CITIC PACIFIC MINING

CPM Ref: DR050842

22 December 2021

Attention: EPA Services
registrar@dwer.wa.gov.au

Department of Water and Environmental Regulation
Locked Bag 10
Joondalup DC
JOONDALUP WA 6027

Dear Sir / Madam

SINO IRON MINE CONTINUATION – MINISTERIAL STATEMENT 1066 – SECTION 38 REFERRAL – ENVIRONMENTAL PROTECTION ACT 1986

Please find enclosed a referral under S.38 of the *Environmental Protection Act 1986* for the Sino Iron Mine Continuation Proposal.

This submission is made by CITIC Pacific Mining Management Pty Ltd (CPM), on behalf of Sino Iron Pty Ltd and Korean Steel Pty Ltd proponents of the Sino Iron Mine Continuation (approved under Ministerial Statement 1066).

This submission has been prepared by Strategen-JBS&G in consultation with relevant CPM personnel. Dr Tom Hatton was engaged to conduct an independent third party peer review of a draft version of the Environmental Review Document (Attachment A). His comments have been incorporated and/or addressed within the final version.

If you would like to discuss any aspect of our submission further, please don't hesitate to contact me on (08) 9226 8316 or email Bruce.Watson@citicpacificmining.com.

Yours sincerely

Bruce Watson
General Manager – Sustainability and Environment
CITIC Pacific Mining Management Pty Ltd

CC Shaun Meredith – Executive Director, Science & Planning, EPA Services
Darren Walsh – Executive Director, Strategen-JBS&G

ENC Attachment A: Review of draft ERD for Sino Iron Mine Continuation – LoM Dewatering & Discharge (Dr Tom Hatton)
Attachment B: DWER Form – Referral of a Proposal under S.38 of the EP Act
Attachment C: Sino Iron Mine Continuation: Section 38 Referral (including technical reports)

ATTACHMENT A – Review of draft ERD for Sino Iron Mine Continuation – LoM Dewatering & Discharge (Dr Tom Hatton)

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Phone +61 417 689 619
E-Mail for orders, general information, remittance advice:: drtomhatton@gmail.com

Date: 18 December 2021

Bruce Watson

Manager Sustainability and Environment
CITIC Pacific Mining Management
GPO Box 2732
PERTH WA 6001

re: Review of draft ERD for Sino Iron Mine Continuation – LoM Dewatering and Discharge

Bruce,

I have reviewed in detail the draft Environmental Review Document for the s38 referral of the *Sino Iron Mine Continuation – Revised Proposal for Life of Mine Dewatering and Discharge*.

Apart from some very minor editorial suggestions, the draft ESD complies with the required EPA guidelines for characterizing the proposed revisions to the project, the environmental factors at potential risk, and the mitigations proposed to minimize actual impacts. Further, the data and analyses used in support of conclusions regarding impacts and their significance are sound, robust and generally conservative in nature.

More specific observations on the draft ESD are as follows.

- The proposed changes (dewatering and discharge) are clearly defined, and the consideration of potential impacts benefit from previous regulatory framing of assessment, conditioning, licensing and monitoring.
- The proposal includes a clear and robust consideration of alternatives to the requested changes.
- As a consequence, the identification of key preliminary environmental factors is sound and complete, noting the addition of potential cumulative impacts on the surrounding region, and a consideration of GHG emissions. Subsequent considerations of environmental factors not relevant to the proposal are sufficient.
- Apart from a relatively small increase in GHG emissions, the ERD correctly identifies the consequent pressures upon the environment result from additional lowering of the local groundwater table and the increased discharge of abstracted groundwater to the Fortescue River.
- The ERD documents extensive and ongoing consultation with stakeholders, including traditional owners and other beneficial users of the local environment, and the reported issues arising from those consultations are directly addressed in the subsequent analyses, and in my view, sufficiently allayed.

- The consideration of the Precautionary Principle, as drafted, could be more explicit regarding the conclusions about the lack of serious or irreversible environmental damage are based on robust scientific data and analysis.
- Conclusions regarding the impacts on Inland Waters are based on substantial monitoring of river and river pool baselines, systems responses to groundwater abstraction and discharge to date, and robust modelling.
- The key conclusion on impacts to river water quality are quite robust and appropriately conservative. That is, the increase to 21 GL/a discharge represents a very small change in water quality over baseline levels, noting the large natural variability in flow and salinity.
- The anticipated increase in the extent and timing of groundwater drawdown is based on modelling using a well-justified and described conceptual hydrogeological model and parameterized and constrained by available hydrological data and benefiting from monitoring of the aquifers' responses to historical abstractions.
- The predicted consequences to tidal and river pools, and pastoral bores from groundwater abstraction are sufficiently justified and defendable.
- Baseline / background levels of water quality components other than TDS and the conclusions regarding the (ecologically insignificant) increases in nitrates, phosphorous and metals are sound and robust.
- The groundwater modelling justifies the request to increase abstraction to 21 GL/a.
- Based on the modelled spatial responses to groundwater, and the condition and needs of groundwater-dependent vegetation, the conclusions drawn regrading the extent of impacts from the revised proposal on vegetation are justified.
- With respect to the development of a pit lake post-mining, it would be good to include a statement (based on the geology section) that makes it clear why there is no prospect of acid-forming materials making the resulting water quality anything other than simply salty.
- I concur with the conclusion that there will be no significant residual impacts resulting from groundwater drawdown, given the modelled outcomes, their conservative nature, and the commitments to monitoring and opportunities for adaptive management.
- The conclusions regarding potential impacts to Marine Environmental Quality are well-supported on the basis of background levels and variability, the responses to date from discharges, and what is known about the effects of different levels of nutrient levels and loads on the marine environment. The expectation that levels remain within current license limits for salinity concentration and nitrate loads, and that some adaptive management is available should monitoring show otherwise, gives confidence that this environmental objective can be met.

- It is reasonable to make the primary concern for any impacts on benthic habitats to be local mangroves, given their position in the estuary and salt tolerances. The general lack of impacts on mangroves from health monitoring to date at lower discharge levels is encouraging.

- While there is an extensive list of marine fauna that might live in the area, lack of any recorded sawfish species of concern is noted. Moreover, the euryhaline nature of intertidal and estuarine species in general, combined with the relatively significant increases in salinity resulting from this proposal against a widely varying natural background strongly supports the conclusion that any impacts on the identified organisms, if present, would be immaterial. This extends to expected levels of ammonia, even in the very localized area around the diffusers.

- The potential impacts on the extent of additional impacts to groundwater-dependent vegetation, when placed in the context of the degraded condition of those areas (due to mesquite infestation) , the limited impact on GDE health to date from groundwater drawdowns, as well as the regional extent of those vegetation types, is considered non-significant. This conclusion is well-defended.

- GHG emissions will increase because of the energy associated with additional pumping. Given this represents only a 0.5% increase in authorized GHG emissions from the existing project, and that the realized GHG emissions from the latter are 74% less than the authorized extent to date, then it reasonable to conclude that this is not a significant residual impact arising from the revised proposal since it represents no increased in authorized extent. Nevertheless, the commitment to progress toward carbon neutrality by 2050 and to a review of the GHG Management Plan within 12 months is a positive addition to the proposal and ESD.

- The conclusion that there is no likely significant residual impact requiring offsets is supported by the analyses.

- The cumulative impact analysis has identified existing and reasonably foreseeable developments in that part of the Pilbara coast. It would be good to include a simple description up front of what is considered to be the relevant region surrounding the proposal (e.g., the Fortescue River Delta and MMA). This would be to make clear that while the two salt projects to the north and south will have impacts on their local marine environments, they are distant from any locals impacts on the region in question.

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Sincerely,

Dr Tom Hatton, Director

ATTACHMENT B – DWER Form – Referral of a Proposal under S.38 of the EP Act

Form

Referral of a proposal under s. 38 of the EP Act

PART A: PROPONENT AND REFERRER INFORMATION AND PROPOSAL DESCRIPTION	
Referrer information	
Who is referring this proposal?	✓ Proponent ☐ Decision-making authority ☐ Community member/third party
Name of the referrer *Name of the person or organisation referring*	CITIC Pacific Mining Pty Ltd on behalf of Sino Iron Pty Ltd and Korean Steel Pty Ltd
Contact details (for the EPA's assessment of this proposal) *Name, organisation, position, email, phone and address*	Dr Bruce Watson | General Manager | Sustainability & Environment CITIC Pacific Mining | Sino Iron project T (08) 9226 8316 | M 0400 468 806 | Bruce.Watson@citicpacificmining.com
Does the referrer request that the EPA treat any part of the proposal information in the referral as confidential? *Provide confidential information in a separate attachment.*	☐ Yes ✓ No
Declaration I, Bruce Watson declare that I am authorised to refer this proposal on behalf of CITIC Pacific Mining and further declare that the information contained in this form is true and not misleading.	
Proponent information	
Name of the proponent/s *Include Trading Name if relevant*	**Sino Iron Pty Ltd** **Korean Steel Pty Ltd**
Australian Company Number(s) ✓ Australian Business Number(s) ☐	058 429 708 058 429 600
Pre-referral discussions	
Have you had pre-referral discussions with the EPA (including the EPA Services of DWER)? *If so, provide name, date, and overview of discussions.*	✓ Yes ☐ No November 2021 S Meredith , T Sinclair, Ongoing discussions regarding information required to support referral
Proposal information	
Proposal name	Sino Iron Mine Continuation Mine Continuation Project: Revised Proposal for Life of Mine Dewatering and Discharge

<table>
<tr><td>What is the proposal? (Include general description in the Instructions and template: How to identify the content of a proposal)</td><td colspan="2">Revised proposal for the life of mine dewatering and discharge to the Fortescue River as it relates to the approved expansion of the approved iron ore mine, processing plant and export facilities in the Cape Preston area. In addition to the proposal approved under Ministerial Statement No. 635, as amended by Ministerial Statement No. 822, the expansion includes the following:
Mine and processing plant: deepening the mine pit, additional infrastructure (including waste storage, creek diversion and infrastructure corridors), additional dewatering and discharge of surplus dewater.
Port: an increase in port stockyard capacity.</td></tr>
<tr><td>Have you provided electronic spatial data, maps, and figures in the appropriate format?</td><td colspan="2">✓ Yes
☐ No</td></tr>
<tr><td>What type of proposal is being referred?

For significant amendment or derived proposal, provide the associated existing Ministerial statement number/s

For a proposal under an assessed planning scheme, provide the scheme number and name</td><td colspan="2">✓ significant proposal. Choose which type of significant proposal
    ☐ new proposal
    ☐ significant amendment (proposal only)
    ☐ significant amendment (conditions only)
    ✓ significant amendment (proposal and conditions)
☐ strategic proposal
☐ derived proposal
☐ proposals of a prescribed class
☐ proposal under an assessed planning scheme</td></tr>
<tr><td colspan="3">Proposal content: Complete the corresponding template (Proposal Content Document) from the Instructions and template: How to identify the content of a proposal for the type of proposal identified above. The completed form must be submitted with the referral.</td></tr>
<tr><td>Alternatives</td><td colspan="2">Refer to Section 1.2 of the attached supporting document. There are no alternatives to increased groundwater abstraction and associated drawdown which is required for dry, safe and efficient mining.

An alternative to discharge to the Fortescue River would be discharge to evaporation ponds and utilise a quantity for dust suppression. However, there is insufficient area within existing evaporation and storage ponds for disposal of dewater via evaporation and dust suppression.</td></tr>
</table>

PART B: ASSESSMENT OF ENVIRONMENTAL IMPACTS			
Environmental factors			
What are the likely significant environmental factors for this proposal?		✓ Benthic Communities and Habitat ☐ Coastal Processes ✓ Marine Environmental Quality ✓ Marine Fauna ✓ Flora and Vegetation ☐ Landforms ☐ Subterranean Fauna ☐ Terrestrial Environmental Quality ☐ Terrestrial Fauna ✓ Inland Waters ☐ Air Quality ☐ Greenhouse Gas Emissions ☐ Social Surroundings ☐ Human Health	
*For **each** of the environmental factors identified above, complete the following table, or provide the information in a supplementary report*			
Potential environmental impacts – for each environmental factor			
1	**EPA policy and guidance**	Refer to Section 5 to 10 of the attached supporting document.	
2	**Receiving environment**		
3	**Likely environmental impacts**		
4	**Application of the mitigation hierarchy**		
5	**Assessment and significance of residual impacts**		
6	**Likely environmental outcomes**		
Holistic impact assessment			
Refer to Section 13 of the attached supporting document.			
Cumulative environmental impact assessment			
Refer to Section 14 of the attached supporting document.			
Consultation			
Refer to Section 3 of the attached supporting document.			
Supporting documents			
Provide a list of the supporting documents *Sino Iron Mine Continuation Section 38 Environmental Protection Act 1986 Referral Supporting Document.*			

Has the referrer provided survey information according to the *Instructions and Form: IBSA Data Packages* and/or the *Instructions and form: IMSA Data Packages*	☐ Yes ☐ No
Conclusion	
Do you consider the proposal may have a significant effect on the environment? No -Refer to Section 15 of the attached supporting document.	

PART B: ASSESSMENT OF ENVIRONMENTAL IMPACTS FOR SIGNIFICANT AMENDMENTS ONLY	
Type of significant amendment	☐ significant amendment to the approved proposal ☐ significant amendment to the implementation conditions ✓ significant amendment to both the proposal and the implementation conditions
Information of the approved proposal	Refer to the attached supporting document.
Combined effects of the approved proposal and significant amendment	Refer to Section 14 of the attached supporting document.
Analysis of existing implementation conditions	Refer to the attached supporting document – discussed in context of key environmental factors where relevant.
Previous changes to the Proposal and or implementation conditions	Refer to Section 1 of the attached supporting document.
Compliance	Refer to Section 2.1 of the attached supporting document
Environmental Performance	
Control of implementation of significant amendment	Operation in accordance with: • approved Operational Environmental Management Plan under MS1066, as amended from time to time; • Part V licence conditions relevant to mine dewater quality and discharge monitoring requirements and mangrove monitoring requirement; • Groundwater operating strategy (GLOS), approved as per Rights in Water and Irrigation Act 1914; and • Groundwater Dependant Vegetation Monitoring Plan, prepared to meet the requirements of the Part V licence and RIWI Act licences and GLOS.;

PART B: ASSESSMENT OF ENVIRONMENTAL IMPACTS FOR A PROPOSAL UNDER AN ASSESSED SCHEME ONLY

What new environmental issues are raised by the proposal that were not assessed during the assessment of the planning scheme?	NOT APPLICABLE
How does the proposal not comply with the assessed scheme and/or the environmental conditions in the assessed planning scheme?	

PART B: ASSESSMENT OF ENVIRONMENTAL IMPACTS FOR DERIVED PROPOSALS ONLY	
Demonstrate how the proposal will meet the environmental outcomes defined through the assessment of the strategic proposal	NOT APPLICABLE
Provide an analysis of the existing implementation conditions of the related strategic proposal in relation to the derived proposal	

PART C: OTHER APPROVALS AND REGULATION	
Decision-making authorities and their approvals	
Provide a table list of the decision-making authorities, associated legislation or agreement regulating the activity and the specific approval required. (Example table at the end of form)	Refer to Section 2.2 of the attached supporting document.
Provide a summary of the statutory decision-making processes you consider can mitigate the potential impacts of the proposal on the environment. (Note: this should be a summary of the information provided in Part B section 2.4).	
Tenure and Local Government approvals	
Location of proposal: a) street address, lot number, suburb, and nearest road intersection; or b) if remote, the nearest town and distance and direction from that town to the proposal site.	Cape Preston
Name of the Local Government Authority in which the proposal is located.	Roebourne

Is rezoning of any land required before the proposal can be implemented? If yes, please provide details.	☐ Yes ✓ No
What is the current land use on the property, and the extent (area in hectares) of the property?	Pastoral Lease Mining Operations
Does the proponent have the legal access required for the implementation of all aspects of the proposal? ***If yes**, provide details of legal access authorisations / agreements / tenure.* ***If no**, what authorisations / agreements / tenure is required and from whom?*	✓ Yes ☐ No
Commonwealth Government approvals	
Does the proposal involve an action that may be or is a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)?	☐ Yes ✓ No
Has the proposed action been referred? If yes, when was it referred and what is the reference number (EPBC No.)?	☐ Yes ✓ No Date: ________ EPBC No.: _________
If referred, has a decision been made on whether the proposed action is a controlled action? If 'yes', check the appropriate box and provide the decision in an attachment.	☐ Yes ☐ No ☐ Decision – controlled action ☐ Decision – not a controlled action
If the proposal is determined to be a controlled action, do you request that this proposal be assessed under a Bilateral Agreement or as an accredited assessment?	☐ Yes - Bilateral ☐ No ☐ Yes - Accredited
Is approval required from other Commonwealth Government/s for any part of the proposal? *If yes, describe.*	☐ Yes ✓ No Approval:
Decision-making authority referrals ONLY	
What approval/s, under your authority, are required for this proposal? *Please provide details.*	N/A

ATTACHMENT C – Sino Iron Mine Continuation: Section 38 Referral (including technical reports)

Sino Iron Mine Continuation

Mine Continuation Project: Revised Proposal for Life of Mine Dewatering and Discharge

Section 38 Environmental Protection Act 1986 Referral Supporting Document

December 2021

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Printed copy expires one-week from print date.
Refer to Server for current version

Print Date: 22 December 2021

About this document

Author/Custodianship

Author:	Strategen-JBS&G	**Custodian:**	Bruce Watson

Document details

Document No.	DR050842	**Revision No.**	0
IAP Classification		**Doc. Status**	Approved
		Information Classification	Confidential

Document revision history

Revision	Date	Change By	Amendment
0	21 Dec-21	N/A	Issued for submission to OEPA

Distribution list

When this document is updated, the following people must receive a copy of the updated version:

Name	Position/title
Qiang Yue	Chief Operating Officer
Bob Goodwin	Deputy Chief Operating Officer
Xianglin Cheng	General Manager - Mining
Jillian Baroni	Principal Hydrogeologist
Bruce Watson	General Manager Sustainability and Environment

Related/referenced documents

Document title	Document ID
Sino Iron Mine Continuation – Ministerial Statement 1066	DR044905
Iron Ore Mine, Downstream processing (Direct – Reduced Hot Briquetted Iron) and Port Construction, Cape Preston, Pilbara – Ministerial Statement 635	DR010937

Document approval

	Name	Signature	Date
Written by	Strategen-JBS&G		17 December 2021
Peer Reviewed by	Dr Tom Hatton		18 December 2021
Approved by	B Watson	[signature]	20 December 2021

Executive Summary

The existing Sino Iron Mine Continuation Proposal (approved proposal), approved under Ministerial Statement 1066 (MS1066) is located at Cape Preston, approximately 80 km south-west of Karratha, within the Pilbara region of Western Australia (Figure ES 1) and involves the open cut mining, processing and export of magnetite ore.

This revised proposal seeks to increase groundwater abstraction and dewater discharge to the Fortescue River and estuary from 12 GL/a to up to 21 GL/a progressively over the life of mine (LoM) to allow for advanced dewatering ahead of mining and ensure dry, safe, efficient mining operations. The revised proposal will not require changes to the development envelope, infrastructure or disturbance footprint.

Stakeholder consultation has continued for the approved and revised proposals. The views expressed by key stakeholders have been incorporated into the operational planning and environmental management processes for the approved and revised proposals.

Table ES 1 defines the general proposal content description, which remains the same as the approved proposal as per Table 1 of Attachment 2 to MS 1066.

Table ES 2 provides a summary of the proposal content elements. Figure ES 1 presents the regional location of the approved and revised proposal.

Table ES 1 General proposal content description

Short Description	Expansion of the approved iron ore mine, processing plant and export facilities in the Cape Preston area. In addition to the proposal approved under Ministerial Statement No. 635, as amended by Ministerial Statement No. 822, h expansion includes the following: • Mine and processing plant: deepening the mine pit, additional infrastructure (including waste storage, creek diversion and infrastructure corridors), additional dewatering and discharge of surplus dewater. • Port: an increase in port stockyard capacity.

Table ES 2 Proposal content elements

Proposal Element	Location / Description	Existing Proposal extent, capacity or range	Proposed maximum extent, capacity or range	Combined maximum extent, capacity or range
Physical Elements - Mine				
Mine and associated infrastructure	Figure 1	Additional clearing of no more than 7,366 ha (from 2,734 ha to 10,100 ha) within a development envelope of 22,737ha	No change	Additional clearing of no more than 7,366 ha (from 2,734 ha to 10,100 ha) within a development envelope of 22,737ha
Pit Depth	Figure 1	Additional 180m (from 220m to 400m)	No change	Additional 180m (from 220m to 400m)

Proposal Element	Location / Description	Existing Proposal extent, capacity or range	Proposed maximum extent, capacity or range	Combined maximum extent, capacity or range
Operational Elements - Mine				
Pit Dewatering	MS1066, Figure 1	Additional abstraction of up to 4 GL/a (from 8 GL/a to 12 GL/a) of groundwater.	Additional abstraction of up to 9 GL/a (from 12 GL/a to 21 GL/a) of groundwater	Dewatering of up to 21 GL/a of groundwater
Surplus Dewater Management	Fortescue River	Additional disposal of up to 4 GL/a (from 8 GL/a to 12 GL/a) of dewater discharge to Fortescue River.	Additional disposal of up to 9 GL/a (from 12 GL/a to 21 GL/a) of dewater discharge to Fortescue River.	Disposal of up to 21 GL/a of dewater
Operational Elements - Port				
Port stockyard capacity	MS1066, Figure 1	Additional 2Mt (from 1Mt to 3Mt)	No change	Additional 2Mt (from 1Mt to 3Mt
Proposal elements with greenhouse gas emissions				
Construction elements				
Not Applicable				
Operation elements of revised proposal				
Scope 1	Dewatering and Discharge	Up to 12 GL/a 32,651 tCO_2e per annum	Increase from 12 to 21 GL/a 24,489 tCO_2e per annum	Up to 57,140 tCO_2e per annum
Scope 2	None		No change	
Scope 3	None		No change	
Total Project Emissions				
Scope 1	Approved proposal elements: power station, process gas production for the pellet plant and direct reduced iron (DRI) plant, diesel emissions from mobile equipment and land clearing: 4.86 $MtCO_2e$ per annum		No change - dewatering and discharge emissions incorporated into combined maximum of 4.86 $MtCO_2e$ per annum for the life of mine	
Decommissioning				
Removal of all process related infrastructure within 2 years of operations (excluding periods of care and maintenance)				

Proposal Element	Location / Description	Existing Proposal extent, capacity or range	Proposed maximum extent, capacity or range	Combined maximum extent, capacity or range
Rehabilitation				
Progressive rehabilitation over the life of the mine. Final closure and rehabilitation within 10 years of ceasing operations				
Other elements which affect extent of effects on the environment				
Proposal time	Maximum Project Life	42 years	No change	42 years
	Operations Phase	40 years	No change	40 years
	Decommissioning Phase	2 years	No change	Approximately 2 years

Key Environmental Factors

The preliminary key environmental factors for the revised proposal are:

- Inland Waters;
- Marine Environmental Quality;
- Benthic Communities & Habitat;
- Marine Fauna; and
- Flora and Vegetation.

Greenhouse gas emissions for the revised proposal, as related to the increased discharge component, are addressed in Section 10 with other environmental factors relevant to the Proposal.

Table ES3 provides a summary of the key Environmental Factors, the potential effects, the proposed mitigation measures and predicted outcome.

Table ES 3 Summary of potential impacts, proposed mitigation and proposed environmental outcomes

Key Environmental Factor	Inland Waters
Potential Impacts	Groundwater drawdown from dewatering has potential to: • modify groundwater and surface water flows and quality and • affect groundwater dependant ecosystems. Discharge of mine dewater has potential to modify surface water flows and quality in the Fortescue River and estuary. Formation of a pit lake after closure has the potential to affect water quality within the pit lake and surrounding environment.

Key Environmental Factor	**Inland Waters**
Mitigation Hierarchy	**Avoid:** • Maintain the rate of discharge to the Fortescue River of up to 667 L/sec. **Minimise:** • Maintain optimum diffuser operation to ensure that predicted mixing and dilution is achieved (RPS 2021A). • Maintain dewater discharge infrastructure proactively to avoid uncontrolled release of hypersaline water to the environment. • Investigate, define and refine the hydrogeological model throughout the LoM to optimise groundwater abstraction and dewater discharge. • Monitor discharge water quality against the limits outlined in EP Act Licence L8308/2008/2. • Monitor surface water quality in accordance with EP Act Licence L8308/2008/2. • Implement mine dewater discharge adaptive management measures in accordance with the EP Act Licence in the event that discharge water quality exceeds licence discharge limits. The adaptive measures may include altering discharge volumes, dilution with fresher water sources and/or reverting to tidal based discharge regime to improve dispersion.
Residual impacts, including assessment of significance	**Residual impacts:** • Groundwater drawdown is not expected to have a significant impact on GDV at a local or regional level. • Groundwater drawdown is not expected to impact riverine pools due to the disconnected nature of pools from groundwater sources (PSM, 2020). • The proposed 21 GL/a discharge rate, equivalent to 0.0024 GL/hr, represents just 2.7% of the peak tidal volume flux during neap tides and only 0.3% of the peak flux during spring tides. This indicates that the discharge volume is not significant in the context of the overall volume of the Fortescue River estuary (RPS, 2021a). • The salinity (TDS)[1] concentration in discharge water is predicted to remain within EP Act Licence L8308/2008/2 limits. • Baseline salinity concentrations will be maintained at monitoring locations FR1 and FR3 for the increased discharge scenario (Table 5 20) over a full tidal cycle. (BMT, 2021). • Groundwater drawdown in pastoral bores is not expected to significantly impact pastoral activities (PSM, 2020). • The hypersaline mine pit lake will act as a terminal sink with the groundwater level remaining below the natural ground water table making groundwater seepage from the mine pit lake to other groundwater sources unlikely (PSM, 2020). • Resource definition modelling indicates only 0.6% of the final pit wall surface is predicted to contain potentially acid forming materials, it is anticipated that this will not significantly affect the pit lake pH. Based on the model predictions, implementation of mitigation measures and predicted residual impacts, the revised proposal is expected to meet the EPA objective for Inland Waters.
Proposed environmental outcomes	• River pools will not be affected as they are disconnected from the groundwater; • Water quality parameters (salinity) as measured at FR1 and FR3 will remain within baseline levels for the MCP; and

[1] Salinity measured as Total dissolved solids (TDS).

Key Environmental Factor	Inland Waters
	• There will be no significant loss of GDV from Project activities beyond both the 5 m drawdown contour and areas approved for clearing
Assessment of offsets	Not applicable
Key Environmental Factor	**Marine Environmental Quality**
Potential Impacts	Discharge of mine dewater has the potential to affect the water quality of the Fortescue River and estuary.
Mitigation Hierarchy	**Avoidance:** • Maintain the rate of discharge to the Fortescue River of up to 667 L/sec. **Minimise:** • Maintain optimum diffuser operation to ensure that predicted mixing and dilution is achieved (RPS APASA, 2017). • Maintain dewater discharge infrastructure proactively to avoid uncontrolled release of hypersaline water to the environment. • Monitor discharge water quality against the limits outlined in EP Act Licence L8308/2008/2. • Monitor surface water quality in accordance with EP Act Licence L8308/2008/2 (2021b). • Implement discharge monitoring as outlined in Section 6.7. • Implement mine dewater discharge adaptive management measures which may include altering discharge volumes, dilution with fresher water sources and/or reverting to tidal based discharge regime to improve dispersion.
Residual impacts, including assessment of significance	**Residual Impact:** • The proposed 21 GL/a discharge rate, equivalent to 0.0024 GL/hr, represents just 2.7% of the peak tidal volume flux during neap tides and only 0.3% of the peak flux during spring tides. This indicates that the discharge volume is not significant in the context of the overall volume of the Fortescue River estuary (RPS, 2021a). • The salinity concentrations in the discharge water are predicted to remain within EP Act Licence L8308/2008/2 limits. • Early detection of increases in discharge salinity concentrations will be identified through continuation of the EP Act Licence L8308/2008/2 (2021b) discharge monitoring program and implementation of adaptive management measures that will include diverting discharge water to holding ponds for dilution and re-testing. • Discharge modelling shows baseline salinity and ammonia concentrations will be maintained at FR1 and FR3 monitoring locations for the 70 ppt scenario over a full tidal cycle. • Early detection of changes in surface water salinity and ammonia concentrations will be identified through continuation of the EP Act Licence L8308/2008/2 (2021b) surface water monitoring program. • Discharge modelling (RPS 2021A) shows tidal energy drives the full flushing of the estuary ensuring that long term discharge does not lead to localised impacts on water quality within Fortescue River and estuary. • Implementation of adaptive management actions as described in the Fortescue River Estuary Water Quality Management Plan (EQMP) will ensure that the proposed management criteria are maintained within the Fortescue River and estuary.

Key Environmental Factor	**Inland Waters**
	Based on the model predictions and when mitigation measures are implemented the EPA objective for Marine Environmental Quality is expected to be achieved.
Proposed environmental outcomes	• Marine water quality parameters (salinity (TDS), ammonia), as measured at FR1 and FR3 will remain within the proposed management criteria as detailed within the Fortescue River Estuary EQMP.
Assessment of offsets	Not applicable
Key Environmental Factor	**Benthic Communities & Habitats**
Potential Impacts	Discharge of groundwater with a salinity above seawater to the receiving environment may lead to persistent increases in salinity resulting in exceedance of the tolerance limits of communities and osmotic stress.
Mitigation Hierarchy	**Avoid:** • Maintain the rate of discharge to the Fortescue River of up to 667 L/sec **Minimise:** • Maintain optimum diffuser operation to ensure that predicted mixing and dilution is achieved (RPS APASA 2017). • Maintain dewater discharge infrastructure proactively to avoid uncontrolled release of hypersaline water to the environment. • Monitor discharge water quality against the limits outlined in EP Act Licence L8308/2008/2. • Continued monitoring of surface water quality as prescribed in EP Act Licence L8308/2008/2 (2021b). • Implement mine dewater discharge adaptive management measures in accordance with the EP Act Licence in the event that discharge water quality exceeds licence discharge limits. The adaptive measures may include altering discharge volumes, dilution with fresher water sources and/or reverting to tidal based discharge regime to improve dispersion. • Implement discharge monitoring as outlined in Section 6.7. • Implement mangrove monitoring in accordance with current EP Act Licence and the Fortescue River Estuary EQMP, to identify early signs of health decline associated with the revised proposal.
Residual impacts, including assessment of significance	**Residual Impact:** • The proposed 21 GL/a discharge rate, equivalent to 0.0024 GL/hr, represents just 2.7% of the peak tidal volume flux during neap tides and only 0.3% of the peak flux during spring tides. This indicates that the discharge volume is not significant in the context of the overall volume of the Fortescue River estuary (RPS, 2021a). • The salinity (TDS) concentrations in the discharge water are predicted to remain within EP Act Licence L8308/2008/2 limits. • Discharge modelling shows baseline salinity and ammonia concentrations will be maintained at FR1 and FR3 monitoring locations for the 70 ppt scenario over a full tidal cycle. • Early detection of increases in discharge salinity (TDS) concentrations will be identified through continuation of the EP Act Licence L8308/2008/2 (2021b) discharge monitoring program and implementation of adaptive management measures that will include diverting discharge water to holding ponds for dilution and re-testing. • Early detection of changes in surface water salinity and ammonia concentrations will be identified through continuation of the EP Act Licence L8308/2008/2 (2021b) surface water monitoring program.

Key Environmental Factor	Inland Waters
	• Discharge modelling shows tidal energy drives full flushing of the estuary ensuring that long term discharge does not lead to localised impacts on water quality within Fortescue River and estuary. • Implementation of adaptive management actions will ensure that baseline salinity and ammonia concentrations are maintained within the Fortescue River and estuary over a full tidal cycle. • Implement mangrove monitoring in accordance with current EP Act Licence and the Fortescue River Estuary EQMP, to identify early signs of health decline associated with the revised proposal On this basis it is considered that the EPA objective for Benthic Communities and Habitats will be achieved for the revised proposal.
Proposed environmental outcomes	• No predicted adverse impacts to mangroves under the revised proposal outside of the initial discharge zone (20m up and downstream of the diffuser) as verified by the mangrove monitoring program.
Assessment of offsets	Not applicable
Environmental Factor	**Marine Fauna**
Potential Impacts	Discharge of groundwater with a salinity above seawater to the receiving environment may lead to short term increases in salinity within the Fortescue River and estuary and exceedance of species salinity tolerance limits (BMT, 2021). Such increases will be increasingly more pronounced when increasing discharges occurs on an incoming tide.
Mitigation Hierarchy	**Minimise:** • Maintain optimum diffuser operation to ensure that predicted mixing and dilution is achieved. • Monitor discharge water quality against the limits outlined in EP Act Licence L8308/2008/2 (2021b). • Monitor surface water quality as prescribed in EP Act Licence L8308/2008/2 (2021b). • Implement discharge monitoring (as outlined in Section 6.7). • Implement mine dewater discharge adaptive management measures in accordance with the EP Act Licence in the event that discharge water quality exceeds licence discharge limits. The adaptive measures may include altering discharge volumes, dilution with fresher water sources and/or reverting to tidal based discharge regime to improve dispersion.
Residual impacts, including assessment of significance	**Residual Impact:** • The proposed 21 GL/a discharge rate, equivalent to 0.0024 GL/hr, represents just 2.7% of the peak tidal volume flux during neap tides and only 0.3% of the peak flux during spring tides. This indicates that the discharge volume is not significant in the context of the overall volume of the Fortescue River estuary (RPS, 2021a). • The salinity concentrations in the discharge water are predicted to remain within EP Act Licence L8308/2008/2 limits. • Discharge modelling shows baseline salinity concentrations will be maintained at FR1 and FR3 monitoring locations for the increased discharge scenario over a full tidal cycle. • Early detection of increases in discharge salinity will be identified through continuation of the discharge monitoring program and implementation of adaptive management measures. • The 90% species protection guideline level will be achieved at FR1 and FR3 monitoring locations for the increased discharge scenario based on current ammonia concentrations.

Key Environmental Factor	**Inland Waters**
	• Early detection of changes in surface water salinity and ammonia concentrations will be identified through continuation of the surface water monitoring program within the EP Act Licence L8308/2008/2 (2021b). • Implementation of adaptive management actions will ensure that baseline salinity and ammonia concentrations are maintained within the Fortescue River and estuary over a full tidal cycle.

Proposed environmental outcomes	• Environmental water quality parameters (salinity, ammonia) as measured at FR1 and FR3 will remain within the proposed management criteria as detailed within the Fortescue River Estuary EQMP; such that:
	  o baseline salinity concentrations will be maintained at FR1 and FR3 monitoring locations for the increased discharge scenario over a full tidal cycle; and
	  o ammonia concentrations will meet the 90% species protection guideline limit (ANZG, 2018) at FR1 and FR3 monitoring locations.

Assessment of offsets	Not applicable
Environmental Factor	**Flora and Vegetation**
Potential Impacts	Groundwater drawdown has the potential to reduce the available water to groundwater dependent ecosystems (GDV) that may result in potential impacts to vegetation health. Groundwater drawdown has the potential to reduce available water to Mesquite populations with the potential to impact to vegetation health resulting in a positive environmental outcome.
Mitigation Hierarchy	**Avoid:** • Ongoing refinement of the groundwater model will more accurately predict LoM groundwater abstraction rates and associated groundwater drawdown with the potential to better predict and manage impacts to GDV health. **Minimise:** • Review the existing GDV Management Plan (GDVMP) in line with the revised drawdown extent and include additional GDV monitoring locations within new drawdown areas. • Monitor GDV response to ground water drawdown within the drawdown extent for the revised proposal and at appropriate reference locations in accordance with the methods outlined in the GDVMP. • Implement contingency actions outlined within the GDVMP when trigger levels are exceeded.
Residual impacts, including assessment of significance	**Residual Impact:** • No Threatened Flora species listed under the *Biodiversity Conservation Act 2016* (BC Act) or *Environment Biodiversity and Conservation Act 1999* (EPBC Act) will be affected by the revised proposal. • No Priority Flora species as listed by DBCA will be affected by the revised proposal. • Groundwater drawdown at the $\geq$5.0 m drawdown contour will increase by 18.4 % over the remaining 40 years of mine life (to 2061). • GDV located within the $\geq$5.0 m drawdown contour is highly to moderately impact by the declared weed mesquite and is located in an area that experiences seasonally variable groundwater levels of up to 6m.

Key Environmental Factor	Inland Waters
	• Small scale, localised impacts to GDV health may occur, however is not expected to be significant within the Fortescue River floodplain or broader Fortescue River region.
Proposed environmental outcomes	• There will be no significant loss of GDV from Project activities beyond both the 5 m drawdown contour and areas approved for clearing, such that the area of GDV potentially impacted will increase by 18.4 % compared to current abstraction rate to a total of 4,667.4 ha within the >5 m groundwater drawdown contour.
Assessment of offsets	Not applicable

Consistent with the approach adopted for the approved proposal, the revised proposal has sought to avoid and minimise the potential effects to key environmental factors through implementation of mitigation and adaptive management measures.

Overall, the environmental effect of the approved proposal and revised proposal (combined) are not anticipated to result in any significant environmental effects to the representation, diversity, viability or ecological function of the biological values with residual effects considered to be environmentally acceptable. The revised proposal can be appropriately managed in accordance with the existing environmental management framework currently applied to the approved proposal.

Figure ES 1 Project Location and Development Envelope (MS1066, Figure 1)

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1 Proposal

This document provides supporting information for the referral of the Sino Iron Mine Continuation Proposal - Revised Proposal (the proposal) by Sino Iron Pty Ltd (Sino Iron) and Korean Steel Pty Ltd (Korean Steel) (the Proponent).

CITIC Limited (formerly named CITIC Pacific Limited) is the ultimate owner of Sino Iron Pty Limited (Sino Iron) and Korean Steel Pty Limited (Korean Steel). Sino Iron and Korean Steel each hold mining rights and subleases authorising the extraction of a combined two billion tonnes (Bt) of magnetite ore, from an orebody known as the George Palmer deposit, located in the West Pilbara region of Western Australia, and contained entirely within Mining Leases M08/123, M08/124 and M08/125.

In 2006, CITIC Limited established CITIC Pacific Mining Management Pty Ltd (CPM) to manage development and ongoing operation of its iron ore mine and export facilities at Cape Preston collectively referred to as the Sino Iron Project.

CPM conducts mining activities on behalf of Sino Iron and Korean Steel, the proponents for the Sino Iron Project (approved proposal) authorised pursuant to Ministerial Statement 635 granted in 2003 (as amended from time to time).

Reference to the proponent within this document refers to Sino Iron and Korean Steel and their management representative CPM.

This proposal seeks approval for the increased mine dewatering required to support the life of mine to 2061, and the associated increased dewatering discharge to the Fortescue River as detailed in Section 1.1. The increased dewatering is required to enable advanced dewatering ahead of mining for dry, safe and efficient mining operations.

The Sino Iron Mine Continuation Proposal (approved proposal), approved under Ministerial Statement 1066 (MS1066), and the revised proposal are located at Cape Preston, approximately 80 km south-west of Karratha, within the Pilbara region of WA (Figure 1).

Approved changes to MS1066 occurred on the 18 July 2018 and 1 September 2021 to increase groundwater abstraction for mine dewatering and dewater discharge to the Fortescue River and estuary from 8 GL/a to 12 GL/a.

The approved proposal consists of the following approved components:

- Ministerial Statement (MS) 635, issued on 20 October 2003 for Iron Ore Mine, Downstream Processing (Direct Reduced and Hot Briquetted Iron) and Port Construction, Cape Preston, Pilbara. MS635 approved the construction and operation of a 44.8 million tonnes per annum (Mtpa) iron ore mine, power station, desalination plant, processing plant, accommodation and port facilities in the Cape Preston area. The processing plant was to produce pelletised, direct reduced and hot briquetted iron.
- MS 635, Attachments 1 to 5 have resulted in approvals to increase the mining rate of ore to 95 Mtpa, the production of concentrate to 27.6 Mtpa and produced waste to tailings storage to 67.4 Mtpa. Other approved

changes include a mine pit area of 360 hectares (ha), waste dumps of 600 ha, tailings storage facilities (TSF) of 987 ha, and other facilities for a total disturbed area of 2,734 ha and discharge of up to 2 GL/a of dewatered groundwater from the mine pit to the mouth of the Fortescue River.

Attachments 1 to 5 include the following approved changes:

- Attachment 1 to MS 635, Change to Proposal (s 45c), issued 8 September 2004, increased the rates of mining, processing and waste production.
- Attachment 2 to MS 635, Change to Proposal (s 45C), issued 13 February 2009 approved changes to supporting infrastructure.
- Attachment 3 to MS 635, Change to Proposal (s 45C), issued 18 March 2009 included relocation of proposed pellet plant from its original location near the mine site to the port at Cape Preston.
- Attachment 4 to MS 635, Change to Proposal (s 45C), issued 3 July 2009 approved changes to increase the area of the mine pit, waste rock dumps and TSF and increase the mining, processing and disposal rates.
- Attachment 5 to MS 635, Change to Proposal (s 45C), issued 31 August 2016 increased disturbance for roads and supporting infrastructure including a dewater discharge pipeline from mine to the Fortescue River.
- MS 822, to amend conditions applying to a proposal (s.46 Inquiry), issued on 23 December 2009, amended conditions in Statement 635 to remove requirements for further investigations into seawater quality at the location of the marine outfall and replaced them with conditions related to Ecological Protection Areas. (Condition 7-1 5 (Marine Management Plan) and 8-1 to 8-4 (Marine Wastewater Outfall) of Statement No 635 were deleted and replaced with revised conditions 8-1 to 8-8).

MS1066, issued on 20 October 2017, approved the implementation of the Sino Iron Mine Continuation proposal (described in Table 1-1), the expansion of the approved iron ore mine, processing plant and export facilities in the Cape Preston area, subject to implementation conditions in MS635, as amended by MS822 and further amended to replace condition 16 of MS 635 with a revised Condition 17: Amendment of plans, reports, systems or programs.

The following changes to MS1066 have been approved under s.45C of the EP Act.

- Attachment 1: On 18 July 2018, a change to the proposal to allow dewatering of up to 12 GL/a.
- Attachment 2: On 1 September 2021 an increase in discharge of mine dewater to the Fortescue River and estuary was approved from 8 GL/a to 12 GL/a, consistent with the increase in mine pit dewatering approved on 18 July 2018.

1.1 Proposal Content

The proposal is described in Table 1-1, which is consistent with the approved proposal as per Table 1 of Attachment 2 to MS 1066 dated 1 September 2021.[2] The extent of the proposal is defined in Table 1-2.

Table 1-1: General proposal content description

Proposal Title	Sino Iron Mine Continuation Proposal
Proponent Name	Sino Iron Pty Ltd and Korean Steel Pty Ltd
Short Description	Revised proposal for the life of mine dewatering and discharge to the Fortescue River as it relates to the approved expansion of the approved iron ore mine, processing plant and export facilities in the Cape Preston area. In addition to the proposal approved under Ministerial Statement No. 635, as amended by Ministerial Statement No. 822, the expansion includes the following: • Mine and processing plant: deepening the mine pit, additional infrastructure (including waste storage, creek diversion and infrastructure corridors), additional dewatering and discharge of surplus dewater. • Port: an increase in port stockyard capacity.

Table 1-2: Proposal content elements

Proposal Element	Location / Description	Existing Proposal extent, capacity or range	Proposed maximum extent, capacity or range	Combined maximum extent, capacity or range
Physical Elements - Mine				
Mine and associated infrastructure	Figure 1	Additional clearing of no more than 7,366 ha (from 2,734 ha to 10,100 ha) within a development envelope of 22,737ha	No change	Additional clearing of no more than 7,366 ha (from 2,734 ha to 10,100 ha) within a development envelope of 22,737ha
Pit Depth	Figure 1	Additional 180m (from 220m to 400m)	No change	Additional 180m (from 220m to 400m)
Operational Elements - Mine				
Pit Dewatering	Figure 1	Additional abstraction of up to 4 GL/a (from 8 GL/a to 12 GL/a) of groundwater.	Additional abstraction of up to 9 GL/a (from 12 GL/a to 21 GL/a) of groundwater	Dewatering of up to 21 GL/a of groundwater
Surplus Dewater Management	Fortescue River	Additional disposal of up to 4 GL/a (from 8 GL/a to 12 GL/a) of dewater	Additional disposal of up to 9 GL/a (from 12 GL/a to 21 GL/a) of dewater	Disposal of up to 21 GL/a of dewater

[2] https://www.epa.wa.gov.au/sites/default/files/1MINSTAT/Statement%201066.pdf

Proposal Element	Location / Description	Existing Proposal extent, capacity or range	Proposed maximum extent, capacity or range	Combined maximum extent, capacity or range
		discharge to Fortescue River.	discharge to Fortescue River.	
Operational Elements - Port				
Port stockyard capacity	Figure 1	Additional 2Mt (from 1Mt to 3Mt)	No change	Additional 2Mt (from 1Mt to 3Mt
Proposal elements with greenhouse gas emissions				
Construction elements				
Not Applicable				
Operation elements of revised proposal				
Scope 1	Dewatering and Discharge	Up to 12 GL/a 32,651 tCO_2e per annum	Increase from 12 to 21 GL/a 24,489 tCO_2e per annum	Up to 57,140 tCO_2e per annum
Scope 2	None		No change	
Scope 3	None		No change	
Total Project Emissions				
Scope 1	Approved proposal elements: power station, process gas production for the pellet plant and direct reduced iron (DRI) plant, diesel emissions from mobile equipment and land clearing: 4.86 $MtCO_2e$ per annum		No change - dewatering and discharge emissions incorporated into combined maximum of 4.86 $MtCO_2e$ per annum for the life of mine	
Decommissioning				
Removal of all process related infrastructure within 2 years of operations (excluding periods of care and maintenance)				
Rehabilitation				
Progressive rehabilitation over the life of the mine. Final closure and rehabilitation within 10 years of ceasing operations				
Other elements which affect extent of effects on the environment				
Proposal time	Maximum Project Life	42 years	No change	42 years
	Operations Phase	40 years	No change	40 years
	Decommissioning Phase	2 years	No change	Approximately 2 years

1.1.1 Revised Proposal

The revised proposal seeks to increase groundwater abstraction for mine dewatering from 12 gigalitres per annum (GL/a) to up to 21 GL/a progressively over the Life of Mine (LoM) with the rate of dewater discharge to the Fortescue River and estuary also proposed to increase from 12GL/a to 21 GL/a.

The primary driver for the increased abstraction and discharge is to facilitate dewatering in advance of mining for dry, safe and efficient mining operations over the LoM.

The maximum rate of discharge (667 L/sec) will remain the same with the period of discharge increasing from up to 13.7 hr/day to up to 24 hr/day to achieve the increased discharge volume.

The diffuser outfall will remain at its current location with no change to discharge infrastructure required in line with no change to the discharge rate (667 L/sec).

Additional abstraction bores will be installed within and around the mine pit at locations where groundwater storage and flows are expected to be intercepted.

Ongoing assessment of hydrogeological conditions will be undertaken over the LoM, based on data collected during mining operations, to better inform groundwater abstraction activities.

The increase in groundwater abstraction and dewater discharge will be managed consistent with existing abstraction and discharge activities in accordance with Ministerial Statements 635 and 1066, Department of Water and Environmental Regulation (DWER) Licence to Operate L8308/2008/2, RIWI Act groundwater licences, and the existing Operational Environmental Management Plan (OEMP).

Figure 1 presents the development envelope for the approved proposal and revised proposal. No changes to the development envelope are required for the revised proposal.

The key environmental factors for the revised proposal are:

- Inland waters
- Marine environmental quality
- Benthic communities & habitats
- Marine fauna
- Flora and vegetation

A summary of the key Environmental Factors, the potential effects, the mitigation measures proposed to be implemented the expected outcome are presented Table ES

The potential impacts to the quality of the water within the Fortescue River and estuary from the revised proposal are relevant to the Environmental Factors of Inland Waters and Marine Environmental Quality. The potential impacts to hydrological regimes and the quality of groundwater and surface water within the Fortescue River and estuary are addressed in the Environmental Factor of Inland Waters presented in Section 5. The potential impacts to the Ecological Protection Objectives of the Fortescue River and estuary are presented in the Environmental Factor of Marine Environment in Section 6.

The assessment of potential impacts to benthic processes of the Fortescue River and estuary are addressed in the Environmental Factor of Benthic Communities & Habitats in Section 7.

The assessment of potential impacts to flora and vegetation within and surrounding the mine are addressed in the Environmental Factor of Terrestrial Flora and Vegetation in Section 9.

Other environmental factors that will not be significantly impacted by the revised proposal are outlined in Section 10.

Figure 1 Approved proposal location and Development Envelope (MS1066, Figure 1)

1.2 Proposal Alternatives

There are no alternatives to increased groundwater abstraction and associated drawdown which is required for dry, safe and efficient mining. However, modelling was undertaken to inform groundwater abstraction under a range of pumping scenarios. These are described in Section 5.4.3.2 and Section 5.4.3.3. Whilst the groundwater drawdown extent predicted for each scenario varied, the comparative drawdown extents and associated environmental effects were not significantly different.

An alternative to discharge to the Fortescue River would be discharge to evaporation ponds and utilise a quantity for dust suppression. However, there is insufficient area within existing evaporation and storage ponds for disposal of dewater via evaporation and dust suppression. For the current approved dewatering volume of 12 GL/a, the existing ponds provide 5 days storage. At the proposed LoM volume of 21 GL/a this reduces to 1 day of storage. Furthermore, due to the limited disturbance footprint available for expansion, there is limited capacity to construct additional ponds.

1.2.1 Justification

The approved proposal has been in operation since 2013 producing magnetite iron ore for overseas markets. The approved proposal provides regional and local employment, business opportunities and direct and indirect employment with over 3,000 direct employees and 10,000 indirect employees, including Contractors.

Additionally, the approved proposal provides a revenue stream for the West Australian Government through the payment of royalties (~$140M/pa), payroll taxation (~$26.5M/pa) and local content opportunities (~$365M/pa) during each year of operation contributing 1 billion in revenue per annum for the local Western Australian Economy.

The objective of the revised proposal is to increase the current volume of groundwater abstraction and dewater discharge to the Fortescue River to facilitate dewatering ahead of mining and achieve dry, safe and efficient mining conditions over the LoM.

Due to shallow ground water conditions, groundwater abstraction has been undertaken since the commencement of mining in 2010 and is critical to mining operations.

Pit dewatering is driven by recharge to groundwater aquifers from rainfall, stream flow and the marine environment (PSM, 2020). Dewater volumes have historically been difficult to predict due to the complex interaction between groundwater and surface water and groundwater inflows from tidal creeks that are intermittent and difficult to quantify (PSM, 2020).

Historical abstraction from the pit floor sumps has been hypersaline indicating the likely dominant source as tidal creeks that provide a perennial recharge source (PSM, 2020).

The proponent's understanding of the hydrogeology within and surrounding the mine continues to develop through analysis of operational data. Updated hydrogeological modelling indicates that as mining progresses and the pit depth increases, recharge from tidal creeks is likely to increase resulting in a need for additional production bores to manage higher volumes of abstraction (PSM, 2020).

Groundwater has historically been abstracted from dewatering sumps in the mine pit floor and dewatering bores at the pit wall crest. To date, there has not been sufficient dewatering for advance dewatering, often resulting in wet, unsafe and inefficient mining conditions (PSM, 2020).

While groundwater is utilised in some areas for dust suppression (roads), the hypersaline groundwater impacts ore salinity levels if used for dust suppression in the vicinity of mining and processing ore. In addition, groundwater cannot be used in the process plant as the plant requires water with a salinity (TDS) <2,000 mg/L. Excess TSF decant and seepage water with a salinity (TDS) <5,000 mg/L is the preferred water source for dust suppression as it reduces the risk of corrosion to mining infrastructure, plant and equipment.

Mining operations are expected to continue to 2061 and therefore an increase in groundwater abstraction and discharge to Fortescue River over the LoM is required.

Groundwater abstraction and dewatering activities will continue be managed in accordance with the conditions of MS635 (as amended) and future conditions that may be determined appropriate as a part of this assessment.

1.3 Local and Regional Context

The revised proposal is located at Cape Preston, 1,490km from Perth and 80 km south-west of Karratha in the Pilbara Region of Western Australia. The Port of Cape Preston was established in 2003 to export iron ore from the Pilbara region to overseas markets. The approved proposal commenced operation in 2010 with export of ore from Cape Preston.

The proposed Ports of Cape Preston East and West are located immediately adjacent to the existing Port of Cape Preston and 40km north-east of the Port respectively. Cape Preston East Iron Ore Export Facility has been earmarked as the location for a multi-user transhipment port for the export of iron ore and other bulk minerals whilst Cape Preston West has been earmarked as the location for a multi-user port for the export of salt and other bulk minerals.

Cape Preston East Iron Ore Export Facility was granted environmental approved in September 2013 under Ministerial Statement 949 (MS949). A number of S.45C changes were approved in 2015, 2017 and 2018 including a change to the proposal name to Cape Preston East – Multi Commodity Export Facility (Cape Preston East). In 2018, an application was made by BC Iron Minerals Limited under s.46 to change the conditions of MS949 to extend substantial commencement of Cape Preston East. On 6 August 2020, Ministerial Statement 1149 was issued extending substantial commencement to 9 September 2023.

Mardie Minerals Pty Ltd is seeking to develop the Mardie Project (MP), a greenfield high-quality salt and potash project in the Pilbara region of Western Australia. Mardie Minerals is a wholly-owned subsidiary of BCI Minerals Limited. The Proposal is an evaporative solar project that utilises seawater to produce raw salts as a feedstock for dedicated processing facilities that will produce a high purity salt, fertiliser grade sulphate of potash (SoP) product, and potentially other commercial by-products. Production rates of 4.0 million tonnes per annum (Mtpa) of salt (NaCl), 100 kilotonnes per annum (ktpa) of SoP, and up to 300 ktpa of other salt products are being targeted, sourced from a 150 GL/yr seawater intake (Preston, 2020). Following a Public Environmental Review, Ministerial Statement 1175 was granted on 24 November 2021.

Leichhardt Industrials Pty Ltd is seeking to develop the Eramurra Solar Salt Project (ESSP) in the Cape Preston East area, approximately 55 kilometres (km) west-south-west of Karratha in Western Australia (WA). The ESSP will utilise seawater and evaporation to produce a concentrated salt product for export at a production rate of up to 4.2 million tonnes per annum (Mtpa) (Preston, 2021). The ESSP is currently being assessed by the EPA at the level of assessment of Public Environmental Review (EPA, 2021b).

The potential local and regional cumulative effects of the revised proposal and the MP and ESSP have been considered in Section 14 within this report.

The approved proposal is surrounded by the Mardie pastoral station which has been used for pastoral purposes for over 100 years and has Australia's largest mesquite infestation (a declared Weed of National Significance). A frequently used boat ramp and unregulated camping area (with no ablution facilities) is close by and is heavily utilised during the winter months. Monitoring by the proponent has shown that during peak periods in excess of 30 camping groups stay for extended periods of time (months).

The approved proposal is located on the traditional land of the Yaburara and Mardudhunera People (Figure 2). The Proponent has a long standing, positive relationship with the Yaburara and Mardudhunera people that has been formalised through the Cape Preston Project Deed (Yaburara and Mardudhunera Mardie Indigenous Land Use Agreement) registered on 6 November 2015. Since determination of this Agreement, Yaburara and Mardudhunera have become Mardudhunera.

2 Legislative Context

2.1 Environmental Impact Assessment Process

This Environmental Review has been prepared in accordance with Environmental Protection Authority (EPA) *Instructions on how to prepare an Environmental Review Document* (EPA 2020b) to support referral of the revised proposal under s.38 of the EP Act.

In accordance with the EPA's (2021) *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures*, this Environmental Review aims to provide sufficient information for the EPA to assess the revised proposal at the referral stage. Specifically, this Environmental Review provides a comprehensive review of environmental factors relevant to the revised proposal.

The revised proposal will continue to be managed in accordance with existing approved practices. The Proponent has demonstrated a high standard of environmental performance and compliance for the approved proposal and has undertaken substantial consultation for the revised proposal with government Decision-Making Authorities (DMAs).

The approved proposal has in place appropriate secondary approvals (including licences where required) and well-established relationships with relevant DMAs.

The revised proposal is not considered a controlled action as the proposal is not expected to have a significant impact on Matters of National Environmental Significance (MNES) and accordingly has not been referred to the Department of Agriculture, Water and the Environment (DAWE) for assessment under Section 143 of the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act).

2.2 Other approvals and regulation

The revised proposal is located within the Mardie Station Pastoral Lease (approximately 225,000 ha), which is operated by Pastoral Management Pty Ltd (PMPL) (a subsidiary company of CITIC Limited) as a cattle station outside the approved mining areas.

With the exception of L08/126 (held by PMPL), the revised proposal is located within 'Area A' under the *State Agreement Act Iron Ore Processing (Mineralogy) Agreement Act 2002* (IOPAA). The proponents are parties to the IOPAA and will implement the revised proposal in accordance with proposals approved under the State Agreement. Other approvals required for this proposal are described in Table 2-1.

Table 2-1 Other Approvals and Regulation

Decision-making authority	Legislation or Agreement regulating the Activity	Approval Required for Relevant Proposal Element(s)	Does the DMA process mitigate impacts on the environment?	Details of how the DMA process mitigates impacts and how the EPAs factor objectives will be met.
Department of Jobs, Tourism, Science and Innovation (JTSI)	IOPAA	**Mining and processing activities:** **Approved Proposals or Additional Proposals (AP's)**	No	**Nothing in the IOPAA exempts CPM from compliance with the EP Act.**
Department of Planning Lands and Heritage (DPLH)	*Aboriginal Heritage Act 1972*	**Disturbance to Aboriginal Heritage sites:** Section 18 consent	Yes - partially	**Potential impact: loss of, or damage to, Registered Aboriginal Heritage sites or other aspects of cultural significance.** A section 18 consent allows for disturbance to the site under specified conditions. Consent under s18 of the AH Act is required where impact to an Aboriginal Heritage site is unavoidable. The issue of a Section 18 consent alone does not fully meet the EPA objectives for this factor. Whilst ongoing negotiation is not a requirement of the AH Act or s18, the Proponent has entered into an agreement with, Yaburara & Mardudhunera Traditional Owners. CPM will maintain ongoing consultation with the Mardudhunera Traditional Owners in accordance with the Indigenous Land Use Agreement (ILUA) throughout the life of the Proposal (Section 3.1.2).
DWER	*Rights in Water and Irrigation Act 1914* (RIWI Act)	**Groundwater abstraction:** Section 5C Licence to take groundwater Section 26D Licence to construct wells	Yes	**Potential impact(s): increased drawdown impact on groundwater dependant vegetation (GDV)** The Proposal is approved to abstract up to 12 GL/year under 5C Licences to Take Water (GWL167151 and GWL201437) in accordance with an approved Groundwater Licence Operating Strategy (GLOS). This will require amendment to increase dewatering under this Proposal.

