MACHEnergy

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23 December 2021

Mr Joe Fittell
Team Leader
Resource Assessments (Coal & Quarries)
Department of Planning, Industry and Environment

By email c/o sarah.clibborn@planning.nsw.gov.au

RE: MOUNT PLEASANT OPTIMISATION PROJECT – REQUEST FOR INFORMATION

Dear Joe,

Further to the New South Wales (NSW) Department of Planning, Infrastructure and Environment (DPIE) request for additional information regarding the Mount Pleasant Optimisation Project (the Project) (letter dated 14 October 2021), please find below and attached MACH Energy Australia Pty Ltd's (MACH's) responses to the targeted peer review completed by Hugh Middlemiss of HydroGeoLogic Pty Ltd (referred to herein as the 'HydroGeoLogic Review').

Subsequent to receipt of DPIE's request for additional information, MACH and its specialists met with HydroGeoLogic and DPIE representatives on 2 December 2021 to discuss the review findings.

The HydroGeoLogic Review provides a number of comments and recommendations related to:

- The Project final landform and analysis of alternative final void scenarios.
- Technical queries regarding the final void water balance and groundwater modelling.
- Final void water quality, including potential for off-site water quality impacts and the influence of potentially acid forming (PAF) materials on long-term water quality.
- Potential impacts on the flow-duration character of the Hunter River as a result of post-mining groundwater take.

The following supplementary technical analysis has been prepared to address the recommendations in the HydroGeoLogic Review and subsequent advice received in the joint meeting:

- *Mount Pleasant Optimisation Project – Response to DPIE Groundwater Peer Review* prepared by Australasian Groundwater and Environmental Consultants Pty Ltd (AGE, 2021) (Attachment A), which has been peer reviewed by Brian Barnett (Jacobs, 2021) (Attachment B).
- *Mount Pleasant Optimisation Project – Responses to Peer Review Comments on Final Void Modelling* (Hydro Engineering Consultants Pty Ltd [HEC], 2021) (Attachment C).
- *Geochemistry Methods, Assumptions, and Estimated Spoil Seepage Salinity and Soluble Metal/Metalloid Concentrations - Technical Memorandum* (RGS Environmental Consultants Pty Ltd [RGS], 2021) (Attachment D).

The development and optimisation of the Project final landform and associated consideration of alternatives in the Project Environmental Impact Statement (EIS), along with a simple summary of the key outcomes of the supplementary technical analysis conducted in response to the HydroGeoLogic Review, is provided below.

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Development and Optimisation of Project Final Landform

A detailed description of the Project final landform and analysis of potential alternatives is provided in the Project Evaluation and Conclusion (Section 8 of the EIS) and Rehabilitation and Mine Closure Addendum (Attachment 8 of the EIS), the *Mount Pleasant Optimisation Project – Submissions Report* and in the supplementary information provided to DPIE on 22 September 2021 (relevant extracts provided in Attachment E).

As documented in Section 3 of the Rehabilitation and Mine Closure Addendum, MACH has been consulting with stakeholders and developing the Project final landform since it acquired the Mount Pleasant Operation in 2016.

MACH is aware of the level of local interest with respect to the shape and form of Mount Pleasant Operation final mine landforms. Accordingly, MACH has undertaken a comprehensive approach to landform design based on the following key design principles that were developed based on feedback from stakeholders (including DPIE, Muswellbrook Shire Council and the NSW Resources Regulator):

- The emplacement landform has been designed to look less "engineered" when viewed from Muswellbrook (i.e. incorporation of macro-relief to avoid simple blocky forms).
- Surface water drainage from the waste emplacement landform incorporates micro-relief to increase drainage stability, avoid major engineered drop structures and limit erosion.
- The final void (and associated drainage network) is shaped to reflect a less engineered profile that is more consistent with the surrounding natural environment.
- The final void has been designed as a long-term groundwater sink to maximise groundwater flows from the Eastern Out-of-Pit Emplacement to the final void.
- MACH continues to progressively develop and revegetate the final landform to reduce visual impacts in Muswellbrook and continue to monitor the performance of rehabilitation and implement remediation as required.

The proposed final landform has been developed using the GeoFluv™ methodology to address these key design principles and iteratively tested using static erosion risk assessment and SIBERIA Landscape Evolution Modelling (LEM). The final landform design is fully integrated into the operational mine plan using Spry™ software that provides integrated dig scheduling, dump scheduling and mine haulage.

The progressive rehabilitation methods that are used to implement and monitor the final landform are described in Section 7 of the Rehabilitation and Mine Closure Addendum.

MACH's final landform design and implementation process was recognised in 2021 by the NSW Resources Regulator in the *Rehabilitation Information Release – Geomorphic landform establishment at Mount Pleasant Operations coal mine* (August, 2021)[1]. The NSW Department of Mining, Exploration and Geoscience (MEG) Submission on the Project also stated the following with respect to the landform design and final void (February 2021):

> *The Proponent is very conscious of the visual aspects of the mine due to the proximity of the mine to Muswellbrook. This in part has affected the mining design and order of operations to date. The final landform has been designed to look natural through the implementation of geomorphic landform design and the final void will be hidden behind from view.*

[1] https://www.resourcesregulator.nsw.gov.au/__data/assets/pdf_file/0008/1327760/RIR21-03-Geomorphic-landform-establishment-at-Mount-Pleasant-Operations.pdf

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MACH's design process has involved numerous iterations of the Project final landform, with each iteration incorporating incremental improvements to optimise the design and integrate the key design principles outlined above. EIS Figures 3-17 and 3-18 show the outcomes of this process. An overview of the most significant landform iterations over the last five years when developing the EIS final landform is provided in Table 1 and shown on Figures 1 to 3.

Table 1
Key Final Landform Development Iterations

Figure	Landform Iteration	Description and Incremental Improvements
1	Pre-MACH Acquisition Life of Mine Plan (2016)	• Final landform based on life of mine planning completed prior to the MACH acquisition of the Mount Pleasant Operation in 2016. • No geomorphic design principles or macro-relief incorporated in final landform. • Extraction of permitted resources in mining lease (i.e. to the boundary of the depth restriction) – not limited to Project life.
2	Initial MACH Life of Mine Final Landform (2018)	• Initial "engineered" final landform based on MACH life of mine planning. • Eastern toe of the emplacement adjusted to better align with the underlying topography (i.e. existing spurs and valleys) as proposed in Modification 3. • No geomorphic design or macro-relief applied to initial landform – simple flat-topped waste emplacement. • Full extraction of permitted resources in mining lease – not limited to Project life.
	Initial Project Geomorphic Conceptual Final Landform (Early 2019)	• Open cut extent limited to Project life. • Initial geomorphic design applied to waste emplacement exterior slopes. • Designed to look less "engineered" when viewed from Muswellbrook (i.e. incorporation of macro-relief to avoid simple blocky forms). • No geomorphic design principles applied to internally draining batters (e.g. final void).
	Project CPDP Conceptual Final Landform (October 2019)	• Incorporates backfill of approximately 1.5 kilometres of the northern part of the final void. • Geomorphic design applied to waste emplacement lowwall (i.e. interior slopes). • Blasting and shaping of final void highwall to reduce slopes.
	Project Conceptual Final Landform – Void Refinements (May 2020)	• Final void further softened in profile, with pit floor raised in some areas. • Slopes further reduced on western highwall and southern endwall. • Geomorphic design incorporated into upper final void slopes.
3	EIS Conceptual Project Final Landform (January 2021)	• Additional refinements associated with optimising slopes and landforms adjoining final void waterbody. • Additional landform and slope refinements arising from the outcomes of SIBERIA LEM and static erosion modelling.

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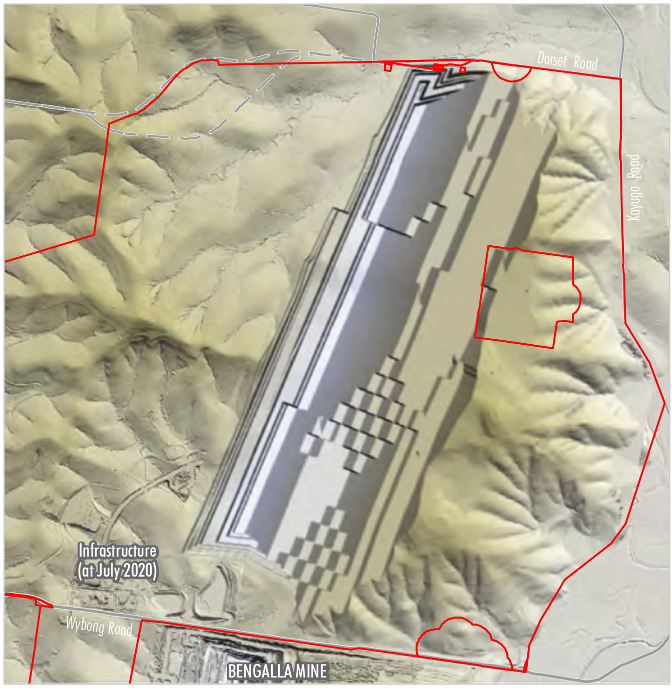
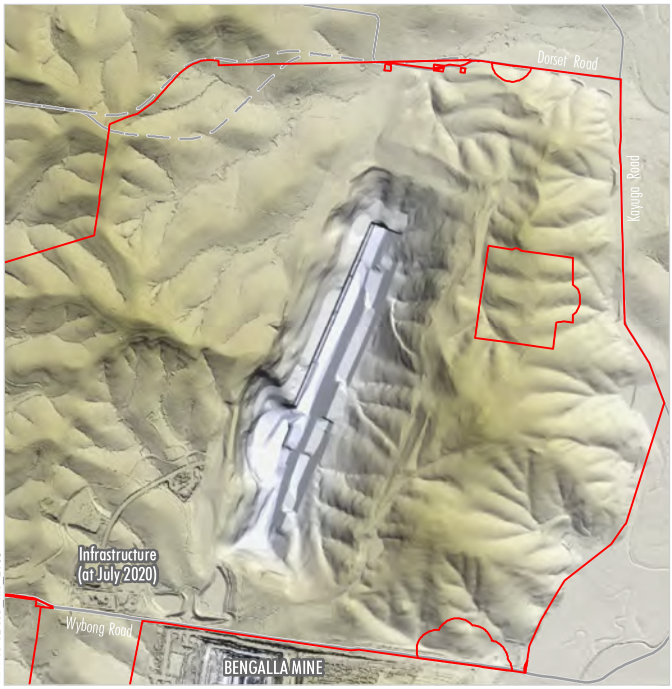
Figure 1
Pre-MACH Acquisition Life of Mine Plan

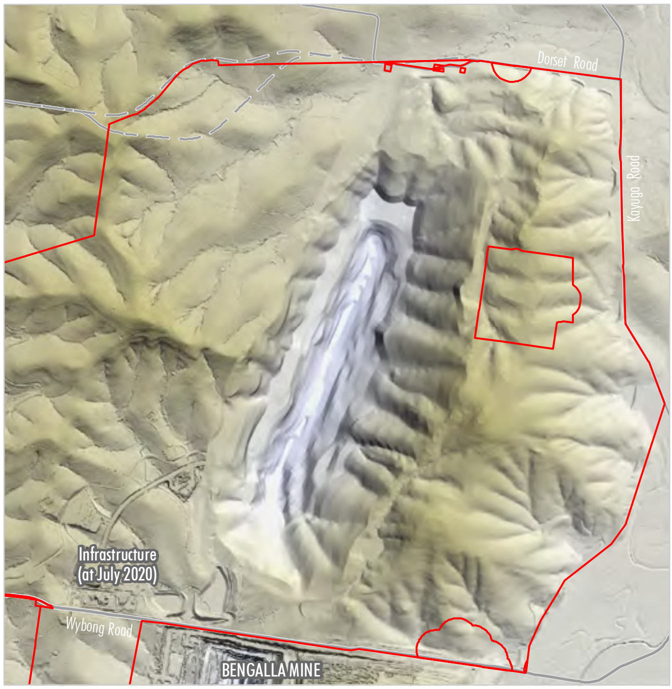
Initial MACH Life of Mine Final Landform (2018)



Initial Project Geomorphic Conceptual Final Landform (Early 2019)



Project CPDP Conceptual Final Landform (October 2019)



Project Conceptual Final Landform - Void Refinements (May 2020)

MAC-18-02 SSD_RtS_238B

N

0 2

Kilometres

GDA 1994 MGA Zone 56

LEGEND

Mining Lease Boundary (Mount Pleasant Operation)

NOTE: Refer Figure 3 for EIS Project Conceptual Final Landform.

Source: MACH (2021); NSW Spatial Services (2021)

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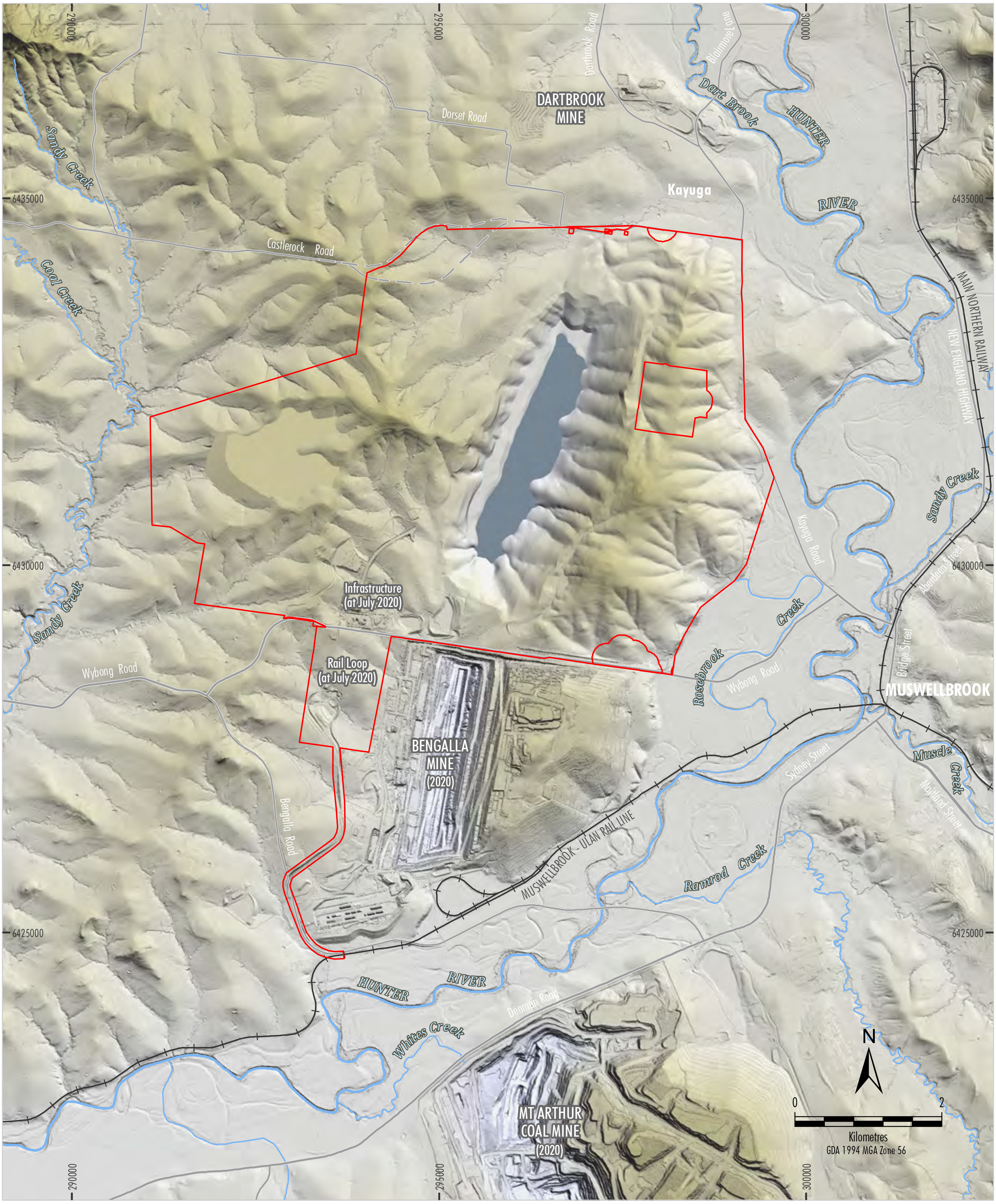
MOUNT PLEASANT OPTIMISATION PROJECT

Key MACH Final Landform Design Iterations

Figure 2



LEGEND

Mining Lease Boundary (Mount Pleasant Operation)

Source: MACH (2020); NSW Spatial Services (2020)
File: 19116801_v14_WithFinalVoidMods_20201027
(void water level 90 m AHD)

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EIS Conceptual Project Final Landform (January 2021)

Figure 3

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Analysis of Additional Final Landform Alternatives

As described above and in Attachment E, MACH has gone to some length to design a Project conceptual final landform that is an optimum compromise between a range of competing priorities, including the size of void, landform slopes, mining costs, land disturbance area and associated mine rehabilitation outcomes (Figure 4).

MACH would continue to consider and refine final void design and land use options over the life of the Project, including potential beneficial uses of the final void (e.g. for off-river storage of supplementary water flows in the Hunter River).

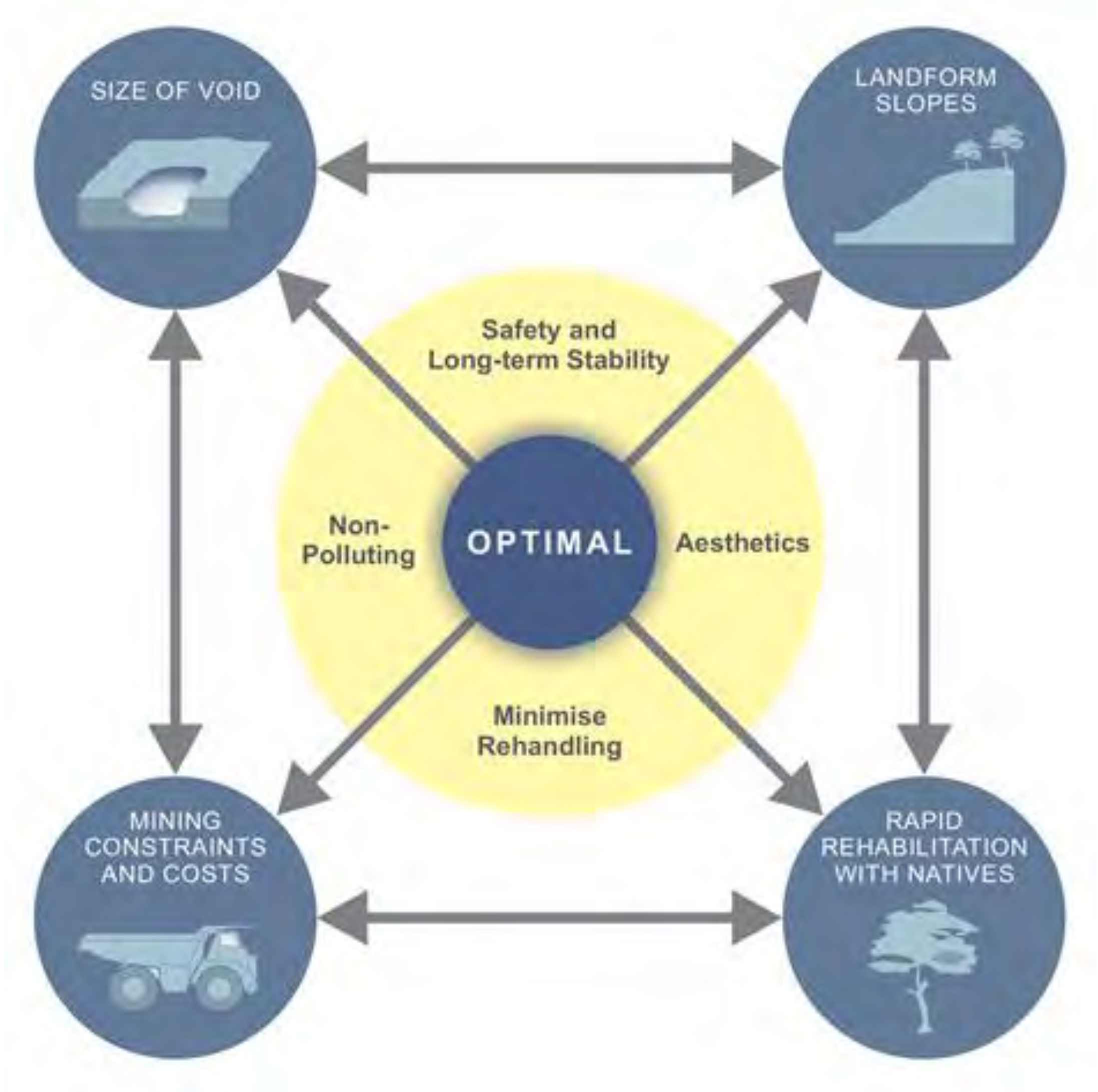

Figure 4
Final Void Optimisation Context

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The HydroGeoLogic Review recommends further analysis of a range of final void and no void configurations to identify whether an alternative arrangement could result in post-mining groundwater levels, flows and water quality that would avoid, mitigate or minimise groundwater-related impacts. The HydroGeoLogic Review refers to the following component of the Secretary's Environmental Assessment Requirements (SEARs) (emphasis added):

Rehabilitation and Final Landform – including

- *a description of final landform design objectives, having regard to achieving a natural landform that is safe, stable, non-polluting, fit for the nominated post-mining land use and sympathetic with surrounding landforms;*
- *an analysis of final landform options, including the short and long-term cost and benefits, constraints and opportunities of each, and detailed justification for the preferred option;*
- *identification and assessment of post-mining land use options, having regard to any relevant strategic land use planning or resource management plans/policies;*
- *rehabilitation objectives and completion criteria to achieve the nominated post-mining land use;*
- *a detailed description of the progressive rehabilitation measures that would be implemented over the life of the development and how this rehabilitation would be integrated with surrounding mines and land uses;*
- *a detailed description of the proposed rehabilitation and mine closure strategies for the development, having regard to the key principles in Strategic Framework for Mine Closure; and*
- *the measures which would be put in place for the long-term protection and/or management of the site and any biodiversity offset areas post-mining;*

The Rehabilitation and Final Landform SEARs were addressed in Section 8 of the EIS and the Rehabilitation and Mine Closure Addendum (Attachment 8 of the EIS), including Section 5.4, which presented a summary of alternative landforms that were considered, including:

- the originally approved Mount Pleasant Operation final landform;
- a 'No Void' scenario (as requested by Muswellbrook Shire Council); and
- a 'Partial Backfill' scenario (as requested by the Resources Regulator).

