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5. Potential Environmental Impact of Project Changes

5 Potential Environmental Impact of Project Changes

5.1 Introduction

This section provides updated environmental impact assessment information addressing the relevant project and assessment changes that have occurred to the environmental impact statement (EIS) since the Draft EIS was submitted (refer to **Supplementary EIS Section 4 – Summary of Project Changes**). Brief qualitative discussion is provided to address project changes of limited impact to the environmental impact assessment or performance discussed in the Draft EIS. The more substantial project changes are discussed in further detail and are supported by modelling and specialist assessment.

Supplementary EIS Section 5.2 provides further discussion of the significance of the project changes presented in **Supplementary EIS Section 4 – Summary of Project Changes** and where relevant, identifies the assessment approach taken.

In summary and as discussed in **Supplementary EIS Section 4 – Summary of Project Changes**, the project changes that have been made since the Draft EIS submission include:

Open cut domain:

- Incorporation of greater clarity on the adaptive management process and how it applies to the final void closure decision-making process.

North Overburden Empacement Facility (NOEF) domain:

- Substitution of the proposed compacted clay layer (CCL) within the NOEF cover system with a geosynthetic liner (GSL), in order to provide refined performance.
- Optimisation of the NOEF cover system above the GSL to reflect revised cover system construction and performance requirements.
- Optimisation of the NOEF low permeability foundation thickness from 500 millimetres (mm) to 250 mm based on refined cover system performance achieved by the GSL, increased density and reduced permeability of the CCL due to loading by the NOEF above, reduce risks of instability near the toe due to high pore pressures, and the lack of sensitivity of NOEF long-term performance to this parameter.
- Adjustment of the upper NOEF batter slope from a 1V:2.5H slope to a shallower 1V:3H slope, in order to provide better environmental performance (e.g. reduced potential for erosion) and enable easier construction and maintenance.
- Minor modification of stockpile/borrow locations and associated road network to the north of the NOEF, including a small civil fleet infrastructure area.
- Minor modification to the NOEF southeast stage outer extent to facilitate water management system infrastructure.
- A change to the MRM4 cultural heritage site relocation as a result of discussions with the Aboriginal Areas Protection Authority (AAPA) and Custodians. The MRM4 cultural heritage site will be relocatedto within the boundary of the MRM3 cultural heritage site, instead of the previously proposed location at the base of Barramundi Dreaming.
- An administrative change to remove the East Perimeter Runoff Dam (EPROD) from the project that is the subject of the EIS.

Tailing Storage Facility (TSF) domain:

- Removal of the TSF East Quarry from the proposal.
- An administrative change to incorporate the combined use of TSF Cells 1 and 2 for LOM tailings storage in the the project that is the subject of the EIS.

A number of refinements have also been made to the assessment models utilised in the Draft EIS. The results of these are presented in this Supplementary EIS as a validation of, and update to, the modelling work completed in the Draft EIS. As discussed in **Supplementary EIS Section 4 – Summary of Project Changes** the modelling assessment changes include:

- Validation and substitution of the DUMPSIM NOEF unsaturated flow modelling with TOUGH2/GOLDSIM NOEF unsaturated flow modelling.
- Updates of the hydrodynamic modelling of the mine pit lake limnology, including assessment of the various McArthur River connectivity scenarios and 'extreme event' conditions.
- Updates of the final void, groundwater and waterways models to account for the updated outputs from the above models which also incorporate relevant performance updates from the proposed project changes. These models were also updated with additional data and information gathered since the Draft EIS was submitted. Further information on the additional data incorporated is provided in the respective technical assessment appendices. These are identified in **Supplementary EIS Section 5.3** below.

A summary of the updated impact assessment is provided in **Supplementary EIS Section 5.3** below, with technical supporting information provided in the appendices.

5.2 Significance of Changes and Assessment Requirement

Supplementary EIS Table 5-1 presents the significance of project changes. Where the effect of project changes on the impact assessment presented in the Draft EIS is negligible, brief qualitative comment is provided. The more substantial project changes are discussed in further detail in **Supplementary EIS Section 5.3** and are supported by updated modelling and specialist assessment presented in the Supplementary EIS appendices.

