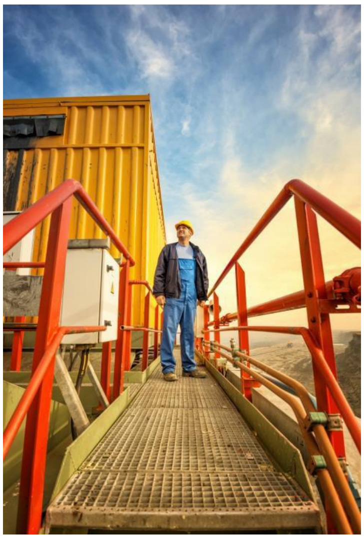


Taroborah Coal Project

Response to Submissions on the Draft Environmental Impact Statement

Prepared for:

Department of Environment and Heritage Protection

24 November 2014

Mr Glen Schulz
Principal Environmental Officer
Statewide Environmental Assessments
Department of Environment and Heritage Protection
Level 9, 400 George Street
Brisbane QLD 4000

Dear Mr Schulz,

RE: Response to Submissions on the Draft EIS for the Taroborah Coal Project

Following the public review of the Draft Environmental Impact Statement (EIS) for the Taroborah Coal Project, which occurred over the period 15 May 2014 through 26 June 2014, approximately 178 different comments/queries were submitted by a total of 26 separate entities as follows:

- Australian Government - Department of the Environment and Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development
- Queensland Government - Thirteen Departments including Environment and Heritage Protection
- Central Highlands Regional Council
- Two Government owned corporations – Sunwater and Ergon Energy
- One Public corporation - Aurizon
- One community-based organisation – Fitzroy Basin Association
- Six private individuals

The following provides a summary of the public submissions as well as responses to those submissions from the Proponent for the Taroborah Coal Project, Shenhuo International Group Pty Ltd.

The document is organised by EIS chapter / appendix in order that all submissions that relate to a particular area of assessment are grouped together for ease of review.

Respectfully submitted on behalf of Shenhuo International Group Pty Ltd by

David Thomas
Principal Consultant
IMC Mining Pty Ltd
Project Manager for Taroborah
Level 14, HSBC Building
300 Queen Street
Brisbane QLD 4000

Table of Contents

Attachments

1. EXECUTIVE SUMMARY

1.1 Page 9, Rehabilitation and Decommissioning - Dams

Submitter:

Department of Natural Resources and Mines

Submission:

If mine infrastructure is not removed from site and/or remediated, but rather, is left in place for the subsequent landowner, then capture of overland flow post mine operation will need to comply with the provisions of the Water Act 2000 and the Water Resources (Fitzroy Basin) Plan 2011.

Response:

Requirements are acknowledged by the Proponent and appropriate wording to this effect will be incorporated in the final EIS document.

EIS Amendment:

A third paragraph has been added under the Dams subheading of the Executive Summary as follows.

"If the mine water management infrastructure is not removed from site and/or remediated, but rather, is left in place for the subsequent landowner, then capture of overland flow post mine operation will need to comply with the provisions of the Water Act 2000 and the Water Resources (Fitzroy Basin) Plan 2011."

1.2 Page 13, Road Impact Assessment – Stock Routes

Submitter:

Department of Natural Resources and Mines

Submission:

The Road Impact Assessment fails to consider stock routes and the potential future impacts of the proposal on travelling stocks.

Response:

See response for same issue in Section 5.10 of this document.

EIS Amendment:

An additional sentence is added under the Road Impact Assessment subheading of the Executive Summary as follows:

"A stock route running northward from Lake Maraboon to the Capricorn Highway will need to be relocated approximately 3km to the west in order to accommodate the planned opencut pit and mine surface infrastructure"

1.3 Page 21-22, Indigenous Cultural Heritage – CHMP

Submitter:

Department of Aboriginal and Torres Strait Islander and Multicultural Affairs

Submission:

In accordance with Part 7 of the Aboriginal Cultural Heritage Act 2003, a Cultural Heritage Management Plan (CHMP) is currently being negotiated. Written notice to develop a CHMP under Part 7 of the ACHA was received 30 January 2014.

DATSIMA recommends that negotiations regarding the CHMP be continued to include both the Bidjara #7 Peoples and the Western Kangoulu People and be registered when finalised.

Response:

Acknowledged, and negotiations with both parties are continuing.