Decision-making authority	Legislation or Agreement regulating the Activity	Approval Required for Relevant Proposal Element(s)	Does the DMA process mitigate impacts on the environment?	Details of how the DMA process mitigates impacts and how the EPAs factor objectives will be met.
				As part of the assessment and approval of this increase in allocation, DWER considers the availability of water in the resource area in accordance with the relevant area water allocation plan. These plans outline how much water can be taken from groundwater resource whilst protecting the sustainability of the resource and the water-dependent environment. Water allocation plans take into consideration latest climate information, especially changing rainfall, to manage water resources into the future. The GLOS describes the monitoring and management and reporting required to ensure that the groundwater abstraction can be managed with low risk to GDV and river pools. Compliance with the GWL will ensure the EPA objectives for inland waters can be met.

3 Stakeholder Engagement

3.1 Key Stakeholders

3.1.1 State and Commonwealth agencies

The proponent has an ongoing consultation strategy with relevant stakeholders for the approved proposal. The proponent has engaged with the following stakeholders for the revised proposal and will continue to engage as relevant throughout the life of the proposal.

State Government agencies:

- Department of Biodiversity Conservation and Attractions (DBCA)
- Department of Mining, Industry Regulation and Safety (DMIRS)
- Department of Water and Environmental Regulation (DWER)
- Environmental Protection Authority (EPA)

Other relevant stakeholders:

- Pastoral Management Pty Ltd (PMPL)

Comments and advice received from government agencies and other relevant stakeholders have been considered and will be incorporated into operational management relevant to the revised proposal as outlined in Table 3-1.

Table 3-1 Key Stakeholder Consultation

Stakeholder	Interests	Date	Topics of discussion	Status
PMPL Charles Yau PMPL Director [CPM CFO]	Lessee and operator of Mardie Station	06/12/21	Impacts to pastoral potential and assets.	Complete.
Traditional Owners Yaburara and Mardudhunera Native Title Determinants (YMTO) via Gary Blinco CPM Superintendent – Heritage & Indigenous Affairs	Impacts to access to their land and activities. Impacts on fish stocks and water quality.	23/03/21	Volume of water, water quality, predicted impacts on water quality and traditional values	Complete. Offer for additional consultation made, pending feedback.
DPIRD – Dept. of Fisheries	Fish stocks, impacts on	24/09/21	Water quality, volume of water,	Complete.

Stakeholder	Interests	Date	Topics of discussion	Status
Mike Dunne Supervising Fisheries and Marine Officer	fishing, regulation of fishing in the area, impacts on industry		industry concerns, commercial fishing boundaries	
Mark Pagano Aquatic Resource Management		09/11/21		Ongoing.
DPIRD Lara Martin Biosecurity Officer	Mesquite management impacts on pastoral activities	23/09/21	Henry advised no comments from DPIRD.	Complete. Spoke to Henry Smolinski and Lara Martin
DBCA Charlotte Patrick Senior Environmental Officer Environmental Management Branch	Impacts on marine fauna and aquatic biota	01/11/21	Marine fauna, water quality, diffuser infrastructure, nature reserves	Complete
City of Karratha Ranger Services	Impact on amenity and tourism	07/10/21	Tourism impacts Fortescue River Road.	Complete. Email response from Joshua Allbeury – CoK will provide comment as part of the future Part V referral process.
EPA Shaun Meredith General Manager EPA Strategy and Guidance	Impacts on environmental values, Fortescue River estuary, marine fauna, GDE		Adequacy of technical studies, peer reviews, agreed approach / level of assessment. Define Evs and EQOs	Ongoing.
Western Australian Fishing Industry Council (WAFIC)	Nursery for fish, impacts on catch, associated financial impacts	13/10/21	On advice from DoF Water quality, volume of water, industry concerns, commercial fishing boundaries.	Complete. WAFIC contacted key fishers to discuss proposal. No feedback to date
DWER Water Division	Monitoring bores on Mardie, RIWI Act amendments to 5C Licences	08/09/21 08/11/21	Adequacy of technical studies	CPM provided LOM pit dewatering model prediction report and independent peer review on 9/12/20. Submission note attached.

Stakeholder	Interests	Date	Topics of discussion	Status
				CPM engaged DWER Water providing a presentation and consultation on the findings of the model prediction report on 16/2/21. Verbal feedback from DWER Water after the submission and presentation was that the modelling report and presentation was sufficiently robust and acceptable noting the data limitations due to the stage in mining achieved.
DMIRS Melissa Harrison Team Leader Resource and Environmental Compliance Division	Mining Lease, pollution prevention, mine closure	21/09/21	Courtesy email. No change to Mining Proposal activities	Complete. Email response from Melissa Harrison noted and placed on file with tenement L08/126

3.1.2 Aboriginal Stakeholders

The proponent has consulted extensively with the Mardudhunera Traditional Owners (formerly Yaburara & Mardudhunera) on the approved proposal, and this revised proposal.

A site meeting was held with the Mardudhunera Traditional Owners on 23 March 2021 to specifically discuss increases in discharge of dewater to the Fortescue River and estuary of 12 GL/a and 21 GL/a over the LoM. Following these discussions, the Mardudhunera Traditional Owners advised that they had no objection to the revised proposal (CPM, 2021) (Appendix 1).

The proponent has committed to keeping the Mardudhunera Traditional Owners informed through regular project updates via the Wirrawandi Aboriginal Corporation, which will include relevant information regarding environmental management.

3.2 Stakeholder Engagement Process

The proponent engages with government DMA's and other stakeholders (including landholders, Aboriginal groups and local government authorities) on a regular, periodic basis to provide updates and information regarding potential and identified changes to the key characteristics of the approved proposal.

Information provided by DMA's during consultation and discussions are considered and where appropriate incorporated into decision making regarding the current approved proposal and future proposals.

In addition, the proponent reports regularly to DWER in accordance with conditions of MS 635, 822, 1066 and 1169, Operating Licences L8659/2012/2, L8758/2013/1 and L8308/2008/2 (DWER, 2015, 2021a, 2021b) and Groundwater abstraction licences GWL167151(8) and GWL201437(2).

Consultation with the Aboriginal stakeholders is informed by the Cape Preston Project Deed (Yaburara and Mardudhunera Mardie Indigenous Land Use Agreement) registered on 6 November 2015. This Agreement sets out the terms of engagement and consultation regarding the approved proposal, its impact and any anticipated changes to the key characteristics of the approved proposal.

The proponent meets regularly with Mardudhunera Traditional Owners to provide updates on issues that are of particular interest and importance to the group.

3.3 Stakeholder Consultation Outcomes

Key issues raised by Stakeholders during the consultation and discussions outlined in Table 3-2 include:

- Management of weeds, in particular a potential increase in mesquite population
- Impacts to on the environmental values of the Fortescue River and estuary, including water quality, marine fauna, aquatic biota, benthic habitats
- Impacts on amenity and tourism
- Management of potential impacts on water quality and prevention of pollution
- Impacts on fish nurseries, impacts on commercial catch for key commercial fish species and associated financial impacts.
- Impacts on pastoral activities, in particular impacts on groundwater bores.

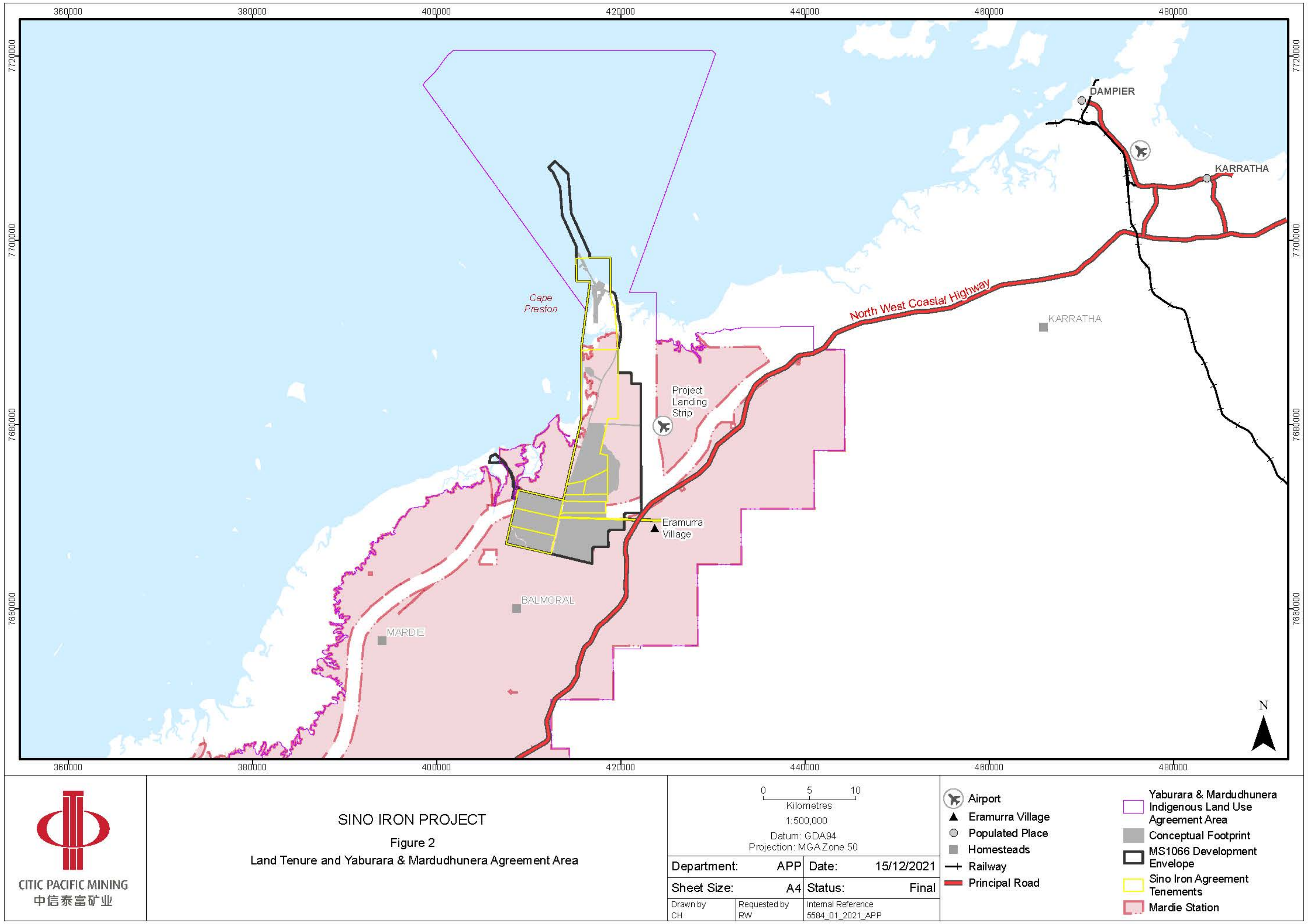
These concerns have been taken into consideration in determining the key environmental factors and during the assessment of potential impacts of the revised proposal.

Table 3-2 Stakeholder Consultation Outcomes

Stakeholder Concerns	Environmental Factor	Assessment of impact and potential outcome
Increase in mesquite population	Terrestrial Flora and Vegetation	Groundwater drawdown has the potential to affect the mesquite within the drawdown zone as it will reduce the groundwater resources available to mesquite individuals.
Impacts on Fortescue River and estuary	Inland Waters Marine Environmental Quality	Hydrodynamic modelling predicts that water quality within the Fortescue River and estuary will return to pre-impact baseline quality over a full tidal cycle. Short term elevations in salinity

Stakeholder Concerns	Environmental Factor	Assessment of impact and potential outcome
environmental values	Marine Fauna Benthic Communities and Habitats	concentrations are well within the natural salinity variation of the Fortescue River and Estuary. Consequently, there is unlikely to be adverse impacts to marine environmental quality, marine fauna or benthic communities and habitats
Impacts on amenity and tourism	Inland Waters Marine Environmental Quality Marine Fauna Benthic Communities and Habitats	Modelling and assessments undertaken as a part of the assessment of impacts of the revised proposal indicate that the values of Fortescue River and estuary will not be impacted by the increase dewater discharge.
Impacts on water quality	Inland Waters Marine Environmental Quality	Hydrodynamic modelling predicts that water quality within the Fortescue River and estuary will return to pre-impact baseline quality over a full tidal cycle.
Impacts on fish nurseries, important commercial fish species and commercial fish catch	Inland Waters Marine Environmental Quality Marine Fauna Benthic Communities and Habitats	Hydrodynamic modelling predicts that water quality within the Fortescue River and estuary will return to pre-impact baseline quality over a full tidal cycle. Short term elevations in salinity concentrations are well within the natural salinity variation of the Fortescue River and Estuary. Consequently, there is unlikely to be adverse impacts to marine fauna or benthic communities and habitats. It is therefore unlikely that fish nurseries or commercial fish species will be impacted by the revised proposal.
Impacts on pastoral activities	Inland Waters	Whilst groundwater drawdown from the revised proposal will result in drawdown at some pastoral bores on the Mardie Pastoral Station, pastoral activities will not be affected.

Figure 2 - Land Tenure and Yaburara & Mardudhunera Agreement Area



4 Object and Principles of the EP Act

The EPA uses environmental principles, factors and objectives as the basis for assessing whether a revised proposal's impact on the environment is acceptable. The environmental principles, factors and objectives underpin the environmental impact assessment process.

Section 4A of the EP Act establishes the object and principles of the Act. The object of the EP Act is to protect the environment of the State, having regard to key environmental principles.

The proponent has considered these principles in relation to the development and implementation of the revised proposal. Table 4-1 outlines how the principles will be addressed by the revised proposal.

Table 4-1 - EPA Act Principles

Principle	How it will be addressed by the revised proposal
Precautionary principle Where there are threats of serious irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, decisions should be guided by: 1. careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and 2. an assessment of the risk-weighted consequences of various options.	The revised proposal has used existing environmental data and additional supplementary studies to inform hydrogeological and hydrological modelling. Discharge modelling has been independently peer reviewed. Consultation with relevant government agencies has occurred to ensure that relevant environmental impacts are identified and comprehensive management measures developed to avoid or minimise impacts on identified environmental values. No serious or irreversible environmental damage is anticipated by this proposal, and the scientific data and analyses underpinning this conclusion is robust.
Intergenerational equity The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.	The revised proposal can be designed and implemented without significant impacts on the health, diversity or productivity of the environment.
Conservation of biological diversity and ecological integrity Conservation of biological diversity and ecological integration should be a fundamental consideration.	Survey work has been used to identify and confirm the range and condition of the environmental factors within and surrounding the development boundary. The revised proposal will not substantially reduce the extent of any vegetation type or habitat within the Cape Preston area. The findings indicate that with appropriate design and implementation of management plans that no likely significant biodiversity or ecological impacts will result from the proposed development at local or regional level.
Improved valuation, pricing and incentive mechanisms 1.Environmental factors should be included in the valuation of assets and services.	Environmental constraint avoidance and management costs have been considered in the design of the revised proposal.

<table>
<tr><th>Principle</th><th>How it will be addressed by the revised proposal</th></tr>
<tr><td>2. The polluter pays principle – those who generate pollution and waste should bear the cost of containment, avoidance or abatement.
3. The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste.
4. Environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentive structures, including market mechanisms, which benefit and/or minimise costs to develop their own solutions and responses to environmental problems.</td><td></td></tr>
<tr><td>Waste minimisation
All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.</td><td>Waste will be minimised by adopting the hierarchy of waste controls; avoid, minimise, reuse, recycle and safe disposal.</td></tr>
<tr><td colspan="2">With regard to the object of the EP Act being "to protect the environment of the State" having regard to the above principles, the Proponent has sought to avoid and minimise the potential effects to key environmental factors through implementation of mitigation and adaptive management measures.
Overall, the environmental effect of the approved proposal and revised proposal (combined) are not anticipated to result in any significant environmental effects to the representation, diversity, viability or ecological function of the biological values with residual effects considered to be environmentally acceptable. The revised proposal can be appropriately managed in accordance with the existing environmental management framework currently applied to the approved proposal.</td></tr>
</table>

4.1 Environmental Factors and Objectives

The preliminary key environmental factors identified for the proposal are:

- Inland waters;
- Marine environmental quality;
- Benthic communities and habitat;
- Marine fauna; and
- Flora and vegetation.

Greenhouse gas emission as they relate to the revised proposal are addressed in Section 11.

The potential impacts identified for each key environmental factor and an assessment of the impacts and predicted significance and outcomes, with respect to the EPA objectives, are assessed further in Section 5 to Section 10 of this document.

Table 4-2 describes the policy and guidance that has been considered with respect to all key environmental factors and objectives, addressed in Sections 5 to 10.

Table 4-2: Policy and guidance relevant to all factors

Policy and Guidance	Key Aspects
Statement of Environmental Principles, Factors, Objectives and aims of EIA (EPA 2021)	This statement communicates how, for the purposes of environmental impact assessment, the EPA: • Considers the object and principles of the EP Act; • Considers what the aims of environmental impact assessment (EIA) should be; • Uses environmental factors and objectives to organise and systemise EIA and reporting; • Considers significance throughout the EIA process; • Takes a holistic view of the environment and a proposal or scheme's potential impact on the environment; and • Considers cumulative effects when assessing a proposal or scheme's potential impact on the environment.
WA Environmental Offsets Policy (GoWA 2011); and **WA Environmental Offsets Guidelines (GOWA 2014)**	The Western Australian Government's Environmental Offsets Policy seeks to protect and conserve environmental and biodiversity values for present and future generations. This policy ensures that economic and social development may occur while supporting long term environmental and conservation values. These guidelines complement and expand on the WA Environmental Offsets Policy 2011 (offsets policy) by clarifying the determination and application of environmental offsets in Western Australia.

4.2 Other environmental factors

Other environmental factors, which are not considered by the Proponent to be key environmental factors are discussed in Section 10 and include:

- Coastal Processes;
- Terrestrial Fauna;
- Terrestrial Environmental Quality;
- Subterranean Fauna;
- Social Surroundings; and
- Greenhouse Gas Emissions.

Environmental factors determined not to be relevant to the Proposal and the relevant justification are provided in Table 4-3.

Table 4-3: Environmental factors not relevant to the proposal

ENVIRONMENTAL FACTOR	Justification
Land - Landforms	Landforms will not be impacted by the revised proposal.
Air - Air Quality	The revised proposal is not expected to impact on environmental values related to air quality.
People - Human Health	The EPA Guidance for this factor provides the specific framework for considering the possible impacts to human health arising from the emission of radiation. Emission of radiation is not a consideration for this proposal. Radiation emissions are not a relevant consideration for the revised proposal.

5 Inland Waters

5.1 EPA Objective

The EPA objective for Inland waters is to *maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.*

5.2 Policy and objective

The relevant EPA policy and guidance for Inland waters is:

- Environmental Factor Guideline - Inland Waters (EPA 2018a)

5.3 Receiving Environment

A summary of work completed to describe the receiving environment relating to Inland waters is included in Table 5-1.

Table 5-1 Summary of baseline studies relevant to Inland Waters

Author/date	Survey/ investigation name	Study area, type, timing	Study standard, guidance and limitations
Recent completed work			
BMT, 2021 (Appendix 4)	Technical Note: CPM Management pit dewatering: Groundwater discharge to the Fortescue River, December 2021	An assessment of environmental/ecological values and functions of the Fortescue rivermouth and marine outflow in the vicinity of the discharge An evaluation of both short, and longer term, extent of impacts of additional loadings of total dissolved solids (TDS) and nutrients (and associated localised increases in concentrations) from the discharge on the environmental values of the Fortescue River and Estuary; taking into account seasonal variability, and providing recommendations in relation to potential changes to operating regime.	ANZECC/ARMCANZ Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCAZ, 2000) Water Quality Protection Guidelines (No. 1-11) (DoW & DoIR, 2000) State Water Quality Management Strategy (ANZECC and ARMCANZ, 2001)
RPS APASA 2021a (Appendix 5)	Discharge Modelling Assessment Fortescue River Outfall, report prepared for CPM Management Pty Ltd, 2021	Delft3D-FLOW hydrodynamic model	Model peer reviewed by Dr Peter Yates (HydroNumerics).

Author/date	Survey/ investigation name	Study area, type, timing	Study standard, guidance and limitations
PSM, 2020 (Appendix 2)	LoM Dewatering Prediction Report	FEFLOW groundwater flow model	Model peer reviewed by A.Knapton (CloudGMS) and adheres to Barnett, B et al 2012 Australian Groundwater Modelling Guidelines
Previously completed work			
Cloud GMS 2017	Sino Iron Expansion Proposal Groundwater Modelling Study	Hydrogeological assessments of the effect of the approved proposal during life of mine and post closure.	Peer reviewed model by H.Middlemis (Hydrogeologic) and model adheres to Barnett, B et al. 2012 Australian Groundwater Modelling Guidelines
RPS APASA 2017	Discharge Modelling Assessment – Fortescue River Outfall	Delft3D-FLOW hydrodynamic model	Model peer reviewed by P.Treloar (Cardno (NSW/ACT) Pty Ltd).
RPS APASA 2016	Cape Preston Pit Water River Discharge Assessment	Nearfield dilution assessment for the discharge of 2 GLpa.	Desktop assessment.
Aquaterra 2009a	Mineralogy Expansion Projects (Stages 3-5) – Hydrogeological assessment	Hydrogeological assessments (prediction of groundwater inflows and drawdown) of Stages 3-5 Mineralogy Expansion Proposal conducted in 2009.	
Aquaterra 2009b	Mineralogy Expansion Projects (Stage 3-5) Surface Water Management	Surface water assessment (including 1 in 100-year ARI flood assessment) of the Fortescue River and Du Boulay Creek floodplain adjacent to the development envelope for the Stages 3-5 Mineralogy Expansion Proposal conducted in 2009	
Aquaterra 2001	Austeel Iron Ore Project Prediction of Groundwater Level Drawdown	Groundwater model of existing approved proposal.	

5.3.1 Climate

The Pilbara bioregion has an arid to tropical climate with average maximum temperatures over 40°C from November to February and an average maximum of 25°C during the winter months (Leighton, 2004; McKenzie et al., 2009).

Annual rainfall across the broader Pilbara region averages approximately 290 mm and is most prevalent over the summer months in association with cyclonic activity to the north and northwest, though annual rainfall is highly variable (McKenzie et al., 2009).

The climate of the Roebourne subregion, in which the mouth of the Fortescue River is located, is defined as arid (semi-desert) tropical with highly variable rainfall and cyclonic activity, primarily over summer (Kendrick & McKenzie, 2001).

Rainfall is episodic and inconsistent with most falls generated severe tropical cyclone activity (in terms of both strength and frequency of occurrence) in the predominant summer months of December to April, with extremely rare occurrences also possible in November and May. Tropical cyclones tend to be most severe in late March and April, when sea surface temperatures typically reach a peak, and they are most frequent in the months of January to March (Preston, 2020). A large percentage of annual rainfall is from Individual events ranging from 50 to 160 mm in a single day and providing an important source of recharge to the water table (PSM, 2020).

Local rainfall data has been collected onsite since August 2006 and from the Bureau of Meteorology (BoM) station at Mardie (Station No. 005008) located approximately 20 km southwest of the approved proposal area. Monthly rainfall and average monthly rainfall during 2014 to April 2020 is presented in Table 5-2. The annual average rainfall for the period 1885 to 2019 from Mardie Station was 272 mm (PSM, 2020).

Rainfall varies widely across catchments in the Pilbara due to spatial variability in rainfall distributions within catchments and sub-catchments. Rainfall gauges at Mardie and the differ outfall for individual episodic events, monthly and annually.

Average annual evaporation is between 3,200 to 3,600 mm and exceeds rainfall in each month highlighting the importance of high rainfall events to recharge of groundwater.

Table 5-2 Sino Iron Project Onsite and Mardie (BoM) Rainfall Statistics Summary

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Sino Iron Project													
2006								0.0	1.8	9.9	0.0	0.4	-
2007	3.8	0.2	54.5	29.6	0.0	0.0	5.0	0.0	0.0	0.1	0.0	0.8	93.9
2008	1.5	92.0	193.9	0.2	16.9	53.2	28.0	1.1	0.0	9.8	3.8	8.4	408.9
2009	90.4	188.8	2.8	0.0	7.0	30.0	2.0	0.0	0.0	0.0	0.0	2.5	323.5
2010	0.5	1.0	4.0	0.3	13.0	0.0	9.0	1.5	14.5	0.0	0.0	38.8	82.5
2011	79.5	316.3	9.8	14.8	47.5	80.8	14.0	0.0	0.0	0.0	6.0	0.0	568.6
2012	89.3	18.8	47.0	1.3	0.0	16.8	0.0	0.3	0.0	0.0	0.0	57.3	230.5
2013	174.8	47.5	0.8	0.0	17.0	159.5	0.0	0.0	0.0	6.8	0.0	45.5	451.8
2014	24.5	4.3	8.3	2.3	43.3	13.0	0.0	0.0	0.5	0.3	0.0	0.0	96.3
2015	0.8	61.5	78.3	15.5	160.8	2.5	3.5	0.0	0.3	0.0	0.0	0.0	323.0
2016	62.0	5.8	0.0	0.0	28.3	158.8	105.3	6.5	1.3	2.0	4.3	25.3	399.3
2017	56.0	251.3	54.8	0.3	0.0	0.3	0.0	1.8	4.0	0.0	0.0	4.8	373.0
2018	9.8	20.0	18.3	0.0	0.0	47.8	0.0	0.5	0.0	0.0	0.0	0.0	96.3
2019	15.5	15.5	16.3	7.0	0.0	16.3	2.8	0.0	0.3	0.0	0.0	19.8	92.8
2020	21.5	66.0	14.3	0.5	37	3.2	9.5	6.3	0.0	0.0	0.0	122.3	280.5
2021	18.5	77.0	31.5	21.5	135.3	15.3	1.0	0.0	0.0	-	-	-	-

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Avg (2006-2021)	43.2	77.7	35.6	6.2	33.7	39.8	12	1.1	1.4	1.9	0.9	21.7	272.9
Mardie													
Avg (1885-2021)	37.9	62.6	48.8	19.5	37.1	37.0	13.7	7.0	1.3	0.8	1.4	9.3	275.4

5.3.1.1 Climate Change

Current trends

Australia's climate has warmed on average by 1.44 ± 0.24 °C since national records began in 1910, leading to an increase in the frequency of extreme heat events.

Rainfall and streamflow have increased across parts of northern Australia since the 1970s.

There has been a decrease in the number of tropical cyclones observed in the Australian region since 1982.

Oceans around Australia are acidifying and have warmed by around 1 °C since 1910, contributing to longer and more frequent marine heatwaves.

Sea levels are rising around Australia, including more frequent extremes, that are increasing the risk of inundation and damage to coastal infrastructure and communities (BOM and CSIRO, 2020).

Future trends

In the coming decades northern Western Australia can expect to experience:

Continued warming, with more extremely hot days and fewer extremely cool days.

More intense short-duration heavy rainfall events throughout the country.

Fewer tropical cyclones, but a greater proportion projected to be of high intensity, with ongoing large variations from year to year.

More frequent, extensive, intense and longer-lasting marine heatwaves leading to increased risk of more frequent and severe bleaching events for coral reefs, including the Great Barrier and Ningaloo reefs.

Continued warming and acidification of its surrounding oceans.

Ongoing sea level rise with potential ice loss from the Antarctic ice sheet suggesting that the upper end of projected global mean sea level rise could be higher than previously assessed (as high as 0.61 to 1.10 m global average by the end of the century for a high emissions pathway, although these changes vary by location).

More frequent extreme sea levels. For most of the Australian coast, extreme sea levels that had a probability of occurring once in a hundred years are projected to become an annual event by the end of this century with lower emissions, and by mid-century for higher emissions.

Projections of Australia's average temperature over the next two decades show:

- Every year is now warmer than the range it would have been in a world without human influence, known as climate change 'emergence'.
- The year 2019 was Australia's hottest year on record, due to the combination of climate variability and long-term warming. This is expected to be an average year in a world where the global mean temperature is 1.5 °C above the pre-industrial baseline period of 1850–1900

(BOM and CSIRO 2020).

The Cape Preston area is therefore likely to experience more intense short duration rainfall events, less but more intense tropical cyclones, temperature increases, sea level rises, marine heatwaves and ocean acidification over the coming decades.

5.3.2 Surface water hydrology

The lower Fortescue River is a major watercourse with a catchment area of 20,000 km^2 (Figure 4). The approved proposal development envelope is located adjacent to the Fortescue River.

The Edwards and Du Boulay Creeks have catchment areas of 210 and 30 km^2, respectively and drain ridges to the east and southeast of the Development Envelope. The creek flow channels are between 5 to 10 m wide with gravel beds and riparian vegetation along the river banks. The Du Boulay Creek is incised in the flood plain of the Fortescue River with the upper western reaches connected via braided river channels. The creeks flow in a north-westerly direction through the Development Envelope to the Fortescue River (Aquaterra 2009b) (PSM, 2020)

The stream flow and flood events on the lower Fortescue River and Du Boulay and Edwards Creeks are important recharge mechanisms for the Lower Fortescue Alluvial Aquifer and alluvium on the broader river delta and floodplain areas (PSM, 2020).

Flow in the lower Fortescue River is episodic. Flooding can extend across a 20 km wide floodplain. Stream flow and residual surface water pools can persist for months after high-rainfall events. (Aquaterra 2009b).

The lower Fortescue River estuary experiences strong tidal influence (spring tidal range of ~4.7 m) that extends approximately 6 km inland. At the mouth of the Fortescue River the channel is in excess of 200 m wide forming an estuarine environment of salt marsh and intertidal flats (PSM, 2020).

Upstream of the estuary the Fortescue River has a well-defined main flow channel, ranging from 4 to 6 m deep and up to 100 m wide. The combination of a wide well-defined channel and high tidal range provides high flow velocities in the river mouth with flows frequently exceeding 0.1 m/s (RPS APASA 2017).

The strong tidal influence means the estuary has a low sediment trapping efficiency with naturally high turbidity and well mixed waters (RPS APASA 2017). In addition to the strong tidal flows, the river mouth also experiences a very high rate of flushing from the discharge of water during the wet season. At the DWER Bilanoo gauging station (~35 km upstream) the long-term mean annual discharge of the river is 305 GL/a and on average more than 90% occurs during the wet season from January to April (DWER, 2019) (Figure 3)

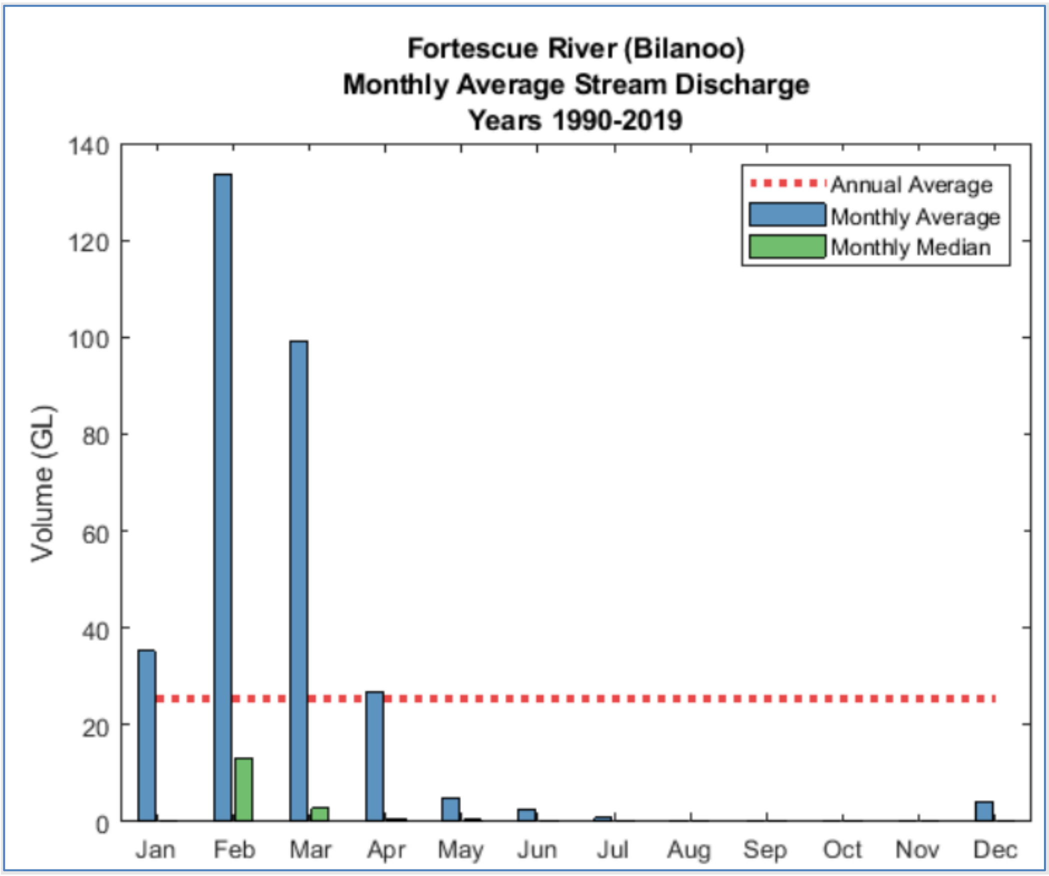
Regional gauged flows provide a subtle indication of potential drying cycles during periods 2002 to 2009 and 2012 to 2019. Drying cycles are likely to be characterised by lower recharge as compared to previous wetter periods and a progressive decline in water table levels (RPS APASA 2017).

A description of the permanent, semi-permanent and intermittent pools of the Fortescue River are outlined in 5.3.2.1.

Baseline surface water quality of the Fortescue River and estuary is presented in Section 5.5.1.2 and Section 6.3.1.

Figure 3 - Measured monthly river discharge at Bilanoo 1990-2019

Data source: (DWER, 2019)



5.3.2.1 River pools

River pools occur within the Lower Fortescue Alluvial Aquifer system where surface water from river flow events collects and/or the river channel intersects the water table (PSM, 2020) (Figure 4).

An assessment of the permanency of river pools was conducted through analysis of satellite imagery (Cloud GMS 2017) and pool and groundwater level data. This assessment identified two permanent pools (Marda and Post Office) (both tidal), seven semi-permanent pools (Tom Bull (tidal), Mungajee, Bilanoo, Stewart, Chuerdoo, Jilan Jilan and one unnamed) and two unnamed intermittent pools.

The interaction between these river pools and groundwater is described (Loomes 2010 and Commander,1993; PSM, 2020) as follows:

- The Fortescue River and its pools are connected to the Lower Fortescue Alluvial Aquifer with the permanence of this connection determined by the elevation of the water table and the bottom of pools.
- Tom Bull Pool and Marda Pool occur in proximity to the mouth of the Fortescue River and DuBoulay River and are inundated by spring tides with the quality of water varying from fresh to saline dependent on transient stream flow and tidal contributions.
- The pools potentially transition from gaining to losing systems seasonally and episodically in response to flooding, water loss by evaporation and transpiration by riparian vegetation.
- During river flow and flood events the groundwater is recharged from stream flow and the water table rises. When the river is in flood connection is enhanced and the pools recharge the Lower Fortescue Alluvial Aquifer.
- During periods of low or no flow groundwater discharges to pools, intermittent pools begin to dry as the water table drops disconnecting from the bottom of semi-permanent pools.
- Drought conditions and a declining groundwater table result in shallower pool depths and disconnection of semipermanent pools from the water table.
- There are no non-tidal permanent pools on Du Boulay Creek and Fortescue River (in the vicinity of the mining leases) and pools in the river upstream of the tidal influence are ephemeral to semi-permanent.

The closest pools to the approved proposal area are Tom Bull Pool, a semi-permanent tidal pool ~2 km west and Mungajee Pool a semi-permanent pool ~3.2 km southwest (Morgan et al, 2009; PSM, 2020). Monitoring has shown that Mungajee Pool experiences dry periods and is likely to be intermittent.

The tidal or intermittent nature of these river pools suggest that groundwater provides a temporary and minor contribution.

Figure 4 Topography and surface hydrology

5.3.2.2 Tidal Systems

Northern sections of the approved proposal area are influenced by tidal inundation. Tidal reaches and associated mangroves extend 3 to 5 km upstream from the mouths of the Fortescue River, and Du Boulay and Edwards creeks. Salt accumulation on the upper tidal reaches is enabled by lower circulation and mixing in tidal reaches, shallow depths to the water table and evaporation-concentration effects. A saltwater interface is known to extend inland toward the existing pit with seawater and hypersaline groundwater present at shallow depths (PSM, 2020).

The presence of hypersaline groundwater upstream of the tidal reaches of the Du Boulay and Edwards creeks reflects groundwater discharge to streams, high evaporation rates and shallow water table depths. Tidal inundation was monitored in Du Boulay Creek during 2016 (Figure 5) and indicated high and low tide elevations between 1.0 to 1.7 m AHD. It is assumed that on the seaward side of the tidal limits, the water table elevations would be influenced by recharge from tides (PSM, 2020).

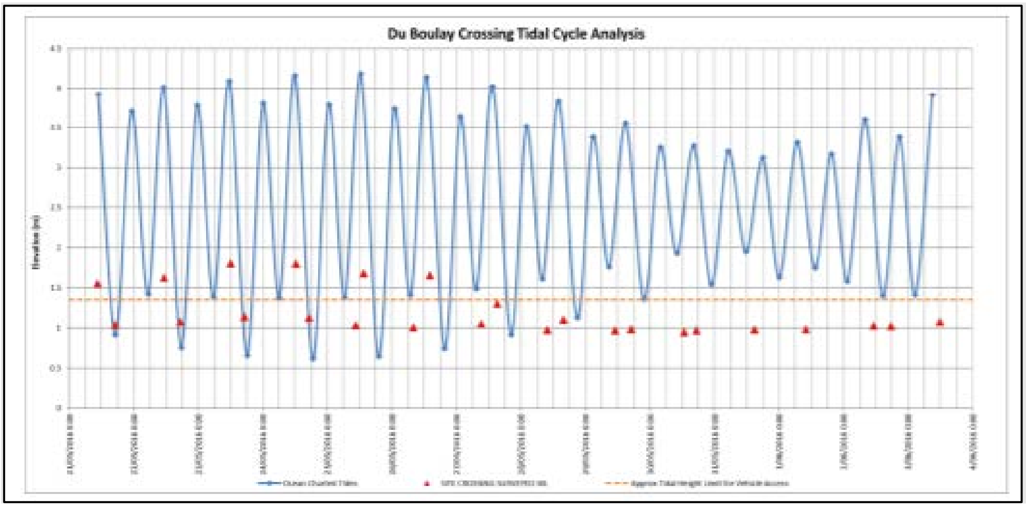


Figure 5 Du Boulay Crossing Tidal Cycle

5.3.3 Geology

The approved proposal is located on the western edge of the Hamersley Province, within the Pilbara region of Western Australia. The regional geology consists of basement rocks predominately of the Proterozoic Brockman Iron Formation that strike north-northeast and dip westerly at approximately 45 degrees. In the west an alluvial sequence on-laps the Brockman Iron Formation.

The mine orebody is held within the Hamersley Basin Joffre Member of the Brockman Iron Formation. Within the Brockman Iron Formation are the Yandicoogina Shale (which overlies the Joffre Member) and the Whaleback Shale and Dales Gorge Member which underlie the Joffre. Beneath the Brockman Iron Formation are the Mt McRae Shale and the Mt Sylvia Formation and the Wittenoom (Dolomite) Formation. Overlying the Brockman Iron formation is the Weeli Wolli Formation. The rocks dip steeply to the west and so become younger from east to west. The sequence is impacted by faulting resulting in some repetition or absence of the units within the stratigraphic sequence. The faults influence the hydrogeology with fractured rocks providing preferred flow paths and enabling deeper penetration of weathering.

The area is intruded by a series of dolerite dykes that strike north northeast, dip steeply eastwards and are typically thin compared with the orebody sequences. Dolerites have also intruded to a lesser extent along an additional southeast to northwest trending fault axis.

Further east lie Archean basalts and volcanic tuffs of the Kylena and Maddina Formations of the Fortescue Group.

The Joffre is oxidized at surface, with oxidation typically penetrating to a depth of 40-50m, deeper in some areas of structures (up to 150m along NE fault), and has enhanced hydraulic conductivity compared with the fresher basement rock below.

To the west of the orebody is an alluvial sequence comprising recent and palaeochannel fill of the Fortescue River Floodplain. The sequence consists of Late Devonian to Cretaceous aged Winning Group sediments of the Carnarvon Basin. The Winning Group onlaps the western edge of the Hamersley Basin consists of the basal Cretaceous Yarraloola Conglomerate, thin expressions of Tertiary Robe Pisolite, the Tertiary Trealla Limestone and finally Quaternary Fortescue River alluvial sediments. These units near the mine unconformably overly the Weeli Wolli Formation basement rocks.

The upper alluvial aquifer is a much more significant aquifer regionally than the orebody aquifer. The alluvial aquifer spans over the Fortescue River delta area across an area of approximately 200km^2 and the orebody aquifer in the mine area is approximately 20km^2 shown in Figure 6.

Groundwater recharge in the area occurs from perennial tidal recharge to alluvial sediments and extension of faults, episodic and seasonal rainfall recharge and transient and perennial recharge, and potentially from water storage nearby the mine pit (TSF, water storage ponds).

Groundwater flow has been changed by dewatering and drawdown; whereby the pit now acts as a large hydraulic sink inducing groundwater flow from all directions; regionally flow is to the northwest towards the ocean.

5.3.4 Groundwater hydrogeology

There are two principal aquifer systems within the larger approved proposal area:

- Superficial aquifer, formed from alluvial sands and gravels including:
  - the Lower Fortescue Alluvial Aquifer
  - Creek-bed gravels and localised incised sand and gravel-filled channels beneath the Du Boulay and Edwards creeks.

- Weathered and fractured rocks of the Hamersley Group including fractured dolomites of the Paraburdoo Member, Wittenoom Formation based on recent discovery.

The superficial aquifer is typically an unconfined or semi-confined aquifer system hosted in alluvial beds beneath the Fortescue River, Du Boulay and Edwards creeks and immediate surrounds. The alluvial beds occur at shallow depths (0 to 40 m) beneath or near current drainage lines. These beds tend to be intermixed between bands of clayey alluvium that limit vertical hydraulic connection between recharge sources and the groundwater environment.

Beneath the Lower Fortescue Alluvial Aquifer is a palaeochannel incised into the underlying basement. The basal portions of the palaeochannel host the widely variable Yarraloola Conglomerate, which forms a local-scale aquifer.

Overlying the Yarraloola Conglomerate are potential confining beds formed by Robe Pisolite, Trealla Limestone and clayey alluvium. Aquifer tests in the Yarraloola Conglomerate indicate the confining beds are leaky, enabling the vertical propagation of drawdown into the underlying bedrock and overlying Lower Fortescue Alluvial Aquifer.

The Quaternary alluvium outside of the Lower Fortescue Alluvial Aquifer is predominantly clayey, described as sandy clays, clays, silty clays with localised calcrete and silcrete cementation. These descriptions reflect an aquitard, with the possibility of local scale minor aquifers where the alluvium is comprised of sand.

The Trealla Limestone and Robe Pisolite are also interpreted as aquitards. The typical basement rock mass units are not aquifers; it is only where the rock mass fabrics have enhanced secondary porosity due to fractures and weathering that preferred flow paths occur as aquifers. At depths below 200 m the fractured rock aquifer tends to close and is characterised by high quality rock mass with limited defects. In June 2019, Mira Geoscience was commissioned to complete a Sub-Audio Magnetics (SAM) survey across northern sections of the pit to identify potential water-bearing faults and structures. The results support transmissive faults and structures north of the pit and provide a blueprint for fault delineation for the conceptual hydrogeological model and predictive model setup (PSM, 2020).

Each aquifer system is summarised in **Table 5-3**.

Table 5-3 Summary of Aquifer Systems

Aquifer System	Stratigraphy	Thickness (m)	Description
Superficial Aquifer	Quaternary Gravel, Sand, Cobble beds	1 to 12	• Well sorted, rounded to sub rounded sands, gravels and cobble beds. Typically intermixed with silty, sandy, clay horizons • Lower Fortescue Alluvial Aquifer
	Local Incised Channels of Quaternary Alluvium	2 to 30	• Creek-bed gravels • Sand and gravel-filled incised channels beneath the Du Boulay and Edwards creeks • Local-scale and discontinuous features which are not mapped.
	Yarraloola Conglomerate	10 - 70	Widely variable lithology and aquifer including conglomerate and conglomeratic sandstone and

Aquifer System	Stratigraphy	Thickness (m)	Description
			clayey to sandy gravel, commonly with silica and iron cementation. Secondary porosity in the form of solution channels and cavities occur in the cementation fabrics.
Fractured Rock Aquifer	Weathered bedrock	5 - 100	Weathered and fractured rocks of the Hammersley Group, including cherty banded iron formation sediments. Characterised by low storage and primary porosity. Increased primary porosity and permeability associated with defects and dolerite sill and dolerite dyke contact zones.
	Fresh bedrock	NA	Fractures associated with faults are known to occur at depth up to about 250 m within fresh bedrocks, including in dolomites of the Wittenoom Formation. For the general fresh rock mass at depths below 200 m, the fractured rock aquifer is characterised by high quality, fresh rock with some defects which enable depressurisation to less than hydrostatic pore pressures. Non-significant aquifer.

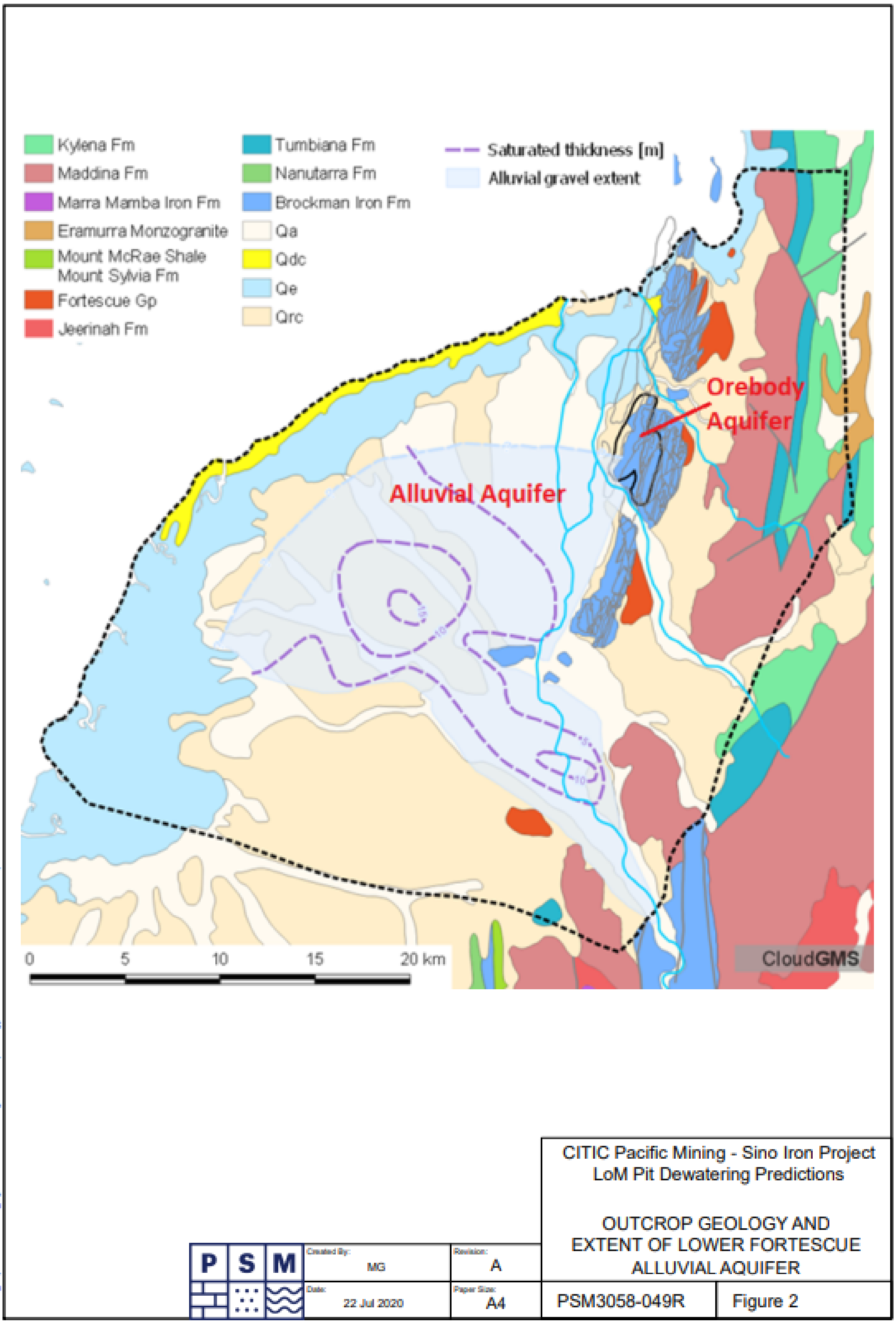


Figure 6 Outcrop geology and extent of lower Fortescue Alluvial Aquifer

5.4 Groundwater abstraction and management

5.4.1 Background

Groundwater interception and abstraction for the approved proposal has been primarily managed via in pit sump-pumping from the pit-floor with the ex-pit production bores delivering lesser localised dewatering benefits.

Sump pumping has not allowed dewatering of the pit ahead of mining resulting in groundwater on the pit floor causing adverse impacts on mining. It is recognised that as the pit deepens, the risk of increased groundwater presence on the pit floor increases, creating a clear driver for active pit dewatering (PSM, 2020).

Mining has generally experienced greater groundwater inflows and higher abstraction demands than expected from hydrogeology assessments and predictive models (Table 5-4). The high salinity (TDS) of groundwater intercepted in the pit to date is thought to be due to a high percentage of recharge from stream flow and tidal sources (PSM, 2020).

The proponent has recently implemented initiatives to facilitate more proactive dewatering including:

- 2020 – Drilling targeting fault structures and associated fractures in the Wittenoom Formation on the northern pit crest of the East Pit. Two new high-yielding production bores were installed and will be commissioned in 2022 (Figure 7).
- 2019 - Commissioning of Western Production Bores Figure 7) located on the western pit crest to manage potential inflows from the western superficial aquifer and fractured bedrock aquifer.
- 2019 - Commissioning of East Pit Production Bores (
- Figure 7) located on the northern pit crest to target the fractured rock bedrock aquifer.
- 2018 - Drilling of depressurisation drain holes on the east pit foot wall to reduce pore pressures behind the pit face

Current approved groundwater abstraction volumes are not expected to allow for dewatering in advance of mining over the LoM. The proponent has undertaken further hydrogeological investigations and modelling to better predict the groundwater abstraction volumes that are likely to be required to facilitate dry, safe mining conditions (PSM, 2020). These investigations and modelling are presented in Sections 5.4.2 and 5.4.3.4.

Table 5-4 Annual abstraction volumes 2010 – 2021

Year	Groundwater Abstraction (GL/annum				Sump Contribution (%)	Total Abstraction (GL)
	Fractured Rock Dewatering Bores	Western Bore field	Total Bores	Total Sumps		
2010	1.4	0.1	1.5	0.1	6	1.6
2011	1.1	0.1	1.2	0.4	23	1.6
2012	0.7	0.1	0.8	1.2	59	2.1
2013	0.2	0.1	0.3	2.8	91	3.1
2014	0.1	0.1	0.2	3.0	93	3.2
2015	0.1	0.1	0.2	3.3	93	3.6
2016	0.2	0.1	0.3	3.6	92	3.9
2017	0.6	0.2	0.8	3.8	84	4.5
2018	1.0	0.1	1.13	4.7	81	5.8
2019	1.1	0.6	1.8	4.8	72	6.6
2020	1.3	0.1	1.4	6.7	82	8.2
2021 YTD (Nov)	**1.0**	**0**	**1.0**	**6.4**	**86**	**7.4**

5.4.2 Approved groundwater drawdown

The existing approved proposal includes dewatering to allow mining to a depth of 400 m. Approval was granted on 18 July 2018 for additional abstraction of groundwater for mine pit dewatering to up to 12 GL/a. This approval was based on updated hydrogeological modelling that predicted the extent of groundwater drawdown at 5 m, 1 m and 0.5 m to be at approximately 2 km, 5 km and 7 km respectively from the mine pit. The 5 m drawdown contour being almost entirely within the disturbance footprint (Figure 8).

Groundwater drawdown was determined unlikely to have a significant impact on high quality GDE, tidal pools or other groundwater users.

Dewatering of groundwater has been conducted to support the existing approved proposal and is subject to a licence issued by the DWER under the RIWI Act that specifies the maximum dewatering rate and includes conditions for monitoring. A Groundwater Licence Operating Strategy has been prepared and approved by DWER with reporting of abstraction volumes and monitoring results annually.

Based on data collected during current operations an update to the hydrogeological model was completed in 2020 and included updates to the recharge assumptions including tidal sources.

Figure 7 Groundwater production bores

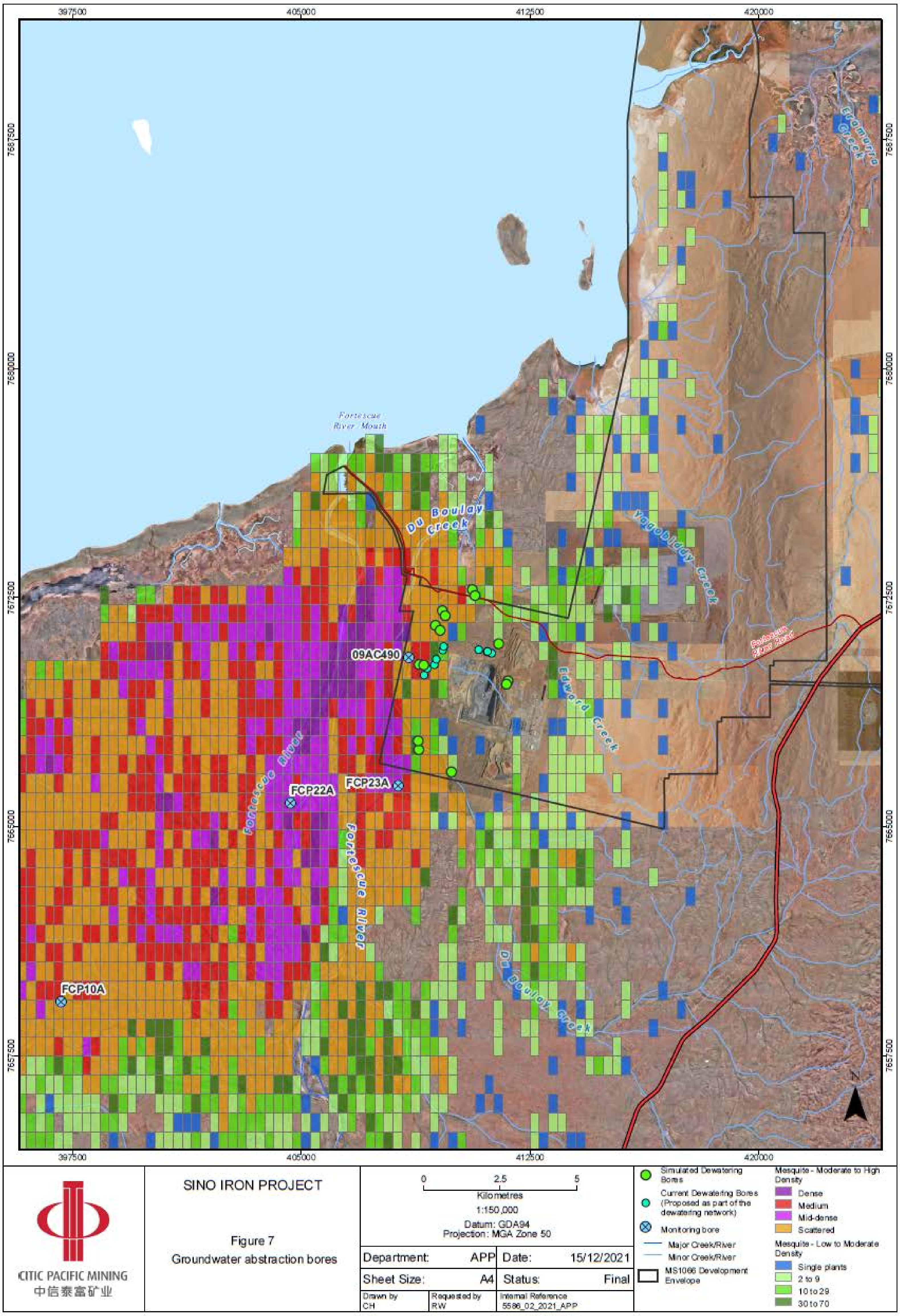
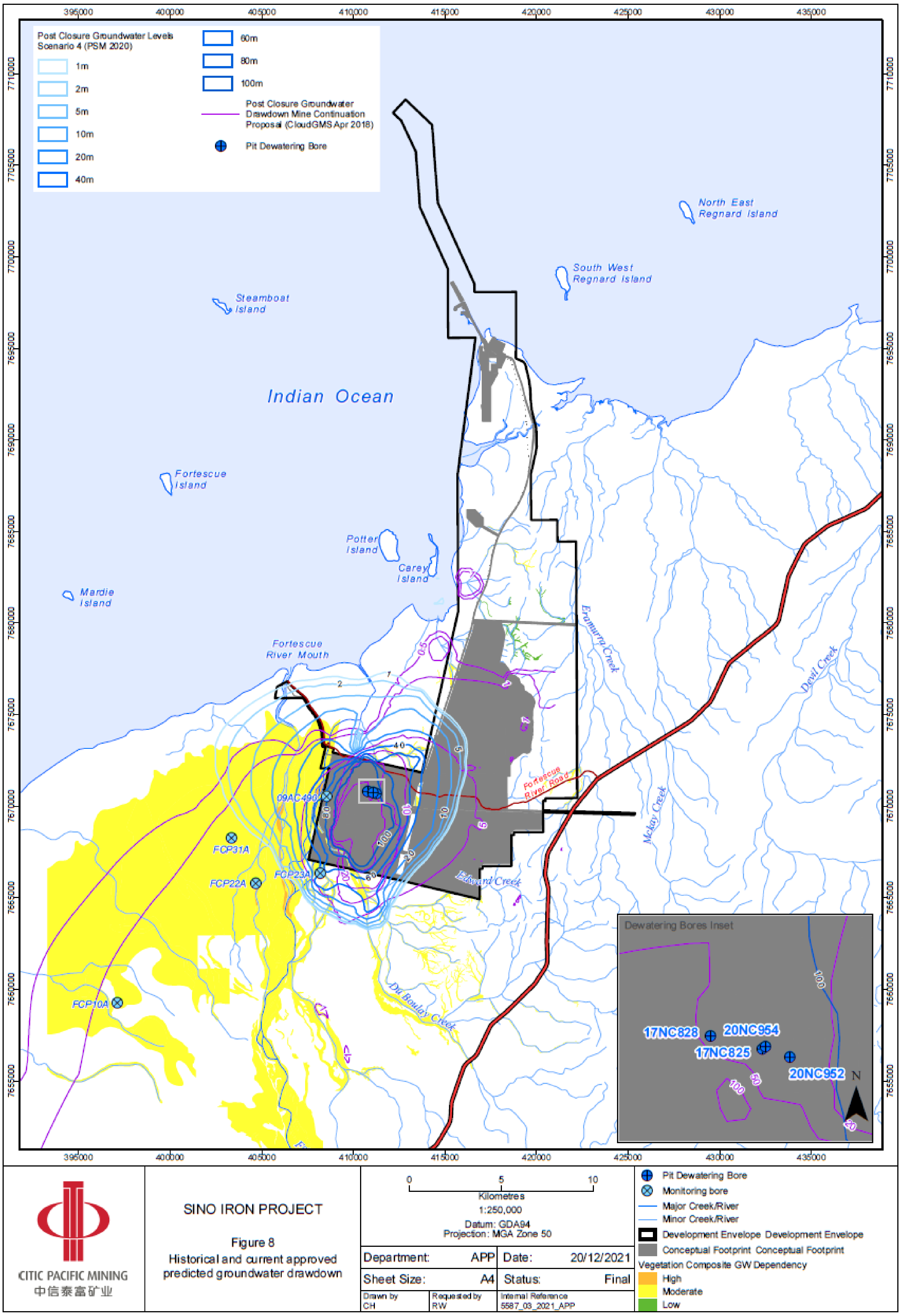


Figure 8 Historical and current approved predicted groundwater drawdown



5.4.3 Revised Proposal

5.4.3.1 Hydrogeological model

A groundwater model has been updated (Appendix 2) with an improved conceptual understanding of the hydrogeology; the refinement of the conceptual understanding is fundamental to the groundwater model providing a reasonable representation of the project setting and the pit dewatering demands. This area of understanding is fundamental to the predictions and is under continual development and improvements further to continued data collection as mining progresses.