Table 5-1 Significance of Changes and Assessment Requirement

Project Aspect	Significance of Change	Assessment Comment	Supporting Technical Appendix (Supplementary EIS Appendices)
Open Cut Domain			
Final void closure sequence	Negligible	Modelling of both the backflow and flowthrough mine pit lake proposals has now been completed. Both proposals have been assessed through the limnology, mine pit lake, groundwater and waterways (surface water) models. Modelling has determined that both mine pit lake closure proposals are effective and, with the mitigation and management measures proposed in the Draft EIS, both present similar risks and opportunities to those presented in the Draft EIS.	**Appendix M – Updated Mine Pit Lake Modelling Report** **Appendix N – Updated Water Balance and Waterways Modelling Report** **Appendix O – Revised Limnology Study**
NOEF Domain			
NOEF cover system – barrier layer material	Significant	The NOEF cover system barrier layer has been changed from a CCL to a GSL. The GSL is modelled to improve cover system performance, by decreasing permeability and therefore has had an important influence on NOEF seepage estimates, which in turn affects groundwater and surface water environments. The influence of the GSL has been incorporated into the updated NOEF stability assessment, unsaturated flow modelling, the groundwater modelling and the water balance/waterways modelling. These are discussed further in **Supplementary EIS Section 5.3** with supporting technical assessment provided in the appendices.	**Appendix E – Updated Geotechnical Report** **Appendix G – GSL Cover Design Report** **Appendix H – Geosynthetic Liner Design Details** **Appendix K – Revised NOEF Unsaturated Flow (TOUGH 2) Report** **Appendix L – Revised Groundwater Modelling Report** **Appendix N – Updated Water Balance and Waterways Modelling Report**

Project Aspect	Significance of Change	Assessment Comment	Supporting Technical Appendix (Supplementary EIS Appendices)
NOEF low permeability foundation thickness	Negligible	The NOEF low permeability foundation thickness has been optimised from 500mm to 250mm based on refined cover system performance achieved by the GSL, increased density and reduced permeability of the CCL due to loading by the NOEF above, reduce risks of instability near the toe due to high pore pressures, and the lack of sensitivity of NOEF long-term performance to this parameter. The modelling identifies that a marginal increase in basal seepage of between 16% and 30% is expected during the construction phase, if no consolidation effects are considered. From approximately 2038 on, there is no material difference. The seepage collection, management and monitoring systems proposed in the Draft EIS will effectively manage the extra basal seepage during the construction and draindown period. Technical supporting information is provided in the appendices.	**Appendix K – Revised NOEF Unsaturated Flow (TOUGH 2) Report**
NOEF upper slope angle	Negligible	The upper slope of the NOEF has been modified from a 1V:2.5H slope to a 1V:3H slope, in order to provide a greater geotechnical factor of safety. This will have a negligible effect on the impact assessment provided in the Draft EIS. Technical supporting information is provided in the appendices.	**Appendix E – Updated Geotechnical Report**

Project Aspect	Significance of Change	Assessment Comment	Supporting Technical Appendix (Supplementary EIS Appendices)
NOEF stockpile/borrow footprints and locations	Negligible	Minor modification of the stockpile/borrow locations and associated road network to the north of the NOEF has been proposed. These have been modified following further detailed design and optimisation. The footprints also provide additional offset to the MRM3 cultural heritage site. The realignment of boundaries has resulted in a minor increase in the disturbance of potential Gouldian Finch nesting habitat, however the disturbance is of the same magnitude as was presented in the Draft EIS. The modifications will therefore have a negligible effect on the impact assessment and management and mitigation measures provided in the Draft EIS. The revised layout is incorporated in the figures presented in **Supplementary EIS Section 6 – Simplified Project Description.**	N/A
NOEF southeastern boundary	Negligible	A minor modification of the NOEF southeaster stage extent has been proposed to better facilitate water management system infrastructure. The changes have a negligible effect on the impact assessment provided in the Draft EIS. The revised boundary alignment is incorporated in the figures presented in **Supplementary EIS Section 6 – Simplified Project Description.**	N/A

