 provides details on characterisation of the environment and understanding of likely groundwater impacts so that impacts to EPBC protected matters could be identified, and management measures designed so that DCCEEW are capable of assessing impacts to Matters of National Environmental Significance
	e. include the details of a review of the draft GMMP by an independent suitably qualified hydrologist and how the recommendations of the independent suitably qualified hydrologist's review have been addressed and resulted in changes to the GMMP.	Section 4.2 and Table 13. Peer Review included in Appendix C. An Audit Review (GMMP Rev H) was undertaken by CyMod on 29 November 2023. The Audit Review undertaken by the independent suitably qualified hydrologist concluded that Mardie Minerals addressed the reviewer's comments adequately (Appendix G). Further details of peer review is provided in Section 4.2.1.
5	In the event that any threshold criterion specified in the GMMP, in accordance with condition 3-4(5) and 3-4(6) of the WA Approval is exceeded, the approval holder must:	Reporting and investigation procedures have been developed following the exceedance of any trigger and threshold values in the GMMP and are described in Section 3.3 and 3.4.
	a. undertake the actions required under condition 3-7 of the WA Approval and provide the same information and the report required under condition 3-7(5) of the WA Approval, to the Department, within the same timeframes as specified under condition 3-7 of the WA Approval.	In the event that monitoring has indicated an exceedance of trigger and/or threshold values specified in the GMMP then Mardie Minerals will undertake the following: report exceedance in writing to the CEO & DCCEEW; implement appropriate contingency actions required by the GMMP within 7 days of exceedance notification; investigate to determine the cause of the exceedances; investigate and provide to the CEO any potential harm that exceedance may have caused to the environment; provide a report to the CEO within 21 days of the threshold criteria exceedance. Report to include: details of contingency actions; effectiveness of the contingency actions; findings of the investigation into the exceedance; measures to prevent the threshold criteria being exceeded in the future; measures to prevent, control and abate impacts that may have been caused; and justification of the threshold criteria remaining or being adjusted to better manage outcomes of the GMMP. Timeframes are specified in Section 3.4 of GMMP and in Table 19.
	b. within 6 months of any such exceedance, have the GMMP reviewed by an independent suitably qualified hydrologist to advise if the GMMP needs to be revised to prevent any possibility of the exceedance reoccurring and submit the report of the independent suitably qualified hydrologist to the Department. If the review of the GMMP by an independent suitably qualified hydrologist recommends that the GMMP be revised, the approval holder must submit the revised GMMP to the Department for the approval of the Minister within 8 months of any such exceedance.	GMMP to be reviewed by independent hydrologist as required. Review processes outlined in Section 4.2.
	c. within 6 months of any such exceedance develop a Remediation Plan to be submitted to the Department for the Minister's approval for the any impact(s) to	Exceedance reporting and management actions. Refer to Section 3.4 and Table 19 of the GMMP.

Cond. #	Condition Requirement	How/Where addressed in GMMP
	protected matters arising from the exceedance as detailed in the report required under condition 3-7(5) of the WA Approval and condition 5(b).	This GMMP acknowledges that in accordance with Condition 5(c) of EPBC 2018/8236, exceedance of threshold criteria specified in the GMMP will also trigger the development of a Remediation Plan.
	d. If a Remediation Plan is submitted in accordance with condition 5(c) and that Remediation Plan has not been approved by the Minister in writing within 9 months of the exceedance event, and the Minister notifies the approval holder that the Remediation Plan is not suitable for approval, the Minister may, at least two months after so notifying the approval holder, approve a version of the Remediation Plan revised by the Department. The approval holder must implement the approved Remediation Plan.	Conditions requiring a Remediation Plan are detailed in Section 3.4 reporting of the GMMP. The Remediation Plan is to be reviewed alongside the GMMP by an independent suitably qualified hydrologist within 6 months of the exceedance being reported. The Remediation Plan will describe contingency measures and remediation actions to be undertaken in response to a threshold exceedance
	e. If the Minister determines that it is not possible to remediate the impact of the exceedance, then the approval holder must, within 10 months of the exceedance of the threshold criterion, submit an Offset Strategy specifying how the impact will be offset in accordance with the Environmental Offsets Policy. If the Offset Strategy has not been approved by the Minister in writing within 11 months of the exceedance event, and the Minister notifies the approval holder that the Offset Strategy is not suitable for approval, the Minister may, at least two months after so notifying the approval holder, approve a version of the Offset Strategy revised by the Department. The approval holder must implement the approved Offset Strategy for the remainder of the life of the project.	Mardie Minerals will develop an Offset Strategy to deal with the impact if the Minister or Department considers that it is no longer possible to remediate the impact caused by the exceedance. To be actioned at a time specified in the Offset Strategy and as approved by the Minister.
6	The approval holder must have the GMMP reviewed by an independent suitably qualified hydrologist at least once before every 10-year anniversary of the first approval of the GMMP and subsequently every 10 years for the life of the project or unless specified by the Minister in writing. If the independent suitably qualified hydrologist recommends revision of the GMMP, the approval holder must, within 6 months of receiving the recommendation of the independent suitably qualified hydrologist, submit a revised GMMP addressing the recommendations of the independent suitably qualified hydrologist accompanied by the recommendations of the independent suitably qualified hydrologist to the Department within 3 months of the most recent 10-year anniversary of the first approval of the GMMP, for approval by the Minister.	The current GMMP at the 10-year anniversary of the project must be reviewed by an independent hydrologist and subsequently reviewed every 10 years thereafter. To be actioned at the 10 year anniversary of the Project. Included in Section 4.2 .
7	If a revised GMMP is submitted in accordance with condition 5(b) or condition 6 and that GMMP has not been approved by the Minister in writing within 10 months of the exceedance event, and the Minister notifies the approval holder that the GMMP is not suitable for approval, the Minister may, at least two months after so notifying the approval holder, approve a version of the GMMP revised by the Department.	As per Section 3.4. To be actioned at time of exceedance.
Ministerial Statement 1175 (superseded, included here to comply with requirements under EPBC 2018/8236)		
3-1	The proponent shall ensure that the following outcomes are achieved: (1) no adverse impact to water levels or water quality in Mardie pool as a result of changes to groundwater regimes or groundwater quality; (2) no adverse impact to water levels or water quality in Mardie pool as a result of surface water flows associated with the proposal; (3) no changes to the extent of surface water flooding extent during a one (1)-year ARI or changes to tidal inundation as a result of the construction of the intertidal causeway that are greater than predicted in Mardie Project – Environmental Review Document (June 2020); Page 5 of 40	Addressed in this GMMP Section 2.3.4 Section 2.8.4 Appendix Q Section 2.9 Section 3.2

Cond. #	Condition Requirement	How/Where addressed in GMMP
	(4) no changes to the health, extent of diversity of more than five (5) ha of intertidal benthic communities and habitat, including mangrove, samphire and algal mat as a result of changes to groundwater regimes or groundwater quality associated with the proposal; (5) decreased freshwater inundation attributable to the project of no more than fifty-two (52) ha of coastal samphire; (6) decreased freshwater inundation attributable to the project of no more than thirteen (13) ha mangroves outside the RRDMMA; and (7) decreased freshwater inundation attributable to the project of no more than 130 ha mangroves within the RRDMMA, subject to the requirements of condition 2-3.	
3-3	The proponent shall prepare and submit to the CEO a Groundwater Monitoring and Management Plan.	GMMP Plan for the Mardie Project submitted.
	(1) The proponent shall submit with the Groundwater Monitoring and Management Plan, a peer review of the plan carried out by an independent person or independent persons with relevant expertise determined by the CEO, that provides an analysis of the suitability of the plan to meet the outcomes of conditions 3-1(1) and 3-1(4).	Section 4.2 and Table 13. Peer Review included in Appendix C. An Audit Review (GMMP Rev H) was undertaken by CyMod on 29 November 2023. The Audit Review undertaken by the independent suitably qualified hydrologist concluded that Mardie Minerals addressed the reviewer's comments adequately (Appendix G).
	(2) The proponent shall not commence transfer of seawater, brine or waste product into any evaporation or crystallizer ponds associated with the proposal until the CEO confirmed by notice in writing that the Groundwater Monitoring and Management Plan meets the requirements of condition 3-4.	Noted .
3-4	The Groundwater Monitoring and Management Plan required by condition 3-3 shall:	Noted, This GMMP (Rev K) addresses the primary outcomes of the Project.
	(1) when implemented, substantiate, and ensure that the outcome of conditions 3-1(1) and 3-1(4) will be met;	
	(2) provide the details, including timing, of hydrogeological investigations to be carried out that will: (a) provide a detailed understanding of the hydrological regime in the project area; (b) inform the final design of monitoring that will meet the requirement of condition 3-4(1); and (c) inform the final design of management and mitigation actions that will be implemented to meet the outcomes of conditions 3-1(1) and 3-1(4);	Refer to recent AQ2 Mardie Project Pond 1 Modelling Assessment prepared for Mardie minerals dated October 2023 **Appendix A** and Sections 2.7.1 and 2.8.4**.**
	(3) detail the timing of monitoring bore installation and collection of baseline data, providing justification to demonstrate that data will represent baseline where it is collected after the commencement of operations;	GMMP includes update of existing monitoring bores installed (Tables 4, 6 and 7). Mardie Minerals remains committed to monitoring, maintaining and upgrading the monitoring bore network to satisfy the primary objectives and outcomes of the Project and in accordance with the relevant Approval Conditions.
	(4) detail the methodology of seepage recovery actions that will be implemented where seepage from evaporation ponds to groundwater is detected;	Refer to Trigger and Threshold section 3.2.
	(5) specify early warning trigger criteria that will trigger the implementation of management and/or contingency actions to prevent non-compliance with conditions 3-1(1) and 3-1(4).	Refer to Trigger and Threshold Section 3.1 and 3.2. Trigger and threshold values have been calculated using the most recent groundwater monitoring data to date. The M-BACI method is proposed to implemented as discussed in section 2.3.3. Mardie Minerals are committed to reviewing and continually updating these values once new data is collected following filling the Ponds.
	(6) specify threshold criteria to demonstrate compliance with condition 3-1(3).	

Cond. #	Condition Requirement	How/Where addressed in GMMP
	(7) specify the methodology of a monitoring program to determine if trigger criteria and threshold criteria have been met and meet the requirement of condition 3-4(1).	Refer to Trigger and Threshold sections 3.1 and 3.2.. Groundwater sampling and monitoring program including frequency is included in Section 3
	(8) specify management and/or contingency actions to be implemented if the trigger criteria required by condition 3-4(5) and/or the threshold criteria required by condition 3-4(6) have not been met; and	GMMP Adaptive Management and Review actions are outlined in Section 4.
	(9) provide the format and timing for the reporting of monitoring results against trigger criteria and threshold criteria to demonstrate that the outcomes in conditions 3-1(1) and 3-1(4) have been met over the reporting period in the Compliance Assessment Report required by condition 18-6.	Refer to Compliance Reporting in Section.4.
3-5	The exceedance of a threshold criteria, regardless of whether management actions or threshold contingency actions have been or are being implemented, constitutes non-compliance with these conditions.	Refer to Compliance Reporting in Section.4.
3-6	The proponent shall implement the most recent version of the Groundwater Monitoring and Management Plan which the CEO has confirmed by notice in writing, addresses the outcomes of conditions 3-1(1) and 3-1(4).	Noted.
3-7	In the event that monitoring or investigations at any time indicate an exceedance of threshold criteria specified in the Groundwater Monitoring and Management Plan confirmed under condition 3-6, the proponent shall:	GMMP Reporting requirements including investigative reporting are described in Section 4.
	(1) report the exceedance in writing to the CEO within seven (7) days of the exceedance being identified;	The reporting section (Section 4) of this GMMP includes compliance and regulatory reporting requirements. If groundwater monitoring has indicated an exceedance of trigger and threshold values specified in the GMMP then Mardie Minerals will undertake the following: report exceedance in writing to the CEO; implement appropriate contingency actions required by the GMMP within 7 days of exceedance notification; investigate to determine the cause of the exceedances; investigate and provide to the CEO any potential harm that exceedance may have caused to the environment; provide a report to the CEO within 21 days of the threshold criteria exceedance. Report to include: details of contingency actions; effectiveness of the contingency actions; findings of the investigation into the exceedance; measures to prevent the threshold criteria being exceeded in the future; measures to prevent, control and abate impacts that may have been caused; and justification of the threshold criteria remaining or being adjusted to better manage outcomes of the GMMP.
	(2) implement the contingency actions required by the Groundwater Monitoring and Management Plan within seven (7) days of the exceedances being reported and continue implementation of those actions until the CEO has confirmed by notice in writing that it has been demonstrated that the threshold criteria are being met and implementation of the threshold contingency actions are no longer required;	
	(3) investigate to determine the cause of the threshold criteria being exceeded;	
	(4) investigate to provide information for the CEO to determine potential environmental harm or alteration of the environment that occurred due to threshold criteria being exceeded;	
	(5) provide a report to the CEO within twenty-one (21) days of the threshold criteria exceedance being reported. The report shall include: (a) details of contingency actions implemented; (b) the effectiveness of the contingency actions implemented against the threshold criteria; (c) the findings of the investigations required by conditions 3-7(3) and 3-7(4); (d) measures to prevent the threshold criteria being exceeded in the future; (e) measures to prevent, control or abate impacts which may have occurred; and (f) justification of the threshold criteria remaining, or being adjusted based on better understanding, demonstrating that the outcome in conditions 3-1(1) and 3-1(4) will be met.	
3-8	The proponent:	GMMP review is described in Section 4.2. Mardie Minerals will undertake a review of the current GMMP by an independent hydrologist every five years for WA Approval 1175 and every 10 years for the EPBC Approval 2018/8236.
	(1) may review and submit proposed amendments to the Groundwater Monitoring and Management Plan;	

Cond. #	Condition Requirement	How/Where addressed in GMMP
	(2) shall review and submit proposed amendments to the Groundwater Monitoring and Management Plan as and when directed by the CEO; and (3) shall review and submit proposed amendments to the Groundwater Monitoring and Management Plan every five (5) years.	
3-9	The proponent shall continue to implement the Groundwater Monitoring and Management Plan or any subsequent revisions as confirmed by the CEO in condition 3-3, until the CEO has confirmed by notice in writing that the proponent has demonstrated that the environmental outcomes detailed in conditions 3-1(1) and 3-1(4) have been met.	Noted
Ministerial Statement 1211		
A1-1	Groundwater abstraction - No dewatering of groundwater for any reason except to meet the requirements of condition B3-2.	Noted.
B1-1	The proponent must ensure the implementation of the proposal achieves the following environmental outcomes: (4) no change in the health, extent of coverage, or species diversity of intertidal benthic communities more than 100 m seaward of the pond walls as shown in Figure 2; and (5) adverse impacts to intertidal benthic communities are limited to an area within 100 m of the pond wall defined in Figure 2.	Groundwater modelling outcomes described in section 2.7.1 with respect to impacts in proximity to pond walls. BCHMMP linkages to GMMP described in Appendix Q.
B3-1	The proponent must ensure the implementation of the proposal achieves the following environmental outcomes: (1) no adverse impact to water levels or water quality in Mardie Pool as a result of changes to groundwater regimes or groundwater quality (4) no changes to the health, extent or diversity of intertidal benthic communities and habitat, including mangrove, coastal samphire and algal mat as a result of changes to groundwater regimes or groundwater quality associated with the proposal;	Section 2.4, and Appendix Q describe the key environmental objectives and outcomes with respect to these values. Trigger and threshold criteria are established for groundwater level and EC with respect to preventing unauthorized impacts to these values (Section 3.1).
B3-2	The proponent must: implement the Groundwater Monitoring and Management Plan (GMMP; Rev F, submitted March 2023), once updated and approved in accordance with condition B3-3, and subject to the requirements of condition C1-1(3), with the purpose of ensuring the benthic communities and habitat environmental outcomes in condition B3-1 (1) and (4) and condition B1-2 are achieved, monitored, substantiated and satisfy the requirements of conditions C4 and condition C5; and review the GMMP environmental management plan (Rev F, submitted March 2023); within one (1) year of the date of this statement to include: the relationship between the GMMP environmental management plan and the BCHMMP environmental management plan, and how these plans work together to ensure overlapping and holistic impacts are managed and monitored, to ensure the environmental outcomes and objectives relevant to both plans are achieved.	This GMMP (Rev M) has incorporated feedback from DWER and DCCEEW, peer review recommendations, updated technical studies including modelling and data collection from bores installed since 2022.
B3-3	The GMMP (Rev F, submitted March 2023) environmental management plan required by condition B3-2 is to be updated with project specific trigger values at the completion of baseline data collection.	As per commitments in Section 3.5.

Cond. #	Condition Requirement	How/Where addressed in GMMP
C1-1	The proponent must not undertake: (3) transfer of seawater, brine and/or waste product associated with the Mardie Project until the CEO has confirmed in writing that the environmental management plan required by condition B3-2 has been updated in accordance with condition B3-3 and meets the requirements of condition C4;	Noted.
C2-1	Upon being required to implement an environmental management plan under Part B, or after receiving notice in writing from the CEO under condition C1-1 that the environmental management plan(s) required in Part B satisfies the relevant requirements, the proponent must: implement the most recent version of the confirmed environmental management plan; and continue to implement the confirmed environmental management plan referred to in condition C2-1(1) other than for any period which the CEO confirms by notice in writing that it has been demonstrated that the relevant requirements for the environmental management plan have been met, or are able to be met under another statutory decision-making process, in which case the implementation of the environmental management plan is no longer required for that period.	Mardie Minerals will implement the GMMP as and when approved by the CEO.
C2-2	The proponent: may review and revise a confirmed environmental management plan provided it meets the relevant requirements of that environmental management plan, including any consultation that may be required when preparing the environmental management plan; must review and revise a confirmed environmental management plan and ensure it meets the relevant requirements of that environmental management plan, including any consultation that may be required when preparing the environmental management plan, as and when directed by the CEO: and must revise and submit to the CEO the confirmed environmental management plan if there is a material risk that the outcomes or objectives it is required to achieve will not be complied with, including but not limited to as a result of a change to the proposal.	Noted for future revisions to the GMMP.
C2-3	Despite condition C2-1, but subject to conditions C2-4 and C2-5, the proponent may implement minor revisions to an environmental management plan if the revisions will not result in new or increased adverse impacts to the environment or result in a risk to the achievement of the limits, outcomes or objectives which the environmental management plan is required to achieve.	Noted for future revisions to the GMMP.
C2-6	Confirmed environmental management plans, and any revised environmental management plans under condition C2-4(1), must be published on the proponent's website and provided to the CEO in electronic form suitable for online publication by the DWER within twenty (20) business days of being implemented, or being required to be implemented (whichever is earlier).	Mardie Minerals will publish the GMMP once approved.
C3-1	The proponent must undertake monitoring capable of: substantiating whether the proposal limitations and extents in Part A are exceeded; and detecting and substantiating whether the environmental outcomes identified in Part B are achieved (excluding any environmental outcomes in Part B where an	Monitoring is described in Appendix Q, and Section 3.1, Section 3.2 and Section 3.3.

Cond. #	Condition Requirement	How/Where addressed in GMMP
	environmental management plan is expressly required to monitor achievement of that outcome).	
C3-2	The proponent must submit as part of the Compliance Assessment Report required by condition D2, a compliance monitoring report that: (1) outlines the monitoring that was undertaken during the implementation of the proposal; (2) identifies why the monitoring was capable of substantiating whether the proposal limitation and extents in Part A are exceeded; (3) for any environmental outcomes to which condition C3-1(2) applies, identifies why the monitoring was scientifically robust and capable of detecting whether the environmental outcomes in Part B are met; (4) outlines the results of the monitoring; (5) reports whether the proposal limitations and extents in Part A were exceeded and (for any environmental outcomes to which condition C3-1 (2) applies) whether the environmental outcomes in Part B were achieved, based on analysis of the results of the monitoring; and (6) reports any actions taken by the proponent to remediate any potential non-compliance.	Reporting is described in Section 3.4 in accordance with the condition and sub conditions
C4-1	The environmental management plans required under condition B1-4, condition B2-2, condition B3-2, condition B4-3, condition B5-3, condition B5-4, condition B6-4, condition B6-6 and condition B8-3 must contain provisions which enable the substantiation of whether the relevant outcomes of those conditions are met, and must include: (1) threshold criteria that provide a limit beyond which the environmental outcomes are not achieved; (2) trigger criteria that will provide an early warning that the environmental outcomes are not likely to be met; (3) monitoring parameters, sites, control/reference sites, methodology, timing and frequencies which will be used to measure threshold criteria and trigger criteria. Include methodology for determining alternative monitoring sites as a contingency if proposed sites are not suitable in the future; (4) baseline data; (5) data collection and analysis methodologies; (6) adaptive management methodology; (7) contingency measures which will be implemented if threshold criteria or trigger criteria are met; and (8) reporting requirements.	This GMMP has been prepared in accordance with this Condition.
C4-4	The environmental management plan required under condition B3-2 is also required to: (1) when implemented, substantiate and ensure that the outcome of conditions B3 - 1 (1) and B3-1 (4) will be met; (2) provide the details, including timing, of hydrogeological investigations to be carried out that will: (a) provide a detailed understanding of the hydrological regime in the project area;	This GMMP has been prepared in accordance with this Condition.

Cond. #	Condition Requirement	How/Where addressed in GMMP
	(b) inform the final design of monitoring that will meet the requirement of condition C4-1; (c) inform the final design of management and mitigation actions that will be implemented to meet the outcomes of conditions B3 -1 (1) and B3-1 (4); and (3) detail the timing of monitoring bore installation and collection of baseline data, providing justification to demonstrate that data will represent baseline where it is collected after the commencement of operations.	
D1	Non-compliance Reporting	Reporting is described in Section 3.4 in accordance with the condition and sub conditions
D2	Compliance Reporting	Reporting is described in Section 3.4 in accordance with the condition and sub conditions

2.6 Association with other Management Plans

This GMMP provides monitoring and management actions related to possible groundwater seepage and/or mounding from pond filling and operations. Any exceedance of trigger and threshold values in the GMMP will trigger a range of actions (See section 3.3.2) which include the implementation of monitoring actions as presented in the approved Benthic Community and Habitat Management and Monitoring Plan (BCHMMP) and the Migratory Shorebird Monitoring and Management Plan (MSMMP) (refer Table 16 and Table 17; Section 3.2).

Similarly, investigations into trigger and threshold exceedances under the BCHMMP and MSMMP will include a review of monitoring data collected under the GMMP, and the implementation of additional monitoring if required.

The GMMP, MSMMP and BCHMMP interrelate to meet Conditions 3-1(4) and 6 of MS 1211, and Condition 23 of EPBC 2018/8236 and Condition 46 and Condition 58 of EPBC 2022/9169. A review of this GMMP alongside the BCHMMP and MSMMP will be completed and submitted by the 19th October 2024 as per Condition B3-2(2) of MS-1211. Adaptive management of this plan in relation to the GMMP is described further in Section 4.

2.7 Relevant Technical Studies

There are a number of technical studies that have been undertaken to support the development and /or implementation of this GMMP.

Significant work, including bore installation and monitoring, monitoring at Mardie Pool and Mt Salt, and groundwater modelling, has been completed in support of developing the GMMP for the Original Project and to support the EIA for the Optimised Mardie Project.

A summary of the key studies and investigations that have been undertaken, or are ongoing, is provided in Table 3.

This GMMP is intended to be reviewed and updated as ongoing monitoring and operations progress.

Table 3 Status of Key Studies and Investigations

Investigation	Details	Status (March 2024)
Terrestrial Monitoring Bore Drilling Program	Installation of monitoring bores in the vicinity of Mardie Pool and evaporation ponds to permit water level and quality investigations.	Completed
Coastal Monitoring Bore Drilling Program	Installation of monitoring bores on the coastal side of evaporation ponds and near the RRDMMA to permit water level and quality investigations.	
Aquifer Testing.	Pumping tests of test bores within the Fortescue Alluvial aquifer and Carnarvon Superficial aquifer to quantify aquifer parameters.	
Conceptual Hydrogeological model and impact modelling across 2D transects	Development of a conceptual model and numerical impact modelling across 4 representative transects for a range of scenarios to estimate potential for environmental impacts from groundwater mounding or seepage from evaporation ponds.	Conceptual model and impact modelling of transects Pond 1, Pond 6 and Mardie Pool completed and attached – Appendix A. Transect Pond 8 completed.

Investigation	Details	Status (March 2024)
Regional Groundwater modelling.	Development of a regional groundwater flow model to assess the potential impacts of the proposed evaporation ponds on the regional groundwater system.	Refer to Appendix Q
Mardie Pool Transient Electromagnetic (TEM) Survey.	Non-invasive TEM survey to investigate groundwater salinity distribution in areas where drilling was not permitted by traditional owners.	Completed
Mardie Pool Surface Water/Groundwater Interaction Investigation.	Data collection began October 2022.Ongoing incorporation into conceptualisation and groundwater modelling.	Collection of water level and quality data ongoing on a quarterly frequency. Groundwater Investigation Report included as Appendix M
Baseline Groundwater level and quality monitoring.	Acquisition of water level, water samples and electrical conductivity (EC) profiles from all monitoring network bores to characterise natural variation and ongoing variations which may be due to effects of the project.	Ongoing monitoring as described in this GMMP for each bore network.
Mt Salt Mound source analysis.	Site visit November 2022 and August 2023 found no discharge was evident at that time. Should artesian water discharge be found at Mt Salt, water samples will be taken to be compared to potential upgradient groundwater sources. Spring source will be investigated through analysis of stable isotopes or radionuclides.	Ongoing quarterly visits will continue noting that to date, there has been no water discharge at the site.
Development of trigger and threshold criteria.	Development of trigger and threshold criteria for groundwater quality from the baseline groundwater quality data.	Triggers and Thresholds developed (See Table 16 and Table 1617 and details contained in Appendix E1 and Appendix E2).

2.7.1 Conceptual Hydrogeological Model

Model Development and Inputs

AQ2 Consultants have undertaken the Conceptual Hydrological Modelling for the Mardie Project and the most recent update of the modelling is provided as an attachment in Appendix A.

The objective of the groundwater modelling was to predict the potential water level and salinity impacts of seepage (leakage) related to the operation of the Mardie Project on the underlying groundwater system. Available groundwater monitoring, that extends as far back as February 2022, shows fluctuations in groundwater levels due to recharge to groundwater from extremely high tides. As a result, groundwater levels in the modelled catchment are not readily described by a long-term average or steady state water level calibration.

The density dependent flow and transport groundwater models were developed consistent with the hydrogeological understanding as described in Section 4 of Appendix A and the principles outlined in the Australian Groundwater Modelling Guidelines (Barnett et al, 2012).

The key hydrogeological inputs to the model include:

- The presence of two significant, distinct unconfined aquifer systems: the Fortescue Alluvial aquifer and the alluvial aquifer of the Coastal Plain
  - The coastal plain alluvial aquifer is generally unconfined and formed in Pliocene / Quaternary sediments. The hydrostratigraphy of the coastal aquifer has been defined through data from geotechnical investigations across the intra-tidal zone and deeper (~30m) investigative test bores in the hinterland area to the south-east.
  - The Fortescue River alluvial valley forms a large aquifer of fresh groundwater across the alluvial fan west of the main river channel. Silt and gravel content is variable both vertically and horizontally, resulting in highly variable aquifer transmissivity and variations in water quality.
- Regional groundwater levels and flow generated from water levels measured in groundwater investigation bores which have been installed since 2019 at Mardie showing flat groundwater gradients and negligible lateral groundwater flow from the sabkha to the ocean and parallel to the coast.
- Groundwater recharge is periodical and associated with high tide infiltration. Some direct recharge to the coastal plain will occur during major rainfall events when extensive flooding overbanks from the water courses and moves as sheet flow across the plain.
- Water quality observations from test pits and bores over a number of years including salinity profiles from north of the Mardie pool, and from deep/shallow bores across the sabkha.
- Hydrogeological parameters derived from constant rate tests and falling/rising head tests carried out in a selection of Test Production bores and monitoring bores across the project site over several campaigns as well as data gathered from previous work in the area.

Conceptual Model

The conceptual hydrogeological model is presented in Figure 6 below and summarised as follows:

<u>Coastal Sabkha:</u>

- The dominant groundwater influence in this area is the body of hypersaline water which has developed over an extensive period beneath the tidal flats (the sabkha). It extends for 30 km parallel to the coastline and approximately 5-10km inland and is up to 5km wide (Figure 9).
- Recharge of fresh groundwater water occurs inland and across the hinterland, flowing gradually towards the coast. The fresh water intersects the hypersaline brine of the sabkha inland from the eastern edge of the tidal zone, where a wedge of hypersaline water is confined by the hydraulic pressure of the fresh water. Diffusion of hypersaline water into the fresh water occurs at this point.

- On the seaward side of the sabkha a seawater-hypersaline interface is present, and the base of the hypersaline plume extends to the sea floor where rapid mixing with sea water occurs.
- During large rainfall flood events, fresh water will flood from creeks and overtop the hypersaline brine of the sabkha to flow across the flats to the ocean. This may dissolve some surficial salt and deposit silt across the sabkha for a short time, however the salt accumulation process will resume at the next high tides following the recession of flooding.
- Climatic conditions characterised by very hot summers, mild winters and variable rainfall, along with evaporation rates of around 3.4 metres per annum, 12 times annual rainfall.

Mardie Pool:

- Mardie Pool is likely to become a gaining stream or losing stream depending on the prevailing pool and groundwater levels.
- It will fill to the overflow level during significant rainfall events. After flowing for a short period of time, outflow stops and the level in the pool will fall due to evaporation and loss of water through seepage.
- While the groundwater level in in the surrounding aquifer is lower than the level in the pool Mardie Pool acts as a losing stream. Fresher groundwater will gradually seep into the banks and base of Mardie Pool.
- After extended dry periods the level of water within Mardie Pool falls below the groundwater level noted in adjacent monitoring bores. Analysis of recession curves for the pool indicate that the pool water level is likely being supplemented with groundwater inflow (the pool becomes a gaining stream), hence remaining a permanent surface water feature throughout the dry season.
- Groundwater in bores to the north of Mardie Pool is saline at a depth which is below the base of Mardie Pool. While Mardie Pool is known to become more saline due to evaporation in dry periods, the pool is filled with fresh water during flood events. It is unclear whether saline groundwater contributes to the increase of salinity in Mardie Pool.

Model Durations

The prediction models have been run to predict the impacts of leakage from the ponds and the crystalliser. Based on the expected operation of the project, pond leakage has been simulated assuming that the operational level or the fill level of the ponds persists for the duration of the predictions. The predictions also make assumptions about the duration of leakage from the crystallisers (long term leakage and short-term leakage are simulated even though leakage from the crystallisers would be managed to maximise recovery of product and minimise leakage). The predictions also include variable conditions associated with tidal fluctuations, recharge from tidal inundation and the estimated seasonal fluctuations at Mardie Pool. Predictions were run for the following durations:

- For Pond 1 predictions were run for a period of three years,
- For the crystalliser and Mardie Pool predictions were run for a period of 10 years
- For Pond 6 and the crystalliser, predictions were also run for a period of 10 years
- For Pond 8, predictions were also run for a period of 20 years

Modelling of all transects is being undertaken for the life of the project and will be finalised in mid-September. It will be included in the updated GMMP submitted after pond 3 filling.

The ponds are located on predominantly low permeability clayey material (AQ2, 2024). The infiltration and storage capacity of this clayey material is limited. As a result, quasi steady state water level and salinity conditions (or equilibrium conditions) are predicted to be reached in and around the area of Pond 1 in less than a year. For the predictions that include the unlikely scenario of long term or persistent leakage from the crystalliser, prediction results also show that the water level impacts of crystalliser leakage also reach quasi steady state water level conditions within 5 years. For predictions that include crystalliser leakage for a period of only a year (the likely operational scenario) a short-term

peak in water level is reached consistent with the duration of the leakage period of one year, which is predicted to rapidly dissipate. When leakage from Pond 6 is simulated, quasi steady state water levels are predicted within a year of the simulation of Pond 6 leakage.

The current prediction periods have made a number of assumptions about future tidal and climate conditions based on the current understanding. The predictions have shown the development of steady state water level conditions in and around the proposed project development within the prediction periods simulated.