The groundwater model contains many assumptions, and one of the most significant assumptions is the recharge mechanisms around the faults and the tidal flats. Due to the relatively early stage in mining and complexity of the aquifer/recharge systems, these assumptions are estimated and will be better-informed as the aquifer is stressed over time.

5.4.3.2 Modelled dewatering strategies

Three pit dewatering strategies were modelled:

- No Production Bores: Sump-pumping only, with sumps progressively adjusted to lower mining bench elevations;
- Production Bores A: Sump pumping with a combination of production bores on faults and existing production bores. Production bores on faults and confluences of faults (preferred option); and
- Production Bores B: Sump pumping with a combination of production bores on faults with pumping (at seepage faces).

All predictions show there is a balance between production bore and sump-pumping abstraction.

The no intervention - sump-pumping - strategy intercepts the least inflows but does not enable adequate or advance pit dewatering for mining to proceed in dry, safe conditions.

In all strategies involving production bores the cumulative abstraction volumes are greater, as production bores induce a broader spread of drawdown, with the greatest abstraction volumes aligned to strategies that promote the most advance mine pit dewatering (PSM, 2020).

5.4.3.3 Model scenarios and predicted dewatering strategy

Table 5-5 outlines the four scenarios considered in the predictive modelling.

Table 5-5 Modelled scenarios including parameterisation and bore scenarios

Scenario No.	Scenario	Parameterisation	Bore scenario
1	Parameterisation A + No Production Bores	Parameterisation A Base case geological block model	'No Production Bores' case: Sump-pumping only, with sumps progressively adjusted to

Scenario No.	Scenario	Parameterisation	Bore scenario
		Faults extended to ocean and constant head recharge boundaries along northern model extent	lower mining bench elevations
2	Parameterisation A + Production Bores A		'Production Bores A' case: Combination of production bores and faults and existing production bores. Production bores on faults and confluences of faults
3	Parameterisation A + Production Bores B		Production Bores B case: Production bores on faults with pumping (as seepage faces).
4	Parameterisation B + Production Bores B	Parameterisation B Decreased hydraulic conductivity for Yarraloola Conglomerate and decreased porosity for alluvium, Trealla Limestone and Yarraloola Conglomerate. Tidal reach reduced to an area near the pit Faults are limited to the area surrounding the pit and do not extend to the northern model extent	

Annual mass balance calculations were undertaken for the period 2016 to 2061 to characterise the location of ground water abstraction (sumps, production bores on structure and existing production bores) and contributions from rainfall recharge, and tidal and seashore recharge sources (PSM, 2020).

Predicted source contributions are summarised in Table 5-6 for Scenarios 2, 3, and 4 showing selected annual snapshots of the comparative percentage contributions from rainfall recharge, tidal reaches and the ocean. Predicted comparative source contributions are detailed in Table 5-7.

The comparative recharge contributions from the tidal creeks highlights Scenario 4 as having more dominant tidal creek contributions and higher inflows to pit dewatering. In the other scenarios, the recharge contributions from tidal creeks are not significant.

Table 5-6 Predicted Source Contributions - Scenarios 2, 3 and 4

Year	Source Contributions (GL/annum)					
	Total inflows to pit sumps and bores	Rainfall recharge	Seawater		Tidal Reach	
			Inflow	Outflow	Inflow	Outflow
Scenario 2						
2016	3.3	13.3	0.4	1.3	0.5	1.7
2018	6.2	1.5	0.4	1.2	0.7	1.0
2020	8.1	8.5	0.6	1.4	1.1	0.6
2030	13.3	8.4	3.8	1.3	1.8	0.0
2040	14.3	8.4	5.1	1.4	1.8	0.0
2050	14.3	8.3	5.8	1.5	1.8	0.0
2061	15.3	8.4	6.1	1.5	1.8	0.0
Scenario 3						
2016	3.3	13.3	0.4	1.3	0.5	1.7
2018	6.2	1.5	0.4	1.2	0.7	1.0
2020	8.2	8.5	0.6	1.4	1.1	0.9
2030	17.3	8.4	6.7	1.1	1.8	0.0
2050	15.8	8.3	7.5	1.1	1.8	0.0
2061	16.0	8.4	7.4	1.1	1.9	0.0
Scenario 4						
2016	3.6	13.3	0	2.7	0.1	0
2018	5.3	1.5	0	2.5	1.0	0
2020	6.6	8.5	0.1	2.4	2.3	0.0
2030	19.9	8.4	1.7	2.0	12.4	0.0
2040	20.1	8.4	1.7	2.1	12.4	0.0
2050	20.1	8.3	1.7	2.2	12.4	0.0
2061	20.4	8.4	1.7	2.1	12.4	0.0

Table 5-7 Predicted Comparative Source Contributions (%), Scenarios 2,3 & 4

Year	Source Contributions (percentage)			
	Total inflows to pit sumps and bores	Rainfall recharge	Seawater	Tidal Reach
Scenario 2				
2020	8.1	100	0	0
2030	13.3	63	23	14
2040	14.3	59	29	13
2050	14.3	58	29	13
2061	15.3	55	33	12
Scenario 3				

Year	Source Contributions (percentage)			
	Total inflows to pit sumps and bores	Rainfall recharge	Seawater	Tidal Reach
2020	8.2	100	0	0
2030	17.3	55	36	9
2040	16.8	54	36	9
2050	15.8	55	34	10
2061	16.0	53	35	12
Scenario 4				
2020	6.6	100	0	0
2030	19.9	42	0	58
2040	20.1	42	0	58
2050	20.1	41	0	59
2061	20.4	41	0	59

Predicted annual pit dewatering abstraction volumes to 2025 and in subsequent 5-year annual snapshots from 2030 to 2061 are described in Table 5-8 for Scenario 1 through Scenario 4. The short-term peaks in predicted abstractions are impractical in pit dewatering and groundwater management design and therefore have been smoothed and are presented in Table 5-9 (differences shown in red) to lower rates sustained longer-term. Comparative smoothed pit dewatering abstraction rates are shown in Figure 9.

Table 5-8 Predicted annual pit dewatering abstraction volumes (GL/a)

Year	Flows (GL/a)									
	Scenario 1	Scenario 2			Scenario 3			Scenario 4		
	Pit sumps only	Pit sumps	Prod. Bores	Total inflows	Pit sumps	Prod. Bores	Total inflows	Pit sumps	Prod. Bores	Total inflows
2016	3.2	3.3	0.0	3.3	3.3	0.0	3.3	3.6	0.0	3.6
2017	6.7	7.0	0.0	7.0	7.0	0.0	7.0	4.7	0.0	4.7
2018	5.4	6.2	0.0	6.2	6.2	0.0	6.2	5.3	0.0	5.3
2019	6.0	6.4	2.1	8.5	6.4	2.1	8.5	3.6	2.1	5.7
2020	10.2	6.6	1.6	8.1	6.6	1.6	8.2	5.0	1.6	6.6
2021	8.1	6.9	2.1	9.0	4.4	7.8	12.2	3.1	6.1	9.2
2022	8.3	5.4	10.6	16.0	0.3	43.5	43.8	0.0	31.5	31.5
2023	13.1	5.5	10.6	16.1	0.1	25.2	25.3	0.0	24.0	24.0
2024	8.9	6.1	10.7	16.8	0.5	21.0	21.5	0.2	21.8	22.0
2025	8.7	3.8	10.4	14.2	0.3	19.4	19.7	0.1	20.5	20.6
2030	8.0	2.9	10.4	13.3	0.2	17.1	17.3	0.1	19.8	19.9
2035	10.3	4.0	9.9	14.0	0.2	16.4	16.6	0.1	20.3	20.4
2040	11.6	4.3	10.0	14.3	0.3	16.5	16.8	0.2	20.0	20.1
2045	12.2	5.2	9.3	14.6	1.2	15.0	16.2	1.1	18.7	19.8
2050	11.9	5.0	9.3	14.3	1.5	14.3	15.8	1.5	18.6	20.1
2055	12.0	4.9	9.3	14.2	1.4	14.2	15.6	1.5	18.9	20.4

Year	Flows (GL/a)									
	Scenario 1	Scenario 2			Scenario 3			Scenario 4		
	Pit sumps only	Pit sumps	Prod. Bores	Total inflows	Pit sumps	Prod. Bores	Total inflows	Pit sumps	Prod. Bores	Total inflows
2061	14.0	6.0	9.3	15.3	1.7	14.3	16.0	1.8	18.6	20.4

Table 5-9 Conceptual Pit Dewatering Strategy Abstraction (smoothed) GL/a

Year	Flows (GL/a)									
	Scenario 1	Scenario 2			Scenario 3			Scenario 4		
	Pit sumps only	Pit sumps	Prod. Bores	Total inflows	Pit sumps	Prod. Bores	Total inflows	Pit sumps	Prod. Bores	Total inflows
2016	3.2	3.3	0.0	3.3	3.3	0.0	3.3	3.6	0.0	3.6
2017	6.7	7.0	0.0	7.0	7.0	0.0	7.0	4.7	0.0	4.7
2018	5.4	6.2	0.0	6.2	6.2	0.0	6.2	5.3	0.0	5.3
2019	6.0	6.4	2.1	8.5	6.4	2.1	8.5	3.6	2.1	5.7
2020	7.2	6.6	1.6	8.1	6.6	1.6	8.2	5.0	1.6	6.6
2021	8.2	6.9	2.1	9.0	4.4	7.8	12.2	3.1	6.1	9.2
2022	9	5.4	10.6	16.0	0.3	16	16.3	0.0	16	16
2023	9.5	5.5	10.6	16.1	0.1	22	22.1	0.0	24.0	24.2
2024	10.1	6.1	10.7	16.8	0.5	22	22.5	0.2	24.0	24.2
2025	10.3	3.8	10.4	14.2	0.3	22.0	22.3	0.1	25.0	25.1
2030	10.5	2.9	10.4	13.3	0.2	22.0	22.2	0.1	24.0	24.1
2035	10.8	4.0	9.9	14.0	0.2	22.0	22.2	0.1	24.0	24.1
2040	11.6	4.3	10.0	14.3	0.3	22.0	22.3	0.2	21.0	21.2
2045	12.2	5.2	9.3	14.6	1.2	22.0	23.2	1.1	18.7	19.8
2050	11.9	5.0	9.3	14.3	1.5	16	17.5	1.5	18.6	20.1
2055	12.0	4.9	9.3	14.2	1.4	15	16.4	1.5	18.9	20.4
2061	14.0	6.0	9.3	15.3	1.7	15	16.7	1.8	18.6	20.4

Figure 9 indicates incremental increases in future abstraction of 6 GL/decade.

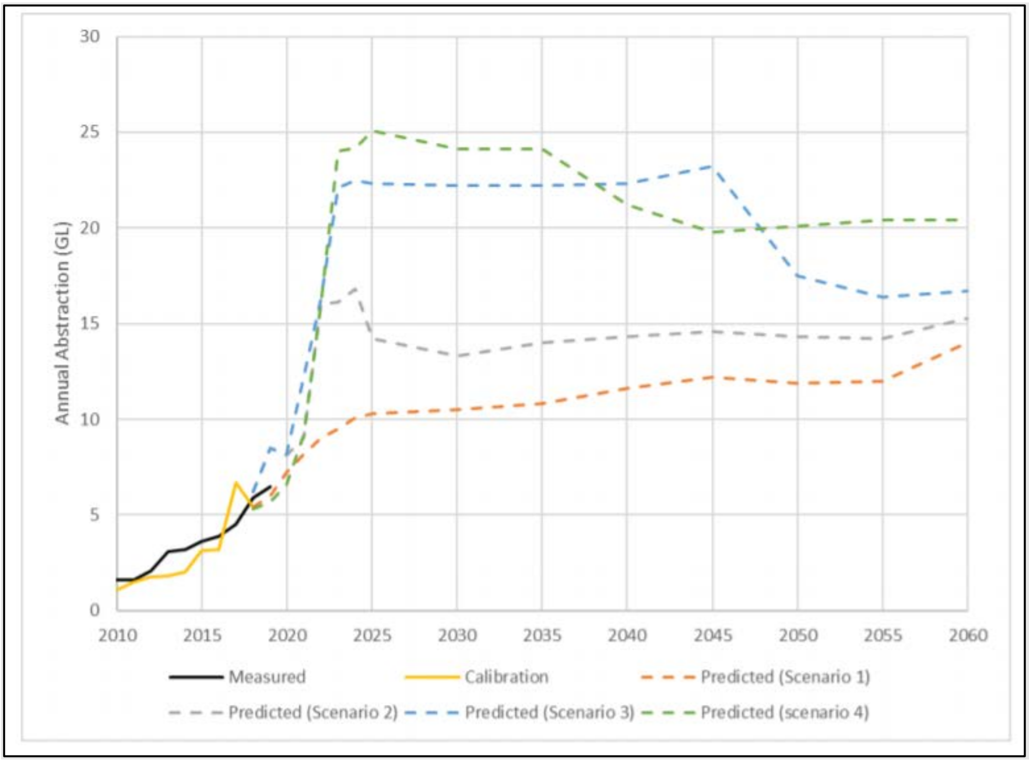


Figure 9 Observed, Simulated & Smoothed Predicted Abstraction 2010-2061

The model predicts a peak in sump-pumping and production bore pit dewatering abstraction in 2022 as increasing numbers of pit-perimeter production bores are commissioned. Predicted smoothed peak abstraction rates shown in Figure 9 are summarised as follows:

- Scenario 1 – 14.0 GL/annum in 2061 - intercepts the least inflows but does not enable pit dewatering in advance of mining
- Scenario 2 - reasonably consistent rates from 13.3 to 16.8 GL/annum from 2022 to 2061
- Scenario 3 – 22.1 to 23.2 GL/annum range of abstraction rates from 2022 to 2045
- Scenario 4 – 19.8 to 25.1 GL/annum range of abstraction rates from 2022 to 2061.

Scenarios 2, 3 and 4, cumulative abstraction volumes are greater as the use of production bores induces a broader spread of drawdown and steepens hydraulic gradients from the tidal and ocean recharge zones.

Contributions from tidal reaches and seawater sources vary dependent on simulated fault zones and boundary conditions. In scenarios 2 and 3, faults extend north from the pit and intersect the Indian Ocean with seawater and tidal reach contributions ranging from 23 to 41 per cent and 10 to 14 per cent, respectively. Scenario 4 has enhanced fault connection to tidal creeks with predicted future tidal contributions ranging from 58 to 59 per cent, with no seawater contribution.

Circumstances where high volumes of water are available from tidal creeks or the Indian Ocean and the available water is strongly connected to preferred flow paths may result in higher inflow rates than predicted (PSM, 2020).

Whilst scenario 4 induces higher abstraction volumes and provides the most advance dewatering ahead of mining, from a practical operational perspective and based on current abstraction management, a situation in the range of Scenario 2 to Scenario 4 is the most likely arrangement for future pit dewatering.

5.4.3.4 Predicted Groundwater drawdown for the revised proposal

The increased abstraction rate will increase the extent of dewatering contours at the end of mining (2061) in comparison to the projected contours for the current approved 12 GL/a as shown in shown in Figure 10.

The primary indicator of the drawdown impact is the groundwater dependent vegetation (GDV), which is discussed further in Section 9.3.3. This is based on the outcomes of the risk assessment undertaken for the approved proposal, informed by groundwater drawdown modelling, vegetation mapping and knowledge of species' ecological water requirements, that indicates the loss of GDV is expected where groundwater drawdown exceeds 5 m.

The increased abstraction rate will increase the extent of the predicted dewatering contours at the end of mining such that the 5 m predicted contour will, at its furthest, extend 6.5km from the pit crest (Figure 11). As detailed in Figure 11, whilst the 5 m contour will extend further west compared to the original MS635 model (Aquaterra 2001) and revised MS1066 model (CloudGMS 2017), it will be in an area that is subject to seasonally highly variable groundwater levels from flows in the Fortescue River. Fluctuations of up to 6 m having been recorded in some bores located close to the Fortescue River. The impact of increased extent of dewatering is therefore not considered different from the originally assessed impacts of groundwater abstraction.

Drawdown at sensitive locations including regional bores, tidal pools, GDE and other user bores are described in Section 5.4.3.5 to Section 5.4.3.8.

Figure 10: Post closure groundwater levels compared to approved levels

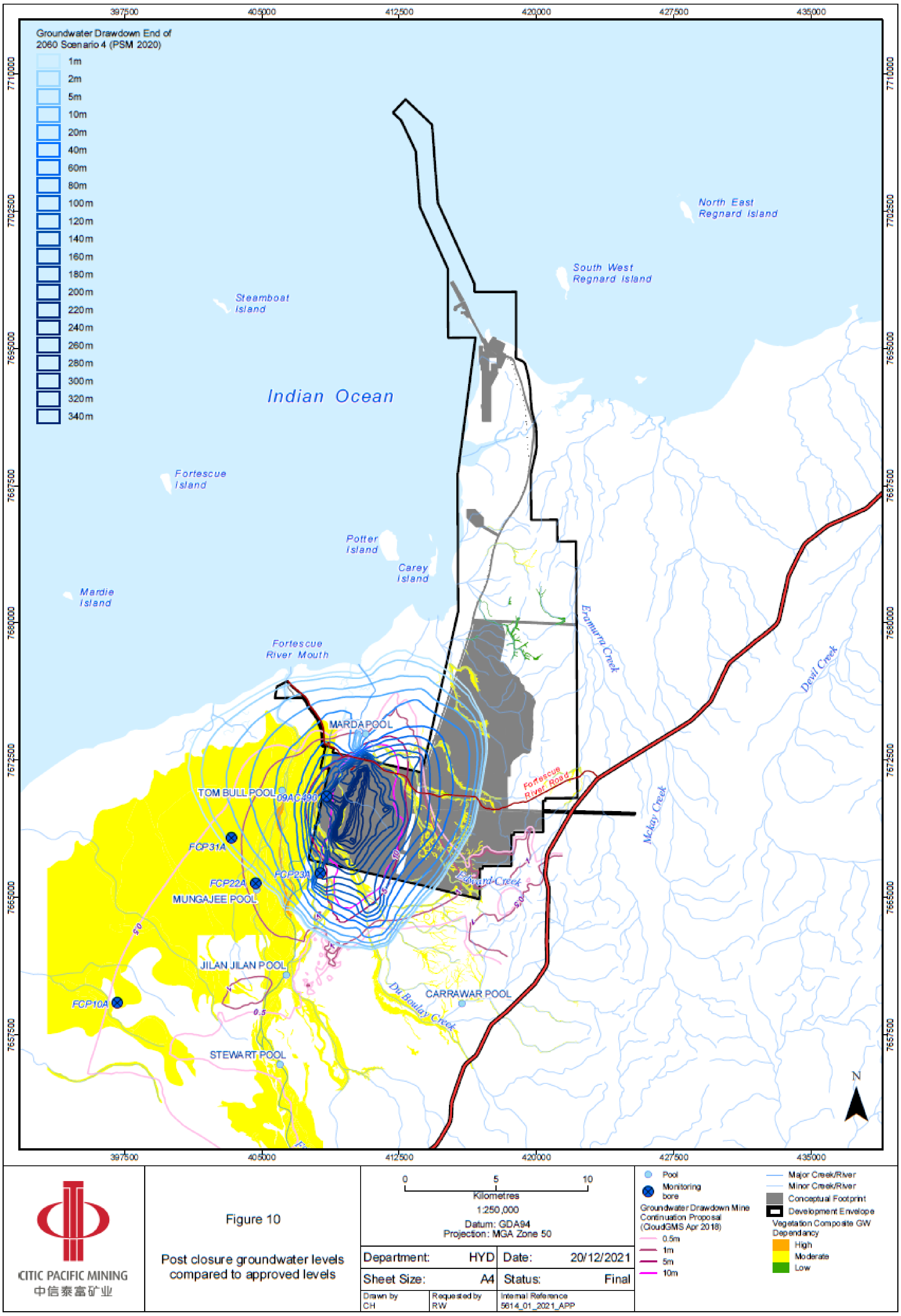
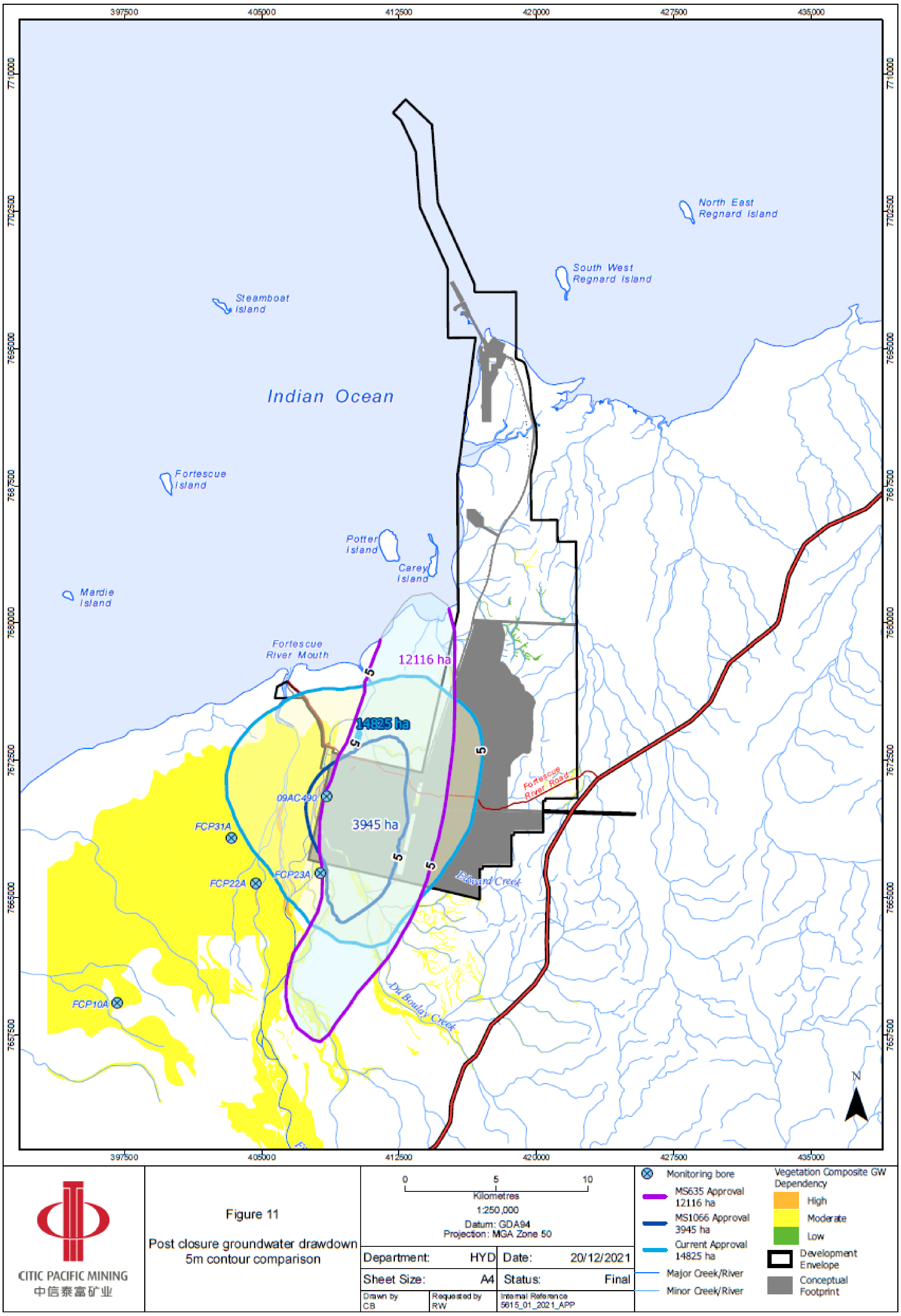


Figure 11: Post closure groundwater drawdown 5 m contour comparison



5.4.3.5 Predicted Changes in Regional drawdown

Of the key regional reference monitoring bores only FCP31A is within the predicted drawdown extent. Predicted drawdown at FCP31A is presented in Figure 12 and Figure 13 for Scenarios 2, and 4, respectively.

Scenario 4 shows initial drawdown then stabilises by 2025 whilst Scenario 2 shows longer term drawdown. The difference in drawdown relates to the larger recharge from tidal sources in Scenario 4 that offset the drawdown from pit dewatering from 2025 onwards. This is most apparent at bore FCP31A and at Marda Pool (Figure 12 and Figure 13) (PSM, 2020).

The predicted drawdown for both scenarios is presented in Table 5-10 and Figure 12 and Figure 13 and indicates that the change in drawdown at monitoring bore FCP31A is greatest under Scenario 4 at ~3.5 m during mining operations and stabilising to <1 m post closure.

Table 5-10 Predicted drawdown for regional reference monitoring bores

Bore	Predicted change from Current	
	LoM	Steady-state post closure
Scenario 2		
FCP31A	Decline by ~2.5 m	Decline by ~1 m
Scenario 4		
FCP31A	Decline by ~3.5 m	<1 m drawdown

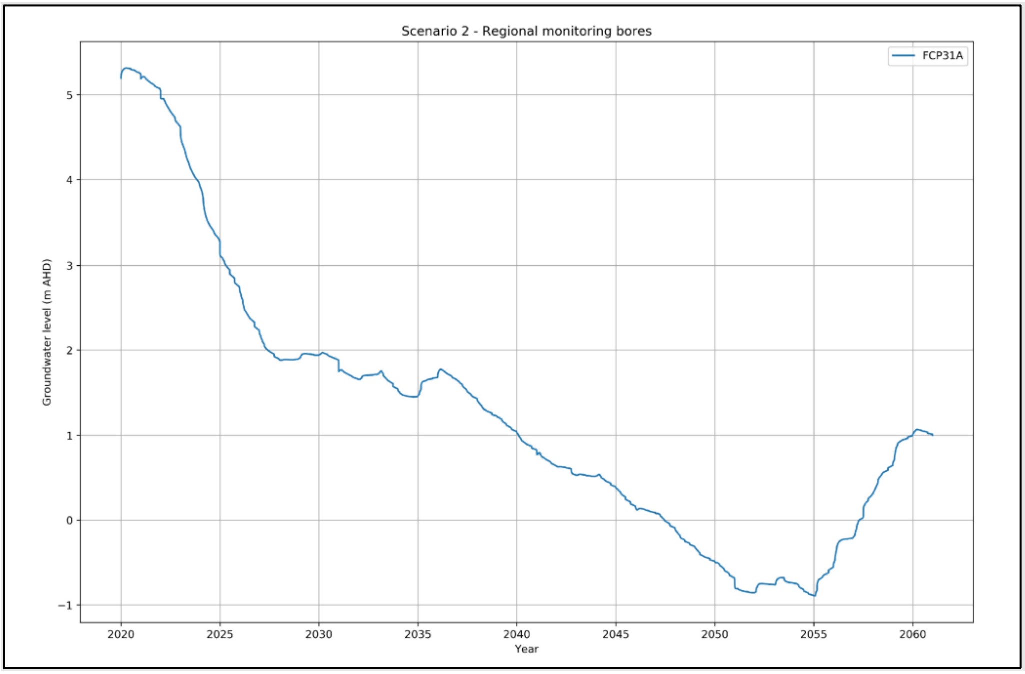


Figure 12 Scenario 2 regional bore hydrograph

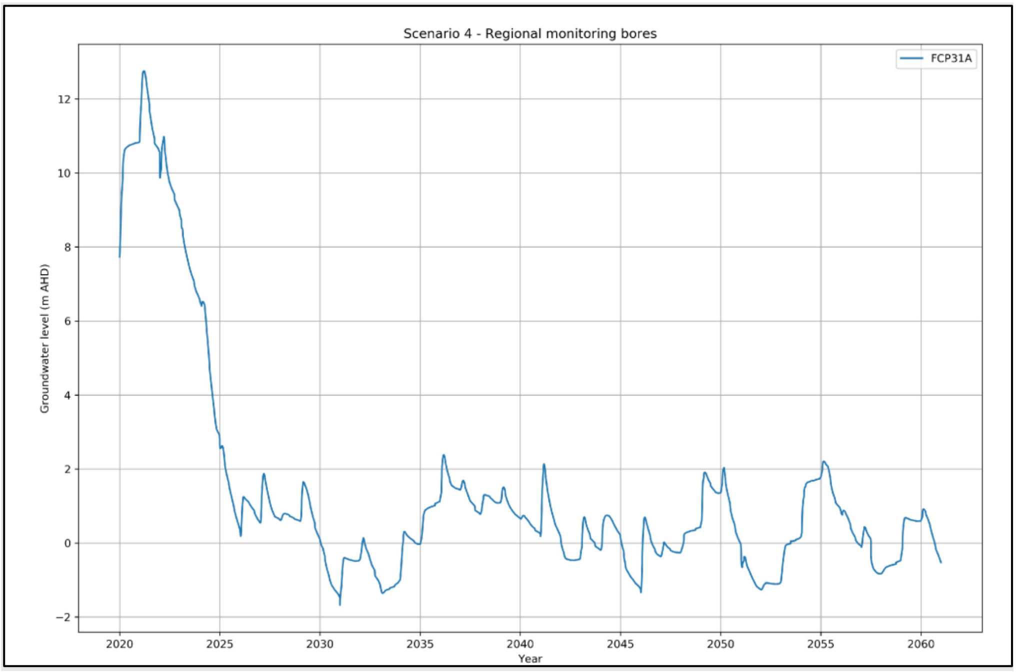


Figure 13 Scenario 4 regional bore hydrograph

5.4.3.6 GDE Monitoring Bores

The predicted change in drawdown at GDE monitoring bores (Figure 14) are presented in Figure 15 and Figure 16 and Table 5-11. Differences between the scenarios are based on the different recharge source assumptions (PSM, 2020).

Scenario 2 shows a gradual decline in the groundwater over the duration of mining with maximum drawdown reached by 2050, whilst Scenario 4 shows an initial rapid decline that stabilises post closure. Whilst the groundwater drawdown for both scenarios at the majority of bores will increase significantly both during operations and post closure, as compared to the current state, this does not necessarily equate to an overall increase in impacts to GDV health. A comprehensive assessment of impacts to GDE is presented in Section 9.

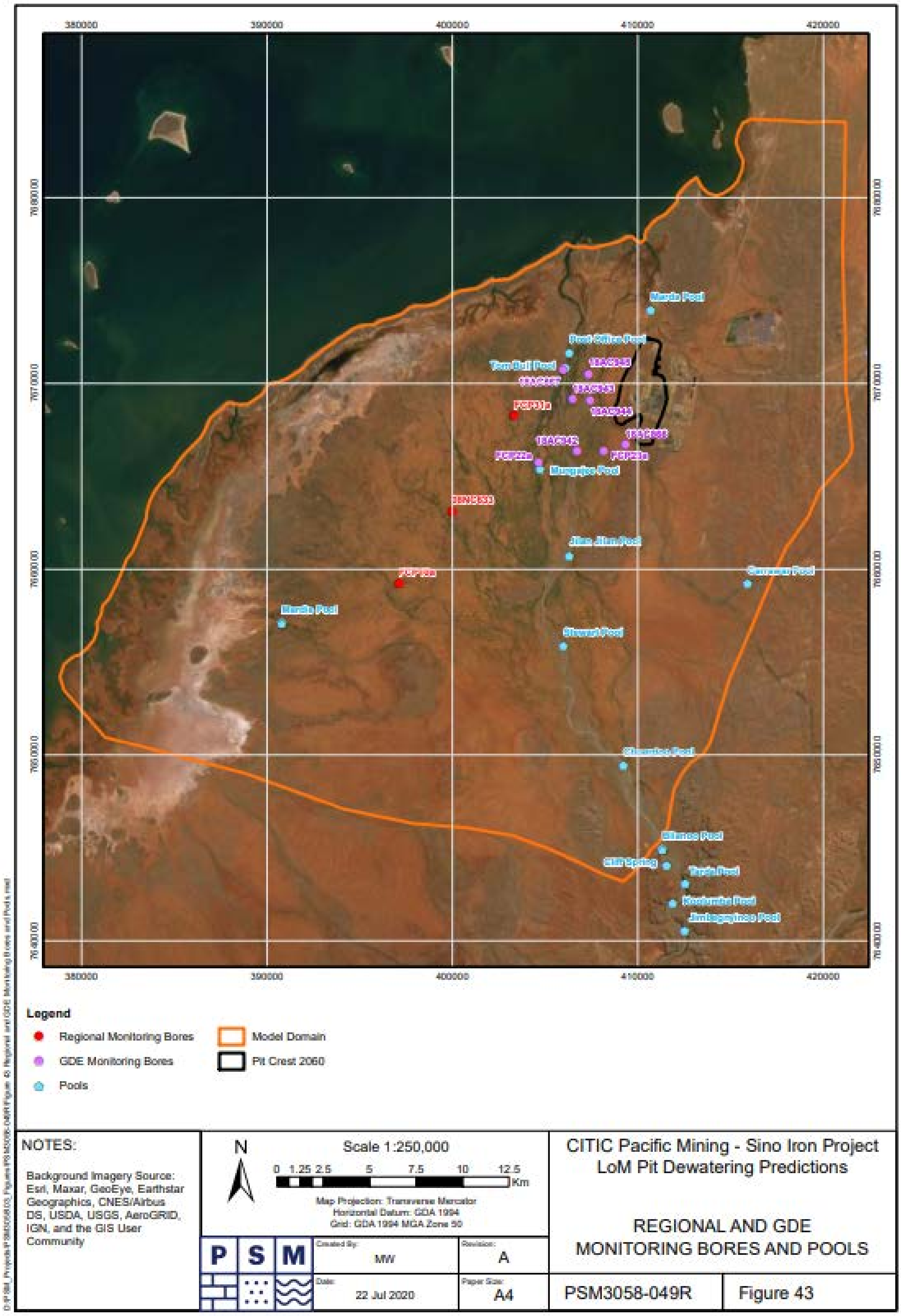


Figure 14 Regional and GDE monitoring bores and pools

Table 5-11 Predicted groundwater head change for GDE Monitoring Bores

Bore	Predicted change from current	
	LoM	Steady-state post-closure
Scenario 2		
FCP22A	Decline by ~4 m	<1 m drawdown
FCP23A	Decline by ~85 m	Decline by ~54 m
18AC866	Decline by ~125 m	Decline by ~130 m
18AC867	Decline by ~16 m	Decline by ~14 m
18AC942	Decline by ~13 m	Decline by ~8 m
18AC943	Decline by ~17 m	Decline by ~13 m
18AC944	Decline by ~57 m	Decline by ~41 m
18AC945	Decline by ~42 m	Decline by ~35 m
Scenario 4		
FCP22A	Decline by ~4 m	<1 m drawdown
FCP23A	Decline by ~120 m	Decline by ~50 m
18AC866	Decline by ~170 m	Decline by ~67 m
18AC867	Decline by ~21 m	Decline by ~12 m
18AC942	Decline by ~20 m	Decline by ~7 m
18AC943	Decline by ~22 m	Decline by ~11 m
18AC944	Decline by ~82 m	Decline by ~40 m
18AC945	Decline by ~67 m	Decline by ~34 m

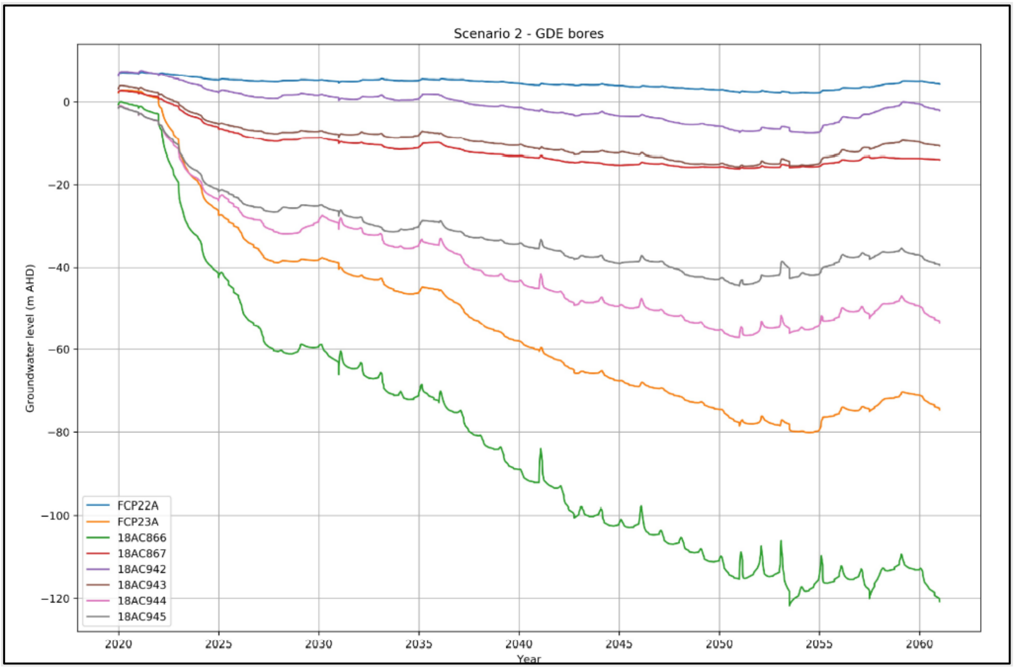


Figure 15 Scenario 2 GDE hydrograph

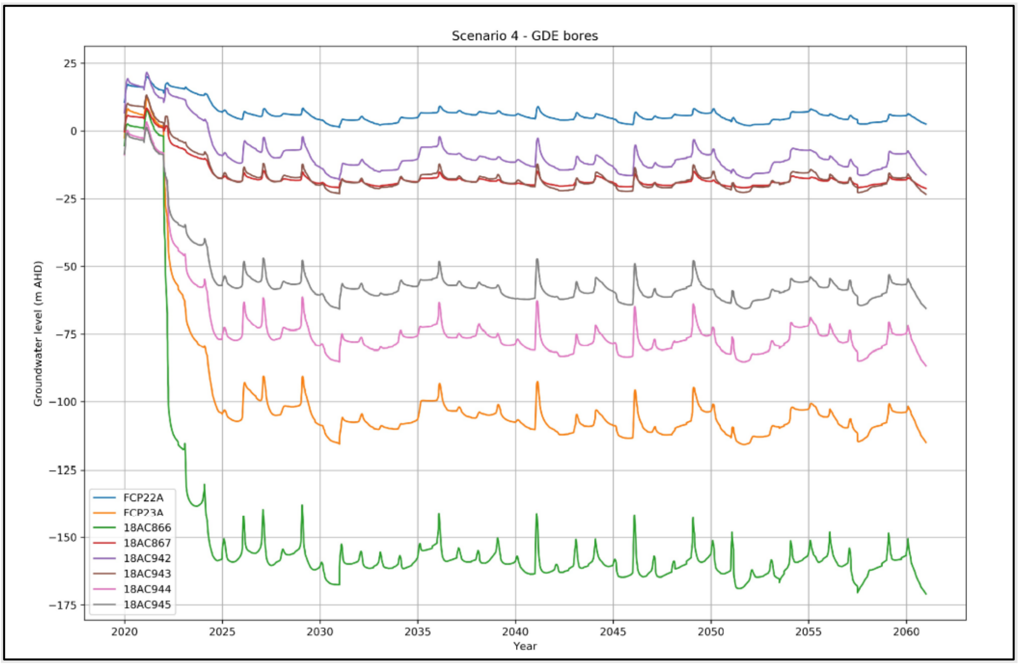


Figure 16 Scenario 4 GDE Hydrograph

5.4.3.7 Tidal and River Pools

The locations of tidal and river pools in the study area are shown Figure 14. The estimated drawdown extent is presented in Figure 17 and Figure 18 for Scenario 2 and 4, respectively. The inferred and predicted classification of these pools in terms of their connectedness with groundwater are summarised in Table 5-12. These pools currently have little or intermittent dependence on groundwater and are strongly influenced by tides. Whilst both scenarios show a decline in groundwater over the life of mine, the pools are not expected to be significantly affected by the decrease in local groundwater heads during and post-mining (PSM, 2020).

Table 5-12 Current and change classification of river pools

Pool	System classification		
	Current	LoM	Steady-state post-closure
Marda	(Tidal)	Disconnected Losing	Disconnected Losing
Post Office	(Tidal; permanent)	Disconnected Losing	Disconnected Losing
Tom Bull	(Tidal; permanent)	Disconnected Losing	Disconnected Losing
Mungajee	Disconnected Losing (Not tidal; intermittent)	Disconnected Losing	Transition (<1 m drawdown)

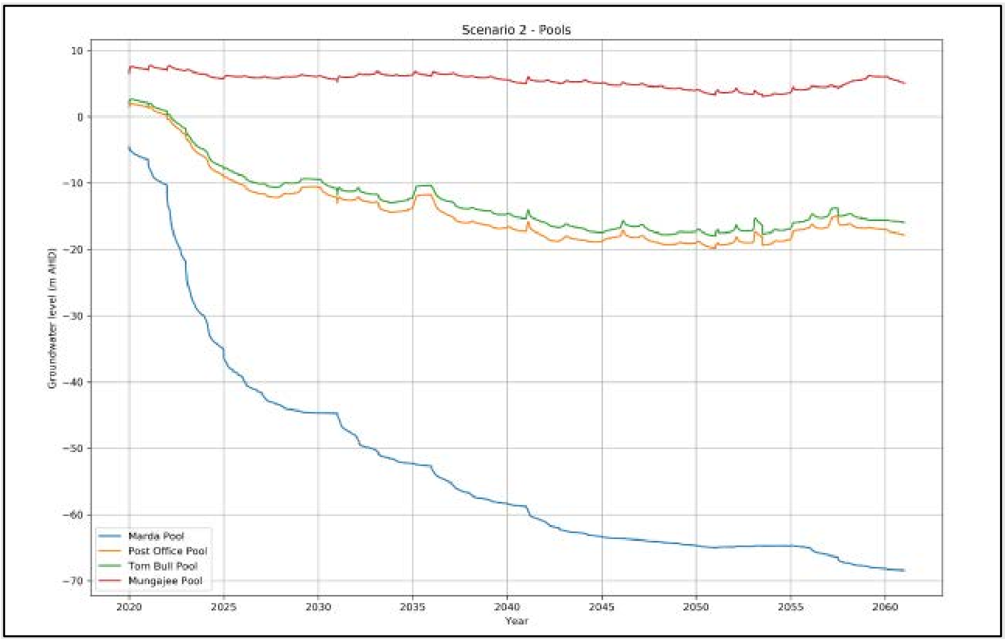


Figure 17 Scenario 2 Pools

Figure 18 Scenario 4 Pools

5.4.3.8 Other Users

Figure 19 and Figure 20 present the groundwater drawdown contours for scenarios 2, 3 and 4 at closure (2061) and the locations of existing pastoral bores in the study area. The predicted drawdown extent during mining and post-closure is summarised in Table 5-13. All other bores in the study area are expected to show drawdowns of less than 1 m.

Table 5-13 Predicted minimum groundwater heads for pastoral bores

Well	Predicted minimum Groundwater Head (m AHD)	
	LoM	Steady-state post-closure
Scenario 2		
Marda Well	-16	-9
Edwards Bore	-50	-35
Fortescue Bore	-70	-43
Scenario 4		
Marda Well	-20	-0.5
Edwards Bore	-90	-32
Fortescue Bore	-105	-39

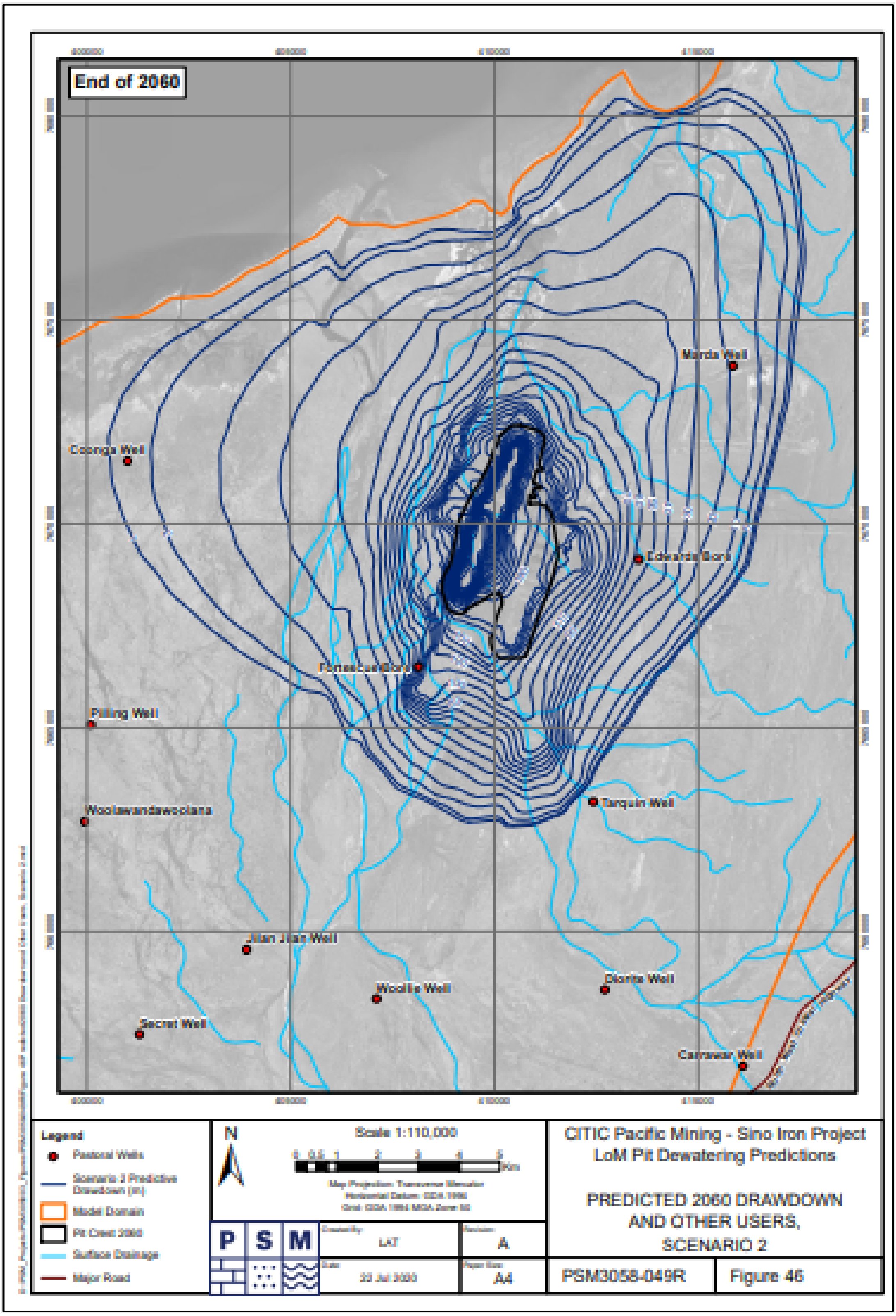


Figure 19 Predicted 2061 drawdown and other users Scenario 2

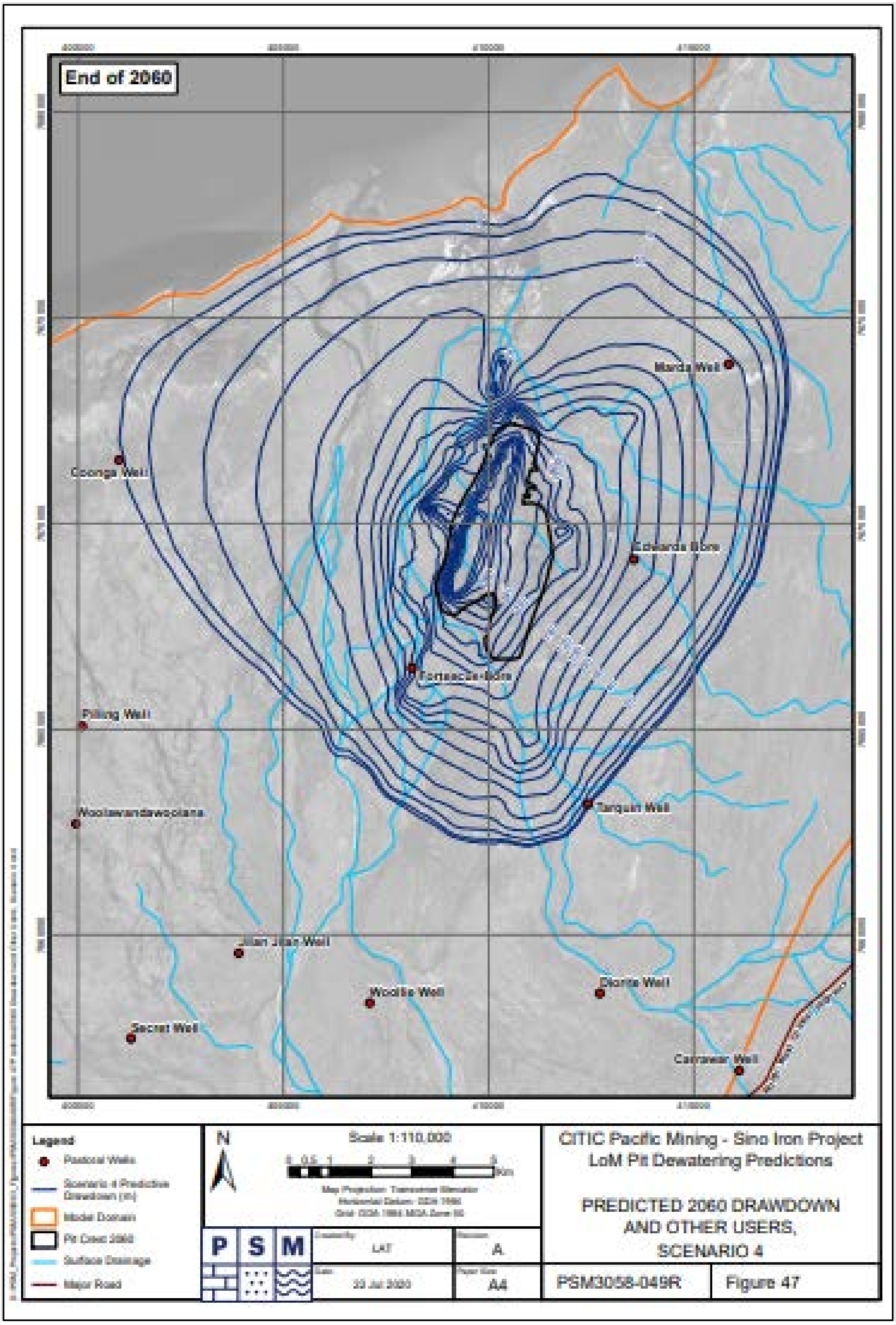


Figure 20 Predicted 2061 drawdown and other users, scenario 4

5.5 Surface Water discharge management

5.5.1 Current discharge, approvals and water quality

5.5.1.1 Historical and current approvals

MS 635 was issued in October 2003 authorising pit dewatering, with the water to be of suitable quality to supplement requirements.

Subsequent investigations and analysis of process requirements identified that while some water can be used for on-site purposes (e.g. dust suppression) there would be an excess of pit water that could not be used effectively in the process stream. On 31 August 2016, MS635 was revised via a section 45C approval to accommodate surplus dewater discharges (up to 2GL/a) to the Fortescue River.

The Sino Iron Mine Continuation Proposal (MCP) was approved under Ministerial Statement 1066 (MS 1066) and included an increase to pit dewatering and surplus dewater discharges to the Fortescue River from 2 GL/a to up to 8 GL/a on 20 October 2017. An increase in pit dewatering from 8 GL/a to 12 GL/a was approved on 18 July 2019. A corresponding increase in the volume of surplus dewater discharges to the Fortescue River was approved from 8 GL/a to 12 GL/a on 1 September 2021.

EP Act Licence L8308/2008/2 (2021b) has been amended as required to reflect the Part IV approvals. The current version of the licence is conditional upon discharges commencing 60 minutes prior to the turning of the tide from incoming to outgoing and ceasing 30 minutes prior to the turning of the tide from outgoing to incoming.

Licence conditions relating to monitoring of discharge water, surface water quality are outlined in Table 5-14, Table 5-15 and Table 5-16, with monitoring locations shown on Figure 23.

The licence holder must ensure that emissions from the discharge point listed in Condition 17 (replicated in Table 5-14) for the corresponding parameter do not exceed the corresponding limit when monitored in accordance with Condition 22.

Table 5-14 : Emission and discharge limits

Discharge Point	Parameter	Limit
FR2	Cumulative Volume	12 GL/a
	pH[1]	6-9 pH units
	Temperature[1]	<65 °C
	Total Dissolved Solids[1]	<70,000 mg/L
	Nitrate	<50 mg/L
	Cadmium	<0.1485 mg/L
	Chromium (VI)	<0.1188 mg/L
	Cobalt	<0.027 mg/L
	Copper	<0.0351 mg/L
	Lead	<0.1188 mg/L
	Mercury	<0.0108 mg/L

Discharge Point	Parameter	Limit
	Nickel	<1.89 mg/L
	Silver	<0.0378 mg/L
	Vanadium	<2.7 mg/L
	Zinc	<0.405 mg/L
	Total Recoverable Hydrocarbons	<15 mg/L

Note 1: In-field non-NATA accredited analysis permitted

Condition 22 of the licence requires that the licence holder must monitor emissions in accordance with the requirements specified in Table 10 (replicated in Table 5-15) and record the results of all such monitoring.

Table 5-15 Emissions to surface water

<table>
<tr><th>Discharge point</th><th>Parameter</th><th>Units</th><th>Averaging period</th><th>Frequency</th><th>Method</th></tr>
<tr><td rowspan="22">FR2 – monitoring conducted in-pipe from a sampling tap</td><td>Volumetric flow rate</td><td>m3/day</td><td>Annual</td><td>Daily</td><td>AS/NZS 5667.6</td></tr>
<tr><td>pH[3]</td><td>pH units</td><td rowspan="21">Spot Sample</td><td rowspan="21">Monthly</td><td rowspan="21">AS/NZ 5667.1
AS/NZS 5667.6</td></tr>
<tr><td>Temperature[3]</td><td>ºC</td></tr>
<tr><td>Electrical Conductivity [3]</td><td>µS/cm</td></tr>
<tr><td>Dissolved Oxygen [3]</td><td rowspan="17">mg/L</td></tr>
<tr><td>Total Dissolved Solids</td></tr>
<tr><td>Total Suspended Solids</td></tr>
<tr><td>Total Nitrogen</td></tr>
<tr><td>Bioavailable Nitrogen</td></tr>
<tr><td>Nitrate</td></tr>
<tr><td>Ammonia</td></tr>
<tr><td>Total Phosphorus</td></tr>
<tr><td>Bioavailable Phosphorus</td></tr>
<tr><td>Bioavailable Organic Carbon</td></tr>
<tr><td>Chlorophyll a</td></tr>
<tr><td>Aluminium</td></tr>
<tr><td>Arsenic</td></tr>
<tr><td>Boron</td></tr>
<tr><td>Cadmium</td></tr>
<tr><td>Chromium (III)</td></tr>
<tr><td>Chromium (VI)</td></tr>
</table>

Discharge point	Parameter	Units	Averaging period	Frequency	Method
	Cobalt				
	Copper				
	Iron				
	Lead				
	Mercury				
	Manganese				
	Nickel				
	Selenium				
	Silver				
	Strontium				
	Vanadium				
	Zine				
	Total Recoverable Hydrocarbons				

Note 3: In-field non-NATA accredited analysis permitted

Condition 27 requires that the licence holder must monitor the groundwater and surface water for concentrations of the parameters in accordance with Table 13 (replicated in Table 5-16).