Project Aspect	Significance of Change	Assessment Comment	Supporting Technical Appendix (Supplementary EIS Appendices)
Receiving location of the removed MRM4 artefact site.	Noteworthy	The relocated MRM4 cultural heritage site will be placed within the boundary of the MRM3 cultural heritage site, instead of the previously proposed location at the base of Barramundi Dreaming. The decision to alter the receiving location was made in agreement with the Traditional Owners, MRM and the Northern Territory Government. All other aspects of the impact assessment presented in the Draft EIS, including management of MRM4 artefacts remain unchanged.	**Appendix Q – Stakeholder Consultation Report**
Administrative change to remove EPROD from EIS project definition	Negligible	Approval will be through a Mining Management Plan (MMP) with construction completed prior to the 2018-19 wet season. This will improve the site water balance, environmental performance and open cut inundation risk in the short term and lower the risk of potential overflows. The EPROD design to be lodged in the proposed MMP amendment will also include a number of design and performance improvements, including a high-density polyethylene (HDPE) liner and underdrains. The impact assessment and mitigation measures presented in the Draft EIS are therefore considered to be conservative.	N/A
TSF Domain			
Removal of the TSF East Quarry	Negligible	The TSF East Quarry has been removed from the proposal, with an alternate source (the Woyzbun Quarry) to be used. The revised project footprint is presented in **Supplementary EIS Section 6 – Simplified Project Description.**	N/A

Project Aspect	Significance of Change	Assessment Comment	Supporting Technical Appendix (Supplementary EIS Appendices)
Administrative change to incorporate TSF LOM Plan into the EIS project definition	Negligible	The TSF LOM Plan has been incorporated into the EIS process due to uncertainty associated with the ability of the Departmernt of Primary Industry and Resources to approve the proposed use of the TSF Cell 1 footprint through an MMP amendment under the Mining Management Act. The impact assessments completed in both the Draft EIS and Supplementary EIS (refer to **Supplementary EIS Section 5.3**) have incorporated the revised LOM TSF plan with a combined Cell 1 and 2 (and no use of Cell 3 or 4 for tailings storage). Hence there is no requirement for additional or revised impact assessment.	**Appendix I – Updated Tailings Storage Facility Life of Mine Plan**

5.3 Impact Assessment

This section presents the findings of the updated impact assessment modelling completed since the Draft EIS was submitted. The revised assessment is primarily associated with water resources and the resultant influences on aquatic ecology. Similar to the methodology implemented for the Draft EIS, the assessment of potential impacts on water resources utilises a series of complex integrated modelling software packages to determine mine site water characteristics over time and the influence this has on the downstream environment. The models address water flow and chemical evolution within the NOEF, resultant seepage from the NOEF, flows and water quality within the groundwater system and interaction with the constructed and natural surface water systems. Evaluation of the surface water system incorporates assessment of mine pit lake limnology and water quality, and the interaction of the mine pit lake with the broader surface water environment. The site water balance has also been updated.

In addition to the relevant project changes discussed above, the information presented below also includes a number of methodological and data changes. These are discussed further in **Supplementary EIS Section 4.3** and includethe following:

- Validation and substitution of the DUMPSIM NOEF unsaturated flow modelling with TOUGH2/GOLDSIM NOEF unsaturated flow modelling.
- Updates of the hydrodynamic modelling of the mine pit lake limnology, including assessment of the various McArthur River connectivity scenarios and 'extreme event' conditions.
- Updates of the mine pit lake, groundwater and waterways models to account for the updated outputs from the above models, which also incorporate relevant performance updates from the project changes. These models were also updated with additional data and information gathered since the Draft EIS was submitted.