Further discussion and diagrams were provided in MACH's response to DPIE's information request (dated 22 September 2021; Attachment E), including further information regarding the benefits associated with the single final void proposed in the Project EIS relative to the final landform presented in the original approval documentation for the Mount Pleasant Operation.

The analysis of alternatives considered the full range of competing priorities outlined on Figure 4 and concluded that any environmental benefit associated with the 'No Void' and 'Partial Backfill' scenarios was outweighed by the range of negative environmental consequences and significant additional operational costs.

In the meeting on 2 December 2021, the significant work that MACH has completed to optimise the Project final landform was acknowledged, however, additional justification of the non-polluting status of this landform was requested. This is addressed below and in Attachments A to D.

Groundwater and Surface Water Modelling Technical Queries

The HydroGeoLogic Review requested further technical information regarding the following:

- A perceived difference in the long-term final void water level reported in the Project Surface Water and Groundwater Assessments.
- The final void water level versus groundwater inflow relationship used in the final void water balance.
- Sensitivity testing of the western 'no flow' groundwater model boundary.

Reported Final Void Water Level

The final void water level reported in the Groundwater Assessment (AGE, 2020) is 90 metres Australian Height Datum (mAHD). The final void water level reported in the Surface Water Assessment (HEC, 2020) is 80 metres (m) above the base of the void, which is at 10 mAHD. Accordingly, the two reports are consistent with respect to the equilibrium elevation.

Final Void Water Level Versus Groundwater Inflow Relationship

AGE (2021) has undertaken further groundwater modelling using an alternative methodology to address the recommendation in the HydroGeoLogic Review (Attachment A). The revised stage-inflow curve generated by AGE has been used by HEC (2021) in an updated final void water balance (Attachment C).

In summary, the revised modelling approach for the stage-inflow curve results in a lower predicted final void water level of approximately 75 mAHD compared to the EIS prediction of 90 mAHD (Attachment C). The revised Conceptual Project Final Landform with an equilibrium water level of 75 mAHD is shown on Figure 5.

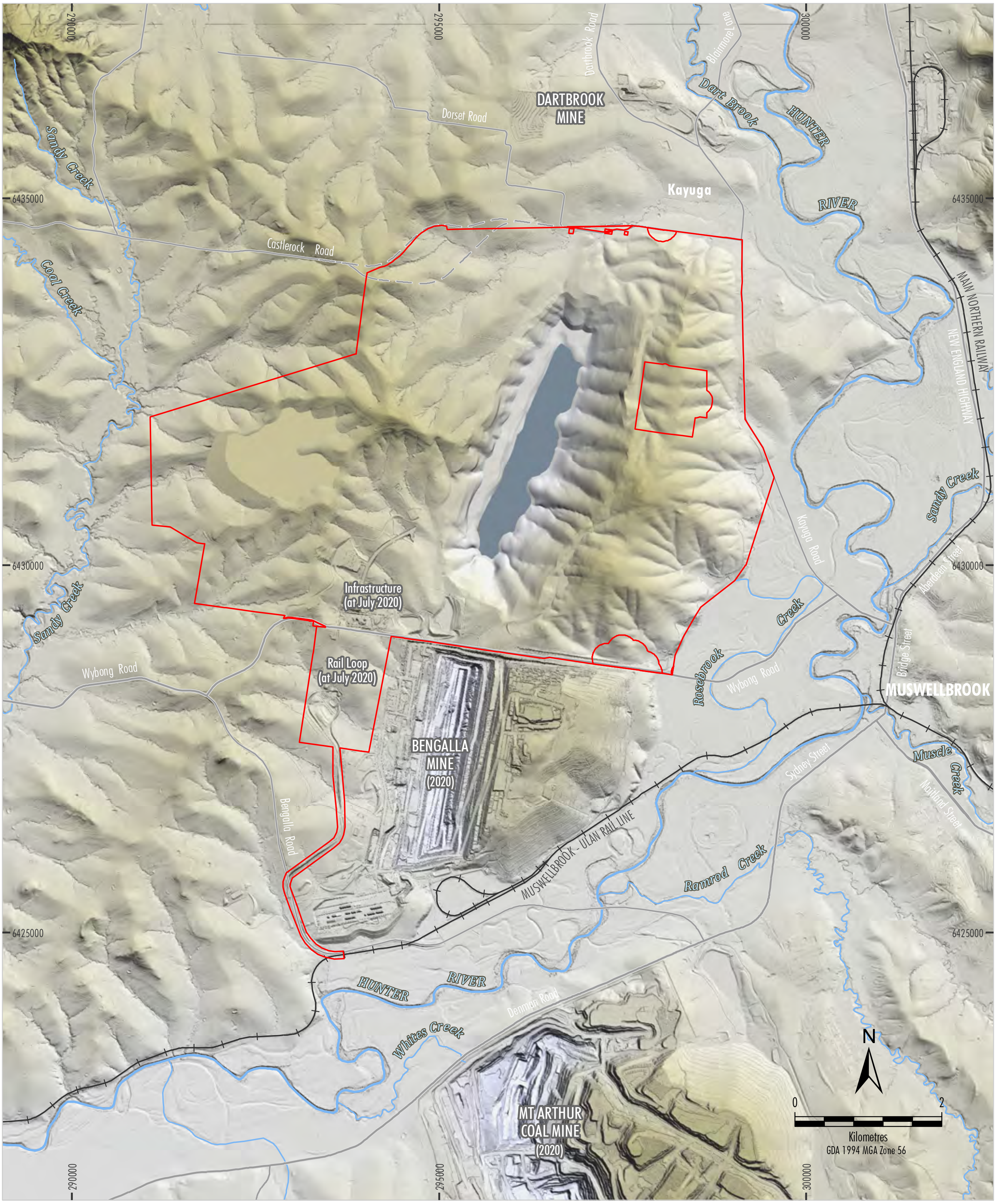
Based on this revised equilibrium level, the risk of potential void overflows and/or groundwater seepage is reduced using the alternative modelling methodology (i.e. the methodology adopted in the EIS Surface Water and Groundwater Assessments is conservative). Updated groundwater recovery modelling using the 75 mAHD final void water level indicates negligible changes in the predicted post-mining groundwater drawdowns (including at privately-owned bores) and only very minor consequential change to Project water licensing requirements (Attachment A).

Final Void Water Quality

The HydroGeoLogic Review recommended additional analysis of the water quality/geochemistry of the final void lake, including consideration of:

- potential exposure of PAF material in the final void; and
- whether a poor-quality groundwater plume may develop under the final void lake and if so, investigate the transport and fate or stability of any plume.

The Geochemistry Assessment (Appendix K of the EIS) concluded the waste rock and coal reject materials generated from the Project would generally be expected to be non-acid forming (NAF). The acid base accounting test work indicates, however, that a small portion of the geological material at the Mount Pleasant Operational, namely the Wynn Seam coal and overlying Archerfield Sandstone interburden are PAF (RGS, 2020).



LEGEND

Mining Lease Boundary (Mount Pleasant Operation)

Source: MACH (2021); NSW Spatial Services (2020)
File: 19116801_v14_WithFinalVoidMods_20201027
(void water level 75 m AHD)

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Conceptual Project Final Landform - Revised Final Void Water Level

Figure 5

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The Wynn Seam and Archerfield Sandstone are currently mined by the approved Mount Pleasant Operation and managed in accordance with the approved Mining Operations Plan and Rehabilitation Management Plan, which states:

> *Therefore, due to the predicted small proportion of potentially acid forming material, it is expected that operational blending during ROM coal dumping will produce a non-acid forming material within the Overburden Emplacement and back-filled open cuts. The management strategy for the MPO will provide that no zones of poorly blended, potentially acid forming material are exposed in the final surface of the Overburden Emplacement and back-filled open cuts. This will be achieved by excluding the material identified as potentially being acid forming (i.e. non-economic coal and identified coal seam roof and floor rock from the Wynn Seam) from the final face of the Overburden Emplacement with a minimum cover of 10 m of inert material overlying the potentially acid forming material.*

This is consistent with the management recommendations made by RGS (2020; 2021).

Further to the above, Section 3 of the EIS described the following management measures for the final void:

> *If PAF material is exposed in the floor of the final void, it would be either:*
>
> - *covered with NAF waste rock material to a minimum depth of 5 m;*
> - *excavated and disposed of as PAF waste rock material (as described above); or*
> - *flooded with water from the site water management system.*

RGS (2021) also reviewed the potential salinity of groundwater reporting to the final void from the backfilled spoil based on the outcomes of geochemical testwork, and concluded (Attachment D):

> *The static and kinetic geochemical information on spoil salinity reviewed in this Technical Memorandum suggests that a median salinity value in the range 600 to 900 µS/cm is likely to be generated for leachate from backfilled spoil materials reporting to the final pit void.*

HEC (2021) completed updated final void water balance modelling using the revised salinity for groundwater inflows from spoil together with the updated groundwater stage-inflow curve derived by AGE (2021). The revised final void water balance resulted in a predicted final void salinity of approximately 25,000 microSiemens per centimetre (µS/cm) after 1,000 years at an equilibrium level of approximately 75 mAHD (Attachment C).

To address the comments provided with respect to confirming that the proposed Project final landform would be non-polluting, AGE (2021) has reviewed the potential for denser saline water to migrate out of the final void. This involved calculating an equivalent freshwater head for the saline water in the void. In summary, this additional analysis concluded (Attachment A):

- the equivalent freshwater head for the final void water level (at 25,000 µS/cm) is 0.6 m higher than the modelled equilibrium water level (i.e. more than 70 m below the lowest observed water level in the alluvium); and
- the water density required to result in saline water migrating away from the void lake would be 1.892 kilograms per litre, which significantly exceeds the solubility of salt (Attachment B).

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This confirms the findings of the EIS that the Project single final void would be a groundwater sink (i.e. non-polluting).

Brian Barnett has reviewed the additional material prepared by AGE and concludes (Attachment B):

> *In conclusion, I can confirm that I believe the recent groundwater assessment work undertaken by AGE has effectively responded to the concerns raised in Mr Middlemis' review.*

Please feel free to contact me if you require further information.

Yours sincerely,

Chris Lauritzen
General Manager - Resource Development
Mount Pleasant Operation

Enclosed: **Attachment A – Mount Pleasant Optimisation Project – Response to DPIE Groundwater Peer Review (AGE, 2021)**
Attachment B – Groundwater Impact Assessment Review (Brian Barnett, 2021)
Attachment C – Mount Pleasant Optimisation Project – Responses to Peer Review Comments on Final Void Modelling (HEC, 2021)
Attachment D – Geochemistry Methods, Assumptions, and Estimated Spoil Seepage Salinity and Soluble Metal/Metalloid Concentrations - Technical Memorandum (RGS, 2021)
Attachment E – Extract from MACH Response to DPIE Information Request (22 September 2021)

Attachment A

Mount Pleasant Optimisation Project – Response to DPIE Groundwater Peer Review (AGE, 2021)

22 December 2021

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Attention: Chris Lauritzen

Dear Chris,

Mount Pleasant Optimisation Project – response to DPIE groundwater peer review

1 Introduction

The Environmental Impact Statement (EIS) prepared for the Mount Pleasant Optimisation Project (the Project) was placed on public exhibition across February to March 2021 (SSD-10418)[1]. The Project proposes extraction of additional coal reserves within Mount Pleasant Operation (MPO) Mining Leases and an increase in the rate of coal extraction, without significantly increasing the total disturbance footprint.

The New South Wales Department of Planning, Industry and Environment (DPIE) commissioned Hugh Middlemis of HydroGeoLogic Pty Ltd (HGL) to undertake a targeted peer review of the groundwater aspects of the post-mining final void study presented in the EIS[2] (referred to in this report as the HGL Peer Review).

The HGL Peer Review included several recommendations that the DPIE have forwarded to MACH Energy Australia Pty Ltd (MACH) to address. MACH has requested that Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) assist in addressing the recommendations raised in the HGL Peer Review. This has included:

- Preparation of an alternative groundwater stage-inflow curve.
- Sensitivity testing of alternative western model boundary conditions.
- Assessment of potential groundwater impacts based on a revised final void water level (provided by Hydro Engineering & Consulting Pty Ltd [HEC] based on final void modelling using the updated groundwater stage-inflow curve developed by AGE).
- Further analysis of potential impact pathways from the final void (i.e. potential for density-driven flow).

To address the above scope items, AGE used the numerical groundwater model developed for the Project[3] and the results are summarised in this letter report.

[1] MACH (2021). "Mount Pleasant Optimisation Project Environmental Impact Statement". February 2021.
[2] HGL (2021). "Mount Pleasant Optimisation Project Rehabilitation and Mine Closure. Targeted Peer Review of the Groundwater Impact Assessment Final Void Issues". Prepared 7 October by HydroGeoLogic Pty Ltd on behalf of NSW DPIE.
[3] AGE (2020). "Mount Pleasant Optimisation Project – Groundwater Assessment". Prepared on behalf of MACH Energy Australia Pty Ltd December 2020.

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2 Final void stage-inflow curve

A stage-inflow curve for groundwater inflow to the mine void was produced as part of the EIS using the numerical groundwater model. The original curve was the result of a single transient model run where the post-mining water elevation in the void was unbound (i.e. not set to a specific level). This initial curve was then provided to HEC to inform the groundwater inflow component of a GoldSim water balance model[4] that included the void. The validity of the original stage-inflow curve produced by AGE was questioned within the HGL Peer Review.

To address the concerns raised in the HGL Peer Review, an alternative modelling methodology has been undertaken to develop a revised stage-inflow curve. The revised curve is the product of eight separate transient model scenarios. Each of the model scenarios applied a constrained elevation within the void throughout the post-mining period via the General Head Boundary (GHB) package in MODFLOW. Water elevation in the void was set at a minimum of 10 metres Australian Height Datum (mAHD) (base of the pit) in the first scenario, and then increased by 20 m intervals in subsequent model runs up to an eighth run with fixed elevation of 150 mAHD in the void. Groundwater inflow rates were then extracted from each of these runs and the equilibrated inflow rates recorded. In all long term predictive scenarios, post-mining equilibration was found to occur more than 200 years after mining ceases.

Figure 2.1 shows the revised stage-inflow curve for the void and the curve produced during the EIS. The revised curve illustrates a smooth reduction in groundwater inflow as the void water elevation increases and the flow gradient towards the void eases. The inflows range from 0.2 megalitres per day (ML/day) at an elevation of 150 mAHD to 3.6 ML/day when the void water level is effectively level with the pit base at 10 mAHD.

The revised stage-inflow curve was provided to HEC to inform updated GoldSim modelling of the void. HEC also revised the groundwater salinity assumption in the GoldSim model based on additional technical analysis prepared by RGS Environmental Consultants Pty Ltd in response to another recommendation made in the HGL Peer Review.

The key findings were:

- The revised groundwater salinity assumption results in a substantially lower long-term electrical conductivity (EC) value compared to the original results (reduction from 70,000 microSiemens per centimetre (µS/cm) to 25,000 µS/cm after a period of 1,000 years);
- The lower salinity drives a marginally higher evaporation rate from the void; and
- The revised stage-inflow curve results in a lower predicted final void water level of approximately 75 mAHD compared to the EIS prediction of 90 mAHD.

AGE has re-assessed potential post-mining impacts based on the updated void water level elevation result from the GoldSim model. These outputs are presented and discussed in Section 4.

The HGL Peer Review also identified that the inflow at the end of mining (1.6 ML/day) and at the start of the post-mining recovery (3.5 ML/day) do not match up. This is because during the mining period the drains representing dewatering across the pit are left on once they become active. In the post-mining simulation the hydraulic properties and recharge across the spoiled (backfilled) areas are changed, and these backfilled areas become saturated and provide additional inflow into the void. This approach is considered to be appropriate as it would take some time for the spoil to become saturated and therefore any contribution of spoil leachate to groundwater inflows during the mining phase is considered negligible.

[4] HEC (2020). "Mount Pleasant Optimisation Project – Surface Water Assessment". Prepared on behalf of MACH Energy Australia Pty Ltd December 2020.

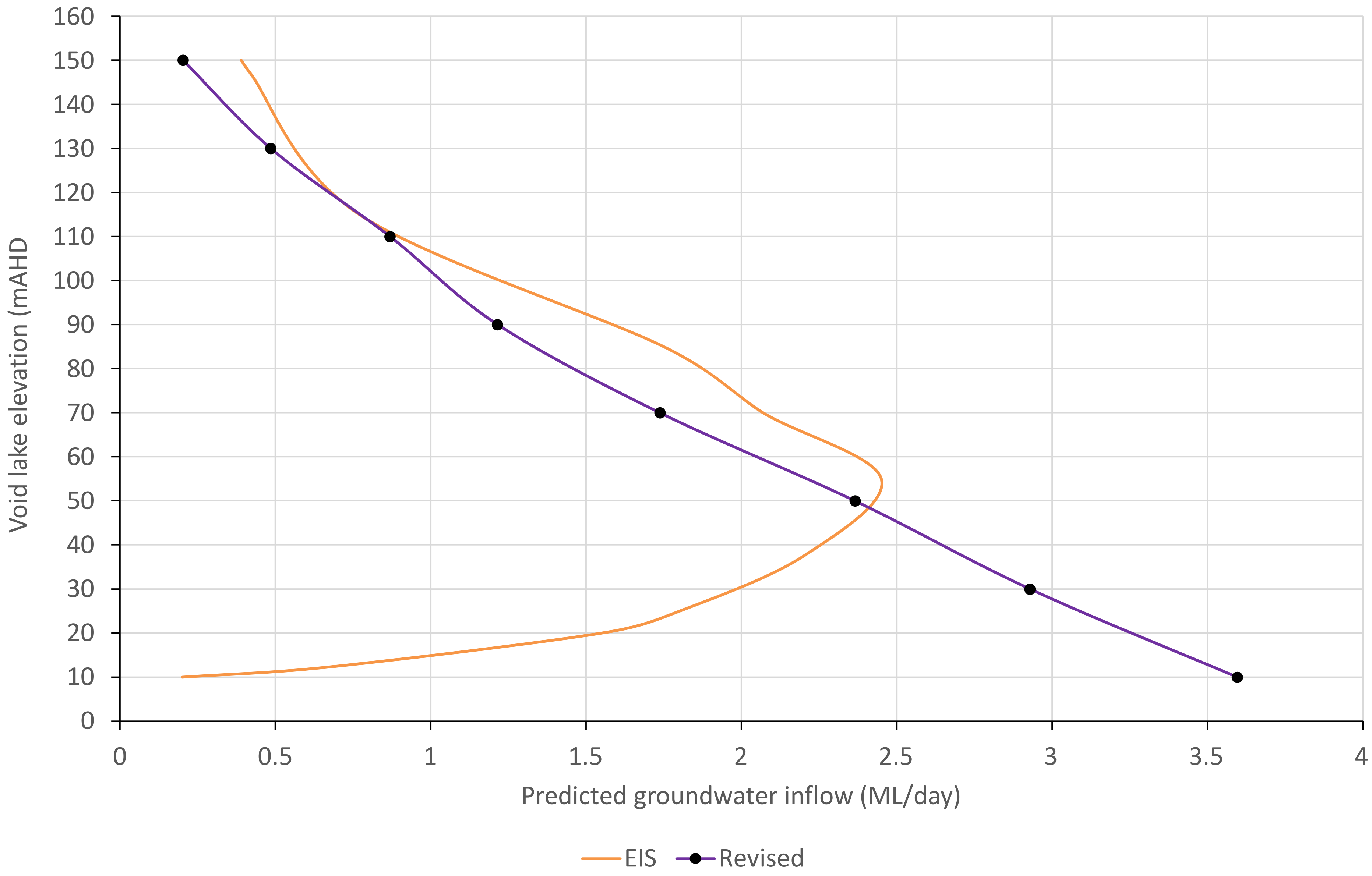


Figure 2.1 Revised MPO Final void stage-inflow relationship

3 Western boundary sensitivity

The numerical groundwater model utilised for the Project incorporated a regional thrust fault known as the Mt Ogilvie Fault (the Fault). The Fault is described in Section 4.1 of the Project Groundwater Assessment[3], which states:

> *The main structural feature west of the Project is the Mt Ogilvie thrust fault. This structure, approximately 10 km west of the Project trends north to south. Throw along the fault has forced the Wittingham Coal Measures up where they now lie adjacent to the younger Newcastle Coal Measures. Throw along the Mt Ogilvie fault has led to a maximum displacement of 100 to 200 m beneath Sandy Creek (HydroSimulations, 2013; MER, 2006). Further south this structure weakens, with the throw declining so that the fault/structure forms a roll-over or monocline (HydroSimulations, 2013 and 2015).*

Based on literature review, the Fault was conceptualised as a 'no flow' boundary that hydraulically disconnects groundwater flow across the fault plane. Consequently, the western boundary of the model domain was established in line with the Fault acting as a barrier to flow and preventing groundwater impacts from being realised to the west of the Fault. This concept was questioned during the HGL Peer Review on the basis that the fault was conceptualised as a roll-over feature for the Spur Hill Underground Project (approximately 15 km south west of the MPO). The HGL Peer Review included a recommended action to test the sensitivity of the Fault by representing the western boundary of the model in an alternative manner.

The sensitivity of the Fault was investigated through use of the GHB package in MODFLOW. To enable flow through the extent of the Fault, rather than a 'no flow' condition, each cell immediately adjacent the western boundary of the model was set with a constrained head value for an entire model run (years 1990 to 3048) using the GHB package. This was applied through each layer of the model (Layer 1 down to Layer 20), and the head values assigned were those determined by the pre-mining steady state model being consistent with groundwater conditions in 1990.

The impact due to the Project assuming flow is able to cross the Fault plane was assessed by calculating the difference in flow through the GHB cells in a model scenario without the Project and a scenario incorporating mining planned for the Project.

Figure 3.1 depicts the predicted reduction in groundwater flow at the location of the Fault due to the Project. Two predictive scenarios were evaluated: a scenario pertaining to the original void equilibrium level of 90 mAHD, and a scenario using the revised predicted equilibrium level of 75 mAHD.

The curves demonstrate that the peak reduction in flow owing to the Project is predicted to remain below 1.3 cubic metres per day (m^3/day) (<0.5 ML/year) for either final void scenario. This indicates that the Project would have a negligible incremental impact on regional groundwater flow across the western model boundary assuming connected flow conditions through the Fault. This is consistent with the conceptualisation described in the Project Groundwater Assessment (as summarised above) and confirms that it is appropriate to continue using the no-flow boundary in the model.