EIS Amendment:

None

2. SECTION 1 - INTRODUCTION

2.1 Section 1.2, Page 1-7 - Project Description

Submitter:

Department of Natural Resources and Mines

Submission:

A large dam that currently exists within the project tenement boundary may be used as a water source for mining operations. The capture of overland flow for project activities via the use of this dam is permissible, provided these works are notified.

Response:

In the event this dam is indeed used as a water supply source for the project, the existing overland flow captured by this dam will be notified under Section 111 of the Water Resources (Water Resources (Fitzroy Basin) Plan 2011, or such other legislation that is applicable at the time.

EIS Amendment:

None

2.2 Section 1.3 - Project Objectives and Scope

Submitter:

Department of State Development, Infrastructure and Planning

Submission:

The Project Objectives and Scope section does not consider the potential impact on the areas of regional interest that are affected by the project area i.e. the Priority Agricultural Area (PAA) or the potential existence of priority agricultural land uses (PALUs) in considering alternative locations.

This section should incorporate the potential impact on the areas of regional interest.

Response:

This section will be reworded to address PAA and PALU’s. It should be noted that only a small area of PAA exists within the MDL boundary and which, in the Proponent’s opinion after assessment, is incorrectly mapped in the Government’s database. The northwest

boundary of the Central Queensland PAA is located so as to coincide with a physical feature (Fork Lagoons Road) rather than land use capability. The PAA existing within the MDL boundary is an extension of the EIS mapped Rolleston/ Glengallen soil management unit (SMU) and contains sandstone outcropping, steep slopes and heavy timber. This SMU has a land suitability classification for cattle grazing and broadacre cropping of 4, which is considered marginal with severe limitations. (See Section 6.4 of Appendix 7 of the EIS)

EIS Amendment:

The fifth paragraph of Section 1.3.1 has been modified into three paragraphs, as follows:

"The presence of Priority Agricultural Area (PAA) and potential Strategic Cropping Land Area (SCA) within MDL467 (as identified by the QLD Government SCL Trigger Map, December 2012), meant that further modifications might be required to the mine plan in order to minimise Project impacts upon Priority Agricultural Land Uses (PALUs) and SCA.

In the first instance, while there is a small area of PAA within the northeast portion of MDL467, after assessment this area is considered to be incorrectly mapped in the Government's database. The northwest boundary of the Central Queensland PAA that lies within MDL467 is located so as to coincide with a physical feature (Fork Lagoons Road) rather than land use capability and the existence of PALUs. The PAA existing within the MDL boundary is an extension of the EIS mapped Rolleston/ Glengallen soil management unit (SMU) and contains sandstone outcropping, steep slopes and heavy timber. This SMU has a land suitability classification for cattle grazing and broadacre cropping of 4, which is considered marginal with severe limitations (See Section 6.4 of Appendix 7 of this EIS) and has never hosted a PALU.

To determine the extent of SCA, cropping history and zonal site assessments were conducted for the Project site in order to ground-truth the initial QLD Government SCL Trigger Mapping within MDL467 and produce revised SCA validation areas for submission to the QLD Government. This ground-truthing resulted in Project modifications allowing for a smaller footprint and a significant reduction in the area of impacted SCA and Brigalow Woodland that would have also been impacted by the original mine plan."

2.3 Section 1.5, Page 1-24 and Section 4.10, Public Consultation

Submitter:

Department of Aboriginal and Torres Strait Islander and Multicultural Affairs

Submission:

Within the Table in Section 1.5 there has been no engagement with other Aboriginal and Torres Strait Islander peoples listed, only with Traditional Owner groups.

Within both of these Sections there is no information regarding Aboriginal responses on:

- How many Aboriginal people were consulted; and
- In Section 4.10.1.11 there were concerns around Indigenous employment, health and education.

DATSIMA recommends that more detailed information be gathered on engagement with local Aboriginal and Torres Strait Islander peoples as well as the Traditional Owners occur.

Response:

There was one other engagement with Aboriginal and Torres Strait Islander peoples that was undertaken initially, but not rightfully acknowledged in Table 1.2. This was Tegan, whose position is more correctly titled "Indigenous Child and Youth Health Coordinator, Central Highlands Community Health Centre". Recently (August 2014), the Proponent held discussions with David Thompson of DATSIMA's Rockhampton office on various topics, but primarily with regard to employment of Indigenous peoples and use of Indigenous owned

businesses.