5.3.1 NOEF Modelling

NOEF unsaturated flow modelling was completed in the Draft EIS to determine the long-term performance of the NOEF and to predict seepage qualities and flows. The assessment utilised the DUMPSIM evaluation process (refer to **Draft EIS Appendix P – NOEF Mine Drainage Report**). To validate the results of this assessment and to address the relevant project changes discussed above, the assessment has been independently replicated, utilising the industry standard software packages TOUGH2 and GOLDSIM. A detailed technical assessment report is provided in **Supplementary EIS Appendix K – Revised NOEF Unsaturated Flow Modelling (TOUGH 2) Report**. The technical assessment report describes the model inputs, model construction, functionality and characteristics and provides a detailed presentation of the model results. A summary of the model inputs and assessment results is provided below in the context of the Draft EIS assessment.

The key project changes incorporated into the model included the following:

- Substitution of the CCL within the NOEF cover system with a GSL.
- Optimisation of the NOEF cover system above the GSL to reflect revised cover system construction and performance requirements.
- Optimisation of the foundation low permeability layer thickness.
- Adjustment of the upper NOEF batter slope from a 1V:2.5H slope to a shallower 1V:3H slope.
- Additional sensitivity runs including partial acidification of the NOEF, doubling ofpotential acid forming (PAF) material quantities and partial failure of the cover system.

The TOUGH2 model itself is constructed in a different way and has different functionality to the DUMPSIM modelling conducted in the Draft EIS. To enable direct comparison with the Draft EIS results, based on the alternative modelling approach, the CCL cover system has also been assessed. Further information on these aspects is included in **Supplementary EIS – Appendix K Revised NOEF Unsaturated Flow (TOUGH 2) Report.**

As was presented in the Draft EIS, oxidation of sulphide material is the primary influence on water quality within and draining from the NOEF. The rate of contaminant loading from sulphide oxidation is directly related to the availability of water and oxygen within the NOEF. The characteristics of the NOEF seepage is therefore dependent on the flow of water through the NOEF (the contaminant transport mechanism) and the availability of oxygen, which drives the generation of contaminants.

The model has confirmed that infiltration into the NOEF will be higher during construction prior to the cover system being established. As discussed in the Draft EIS, MRM will operate an extensive water management system during this period. The model identifies that a draindown period will occur following installation of the cover system barrier layer and that following the draindown period, seepage rates will be relatively stable. Stable seepage rates are anticipated to be achieved within 20 to 30 years of cover establishment.

The long-term net percolation through the cover (ultimately determining the infiltration into the NOEF) is modelled to be less than 1% of rainfall with the new proposed GSL barrier layer, after allowing for defects. Toe seepage will be higher during construction however, following installation of the GSL cover system, will reduce to negligible volumes as water mounding above the low permeability foundation dissipates. Basal seepage will reduce over time and will remain below those rates predicted in the Draft EIS.

The model demonstrates that with the proposed GSL, the contaminant flows from the NOEF are reduced when compared to those predicted in the CCL case. However, concentrations of some contaminants are predicted to be higher than those presented in the Draft EIS due to the interaction between reduced water volumes and mineral solubilities. Seepage from the NOEF is still predicted to be neutral to slightly alkaline in the long-term, and to be characterised by elevated sulphate and magnesium. Because of the neutral pH, solubility and mobility of metals is anticipated to be low.

The updated model provides greater transparency and confidence in the model results. Coupled with the proposed project changes, in particular the move to a GSL barrier layer in the cover system, modelling confirms that the surface water and groundwater management system proposed in the Draft EIS will provide an effective management solution for the maintenance of downstream environmental values.