Figure 6 Conceptual Hydrogeological Model

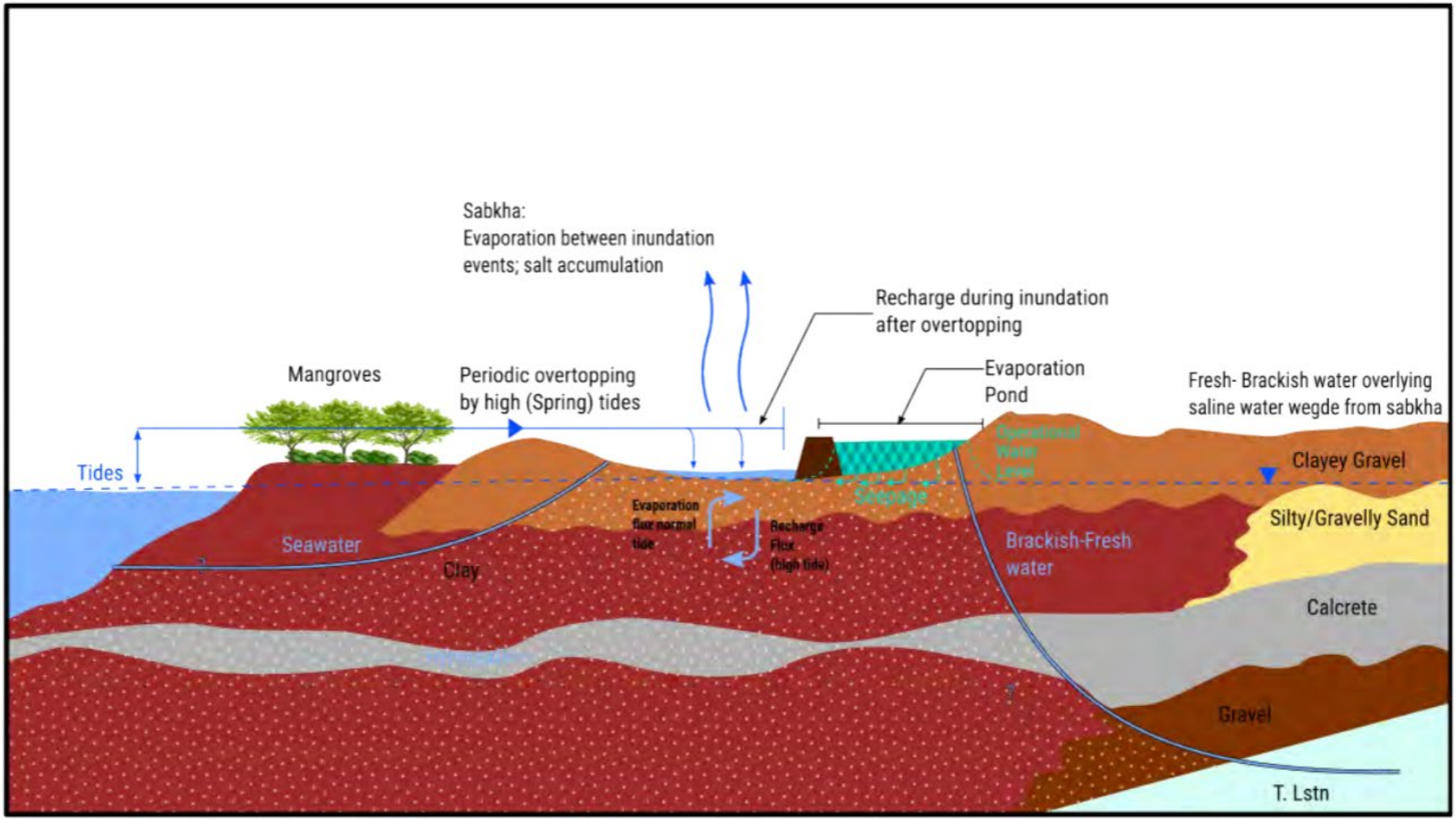
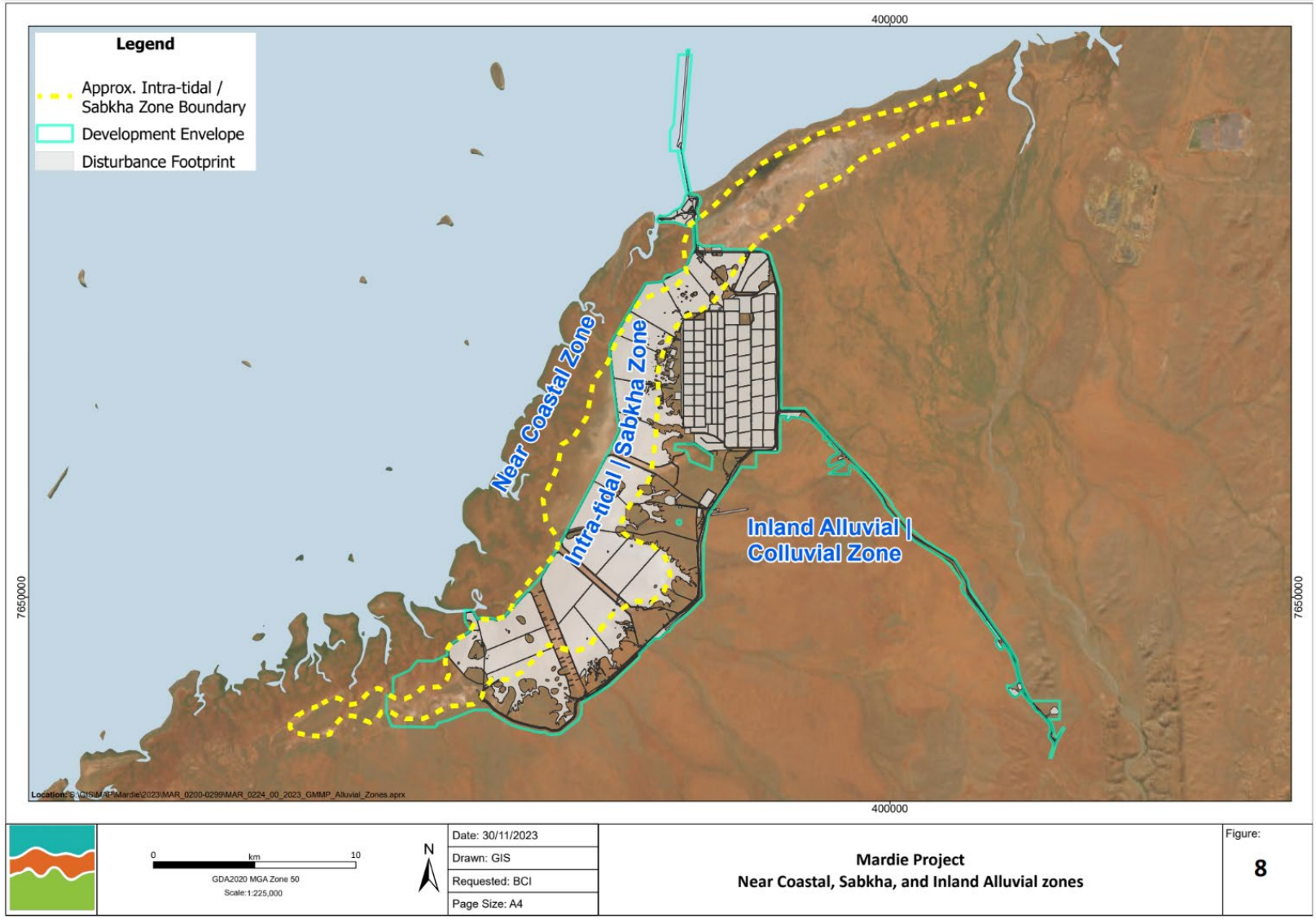


Figure 7 Near-coastal, Sabkha and Inland Alluvial zones



2.8 Groundwater Monitoring Bore Network

BCI has installed a total of 74 groundwater bores across the Development Envelope, specifically for environmental monitoring. The 74 groundwater bores are comprised of:

- 18 terrestrial groundwater bores (all telemetered),
- 56 coastal bores (all telemetered)

A further 16 Gas Pipeline bores have also been historically monitored (see Table 7).

As detailed in the sections below, all of these bores were installed and collecting data between 2022 and current.

Note that two surface water sites within Mardie Pools bores will be monitored manually on a monthly basis.

2.8.1 Terrestrial Groundwater Monitoring Bore Network

Eighteen (18) monitoring bores were installed between 2022 and 2024 to provide data on groundwater characteristics (levels and quality) in the vicinity of Mardie Pool and Mardie Creek, and in areas surrounding the proposed Crystallisers (Figure 8). Baseline data collection commenced from April 2022 across these bores.

Four monitoring bores were installed up hydraulic gradient from Mardie Pool and adjacent to the proposed crystalliser, to serve as an early warning of changes in salinity and water level if hypersaline seepage or mounding from the crystallisers were to occur in future (MP06, MP14 to MP16).

Four bores were installed parallel to Mardie Creek, outside the heritage buffer zone and between Mardie Pool and the Crystallisers ponds (sites MP02 to MP05), to provide data on groundwater flow directions and gradients between the Crystallisers and Mardie Pool.

Three monitoring bores (MP07, MP11-12) were placed up-gradient from the Primary Crystallisers for background monitoring within the Fortescue Alluvial Valley. Three monitoring bores (MP08-10) were installed down gradient from the Secondary and KTMS Crystallisers to detect changes to the groundwater regime due to the crystallisers. An additional bore (MP20) has been installed at the north-east corner of the Crystallisers (Figure 8) in July 2024.

Three bores (MP17-19) were placed along the creek line to the east of Mardie pool to characterise groundwater conditions in the Mardie Creek channel upstream of Mardie Pool. Monitoring bore details, and status of the monitoring and telemetry infrastructure is provided below in Table 4..

Figure 8 Terrestrial Groundwater Monitoring Bore Locations

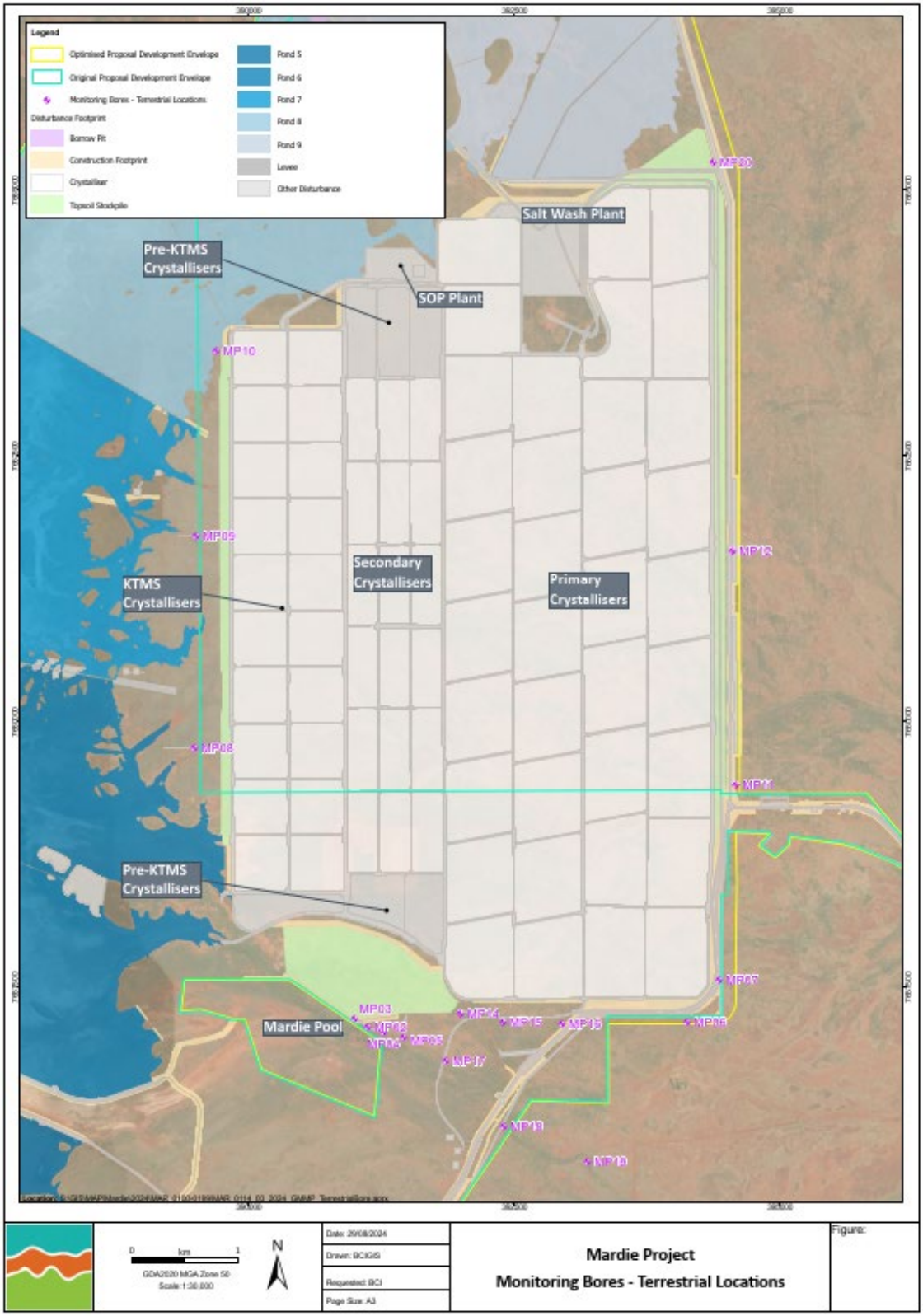


Table 4 Terrestrial Monitoring Network

Location)	Bore ID	Easting (GDA2020, MGA50)	Northing (GDA2020, MGA50)	Design	Purpose	Installation Date	Telemetry Installation Date (begin hourly WL/EC)
Mardie Pool – North Side Outside Channel	MP02	391123	7657129	Fully screened	Second line of detection of seepage from Crystalliser.	4/3/22	21/8/24
	MP03	390990	7657206			5/3/22	5/7/24*
	MP04	391272	7657080			2/3/22	20/8/24
	MP05	391458	7657027			1/3/22	5/7/24*
Primary Crystalliser – Adjacent	MP06	393708	7657166		First line of early detection of seepage from Primary Crystalliser.	10/3/22	23/8/24
Primary Crystalliser – Up Gradient	MP07	394434	7657578		Background monitoring upgradient from Primary Crystalliser.	13/3/22	21/8/24
Secondary/KTMS Crystallisers – Down Gradient	MP08	389493	7659744		Down-gradient monitoring of Secondary Crystalliser.	17/3/22	22/8/24
	MP09	389507	7661739		Down-gradient monitoring of KTMS.	18/3/22	4/7/24
	MP10	389699	7663493			12/2/22	22/8/24
Primary Crystalliser – Up Gradient	MP11	394585	7659412		Background monitoring upgradient from Primary Crystalliser.	16/2/22	21/8/24
	MP12	394558	7661615			14/2/22	5/7/24
	M20	394374.0	7665261.8			26/5/24	30/6/24

Location)	Bore ID	Easting (GDA2020, MGA50)	Northing (GDA2020, MGA50)	Design	Purpose	Installation Date	Telemetry Installation Date (begin hourly WL/EC)
Primary Crystalliser – Adjacent	MP13+	391991	7657709		First line of early detection of seepage from Primary Crystalliser	20/3/22	n/a - decommissioned
	MP14	391996	7657266			22/2/22	5/7/24
	MP15	392396	7657184			24/2/22	4/7/24
	MP16	392950	7657160			26/2/22	21/8/24
Mardie Creek - Upstream	MP17	391860	7656800		Upstream channel monitoring for base flow, adjacent to crystalliser.	28/2/22	4/7/24
	MP18	392404	7656195		Upstream channel monitoring for base flow.	20/3/22	5/7/24
	MP19	393660	7655367			21/3/22	6/7/24

* MP03 and MP05 have hourly WL logger measurements since 6/10/22
+ MP13 has not been included in the total of the 18 terrestrial bores as it is located within the crystalliser footprint and has been decommissioned.

Groundwater salinity in the terrestrial bores to the north and east of Mardie Pool have exhibited relatively consistent salinity (EC) levels since July 2022 (Table 5), coincident with significant rainfall/recharge following a long period of no rainfall. All bores except for those near the tidal flats showed brackish water quality during this time.

Table 5 Terrestrial Monitoring Bore Water Quality Data (lower and upper EC range across water column where available)

Location	EC April 2022 (µS/cm)	EC July 2022 (µS/cm)	EC November 2022 (µS/cm)	EC April 2023 (µS/cm)	EC September 2023 (µS/cm)	EC December 2023 (µS/cm)	EC March 2024 (µS/cm)
MP02	2500	2200	2200	2290-108200	1986-80312	2357-82440	2338–78676
MP03	2800	2100	3300	2760-87360	2555-108159	2626-125371	2384-117712
MP04	1900	4200	2200	3866-27370	2575-5043	2436-2628	2402–2402
MP05	2100	3000	2200	2642-2658	2935-2821	1416-2827	2597–2613
MP06	1400	1400	1500	1600-1594	1812-1665	1663-1781	765-1573
MP07	1400	1400	1400		1669-1585	866-2158	1546-1540
MP08	120000	82000	85000	86310->200000	82907-199073	87288-191222	98049–186864
MP09	160000	82000	93000	87220->200000	84002-181001	87954-148179	39265-189799
MP10	190000	99000	100000	104500->200000	103463-211619	98597-211949	108545-196311
MP11	1100	1100	1200	1303-1244	1272-1282	1382-1288	1210-1206
MP12	1100	1200	1200	1431-1284	1186-1315	1817-1337	1222-1234
MP13+	8600	7700	7800	8202-34700	8212-40728	8948-40336	8246-37094
MP14	1900	1900	2100	2185-2150	2141-2180	2165-2207	2093-2008
MP15	1500	1600	1700	1797-1789	1766-1809	1712-1812	1654-1684
MP16	1500	1500	1500	1500	1652-1836	1685-1850	1545-1711
MP17	3200	2500	2500	2717-2686	2865-2773	2876-2832	2613-2534
MP18	2500	3600	4700	1682-4212	2896-3873	3547-3717	3204-3297
MP19	2600	550	790	1465-1581	1731-1628	2007-1822	1807-1896

Location	EC April 2022 (µS/cm)	EC July 2022 (µS/cm)	EC November 2022 (µS/cm)	EC April 2023 (µS/cm)	EC September 2023 (µS/cm)	EC December 2023 (µS/cm)	EC March 2024 (µS/cm)
MP20							Installed May 2024. EC 3270 *
Mardie Pool West	n/a	890	2800	6536-6299	11766-10865	26571-25780	68301-66112
Mardie Pool East	n/a	1100	2500	6615-2864	13263-12148	35636-35756	76274-75890

+MP13 has not been included in the total of the 18 terrestrial bores as it is located within the crystalliser footprint and has been decommissioned.
*MP20 has single logger point not profiles.

2.8.2 Gas Pipeline Corridor Monitoring Bore Network

Monitoring bores and vibrating wire piezometers (VWPs) located along the Chevron-Santos pipeline corridor between Ponds 1, 2 and 3 and at the western end of the corridor on the seaward side of Ponds 1 and 3 (the "GBH" series of bores) (Table 6, Figure 9) provide more than two years of detailed water level data for this area (with some breaks in continuity).

Figure 10 display hydrographs from bores which were originally installed for monitoring of the gas pipeline corridor. The chart displays the differing response to rainfall and tidal recharge with distance from the coast. This long-term (18 months) dataset was also used to inform the modelling of the Pond 1 Section (refer Section 2.8.4). The data indicate the following (after Golder 2022):

- Groundwater level behaviour is consistent for monitoring sites located within similar geomorphological domains (in general grouped by similar distance from the coast).
- A significant rise of groundwater level is evident following rainfall events, with up to 2m increase for the inland bores (GBH01/04/19) and variation of 0.5 m for those sites at the western end of the pipeline corridor near the western side of Ponds 1 and 3. Inundation during rainfall events is characterised by the recorded bore GWL appearing to be above ground level.
- Bores at the western end of the pipeline corridor are affected by both rainfall events and tides, however the bores are not affected by every Spring Tide period. Response appears to be dependent upon whether inundation occurs at the maximum high tide levels in the cycle.
- Groundwater levels in bores GBH07/08/15 appear to become stable for several weeks in July 2022. Water level in all bores is constantly in flux at all other times. The closest bore to the coast, GBH16, exhibits tidal variations in this period.

Four VWP sites were installed in 2021 in the embankment of and adjacent to a trial pond constructed as part of engineering investigations. The location of the sites is provided in **Table 8** (the "VWP" series). The trial pond has since been incorporated into Pond 5. The data from these VWPs indicates the following:

- Tidal response is similar to GBH16 for VWP01/03/04 which are located within the embankments. These VWPs also show similar response to the major rainfall event of May-June 2022.
- VWP02, on the coastal side of the Pond 5 wall, displays a consistent three-week cycle of 0.1 m range which may be due to instrument-related drift (to be confirmed).

From the gas corridor network, a subset of 6 bore/VWPs has been selected to be representative of conditions on the coastal side of the evaporation ponds and will be used in monitoring under this Plan, with Trigger and Threshold values set. These are:

- S01-A, S02-A – coastal side of Pond 1.
- N01-A, N02-A – coastal side of Pond 3.
- VWP01, VWP02 – coastal side of Pond 5.

Table 6 Gas Pipeline Corridor Monitoring Bore Locations

Bore ID	Easting (GDA2020, MGA50)	Northing (GDA2020, MGA50)	Area Monitored	Baseline Collection Start Date	Telemetry Installation Date	SWL / EC / Telemetry
GBH16	382760	7650682	Pond 3 western corner	February 2022	n/a	Y / N / N
GBH15	383112	7649831	Pipeline Corridor Pond 1/3		n/a	Y / N / N
GBH08	383040	7649412			n/a	Y / N / N
GBH07	383422	7648484			n/a	Y / N / N
GBH04	384257	7646450			n/a	Y / N / N
GBH19	384084	7645939			n/a	Y / N / N
GBH01	384814	7645073			n/a	Y / N / N
N01-A	382834	7651093	Pond 3 western corner	April 2023	13/4/23(WL) 1/5/24(EC)	Y / Y / Y
N02-A	382774	7651011			13/4/23(WL) 21/3/24 (EC)	Y / Y+ / Y
N02-B	382762.4	7651011.1			13/4/23(WL) 21/3/24 (EC)	Y / Y / Y
N03-A	382747	7650901			12/8/23	Y / N / Y
N03-B	382757	7650800			12/8/23	Y / N / Y
N04-A	382742	7650801			12/8/23	Y / N / Y
N04-B	382890	7650340			12/8/23	Y / N / Y
S01-A	382051	7650222	Pond 1 northern corner	April 2023	14/4/23(WL) 21/3/24(EC)	Y / Y / Y
S02-A	382404	7650023			15/4/23(WL, 21/3/24(EC)	Y / Y / Y

Figure 9 Gas Pipeline Corridor Monitoring Bore Locations

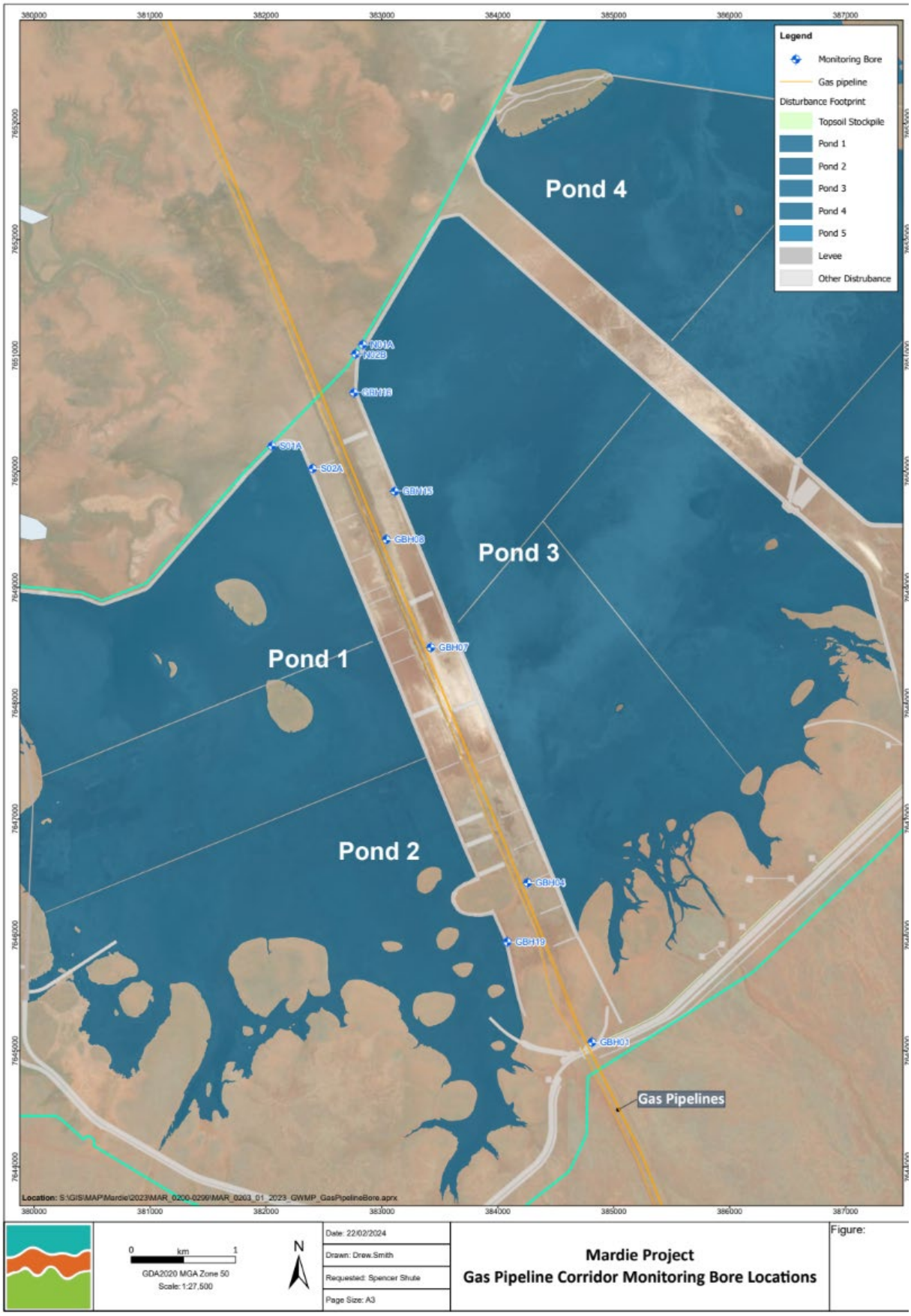
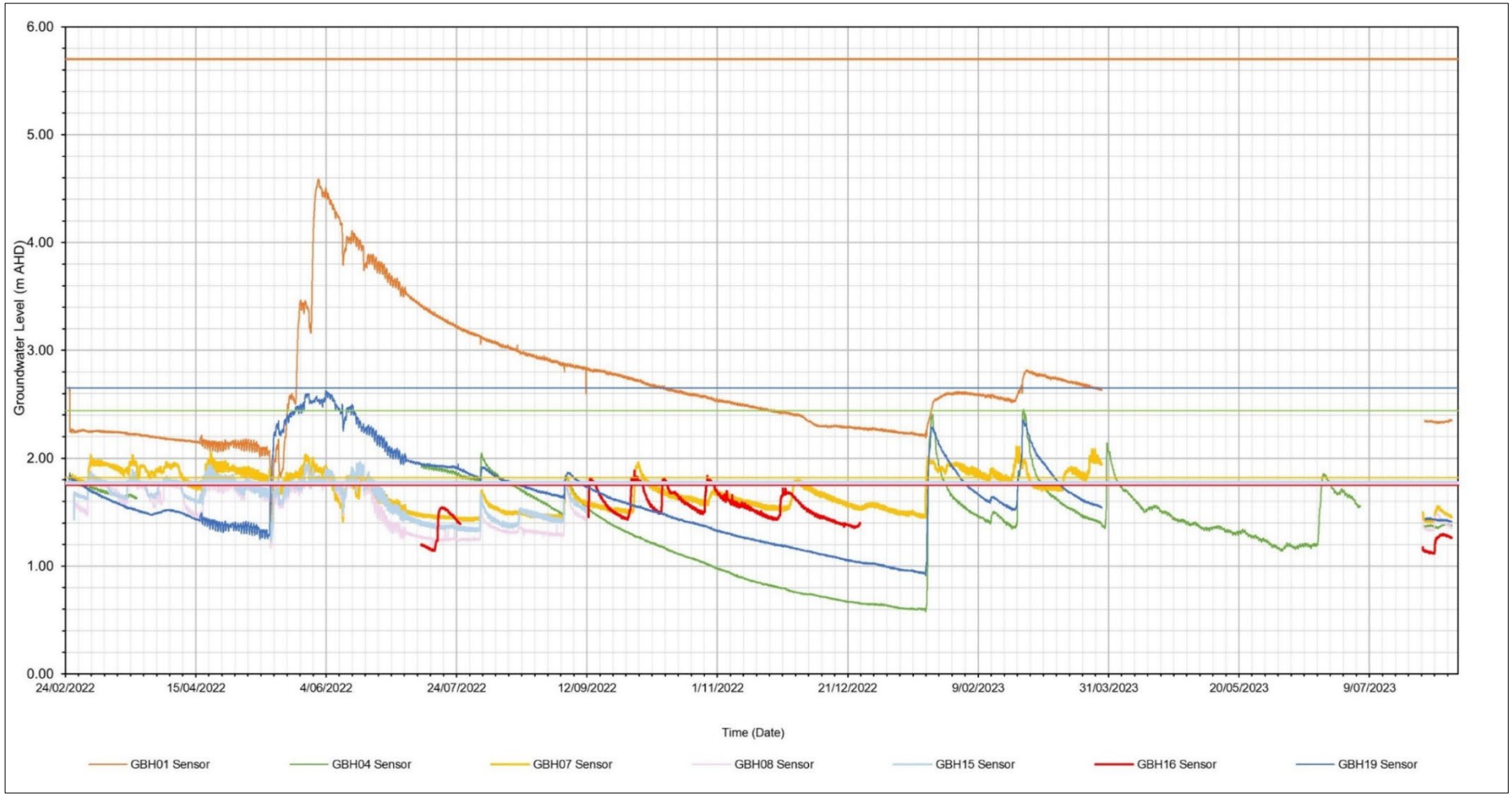


Figure 10 Gas Pipeline Corridor Monitoring Bore Hydrographs (Feb 2022-July 2023)



2.8.3 Coastal Monitoring Bore Network

A total of 58 coastal monitoring bores have been installed along the western side of the evaporation ponds. Transects and single nested bore sites have been positioned to assist with characterisation of the groundwater regime beneath the supratidal flats and to permit detection of changes in levels and gradients (vertical and horizontal), and groundwater changes which may be attributed to surface flow variations at the western boundary of the project. Details and the purpose of each monitoring bore is provided below in **Table 7**. The location of the coastal monitoring bores is shown in Figure 11.

Water level and EC loggers are all in place in all coastal monitoring bores and are recording continuous data. Table 8 describes when permanent telemetry was installed for each bore.

Coastal monitoring bores CMB6_1S, CMB6_1D, S01A and S02A, to the west of Pond 1, are in place and will provide an early warning of any potential impact in the direction of the RRDMMA. Bores RRDMMA_1 and RRDMMA_2 are no longer proposed, as the current evaporation pond footprint design, as updated in 2023, avoids this area.

The coastal monitoring bores (CMB bores) have been installed with short screens and sealed to access the groundwater at discrete depths. Bores were installed as deep/shallow pairs adjacent to each other as follows:

- Shallow bores generally have screens from 0.5 to 2mbgl.
- Deep bores generally have 1.5m – 2m screen at the base of the casing string (which is variably at 7-10mbgl).
- In most cases a bentonite seal was installed from above the screen up to near surface.