Table 5-16 Monitoring of ambient concentrations

Monitoring location as depicted in Schedule 1	Parameter	Units	Averaging period	Frequency	Method
Surface Water					
	pH[3]	pH units	Spot Sample	Monthly	AS/NZ 5667.1 AS/NZS 5667.6
	Temperature[3]	ºC			
	Electrical Conductivity [3]	µS/cm			
	Dissolved Oxygen [3]	mg/L			
	Total Dissolved Solids				
	Total Suspended Solids				
	Total Nitrogen				
	Bioavailable Nitrogen				
	Nitrate				
	Ammonia				
	Total Phosphorus				

Monitoring location as depicted in Schedule 1	Parameter	Units	Averaging period	Frequency	Method
	Bioavailable Phosphorus				
	Bioavailable Organic Carbon				
	Chlorophyll a				
	Aluminium				
	Arsenic				
	Boron				
	Cadmium				
	Chromium (III)				
	Chromium (VI)				
	Cobalt				
	Copper				
	Iron				
	Lead				
	Mercury				
	Manganese				
	Nickel				
	Selenium				
	Silver				
	Strontium				
	Vanadium				
	Zine				
	Total Recoverable Hydrocarbons				

Note 3: In-field non-NATA accredited analysis permitted

5.5.1.2 Background surface water quality

Baseline data was collected between April 2014 and November 2016 (Figure 22) prior to commencement of discharge in 2017. Baseline concentrations are presented in Table 6-1 in Section 6.3.1.

Table 6-2 (Section 6.3.1) presents the baseline nutrient and chlorophyll-a concentrations in baseline samples collected. All samples were found to be slightly above ANZG (2018) indicative values for turbid macrotidal areas (DAL 2000, Maunsell 2002).

Total dissolved salts (TDS) in both the discharge waters and ambient waters are dominated by inorganic salts, with sodium, chloride, magnesium, calcium and potassium accounting for 90-95% of the TDS. On this basis TDS concentration (mg/L) is considered equivalent to salinity (ppt).

Based on analysis of the expected concentrations of potential chemicals in the discharge and the relevant threshold concentrations for each chemical, salinity was identified as the discharge chemical requiring the highest dilution to achieve its concentration target (Strategen, 2017).

The measured baseline salinity values in the Fortescue River estuary prior to the diffuser installation were within the range of 36,400 mg/L (36.4 ppt) to 52,100 mg/L (52.1 ppt) with a median salinity (TDS) of 42,900 mg/L (42.9 ppt) (Figure 21). Baseline salinity values were measured approximately 1 km upstream (FR3) and 1 km downstream (FR1) of the diffuser location, and near to what is now the diffuser location (FR2). The upstream location tended to have higher salinity than the downstream location on several sampling occasions and there were no apparent seasonal trends in the data (RPS 2021).

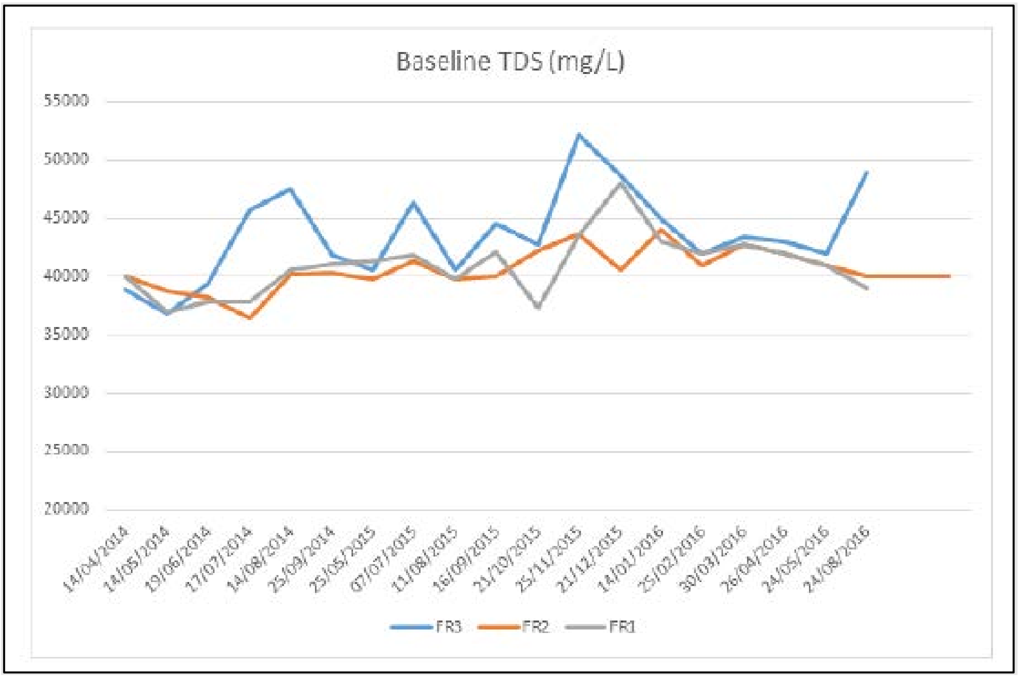


Figure 21 Measured salinity in Fortescue River (prior to diffuser installation

Overall, the measurements indicate that salinity concentrations in the estuary are typically higher than would be expected in adjacent ocean waters (~36 ppt).

The levels of higher baseline salinity in the estuary can be explained by contributions from evaporation and groundwater. The groundwater quality around the mine ranges from brackish within the south of the deposit to saline and hypersaline in the north, associated with the naturally occurring saline seawater wedge and evapoconcentration processes occurring naturally on the tidal flats. Periodic contributions of hypersaline groundwater are discharged via baseflow to the Fortescue River during periods when the water table is above the riverbed and river water levels. (PSM, 2020).

Figure 22 Fortescue River baseline sampling locations FR1, FR2 and FR3

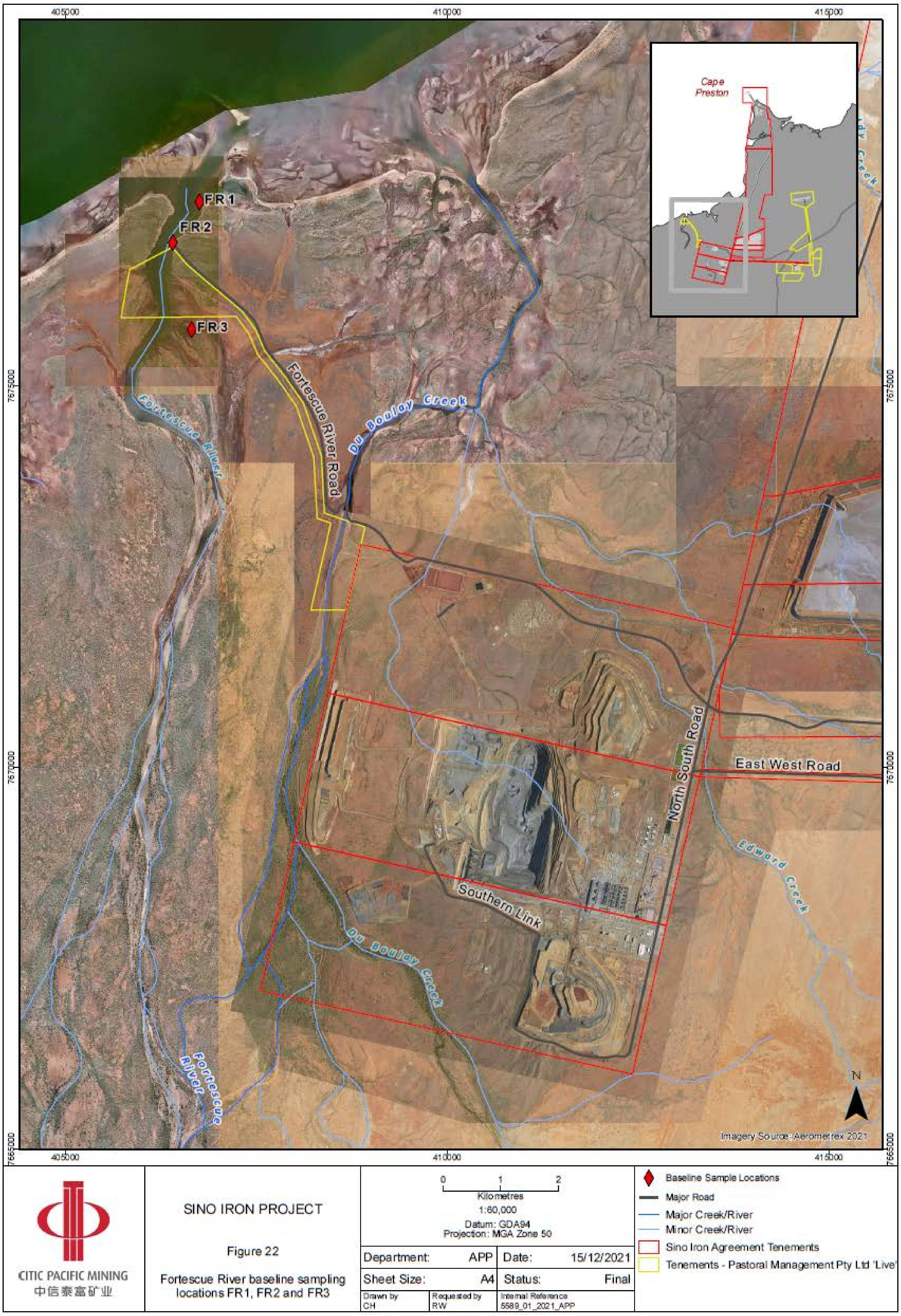
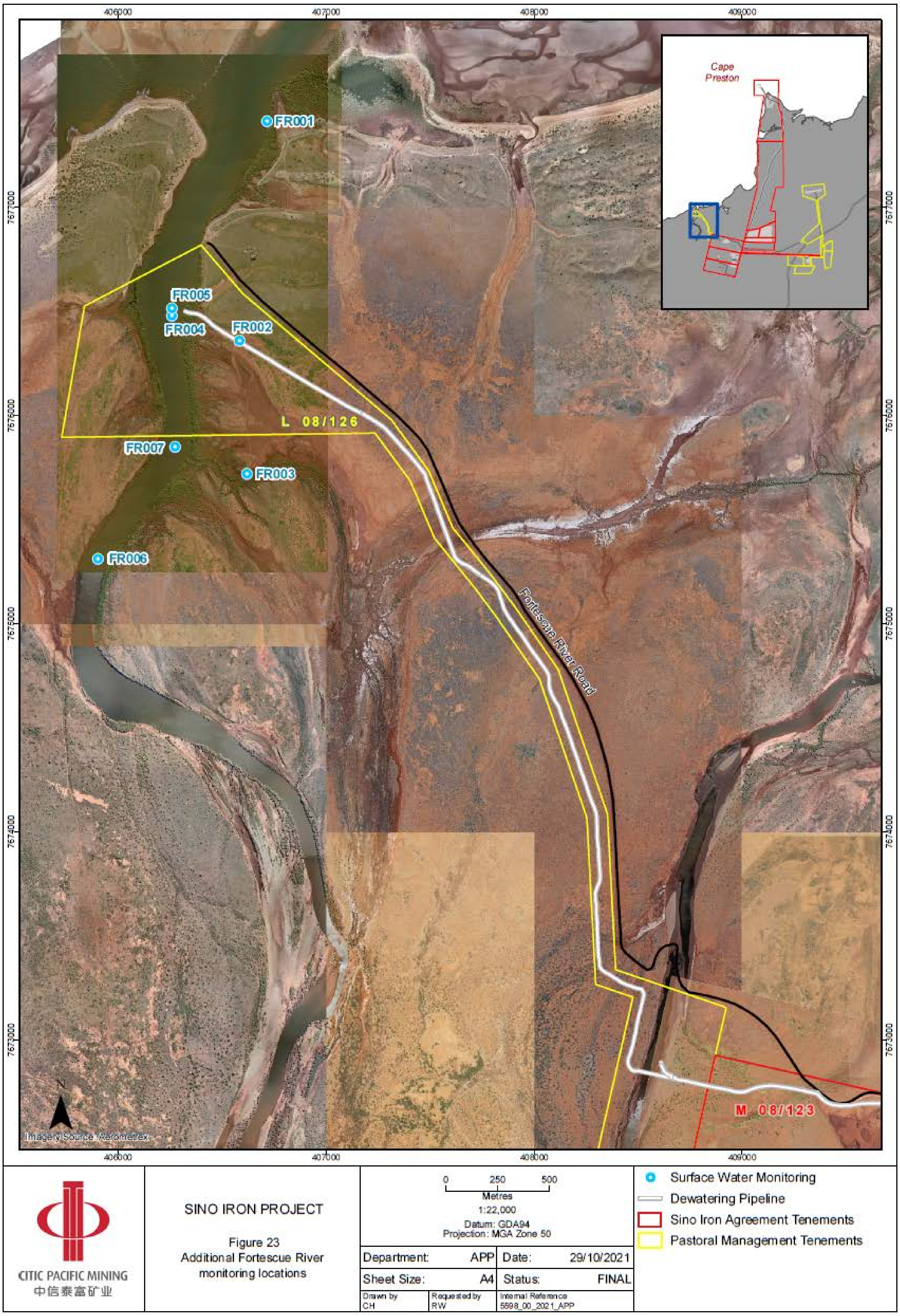


Figure 23 L8308/2008/2 Ambient Surface Water Monitoring Location



The monthly groundwater baseflow to the Fortescue River is highly variable with the largest flows typically occurring in the wettest months of February and March. The average baseflow volumes in the wettest months are very large relative to the volume of the estuary, implying flushing of the estuary by the baseflow many times over. However, years with little or no flow in these months are not uncommon, occurring approximately one in every four years (PSM, 2020).

Satellite images indicate relatively flat salt pans that are likely inundated during high spring tides but remain disconnected from the estuary otherwise. The salt that is evapo-concentrated in the salt pans will return to the estuary following flood events or via groundwater seepage (PSM, 2020).

5.5.1.3 Measured surface water quality

Monitoring for the parameters outlined in Table 5-16 water quality sampling has been conducted monthly at far-field monitoring sites FR1 and FR3 (located ~1 km upstream and downstream of emission point FR2) and nearfield monitoring sites FR4 and FR5 (located ~18m upstream and downstream of emission point FR2) and reported annually in accordance with Licence No. L8308/2008/2 (DWER 2021b). Data has been collected for the last 3 years (2017/18, 2018/19, 2019/20 and 2020/2021) since discharge commenced in 2017.

TDS in the discharge water during the period 2017 to 2021 ranged between 32,200 and 69,200 mg/L (median TDS of 58,400 mg/L) depending on seasonal influences and the area of mining, with the eastern and northern pits generally more saline than the western and southern pits. Prior to the commencement of discharge, median baseline TDS at FR1, FR2 and FR3 was 41,050 mg/L. Surface water monitoring during 2017 - 2020 at sites FR1 and FR3 identified that TDS concentrations were within the baseline concentration range at all sites (Table 5-17). (BMT, 2021).

Table 5-17 Total dissolved solids concentrations at FR1 and FR3

Parameter	Seasonal Baseline range (mg/L)	Median baseline (FR1, 2 and 3) (mg/L)	FR1				FR3			
			20/21	19/20	18/19	17/18	20/21	19/20	18/19	17/18
TDS	36,400 - 52,100	41,050	41,200	42,300	42,450	42,350	43,450	42,500	42,300	42,900

Data collected for other key parameters are presented in Section 6 in the context of assessing potential impacts to Marine Environmental Quality.

5.5.1.4 Current discharge to Fortescue River

The current approval of 12 GL/a is based on a discharge rate of 667 L/sec over an average period of 13.7 hrs/day conditional on discharge commencing 60 minutes prior to the turning of the tide from incoming to outgoing and ceasing 30 minutes prior to the turning of the tide from outgoing to incoming (EP Act Licence L8308/2008/2, 2021b).

The current approval was supported by a diffuser assessment hydrodynamic modelling study (RPS APASA, 2017) that was peer reviewed by P.Treloar (Cardno (NSW/ACT) Pty Ltd).

The diffuser assessment (RPS APASA, 2017) modelled three discharge scenarios 2 GL/a, 6 GL/a and 8 GL/a. The model objective was to achieve 27 times dilution for salinity within 10-20 m of the discharge location. The modelled scenarios were based on a discharge salinity concentration of 70 ppt and a discharge period commencing 30 minutes after the turning of the tide and ceasing 1 hour prior to the next low tide. The discharge rate was 667 L/sec. Additional diffusers were installed with each increase in the annual discharge volume, to a total of four diffusers and 56 discharge ports.

Figure 23 presents the location of the dewater discharge pipeline, diffuser and monitoring locations in the Fortescue River and estuary. The approved dewater discharge outfall is located approximately 1km upstream from the mouth of the Fortescue River (116.10° E, 21.00° S) in the tidally influenced estuary.

Calibration of the diffuser model compared predicted diffuser performance and monthly field measurements at monitoring locations FR1, FR3, FR4 and FR5 (Figure 23). The results of the calibration confirmed that diffuser performance in the near-field and far-field was in line with predicted performance of the original discharge modelling studies (RPS, 2016, 2017). The field measurements confirmed that water discharged from the diffuser system (with TDS concentration of up to 70,000 mg/L) is rapidly diluted in the near-field zone of the diffuser with salinity concentrations in the estuary remaining within the baseline concentration range over a full tidal cycle.

The diffuser modelling was used to support the increased discharge of 12 GL/a based on the same discharge flow rate (667 L/sec) with a small increase to the discharge period.

5.5.2 Revised Proposal

The revised proposal seeks to increase the current approved discharge volume at the Fortescue River outfall from 12 GL/a to 21 GL/a.

The approved discharge volume of 12 GL/a is based on a discharge rate of 667 L/s with an average discharge period of 13.7 hours per day (commencing 60 minutes prior to the turning of the tide and ceasing 30 minutes prior to next incoming tide).

The discharge flow rate (667 L/sec) will remain the same for the increased volume of 21 GL/a with an increase in the discharge period to up to 24 hours. Consequently, the diffuser modelling and calibration results are considered relevant for the increased discharge of 21 GL/a.

5.5.2.1 Modelling for revised proposal discharge increase

The Fortescue River Discharge Modelling: Background Salinity Variability Study (Appendix 5) (hydrodynamic modelling) undertaken by RPS in December 2021 for the increased discharge of 21 GL/a was based on the same discharge rate (667 L/sec) modelled for the approved discharge volume of 12 GL/a.

The study investigated two scenarios, a background (no discharge) scenario and a 70 ppt salinity (TDS 70,000 mg/L) concentration scenario (worst case).

The objective of the study was to assess the potential for salinity to accumulate in the estuary under the discharge regime of 21 GL/a in the context of known historic variability in background salinity concentrations. The different scenarios tested in the study were designed to characterise background variability using historical measured data that enables the above-background contribution of the discharge to be accurately evaluated (RPS, 2021a).

The potential for salinity build-up is presented as a time series of depth averaged salinity values at the three licenced monitoring locations for comparison to historic measurements (Figure 23) (RPS, 2021a).

5.5.2.2 Modelled *scenarios*

Two scenarios were modelled:

- background (no-discharge) scenario
- 70 ppt discharge scenario

The increased discharge volume of 21 GL/a is based on 667 L/s with an increased duration of up to 24 hrs/day.

The hydrodynamic model was run for an initial five-day period with a baseline salinity concentration of 37 ppt. A salinity gradient was introduced at day 4, based on the 20th, 50th and 80th percentiles from baseline sampling data measured at monitoring locations FR1, FR2 and FR3 (Figure 22) and an average of offshore data measured at Cape Preston. The scenarios were then replicated three times with each replicate initialised with a different background salinity gradient. The model was run for a further 24 hours to smooth gradients. The percentile values of salinity are presented in Table 5-18. Table 5-19 details percentiles of background salinity values at monitoring locations based on 21 GL/a.

Table 5-18 Summary of modelled scenarios for 21 GL/a

Scenario number	Discharge flow rate (L/s)	Discharge duration (hrs/day)	Discharge salinity (ppt)	Percentile for initial salinity gradient
1-A	0	0	NA	20th
1-B	0	0	NA	50th
1-C	0	0	NA	80th
2-A	667	24	70	20th
2-B	667	24	70	50th
2-C	667	24	70	80th

Table 5-19 Percentiles of background salinity values at monitoring locations based on 21 GL/a

Location	(A) 20^{th} percentile salinity (ppt)	(B) 50^{th} percentile salinity (ppt)	(C) 80^{th} percentile salinity (ppt)
Offshore (approx.)	37.0	37.0	37.0
FR1	38.8	39.0	42.2
FR2	39.8	40.2	42.0
FR3	40.6	43.0	46.8

All production simulations were run for a one-month period. Sea water was the only natural source of salinity input to the estuary included during the one-month simulation period, allowing the contribution of salinity from the discharge to be clearly identified in the results.

The simulation period was selected to cover spring and neap tide cycles. The average predicted volume of the estuary over the simulation period was approximately 1.25 GL per day however, during flood spring tide periods the volume of the estuary can vary five-fold within four hours from around 0.5 GL to around 3 GL per day, with the reverse occurring on a spring ebb tide as shown in Figure 24 (RPS, 2021a)

The rate of change in volume in the estuary was calculated in absolute terms and compared to the proposed discharge per hour rate. The peaks in tidal volume flux typically range from around 0.09 GL/hr during neap tides to 0.85 GL/hr during spring tides. The proposed 21 GL/a discharge rate, equivalent to 0.0024 GL/hr, represents just 2.7% of the peak tidal volume flux during neap tides and only 0.3% of the peak flux during spring tides. This indicates that the discharge volume is not significant in the context of the overall volume of the Fortescue River estuary (RPS, 2021a).

The direction of tidal flux oscillates upstream and downstream with a significant proportion of the outgoing water recycled by the next incoming tide. The hydrodynamic model results also quantify the net exchange between the estuary and offshore waters that occur with each tidal cycle (RPS, 2021a).

Figure 24 presents the modelled rate of hourly change in volume of the Fortescue River estuary over the one-month simulation period.

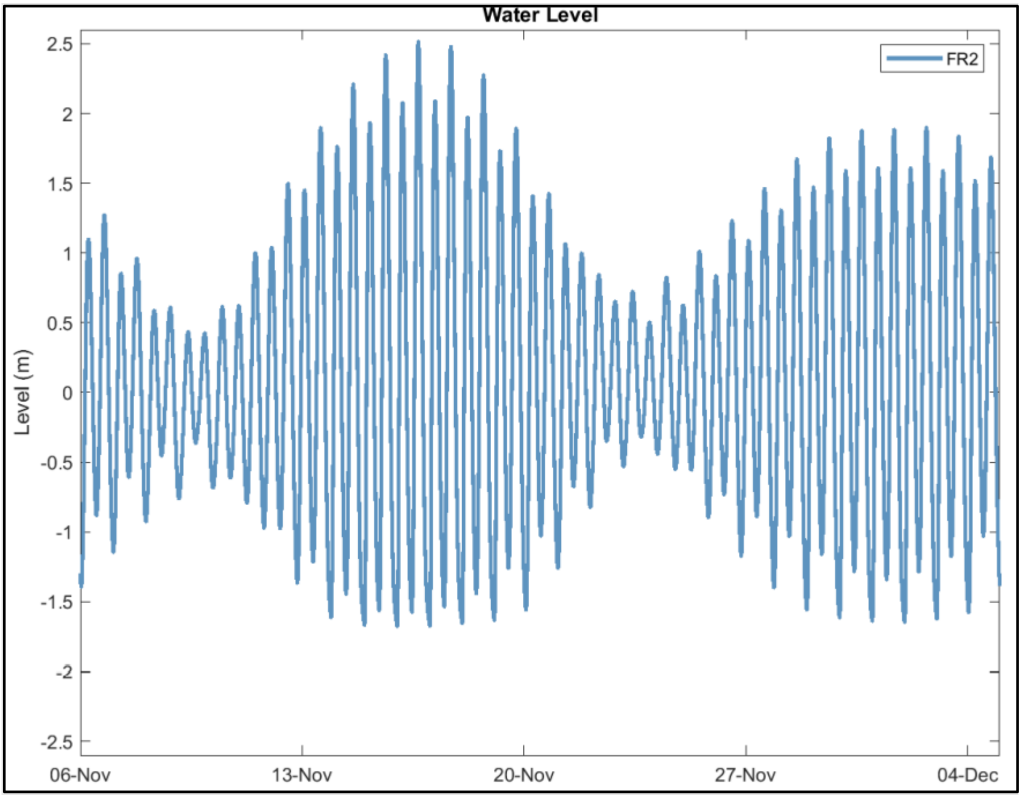


Figure 24 Modelled changes in water level at the FR2 station over the one-month simulation period

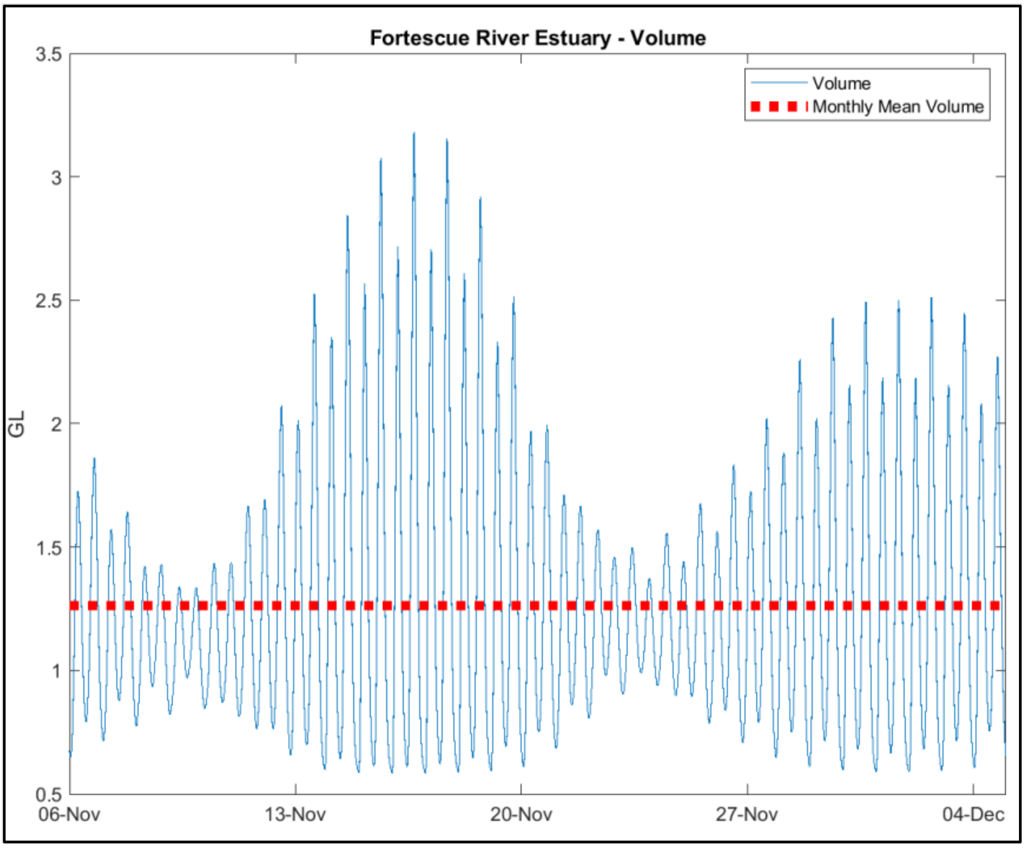


Figure 25 Modelled rate of hourly change in volume of Fortescue River estuary over one-month simulation period

Scenario 1 – Background (No-Discharge) Cases

Time series of depth-averaged salinity at each monitoring station were calculated for the 20th, 50th and 80th percentile cases for Scenario 1 (Figure 26) The results confirm that the salinity gradient for the 20th and 80th percentile cases was eroded in approximately two weeks and approximately three weeks respectively.

On completion of the one-month simulation period, the initial salinity gradient between the monitoring stations was essentially eliminated in all three replicate simulations. This was confirmed by spatial maps corresponding to the end of the simulation period (Figure 27), which indicate that the initial gradient was almost completely flushed from the estuary after one month. At the end of the simulation period the salinity values at all three stations were in the range of 37.0 ppt to 37.2 ppt (Figure 26) with the implication that tidal forces drive the full flushing of the estuary over a time scale of approximately one month.

Figure 27 shows the instantaneous water level (left-most panel) and salinity maps (remaining panels) for the background (no-discharge) scenarios at the end of the one-month simulation period. The second, third and fourth panels show the mid-depth salinity for the 20th, 50th and 80th percentile gradient cases (Scenarios 1-A, 1-B and 1-C), respectively.

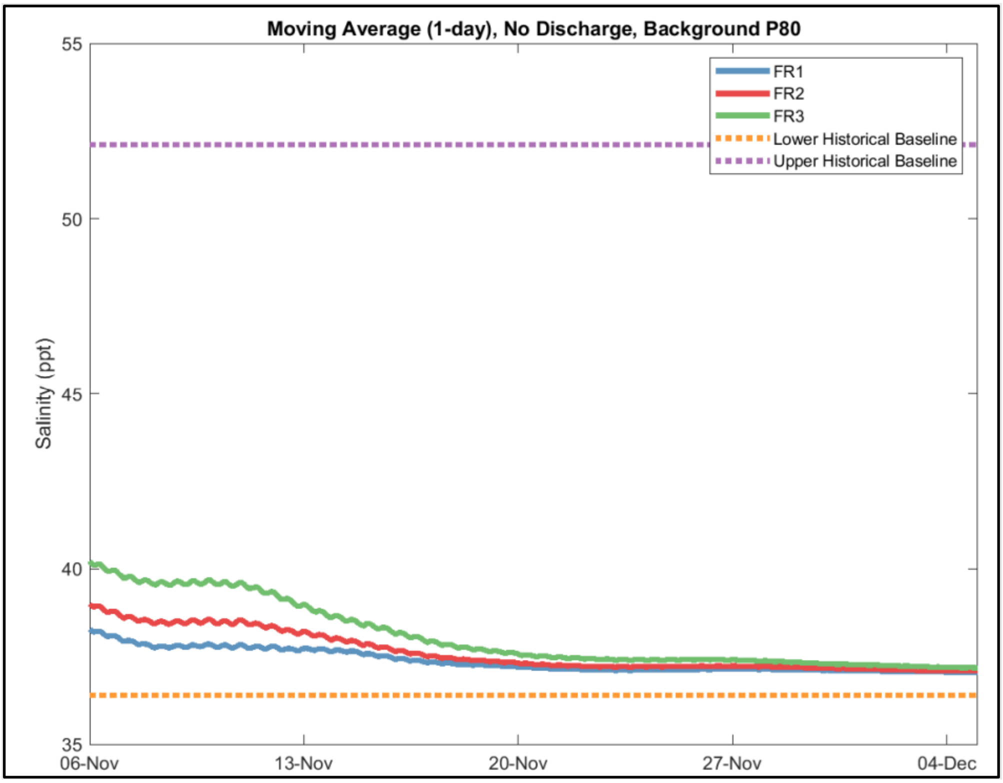


Figure 26 Scenario 1C: Filtered (24 hr moving avg) time series of modelled depth averaged salinity at monitoring stations for the background (no discharge) 80th percentile case

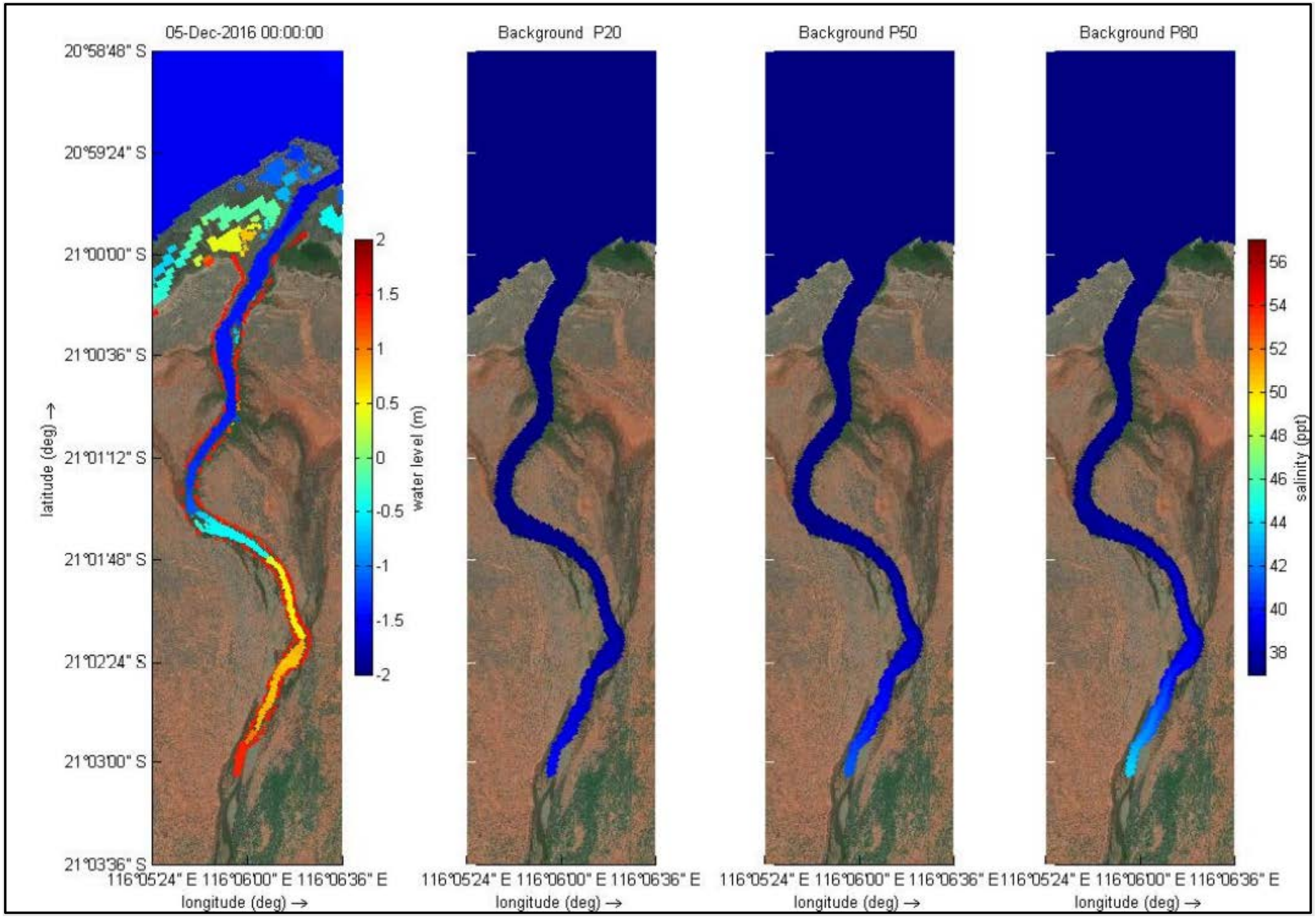


Figure 27 Instantaneous water level (left panel) and salinity (remaining panels) for background (no-discharge) scenario

Scenario 2 – 70 ppt Discharge Cases

Time series of depth-averaged salinity at each monitoring station for the 20th, 50th and 80th percentile scenarios was within the baseline salinity concentration range. The peak salinity values for all scenarios were reached just at the end of the first neap tide period (at both FR2 and FR3) and were in the range of 47 ppt to 48 ppt, regardless of the initial baseline salinity gradient that was applied. The filtered peak values were eroded over the period of a few days as the spring tides became dominant over the neap tides. This pattern was repeated during the next neap-spring transition (RPS, 2021a).

For all three scenarios the salinity values at FR1 tended to be lower than the values at FR2 and FR3 reflecting increased mixing with offshore waters closer to the mouth of the estuary. Only a small salinity gradient was observed between FR2 and FR3 indicating no significant local accumulation of salinity near the diffuser at FR2. This result was expected given the large volume fluctuation, high current speeds and associated mixing energy that occurs with regularity in the estuary (RPS, 2021a).

At the end of the simulation period the salinity values at the FR2 and FR3 stations were in the range of 41.1 ppt to 41.6 ppt (Table 5-20). These results are within the baseline salinity concentration range indicating that full flushing of the estuary occurs over a one-month time scale significant enough to remove most traces of the discharge salinity (RPS, 2021a).

Figure 28 shows the instantaneous water level (left-most panel) and salinity maps (remaining panels) for the 70 ppt discharge scenarios at the end of the simulation period. The second, third and fourth panels show the mid-depth salinity for the 20th, 50th and 80th percentile gradient cases (Scenarios 2-A, 2-B and 2-C), respectively.

A localised patch of slightly increased salinity near the FR2 location is visible in Figure 28 (in each of the panels), indicating a signature of the discharge from the diffuser. The slightly elevated salinity signature from the discharge is directed downstream in this time instance and is particularly visible because of the low water level, but in reality, this signature will move continuously in response to the direction and strength of the tidal flows.

Table 5-20 Summary statistics, filtered depth-averaged salinity Scenario 2

Scenario	Location	Initial Baseline	Salinity (ppt)		
			50th percentile	80th percentile	End of Tide Cycle (one month)
2-A	FR1	P20	40.3	41.5	39.4
	FR2		42.3	43.9	41.1
	FR3		42.6	43.9	41.5
2-B	FR1	P50	40.4	41.6	39.5
	FR2		42.3	44.0	41.1
	FR3		42.8	44.0	41.6
2-C	FR1	P80	40.5	41.6	39.5
	FR2		42.6	44.1	41.1

Scenario	Location	Initial Baseline	Salinity (ppt)		
			50th percentile	80th percentile	End of Tide Cycle (one month)
	FR3		43.2	44.2	41.6

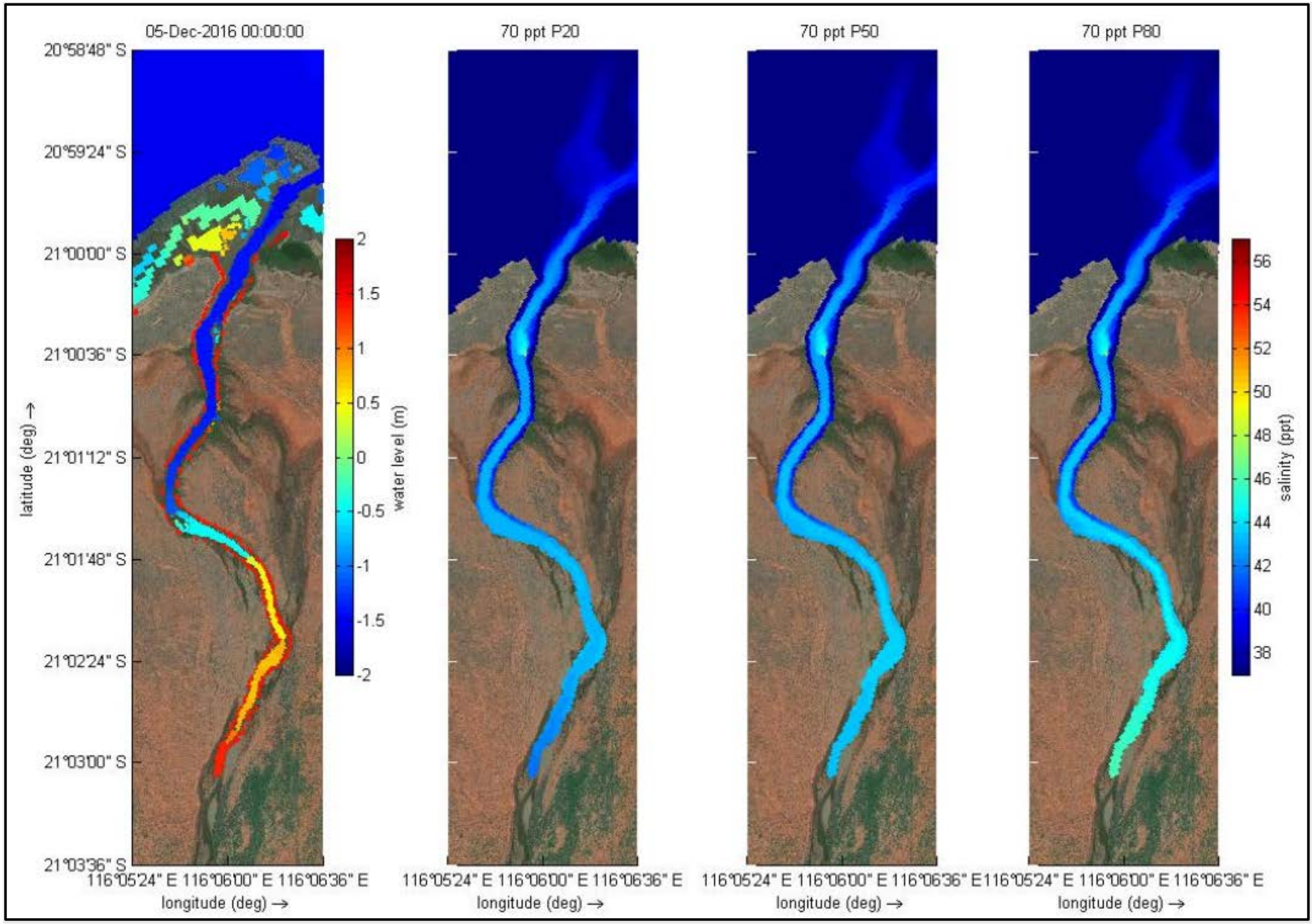


Figure 28 Instantaneous water level (left panel) & salinity (remaining panels) for the 70 ppt discharge scenario at the end of the simulation period

5.5.2.3 Model results

The model results for a no-discharge scenario shows the full flushing of the estuary over a time scale of approximately one month (RPS, 2021a).

The higher levels of baseline salinity compared to seawater indicate that natural sources of salinity input to the estuary are significant over the time scale of one month and that both the natural and discharge sources will contribute to salinity concentrations in the estuary under the increased discharge regime (RPS, 2021a).

The proposed 21 GL/a discharge rate (0.0024 GL/hr) represents 2.7% of the peak tidal volume flux during neap tides and only 0.3% of the peak flux during spring tides indicating that the hydrological regime at the mouth of the Fortescue River will not generally be affected by the addition of the discharge water volume due to the comparatively high variability in natural flow volumes driven by the high tidal range (RPS, 2021a).

The localised direct impact of discharge from the diffuser system on the hydrological regime is predicted to be confined to the near-field mixing zone (<20 m) (RPS, 2021a).

The model indicates the potential for some stratification of the discharge during neap tides but with vertical mixing otherwise. The expected mixing is driven by the relatively shallow depth and the large volumes of water exchanged in the estuary during regular and spring tides. This behaviour is consistent with CPM monitoring data to date that does not show evidence of stratification under current operating conditions (RPS, 2021a).

The filtered time series model results for all discharge scenarios indicate a downward salinity trend during spring tides and an upward trend during neap tides with daily averaged peaks and troughs (that only persist for a few days) synchronised with spring-neap tidal cycles (RPS, 2021a).

A comparison of the end-of-month result for the no discharge scenario and the 70 ppt scenario shows a difference in salinity at FR1 of 2.4 ppt, at FR2 of 4.0 ppt and at FR3 from 4.4 to 4.5 ppt. The consistent salinity differences for the 70 ppt scenario demonstrates that salt from the discharge is predicted to be dispersed from the estuary with similar effectiveness regardless of the baseline salinity concentrations (RPS, 2021a).

The modelled scenarios assumed no baseline flow in the Fortescue River which is highly conservative with respect to the flushing of salinity in the estuary (RPS, 2021a) in particular during high rainfall months.

This study presented filtered time series results, averaged over depth and presented as a 1-day moving average to summarise predicted build-up of salinity in response to the discharge. This method removes short-term peaks and troughs present in the raw data and occasional changes in salinity at depth, particularly during neap tides (RPS, 2021a). While the time averaged contribution of the discharge indicates temporary peaks of around 10 ppt (in addition to the historical baseline data range) for 3 to 4 days (during neap tides), these fluctuations are considered within the range of natural variation and baseline salinity concentrations of 36.4 ppt to 52.1 ppt (RPS, 2021a). The predicted change in salinity relative to baseline is shown in Table 5-21 (BMT 2021).

Table 5-21 Predicted change in salinity (TDS) of discharge relative to baseline concentration range within the Fortescue River estuary

Predicted Salinity of discharge (TDS, mg/L)	Baseline concentration range (mg/L)	Modelled median concentration at FR1 (mg/L)	Modelled median concentration at FR3 (mg/L)
70,000	36,400 - 52,100	43,766	45,867

The predicted change in salinity compared to current monitoring data is shown in Table 5-22. The data shows that the predicted median salinity over the one month modelled period is expected to remain within baseline concentrations at FR1 and FR3 monitoring sites.

Table 5-22 Predicted salinity (TDS) concentrations in the Fortescue River estuary for the increased discharge relative to current discharge monitoring concentrations

Predicted Salinity of discharge (TDS, mg/L)	2020/2021 median concentration at FR1 (mg/L)	Modelled median concentration at FR1 (mg/L)	2020/2021 median concentration at FR3 (mg/L)	Modelled median concentration at FR3 (mg/L)
70,000	41,200	43,766	43,450	45,867

5.6 Potential Impacts

The following potential impacts have been identified as relevant to the environmental factor of Inland Waters:

- Groundwater drawdown from dewatering has potential to
    - modify groundwater and surface water flows
    - affect ground water dependant ecosystems
- Discharge of mine dewater has potential to modify surface water flows and water quality in the Fortescue River and estuary.
- Formation of a pit lake after closure has the potential to affect water quality within the pit lake and surrounding environment.

5.7 Assessment of Impacts

5.7.1 Groundwater drawdown

Groundwater drawdown associated with increased groundwater abstraction has the potential to impact GDE, pastoral monitoring bores and riverine pools.

Of the scenarios modelled, Scenarios 2 and 4 have the potential to achieve the objective of dewatering in advance of mining and are therefore the focus of this assessment (PSM, 2020).

The simulated hydrographs for Scenario 2 and 4 reflect the different source contributions in the models, with Scenario 2 dominated by rainfall recharge sources and Scenario 4 dominated by recharge from tidal sources (PSM, 2020).

From a regional perspective only bore FCP31A is within the predicted drawdown extent for both Scenarios (Figure 19 and Figure 20). The predicted maximum drawdown over LoM is ~3.5m under scenario 4 levelling to a steady state post closure drawdown of <1m. Scenario 2 indicates a drawdown of ~2.5 m during LoM with a steady state post closure drawdown of ~1m. Based on these modelling results it is unlikely that groundwater will be significantly impacted by the revised proposal at a regional scale (PSM, 2020).

Bores located within areas of GDE (Figure 40) show a gradual and significant decline over the LoM for both Scenario 2 and 4 and remain depressed in the long-term post closure (Figure 15 and Figure 16). Based on these predictions there is the potential for groundwater drawdown over the LoM to impact GDE. These potential impacts will be discussed in Section 9 and will consider other factors including the relative contribution of surface flows to GDE and the quality and extent of GDE within the drawdown extent (PSM, 2020).

Tidal pools considered in this study (Figure 14) are predicted to have little or intermittent dependence on groundwater and are not expected to be significantly affected by groundwater drawdown during and post-mining (PSM, 2020).

A number of existing pastoral bores are predicted to experience drawdown of between ~16 m and ~70 m for Scenario 2 and between ~20 m and ~105 m for Scenario 4 during LoM. Whilst steady state post closure indicates some recovery, drawdown of up to ~43 m and ~39 m for Scenario 2 and 4 respectively will remain post closure. As all bores are located within pastoral lands held by the proponent the predicted drawdown is not expected to significantly impact on pastoral activities (PSM, 2020).

In conclusion the increase in groundwater drawdown is not expected to have significant impact on high value ecosystems or other groundwater users within the drawdown extent.

5.7.2 Discharge to Fortescue River

The proposed 21 GL/a discharge represents 2.7% of the peak tidal volume flux during neap tides and only 0.3% of the peak flux during spring tides within the Fortescue River and estuary. This small contribution to the overall volume in the estuary indicates that the Fortescue River and estuary are unlikely to be affected by the increase in discharge volume due to the naturally high flow volumes within the estuary driven by a high tidal range. In addition, it is predicted that the direct impact of discharge from the diffuser system will be confined to the near-field mixing zone of <20 m (RPS, 2021a).

Model results for a no-discharge scenario concluded that continuous natural sources of salinity input to the Fortescue estuary are significant over the time scale of one month, indicating that both natural sources and dewater discharge will contribute to the expected salinity in the estuary under the expanded discharge regime (RPS, 2021a).

Modelling predictions of the increased dewater discharge of 21 GL/a for the no discharge and 70 ppt scenarios show consistent salinity concentrations at all three monitoring locations indicating that salt from the discharge is predicted to be dispersed by the estuary with similar effectiveness regardless of the salinity concentrations (RPS, 2021a).

In conclusion the model predicts that by the end of a full tidal cycle the contribution of the discharge above background, at all monitoring locations, is less than 4.5 ppt (70 ppt scenario) indicating that salinity concentrations over a one month modelled period will remain within the pre-impact baseline salinity concentration range at both FR1 and FR3 (Table 5-21).

Aside from the model predictions, periodic changes in the water quality of the Fortescue River and estuary occur due to natural influences, in particular large rainfall events and high tidal surges. Figure 29 and Figure 30 presents a series of satellite images taken of the Fortescue River and estuary on the 8 and 14 February 2021 during and following Cyclone Damien that made landfall on 8 February 2021 with significant rainfall received within the catchment (Source CPM, 2021).

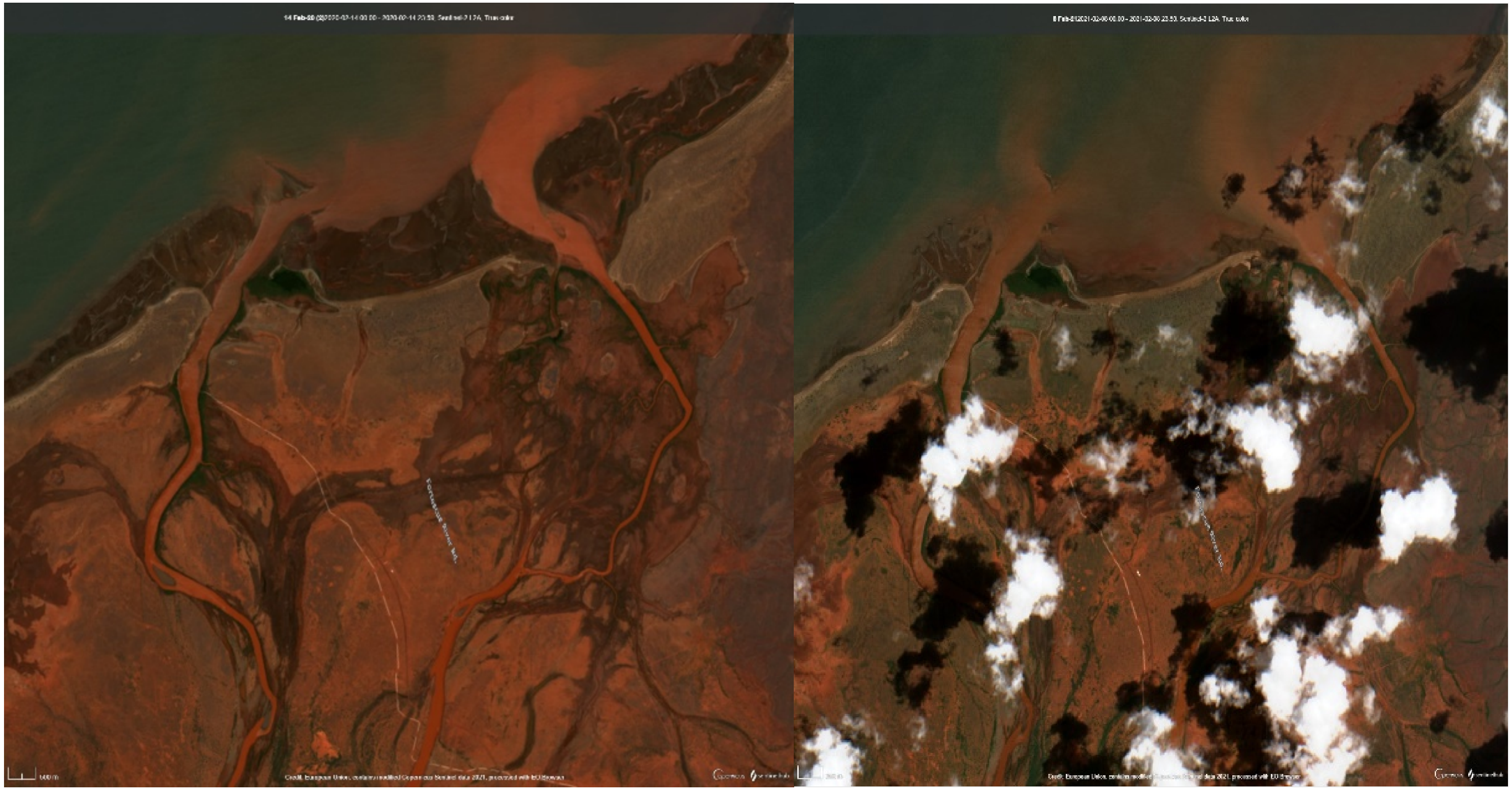


Figure 29 Satellite Imagery during and following Cyclone Damien

Figure 30 Satellite Imagery during and following Cyclone Damien

Climate change modelling over the next 50 years predicts more intense short duration rainfall events and less but more intense cyclone activity with predicted intense sea level rises (BOM and CSIRO, 2020) in the Cape Preston area. These changes are likely to result in higher tides and greater flushing of the Fortescue River and estuary with tidal influences remaining the primary flow mechanism.

Based on the model predictions, the expanded discharge of 21 GL/a is not expected to have a significant effect on water quality within the Fortescue River estuary.

An assessment of the potential impact of the short-term fluctuations in salinity concentrations during the full tidal cycle on Benthic Processes will be considered in Section 7.

5.7.3 Formation of pit lake

The post-closure formation of pit lake has been informed by the predictive groundwater model. The post-closure model is a steady-state model, hence independent of time. For the post-closure model, the approach used was to simulate groundwater flow to, and evaporation losses from the final void with intention to resolve broadly indicative steady-state pit-lake elevations and residual drawdowns of the water table within the groundwater catchment. There is no indication provided by these models of the passage of time between cessation of mining and attainment of steady-state pit-lake elevations. Ultimately, there will be time and pit-lake elevation sensitivity dependent on climate change and frequency of high-recharge rainfall events and TDS effects on transient rates of evaporation from the pit-lake, amongst other factors (PSM. 2020).

The model layers, in the area where voids are planned, were assigned very high hydraulic conductivity (1,000 m/day) and specific yield of 0.99 (dimensionless) to allow the voids to be represented as water-filled bodies as groundwater heads recovered. The evaporation losses were simulated by representing, as a well boundary, the volumetric rate of evaporation from each pit based on the pit lake surface area at a steady-state elevation, and assuming a pan coefficient of 0.7. The predicted steady-state elevations for the pit lake imposed residual drawdowns in the range from 110 to 120 m, hence with the pit lake being below sea-level at elevations -105 to -115 m AHD for the two parameterisation cases considered (PSM, 2020)

Average climate conditions (that is no seasonal variations) were represented, with the higher seasonal rainfall on the floodplains averaged throughout the year. Although the post-closure simulations enabled estimation of long-term steady-state residual drawdowns, these do not provide estimates for the times for steady-state to be achieved (PSM, 2020).

Predicted long-term steady-state residual drawdowns, along with particle tracking of groundwater inflow to the pit that the groundwater flow completely surrounds the pit, indicating that the pit is a sink at the end of mining and following development of the pit lake. It is also likely because of this that the poorer groundwater quality in the vicinity of the pit sink will not be drawn into areas further afar of better groundwater quality. The resulting water quality residing in the pit lake will evolve to become hypersaline through evaporation-concentration processes (PSM 2020).

Geological resource modelling has indicated that approximately 0.6% of the final mine pit wall will consist potentially acid forming materials. It is considered unlikely that an acid lake will be generated.

5.8 Mitigation

The following mitigation measures aim to ensure no significant impact to groundwater and surface water flow or quality as a result of implementation of the revised proposal.

Avoid:

1. Maintain the rate of discharge to the Fortescue River of up to 667 L/sec.

Minimise:

2. Maintain optimum diffuser operation to ensure that predicted mixing and dilution is achieved (RPS APASA, 2017).
3. Investigate, define and refine the hydrogeological model throughout the LoM to optimise groundwater abstraction and dewater discharge.
4. Monitor discharge water quality against the limits outlined in EP Act Licence L8308/2008/2 (Table 5-14).
5. Monitor surface water quality in accordance with EP Act Licence L8308/2008/2 (Table 5-16).
6. Maintain dewater discharge infrastructure proactively to avoid uncontrolled release of hypersaline water to the environment.
7. Implement mine dewater discharge adaptive management measures in accordance with the EP Act Licence in the event that discharge water quality exceeds licence discharge limits. The adaptive measures may include altering discharge volumes, dilution with fresher water sources and/or reverting to tidal based discharge regime to improve dispersion.

When mitigation and management measures have been implemented, it is expected that the revised proposal will result in the following outcomes in relation to Inland waters:

1. Groundwater drawdown at the >5.0 m drawdown contour will increase by 18.4 %.
2. GDV located within the >5.0 m drawdown contour is highly to moderately impacted by the declared weed mesquite and is located in an area that experiences seasonally variable groundwater levels of up to 6m.
3. Groundwater drawdown is not expected to impact riverine pools due to the disconnected nature of pools from groundwater sources (PSM, 2020).
4. Surface water quality is not expected to be affected by short term peaks in salinity levels associated with dewater discharge due to the low percentage of discharge water as compared to the total volume of water within the estuary, the operation of the diffusers which are designed to rapidly the

discharge and the efficient flushing of discharge water within the estuary across a full tidal cycle (RPS, 2021a).