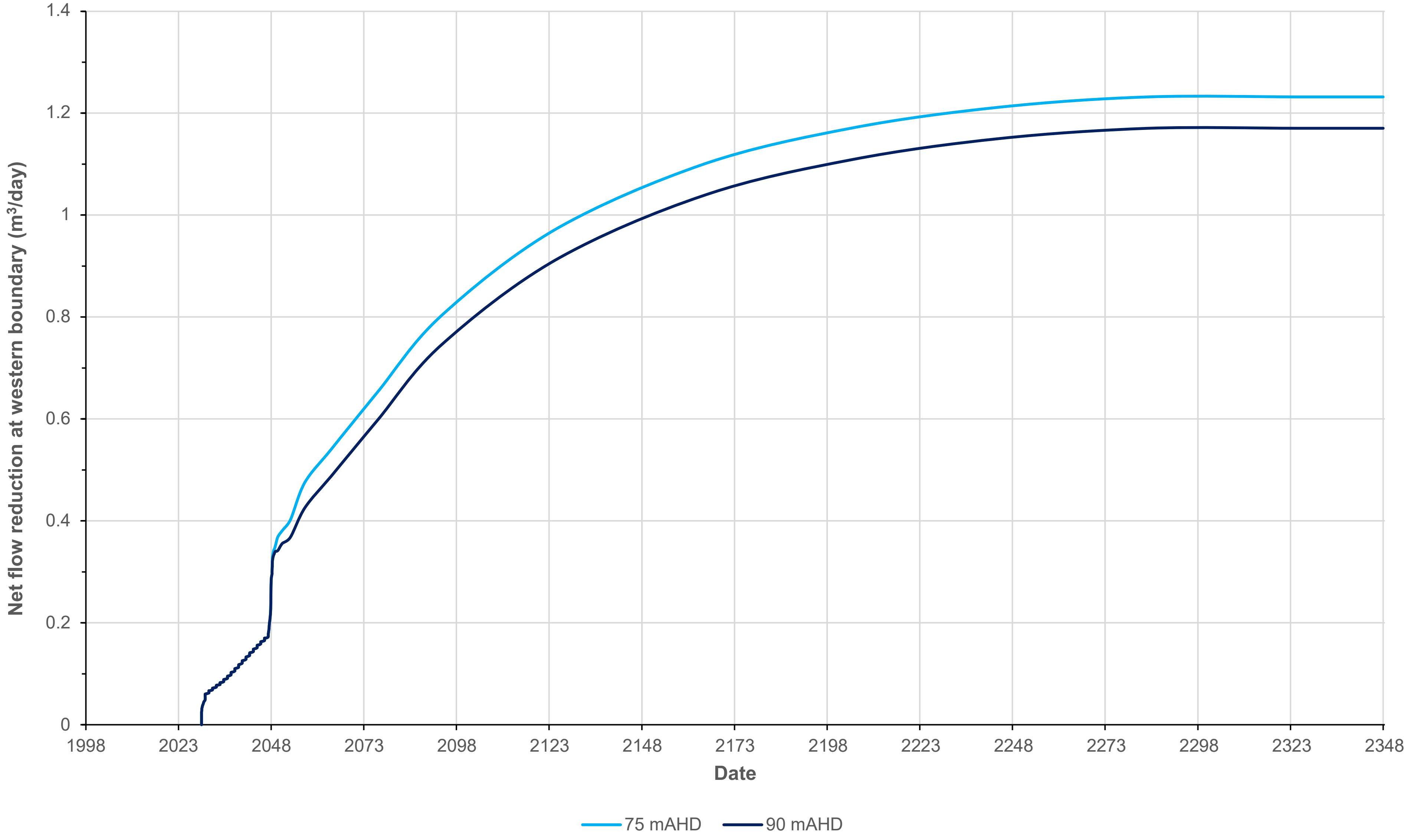


Figure 3.1 Net flow reduction at western model boundary

4 Reassessment of post-mining recovery

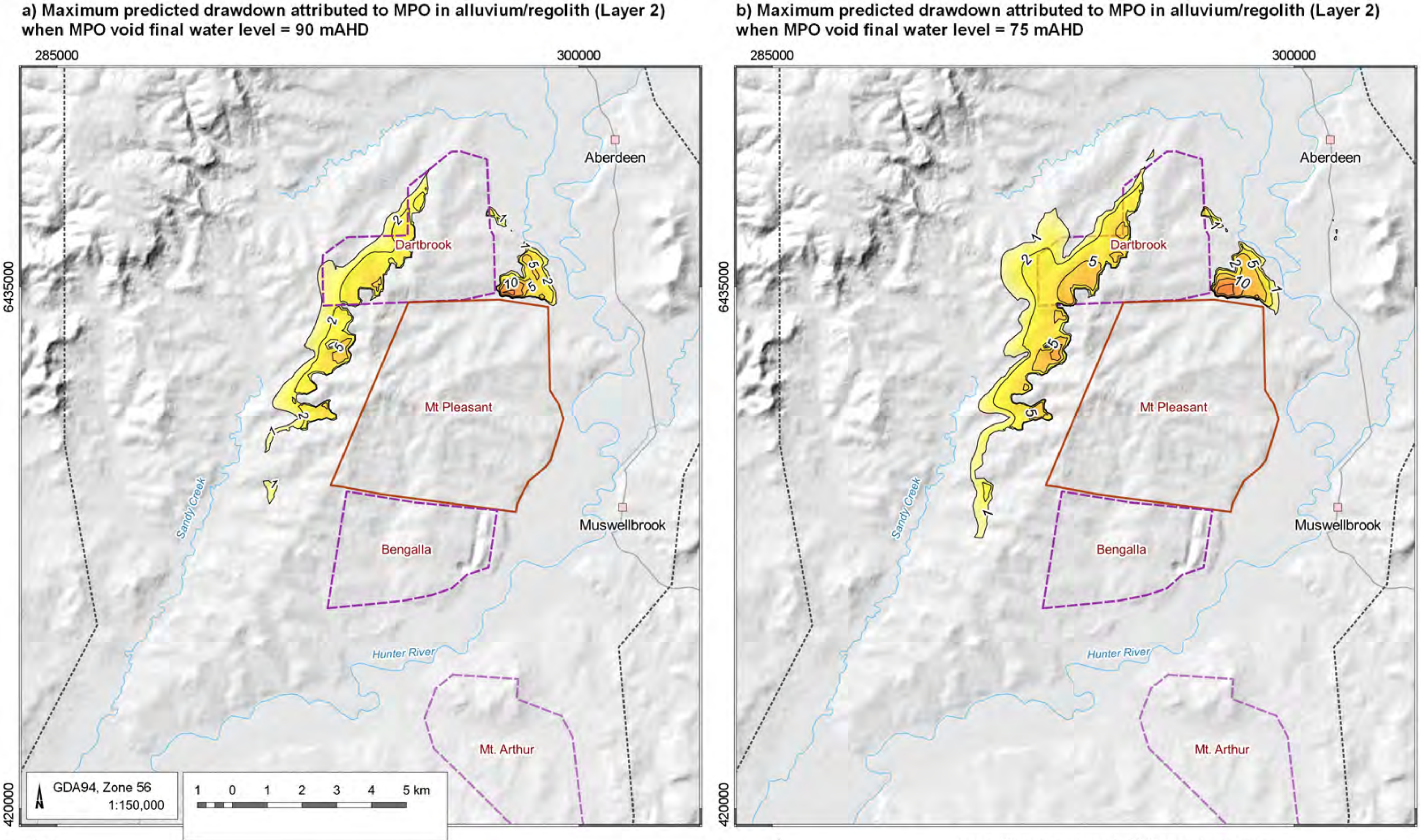
4.1 Post-mining drawdown

The HGL Peer Review recommended that alternative final void configurations be modelled to allow sensitivity in the post-mining recovery modelling outcomes. As discussed in Section 2, AGE developed a revised stage-inflow curve to inform an updated long-term void water level in the Project void through use of the HEC GoldSim model. The GoldSim model was run using the alternative stage-inflow curve, which resulted in a long-term void water level of 75 mAHD in the void. The 75 mAHD level in the void has been integrated into a predictive scenario using the groundwater model to quantify changes to impact predictions compared to the original 90 mAHD void modelling scenario.

Drawdown maps depicting the maximum predicted groundwater drawdown in the post-mining period were produced for both the alluvium/regolith and the Edderton Seam as shown in Figure 4.1 and Figure 4.2, respectively. The left window in both figures represents predictions for the original 90 mAHD level, and the right window shows the results for a 75 mAHD level in the void.

The MPO (incorporating the Project) is predicted to result in only limited drawdown in the alluvium to the north of the Project, near the existing Dartbrook Mine. Limited drawdown is predicted in the Hunter River alluvium as the majority of the target seams subcrop west of the alluvium extent. At the northern boundary of the Project, the Edderton Seam subcrop extends closer to and then under the alluvium. This is the cause of the predicted drawdown in the alluvium to the north. Figure 4.1 highlights that a revised final void water level of 75 mAHD predominantly results in increases to the predicted extent of shallow drawdown in the alluvium/regolith to the west of the Dartbrook Mine, and the magnitude of drawdown increases above the north-east boundary of the MPO are minor.

Figure 4.2 demonstrates that the predicted drawdown extent in the Edderton Seam increases in the south, with some minor increases also apparent to the north and west. The predicted drawdown extent remains unchanged in the east at depth due to the sub-cropping of the coal seam. The magnitude of drawdown in the Edderton Seam is predicted to increase in a 75 mAHD final void water level scenario, however this does not result in a material increase in drawdown in the shallower layers (as demonstrated on Figure 4.1).



LEGEND

- Populated place
- Drainage
- Road
- Mt Pleasant mine
- Surrounding mines
- Model boundary
- Drawdown contour (m)

Drawdown (m)

0	20
1	50
2	100
5	200
10	500

Mount Pleasant response to DPIE groundwater review (MPO5001.001)

AGE

Post recovery drawdown attributed to MPO (incorporating the Project) in alluvium/ regolith (Layer 2)

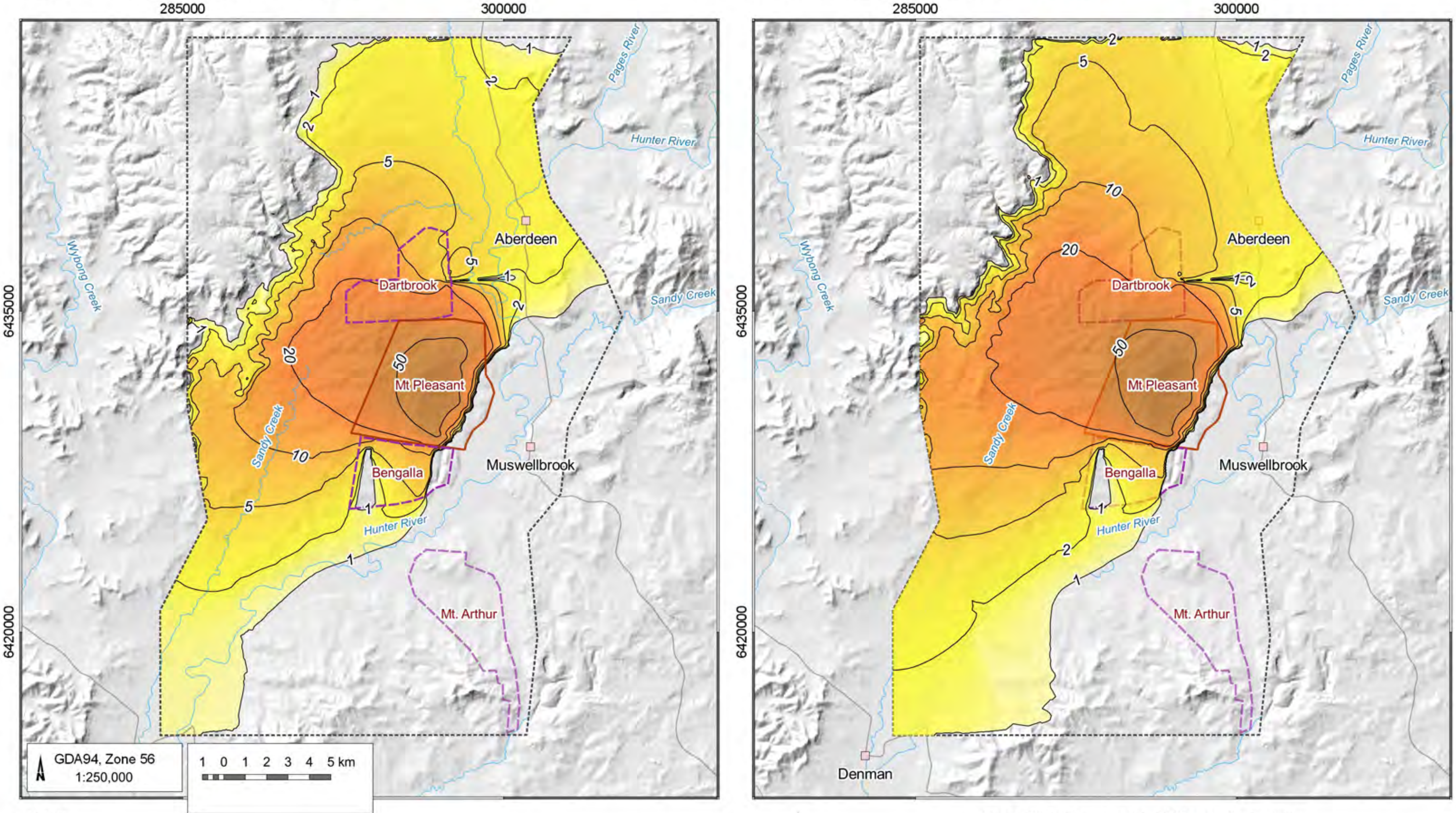
DATE
22/12/2021

FIGURE No:
4.1

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:\Projects\G1970.Mt Pleasant GIA\3_GIS\Workspaces\GIA_report\MPO5001_outputs_workspace.qgs

a) Maximum predicted drawdown attributed to MPO in Edderton Seam (Layer 18) when MPO void final water level = 90 mAHD

b) Maximum predicted drawdown attributed to MPO in Edderton Seam (Layer 18) when MPO void final water level = 75 mAHD



LEGEND

- Populated place
- Drainage
- Road
- Mt Pleasant mine
- Surrounding mines
- Model boundary
- Drawdown contour (m)

Drawdown (m)

0
1
2
5
10
20
50
100
200
500

Mount Pleasant response to DPIE groundwater review (MPO5001.001)

AGE

Post recovery drawdown attributed to MPO (incorporating the Project) in Edderton Seam (Layer 18)

DATE
22/12/2021

FIGURE No:
4.2

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:\Projects\G1970.Mt Pleasant GIA\3_GIS\Workspaces\GIA_report\MPO5001_outputs_workspace.qgs

4.2 Water licensing requirements

The *Water Management Act, 2000* and the Aquifer Interference Policy (AIP) require that all groundwater taken, either directly or indirectly, is accounted for via Water Access Licence (WAL) entitlements. Groundwater intercepted from the mining area is considered a direct take from the Permian groundwater system, whilst the changes in flow occurring within the Quaternary alluvium and rivers resulting from the depressurisation of the underlying Permian is considered an indirect take.

A summary of the water licensing requirements for the MPO (incorporating the Project) is provided in Table 4.1. The numbers in Table 4.1 show the comparison of the groundwater take predictions for the 90 mAHD level void scenario (as presented in the EIS) and the revised predictions for a 75 mAHD void water level. Slight increases in licensing requirements are evident for each Water Source zone as a result of adopted a 75 mAHD final void water level. In either case, MACH holds sufficient licences to account for the take from each water source, with the exception of the Dart Brook Water Source (consistent with the description in the EIS).

Table 4.1 Water Licensing Requirements for the MPO (incorporating the Project) post-mining

Water sharing plan	Water source/management zone	Share component (Units)	Peak volume requiring licensing post-mining for 90 mAHD void (ML/year)	Peak volume requiring licensing post-mining for 75 mAHD void (ML/year)
Hunter Regulated River Water Source, 2016	Hunter Regulated River (Management Zone 1A)	961 (High) 2,937 (General)	32	33
Hunter Unregulated and Alluvial Water Sources, 2009	Hunter Regulated River Alluvial	285	34	37
	Muswellbrook	41	6	7
	Dart Brook	Nil	13	14
North Coast Fractured and Porous Rock Groundwater Sources, 2016	Sydney Basin	730	44 (547 if spoil included)	48 (594 if spoil included)

4.3 Neighbouring bore drawdown predictions

An assessment of drawdown in private bores was conducted, considering both impacts of the MPO (incorporating the Project) with a void water level of 90 mAHD and a void water level of 75 mAHD.

A total of six bores on private property were predicted to experience drawdown exceeding 2 m due to MPO over the post-mining period for either void scenario as shown in Table 4.2. The increase in drawdown as a result of the revised 75 mAHD water level is minor, which conceptually aligns with the modest change in hydraulic flow gradients imposed by the lower void water level. Consistent with the EIS results, the same six bores were identified to exceed 2 m drawdown if the long-term water level stabilises at 75 mAHD in the void.

Table 4.2 Drawdown in private bores post-mining

Bore ID	Depth (mTOC)	GWL (mBGL)	Electrical Conductivity (µS/cm)	Post-mining		Type
				Long-term drawdown: 90 mAHD void	Long-term drawdown: 75 mAHD void	
BELGRAVE	23.85	7.16	6,280	16.59	18.03	Well - Stock & Monitoring
CAS1_G	28.23	11.73	8,040	32.50	34.04	Bore - Not in Use
CAS2_G	65	39.71	13,045	16.41	16.86	Bore - Monitoring (Not in Use)
CAS3_G	76.7	Dry	Dry	16.37	16.77	Bore - Not in Use*
CAS4_G	34.8	27.89	10,585	12.77	13.99	Bore - Monitoring (Not in Use)
JLON1	52	Dry	Dry	18.82	22.57	Well & Bore - Monitoring*

Notes: *Groundwater level & EC data for all bores is sourced from regional monitoring/MPO census data from 2016-2020.*

** = Bore observed to be dry.*

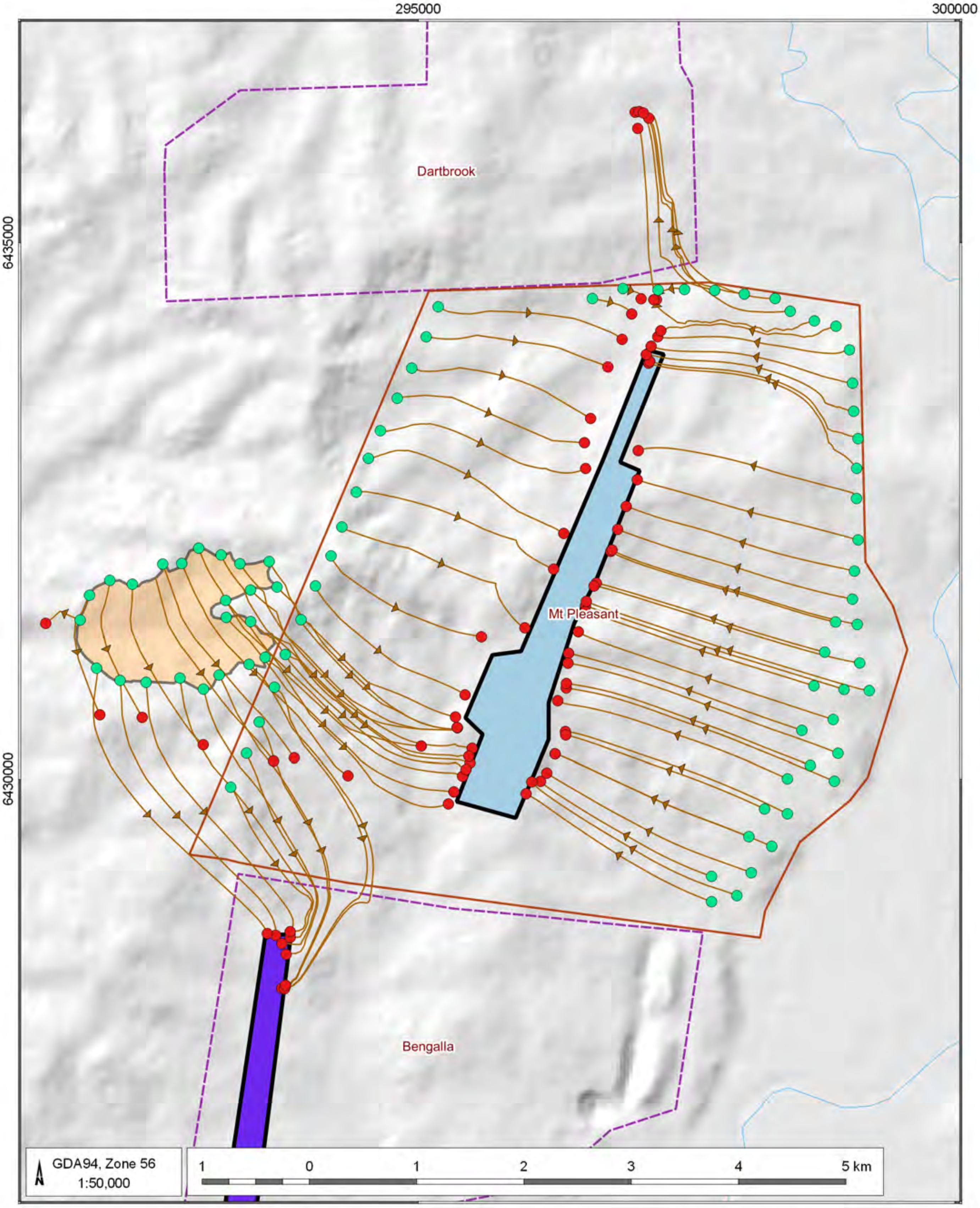
mTOC = metres below top of casing.

mBGL = metres below ground level.

4.4 Particle pathlines

The EIS included particle path modelling to ascertain the predicted flow paths of particles originating from sensitive areas including the out-of-pit waste emplacement zones and the Fines Emplacement Area. To evaluate any changes in predicted flow regimes with the void water level at 75 mAHD, mapping of the particle pathlines has been reproduced using the particle tracking software MODPATH as in the EIS.