EIS Amendment:

The following paragraph has been added after paragraph 4 in Section 1.5:

"In addition to Traditional Owner groups, consultation was undertaken with a broader range of local Indigenous stakeholders – including the Queensland Department of Aboriginal and Torres Strait Islander and Multicultural Affairs (DATSIMA), the Central Highlands Aboriginal Corporation and local health service providers - to understand Indigenous health, education and employment issues across the region. As a result of this consultation, an Indigenous Participation Plan was development for the Taroborah project."

Also, another bullet point has been added to the list on page 1-22:

"• Engagement with DATSIMA's Rockhampton office in September 2014."

In Table 1.2 on page 1-27:

Tegan's 'position' has been changed to: "Indigenous Child and Youth Health Coordinator, Central Highlands Community Health Centre"

And finally, the contact with DATSIMA has been added to Table 1.2 as follows:

Stakeholder	Position	Date of Contact	Subject
David Thompson	Program Manager, DATSIMA	28 Aug 2014	Discussed that the key issue for Central Queensland Indigenous communities was employment. Advised that there were many opportunities to source labour (both Indigenous and non-Indigenous) from communities such as Woorabinda, Alpha, Winton and Blackall. DATSIMA can support Taroborah by recruiting and training local Indigenous candidates. There are also opportunities to support local Indigenous businesses – projects can work with DATSIMA and ICN to identify and realise these business opportunities

2.4 Section 1.5, Page 1-24 – Stakeholder Consultation

Submitter:

Department of Environment and Heritage Protection

Submission:

In Table 1.2, Stakeholder Consultation Summary Register, the proponent lists Olivia Gourley from the Department of Environment and Heritage Protection (EHP) in Emerald as a stakeholder who was consulted in October 2013 about watercourse buffer zones, triggers and offsets. However, there is no record of anyone by that name working for EHP in the Emerald Office and at that time watercourse related issues were being assessed by the Department of Natural Resources and Mines.

Provide clarification about who and from what department the advice about watercourse related issues was sought in October 2013.

Response:

Olivia Gourley was consulted by telephone in October 2013 in relation to watercourse offset requirements. Her "location" was incorrectly indicated as Emerald Region in the table

Her full contact details are provided below:

Olivia Gourley
Senior Environmental Officer
Environmental Standards and Compliance, North Region
Department of Environment and Heritage Protection
Telephone: (07) 4722 5270 Facsimile: (07) 4722 5351
Email: olivia.gourley@ehp.qld.gov.au
www.ehp.qld.gov.au

EIS Amendment:

Table entry for this contact updated as follows:

Stakeholder	Position	Date of Contact	Subject
Olivia Gourley	Department of Environment and Heritage Protection, Environmental Standards and Compliance, North Region	Oct 2013	Watercourse offsets in the Emerald region, buffer zones around each watercourse and triggers

2.5 Section 1.6 - Project Approvals

Submitter:

Department of State Development, Infrastructure and Planning

Submission:

The Project Approvals section is silent on the *Regional Planning Interests Act 2014* (RPI Act) and does not identify that an assessment application for a Regional Interests Development Approval (RIDA) will be required if an area of regional interest is impacted by the project.

Section 5 of the RPI Act states that:

1) This Act applies despite any resource Act, the Environmental Protection Act, the Sustainable Planning Act 2009 or the Water Act 2000 (each the other Act).

2) Any restriction or requirement under this Act applies as well as any restriction or requirement under the other Act.

The commencement date for the RPI Act was 13 June 2014.

The EIS refers to the Strategic Cropping Land Act 2011. This Act was repealed and replaced by the RPI Act.

Recommendations:

Conditions of the Environmental Authority should make reference to the RPI Act, plus there is a requirement to obtain a Regional Interests Development Approval where an area of regional interest is impacted.

All references to the Strategic Cropping Land Act 2011 are to be replaced by the RPI Act

Response:

It should be noted that the Draft EIS was silent on the RPI Act because the RPI Act did not come into being until after publication of the Draft EIS.

Reference to the RPI Act will be included in Section 1.6 of the final EIS document.

EIS Amendment:

Reference to Strategic Cropping Land Act 2011 removed from Table 1.3 and Section 1.6.3.21 - Strategic Cropping Land Act 2011 deleted.

A new Section 1.6.3.27 - Regional Planning Interests Act 2014 has been added as follows:

"The *Regional Planning Interests Act 2014* (RPI Act) commenced on 13 June 2014. The RPI Act identifies and protects areas of Queensland that are of regional interest. In doing this, the RPI Act seeks to manage the impact and support coexistence of resource activities and other regulated activities in areas of regional interest. The RPI Act is supported by the Regional Planning Interests Regulation 2014 (RPI Regulation).