A number of sensitivity assessments have also been completed to test the model sensitivity to various different parameters and scenarios. Further information on the NOEF unsaturated flow modelling results is provided in **Supplementary EIS Appendix K – Revised NOEF Unsaturated Flow (TOUGH 2) Report.**

5.3.2 Groundwater Modelling

A site wide groundwater model was utilised as part of the Draft EIS assessments to determine the effect of mine infrastructure on the groundwater system, and to in turn determine the influence of groundwater flows and qualities on the surface water environment (refer to **Draft EIS Appendix T – Groundwater Impact Assessment Report**). The site wide groundwater model has been updated as part of the Supplementary EIS, primarily to assess the effect of project changes on the groundwater environment. The model also incorporates geological and hydrogeological data that has been

collected since the Draft EIS was submitted. A detailed technical assessment report is provided in **Supplementary EIS Appendix L – Revised Groundwater Modelling Report**. A summary of the model inputs and assessment results is provided below in the context of the Draft EIS assessment.

The key project changes incorporated into the model included:

- updated outputs from the NOEF unsaturated flow model (refer to **Supplementary EIS Section 5.3.1**); and
- updated geological and hydrogeological information obtained from 2016 and 2017 data reviews and field programs.

The updated groundwater model has produced similar results to those presented in the Draft EIS, although the volumes and concentrations reporting from the NOEF have changed as discussed in **Supplementary EIS Section 5.3.1** above.

Both EIS cases show that the Barney Creek Diversion will be the key receptor of NOEF basal seepage in Closure, and is predicted to experience an increase in sulphate concentration as the groundwater system recovers after cessation of open cut dewatering. The updated groundwater model has predicted slightly higher loads of sulphate reporting to the Barney Creek Diversion in Closure than were predicted in the Draft EIS. The effect of this is assessed further in **Supplementary EIS Section 5.3.5**. Sulphate loads reporting from the TSF to Surprise Creek are similar to those predicted in the Draft EIS, with a similar reduction in load reporting to the creek following removal of the tailings for reprocessing and final placement within the open cut void.

Detailed assessment of metal migration and attenuation has also been completed as part of the model update. The results of this assessment indicate that very little metal breakthrough to the surface water system is anticipated in the long-term assessment period. For example, zinc load at the Barney Creek diversion is predicted to increase from 0.04 kilograms per day (kg/day) to 0.05 kg/day over the 1000 year assessment period.

A number of sensitivity assessments have also been completed to test the model sensitivity to a number of different parameters and scenarios. Further information on the updated groundwater modelling results is provided in **Supplementary EIS Appendix L – Revised Groundwater Modelling Report.**

5.3.3 Mine Pit Lake Modelling

Modelling of the mine pit lake water body was completed as part of the Draft EIS to determine the water quality characteristics of the mine pit lake and to assess how they change over time. This was particularly important during the period of rapid filling of the final void with river water and over the period of staged connection with the McArthur River. The key considerations for water quality included the expression of tailings pore water in the lake as the deposited tailings consolidate, release of oxidation products from certain material types within the in-pit dump, and interaction with reactive materials on the surface of final void walls.

These aspects continue to be the primary considerations within the updated modelling. The approach to the updated modelling is consistent with the approach taken in the Draft EIS. A detailed technical assessment report is provided in **Supplementary EIS Appendix M – Updated Mine Pit Lake Modelling Report**. The technical assessment report describes the model inputs, model construction, functionality and characteristics and provides a detailed presentation of the model results. A summary of the model inputs and assessment results is provided below in the context of the Draft EIS assessment.

The key project changes incorporated into the model included:

- Incorporation of mine pit lake stratification (refer to **Supplementary EIS Section 5.3.4**) which was conservatively omitted from the Draft EIS mine pit lake modelling.
- Updated inflow volumes from the groundwater and surface water models.
- Refinement of the mine pit lake geochemical thermodynamics.

The updated assessment approach is consistent with the approach taken in the Draft EIS, with the exception of the inclusion of stratification. The results determined from the updated modelling are presented below.

The modelling has determined that removal and treatment of the tailings pore water from within the final void, as the tailings are deposited and settle, is key to reducing the contaminant load within the mine pit lake water body. Rapid filling of the final void with river water continues to be an important component of the mine pit lake establishment and will limit further oxidation of tailings, overburden and reactive sections of the final void walls through inundation.