Figure 4.3 displays the predicted particle pathlines for the 75 mAHD level void scenario. All particle starting locations and the length of the recovery period (1,000 years) were the same as for the EIS. Overall, the predicted flow trends of the particles do not change for a void water level of 75 mAHD: particles either migrate to the Project final void, the Bengalla void or over Dartbrook.



LEGEND

- Bengalla
- Dartbrook
- Mount Pleasant
- Model boundary
- Final Western Tailings Dam
- Drainage
- MPO final void
- Bengalla final void
- Particle start point
- Particle pathlines
- Particle termination point

Mount Pleasant response to DPIE groundwater review (MPO5001.001)

Predicted particle pathlines post-mining for 75 mAHD MPO void

AGE

DATE 03/12/2021

FIGURE No: **4.3**

5 Further analysis of final void option - potential for alternate pathways

The HGL Peer Review identified that further analysis of the post-mining option was required, with particular reference to the potential for the denser saline water to migrate out of the final void.

To understand if the saline water in the void has the potential to migrate away from the void lake pit, the saline water in the void is converted to an equivalent freshwater head. The calculated equivalent freshwater head can be compared to elevations in the receiving environment to determine if there is a gradient away from the void lake and the potential for migration.

The equation to calculate the equivalent freshwater head is presented below[5]:

$$H_f = \frac{\rho}{\rho_f} H$$

where;

- H_f is equivalent head of freshwater.
- ρ is density of saline water.
- ρ_f is density of freshwater.
- H is head of saline water.

The density of the saline water is dependent on the amount of salt dissolved in the water. This is usually measured in units of EC. HEC[4] have updated their assessment of EC and assessed the EC of the water in the final void will be approximately 25,000 µS/cm after 1,000 years, assuming a source concentration of 900 µS/cm (determined from proportional contributions from groundwater, spoil water, and rainfall) and an increasing concentration due to evaporative loss of water.

Calculating the density of the saline water (ρ) requires conversion of the predicted EC in the pit void to a density through Total Dissolved Solids (TDS). The 25,000 µS/cm converts to a TDS value of 16,000 mg/L. The 16,000 mg/L water equates to a density of the saline water of 1009.1 kg/m^3 (1.0091 kg/L).

The head of saline water in the void (length of the water column) is 65 m determined from the predicted void water level of 75 mAHD minus the elevation at the base of the void of 10 mAHD.

Assuming the density of freshwater is 1 kg/L, the equation for equivalent freshwater head becomes:

$$H_f = \frac{1.0091}{1} 65$$

$$H_f = 65.59\, m$$

The nearby low points in the pre-mining and post-mining water table are the water levels in the Hunter River alluvium. The lowest observed level in the alluvium adjacent to the mine is approximately 133 mAHD.

[5] Kuniansky, E., L. (2018). An Open Source Spreadsheet for Calculation of Equivalent Freshwater Altitude in Brackish Water Mixing Zone of an Aquifer with Documentation for Appropriate Use (ver 1.00, April, 2018). U.S Geological Survey software release. https://doi.org/10.5066/F798869Q.

The change in head associated with the salinity of the void water is not significant, and the increase is well below any target that would result in the denser water migrating away from the void lake. The density to create an equivalent freshwater head of 123 m above the void floor is 1.892 kg/L, which indicates a TDS of 853,500 mg/L would be required to increase the void lake water level to a point where migration from the void lake to the alluvium would begin to be possible. This also conservatively ignores potential mounding in the spoil between the void and the alluvium.

6 Conclusion

The response to the HGL Peer Review presented above has resulted in some minor adjustments to the final void water level and resulting post mining predictions, testing of original assumptions on the western model boundary, and investigating the potential for density driven flow away from the post mining void. These changes result in some very minor increases in predicted water take and the maximum predicted extent of drawdown post mining. Notwithstanding, the overall conclusions of the original impact assessment have not been changed.

If you have any queries, please do not hesitate to call.

Yours faithfully,

Andrew Durick
Director / Modelling Team Lead / Principal – Groundwater Modeller
Australasian Groundwater and Environmental Consultants Pty Ltd

Attachment B

Groundwater Impact Assessment Review (Brian Barnett, 2021)

Jacobs

Memorandum

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www.jacobs.com

Subject	**Groundwater Impact Assessment Review**	**Project Name**	Mount Pleasant response to DPIE groundwater review
Attention	Chris Lauritzen	**Project No.**	IA236700
From	Brian Barnett		
Date	23 December, 2021		
Copies to			

I was requested to review a report prepared by Australian Groundwater and Environmental Consultants (AGE) dated 22 December, 2021. The report summarises AGE responses to questions raised by Hugh Middlemis of HydrGeoLogic Ltd., in his review of groundwater assessment included in the Mount Pleasant Optimisation Project Environmental Impact Statement (EIS).

In preparing my review I was provided with a copy of the HydoGeoLogic review and I have been involved in discussions with AGE modellers and Resource Strategies staff responsible for preparing the EIS. I also attended a meeting with Mr Middlemis, MACH Energy, DPIE, AGE and Resource Strategies staff on 2nd December, 2021.

The report addresses four issues:

- The final void stage-inflow curve derived by the numerical groundwater model. Mr Middlemis has questioned the shape of the final void stage-inflow curve presented in EIS documentation. The curve shows a counter-intuitive reduction in inflow rates as the void water level reduces from 60 m to 10 m AHD.
- The use of a no-flow boundary on the model's western boundary. The groundwater model includes a no-flow boundary condition aligned with the Mt Ogilvie Fault that defines the western boundary of the model domain. Mr Middlemis questions whether the choice of boundary condition has had an impact on the model predictions and whether it is consistent with current knowledge of the Mt Ogilvie Fault.
- Reassessment of final landform and post mining recovery. Mr Middlemis has questioned whether there has been adequate assessment of alternative landforms as required in the Planning Secretary's Environmental Assessment Requirements (PSEARs).
- Further analysis of potential pollution arising in the long term post-closure. The PSEARs includes a requirement that the final landform be non-polluting. Mr Middlemis has requested that evidence be presented to help illustrate whether this requirement is likely to be met.

Important material presented in the AGE letter report includes:

- A revised final void stage-inflow relationship (shown as Figure 2-1) that has a much more intuitive shape than the original. The difference between the two curves relates to the method by which they have been estimated. The curve included in the original EIS documentation was obtained from a transient model simulation of the post-mining recovery. The rising inflows with increasing water level (between 10 and 60 m AHD) reflects the transient recovery and release of water from spoil placed in the void. The method used to derive this curve is less relevant than the steady state method (described below) as it does not represent a steady inflow condition and includes a transient groundwater recovery response. It is applicable to a single post-mining scenario and cannot be used to indicate equilibrium inflows at various stage elevations. The AGE report presents a revised stage-inflow relationship that is based on a number of steady state simulations. I consider that the AGE report adequately answers the question raised by Mr Middlemis and that the revised curve is a much more useful representation of inflows to the void that can be expected in long term post-closure environment.

- Figure 3-1 of the AGE report presents the predicted change in flux across the western boundary that would be expected as a result of mining. The figure suggests that significant mining induced drawdown responses do not propagate to the boundary and hence it may be argued that the assumed flow condition on the boundary will have little or no impact on predictive mining scenarios. I consider the work to be an appropriate response to the issue raised by Mr Middlemis.
- Section 4 of the AGE report is aimed at responding to Mr Middlemis' suggestion that the PSEAR requires numerous final landform options to be assessed through groundwater modelling. In this particular issue, I do not share the same opinion as Mr Middlemis. I do not interpret the PSEAR as expecting multiple landform alternatives to be assessed through groundwater modelling. While the PSEAR requires *"an analysis of final landform options, including the short and long-term cost and benefits, constraints and opportunities of each, and detailed justification for the preferred option.",* I find it difficult to reconcile this requirement with Mr Middlemis, recommendation to *"apply the modelling tools to investigate a comprehensive range of final void and no void configurations in terms of recharge and evaporation rates and/or aquifer properties to identify whether or not an alternative arrangement could result in post-mining groundwater levels, flows and water quality that would avoid, mitigate or minimise groundwater-related impacts…",*[1] Indeed, the PSEAR criteria for assessing various final landform options are short and long-term costs and benefits and the constraints and opportunities. In my opinion the PSEAR can be met by determining whether the final landform is likely to be non-polluting. This question is discussed in more detail in Section 5 of the AGE report.
- In Section 5, AGE addresses the question as to whether the final landform is expected to be non-polluting. The argument put forward here is that provided groundwater gradients are maintained towards the final void then the pit lake will remain a groundwater sink and groundwater pollution will not occur. The salinity of water in the void gradually increases with time due to the salt contained in groundwater entering the void and the concentrating effects of evaporation. The increase of water salinity in the final void will continue unabated and will lead to an increase in density of the pit lake water. The pit lake will be non-polluting provided the increase in density of the water in the pit lake is not sufficient to reverse the groundwater gradients towards the void. In Section 5, AGE has calculated that the salinity would need to be 850,000 mg/L before the pressure at the base of the pit lake would exceed

[1] HGL (2021). "Mount Pleasant Optimisation Project Rehabilitation and Mine Closure. Targeted Peer Review of the Groundwater Impact Assessment Final Void Issues". Prepared 7 October by HydroGeoLogic Pty Ltd on behalf of NSW DPIE.

the lowest groundwater level measured in Alluvium near the mine site. Since the solubility of sodium chloride at 25 °C is about 360,000 mg/L, it is highly unlikely that the pit lake will ever generate high enough pressures to overturn gradients towards the void and hence is effectively non-polluting. I believe that the calculations presented in Section 5 of the AGE report address the PSEAR requirement regarding the non-polluting nature of the final void and also address Mr Middlemis' query on this matter.

In conclusion, I believe the recent groundwater assessment work undertaken by AGE has effectively responded to the concerns raised in Mr Middlemis' review.

Attachment C

Mount Pleasant Optimisation Project – Responses to Peer Review Comments on Final Void Modelling (HEC, 2021)

23 December 2021

MACH Energy Australia Pty Ltd
PO Box 2115
Dangar NSW 2309
Via email
Attention: Chris Lauritzen

Chris,

Re: Mount Pleasant Optimisation Project – Responses to Peer Review Comments on Final Void Modelling

1. BACKGROUND

HydroGeoLogic (2021) conducted a peer review of the Mount Pleasant Optimisation Project Surface Water Assessment (SWA), prepared by Hydro Engineering & Consulting Pty Ltd (HEC, 2020), and the Groundwater Impact Assessment (GIA), prepared by Australasian Groundwater and Environmental Consultants (AGE, 2020). The key outcomes of the peer review pertained to the post-mining final void modelling and the potential impact of the predicted baseflow reduction associated with the Mount Pleasant Optimisation Project (the Project) on flow in the Hunter River.

Accordingly, HEC were requested by MACH Energy Australia Pty Ltd (MACH Energy) to undertake the following works necessary to inform responses to the HydroGeoLogic peer review comments in relation to the SWA:

- update of the final void water balance model to simulate a revised groundwater stage-inflow relationship and revised salinity value for spoil seepage inflow;
- analysis of the final void water quality based on advice from the geochemistry specialists; and
- additional analysis of potential Hunter River baseflow impacts, with reference to flow duration curves.

This letter report presents the outcomes of the above tasks.

2. FINAL VOID WATER AND SALT BALANCE UPDATE

The final void water balance model detailed in the SWA (HEC, 2020) was updated to simulate a revised groundwater stage-inflow relationship and a revised salinity value for seepage from in-pit spoil.

It is understood that the numerical groundwater model developed for the Project was revised in accordance with the HydroGeoLogic (2021) peer review comments. The revised predicted rates of groundwater inflow versus water level in the final void were provided by AGE and are plotted in Figure 1. The total inflow presented in the GIA and simulated for the SWA final void water and salt balance is also plotted for comparative purposes (GIA Total).

The groundwater inflow to the final void comprises both the predicted rate of seepage from in-pit spoil and groundwater inflow from hard rock surrounding the final void. The proportion of groundwater inflow from hard rock was estimated at 8% of the total inflow while seepage from in-pit spoil was estimated at 92% of the total inflow (AGE, 2020).

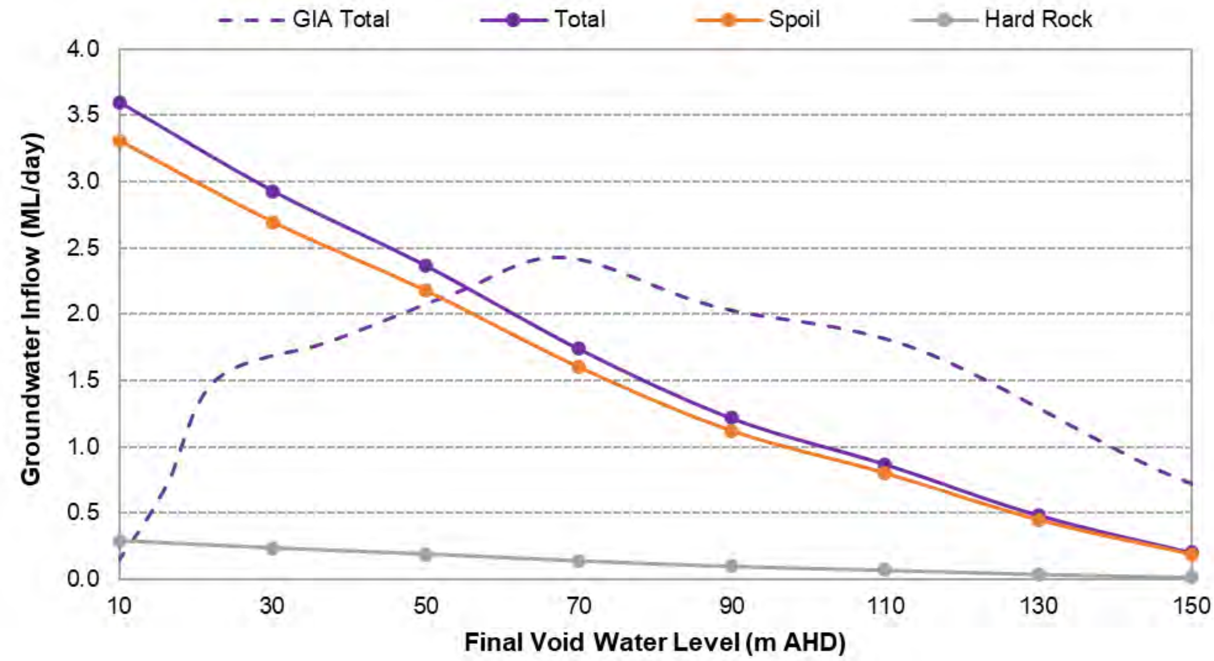

Figure 1 Revised Final Void Groundwater Inflow Predictions

HEC (2020) previously modelled the total groundwater inflow to the final void with an estimated electrical conductivity (EC) value of 5,522 µS/cm based on the average of EC records for the Project open cut pits up to September 2020. RGS Environmental Consultants Pty Ltd (RGS, 2021) have now provided an estimate of the potential salinity of groundwater reporting to the final void from the in-pit spoil based on the results of static and kinetic geochemical testing. A median salinity value in the range of 600 to 900 µS/cm was estimated by RGS (2021) for seepage inflow from spoil, with the upper value of 900 µS/cm adopted in the updated final void water and salt balance modelling.

RGS (2021) note that there are a number of factors which could influence the salinity of seepage from the in-pit spoil to the final void over time, however temporal changes to salinity were not provided. Therefore, a constant value of 900 µS/cm EC for the in-pit spoil seepage was conservatively adopted for the full model simulation period.

Consistent with the approach adopted in the SWA, the model effectively assumes that the interstitial void space of the in-pit spoil is saturated at the commencement of the simulation period.

Model-predicted final void water levels and EC values are shown in Figure 2.

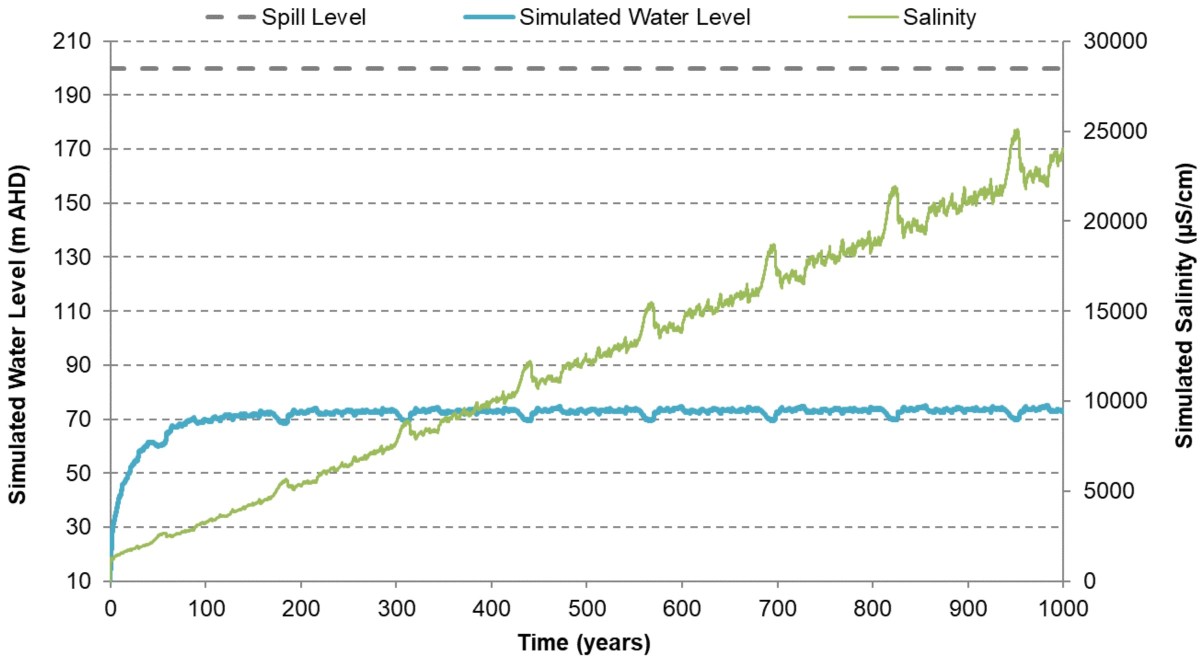

Figure 2 Updated Final Void Water Level and Salinity Prediction

The results in Figure 2 indicate that the final void is predicted to reach a peak water level of approximately 75 m AHD; 125 m below the spill level (i.e. the final void is contained). Equilibrium levels would be reached slowly over a period of more than 500 years. Note that, given the water level and groundwater flux relationship provided, groundwater outflow was not simulated to occur – i.e. the final void would remain a groundwater sink. Final void salinity is predicted to increase slowly as a result of evapo-concentration, with a predicted peak salinity of approximately 25,000 µS/cm after 950 years.

The above results compare with a predicted peak water level of approximately 90 m AHD and salinity of approximately 70,000 µS/cm after 1,000 years based on the final void water and salt balance modelling presented in the SWA (HEC, 2020). In addition to the revised groundwater inflow rates simulated in the updated final void water and salt balance, the predicted lower salinity results in marginally higher evaporation rates from the void, which also contributes to the reduction in the predicted peak water level.

3. POTENTIAL WATER QUALITY IMPACTS

RGS (2021) has recommended that any material identified as Potentially Acid Forming (PAF) should be preferentially placed in the in-pit waste emplacement and covered with a minimum of 10 m of non-acid forming (NAF) material as detailed in the approved Mining Operations Plan (MACH Energy, 2020) for the Project. In addition, as described in Section 3 of the Project Environmental Impact Statement, any PAF material exposed in the lower part of the highwall at the conclusion of mining would be:

- covered with NAF waste rock material to a minimum depth of 5 m;
- excavated and disposed of as PAF waste rock material (as described above); or

- flooded with water from the site water management system.

Materials identified as PAF are likely to comprise a relatively small proportion of materials to remain in the open pit, however, if left exposed to oxidising conditions, these materials have the potential to disproportionately contribute to the salinity of the final void stored water. As such, it is recommended that PAF materials are managed as recommended by RGS (2021) in order to reduce the potential for higher salinity values or other constituents to be generated in runoff to the final void.

4. POTENTIAL BASEFLOW REDUCTION IMPACTS

Changes in groundwater-derived baseflow associated with the Project were predicted by AGE (2020) for the Hunter Regulated River Water Source and the Hunter Unregulated and Alluvial Water Sources. AGE has advised that revisions to the numerical groundwater model have resulted in negligible changes to the predicted 'during mining' baseflow reduction rates and, as such, the predicted baseflow reduction rates during mining presented in the GIA (AGE, 2020) and shown in Table 1 remain valid for this assessment.

AGE has revised the predicted 'post-closure' baseflow reduction rates based on the revised predicted final void peak water level of approximately 75 m AHD (refer Section 2). The revised predicted post-closure baseflow reduction rates are shown in Table 1.

Table 1 Maximum Predicted Baseflow Reduction During Mining and Post-Closure

Water Sharing Plan	Water Source	During Mining Predicted Baseflow Reduction (ML/year)	Post-Closure Predicted Baseflow Reduction (ML/year)
Hunter Regulated River Water Source, 2016	Hunter Regulated River (Management Zone 1A)	27	33
Hunter Unregulated and Alluvial Water Sources, 2009	Muswellbrook Water Source (Sandy Creek)	2	7
	Dart Brook	6	14
Total		35	54

The total predicted reduction in baseflow from the Hunter River and its tributaries during mining (35 ML/year) amounts to approximately 0.015% of the 227,932 ML mean annual total flow in the Hunter River at Denman (GS 210055). The total predicted reduction in baseflow from the Hunter River and its tributaries post-closure (54 ML/year) amounts to approximately 0.02% of the 227,932 ML mean annual total flow in the Hunter River at Denman (GS 210055).

In addition to assessing the predicted baseflow reduction rates in relation to the mean annual flow of the Hunter River at Denman, HydroGeoLogic (2021) recommended that the effect of the predicted baseflow reduction associated with the Project be assessed in relation to the flow duration relationship of the Hunter River at Denman.

The SWA presented a flow duration curve for the Hunter River at Denman which was derived from streamflow data recorded at the WaterNSW Hunter River at Denman gauging station (GS 210055) for the period February 1959 to April 2020 (HEC, 2020). This dataset has been updated to include additional streamflow data recorded between April 2020 and November 2021[1]. The predicted baseflow reduction rates during mining and post-closure have been

[1] Data source: https://realtimedata.waternsw.com.au/ - accessed 25 November 2021

applied to the daily streamflow data recorded over this period and flow duration curves derived. Figure 3 presents the flow duration curve prior to mining (existing) and the predicted flow duration curve during mining and post-closure.

