

Review of Groundwater Monitoring & Management Plan for Mardie Salt and Potash Project

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Mardie Project Groundwater Monitoring and Management Plan - Optimised Design

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ABSTRACT

The proposal of Mardie Salt and Potash Project, an evaporative solar facility for high quality salt and sulphate of potash production, located at Mardie, approximately 80 km southwest of Karratha, in the Pilbara region of Western Australia. The Mardie Project Groundwater Monitoring and Management Plan - Optimised Design (GWMMP-OD) describes the monitoring and management measures to be implemented by Mardie Minerals during the construction and operation of the Project; to ensure minimal residual impact on the groundwater dependent ecosystems and other vegetation, by minimising changes to groundwater regimes. GWMMP-OD consists of sections including context, scope and rationale, baseline data, potential ecological stressors, monitoring and investigations, review, responses to potential environmental impacts, reporting, groundwater and seepage modelling, adaptive management and review, and stakeholder consultation. GWMMP-OD proposal was reviewed independently, prior to submission to WA Department of Water and Environment Regulation (DWER) for approval. It contains the required information based on relevant conditional clauses of Ministerial Statement No 1175.

Herein, GWMMP-OD proposal was independently reviewed. This review has the same pattern as the GWMMP-OD report and presents the comments and assessment of each specific section of GWMMP-OD separately, in the hope to improve the clarity of the project and bring forward a different perspective. Although the plan has been designed appropriately and aligned with the current guidelines, it needs to be revised based on the review comments. Following the implementation, a secondary review of the new version of GWMMP-OD is required.

Some of the important comments are concerning: justification for the monitoring well positions and their adequacy, plan and potential steps to minimise these preliminary triggers, monitoring the magnitude of vertical hydraulic gradients and vertical variations of salinity, monitoring the magnitude of vertical hydraulic gradients and vertical variations of salinity, establishing linkage between the investigations and the claimed identification data for the conceptualisation, and management and mitigation actions of the potential environmental impacts and risks of long-term environmental changes such as climate change.

1. INTRODUCTION

The review report is to assess the Mardie Project Groundwater Monitoring and Management Plan - Optimised Design (GWMMP-OD). The Groundwater Monitoring & Management Plan (GWMMP), document number BCI-ADM-TEM-011 Rev 2, dated 14-Dec-2021. The GWMMP-OD incorporated the monitoring network design and outlining the proposed future works by AQ2 (Proposed Investigation and Monitoring Program - Revised Layout). The GWMMP-OD will be submitted to the WA Department of Water and Environment Regulation (DWER) by Mardie Minerals Pty Ltd (Mardie Minerals).

The proposal of Mardie Salt and Potash Project, an evaporative solar facility for high quality salt and sulphate of potash (SoP) production, is located at Mardie, approximately 80 km southwest of Karratha, in the Pilbara region of Western Australia (WA). The GWMMP-OD describes the monitoring and management measures to be implemented by Mardie Minerals during the construction and operation of the Mardie Project (the Proposal or the Project) to minimise the impact on the groundwater dependent ecosystems and other vegetation. The key two objectives of GWMMP-OD are: (1) to plan groundwater monitoring network and additional baseline investigations and (2) to propose groundwater recovery systems to protect the environmental values. The potential sensitive receptors - namely mangroves, algal mat, sapphire and sub-tidal Benthic Communities and Habitat (BCH)- are assessed as secondary parameters to assess changes in groundwater.

The purpose of this report is to provide an independent peer review of the GWMMP, and to assess and analyse the suitability of GWMMP to adequately and correctly address the study outcomes to achieve the objectives with confidence. The specific condition under which this peer review is required, are condition clauses 3-3 and 3-4 of Ministerial Statement No 1175 which are quoted in the following. Condition 3-4 specifies conditions that the GWMMP must address.

3-3 The proponent shall prepare and submit to the CEO a Groundwater Monitoring and Management Plan.

(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).

(2) The proponent shall not commence transfer of seawater, brine or waste product into any evaporation or crystalliser 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.

3-4 The Groundwater Monitoring and Management Plan required by condition 3-3 shall:

(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);

(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;

(4) detail the methodology of seepage recovery actions that will be implemented where seepage from evaporation ponds to groundwater is detected;

(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).

(6) specify threshold criteria to demonstrate compliance with condition 3-1(3).

(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).

(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

(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.