Table 7 Coastal Monitoring Bore Network

Location	Bore ID	Easting (GDA2020, MGA50)	Northing (GDA2020, MGA50)	Purpose	Telemetry (WL) Installation Date	Telemetry (EC) Installation Date	SWL / EC / Telemetry*
Coastal	CMB01_1D	383372	7652041	To quantify the magnitude of vertical hydraulic gradients and vertical variations of salinity. Monitor gradients and salinity in the inter-tidal zone between ponds and near the algal mat/ mangrove areas.	16/8/23	20/03/2024	Y / Y / Y
	CMB01_1S	383371	7652040		16/8/23	20/03/2024	Y / Y / Y
	CMB01_2D	383128	7652269		16/8/23	20/03/2024	Y / Y / Y
	CMB01_2S	383129	7652266		16/8/23	20/03/2024	Y / Y / Y
	CMB01_3D	382980	7652508		17/8/23	20/03/2024	Y / Y / Y
	CMB01_3S	382978	7652508		17/8/23	20/03/2024	Y / Y / Y
	CMB02_1D	384936	7654966		16/8/23	20/03/2024	Y / Y / Y
	CMB02_1S	384937	7654967		16/8/23	20/03/2024	Y / Y / Y
	CMB03_1D	386909	7659595		27/10/23	n/a	Y / Y / Y
	CMB03_1S	386816	7659632		6/10/23	n/a	Y / Y / Y
	CMB04_1D	386279	7662680		27/9/23	20/03/2024	Y / Y / Y
	CMB04_1S	386277	7662679		27/9/23	20/03/2024	Y / Y / Y
	CMB04_2D	386097	7662766		28/9/23	20/03/2024	Y / Y / Y
	CMB04_2S	386095	7662768		28/9/23	20/03/2024	Y / Y / Y
	CMB04_3D	385931	7662835		10/10/23	20/03/2024	Y / Y / Y
	CMB04_3S	385933	7662834		8/10/23	20/03/2024	Y / Y / Y

Location	Bore ID	Easting (GDA2020, MGA50)	Northing (GDA2020, MGA50)	Purpose	Telemetry (WL) Installation Date	Telemetry (EC) Installation Date	SWL / EC / Telemetry*
	CMB05_1D	388059	7665542		27/10/23	20/03/2024	Y / Y / Y
	CMB05_1S	388054	7665546		9/10/23	6/05/2024	Y / Y / Y
	CMB05_2D	387975	7665603		10/10/23	5/05/2024	Y / Y / Y
	CMB05_2S	387976	7665601		10/10/23	5/05/2024	Y / Y / Y
	CMB05_3D	387915	7665650		27/10/23	5/05/2024	Y / Y / Y
	CMB05_3S	387917	7665647		10/9/23	5/05/2024	Y / Y / Y
	CMB06_1D	378175	7647383		16/8/23	21/03/2024	Y / Y / Y
	CMB06_1S	378176	7647381		16/8/23	21/03/2024	Y / Y / Y
	CMB07D	384516	7651674		11/05/2024	11/05/2024	Y / Y / Y
	CMB07S	384516	7651674		11/05/2024	11/05/2024	Y / Y / Y
	CMB08D	386569	7649911		10/05/2024	10/05/2024	Y / Y / Y
	CMB08S	386568	7649917		10/05/2024	10/05/2024	Y / Y / Y
	CMB09D	386918	7656926		10/05/2024	10/05/2024	Y / Y / Y
	CMB09S	386918	7656926		10/05/2024	10/05/2024	Y / Y / Y
	CMB10D	388113	7656366		10/05/2024	10/05/2024	Y / Y / Y
	CMB10S	388113	7656366		10/05/2024	10/05/2024	Y / Y / Y
	CMB12_1D	385780	7656579		11/05/2024	11/05/2024	Y / Y / Y
	CMB12_1S	385780	7656579		11/05/2024	11/05/2024	Y / Y / Y
	CMB12_2D	385710	7656612		11/05/2024	11/05/2024	Y / Y / Y
	CMB12_2S	385710	7656612		11/05/2024	11/05/2024	Y / Y / Y
	CMB13_1D	386494	7657965		2/07/2024	2/07/2024	Y / Y / Y
	CMB13_1S	386494	7657965		2/07/2024	2/07/2024	Y / Y / Y
	CMB13_2D	386423	7657997		2/07/2024	2/07/2024	Y / Y / Y
	CMB13_2S	386423	7657997		2/07/2024	2/07/2024	Y / Y / Y
	CMB14_1D	386404	7659938		6/06/2024	6/06/2024	Y / Y / Y
	CMB14_1S	386404	7659938		6/06/2024	6/06/2024	Y / Y / Y
	CMB14_2D	386331	7659955		3/07/2024	3/07/2024	Y / Y / Y
	CMB14_2S	386331	7659955		3/07/2024	3/07/2024	Y / Y / Y
	CMB15_1D	387260	7664375		21/08/2024	21/08/2024	Y / Y / Y
	CMB15_1S	387260	7664375		21/08/2024	21/08/2024	Y / Y / Y
	CMB15_2D	387180	7664416		21/08/2024	21/08/2024	Y / Y / Y
	CMB15_2S	387180	7664416		21/08/2024	21/08/2024	Y / Y / Y
	CMB16_1	391196	7667097		10/05/2024	10/05/2024	Y / Y / Y
	CMB16_2	391209	7667196		6/06/2024	6/06/2024	Y / Y / Y

Location	Bore ID	Easting (GDA2020, MGA50)	Northing (GDA2020, MGA50)	Purpose	Telemetry (WL) Installation Date	Telemetry (EC) Installation Date	SWL / EC / Telemetry*
	N01A	382834	7651093		13/04/2023	1/05/2024	Y / Y / Y
	N02A	382774	7651011		13/04/2023	21/03/2024	Y / Y / Y
	N02B	382774	7651011		13/04/2023	21/03/2024	Y / Y / Y
	S01A	382051	7650222		14/04/2023	21/03/2024	Y / Y / Y
	S02A	382404	7650023		15/04/2023	21/03/2024	Y / Y / Y
	VWP-01	385604	7656160		16/8/23	n/a	Y / N / N
	VWP-02	385611	7656435		16/8/23	n/a	Y / N / N
	VWP-03	385784	7656552		16/8/23	n/a	Y / N / N
	VWP-04	385537	7655654		16/8/23	n/a	Y / N / N
RRDMMA	RRDMMA_1	376108	766310		**Current evaporation pond footprint design avoids this area.**		
	RRDMMA_2	373599	7645025				

* This column describes the installation status of Groundwater level loggers, EC loggers, and Telemetry. As of 26 August 2024, all bores are equipped with WL/EC loggers and telemetry except VWP-0X series which are grouted VWP installations and are equipped with pressure (WL) loggers only.

Water level records indicate the following:

- Similar to GBH16 at the western end of the pipeline corridor, these bores exhibit strong response to spring tides which extend inland to this area. Water level increases 0.2-0.3 m over several days across the Spring tide period, followed by gradual recovery (falling) until the next impinging Spring tide.
- The rainfall event of 18-20 June 2023 (total rainfall 32 mm at Mardie BoM site) produced a rapid water level increase of 0.25-0.35 m. Greater response to rainfall was observed in bores on the northern side of the pipeline, possibly indicating preferential pooling of overland flow.

On the coastal sabkha, recharge is driven by cyclic tidal inundation. Hydrographs in Figure 12 provide examples of monitoring bore response to tidal inundation on the sabkha area between Pond 3 and the nearest mangroves to the west. At these locations deep bores are screened at approximately 8-10m below ground level (bgl) and shallow bores are screened across the water table. Water levels at the bores display a distinct rapid recharge at the time of inundation from high Spring tides. Data indicates that the soil profile is generally fully saturated by the first Spring tide which reaches the bore. The following high tides consequently keep the storage full until tides recede in following days to the point where the bore location is not inundated. From this time until the next inundation the water level in the bore gradually falls, while overprinted with a small tidal pressure pulse. The water level recession between inundation events is due to evaporative discharge.

Figure 11 Coastal Monitoring Bore Locations

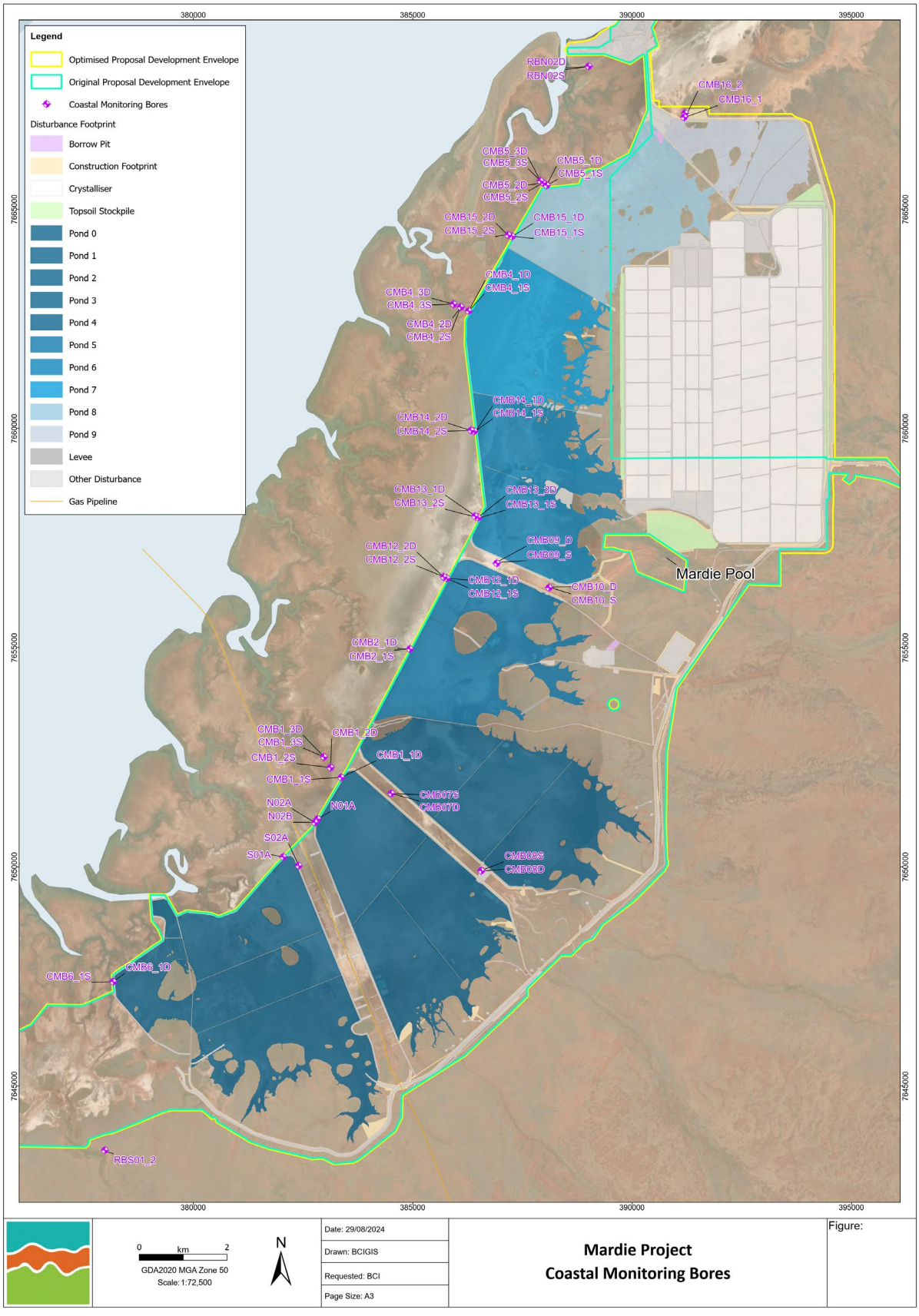
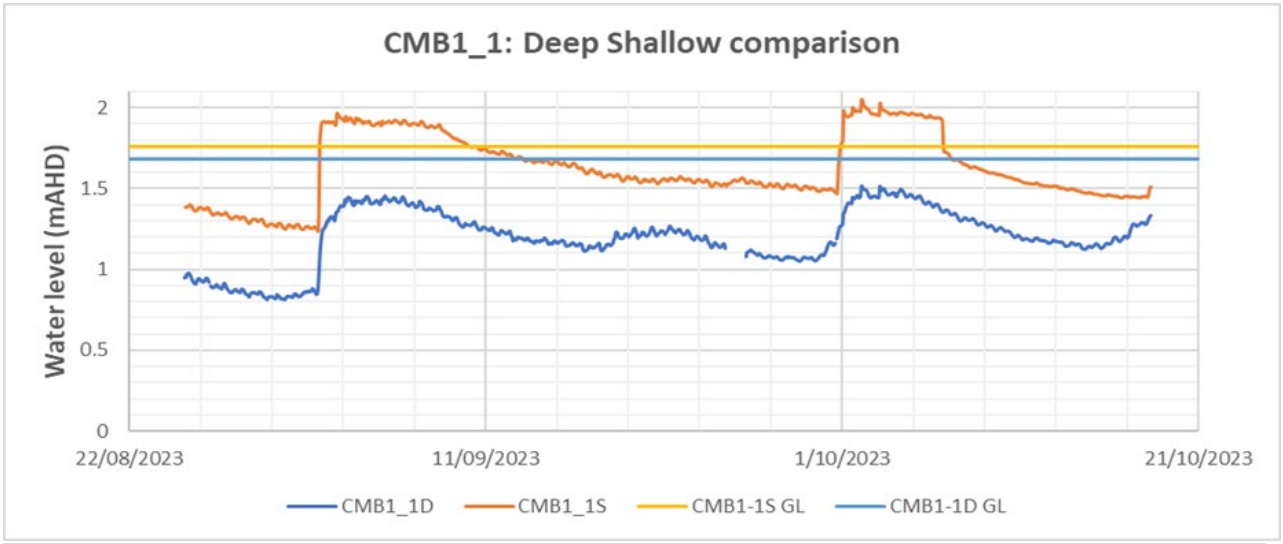
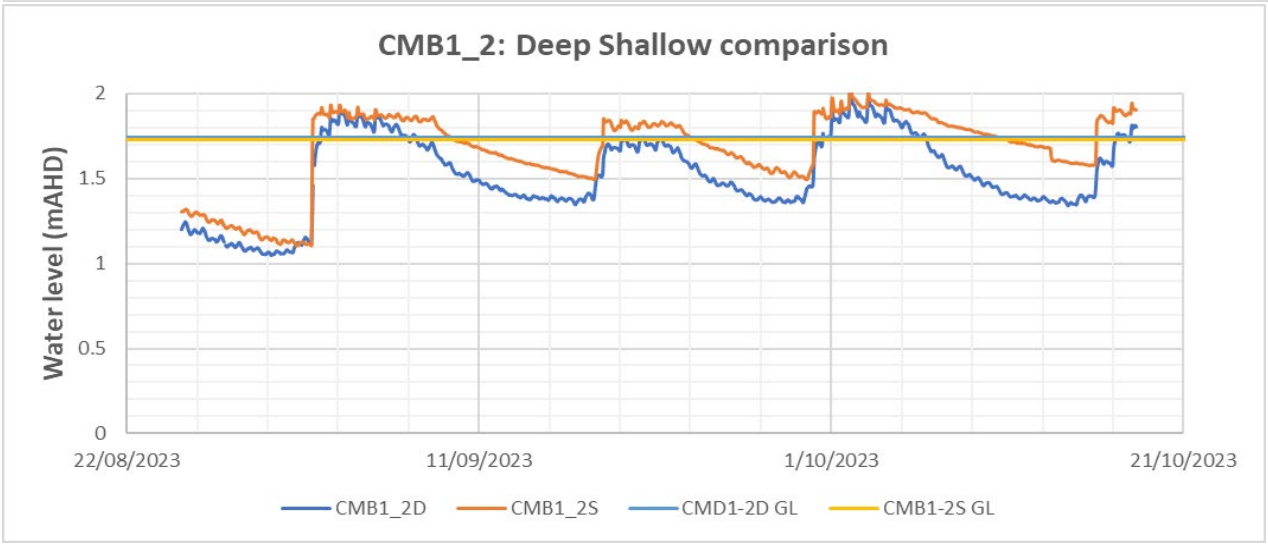
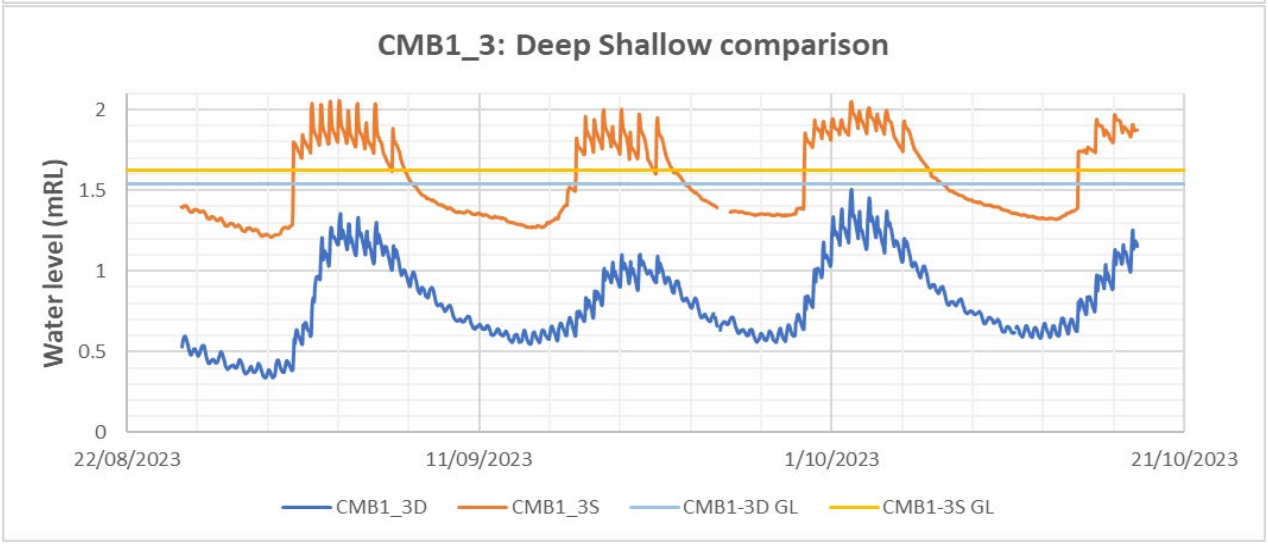


Figure 12 Coastal Monitoring Hydrographs







Hypersaline groundwater was noted across the entire intra-tidal zone and in some deep bores on the upland alluvial plain to the south-east. A selection of deep and shallow bores (2m/~8m pairings) installed on the sabkha in 2023 have consistently displayed the presence of hypersaline water in the EC range 160 000- 220 000 uS/cm (**Table 8**), indicating that the quality of water is similar throughout the soil profile relevant to the receptors in this area (algal mats and mangroves).

One shallow bore adjacent to mangroves and creeks west from Pond 3 (CMB1_3S) presented slightly less hypersaline, likely due to tidal flushing.

Bores adjacent to Pond 1 and a tidal creek at the south end of the project (CMB6_1S/D) presented salinity closer to that of seawater.

Table 8 Coastal Monitoring Bore Network Salinities (at time of installation) (from AQ2 2024)

Bore ID**	Easting GDA2020 MGA50	Northing GDA2020 MGA50	Sample Conductivity (uS/cm)	Calculated TDS* (mg/L)
CMB1_1D	383346	7652050	189000	141000
CMB1_1S	383346	7652050	184000	138000
CMB1_2D	383129	7652268	173000	130000
CMB1_2S	383129	7652268	153000	114000
CMB1_3D	382977	7652509	169000	127000
CMB1_3S	382977	7652509	113000	85000
CMB2_1D	384909	7655003	202000	151000
CMB2_1S	384909	7655003	206000	155000
CMB6_1D	378177	7647380	57000	43000
CMB6_1S	378177	7647380	73000	55000

* assumed conversion factor 0.75, compensated to 25degC at measurement

** D = deep screen 7-10m, S = shallow screen across water table

2.8.4 Impact Modelling Outcomes

Modelling has recently been completed (January 2024 and April 2024) across four transects for the underlying groundwater system with the objective of predicting the water level and salinity impacts of specific scenarios that would generate measurable groundwater level and quality impacts.

Figure 13 shows the location of the model transects. The full modelling report is provided in Appendix A and the Pond 8/9 technical memo in Appendix O.

The model was developed using Modflow USG (Panday et al, 2017) operating under the Groundwater Vistas graphical user interface (ESI, 1996 to 2021). The model uses a 2D approach to simulate the flow and salinity conditions under a range of operating scenario's that simulate the conditions of leakage or groundwater pressure affecting the underlying groundwater resource. This results from this approach then inform the monitoring of groundwater changes with the knowledge that a leakage scenario from the ponds should be observable through groundwater observations.

This transect impact modelling undertaken has indicated that changes to groundwater quality and inundation regime are likely to be associated with worst case 'leaky pond' scenarios (which if observed will be minimised to ensure production efficiencies) and are very localised (within approximately 100m of the pond walls).

Potential environmental impacts resulting from these unlikely and localised changes to groundwater have been mitigated / avoided where appropriate by the design of the pond self sealing halite crust/ algal mat floor; through proactive monitoring, operational practices and by seeking to adjust the position of pond walls to ensure a buffer is in place with sensitive receptors. Additionally, the modelling identifies impacts that are contemplated to be within the approved clearing thresholds approved as part of the original Mardie assessment and OMP projects.

Figure 13 shows the location of the model transects. The full modelling report is provided in Appendix A and the Pond 8/9 technical memo in Appendix O.

The model was developed using Modflow USG (Panday et al, 2017) operating under the Groundwater Vistas graphical user interface (ESI, 1996 to 2021). The model uses a 2D approach to simulate the flow and salinity conditions under a range of operating scenario's that simulate the conditions of leakage or groundwater pressure affecting the underlying groundwater resource. This results from this approach then inform the monitoring of groundwater changes with the knowledge that a leakage scenario from the ponds should be observable through groundwater observations.

Pond 1 Transect

Three model scenarios were tested in the model and compared to a no development scenario:

1. Leakage from Pond 1 at a decreasing rate of seepage from 237 mm/yr initial to 9mm/yr from year 3 onwards
2. Leakage from the Ponds being a function of water stored
3. As per scenario 2 with enhanced leakage

Prior to the construction and development of Pond 1, the area across the entire sabkha along the modelled section, was also subject to tidal inundation during very high tides. This water collected in the sabkha areas and recharged the underlying shallow groundwater. These shallow groundwater levels were in turn then subject to evaporative losses, driving the development of salinity in the sabkha.

These processes are simulated in the model. The model was developed using Modflow USG (Panday et al, 2017) operating under the Groundwater Vistas graphical user interface (ESI, 1996 to 2021). The model uses a 2D approach to simulate the flow and salinity conditions.

The following observations are made regarding the predicted water levels (Figure 18; s5.2, Appendix A):

- Downstream of Pond 1 model predicted water levels respond to tidal inundation / recharge, with a similar water level trend predicted for all scenarios. For Scenarios 1 to 3, higher water levels are predicted between recharge events when compared to the No Development scenario due to the leakage simulated from Pond 1.
- Under Pond 1 the tidal recharge response is no longer predicted. For Scenario 1, which assumes that the pond and underlying groundwater system are de-coupled, water levels are predicted close to ground level (i.e., the aquifer is predicted to be brim full). For Scenarios 2 and 3, the predicted water level reflects the water level simulated in Pond 1.
- Upstream of Pond 1 water levels are predicted to decrease and no longer show the response to tidal recharge / inundation once the pond is constructed. Water levels are predicted to increase by less than 0.1 m over the duration of the prediction but are lower than those predicted for the No Development Scenario.
- The model predicted salinity profiles show limited change over the prediction period, with some small decreases in salinity predicted resulting from the seepage of less saline water into the top of the profile. Over the prediction period a small decrease of salinity (up to 1,000mg/L) is predicted at the observation points immediately downstream of Pond 1.

Analysis of the model predicted water balance suggests that for Scenarios 2 and 3, which simulate the head dependent leakage out of Pond 1, the predicted rate of leakage drops rapidly after the pond is filled. The rate of leakage out of Pond 1 decreases from around 50 kL/d over the length of the modelled section to less than 1 kL/d, over a period of a month (assuming that the pond is at operational level from the start of Scenarios 2 and

3). Additionally, for Scenario 3, there is not a significantly greater amount of leakage predicted from the base of Pond 1.

In summary, these modelling prediction results suggest that the leakage from the base of Pond 1 is limited by the small amount of aquifer storage and aquifer transmissivity in the aquifer units surrounding the Pond.

Nevertheless, BCI is undertaking an update of the Impact Modelling to run an additional scenario for standard operating conditions using the predicted permeability factor for the self-sealing algal mat / halite crust. This additional modelling scenario does not affect the other scenarios completed as they have been used to determine conservative impact scenarios which then inform groundwater monitoring triggers and thresholds.

Development of the algal crust is a biological process dependent on multiple factors, including temperature, salinity and availability of nutrients. The transect modelling completed by AQ2 simulates the minimisation of pond leakage through the development of the algal crust by applying different constants (i.e not dynamically) to describe the permeability of the underlying soils/geology based on the three possible scenarios, i.e.:

1. Leakage from Pond 1 at a decreasing rate of seepage from 237 mm/yr initial to 9mm/yr from Year 3 onwards. These rates were determined from work undertaken early in the project development phase. This scenario assumes there would be seepage from the ponds in Year 1, as there would be no halite crust formed yet, but the seepage would decrease over time (i.e. through tot Year 3) as the halite crust forms. The model assumes a fix parameter for the decrease of seepage over time based on the halite crust formation and the underlying soils / geology.
2. Leakage from the ponds being a function of the water stored. This would be the equivalent of Year 2 of operations with the halite crust formed which would prevent leakage.
3. As per scenario 2, with enhanced leakage, which assumes no halite crust in place during operations.

Mardie Pool

For Mardie Pool, a leakage scenario from the Crystallisers, a component of the OMP, was undertaken due to their upstream proximity, noting that Pond 6 is downstream of the Mardie Pool and the groundwater gradient is relatively flat and towards the coast.

The modelling predicted that water level and salinity impacts on Mardie Pool resulting from short term leakage from the crystallisers are predicted to be so small as to be very unlikely to cause adverse impacts (refer to Figure 20 in Section 5.3 of Appendix A).

Leakage from the crystalliser, in the unlikely event that it occurs, is expected to result in additional discharge of groundwater to Mardie Pool. The nature of Mardie Pool (the area of the upstream surface water catchment relative to the size of Mardie Pool and the maintenance of this catchment during operation of the project) is such that it will likely continue to be flooded and over topped on an annual basis in the future. Any potential leakage from the crystallisers would be managed quickly to prevent loss of production. Water level impacts of any leakage from the crystallisers are therefore predicted to be short-term, and to occur in close proximity to the crystalliser only.

Nevertheless, BCI is undertaking an update of the Impact Modelling to run an additional scenario for standard operating conditions using the predicted permeability factor for the self-sealing algal mat / halite crust. This additional modelling scenario does not affect the other scenarios completed as they have been used to determine conservative impact scenarios which then inform groundwater monitoring triggers and thresholds.

Pond 6 Transect

For Pond 6 the predicted groundwater changes are (Figure 19; App A, s5.4 - noting that this modelling scenario was undertaken to include the OMP):

- Downstream at up to 100m from the Pond walls a potential water level increase of up to 0.5m under the modelled scenarios.

- Limited changes to salinity with a potential decrease of up to 1,000 mg/L downstream of Pond 1 against a background of 100,000 mg/L

The predicted variation in water levels is less than the pre-development simulated water level variation at this location. Predicted salinity increases from the operation of Pond 6 are limited to the immediate area and immediately upstream.

Nevertheless, BCI is undertaking an update of the Impact Modelling to run an additional scenario for standard operating conditions using the predicted permeability factor for the self-sealing algal mat / halite crust. This additional modelling scenario does not affect the other scenarios completed as they have been used to determine conservative impact scenarios which then inform groundwater monitoring triggers and thresholds.

Pond 8 Transect

Transect Impact Modelling has been undertaken for the Pond 8/9 Transect and the technical Memo is provided at Appendix O.

This density dependent two-dimensional section model sits across Ponds 8 and 9 which are components of both the Original and Optimised Mardie Projects. Given the proximity of these Ponds to BCH and the increased salinity of the product held in these ponds a number of modelling scenarios were undertaken to determine potential impacts associated with expected operational performance, as well as the leakage/pressure scenarios used for the other transect impact models.

The Impact scenarios are:

- Scenario A: Pond 8 leakage and Crystalliser leakage as worst case scenario. This is a similar leakage scenario to those run on the other transects.
- Scenario B: Pond 8 leakage and Crystalliser leakage as operational scenario. This is an additional operational scenario.
- Scenario C: Pond 8 leakage with adjustments to the Pond wall and additional halite crust development. This is an operational mitigation scenario and Appendix P shows the realignments to the Pond Walls that will be implemented to increases the buffer from the Develop Envelope / Pond Walls to the Mangrove BCH habitat.

The impact modelling findings are:

- The operational scenarios (B and C) result in significantly lower salinity profiles downstream than the leakage scenario.
- The model results suggests that with a reduced rate of simulate leakage from Pond 8, consistent with the long-term operating strategy of Pond 8, there are limited predicted salinity impacts immediately downstream of Pond 8 (refer to Figures 9 - 12 in Appendix O).