Together, the RPI Act and RPI Regulation seek to strike an appropriate balance between protecting priority land uses and delivering a diverse and prosperous economic future for our regions. In addition, the RPI Act provides the framework for implementing the policies of the government's new generation statutory regional plans, of which the Central Queensland Regional Plan 2013 is relevant to the Project.

The RPI Act protects:

- living areas in regional communities
- high-quality agricultural areas from dislocation
- strategic cropping areas
- regionally important environmental areas.

A regional interests development approval (RIDA) may be required when a resource or regulated activity is proposed to be located in an area of regional interest. To obtain a RIDA, an assessment application must be made to the Chief Executive of the Department of State Development Infrastructure and Planning (DSDIP).

The Queensland government recognises that Priority Agricultural Areas (PAA) and Strategic Cropping Areas (SCA) are a finite resource that is subject to competing land uses from agriculture, mining and urban development sectors, and therefore, must be conserved and managed for the long-term benefit of all Queenslanders.

PAA and SCA legislation applies to approximately 42 million ha of Queensland. Within this area, trigger mapping identifies 7.57 million ha as areas where SCA may exist and where developers will need to undertake on-ground assessments using the proposed criteria.

An SCA validation process (under the previous SCL Act legislation) has been undertaken to confirm the SCA area within the Project site.

Since the Project development will be conducted within SCA, which is an area of regional interest in the Central Queensland Regional Plan, the RPI Act legislation applies to this Project and a RIDA may need to be obtained."

2.6 Section 1.6.3, Page 1-37 – Queensland State Legislation Approvals

Submitter:

Department of Agriculture, Forestry and Fisheries – Resource, Planning and Skills

Submission:

If the final MLA boundaries overlay any priority agricultural areas in the Central Queensland

Regional Plan, the Proponent is requested to update the list of Queensland State Legislation approvals to include the Regional Planning Interests Act 2014.

Response:

It should be noted that the MDL boundary does overlay PAA, but the eventual ML boundary will likely not. However, as discussed in the response in Section 2.5 of this document, a reference to the RPI Act will be included in the list of Queensland State Legislation approvals potentially required.

EIS Amendment:

As noted above in Section 2.5 above.

2.7 Section 1.6.3.2, Page 1-39 – Project ERA's

Submitter:

Department of Environment and Heritage Protection

Submission:

ERA 16 – Extraction and screening has not been included in Table 1.4. It is feasible that during the course of operations ERA 16 would be undertaken when laying bases for pads, constructing road or rail infrastructure or during underground operations.

Confirm if ERA 16 would be undertaken and, if so, nominate a threshold and aggregate environmental score.

Response:

The Proponent does not believe that ERA 16 would apply to the Project per clause 16(2)(a) of Schedule 2 of the *Environmental Protection Regulations 2008* as any extraction and screening of material would be carried out under an environmental authority for a resource activity. Nonetheless, ERA 16 will be added to Table 1.4 in the EIS.

EIS Amendment:

ERA16 added to Table 1.4 as follows:

Environmentally Relevant Activity	Threshold	Aggregate Environmental Score
Extracting and Screening (ERA 16 (1))	Extracting, other than by dredging, more than 1,000,000 t of material in a year	57

2.8 Section 1.6.3.18, Page 1-44 – Land Protection (Pest and Stock Route Management) Act 2002

Submitter:

Department of Natural Resources and Mines

Submission:

The second paragraph incorrectly lists EHP as being responsible for the *Land Protection*

(Pest and Stock Route Management) Act 2002. The Department responsible for providing the framework of legislation and policy for stock route management and support for local government is the Department of Natural Resources and Mines (DNRM).

Response:

Acknowledged by the Proponent and will be corrected in the final EIS document.

EIS Amendment:

Second paragraph of Section 1.6.3.18 amended as follows:

"Additionally, under the LP Act, the integrity of stock routes must also be maintained. Under the LP Act, the administration of the stock route network (SRN) is shared between local government and the Department of Natural Resources and Mines (DNRM). Local government is responsible for day-to-day management, while DNRM is responsible for providing the framework of legislation and policy for stock route management and support for local governments."

2.9 Section 1.6.3.20, Page 1-45 – Queensland State Legislation Approvals

Submitter:

Department of Agriculture, Forestry and Fisheries – Fisheries Queensland

Submission:

The description of approvals required under the Fisheries Act 1994 should include operational works that is the building or raising of waterway barrier works, disturbance of marine plants or works within a declared Fish Habitat Area.