Stratification of the mine pit lake is likely and has therefore been included in the assessment. The limnological study that has determined the characteristics of the mine pit lake stratification is discussed in **Supplementary EIS Section 5.3.4**. The assessment has determined that the poorer quality water will remain in the lower levels of the mine pit lake, with the upper layers comprised of the best water quality. The limnology study has also assessed the likelihood of the various layers mixing together (refer to **Supplementary EIS Section 5.3.4** for more information).

With the proposed interaction with the McArthur River, the model predicts that an acceptable salinity, neutral pH and low metal mine pit lake outflow can be maintained. The waterways model (refer **Supplementary EIS Section 5.3.5**) assesses the interaction of these outflows with the McArthur River downstream of the mine site, along with other inputs to the surface water system.

A number of sensitivity assessments have also been completed to test the model sensitivity to a various parameters and mine pit lake scenarios. Further information on the updated mine pit lake modelling results is provided in **Supplementary EIS Appendix M – Updated Mine Pit Lake Modelling Report.**

5.3.4 Mine Pit Lake Limnology

A mine pit lake limnological study was completed as part of the Draft EIS to determine the hydrodynamic characteristics of the mine pit lake and the influence of river connection on lake stratification stability. The limnology study has been updated including assessment of alternative scenarios and 'extreme event' conditions. Results from the updated limnology study were coupled with the mine pit lake water quality results discussed above in **Supplementary EIS Section 5.3.3** to predict the water qualities in the upper layer of the mine pit lake that would interact with the McArthur River during each of the mine pit lake closure stages. Refer to **Supplementary EIS Appendix D – Pit Lake Closure with Strategic Riverine Connectivity** for more information on mine pit lake establishment and closure. A detailed updated limnological technical assessment report is provided in **Supplementary EIS Appendix O – Revised Limnology Study**. The technical assessment report describes the model inputs, model construction, functionality and characteristics and provides a detailed presentation of the model results. A summary of the model inputs and assessment results is provided below in the context of the Draft EIS assessment.

The limnology study completed in the Draft EIS assessed a single scenario focussed on the flowthrough mine pit lake scenario. The updated model incorporates the following changes and assessment scenarios:

- Updated model characteristics and assumptions based on review and revision of the previous model.
- Update of the flowthrough mine pit lake assessment to account for the above, and for comparison with the Draft EIS assessment.
- A new assessment of the backflow mine pit lake scenario to determine the suitability of this scenario for long-term application.
- An assessment of an 'extreme event' scenario whereby the concurrent impact of a cyclone, 1000 year annual recurrence interval (ARI) flood and levee failure was assessed to determine the impact on mine pit lake stratification.

In summary, the results determined that both the flowthrough and backflow mine pit lake closure options present effective long-term closure options for the MRM final void. The results also showed that the mine pit lake would only partially mix in the upper zones during the extreme event scenario and that stratification would re-establish following infrastructure repair. Further discussion of the results for each scenario is provided below. Detailed model outputs are provided in **Supplementary EIS Appendix O – Revised Limnology Study.**

The modelling of the flowthrough mine pit lake identifies that a significant thermocline (zone of significant temperature change) is maintained at approximately 20-30 m deep during summer months and at approximately 70 m during the winter. This is significant as the water below this zone is unlikely to mix with water above the zone, meaning that the surface waters retain many of the characteristics of the river water that flush through it and the waters below, which are influenced by the tailings pore water, remain deep within the mine pit lake. Therefore the waters that interact with the McArthur River system are predicted to be of good quality.

The modelling of the backflow mine pit lake presents similar results to the flowthrough mine pit lake modelling. A significant shallow thermocline exists during summer with deepening occurring during the winter months due to the influence of cooler air temperatures. As occurs in the flowthrough mine pit lake, better quality water is retained in the surface zone of the mine pit lake, with poorer quality waters remaining at depth.