Figure 13 Mardie Project Pond Sections

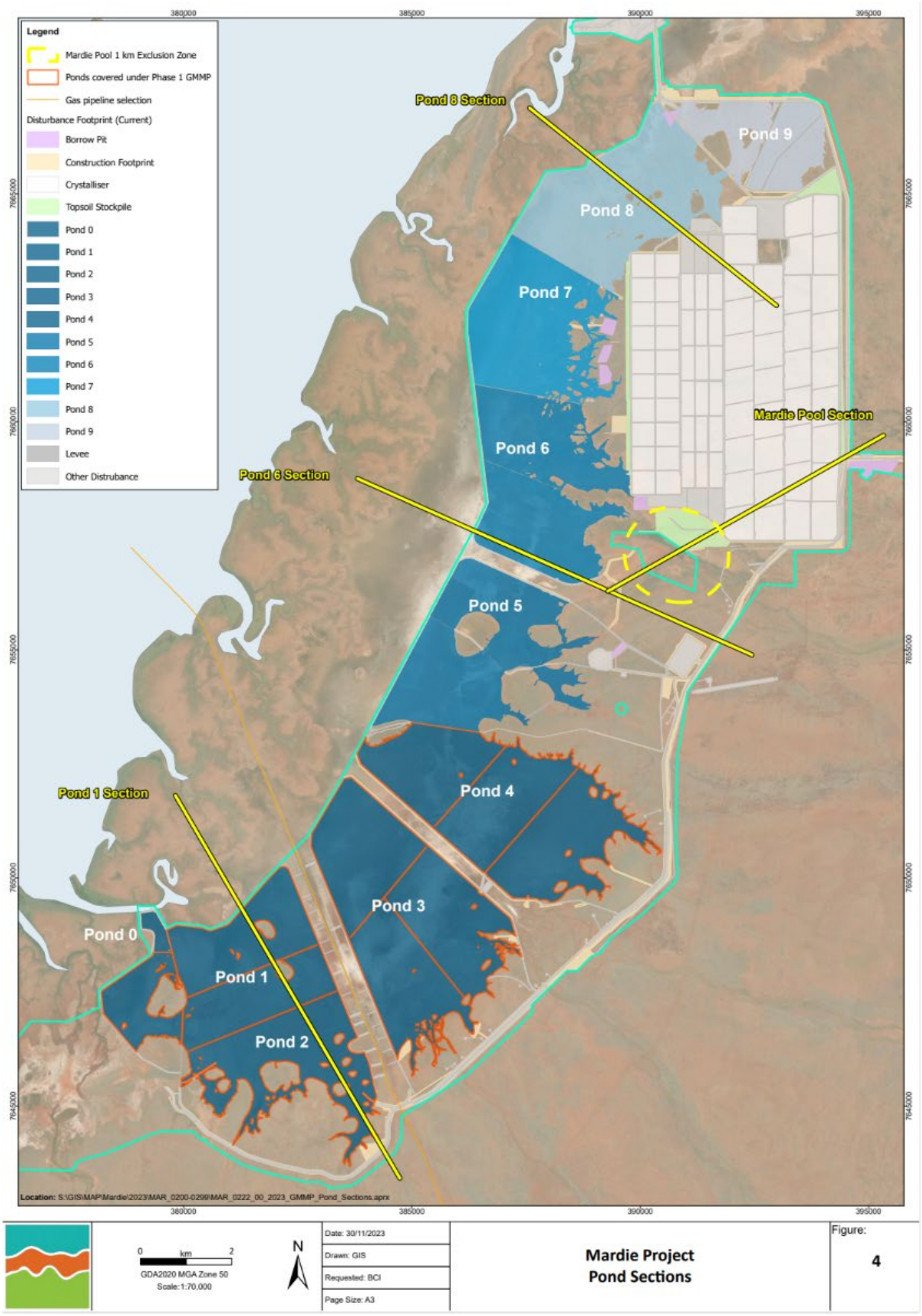


Figure 14 Modelled Impacts to Groundwater and EC – Transect 1

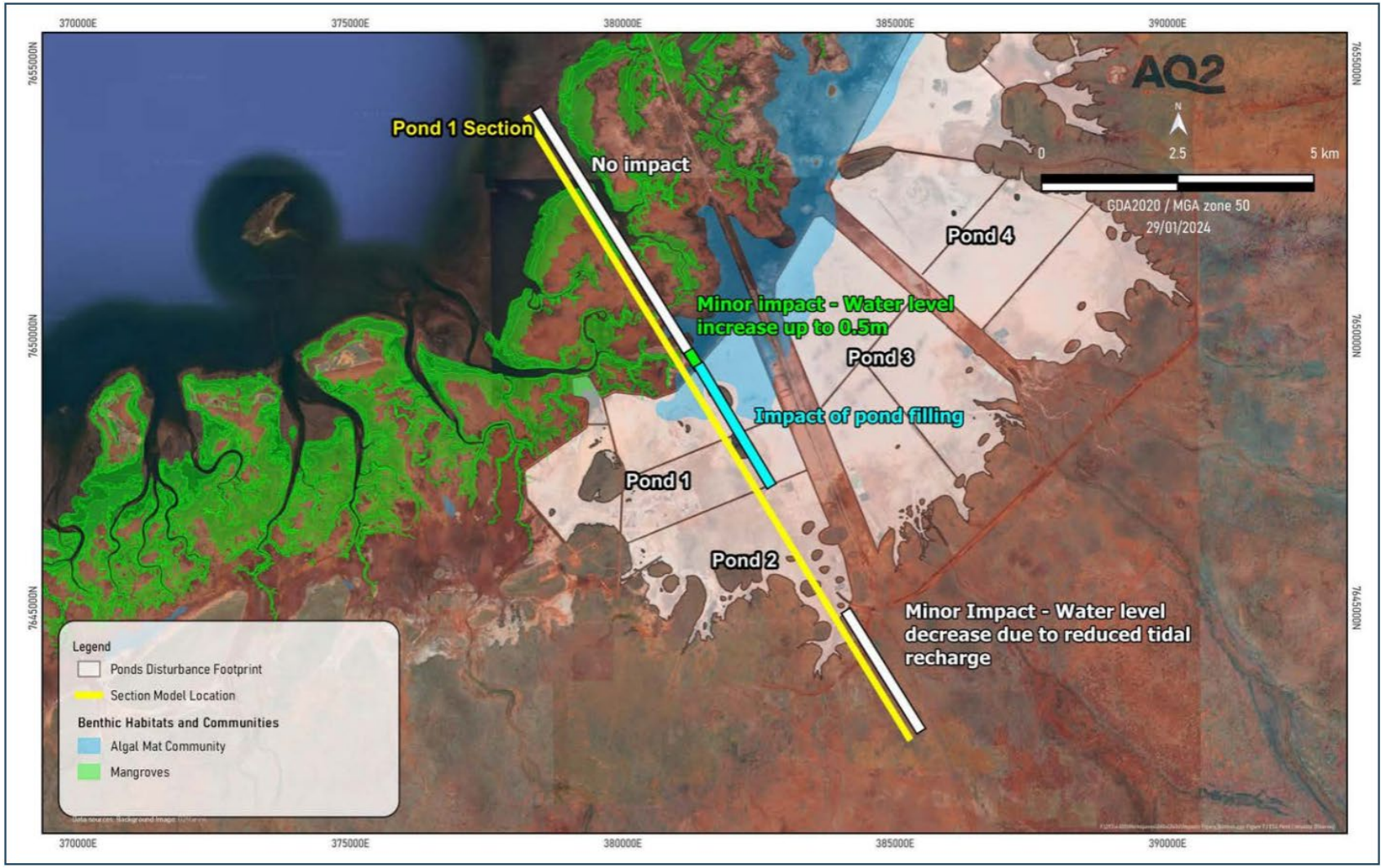


Figure 15 Modelled Impacts to Groundwater and EC – Transect 6

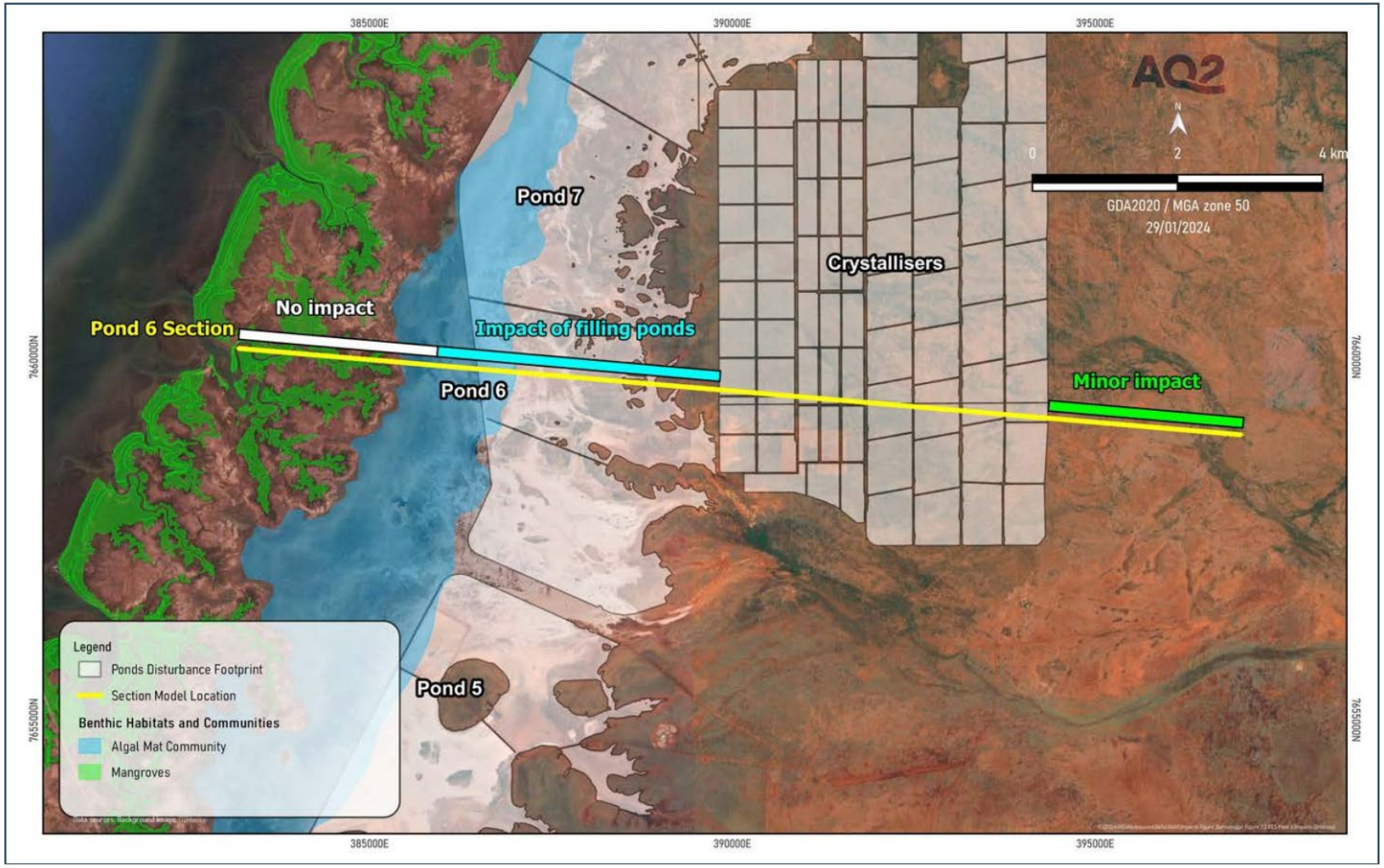
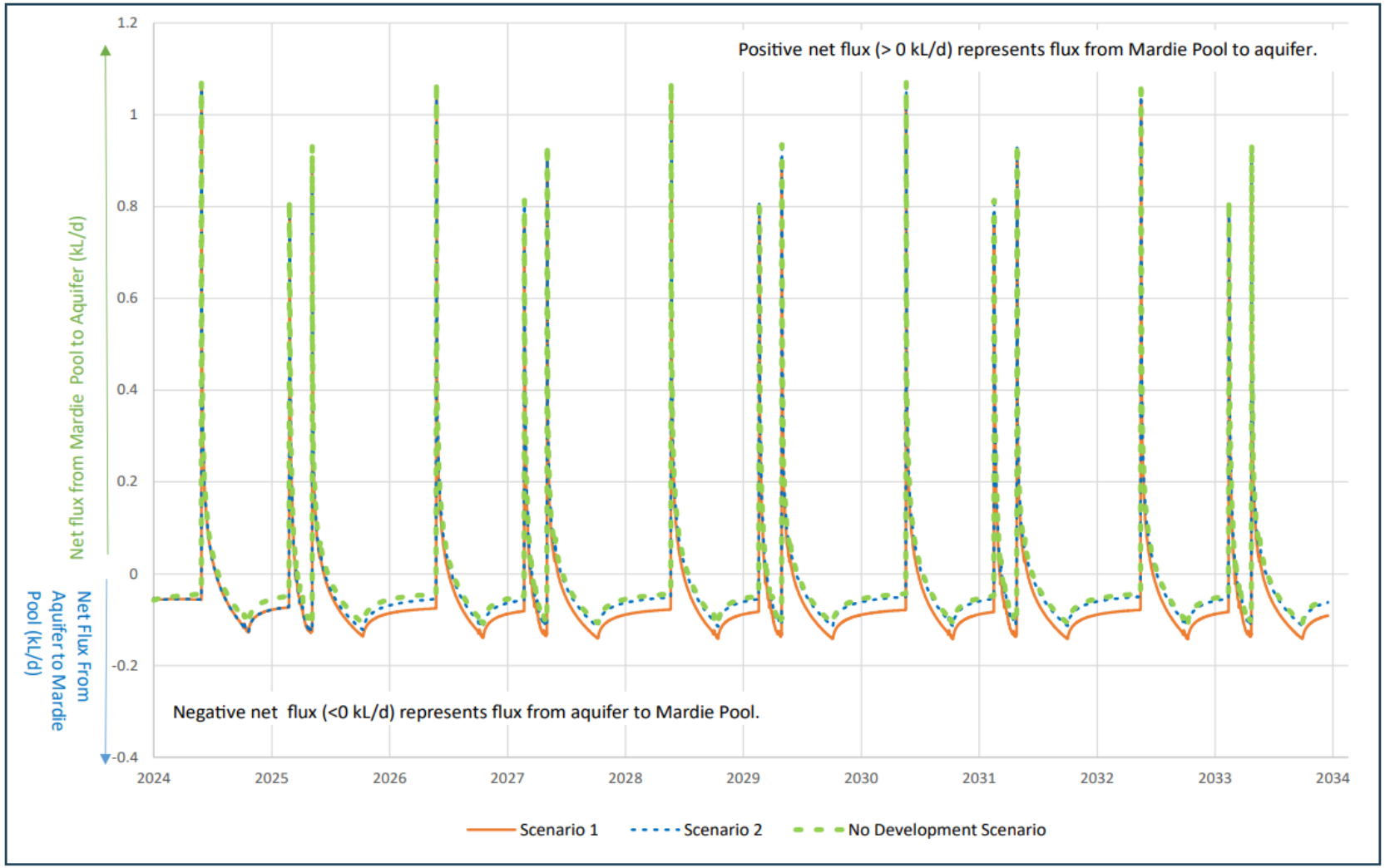


Figure 16 Modelled Impacts to Groundwater and EC – Transect Mardie Pool



2.9 Impacts to Matters of National Environmental Significance (MNES)

With regards to potential groundwater impacts to protected matters, the EPBC Approval 2018/8236 and EPBC 2022/9169 requires the GMMP to inform monitoring and management actions to prevent unapproved impacts to the:

- Mardie Pool (as a potential freshwater source for terrestrial MNES),
- terrestrial, intertidal and subtidal protected matters and habitats (including migratory shorebirds and their habitat).

It is important to note that not all of the MNES considered under EPBC Approval 2018/8236 and EPBC 2022/9169 have the potential to be impacted by any groundwater changes resulting from this project.

The GMMP presents an assessment of potential impacts to MNES and how these will be mitigated and managed with respect to the monitoring and management of groundwater.

2.9.1 Protected Matters

The controlling provisions for the Original Mardie Project were listed threatened species and communities; listed migratory species and the Commonwealth marine area.

The Protected matters for the Original Mardie Project as per the EPBC Approval 2018/8236 are:

- EPBC listed terrestrial fauna species including:
  - Pilbara leaf-nosed bat
  - Pilbara olive python
  - Northern Quoll
- EPBC listed marine fauna species including:
  - Marine turtles
  - Green sawfish
  - The short-nosed sea snake
  - Manta rays
  - Humpback whales
  - Australian humpback dolphin
  - Dugong
- EPBC Act flora species including *Minuria tridens*
- Threatened and Migratory Sea and Shorebirds.

Whilst the EPBC Approval 2018/8236 does not include migratory shorebirds, algal mats and Mardie Pool as protected matters (noted here for relevance to the GMMP), the EPBC Conditions relating to the GMMP (Conditions 3 and 4) (Rev M) require the GMMP to prevent impacts to the Mardie Pool, terrestrial, intertidal and subtidal protected matters and habitats.

The controlling provisions for the Optimised Mardie Project (EPBC 2022/9169) are listed threatened species and communities and listed migratory species.

A number of MNES were identified and assessed as potentially impacted by the Optimised Mardie Project (Preston Consulting, 2022: Section 12.1, p. 272) with potential impacts to the following MNES:

- Pilbara leaf-nosed bat
- Australian Humpback Dolphin
- Humpback Whale
- Dugong

- Hawksbill Turtle
- Green Turtle
- Flatback Turtle
- Loggerhead Turtle
- Green Sawfish
- Threatened and Migratory Sea and Shorebirds
- Minnie Daisy.

Appendix H provides an assessment against the Commonwealth's Significance Impact Guidelines (2014) for potential impacts to the listed threatened species and ecological communities and listed migratory species.

The precise nature of indirect impacts to MNES resulting from impacts to algal mats, in particular, is uncertain. Information collected to date through the migratory shorebird monitoring (Phoenix 2021a,b; 2022a,b; 2023a,b) indicates that the mats are not likely foraging habitat for shorebirds, however it is acknowledged that the role of algal mats in nutrient cycling or as primary producers is not fully understood.

In line with the precautionary approach, and to build understanding of the potential indirect relationship between algal mats and MNES, Mardie Minerals has committed to undertaking targeted research (through the approved Research Offset Plan) and detailed monitoring (through the approved BCHMMP).

For example, as part of the Mardie Marine Research Offset Plan, BCI has engaged Dr Kathryn McMahon from ECU to assess the ecological value and productivity of algal mats. The research will:

- Investigate and obtain quantitative data on carbon and nitrogen cycling within algal mats
- Undertake investigations to determine the carbon and nitrogen flux from the algal mat to estimate total percentage to ecosystem
- Investigate the reliance of detritus feeders on the Mardie algal mats, typically on the seaward edge
- Provide an assessment of the ecological value algal mats provide based upon investigative findings and quantitative data obtained on the primary productivity, nutrient and carbon fixing and flus to support a robust impact assessed from any impacted algal mat communities from the Proposal.

DCCEEW approved the Marine Research Offset Proposal for the OMP on 3 July 2024 and hence results from the above listed research for the algal mats is still pending.

Information collected through this work will be incorporated into future revisions of this GMMP to ensure potential impacts to algal mats are appropriately managed (e.g. through adjustment of controls).

2.9.2 Potential environmental impacts and risks

Conceptual Hydrogeology Modelling and Coastal Transect Modelling was undertaken by AQ2 (refer to Section 2.7.1) in January 2024 as part of hydrogeological investigations to characterise the groundwater regime and flow (AQ2, 2024). The purpose of this modelling was to identify potential impacts within and outside the Development Envelope as required under the EPBC Conditions. Representative transects were used for this impact modelling consistent with the conceptual hydrogeological model with regards to groundwater movement and gradients. The impact modelling was undertaken under a number of potential impact pathway scenarios to inform potential impacts to Mardie Pool, terrestrial, intertidal and subtidal habitats and protected matters as per Condition 4b of the EPBC Approval 2018/8236.

Impact pathways relevant to this GMMP include:

- Potential movement of hypersaline groundwater as a result of hydrostatic pressure of the brine in the ponds; and
- Impacts to groundwater regimes and quality due to saline seepage or leaks from evaporation ponds.

Potential indirect impacts to the protected matters and MNES include alterations to the groundwater regimes and groundwater quality which may impact the health, extent or diversity intertidal BCH (i.e. mangroves, samphire and algal mats), Mardie Pool and the migratory sea and shorebirds that utilise the BCH (refer to Table 12 and Appendix H).

Transect modelling undertaken by AQ2 (see Section 2.8.4) has indicated that changes to groundwater quality and inundation regime are likely to be associated with worst case 'leaky pond' scenarios and are very localised (within approximately 100m of the pond walls). A detailed monitoring and management program has been developed to measure daily groundwater level and quality in real time through the extensive groundwater monitoring bore network (refer to Section 2.8). This is supported by a reporting framework that requires BCI to alert the regulator to exceedances of very conservative triggers (set at 95% confidence intervals of previously observed data, so are within the natural/observed range of groundwater parameters). Importantly, too, these changes are occurring in a highly variable environment where groundwater levels vary daily across a range of 0.6-1.16m, and annually across a range of 1.1-1.6m. The resilience of biota in such an environment is likely to present an intrinsic protection against further impacts resulting from this project.

Impact modelling was undertaken under a number of scenarios in accordance with the conceptual model and is described in Section 2.7.1 and Section 2.8.4.

This GMMP has been designed to ensure indirect impacts associated with changes to groundwater quality and levels are managed to achieve the key environmental outcomes, comply with the EPBC approval conditions and inform the Optimised Mardie Project EPBC approval decision. This GMMP is also linked in its function to the BCHMMP and MSMMP (Section 2.6) such that if unexpected changes to key environmental values resulting from groundwater are observed, appropriate management actions and (in worst case) remediations need to be undertaken in consultation with, and with the approval of, the regulators.

2.9.3 Modelling outcomes

As detailed in Section 2.7.1 and Section 2.8.4, Conceptual Hydrogeology Modelling and Coastal Transect Modelling was undertaken in January 2024 as part of hydrogeological investigations to characterise the groundwater regime and flow (AQ2, 2024). In the intra-tidal zone and beneath the tidal flats, groundwater gradient is essentially flat. This is indicative of negligible lateral groundwater flow across this zone. There appears to be minimal lateral movement of groundwater from the sabkha to the ocean (or from the ocean inland), and negligible lateral movement of groundwater parallel to the coast, due to the very low permeability of the clay strata beneath the flats. It is therefore expected that changes to the groundwater regime due to loading or seepage from ponds will not propagate far from the ponds (either towards or parallel to the coast.

The conceptual hydrogeological model and Pond 1 and 6 Section modelling confirm that given the nature of the sabkha system, with predominantly vertical circulation and low horizontal permeability, minimal horizontal movement of groundwater is expected following the filling of the Ponds 1 to 6.

Impact modelling was undertaken under a number of potential impact pathway scenarios to inform potential impacts to Mardie Pool, terrestrial, intertidal and subtidal habitats and protected matters as per Condition 4b of the EPBC Approval 2018/8236.

The purpose of this modelling was to identify potential impacts within and outside the development envelope as required under the EPBC Conditions. Representative transects were used for this impact modelling consistent with the conceptual hydrogeological model with regards to groundwater movement and gradients.

Pond 1 Impact Pathway

The Pond 1 impact modelling pathway relates to the Algal Mat habitat on the seaward side of the Evaporation Ponds at the southern end of the project, and on the inland side, low to mid hummock grasslands.

The relevant groundwater impact pathways to habitats would arise from either of the following scenarios:

- Potential Movement of Hypersaline Groundwater as a Result of Hydrostatic Pressure of the Brine in the ponds; and
- Impacts to groundwater regimes and quality due to saline seepage or leaks from evaporation ponds.

Both impact pathway scenarios were simulated in the groundwater impact modelling with the predicted groundwater changes under the scenarios noted above being (refer to Section 5.2 in Appendix A,):

- Similar water levels downstream of pond 1 due to tidal inundation and recharge, with a potential increase of up to 0.5m within 5m of the pond walls
- Upstream of pond 1, predicted decrease in groundwater level of up to 0.1m
- Limited changes to salinity with a potential decrease of up to 1,000mg/L downstream of Pond 1 against a background of 100,000 mg/L

With regards to the significance of these groundwater changes, should they occur, the modelling results provide guidance for the trigger and threshold criterion (Section 3.3) that will utilise the Coastal Monitoring Bore network to identify groundwater changes. Any exceedance will trigger an investigation that will then determine if impacts have occurred to these habitats, their significance (including to MNES), and the required actions to rectifying the causal factors and remediate / offset impacts in accordance with the EPBC Conditions.

Mardie Pool Impact Pathway

For Mardie Pool, a leakage scenario from the Crystallisers, a component of the OMP, was undertaken due to their upstream proximity, noting that Pond 6 is downstream of the Mardie Pool and the groundwater gradient is relatively flat and towards the coast.

The groundwater modelling in Sections 2.7.1, and Section 2.8.4 and Appendix A describe the potential impacts to Mardie Pool including salinity impacts.

The Conceptual Model states (AQ2 Report, Appendix A, Section 4.7) that groundwater in the vicinity of the Mardie Pool is saline below the base of Mardie Pool and that whilst Mardie Pool is known to become more saline due to evaporation, the pool is filled with freshwater during flood events.

The Impact Modelling (Section 2.8.4) then examines the project specific impacts that may occur through a number of scenarios and considers existing background salinity levels. Figure 5.28 in Appendix A provides salinity profiles used for modelling.

The Monitoring Program includes Bores that are located between the Crystalliser Ponds and the Mardie Pool and are measuring GW level and Salinity.

The Impact Modelling shows that in a leakage scenario, salinity would be detected at nearby bores MP02 and MP03 allowing for early detection.

The Trigger and Threshold methodology proposed seeks to monitor changes to these parameters. If a trigger is exceeded, an investigation is required. As part of that investigation, there will be consideration of environmental and project related factors.

The modelled ongoing leakage scenario would result in salinity changes at Mardie Pool as shown in Figure 5.33 in Appendix A. The (bottom) water level at Mardie Pool is around 1.82m AHD. Figure 5.33 in Appendix A shows potential salinity increases below 0m AHD, consistent with the density of more saline water in the current aquifer underlying the pool.

Pond 6 Impact Pathway

For Pond 6, the impact modelling pathway relates to Algal Mat habitat on the seaward side of the Evaporation Ponds, and further seaward, samphire mudflats. And on the inland side, shrubland and mixed grasses.

The relevant groundwater impact pathways to habitats would arise from either of the following scenarios:

- Potential Movement of Hypersaline Groundwater as a Result of Hydrostatic Pressure of the Brine in the ponds; and
- Impacts to groundwater regimes and quality due to saline seepage or leaks from evaporation ponds.

Both impact pathway scenarios were simulated in the groundwater impact modelling with the predicted groundwater changes under the scenarios noted above being (refer to Section 5.4 in Appendix A) - noting that this modelling scenario was undertaken to include the OMP crystallisers area also:

- Further downstream at up to 100m a potential water level increase of up to 0.5m
- Under the leakage scenario tested, there is a predicted increase in salinity from 108,000 mg/L to 110,000 mg/L

With regards to the significance of these groundwater changes, should they occur, the modelling results provide guidance for the trigger and threshold criterion (Section 3.3) that will utilise the Coastal Monitoring Bore network, and the Terrestrial monitoring bore network adjacent to the Crystallisers, to identify groundwater changes. Any exceedance will trigger an investigation that will then determine if impacts have occurred to these habitats, their significance (including to MNES), and the required actions to rectifying the causal factors and remediate / offset impacts in accordance with the EPBC Conditions.

Pond 8 Impact Pathway

For Ponds 8 and 9, given the proximity of these Ponds to BCH and the increased salinity of the product held in these ponds a number of modelling scenarios were undertaken to determine potential impacts associated with expected operational performance, as well as the leakage / pressure scenario used for the other transect impact models (refer to Section . 2.8.4and Appendix O). A key consideration under this modelling was permeability factor for the self-sealing algal mat / halite crust as well as consideration being given to the potential to adjust the Pond 8/9 wall alignment away from areas of Mangrove to ensure a 100-150m buffer zone is present.

These additional modelling scenarios do not affect the other scenarios completed as they have been used to determine conservative impact scenarios which then inform groundwater monitoring triggers and thresholds.

The potential impact pathways under the modelling are that:

- At 5m downstream of the pond wall, the operational scenarios (refer to Figure 11 and Figure 12 in Appendix 0) result in that are comparable to the background salinity profiles (Figure 6 in Appendix O).
- At 100m downstream of the pond wall, the operational scenarios result in salinity profiles (refer to Figure 9 and Figure10 in Appendix O) that reach a maximum of around 100,000 mg/L, comparable with background salinity profiles (refer to Figure 6 in Appendix O) albeit at a shallower depth.

The transect modelling shows a potential for upward displacement of the existing saline groundwater (crica 100,000 mg/l) at 100 m downstream of the pond wall with little change between the 5 and 20 year modelled timeframes.

Consistent with the impact modelling scenarios, BCI are adjusting the alignment of Pond 8 and 9 walls to achieve a greater buffer between the development envelope and BCH such as mangrives and tidal creeks in proximity to these ponds. The realignments are provided in Appendix P.

Modelling results are provided in detail in Appendix A and Appendix O and a number of scenarios were tested to simulate either a leakage or groundwater pressure from the Ponds. The model then predicted groundwater level and salinity changes.

As detailed in Section 3 below, groundwater level and salinity have been chosen as the key indicators to measure observed and actual changes to groundwater from leakage or pressure noting that there will be

concurrent monitoring of the structural integrity of the ponds to identify and mitigate and leakage and/or spills.

Thus, the risk of impact to BCH from the presence of the ponds is considered to be low. This risk is further mitigated by the ongoing monitoring of both groundwater (levels and quality), and BCH health (under the BCHMMP) adjacent to the ponds. The breaching of triggers for either of these will trigger investigations and, should a significant impact to BCH be attributable to changes in groundwater,

BCH has committed to undertaking a range of operational actions in response to exceedances. Under normal operating intent, a pond brine demand model will be used for operational control analysis and to calculate a steady-state average brine density for each pond, and this will become the 'target' density. The pond brine demand model will be used to determine how much brine needs to be added the pond system to maintain steady-state during operations. Sampling runs will be conducted to determine the actual pond depths and densities, and a 'Brine Movement Plan' will be developed from the model based on the relationship of each pond, i.e.:

Total flow into pond = Brine Evaporated + Seepage Loss + Brine Transferred to downstream pond + Brine to increase pond depth + Brine to decrease pond density.

The 'Brine Movement Plan' will be reviewed on a weekly basis, and modified if required, subject to climate conditions and operational performances. Each pond will equilibrate to a density that matches its outflow density. BCI Minerals will install three types of flow control devices to vary the brine flow between ponds as the evaporation rate changes with the seasons in order to maintain the brine composition and depth in each pond within the target range, i.e. gate culverts will either be opened or closed, overflow weirs will either be opened or closed, or pumps will be used to pump brine upstream or downstream in the pond system.

One of the management measures to modify the brine density in the ponds also include shandying additional seawater from the primary or secondary seawater intake system, that will dilute the brine or slow down the evaporation process.

In the event that constant modifications to the Brine Movement Plan cannot return a pond to its 'target' brine density, the pond may be emptied BCI Minerals' objective will be to minimise the brine loss from emptying a pond, as the brine is a critical input into salt production *per se*, Discharge of seawater or brine to the environment through emptying a pond may therefore not be the full volume of the pond, but will be controlled to be within a set volume to enable faster recovery of the pond to operational status.

It should be noted that prior to the proposed emptying of a pond and discharge of seawater or brine to the environment, BCI Minerals will conduct an internal investigation into the possible implementation options considered and the proposed mitigation actions to proposed be implemented; BCI Minerals will provide the proposed plan to State and Commonwealth agencies for review and approval prior to emptying of the pond.

2.9.4 Risk Assessment

The risk assessment provided in Table 12 is a subset of the Project Environmental Risk Register which is maintained and regularly updated as part of the Mardie Minerals Environmental Management System. The scope of the risk assessment is based on the most recent Conceptual and Impact Hydrogeological Modelling (Appendix A) and details risks associated with changes to groundwater regimes and groundwater quality.

This Risk Assessment should be considered in conjunction with the BCHMMP risk assessment as the two plans are connected where changes are observed to groundwater and BCH condition and investigation determines that the changes are project related (see Section 3.1.4).

Risk Criteria

Each environmental risk is given a rating in terms of likelihood and consequence using the criteria in Table 9 and Table 10.

Table 9 Risk criteria matrix: Likelihood of impact occurring

Qualitative measure of likelihood (how likely is it that this event/issue will occur after control strategies have been put in place)	
Highly likely	Is expected to occur in most circumstances
Likely	Will probably occur during the life of the project
Possible	Might occur during the life of the project
Unlikely	Could occur but considered unlikely or doubtful
Rare	May occur in exceptional circumstances

Table 10 Risk Criteria matrix: Consequence of impact

Qualitative measure of consequences (what will be the consequence/result if this issue does occur rating)	
Minor	Minor incident of environmental damage that can be reversed
Moderate	Isolated but substantial instances of environmental damage that could be reversed with intensive efforts
High	Substantial instances of environmental damage that could be reversed with intensive efforts
Major	Major loss of environmental amenity and real danger of continuing
Critical	Severe widespread loss of environmental amenity and irrecoverable environmental damage

A risk score is assigned to inherent and treated risk pathways identified with the project activities. The risk score is assigned using the risk matrix (Table 11) to generate a risk rating of low, medium, high or severe. In general, risk scores can be reduced by implementing a treatment that will reduce the likelihood of the impact from occurring. If a risk is eliminated or substituted, then the consequence can be reduced, reducing the risk score.

Table 11 Risk criteria matrix: Risk levels

	Consequence				
	Minor	Moderate	High	Major	Critical
Highly Likely	Medium	High	High	Severe	Severe
Likely	Low	Medium	High	High	Severe
Possible	Low	Medium	Medium	High	Severe
Unlikely	Low	Low	Medium	High	High

Rare	Low	Low	Low	Medium	High

The risk assessment relies on the comprehensive description of Project activities, so that associated risks and potential impacts can be identified. The aspects and activities of the Project are fully listed in the Project Environmental and Heritage Risk Assessment. Only hazards that result in impacts to groundwater are discussed. The risk assessment is outlined in Table 12.