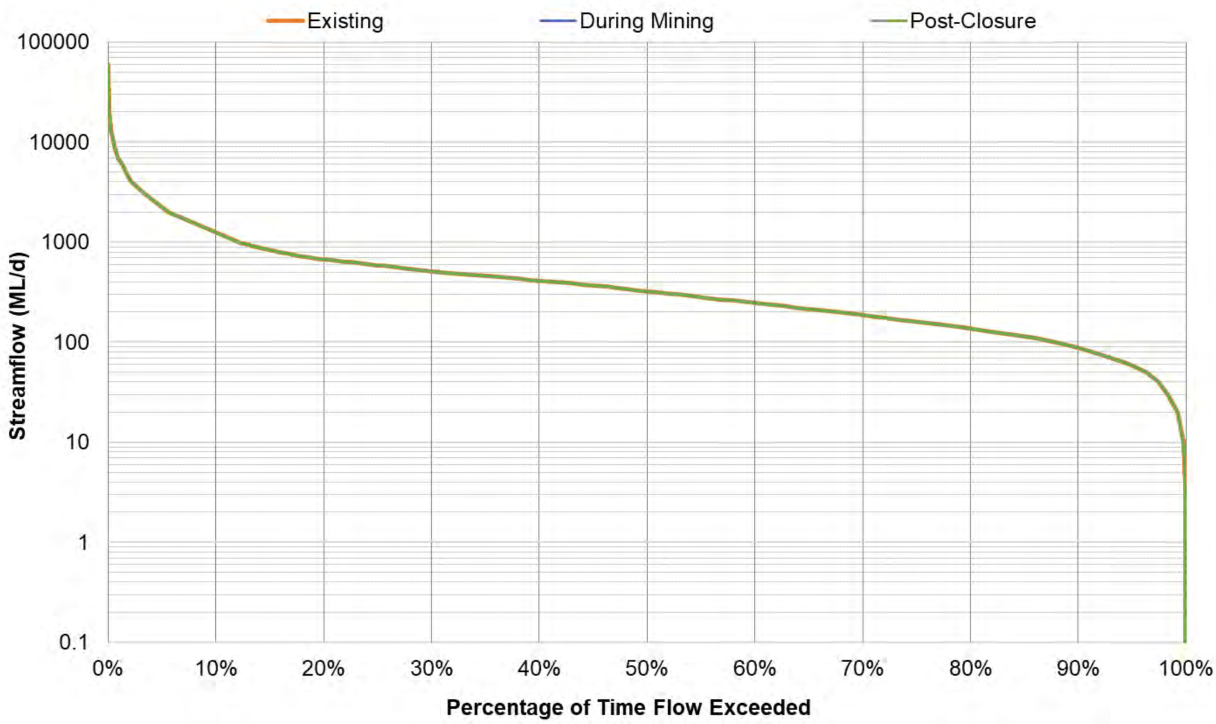

Figure 3 Hunter River at Denman (GS 210055) Flow Duration Curves

The data presented in Figure 3 illustrates that there is negligible difference in the existing, during mining and post-closure flow duration curves derived for the Hunter River at Denman (GS 210055). Accordingly, the potential baseflow reduction associated with the Project during mining and post-closure represents a very small and likely indiscernible impact to flow in the Hunter River at Denman.

5. CLOSURE

Thank you for the opportunity to be of service. Please do not hesitate to contact the undersigned if you have any queries.

Yours faithfully,

Camilla West
Associate Scientist

Tony Marszalek
Senior Principal Engineer

References:

AGE (2020). "Mount Pleasant Optimisation Project Groundwater Impact Assessment". Australasian Groundwater and Environmental Consultants Pty Ltd technical report prepared for MACH Energy Australia Pty Ltd, October.

HEC (2020). "Mount Pleasant Optimisation Project Surface Water Assessment". Prepared for MACH Energy Australia Pty Ltd, December.

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Attachment D

Geochemistry Methods, Assumptions, and Estimated Spoil Seepage Salinity and Soluble Metal/Metalloid Concentrations - Technical memorandum (RGS, 2021)

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From:	**RGS Environmental Consultants Pty Ltd 3/30 Lensworth Street, Coopers Plains QLD 4108**
To:	**MACH Energy Australia**
Project Name:	**001_2021099_MACH Energy MPOP Spoil Salinity_WQ_Rev4_23122021**
Attention:	**Chris Lauritzen**
Content:	**Geochemistry methods, assumptions, and estimated spoil seepage salinity and soluble metal/metalloid concentrations - Technical memorandum**

MINE WASTE AND WATER MANAGEMENT

1 Introduction

RGS Environmental Consultants Pty Ltd (RGS) was requested by MACH Energy Australia Pty Ltd (MACH Energy) to assist in addressing comments raised by a peer review of the Groundwater Impact Assessment for the proposed Mount Pleasant Optimisation Project ('the Project') commissioned by the Department of Planning, Industry and Environment (DPIE).

Both the Surface Water[1] and Groundwater[2] Impact Assessments were included as appendices to an Environmental Impact Statement (EIS) submission for the Project. A peer review of the Groundwater Impact Assessment undertaken by HydroGeoLogic Pty Ltd (HGL), on behalf of the DPIE, queried the potential impacts on final void lake water quality of potentially acid forming (PAF) materials identified by RGS[3] on the basis that they may be exposed in the final void highwall.

MACH Energy has also requested that RGS provide an estimate of the potential salinity and soluble metal/metalloid concentrations of groundwater[4] reporting to the pit void from the backfilled spoil in the planned final landform, based on the findings of the static and kinetic geochemical test program completed in 2020[3].

This Technical Memorandum describes the previous works, data, and assumptions RGS has used to indicate the potential salinity and soluble metal/metalloid concentrations of groundwater reporting to the final pit void through backfilled mine spoil.

1.1 Background

The Project proposes extraction of additional coal reserves within Mount Pleasant Operation Mining Leases and an increase in the rate of coal extraction, without significantly increasing the total disturbance footprint. The Mount Pleasant Operation is located approximately three kilometres northwest of Muswellbrook in the Upper Hunter Valley of New South Wales (**Figure 1-1**). The mine is directly adjacent to Bengalla Coal Mine, which has been operating for an extended period and is mining similar strata to the Project.

[1] HEC (2020) Mount Pleasant Optimisation Project – Surface Water Impact Assessment. Prepared for MACH Energy Mount Pleasant Optimisation Project – Environmental Impact Statement (Appendix D) by Hydro Engineering & Consultants Pty Ltd.
[2] AGE. (2020). Mount Pleasant Optimisation Project – Groundwater Impact Assessment. Prepared for MACH Energy Mount Pleasant Optimisation Project – Environmental Impact Statement (Appendix C) by Australasian Groundwater and Environmental Consultants.
[3] RGS. (2020). Mount Pleasant Optimisation Project – Geochemistry Assessment. Prepared for MACH Energy Mount Pleasant Optimisation Project – Environmental Impact Statement (Appendix K) by RGS Environmental Consultants Pty Ltd
[4] Groundwater in this context refers to water that has moved through the backfilled spoil and enters the pit void (i.e. spoil seepage).

Figure 1-1: Project location

The typical stratigraphic profile at the Project and the coal seams to be mined are illustrated in **Figure 1-2**. There are 11 coal seams to be mined at the Project ranging from the Warkworth A Seam down to the Edderton Seam and both overburden and interburden units associated with accessing these seams will be disturbed during open pit mining. The overburden and interburden materials predominantly comprise sandstone, with some seam roof, parting, and floor materials consisting of mudstone and claystone.

1.2 Regional geology

The Mount Pleasant Operation is located on the western side of the Hunter Dome Belt, which is a section of the northern part of the early Permian to late Triassic aged Sydney Basin. The Hunter Dome Belt hosts north-south trending anticlines and synclines, of which one is the Muswellbrook Anticline.

The Gyarran Volcanics form the basement unit of the Sydney Basin, which outcrops in the hinge of the Muswellbrook Anticline. This is overlain by the Greta Coal Measures, the Maitland Group and the Whittingham Coal Measures. The Whittingham Coal Measures host the seams targeted at the Mount Pleasant Operation. In the east of the Project area the outcropping coal measures have been covered by alluvium deposited by the Hunter River. To the west of the Project area, the Whittingham Coal Measures are overlain by the Watts Sandstone and Newcastle Coal Measures (previously called the Wollombi Coal Measures).

1.3 Local geology

The 11 target coal seams are hosted within the Whittingham Coal Measures on the western limb of the Muswellbrook Anticline. The topography of the Whittingham Coal Measures, the major geological unit in the Project area, rises to the west with weathering extending to a depth of 9 to 35 metres (m), averaging 20 m. The stratigraphy of the Whittingham Coal Measures is shown in **Figure 1-2**. The seams within the Whittingham Coal Measures that are targeted at the Project consist of the Jerry's Plains and Vane Subgroups, which are separated stratigraphically by the Archerfield Sandstone. There is a gradational boundary between the Archerfield Sandstone and Bulga Formation. Near Muswellbrook, the Bulga Formation-Archerfield Sandstone sequence combines to form a single unit (Sniffin and Beckett, 1995[5]). Typically, the Archerfield Sandstone contains finely disseminated pyrite, which imparts a characteristic bronze colour to the sandstone.

The coal seams in the Mount Pleasant area are split into 71 plies ranging from 0.3 to 2.3 m thick. Partings within the coal seams are less than 0.3 m thick and seams are identified using coal brightness properties, marker horizons and the stratigraphic relationships between the seams. The Jerry's Plains Subgroup includes (in descending order) the Bowfield, Warkworth, Mt Arthur, Piercefield (PF), Vaux (VA), Broonie (BR) and Bayswater (BY) seams, and is typically composed of sandstone, siltstone, coal and tuffaceous claystone. The Vane Subgroup, which underlies the Archerfield Sandstone, consists of (in descending order) the Wynn (WN), Edderton (ED), Clanricard (CL), Bengalla, Edinglassie and Ramrod Creek seams, and typically consists of sandstone, siltstone and coal beds. The coal at the Project has a moderate propensity for self-heating and spontaneous combustion, which is managed as per the Spontaneous Combustion Management Plan.

The overburden and interburden materials at the Project area are predominantly sandstone, with some seam roof, parting and floor materials consisting of mudstone and claystone. The sandstone frequently contains bands of siderite. The basement unit of the area is the Gyarran Volcanics, which outcrops in the hinge of the Muswellbrook Anticline.

[5] Sniffin, M. and Beckett, J. (1995). *Sydney Basin – Hunter Coalfield*. In: Ward CR, Harrington H.J., Mallett CW and Beeston J.W. (eds). Geology of Australian Coal Basins (pages 177-195). Geological Society of Australia Incorporated, Coal Group Special Publication No. 1. Geological Society of Australia, Sydney.

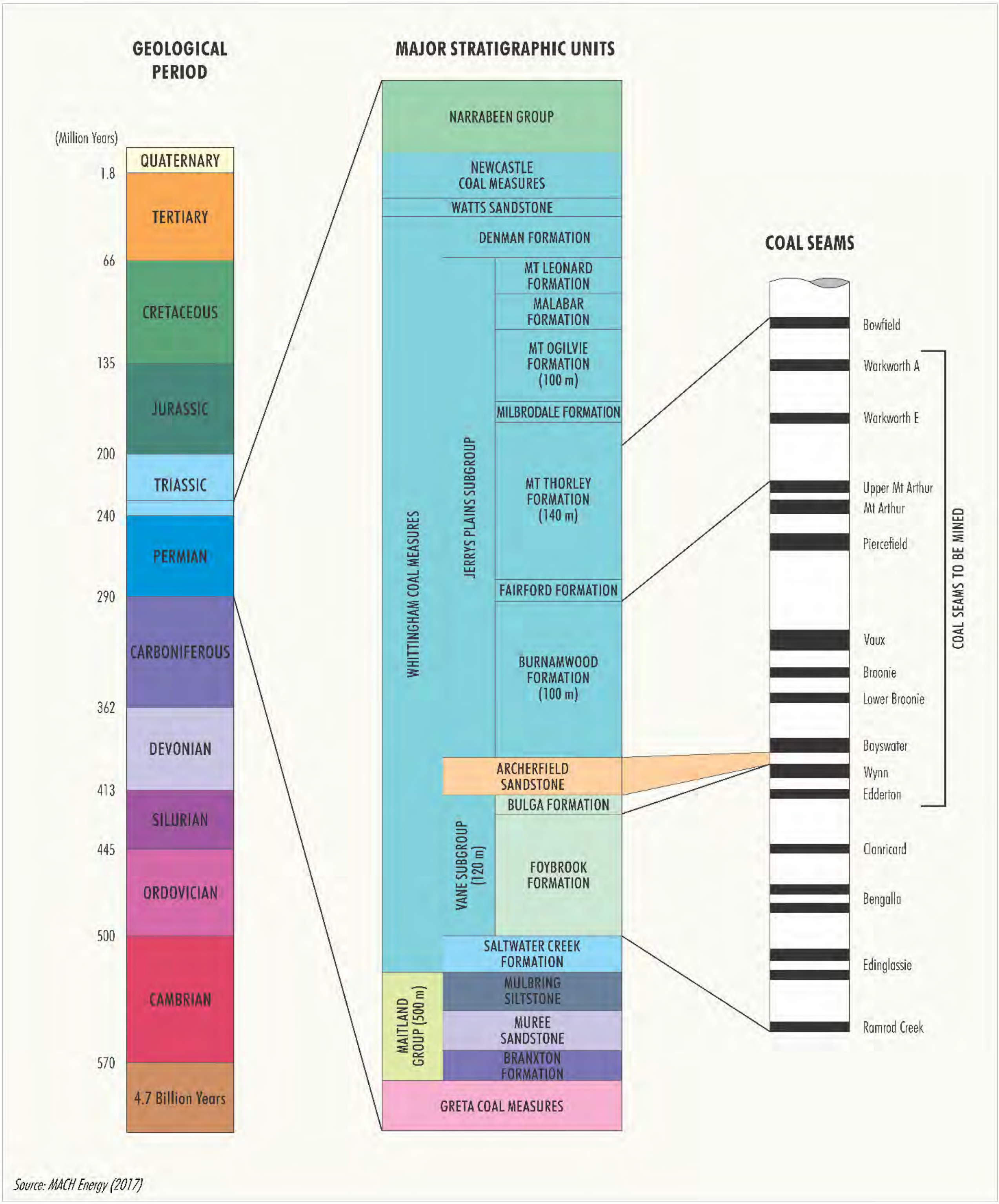

Figure 1-2: Stratigraphic column for the Project area

2 Conceptual model

The salinity and soluble metal/metalloid concentrations in groundwater which has interacted with mining materials in a final landform may be influenced by a number of factors. The conceptual groundwater model developed by AGE[2] shows that there are many potential factors that may influence the salinity and soluble metal/metalloid concentrations of groundwater reporting to the final void waterbody from the spoil (**Figure 2-1).** Due to the potential complexity of interactions that may influence the quality of groundwater from the spoil RGS recommends caution when using single values to inform the modelling of salinity and metals/metalloids derived from groundwater that has interacted with spoil.

RGS assumes that any material identified as Potentially Acid Forming (PAF) placed in the in-pit or out-of-pit waste emplacement will be covered with a minimum of 10 m of Non-Acid Forming (NAF) material as detailed in the approved Mining Operations Plan[6] for the Mount Pleasant Operation and that any PAF material exposed in the lower part of highwall at the conclusion of mining will be managed as follows (as described in Section 3 of the EIS):

- covered with NAF waste rock material to a minimum depth of 5 m;
- excavated and disposed of as PAF waste rock material (as described above); or
- flooded with water from the site water management system.

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[6] MACH Energy. (2020). Mount Pleasant Operation Mining Operations Plan and Rehabilitation Management Plan. Version 4. 29 July.

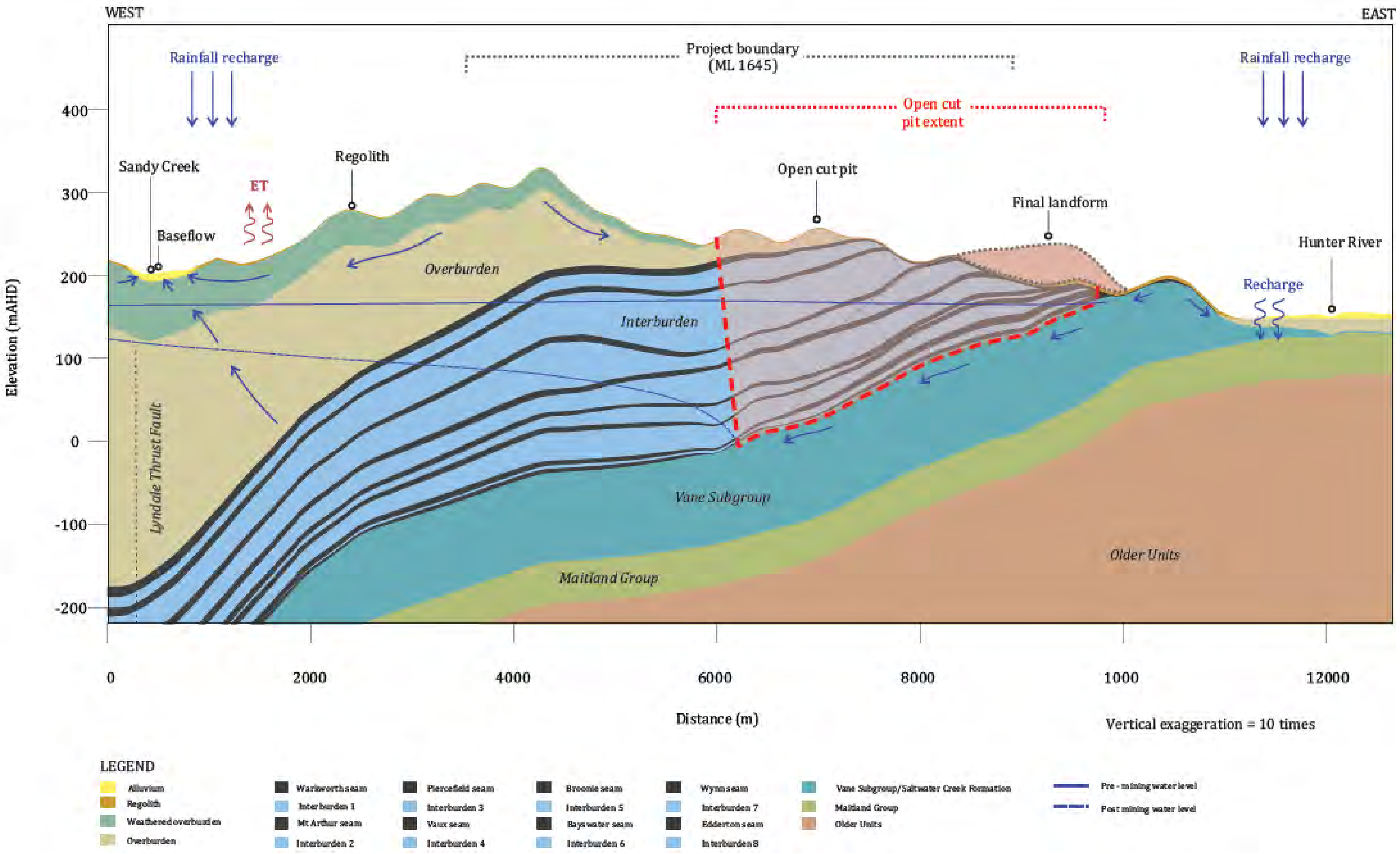


Figure 2-1: Conceptual groundwater model (AGE, 2020)

3 Geochemical Information

RGS has undertaken several mine waste geochemistry studies over the past two decades at Bengalla Mine and other mines accessing coal from target seams by open cut methods located in similar strata to that being mined at the Project. RGS has also completed a geochemical assessment of mine materials at the Project to support the submission of the Project EIS[3]. The work program was designed and completed in accordance with relevant industry guidelines (AMIRA, 2002[7]; COA, 2016[8]; and INAP, 2021[9]). The assessment included a review of existing information for the site geochemistry, as well as a review of geochemical assessments completed at the nearby Bengalla Mine and Mt Arthur Coal Mine. The surface water results for the Mount Pleasant Operation, Bengalla Mine and Mt Arthur Coal Mine were reviewed, as well as the available geological mapping and drill hole logs for the Mount Pleasant Operation area.

3.1 Existing information

The findings of the review process were used to develop a program of sampling and static/kinetic geochemical testing of drill core to confirm the geochemical nature of the overburden, interburden, roof, floor and coal reject materials. The review found that the overburden and interburden units of the Jerry's Plan Subgroup were expected to be NAF, have excess Acid Neutralising Capacity (ANC), and have low oxidisable sulfur content. These materials were expected to have a very low risk of acid generation and a high factor of safety with respect to potential for Acid and Metalliferous Drainage (AMD).

The occurrence of PAF materials was expected to be limited to strata and material processed from the Vane Subgroup that comprises BY-WN interburden (i.e., Archerfield Sandstone), WN interburden (roof, floor and parting) and coarse rejects derived from processing the WN seam (and possibly the ED seam).

3.2 Development of static and kinetic geochemical test program

Static geochemical testing provides a result based on analysis of a sample material at a single point in time. Kinetic testing provided information of the dynamic geochemical characteristics of sample materials over time. To provide context for the groundwater salinity predictions, RGS has derived the salinity analysis methodology and results that are summarised in **Sections 3.3 and 3.4**. To provide context for the soluble metal/metalloid predictions, RGS has derived the analysis methodology and results summarised in **Sections 3.5** and **3.6**.

3.3 Static testing - Electrical Conductivity

Representative samples of mine materials from the Project (including overburden, interburden, and coal reject materials) were initially subjected to static electrical conductivity (EC) analysis at ALS Environmental Laboratory (ALS) in Brisbane. EC results are indicative of the initial salinity of a sample and are reported in units of micro-Seimens per centimetre (µS/cm). To assess the EC of the samples, sample materials were pulverised to pass a 75 µm sieve size and agitated in deionised water over a period of 16 hours at a 1:5 (w/v) solid to deionised water ratio.

The pulverising of the samples greatly increases the surface area of particles in the sample. This creates a larger surface relative to in situ sample materials for the exchange of salts between the sample particles and the deionised water. Because of this sample preparation process, salinity results obtained from pulverised sample materials is generally higher relative to the salinity from in situ materials and essentially represents a "worst-case" scenario.