The modelling of the extreme event scenario incorporated simultaneous occurrence of a cyclone, 1000 year ARI flood event and failure of both mine pit lake levees. This scenario was modelled to test the mine pit lake response to a significant amount of energy and turbulence and to determine to what depth waters would mix in such a scenario. The modelling identifies that some mixing occurs to a depth of approximately 130 m however, following the event and associated restoration of levee functionality, the previously observed stratification is re-established. It is important to note that even in this 'extreme event' scenario, mixing does not occur deep enough to effect the deposited tailings at the base of the mine pit lake.

The technical assessment report provides further analysis of a number of mine pit lake characteristics during the three closure scenarios, and is presented in **Supplementary EIS Appendix O – Revised Limnology Study.**

5.3.5 Waterways Modelling

The waterways model developed for the Draft EIS links together the key site infrastructure, the water management system and the groundwater environment with the surface water system. The model brings together the various influences on surface waters within the mineral leases and assesses the potential impacts on the downstream environment. The waterways model has been updated, primarily to incorporate the updated NOEF TOUGH2, groundwater, mine pit lake and limnology model results discussed above and to confirm the effectiveness of the water management system proposed in the Draft EIS. A detailed technical assessment report is provided in **Supplementary EIS Appendix N – Updated Water Balance and Waterways Modelling Report**. The technical assessment report describes the model inputs, model construction, functionality and characteristics and provides a detailed presentation of the model results. The technical assessment report also provides results for a number of sensitivity assessments. A summary of the model inputs and assessment results is provided below in the context of the Draft EIS assessment.

The key project changes incorporated into the model included:

- Updated inputs from the NOEF TOUGH2, groundwater, mine pit lake and limnology models.
- Updates to the water management system infrastructure, including:
    - HDPE lining of the water management dam; and
    - composite HDPE/CCL lining of EPROD.
- Updates of storage water inventories.
- Updated runoff quantities from the redesigned NOEF cover system.
- A number of operational improvements associated with water management efficiencies.

In summary, the updated waterways modelling determined that the surface water management system proposed in the Draft EIS continues to be effective in managing surface water flows and water qualities. As per the Draft EIS, the updated modelling also concludes that, with appropriate mitigation measures in place, the potential impact of the proposed mining operations on surface flows and water qualities in the surface waters downstream of MRM are predicted to be insignificant and remain within the current waste discharge licence requirements at the downstream monitoring site SW11. Further information is provided below in the context of the operational and closure periods.

The results indicate that, with the adopted mine site water management system (including the Barney Creek sumps), the predicted contaminant concentrations passing SW11 will remain below the established contaminant trigger values during the operational period of mining. Sulphate and Zinc concentrations tend to become elevated during the dry season when compared with the adopted background concentrations due to predicted groundwater inflows to Barney Creek and Surprise Creek. The other contaminants assessed tend to be similar to background flow concentrations.

The results indicate that, with the adopted mine pit lake opening configuration and Barney Creek collection sumps, predicted contaminant concentrations passing SW11 will remain below the established contaminant trigger values during the Closure assessment period. Sulphate and Zinc concentrations tend to become elevated when compared with background concentrations during interaction with the mine pit lake and in the dry season due to the predicted influence of groundwater inflows to Barney Creek and Surprise Creek.

The following is of note:

- There is almost no difference in contaminant concentrations at SW11 when stratification is included in the mine pit lake assessment when compared to the mixed case which was conservatively presented in the Draft EIS.
- The calculated median and 95th percentile contaminant concentrations are below the adopted SW11 trigger values for the assessed stratified and mixed cases.
- Median sulphate and zinc concentrations are predicted to peak in August/September when the McArthur River flows drop below 50 megalitres per day (ML/d) and before the Barney Creek collection sumps are operated. Towards the end of the dry season, predicted SW11 concentrations trend back towards background concentrations due to the operation of the Barney Creek sumps and groundwater inflows to the waterways reduce as the groundwater table lowers over the dry season.
- The other assessed contaminants tend to be similar to background flow concentrations.