5. Baseline salinity concentrations at monitoring locations FR1 and FR3 for the 70 ppt discharge scenario (Table 5-20) will be achieved over a full tidal cycle. (BMT, 2021).
6. Groundwater drawdown in pastoral bores is not expected to significantly impact pastoral activities (PSM, 2020).
7. The hypersaline mine pit lake will act as a terminal sink with the groundwater level remaining well below the natural ground water table making, groundwater seepage from the mine pit lake to other groundwater sources unlikely (PSM, 2020).

Based on the model predictions, implementation of mitigation measures and predicted residual impacts, the revised proposal is expected to meet the EPA objective for Inland Waters.

The predicted outcome for the Environmental Factor of Flora and Vegetation from groundwater drawdown and dewater discharge is outlined in Section 9.

5.9 Assessment and significance of residual impact

Taking into account the development of adaptive management processes and the conservative nature of the modelling conducted, it is expected that the inland waters environmental quality objectives will not result in significant residual environmental impacts. The projected rate of dewatering will not reach the maximum of 21 GL/a immediately, there will be a staged ramp up to manage operational requirements over the remaining life of mine, with the maximum extent predicted to occur by 2040.

5.10 Environmental outcome

CPM expects that the following environmental outcomes will be achieved during the implementation of this revised proposal.

- river pools will not be affected as they are disconnected from the groundwater;
- water quality parameters (salinity) as measured at FR1 and FR3 will remain within recorded baseline levels for the MCP; and
- there will be no significant loss of GDV from Project activities beyond both the 5 m drawdown contour and areas approved for clearing.

6 Marine Environmental Quality

6.1 EPA Objective

The EPA objective for Marine Environmental Quality is to *maintain the quality of water, sediment and biota so that environmental values are protected.*

6.2 Policy and Guidance

The relevant policies for Marine Environmental Quality are:

- Environmental Factor Guideline - Marine Environmental Quality (EPA 2016f)
- Technical Guidance Protecting the Quality of Western Australia's Marine Environment (EPA 2016n).

6.3 Receiving Environment

A summary of work completed to describe the receiving environment for Marine Environmental Quality is the same as the undertaken for Inland Waters and is summarised in Table 5-1.

6.3.1 Marine Environmental Quality

Section 5.3.1.1 provides a detailed description of the surface water hydrological processes of the Fortescue River and estuary.

The Fortescue River function is tidally dominated with naturally high turbidity and low sediment trapping efficiency. The catchment is remote and relatively undeveloped with the exception of seasonal recreational use (fishing and camping), historical and current pastoral activities and small volumes of dewater discharge associated with the approved proposal. (RPS 2021a).

Baseline field sampling collected between April 2014 and November 2016 (Figure 21) at monitoring locations FR1, FR2, FR3 (Figure 21) prior to commencement of discharge in 2017 (RPS, RPS, 2021a) are outlined in Table 6-1.

Total Dissolved Solids (TDS) has been assessed as a 'physical and chemical stressor' using a threshold derived from baseline concentrations prior to construction of the outlet.

The composition of TDS (salinity) in both the discharge waters and ambient waters is dominated by inorganic salts with sodium, chloride, magnesium, calcium and potassium accounting for approximately 90-95% of the salinity (TDS) mass. On this basis the salinity (TDS) concentration (mg/L) is considered equivalent to salinity (ppt) for the assessment of water quality (RPS, RPS, 2021a).

Baseline salinity (TDS) values ranged from 36,400 mg/L (36.4 ppt) to 52,100 mg/L (52.1 ppt) with median salinity (TDS) ranging from 40,800 mg/L (40.8 ppt) to 42,900 mg/L (42.9 ppt) (at monitoring locations FR1, FR2 and FR3) (Table

6-1) indicating that salinity concentrations in the estuary are much higher than in adjacent ocean waters (36 ppt).

Ammonia was assessed as a toxicant against the relevant ANZECC species protection guidelines.

For nutrients it is the load to the environment rather than the final concentration that determines risk. All baseline samples (including metals) were all found to be slightly above ANZECC & ARMCANZ (2000) indicative values for turbid macrotidal areas (DAL 2000, Maunsell 2002).

Table 6-1 Baseline values for key water quality parameters

Parameter	Baseline Range mg/L	Baseline Median Range mg/L
Salinity (TDS)	36,400 – 52,100[1]	40,800 - 42,900[2]
Ammonia	0.0 - 0.14	0.03 - 0.045
TN	0.0 – 1.1	0.2
Nitrate	0.0 – 0.23[1]	0.015-0.03[2]
TP (bio-available phosphorous)	0.01 – 0.36	0.02-0.03

1. Lowest and highest concentrations recorded at monitoring locations FR1, FR2 and FR3
2. Median baseline range for monitoring locations FR1, FR2 and FR3

An analysis of salinity (TDS) and nitrate in the discharge water determined that salinity (TDS) required the highest dilution to achieve the baseline concentration threshold at monitoring locations FR1 and FR3. (Strategen, 2017).

Whilst the existing ambient monitoring regime includes total suspended solids and metal concentrations, monitoring criteria has not been defined as TSS are higher in the receiving environment and metal concentrations in the discharge were typically below the limit of reporting for the lab (BMT 2021).

6.3.2 Current approved discharge

On 1 September 2021 the EPA approved an increase in the discharge of groundwater to Fortescue River of up to 12 GL/a based on a discharge rate of 667 L/sec and discharge salinity (TDS) concentration of 70,000 mg/L (70 ppt).

Field measurements have been collected since discharge commenced in 2017/18, 2018/19, 2019/20 and 2020/21 to confirm modelled water quality predictions.

Monthly field measurements demonstrate that water discharged from the diffuser system is rapidly diluted in the near-field zone of the diffuser with salinity concentrations in the estuary remaining within the range of baseline concentrations (Table 6-1).

6.3.3 Revised Proposal

The revised proposal will increase the current approved discharge volume at the Fortescue River outfall from 12 GL/a to 21 GL/a.

The approved discharge of 12 GL/a maintained the previously approved discharge rate of 667 L/s based on a discharge salinity (TDS) concentration of

70,000 mg/L (70 ppt) with discharge scheduled to commence 60 minutes prior to the turning of the tide and ceasing 30 minutes prior to next incoming tide.

The proposed increased discharge of 21 GL/a will likewise maintain the approved discharge rate of 667 L/s based on a worst-case discharge salinity (TDS) concentration of up to 70,000 mg/L (70 ppt) with an increase to the discharge duration of up to 24 hrs/day, predicted in the hydrodynamic modelling presented in Section 5 (Inland Waters).

The revised proposal relies on the following studies:

- Technical Note: CPM Management pit dewatering: groundwater discharge to Fortescue River (BMT, 2021)
- Fortescue River Discharge Modelling: Background Salinity Variability Study (RPS, RPS, 2021a)

6.4 Potential Impacts

6.4.1 Environmental Quality Management Framework

The EPA, Technical Guidance, Protecting the Quality of Western Australia's Marine Environment (EPA, 2016n) sets out the Environmental Quality Management Framework (EQMF) for marine coastal environments within Western Australia. The EPA (2016n) defines Environmental Values (EV), Environmental Quality Objectives (EQO), Environmental Quality Criteria (EQC) and Levels of Ecological Protection (LEPs) for maintenance of ecosystem integrity.

Table 6-2 outlines the five EV and corresponding EQO that apply to Western Australian coastal waters (EPA 2016n). The EQO, *maintenance of ecosystem integrity* is considered a suitable proxy for the EQO of maintenance of fishing and aquaculture, recreation and aesthetics, cultural and spiritual values and industrial water supply (EPA 2016n).

In the context of the EQO for maintenance of ecosystem health the corresponding EQC should be clear, measurable and auditable (EPA, 2016n). It should also be determined based on the risk to environmental quality and be within the scientific limits of acceptable change to a measurable environmental quality indicator important for the protection of the associated environmental value (EPA, 2016n).

Table 6-2 Summary of Environmental Values and Environmental Quality Objectives

Environmental values	Environmental Quality Objective	Relevant for the development of specific EQG
Ecosystem health	Maintenance of ecosystem integrity	**Yes**
Fishing and aquaculture	Maintenance of aquatic life for human consumption	Protection of ecosystem integrity is an adequate proxy **s**
	Maintenance of aquaculture	Protection of ecosystem integrity is an adequate proxy

Environmental values	Environmental Quality Objective	Relevant for the development of specific EQG
Recreation and aesthetics	Maintenance of primary contact recreation values	Protection of ecosystem integrity is an adequate proxy
	Maintenance of secondary recreational values	Protection of ecosystem integrity is an adequate proxy
	Maintenance of aesthetic values	**Yes**
Cultural and spiritual	Maintenance of Cultural and spiritual values	Protection of ecosystem integrity is an adequate proxy
Industrial water supply	Maintenance of Industrial water supply values	Protection of ecosystem integrity is an adequate proxy

Two EQO were identified for the revised proposal to protect the EV of the Fortescue River and estuary. The remaining EV and EQO are still relevant to the assessment and will be protected through the maintenance of ecosystem integrity.

6.4.2 Environmental quality indicators and criteria

The Fortescue River and estuary is subject to a number of pressures (EPA, 2016n), including nutrient loads from pastoralism, recreational camping and fishing and historical and current hyper-saline discharges from the approved proposal.

The proposed change in process will not modify the concentration of potential analytes in the discharge but will increase the annual volume discharged from 12 GL/annum to 21 GL/annum. The higher discharge volume will be achieved by discharging at the same flow rate (up to 667 L/sec) over a longer period (up to 24 hrs/day). This discharge has the potential to affect marine water quality and dependent organisms in the river and adjacent ocean.

Projected concentrations of chemical constituents of concern (TDS and ammonia) at sites FR1 and FR3 were determined using modelling (RPS 2020). A time-series of projected 50th percentile TDS and 95th percentile ammonia concentrations at sites FR1 and FR3 were used to derive summary statistics for comparison to the relevant triggers. Justification for the proposed management criteria is outlined in the Fortescue River Estuary Environmental Quality Management Plan (Appendix 8).

Table 6-3: Modelled Ambient Concentrations & Proposed Management Criteria

Indicator	Modelled Concentration (21GL/a)		EQMP Criteria	
	FR1 (mg/L)	FR3 (mg/L)	Trigger Criteria	Threshold Criteria
TDS (mg/L)	43,766[1]	45,867[1]	48,035	52,100
Ammonia (mg/L)	0.86[2]	0.98[2]	0.91	1.2

[1] Modelled Median
[2] Modelled 95th Percentile

6.5 Potential Impacts

The following potential impacts have been identified as relevant to the environmental factor of Marine Environmental Quality:

- Osmotic Stress: the discharge of high salinity groundwater to the receiving environment may lead to persistent increases in salinity that may result in impacts to marine ecosystems and communities.
- Nutrient Stress; Additional nutrient load in the discharge could stimulate algal growth.
- Toxicity: Elevated ammonia in the discharge could cause short term toxicity near the diffuser. The introduction of toxicants may adversely impact communities near the diffuser.

6.6 Assessment of Impacts

Salinity is assessed as a 'stressor' (EPA 2016n). Salinity (TDS) for the modelled one-month period (full tidal cycle) is projected to remain within the baseline concentration range for the 70,000 mg/L discharge scenario at both FR1 and FR3 monitoring locations (RPS, RPS, 2021a) (Table 6-4).

Table 6-4 Projected salinity (TDS) concentrations for the 21 GL/a discharge relative to 2020/2021 concentrations

Parameter	Baseline salinity range	2020/2021 median concentration at FR1 (mg/L)	Modelled median concentration at FR1 (mg/L)	2020/2021 median concentration at FR3 (mg/L)	Modelled median concentration at FR3 (mg/L)
Salinity (TDS) (70,000 mg/L)	36,400 - 52,100	41,200	43,766	43,450	45,867

Concentration of ammonia in the discharge were high relative to baseline and as a result the 95th percentile ammonia concentration was an order of magnitude higher at sites FR1 and FR2 than the median baseline concentrations. Nevertheless, 95th percentile ammonia concentrations were lower than the 90% species protection guideline at each location and on each sampling occasion (BMT 2021).

Table 6-5 Projected salinity (TDS) concentrations for the 21 GL/a discharge relative to 2020/2021 concentrations

Parameter	ANZECC 90% species protection Guideline	2020/2021 95th percentile concentration at FR1 (mg/L)	Modelled 95th percentile concentration at FR1	2020/2021 95th percentile concentration at FR3 (mg/L)	Modelled 95th percentile concentration at FR3
Ammonia	1.2	0.18	0.86	0.25	0.98

Total nitrogen loads are projected to increase by 0.24 tonnes/day (from 0.32 to 0.56 tonnes/day). Nitrate loads are expected to increase by 0.10 tonnes/day (from 0.16 to 0.26 tonnes/day). Phosphorus loads are expected to increase by 0.00104 tonnes/day (from 0.00066 to 0.0017 tonnes/day). While there are no formal assessment guidelines for nutrient loads, the loads (e.g. average nitrogen load of 560 kg/day) are small compared to other approved sustainable discharges (e.g., nitrogen load of up to 4900 kg/day from Perth's Sepia Depression Ocean Outlet) (BMT, 2021).

Table 6-6 Projected nutrient loads for the 21 GL/a discharge relative to historical and current loads (BMT 2021)

Parameter	Date	Median groundwater concentration (mg/L)	Authorised Discharge volume (up to GL/year)	Load (t/day)
Total nitrogen (TN)	2017/2018	27.05	2	0.15
	2018/2019	9.4	8	0.21
	2019/2020	9.8	8	0.21
	2020/2021	9.8	12	0.32
	Modelled	9.8	21	0.56
Nitrate (NOx)	2017/2018	12.5	2	0.069
	2018/2019	3.5	8	0.076
	2019/2020	4.5	8	0.099
	2020/2021	4.7	12	0.16
	Modelled	4.5	21	0.26
Phosphorous (TP)	2017/2018	0.12	2	0.00066
	2018/2019	0.025	8	0.00056
	2019/2020	0.03	8	0.00066
	2020/2021	0.03	12	0.00066
	Modelled	0.03	21	0.0017

6.7 Mitigation

The objective for the mitigation of impacts to Marine Environmental Quality is to minimise impacts on water and sediment quality and biota from the revised proposal.

To achieve this objective, existing management measures prescribed in EP Act Licence L8308/2008/2 (2021b) will continue to be implemented.

In addition, a campaign-based monitoring program will be implemented during the initial stages of the increased discharge regime (21 GL/a over a 24-hour period) to confirm model predictions relating to dispersion and dilution of the discharge over the full tidal cycle including during spring and neap tides. The monitoring program will be developed with the assistance of a specialist expert consultant and will consider a range of methods to track dispersion and may include a dispersion plume dye trial. The objective of this monitoring program is to ensure that long term discharge does not lead to localised impacts on water quality.

Avoidance

1. Maintain a discharge rate of up to 667 L/sec to ensure optimum operation of diffuser.

Minimisation

2. Maintain optimum diffuser operation to ensure that predicted mixing and dilution is achieved (RPS APASA, 2017).
3. Maintain dewater discharge infrastructure proactively to avoid uncontrolled release of hypersaline water to the environment.
4. Monitor discharge water quality against the limits outlined in EP Act Licence L8308/2008/2 (2021b).
5. Monitor surface water quality in accordance with EP Act Licence L8308/2008/2 (2021b).
6. Implement dispersion and dilution monitoring program.
7. Implement mine dewater discharge adaptive management measures which may include altering discharge volumes, dilution with fresher water sources and/or reverting to tidal based discharge regime to improve dispersion.

6.8 Assessment and significance of residual impact

Based on the predicted salinity and nutrient concentrations of the increased discharge volume and with the implementation of mitigation and management measures, the following outcomes are expected:

1. The salinity (TDS) concentration in discharge water is predicted to remain within EP Act Licence L8308/2008/2 limits.
2. Baseline salinity concentrations will be maintained at FR1 and FR3 monitoring locations for the 70 ppt scenario over a full tidal cycle.
3. Early detection of increases in discharge salinity concentrations will be identified through continuation of the EP Act Licence L8308/2008/2 (2021b) discharge monitoring program and implementation of adaptive management measures that may include altering discharge volumes, dilution with fresher water sources and/or reverting to tidal based discharge regime to improve dispersion.
4. Early detection of changes in surface water salinity concentrations will be identified through continuation of the EP Act Licence L8308/2008/2 (2021b) surface water monitoring program.
5. Ammonia concentrations will satisfy the 90% species protection guideline at FR1 and FR3.
6. Implementation of adaptive management actions will ensure that salinity baseline concentrations are maintained within the Fortescue River and estuary.

The Fortescue River is a highly variable environment and experiences significant volumes of fresh water during rain events, which could emanate from any part of its expansive catchment. Modelling conducted has confirmed that water quality within the Fortescue River, as a result of the revised proposal, will remain within the baseline environmental water quality. In particular, it is expected that the salinity variability will be within the tolerance level of fauna which may inhabit or frequent the Fortescue River

It is therefore expected that the EPA objective for Marine Environmental quality will be achieved.

6.9 Environmental outcome

The environmental outcome as a result of the implementation of this proposal is:

- Marine water quality parameters (salinity (TDS), ammonia as measured at FR1 and FR3 will remain within the proposed management criteria as detailed within the Fortescue River Estuary EQMP.

7 Benthic Communities and Habitats

7.1 EPA Objective

The EPA objective for Benthic Communities and Habitats is to *protect benthic communities and habitats so that biological diversity and ecological integrity are maintained*.

7.2 Policy and Guidance

The relevant policy and guidelines for Benthic Communities and Habitats are:

- Environmental Factor Guideline – Benthic Communities and Habitats (EPA, 2016a)
- Technical Guidance Protection of Benthic Communities and Habitats, (EPA, 2016o)
- Guidance for the Assessment of Environmental Factors Western Australia (in accordance with the Environmental Protection Act 1986) - Guidance Statement for Protection of Tropical Arid Zone Mangroves Along the Pilbara Coastline. Environmental Protection Authority, Perth, Western Australia (EPA, 2001)

7.3 Receiving Environment

A summary of work completed to describe the receiving environment and the potential impacts of the revised proposal with respect to the values of the Fortescue River estuary water quality, as it impacts on Benthic Communities and Habitats, is outlined in Table 5-1.

Significant regional Benthic Community Habitat (BCH) studies were undertaken for the Mardie Salt Project (the Study Area). These studies are considered relevant in describing the Benthic Habitats of the Pilbara Region and the Fortescue River Delta and Mangrove Management Area and have informed this assessment. These studies are outlined in Table 7-1

Figure 31 presents the Benthic Habitats within the Fortescue River Delta and Mangrove Management Area (MMA).

Table 7-1 Regional BCH Studies relevant to the Fortescue River Delta and Mangrove Management Area

Author/date	Survey/ investigation name	Study area, type, timing	Study standard, guidance & limitations
O2 Marine (2018)	Mardie Salt Project, Snapshot Survey of the Benthic Habitats and Communities at the Proposed Bitterns Pipeline and Outfall Infrastructure Options	Targeted survey undertaken in March 2018 of BCH values within and surrounding the proposed bittern's pipeline and outfall infrastructure options.	The studies were conducted in accordance with: Technical Guidance, Protection of benthic communities and habitats (EPA, 2016) Guidance Statement No. 1, Protection of tropical arid zone mangroves along the Pilbara coastline, Western Australia, (EPA, 2001). Technical Guidance, Protecting the Quality of Western Australia's Marine Environment (EPA 2016) Environmental Factor Guideline, Benthic Communities and Habitats (EPA 2016) Technical Guidance, Environmental Impact Assessment of Marine Dredging Proposals (EPA, 2016) Technical Guidance, Protecting the Quality of Western Australia's Marine Environment (EPA 2016)
O2 Marine (2020a)	Mardie Project, Intertidal Benthic Communities and Habitat. Report prepared for Mardie Minerals Ltd	The study was undertaken in August and October 2017 over an 75km stretch of coastline from the southern boundary of Mangrove Management Area 8 and the Fortescue River Delta in the north to the Robe River Delta in the south. The study mapped the local and regional intertidal benthic communities and habitats within Local Assessment Units (LAU).	
O2 Marine (2020b)	Mardie Project, Subtidal Benthic Communities and Habitat. Report prepared for Mardie Minerals Ltd	The study was undertaken from March 2018 to January 2019 to map the local and regional subtidal habitats within LAU. Surveys were undertaken at 206 locations using drop camera / towed video at all locations and diving / snorkelling to verify habitat in low visibility areas.	
O2 Marine (2020c)	Mardie Project, Benthic Communities and Habitat Cumulative Loss Assessment. Report prepared for Mardie Minerals Ltd	The study outlines the benthic communities and habitat cumulative loss assessment to meet the requirements outlined in the Mardie Project Environmental Scoping Document.	
O2 Marine (2020d)	Mardie Project, Expert Advice on the Significance of the BCH Impacted by the Proposal from a Local and Regional Perspective	The assessment addresses the Mardie Salt ESD requirement for expert review and advice of the documentation and maps relevant to the studies undertaken to characterise intertidal and subtidal BCH within the project area and local and regional surrounding areas. Other regional information on BCH has also been assessed.	
Preston Consulting,	A report on the environmental values within the Mardi Salt proposal area,	The key environmental factors identified for the Mardie Salt Project includes:	

Author/date	Survey/ investigation name	Study area, type, timing	Study standard, guidance & limitations
2020, Mardie Project, Environmental Review Document	the potential impacts of the proposal on the environment and the avoidance and mitigation measures that will be implemented to reduce potential impacts.	• Inland Waters • Marine environmental quality • Benthic communities and habitats • Marine fauna • Flora and vegetation • Terrestrial fauna • Social surroundings.	
Stantec (2018)	Assessment of Mangal and Algal Communities for the Mardie Solar Salt Project	Two field surveys were undertaken as part of this assessment. A reconnaissance survey in August 2017 of the Project covering an 20km area of coastline. The second undertaken in October 2017 covering an 75km area of coastline from 20km south of Robe River to north of the Fortescue River. The survey mapped the mangal and algal communities within LAU.	

7.3.1 Benthic Communities and Habitat

Recent intertidal BCH surveys were conducted for the Mardie Salt Project (EPA Assessment No. 2167) at a regional (Stantec, 2018) and local scale (O2 Marine, 2020a). The regional survey covered 82,833 ha extending 75 km along the coastline including areas within the EPA defined Fortescue River Mangrove Management Area 8 (EPA,2001) (Fortescue River MMA). The study identified broad habitat zones including mapping and analysis of mangroves, algal mats, samphire and mud/salt flats (Figure 31) (Preston, 2020).

Survey results relevant to the Fortescue River MMA are included in Section 7.3.2 and 7.3.3.

The BCH baseline information and data contained within the Stantec (2018) and O2 Marine studies (2020a, 2020b, 2020c and 2020d) are considered relevant to the revised proposal as they represent the most up to date information on BCH within the Pilbara region and Fortescue River Delta and Fortescue River MMA.

The regionally significant arid zone mangroves spatial data (published as part of the Pilbara Coastal Water Quality outcomes) within the Fortescue River Delta is restricted to the coast and does not extend up the river.

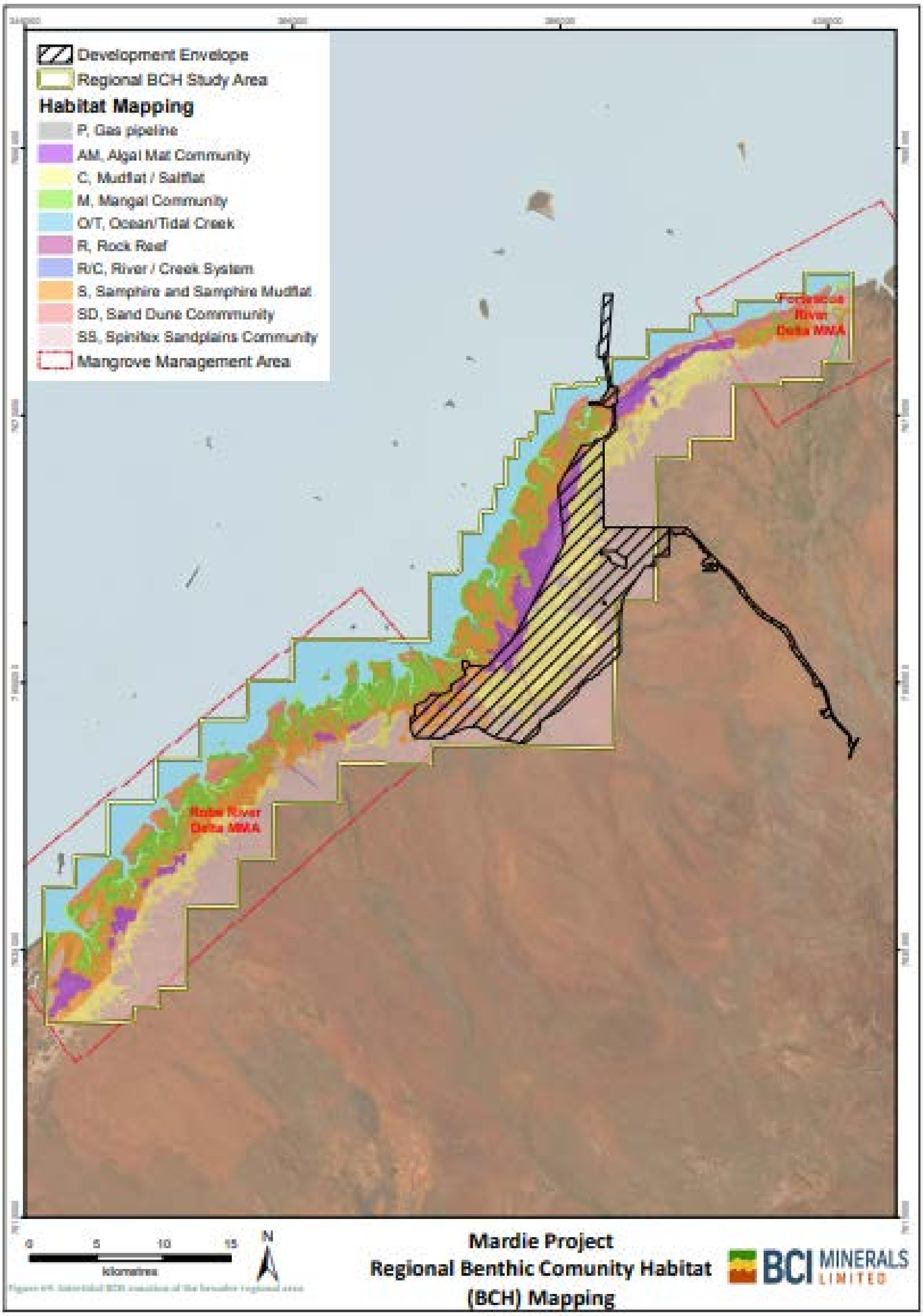


Figure 31 Benthic Habitats in the Fortescue River Management Area

7.3.2 Intertidal Communities and Habitats

7.3.2.1 Mangroves

Mangroves play a key role in primary and secondary productivity and carbon and nutrient cycling in intertidal environments. Mangrove habitats act as sinks for dissolved nitrogen, phosphorous, carbon and silicon and are rich in organic matter from leaf litter that contributes to the food web. Mangroves provide shelter, feeding, nursery and breeding for marine biota and migratory and resident birds (Preston, 2020).

The waters in and around Mangroves are home to a higher density of juvenile fish than adjacent coastal waters, with most fish spending part of their juvenile stage in mangrove communities (Holgium. 2001). Arid zone algal mat and mangrove communities have lower rates of primary and secondary production, lower species richness and limited habitats than tropical mangrove communities resulting in a comparably low level of biodiversity, although abundance of associated fauna can be very high. Higher rates of catch for commercial fish and prawn species are experienced in areas close to mangrove habitats (Holgium et. al., 2001).

Mangrove communities in the Pilbara have lower species richness with reduced variation of assemblages compared to those in the Kimberley (URS, 2010). The Pilbara has a tropical arid climate, lower tidal variations and rivers, creeks and estuaries that are less well developed than the Kimberley. The intertidal zones in the Kimberley and Pilbara are distinctly different, with the Pilbara characterised by large expanses of mudflats/salt flats and algal mats along the landward margins of intertidal zones whilst similar areas in the Kimberly contain several species of mangrove, that do not occur in the Pilbara due to hypersaline conditions.

Seven species of Mangroves are known to occur within the Pilbara region (EPA, 2001). Of these, three species representing two families were identified during surveys undertaken by Stantec (2018) and O2 Marine (2020). These included:

- Avicennia marina (Avicenniaceae);
- Ceriops australis (Rhizophoraceae); and
- Rhizophora stylosa (Rhizophoraceae).

Sites within 'regionally significant' mangrove areas (Robe River and Fortescue River Deltas) were typically identified to support less dense, but taller and thicker trees which comprise a higher or comparable canopy cover to that recorded within mangrove sites in the broader Study Area. The Robe River Delta contains a higher proportional composition of multi-stemmed *R. stylosa* trees than other sites, whereas the Fortescue River Delta site is dominated by tall, thick *A. marina* trees which are broadly spatially dispersed. (Stantec, 2018).

Benthic Habitats of the Fortescue River were mapped in 2001 with mangroves covering an area of ~120 ha (EPA, 2001).

Salinity

The major contributing factor for mangrove distribution is the salinity gradient (Paling et. al. 1990) (URS, 2010a). Salinity gradients are responsible for altering mangrove species distribution (through altered salt tolerances between species) and mangrove community structure (URS, 2010a).

Due to the extreme water and salinity stresses in the Pilbara intertidal zone mangroves are of relatively lower productivity than the mangrove communities of the wet tropics (BMT, 2021). The tolerance of mangroves to a high saline environment is also tightly linked to population genetics with Western Australian species known to tolerate high salinity concentrations. *A. marina* has the widest salt tolerance range and can occur in salinity gradients from seawater (~45 ppt) to up to 90 ppt (Gordon, 1988), preferring salinity at the lower end of the range to thrive.

Whilst mangroves are considered salt tolerant, salinity is an important factor limiting propagule germination, seedling growth and reproduction (BMT, 2021). Salinity tolerance in mangroves depends on a range of adaptations, including ion compartmentation, osmoregulation, selective transport and uptake of ions, maintenance of a balance between the supply of ions to the shoot, and capacity to accommodate salt influx (BMT, 2021).

Hydrology

Fresh groundwater or surface water flows can be important pathways for the removal of salt extruded through mangrove roots and the removal of wastes, such as sulphides, methane etc. During extended drought periods, freshwater flows drastically subside resulting in increased salinities, particularly at the higher tidal elevations (Alonghi, 2009a). The reliance of freshwater input in maintaining mangrove systems typically decreases with increasing aridity (Semeniuk, 1983; Gordon, 1988). This is particularly relevant in the Pilbara as rainfall is highly sporadic and often extended periods of drought are experienced. The Pilbara region is known to support the most arid mangrove assemblages in Australia (EPA, 2001).

Freshwater flows may also provide nutrient inputs; however, this is highly dependent upon local climatology and season (Alonghi, 2009a). A recent study within Exmouth Gulf concluded that freshwater inputs had a negligible influence on the regulation of salinity, nutrient flows and removal of wastes, due to the high evaporation rate, limited catchment area, low rainfall and lack of perennial rainfall (Biota, 2005). Due to the similarity of mangrove associations, climate and catchment characteristics between Fortescue and Robe River Deltas and Exmouth Gulf, the same reduced reliance on freshwater inputs for maintenance on mangroves is expected, as opposed to highly seasonal tropical mangrove assemblages, existing in northern Australia (Preston, 2020).

7.3.2.1 Algal mats

Recent regional surveys undertaken by Stantec (2018) within the Robe River and Fortescue River Deltas in the Pilbara region for the Mardie Salt Project, identified algal mat communities as either contiguous or fragmented. The following information is provided for local and regional context, given the proximity of the Fortescue River estuary to the revised proposal, being downstream of the current dewater discharge location.

Contiguous algal mats were described as extensive, thicker (1 - 5 mm) and more cohesive, characterised by a smooth appearance (Stantec 2018). Fragmented algal mats were thinner (1 – 3 mm) and patchier, often appearing pustular (Stantec 2018). Continuous and fragmented communities were comparable in terms of composition of taxa with little variation among assemblages across the entire Mardie Salt Study Area. The algal mats surveyed within the intertidal zone for the Mardie Salt Project are considered representative of algal mat habitats studied in similar sites across Pilbara region, including at Exmouth Gulf and south of Onslow (Stantec, 2018).

The algal mats were dominated by filamentous cyanobacteria including *Microcoleus* and *Lyngbya,* while *Calothrix* and *Schizothrix* with a diversity comparable to global and Pilbara coast communities and occurred at elevations of between 1.1 - 1.3 m Australian Height Datum (mAHD).

Algal mats thrive in shallow aquatic ecosystems, including tidal flats and coastal and hypersaline lagoons because of their ability to tolerate extremes in salinity, desiccation, temperature and ultraviolet radiation (Lee and Joyce, 2006). High salinity and dehydration were observed as controlling factors within algal mats at higher elevation in studies along the Exmouth Gulf and Onslow Coast (Biota, 2005) and (URS, 2010a). These observations may apply to the Fortescue River estuary (downstream of the revised proposal discharge location) given similar conditions.

Mudflats/saltflats were present on the landward edge of algal mat communities throughout the Mardie Salt Project Study Area, likely indicating the point at which maximum salinity levels are reached or exceeded.

Mudflats/saltflats are characterised by very high salinity, little to no tidal inundation and are extremely dry (Biota, 2005 and URS, 2010a). Grazing by invertebrates, molluscs and fish at high tides was also noted by Paling (1994) as a controlling factor in the distribution of algal mats at the lower gradient. (Stantec, 2018).

Whilst salinity and grazing are thought to impact distributions, uniquely, the two large algal mat communities occurring within the Mardie Salt Study Area are located in lower lying areas than the seaward BCH communities. This has created a unique environment where tidal creeks drain into algal mat communities, and when tides recede water remains over the algal mats for some time. This typically results in a shallow water level remaining during spring tidal cycles which are then exposed to periods of around 7 - 10 days whereby no tidal inundation would occur. This cycle results in a continuous saline water source entering the algal mat communities, resulting in intense evaporation and causing frequently changing and extremely high salinity levels within the algal mat communities.

Assessment of the extent of cyanobacteria mats is challenging due to a lack of knowledge about the factors that control their distribution. What is known suggests substantial variability in the extent of mats on an interannual basis, driven primarily by rainfall, which makes mapping difficult and introduces doubt over long term estimations of areal coverage (O2 Marine, 2020a). Primary productivity that occurs within algal mats is directly related to the nitrogen-fixing characteristics of the cyanobacteria that dominate the species composition within the Mardie Salt Study Area. Whilst there are specific areas located within the Study Area assigned with the BCH type of algal mat, it is widely understood that nitrogen-fixing cyanobacteria are present within most intertidal BCH, particularly mangroves (Pearl et al., 1993, Alongi, 1994, Holgium et. al., 2001 and Alongi, 2009).

7.3.2.2 Samphire/Samphire mudflats

Samphire/Samphire Mudflats are distributed over ~6,000 ha, comprising ~17% of the mapped intertidal BCH within the Mardie Salt Project study area. Samphire/Samphire Mudflats are associated with a wide range of both intertidal and terrestrial habitats types including Algal Mats, Mudflats/Saltflats, Mangroves and terrestrial flora associations. Regionally, they are typically located on the landward extent of Mangroves, but can also be located on the seaward extent of Algal Mats, landward of the Algal Mats and seaward of Mudflat/Saltflats. Samphire/Samphire Mudflats vary in ecological value with higher values occurring in higher density samphire closest to the coast (O2, 2020a).

Salinity is predicted to be the primary driver of samphire zonation (O2 Marine, 2020a). Soil salinity generally increases with distance from the coast, with a clear linkage to tidal inundation frequency. In the intertidal zone tidal inundation flushes the soils of evapoconcentrated salts and maintains a consistent range of soil salinities. Soils in the upper reaches of the intertidal zone are rarely inundated and as a result the evapoconcentration of tidal waters results in hypersaline conditions. This is evident in coastal samphire vegetation that is inundated regularly as opposed to sparser samphire vegetation further inland that is only inundated in extreme events. Areas where soil salinity is lower are more suitable habitat for invertebrates, with higher numbers recorded closer to the coast (O2 Marine, 2020a).

Samphire vegetation types further inland contain flora known to be terrestrial, including *Eragrostis falcata* grasses, occurring across WA and in salt lakes and saline flats. Inland samphire communities are present at the transition between BCH and terrestrial vegetation, and in some cases may not be considered BCH. This difference is aligned with migratory shorebird records that are predominantly in coastal samphire vegetation. Phoenix surveys also identified that the great majority of the bird observations were in the tidal samphire likely due to lower soil salinities closer to mangroves and tidal creeks due to more regular and longer inundation of the substrate with a corresponding increase in invertebrate infauna (Dr Russell Hanley, 2020) (O2 Marine, 2020d). Based on the above, the inland samphire vegetation types are considered to have lower ecological value and usage by significant fauna.

7.3.2.3 Mudflats and salt flats

Mud flats and saltmarsh/salt flats comprise 8.3 km^2 and 13.80 km^2 respectively within the Fortescue River (BMT, 2021).

Salt marshes and flats are subject to rapid wetting during flooding periods followed by a slow drying period as the water progressively evaporates. As a result, the salinity of the surface water varies over time and becomes progressively more saline as it evaporates.

Species tolerance within these environments can be achieved through behavioural, ecological and/or physiological mechanisms (Drouin et al. 1985; Helmuth 1998; Zardi et al. 2006; Michalec et al. 2010) (BMT, 2021) such as the response of sessile molluscs to low tides involving closure of shell valves (bivalves) or operculum (gastropods) isolating them from the environment for a period of hours (Hoyaux et al. 1976; Davenport & Wong 1986; Berger & Kharazova 1997; HRSBrenko 2006) (BMT, 2021).

The change from mudflat to saltflat is often imperceptible due the gradual alteration between habitats (O2 Marine, 2020a). Mudflat/Saltflats cover the largest area of intertidal BCH and are the dominant intertidal BCH occurring within the Mardie Salt Project Study Area covering an area of 10,000 ha and representing approximately 29% of the intertidal BCH within the Study Area (O2 Marine, 2020a) (Figure 31).

Mudflats/Saltflats are typically widespread across the supratidal zone between the landward edge of Algal Mats or Samphire/Samphire Mudflats and the terrestrial boundary. Data collected by Soilwater Group, (SWG, 2019) indicates soil salinities collected from mudflats range from 52.7 - 4,420 mS/m whilst sulphur, organic carbon and potassium were typically lower than algal mats suggesting a low biological component (Soil Science Unpublished data). This is typical of intertidal BCH studies undertaken within the Pilbara (Preston, 2020).

Mudflats/Saltflats are typically hypersaline and support little to no flora or fauna communities. Phoenix (2020b) surveys identified very few associated faunal observations and often went minutes without observing a single bird, and when observed they were typically individuals or small groups (e.g., Red-capped Plover).' SKM (2011) also identified very few benthic invertebrate species from a study area within Port Hedland, also noting the absence of molluscs and insects. SKM (2011) noted that within these systems tidal inundation is highly infrequent and short in duration and the soil and porewater salinities typically exclude organisms (Preston, 2020).

7.3.3 Subtidal Benthic Communities and habitats

Bare sand substrate

Bare sand substrate, comprising fine silty to coarse sands, is the dominant sub tidal BCH in the nearshore subtidal zone of the Pilbara (Figure 31) within the study area and at Cape Preston where studies identified ~70% sand. Bare or unvegetated substrate is afforded the lowest level of protection given the limited contribution to primary production and low relative value as marine fauna habitat. However, this BCH does support microphytobenthic algal communities and benthic infauna.

Seagrass

Seagrasses are known to provide valuable ecosystem services such as carbon storage, filtering nutrients and particles from the water column, stabilising sediments and providing high primary productivity (McKenzie et al., 2006). Seagrass meadows also provide an important source of foraging habitat for Dugong, marine turtles and commercially important fisheries species, such as prawns.

It is well documented that seagrass habitats in the Pilbara vary greatly between seasons and years. *Halophila sp.* seagrass meadows occur in the Pilbara region east of Cape Preston (O2 Marine, 2018) and near Coolgra Point (Chevron, 2014) with densities up to 50% recorded at both locations. *Halophila sp.* is the most widespread of the tropical seagrass species, can colonise the widest range of habitat types and appears to be genetically diverse.

Dugong activity in the vicinity of the dense seagrass meadows east of Cape Preston were observed during a 2018 reconnaissance survey with four individual observations recorded over two days (O2 Marine, 2018).

The meadows east of Cape Preston and at Coolgra Point are considered high quality and regionally significant.

Corals

Corals are an important contributor to primary production, nutrient recycling, and providing habitat and a food source for a myriad of marine species. In addition to ecosystem services relating to fishing and recreational use including tourism, corals are very significant due to their ability to form habitats with high levels of associated biodiversity (O2 Marine, 2020b).

Coral species were identified within the study area in low to moderate densities and confined to sediment tolerant species (e.g. *Faviidae, Dendrophyllidae, Mussidae and Poritidae*). Corals within the Mardie, Onslow and Cape Preston coastal waters experience turbid waters for most of the year, particularly in the summer months, due to stronger winds and the generation of wind swell resulting in the uplift of fine sediment in the water column (O2 Marine, 2020b).

The coral families found at Mardie, Onslow and Cape Preston support dominant coral species that have a high tolerance to the natural stressors (i.e. cyclones, waves, sedimentation, etc.) that are commonly experienced in the region (Ayling & Ayling, 2005; Chevron, 2014).

A marked increase in diversity and abundance of coral species was observed at the fringing reefs surrounding the nearby islands, indicating that these areas represent the most regionally significant coral habitats.

Macroalgae

Macroalgae are locally and regionally widespread within the Pilbara region with as many as 187 different algal species found in the region by the Pilbara Marine Conservation Partnership (Kendrick and Olsen, 2017). Macroalgae are generally restricted to hard substratum in subtidal and lower intertidal areas and appear to be most dominant on shallow hard pavement, platforms and flats that surround islands (Chevron, 2015b). The species observed in the study area are typical of the turbid nearshore Pilbara environment and have been observed in similar areas including Cape Preston, Onslow and Dampier (O2 Marine, 2020b).

Macroalgae are an important component of tropical reef ecosystems as they contribute to the productivity of a system as a food source, provide habitat for a range of economically and ecologically important species, contribute to local sediments and play an important role in the nutrient cycle from decomposition (Kendrick and Olsen, 2017). Some algae are significant in formation and maintenance of coral reefs (Kenrick and Olsen 2017).

Filter feeders

Filter feeder communities include bivalves, hard and soft corals, sea squirts and sponges. Filter feeder communities found in the Pilbara dominate the seafloor where waters are turbid or deep and sunlight penetration is low. Sponges comprise the highest abundance and diversity of filter feeders in the Pilbara with 1,233 species identified in the Pilbara (Abdul et al., 2019).

Sessile filter feeder communities, found in nearshore Pilbara environments, include hydroids, bryozoans, ascidians, gorgonians and soft corals (Abdul et al., 2019) and are often found in association with algae, coral, seagrass or sponge in habitats with low to dense cover.

These associations are also found in Onslow, common on the sand veneered pavement and dominated the inner shelf. At some sites, filter feeders such as hydroids were found in isolation with sparse community structure and nutrient cycle (Sanchez et al., 2016 & Abdul et al., 2019).

Benthic filter feeders play an important role in ecological connectivity and in providing food for pelagic, demersal and commercially important species.

Marine Parks and Nature Reserves

Conservation of ecologically significant marine, estuarine or terrestrial ecosystems are managed through reserves established under the *Conservation and Land Management Act 1984*. The nearest Marine Park is the Montebello Islands Marine Park, which is located ~90 km northwest of the revised proposal area. All inshore islands of the West Pilbara are listed as Class C Nature Reserves with the closest islands (Passage Islands group, Sholl Island, Angle Island and Mardie Island) located ~30 km west of the revised proposal area. Inshore islands are important for migratory seabirds, turtles and dugong and support large areas of macroalgal beds and biogenic coral reef and coral communities on pavement.

7.4 Potential Impacts

Benthic habitats respond to changes in environmental conditions and could potentially be impacted by changes in water quality associated with the increased discharge volume (BMT, 2021).

The discharge of higher salinity groundwater to the receiving environment may lead to increases in salinity and exceedance of tolerance limits of communities resulting in osmotic stress (BMT, 2021).

The extent and impact of dewater discharge on hydrological processes is outlined in Section 5 (Inland Waters) while Section 6 (Marine Environmental Quality) describes the impact of groundwater discharge on marine environmental quality.

7.5 Assessment of Impacts

Mangrove communities are considered the indicator species for impact to benthic communities and habitats as they occur within tidally influenced reaches of the Fortescue River and estuary with lower salinity concentrations and therefore lower salinity tolerances of all benthic communities within the Fortescue River MMA. Adverse effects associated with the revised proposal are therefore likely to be detected within mangrove communities prior to other benthic habitats.

Baseline salinity of concentrations up to 52,100 mg/L suggest that local species are likely to be adapted to a wide variation in salinity concentrations within the Fortescue River and estuary environment. Predicted median salinity concentrations (RPS, 2021a) at all monitoring locations for the increased discharge (21 GL/a over 24 hours) will remain within baseline concentrations at monitoring locations FR1 and FR3.

Total nitrogen loads are projected to increase by 240 kg/day (from 320 kg/day to 560 kg/day), with nitrate loads expected to increase by 100 kg/day (from 160 kg/day to 260 kg/day) and phosphorus loads expected to increase by 1.04 kg/day (from 0.66 to 1.7 kg/day) (refer to Table 6-10). Whilst there are no formal guidelines for nutrient loads, the predicted elevated nutrient loads are not expected to increase the potential for algal blooms due to the phosphorus limiting potential of highly mixed, turbid environments.

Predicted water quality in the Fortescue River and estuary based on the increased discharge volume of, up to, 21 GL/a and expanded discharge duration of up to 24 hrs/day is expected to remain within the proposed management criteria as detailed within the Fortescue River Estuary EQMP and well within the known tolerance of benthic habitats. In the context of the size, volume and efficient tidal flushing of the Fortescue River and estuary it is unlikely that the nutrient load increase will have a significant impact to benthic communities and habitats of the Fortescue River and estuary given that the increased discharge represents just 2.7% of the peak tidal volume flux during neap tides and only 0.3% of the peak flux during spring tides.

Potential Mangrove Loss

Mangroves within the Pilbara region and within the Fortescue River MMA occur within a largely uncleared landscape. Intertidal BCH within the Fortescue and Roebourne MMA currently have at least 92% of their pre-European extent remaining (O2 Marine, 2020c). The BCH generally represents widespread communities and is well represented with many having distributions either within the Australian tropics or internationally (O2 Marine, 2020c).

There has been minimal clearing in the local area, limited to that required for pastoral purposes and the Cape Preston port development.

Any impact to mangrove health is expected to be highly localised within an area of 20m surrounding the diffuser. Adverse impacts to mangroves are not predicted under the revised proposal outside of the initial discharge zone (20m up and downstream of the diffuser).

Mangrove Monitoring

Condition 28 of EP Act Licence L8308/2008/2 (2021b) requires the licence holder to conduct a vegetation monitoring programme in accordance with the requirements specified in Table 14 (replicated in Table 7-2) of the licence and record the results of all monitoring activity conducted under the programme.

Table 7-2 Monitoring of ambient vegetation health

Monitoring location (L8308/2008/2)	Parameter	Averaging period	Frequency
FR2 (discharge point)	Visually estimate the average foliage cover	Visual inspection	Annually
	Score the health condition		
	General environmental description of the site and record any changes since previous monitoring		
	Take replicate photographs of foliage density and shadow areas beneath trees		

Annual monitoring in accordance with the EP Act licence commenced in Aug-17.

The results of the mangrove ambient vegetation health monitoring conducted at FR2 discharge (August 2020) showed signs of a decline in health of one of the mangrove reference trees (FR001-A). this tree is located at the furthest distance from the river and is considered to be outside the influence of river levels and more dependent on seasonal rainfall.

CPM engaged an independent consultant to assess the tree health and found the reduction in foliage was due to natural causes. The health decline was considered to be due to below average rainfall that resulted in reduced flushing and an increase in soil salinity. It was also noted that this mangrove tree is located in close proximity to a camping area and external influences from the general public cannot be ruled out. Increased mangrove health monitoring frequency since early January 2021 saw FR001-A showing signs of health recovery with improved foliage cover and growth, considered likely due to the increased rainfall from late 2020 to mid-2021.

All other mangroves assessed were found to be healthy and no observable change to the previous assessment conduct in August 2019.

As detailed within the Fortescue River Estuary EQMP (refer to Appendix 8), it is proposed to expand the existing mangrove health monitoring program to include additional impact and control transects and increase the frequency to biannual.

7.6 Mitigation

The objective for the mitigation of impacts to Benthic Habitats is to minimise impacts on the biological diversity and ecological integrity.

To achieve this objective the following mitigation measures will be implemented:

Avoid:

1. Maintain the rate of discharge to the Fortescue River of up to 667 L/sec

Minimise:

2. Maintain optimum diffuser operation to ensure that predicted mixing and dilution is achieved (RPS APASA 2017).
3. Maintain dewater discharge infrastructure proactively to avoid uncontrolled release of hypersaline water to the environment.

4. Monitor discharge water quality against the limits outlined in the EP Act Licence L8308/2008/2 (2021b).
5. Monitor surface water quality in accordance with EP Act Licence L8308/2008/2 (2021b)
6. Implement mine dewater discharge adaptive management measures these may include storage and dilution of mine pit dewater to achieve discharge water quality limits prior to discharge to Fortescue River and estuary
7. Implement discharge plume monitoring as outlined in Section 6.7.
8. Update the GDVMP to update the management zone boundary to reflect revised predicted groundwater drawdown contours and review and update monitoring locations within the management zone boundary, establishing new monitoring locations where required.
9. Monitoring of Benthic Habitats (using mangroves as the indicator species) as outlined in the OEMP and the GDVMP to identify early signs of health decline associated with the revised proposal.

7.7 Assessment and significance of residual impact

Based on the results of the hydrodynamic modelling (RPS 2021a) and the assessment of potential impacts to ecological values relevant to the increased discharge (21 GL/a over 24 hours) (BMT, 2021) and following the implementation of mitigation measures it is considered that:

1. The salinity (TDS) concentration in discharge water is predicted to remain within EP Act Licence L8308/2008/2 limits.
2. Baseline salinity concentrations will be maintained at FR1 and FR3 monitoring locations for the 70 ppt scenario over a full tidal cycle.
3. Early detection of increases in discharge salinity concentrations will be identified through continuation of the EP Act Licence L8308/2008/2 (2021b) discharge monitoring program and implementation of adaptive management measures that may include altering discharge volumes, discharge with fresher water source and/or reverting to tidal based discharge regime to improve dispersions.
4. Early detection of changes in surface water salinity concentrations will be identified through continuation of the EP Act Licence L8308/2008/2 (2021b) surface water monitoring program.
5. Ammonia concentrations will satisfy the 90% species protection guideline at FR1 and FR3.
6. Plume dispersion modelling will ensure that long term discharge does not lead to localised impacts on water quality within Fortescue River and estuary.
7. Mangrove monitoring, including site-based monitoring and use of aerial imagery will identify changes to mangrove health to provide an early

indicator of stress to Benthic Habitats generally (refer to Fortescue River Estuary Environmental Quality Management Plan in Appendix 8).

On this basis it is considered that the EPA objective for Benthic Communities and Habitats will be achieved for the revised proposal.

7.8 Environmental outcome

The environmental outcomes resulting from the implementation of the proposal, with respect to benthic communities and habitat are:

- No predicted adverse impacts to mangroves under the revised proposal outside of the initial discharge zone (20m up and downstream of the diffuser) as verified by the mangrove monitoring program (refer to Appendix 8).

8 Marine Fauna

8.1 EPA Objective

The EPA objective for Marine Fauna is to ensure that biological diversity and ecological integrity is maintained.

8.2 Policy and Guidance

The relevant policy and guidelines for Marine Fauna are:

- Environmental Factor Guideline – Marine Fauna (EPA, 2016g)
- Environmental Factor Guideline, Benthic Communities and Habitats (2016a)
- Environmental Factor Guideline, Marine Environmental Quality (2016f)
- Technical Guidance - Protection of Benthic Communities and Habitats (2016o)
- Technical Guidance, Protecting the Quality of Western Australia's Marine Environment (2016n)
- Environmental Factor Guideline, Inland Waters Environmental Quality (2018a)

8.3 Receiving Environment

8.3.1 Marine Fauna

The most significant risk to marine fauna from the revised proposal is the potential effect that a change in the quality of water in the Fortescue River and estuary may have on conservation significant species habitat or individuals. The assessment of marine fauna likely to occur in the receiving environment is therefore focused on conservation significant and commercially important species that have a preference for near shore, shallow estuarine and riverine environments.

The information presented in this Section and Sections 8.4, 8.6 and 6 will focus on the marine fauna that is likely to occur within the Fortescue River and estuary and is based on a recent search of the approved and revised proposal area and a 50 km buffer using the DAWE protected matters search.

Marine Mammals

Marine Mammals with the potential to occur within and surrounding the Fortescue River and estuary include:

- **Dugong (*Dugong dugon*) –** Listed as a migratory species under the EPBC Act, as specially protected under the Biodiversity Conservation Act (BC Act) and as vulnerable under the International Union for Conversation of Nature (IUCN), Dugongs are known to inhabit shallow coastal waters in Queensland and Western Australia and occur broadly in the Indian and Pacific Oceans. Dugongs prefer shallow, warmer coastal waters and are often observed grazing in seagrass meadows (DAWE, 2021). Dugong habitat occurs in the Cape Preston area with several Dugong observed during previous surveys in the area (O2 Marine, 2018)
- **Indo-Pacific / Spotted Bottlenose Dolphin (*Tursiops aduncus*)** – Listed as a migratory species under the EPBC Act, the Indo-Pacific Bottlenose Dolphins have been confirmed to occur in estuarine and coastal waters of eastern, western and northern Australia (DAWE, 2021). Whilst this species has not been recorded in the region suitable habitat occurs within the Cape Preston area and this species is most likely to occur in winter months when food sources are abundant (O2 Marine, 2018).
- **Australian Snubfin Dolphin (*Orcaella heinsohni*)** – Listed as a migratory species under the EPBC Act, as a priority 4 under the BC Act and as vulnerable under the IUCN, the Australian Snubfin Dolphins occur in northern Australia, from Broome on the west coast to the Brisbane River on the east coast. Aerial and water-based surveys indicate that Australian Snubfin Dolphins occur mostly in protected shallow waters close to the coast, and close to river and creek mouths. This dolphin species occurs throughout the region and are likely to be present in shallow and nearshore waters from June – September when food sources are abundant (DAWE, 2021).

Elasmobranch

Elasmobranch species with the potential to occur within the Fortescue River and estuary include:

- **Dwarf Sawfish (*Pristis clavata*)** – Listed as vulnerable under the EPBC Act, as priority 1 under the BC Act and as endangered under the IUCN, the species' is thought to inhabit shallow (2-3 m) coastal waters and estuarine environments across Northern Australian (Cairns and the Cape York Peninsula) waters and down to the Pilbara coast in Western Australia. There are no records of this species occurring in the region, with the western extent of this species range not fully understood (DAWE, 2021). Suitable habitat is however present in the local and regional area.
- **Green Sawfish (*Pristis zijsron*)** – Listed as vulnerable under the EPBC Act and the BC Act and as critically endangered under the IUCN, the green

sawfish has been recorded in Northern Australia, from Eighty Mile Beach in Western Australia to Cairns in North Queensland with occasional records as far south as Sydney (DAWE, 2021). This species prefers shallow coastal marine and estuarine habitats. Green sawfish are known to be pupped near the Ashburton River mouth and utilise the estuary and nearby mangrove creeks for about 3 – 6 months prior to moving offshore to mature to up to 3m in length. This species is known to occur in the region from recent scientific studies with suitable habitat present in the local and regional area (Morgan et al, 2015).

- **Narrow Sawfish (*Anoxypristis cuspidate*)** – Listed as a migratory species under the EPBC Act and as endangered under the IUCN, the Narrow Sawfish is an Indo-West Pacific species occurring from the northern Persian (Arabian) Gulf to Australia and north to Japan. It is a bentho-pelagic species occurring in inshore and estuarine environments to offshore habitats, to a depth of up to 100 m. The species prefers sheltered bays with sandy bottoms and feed on small fish and cuttlefish. The species has not been recorded in the region however potential habitat is present in the local and regional area (DAWE, 2021).
- **Grey Nurse Shark (*Carcharias taurus*)** – Listed as vulnerable under the EPBC Act and the BC Act, the Grey Nurse Shark is typically found in sub-tropical to cooler waters. The Western Australian population occurs in the cooler waters of the South West and has been recorded as far north as the North West Shelf and in and around the Muiron Islands. Potential suitable habitat occurs in the region (DAWE, 2021).
- **Reef Manta Ray (*Manta alfredi*)** – Listed as migratory under the EPBC Act and BC Act and as vulnerable under the IUCN, the Reef Manta Ray is generally found in inshore habitats (within a few km of land) in tropical and subtropical environments, near coral and rocky reefs in atolls and bays, likely due to available food within these areas (O2 Marine, 2020e). Reef manta rays occur predominantly in Indian and Pacific Oceans in coastal waters in Australia, Japan, South Africa, Thailand and Hawaii (DAWE, 2021). Whilst this species has not been recorded in the area, potential habitat does occur regionally.

Sawfish

Whilst there are no records of the Dwarf or Green sawfish occurring in the Fortescue River and Estuary, they are known to occur in similar riverine and estuarine environments within the Pilbara and Kimberley regions of Western Australia. These species were generally located < 700m upstream[3] and preferentially where the salinity ranged from 34.2 – 35.1 ppt[4].