The GWMMP consists of 10 sections including: (1) Context, scope and rationale, (2) Baseline data, (3) Potential ecological stressors, (4) Monitoring and investigations, (5) Review, (6) Responses to Potential environmental impacts, (7) Reporting, (8) Groundwater and seepage modelling, (9) Adaptive management and review, and (10) Stakeholder consultation. The approach that is used in this review, is to follow the same format as the GWMMP-OD and present the comments and assessment of each specific section of GWMMP-OD separately. In a final section of the report all the major comments and major concerns are summarized.

2. REVIEW of the GWMMP-OD

2.1. Context, scope and rationale

GWMMP-OD clearly described the proposal elements, the location of ponds and infrastructure, and the key environmental factors. Groundwater dependent vegetation and ecosystems, as well as vegetation adjacent to ponds that may be sensitive to groundwater mounding are the environmental values that may be impacted by Mardie Project. The scope and requirements as specified within Condition 3-4 of Ministerial Statement 1175 and management objectives were carefully defined.

2.1.1. Comments on 2.1

- Considering the expected operating life of the project of greater than sixty years, management and mitigation actions of the potential environmental impacts and risks of long-term environmental changes such as climate change could be addressed.
- Based on Benthic Communities and Habitat Monitoring and Management Plan (dated 10 November 2020) the project activities may directly affect BCH, including mangrove habitat, algal mat habitat, samphire mudflat habitat, and vegetated sub-tidal habitat. The indirect impacts of the project on BCH have also been properly listed, however discussion of indirect impacts can be suggested.
- A management objective for groundwater base on Management Objectives section (1.5) is *“Ensure that indirect impacts to vegetation and ecosystems because of changes to groundwater regimes are minimised”*. To further clarify discussion of, how can the impact be quantified and what level of impact is acceptable, and which party is responsible for the endorsement of minimised impacts based on ongoing monitoring are important points to emphasise.

2.2. Baseline data

The updated Groundwater Risk Assessment (GRA) for the revised Project layout by AQ2 (2021) was considered to define the baseline data and the potential impacts of the Project on groundwater receptors in the vicinity of Mardie Pool and coastal habitats. A summary of the relevant findings of AQ2 data review was provided in the Table 4 of GWMMP-OD. Conceptual geological models proposed based on Soilwater Group (2019) and CMW (2020) studies, some differences were noticed between these models. The current groundwater quality was established based on several sources. To address the gaps of the baseline data expansion investigations was suggested to achieve the objectives confidently.

2.2.1. Comments on 2.2

- Figures 5, 6 and 7 shows the conceptual and cross section geological profiles. It is helpful to show the cross-section lines in the plan view of the site (e.g. Figure 4).
- Is it possible to provide and illustrate the borehole locations that have been considered for defining the current groundwater quality? Is it possible to provide the contours of groundwater salt concentrations?
- It was stated that *“The groundwater in the calcarenite aquifer is brackish to saline with better quality being associated with the Mardie-pool creek line (likely to result from recharge)”*. Is Mardie-pool a freshwater lens or a gaining surface water body (i.e. getting discharged by groundwater)?

- It was stated that *“Previous investigations at Mardie have indicated that the sea water interface (SWI) is well inland of the coast.”*. Is a SWI investigation (e.g., field measurements and if required numerical modelling) required to find out the SWI interface?
- Water quantity (flux) and quality (salinity or EC) should be measured in creeks.
- It is recommended that the contours of water table and salt concentrations before and after project to be measured and provided.
- In the relevant section to further investigations to address the gaps of the baseline data, addition of more detailed discussion of the hydrological regime in the project area, can be beneficial. Further justification to demonstrate that generated data will accurately represent baseline is recommended.

2.3. Potential ecological stressors

Ecological stressors for the optimised layout were described. Appropriately, further investigation by applying density flow modelling was suggested to study seepage of hypersaline water from evaporation ponds and crystallisers. Fortescue alluvial aquifer formations was explained, and riparian vegetation of Fortescue River valley were illustrated. It was thought that only Mardie Pool riparian vegetation could potentially be impacted by hypersaline seepage from crystallisers. Coastal vegetation, mangrove habitat and algal mats, are within the development envelop and to the west of the proposed evaporation ponds. Key assumptions and uncertainties were identified and itemised.