Samples for geochemical assessment are typically stored in heavy-duty plastic bags when collected. While the bags are typically sealed, it is rare that the seal is airtight. This can result in some dehydration of the sample as moisture contained in the sample evaporates. Salts that were present in the initial sample moisture are then concentrated on the surfaces of the sample material as evaporation occurs. These salts may contribute to a

[7] AMIRA (2002). ARD Test Handbook: Project 387A Prediction and Kinetic Control of Acid Mine Drainage, Australian Minerals Industry Research Association, Ian Wark Research Institute and Environmental Geochemistry International Pty Ltd, May 2002.

[8] COA (2016). *Leading Practice Sustainable Development Program for the Mining Industry. Prevention and Acid and Metalliferous Drainage*. Commonwealth of Australia, Canberra ACT. September.

[9] INAP (2020). *Global Acid Rock Drainage Guide (GARD Guide)*. Document prepared by Golder Associates on behalf of the International Network on Acid Prevention (INAP). June 2009 (http://www.inap.com.au/).

"first flush" effect where the initial analysis of a sample returns results elevated relative to what may naturally occur.

While the above factors may contribute to an elevated salinity result, this is potentially offset to some extent as the results are reported without correction for the 1:5 (w/v) laboratory method dilution factor. Hence, RGS generally recommends that a wide range of samples initially undergo static salinity analysis in a screening process to inform the creation of representative composite samples for dynamic salinity analysis in kinetic leach column (KLC) tests (this was undertaken as described in **Section 3.4**).

The static salinity test results from representative samples of overburden and interburden materials are presented in **Figure 3-1.** Average EC values and standard deviation (SD) values for these salinity data as well as the number of samples are provided in **Table 3-1**. Of note are the salinity values (highlighted in yellow) for the materials derived from the Vane Subgroup [Bayswater-Wynn Interburden (i.e. Archerfield Sandstone), Wynn Roof, Floor and Parting], which can be higher than the salinity values for the sample materials representing the Jerry's Plain Subgroup.

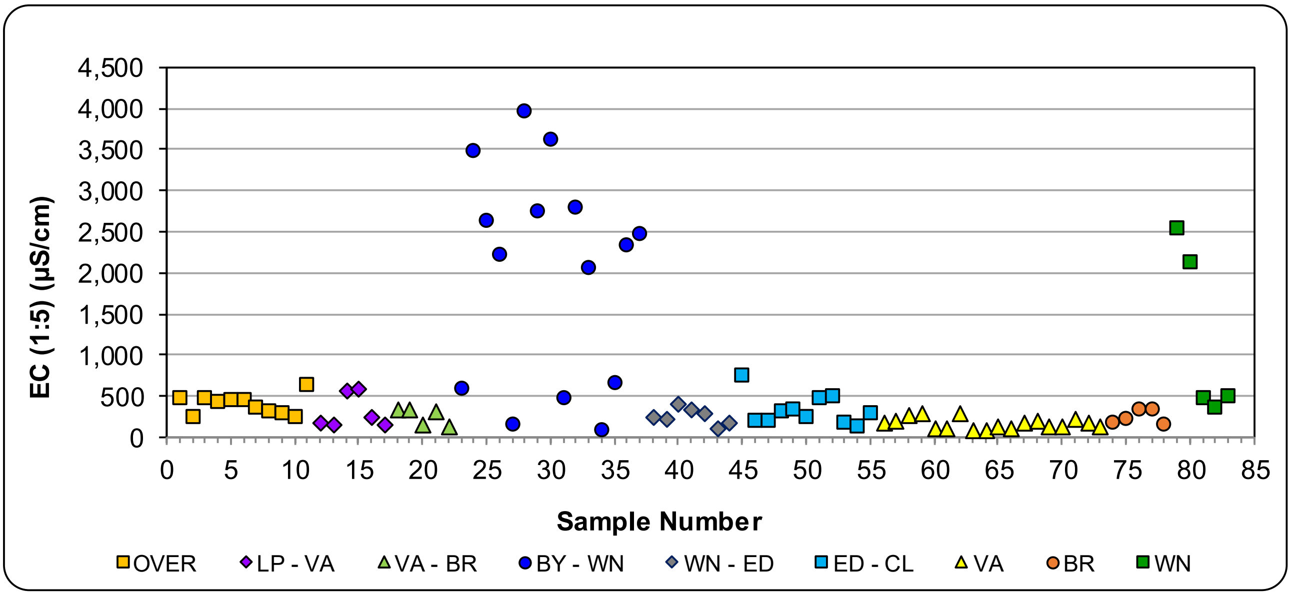


Figure 3-1: Static salinity test results for overburden and interburden

Table 3-1: Static EC results for overburden and interburden

Material	Average 1:5 EC	1:5 EC SD	No. of samples
Overburden (OVER)	400	117	11
Lower Piercefield (LP) -Vaux (VA) Interburden	316	206	6
Vaux (VA) – Broonie (BR) Interburden	259	106	5
Bayswater-Wynn Interburden (Archerfield Sandstone)	2,027	1,306	15
Wynn (WN) – Edderton (ED) Interburden	255	99	7
Edderton (ED) – Clanricard (CL) Interburden	333	183	11
Vaux (VA) (Roof/Floor/Parting)	171	68	18
Broonie (BR) (Roof/Floor/Parting)	254	90	5
Wynn (WN) (Roof/Floor/Parting)	1,201	1,047	5
All samples	648	913	83

3.4 KLC testing - Electrical Conductivity

KLC analysis of mine material salinity was undertaken using a methodology aligned to the standard AMIRA methodology used under free draining (i.e. fully oxidising) conditions[6].

Composite samples were prepared for use in the KLC tests based on material type and the results of static Acid Base Accounting analyses described in **Section 3.3**[3]. These samples were crushed to pass a 20 mm sieve size rather than being pulverised as for the static sample test program. The larger sized particles in the KLC tests have less surface area than pulverised samples, but still have a relatively small particle size distribution and higher surface area than in situ materials in the field. A “first flush” effect was expected and observed in the initial leachates from the KLC tests due to sample preparation methodology, but this effect did not unduly influence EC values in KLC leachates in subsequent leaching events.

Deionised water was added to each of the KLC tests and the resulting leachate collected on a monthly basis. A total of seven leachates were collected from each column over a test period of six months. As soon as the KLC leachates were collected, they were sent to a commercial laboratory (ALS Stafford) for a range of analyses, including EC.

As with the static salinity analysis results, the salinity values for the materials derived from the Vane Subgroup [Bayswater-Wynn Interburden (i.e. Archerfield Sandstone), and Wynn Partings], were higher than the salinity values for the sample materials representing the Jerry’s Plain Subgroup.

Overall, the KLC test results confirmed that if left unmanaged under freely oxidising conditions, some of the materials derived from the Vane Subgroup have the potential to generate acidic drainage with elevated salinity levels. In contrast, materials from the Jerry’s Plains Subgroup are likely to generate pH neutral to slightly alkaline drainage with lower salinity levels.

3.5 Static testing – Soluble Metal/Metalloid Concentrations

Following static geochemical screening tests, ten representative composite samples of NAF and PAF overburden and interburden materials from the Project were subjected to static water extract leaching tests at ALS laboratory.

The static soluble metal/metalloid concentration results obtained are indicative of the soluble metal/metalloid concentrations in that could occur for sample materials pulverised to pass a 75 µm sieve size and agitated in deionised water over a period of 16 hours at a 1:5 (w/v) solid to deionised water ratio.

The pulverising of the samples greatly increases the surface area of particles in the sample. This creates a larger surface relative to in situ sample materials for dissolution from the sample particles and the deionised water and essentially represents a “worst-case” scenario. Essentially, sample preparation may contribute to a “first flush” effect where the initial analysis of a sample returns results elevated relative to what may naturally occur.

While the above factors may contribute to an elevated soluble metal/metalloid concentration result, this is potentially offset to some extent as the results are reported without correction for the 1:5 (w/v) laboratory method dilution factor.

Due to these factors, RGS generally recommends that selected representative composite samples are also subjected to dynamic metal/metalloid leaching analysis in KLC tests (this was undertaken as described in **Section 3.6**).

The soluble concentration of metals/metalloids in static and kinetic tests represents potential localised pore water chemistry under freely oxidising leaching and pH conditions that are only likely to occur near the surface of spoil areas. The bulk spoil materials may experience different pH, redox, temperature and hydrological/hydrogeological conditions compared to surface materials and therefore metal/metalloid solubilities may be very different. For example under pH neutral or mildly alkaline conditions metal solubilities are generally much lower than under acidic conditions.

Similarly the soluble metal/metalloid concentrations in the final void pit lake will be strongly influenced by factors such as pH, redox and temperature conditions; and limnological considerations also need to be taken into account, if the water body is prone to climatic/salinity related stratification, for example. In general, static and kinetic leach data for soluble metal/metalloids from backfilled spoil derived from small scale laboratory tests cannot be used directly in final void pit lake calculations as geochemical modelling is generally required utilising assumed, or preferably measured, criteria for variable parameters such as pH, redox potential, temperature and metal/metalloid solubility/precipitation kinetics under specific conditions. Unlike salinity, the use of a weighted average methodology for deriving potential soluble metal/metalloid concentrations from groundwater that has interacted with spoil is not appropriate.

Nevertheless, the soluble metal/metalloid concentrations derived from static and kinetic tests can provide a qualitative indication of particular metals/metalloids that are either sparingly soluble, or those that may have the potential to be released into solution, under specific conditions and identifies specific metals/metalloids that should be included in the site water quality monitoring program.

Summary statistics for the soluble metal/metalloid concentrations derived from the static geochemical test program for representative samples of NAF and PAF overburden and interburden materials are presented in **Table 3-2**. Where necessary, a value of half of the laboratory Limit of Reporting (LoR) was used to calculate statistical parameters. The three composite PAF samples represent interburden materials between the BY and WN seam [Bayswater-Wynn Interburden (i.e. Archerfield Sandstone), and within the WN seam [Wynn Roof, Floor and Parting] derived from the Vane Subgroup. The remaining seven composite NAF samples represent overburden and interburden materials from the Jerry's Plain Subgroup.

Elevated soluble metal/metalloid concentrations for manganese (Mn), selenium (Se) and zinc (Zn) were observed in leachate from the static geochemical test program for one of the PAF BY-WN interburden samples, when compared to applied water quality guidelines for freshwater aquatic ecosystems (95 % species protection) (ANZG, 2018[10]). However, all soluble metals/metalloid concentrations were less than the applied livestock drinking water quality guideline values. Most metals/metalloids in NAF and PAF sample materials were, at least initially, sparingly soluble and dissolved concentrations were typically less than the laboratory Limit of Reporting (LoR).

Table 3-2: Static soluble metal/metalloid results for NAF overburden and interburden

Major Ions	Limit of Reporting (mg/L)	Freshwater Aquatic Ecosystems[9] (mg/L)	Livestock Drinking Water[9] (mg/L)	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Average (mg/L)	Standard Deviation (mg/L)	Number of results above LoR
Calcium (Ca)	2	-	1,000	2	138	44	61	59	7
Magnesium (Mg)	2	-	-	4	94	40	40	36	7
Potassium (K)	2	-	-	14	28	18	19	5	7
Sodium (Na)	2	-	-	40	68	46	49	10	7
Chloride (Cl)	2	-	-	8	46	22	24	15	7
Fluoride (F)	0.2	-	2	0.4	2.6	0.6	0.9	0.8	7
Sulfate (SO_4)	2	-	1,000	20	730	278	324	306	7
Trace Metals/Metalloids									
Aluminium (Al)	0.2	0.055	5	<0.2	<0.2	---	---	---	0
Antimony (Sb)	0.02	-	-	<0.02	<0.02	---	---	---	0
Arsenic (As) - trivalent	0.02	0.024 **	0.5	<0.02	<0.02	---	---	---	0
Boron (B)	0.2	0.37	5	<0.2	<0.2	<0.2	---	---	0
Cadmium (Cd)	0.02	0.0002	0.01	<0.02	<0.02	<0.02	---	---	0
Chromium (Cr) - total	0.02	0.001 (hex)*	1 (total)	<0.02	<0.02	<0.02	---	---	0
Cobalt (Co)	0.02	-	1	<0.02	<0.02	<0.02	---	---	0
Copper (Cu)	0.02	0.0014	1	<0.02	<0.02	<0.02	---	---	0
Iron (Fe)	0.2	-	-	<0.2	<0.2	<0.2	---	---	0
Manganese (Mn)	0.02	1.90	-	<0.02	1.36	0.40	0.57	0.59	4
Molybdenum (Mo)	0.02	-	0.15	<0.02	0.04	<0.02	---	---	1
Nickel (Ni)	0.02	0.011	1	<0.02	<0.02	<0.02	---	---	0
Selenium (Se)	0.02	0.011	0.02	<0.02	0.02	<0.02	---	---	2
Thorium (Th)	0.002	-	-	<0.002	<0.002	<0.002	---	---	0
Uranium (U)	0.002	-	0.2	<0.002	0.002	<0.002	---	---	1
Zinc (Zn)	0.02	0.008	20	<0.02	<0.02	<0.02	---	---	0

10 ANZG (2018). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT.

Table 3-3: Static soluble metal/metalloid results for PAF overburden and interburden

Major Ions	Limit of Reporting (mg/L)	Freshwater Aquatic Ecosystems[9] (mg/L)	Livestock Drinking Water[9] (mg/L)	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Average (mg/L)	Standard Deviation (mg/L)	Number of results above LoR
Calcium (Ca)	2	-	1,000	292	292	6	101	166	3
Magnesium (Mg)	2	-	-	186	186	6	66	104	3
Potassium (K)	2	-	-	14	14	10	9	5	3
Sodium (Na)	2	-	-	48	48	42	33	20	3
Chloride (Cl)	2	-	-	10	10	8	9	1	3
Fluoride (F)	0.2	-	2	<0.2	1.6	1.3	1.3	0.4	2
Sulfate (SO_4)	2	-	1,000	24	1,418	32	491	803	3
Trace Metals/Metalloids									
Aluminium (Al)	0.2	0.055	5	<0.2	<0.2	<0.2	---	---	0
Antimony (Sb)	0.02	-	-	<0.02	<0.02	<0.02	---	---	0
Arsenic (As) - trivalent	0.02	0.024 **	0.5	<0.02	<0.02	<0.02	---	---	0
Boron (B)	0.2	0.37	5	<0.2	<0.2	<0.2	---	---	0
Cadmium (Cd)	0.02	0.0002	0.01	<0.02	<0.02	<0.02	---	---	0
Chromium (Cr) - total	0.02	0.001 (hex)*	1 (total)	<0.02	<0.02	<0.02	---	---	0
Cobalt (Co)	0.02	-	1	<0.02	0.24	<0.02	---	---	1
Copper (Cu)	0.02	0.0014	1	<0.02	<0.02	<0.02	---	---	0
Iron (Fe)	0.2	-	-	<0.2	<0.2	<0.2	---	---	0
Manganese (Mn)	0.02	1.90	-	<0.02	24.20	<0.02	---	---	1
Molybdenum (Mo)	0.02	-	0.15	<0.02	<0.02	<0.02	---	---	0
Nickel (Ni)	0.02	0.011	1	<0.02	0.36	<0.02	---	---	1
Selenium (Se)	0.02	0.011	0.02	<0.02	<0.02	<0.02	---	---	0
Thorium (Th)	0.002	-	-	<0.002	<0.002	<0.002	---	---	0
Uranium (U)	0.002	-	0.2	<0.002	<0.002	<0.002	---	---	0
Zinc (Zn)	0.02	0.008	20	<0.02	0.12	<0.02	---	---	1

3.6 KLC testing - Soluble Metal/Metalloid Concentrations

KLC analysis of three NAF and two PAF overburden and interburden sample materials was undertaken using a methodology aligned to the standard AMIRA methodology used under free draining (i.e. fully oxidising) conditions[7].

Composite samples were prepared for use in the KLC tests based on material type and the results of static Acid Base Accounting and metal/metalloid analyses described in **Sections 3.3**[3] and **3.5**. The KLC samples were tested using the methodology detailed in **Section 3.4**. Again due to sample preparation, a "first flush" effect was expected and observed in the initial leachates from the KLC tests due to sample preparation methodology, but this effect did not unduly influence soluble metal/metalloid values in KLC leachates in subsequent leaching events which was more controlled by pH and acidity.

The KLC test results shown in **Tables 3-4** and **3-5** demonstrate that, in common with the static leachable metal/metalloid analysis results, soluble metal/metalloid values for the materials derived from the Vane Subgroup [Bayswater-Wynn Interburden (i.e., Archerfield Sandstone), Wynn Partings, and Wynn Coarse Rejects], are higher than soluble metal/metalloid values for the sample materials representing the Jerry's Plain Subgroup. In particular, some soluble metal/metalloid concentrations are greater than the applied water quality guideline values for livestock drinking water (irrigation water values used for iron (Fe and Mn) (ANZG, 2018[10]).

Overall, the KLC test results confirmed that if left unmanaged under freely oxidising conditions, some of the materials derived from the Vane Subgroup have the potential to generate acidic drainage with elevated soluble metal/metalloid concentrations. In contrast, materials from the Jerry's Plains Subgroup are likely to generate pH neutral to slightly alkaline drainage with very low soluble metal/metalloid concentrations.

Table 3-4: KLC soluble metal/metalloid results for NAF overburden and interburden

Major Ions	LoR	Freshwater Aquatic Ecosystems[9] (mg/L)	Livestock Drinking Water[9] (mg/L)	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Average (mg/L)	Standard Deviation (mg/L)	Number of results
Calcium (Ca)	1	-	1,000	<1	22	6	8	7	18
Potassium (K)	1	-	-	2	8	3	3	2	21
Magnesium (Mg)	1	-	-	<1	24	5	8	7	19
Sodium (Na)	1	-	-	17	100	40	48	26	21
Chloride (Cl)	1	-	-	6	82	16	21	17	21
Fluoride (F)	0.1	-	2	0.2	1.4	0.5	0.6	0.4	21
Sulfate (SO_4)	1	-	1,000	17	314	91	104	86	21
Trace Metals/Metalloids									
Aluminium (Al)	0.01	0.055	5	<0.01	1.28	0.18	0.32	0.36	19
Arsenic (As)	0.001	0.024	0.5	<0.001	0.009	0.004	0.004	0.002	17
Boron (B)	0.05	0.37	5	<0.05	0.05	<0.05	---	---	1
Cadmium (Cd)	0.0001	0.0002	0.01	<0.0001	0.0001	<0.0001	---	---	3
Cobalt (Co)	0.001	-	1	<0.001	0.015	0.006	0.006	0.005	11
Copper (Cu)	0.001	0.0014	1	<0.001	0.006	0.002	0.003	0.001	18
Iron (Fe)	0.05	-	1	<0.05	0.16	0.12	0.12	0.03	11
Mercury (Hg)	0.0001	0.0006	-	<0.0001	<0.0001	<0.0001	---	---	0
Manganese (Mn)	0.001	1.9	2	<0.001	0.030	0.006	0.010	0.009	20
Molybdenum (Mo)	0.001	-	0.15	0.002	0.042	0.006	0.009	0.009	21
Nickel (Ni)	0.001	0.011	1	<0.001	0.016	0.005	0.006	0.006	13
Lead (Pb)	0.001	0.0034	0.1	<0.001	0.003	<0.001	---	---	1
Antimony (Sb)	0.001	-	-	<0.001	0.002	<0.001	---	---	1
Selenium (Se)	0.01	0.011	0.02	<0.01	0.10	0.03	0.04	0.03	16
Strontium (Sr)	0.001	-	-	<0.001	1.230	0.515	---	---	12
Vanadium (V)	0.01	-	-	<0.01	<0.01	<0.01	---	---	0
Zinc (Zn)	0.005	0.008	20	<0.005	0.057	<0.005	---	---	10

Table 3-5: KLC soluble metal/metalloid results for PAF overburden and interburden

Major Ions	LoR	Freshwater Aquatic Ecosystems[9] (mg/L)	Livestock Drinking Water[9] (mg/L)	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Average (mg/L)	Standard Deviation (mg/L)	Number of results
Calcium (Ca)	1	-	1,000	28	229	121	124	61	14
Potassium (K)	1	-	-	<1	4	3	3	1	8
Magnesium (Mg)	1	-	-	31	750	414	375	234	14
Sodium (Na)	1	-	-	<1	84	39	40	29	9
Chloride (Cl)	1	-	-	1	17	5	6	4	14
Fluoride (F)	0.1	-	2	<0.1	4.4	0.3	1.2	1.6	9
Sulfate (SO_4)	1	-	1,000	396	8,230	2,575	3,841	2,998	14
Trace Metals/Metalloids									
Aluminium (Al)	0.01	0.055	5	2	381	15	88	115	14
Arsenic (As)	0.001	0.024	0.5	<0.001	1.640	0.009	0.424	0.630	13
Boron (B)	0.05	0.37	5	<0.05	<0.05	<0.05	---	---	0
Cadmium (Cd)	0.0001	0.0002	0.01	0.001	0.038	0.004	0.011	0.012	14
Cobalt (Co)	0.001	-	1	0.267	3.260	0.524	1.211	1.125	14
Copper (Cu)	0.001	0.0014	1	0.062	2.880	0.180	0.633	0.839	14
Iron (Fe)	0.05	-	1	12	4,030	156	983	1,266	14
Mercury (Hg)	0.0001	0.0006	-	<0.0001	0.0003	<0.0001	0.000	0.000	2
Manganese (Mn)	0.001	1.9	2	0.6	172.0	11.9	51.0	63.3	14
Molybdenum (Mo)	0.001	-	0.15	<0.001	0.022	---	---	---	7
Nickel (Ni)	0.001	0.011	1	0.676	5.31	1.305	2.002	1.539	14
Lead (Pb)	0.001	0.0034	0.1	<0.001	0.056	0.002	0.009	0.019	8
Antimony (Sb)	0.001	-	-	<0.001	<0.001	<0.001	---	---	0
Selenium (Se)	0.01	0.011	0.02	<0.01	0.050	0.020	0.022	0.012	10
Strontium (Sr)	0.001	-	-	<0.001	3.630	1.051	1.397	1.301	8
Vanadium (V)	0.01	-	-	<0.01	1.060	---	---	---	7
Zinc (Zn)	0.005	0.008	20	0.74	31.20	2.40	9.21	10.81	14

4 Mine Planning Information

The Project would involve the removal of approximately 1,535 million bank cubic metres (Mbcm) of overburden and interburden material and generate approximately 85 million tonnes of coal reject material[11]. Accordingly, coal reject would represent a very small portion of the overall waste emplacement and will be covered with a minimum of 10 m of NAF material in accordance with the Mining Operations Plan (Section 2)[6].