Table 12 Risk Assessment

Factors for the Original and Optimised Project– MNES of relevance to groundwater matters	Environmental Risk	Possible Risk Pathway	Potential Impact on MNES	Risk Rating			Control / Management Measures to reduce the likelihood of the risk (Mitigation measures that will be implemented to address the risk or uncertainty)	Residual Risk Rating following implementation of Control / Management		
				Likelihood	Conseq.	Risk Rating		Likelihood	Conseq.	Risk Rating
Benthic communities and habitats (BCH) which includes: mangrove; algal mat and samphire communities	Change to groundwater level and quality	Seepage from ponds and/or crystalliser A spill and/or leak of brine from the ponds/crystalliser or pipelines	Increased groundwater levels and/or changes to the quality of the existing groundwater may have an indirect impact to the health of the BCH resulting in: Loss of BCH (i.e. BCH unable to tolerate the change and BCH die) Loss of BCH contribution to the nutrient cycle (i.e. decline in the health of the BCH resulting in a reduction of their contribution to the nutrient cycle) Loss of BCH resulting in a reduction to the foraging habitat for migratory shorebirds	Possible	High	Medium	Control / Management to address possible risk of seepage from ponds and/or crystalliser: The design of the project has been amended to move the crystalliser ponds (which will be lined) further away from Mardie Pool (from ~250m to ~1km northwards) to prevent any potential indirect impact from seepage. Updated modelling at the completion of filling Pond 1 – Pond 3, with real-time monitoring date to validate the potential risks impacts to groundwater levels and quality. Ongoing daily monitoring of groundwater levels and quality (salinity) will be conducted so the model can be verified. Weekly visual inspections of Pond condition and any leakage, and the follow up of evidence through internal investigations (noting these are not trigger or threshold exceedance events) Weekly visual inspections and observations of adjacent habitat areas to the Evaporation Ponds such as Algal Mats (noting these are not trigger or threshold exceedance events) Daily site inspections of water infrastructure – pumps, roads, flow equipment. Control pumps for seawater controlled by the Digital Control Centre via telemetry Weekly pond testing of brine density as a control of evaporation versus losses Operational pond modelling to calculate steady state brine densities and pond depths with weekly review frequencies. Ongoing BCHMMP monitoring and if required, implementation of the reactive monitoring as outline in Section 3.1.3.3. of the BCHMMP. Ongoing monitoring and if required, implementation of reactive monitoring as outlined in Section 2.2.6 of the MSMMP. Continue with routine monitoring of exceedance/s of the threshold criterion Implement any additional measures to minimise/prevent unauthorised harm to Protected Matters Continue with routine monitoring of Protected Matters in accordance with EPBC 2022/9169 and MS 1211 Outline management options to avoid future exceedances. Control / Management to address possible risk of spill or leak of brine from ponds and/or crystalliser o pipelines: Pipelines will utilise industry-standard materials to minimise the chance of leaks, and mitigation will be implemented to reduce this risk further. Ponds have been designed with adequate freeboard and overflow features to minimise the risk of unplanned overflows and wall breaches. Ongoing daily monitoring of groundwater levels and quality (salinity) will be conducted so the model can be verified.	Unlikely	Moderate	Low

Factors for the Original and Optimised Project– MNES of relevance to groundwater matters	Environmental Risk	Possible Risk Pathway	Potential Impact on MNES	Risk Rating			Control / Management Measures to reduce the likelihood of the risk (Mitigation measures that will be implemented to address the risk or uncertainty)	Residual Risk Rating following implementation of Control / Management		
				Likelihood	Conseq.	Risk Rating		Likelihood	Conseq.	Risk Rating
							Weekly visual inspections of Pond condition and any leakage, and the follow up of evidence through internal investigations (noting these are not trigger or threshold exceedance events) Weekly visual inspections and observations of adjacent habitat areas to the Evaporation Ponds such as Algal Mats (noting these are not trigger or threshold exceedance events) Daily site inspections of water infrastructure – pumps, roads, flow equipment. Control pumps for sweater controlled by the Digital Control Centre via telemetry Ongoing pumping and water management infrastructure maintenance programs Weekly pond testing of brine density as a control of evaporation versus losses Operational pond modelling to calculate steady state brine densities and pond depths with weekly review frequencies. Continue with routine monitoring of exceedance/s of the threshold criterion. Implement any additional measures to minimise/prevent unauthorised harm to Protected Matters Continue with routine monitoring of Protected Matters in accordance with EPBC 2022/9169 and MS 1211 Outline management options to avoid future exceedances. Ongoing monitoring and if required, implementation of reactive monitoring as outlined in Section 2.2.6 of the MSMMP. Continue with routine monitoring of exceedance/s of the threshold criterion.			
Benthic communities and habitats (BCH) which includes: mangrove; algal mat and samphire communities	Change to groundwater levels and quality	Release of concentrated water/brine into the environment as a potential remediation response to an exceedance of trigger thresholds Note: If BCI were to take this action, the concentrated water/brine would only be released into the Marine Environment and will not be disposed of to the terrestrial environment. Therefore, BCI has not considered the potential risk against the terrestrial MNES of relevance to groundwater matters in this table.	Increased groundwater levels and/or changes to the quality of the existing groundwater may have an indirect impact to the health of the BCH resulting in: Loss of BCH (i.e. BCH unable to tolerate the change and BCH die) Loss of BCH contribution to the nutrient cycle (i.e. decline in the health of the BCH resulting in a reduction of their contribution to the nutrient cycle) Loss of BCH resulting in a reduction to the foraging habitat for migratory shorebirds	Possible	High	Medium	Control / Management to address possible risk of releasing concentrated water/brine into the environment as a potential remediation response to an exceedance of trigger thresholds: Bespoke risk assessment and review of potential impact to MNES in consultation with the regulators, prior to the release of any concentrated water/brine. Shut off water flows into pond/s if leaks are detected, or adjust the brine flows between ponds (using pumps, gates and weirs) Increase the appropriate freeboard of the pond and adjust pond operating level Install cut-off bores, sumps and/or trenches and pump the water to the appropriate salinity pond Rectify breaches in pond walls to be structurally stable, fix containment systems and leaks in internal drainage structures Review the steady-state average brine density for each pond, and modify the 'Brine Movement Plan' Dilute the brine or slow down the evaporation process by pumping additional seawater (i.e. shandying) from the primary or secondary seawater intake system Continue with routine monitoring of exceedance/s of the threshold criterion Implement any additional measures to minimise/prevent unauthorised harm to Protected Matters	Unlikely	Moderate	Low

Factors for the Original and Optimised Project– MNES of relevance to groundwater matters	Environmental Risk	Possible Risk Pathway	Potential Impact on MNES	Risk Rating			Control / Management Measures to reduce the likelihood of the risk (Mitigation measures that will be implemented to address the risk or uncertainty)	Residual Risk Rating following implementation of Control / Management		
				Likelihood	Conseq.	Risk Rating		Likelihood	Conseq.	Risk Rating
							Continue with routine monitoring of Protected Matters in accordance with EPBC 2022/9169 and MS 1211 Outline management options to avoid future exceedances. Ongoing BCHMMP monitoring and if required, implementation of the reactive monitoring as outline in Section 3.1.3.3. of the BCHMMP. Ongoing monitoring and if required, implementation of reactive monitoring as outlined in Section 2.2.6 of the MSMMP Implementation of monitoring as required under the Marine Environmental Quality Monitoring and Management Plan (MEQMMP) and if required, implement reactive monitoring/management in the event that environmental quality objectives are determined to be at risk			
Benthic communities and habitats (BCH) which includes: mangrove; algal mat and samphire communities	Decline in soil or groundwater quality leads to contaminated site.	Inefficiency of oil water separators leads to discharge of hydrocarbon contaminated water and seepage into groundwater	Increased groundwater levels and/or changes to the quality of the existing groundwater may have an indirect impact to the health of the BCH resulting in: Loss of BCH (i.e. BCH unable to tolerate the change and BCH die) Loss of BCH contribution to the nutrient cycle (i.e. decline in the health of the BCH resulting in a reduction of their contribution to the nutrient cycle) Loss of BCH resulting in a reduction to the foraging habitat for migratory shorebirds	Possible	Moderate	Medium	Control / Management to address possible risk of a decline in soil and groundwater quality due to operational inefficiencies of oily water separators: Discharge of treated wastewater to be regulated under Part V of the Environmental Protection Act. Adherence to the monitoring and reporting regime for the operation as regulated under the EP Act Part V approval. Contamination regulated under Part V of the Environmental Protection Act. and the Contaminated Sites Act if not remediated. Ongoing daily monitoring of groundwater levels and quality. Daily site inspections of water infrastructure and equipment. Spill kits located at key areas; All spills controlled, contained and cleaned up; Hydrocarbons and chemicals stored within suitably bunded areas; Spill kits regularly checked and replenished, if required. All hydrocarbons and chemical spills recorded. Continue with routine monitoring of exceedance/s of the threshold criterion. Implement any additional measures to minimise/prevent unauthorised harm to Protected Matters Continue with routine monitoring of Protected Matters in accordance with EPBC 2022/9169 and MS 1211 Outline management options to avoid future exceedances	Unlikely	Moderate	Low
Mardie Pool as a source of freshwater to MNES (i.e. Pilbara Leaf-nosed Bat and Pilbara Olive Python)	Change to groundwater levels and quality	Seepage from ponds and/or crystalliser A spill or leak of brine from the ponds/crystalliser or pipelines	Changes to the groundwater level and quality of the existing groundwater at Mardie Pool, may result in and alteration to the foraging behaviors of MNES due to a: Decline in the health and/or loss of native vegetation (i.e. foraging habitat to MNES) Reduced presence of MNES if Mardie Pool is no longer a potential source of freshwater.	Possible	High	Medium	Control / Management to address possible risk of seepage from ponds and/or crystalliser: The design of the project has been amended to move the crystalliser ponds (which will be lined) further away from Mardie Pool (from ~250m to ~1km northwards) to prevent any potential indirect impact from seepage. Updated modelling at the completion of filling Pond 1 – Pond 3, with real-time monitoring date to validate the potential risks impacts to groundwater levels and quality. Ongoing daily monitoring of groundwater levels and quality (salinity) will be conducted so the model can be verified. Weekly visual inspections of Pond condition and any leakage, and the follow up of evidence through internal investigations (noting these are not trigger or threshold exceedance events)	Unlikely	Moderate	Low

Factors for the Original and Optimised Project– MNES of relevance to groundwater matters	Environmental Risk	Possible Risk Pathway	Potential Impact on MNES	Risk Rating			Control / Management Measures to reduce the likelihood of the risk (Mitigation measures that will be implemented to address the risk or uncertainty)	Residual Risk Rating following implementation of Control / Management		
				Likelihood	Conseq.	Risk Rating		Likelihood	Conseq.	Risk Rating
							Weekly visual inspections and observations of adjacent habitat areas to the Evaporation Ponds such as Algal Mats (noting these are not trigger or threshold exceedance events) Daily site inspections of water infrastructure – pumps, roads, flow equipment. Control pumps for seawater controlled by the Digital Control Centre via telemetry Weekly pond testing of brine density as a control of evaporation versus losses Operational pond modelling to calculate steady state brine densities and pond depths with weekly review frequencies. Continue with routine monitoring of Protected Matters in accordance with EPBC 2022/9169 and MS 1211. Control / Management to address possible risk of spill or leak of brine from ponds and/or crystalliser o pipelines: Pipelines will utilise industry-standard materials to minimise the chance of leaks, and mitigation will be implemented to reduce this risk further. Ponds have been designed with adequate freeboard and overflow features to minimise the risk of unplanned overflows and wall breaches. Ongoing daily monitoring of groundwater levels and quality (salinity) will be conducted so the model can be verified. Weekly visual inspections of Pond condition and any leakage, and the follow up of evidence through internal investigations (noting these are not trigger or threshold exceedance events) Weekly visual inspections and observations of adjacent habitat areas to the Evaporation Ponds such as Algal Mats (noting these are not trigger or threshold exceedance events) Daily site inspections of water infrastructure – pumps, roads, flow equipment. Control pumps for sweater controlled by the Digital Control Centre via telemetry Ongoing pumping and water management infrastructure maintenance programs Weekly pond testing of brine density as a control of evaporation versus losses Operational pond modelling to calculate steady state brine densities and pond depths with weekly review frequencies. Continue with routine monitoring of Protected Matters in accordance with EPBC 2022/9169 and MS 1211			
Mardie Pool as a source of freshwater to MNES (i.e. Pilbara Leaf-nosed Bat and Pilbara Olive Python)	Changes to groundwater level and quality	Groundwater drawdown from operations of the bore required to supply water to the camp facilities.	Changes to the groundwater level and quality of the existing groundwater at Mardie Pool, may result in and alteration to the foraging behaviors of MNES due to a: Decline in the health and/or loss of native vegetation (i.e. foraging habitat to MNES)	Possible	Moderate	Medium	Control / Management to address possible risk of changes to groundwater levels and quality from drawdown from operational bores to supply water to camp facilities: Construction and operation of the water source bore(s) in accordance with the granted 5C licence granted under the RIWI Act. Ongoing daily monitoring of groundwater levels and quality (salinity). Daily site inspections of water infrastructure – pumps, roads, flow equipment.	Unlikely	Moderate	Low

Factors for the Original and Optimised Project– MNES of relevance to groundwater matters	Environmental Risk	Possible Risk Pathway	Potential Impact on MNES	Risk Rating			Control / Management Measures to reduce the likelihood of the risk (Mitigation measures that will be implemented to address the risk or uncertainty)	Residual Risk Rating following implementation of Control / Management		
				Likelihood	Conseq.	Risk Rating		Likelihood	Conseq.	Risk Rating
			Reduced presence of MNES if Mardie Pool is no longer a potential source of freshwater.				Continue with routine monitoring of exceedance/s of the threshold criterion. Implement any additional measures to minimise/prevent unauthorised harm to Protected Matters Continue with routine monitoring of Protected Matters in accordance with EPBC 2022/9169 and MS 1211 Outline management options to avoid future exceedances.			
Mardie Pool as a source of freshwater to MNES (i.e. Pilbara Leaf-nosed Bat and Pilbara Olive Python)	Decline in soil or groundwater quality leads to contaminated site.	Inefficiency of wastewater treatment plant (WWTP) to discharge contaminated water and seepage into groundwater	Changes to the groundwater level and quality of the existing groundwater at Mardie Pool, may result in and alteration to the foraging behaviors of MNES due to a: Decline in the health and/or loss of native vegetation (i.e. foraging habitat to MNES) Reduced presence of MNES if Mardie Pool is no longer a potential source of freshwater.	Possible	High	Medium	Control / Management to address possible risk of a decline in soil and groundwater quality due to operational inefficiencies of wastewater treatment plant: Discharge of treated wastewater to be regulated under Part V of the Environmental Protection Act. Adherence to the monitoring and reporting regime for the operation of the WWTP as regulated under the EP Act Part V approval. Contamination regulated under Part V of the Environmental Protection Act. and the Contaminated Sites Act if not remediated. Ongoing daily monitoring of groundwater levels and quality. Daily site inspections of water infrastructure and equipment. Continue with routine monitoring of exceedance/s of the threshold criterion. Implement any additional measures to minimise/prevent unauthorised harm to Protected Matters Continue with routine monitoring of Protected Matters in accordance with EPBC 2022/9169 and MS 1211 Outline management options to avoid future exceedances.	Unlikely	Moderate	Low
Mardie Pool as a source of freshwater to MNES (i.e. Pilbara Leaf-nosed Bat and Pilbara Olive Python)	Decline in soil or groundwater quality leads to contaminated site.	Inefficiency of oil water separators leads to discharge of hydrocarbon contaminated water and seepage into groundwater	Changes to the groundwater level and quality of the existing groundwater at Mardie Pool, may result in and alteration to the foraging behaviors of MNES due to a: Decline in the health and/or loss of native vegetation (i.e. foraging habitat to MNES) Reduced presence of MNES if Mardie Pool is no longer a potential source of freshwater. habitat for migratory shorebirds	Possible	Moderate	Medium	Control / Management to address possible risk of a decline in soil and groundwater quality due to operational inefficiencies of oily water separators: Discharge of treated wastewater to be regulated under Part V of the Environmental Protection Act. Adherence to the monitoring and reporting regime for the operation as regulated under the EP Act Part V approval. Contamination regulated under Part V of the Environmental Protection Act. and the Contaminated Sites Act if not remediated. Ongoing daily monitoring of groundwater levels and quality. Daily site inspections of water infrastructure and equipment. Spill kits located at key areas; All spills controlled, contained and cleaned up; Hydrocarbons and chemicals stored within suitably bunded areas; Spill kits regularly checked and replenished, if required. All hydrocarbons and chemical spills recorded. Continue with routine monitoring of exceedance/s of the threshold criterion. Implement any additional measures to minimise/prevent unauthorised harm to Protected Matters Continue with routine monitoring of Protected Matters in accordance with EPBC 2022/9169 and MS 1211 Outline management options to avoid future exceedances	Unlikely	Moderate	Low

Factors for the Original and Optimised Project– MNES of relevance to groundwater matters	Environmental Risk	Possible Risk Pathway	Potential Impact on MNES	Risk Rating			Control / Management Measures to reduce the likelihood of the risk (Mitigation measures that will be implemented to address the risk or uncertainty)	Residual Risk Rating following implementation of Control / Management		
				Likelihood	Conseq.	Risk Rating		Likelihood	Conseq.	Risk Rating
Habitat (native vegetation) for terrestrial MNES fauna species	Change to groundwater levels and quality	Seepage from ponds and/or crystallisers A spill or leak of brine from the ponds/crystalliser or pipelines	Indirect impact to the health of terrestrial fauna habitat for MNES	Possible	High	Medium	Control / Management to address possible risk of seepage from ponds and/or crystalliser: The design of the project has been amended to move the crystalliser ponds (which will be lined) further away from Mardie Pool (from ~250m to ~1km northwards) to prevent any potential indirect impact from seepage. Updated modelling at the completion of filling Pond 1 – Pond 3, with real-time monitoring date to validate the potential risks impacts to groundwater levels and quality. Ongoing daily monitoring of groundwater levels and quality (salinity) will be conducted so the model can be verified. Weekly visual inspections of Pond condition and any leakage, and the follow up of evidence through internal investigations (noting these are not trigger or threshold exceedance events) Weekly visual inspections and observations of adjacent habitat areas to the Evaporation Ponds such as Algal Mats (noting these are not trigger or threshold exceedance events) Daily site inspections of water infrastructure – pumps, roads, flow equipment. Control pumps for seawater controlled by the Digital Control Centre via telemetry Weekly pond testing of brine density as a control of evaporation versus losses Operational pond modelling to calculate steady state brine densities and pond depths with weekly review frequencies. Continue with routine monitoring of Protected Matters in accordance with EPBC 2022/9169 and MS 1211 Control / Management to address possible risk of spill or leak of brine from ponds and/or crystalliser o pipelines: Pipelines will utilise industry-standard materials to minimise the chance of leaks, and mitigation will be implemented to reduce this risk further. Ponds have been designed with adequate freeboard and overflow features to minimise the risk of unplanned overflows and wall breaches. Ongoing daily monitoring of groundwater levels and quality (salinity) will be conducted so the model can be verified. Weekly visual inspections of Pond condition and any leakage, and the follow up of evidence through internal investigations (noting these are not trigger or threshold exceedance events) Weekly visual inspections and observations of adjacent habitat areas to the Evaporation Ponds such as Algal Mats (noting these are not trigger or threshold exceedance events) Daily site inspections of water infrastructure – pumps, roads, flow equipment. Control pumps for sweater controlled by the Digital Control Centre via telemetry Ongoing pumping and water management infrastructure maintenance programs	Unlikely	Moderate	Low

Factors for the Original and Optimised Project– MNES of relevance to groundwater matters	Environmental Risk	Possible Risk Pathway	Potential Impact on MNES	Risk Rating			Control / Management Measures to reduce the likelihood of the risk (Mitigation measures that will be implemented to address the risk or uncertainty)	Residual Risk Rating following implementation of Control / Management		
				Likelihood	Conseq.	Risk Rating		Likelihood	Conseq.	Risk Rating
							Weekly pond testing of brine density as a control of evaporation versus losses Operational pond modelling to calculate steady state brine densities and pond depths with weekly review frequencies. Continue with routine monitoring of Protected Matters in accordance with EPBC 2022/9169 and MS 1211.			
Habitat (native vegetation) for terrestrial MNES fauna species	Decline in soil or groundwater quality leads to contaminated site.	Inefficiency of oil water separators leads to discharge of hydrocarbon contaminated water and seepage into groundwater	Changes to the groundwater level and quality of the existing groundwater may result a: Decline in the health and/or loss of native vegetation (i.e. foraging habitat to MNES)	Possible	Moderate	Medium	Control / Management to address possible risk of a decline in soil and groundwater quality due to operational inefficiencies of oily water separators: Discharge of treated wastewater to be regulated under Part V of the Environmental Protection Act. Adherence to the monitoring and reporting regime for the operation as regulated under the EP Act Part V approval. Contamination regulated under Part V of the Environmental Protection Act. and the Contaminated Sites Act if not remediated. Ongoing daily monitoring of groundwater levels and quality. Spill kits located at key areas; All spills controlled, contained and cleaned up; Hydrocarbons and chemicals stored within suitably bunded areas; Spill kits regularly checked and replenished, if required. All hydrocarbons and chemical spills recorded. Daily site inspections of water infrastructure and equipment. Continue with routine monitoring of exceedance/s of the threshold criterion. Implement any additional measures to minimise/prevent unauthorised harm to Protected Matters Continue with routine monitoring of Protected Matters in accordance with EPBC 2022/9169 and MS 1211 Outline management options to avoid future exceedances.	Unlikely	Moderate	Low
Habitat (native vegetation) for terrestrial MNES fauna species	Changes to groundwater level and quality	Groundwater drawdown from operations of the bore required to supply water to the camp facilities.	Changes to the groundwater level and quality of the existing groundwater may result in a: Decline in the health and/or loss of native vegetation (i.e. foraging habitat to MNES)	Possible	Moderate	Medium	Control / Management to address possible risk of changes to groundwater levels and quality from drawdown from operational bores to supply water to camp facilities: Construction and operation of the water source bore(s) in accordance with the granted 5C licence granted under the RIWI Act. Ongoing daily monitoring of groundwater levels and quality (salinity). Daily site inspections of water infrastructure – pumps, roads, flow equipment. Continue with routine monitoring of exceedance/s of the threshold criterion. Implement any additional measures to minimise/prevent unauthorised harm to Protected Matters Continue with routine monitoring of Protected Matters in accordance with EPBC 2022/9169 and MS 1211 Outline management options to avoid future exceedances	Unlikely	Moderate	Low
M.tridens	Change to groundwater levels and quality	Seepage from ponds and/or crystallisers A spill or leak of brine from the ponds/crystalliser or pipelines	Changes to the groundwater level and quality of the existing groundwater may result in a: Decline in the health and/or loss of *M.tridens*	Possible	Moderate	Medium	Control / Management to address possible risk of decline in health and/or loss of M. tridens from a change to groundwater levels and quality from seepage of ponds/crystalliser and/or a leak/spill of brine from the ponds/crystalliser/pipelines:	Unlikely	Moderate	Low

Factors for the Original and Optimised Project– MNES of relevance to groundwater matters	Environmental Risk	Possible Risk Pathway	Potential Impact on MNES	Risk Rating			Control / Management Measures to reduce the likelihood of the risk (Mitigation measures that will be implemented to address the risk or uncertainty)	Residual Risk Rating following implementation of Control / Management		
				Likelihood	Conseq.	Risk Rating		Likelihood	Conseq.	Risk Rating
							Annual health monitoring of *M.tridens* located within the Development Envelope. Implementation of the Offset and Research Strategy for *M.tridens*. Pipelines will utilise industry-standard materials to minimise the chance of leaks, and mitigation will be implemented to reduce this risk further. Ponds have been designed with adequate freeboard and overflow features to minimise the risk of unplanned overflows and wall breaches. Ongoing daily monitoring of groundwater levels and quality (salinity) will be conducted so the model can be verified. Weekly visual inspections of Pond condition and any leakage, and the follow up of evidence through internal investigations (noting these are not trigger or threshold exceedance events) Weekly visual inspections and observations of adjacent habitat areas to the Evaporation Ponds such as Algal Mats (noting these are not trigger or threshold exceedance events) Daily site inspections of water infrastructure – pumps, roads, flow equipment. Control pumps for sweater controlled by the Digital Control Centre via telemetry Ongoing pumping and water management infrastructure maintenance programs Weekly pond testing of brine density as a control of evaporation versus losses Operational pond modelling to calculate steady state brine densities and pond depths with weekly review frequencies. Continue with routine monitoring of Protected Matters in accordance with EPBC 2022/9169 and MS 1211.			
M.tridens	Changes to groundwater regime	Groundwater drawdown from operations of the bore required to supply water to the camp facilities.	Changes to the groundwater level and quality of the existing groundwater may result in a: Decline in the health and/or loss of *M.tridens*	Unlikely	Moderate	Low	Control / Management to address possible risk of changes to groundwater levels and quality from drawdown from operational bores to supply water to camp facilities: Construction and operation of the water source bore(s) in accordance with the granted 5C licence granted under the RIWI Act. Ongoing daily monitoring of groundwater levels and quality (salinity). Daily site inspections of water infrastructure – pumps, roads, flow equipment. Continue with routine monitoring of exceedance/s of the threshold criterion. Implement any additional measures to minimise/prevent unauthorised harm to Protected Matters Continue with routine monitoring of Protected Matters in accordance with EPBC 2022/9169 and MS 1211 Outline management options to avoid future exceedances	Unlikely	Moderate	Low
M.tridens	Decline in soil or groundwater quality leads to contaminated site.	Inefficiency of wastewater treatment plant (WWTP) to discharge contaminated water and seepage into groundwater	Changes to the groundwater level and quality of the existing groundwater may result in Decline in the health and/or loss of *M.tridens*	Possible	Moderate	Medium	Control / Management to address possible risk of a decline in soil and groundwater quality due to operational inefficiencies of wastewater treatment plant: Discharge of treated wastewater to be regulated under Part V of the Environmental Protection Act. Adherence to the monitoring and reporting regime for the operation of the WWTP as regulated under the EP Act Part V approval.	Unlikely	Moderate	Low

Factors for the Original and Optimised Project– MNES of relevance to groundwater matters	Environmental Risk	Possible Risk Pathway	Potential Impact on MNES	Risk Rating			Control / Management Measures to reduce the likelihood of the risk (Mitigation measures that will be implemented to address the risk or uncertainty)	Residual Risk Rating following implementation of Control / Management		
				Likelihood	Conseq.	Risk Rating		Likelihood	Conseq.	Risk Rating
							Contamination regulated under Part V of the Environmental Protection Act. and the Contaminated Sites Act if not remediated. Ongoing daily monitoring of groundwater levels and quality. Daily site inspections of water infrastructure and equipment. Continue with routine monitoring of exceedance/s of the threshold criterion. Implement any additional measures to minimise/prevent unauthorised harm to Protected Matters Continue with routine monitoring of Protected Matters in accordance with EPBC 2022/9169 and MS 1211 Outline management options to avoid future exceedances			
M.tridens	Decline in soil or groundwater quality leads to contaminated site.	Inefficiency of oil water separators leads to discharge of hydrocarbon contaminated water and seepage into groundwater	Changes to the groundwater level and quality of the existing groundwater may result in: Decline in the health and/or loss of *M.tridens*	Possible	Moderate	Medium	Control / Management to address possible risk of a decline in soil and groundwater quality due to operational inefficiencies of oily water separators: Discharge of treated wastewater to be regulated under Part V of the Environmental Protection Act. Adherence to the monitoring and reporting regime for the operation as regulated under the EP Act Part V approval. Contamination regulated under Part V of the Environmental Protection Act. and the Contaminated Sites Act if not remediated. Ongoing daily monitoring of groundwater levels and quality. Daily site inspections of water infrastructure and equipment. Spill kits located at key areas; All spills controlled, contained and cleaned up; Hydrocarbons and chemicals stored within suitably bunded areas; Spill kits regularly checked and replenished, if required. All hydrocarbons and chemical spills recorded. Continue with routine monitoring of exceedance/s of the threshold criterion. Implement any additional measures to minimise/prevent unauthorised harm to Protected Matters Continue with routine monitoring of Protected Matters in accordance with EPBC 2022/9169 and MS 1211 Outline management options to avoid future exceedances	Unlikely	Moderate	Low
Threatened migratory sea and shorebirds	Change to groundwater regime and quality	Seepage from ponds and/or crystallisers A spill or leak of brine from the ponds/crystalliser or pipelines	Increased groundwater levels and/or changes to the quality of the existing groundwater may have an indirect impact to migratory shorebirds as a results of: Loss of BCH (i.e. BCH unable to tolerate the change and BCH die) Loss of BCH contribution to the nutrient cycle (i.e. decline in the health of the BCH resulting in a reduction of their contribution to the nutrient cycle) Loss of BCH resulting in a reduction to the foraging habitat for migratory shorebirds	Possible	High	Medium	Control / Management to address possible risk of seepage from ponds and/or crystalliser: The design of the project has been amended to move the crystalliser ponds (which will be lined) further away from Mardie Pool (from ~250m to ~1km northwards) to prevent any potential indirect impact from seepage. Updated modelling at the completion of filling Pond 1 – Pond 3, with real-time monitoring date to validate the potential risks impacts to groundwater levels and quality. Ongoing daily monitoring of groundwater levels and quality (salinity) will be conducted so the model can be verified. Weekly visual inspections of Pond condition and any leakage, and the follow up of evidence through internal investigations (noting these are not trigger or threshold exceedance events)	Unlikely	Moderate	Low

Factors for the Original and Optimised Project– MNES of relevance to groundwater matters	Environmental Risk	Possible Risk Pathway	Potential Impact on MNES	Risk Rating			Control / Management Measures to reduce the likelihood of the risk (Mitigation measures that will be implemented to address the risk or uncertainty)	Residual Risk Rating following implementation of Control / Management		
				Likelihood	Conseq.	Risk Rating		Likelihood	Conseq.	Risk Rating
							Weekly visual inspections and observations of adjacent habitat areas to the Evaporation Ponds such as Algal Mats (noting these are not trigger or threshold exceedance events) Daily site inspections of water infrastructure – pumps, roads, flow equipment. Control pumps for seawater controlled by the Digital Control Centre via telemetry Weekly pond testing of brine density as a control of evaporation versus losses Operational pond modelling to calculate steady state brine densities and pond depths with weekly review frequencies. Ongoing BCHMMP monitoring and if required, implementation of the reactive monitoring as outline in Section 3.1.3.3. of the BCHMMP. Ongoing monitoring and if required, implementation of reactive monitoring as outlined in Section 2.2.6 of the MSMMP. Continue with routine monitoring of exceedance/s of the threshold criterion Implement any additional measures to minimise/prevent unauthorised harm to Protected Matters Continue with routine monitoring of Protected Matters in accordance with EPBC 2022/9169 and MS 1211 Outline management options to avoid future exceedances. Control / Management to address possible risk of spill or leak of brine from ponds and/or crystalliser o pipelines: Pipelines will utilise industry-standard materials to minimise the chance of leaks, and mitigation will be implemented to reduce this risk further. Ponds have been designed with adequate freeboard and overflow features to minimise the risk of unplanned overflows and wall breaches. Ongoing daily monitoring of groundwater levels and quality (salinity) will be conducted so the model can be verified. Weekly visual inspections of Pond condition and any leakage, and the follow up of evidence through internal investigations (noting these are not trigger or threshold exceedance events) Weekly visual inspections and observations of adjacent habitat areas to the Evaporation Ponds such as Algal Mats (noting these are not trigger or threshold exceedance events) Daily site inspections of water infrastructure – pumps, roads, flow equipment. Control pumps for sweater controlled by the Digital Control Centre via telemetry Ongoing pumping and water management infrastructure maintenance programs Weekly pond testing of brine density as a control of evaporation versus losses Operational pond modelling to calculate steady state brine densities and pond depths with weekly review frequencies. Continue with routine monitoring of exceedance/s of the threshold criterion.			