2.3.1. Comments on 2.3

- It is recommended to include the salt precipitation and dissolution processes in modelling investigations and if required collect the relevant data.
- It is helpful to add the cross-section lines (location) on Figure 8 (Fortescue alluvial aquifer cross section) in the plan view of the site.
- In the key assumptions and uncertainties section the extreme scenarios and conditions including climate change, storms and floods may be addressed. There is uncertainty about natural recharge and evaporation estimates and changes.
- The soil properties and characteristics such as porosity and permeability change due to the salt precipitation and dissolution in porous media, it is recommended to consider a one-dimensional modelling that includes these processes. Based on this analysis the groundwater recharge due to the project may be influenced considerably.
- *“The actions triggers provided in this GMMP are preliminary only”*, what is the plan and potential steps to prevent and minimise these preliminary triggers?
- The considered strategy to address uncertainty is *“Ensure the groundwater investigation and monitoring networks is capable of providing sufficient information to quantify the use of fresh groundwater by BCH, so that response triggers can be optimised to suit the GMMP’s objectives.”*. Is the information sufficient? How are triggers optimised?
- It was assumed that *“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 wells.”*. *“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.”*. It is a fair assumption, yet further and adjustable sampling, and modelling is required. It is advised to provide the quantitate requirements to implements these strategies.

2.4. Monitoring and investigations

Ongoing investigations including Airborne Electromagnetics survey, Mardie Pool bathymetry, and geological fault on Creek and pool development were mentioned. Terrestrial and coastal groundwater monitoring bore networks for Mardie pool and crystallisers, and mangrove and algal mat ecosystems were proposed. Nineteen bores were considered as terrestrial monitoring network phase 1. The technical and legitimate constraints to locating the groundwater monitoring bores such as land tenure boundaries, Aboriginal heritage, and Project footprint design were mentioned. On the assumption of future access to heritage areas around Mardie Pool a Phase 2 of terrestrial monitoring network including 6 bores was proposed. Installation of a monitoring bore network be installed along the western side of the planned evaporation ponds were planned as coastal bore network with three transects of bore sites, each consisting of three sets of bores. Bore installation schedule was described. The groundwater monitoring program including water quality measurement, hydraulic testing and monitoring schedule details were provided.

2.4.1. Comments on 2.4

- Monitoring network bores positions and timings were well explained for sensitive environmental groundwater dependent ecosystems. However, the justifications for the monitoring well positions and their adequacy need further expansion.
- Vertical groundwater gradient and therefore vertical groundwater flow and salinity transport, around crystallisers and evaporation pools, is likely due to the density dependent flow and convective flow. It is recommended, to consider multilevel bores or set of bores with various screen level, in the monitoring bore networks to measure the magnitude of vertical hydraulic gradients and vertical variations of salinity.
- It is suggested that the water quality data for Mardie pool and creeks to be collected in the same time period as when the groundwater monitoring networks are sampled .
- There is no costal monitoring bore at the location west side of pond 1 and around Robe River delta. Isn't the vegetation patch at the location environmentally sensitive? If so, necessary monitoring bores need to be discussed.

2.5. Review

Groundwater monitoring and investigation program may need to be reviewed and readjusted following the analysis of incoming field results as well as the numerical modelling outcomes.

2.5.1. Comments on 2.5

- The review procedure of the results is strongly supported. It is required that the adjusted GWMMP with details and including the outcomes of field and modelling investigations to be peer reviewed independently and endorsed.

2.6. Responses to Protentional environmental impacts

It was considered that the potentially be affected receptors were Mangrove habitat, Algal mat habitat, and Mardie Pool. It was considered that potential mitigation measures would be proposed after the groundwater flow and quality regime investigation. Response measures including more frequent monitoring, seepage recovery and mitigation measures were suggested.

2.6.1. Comments on 2.6

Due to the lack information, the responses to protentional environmental impacts are vague at this stage. The early warning trigger criteria is also ambiguous. Condition 3-4 requires, “*detail the methodology of seepage recovery actions*” and “*specify early warning trigger criteria*”. To meet these criteria, the GWMMP needs to receive necessary approval, to initiate the project to be able to collect required preliminary data, and subsequently provide a more comprehensive assessment and report, for the expansion and finalisation of the plan.

2.7. Reporting

The format and timing for the reporting as a Compliance Assessment Report for the Compliance Branch at the Office of the Environmental Protection Authority were given.