Data provided by MACH Energy mine planners provides an indication of the volume of each type of overburden/interburden material that will be removed and emplaced in the waste emplacement (**Table 4-1**).

Table 4-1: Volume of Overburden/Interburden Material Produced for the Project

Mine Plan Model Waste Group	Representative Geochemistry Sample*	Proportion of Total Waste (%)
01 DOW	OVER	14.9%
02 BOWFIELD 1	OVER	0.0%
03 BOWFIELD 2	OVER	0.2%
04 WARKWORTH 1	OVER	4.3%
05 WARKWORTH 2	OVER	0.7%
06 WARKWORTH 3	OVER	0.6%
07 WARKWORTH 4	OVER	0.3%
08 MOUNT ARTHUR 1	OVER	3.9%
09 MOUNT ARTHUR 2	OVER	1.6%
10 PIERCEFIELD 1	OVER	3.1%
11 PIERCEFIELD 2	OVER	10.7%
12 VAUX 1	LP-VA	11.4%
13 VAUX 2	VA	10.9%
14 BROONIE 1	VA – BR	1.5%
15 BROONIE 2	VA – BR	14.0%
16 BROONIE 3	BR	0.7%
17 BAYSWATER 1	BR	1.7%
18 BAYSWATER 2	BR	0.9%
19 WYNN 1	WN	9.5%
20 WYNN 2	BY – WN	5.5%
21 EDDERTON 1	WN – ED	3.8%

* Refer to Table 5.1 of RGS (2020)[3] for description of each stratigraphic unit.

5 Conclusions

The salinity (and soluble metal/metalloid) results obtained for the 2020 static and kinetic geochemical assessment program completed on representative samples of mine materials from the Project align well with those expected from a review of existing information for the site geochemistry, as well as a review of geochemical and water quality information from existing assessments completed at the Project and nearby Bengalla Mine and Mt Arthur Coal Mine[3].

The weighted average median and 95th percentile EC (salinity) values from the 2020 geochemical assessment program have been derived from the static geochemical test results and are summarised in **Table 5-1**.

[11] MACH Energy (2020) Mount Pleasant Optimisation Project – Environmental Impact Statement.

Table 5-1: Median and 95th percentile salinity values for spoil materials from the Project

Material Group	Proportion of Total Waste (%)	Median EC (µS/cm)	95th Percentile EC (µS/cm)
OVER	40.3	430	559
LP-VA	11.4	211	584
VX	10.9	158	296
VA – BR	15.5	322	347
BR	3.3	236	349
BY – WN	5.5	2,350	3,732
WN	9.5	501	2,458
WN – ED	3.8	251	383
Weighted Average	100.0	459	843

The median weighted average salinity value for all of the overburden and interburden samples tested by RGS is 459 µS/cm and this value is relatively consistent with salinity values monitored in the SD1 and SD3 sediment dams at the site (598 and 662 µS/cm, respectively). The 95th percentile weighted average salinity value for overburden and interburden (843 µS/cm) is also consistent with the value utilised for "waste rock" materials by HEC[1] (833 µS/cm) to model inflow salinity to site water storages based on site monitored water quality records. Based on the available geochemical information on the salinity of overburden and interburden materials at Mount Pleasant Operation, it is expected that the salinity of groundwater reporting to the final pit void through backfilled mine spoil will be influenced by the salinity of the spoil materials. The static and kinetic geochemical information on spoil salinity reviewed in this Technical Memorandum suggests that a median salinity value in the range 600 to 900 µS/cm is likely to be generated for leachate from backfilled spoil materials reporting to the final pit void.

The level of confidence in the salinity data used by HEC for final void salinity modelling and consistency with the RGS 2020 geochemical assessment data is contingent upon MACH Energy implementing specific measures to manage PAF materials encountered during mining. Specifically, any material identified as PAF should be preferentially placed in the in-pit waste emplacement and covered with minimum of 10 m of NAF material as soon as practicable as detailed in the Mining Operations Plan for the Mount Pleasant Operation[5]. In addition, as described in Section 3 of the Project Environmental Impact Statement, any PAF material exposed in the lower part of the highwall or floor of the final void should be:

- covered with NAF waste rock material to a minimum depth of 5 m;
- excavated and disposed of as PAF waste rock material (as described above); or
- flooded with water from the site water management system.

It is important to note that the only PAF materials likely to be encountered at the project are associated with Vane Subgroup strata [Bayswater-Wynn Interburden (i.e. Archerfield Sandstone), Wynn Partings, and Wynn Rejects] lower in the stratigraphic profile of the seams planned to be mined. Whilst these materials make up a relatively small proportion of the materials likely to remain in the open pit, they have the potential to disproportionately contribute to the salinity (and soluble metal/metalloid concentrations) of the final void water quality if left exposed to oxidising conditions. It is therefore advisable to cover these materials within a few weeks of initial exposure to avoid oxidation and subsequent oxidation products to contribute to salinity (and metal/metalloid concentrations).

If the PAF materials are not managed and are exposed to oxidising conditions for a period of time, there is potential for higher salinity (and also elevated metal/metalloid values) to be generated by spoil materials which for salinity may be closer to the 95th percentile values described in **Table 5-1** and this would influence the validity if the salinity (or soluble metal/metalloid) values used by HEC for groundwater through spoil materials in any future salinity (or soluble metal/metalloid) inflow modelling exercise.

6 Closing

RGS trusts that the information contained in this Technical Memorandum is sufficient to assist in defining the potential salinity and soluble metal/metalloid concentrations for groundwater inflows through backfilled spoil at the open pit.

Please contact Alan Robertson on 07 3344 1222 (office) if you require further information.

Yours sincerely,
RGS ENVIRONMENTAL CONSULTANTS PTY LTD

Alan M Robertson

Dr. Alan M. Robertson
Managing Director/Principal Geochemist

RGS

MINE WASTE AND
WATER MANAGEMENT

Attachment E

Extract from MACH Response to DPIE Information Request (22 September 2021)

The total unsurveyed area and the zones shown on Figure 3, 4a and 4b reflect the revised Northern Link Road Options 1 and 2 alignments, and incorporate the Aboriginal heritage surveys undertaken as part of the Bengalla Mine Continuation Project (AECOM, 2013)[5] and the Project ACHA (Appendix G of the Project EIS).

Also within the Development Consent Application Area (SSD 10418) are a number of areas within the approved Bengalla Mine Disturbance Boundary (SSD-5170) which have not been subject to additional Aboriginal heritage surveys by the Mount Pleasant Operation, as no additional Project development is proposed.

Final Landform

<u>Relevant Quotes:</u>

> 7. *Further analysis and justification is required with respect to the proposed final landform. In particular:*
>   a. *The EIS does not provide sufficient information and justification for the size and depth of the final void. Please clarify the size and depth of the proposed final void and the proposed slope (%) of the internal batters;*
>   b. *Further options analysis should be provided to refine and improve the design of the proposed final void. For example, reducing the total depth, total size, and slope of the internal batters (currently up to 18 degrees); and*
>   c. *Please provide a comparison of the proposed final void for the project relative to the currently approved final voids, including size and depth of the voids and a figure showing their relative locations.*

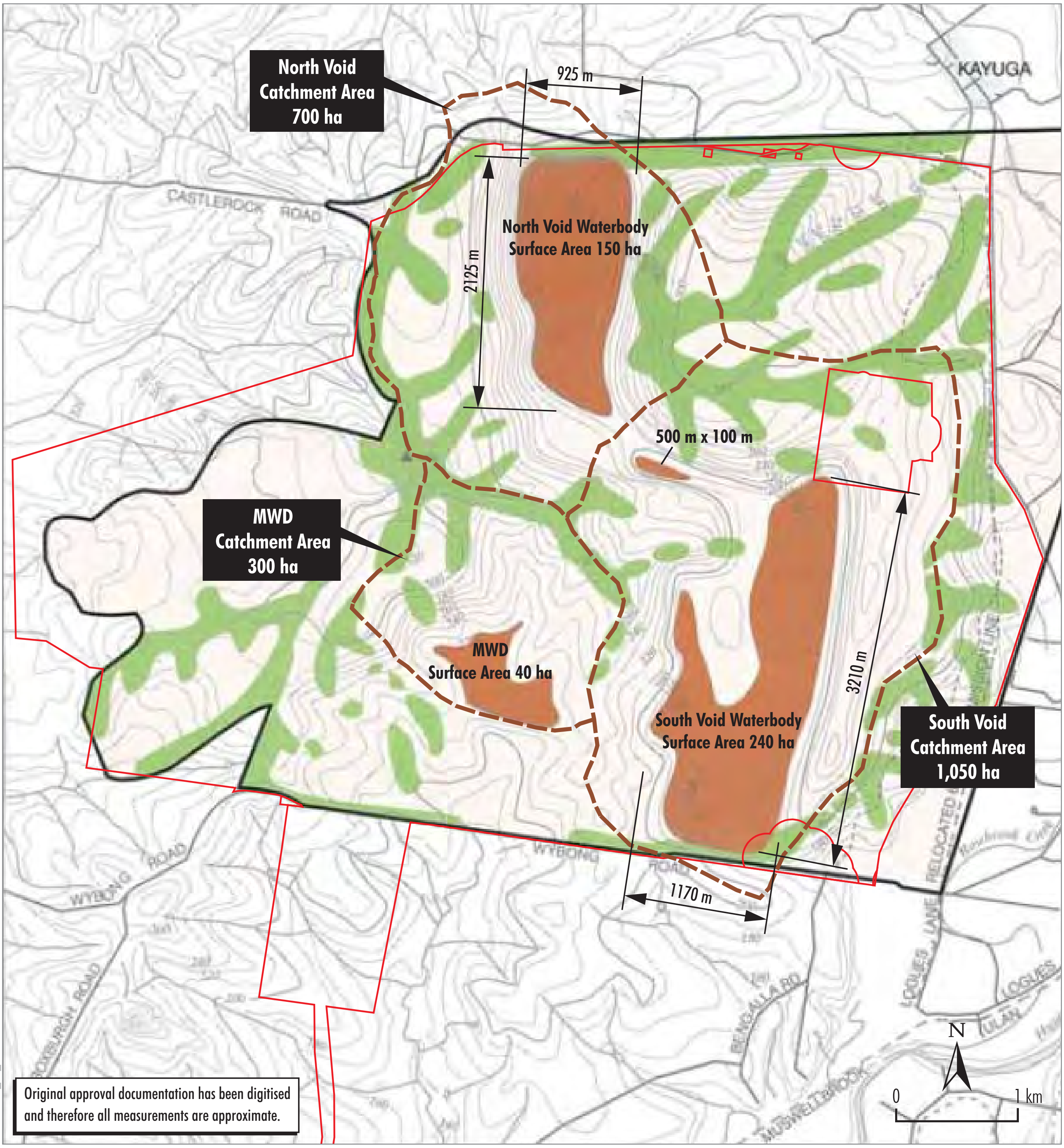
<u>Response:</u>

Figures 5 and 6 illustrate in plan view the approximate area and dimensions of the multiple final voids shown in the landform presented in the original approval documentation for the Mount Pleasant Operation, and the single final void proposed in the Project EIS. Figures 7 and 8 illustrate how these features differ in physical location, depth and extent in both plan and cross-sectional views.

Figure 7 also provides a comparison of the final void catchment and waterbody areas of the Project relative to the original approval documentation for the Mount Pleasant Operation under Development Consent DA 92/97. As is evident from Figure 7 and Figure 8:

1. The Project would result in fewer final voids (i.e. one).
2. The Project would result in a material reduction in the total catchment area of final voids, relative to the originally approved final landform.
3. The Project final void would be materially deeper, relative to the natural land surface, which is a function of the coal seams dipping to the west, and the Project more efficiently extracting all coal seams to the Edderton Seam floor in North Pit.
4. The projected Project final void waterbody would be materially smaller than the combined extent of the multiple “final void” areas approved under Development Consent DA 92/97 in 1999, which is logical as the total catchment area excised from the Hunter River catchment is much smaller.

[5] AECOM Australia Pty Ltd (2013) *Bengalla Continuation of Mining Projects Aboriginal Archaeology and Cultural Heritage Impact Assessment.* Prepared for Hansen Bailey Environmental Consultants.



Source: Coal & Allied (1997)

LEGEND

- Mining Lease Boundary
- Final Void Waterbody [1]
- Final Void Catchment Boundary
- Native Vegetation
- Pasture

[1] While it is difficult to determine categorically from the earlier approval documentation what the extents of the long-term equilibrium waterbodies for the Original EIS landforms would be, for the purposes of this comparison MACH has taken the extents of the "final void" areas shown in the Original EIS as an indicative equilibrium waterbody extent.

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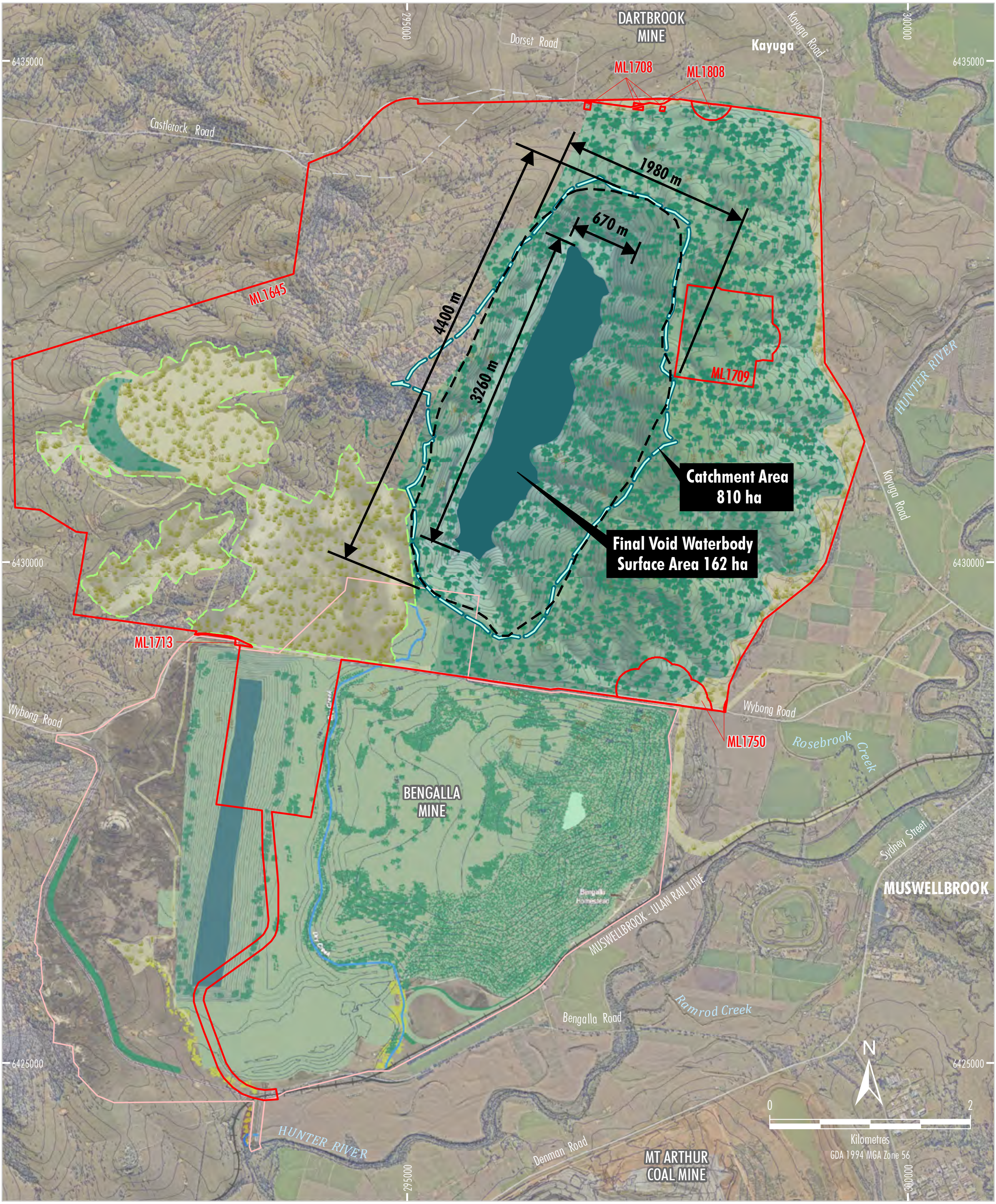
MOUNT PLEASANT OPTIMISATION PROJECT

Original EIS Indicative Final Void Metrics

Figure 5



LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Final Landform Contour (10 m interval)
- Project Final Void Waterbody
- Project Final Void Indicative Extent
- Project Final Void Catchment Area

Secondary/Post-mining Land Use Domains

- Domain A - Final Void
- Domain C - Agricultural Land
- Domain D - Native Woodland/Grassland
- Potential High Intensity Agriculture Area

Bengalla Mine Conceptual Final Landform *

- Project Boundary (Appendix 2 of Development Consent SSD-5170) (Dated 23 December 2016)

* Digitised from Appendix 9 of Development Consent (SSD-5170) and amended in the Mount Pleasant Operation CHPP area.

Source: MACH (2021); Bengalla Mine (2016); NSW Spatial Services (2021); Department of Planning and Environment (2016)
Orthophoto: MACH (2020)

Note: Light vehicle access roads and upslope diversions associated with minimising the catchment of the final void and Fines Emplacement Area are not shown.

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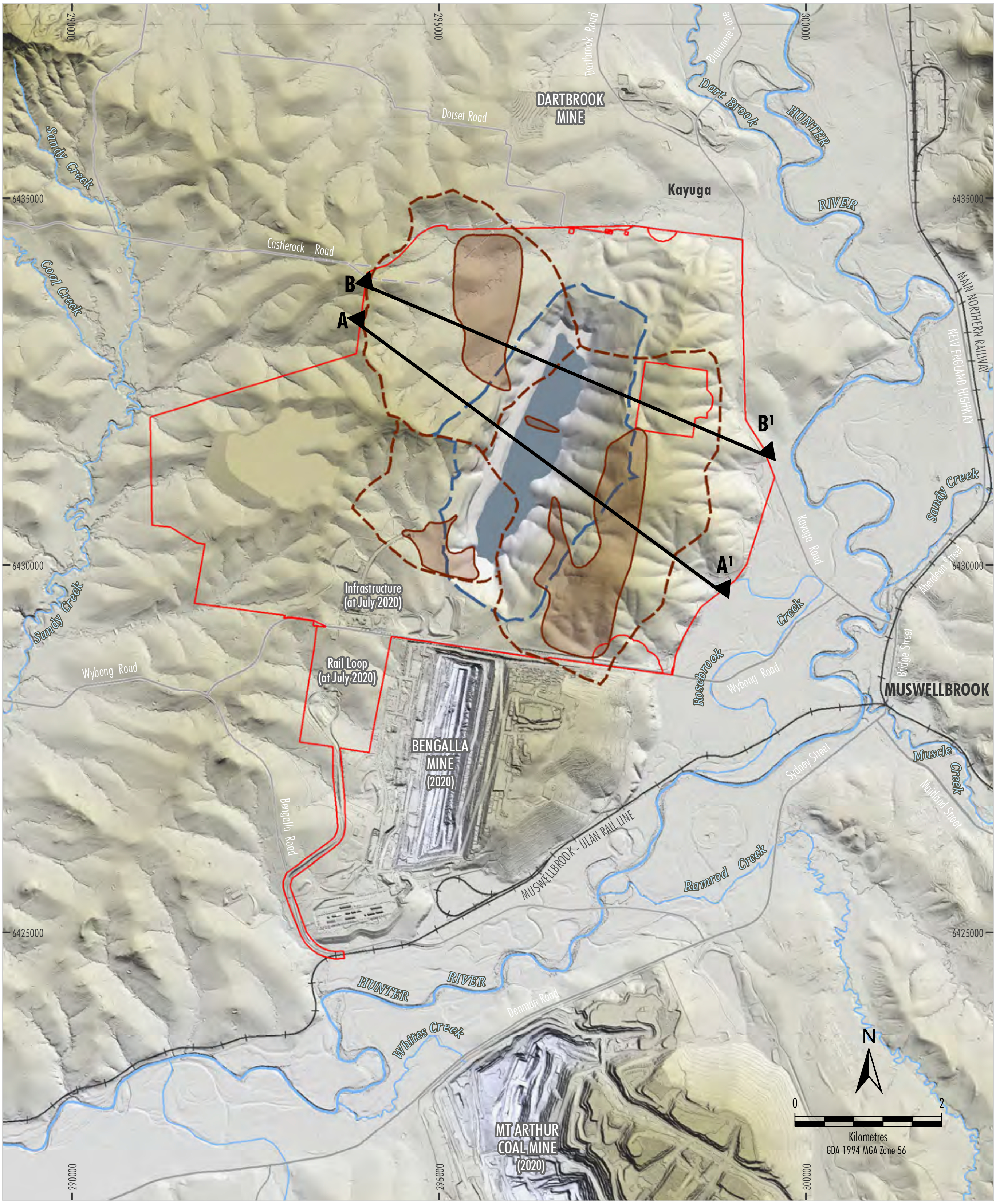
MOUNT PLEASANT OPTIMISATION PROJECT

Conceptual Final Land Use Areas Metrics

Figure 6



LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Original EIS Final Void Waterbody [1]
- Original EIS Void Catchment Area
- Project Final Void Waterbody
- Project Final Void Catchment Area

Source: MACH (2021); NSW Spatial Services (2021)

Refer Figure 8 for Cross-sections.

[1] While it is difficult to determine categorically from the earlier approval documentation what the extents of the long term equilibrium waterbodies for the Original EIS landforms would be, for the purposes of this comparison MACH has taken the extents of the "final void" areas shown in the Original EIS as an indicative equilibrium waterbody extent.