Factors for the Original and Optimised Project– MNES of relevance to groundwater matters	Environmental Risk	Possible Risk Pathway	Potential Impact on MNES	Risk Rating			Control / Management Measures to reduce the likelihood of the risk (Mitigation measures that will be implemented to address the risk or uncertainty)	Residual Risk Rating following implementation of Control / Management		
				Likelihood	Conseq.	Risk Rating		Likelihood	Conseq.	Risk Rating
							Implement any additional measures to minimise/prevent unauthorised harm to Protected Matters Continue with routine monitoring of Protected Matters in accordance with EPBC 2022/9169 and MS 1211 Outline management options to avoid future exceedances. Ongoing monitoring and if required, implementation of reactive monitoring as outlined in Section 2.2.6 of the MSMMP. Continue with routine monitoring of exceedance/s of the threshold criterion.			
Threatened migratory sea and shorebirds	Change to groundwater levels and quality	Release of concentrated water/brine into the environment as a potential remediation response to an exceedance of trigger thresholds Note: If BCI were to take this action, the concentrated water/brine would only be released into the Marine Environment and will not be disposed of to the terrestrial environment. Therefore, BCI has not considered the potential risk against the terrestrial MNES of relevance to groundwater matters in this table.	Increased groundwater levels and/or changes to the quality of the existing groundwater may have an indirect impact to the health of the BCH resulting in: Loss of BCH (i.e. BCH unable to tolerate the change and BCH die) Loss of BCH contribution to the nutrient cycle (i.e. decline in the health of the BCH resulting in a reduction of their contribution to the nutrient cycle) Loss of BCH resulting in a reduction to the foraging habitat for migratory shorebirds	Possible	High	Medium	Control / Management to address possible risk of releasing concentrated water/brine into the environment as a potential remediation response to an exceedance of trigger thresholds: Bespoke risk assessment and review of potential impact to MNES in consultation with the regulators, prior to the release of any concentrated water/brine. Shut off water flows into pond/s if leaks are detected, or adjust the brine flows between ponds (using pumps, gates and weirs) Increase the appropriate freeboard of the pond and adjust pond operating level Install cut-off bores, sumps and/or trenches and pump the water to the appropriate salinity pond Rectify breaches in pond walls to be structurally stable, fix containment systems and leaks in internal drainage structures Review the steady-state average brine density for each pond, and modify the 'Brine Movement Plan' Dilute the brine or slow down the evaporation process by pumping additional seawater (i.e. shandying) from the primary or secondary seawater intake system Continue with routine monitoring of exceedance/s of the threshold criterion Implement any additional measures to minimise/prevent unauthorised harm to Protected Matters Continue with routine monitoring of Protected Matters in accordance with EPBC 2022/9169 and MS 1211 Outline management options to avoid future exceedances. Ongoing BCHMMP monitoring and if required, implementation of the reactive monitoring as outline in Section 3.1.3.3. of the BCHMMP. Ongoing monitoring and if required, implementation of reactive monitoring as outlined in Section 2.2.6 of the MSMMP.	Unlikely	Moderate	Low

2.9.5 Environmental Management Measures

The leakage of water from Ponds and pressure on groundwater system has the potential to impact protected matters within the development area and adjacent areas. Modelling was undertaken under these scenarios to develop an understanding of the scale of potential impacts to then inform the development of indicators and relevant trigger and threshold criteria for the implementation of investigation and management actions.

Whilst there is a residual risk of changes to groundwater regimes in the very near vicinity to the Ponds (within 100 m) and hence potential impacts to BCH, the management actions associated with this plan including daily trigger threshold monitoring, the monitoring of Pond wall integrity, mitigation measures such as reversal of pond filling and the BCHMMP management actions are considered appropriate to reduce the likelihood of unauthorised impacts to protected matters.

To the extent any deviation between the onsite measurements and the modelling predictions is observed, an adaptive management has been incorporated into the revised GMMP to ensure the Groundwater Objective is achieved, outlined in greater detail in Section 4. Further to this, as detailed in the Approval conditions, there are subsequent remediation requirements that need to be implemented as part of threshold exceedance investigations and these are described in Section 3.4.3.

Mardie Minerals is committed to ensure that the Project will be implemented in a manner that ensures the ecological integrity and function of the intertidal habitats that support the presence of EPBC Act Listed Threatened and Migratory Species are maintained. This is evidenced by the additional $372,000 (beyond what has been conditioned) that has been committed to research of Green Sawfish and Migratory birds, as per the recently submitted Research Offsets Proposal.

2.10 Residual Uncertainties and Precautionary Strategies

The key assumptions and uncertainties, and the status of proposed strategies to address these, are listed in Table 13Table 13.

Table 13 Key Assumptions and Uncertainties and Status of Strategies to Address

Item	Assumption/ Uncertainty	Strategy to address uncertainty	Timing	Status of Strategies to Address
1	The hydrogeological model lacks certainty on groundwater conditions in the deeper substrates, particularly to the west of the project.	• Installed shallow and deep boreholes in coastal zones to measure vertical salinity distributions in mangrove stands, algal mats and samphire communities to determine water quality and the existence (or not) of fresh groundwater flows. • Hydraulic testing programme to determine in-situ permeability of gravelly clay layers and potential for transportation of hypersaline seepage from the ponds to BCH and Mardie Pool.	• Terrestrial bores were installed in March 2022. Some coastal bores were installed in February 2022 and additional new coastal bores were installed adjacent to Ponds 1-5 in July 2023, and the coastal monitoring network for Ponds 1-8 was completed in July 2024. • A series of pumping tests was completed in Q4 2022 to inform the regional groundwater impacts modelling.	• There are a total of 56 coastal bores from Pond 1 through to Pond 8 that have now been installed from August 2023 through to August 2024 in addition to the existing gas pipeline bore which were installed and commissioned between July 2021 and April 2023. • The Coastal Monitoring bores have been installed as nested shallow and deep pairs to assist with characterisation of the groundwater regime beneath the supratidal flats and to permit detection of changes in levels and gradients (vertical and horizontal), and groundwater changes which may be attributed to surface flow variations at the western boundary of the project. • Deep bores have been installed generally between 7 and 10 metres below ground level. • Groundwater modelling completed in 2024 has included data from across the installed Coastal Bore monitoring network on the western edge of the Project. • Section 2.6 of the GMMP and Appendix A describe how the

Item	Assumption/ Uncertainty	Strategy to address uncertainty	Timing	Status of Strategies to Address
				hydrogeological model has been updated with this additional data to characterise the groundwater conditions and model. • AQ2 has completed impact modelling across 4 transects as per the Groundwater Memo. the modelling report is provided in Appendix A of this GMMP.
2	Changes to groundwater levels and quality can be detected and responded to effectively before an ecological impact occurs.	• Acquire and utilise long-standing groundwater data from multiple sites to appropriately characterise the groundwater system in and around the development envelope. • Augment the existing groundwater bore network by designing and implementing a groundwater bore monitoring network that is capable of measuring and identifying changes in groundwater levels and quality (EC) at all ponds. • Develop a groundwater monitoring methodology capable of detecting changes in groundwater levels and EC prior to the commencement of filling of ponds • Develop trigger and threshold-based management protocols to ensure there is an appropriate response to any detected changes in groundwater •	• The inland monitoring bore network around Mardie Pool and Crystallisers has been in place since April 2022 to acquire historical baseline groundwater level and quality data. • Coastal monitoring bores installed adjacent to Ponds 1-5 in July 2023 and up to Pond 8 in October 2023 continue to acquire baseline groundwater water level and salinity data in the intertidal zone. • Historical bore/VWP data has been identified and incorporated to the coastal network, providing baseline groundwater levels and improving understanding of the system since July 2021 for Ponds 1-5. • As monitoring methodology evolves to detect and measure potential changes to groundwater level and EC that may result from the operation of the project, we have continued to build/augment	• As at August 2024, 74 bores have been installed for the purpose of monitoring groundwater associated with the Mardie project, bringing the total number of bores at the Mardie site to over 100. • 74 monitoring bores are telemetered to deliver hourly data on groundwater level and EC • We now have more than 1 years worth of data for several of these bores. • A m-BACI monitoring methodology to determine short- and long-term changes in groundwater level and to set triggers and thresholds using 3 month data series was developed and provided to DCCEEW in April 2024 (Rev L of the GMMP), and updated with contemporary data and resubmitted in June 2024 (Appendix E1 and E2). • A similar methodology for identifying short- and long-term changes in groundwater salinity

Item	Assumption/ Uncertainty	Strategy to address uncertainty	Timing	Status of Strategies to Address
			groundwater bore monitoring network to ensure that measurements are spatially appropriate and can identify changes at time-scales appropriate for the highly variable (tidally influenced) groundwater environment • Finalise monitoring methodology, including development of triggers and thresholds prior to filling of ponds • Updated/approved management plan to outline management protocols to be undertaken should triggers/thresholds be breached.	and setting triggers and thresholds was developed and provided to DCCEEW in July 2024 (Appendix E2). • This GMMP has been updated to describe protocols to be undertaken should triggers/thresholds be breached (Section3.3).
3	The level of reliance on 'fresh' groundwater by the various benthic primary producer communities at Mardie, including mangroves, samphire wetlands and algal mats over various timeframes requires quantifying.	• Ensure the groundwater investigation and monitoring network provides sufficient information to characterise the groundwater regime (flow and quality) in the vicinity of coastal and inland groundwater receptors. • Quantify natural groundwater quality/level variation within the dynamic coastal tidal system and the inland system to determine appropriate trigger and threshold values.	• The coastal monitoring network consisting of 56 bores was completed in the period August 2023 to July 2024 adjacent to Ponds 1-8. • The inland monitoring network of 18 bores was completed in April 2022. • Baseline groundwater monitoring is in place across inland areas (from April 2022) and Ponds 1-5 (from July 2021 in historical bores) with full monitoring coverage across all sites from August 2024 upon commissioning of final bores.	• The groundwater modelling report provided in the GMMP (as Appendix A) describes the physical characteristics of the benthic communities on the western edge of the Project. • These areas are dominated by significant tidal fluctuations and tidal inundation of up to 4-6 hours in every 12 hour tidal cycle. • Groundwater level and quality data from coastal monitoring bores is regularly reviewed to detect changes to the groundwater regime.

Item	Assumption/ Uncertainty	Strategy to address uncertainty	Timing	Status of Strategies to Address
				• To date there has been no evidence of 'fresh' groundwater in the vicinity of the evaporation ponds or benthic primary producer communities to the west. No reliance on 'fresh' groundwater is believed to occur in the coastal habitat. • Regional studies being undertaken by WAMSI at several sites along the Pilbara coast have reported similarly high salinities in surface sediments within these communities. • Coastal sites will continue to be monitored for evidence of freshwater ingress.
4	The ecological water requirements of Mardie Pool are not known with certainty.	• Ensure the groundwater and surface water monitoring network provides sufficient information to characterise the groundwater/surface water regime (flow and quality) for Mardie Pool and surrounds. • Use the monitoring network to investigate the existing groundwater quality and flow regime in the context of the various vegetation species surrounding Mardie Pool. • Employ remote sensing methods (geophysical survey) to identify the location of the saline water interface and its interaction with Mardie Pool where bore coverage is limited.	• Groundwater and surface water data collected since April 2022 has been used to inform seepage modelling in the vicinity of Mardie Pool and the crystallisers (completed May 2024) • Compilation of baseline data will continue until filling of the adjacent crystallisers. • Operational data will be regularly assessed against groundwater modelling. Model will be recalibrated as necessary.	• The ecological importance of Mardie Pool was assessed as part of the Mardie Project EIS process and EPBC 2018/8236 describes the required monitoring of surface and groundwater flows to the Mardie Pool to protected relevant MNES. Whilst the Pool was found to be an important terrestrial fauna feature, it is heavily impacted by Mesquite encroachments and cattle access. • Groundwater and surface water monitoring in the vicinity of the Pool shows that the water level and water quality is likely to be significantly affected by periods of surface flow where the pool fills and overflows

Item	Assumption/ Uncertainty	Strategy to address uncertainty	Timing	Status of Strategies to Address
				and periods of drought where the water level falls and becomes more saline through evaporation. • During extended dry periods the surface level falls below groundwater levels and hence is supplemented by groundwater. • Ongoing monitoring in the vicinity of the Pool is a requirement of Project Approval Conditions. • Mardie Pool transect impact modelling was completed in January 2024 and included in Appendix A. • The GMMP has established monitoring and trigger/threshold mechanisms to detect any potential leakage to groundwater. • Ongoing monitoring and investigations will inform subsequent iterations of the GMMP and supporting recalibration of the groundwater model following commencement of operations.
5	The extents, severity and impact on vegetation of potential groundwater mounding from the ponds is not able to be predicted with reliability,	• Ensure the monitoring and investigations described in (2) include transects perpendicular to the ponds.	• Several transects of monitoring bores have been installed perpendicular to the ponds and Mardie Creek (parallel to groundwater gradient) to inform sectional groundwater modelling.	• Groundwater impact modelling has recently been completed along with updates to the conceptual groundwater model based on groundwater data collected into 2024.

Item	Assumption/ Uncertainty	Strategy to address uncertainty	Timing	Status of Strategies to Address
	owing to the scale of the project.		• Baseline groundwater monitoring is in place across inland areas (from April 2022) and Ponds 1 to 5 (from July 2021 in historical bores). • The coastal monitoring network consisting of 56 bores was completed in the period August 2023 to July 2024 adjacent to Ponds 1-8. • Updated modelling of the Pond 1, Pond 6, Pond 8 and Mardie Pool transects was completed in May 2024	• The impact pathway associated with a loss of product water to groundwater resources is described in Appendix A and in Section 2.9 of the GMMP. • Noting the conceptual hydrological model (refer Section 2.7.1) and the outcomes of the Pond 1, 6 and 8 transect modelling (refer Section 2.8.4), significant changes to groundwater levels and quality beyond the immediate vicinity of the evaporation ponds and crystalliser are not expected.
6	The action triggers provided in this GMMP are calculated on baseline data collected to the current time.	• To meet the GMMP's objectives, the groundwater investigation and monitoring network must accurately quantify BCH's use of fresh groundwater, allowing for response triggers that align with natural groundwater variations. • Review the triggers and thresholds following groundwater modelling to incorporate knowledge of the regional and local groundwater flow regime.	• Triggers and thresholds have been developed. • Ponds 1 to 3 filling not predicted to affect Ponds 6 to 9 groundwater levels. • Coastal monitoring bores are in place adjacent to Ponds 1-8 and are providing baseline water level and quality data for review of trigger levels. • Groundwater monitoring to date has indicated that fresh water is not present to the west of the ponds in the vicinity of coastal benthic habitats.	• Trigger and threshold values have been developed, consistent with ANZG (2018), for EC/salinity and groundwater level and have been updated in the most recent version of the GMMP • The quantum of baseline data collected to inform triggers and threshold development is described in the GMMP with respect to terrestrial bores (Section 2.8.1) the gas pipeline bores (Section 2.8.2) and Coastal Monitoring Bores (Section 2.8.3). • As discussed in Section 3.1.1 due to significant seasonal variations, a modified BACI approach for short-

Item	Assumption/ Uncertainty	Strategy to address uncertainty	Timing	Status of Strategies to Address
				term triggers and thresholds for groundwater level and EC (salinity) has been proposed. • A methodology for detecting longer term changes has also been developed and is provided in Section 3.1.2 and Appendix E2 (DAA, 2024b) • Trigger levels and thresholds are being reviewed as more baseline data becomes available.
7	Brine losses to the environment as seeps and leaks will diminish over time, due to geological and biological processes reducing infiltration rates through the clay floors and walls.	• This assumption may be able to be confirmed through the monitoring described above. Additional investigations would be required for ponds where seepage losses have become an issue.	• The modelling does not predict significant losses of brine or impacts to adjacent groundwater or benthic communities.	• The ongoing monitoring of groundwater levels and quality throughout the coastal monitoring bore network will confirm leakage rates against the model outputs following the commencement of pond filling
8	Influence of Sino Iron Project dewatering	Groundwater modelling will assess the impact of dewatering at Sino Iron on water levels and flow at Mardie Project. The potential for impacts on receptors like Mardie pool, Mt Salt Mound Spring and others will be assessed to determine necessary mitigation measures or monitoring locations.	• Previous modelling by Strategen (2017) indicates the potential groundwater drawdown beneath the proposed crystallisers due to dewatering at Sino Iron Mine would be between 0 to 0.3 metres (after 60 years). However, it is also indicated that this drawdown is not likely to have a significant impact on the groundwater	• Regional impacts modelling is in progress and due for completion in Q4 2024. The regional modelling incorporates relevant background water level and quality data collected from the current monitoring network and incorporates learnings from the ongoing monitoring data review.

Item	Assumption/ Uncertainty	Strategy to address uncertainty	Timing	Status of Strategies to Address
			regime near the Mardie Project crystallisers and Mardie Pool • Regional impacts modelling, to assess the impacts of the Mardie project is in progress and due for completion during Q4 2024.	

3. PROVISIONS OF THE PLAN

3.1 Rationale for Choice of Management Framework

Mardie Minerals recognises that the EPA prefers outcome-based provisions, and these have been maximised in our approach. Mardie Minerals has developed an **outcome-based** management framework for implementation of the GMMP. Outcome-based elements focus on monitoring and evaluating specific measurable outcomes, usually driven by trigger and threshold criteria and are performance based.

The management actions have been designed to meet the overall objective, with the management targets designed to assess the effectiveness of management actions. This Plan also describes the monitoring and reporting approach that will be undertaken to assess the effectiveness of the management actions in meeting the environmental outcomes.

The outcome-based provisions of this Plan are set out in Section 3.2.

3.1.1 Primary factors: groundwater level and electrical conductivity

Groundwater related impact risks resulting from evaporative salt production (i.e. by evaporating sea water in ponds above groundwater that is naturally highly concentrated already) are very low because of their natural alignment with flooding and evaporation processes already occurring at the site. This is particularly true for the lower ponds on the Mardie project, where any seepage is likely to have a diluting effect on groundwater that is naturally 3-4 times the salinity of sea water. Risk (or at least likelihood of impacts) is further reduced by consideration of the transect modelling undertaken for this project, which shows that even under an operationally unsustainable, worst-case 'leaky pond' scenario, there would only be a potential seasonal increase in groundwater level of up to 0.5m observable 100m on the coastal side of the Pond wall. This increase in groundwater level would be in an area that has been shown (through our extensive coastal bore network) to exhibit tidally induced daily variations in groundwater levels of 0.6 to 1.16m, and annual variability in groundwater levels of 1.1 to 1.6 m (see DAA report, Appendix E). For Mardie Pool also, all modelling has indicated that under a similarly unsustainable leaky pond scenario, there will be no impact to Mardie pool.

The key impact pathway to groundwater quality at the Mardie Pool is the potential leakage of highly saline water for the crystallisers down into the groundwater table. The overriding potential impact source will be salinity, both directly, through the creation of osmotic stress in vegetation/cyanobacteria, and indirectly, through the limitation of macronutrient availability for some vegetation (Ahmed et al 2022). Electrical Conductivity (EC) as a measure of salinity was therefore assessed as the most appropriate ongoing groundwater indicator for identifying changes. Additionally, Bromide has also been chosen as a groundwater quality indicator as it a direct measure of brine associated with seawater with a low risk of variation – measurement of Bromide simply confirms the source of brine impacts being due to the concentration of seawater.

Whilst other quality indicators such as nutrients and metals were monitored during the EIS process, they were not considered suitable for use as indicators for triggers and thresholds due to their very low concentrations and the strength of EC as a reliable indicator of change with respect to groundwater quality. BCI commits to providing further justification of this through more direct comparison against the ANZECC (2000) Marine Water Quality Guidelines in the revision of this GMMP to be provided after filling of pond 3.

Where there is a surface incident involving the potential leakage of contaminants, additional water quality parameters would be included in a targeted monitoring program for that event. During normal operations, there is not expected to be any additional contaminants associated with the production of salt that would represent a significant impact pathway to groundwater. This approach is consistent with the EPA Decision Reporting for the Original and Optimised Projects (Section 2.1.4 and 2.1.6 respectively of the EPA Decision reports).

3.1.2 Groundwater Level - Coastal Bores / Pipeline Bores

Groundwater level is a key indicator for detecting potential changes to groundwater regimes as a result of the Project and as required under both EPBC and MS1211 conditions (Section 2.4), Data Analysis Australia (DAA) was engaged to design a statistically sound method for establishing operational trigger and threshold criteria and an analysis tool to identify groundwater level changes and whether these could be attributed to environmental, or project related causal factors.

Information Review

DAA conducted a thorough analysis of groundwater level data collected from 18 bores on the Mardie site (as detailed in Section 2.7) to determine the most suitable method. A long-term dataset from four bores within the gas pipeline corridor were identified, which captures the long-term (2 years) variability in groundwater levels across the tidal flats. The long-term water level dataset collected from the gas pipeline corridor bores, as well as the more recent data from the coastal monitoring bore network (see Section 2.8.3), shows significant temporal variation in response to tidal influence, significant rainfall events and other factors such as barometric pressure and wind direction and speed (the latter affect the flooding and persistence of marine waters across the tidal flat). The key findings from that review were that bores typically exhibit two types of seasonality with bores nearer the ocean and influenced by tides showing biweekly seasonality and bores further from the ocean showing monthly seasonality. The review also identified that the coastal monitoring network did not have a full 24 months of data as recommended by the ANZG (2018).

ANZG Consistency

Noting the above finding, an alternative approach, endorsed and consistent with ANZG (2018), has been proposed that uses a Modified Before/After Control Impact (BACI) methodology to identify robust triggers and threshold criteria. DAA has proposed a modified Before/After Control Impact (M-BACI) design that is characterised by:

- Careful analysis of bores to find appropriate matching
- Multiple reference bores for each control bore
- Statistical time series analysis techniques (ARIMA)
- Dynamic triggers and thresholds to account for seasonal variability

The proposed methodology also implements a continuous collection of data with daily measurement, over and above the quarterly frequency noted in the ANZG (2018).

The ANZG (2018) guidance states that “model-based inference can be very general and precise from a limited number of sample observations” and that the inference though depends on the availability of data and the system conceptualisation. Further guidance is then provided to address data availability through time series analysis in order to identify long-term trends, seasonal fluctuations and non-seasonal variations.

The proposed methodology utilises a time series method (Auto-Regressive Integrated Moving Average (ARIMA) modelling) because of the richness and temporal variation observed, noting that the guidelines do give reference throughout to accounting for seasonality in an appropriate way, where seasonal factors exist and the ANZG (2018) do reference the ARIMA model.

Summary of the Proposed Methodology and Implementation

The monitoring and analysis methodology for assessing short- and long-term impacts to groundwater level and salinity are detailed in the attached DAA reports (Appendices E1 for groundwater level, and Appendix E2 for salinity, respectively).

The model based mBACI approach used in these reports requires the establishment of three reference bores for each groundwater bore that is most likely to be impacted by pond filling. The methodology assumes that if the water level patterns of the impact and reference bores are similar for the last 3-months, then they should remain similar. If they do not, then any changes may have been caused by an external source.

The preference for multiple reference bores provides redundancy and gives further insight into the potential source of change if a change between impact and control bores is identified. This methodology enables reference bores to be rematched when needed (for example, when full data sets for other potential matching bores become available).

Once reference bores have been chosen, a statistical time series model (ARIMA) is fitted to data from the impact bore and its reference bores to predict what we expect to happen at the impact bore for the next seven days. The ARIMA model is informed by the hourly groundwater level and EC data collected across the bore field. This methodology for using that data to determine compliance with triggers and thresholds is compliant with the ANZ Guidelines (2018) and is well suited to understanding the various factors impacting upon the groundwater data, including both human impacts and natural impacts such as seasonality.

Triggers and thresholds are only breached when the impact bore behaves differently to its reference bores. The selection of the location of the impact and reference bores has been made such that if the impact bore does behave differently to the reference bores (and it is not the result of any data anomaly), it is most likely to be as a result of the operation of the project.

The mBACI analysis undertaken on a daily basis for this project will consider the mean response (magnitude of change) from impact and reference bores. The proposed methodology is far more rigorous than the standard approach of using a fixed trigger or threshold value, as it allows for changes in temporal trend and seasonality as well as magnitude to be separated from the 'impact' change of filling ponds. It also enables far more timely identification of impacts (close to real time) than for the standard requirement of collecting monthly groundwater data.

Review after filling pond 3

For the purposes of filling ponds 1-3, the reference bores chosen in the current DAA reports (Appendices E1 and E2) are located in the proximity of Pond 8. These reference bores provide the best match to Pond 1, 2 and 3 impact bores and enable determination of short-term compliance against trigger and threshold increases of 0.1-0.15m with a high level of reliability. This may be improved upon as operational data becomes available.

After Pond 3 filling, we will have an appropriate dataset from all 74 bores across the network to enable us to determine the best 'matched' bores for each proposed impact bore. BCI commits to updating the DAA reports with all available data and the incorporating any learnings from the pond filling into this GMMP. Using this data will enable the most accurate determination of whether trigger and threshold values have been exceeded in future. If, at that time, it is recommended by DAA that we change reference bores, this will be clearly reported and subject to the approval of DCCEEW in the updated GMMP.

Trigger and Threshold Criteria

As articulated in the DAA reports, a conservative approach to developing trigger and threshold criteria for detecting groundwater level changes was taken, consistent with ANZG (2018).

The triggers and thresholds in Table 16 are based on exceeding 95% confidence intervals over a number of consecutive days. Adding to the conservative nature of the approach is that once operational, the trigger forecasts will be updated daily in real time.

Triggers are defined as an actual groundwater value falling outside the 95% predicted value on a single day. Thresholds are defined as seven consecutive days of triggers.

Whilst this method is sensitive to false positive trigger notifications, this will allow for the very close examination of data particularly through the staged filling process.

It is expected that this process may result in a number of "false positive" triggers (refer to false positive section below) which will require investigation.

The approach is consistent with the ANZG guidelines specifying that the triggers and thresholds should be set seasonally, where seasonal variation exists, with the model picking up this seasonality on a continuum. Fixed value trigger and threshold criteria were not considered appropriate given the large daily variation and inconsistency with the modelling methodology.

The criteria will be supported by an analysis and reporting tool being developed by DAA that will provide daily review of data integrity, trigger and threshold alerts and a reporting function at selected frequencies, for example weekly or fortnightly.

Tidal Effects

With the review of data sets and in consideration of the progression of paired impact and reference bores in the Trigger/Threshold methodology an inclusion of tidal effects into the coastal bore groundwater level model is being developed.

Tidal effects are both stronger and more complex than originally realised. The lunisolar synodic fortnightly cycle (MSf) with a period of 14.765 days is particularly strong, as are some of the high order harmonics.

This means that explicitly fitting or adjusting for the tidal effects on the bore water level data will remove a substantial part of the "noise", giving greater statistical power for any monitoring process. DAA will first apply this to the existing short term monitoring analysis.

The monitoring of long-term effects can also be carried out by analysing the tide corrected daily average levels and including a trend or "expected project impact" term in the model.

The approach will be similar to the short-term change detection but using the full dataset, not a moving window. Consideration will be given to appropriately incorporating fixed thresholds or trigger levels for this long-term context, although the precise methodology and size still needs to be determined.

The data suggests that some bores have an annual cycle (with period 365.2563 days) that could also be a trend. Only when we have a full year of data (or more) will it be evident what is happening here.

Hence fine tuning of the existing short-term monitoring in the immediate term (with ongoing refinement and review as appropriate) and a development of a longer-term monitoring over the next few months will occur. The annual review process will be used to review the longer-term monitoring methodology.

Environmental and Incremental Change Detection

The model-based mBACI approach in the analysis is well suited to understanding the various factors impacting upon the groundwater data, including both human impacts and natural impacts such as seasonality. Fundamentally, reference bores and impact bores are expected to (indeed have been tested to determine that they will) be concurrently influenced by natural variability (e.g. on seasonal or longer term cycles). Triggers and thresholds are only realised when the impact bore behaves differently to its reference bores. The selection of the location of the impact and reference bores has

been made such that if the impact bore does behave differently to the reference bores (and it is not the result of any data anomaly), it is most likely to be as a result of the operation of the project.

With regards to the detection of longer-term incremental changes, both incremental and immediate changes will be detected by the methodology as a result of comparing the impact bore to reference bores. Incremental deviations/impacts will result in additional triggers and thresholds due to poorer model fits/model predictions.

Recent review of the model has occurred and considered the relationship between tidal inundation and the reference bores. This means that fitting or adjusting the tidal effects on the bore water level data will remove a substantial part of the "noise", giving greater statistical power for any monitoring process. The monitoring of long-term effects can be carried out by analysing the tide corrected daily average levels and including a trend or "expected project impact" term in the model.

The approach will be similar to the short-term change detection but using the full dataset, not a moving window. Consideration will be given to appropriately incorporating fixed thresholds or trigger levels for this long-term context.

Impact and Reference Bores

Optimal reference bores were selected for each impact bore using Dynamic Time Warping (DTW). Through advanced statistical analysis, impact and reference bores for Ponds 1 to 5 have been selected and shown in Appendix E1Table 14.

The use of three reference bores for each impact bore improved forecast accuracy and trigger detection as well as being consistent with guidelines (a deviation from just one reference bore suggests a change in the reference bore, rather than the impact bore).

With the additional months data now available, Data Analysis Australia is also refining and reviewing the choice of control bores for each reference bore to take into account the explicit incorporation of tidal factors to ensure the matches are appropriate prior to monitoring.

Where more northerly bores (or bores that are less likely to become impact bores themselves in the near future or at any time) are deemed suitable as a control bore for statistical purposes, these bores will be chosen in preference to closer bores that will become impact bores, to reduce/minimise the need to change control bores during the monitoring.

Additionally, they are being rechecked for matching purposes with the tidal influences being explicitly taken into account giving an improved understanding of the relationships between bores. This may mean revisions to what are considered controls, although the principle of having control bores will be the same.

As more data becomes available through the filling of Ponds the DTW will inform a review and selection of impact and reference bores for the rest of the Ponds and for those Ponds where impacts are detected and therefore new Reference bores are deemed necessary.

False Positives

As outlined in the updated Monitoring methodology reports from DAA (see Appendix E1, page 17); Since running the models on a daily basis from 1/7/2024, only 3 one-day ahead triggers have been set across all bores combined. This improvement from early model runs is likely due to model stabilisation, but could also be natural variation from month to month.

7 day triggers have identified more false triggers than 1 day triggers, however this is expected due to the forecasts being made 7 days in advance. Often the actual groundwater value will be outside the forecast prediction interval due to a change observed in both the impact bore and reference bores during that week, however, as the change in the reference bores have also not yet been observed when forecasting 7 days in advance, this is cannot be identified until reviewing the trigger.

Importantly, no false positive threshold events have been observed in any of the data sets, which points strongly to the robustness of the methodology.

By the end of the filling of ponds 1 to 3, analysis will be undertaken to assess the false positives and power of introducing a second criterion into the definition of a trigger. The existing criterion (the predicted value falling outside the 95% prediction interval) will remain, however, an additional criterion may be added to incorporate a magnitude effect as well.

The intent of this criterion is to minimise false positive outcomes, but also has been deemed appropriate by reviewing outcomes of applying the methodology to current data (prior to pond filling), whereby it has been observed that the triggered values are well within range of the existing natural variation.

Online Tool

An online tool is underdevelopment to be used for real time alerts and data analysis. The online tool is currently under development in prototype model. It is being developed in the statistical package R, using R Shiny.

Whilst not critical for undertaking analysis of whether triggers or thresholds are exceeded (this can be done manually, and this will be the case until the online tool is finalised), the tool will allow direct data access to enable automated data downloads for the short-term monitoring on an automated, time granular level. Daily or twice weekly alerts of triggers/thresholds being exceeded for the short-term monitoring will be in place prior to pond filling depending on the status of the automated data downloads.

Automated emails will be sent to team members at BCI whenever a trigger or threshold is observed. The tool will show graphical displays of the data (impact and reference bores) to assist with the understanding, review and investigation. Standardised reports (for example, on a monthly basis) will also be generated.