Response:

The Proponent has spoken with DAFF in relation to any potential impacts on fisheries. The Proponent has clarified with DAFF that the Project will not involve barriers on, or crossings of, either Taroborah Creek or Retreat Creek, such that fish ladders or similar measures would be required.

EIS Amendment:

None required.

2.10 Section 1.6.3.24, Page 1-46 – Queensland State Legislation Approvals

Submitter:

Department of Agriculture, Forestry and Fisheries – Forestry

Submission:

Requirements under the Forestry Act 1959 are incompletely captured. The Proponent is advised to note and include the following:

If not authorised under other legislation the Proponent must arrange any necessary sales permit/s if State-owned forest products and/or quarry material administered under the Forestry Act 1959 are proposed or likely to be used for Project related activities or other activities on or off the project area.

Notes:

- DAFF requires a suitable timeframe (6 months) to arrange appropriate salvage harvesting of any State-owned forest products administered under the Forestry Act 1959 prior to any native vegetation (terrestrial flora) clearing or alternatively

the Proponent, in consultation with DAFF, may arrange for the sawlogs to be felled and stockpiled for later sale by DAFF.

- Forestry Act 1959 authorisations are required for the taking and use of State-owned quarry material on the Project site and/or off the Project site. This includes the moving of State-owned quarry material off the project area.
- The Proponent should liaise with DAFF and other affected parties to ensure that the location and positioning of the proposed project infrastructure and/or proposed offset areas avoid sterilising and/or restricting the future utilisation and/or access to currently operational or known commercial deposits of State-owned quarry material.
- The Project is to ensure that if State-owned quarry material administered under the Forestry Act 1959 is required from an existing quarry, that the quarry operator holds:
    - A current Sales Permit under the Forestry Act 1959;
    - The associated required planning Development Approval or evidence of an exemption;
    - Relevant environmental authorities under the Environmental Protection Act 1994; and
    - All of which must be consistent with the quantity of required quarry material and the approved operational and supply arrangements.
- In addition where a mining lease applies then:
    - The removal of State-owned quarry material off a mining lease area will require an authority under the Forestry Act 1959.
    - The removal of State-owned quarry material off a mining lease where stored for later use on an adjoining/nearby mining lease requires an authority under the Forestry Act 1959.

Response:

The Proponent notes the statutory obligation to obtain approvals for the taking and use of quarry materials and timber products on the relevant leasehold areas and this will be mentioned in the final EIS and approvals sought at the appropriate time.

The Proponent does not intend to affect or harvest any forest products, and note the statutory obligations in the event that they do.

Currently, there aren't any operational quarries within or immediately surrounding the Project site, nor is the Proponent aware of any known occurrences of commercial quarry materials within the Project site. Prior to final design of the mine, the Proponent will liaise with DAFF to ensure that any potential future quarry operations are not sterilized through the location of mine infrastructure or offset areas.

EIS Amendment:

Section 1.6.3.24 (now 1.6.3.23) is amended to read as follows:

"The purpose of the *Forestry Act 1959* (Forestry Act) is 'to provide for forest reservations, the management, silvicultural treatment and protection of State forests, and the sale and disposal of forest products and quarry material, the property of the Crown on State forests, timber reserves and on other lands'.

Although Fairbairn State forest is located directly adjacent to the north-east, east and south-east of MDL467, in terms of Section 39 of the Forestry Act, the Project will not interfere with any forest products within these State forests and the surrounding leased State owned lands, and note the statutory obligations in event they do.

The taking and use of quarry material from the Project site will occur as a necessary consequence of removing overburden in the opencut mining operation, and a Forestry Act authorisation will be obtained prior to undertaking these operations.

Currently, there aren't any operational quarries within or immediately surrounding the Project site, nor is the Proponent aware of any known occurrences of commercial quarry materials within the Project site. Prior to final design of the mine, the Proponent will liaise with DAFF to ensure that any potential future quarry operations are not extracted or sterilized through the location of mine infrastructure or offset areas, and seek appropriate approvals."

2.11 Section 1.6.3.32, Page 1-49 – Land Act 1994

Submitter:

Department of Natural Resources and Mines

Submission:

This section acknowledges that the Taroborah Project site includes stock routes which run both north-south and east-west of MDL467, and refers to Section 4.2 of the EIS for details of the SRN. The assessment of impacts on the SRN referred to in Section 4.2 is inadequate.