A regional survey was conducted across northern Australia in 2004 to determine the regional status of Sawfish *(Pristidae)* and to assess their distribution in rivers and estuaries, spatial occupancy in each catchment and relative abundance in particular river systems (Thorburn et al. 2004). The survey was conducted over six months and surveyed 137 sites within 39 river/creek systems in Western Australia, Northern Territory and Queensland covering 30,000 km (DAWE,

[3] https://researchrepository.murdoch.edu.au/id/eprint/38844/1/neonate-and-juvenile-green-sawfish-Pristis-zijsron.pdf
[4] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=68442

2021). The survey caught three Green Sawfish (*Pristis zijsron*), 16 Dwarf Sawfish (P. clavata), 17 Freshwater Sawfish (P. microdon) and two Narrow Sawfish (Anoxypristis cuspidate) (Stevens et al. 2005). Of the 44 Dwarf Sawfish captured during the period 2002 – 2004 (including during the survey) 41 were captured in estuarine waters of the Fitzroy River (Western Australia), the May River (Kimberley Region, WA) and Robinson Rivers (Western Australia / Northern Territory), with three captured in the marine waters of King Sound (Western Australia) (Thorburn et al. 2004).

Surveys were conducted in April and October 2011 near the town of Onslow within Four Mile Creek, Hooley's Creek and the Ashburton Estuary to understand the presence and relative abundance of Sawfish (*Pristidae)* in the southern Pilbara region of Western Australia (Morgan et al, 2015). A total of 39 Green Sawfish (*P. zijsron)* were captured during the survey, including seven males and three females in April, and 14 males and 15 females in October 2011. Several distinct size classes were observed (767–972, 1350–1526 and >1990 mm) in October, with no clear group of larger-sized individuals observed in April. Larger numbers were caught in October 2011 due to recent pupping presumably at, or in close proximity to the site, with neonates making up almost half the individuals caught (Morgan et al, 2015).

A behavioural study of the Critically Endangered large tooth Sawfish (*Pristis pristis)* spanning an 8-year period, (2008 to 2015) in the freshwater reaches of the Fitzroy River, Western Australia, determined that this sawfish species moves between a range of riverine mesohabitats due to changes in multiple abiotic and biotic variables (Whitty et al, 2017). This study confirmed that sawfish movement in marine systems is predominately governed by tides (e.g. Stevens et al. 2008, Papastamatiou et al. 2015) whereas movements in estuarine environments are driven by light intensity and tidal movement (Whitty et al. 2009, Simpfendorfer et al. 2010, Poulakis et al. 2016, Huston et al. 2017).

The Dwarf and Green Sawfish have the potential to occur within the Fortescue River and estuary, based on the presence of sawfish species within similar riverine and estuarine environments in the Pilbara and Kimberley regions of Western Australia. If present, Dwarf and Green Sawfish could potentially be affected by short term, minor elevations in salinity and ammonia within the Fortescue River as a result of the revised proposal.

Sharks

Sharks are known to inhabit a variety of coastal and offshore habitats at varying depths. Several shark species were observed during a recent survey off the Pilbara coast (Stantec, 2018) within the nearshore environment including, Whitetip Reef Shark, Blacktip Reef Shark, Grey Reef Shark, Bull Shark and Tiger Shark and have the potential to occur in shallow riverine environments.

Rays

A number of Rays were observed during a recent survey of the Pilbara coast (Stantec, 2018) in the nearshore coastal waters including Stingray, Eagle Ray, Shovelnose Ray, Giant Manta Ray and Reef Manta Ray. Manta rays have been sighted sparsely distributed further offshore at depths of 50 - 150 m (O2 Marine, 2020e).

Fish

Desktop assessments identified 31 listed marine species from the order of ray finned fishes, sygnathiformes including the family Sygnathidea (seahorses, pipefishes, pipe horses and seadragons). Seahorse preferences for suitable habitat can be very diverse. Four species reported from the region each have individual preferences for suitable habitat ranging from soft bottom debris, algal rubble reefs, seagrass beds and coral reefs (Kangas et al., 2006). This information suggests there is a moderate potential that some of these species may occur in local area. Finfish diversity in the region is high with at least 456 species known to exist in the Montebello marine park region.

Mangrove communities are particularly important in the region as they play a role in providing suitable habitat and nursery areas for fishes and crustaceans, including commercially important species (O2 Marine, 2020e). Six species of fish were recorded during recent intertidal surveys in the region (Stantec, 2018). These species were from the families Serranidae (includes seabass and gropers), Lutjanidae (snappers), Lethrinidae (includes emperors and breams, Mullidae (goatfish), Carangidae (includes jacks, pompanos, jack mackerels, runners, and scads) and Siganidae (rabbitfish), with Gobidae (mudskipper) recorded at three separate sites (O2 Marine, 2020e).

A wide diversity of marine fauna occurs in the Fortescue River and estuary, including a range of euryhaline fishes that are adapted to wide salinity ranges with upper tolerance limits of 60,000 mg/L. These species employ mechanisms that control dynamic changes in osmoregulatory strategy (Kultz 2015). Large barramundi and other estuarine fish species are important for recreational fishing and are likely to be culturally important. Barramundi are frequently farmed in saline groundwater systems with salinities >45,000 mg/L (BMT, 2021).

Invertebrates

A diverse range of predominantly tropical marine invertebrate fauna species associated with macroalgal communities occur in the region. Macroalgal communities occur in association with coral reef, mangroves and subtidal sand and soft bottom habitats. Rocky shores support a variety of mollusk species and other invertebrates that include gastropod molluscs of the families Neritidae, Littorinidae, Potamididae and Ellobiidae, some barnacles, sesarmid and ocypodid crabs and several species of mud lobster and ghost shrimps (O2 Marine, 2020g). All species belong to taxa that are widespread in the Indo-Pacific region, are endemic to shores of the North West Shelf or have biogeographic affinities with that region (O2 Marine, 2020e).

Intertidal species

Mangrove habitats support an assemblage of fishes and invertebrates. Common fish species include mud-skippers and gastropod molluscs of the families Neritidae, Littorinidae, Potamididae and Ellobiidae, some barnacles, sesarmid and ocypodid crabs and several species of mud lobster and ghost shrimps. All of these species belong to taxa that are widespread in the Indo-Pacific region and North-west Shelf.

Fish in mangrove creeks are occasional and sporadic visitors that enter the system opportunistically during high tides and include sharks, longtoms, trevallies, queenfish, mackerel, pike and flatheads. (O2 Marine, 2020e).

Subtidal Marine Fauna Community

Recent surveys of the Pilbara Coastline (O2 Marine, 2020e) identified a low (nearshore) to high (reef fringed islands) abundance of fish and invertebrates. Nearshore species are mainly tropical and short lived with high reproduction and productivity during their short life span. Most species are locally and regionally abundant with dominant species comprising a high proportion (i.e. ~80 - 90%) of marine fauna present. The dominant fishes and invertebrates are those that inhabit muddy / sediment habitats and include ponyfish, goatfish, flathead or crabs and prawns, and the mantis shrimp. Although some dominant fish also suit these habitats (Kangas et al., 2006).

Commercial Fisheries

The North Coast Bioregion (Pilbara/Kimberley) runs from the Ashburton River (21° 46’ S and 114° 50’ E), south of Onslow to the Western Australian / Northern Territory border and is divided into 10 meso-scale regions including the Pilbara inshore and Pilbara offshore. A diverse range of resources occur within the Pilbara inshore and offshore regions that support a number of State managed commercial fishing activities targeting a variety of species including finfish, scalefish and crustaceans (Gaughan, 2021) (DPIRD, 2021).

The Pilbara Demersal Scalefish Fisheries (PDSF) (Figure 33) target Red Emperor (*Lutjanus sebae*), Rankin Cod (*Epinephelus multinotatus*), and Bluespotted Emperor (*Lethrinus punctulatus*). These species have been identified as indicator species (based on their inherent vulnerability and overall risk to sustainability) for assessing the status of the overall resource. The stock status of these indicator species is assessed periodically (~ every 5 years) using a weight-of-evidence approach. A 2016 assessment of these species in the Pilbara estimated the spawning biomass of Red Emperor stock to be currently above the threshold level (which corresponds to BMSY). The stocks of Rankin Cod and Bluespotted Emperor to be well above the target spawning biomass levels indicating that the biomass of these stocks is unlikely to be depleted, recruitment is unlikely to be impaired, and current levels of fishing mortality (catch) are unlikely to cause the stock to become recruitment impaired with the biological stocks classified as sustainable adequate (Gaughan, 2021) (DPIRD, 2021).

The Onslow Prawn Managed Fishery (OPMF) is one of four commercial Prawn Fisheries in the North Coast Bioregion targeting Brown Tiger and Western King Prawns. The OPMF includes the Fortescue, Weld Island, Mangrove Islands and Ashburton Size Managed Fish Grounds (SMFG) as well as the Coolgra Nursery (Figure 34). The Fortescue SMFG is the closest to the revised proposal area (Gaughan, 2021) (DPIRD, 2021).

The nursery areas are *size management fishery grounds* that allow sections of these areas to be fished on a seasonal basis when prawns are considered to have grown to an appropriate size. There are two fishing periods for the season (April to mid-June, then from August to the end of November) with around 90% of the total catch taken in the first fishing period (Gaughan, 2021) (DPIRD, 2021). One boat fished in the OPMF in 2019 whilst the other operators chose to fish elsewhere where catches were likely to be more profitable. The breeding stocks of banana, brown tiger and western king prawns were protected and are considered sustainable adequate.

The Fortescue SMFG is located downstream of monitoring location FR1 at which point water quality parameters are anticipated to have returned to baseline levels, and therefore no impact to the fishery is anticipated.

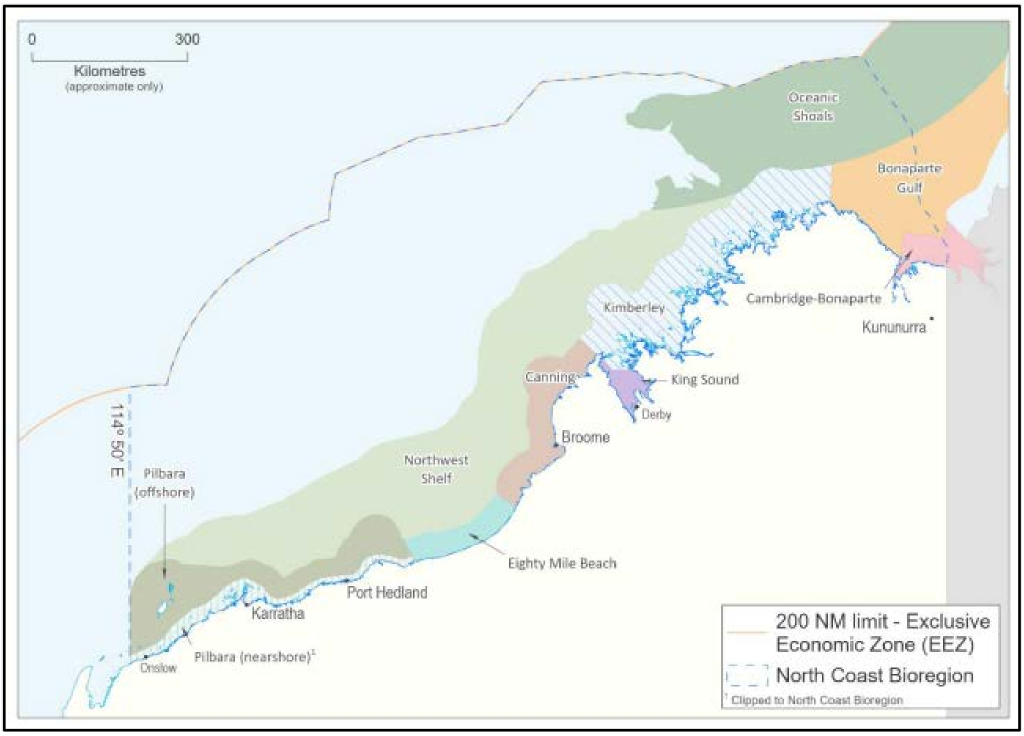


Figure 32 North Coast Bioregion and meso-scale sub regions

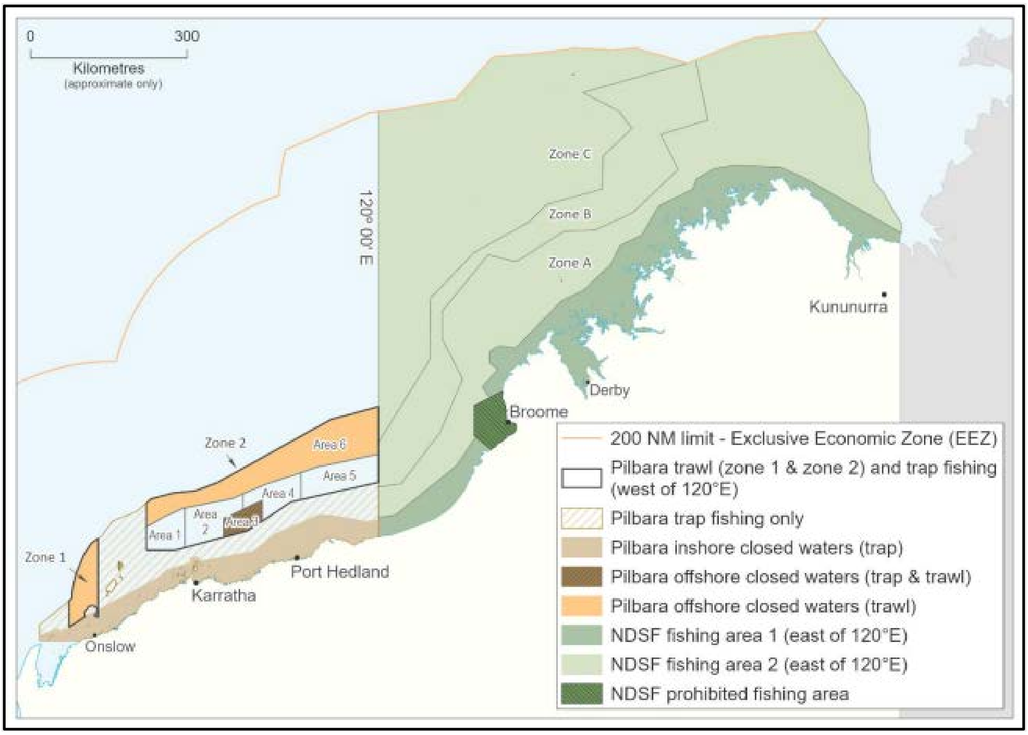


Figure 33 North Coast demersal scalefish fisheries

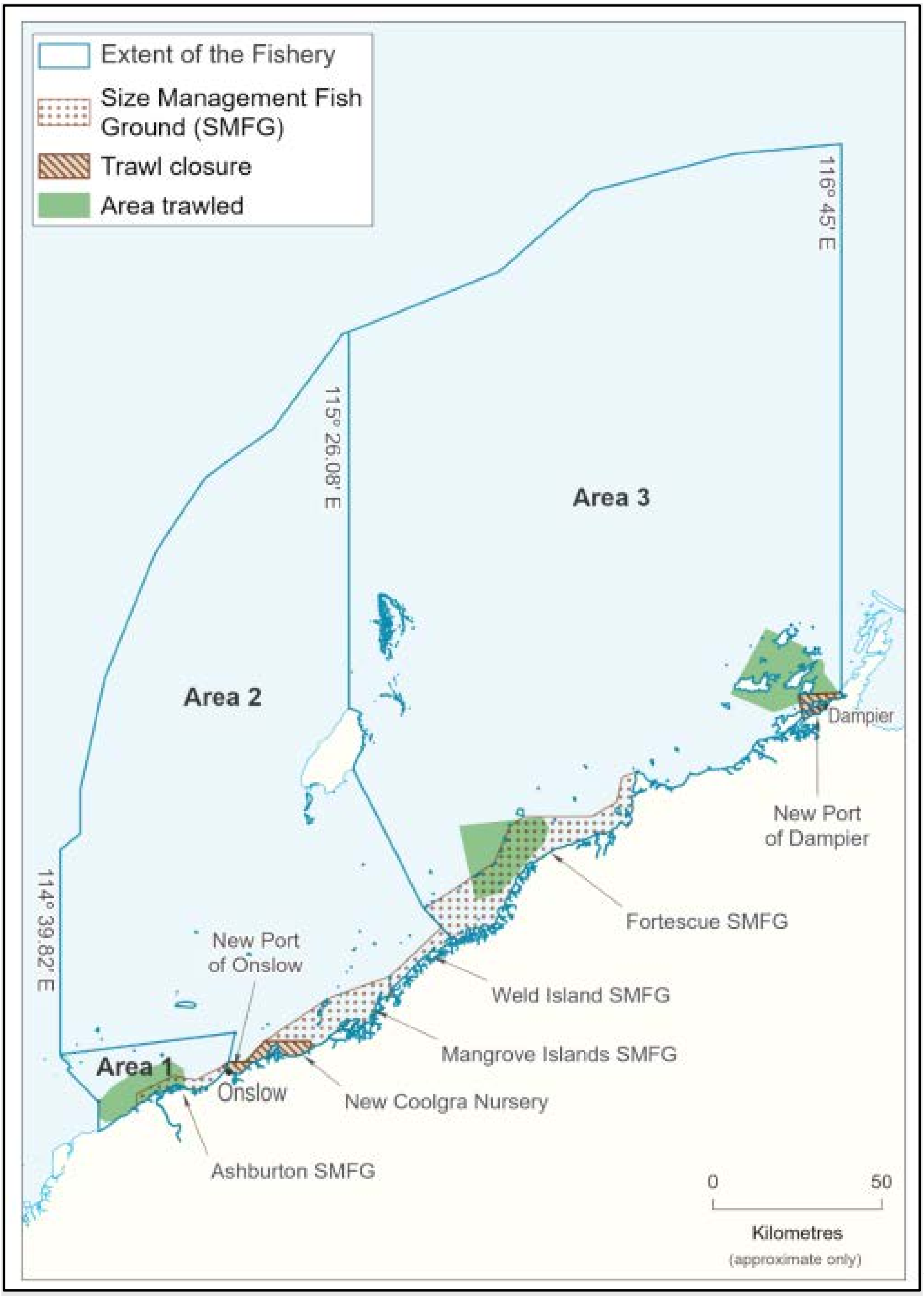


Figure 34 Onslow Prawn Managed Fishery Boundary and areas fished in 2019

8.4 Potential impacts

Marine Fauna respond to changes in environmental and water quality conditions. Discharges of higher salinity groundwater to the receiving environment has the potential to result in short term elevations in salinity concentrations in the Fortescue River and estuary that may lead to osmotic stress and exceedance of tolerance limits of communities (BMT, 2021).

Elevated ammonia in the discharge could cause short term toxicity and adversely impact communities near the diffuser.

8.5 Assessment of Impacts

The assessment of impacts to Marine Fauna is focused on the potential effect of changes in the quality of surface water within the Fortescue River and estuary.

Sections 6.6 and 8.5 provide a detailed assessment of impacts to the Environmental Factors of marine environmental quality and benthic communities and habitats from the revised proposal and are considered relevant to the assessment of impacts to Marine Fauna.

Marine fauna species inhabiting intertidal environments of the Fortescue River and estuary have the potential to be impacted by short term elevations in salinity and ammonia concentrations and nutrient loads.

The EP Act Licence (L8308/2008/2) (2021b) for the approved proposal requires monitoring of the discharge water and the surface water within the Fortescue River and estuary. The licence prescribes discharge limits for salinity, nitrate and metals. Section 6.6 presents the results of modelled predictions for salinity concentrations and ammonia within the Fortescue River and estuary at monitoring locations FR1 and FR2 under the increased discharge scenario of 21 GL/a.

Due to the changing salinities that are characteristic of intertidal habitats, most intertidal species are euryhaline and adopt osmoregulatory mechanisms, such as active ion extrusion to assist them to survive and thrive across a range of salinities (Schulte, 2011).

Modelling of the increased discharge volume indicates that predicted concentrations for salinity and nutrients are expected to remain within the range of baseline concentrations (RPS, 2021a and BMT 2020).

Baseline salinity (TDS) concentrations ranged from 36,400 mg/L (36.4 ppt) to 52,100 mg/L (52.1 ppt) and median salinity (TDS) ranged from 40,800 to 42,900 mg/L (42.9 ppt) at monitoring locations FR1, FR2 and FR3, indicating an ecosystem that is adapted and tolerant to natural elevations in salinity (BMT, 2021). Modelled salinity (TDS) for the full tidal cycle (one-month period) is predicted to remain within the range of baseline concentrations at sites FR1 and FR3, for the 70,000 mg/L (70 ppt) discharge scenario and remain well within the tolerance level of marine fauna that inhabit riverine and estuarine environments (RPS, 2021a).

Modelled 95th percentile ammonia concentrations (Table 6-2 in Section 6.3.1) at sites FR1 and FR3 are expected to meet the ANZG (2018) 90% species protection guideline for ammonia (1.2 mg/L) based on current ammonia discharge concentrations (BMT, 2021). Based on the trend of monitored discharge concentrations to date, ammonia concentrations within the dewater are not anticipated to increase from current levels.

The current and predicted ammonia concentrations at FR1 (0.13) are within the baseline concentration range with FR3 (0.19) slightly above baseline concentrations. These concentrations are well below known ecotoxicity triggers for a range of marine species (fish, crustacean, mollusc). For example, these levels are well below the lowest trigger of 3.65 mg/L for growth suppression and 6.33 mg/L for mortality (NOEC[5] figures, 20 days)[6] for sea bream, *Sparus auratus*, one of a number of major commercial species in this area.

8.6 Mitigation

The objective for the mitigation of impacts to marine fauna as a result of the revised proposal is to ensure that biological diversity and ecological integrity is maintained.

To achieve this objective, existing management measures prescribed in EP Act Licence L8308/2008/2 (2021b) will continue to be implemented in addition to adaptive management measures outlined in the OEMP.

Avoid

1. Maintain a discharge rate of up to 667 L/sec to ensure optimum operation of diffuser.

Minimise

2. Maintain optimum diffuser operation to ensure that predicted mixing and dilution is achieved (RPS APASA, 2017).
3. Monitor discharge water quality against the limits outlined in EP Act Licence L8308/2008/2 (2021b).
4. Monitor surface water quality against the limits outlined in EP Act Licence L8308/2008/2 (2021b).
5. Implement dispersion monitoring program (outlined in Section 6.7).
6. Implement mine dewater discharge adaptive management measures which may include storage and dilution of mine pit dewater to achieve discharge water quality limits prior to discharge to Fortescue River and estuary.
7. CPM commits to undertaking a marine megafauna survey of the estuary, to determine the value of the estuary system to different species and their life-stages over the next 12 months, prior to dewater discharge to the Fortescue River occurring on the incoming tide in addition to the outgoing tide. This information will be used to inform adaptive management measures for the river discharge.

[5] No Observed Effect Concentration
[6] https://www.waterquality.gov.au/anz-guidelines/guideline-values/default/water-quality-toxicants/toxicants/ammonia-2000; 18 November 2020

8.7 Assessment and significance of residual impact

Based on the predicted salinity and ammonia concentrations of the increased discharge volume and with the implementation of mitigation and management measures, the following outcomes are expected:

1. The salinity (TDS) in discharge water is predicted to remain within EP Act Licence L8308/2008/2 limits.
2. Ammonia concentrations are predicted to meet the 90% species protection guideline limit (ANZG, 2018) at FR1 and FR3 monitoring locations.
3. Baseline salinity concentrations will be maintained at FR1 and FR3 monitoring locations for the increased discharge scenario over a full tidal cycle.
4. The 90% species protection guideline level will be achieved at FR1 and FR3 for the increased discharge scenario based on current ammonia concentrations. As the modelling only considered a 1-month tidal cycle, and did not include exchange due to river flow, this is conservative (BMT 2021).
5. Early detection of increases in discharge salinity concentrations will be identified through continuation of the EP Act Licence L8308/2008/2 (2021b) discharge monitoring program and implementation of adaptive management measures that may include altering discharge volumes, dilution with fresher water sources and/or reverting to tidal based discharge regime to improve dispersion.
6. Early detection of changes in surface water salinity and nutrient concentrations will be identified through continuation of the surface water monitoring program within the EP Act Licence L8308/2008/2 (2021b).
7. Early detection of changes to mangroves will be detected through continuation of the EP Act Licence L8308/2008/2 (2021b) mangrove monitoring program.
8. Implementation of adaptive management actions will ensure that baseline concentrations for salinity are maintained within the Fortescue River and estuary over a full tidal cycle.

It is therefore expected that the EPA objective for Marine Fauna will be achieved.

8.8 Environmental outcome

The environmental outcomes resulting from the implementation of the proposal, with respect to marine fauna are:

- Environmental water quality parameters (salinity, ammonia) as measured at FR1 and FR3 will remain within the proposed management criteria as detailed within the Fortescue River Estuary EQMP; such that:

- baseline salinity concentrations will be maintained at FR1 and FR3 monitoring locations for the increased discharge scenario over a full tidal cycle; and
- ammonia concentrations will meet the 90% species protection guideline limit (ANZG, 2018) at FR1 and FR3 monitoring locations.

9 Flora and Vegetation

9.1 EPA Objective

The EPA Objective for Flora and Vegetation is to *protect flora and vegetation so that biological diversity and ecological integrity are maintained*.

9.2 Policy and Guidance

The relevant policy and guidelines for flora and vegetation are:

- Environmental Factor Guideline – Flora and vegetation (EPA, 2016c)
- Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment (EPA, 2016m)

9.3 Receiving Environment

The Cape Preston area has been studied in detail since 2003, including nine flora and vegetation surveys (Table 9-1). A peer review of historical surveys determined that work completed across the broader region, including surveys by Astron (2009a) and AECOM (2009) that integrated earlier studies, was sufficient to meet the requirements of Guidance Statement 51 (EPA 2004) and Position Statement 3 (EPA 2002) (Mattiske 2016). An updated species list including a review of conservation status of vegetation units was prepared to align historical survey work with Level 2 survey standards (Mattiske, 2016) and was accepted by the EPA during its assessment of the MCP (Strategen 2017).

Table 9-1 Summary of environmental studies and survey effort

Author	Survey/ investigations name	Study area, type and timing	Study standard/guidance and limitations
Recently completed work			
Mattiske 2016	*Review of Flora and Vegetation Reports for the Mineralogy project at Cape Preston*	• Peer Review of previously completed work	NA.
Previously completed work			
Maunsell AECOM 2003	*Cape Preston Iron Ore Development. Seasonal Biological Survey – Threatened Flora*	• Mine footprint • Threatened flora survey • June and July 2003	Seasonal conditions led to some limitations in assessment of flora. Also some areas supported degraded vegetation. In part overcome by July assessment in targeted areas.
Astron Environmental Services 2007	*General Purpose Leases G08/52 and G08/53 Additional Vegetation Survey and Mapping*	• Leases G08/52 and G08/53 • Flora and vegetation survey • June 2007	Some limitations on flora coverage due to drier seasonal rainfall conditions prior to the June 2007 assessment.

Author	Survey/ investigations name	Study area, type and timing	Study standard/guidance and limitations
Mattiske Consulting Pty Ltd 2007a	*Flora and Vegetation Survey of Cape Preston Potential Campsites and Airstrips*	• Flora and vegetation survey • February 2007	Some limitations due to seasonal conditions. Coverage of localized areas only (as requested).
Mattiske Consulting Pty Ltd 2007b	*Comparison of Flora and Vegetation Values on Preferred and Original Campsites Cape Preston*	• February 2007	Some limitations due to seasonal conditions. Coverage of localized areas only (as requested).
Maunsell AECOM 2008	*Cape Preston Mining Estate Consolidated Vegetation, Flora and Fauna Assessment*	• Consolidation of surveys by HGM (2001), Maunsell (2003), Maunsell AECOM (2006), Mattiske (2007a), Astron (2007a, 2007b, 2007c)	Desktop study only.
Astron Environmental Services 2008	*Sino Iron Project – Cape Preston. Mapping and Surveying of Groundwater Dependent Ecosystems*	• Leases E08/1414, E08/660, E08/1451, E08/1331, and some adjoining areas to the Northeast on Mardie Station • Groundwater-dependent vegetation survey • September – October 2008	Groundwater-dependent vegetation only; limitations due to drier seasonal conditions prior to assessment.
AECOM 2009	*Balmoral North and Balmoral South Stage 2. Flora and Vegetation Assessment*	• Desktop, reconnaissance and detailed field survey. Flora and vegetation on Balmoral North and South. Some re-assessment of selected 2000 and 2006 quadrats • August – September 2008	Limitations due to timing of assessments in drier months.
Astron Environmental Services 2009a	*Mineralogy Expansion Proposal Desktop Flora and Vegetation Study.*	• Desktop extrapolation of unsurveyed areas based on previous surveys of HGM (2001), Maunsell/ AECOM (2008), AECOM, (2009), Astron (2007a 2007b,2007c), Astron, (2008)	Some limitations associated with no field studies and difficulty of covering flora and vegetation values without ground-truthing.
Astron Environmental Services 2009b	*Waste Rock Dump and Tailings Expansion Areas Vegetation, Flora and Fauna Survey*	• Flora and vegetation survey • WRD expansion area and TSF expansion area • May 2009	• Level 2 survey • Some limitations associated with seasonal conditions; although good rains in January and early February 2009 the months leading up to the assessment in May 2009 were drier.
Astron Environmental Services 2013	*Sino Iron Project Dewatering Pipeline Location Level 1*	• Flora and fauna survey • L08/126 dewatering pipeline corridor	• Level 1 survey • No major limitations. Region well documented,

Author	Survey/ investigations name	Study area, type and timing	Study standard/guidance and limitations
	Flora and Fauna Survey	• July 2013	Level 2 survey previously conducted adjacent to survey area. • No major limitations. Region well documented, Level 2 survey previously conducted adjacent to survey area.

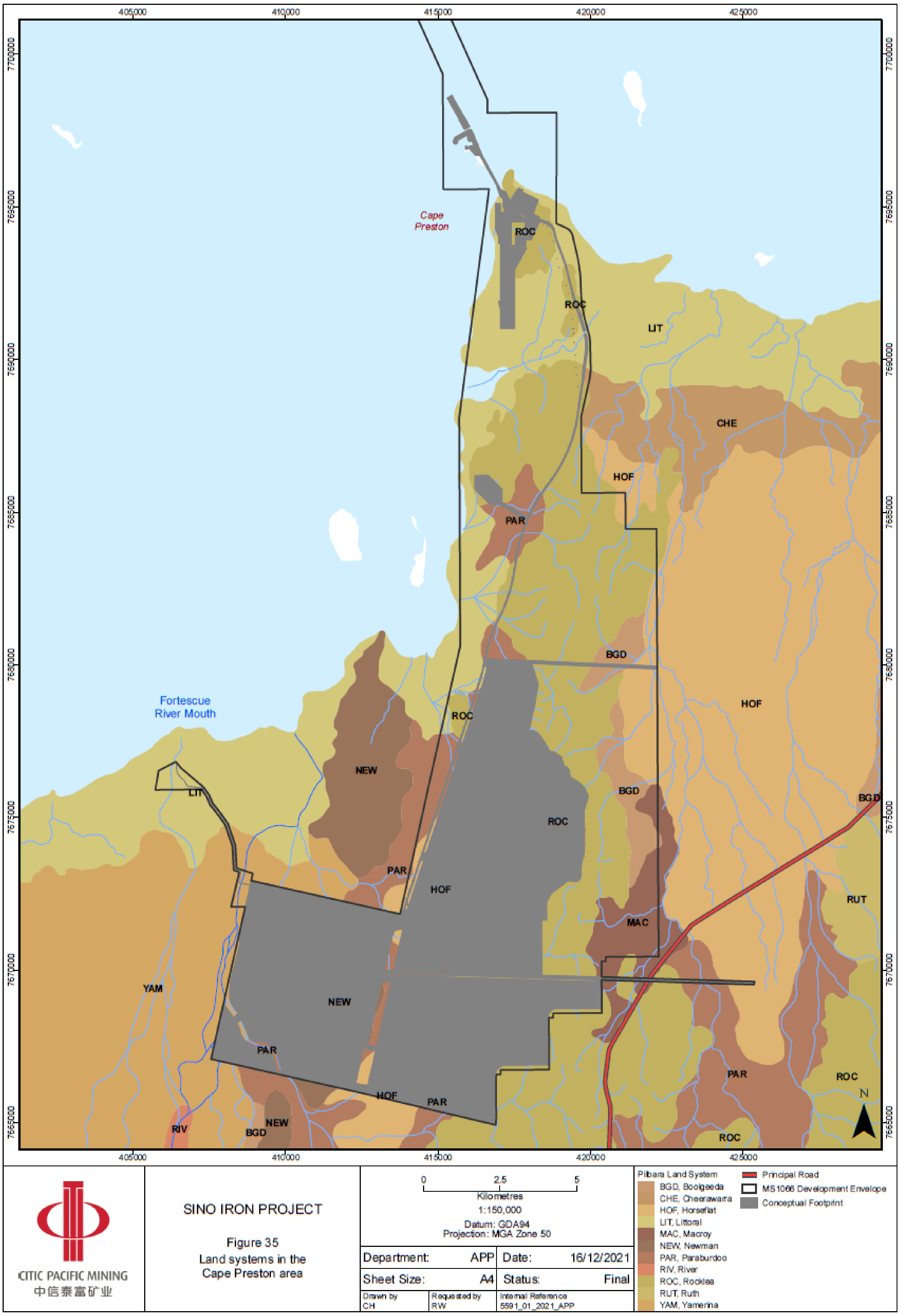
9.3.1 Land Systems

Nine Land Systems are represented within the Development Envelope (Figure 35). The regional extent of clearing for each Land Systems occurring in the Development Envelope is shown for the Pilbara Region and Roebourne Subregion in Table 9-2. Less than 2% of each Land System has been cleared historically within the Pilbara Subregion, showing negligible loss of vegetation to date at a regional scale.

Table 9-2 Extent and clearing of land systems

Land System	Total area of Land System within the Pilbara Region (ha)	% Cleared within Pilbara Region	Total area of Land System within Roebourne Subregion (ha)	% Cleared within Roebourne Subregion	Cleared from the Proposal (ha)	% cleared within Roebourne Subregion including Proposal
Boolgeeda	826,416.12	0.02	27,085.24	0.49	12.4	0.54
Cheerawara	49,210.84	0.01	48,424.73	0.01	2.7	0.02
Horseflat	328,911.14	0.39	297,358.74	0.43	1291.0	0.86
Littoral	248,221.78	0.15	212,125.90	0.18	156.5	0.25
Macroy	1,333,613.73	0.00	5,341.23	0.00	16.4	0.31
Newman	1,458,027.91	0.03	4,872.65	9.17	1283.6	35.52
Paraburdoo	64,135.89	1.52	17,850.10	5.46	2249.5	18.06
River	463,955.92	0.01	125,519.60	0.03	0	0.03
Rocklea	2,428,593.74	0.06	43,182.63	3.36	4104.2	12.86
Yamerina	120,270.82	0.49	119,391.09	0.5	769.9	1.14

Figure 35 Land Systems in the Cape Preston Area



9.3.2 Vegetation mapping

The extent of vegetation surveys (Figure 36) of the Cape Preston area cover approximately 53,000 ha. A total of 98 vegetation communities have been described and mapped within the Cape Preston area of which 69 occur within the Development Envelope (Figure 37). Typical for the Pilbara, the majority of vegetation communities are of low or moderate local conservation significance, with areas of elevated conservation significance generally associated with water courses (AECOM 2009). The landform and conservation significance of the vegetation communities are identified in Table 9-3.

Table 9-3 Landform, vegetation unit and local conservation significance

Landform	Vegetation community	Local conservation significance
Stoney plains	Bx1, Bd1, Bs1	Moderate to High
Clayey plains	Hp, Hp1, Hpg1, Hpg2, Hpg3, Hps1	Moderate to High
Flowlines	Hc1, Hc2	Moderate to High
Beaches	Lb	Low to Moderate
Intertidal zones	Lm	High
Tidal mudflats	Ls1, Ls2, Ls3a	Moderate
Dunes	Ld1, Ld2, Ld3, Ld4, Ld5	High
Sandy plains	Lp1, Lp2, Lp3, Lp4a, Lp4b, Lp5	Moderate
Hills	Lh1, Lh2	Moderate
Plains	Mp1	Moderate
Outcrops	Mr1, Mr2, Mr3, Mr4, Mr5, Mr6	Moderate
Low Hills and slopes	Nh, Nh1, Nh2, Nh3, Nh4, Nh5	Moderate
Minor flowlines	Nc, Nc1, Nc2, Nc3, Nc4	Moderate to High
Rockpiles	Nr, Nr1, Nr2, Nr3, Nr4	Low to Moderate
Plains	Px1, Px2, Px3, Px4, Px5	Moderate
Plains	Pp1, Pp2. Pp3, Pp4	Moderate
Creeklines and Floodplains	Pc, Pc1, Pc2, Pc3, Pc4, Pf1, Pf2, Pf3	High
Creeklines	Rc1, Rc2, Rc3, Rc4	High
Floodplains	Rf1, Rf2, Rf3	Moderate
Low hills and slopes	Roh1, Roh1a, ROh1b, Roh2, ROh2a, ROh2b, ROh2c, ROh3a	Low to Moderate
Plains	ROpl, ROx1, ROp1 (?)	Low to Moderate
Minor flowlines	ROc1, ROc2, ROc3, ROc4, ROc5	Moderate
Rockpiles	Ror, Ror2, Ror1, Ror3	Low to Moderate
Plains	Yp1	Low to Moderate
Tidal creek	Yc1	Moderate

Conservation significant flora and vegetation

No Threatened Flora species as listed under the Biodiversity Conservation Act 2016 are known from within 15 km of the Development Envelope. Thirteen Priority Flora species listed by DBCA have the potential to occur within the broader Cape Preston area, with one, *Goodenia pallida* (P1) having the potential to occur within the Development Envelope (Figure 38). No Priority Flora species were recorded by vegetation surveys within the Development Envelope. Horseflat Land system is listed as a Priority 3 iii Ecological Community (PEC) (DBCA, 2016), and is defined as:

> *communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, inappropriate fire regimes, clearing, hydrological change etc.*

A search of the DAWE EPBC Act Protected Matters database (2021) indicates that there are no Threatened Flora species listed under the EPBC Act known from within 3 km of the Development Envelope. No Threatened or Priority Ecological Communities (listed under the EPBC Act) occur within the Development Envelope.

Figure 36 Vegetation Surveys in Cape Preston Area

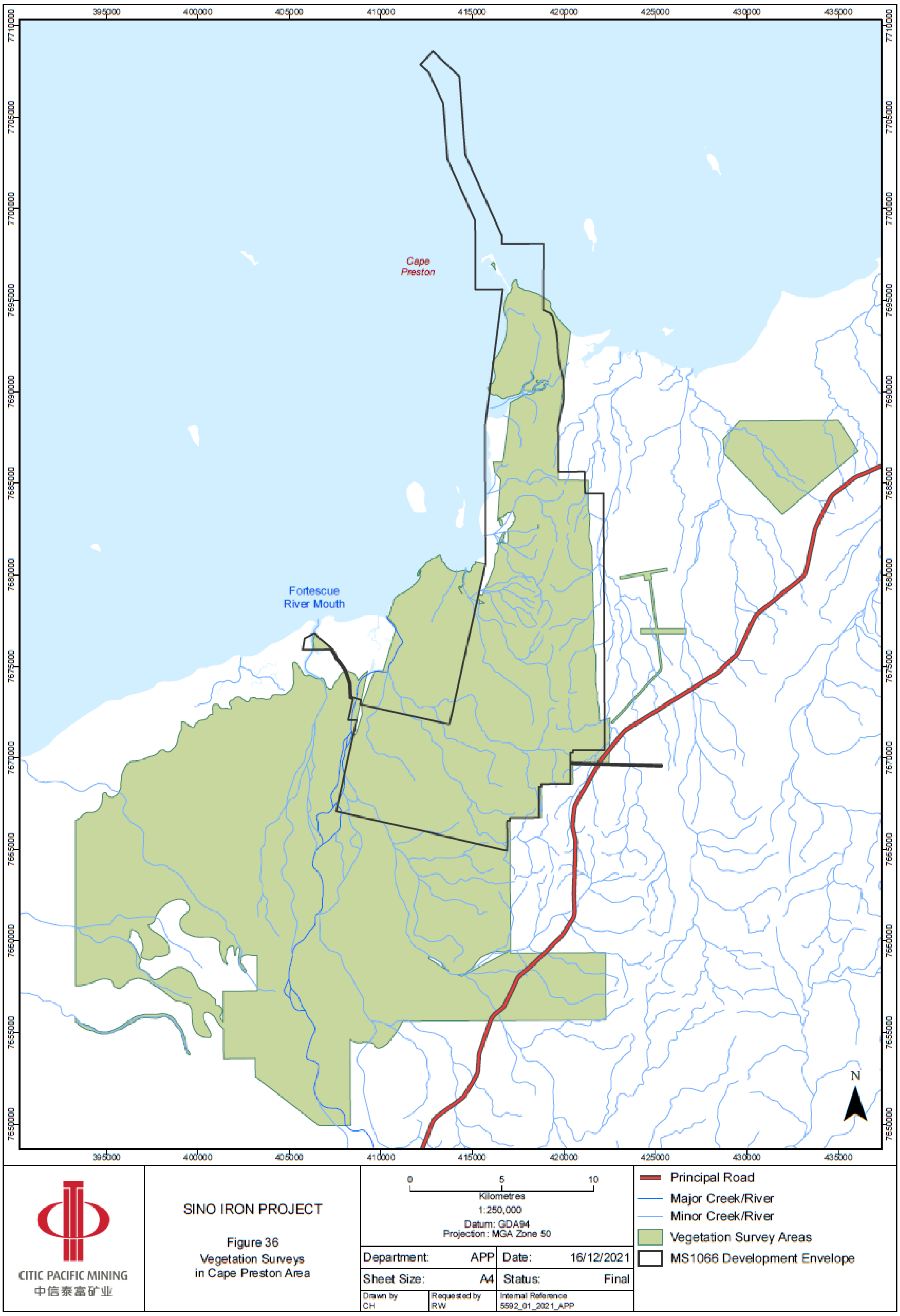


Figure 37 Vegetation Communities in the Cape Preston Area

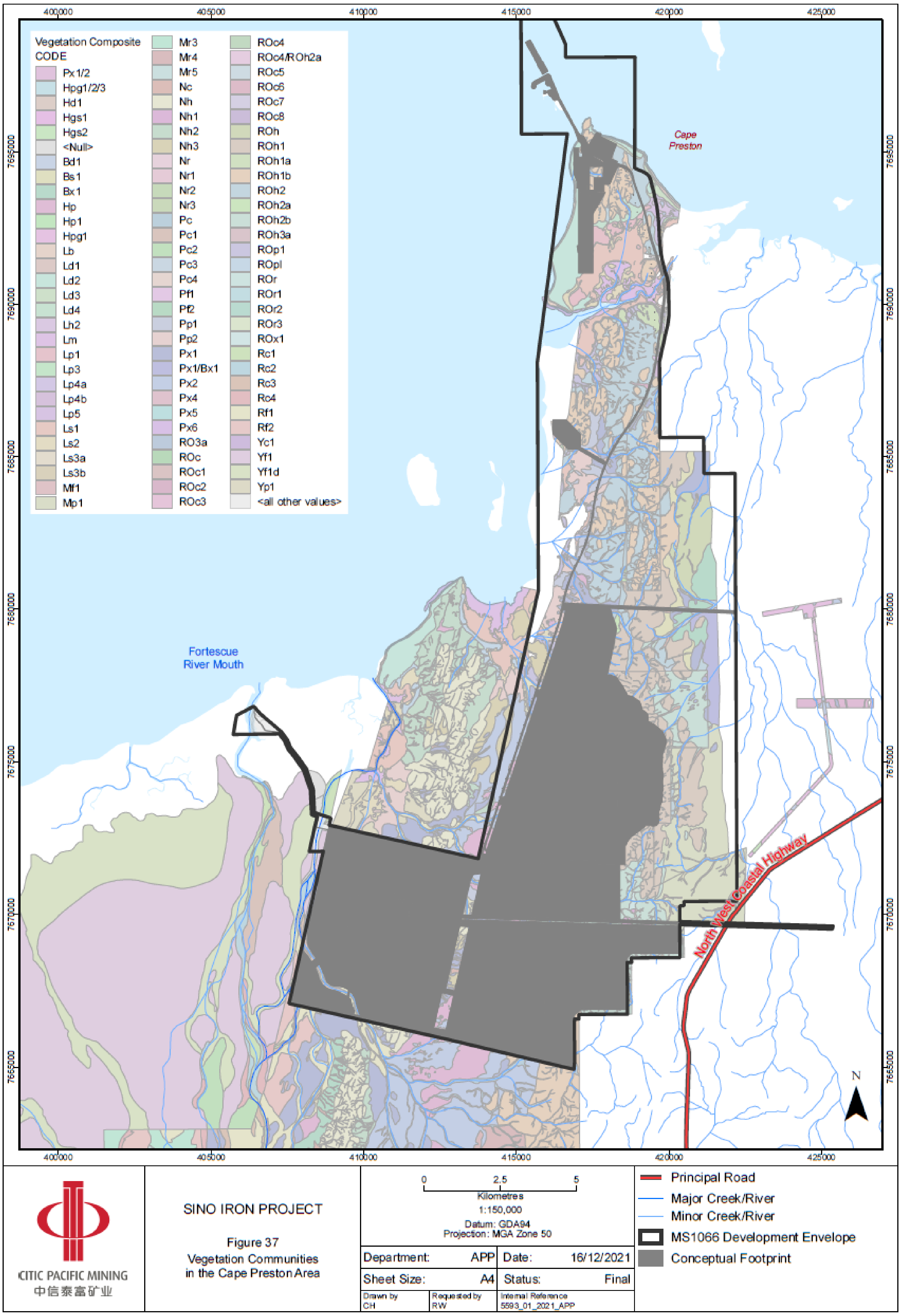
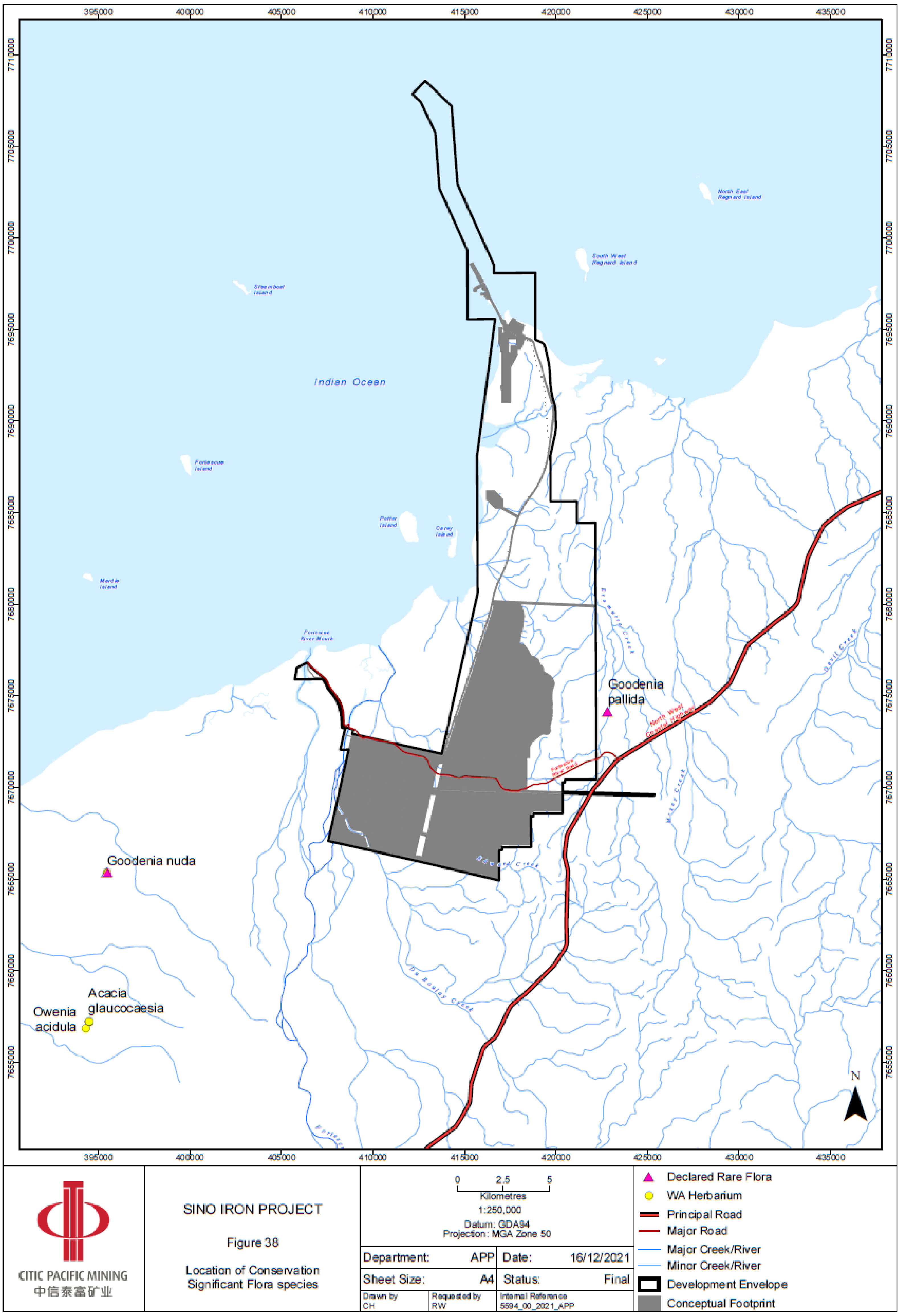


Figure 38 Location of Conservation Significant Flora species



9.3.3 Baseline Groundwater dependant vegetation

The majority of the area west of the Development Envelope is low-lying and has shallow but highly variable groundwater levels. Groundwater levels in bores close to the Fortescue River rise rapidly when the river is in flow and decline rapidly when the river ceases to flow with fluctuations of up to 6 m (Cloud GMS 2017).

Where groundwater is close to the surface it may help support groundwater dependent vegetation that exists predominantly in shallow alluvial aquifers associated with creek lines. The key groundwater source supporting GDV is the superficial aquifer, which typically occurs at depths from 0 to 40 m (PSM2020). This is underlain by a fractured rock aquifer

Groundwater dependent ecosystems (GDEs) require access to groundwater to meet some or all of their water requirements. The flora and vegetation that make up GDEs in the Cape Preston area were surveyed and mapped by Astron in September 2008 (Astron 2009b).

Vegetation was surveyed to the west of the Development Envelope along major and minor watercourses (Fortescue River and Du Boulay Creek respectively) over an area 15 km wide and 35 km long. Thirteen groundwater dependent vegetation (GDV) communities were mapped, ranging from high to low dependence on groundwater (Astron 2009b). The majority of the vegetation along minor ephemeral flowlines was not considered groundwater dependent (Astron 2009b).

In mapping the vegetation communities as groundwater dependent Astron (2008) also identified whether the unit was highly dependent (obligate) or moderately dependent (facultative). Obligate GDEs are highly reliant on groundwater for maintenance of some or all of their ecosystem function. *Melaleuca argentea* is one species identified in the Fortescue area as an obligate phreatophyte (Astron 2008). This species was located along sections of the Fortescue River and Du Boulay Creek. *M. argentea* is highly sensitive to lowering groundwater levels and is likely to show early signs of water stress from significant lowering of the water table over a short period.

Facultative (or opportunistic) GDEs have a low or moderate reliance on groundwater and only require access to groundwater in some landscapes, but in other landscapes can utilise soil moisture to maintain ecosystem function. Species that were identified within the survey area as being facultative included *Eucalyptus camaldulensis, E. victrix and Corymbia candida*, which were located along sections of the Fortescue River and Du Boulay Creek.

Facultative GDEs occur across the majority of the floodplain, which is consistent with the environmental setting as the floodplain receives periods of floodwaters from large rainfall events.

9.3.4 Presence of weeds

The Development Envelope is within an active pastoral station that has is significantly degraded by weed invasion and stock grazing. The condition of the vegetation within the Cape Preston area ranges from completely degraded to very good (Maunsell AECOM 2008, AECOM 2009, Astron 2009a).

The majority of floodplain in the area is invaded by Mesquite (**Prosopis pallida*), Parkinsonia (*Parkinsonia aculeata)* (Declared Plants by the Department of Agriculture and Food, pursuant to s 22 of the Biosecurity and Agriculture Management Act 2007 (BAM Act)) and Buffel grass (*Cenchrus ciliaris*) (Weed of National Significance (WoN)) which is common throughout the Pastoral Lease.

Mesquite is one of 20 WoN in Australia, due to its invasiveness and potential for spread across a wide landscape, impacts on the environment, and socioeconomic impacts. Anderson et al. (undated) conducted an aerial survey to determine the extent and density of mesquite infestations throughout the Pilbara. This mapping was used to determine the extent of mesquite infestations within areas of groundwater-dependent vegetation to the west of the Development Envelope, as mapped by Astron (2008) (Table 9-4, Figure 39 and Figure 40). Over 80% of the groundwater-dependent vegetation within the 5 m contour is infested with mesquite (Figure 41), with over 60% of the area affected by ‘scattered’ to ‘dense’ infestations. The infestation level corresponds closely to availability of water, with the densest infestations found within or directly adjacent to rivers and creek beds.

A field survey was undertaken at 11 sites within the groundwater-dependent vegetation area to ground-truth mesquite infestation levels. Figure 40 illustrates the high levels of infestation (‘scattered’ to ‘dense’) present within groundwater-dependent vegetation especially within the 5 m contour.