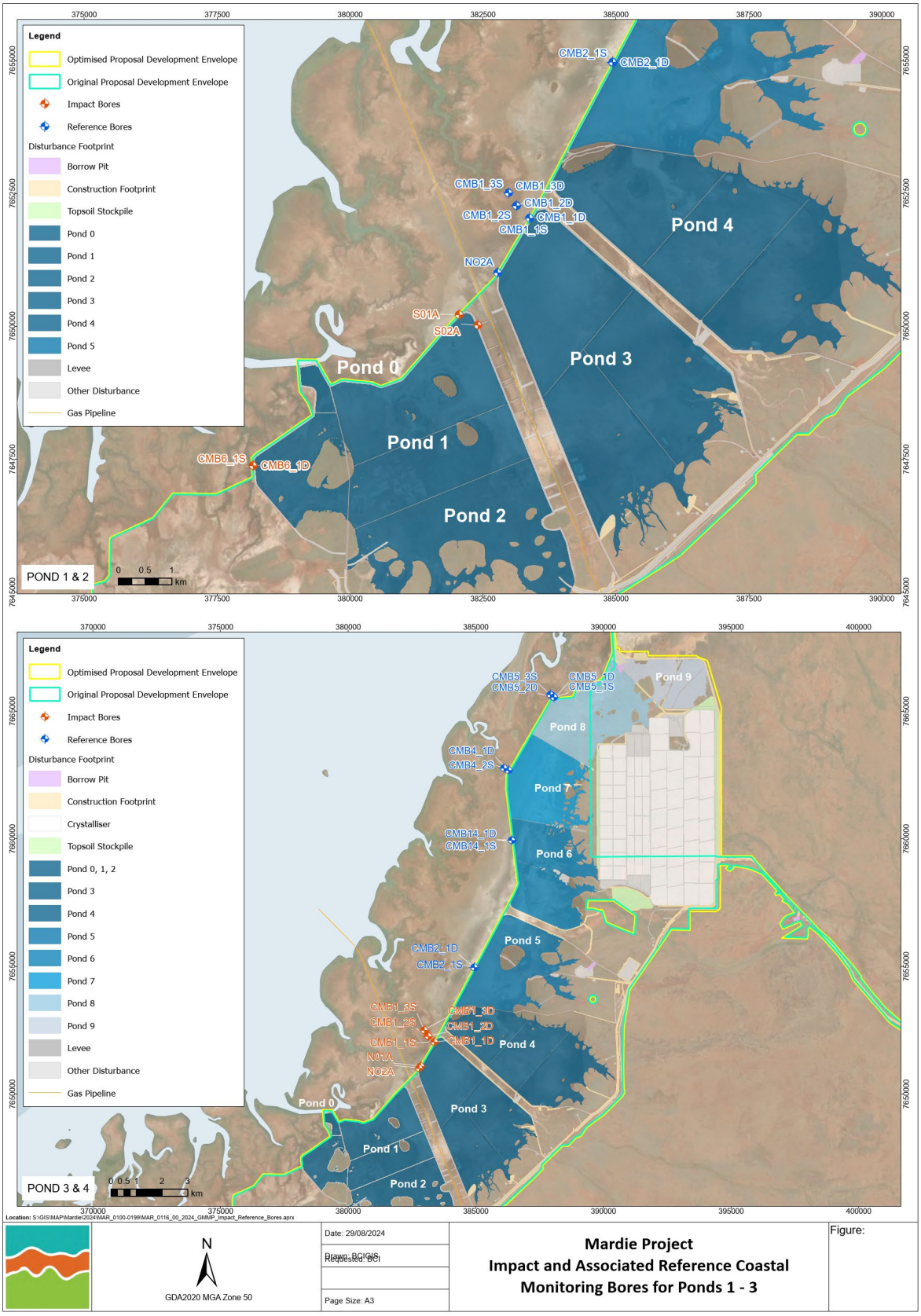
Table 14 Impact and Reference Bore Locations

Location of Bores	Impact Bore ID	Easting (GDA2020MGA50)	Northing (GDA2020, MGA50)	Reference Bore ID	Easting (GDA2020, MGA50)	Northing (GDA2020, MGA50)
Pond 1 (Relevant for Ponds 1 and 2)	CMB6_1D	378175	7647383	CMB1_3D	382980	7652508
				CMB1_2D	383128	7652269
				CMB1_2S	383129	7652266
	CMB6_1S	378176	7647381	CMB1_3D	382980	7652508
				CMB1_2D	383128	7652269
				CMB1_2S	383129	7652266
	S01-A	382051	7650222	N02-A	382774	7651011
				CMB2_1D	383128	7652269
				CMB2_1S	383128	7652269
	S02-A	382404	7650023	CMB2_1D	383128	7652269

Location of Bores	Impact Bore ID	Easting (GDA2020MGA50)	Northing (GDA2020, MGA50)	Reference Bore ID	Easting (GDA2020, MGA50)	Northing (GDA2020, MGA50)
				CMB1_1D	383372	7652041
				CMB2_1S	383128	7652269
Pond 3 (Relevant for Ponds 3 and 4)	CMB1_1D	383372	7652041	CMB2_1D	383128	7652269
				CMB3_1D	386909	7659595
				CMB3_1S	386816	7659632
	CMB1_1S	383371	7652040	CMB2_1S	383128	7652269
				CMB2_1D	383128	7652269
				CMB3_1S	386816	7659632
	CMB1_2D	383128	7652269	CMB2_1D	384937	7654966
				CMB2_1S	384937	7654967
				CMB3_1S	386816	7659632
	CMB1_2S	383129	7652266	CMB3_1D	386909	7659595
				CMB2_1S	384937	7654967
				CMB2_1D	384936	7654966
	CMB1_3D	382980	7652508	CMB4_1D	386279	7662680
				CMB5_1D	388059	7665542
				CMB5_2D	387975	7665603
	CMB1_3S	382978	7652508	CMB5_3S	387917	7665647
				CMB5_1S	388054	7665546
				CMB4_2S	386095	7662768
	N01-A	382834	7651093	CMB2_1S	384937	7654967
				CMB3_1S	386816	7659632

Location of Bores	Impact Bore ID	Easting (GDA2020MGA50)	Northing (GDA2020, MGA50)	Reference Bore ID	Easting (GDA2020, MGA50)	Northing (GDA2020, MGA50)
				CMB2_1D	384936	7654966
	N02-A	382774	7651011	CMB2_1S	384937	7654967
				CMB3_1S	386816	7659632
				CMB2_1D	384936	7654966

Figure 17 Impact and Reference Bore Locations



3.1.3 Electrical Conductivity – Coastal Bores/ Pipeline Bores

EC (salinity) in groundwater has been chosen as an indicator as a change from baseline and/or seasonal values may indicate the presence of brine seepage from the evaporation or crystallizer ponds. The advantage of using EC as an indicator of groundwater quality change is that the potential source of leakage – the evaporation ponds and crystallisers – are carefully managed and monitored and hence the brine concentration from these potential sources will always be measured.

EC data across the Coastal Monitoring bore network has been collected progressively since August 2023 with the progressive installation of new bores and in-situ instrumentation and telemetry.

With an increase in data from the telemetry installation, a similar M-BACI approach to that proposed for the water level criteria has been used to determine trigger and threshold salinity values. This approach, which can be more simply applied to salinity data because it is inherently less variable than tidally influenced groundwater data, is articulated in Appendix E2.

3.1.4 Benthic Communities and Habitats - Indicators

Changes to intertidal benthic communities and habitat (BCH), including mangrove, coastal samphire and algal mat could occur as a result of changes to groundwater regimes or groundwater quality.

Thus, the health, extent and diversity of BCH will be monitored in parallel to the indicators above as detailed in the Benthic Communities and Habitats Monitoring and Management Plan (BCHMMP).

The approved BCHMMP has identified the following Indicators which are presented here in the context of the relationship between the two plans. Note that the response to triggers and thresholds associated with BCHMMP indicators will be undertaken through that plan and not the GMMP:

- Algal Mat Health – quarterly replicate transects
- Mangrove Health – quarterly replicate quadrats
- Samphire Health – quarterly replicate quadrats
- Subtidal seagrass Health – quarterly replica transects
- Tidal flood height / surface water height

3.1.5 Mardie Pool – groundwater level and quality

Mardie Pool has been excluded from the Development Envelope to avoid direct impacts from the proposal. The key impact pathway to groundwater quality at the Mardie Pool is therefore through potential leakage of highly saline water from the crystallisers into the groundwater table.

BCI has installed groundwater monitoring bores between the crystallisers ponds and Mardie Pool (refer to Figure 8 (page 39) and Table 4 (page 40-42)) which will be used to monitor whether the Proposal may have any potential indirect impacts to groundwater at Mardie Pool.

Electrical Conductivity (EC) as a measure of salinity was assessed as the most appropriate ongoing groundwater indicator for identifying changes, as per the objectives of this GMMP. Additionally, Bromide has also been chosen as a groundwater quality indicator as it is a direct measure of brine associated with seawater with a low risk of variation.

Groundwater level monitoring at the Terrestrial Bore Monitoring Network has been ongoing since 2022 as described in Table 4. Manual water level readings are also being taken from Mardie Pool directly (installation of a permanent bore is not possible due to traditional owner concerns regarding disturbance to a sacred site which is also gender restricted (i.e. women only)) for groundwater quality at Quarterly frequencies consistent with ANZG (2018).

The key impact pathway to groundwater quality at the Mardie Pool is the potential leakage of highly saline water from the crystallisers into the groundwater table. Electrical Conductivity (EC) as a measure of salinity was therefore assessed as the most appropriate ongoing groundwater indicator for identifying changes, as per the objectives of this GMMP. Additionally, Bromide has also been chosen as a groundwater quality indicator as it a direct measure of brine associated with seawater with a low risk of variation.

Quarterly EC monitoring has occurred over a 2 year period in April 2022, July 2022, November 2022, April 2023, September 2023, December 2023 and March 2024. The baseline EC (salinity) (µS/cm) and baseline Bromide (mg/L) data have been used to derive interim trigger and threshold values (Table 16).

Interim Trigger and threshold values (Table 15)have been derived based on a High Level of Ecosystem Protection (HEPA) which, based on the recommended approaches and trigger values in ANZECC & ARMCANZ (2000), involves the comparison of 'test' data to the 20th and/or 80th percentile of background data. A high level of ecosystem protection (for marine ecosystems in WA) allows for small detectable changes beyond limits of natural variation, but no resultant effect on biota (EPA 2016). This is equivalent to the process recommended for slightly to moderately disturbed ecosystems as described in ANZG (2018).

We consider these interim triggers to be appropriate for the purpose of providing limits that trigger management actions should they be breached. In line with the ANZ Guidelines (2018), data collected to date spans 2 years of data collection (commencing in April 2022), and incorporates samples from years that were both significantly wetter and drier than average (average rainfall at Mardie = 274.9mm/yr; 2022 had 350.5mm, 2023 had 220mm and to date 2024 is a very low rainfall year (72.2mm compared to the average as at end of July of 255.2mm (Source – Bureau of Meteorology (Mardie weather station) Bureau of Meteorology site location map (bom.gov.au)

It is noted that until recently, the data has been collected quarterly, however given it spans the range of wet and dry years, it is reasonable to expect that fewer data will produce a naturally conservative set of percentile-based triggers and thresholds compared to a more densely populated dataset with a greater density of data collected around a central tendency. This conservatism affords greater protection for Mardie Pool, and we therefore reiterate that the current dataset is appropriate for setting interim triggers and thresholds.

Notwithstanding this, in recent months, all of the Mardie Pool groundwater monitoring bores have been telemetered (refer to Table 4), and now provide hourly water level and conductivity data. This data will augment previously collected data and will be progressively used to update trigger and threshold levels.

In the coming months, as more hourly data becomes available, the method employed above to set interim triggers and thresholds will be considered alongside alternate methods, including the monitoring methodology developed by DAA for the coastal groundwater monitoring bores (Appendix E1 and E2), and a final mechanism for determining triggers and thresholds for Mardie Pool will be outlined in the next version of the GMMP (Rev N), to be submitted after pond 3 filling.

3.1.6 Mt Salt Mound Spring

It has been suggested that the source of Mt Salt spring be determined through water sample analysis. Personnel have visited Mt Salt on several occasions, the most recent being 23 August 2023, but no water has been present. Anecdotal evidence suggests that the mound spring has not flowed for some time.

Mt Salt Mound Spring is within the coastal hypersaline plume of the tidal flats and also in a direction perpendicular to the dominant groundwater gradient so any seepage from the crystallisers is unlikely to have effect in that direction.

Whilst no criteria have been developed in relation to Mt Salt, Mardie Minerals will continue to regularly visit Mt Salt to check for artesian flow.

Table 15: Interim Trigger and Threshold Values for 'Mardie Pool' monitoring bores

Location	Bore ID	Purpose	Salinity Baseline Median Value EC (µS/cm)[1]	Salinity Trigger Value EC (µS/cm)[2]	Salinity Threshold Value EC (µS/cm)[3]	Bromide Baseline Median Value (mg/L)[4]	Bromide Trigger Levels (mg/L)	Bromide Threshold Levels (mg/L)
Primary Crystalliser – Adjacent	MP06	First line of early detection of seepage from Primary Crystalliser	1500	1500	3000	0.970	0.976	1.94
Mardie Pool – North Side Outside Channel	MP02	Second line of detection of seepage from Secondary Crystalliser	2200	2260	4400	1.8	1.86	3.6
	MP03		2200	2680	4400	1.9	3.58	3.8
	MP04		2400	2520	4800	2.1	2.58	4.2
	MP05		1400	1400	2800	0.87	0.9	1.74
Primary Crystalliser – Up Gradient	MP07	Background monitoring up-gradient from Primary Crystalliser	85000	103200	170000	130	142	260
Secondary/ KTMS Crystallisers – Down Gradient	MP08	Down-gradient monitoring of Secondary Crystalliser	82000	106400	164000	110	128	220
	MP09	Down-gradient monitoring of KTMS	99000	118000	198000	150	162	300
	MP10		1100	1200	2200	0.66	0.69	1.32
Primary Crystalliser – Up Gradient	MP11	Background monitoring up-gradient from Primary Crystalliser	1200	1240	2400	0.72	0.762	1.44
	MP12		7800	8020	15600	8.7	8.76	17.4
Primary Crystalliser – Adjacent	MP13	First line of early detection of seepage from Primary Crystalliser	2000	2020	4000	1.5	1.56	3
	MP14		1600	1620	3200	1.1	1.16	2.2
	MP15		1500	1500	3000	0.95	0.98	1.9
	MP16		2500	2640	5000	2.15	4.3	2.18
Mardie Creek - Upstream	MP17	Upstream channel monitoring for base flow, adjacent to crystalliser	2500	3820	5000	3	6	3.72
	MP18	Upstream channel monitoring for base flow	1300	1720	2600	0.37	0.74	0.658
	MP19							

Notes:
[1]: Baseline value calculated as Median EC of samples collected to date. Values to be revised quarterly as more sample data are acquired.
[2]: Trigger value calculated as sustained quarterly EC increases above the 80% percentile. Values to be revised quarterly as more baseline data is acquired and true seasonal/event-driven variations are measured.
[3]: Threshold value calculated as a quarterly EC increase of 100% of baseline (i.e. doubling). Values to be revised quarterly as more baseline data is acquired and true seasonal/event-driven variations are measured

3.2 Outcome-based Provisions

EPA Factors: Inland Waters and Benthic Communities and Habitats.

EPA Objectives:

- To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.
- To protect benthic communities and habitats so that biological diversity and ecological integrity are maintained.

EPBC Approval Objectives

- Protection of EPBC matters and habitats associated with the Mardie Pool, terrestrial, intertidal and subtidal areas

Outcome of Pond filling and operations

- No changes to the health, extent or diversity of intertidal benthic communities and habitat, including mangrove, coastal samphire and algal mat, as a result of changes to groundwater regimes or groundwater quality associated with the proposal.
- No adverse impact to water level or water quality in Mardie Pool as a result of changes to groundwater regimes or groundwater quality

Key Environmental Values: benthic communities and habitats, significant fauna and their habitats.

Key impacts and risks: changes to hydrological regimes or water quality.

Table 16 Outcome-based Provisions and Monitoring – Outcome 1 (BCH)

Outcome 1 No changes to the health, extent or diversity of intertidal benthic communities and habitat, including mangrove, coastal samphire and algal mat as a result of changes to groundwater regimes or groundwater quality associated with the proposal**					
Indicators:	Response actions:	Monitoring Indicators, Methods, and Locations	Monitoring Timing and Frequency	Reporting	Applicable Approvals
Trigger criterion 1 • Observed data outside of ARIMA 95% confidence interval based on approach developed by Data Analysis Australia (Appendix E & K) [1]. **Threshold criterion 1** • Trigger exceedance observed for one week or longer.	**Trigger criterion 1 actions** • Exceedance reporting (as per Section 3.4.2 of this Plan) • Increased data download frequency to daily to support investigation of trends. • Review of available groundwater level data from all available monitoring bores to determine the temporal and spatial trends. • Investigation undertaken and completed to determine cause of trigger criterion within 1 month of detection. • Investigation into BCH health as per the BCHMMP adaptive management framework. • Review of operational control effectiveness – Pond wall integrity, evidence of leakage, operating levels for example.	**Indicator** • Groundwater level change outside of environmental variation. **Method for data collection and analysis** • Continuous water level monitoring in all impact/reference/coastal monitoring bores – download via telemetry / manual. • Daily analysis **Location of impact / reference monitoring bores** • Coastal and Pipeline Monitoring Bores	Daily Monitoring	As per Section 3.4.	MS 1211, EPBC 2018/8236

[1] Because of the cyclical nature of water levels in the region (biweekly cycles related to tidal influences or monthly cycles), a dynamic approach to trigger definition is required rather than simple thresholds on water levels. Mardie Minerals propose to use an Integrated Moving Average (ARIMA) model to detect changes at the impact bore relative to the reference bores. A trigger is defined to occur when the observed water level is outside of the 95% confidence intervals of the ARIMA model forecasts. Use of three reference bores for each impact bore improved forecast accuracy and trigger detection. This approach can be delivered in real time via an online tool that sends trigger alerts as they are detected or monthly. The impact and associated references bores are shown in Figure 17 and detailed in Table 14.

Outcome 1 No changes to the health, extent or diversity of intertidal benthic communities and habitat, including mangrove, coastal samphire and algal mat as a result of changes to groundwater regimes or groundwater quality associated with the proposal**					
Indicators:	Response actions:	Monitoring Indicators, Methods, and Locations	Monitoring Timing and Frequency	Reporting	Applicable Approvals
	Threshold criterion 1 actions Phase 1 • Investigation undertaken to determine cause of threshold exceedance within 1 month of detection. • Investigation into BCH health as per the BCHMMP adaptive management framework. • Review of operational control effectiveness – Pond wall integrity, evidence of leakage, operating levels for example. • Implement relevant management actions under the BCHMMP. • Suspension of any ongoing pond filling/transfer activities. Phase 2 • Exceedance reporting (as per Section 3.4.2 of this Plan) • Depending on the outcomes of initial investigations, operational control mitigation and management measures will be proposed that are specific and measurable to rectify any loss of product from operating ponds. • Examples are provided below that would be considered noting that each exceedance will be considered individually, and also in the context of the overall system performance. • Installation and/or operation of seepage recovery bores or other interception method (e.g.				

Outcome 1 No changes to the health, extent or diversity of intertidal benthic communities and habitat, including mangrove, coastal samphire and algal mat as a result of changes to groundwater regimes or groundwater quality associated with the proposal**					
Indicators:	Response actions:	Monitoring Indicators, Methods, and Locations	Monitoring Timing and Frequency	Reporting	Applicable Approvals
	trenches) down-gradient from the impact site(s) to recover brine seepage). • If required, seepage recovery, would involve the installation of seepage recovery bores or other interception method (e.g. trenches where viable) down-gradient from the potential seepage source. • The recovered groundwater would be pumped to an appropriate disposal location (likely to be the adjacent evaporation pond). • Additional monitoring bores may also be installed between the between the affected bores and the relevant sensitive receptor to assist in confirming the effectiveness of the seepage recovery. Ongoing review of EC and groundwater level data from adjacent bores to determine the effectiveness of seepage recovery methods. Phase 3 • If response measures are not found to be effective in reducing/reversing the impact, commence controlled emptying of the pond(s) adjacent to the impact site(s). • Progressive options may include: transfer of brine into adjacent ponds to reduce level/accelerate evaporation; in-pond dilution and release of brine to the environment at background EC concentration levels.				

Outcome 1 No changes to the health, extent or diversity of intertidal benthic communities and habitat, including mangrove, coastal samphire and algal mat as a result of changes to groundwater regimes or groundwater quality associated with the proposal**					
Indicators:	Response actions:	Monitoring Indicators, Methods, and Locations	Monitoring Timing and Frequency	Reporting	Applicable Approvals
Trigger criterion 2 • Mean monthly EC value in impact monitoring bore(s) is greater than 10% above the median baseline value for the reference bore/s **Threshold criterion 2** • Mean monthly EC value in impact monitoring bore(s) baseline is greater than 20% above the median baseline value for the reference bore/s	**Trigger criterion 2 actions** • Exceedance reporting (as per Section 3.4.2 of this Plan) • Increased data download frequency to daily to support investigation of trends. • Review of available EC data from across all available monitoring bores to determine the temporal and spatial trends. Investigation undertaken and completed to determine cause of trigger criterion within 1 month of detection. • Investigation into BCH health as per the BCHMMP adaptive management framework. • Review of operational control effectiveness – Pond wall integrity, evidence of leakage, operating levels for example. **Threshold criterion 2 actions** Phase 1 • Exceedance reporting (as per Section 3.4.2 of this Plan) • Investigation undertaken to determine cause of threshold exceedance within 1 month of detection. • Implement relevant management actions under the BCHMMP. • Suspension of any ongoing pond filling/transfer activities. Phase 2	**Indicator** Electrical conductivity (EC) change outside of environmental variation **Method for data collection and analysis** • EC logger in coastal monitoring bores / download via telemetry/manual. • Manual monitoring for Terrestrial bores where EC logger not yet installed. **Location of impact / reference monitoring bores** • As shown in Figure 17 and described in Table 14	Once telemetry is installed - daily.	As per Section 3.4.	MS 1211, EPBC 2018/8236

Outcome 1 No changes to the health, extent or diversity of intertidal benthic communities and habitat, including mangrove, coastal samphire and algal mat as a result of changes to groundwater regimes or groundwater quality associated with the proposal**					
Indicators:	Response actions:	Monitoring Indicators, Methods, and Locations	Monitoring Timing and Frequency	Reporting	Applicable Approvals
	• Depending on the outcomes of initial investigations, operational control mitigation and management measures will be proposed that are specific and measurable to rectify any loss of product from operating ponds. • Examples are provided below that would be considered noting that each exceedance will be considered individually, and also in the context of the overall system performance. • Installation and/or operation of seepage recovery bores or other interception method (e.g. trenches) down-gradient from the impact site(s) to recover brine seepage). • If required, seepage recovery, would involve the installation of seepage recovery bores or other interception method (e.g. trenches where viable) down-gradient from the potential seepage source. • The recovered groundwater would be pumped to an appropriate disposal location (likely to be the adjacent evaporation pond). • Additional monitoring bores may also be installed between the between the affected bores and the relevant sensitive receptor to assist in confirming the effectiveness of the seepage recovery. Ongoing review of EC and groundwater level data from adjacent bores to determine the effectiveness of seepage recovery methods. Phase 3				

Outcome 1 No changes to the health, extent or diversity of intertidal benthic communities and habitat, including mangrove, coastal samphire and algal mat as a result of changes to groundwater regimes or groundwater quality associated with the proposal**					
Indicators:	Response actions:	Monitoring Indicators, Methods, and Locations	Monitoring Timing and Frequency	Reporting	Applicable Approvals
	• If response measures are not found to be effective in reducing/reversing the impact, commence controlled emptying of the pond(s) adjacent to the impact site(s). • Progressive options may include: transfer of brine into adjacent ponds to reduce level/accelerate evaporation; in-pond dilution and release of brine to the environment at background EC concentration levels.				

Table 17 Outcome-based Provisions and Monitoring – Outcome 2 (Mardie Pool & Mt Salt Mound)

Outcome 2: No adverse impact to water levels or water quality in Mardie Pool or Mt Salt Mound Spring because of changes to groundwater regimes or groundwater quality					
No. Indicators:	Response actions:	Monitoring Indicators, Methods, and Locations	Monitoring Timing and Frequency	Reporting	Applicable Approvals
Trigger criterion 1 • EC median value in monitoring bore(s) up-gradient from Mardie Pool display sustained EC increases above trigger criteria (Table 15). **Threshold criterion 1** • EC median value in monitoring bore(s) up-gradient from Mardie Pool display sustained EC increases above the threshold criteria (Table 15).	**Trigger criterion 1 exceedance action** • Implement monthly monitoring frequency for water quality at the bore and immediately adjacent bores (where these exist). • Investigation undertaken to determine cause of impact within 1 month of detection. Research undertaken to determine means of mitigating cause of impact if deemed to be attributed to the Proposal. • Review of operational control effectiveness – Pond wall integrity, evidence of leakage, operating levels (for example). **Threshold criterion 1 exceedance action** • Develop and implement Management Response Plan and mitigation actions within 1 month of threshold exceedance.	**Indicator** • Electrical conductivity (EC) Method for data collection and analysis • Water sample from upper 2m of the water column. • EC telemetry data **Location of monitoring sites** • Terrestrial monitoring bores • Additional monitoring bore sites to be located and installed for Mt Salt Mound Spring (pending modelling results)	• Monthly groundwater quality sampling. • Monthly monitoring of EC profiles to be implemented within 1 month of trigger criterion being identified, to end of the quarter.	As per Section 3.4.	MS 1211, EPBC 2018/8236

Outcome 2: No adverse impact to water levels or water quality in Mardie Pool or Mt Salt Mound Spring because of changes to groundwater regimes or groundwater quality					
No. Indicators:	Response actions:	Monitoring Indicators, Methods, and Locations	Monitoring Timing and Frequency	Reporting	Applicable Approvals
	• Depending on the outcomes of initial investigations, operational control mitigation and management measures will be proposed that are specific and measurable to rectify any loss of product from operating ponds. • Examples are provided below that would be considered noting that each exceedance will be considered individually, and also in the context of the overall system performance.				
Trigger criterion 2 • Bromide median concentration increases above the trigger criteria (Table 15). **Threshold criterion 2** • Bromide median concentration in monitoring bore(s) up-gradient from Mardie Pool above the threshold for criteria (Table 15).	**Trigger criterion 2 actions** • Implement weekly monitoring frequency for water quality and level. • Investigation undertaken to determine cause of impact within 1 month of detection. Research undertaken to determine means of mitigating impact if deemed to be attributed to the Proposal • Review of operational control effectiveness – Pond wall integrity, evidence of leakage, operating levels for	**Indicator** • Groundwater quality parameters (bromide concentration) as an indicator of brine derived from sea water. **Method for data collection and analysis** • Water sample from monitoring bores for laboratory analysis. **Location of monitoring sites** • Terrestrial monitoring bores • Additional monitoring bore	• Monthly groundwater quality sampling.		MS 1211, EPBC 2018/8236

Outcome 2: No adverse impact to water levels or water quality in Mardie Pool or Mt Salt Mound Spring because of changes to groundwater regimes or groundwater quality					
No. Indicators:	Response actions:	Monitoring Indicators, Methods, and Locations	Monitoring Timing and Frequency	Reporting	Applicable Approvals
	example. **Threshold criterion 2 action** • Develop and implement Management Response • Plan and mitigation actions within 1 month of threshold exceedance. • Depending on the outcomes of initial investigations, operational control mitigation and management measures will be proposed that are specific and measurable to rectify any loss of product from operating ponds. • Examples are provided below that would be considered noting that each exceedance will be considered individually, and also in the context of the overall system performance.	sites to be located and installed for Mt Salt Mound Spring (pending modelling results)			

3.3 Monitoring Schedule

3.3.1 Groundwater Monitoring

Monitoring commenced in early 2022 across the terrestrial monitoring bore network and will continue as per Table 18. Coastal monitoring bores have all been fitted with depth loggers, set to record water level up to hourly. These remote loggers are connected to telemetry systems for remote data download to enable real time checking / or downloaded.

The current schedule for groundwater monitoring is provided in Table 18.

BCI commits to doing daily downloads of telemetered EC and groundwater level data and analysing them to determine if there have been trigger or threshold exceedances (as outlined in the DAA reports at Appendices E1 and E2) each day of pond filling for ponds 1-3. The need for daily downloads will be reviewed following the filling of Pond 3, and data to support a forward approach will be included in the resubmitted GMMP Rev N.

Mardie Pool sampling is done manually, and does not have a groundwater bore installed (in consideration of cultural heritage concerns relating to the possible disturbance to a sacred site with gender restrictions (i.e. women only)). From the approval of this GMMP, this sampling will be undertaken manually on a monthly basis (subject to Traditional Owner permissions).

3.3.2 Groundwater Management Response Plan Framework (GMRPF)

Mardie Minerals has a range of statutory requirements and other actions required of our approval conditions that will determine our response to any trigger or threshold exceedance of groundwater level or saliinity. The Groundwater Management Response Plan Framework (GMRPF) outlined below is intended to be complementary to those requirements, and will be initiated in the event that there is an exceedance of groundwater level or EC trigger (as outlined in the DAA methodologies in Appendices E1 and E2, respectively).

Trigger Exceedance

If there is an exceedance of a trigger values, the following process will be implemented. The investigation and responses will be dependent on the particulars of the trigger exceedance but as a minimum, BCI will

- **Step 1: Define the exceedance:**
    - Location and date / measurement
    - Scale of exceedance
    - Relationship to previous exceedances (i.e. 1 day v 7 day; is it a threshold exceedance)
- **Step 2: Identify the cause:**
    - Non-operational causes may include sampling/measurement errors, weather/climatic influences, natural variation, sensor or software malfunction;
    - Operational related causes may include seepage from ponds/crystallisers, leak from pipelines or overtopping of ponds.

      Note: Operational related causes might be best assessed by reviewing the effectiveness of existing operational risk reduction controls (e.g. as outlined in Table 12 of this GMMP)

If the cause of the trigger is attributable to the Proposal, BCI will assess and implement an appropriate management and mitigation action. This could be something very minor (e.g. fixing a pipe) or more

significant. Some potential responses are listed below, but note this is not an exhaustive list – it will very much depend on the nature and cause of the trigger exceedance:

- **Step 3: Determine and implement appropriate 'Trigger' response**
    - Make minor repairs, as appropriate
    - Shut off water flows into pond/s if leaks are detected, or adjust the brine flows between ponds (using pumps, gates and weirs)
    - Increase the appropriate freeboard of the pond and adjust pond operating level
    - Install cut-off bores, sumps and/or trenches and pump the water to the appropriate salinity pond
    - Rectify breaches in pond walls to be structurally stable, fix containment systems and leaks in internal drainage structures
    - Review the steady-state average brine density for each pond, and modify the 'Brine Movement Plan'
    - Dilute the brine or slow down the evaporation process by pumping in additional seawater from the primary or secondary seawater intake system.

Which of these (or potentially other) measures is implemented will depend on the nature and location of the mitigation that is required. BCI acknowledges that some of these measures may, in and of themselves, introduce additional impacts to the environment, and so need to be carefully managed. Any plan developed to respond appropriately to a trigger exceedance that minimises environmental impacts will therefore need to be determined and risk assessed prior to implementation. BCI commits to undertaking this bespoke assessment of the response within 5 days of the exceedance. This 5 day timeframe will not preclude the implementation of low-risk responses that could be implemented immediately to minimise environmental risk (e.g. repair of pond walls).

- **Step 4: Monitoring and reporting the 'Trigger' response**
    - Continue with routine monitoring of exceedance/s of the trigger/threshold criterion
    - Implement any additional measures to minimise/prevent unauthorised harm to Protected Matters
    - Continue with routine monitoring of Protected Matters in accordance with EPBC 2022/9169 and MS 1211 and/or update frequency of monitoring
    - Articulating the reporting requirements of this response
    - Outline management options to avoid future exceedances.

The nature and frequency of monitoring will be entirely dependent on Steps 1-3, but will likely involve additional monitoring to be undertaken as part of the BCHMMP and/or the MSMMP. Timeframes for monitoring the response will be bespoke depending on information from steps 1-3 above. Work undertaken during this step of the response will also identify a timeframe for evaluation of the monitoring to be undertaken.

Threshold Exceedance

Threshold exceedance occurs after 7 consecutive days of triggers. The following steps will be undertaken if there is a threshold exceedance:

- **Step 5: Reassess the 'Trigger' response**

- Evaluate the efficacy of the management and contingency measures already implemented
- Evaluate the need for additional monitoring required to investigate potential other causes of the exceedance / impact
- Conduct further technical investigations to be conducted and how to prevent the likelihood of continued exceedances without further management actions or intervention

- **Step 6: Identification and evaluation of additional measures**

It is not possible to reasonably determine what additional measures will be required. It will depend on the nature and location of the mitigation that is required, and the success (or otherwise) of measures implemented to date. BCI acknowledges that some of these additional measures may, in and of themselves, introduce additional impacts to the environment, and so need to be carefully managed. Any plan developed to respond appropriately to a trigger exceedance that minimises environmental impacts will therefore need to be determined and risk assessed prior to implementation. BCI commits to undertaking this bespoke assessment of the response within 10 days of the exceedance. As for the trigger response, this 10 day timeframe will not preclude the implementation of low-risk responses that could be implemented immediately to minimise environmental risk (e.g. repair of pond walls).

- **Step 7: Implementation, Monitoring and ongoing review of additional measures**

Additional measures identified during Step 6 will be implemented. All monitoring and reporting undertaken as a result of implementing Step 4 will be reviewed and changes implemented. A range of other actions may be undertaken depending on the nature and scale of the response, and in close collaboration with the regulators and in accordance with our statutory requirements and other requirements of our conditions of approval.