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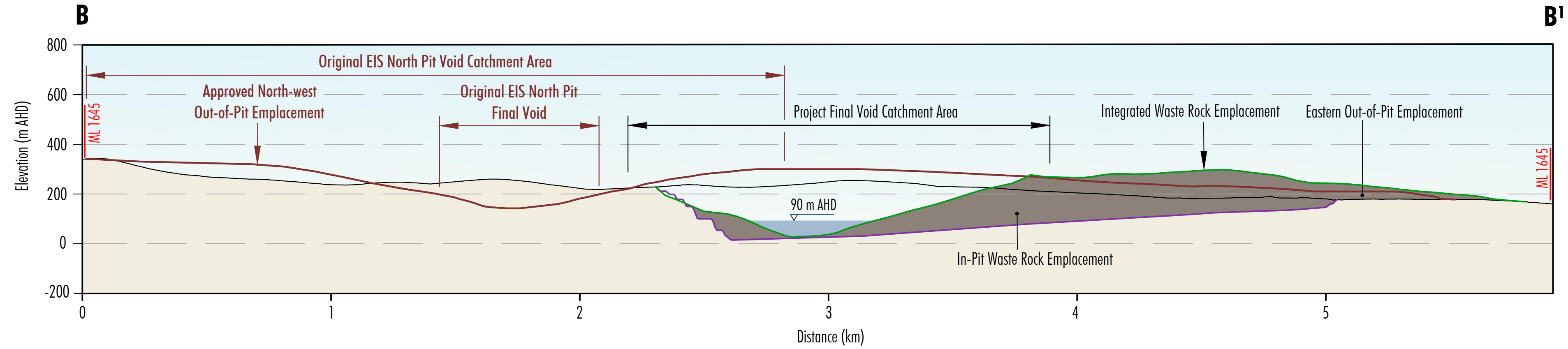
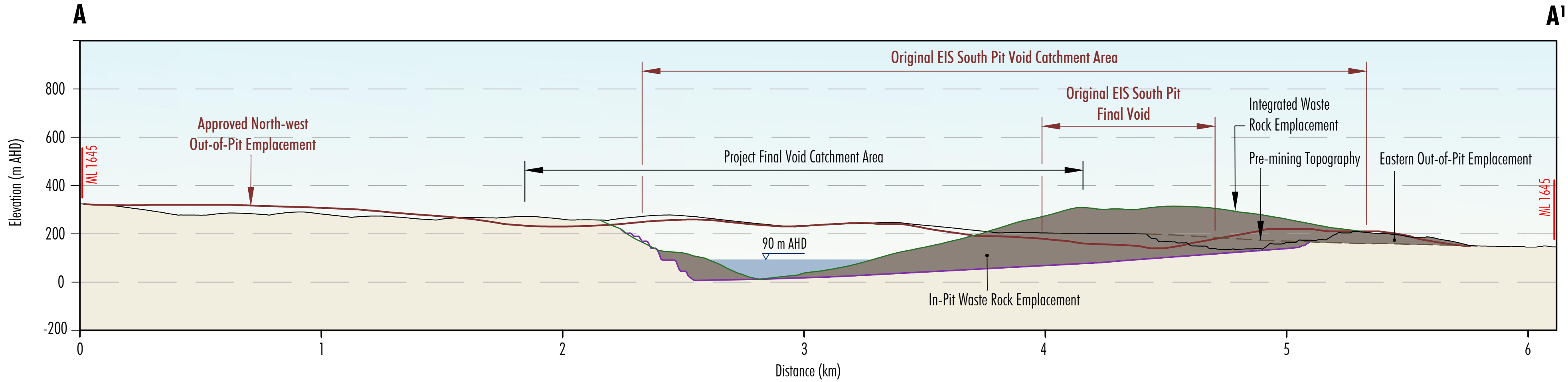
MOUNT PLEASANT OPTIMISATION PROJECT

Comparative Final Void Plan

Figure 7



NORTH PIT
CROSS-SECTION B - B1
Scale 1 Vertical : 1 Horizontal



SOUTH PIT
CROSS-SECTION A - A1
Scale 1 Vertical : 1 Horizontal

LEGEND
- Existing Natural Surface (July 2020)
- Original EIS Final Landform Surface
- Conceptual Project Final Landform Surface
- Project Open Cut
- Project Waste Rock Emplacement
- Project Final Void Waterbody

Refer Figure 7 for cross-section locations.

Source: MACH (2021); AGE (2020); ENRS (2019)

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MOUNT PLEASANT OPTIMISATION PROJECT

Comparative Final Void Cross-sections

Figure 8

In considering the above, the Department should also consider:

- The Project would recover approximately 247 million tonnes of additional run-of-mine (ROM) coal relative to the Mount Pleasant Operation as approved under Development Consent DA 92/97. In total, the Mount Pleasant Operation incorporating the Project would extract some 444 million tonnes of ROM coal.
- The additional Project ROM coal would be recovered from effectively the same total area as the original project by extracting deeper coal to the Edderton Seam floor in North Pit, and hence it follows that the depth of the Project final void would need to correspondingly increase.
- The Project final void would excise much less catchment from the Hunter River than the originally approved final landform.

With respect to slopes, MACH suggests that the Department should also benchmark the final landforms in other recent major open cut coal mining determinations by the Independent Planning Commission (IPC), as multiple recent projects have been approved with residual final void highwalls that are much steeper than the residual slopes that are proposed at the Project.

For example, Mangoola Continuation Project was approved earlier this year with proposed highwall slopes of up to 27 degrees (°) *from vertical* (i.e. 63° from horizontal) in the Northern Void.

As described in the Project EIS and the Submissions Report, the initial Project final void was also initially rectangular in shape and ran the full strike length of the three pits, and had steep unmodified residual highwalls. However, in response to feedback from regulatory and community stakeholders, MACH has re-designed the Project final void to:

- backfill approximately 1.5 kilometre (km) of the northern part of the final void;
- reduce the depth of the final void in the North and Central Pit areas and decrease the slope of the internal batters;
- apply geomorphic design concepts to parts of the Project landform that drain to the final void; and
- push down the western highwall to an overall angle of approximately 18° (from horizontal).

As a result of the above, the Project final void is considered safe, geotechnically stable and minimises the catchment reporting to the void whilst maintaining geomorphic design concepts (i.e. providing sufficient slope length to improve post-mining stability and reduce long-term erosion risk).

MACH has gone to some length to design a landform that is an optimum compromise between a range of competing priorities, including the size of void, landform slopes, mining costs, and land disturbance area and associated mine rehabilitation outcomes (Figure 9). The assertion of some submitters that the Project final landform has not been optimised from a societal perspective is simplistic, and fails to understand the complex nature of final void optimisation.

The residual Project final landform slopes would be consistent with the range of slopes that are present in the natural environment in the Project locality, including natural slopes in the valley to the west of the Project. This is graphically illustrated on Figures 10, 11 and 12. Any further lowering of the Project residual slopes on the western highwall would result in an increase in the Project final void extent, would increase the Project land disturbance area, and would increase associated impacts on biodiversity, heritage resources and surface water catchment excision.

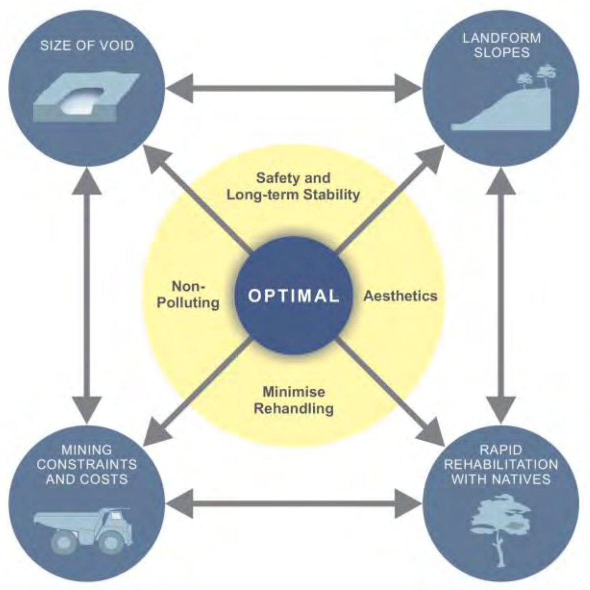


Figure 9 – Final Void Optimisation Context

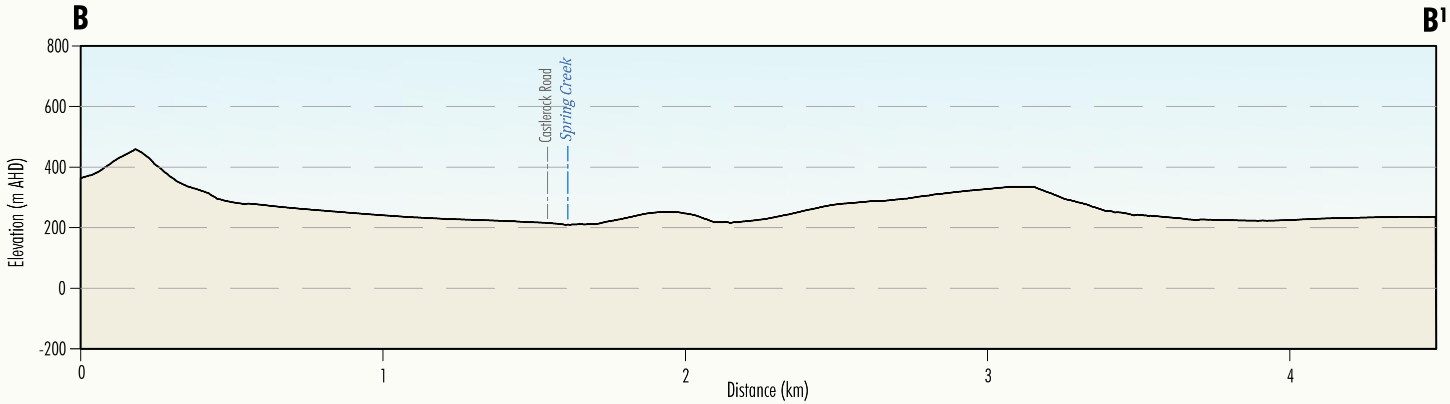
Further, the Project final void location, size and depth reflects the size and geometry of the coal deposit, and the significantly improved efficiency of ROM coal extraction relative to total land disturbance area that the Project would provide in comparison to the originally approved Mount Pleasant Operation.

It is also noted that the NSW Department of Mining, Exploration and Geoscience (MEG) stated the following with respect to the landform design and final void:

> *The Proponent is very conscious of the visual aspects of the mine due to the proximity of the mine to Muswellbrook. This in part has affected the mining design and order of operations to date. The final landform has been designed to look natural through the implementation of geomorphic landform design and the final void will be hidden behind from view.*

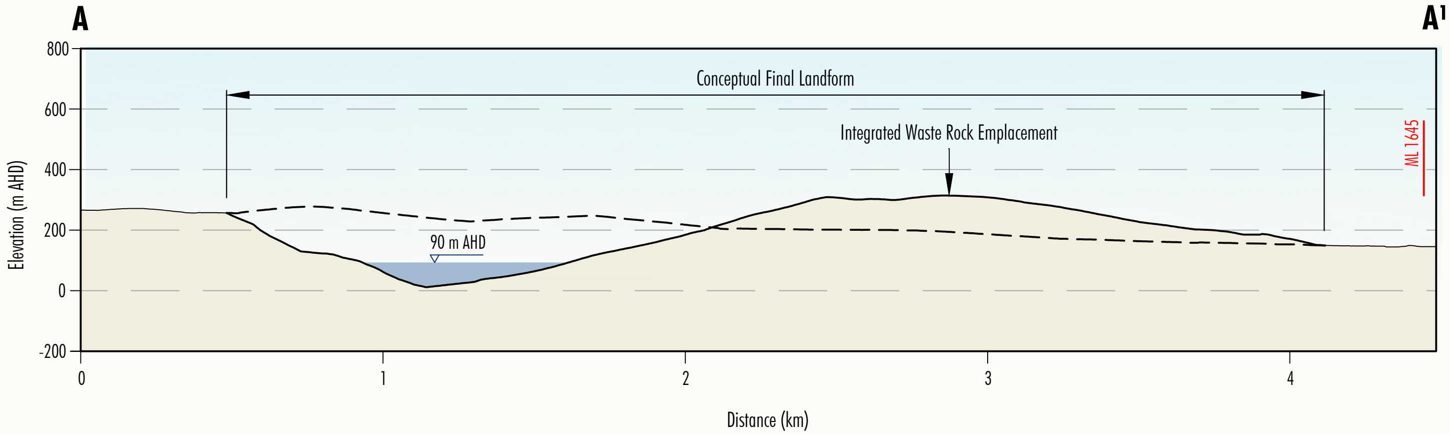
MACH would continue to consider final void land use options over the life of the Project, including potential beneficial uses of the final void (e.g. for off-river storage of supplementary water flows in the Hunter River).

MACH therefore respectfully submits to the Department that the Project final landform design and slopes benchmark favourably with both existing natural landforms in the vicinity of the Project and other recently approved major coal projects in the region. The single Project final void would also result in a material improvement in environmental outcomes relative to the originally approved Mount Pleasant Operation.



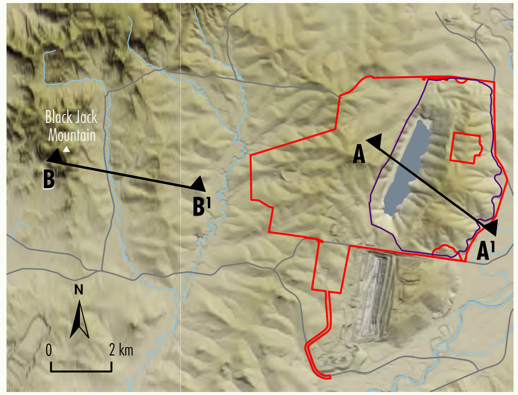
CROSS SECTION B - B¹

Scale 1 Vertical : 1 Horizontal



CROSS SECTION A - A¹

Scale 1 Vertical : 1 Horizontal



PLAN

Conceptual Final Landform

MAC-18-02 SSD RtS_102A 24/11/2020

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Pre-mining Topography
- Approximate Extent of Project Open Cut and Waste Rock Emplacement Landforms
- Project Final Void Waterbody

Source: MACH (2021); NSW Spatial Services (2021)

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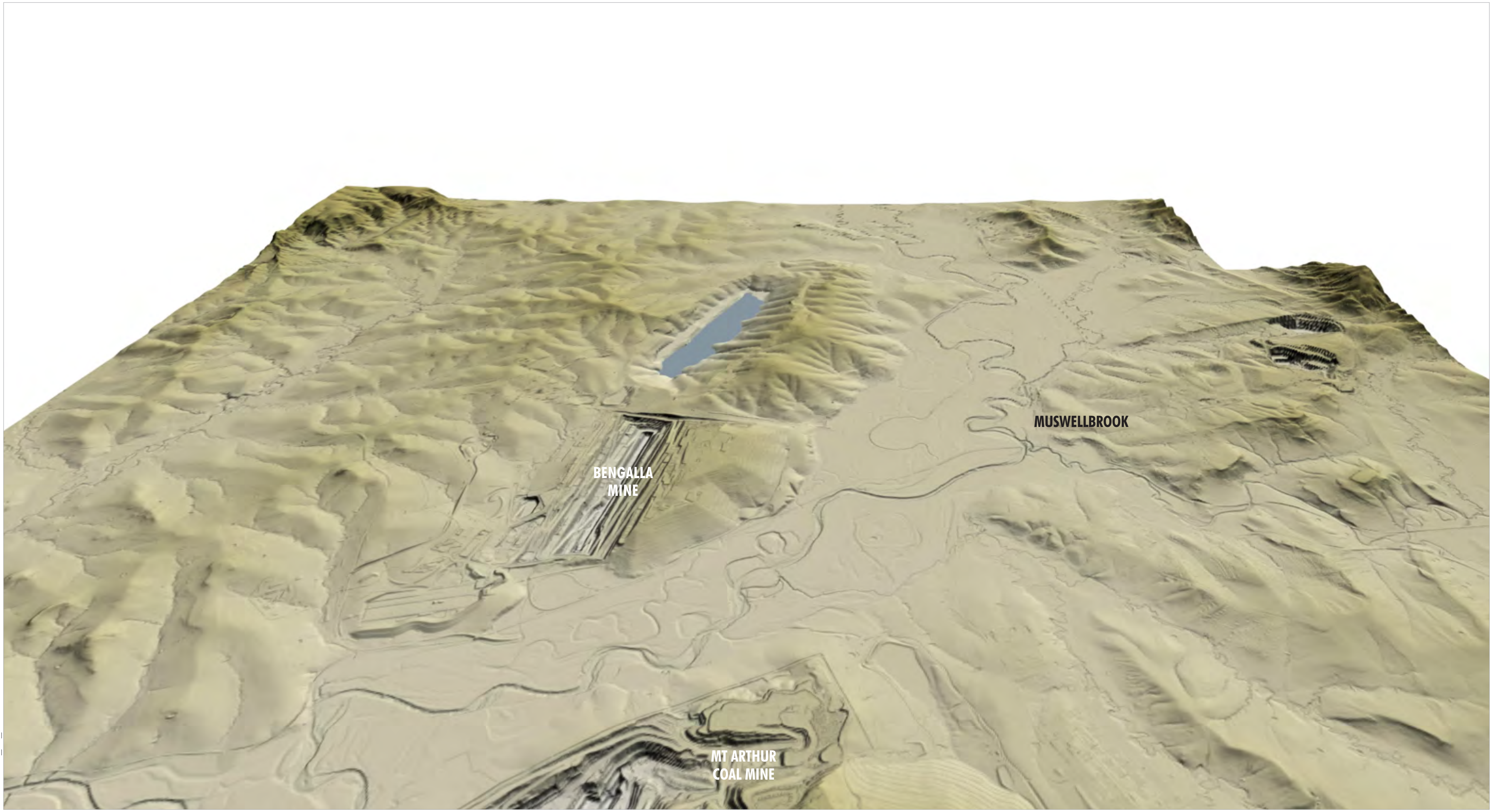
MOUNT PLEASANT OPTIMISATION PROJECT

Conceptual Final Landform and Natural Landform Slope Comparison

Figure 10



MAC-18-02 SSD_RtS_005B

Source: MACH (2021)

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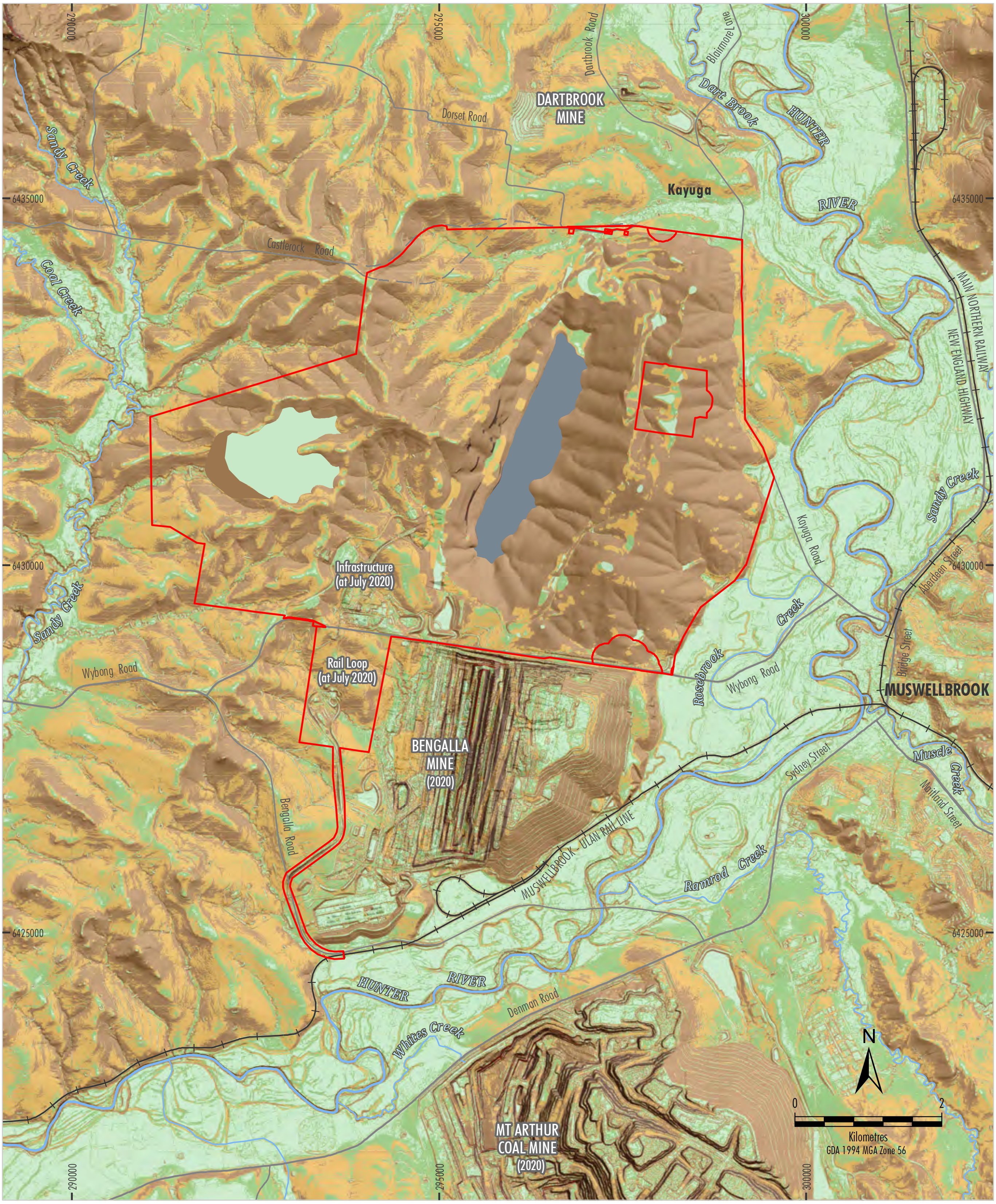
MOUNT PLEASANT OPTIMISATION PROJECT

Project Conceptual Final Landform
Integrated with Existing Landforms

Figure 11



MAC-18-02 SSD_RtS_228B

Source: MACH (2021); NSW Spatial Services (2021)

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Final Void Waterbody

Slope Percent (%)	Slope Classification (degrees)
0.0 - 1.018	Level (<= 0°35')
1.018 - 3.055	Very gently inclined (0°35' - 1°45)
3.055 - 5.678	Gently inclined (1°45' - 3°15')
5.678 - 32.49	Moderately inclined (3°15' - 18°)
32.49 - 57.74	Steeply inclined (18° - 30°)
57.74 - 100	Very steeply inclined (30° - 45°)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Project Final Landform Indicative Slope Map

Figure 12