Table 9-4 Density of mesquite infestations within groundwater-dependent vegetation

Infestation density	Area of groundwater-dependent vegetation affected (ha)	% of groundwater-dependent vegetation affected
1 plant per ha	1924	3.1
2 to 9 plants per ha	5753.5	9.4
10 to 29 plants per ha	3293	5.4
30 to 70 plants per ha	1165.5	1.9
Scattered	15632.5	25.6
Medium	11636.5	19.0
Mid-dense	8158.5	13.3
Dense	2460.5	4.0
None	11137	18.2
Total	**61161**	**100**

Figure 39 Groundwater Dependent Ecosystems

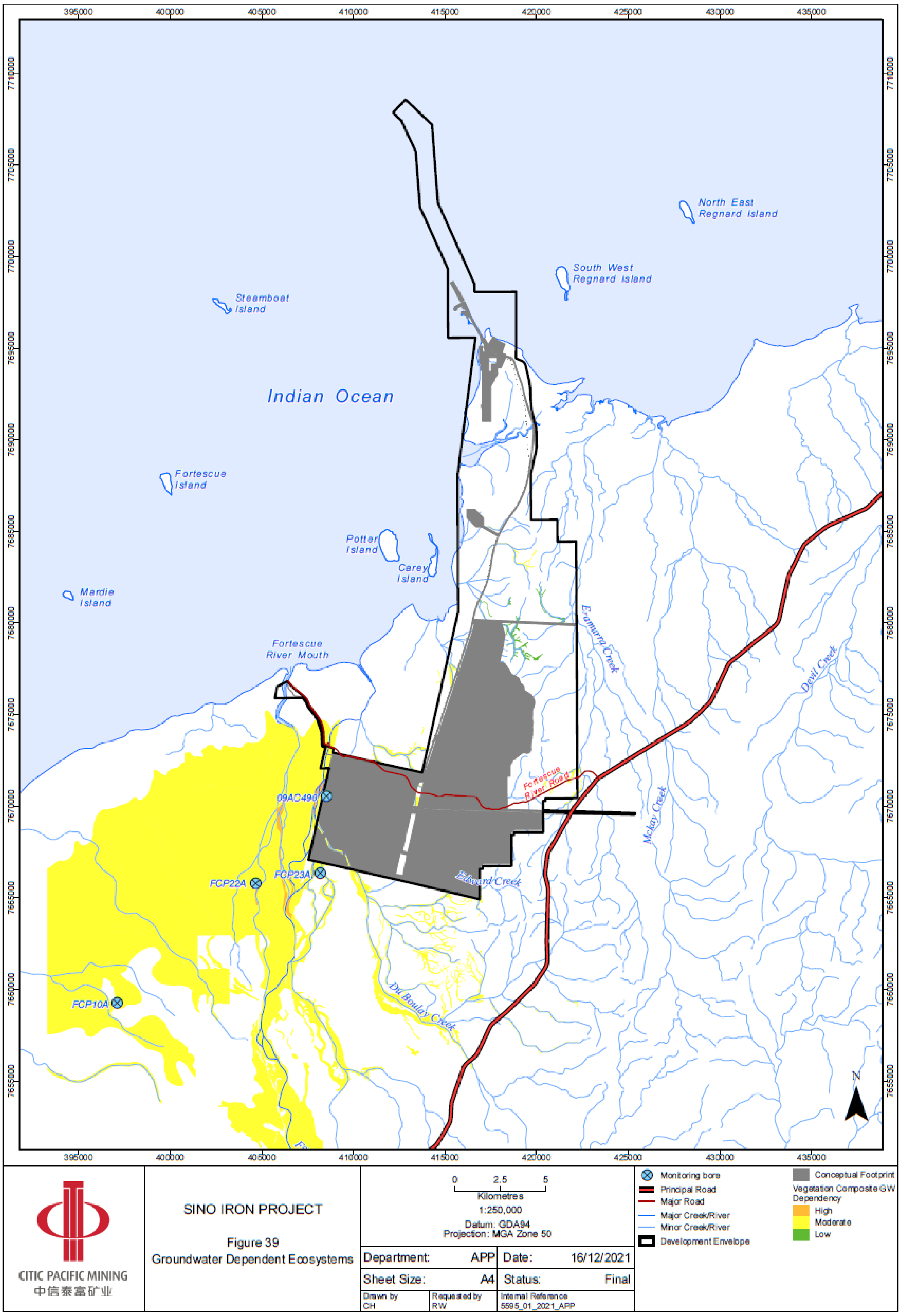
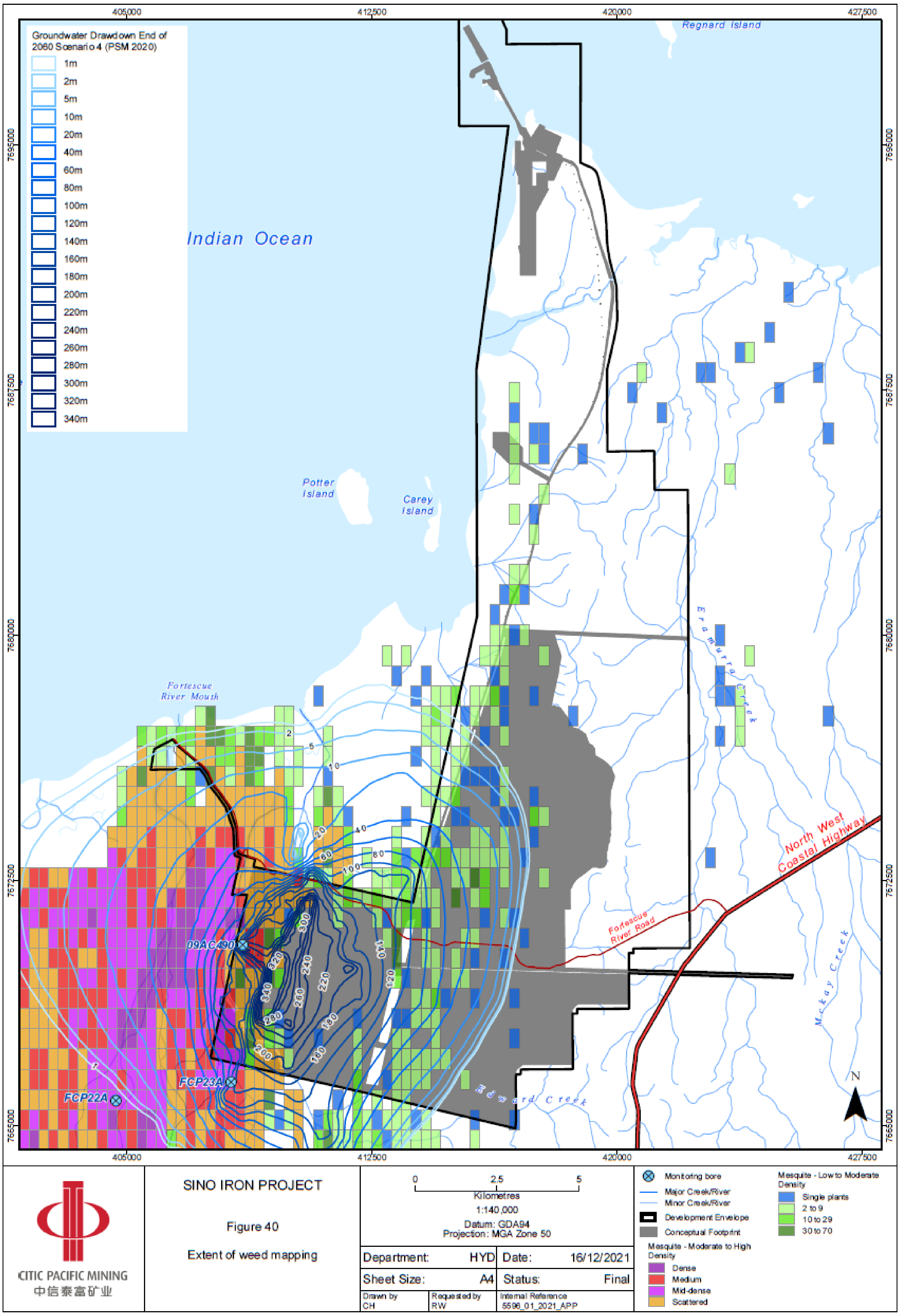


Figure 40 Extent of weed mapping



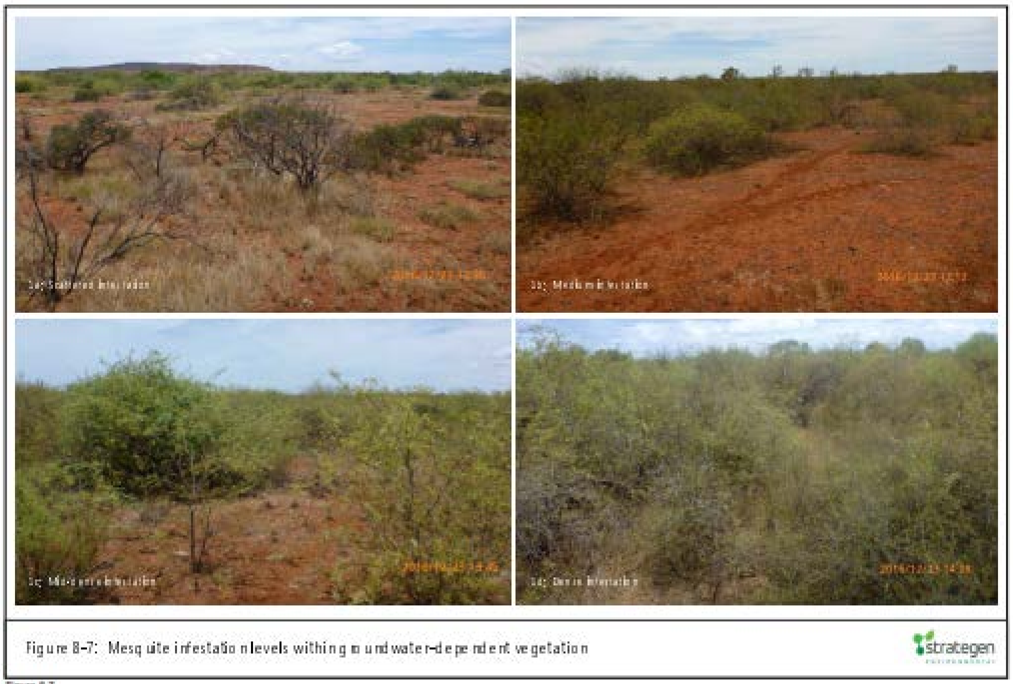


Figure 41 Mesquite infestations at Cape Preston

9.3.5 Current GDV health

Management of GDV was originally prescribed in MS 635 and groundwater licences GWL167151(8) and GWL201437(2) issued under the RIWI Act.

In October 2017 MS 1066 approved the Sino Iron MCP that included groundwater abstraction and mine dewater discharge to the Fortescue River and estuary of up to 8 GL/a. On 18 July 2018 a s.45C application for an increase in groundwater abstraction from 8 GL/a to 12 GL/a was approved.

The GDV Monitoring Plan (GDVMP) was revised to address potential impacts of groundwater drawdown from groundwater abstraction and to amend aspects of the GDV monitoring program. The management outcome of the GDVP is to avoid losses of GDV as a result of drawdown in areas that are both beyond the 5 m drawdown contour and that are not approved for clearing.

The main groundwater dependent (phreatophytic) species that define GDV in the region are:

- *Melaleuca argentea*: a tree that is totally reliant on groundwater (an obligate phreatophyte)
- *Eucalyptus camaldulensis*: a tree that is periodically dependent on groundwater (a facultative phreatophyte)
- *Eucalyptus victrix*: a tree that often occurs as a facultative phreatophyte but may not be dependent on groundwater in some settings.

Based on a risk assessment (informed by groundwater drawdown modelling, vegetation mapping and knowledge of species' ecological water requirements) loss of GDV is expected where groundwater drawdown exceeds 5 m. Loss is defined as mortality of the indicator species within an area of vegetation.

A total of 585.5 ha of GDV is present within the current extent of the >5m drawdown zone and is expected to be lost from drawdown due to pit dewatering. Avoidance of GDV losses from the revised proposal beyond both the 5 m drawdown contour and areas approved for clearing is required.

The area extending 1 km out from the 5 m drawdown contour is delineated as the Drawdown Management Zone. Figure 42 shows the current Drawdown Management Zone and on-ground monitoring locations.

The Monitoring Program includes on-ground monitoring conducted biannually in November (towards the end of the dry season) and May (towards the end of the wet season). Active monitoring sites within the reference area (reference sites) and Drawdown Management zone (potential impact sites) are listed in Table 9-5. These bores provide data from the alluvial aquifer and are therefore the most relevant bores to assess drawdown impacts.

Table 9-5 Active monitoring sites and bores used in the GDV Monitoring Program

Zone	Site	Catchment	Associated bore
Reference	9	Fortescue River	
	11	Due Boulay Creek	
	17	Fortescue River	FCP21A
Drawdown management zone	4	Due Boulay Creek	
	8	Fortescue River	FCP23A
	14	Fortescue River	
	15	Fortescue River	FCP31A
	16	Fortescue River	FCP22A

The monitoring variables currently used to measure performance against management targets are listed in Table 9-6 with respect to project-related and non-project related factors (Astron 2018).

Trigger levels for project-related monitoring variables are listed in Table 9-7. Responses to Trigger exceedances are contained within the GDVMP (Astron 2018) and are outlined in Table 9-8.

Figure 42 GDVMP Monitoring Sites

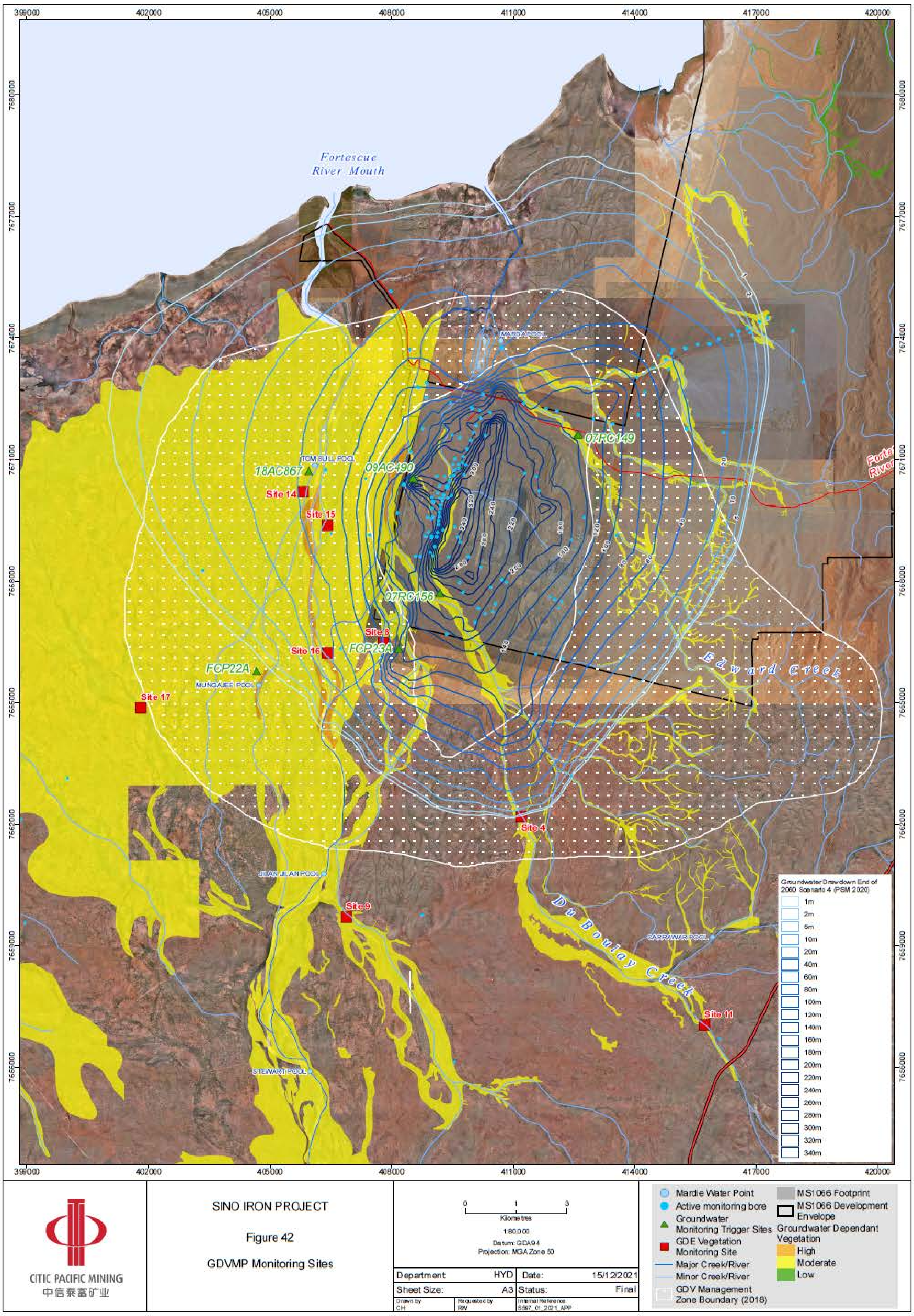


Table 9-6 Summary of monitoring variables for Project-related and non-Project-related factors

Factor	Target Theme	Parameter	Method	Reference/further information	Sampling	Nov-2020	May-2021
Project Related	1) Groundwater level and quality	1a) Depth to groundwater	Automated loggers or manual dipping	-	Monitoring bores	monitored	monitored
		1b) pH and salinity	Temperature/pH/salinity probe and groundwater sampled following bailing	-	Subset of monitoring bores	monitored	monitored
	2) Groundwater dependent tree health	2a) Leaf water potential	Predawn water potential of leaves measured using the pressure chamber technique	Turner (1988)	Permanent sample trees with replication of trees per species (if available) per site	monitored	monitored
		2b) Visual health	Rating of tree health by trained observer based on a published system used in Australia	Souter et al. (2009)	Same as 2a above	monitored	monitored
		2c) Dead/live count	Number of dead and live trees within the defined area that bounds each site	-	Smallest rectangular area bounding all trees and quadrats (geolocated)	monitored	monitored
		2d) PFC	Visual estimate by two trained observers based on reference images	Walker and Hopkins (1990)	Same as 2a above	monitored	monitored
		2e) Remotely sensed index of tree condition	Any recognised index for measurement of vegetation health		Complete (imagery) and site based and *ad hoc* for ground truthing	monitored	monitored
Non-project related	Weather	1a) Annual rainfall	Data sourced from BoM and CPM records	http://www.bom.gov.au/climate/data/	Mardie Station (BoM) and Sino Iron Project (CPM)	External data	External data
		1b) Vapour pressure deficit	Data sourced from BoM	Calculation using Webb (2010)	Mardie Station	External data	External data
		1c) Cyclonic damage area	On-ground inspection with a Global Positioning System and remote sensing imagery to map extent of damage	-	Systematic/targeted	monitored	monitored
		1d) Cyclonic damage severity	On-ground inspection/remote sensing imagery to rate categories of foliage loss	Loss: 0 = < 1 % , 1 = 1 – 25 %, 2 = 26 -75 % and 4 = 76 – 100%	Systematic/targeted	monitored	monitored
	Fire	2a) Fire damage area	As per 1c above	N/A	Systematic/targeted	monitored	monitored
		2b) Fire damage	As per 1d above	Scorch: 0 = < 1 % , 1 = 1 – 25 %, 2 = 26 -75 % and 4 = 76 – 100%	Systematic/targeted	monitored	monitored

Factor	Target Theme	Parameter	Method	Reference/further information	Sampling	Nov-2020	May-2021
	Weeds	3a) Weed cover (%)	Estimated projected foliar cover (all species combined)	-	Within the 10 m x 10 m quadrats at each site	monitored	monitored
		3b) Weed abundance rating	Abundance rating for all species combined	0 – absent, 1 – scarce, 2 – common, 3 – abundant	Within rectangular area bounding site (see 2c in Table 4)	monitored	monitored
	Grazing	4) Grazing damage	Presence of herbivory/dung/erosion due to stock	0 – absent, 1 – scarce, 2 – common, 3 – abundant	As per 3b above	monitored	monitored

Table 9-7 Summary of trigger levels for Project related monitoring variables

Variable	Trigger
2a) Leaf water potential	Mean values at sites are significantly lower than reference sites and lower than: - 1.5 MPa (Ma) - 3.0 MPa (Ec) - 3.6 MPa (Ev)
2b) Visual health (Rating)	Median decline in values for crown condition score significantly greater than reference sites and median value lower than two standard deviations from the long term mean for the site
2d) PFC	Mean decline significantly greater than reference sites and more than 50% of foliage has been lost since monitoring commenced.
2e) Remotely sensed index of tree condition	Mean value of vegetation condition index for GDV tree canopy falls below 2 standard deviations of the baseline mean.

Table 9-8 Response to Trigger Exceedances

Monitoring parameter	Trigger criteria	Response Action	Responsibility
Area of GDV decline since baseline as measured using high resolution multispectral remote sensing imagery	Mean value of vegetation condition index for GDV tree canopy falls below 2 standard deviations of the baseline mean.	The first level of response will be to investigate. This will involve reviewing and evaluating the quality of the data, additional analyses and if necessary, the collection of additional data. The purpose of this review and analysis will be to assess whether the impact is related to dewatering, some other Project activity or is not Project related. If a dewatering related impact is confirmed, one or more of the following management measures will be implemented within a period of 6 months: • modification of dewatering practices • irrigation • revegetation • offsetting – protection of an equivalent area of GDV within the	Environment Department Hydrogeology Department Mining Department
Leaf water potential – predawn leaf water potential using the pressure chamber technique	Mean values at sites are significantly lower than reference sites and lower than: -1.5 MPa (Ma) -3.0 MPa (Ec) -3.6 MPa (Ev)		
Tree visual health assessment (based on Souter et al. 2009)	Median decline in values for crown condition score significantly greater than reference sites and median value lower than two standard deviations from the long term mean for the site		
Project foliar cover (visual estimate by tree)	Mean decline significantly greater than reference sites and more than 50% of foliage has been lost since monitoring commenced.		

Monitoring parameter	Trigger criteria	Response Action	Responsibility
		predicted impact zone. The chosen measure or measures will be dependent on location, extent and severity of impact and the species affected. In order to assess their effectiveness, an increased frequency of monitoring (quarterly) will be conducted at the affected area and at a suitable reference location for a selection of the most appropriate parameters (for example, if irrigation is applied, water potential and tree health to be measured).	

Results of monitoring conducted in November 2020 and May 2021 show that all three GDV species recorded low water stress and high visual health across most sites, consistent with recent trends. While some individual trees showed reduced visual health, no significant differences were recorded between impact and reference sites. Mean leaf water potential remained above trigger values during the monitoring period except for *M. argentea* at Sites 14 and 16 (Potential Impact Sites) for the May 2021 monitoring period. This is likely due to a localised area of saturation of the root zone. Other health parameters are not indicating a decrease in condition and so no immediate action is warranted at this stage

Analysis of remotely sensed data show some small areas of tree decline compared to baseline within, and outside of the Drawdown Management Zone. On ground checks conducted in November 2020, confirmed this with localised reductions in tree health. As the changes were recorded both within, and outside of the Drawdown Management Zone, it is highly unlikely that these changes are due to reductions in groundwater levels. No triggers were exceeded for the remote sensing data component. Weeds were common to abundant across the monitoring area throughout the monitoring period and weed cover within quadrats remained similar to the previous monitoring levels across both potential impact and reference sites.

In summary, the health and condition of groundwater dependent trees remained within acceptable levels throughout the 2020/2021 monitoring period with the exception of *Melaleuca argentea* LWP averages at Sites 14 and 16 (potential Impact) with other health indicators remaining within trigger values.

Rainfall variation and changes to grazing over the monitoring period is likely to have caused fluctuations in weed densities across the monitoring sites.

Continued focus on groundwater levels and GDV health outside of the Drawdown Management Zone is important to ensure external conditions are identified and mine operations are not wrongly attributed to changes in vegetation condition.

9.4 Potential Impacts

The following potential impacts have been identified:

- Groundwater drawdown from dewatering has the potential to reduce the available water to groundwater dependent ecosystems that may result in potential impacts to vegetation health.
- Groundwater drawdown has the potential to reduce available water to Mesquite populations that may impact to vegetation health and result in a positive environmental outcome.

This section describes the impacts of groundwater drawdown on groundwater-dependent ecosystems.

The impact of groundwater drawdown and discharge on hydrological processes is outlined in Section 5 (Inland Waters) whilst Section 6 (Marine Environmental Quality) describes the impact of groundwater discharge on marine environmental quality.

9.5 Assessment of Impacts

The floodplain of the Fortescue River supports vegetation that is moderately to highly dependent on groundwater (Astron, 2009b) and therefore has the potential to be impacted by groundwater drawdown associated with the revised proposal.

Figure 19 and Figure 20 show the predicted groundwater drawdown (PSM, 2020) for Scenario 4 (considered to be the worst case drawdown scenario) (Section 5.4.3.4) in the context of the baseline GDV mapping (Astron, 2009b).

Table 9-9 shows the change in area of GDV that may be affected by the proposed increase in drawdown associated with 21GL/a.

Table 9-9 Area of groundwater dependent vegetation potentially affected by groundwater drawdown

Groundwater dependence	Total mapped extent (ha)	Extent within ≥0.5m drawdown contour		Extent within≥5.0m drawdown contour		Extent within≥10.0m drawdown contour	
		ha	%	ha	%	ha	%
Current 12 GL/a							
High	171.1	171.1	100.0	35.3	20.6	0.0	0.0
Moderate	21,984.0	3,978.96	18.1	550.2	2.5	250.8	1.1
Low	93.3	0.0	0.0	0.0	0.0	0.0	0.0
Total	22,248.5	4,150.10	18.6	585.5	2.6	250.8	1.1

Groundwater dependence	Total mapped extent (ha)	Extent within ≥0.5m drawdown contour		Extent within≥5.0m drawdown contour		Extent within≥10.0m drawdown contour	
		ha	%	ha	%	ha	%
Proposed 21 GL/a (LoM)							
High	171.1	149.7	88	133.0	78	117.4	69
Moderate	21,984.0	5,852.0	27	4,531.3	21	3,527.38	16
Low	93.3	3.1	3	3.1	3	3.1	3
Total	22,248.5	6,004.8	27	4,667.4	21	3,530.5	16

The increased area of potential impact on high dependant GDV is limited to an area of creekline located within area heavily impacted by weed infestation, that is, it is located within the area mapped as high to medium density Mesquite population (Figure 40).

The area of GDV potentially impacted will increase by 18.4 % compared to current abstraction rate to a total of 4,667.4 ha within the >5 m groundwater drawdown contour. Of this 133 ha is high dependant vegetation and 4,531.3 ha is moderately dependant. This GDV is located within an area with moderate to high density of mesquite infestation and accordingly is considered to have limited native vegetation value. In a regional context the loss of GDV represents 0.14 % of the mapped extent of GDV within the Fortescue River region.

Furthermore, while the proposed extent of the predicted 5 m contours will extend further west as a result of this Proposal (21GL/a), they will be in an area that is also subject to seasonally highly variable groundwater levels from flows in the Fortescue River where fluctuations of up to 6m having been recorded in some bores located close to the Fortescue River.

Overall, the increased extent of predicted groundwater drawdown resulting from the Proposed Change will not significantly alter the extent of the potential effects on GDV in either the Fortescue River floodplain or the broader Fortescue River region.

9.6 Monitoring and Mitigation

GDV will continue to be monitored in response to ground water drawdown in accordance with the methods outlined in the GDVMP. In the event that trigger criteria are met or exceeded response actions identified in the GDVMP will be initiated. These may include:

- modification of dewatering practices;
- irrigation;
- revegetation; and
- offsetting – protection of an equivalent area of GDV within the predicted impact zone.

The GDV monitoring program will be reviewed and amended as appropriate, in line with the revised drawdown extent. Additional GDV monitoring locations will be established within new areas of groundwater drawdown and will be included in remote sensed imagery analysis. Reporting of monitoring results will continue as required under current approvals.

9.7 Assessment and significance of residual impact

The revised proposal has the potential to impact areas of groundwater dependant vegetation (GDV) due to groundwater drawdown. Based on the hydrogeological modelling for the increased discharge (21 GL/a) some loss of GDV may occur within the revised drawdown area, in particular in areas where drawdown is $\geq$5m.

The majority of GDV with the potential to be impacted is highly degraded due to impacts from mesquite infestation. Small areas of moderately to highly dependent GDV within creek lines may be impacted, however the small scale of impact is not considered regionally significant given that the vegetation is well represented within regional land systems that are relatively uncleared and have over 80% of their pre-European extent remaining.

Based on the model predictions and when mitigation measures are implemented the EPA objective for Flora and Vegetation is expected to be achieved.

Whilst the area of GDV potentially affected (i.e., within the >5.0m drawdown contour) will increase by 18.4 %, the GDV is located within an area of high to moderate mesquite infestation and seasonally variable groundwater levels of up to 6m. Furthermore, this increase will occur incrementally over the remaining 40 years of mine life (to approximately 2061).

Overall, the increased extent of predicted groundwater drawdown resulting from the Revised Proposal will not significantly alter the extent of the potential effects on GDV in either the Fortescue River floodplain or the broader Fortescue River region.

9.8 Environmental outcome

The environmental outcomes resulting from the implementation of the proposal, with respect to flora and vegetation, as stated in the OEMP and GDVMP is:

- there will be no significant loss of GDV from Project activities beyond both the 5 m drawdown contour and areas approved for clearing, such that the area of GDV potentially impacted will increase by 18.4 % compared to current abstraction rate to a total of 4,667.4 ha within the >5 m groundwater drawdown contour.

10 Consideration of other Environmental Factors or Matters

10.1 Other Factors

The EPA Statement of Environmental Principles, Factors and Objectives (2020a) identifies a number of other environmental factors to be considered for the Proposal, these include:

- Landforms;
- Terrestrial Environmental Quality;
- Subterranean Fauna;
- Air Quality;
- Coastal Processes;
- Human Health; and
- Social Surroundings.

The revised proposal is considered unlikely to result in a significant effect to the above environmental factors, and accordingly, these factors have not been subject to detailed environmental assessment.

Table 10-1 provides a summary assessment of how these other environmental factors have been considered for the revised proposal.

Greenhouse gas emissions, whilst a key factor for the original proposal, as approved under MS635, are not considered a key factor for this revised proposal and are discussed in Section 11.1.

Table 10-1: Other environmental factors

ENVIRONMENTAL FACTOR	EPA OBJECTIVE AND GUIDANCE	Description of the proposal's likely impacts on the environmental factor	Evaluation of why the factor is not a key environmental factor	MANAGEMENT AND PREDICTED OUTCOME
SEA				
Coastal Processes	EPA Objective: *"To maintain the geophysical processes that shape coastal morphology so that the environmental values of the coast are protected."* EPA Guidance: • Environmental Factor Guideline: Coastal Processes (EPA 2016b)	Coastal processes may be affected by the revised proposal due to: • Scouring of the river / estuary bed from the increased volume in discharge resulting in changes to the river bed and coastal processes.	Coastal processes are not considered a key environmental factor for the revised proposal for the following reasons • There will be no direct impact to the bed of the Fortescue River / estuary as no modifications are required to the existing diffuser for the revised proposal. • Discharge will be evenly distributed across the 84 m diffuser into the water column and is unlikely to scour the bed of the Fortescue River or estuary. • The increased discharge of 21 GL/a represents 2.7% of peak tidal volume during neap tides and only 0.3% of the peak volume during spring tides of the Fortescue River and estuary. • Model predications indicate that the increased discharge volume can be efficiently flushed by the tidal processes within the Fortescue River and estuary.	Potential effects to Coastal Processes will be minimised through implementation of the following management actions: • The discharge diffuser will be maintained to optimum operating conditions to ensure that the discharge water is evenly distributed within the water column. • The volume of discharge water will be proactively managed so that no exceedance of the daily discharge volume occurs. It is considered unlikely that the revised proposal will have a significant impact on Coastal Processes as potential effects on this factor can be readily managed.

ENVIRONMENTAL FACTOR	EPA OBJECTIVE AND GUIDANCE	Description of the proposal's likely impacts on the environmental factor	Evaluation of why the factor is not a key environmental factor	MANAGEMENT AND PREDICTED OUTCOME
			• After consideration of significance (*Statement of Environmental Principles, Factors and Objectives)* the revised proposal is not considered to have a significant effect on Coastal Processes. • Fortescue River is subject to significant flood events.	
LAND				
Terrestrial Fauna	EPA Objective: *"To protect terrestrial fauna so that biological diversity and ecological integrity are maintained"* EPA Guidance: Environmental Factor Guideline: Terrestrial Fauna (2016k)	Terrestrial Fauna may be affected by the revised proposal due to: • Increased drawdown of groundwater resulting in loss or impact to Terrestrial fauna habitat, specifically groundwater dependant ecosystems. Conservation significant fauna species occur in a number of habitat types or occur in habitats that are widespread in the region (Ecologia, 2016). Targeted surveys for Northern Quoll (Ecologia 2016) identified that Northern Quoll do occur mainly within the Port area with no individuals recorded within the mine area. Preferred habitat for Northern Quoll includes rugged, rocky areas (boulder	Terrestrial Fauna are not considered a key environmental factor for the revised proposal for the following reasons: • Only small areas of preferred habitat of conservation significant fauna has the potential to be impacted by groundwater drawdown due to the significant Mesquite infestation. Potential areas where conservation significant fauna may inhabit include tidal pools and GDV located along the banks of the Fortescue River. These GDV species are not completely dependent on groundwater for survival and source water from moisture within the soil profile and surface water flow.	Potential effects to Terrestrial Fauna will be minimised through implementation of the following management actions: • Monitoring of high quality GDV likely to be impacted by groundwater drawdown. • Implementation of a groundwater abstraction adaptive management actions should monitoring identify early signs of decline in GDV health. It is considered unlikely that the revised proposal will have a significant impact on Terrestrial Fauna as potential effects on this factor can be readily managed.

ENVIRONMENTAL FACTOR	EPA OBJECTIVE AND GUIDANCE	Description of the proposal's likely impacts on the environmental factor	Evaluation of why the factor is not a key environmental factor	MANAGEMENT AND PREDICTED OUTCOME
		piles) and creeklines. As creekline vegetation is not expected to be significantly affected by groundwater drawdown the impact on Northern Quoll habitat is are not expected to be significant.	• Tidal pools are unlikely to be impacted by ground water drawdown due to the highly intermittent connectivity with groundwater sources. • Predicted increases in tidal inflow to the mining pit is expected as mining deepens and progresses west ward. This tidal inflow is expected to have a mitigating effect on groundwater drawdown overtime. • Due to the small area of fauna habitat likely to be impacted and after consideration of significance (*Statement of Environmental Principles, Factors and Objectives)* the Environmental Factor of Terrestrial Fauna is not considered a key environmental Factor.	
Terrestrial Environmental Quality	EPA Objective: *"To maintain the quality of land and soils so that environmental values are protected."* EPA Guidance: • Environmental Factor Guideline: Terrestrial Environmental Quality (EPA 2016j)	Terrestrial Environmental Quality may be affected by the revised proposal due to: • Increased drawdown of groundwater resulting in partial dewatering of the Lower Fortescue Alluvial Aquifer and impact to the habitat of organisms, biota and fauna that are	Terrestrial Environmental Quality is not considered a key environmental factor for the revised proposal for the following reasons: • The soils of the Fortescue River floodplain are not expected to be significantly impacted by groundwater drawdown as recharge from large, periodic, freshwater floods and tidal flows	Potential effects to Terrestrial Environmental Quality will be minimised through implementation of the following management actions: • Ongoing review of hydrogeological conditions will identify future potential increases in groundwater abstraction that will be

ENVIRONMENTAL FACTOR	EPA OBJECTIVE AND GUIDANCE	Description of the proposal's likely impacts on the environmental factor	Evaluation of why the factor is not a key environmental factor	MANAGEMENT AND PREDICTED OUTCOME
		dependent on soil moisture and contributions from groundwater.	provide the main source of soil moisture. • Low rainfall and recharge occur periodically and it is expected that the aquatic biota and fauna within the soils of the Fortescue floodplain are adapted to periods of wetting and drying. • No additional clearing is required for the Revised Proposal.	subject to further assessment of impacts. • Implementation of groundwater abstraction adaptive management actions should monitoring identify early signs of decline in GDV health (as an indicator of impact Terrestrial Environmental Quality). It is considered unlikely that the revised proposal will have a significant impact on Terrestrial Fauna.
Subterranean Fauna	EPA Objective: *"To protect subterranean fauna so that biological diversity and ecological integrity are maintained."* EPA Guidance: • Technical Guidance: Subterranean Fauna Survey (EPA 2016i)	Subterranean Fauna may be affected by the revised proposal due to: • Increased drawdown of groundwater resulting in loss or impact to subterranean fauna habitat	Subterranean Fauna are not considered a key environmental factor for the revised proposal for the following reasons: • Subterranean fauna habitats in alluvial sediments subject to large, periodic, freshwater floods are likely to be well connected; • Subterranean fauna in alluvial habitats are likely to be readily transported throughout the floodplain by flooding; • Alluvial water tables fluctuate naturally by up to 6 m during flooding and drying cycles, hence drawdown of up to a few metres is unlikely to materially	Potential effects to Subterranean Fauna will be minimised through implementation of the following management actions: • Ongoing review of hydrogeological conditions will identify future potential increases in groundwater abstraction that will be subject to further assessment of impacts. It is considered unlikely that the revised proposal will have a significant impact on Subterranean Fauna as potential effects on this factor can be readily managed.

ENVIRONMENTAL FACTOR	EPA OBJECTIVE AND GUIDANCE	Description of the proposal's likely impacts on the environmental factor	Evaluation of why the factor is not a key environmental factor	MANAGEMENT AND PREDICTED OUTCOME
			change the environment for subterranean fauna; • Drawdown beyond 6 m is limited in extent, around the mine pit; • More than 75% of the floodplain is not predicted to be affected by groundwater drawdown • Predicted increases in tidal inflow to the mining pit is expected as mining deepens and progresses west ward. This tidal inflow is expected to have a mitigating effect on groundwater drawdown overtime. • Aquifers in hard rock fractures that would be mined have limited volume and extent. • Hypersaline aquifers are unlikely to have subterranean fauna. After consideration of significance (*Statement of Environmental Principles, Factors and Objectives)* Subterranean fauna is not considered a key environmental factor.	
PEOPLE				
Social Surroundings	EPA Objective: *"To protect social surroundings from significant harm."* EPA Guidance:	The revised proposal may have an effect on Social Surrounds due to: • The increase in usage of pumps could effect on	Social Surroundings are not considered a key environmental factor for the revised proposal for the following reasons	Potential effects to Social Surroundings will be minimised through implementation of the following management actions:

ENVIRONMENTAL FACTOR	EPA OBJECTIVE AND GUIDANCE	Description of the proposal's likely impacts on the environmental factor	Evaluation of why the factor is not a key environmental factor	MANAGEMENT AND PREDICTED OUTCOME
	• Environmental Factor Guideline: Social Surroundings (EPA 2016h)	amenity at sensitive receptors due to 24 hr/day operations. • The increase in the volume of water discharged to Fortescue River and estuary has the potential to affect the use of the river for recreational fishing and swimming. • The increase in the volume of water discharged to the Fortescue River and estuary has the potential to effect sites that are significant to local Indigenous groups and the local community. • The increase in groundwater abstraction and associated drawdown may have an effect on permanent pools along the Fortescue River. The Fortescue River is used by tourists and visitors to the region for recreational fishing and camping. In addition, the area is likely to hold significant value to the Aboriginal communities within the region. The nearest sensitive receptor is Mardie homestead located	• The noise emitted from night time operation of pumps is expected to be insignificant at the Fortescue camp site and Mardie Station homestead that are located 7km and 30km from the mine respectively. • Based on model predictions the water quality within Fortescue River and Estuary is expected to achieve baseline water quality concentrations. • The limited predicted water table drawdown at the Mungajee permanent pool of between 0.5 to 1 m. • The existence of an Indigenous Land Use Agreement between the proponent and YMTO for the purpose of an iron ore mine. Consultation in accordance with the ILUA will be ongoing throughout the life of the proposal. After consideration of significance (*Statement of Environmental Principles, Factors and Objectives)* the revised proposal is not considered to have a significant effect on social surroundings	• The discharge diffuser will be maintained to optimum operating conditions to ensure that the discharge water is evenly distributed within the water column. • The volume of discharge water will be proactively managed so that no exceedance of the daily discharge volume occurs. • Water quality monitoring of the discharge water and the surface water will be implemented in accordance with the EP Act Licence L8308/2008/2 (2021b) to ensure that the water quality limits are maintained. • The Operational Noise Management Plan caters for noise complaints and their management. It is considered unlikely that the revised proposal will have a significant impact on Social Surroundings as potential effects on this factor can be readily managed.

ENVIRONMENTAL FACTOR	EPA OBJECTIVE AND GUIDANCE	Description of the proposal's likely impacts on the environmental factor	Evaluation of why the factor is not a key environmental factor	MANAGEMENT AND PREDICTED OUTCOME
		~30 km from the discharge location at the Fortescue River.		
Human Health	EPA Objective: *"To protect human health from significant harm."* EPA Guidance: • Environmental Factor Guideline: Human Health (EPA 2016d)	The EPA Guidance for this factor provides the specific framework for considering the possible impacts to human health arising from the emission of radiation. Emission of radiation is not a consideration for this proposal The revised proposal is not expected to have any effect on Human Health.	• Radiation emissions are not a relevant consideration for the revised proposal.	Not applicable

10.2 Greenhouse Gas Emissions

10.2.1 EPA Objective

The EPA Objective for Greenhouse Gas Emissions (GGE) is to reduce net greenhouse gas emissions in order to minimise the risk of environmental harm associated with climate change (EPA, 2020c).

10.2.2 Policy and Guidance

The relevant EPA policy and guidance for Greenhouse Gas Emissions is:

- Environmental Factor Guideline, Greenhouse Gas Emissions (EPA 2020c)

Other relevant State Government Policies includes:

- State Greenhouse Gas Emissions Policy for Major Projects (State Emissions Policy), (Government of Western Australia, 2019)

10.2.3 Receiving Environment

GGE and their impact on global warming and climate change has the potential to significantly impact environments locally, nationally and globally (EPA, 2020c).

The United Nations Framework Convention on Climate Change (UNFCCC) Paris Agreement entered into force on 4 November 2016. Under this Agreement, Australia has committed to reducing GHG emissions by 26 - 28 % below 2005 levels by 2030 with a target to be net zero by 2050. The Paris Agreement states that net zero emissions will be required in the second half of the century to achieve its goals of limiting warming to well below two degrees Celsius above pre-industrial levels. More recently, the Intergovernmental Panel on Climate Change's (IPCC's) 1.5 report indicated that global emissions need to fall by about 45 per cent from 2010 levels by 2030, reaching 'net zero' around 2050, to limit global warming to 1.5 degrees Celsius (EPA, 2020c).

In August 2019 the Government of Western Australia released the State Greenhouse Gas Emissions Policy for Major Projects (State Emissions Policy). The State Emissions Policy commits the State Government to working with all sectors of the Western Australian economy to achieve net zero GHG emissions by 2050 and commits to working with the Australian Government's interim target of emission reductions of 26 - 28 % by 2030. The State Emissions Policy contemplates the development of GHG management plans by proponents of projects with significant emissions to detail their contribution towards achieving net zero emissions by 2050 (Government of Western Australia, 2019).

10.2.4 Potential Impacts

GGE contribute to global warming and climate change and have the potential to result in harmful impacts to the environment.

The source of GGE for the approved proposal are predominantly from the operation of the 480 MW combined cycle energy efficient power station and operation of diesel fuelled mining equipment.

The source of GGE for the revised proposal are from the increased operation of groundwater abstraction and dewater discharge pumps.

10.2.5 Assessment of Impacts

GGE have not been identified as a key environmental factor for the revised proposal, as the change in emissions for the revised proposal is below 100,000 tonnes of scope 1 emissions per annum.

Approved Proposal

GGE associated with the original proposal were considered under the key environmental factor of Air Quality. GGE are now considered as a separate Environmental Factor in accordance with the EPA's 2020 Environmental Factor Guideline – Greenhouse Gas Emissions. (EPA, 2020c)

The estimated GGE authorised under the approved proposal (approved under MS 635) were 4.86 Mtpa of Scope 1 emissions CO_2 equivalents (CO_2-e).

The GGE estimates were based on projected emissions from a proposed 640 MW power station, process gas production for the pellet plant and direct reduced iron (DRI) plant, diesel emissions from mobile equipment and land clearing. The pellet plant and direct reduced iron (DRI) plant approved under MS 635 have not been constructed and a smaller capacity power station of 480 MW was installed and is operational.

Current operational emissions for the Sino Iron project reported under the NGERS for 2020/21 period were 1.24 Mt CO2-e. This represents only 26% of the authorised emissions for the approved proposal, resulting in a 74% reduction in emissions for the 2020/2021 period.

This significant reduction is due to the pellet plant and DRI not being built to this point in time so emissions from process gas and additional electricity generation have not eventuated. An energy efficient 480 MW combined cycle power station was installed instead of the proposed 640 MW power station. In addition to a smaller capacity, the combined cycle technology is 40% more energy efficient than an equivalent sized open-cycle gas turbine power station and is expected to save 440,000 t CO2-e per year. At the start of the project, it was recognised in Australia by the Energy Efficiency Council as 'Best Industrial Energy Efficiency Project' in 2012.

Revised Proposal

GGE are predicted to increase under the revised proposal, as compared to the 2020/2021 reported GGE due to an increase in groundwater abstraction and dewater discharge pumping.

The GGE for the revised proposal are estimated to be an increase of 24,489 t CO2-e per year from 12 to 21 GL (Table 10-2) representing just 0.5% of the authorised emissions for the approved proposal (Greenhouse Gas Emissions Management Plan approved under Condition 11 of MS 635) (Maunsell, 2006) and is 2% of the total emissions (1.24 Mt CO2-e) reported for the 2020/21 period.

Table 10-2 Summary of GGE for the revised proposal

Dewatering Estimated Emissions from 8 GL to 12 GL to 21 GL							
Process	**8 GL**		**12 GL**		**21 GL**		**Increase from 12 to 21 GL**
	Annual Diesel	**Scope 1 Emissions**	**Annual Diesel**	**Scope 1 Emissions**	**Annual Diesel**	**Scope 1 Emissions**	**Scope 1 Emissions**
	kL	**tCO_2e**	**kL**	**tCO_2e**	**kL**	**tCO_2e**	**tCO_2e**
Abstraction - Pumps in Pit	3,786	10,260	5,680	15,390	9,939	26,933	11,543
Abstraction - Submersible Pump	337	913	506	1,370	885	2,398	1,028
Disposal	1,702	4,612	2,553	6,918	4,468	12,107	5,189
Staging System			3,311	8,973	5,795	15,702	6,729
Total		15,786		32,651		57,140	**24,489**

10.2.6 Mitigation

Significant mitigation measures have already been voluntarily implemented for the approved Sino Iron Project through the installation and operation of the 480 MW combined cycle energy efficient power station, expected to save 440,000 t CO2-e per year, reducing GGE over the life of the project.

At Sino Iron approximately 80% of the GHG emissions are from electricity production with combustion of natural gas. The remaining 20% of GHG emissions are from diesel usage, mostly by mobile mining equipment. CPM's power station performed well, comparable with power sector science-based target for 2020 and considerably better than the current Australian regulatory default value for electricity production (NGER). For example, the emission intensity of the power station was typically around ~ 0.41 to 0.42 tCO2e/MWh; well below the Australian regulatory default of 0.538 t CO2e/MWh. To date CPM's power station has consistently performed better than most power stations in Australia. This is due to the extra efficiency in CPM's 480-megawatt natural gas fired combined-cycle power station that uses waste heat from the primary process to then heat water to generate steam and electricity, generating further electrical energy. However, over this current decade, steep emission reductions are expected in the world's emissions in order to meet science-based targets aligned with the Paris Agreement, creating a significant challenge for businesses.

Carbon Neutral by 2050

CPM will continue to investigate measures to further reduce GGE, in particular through new and emerging carbon reduction technologies to effectively manage the very important task to achieve our corporate carbon neutral target. CITIC Ltd, CPM's parent company is listed on the Hong Kong Stock Exchange, announced in 2021 an aspiration to strive to achieve carbon emission peak by 2025 and carbon neutrality by 2050.

In 2021, key climate change management achievements were made. CPM commenced developing a strategy to achieve emission reduction by reviewing the Task Force on Climate-related Financial Disclosures (TCFD) principles with core elements of Governance, Strategy, Risk Management, Metrics and Target setting. Strategy development included a series of suggestions following all four core TCFD principles including governance co-ordination, strategy focus, risk description and metric development. A major achievement included the development of a Governance Structure with the formation of the Carbon Reduction and Neutrality Management Committee and Execution Team.

Part of CPM's strategy is to keep track of suitable decarbonisation technologies as they evolve into the future. These along with the development of emission reduction plans are to be assessed by the Governance Carbon Reduction and Neutrality Management Committee.

During 2022, a feasibility study is planned on photovoltaic power generation and a battery storage system. A potential constraint for major emission reduction investments on the project is life of mine. Before significant investment can be made, securing continuous operations for life of mine with our commercial partner would need to be resolved and is currently under legal processes. As renewable power feasibility is evaluated, we also seek clarification on issues such as land availability.

Other project constraints, include uncertainty in the future emission profile for the project with the Pellet Plant and DRI plant required as part of the IOPPA (State Agreement Act) and approved within Ministerial Statement 635 but these have not yet been built. Update to plans to reduce emissions will need to consider future plans and project constraints.

CITIC Pacific Mining will continue to reduce greenhouse gas emissions with current operations and ongoing energy efficiency initiatives. Once the project specific constraints relating to land access for the purpose of mine continuation have been resolved (i.e. no forced suspension), CPM commits to reviewing the current approved Greenhouse Gas Management Plan for the project with the objective of continuing to reduce net carbon emissions throughout the life of the project. The review will focus on the aspirational goal of achieving carbon neutrality as soon as practicable. To facilitate achievement of this goal, all current emissions reductions, energy efficiency and offsetting strategies will be reviewed, with specific strategies and actions identified for implementation taking into account State Agreement Act obligations with regards to downstream processing. This is also conditional upon the WA government providing security of tenure for renewable energy assets with regards to mining tenure and State Agreement areas. CPM will finalise the review of the GHG Management Plan within 12 months of land access issues being resolved and the revised proposal being approved.

10.2.6.1 Energy Efficiency and Emission Reduction Improvements

Part of CPM's strategy is for current operations to focus on improvement of energy efficiency and this also aligns with the strategy by our steel making customers.

Magnetite concentrate from Sino Iron is a premium iron ore product with high grade and lower impurities. These are important properties for steel makers. Compared with Hematite, Magnetite requires less energy and produces less carbon emission in steel making, which contributes to global emission reduction.

Maintaining a high quality premium product is therefore critical to our customers and CPM operations. CPM instigated improvements as Sino Iron was challenged by the changing nature of ore in the mine pit. Operations were optimised as a result, with new equipment improving iron ore recovery and lowering impurity rates. The new equipment uses less electrical energy than the unit it replaced with an expected 10% savings, whilst operations could process more material. This results in an overall lower energy consumption per unit of product produced. The business case was made, a series of pilot studies followed and in 2021 the optimisation process reached completion. It involved replacing tertiary magnetic separators with new innovative magnetic elutriation columns and optimising operating parameters across all six processing lines. This project was an energy saving win for our operations and our customers.

As this project reached implementation, another efficiency and optimisation study commenced. Reducing the size of material from mined ore to concentrate is a key part of the value adding at Sino Iron. A key technology which can crush material more efficiently stood out to Sino Iron processing engineers. The technology uses high-pressure grinding rolls (HPGR) to feed material in between two hardened metal rollers using pressure and the hard material itself to crush material down. After a series of reviews, alternatives and laboratory studies, a business case followed for a pilot study. In 2022, the project to engineer, procure, construct and commission the addition of the HPGR to a third of the processing lines is planned. This more efficient crushing of material means less energy is used for grinding further down in the process. Adding the HPGR is expected to reduce the overall unit power consumption per wet ton of concentrate by 7% for each of the processing lines on which it is installed.

The installation of a power line to Eramurra accommodation village is also planned. The project is to replace power generation from small inefficient diesel generators with the more energy efficient and lower emission profile combined cycle power station. Expected emissions savings from the power line project is approximately 3,850 t CO2e / year, representing about a 41% reduction in emissions for the Eramurra accommodation village. CPM is awaiting confirmation with the Minister for State Development to confirm if this is acceptable under the IOPAA (State Agreement Act).

10.2.7 Assessment and significance of residual impact and environmental outcome

The revised proposal will not result in an increase in the authorised GGE for the approved proposal and the estimated GGE increase for the revised proposal is within the savings from the operation of the energy efficient 480 MW combined cycle power station.

As noted above, CITIC Pacific Mining will continue to reduce greenhouse gas emissions with current operations and ongoing energy efficiency initiatives, and review the GHG Management Plan within 12 months of land access issues being resolved and the revised proposal being approved, the review will focus on the aspirational goal of achieving carbon neutrality as soon as practicable to ensure the EPA's objective for this factor can be met.

11 Offsets

The Western Australian Government's Environmental Offsets Policy (GoWA 2011) seeks to protect and conserve environmental and biodiversity values for present and future generations. This policy ensures that economic and social development may occur while supporting long term environmental and conservation values.

The WA Environmental Offset Guidelines (Offset Guidelines) (GoWA 2014) complement the WA Environmental Offsets Policy 2011 (offsets policy) by clarifying the determination and application of environmental offsets in Western Australia.

Environmental offsets as defined by the Offset Guidelines are actions that provide environmental benefits which counterbalance the significant residual environmental impacts or risks of a project or activity. Unlike mitigation actions which occur on-site as part of the project and reduce the direct impact of that project, offsets are undertaken outside of the project area and counterbalance significant residual impacts.

Environmental offsets will only be applied where the residual impacts of a proposal are determined to be significant, after avoidance, minimisation and rehabilitation have been pursued.

To ensure consistency and transparency of whether offsets should be applied to a proposal, the significance of residual impacts has been determined through the application of the residual impact significance model provided in the Offsets Guideline. This model outlines how significance is determined and when an offset is likely to be required, or may be required, in relation to relevant EPA environmental factors and the relevant clearing principles in Schedule 5 of the EP Act (GoWA, 2014).

In general, significant residual impacts include those that affect rare and endangered plants and animals (such as declared rare flora and threatened species that are protected by statute), areas within the formal conservation reserve system, important environmental systems and species that are protected under international agreements (such as Ramsar listed wetlands) and areas that are already defined as being critically impacted in a cumulative context. Impacts may also be significant if, for example, they could cause plants or animals to become rare or endangered, or they affect vegetation which provides important ecological functions (GoWA 2014).

The mitigation hierarchy of 'avoid, minimise, rehabilitate and offset' has been considered in the assessment of this proposal. This assessment has determined that this proposal will not have significant residual impacts and as such, no offsets are proposed.

12 Matters of National Environmental Significance

The Commonwealth EPBC Act provides a framework for the protection of 'nationally significant' animals, plants, habitats and places referred to as Matters of National Environmental Significance (MNES) that include:

- World heritage properties
- National heritage places (including Commonwealth Heritage Places);
- Wetlands of international importance (listed under the Ramsar Convention);
- Listed threatened species and ecological communities;
- Migratory species protected under international agreements;
- Commonwealth marine areas;
- The Great Barrier Reef Marine Park; and
- Nuclear Actions including uranium mining.
- A water resource, in relation to coal seam gas activities and large coal mining activities;

The EPBC Act requires that all actions that will or may have a significant impact on a MNES are referred to the Commonwealth Minister for Environment for assessment under the EPBC Act by the DAWE.

In addition, protected matters include proposed actions that will affect Commonwealth land or proposed actions that will be undertaken by a Commonwealth agency.

For consistency with the EPBC Act, the proposal is referred to as the "proposed action" in this section of the referral.

12.1 Controlled Action Provisions

The environmental values of the proposed action have been determined with reference to environmental surveys and assessments and available scientific information on relevant EPBC Act listed species.

The potential impacts of the proposed action were considered with reference to the policy document, *Matters of National Environmental Significance Significant impact guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999* (DAWE, 2009).

12.2 Listed Threatened Species and Communities

A proposed action that has, will have, or is likely to have a significant impact on; a species that is listed as extinct in the wild, critically endangered, endangered or vulnerable; or an ecological community listed as critically endangered or endangered, are required to be referred for assessment under the EPBC Act.

A recent search of the approved and revised proposal area for the MCP and a 50 km buffer using the DAWE protected matters search tool identified 29 listed threatened species (9 birds, 6 mammals, 1 plant, 8 reptiles and 5 sharks) and 44 listed migratory species (8 migratory marine birds, 21 migratory marine species, 3 migratory terrestrial bird species and 12 migratory wetland species). Of the 29 listed threatened species, 5 are listed as critically endangered, 9 are listed as endangered and 15 are listed as vulnerable. Of the 44 Migratory species, 2 are listed as critically endangered, 6 are listed as endangered and 8 are listed as vulnerable. (DAWE, 2021) (Appendix 6).

Based on, the proposed action, the potential environmental impacts of the proposed action and the preferred habitat of the threatened species recorded as having the potential to occur within the search area, it is considered that the revised proposal has the potential to impact on the habitat of the following conservation significant species (DAWE, 2009):

- Northern Quoll (*Dasyurus hallucatus*) (Endangered)
- Minnie daisy (*Minuria tridens*) (Vulnerable)
- Olive Python (*Liasis olivaceus barroni*) (Vulnerable)
- Grey Nurse Shark (west coast population) (*Carcharias taurus*) (Vulnerable)
- Dwarf Sawfish, Queensland Sawfish (*Pristis clavate*) (Vulnerable)
- Green Sawfish, Dindagubba, Narrowsnout Sawfish (*Pristis zijsron*) (Vulnerable)

Sections 12.2.1.1 and 12.2.1.2 present an assessment of the significance of the impacts of the revised proposal on the above threatened species.

12.2.1 Assessment of Significance of impacts

12.2.1.1 Species listed as Critically Endangered and Endangered

Significant impact criteria

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will (DAWE, 2009):

- lead to a long-term decrease in the size of a population
- reduce the area of occupancy of the species
- fragment an existing population into two or more populations
- adversely affect habitat critical to the survival of a species
- disrupt the breeding cycle of a population

- modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
- result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat
- introduce disease that may cause the species to decline, or
- interfere with the recovery of the species.

Northern Quoll (Dasyurus hallucatus) (Endangered)

Northern Quoll (*Dasyurus hallucatus*) is listed as endangered under the EPBC Act and has been recorded in areas surrounding the proposed action.

In the Pilbara region, Northern Quoll prefer land systems comprising basalt hills, mesas (and buttes of limonites), high and low plateaux, lower slopes, occasional fields and stony plains supporting either hard or soft spinifex grasslands (van Vreeswyk et al. 2004) and have also been recorded in sandstone and dolomite hills and ridges, shrublands, sandy plains, clay plans and tussock grasslands and coastal fringes including dune islands and beaches (Biota Environmental Services 2008).

Reconnaissance and targeted Northern Quoll (Dasyurus hallucatus) surveys conducted across the approved proposal area in May and July 2016 (Ecoscape, 2016) identified three male Northern Quolls on the northern end of the breakwater (outside approved proposal area). No females were recorded although they were considered likely to occur in close proximity. Northern Quolls are known to have extensive roaming behaviour and factors such as shelter, high humidity, and abundance of food resources (black rats, house mice, crabs etc.) are the likely drivers for Northern Quolls to utilise the Port area (Ecoscape 2016). In summary, the northern section of the port infrastructure contains a small amount of critical habitat (both natural and artificial) for the species which is likely to be utilised for foraging due to the proximity to the breakwater (Ecoscape 2016).

The proposed action will result in groundwater drawdown from mine dewatering that has the potential to impact on the health of GDV, including GDV that occurs along the banks of the Fortescue River and DuBoulay Creek. As Northern Quolls are known to utilise vegetation along creek banks for foraging, groundwater drawdown has the potential to impact a small area of Northern Quoll foraging habitat along the Fortescue River and DuBoulay Creek. The proposed action will not impact on the critical Northern Quoll habitat within the Cape Preston Port area.

As the mine pit deepens, changes to groundwater drawdown will occur with the extent of drawdown expected to be less for the proposed action than for the MCP approved proposal under MS 1066.

As the wide range of habitats utilised by the Northern Quoll are well represented both locally and regionally and the impacts of the proposed action do not exceed what has already been approved, and as such the proposed action is considered unlikely to have a significant impact on the population or habitat of Northern Quoll either locally or regionally.

12.2.1.2 Species listed as Vulnerable

Significant impact criteria

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of an important population of a species
- reduce the area of occupancy of an important population
- fragment an existing important population into two or more populations
- adversely affect habitat critical to the survival of a species
- disrupt the breeding cycle of an important population
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
- introduce disease that may cause the species to decline, or
- interfere substantially with the recovery of the species.

Six species listed as vulnerable have the potential to occur within the proposed action area. Of the six species, two species have the potential to occur within terrestrial environments and four within marine and coastal environments.

Minnie daisy (Minuria tridens) (Vulnerable)

The Minnie Daisy occurs in the Northern Territory (NT) and Western Australia (WA). In WA, one population was recorded 22 km south of Cue on the Great Northern Highway (Cooke 1986; Lander 1987) in 1987, however 2008 search failed to relocate the population (TSSC 2012). The other population was identified during a survey of the Mardie Salt project located approximately 50 km south of the proposed action area (Phoenix, 2020).

The Minnie Daisy typically occurs on south facing slopes or steep rocky cliffs in low shrubland on dolomite, limestone and calcrete-impregnated sandstone hills and ranges (Cooke 1986; Nano & Pavey 2008) (DAWE, 2020), however the Mardie population was recorded on a coastal sand due in *Triodia epactia* and *Cenchrus ciliaris* grassland. In the Northern Territory *M. tridens* potentially has a negative association with hummock grasses and the national recovery for the species (Nano & Pavey 2008) suggests that habitat that remains free of *C. ciliaris* may be critical for the long term survival of *M. tridens*. It is not known if this association is applicable to the WA populations (Phoenix, 2020).

The closest recorded population of Minnie Daisy is approximately 50 km south of the proposed action area. Groundwater drawdown associated with the proposed action has the potential to impact on 4,667.4 ha of GDV (within the >5.0m drawdown contour), the majority of which is heavily infested with Mesquite. As the Minnie Daisy has not been recorded in the local area and given the low value vegetation that has the potential to be impacted, it is unlikely that the proposed action will have a significant impact on the population or habitat of the Minnie Daisy.

Olive Python (Liasis olivaceus barroni) (Vulnerable)

The Olive Python (Pilbara subspecies) is restricted to ranges within the Pilbara region, north-western Western Australia, such as the Hamersley Range, and islands of the Dampier Archipelago. The Olive Python (Pilbara subspecies) prefers escarpments, gorges and water holes in the ranges of the Pilbara region (Pearson 1993; Wilson & Swan 2003). Individuals are usually in close proximity to water and rock outcrops that attract suitable sized prey species (Pearson 2003). The species is opportunistic and is known to inhabit both natural and man-made habitats (Tutt et al 2002) (DAWE, 2021).