2.7.1. Comments on 2.7

- There is no comment for this section, it was well delivered.

2.8. Groundwater and seepage modelling

Groundwater modelling was effectively utilised to simulate the hydrogeological conditions in the Project area for quantification of fresh and saline water interactions, groundwater recharge into Mardie pool, and groundwater exchanges with the areas of algal mats. A two staged approach was proposed for the study: Stage 1 the interactions between fresher and more saline water close to the coast and around the evaporation ponds, and Stage 2 to simulate the potential interactions of the proposed ponds on the regional groundwater flow system. Modelling approach including data review and conceptualisation, Stage 1 modelling, and Stage 2 regional groundwater modelling were described.

2.8.1. Comments on 2.8

- For the data review and conceptualisation, a list of identification information has been listed, , for example “*Identification of areas or sources of groundwater recharge including recharge from rainfall associated flood plain and flood channels.*”, “*Identification of areas or points of groundwater discharge including groundwater outflow to the coast and surface pools, evapotranspiration from vegetation and shallow water tables*”, and “*Estimates of groundwater recharge and discharge based on regional groundwater gradients.*”. However, it is not very clear how some the information that have been mentioned that would be identified from the investigation data. It is recommended that a clear linkage between the available data and field investigation, and the claimed identification data for the conceptualisation is established in the report.
- Regarding the Stage 1 modelling: Are the unsaturated zone flow and transport processes considered in the simulation? Are the salt precipitation and dissolution processes and their impacts on hydrogeologic properties included in the simulation? Is there any historical data existing? and how the evapotranspiration is estimated?
- Stage 2 regional groundwater modelling is “*the development of a regional groundwater flow model to assess the potential impacts of the proposed evaporation ponds on the regional groundwater system*”. It seems there is an implied assumption that saline water flow (either as seawater intrusion or infiltration from the evaporation ponds) has no influence on groundwater flows paths, what are the justifications for these assumptions and what are the available supporting evidence?

- What are the available historical data for history matching in the Stage 2 regional groundwater modelling?

2.9. Adaptive management and review

An adaptive management approach is applied for improving environmental results and management practices throughout the implementation of the project. Annual review of data, evaluation of monitoring and management outcomes against management targets and the objectives, review of management actions, and identification of potential new management measures and technologies were considered for implementation of the adaptive management approach.

2.9.1. Comments on 2.9

- There is no comment for this section.

2.10. Stakeholder consultation

Formal approval would be sought from DWER for any significant revisions to the GMMP. The main points arising from the submission to the public and WA government departments, including DWER, DAWE and DBCA were included. The plan appropriately emphasises and ensures that incidents, reports and complaints would be recorded, investigated, and acted on in a timely fashion. Regular meetings between groundwater users and stakeholder are maintained. Cultural and Heritage Management Plans and formal working agreements with the YM and KM traditional owner groups will be conducted.

2.10.1. Comments on 2.10

- There is no comment for this section.

3. CONCLUSION

The purpose of this report was to provide an independent peer review of the GWMMP-OD. The suitability of the GWMMP-OD to address the study outcomes adequately and correctly was assessed in depth, and based on this review, the plan has been designed in alignment with the excepted guidelines, however it requires specific improvements to meet its objectives with confidence. Some technical comments were made in an endeavour to provide further modifications and clarifications to the project outlined. Following the implementation of the review comments, a secondary review of the new version of report is required.

In summary, the main aspects that GWMMP-OD need further improvements and elaboration include:

- Justification to demonstrate that generated data will accurately represent the baseline
- Installing multilevel bores or set of bores with various screen level
- Monitoring bores at the location west side of pond 1 and around Robe River delta
- Rationalisation for the monitoring well positions and their adequacy
- Plan and potential steps to minimise identified preliminary triggers
- Hydrological regime in the project area to address the gaps of the baseline data
- Establishing an adequate linkage between the investigations and the claimed identification data for the conceptualisation
- Deeper discussion of the uncertainties about natural recharge and evaporation estimates and changes
- Saline water flow influence on regional groundwater flows paths
- Collecting the water quality data for Mardie pool and creeks
- Review and elaboration on the indirect impacts of the project on BCH, availability of historical data
- Estimation of the evapotranspiration, quantification of the acceptable level of impact
- Salt precipitation and dissolution processes in modelling
- Management and mitigation actions of the potential environmental impacts and risks of long-term environmental changes such as climate change.