- **Step 8: Remediation Plans**

In line with both State and Commonwealth conditions of approval, Mardie Minerals will prepare remediation plans for consideration by the regulators within 6 months of breaching any threshold condition.

Review of process

The GMRPF outlined above will be trialled during the filling of ponds 1-3, and will be reviewed and updated/refined in the subsequent update to this GMMP. Ongoing, this process and the validity of the conclusions reached by using this process will be independently reviewed after 12 months or after the first 10 exceedances occur, and then subsequently again with each scheduled review of the GMMP.

Table 18 Monitoring schedule

Purpose	Location	Parameter/s	Frequency Duration
Terrestrial Monitoring Bores			
Groundwater level	Table 5	Water level	Daily via telemetry
Groundwater quality		EC Bromide/pH	Daily via telemetry Monthly
Coastal Monitoring Bores			
Groundwater level monitoring	Tables 7 and 8	Water level	Daily via telemetry
Groundwater quality		EC	
Ponds			
Structural integrity, leakage and soils associated with evaporation pond walls	All Ponds	Evidence of seepage or spill	Weekly via Site Environmental Management Plan

3.3.3 Benthic Communities and Habitats (BCH)

The BCHMMP (Rev E 13/11/23) describes the monitoring and management measures to be implemented by Mardie Minerals to protect the health, diversity, and extent of BCH.

Monitoring will be undertaken quarterly at each site within the first two years, and then on an ongoing bi-annual (at the end of the dry and the wet seasons) frequency:

- Algal Mat Health – quarterly replicate transects
- Mangrove Health – quarterly replicate quadrats
- Samphire Health – quarterly replicate quadrats
- Subtidal seagrass Health – quarterly replica transects
- Tidal flood height / surface water height

If GMMP triggers are exceeded, monitoring for investigative purposes will also be undertaken as described in Section 3.1.3.3 of the BCHMMP (and as described under Step 4 of the Management Response Plan Framework, (Section 3.3.2).

3.3.4 Operational Monitoring and Controls

BCI Minerals will be undertaking a range of operational management practices that are relevant to achieving the objectives of the GMMP and in particular the management of the Brine product to prevent its loss of containment from the evaporation ponds and other structures. These monitoring activities will trigger review and actions if required, in accordance with the BCI Environmental Management System, the Operational Environmental Management Plan, the BCHMMP and this GMMP.

These measures include:

- Weekly visual inspections of Pond condition and any leakage, and the follow up of evidence through internal investigations (noting these are not trigger or threshold exceedance events)
- Weekly visual inspections and observations of adjacent habitat areas to the Evaporation Ponds such as Algal Mats (noting these are not trigger or threshold exceedance events)
- Daily site inspections of water infrastructure – pumps, roads, flow equipment.

Operational controls within the sea water pumping and storage system of relevance include:

- Pumps for sea water controlled by the Digital Control Centre via telemetry
- Ongoing pumping and water management infrastructure maintenance programs
- Weekly pond testing of brine density as a control of evaporation versus losses
- Operational pond modelling to calculate steady state brine densities and pond depths with weekly review frequencies.

3.4 Reporting

3.4.1 Compliance Reporting

Monitoring data will be assessed against trigger and threshold criteria and reported in both a quarterly summary report and an annual report to the company CEO. If the trigger or threshold criteria (or both) are exceeded during the groundwater monitoring period, the annual report will include a description of the effectiveness of trigger criteria level actions, and threshold criteria contingency actions that have been implemented to manage the impact, as well as an analysis of trends.

A Compliance Assessment Report (CAR) will be submitted to the Compliance Branch at DWER annually. The CAR will document compliance with conditions of approval including assessment of compliance with management plan requirements where management plans form part of the approval conditions. The CAR will be prepared in accordance with the Post Assessment Guideline for Preparing a Compliance Assessment Report, Post Assessment Guideline No. 3 (OEPA, 2012).

A groundwater summary report will be prepared and submitted to DCCEEW and/or DWER (as required) each calendar year as per the EMP. The report will:

- Summarise groundwater level and quality, identifying any exceedance of trigger and threshold criteria.
- Provide details on contingency actions taken in the event of exceedance of trigger and threshold criteria exceedances.

3.4.2 Regulatory Reporting

Annual monitoring reports, as described above, will be provided to DCCEEW on an annual basis.

In accordance with Conditions of MS 1211, EPBC 2018/8236 and EPBC 2022/9169, if monitoring or investigations at any time indicate an exceedance of threshold criteria specified in the GMMP, Mardie Minerals will undertake the following actions:

- Report the exceedance(s) to DCCEEW (in writing) within 7 days of the exceedance(s) being identified.
- Implement the threshold contingency actions required by the GMMP and continue to implement those actions until the CEO (and DCCEEW) has confirmed by notice in writing that it has been demonstrated that the threshold criteria are being met and implementation of the threshold contingency actions are no longer required.
- Within 21 days of being aware of the exceedance (MS1211) Mardie Minerals will provide a report to the CEO (and DCCEEW), including the following:
- Details of contingency actions implemented.
- Implemented threshold contingency actions.
- The effectiveness of contingency actions against threshold criteria.
- Investigation findings.
- Measures to prevent the threshold criteria being exceeded in the future.
- Justification of the threshold criteria remaining or being adjusted based on better understanding.
- These actions will be conducted in accordance with criteria set by MS 1175.
- In accordance with Condition 5(b) of EPBC 2018/8236, Mardie Minerals will within 6 months of any such exceedance, have the GMMP reviewed by an independent suitably qualified hydrologist to advise if the GMMP needs to be revised to prevent any possibility of the exceedance reoccurring and submit the report of the independent suitably qualified hydrologist to the Department. If the review of the GMMP by an independent suitably qualified hydrologist recommends that the GMMP be revised, the approval holder must submit the revised GMMP to the Department for the approval of the Minister within 8 months of any such exceedance.

3.4.3 Remediation Plan

In accordance with Condition 5(c) of EPBC 2018/8236, exceedance of threshold criteria specified in the GMMP will trigger the development of a Remediation Plan to be reviewed alongside the GMMP by an independent suitably qualified hydrologist within 6 months of the exceedance being reported.

The Remediation Plan will describe:

- Contingency measures and remediation actions to be undertaken in response to a threshold exceedance.
- Details of those actions with regards to location, resource requirements, performance indicators and timing to achieve outcomes.
- Responsibilities and how BCI and specialist resources will be utilised, for example technical experts.
- Operational requirements during the term of the remediation action including any amendment or reduction requirements.
- Reporting and review requirements and commitments

If the independent review recommends that the GMMP be revised, Mardie Minerals will submit a revised GMMP to DCCEEW for the approval of the Minister within 8 months of any such exceedance, and an offset strategy to manage impacts where required.

A commitment has been included in Section 3.5 to develop a Project Remediation Plan that will be used as the basis for all Remediation Plan requirements.

3.4.4 Offset Strategy

In accordance with Condition 5(e) of EPBC 2018/8236, Mardie Mineral's note that if the Minister determines that it is not possible to remediate the impact of the exceedance, then Mardie will, within 10 months of the exceedance of the threshold criterion, submit an Offset Strategy specifying how the impact will be offset in accordance with the Environmental Offsets Policy.

If the Offset Strategy has not been approved by the Minister in writing within 11 months of the exceedance event, and the Minister notifies the approval holder that the Offset Strategy is not suitable for approval, the Minister may, at least two months after so notifying the approval holder, approve a version of the Offset Strategy revised by the Department. The approval holder must implement the approved Offset Strategy for the remainder of the life of the project.

3.5 Commitments Register

Table 19 Commitments Register

GMMP Reference	Commitment	Timing / Deliverable	Approval Reference
Modelling			
2.7 2.8.4 Appendix A	Conceptual and Impact Groundwater Model and GMMP update: Pond 1 Transect (Ponds 1, 2 and 3)	Completed, 2024. (Report attached to GMMP Rev M).	MS1211 EPBC 2018-8236; EPBC 2022-9269
2.3 2.8.4	Conceptual and Impact Groundwater Model and GMMP update: Pond 6 Transect (Ponds 4/5 and 6)	Completed, 2024. (Report attached to GMMP Rev M).	MS1211 EPBC 2018-8236 EPBC 2022-9269
	Conceptual Groundwater Model and GMMP update: Mardie Pool / Crystallisers transect.	Completed, 2024. (Report attached to GMMP Rev M).	MS1211 EPBC 2018-8236 EPBC 2022-9269
	Conceptual and Impact Groundwater Model Pond 8 Transect for Ponds 8 and 9 and Crystallisers.	Completed, 2024. (Report attached to GMMP Rev M).	MS1211 EPBC 2018-8236 EPBC 2022-9269
	Conceptual and Impact Groundwater Model *Validation and Calibration* and GMMP update.	Within 12 months of the GMMP approval and on an annual frequency for 3 years after approval of the GMMP.	MS1211, EPBC 2018-8236 EPBC 2022-9269
Appendix Q	Regional Groundwater Model	Commenced, to be completed in Q4 2024. Subsequent update to GMMP.	EPBC 2018-8236 (Groundwater Memo) EPBC 2022-9269

GMMP Reference	Commitment	Timing / Deliverable	Approval Reference
2.5 Table 2	The following investigations are to be undertaken with the findings incorporated into an updated GMMP: • All groundwater monitoring data collected to date and throughout the staged filling to be included in the groundwater model and an automatic model calibration process applied for the successively growing calibration period (e.g., using PEST-IES, White et al., 2020), which will allow for model uncertainty to be quantified as a by-product of the model calibration. The model uncertainty must then be considered in the predictive model simulations. • Model predictions must be undertaken for the entire project lifetime to consider the full impact of the project, including the more slowly occurring impact of salinity changes. • Determine approximate aquifer residence times by collecting environmental tracer data (groundwater	At the conclusion of filling evaporation ponds 1 through 3	EPBC2022/9169 (Condition 63)

GMMP Reference	Commitment	Timing / Deliverable	Approval Reference
	age tracers) to provide greater evidence supporting the proposed "slow" groundwater flow. • .A regional groundwater model that demonstrates an understanding of, and supports the ability to predict, the potential impacts of the proposed action on the regional groundwater system and nearby receptors. This must include groundwater hydrology in areas upstream of the evaporation ponds, for input into the groundwater modelling.		
Monitoring and Survey			
2.7	Initial groundwater bore installation	Completed in 2023.	MS1211, EPBC 2018-8236 EPBC 2022-9269
Section 3.1.3. (Impact and Reference Bores)	Additional bore installation to support ongoing control/reference bore selection and inform Stage 2 Regional Groundwater Modelling	Completed in Q3 2024	MS1211, EPBC 2018-8236 EPBC 2022-9269
3.1.2	Trigger and Threshold Criteria review and Control/Reference Bore Selection for Pond 4 through 8.	Commenced, to be completed in Q3 2024.	MS1211, EPBC 2018-8236 EPBC 2022-9269

GMMP Reference	Commitment	Timing / Deliverable	Approval Reference
3.1.5	Trigger and Threshold Criteria and monitoring frequency review for Mardie Pool.	To be completed within 3 months of commencement.	MS1211, EPBC 2018-8236
3.3	Water level (VWP) and quality (EC/pH) instrumentation/telemetry installation for existing Coastal and Terrestrial Monitoring Bores.	Completed in Q3 2024 (excluding those to be manually monitored)	MS1211, EPBC 2018-8236 EPBC 2022-9269
	Groundwater level / head monitoring	Hourly, with data download via telemetry.	MS1211, EPBC 2018-8236 EPBC 2022-9269
	Groundwater EC monitoring – Coastal Bores	Hourly, with data download via telemetry.	MS1211, EPBC 2018-8236 EPBC 2022-9269
Table 5, 7	Groundwater EC / pH monitoring – Terrestrial Bores	All telemetry installation completed for 74 bores	MS1211, EPBC 2018-8236 EPBC 2022-9269
2.6 Appendix Q	Mardie Pool Surface Water / Groundwater investigation and ongoing monitoring	Completed, 2024. (Report attached to GMMP Rev L) Ongoing Monthly monitoring.	MS1211, EPBC 2018-8236 EPBC 2022-9269
2.6 Appendix Q	Mt Salt Mound Spring Monitoring	Commenced in 2022. Quarterly monitoring ongoing.	MS1211, EPBC 2018-8236 EPBC 2022-9269
3.1.4. 3.3.3	Benthic Communities and Habitat Monitoring	Quarterly for first 2 years, then biannually as per the Benthic Communities and Habitat Monitoring and Management Plan (BCHMMP)	MS1211, EPBC 2018-8236 EPBC 2022-9269
Investigation and Reporting			
3.1	Weekly Pond Condition Inspections	Weekly initially, with review after 6 months	EPBC 2018-8236 EPBC 2022-9269
3.1.1	Monthly control and reference bore matching data review to inform ongoing suitability	Monthly, internal report and action when there is a material finding.	MS1211, EPBC 2018-8236 EPBC 2022-9269
Table 19 3.1.2	Trigger and Threshold Criteria exceedance investigations	From commencement of operations at a frequency and detail described in this Plan in Table 18.	MS1211, EPBC 2018-8236 EPBC 2022-9269
3.4.2	Investigation Reporting	Timing as per the investigation protocols in the GMMP, investigation report.	MS1211, EPBC 2018-8236 EPBC 2022-9269
3.4 2.6	Review of GMMP monitoring data upon a trigger or threshold	As per timing and details in the BCHMMP	MS1211, EPBC 2018-8236 EPBC 2022-9269

GMMP Reference	Commitment	Timing / Deliverable	Approval Reference
	exceedance occurring through the BCHMMP		
3.4 2.6	Review of BCHMMP monitoring and management actions including reactive monitoring whenever a GMMP Threshold exceedance occurs	From commencement of operations at a frequency and detail described in this Plan in Table 18.	MS1211, EPBC 2018-8236 EPBC 2022-9269
3.4.3	Review of the GMMP	October 2024 (MS1211)	MS1211 EPBC 2018/8236
2.5 Table 2	Review of the GMMP, based on the review completed by a reviewer, or reviewers approved by the department. The : • Monitoring required by the approved GMMP, including monitoring bore network, monitoring methodology, monitoring frequency, and trigger and thresholds. • Implementation of the GMMP, • Effectiveness of the GMMP regarding the achievement of its environmental objective • Capacity to measure incremental impacts at the conclusion of the Ramp period • Assessment of whether the GMMP requires revision at this time.	After 2 years of the commencement of the Action	EPBC 2022/9169 (Condition 67)
2.5 Table 2	Revision of the GMMP in line with the recommendations of the review	Following the review of the GMMP as required by Condition 67	EPBC 2022/9169 (Condition 68)

GMMP Reference	Commitment	Timing / Deliverable	Approval Reference
	required by Condition 67 and submitted to the department for approval by the Minister. The revised GMMP must include: • Revised modelling that includes all data collected to date • Revised monitoring and management measures in accordance with recommendations of the review undertaken in Condition 67.		
2.5 Table 2	Review the approved GMMP and submit the findings of each review to the department. The review must be completed by a reviewer or reviewers approved by the department and must include detailed reviews of the: • Monitoring required by the approved GMMP, including monitoring bore network, monitoring methodology, monitoring frequency, and trigger and thresholds. • Implementation of the GMMP, • Effectiveness of the GMMP regarding the achievement of its environmental objective.	At least once within every subsequent 5 year period following the approval of the GMMP.	EPBC 2022/9169 (Condition 69)

GMMP Reference	Commitment	Timing / Deliverable	Approval Reference
2.5 Table 2	The GMMP must be revised in line with the recommendations of the review required by Condition 67 and submitted to the department for approval by the Minister. The revised GMMP must include: • Revised modelling that includes all data collected to date • Revised monitoring and management measures in accordance with recommendations of the review undertaken in Condition 67.	After 2 years of the commencement of the Action	EPBC 2022/9169 (Condition 70)
2.5 Table 2	For any revision of the GMMP, all commitments in the GMMP, including environmental outcomes, management measures, corrective measures, trigger values, thresholds and performance indicators must be SMART and based on referenced or included evidence of effectiveness and in accordance with Condition 65. The GMMP must be consistent with the Environmental Management Plan Guidelines, and must include:		EPBC 2022/9169 (Condition 71)
3.4.1	Monitoring data self assessment protocol - internal	Annual Report	Internal Commitment
	Groundwater summary data report – DWER and DCCEW	Quarterly	MS1211, EPBC 2018-8236 EPBC 2022-9269
	Compliance Assessment Reporting – DWER	Annually	MS1211

GMMP Reference	Commitment	Timing / Deliverable	Approval Reference
	EPBC Compliance Report - DCCEEW	Annually	EPBC 2018/8236 EPBC 2022-9269
3.4.1	10 year Environmental Performance Report	Within 3 months of the expiry of the ten year period from substantial commencement	MS1211, D2-7 EPBC 2022-9269
2.5 Table 2	In the event of seepage and/or brine spill at the evaporation pond walls: • The findings of the seepage and/pr brine spill event investigation; • Details of corrective measures implemented • An evaluation of the effectiveness of the corrective measures implemented.; • Measures to prevent another seepage and/or brie spill event occurring in the future.	In writing, within 5 business days of the event.	EPBC 2022/9169 (Condition 43)
Additional Commitments			
	Agency Communication and Check in: - Fortnightly during Pond filling including data provision	Fortnightly, by phone call / email	NA
2.6	Review of GMMP alongside the BCHMMP	Within 1 year of MS 1211 approval: by 19 October 2024	MS1211, B3-2 (2)
4.2	GMMP review (internal)	Annually and in response to significant amendments	
4.2	Independent GMMP review by suitably qualified hydrologist, and updated GMMP if required	At least once before every 10 year anniversary of the plan for the life of the project	EPBC 2018/8236 EPBC 2022-9269
2.5 Table 2	Independent review of the modified Before/After Control Impact approach proposed by Data Analysis Australia.	At the conclusion of filling evaporation ponds 1 through 3	EPBC 2022/9169 (Condition 63)

GMMP Reference	Commitment	Timing / Deliverable	Approval Reference
2.5 Table 2	Submit a revised GMMP to the department for approval by the Minister. The GMMP must be updated with sufficient information and data to address Condition 62 and Condition 63 and be resubmitted to and approved by the Minister and DWER in writing prior to filling any other ponds.	Within 3 months of the conclusion of filing evaporation ponds 1 through 3	EPBC 2022/9169 (Condition 64)
2.5 Table 2	The approval holder must not undertake any further filling of the ponds until the revised GMMP is approved in writing by the Minister.	Within 3 months of the conclusion of filing evaporation ponds 1 through 3	EPBC 2022/9169 (Condition 64)
2.5 Table 2	The revision required by EPBC 2022/9169 Condition 62 must include: • a table of commitments made in the plan to achieve the environmental outcome, and a reference to exactly where these commitments are detailed in the plan, • details of the data collection and modelling undertaken to inform the GMMP, • impact avoidance, mitigation and/or repair measures, and the timing of those measures, • commitments capable of ensuring that the environmental outcomes are achieved,	Within 3 months of the conclusion of filing evaporation ponds 1 through 3	EPBC 2022/9169 (Condition 65)

GMMP Reference	Commitment	Timing / Deliverable	Approval Reference

	• a monitoring program, which must include:
	  ○ The early warning trigger values for groundwater regimes, groundwater quality, and groundwater levels that will trigger the implementation of management and/or contingency actions to prevent non-compliance with conditions B3-1 of the WA Approval,
	  ○ the thresholds for groundwater regimes, groundwater quality, and groundwater levels to demonstrate compliance with condition B3-1 of the WA Approval,
	  ○ the final design of monitoring that will meet the requirement of condition B3-1 of the WA Approval, including the timing and frequency of monitoring, ensuring monitoring is capable of detecting trigger values and thresholds,		

GMMP Reference	Commitment	Timing / Deliverable	Approval Reference
	○ corrective measures which must be implemented in response to trigger value exceedances, ○ corrective measures which must be implemented in response to threshold exceedances, ○ proposed corrective measures if trigger values are reached, and • details of how trigger value and threshold exceedances will be assessed to determine if the exceedance is a result of the Action, ○ The approval holder must provide written justification in the form of a report as an appendix to the GMMP, for the proposed triggers, limits triggers and indicators as they relates to the protection of MNES habitat by providing analysis of baseline data (from relevant locations in the receiving environment)		

GMMP Reference	Commitment	Timing / Deliverable	Approval Reference

	and comparison with *Australian and New Zealand guidelines for fresh and marine water quality* (2018), or default guideline values for high conservation/ecological value systems.
	• details of seepage recovery measures that will be implemented where seepage from evaporation ponds to groundwater is detected,
	• an assessment of the effectiveness and reliability of the proposed monitoring system, including:
	  ○ demonstrate if and how the monitoring system will be able to detect changes to groundwater regimes, groundwater quality, and groundwater levels until at least the anticipated completion of the Action, and
	  ○ demonstrate if and how the monitoring system will be able to determine if exceedances are attributable to the Action		

GMMP Reference	Commitment	Timing / Deliverable	Approval Reference
	• reporting and review mechanisms to demonstrate compliance with the commitments made in the plan and the requirement specified in condition B3-1 of the WA Approval, including a commitment to review the GMMP at least once every 5 years, • an assessment of risks relating to achieving the environmental outcomes and risk management strategies and/or mitigation measures that will be applied to address identified risks, and • references to other relevant plans or conditions of approval (including state approval conditions).		
2.5 Table 2	If the revised GMMP required in condition 62 is not approved within 12 months of the date of evaporation ponds 1 to 3 being filled, the approval holder must undertake the following: - Empty evaporative ponds 1 to 3. Contents of evaporative ponds is to be disposed in a manner approved in writing by the department.	Within 12 months of the date of the evaporation ponds 1 to 3 being filled	EPBC2022/9169 (Condition 66)

GMMP Reference	Commitment	Timing / Deliverable	Approval Reference
3.3.2	Independent review of assessment of validity of the groundwater impact investigation and response process will be trialled during the filling of ponds 1-3, and will be reviewed and updated/refined in the subsequent update to this GMMP.	independently reviewed after 12 months or after the first 10 exceedances occur, and then subsequently again with each scheduled review of the GMMP.	

4. ADAPTIVE MANAGEMENT AND REVIEW OF THE PLAN

4.1 Adaptive Management Process

Mardie Minerals is committed to improving environmental results and management practices throughout the implementation of the Project and therefore will use an adaptive management approach for this GMMP. Adaptive management practices will include:

- Monitor and evaluate performance against the outcome-based triggers and thresholds. Perform quarterly reviews of monitoring data and compare data and information against established baseline, trigger and threshold values and ongoing monitoring and reference data.
- Monitor and evaluate the effectiveness of the management actions against the management targets.
- Review of management actions throughout the implementation of the Project, and identification of potential new management measures, methodologies, and technologies that may be more effective.
- Specifying monitoring and reporting procedures to provide for continuous improvement, consistent with an adaptive management approach.
- In the event one or more of the triggers, thresholds or management targets has not been met, or is considered at risk of not being met, review and adjust the management measures and monitoring to ensure the objectives are met, based on what is learned from evaluation of the monitoring data, or any new data that becomes available.
- Review any assumptions considering the monitoring data or any new data that becomes available.
- Review/audit of the outcomes and revisions of the GMMP discussed further in Section 4.2 and as per the frequency noted in Section 3.5.

4.2 Review

As per the requirements of both State and Commonwealth regulators, this GMMP and the DAA reports associated with it (Appendices E1 and E2) will be reviewed and resubmitted after filling of pond 3. In addition to the requirements for an updated GMMP outlined in conditions 62-65 of the draft OMP conditions (see table 2, p.20-22), data and other information collected during the filling of ponds 1-3 will be used to:

- Review and refine our groundwater transect modelling and regional modelling and adjust any management requirements accordingly
- Review and refine our groundwater level and salinity monitoring methodology under operating conditions.
- Review and refine operational procedures (e.g. staged filling of ponds) and improve pond filling processes accordingly
- Review and refine our groundwater impact investigation and response process (if trigger or threshold responses are observed) (see Section 3.3.2, p.106)

The approved GMMP will continue to be implemented and should updates or revisions be required based on the outcomes of ongoing modelling and/or gathering of data from additional baseline monitoring, subsequent revisions will be submitted to DCCEEW for review and approval by the Delegate.

GMMP will be reviewed every 12 months and as required following significant amendments for example in response to the adaptive management process outlined above and as described in Table 19.

A separate review, by an independent suitably qualified hydrologist, will be completed at least once before every 10-year anniversary of the first approval of the GMMP, and subsequently every 10 years for the life of the project (unless specified by the Minister in writing). A revised GMMP addressing the recommendations

of this review, accompanied by the recommendations of review, will be submitted to the CEO and DCCEEW for approval, within 3 months of the most recent 10-year anniversary of the first approval of the GMMP.

Mardie Minerals will update and submit proposed amendments to the Plan following every review (if that review recommends changes), including each independent hydrologist review.

All reviews, including annual reviews, will include:

- Outcomes of monitoring programs.
- Recommendations from the reviewer(s), including that of the independent hydrologist.
- Implementation and effectiveness of management measures and monitoring programs.
- Threshold/trigger criteria and threshold/trigger level actions.
- Review of any exceedances and investigations during the review period.
- Longer term trend analysis.
- Changes to relevant legislation, policy, guidelines, management plans and industry practices.
- Changes to operational activities.
- Changes to approval conditions.
- Changes to the conservation status of fauna species.
- The identification of a conservation significant fauna species not previously confirmed within the Project area.
- Recurring incidents of death/injury to a conservation significant fauna species.
- Stakeholder consultation.

4.2.1 Peer Review

An independent peer review was undertaken in 2021 (report dated 5/01/22, Appendix C) with the purpose of providing an assessment and analysis of the suitability of an early version of the GMMP to adequately and correctly address the study outcomes to achieve the objectives with confidence. The peer review was a requirement of Ministerial Statement (1175) 1211 and EPBC 2018/8236 and is included as Appendix C.

The peer reviewer provided a number of recommendations and observations including:

- Justification to demonstrate that generated data will accurately represent the baseline.
  - Provided for in modelling studies and GW level indicator methodology.
- Installing multilevel bores or set of bores with various screen level.
  - Coastal bore network installed – deep and shallow bores.
- Monitoring bores at the location west side of pond 1 and around Robe River delta.
  - Coastal bore network installed – RRDMA avoided.
- Rationalisation for the monitoring well positions and their adequacy.
  - Coastal bore network installed, described in AQ2 reporting.
- Plan and potential steps to minimise identified preliminary triggers.
  - Trigger and threshold criteria, mitigation and management actions.
- Hydrological regime in the project area to address the gaps of the baseline data.
  - Provided for in modelling studies and GW level indicator methodology.
- Establishing an adequate linkage between the investigations and the claimed identification data for the conceptualisation.
  - Conceptualisation in modelling report.

- Deeper discussion of the uncertainties about natural recharge and evaporation estimates and changes.
  - Conceptualisation in modelling report.
- Saline water flow influence on regional groundwater flows paths.
  - Conceptualisation in modelling report.
- Collecting the water quality data for Mardie pool and creeks.
  - Quarterly monitoring since 2022.
- Review and elaboration on the indirect impacts of the project on BCH, availability of historical data.
  - Described in BCHMMP and link to GMMP.
- Estimation of the evapotranspiration, quantification of the acceptable level of impact
  - Conceptualisation in modelling report
- Salt precipitation and dissolution processes in modelling
  - Conceptualisation in modelling report
- Management and mitigation actions of the potential environmental impacts and risks of long-term environmental changes such as climate change.
  - GMMP relevant management and mitigation actions included. Climate Change impacts assessed through EIA process.

The GMMP was subsequently updated to address those matters of relevance under the Federal and State approval conditions noting that a number of observations were considered outside the scope of the GMMP approval conditions.

Following a number of iterations of the GMMP and review by DWER and DCCEEW, a second independent review (Appendix G) was undertaken of the GMMP and the initial peer review recommendations and observations. The review noted that the updated GMMP had adequately addressed the peer review recommendations, and also provided additional observations.

This Revision M represents cumulative updates across bore installation, baseline data gathering and supporting technical studies including modelling. Table 13 provides direct responses to observations and recommendations from these peer reviews.

4.3 Roles and Responsibilities

As outlined in our Environmental Policy, Mardie Minerals is committed to fully complying with applicable environmental laws and regulations and will strive to carry out all activities in a manner that minimises impacts to the environment. Further, Mardie Minerals commits to the sustainable management and efficient use of natural resources, and to the research, development, and management of the surrounding ecosystems.

The GMMP will be implemented within the overarching framework of the BCI Minerals Environmental and Social Management System Framework (June 2021) which includes the responses to incidents, complaints and emergencies, internal review and auditing and implementation of the Mardie Minerals environmental policy.

Mardie Minerals roles and responsibilities relevant to the implementation of the Plan are outlined in Table 20.

Table 20 Roles and Responsibilities for Plan Implementation

Role	Responsibility
Manager Environment and Approvals	Liaise with regulatory authorities as required. Ensure monitoring and management actions are implemented in accordance with this Plan. Ensure reporting to regulatory agencies is undertaken in accordance with this Plan. Manage the review and revision of the GMMP. Lead investigations associated with the plan and monitor and close out corrective actions identified during environmental monitoring or audits Ensure the annual submission of the Ministerial Statement Compliance Assessment Report (CAR) and the annual EPBC compliance report. Ensure other reporting is undertaken in accordance with this Plan (including the reporting/submission of documents and data (as required) under EPBC 2018/8236 Conditions 5 to 9).
Site Environmental Advisor/s	Oversee and support the implementation of GMMP monitoring programs, studies and maintain monitoring records. Support reporting, and the provision of data, to regulators as required under this plan. Develop and deliver awareness training programs to personnel, contactors, and visitors with respect to key requirements under this GMMP. Provide advice to relevant BCI personnel and Contractors to assist them to understand their GMMP responsibilities. Ensure all personnel and contractors involved in GMMP surveys and studies are appropriately experienced, qualified and supervised.
Other Staff and Contactors	Ensure that all relevant activities are undertaken in compliance with this GMMP. Report any events or matters through to Mardie Minerals management. Participate in investigation and inspections as required.

5. STAKEHOLDER CONSULTATION

Mardie Minerals has consulted extensively with and will have ongoing consultation with all stakeholders who are affected by the proposal. This includes (but not limited to):

- Indigenous community groups (Wirrawandi Aboriginal Corporation (WAC), Robe River Kuruma Aboriginal Corporation (RRKAC).
- Neighbouring pastoral lease owners (Pastoral Management Pty Ltd (PMPL)).
- Government agencies (EPA, DMIRS, DWER; DBCA, Department of Planning, Lands and Heritage (DPLH); Main Roads Western Australia (MRWA); Pilbara Ports Authority; Department of Climate Change, Energy, the Environment and Water (DCCEEW)).
- Local Government (Shire of East Pilbara and Town of Port Hedland).
- Community / Special interest Groups (Hampton Harbour Boat and Sailing Club, Nickol Bay Sporting Fishing Club, Wildflower Society, Rangelands Natural Resource Management WA, Birds Australia / Birdlife Australia.

Consultation regarding the Mardie Salt Project has included both the Original and the Optimised Proposals. In addition to the consultation completed in relation to the Proposals, additional consultation has more recently been undertaken with key stakeholders in relation to the Plan and will continue throughout the life of the Project.

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Appendix A: Conceptual Groundwater System and Modelling Assessment (AQ2, 2024)

Appendix B: Mardie Project – Status of Hydrogeological Investigations (AQ2 , 21 December 2023)

Appendix C: Pond Filling Schedule

Appendix D: Staged Filling of Ponds

Appendix E: E1 Mardie Project – Groundwater Level Monitoring (DAA 2024a) and

E2 Mardie Project – Salinity Monitoring (DAA 2024b)

Appendix F: Peer Review of GMMP

Appendix G: Audit of BCI's Responses to Peer Review (CyMod 2023)

Appendix H: Statement Against Significant Guidelines for MNES

Appendix I: Geophysical Survey Report

Appendix J: DWER Comments Response

Appendix K: Triggers and Thresholds Methodology

Appendix L: Groundwater Memo

Appendix M: Groundwater Interaction Assessment

Appendix N: DCCEEW Comments

Appendix O: Pond Transect 8/9 Impact Modelling Memo

Appendix P: Ponds 8 and 9 Wall Realignment

Appendix Q: Additional Context, Scope and Rational Supporting Information (details removed from Section 2 of GMMP (Rev L))