Groundwater drawdown from mine dewatering has the potential to impact on permanent and semi-permanent pools along the Fortescue River, a preferred habitat for the Pilbara Olive Python. The pools are connected to the Lower Fortescue Alluvial Aquifer with the permanence of this connection intermittent due to seasonal changes associated with rainfall, evaporation and drought conditions. The pools also receive inputs from stream flow and tidal contributions and are therefore not fully dependant on groundwater contributions. The impact on these riverine pools from groundwater drawdown is likely to be minimal due to the intermittent nature of the pool connection to the alluvial aquifer and contributions from other sources.

As the preferred habitat of the Pilbara Olive Python is well represented within the Pilbara region and given that permanent and semi-permanent riverine pools are unlikely to be impacted by the proposed action, it is expected that there will be no significant impact to the populations or habitat of the Pilbara Olive Python at a local or regional level.

Grey Nurse Shark (west coast population) (Carcharias taurus) (Vulnerable)

The Grey Nurse Shark (west coast population) has a broad inshore distribution, primarily in sub-tropical to cool temperate waters (Last & Stevens 1994). The population of Grey Nurse Shark (west coast population) is predominantly found in the south-west coastal waters of Western Australia (Environment Australia 2002) and has been recorded as far north as the North West Shelf (Stevens 1999; Pogonoski et al. 2002).

Grey Nurse Sharks are often observed hovering motionless just above the seabed, in or near deep sandy-bottomed gutters or rocky caves, and in the vicinity of inshore rocky reefs and islands (Pollard et al. 1996). The species has been recorded at varying depths, but is generally found between 15–40 m (Otway & Parker 2000). Grey Nurse Sharks have also been recorded in the surf zone, around coral reefs, and to depths of around 200 m on the continental shelf (Pollard et al. 1996). They generally occur either alone or in small to medium sized groups, usually of fewer than 20 sharks (Pollard et al. 1996). Grey Nurse Sharks that are observed alone are thought to be moving between aggregation sites (Environment Australia 2002).

Given the preferred habitat of the Grey Nurse Shark it is not expected to inhabit or frequently visit the Fortescue River or estuary. Consequently, it is considered that the proposed action is unlikely to impact on the population or habitat of this species.

Dwarf Sawfish, Queensland Sawfish (Pristis clavate) (Vulnerable), Green Sawfish, Dindagubba, Narrowsnout Sawfish (Pristis zijsron) (Vulnerable)

Section 8 provides detailed information on the known distribution, habitat type and behaviours of the Dwarf and Green Sawfish within the Pilbara region of WA. Nationally and globally significant sawfish populations are known to occur in the North-West inshore coastal waters and estuarine and riverine environments. Green Sawfish in particular are expected to be present in the creeks and rivers of the Pilbara and are known to use the mouths of major rivers, such as the Ashburton River as pupping grounds during April to October (Morgan et al, 2015). Whilst the distribution of sawfish species is not well understood; the Green Sawfish (*Pristis zijsron*) (*Anoxypristis cuspidata*) is likely to occur in the region, with the Dwarf Sawfish (*Pristis clavata*) having the potential to occur regionally (O2 Marine, 2020g).

The Dwarf and Green Sawfish have the potential to occur within the Fortescue River and estuary, based on the presence of sawfish species within similar riverine and estuarine environments within the Pilbara and Kimberley regions of Western Australia. If present, Dwarf and Green Sawfish could potentially be affected by short term, minor elevations in salinity and ammonia within the Fortescue River as a result of the revised proposal.

As outlined in previous sections of this report (Sections 6.6 and 8.4) salinity and ammonia concentrations within the Fortescue River and Estuary will return to the baseline concentrations over a full tidal cycle within the Fortescue River and Estuary. Short term (up to 3 - 4 days) elevations in salinity over the tidal cycle are within the range of natural baseline concentrations and are therefore expected to be within the tolerance level of these species based on the range of mesohabitats this species occupies at different times of the year within riverine and estuarine environments. Accordingly, the revised proposal is not expected to have a significant impact on the populations or habitat of the Dwarf or Green Sawfish at a local or regional level.

12.2.2 Summary of significance of impacts

The conservation significant species that occur or have the potential to be present within the search area occupy a variety of habitats that are widespread in the region. None of the habitats within areas that have the potential to be impacted by the proposed action are unique locally or regionally significant.

The impacts associated with the proposed action are expected to be minor and short term and are not expected to result in a significant impact to the environment. Given this and based on the widespread distribution of habitats for the recorded conservation significant species, it is unlikely that the proposed action will have a significant impact of Matters of National Environmental Significance.

13 Holistic Impact Assessment

The EIA process needs to consider the connections and interactions between parts of the environment to inform a holistic view of impacts to the whole environment. This requires consideration of the impacts of the Proposal in a regional context as well as at the local scale.

Table 13-1 outlines the activities of the Proposal that involve interactions between key environmental factors and the associated potential impacts and Table 13-2 provides the predicted outcomes of the Proposal in relation to the environmental principles of the EP Act.

Avoidance and minimisation have been the focus for managing the potential environmental impacts of the approved proposal.

A number of assessments and modelling investigations have been conducted to understand the potential environmental impacts of the revised proposal. These studies predict that increases in groundwater abstraction and dewater discharge to the Fortescue River and estuary are unlikely to result in significant impacts to the environment. Modelling predicts that due to the strong tidal flows, and very high rate of flushing over a full tidal cycle, salinity (TDS) and ammonia will remain within pre-impact baseline concentrations. In addition, short term increases in salinity over a full tidal cycle are not expected to result in any significant impact to Benthic Communities or Marine Fauna. Groundwater drawdown associated with abstraction of dewater is not expected to have a significant effect on high value ground water dependant vegetation a sub-regional level.

The proponent will continue to implement the avoidance and mitigation measures described for each key environmental factor, to proactively manage any potential residual impacts from the revised proposal.

Based on the studies undertaken and the mitigation measures proposed, the revised proposal is considered to meet the EPAs objective for all key environmental factors.

Table 13-1: Interaction of Key Environmental Factors

Proposed Activities	Key Environmental Factors – Potential Impacts				
	Inland Waters	**Marine Environmental Quality**	**Benthic Communities and Habitats (BCH)**	**Marine Fauna**	**Flora and Vegetation**
Groundwater abstraction	Drawdown from groundwater abstraction has potential to modify groundwater and surface water flows.	Not applicable	Not applicable	Not applicable	Groundwater abstraction may result in changes in water availability for GDV.
Discharge to Fortescue River	Discharge of mine dewater has the potential to modify surface water flows and water quality in the Fortescue River and estuary.	Discharge of mine dewater has the potential to alter water quality in the Fortescue River and estuary.	Changes in water quality as a result of dewater discharge to the Fortescue River has the potential to impact mangrove health.	Changes in water quality as a result of dewater discharge to the Fortescue River has the potential to impact on sensitive marine megafauna within the estuary.	Changes in water quality as a result of dewater discharge to the Fortescue River has the potential to impact mangrove health.

Table 13-2: Predicted Outcomes and the Environmental Principles of the EP Act

Principle	Consideration
1. The Precautionary Principle Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In application of this precautionary principle, decisions should be guided by: • careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and • an assessment of the risk-weighted consequences of various options. **2. The Principle of Intergenerational Equity** The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations. **3. The Principle of the Conservation of Biological Diversity and Ecological Integrity** Conservation of biological diversity and ecological integrity should be a fundamental consideration.	Predicted environmental outcomes from the Proposal relevant to the objectives for each key environmental factor are as follows: **Inland Waters** • River pools will not be affected as they are disconnected from the groundwater; • Water quality parameters (salinity) as measured at FR1 and FR3 will remain within baseline conditions; and • There will be no significant loss of GDV from Project activities beyond both the 5 m drawdown contour and areas approved for clearing **Marine Environmental Quality** • Marine water quality parameters (salinity (TDS) and ammonia) will remain within the proposed management criteria as defined within the Fortescue River Estuary EQMP. **Benthic Communities and Habitats** • No predicted adverse impacts to mangroves under the revised proposal outside of the initial discharge zone (20 m up and downstream of the diffuser) as verified by the mangrove monitoring program. **Marine Fauna** • Environmental water quality parameters (salinity and ammonia) as measured at FR1 and FR3 will remain within baseline levels recorded for the MCP; such that: o baseline salinity concentrations will be maintained at FR1 and FR3 monitoring locations for the increased discharge scenario over a full tidal cycle; and o ammonia concentrations will meet the 90% species protection guideline limit (ANZG, 2018) at FR1 and FR3 monitoring locations. **Flora and Vegetation** • There will be no significant loss of GDV from Project activities beyond both the 5 m drawdown contour and areas approved for clearing, such that the area of GDV potentially impacted will increase by 18.4 % compared to current abstraction rate to a total of 4,667.4 ha within the >5 m groundwater drawdown contour. **Greenhouse Gas Emissions** • The revised proposal will not result in an increase in the authorised GGE for the approved proposal and CPM will review the GHG management plan as indicated earlier in document. **Conclusion** This EIA considers that the proposal activities are not considered to have significant residual impacts at either a local or regional scale. It is concluded that the EPA objectives for all key factors can be met. The residual impacts resulting from the Proposal can be adequately managed through the implementation of the proposed mitigation measures such that

Principle	Consideration
	the environmental values are conserved and maintained for future generations.
4. Principles Relating to Improved Valuation, Pricing and Incentive Mechanisms Environmental factors should be included in the valuation of assets and services. The polluter pays principles – those who generate pollution and waste should bear the cost of containment, avoidance and abatement. The users of goods and services should pay prices based on the full life-cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste. Environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentive structure, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solution and responses to environmental problems.	Responsibility and associated costs of compliance with all applicable regulatory requirements, and providing for sustainable use of resources and appropriate, management of wastes has been accepted by the Proponent and incorporated into the proposal
5. The Principle of Waste Minimisation All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	The Proponent will continue to review and consider options for reduction in waste and its disposal.

14 Cumulative Impacts

Cumulative impact assessment is considered where there is a likelihood of significant impacts on identified environmental values from more than one activity (MCA 2015).

Cumulative environmental impacts are the successive, incremental, and interactive impacts on the environment of a proposal with one or more past, present and reasonably foreseeable future activities (EPA 2021). The EPA (EPA 2021) defines reasonably foreseeable future activities as:

Third party (or proponent) activities which are already approved, are in a government approvals process, or are otherwise reasonably likely to proceed:

- for proposals assessed at the level of environmental review – at the time an Environmental Review Document (ERD) for a proposal is accepted; or
- or proposals assessed at the level of assessment on referral information – at the time the final referral or required additional information is accepted; and
- existing activities that are reasonably expected to be ongoing.

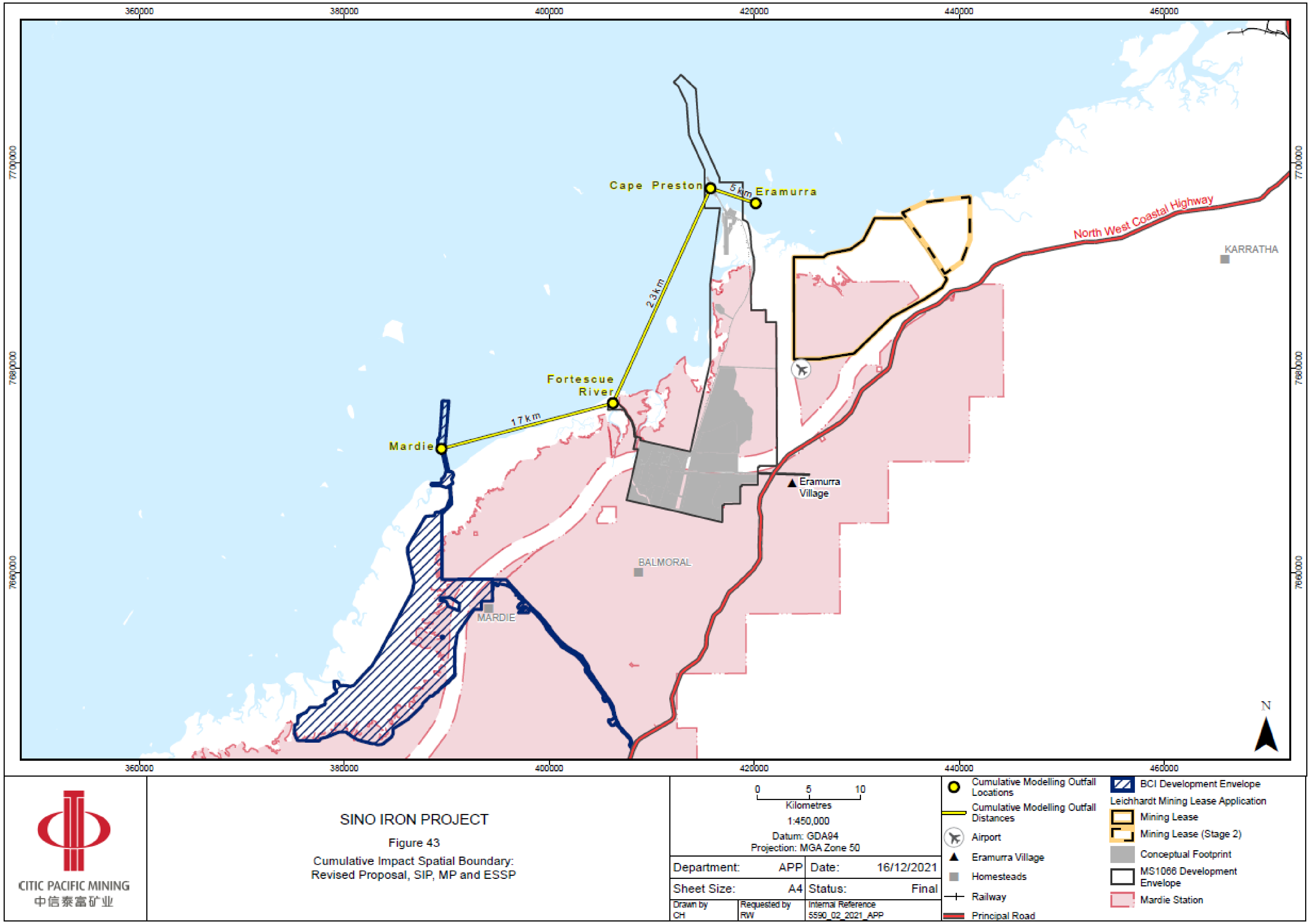
14.1 Scope of Cumulative Impact Assessment

This cumulative impact assessment will assess the revised proposal in addition to the following current and foreseeable future activities (Figure 43):

1. The approved Sino Iron Project.
2. The Mardie Project, BCI Minerals Ltd (EPA Assessment Number: 2167)
3. The Eramurra Solar Salt Project, Leichhardt Industrials Pty Ltd (EPA Assessment Number: 2306).

These projects are located approximately 20 km northwest, 25 km south and 25 km north of the Fortescue River and Estuary respectively and have the potential to impact on environmental factors regionally. These projects are therefore considered relevant to the assessment of cumulative effects to the key Environmental Factors for the revised proposal

Figure 43 Cumulative Impact Spatial Boundary: Revised proposal, SIP, MP and ESSP



14.2 Existing and Reasonably Foreseeable Projects

The Sino Iron Project

The Sino Iron Project approved proposal was authorised under MS 635 and 822 issued on 20 October 2003 and 23 December 2009 respectively.

MS 635 established the implementation conditions for the operation of the original Sino Iron Project and the subsequent Sino Iron MCP Project.

MS 822, conditions 8-1 to 8-8 establish the implementation requirements for the operation of the desalination plant waste water outfall.

The Sino Iron port facilities are located at the Pilbara Port of Cape Preston. The Sino Iron mine is located approximately 25 km from the Cape Preston Port and lies adjacent to the Fortescue River Delta.

The desalination plant operates on seawater intake so the waste discharge is a concentrated form of seawater brine. The discharge rate and salinity of the desalination plant outfall vary in line with CPM operational requirements, with an annual discharge volume of approximately 50 GL per year and a salinity range from 60 ppt to 80 ppt.

The Mardie Project

The Mardie Project (MP), located ~17 km south west of the Fortescue Rivermouth, was referred to the EPA on 17 April 2018 and following a Public Environment Review, the EPA recommended on 7 July 2021 that with the implementation of reasonable conditions the project could be managed to meet the EPA's objectives for the key environmental factors. (EPA, 2021c). Ministerial Statement 1175 was subsequently issued on 24 November 2021. The proposal was also determined to be a controlled action under the EPBC Act to be assessed by the EPA under the Commonwealth accredited process.

The MP lies between the large deltas of the Fortescue and Robe Rivers and has the potential to impact a number of smaller catchments including 6-mile creek, Trevarton Creek, Gerald Creek and Peter Creek.

The key environmental factors considered for the MP include, Inland Waters, Benthic Communities, Marine Environmental Quality, Marine Fauna, Flora and Vegetation, Terrestrial Fauna and Social Surrounds (Preston, 2020).

The Eramurra Solar Salt Project

The ESSP was referred to the EPA on 10 August 2021 and on 6 September 2021, the EPA determined to assess the Project at the level of assessment of Public Environmental Review.

The Proposal is located between the Maitland and Fortescue Rivers, east of Cape Preston, ~25 km from the Fortescue Rivermouth. The Maitland River is a major Pilbara River that is situated within the southwest of the Port Hedland Coastal Basin. It discharges over the coastal flats to the east of the ESSP proposal area and contributes significantly to groundwater recharge (Preston, 2020).

There are several catchments that intersect the ESSP Study Area including Eramurra Creek, Devil Creek and McKay Creek. The location of the ESSP was selected to avoid the major watercourses of the Yanyare and Maitland Rivers and discharge areas and will be designed to allow continued flow of Eramurra Creek to the west and Devil Creek to the east.

14.3 Cumulative Assessment of Key Factors

The preliminary Environmental Factors outlined in the ESSP referral include; Inland Waters, Benthic Communities, Marine Environmental Quality, Marine Fauna, Flora and Vegetation, Terrestrial Fauna, Terrestrial Environmental Quality and Social Surrounds.

Inland Waters

As outlined in Section 5.7 and 7, the revised proposal is unlikely to result in any additional adverse effects to hydrological regimes or the quality of groundwater and surface water.

The Sino Iron Project desalination discharge to the marine environment at Cape Preston Port achieves a high level of ecological protection within 250m of all points of the structures and consequently will not result in any impact to Fortescue River or Estuary.

Both the MP and ESSMP have the potential to impact water quality within their respective catchments due to alteration to tidal regimes and seepage of hypersaline water from crystalliser ponds. The impact of the leaks and spills are expected to be minor and localised within the respective Rob River and Cape Preston and Maitland River deltas (Preston, 2020 & 2021).

Given that neither the MP of ESSMP intersect the Fortescue River Delta (Preston, 2020 & 2021) these projects are not expected to contribute cumulatively to the effects on hydrological regimes, the quality of surface water or groundwater, sediment and biota of the Fortescue River and estuary.

Marine Environmental Quality

As outlined in Section 6, the revised proposal on its own is unlikely to result in any significant adverse effects to the quality of water, sediment and biota within the Fortescue River and estuary or the adjacent marine environment.

The cumulative effects of the revised proposal together with the Sino Iron Project, MP and ESSP have the potential to impact on the water quality of the marine environment due to the following activities:

- Revised proposal – dewater discharge to the Fortescue River and estuary
- Sino Iron Project – desalination plant wastewater discharge to the marine environment at the Port of Cape Preston.
- MP – bitterns’ discharge to the marine environment
- ESSP – bitterns’ discharge to the marine environment.

These activities are located approximately 20 km northwest, 25 km south and 25 km north of the Fortescue River and estuary respectively (Figure 43).

In order to understand the potential cumulative effects of these combined activities, CPM engaged RPS Consulting (RPS, 2021b) (Appendix 9) to undertake cumulative impact modelling to determine if comingling of the outfall discharges was likely.

In summary the modelling predicts that comingling between outfall discharges is unlikely. There is potential for comingling at very low salinities (<0.2 ppt above an assumed 37.0 ppt baseline) between Mardie and Fortescue River outfalls in the dry season. The predicted comingling for both the dry and wet season is shown in Figure 44 and Figure 45, as represented by the 0.15 ppt boundary.

A variation in salinity of this magnitude is significantly less than the natural variability in salinity within the marine environment noted at the CPM desalination plant brine outfall reference monitoring buoy (Jan-18 to Feb-20: Max 38.33 ppt, Min 35.20 ppt, mean 36.42 ppt).

Consequently, discharges associated with the revised proposal, the Sino Iron Project, MP and ESSP are not expected to result in cumulative impacts to the quality of water, sediment and biota within the marine environment.

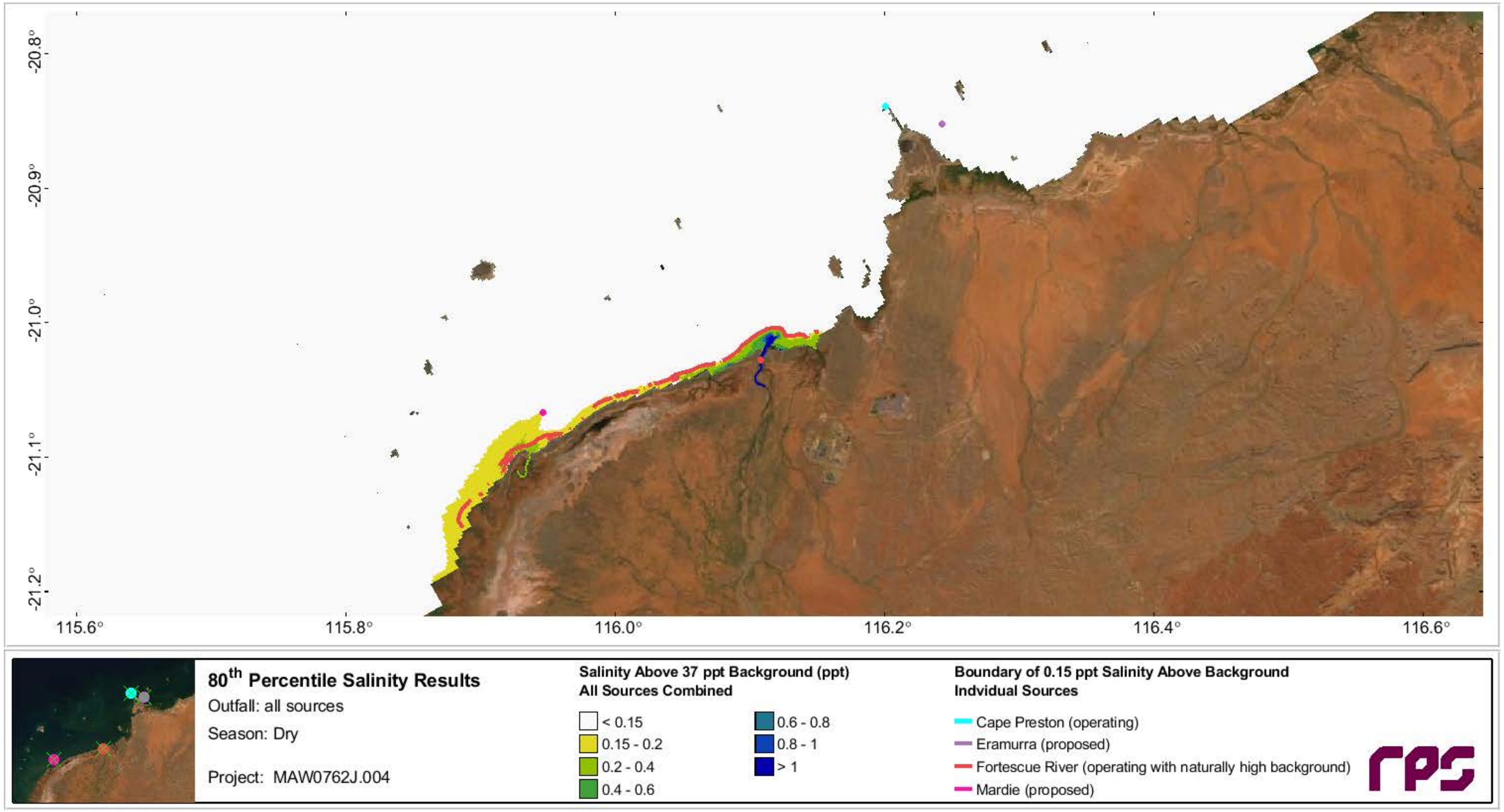


Figure 44: Predicted comingling of saline discharges in the marine environment – dry season

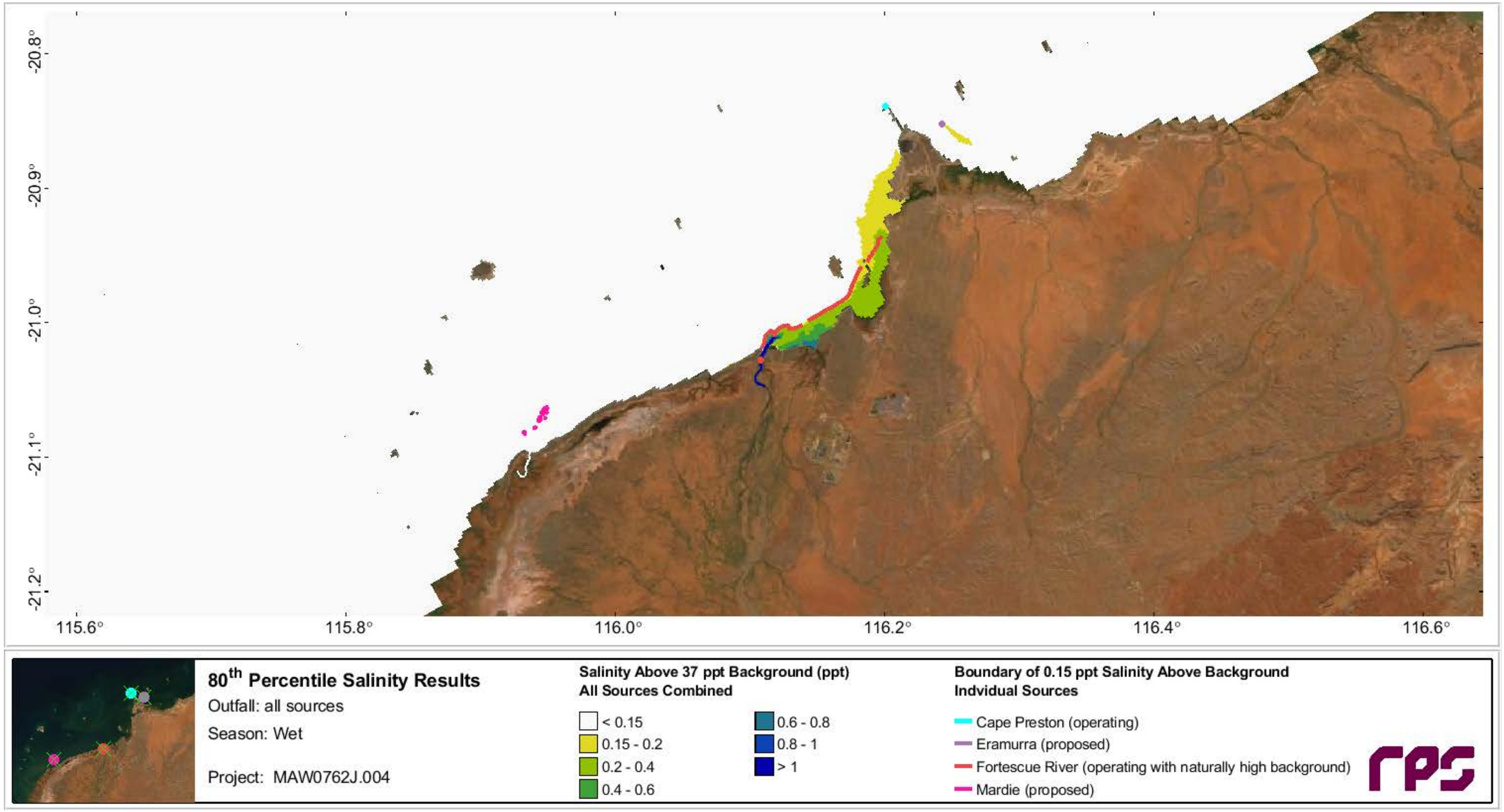


Figure 45: Predicted comingling of saline discharges in the marine environment – wet season

Benthic Habitat

The Sino Iron Project desalination discharge to the marine environment at Cape Preston Port achieves a high level of ecological protection within 250m of all points of the structures and consequently will not result in any impact to Fortescue River or Estuary.

The MP is located within the Robe River Delta and adjacent to the Robe River Mangrove Management Area (Robe River MMA). The MP will directly disturb up to 296 ha of coastal samphire, up to 880 ha algal mat, up to 13 ha of mangroves outside the Robe River MMA and up to 4 ha of mangroves within the Robe River MMA with further indirect impacts to 130 ha of mangroves within the Robe River MMA. (Preston, 2020).

The ESSMP has the potential to disturb up to 14,710 ha within terrestrial and marine environments. The ESSMP is located within the Cape Preston and Maitland River Delta. Specific details of likely impact to benthic habitats are not available at this stage for the ESSMP. Studies conducted to date have identified sparse coral and seagrass habitats and mangrove and samphire mudflat communities within the ESSMP proposal area that are expected to be typical of habitats within the Pilbara Region. The design of the ESSMP aims to avoid and minimise impacts to benthic communities where possible, in particular in areas of dredging and spoil and bittern's disposal (Preston, 2021).

The MP and ESSMP are located within the Robe River Delta and MMA and the Cape Preston and Maitland Delta and MMA respectively. Neither project will impact on the Fortescue River Delta or MMA (Preston, 2020, 2021).

As the revised proposal is unlikely to directly or indirectly impact benthic habitats and the MP and ESSMP are located outside of the Fortescue River Delta and MMA, it is considered that the revised proposal together with the MP and ESSMP will not result in cumulative impacts to Benthic Habitats at a local or regional level.

Marine Fauna

As outlined in Section 8, the revised proposal is unlikely to result in any significant adverse effects to the biological diversity and ecological integrity of marine fauna within the Fortescue River and estuary.

As previously stated, the MP will involve the direct and indirect disturbance to coastal samphire, algal mat and mangrove habitats. In addition, the proposal will disturb ~50 m of low-quality turtle nesting habitat and has the potential to cause death or injury to marine fauna as a result of; vessel strike, dredging and entrapment in seawater intakes, changes in behaviour and potential hearing damage as a result of marine noise emissions and changes to marine turtle nesting behaviours from light spill.

The EPA (2021c) has considered the impact of the MP proposal on marine fauna, in particular conservation significant fauna habitat. The EPA determined that the MP is unlikely to have a significant impact on marine fauna due to, the low-level impact on low quality conservation significant habitat (nesting rookeries and seagrass meadows), the percentage of habitat remaining and the availability of high-quality habitat within offshore islands. The EPA (2021c) further concluded that the impacts are either, not material or are likely to meet the EPA's objective for Marine Fauna once proposed surveys, monitoring, mitigation and management strategies are implemented.

Similarly, the ESSP project intends to avoid and minimise impacts to marine fauna habitat through optimising and realigning development envelopes and disturbance footprints (Preston, 2021). Some impact is expected to fauna habitat within the dredging footprint, however impacts to mangroves and sub-tidal marine fauna habitat is not expected to be significant. Ecological surveys will inform the Proposal's disturbance footprint to minimise impacts to marine fauna habitat where practicable. The proposal is not expected to have a significant impact on conservation significant species with the potential for only localised indirect impacts that are considered readily able to be managed through implementation of mitigation measures (Preston 2021).

The MP and ESSMP are located within the Robe River and Cape Preston and Maitland Deltas and MMA. (Preston, 2020, 2021).

As the revised proposal is unlikely to directly or indirectly impact on conservation significant fauna habitat or individual fauna species and the MP and ESSMP are located outside of the Fortescue River Delta and MMA, it is considered that the revised proposal together with the MP and ESSMP will not result in cumulative impacts to Marine Fauna at a local or regional level.

Flora and Vegetation

The MP will result in the following impacts to flora and vegetation values (Preston, 2020):

- Clearing of 2,319 ha of vegetation in good - to excellent condition.
- Clearing of 145 ha of the Horseflat Priority Ecological Community (PEC), and up to 20 ha of indirect impacts.
- Clearing of 854 ha of landward samphire communities.

The ESSMP will result in disturbance to flora and vegetation that is not expected to be regionally significant due to the largely uncleared landscape and relatively widespread distribution of communities. Disturbance to significant flora and vegetation will be avoided where practicable and will be limited to the minimum required for implementation of the proposal. Localised indirect impacts to downstream creek vegetation associated with alterations to surface water flows within minor tributaries will be limited to a small area between the riverine ponds and the coast (Preston, 2021).

All vegetation associations proposed to be disturbed are well represented within land systems that will have more than 80% of their pre-European extent remaining including after cumulative disturbance associated with the ESSP has been considered (Preston, 2020) with all vegetation associations remaining in the 'Least Concern' category (Preston, 2020).

The revised proposal has the potential to impact areas of groundwater dependant vegetation (GDV) due to groundwater drawdown. The majority of GDV with the potential to be impacted is highly degraded due to impacts from mesquite infestation. Small areas of moderately to highly dependent GDV within creek lines may be impacted, however the small scale of impact is not considered regionally significant given that the vegetation is well represented within regional land systems that are relatively uncleared and have over 80% of their pre-European extent remaining.

Based on the above information it is expected that there will be no local or regional cumulative impacts from the implementation of the revised proposal, the MP and the ESSP.

15 Conclusion

This document has provided information about the existing environment and assessment of the potential impacts resulting from the Revised Proposal, in a local and regional context. The Proponent has conducted relevant environmental studies to inform the environmental impact assessment and considers that the information provided in this proposal addresses the environmental impacts relevant to the Revised Proposal, individually and cumulatively with other existing and foreseeable actions in the region.

The mitigation hierarchy has been applied and residual impacts and outcomes in relation to each key environmental factor have been assessed and are considered to be reasonable following the application of appropriate mitigation and management measures.

Furthermore, discharges associated with the revised proposal, the Sino Iron Project, MP and ESSP are not expected to result in cumulative impacts to the quality of water, sediment and biota within the marine environment.

It is concluded that, as such, the EPA objectives for all key factors can be met and the residual impacts resulting from the Proposal can be adequately managed through the implementation of the proposed mitigation measures such that the predicted environmental outcomes will be achieved.

16 Additional Information

16.1 References

Abdul Wahab MA, Fromont J, Pineda MC, Strehlow B, Duckworth A, Jones R, Webster N. (2019). Defining thresholds and indicators of filter feeder responses to dredging-related pressures - final synthesis report. Report of Theme 6 – prepared for the Dredging Science Node, Western Australian Marine Science Institution, Perth, Western Australia 26 pp

Aecom, 2009, Balmoral North and Balmoral South Stage 2 Flora and Vegetation Assessment, report prepared for Mineralogy, May 2009.

Alongi, D.M., (2009a). Paradigm shifts in Mangrove Biology: Coastal Wetlands and Integrated Ecosystem Approach. Elsevier Science, Ch 22: 615-640.

Alongi, D.M., (2009b). The Energetics of Mangrove Forests. Springer Science and Business Media

ANZECC, 2000, Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Volume 1, The Guidelines (chapters 1 – 7), October 2000.

ANZG, 2018, Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at: <www.waterquality.gov.au/anz-guiedlines> [Accessed October 2020]

Aquaterra, 2001, Austeel Iron Ore Project Prediction of Groundwater Level Drawdown

Aquaterra, 2008c, Balmoral South Iron Ore Project, Fortescue River borefield investigations, report prepared for Australasian Resources Ltd, March 2008.

Aquaterra, 2009a, Mineralogy Expansion Projects (Stages 3-5) Hydrogeological assessment

Aquaterra, 2009b, Mineralogy Expansion Projects (Stage 3-5) Surface Water Management

ARMCANZ, 2000, Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand

Astron Environmental Services, 2007, General Purpose Leases G08/52 and G08/53 Additional Vegetation Survey and Mapping, report prepared for CP Mining Management Pty Ltd.

Astron Environmental Services, 2008, *Sino Iron Project – Cape Preston*, *Mapping and Surveying of Groundwater Dependent Ecosystems*, report prepared for CITIC Pacific Mining Management Pty Ltd.

Astron Environmental Services, 2009a, Mineralogy Expansion Proposal, Desktop Vegetation and Flora Study, report prepared for Mineralogy, July 2009.

Astron Environmental Services, 2009b, Sino Iron Project – Cape Preston Mapping and Surveying of Groundwater Dependent Ecosystems, report prepared for CITIC Pacific Mining Management Pty Ltd, September 2008.

Astron 2018, Sino Iron Project Groundwater Dependent Vegetation Monitoring Plan, unpublished report to Citic Pacific Mining Management Pty Ltd.

Ayling, A.M., and Ayling A.L. (2005). The dynamics of Cairns and Central Section Fringing Reefs. Unpublished report submitted to the Great Barrier Reef Marine Park Authority.

Berger VJ, Kharazova AD, 1997, Mechanisms of salinity adaptations in marine molluscs. Hydrobiologia 355:115–126

Biota Environmental Services, (2005). Yannarie Salt Project Mangrove and Coastal Ecosystem Study: Baseline Ecological Assessment. Prepared for Straits Salt Pty Ltd

BMT, 2021, Technical Note: CPM Management pit dewatering: Groundwater discharge to Fortescue River, December 2021

Bureau of Meteorology (BOM), 2020, Groundwater Dependant Ecosystems Atlas; GDE Atlas Home: Water Information: Bureau of Meteorology (bom.gov.au) last accessed October 2021

Bureau of Meteorology (BOM) and Commonwealth Scientific and Industrial Research Organisation (CSIRO), 2020a, State of the Climate 2020

Chevron. (2014). Gorgon Project: Offshore Domestic Gas Pipeline Installation Management Plan: Summary. Document No: G1-NT-PLNX0001302.

Chevron. (2015b). Gorgon Gas Development and Jansz Feed Gas Pipeline – Coastal and Marine Baseline State and Environmental Impact Report: Domestic Gas PipelineCloud GMS, 2017, Sino Iron Expansion Proposal Groundwater Modelling Study

Commander DP, 1993, *Hydrogeology of the Fortescue River Alluvium,* Unpublished GSWA Hydrogeology Report No. 1993/14.

Cooke, D.A. (1986). Two new species of *Olearia* Moench (Compositae: Astereae) from Central Australia. *Muelleria*. 6(3,4):181-184.

CPM Management Pty Ltd, 2021, Traditional Owner Consultation

DAL, 2000, Austeel Development, Cape Preston, WA Assessment of Source Water Quality and intake and Outlet Locations for Desalination Plant, prepared for Occtech Engineering by DAL, Report no. 99/136/1, Perth, Western Australia, March 2000.

Davenport J, Wong TM, 1986, Observations on the water economy of the estuarine turtles Batagur baska (gray) and Callagur borneoensis (Schlegel and Muller) Comparative Biochemistry and Physiology Part A: Physiology. 84:703-707

Drouin G, Himmelman JH, Beland P, 1985, Impact of tidal salinity fluctuations on echinoderm and mollusc populations. Canadian Journal of Zoology 63:1377–1387

Department of Agriculture Water and the Environment (DAWE) (formerly Department of Environment (DoE), 2009, Matters of National Environmental Significance Significant impact guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999 (DoE, 2009)

Department of Agriculture Water and the Environment (DAWE) (formerly Department of Environment (DoE), 2016, EPBC Act referral guideline for the endangered northern quoll *Dasyurus hallucatus*

Department of Agriculture Water and the Environment (DAWE) (formerly Department of Environment (DoE), 2021, EPBC Act Protected Matters Report

Department of Biodiversity Conservation and Attractions (DBCA), 2016, List of Threatened Ecological Communities (TECs) endorsed by the Western Australian Minister for Environment, [Online], Government of Western Australia, Available from: Community Name (dpaw.wa.gov.au)

Department of Water and Environment and Regulation (DWER), 2015, Licence to Operate L8659/2012/2, Sino Iron Project Transhipment Facility, 12 November 2015 (as amended)

Department of Water and Environmental Regulation (DWER), 2019, Water Information Reporting

Department of Water and Environment and Regulation (DWER), 2021a, Licence to Operate L8758/2013/1, Sino Iron Project Desalination Plant and Bulk Loading Facility, 21 November 2013 (as amended)

Department of Water and Environment and Regulation (DWER), 2021b, Licence to Operate, L8308/2008/2, Sino Iron Project Mine Site, 24 November 2016 (as amended)

Department of Water and Environment and Regulation (DWER), (formerly Department of Water (DoW), groundwater abstraction licence GWL167151(8) and GWL201437(2)

Ecoscape 2016, *Cape Preston Northern Quoll Targeted Survey*, prepared for Citic Pacific Mining Management, July 2016.

Environment Australia (2002). *NON-CURRENT Recovery Plan for the Grey Nurse Shark* (Carcharias taurus) *in Australia*. Available from: http://www.environment.gov.au/coasts/publications/grey-nurse-plan/index.html. In effect under the EPBC Act from 26-Jun-2002. Ceased to be in effect under the EPBC Act from 14-Aug-2014.

Environmental Protection Authority (EPA), 2001, Guidance for the Assessment of Environmental Factors Western Australia (in accordance with the Environmental Protection Act 1986) - Guidance Statement for Protection of Tropical Arid Zone Mangroves Along the Pilbara Coastline. Environmental Protection Authority, Perth, Western Australia, No. 1 April 2001

Environmental Protection Authority (EPA), 2002, Terrestrial Biological Surveys Biological Surveys as an element of Biodiversity Protection Position Statement No. 3

Environmental Protection Authority (EPA), 2004, Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia, Guidance Statement 51

Environmental Protection Authority (EPA), 2016a, Environmental Factor Guideline, Benthic Communities and Habitats

Environmental Protection Authority (EPA), 2016b, Environmental Factor Guideline, Coastal Processes

Environmental Protection Authority (EPA), 2016c, Environmental Factor Guideline, Flora and vegetation

Environmental Protection Authority (EPA), 2016d, Environmental Factor Guideline, Human Health

Environmental Protection Authority (EPA), 2016e (revised date 2018), Environmental Factor Guideline, Landforms

Environmental Protection Authority (EPA), 2016f, Environmental Factor Guideline, Marine Environmental Quality

Environmental Protection Authority (EPA), 2016g, Environmental Factor Guideline, Marine Fauna

Environmental Protection Authority (EPA), 2016h, Environmental Factor Guideline, Social Surrounds

Environmental Protection Authority (EPA), 2016i, Environmental Factor Guideline, Subterranean Fauna

Environmental Protection Authority (EPA), 2016j, Environmental Factor Guideline, Terrestrial Environmental Quality

Environmental Protection Authority (EPA), 2016k, Environmental Factor Guideline, Terrestrial Fauna

Environmental Protection Authority (EPA), 2016l, Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2016

Environmental Protection Authority (EPA), 2016m, Technical Guidance, Flora and Vegetation Surveys for Environmental Impact Assessment

Environmental Protection Authority (EPA), 2016n, Technical Guidance, Protecting the Quality of Western Australia's Marine Environment

Environmental Protection Authority (EPA), 2016o, Technical Guidance - Protection of Benthic Communities and Habitats

Environmental Protection Authority (EPA), 2018a, Environmental Factor Guideline, Inland Waters Environmental Quality

Environmental Protection Authority, 2018b, Mardie Project, Public record pursuant to s39(l) of the Environmental Protection Act 1986

Environmental Protection Authority (EPA), 2020, Environmental Factor Guideline, Air Quality

Environmental Protection Authority (EPA), 2020a, Statement of Environmental Principles, Factors and Objectives

Environmental Protection Authority (EPA), 2020b, Instructions on how to prepare an Environmental Review Document

Environmental Protection Authority (EPA), 2020c, Environmental Factor Guideline, Greenhouse Gas Emissions

Environmental Protection Authority (EPA), 2021b, Eramurra Solar Salt Project, Public record pursuant to s39(1) of the Environmental Protection Act 1986

Environmental Protection Authority (EPA, 2021c), Mardie Project Mardie Minerals Pty Ltd, Report 1704, June 2021

Gaughan, D.J. and Santoro, K. (eds). 2021. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2019/20: The State of the Fisheries. Department of Primary Industries and Regional Development, Western Australia

Gordon, D.M., (1988). Disturbance to mangroves in tropical-arid Western Australia: hyper salinity and restricted tidal exchange as factors leading to mortality. Journal of Arid Environments 15: 117-145.

Government of Western Australia (2019), State Greenhouse Gas Emissions Policy for Major Projects (State Emissions Policy).

Helmuth BST, 1998, Intertidal mussel microclimates: Predicting the body temperature of a sessile invertebrate. Ecological Monographs. 68:51-74

Holguin, G., Vazquez, P., and Bashan, Y., (2001). The role of sediment microorganisms in the productivity, conservation, and rehabilitation of mangrove ecosystems: an overview. Biology and Fertility of Soils 33:265–278.

Huston CA, Stevens PW, Blaxton RM, Tolley SG, Scharer RM, Tornwall BM, Poulakis GR (2017) Diel movements of juvenile smalltooth sawfish: implications for defining the size of a nursery hotspot. Endang Species Res (in press)

Hoyaux J, Gilles R, Jeuniaux C, 1976, Osmoregulation in molluscs of the intertidal zone. Comparative Biochemistry and Physiology Part A: Physiology 53:361-365

Kangas, M. S. (2015). Exmouth Gulf Prawn Managed Fishery. Western Australian Marine Stewardship Council Report Series No. 1, 2015.

Kendrick, G and Olsen, Y. (2017). Characterising macroalgal communities of the Pilbara. Macrophyte interactions. CSIRO

Kultz D, 2015, Physiological mechanisms used by fish to cope with salinity stress. Journal of Experimental Biology 218:1907-1914

Lander, N.S. (1987). New Combinations in *Minuria* DC. (Asteracrar: Astereae). *Nuytsia*. 6(1):63-66.

Last, P.R. & J.D. Stevens (1994). *Sharks and Rays of Australia*. Melbourne, Victoria: CSIRO.

Loomes, R., 2010. 2010 Lower Fortescue River: ecological values and issues, Environmental water report series, report no. 15, Department of Water, Government of Western Australia: Perth

Mattiske Consulting Pty Ltd (Mattiske) 2007a, *Flora and Vegetation Survey of Cape Preston Potential Campsites and Airstrips*, unpublished Report for CITIC Pacific Mining Management Pty Ltd.

Mattiske Consulting Pty Ltd (Mattiske) 2007b, *Comparison of Flora and Vegetation Values on Preferred and Original Campsites Cape Preston*, unpublished Report for CITIC Pacific Mining Management Pty Ltd.

Mattiske Consulting Pty Ltd (Mattiske) 2016, *Review of Flora and Vegetation Reports for the Mineralogy project at Cape Preston*, report prepared for Strategen, Subiaco.

Maunsell 2002, *Marine Survey Report*, prepared for Mineralogy Ltd

Maunsell AECOM *2003, Cape Preston Iron Ore Development. Seasonal Biological Survey – Threatened Flora*

Maunsell 2006, *Greenhouse Gas Management Plan, Iron Ore Mine and Downstream Processing, Cape Preston*, Western Australia, prepared for Mineralogy Pty Ltd

Maunsell AECOM 2008, *Cape Preston Mining Estate Consolidated Vegetation, Flora and Fauna Assessment*, report prepared for International Minerals.

McKenzie, L.J., Erftemeijer, P and Coles, R. (2006). Seagrass ecosystems of Papua. The Ecology of Papua (Volume I & II), Chapter:5.3 (Vol II). Periplus Editions (Singapore), pp. 800-823. Research Gate, https://www.reaserchgate.net/publication/283043957

Michalec FG, Souissi S, Dur G, Mahjoub M-S, Schmitt FG, Hwang J-S, 2010, Differences in behavioural responses of *Eurytemora affinis* (Copepoda, Calanoida) reproductive stages to salinity variations. Journal of Plankton Research 32:805-813

Morgan D, Allen M, Ebner B, Whitty J, Beatty S (February 2015) *Discovery of a pupping site and nursery for critically endangered green sawfish Pristis zijsron* Journal of Fish Biology doi:10.1111/jfb.12668

Nano, C. & C. Pavey (2008). *National Recovery Plan for* Olearia macdonnellensis*,* Minuria tridens *(Minnie Daisy) and* Actinotus schwarzii *(Desert Flannel Flower)*. Department of Natural Resources, Environment, The Arts and Sport, Northern Territory. Available from: http://www.environment.gov.au/resource/national-recovery-plan-olearia-macdonnellensis-minuria-tridens-minnie-daisy-and-actinotus. In effect under the EPBC Act from 13-Nov-2009.

Otway, N.M. & P.C. Parker (2000). *The Biology, Ecology, Distribution, Abundance and Identification of Marine Protected Areas for the Conservation of Threatened Grey Nurse Sharks in South-east Australian Waters*. NSW Fisheries Office of Conservation.

O2 Marine (2018) BCI Minerals – Mardie Salt Project. Snapshot Survey of the Benthic Habitats and Communities at the Proposed Bitterns Pipeline and Outfall Infrastructure Options, March 2018

O2 Marine (2020a) Mardie Project – Intertidal Benthic Communities and Habitat. Report prepared for Mardie Minerals Ltd

O2 Marine (2020b) Mardie Project – Subtidal Benthic Communities and Habitat. Report prepared for Mardie Minerals Ltd

O2 Marine (2020c) Mardie Project – Benthic Communities and Habitat Cumulative Loss Assessment. Report prepared for Mardie Minerals Ltd

O2 Marine (2020d) Mardie Project – Expert Advice on the Significance of the BCH Impacted by the Proposal from a Local and Regional Perspective

O2 Marine (2020e). Mardie Project Marine Fauna Review. Report Prepared for Mardie Minerals Pty Ltd.

O2 Marine (2020f). Mardie Project: Introduced Marine Pest Risk Assessment. Report Prepared for Mardie Minerals Pty Ltd.

Papastamatiou YP, Grubbs RD, Imhoff JL, Gulak SJB, Carlson JK, Burgess GH (2015) A subtropical embayment serves as essential habitat for sub-adults and adults of the critically endangered smalltooth sawfish. Glob Ecol Conserv 3: 764−775

Pearson, D. (2003). Giant Pythons of the Pilbara. *Landscope*. 19(1).

Pearson, D.J. (1993). Distribution, status and conservation of pythons in Western Australia. **In:** Lunney, D. & D. Ayers, eds. *Herpetology in Australia: a Diverse Discipline*. Page(s) 383-395. Royal Zoological Society of NSW, Sydney.

Phoenix (2020). Level 2 Targeted Terrestrial Fauna Survey for the Mardie Salt Project. Report prepared for Mardie Minerals Pty Ltd

Pogonoski, J.J., D.A. Pollard & J.R. Paxton (2002). *Conservation Overview and Action Plan for Australian Threatened and Potentially Threatened Marine and Estuarine Fishes*. Canberra, ACT: Environment Australia. Available from: http://www.environment.gov.au/coasts/publications/marine-fish-action/pubs/marine-fish.pdf.

Pollard, D.A., M.P. Lincoln-Smith & A.K. Smith (1996). The biology and conservation of the grey nurse shark *(Carcharias taurus* Rafinesque 1810) in New South Wales, Australia. *Aquatic Conservation: Marine and Freshwater Ecosystems*. 6.

Poulakis GR, Stevens PW, Timmers AA, Stafford CJ and others (2016) Long-term site fidelity of endangered smalltooth sawfish (Pristis pectinata) from different mothers. Fish Bull 114: 461−475

Preston Consulting, 2020, Mardie Project, Environmental Review Document

Preston Consulting, 2021, S38 Referral Supporting Information Eramurra Industrial Salt Project

PSM Consulting Pty Ltd, 2020, LoM Dewatering Prediction Report

RPS APASA, 2017, Discharge Modelling Assessment Fortescue River Outfall, report prepared for CPM Management Pty Ltd, January 2017

RPS 2021a, Fortescue River Discharge Modelling: Background Salinity Variability Study, May 2021.

RPS 2021b, Fortescue River Discharge Cumulative Impact Modelling, December 2021

Sanchez et al. (2016). Functional Role of Native and Invasive Filter-Feeders, and the effect of Parasites: Learning from Hypersaline Ecosystems. Public Library of Science. Doi:10.1371/journal.pone.0161478

Schulte P.M., 2011, Intertidal fishes, Intertidal Habitats, Encyclopedia of Fish Physiology, Academic Press, Pages 1959-1964, https://doi.org/10.1016/B978-0-12-374553-8.00266-5. https://www.sciencedirect.com/science/article/pii/B9780123745538002665

Semeniuk, V. (1993). The Pilbara Coast: a riverine coastal plain in a tropical arid setting, northwestern Australia. Sedimentary Geology 83: 235-356.

Simpfendorfer CA, Wiley TR, Yeiser BG (2010) Improving conservation planning for an endangered sawfish using data from acoustic telemetry. Biol Conserv 143: 1460−1469

Sinclair Knight Merz (SKM) (2011). Port Hedland Outer Harbour Development. Benthic Primary Producer Assessment: Intertidal. Appendix 13, Port Hedland Outer Harbour Development Project Referral to the EPA. Report prepared for BHP Billiton, October 2011

Soilwater Group (2019a). Mardie Project Seepage Model Results and Potential Environmental Impacts. Unpublished memo prepared for BCI Minerals Pty Ltd.

Soilwater Group (2019b). Summary of laboratory results, Mardie Project. Unpublished memo to CMW Geosciences, prepared on behalf of Mardie Minerals Pty Ltd

Stantec (2018) Assessment of Mangal and Algal Communities for the Mardie Solar Salt Project

Stevens, J.D. (1999). Management of shark fisheries in northern Australia; Part 1. Shotton, R., ed. *Case studies of the management of elasmobranch fisheries. FAO Fisheries Technical Paper*. 378:456-479. FAO, Rome.

Stevens, J.D., R.D. Pillans & J. Salini (2005). *Conservation Assessment of* Glyphis *sp. A (Speartooth Shark),* Glyphis *sp. C (Northern River Shark),* Pristis microdon *(Freshwater Sawfish) and* Pristis zijsron *(Green Sawfish)*. Hobart, Tasmania: CSIRO Marine Research. Available from: http://www.environment.gov.au/coasts/publications/pubs/assessment-glyphis.pdf.

Stevens JD, McAuley RB, Simpfendorfer CA, Pillans RD (2008) Spatial distribution and habitat utilisation of sawfish (Pristis spp.) in relation to fishing in northern Australia. Report to Department of the Environment, Water, Heritage and the Arts, Australian Government, Canberra.

www.environment.gov.au/system/files/resources/ d2b0bb03-401e-4e94-848f-85458e4d7d1e/files/sawfishreport.pdf (accessed 1 January 2017)

Strategen, 2017, Sino Iron Mine Continuation Proposal Environmental Review, report prepared for CPM Management Pty Ltd, April 2017

Thorburn, D.C., S. Peverell, S. Stevens, J.D. Last & A.J. Rowland (2004a). Status of Freshwater and Estuarine Elasmobranches in Northern Australia. *Report to Natural Heritage Trust*. Canberra, ACT: Natural Heritage Trust. Available from: http://www.environment.gov.au/coasts/publications/elasmo-north.html. [Accessed: 04-Jul-2009].

Threatened Species Scientific Committee (TSSC) (2012). *Commonwealth Listing Advice on* Minuria tridens *(Minnie Daisy)*. Department of Sustainability, Environment, Water, Population and Communities. Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/13753-listing-advice.pdf. In effect under the EPBC Act from 29-Jun-2012.

Tutt,M. S. Mitchell, P. Brace & D. Pearson (2002). Conserving Pilbara olive pythons on the Burrup. *Threatened Species Network community grants annual report, Project WA04/100*. Karratha: Nickol Bay Naturalists' Club/WA CaLM.

van Vreeswyk, A.M.E., A.L. Payne, K.A. Leighton & P. Hennig (2004). An inventory and condition survey of the Pilbara region, Western Australia. *Department of Agriculture Technical Bulletin No. 92*.

Whitty JM, Keleher J, Ebner BC, Gleiss AC, Simpfendorfer CA, Morgan DL, 2017, Habitat use of a Critically Endangered elasmobranch, the largetooth sawfish Pristis, in an intermittently flowing riverine nursery, Endangered Species Research, 10.3354/esr00837, 34, (211-227). Crossref

Whitty JM, Morgan DM, Peverell SC, Thorburn DC, Beatty SJ (2009) Ontogenetic depth partitioning by juvenile freshwater sawfish (Pristis microdon:Pristidae) in a riverine environment. Mar Freshw Res 60: 306−316

Wilson, S. & G. Swan (2003). *A Complete Guide to Reptiles of Australia*. Page(s) 480. Sydney: Reed New Holland.

Yeates P, (HydroNumerics), 2020, Expert Review: Salinity Modelling of Mine Pit Water Discharge into Fortescue River

Zardi G, Nicastro K, McQuaid CD, Rius M, Porri F, 2006, Hydrodynamic stress and habitat partitioning between indigenous (Perna perna) and invasive (Mytilus galloprovincialis) mussels: Constraints of an evolutionary strategy. Marine Biology. 150:79-88

16.2 Index of Biodiversity Surveys for Assessments (IBSA) and Index of Marine Surveys for Assessments (IMSA)

No new survey data has been collected to which the IBSA or IMSA data requirements apply.

16.3 Appendices

Appendix 1 – Traditional Owner Consultation

Appendix 2 - LoM Dewatering Report (PSM, 2020)

Appendix 3 - Expert Review: Groundwater Model for Sino Iron 2020 Dewatering mode (V1.1 – Final) (GloudGMS, 2020)

Appendix 4 - Technical Note: CPM Management pit dewatering: Groundwater discharge to Fortescue River (BMT, December 2021)

Appendix 5 - Fortescue River Discharge Modelling: Background Salinity Variability Study (RPS, 2021a).

Appendix 6 - Expert Review: Salinity Modelling of Mine Pit Water Discharge into Fortescue River (Yeates P (HydroNumerics), 2020)

Appendix 7 - EPBC Act Protected Matters Report, 2021

Appendix 8 – Fortescue River Estuary Environmental Quality Management Plan

Appendix 9 – Fortescue River Discharge Cumulative Impact Modelling (RPS, 2021a)