The Adaptive Management Framework (**Supplementary EIS Appendix R – Adaptive Management Report**) identifies that the long term maintenance of an isolated mine pit lake is a fall-back position should the flowthrough or backflow mine pit lake scenarios not meet performance criteria. Therefore as a sensitivity analysis within the waterways model, a long term isolated mine pit lake scenario was considered. The assessment considers the potential impacts on McArthur River water quality at SW11 following the simulated failure of the Mine Levee Wall, caused by a major flood after 950 years of isolation. The McArthur River 0.1% annual exceedance probability (AEP), a 1000 year ARI, flood event was adopted for this sensitivity assessment. The Mine Levee Wall failure allowed McArthur River floodwaters to flowthrough the previously isolated mine pit lake through upstream and downstream levee openings.

The assessment concluded the following:

- Peak contaminant concentrations at SW11 occur early in the event as mine pit lake water flows into the McArthur River during the rising flood limb.
- Water quality at SW11 following the initial mixing with mine pit lake water improves as McArthur River water continues to flow though.
- Flows at SW11 are dominated by McArthur River water flowing in the McArthur River Diversion Channel, rather than flowing through the mine pit lake. Flows through the mine pit lake peak at approximately 2,000 cubic metres per second (m^3/s) compared to peak flows in the McArthur River Diversion Channel of approximately 11,500 m^3/s.
- Calculated sulphate, zinc and arsenic concentrations at SW11 exceed the respective trigger values for a short period of up to approximately two days during the 0.1% AEP flood event:
    - sulphate concentrations at SW11 peak at 405 milligrams per litre (mg/L), compared to a trigger value of 341 mg/L;
    - zinc concentrations at SW11 peak at 0.140 mg/L compared to a trigger value of 0.063 mg/L; and
    - arsenic concentrations at SW11 peak at 0.037 mg/L compared to a trigger value of 0.024 mg/L.

Further assessment of results is provided in **Supplementary EIS Appendix N – Updated Water Balance and Waterways Modelling Report** along with additional sensitivity analysis.

5.3.6 Aquatic Ecology

An assessment of potential risks and impacts to the aquatic ecology values of the McArthur River was completed as part of the Draft EIS, with particular focus on the listed threatened species. The impact assessment focussed on potential impacts of water quality and flow fluctuations and habitat modification as a result of the project proposals. The assessment completed for the Draft EIS considered 26 project aspects. The risk assessment identified 16 low residual risks, 10 medium residual risks and zero high residual risks. The key project aspects with the potential to impact on aquatic ecology were broadly characterised as:

- Reduction in water quality;
- Drawdown;
- Fauna stranding in the final void waterbody (mine pit lake);
- Discharge of surface and groundwater from the final void water body to the McArthur River;
- Reduction in water, sediment and organic matter in the McArthur River;
- Stability of final void waterbody walls, inlet and outlet;
- Expansion of NOEF footprint;
- NOEF effects on surface water and groundwater;
- Uncontrolled release of water from runoff management dams;
- TSF influence on groundwater mounding; and
- Uncontrolled release of tailings through TSF spill and seepage.

The detailed risk assessment and associated discussion is presented in **Draft EIS – Appendix W Aquatic Ecology Impact Assessment Report**. The report discusses the extensive mitigation and management strategies proposed to maintain an acceptable level of risk.

Following review of the revised waterways modelling outputs, the aquatic ecology risk assessment completed for the Draft EIS was reviewed and updated. The revised risk assessment and impact assessment is presented in **Supplementary EIS Appendix J – Aquatic Fauna Update Report**. The updated risk assessment considered 28 project aspects. The risk assessment identified 16 low residual risks, 12 medium residual risks and zero high residual risks.

The key broad project aspects with the potential to impact on aquatic ecology remain the same as those identified in the Draft EIS (as identified above). In both assessments, the importance of monitoring and validation of modelling results is highlighted. MRM maintains its commitment to monitor the performance of proposed management and mitigation strategies and to evaluate potential risks to aquatic ecology throughout the project.