Response:

The Proponent recognises that the existing stock route that runs southward from the Capricorn Highway to Lake Maraboon (and which encompasses the St Helen's access road) will likely need to be relocated to accommodate the Project's operating infrastructure. The relevant DNRM Senior Lands Officer (Stock Routes), Mr Peter Klem, has been contacted and approved a preliminary route for the relocation. Mr Klem and the CHRC stock route officer will continue to be consulted in the detailed planning stages to effect the relocated route, and this recognition will be included in the wording of the final EIS document.

In addition, proper public notice will be given prior to the simultaneous closure of the existing stock route and opening of the relocated stock route.

EIS Amendment:

Section 1.6.3.32 has been amended as follows.

Incorrect reference to Section 4.2 has been replaced with reference to Section 4.3.

The final paragraph in Section 1.6.3.32 now reads as follows:

"Since the Project will require both road and rail connections to the Capricorn Highway and Central West rail line, as well as relocation of a stock route, the Land Act will apply to this Project."

2.12 Section 1.6.4, Page 1-53 – Required Approvals

Submitter:

Department of Natural Resources and Mines

Submission:

The only water approval listed in Table 1.7 is a Water Licence. If a temporary supply of water is required for the project, a water permit may be required.

Response:

The Proponent acknowledges that the taking and using of water for the Project will require government approvals in the form of a licence, permit, or both and that the appropriate approvals will be sought when necessary.

EIS Amendment:

Entry for water approvals in Table 1.7 amended to read as follows:

Requirement	Purpose	Legislation	Administering Authority / Parties	Approval Timing
Water Licenses and/or Permits	A water license is required to take or interfere with water, including that from a water course, overland flow or groundwater. This license is used to manage local water resources. If the taking or interfering is temporary, a water permit may be required.	*Water Act 2000* *Water Regulation 2002* *Water Resource (Fitzroy Basin) Plan 2011*	DNRM	A water license and/or permit will be applied for during the EA approval process in 2015, prior to any water taking

2.13 Section 1.6.5.1, Page 1-57 – State Planning Policies

Submitter:

Department of State Development, Infrastructure and Planning

Submission:

The EIS provides comment on the individual state planning policies which have subsequently been superseded. The issue is that the EIS does not recognise that the numerous State Planning Policies (SPP) were replaced in December 2013 by a single SPP.

Recommendation:

Conditions of the Environmental Authority should recognise the SPP and that the Central Queensland Regional Plan (CQRP) regional policies reflect the intent of the SPPs.

Response:

It should be noted that this section of the Draft EIS was written before the new SPP came into effect. This section will be re-written with reference to the appropriate SPP legislation for the final EIS document.

EIS Amendment:

Section 1.6.5.1 amended to read as follows:

The State Planning Policy (SPP) is a new statutory planning instrument that relates to matters of State interest as currently applicable under the SP Act. This policy incorporates the Central Queensland Regional Plan (CQRP) and provides a framework that simplifies and clarifies the State's interests in relation to planning and development by amalgamating a number of previous state

planning policies under one umbrella. These policies need to be considered in the assessment of relevant development applications lodged under the SP Act.

Under the CQRP, a number of the former SPPs that have been incorporated and are considered to be relevant to the Project are presented in Table 1.8.

Table 1.8 Central Queensland Regional Plan Policies Relevant to the Project

State Planning Policy	Response
Priority Agriculture Areas and Priority Agricultural Land Uses	The CQRP framework is designed to protect Priority Agricultural Areas (PAAs) and Priority Agricultural Land Uses (PALUs) from Projects which result in permanent impacts or diminished productivity within these former Protection Zone areas. Further, potential Strategic Cropping Land (SCL) areas must also be considered when assessing a Project.
Infrastructure	The CQRP framework prioritises the minimisation of impacts on the region's infrastructure that supports economic growth, including transport networks and water supplies.
Priority Living Areas	The CQRP aims protect communities and individuals from the impacts of air, noise and odour emissions, and the impacts from hazardous materials. In addition this policy aims to protect industrial land uses from unreasonable encroachment.
Healthy Waters	The CQRP ensures that development is planned, designed, constructed and operated to manage stormwater and waste water in ways that protect the environmental values prescribed in the Environmental Protection (Water) Policy 2009

2.14 Section 1.6.5 – Central Queensland Regional Plan (CQRP)

Submitter:

Department of State Development, Infrastructure and Planning

Submission:

The EIS is silent on the Central Queensland Regional Plan (CQRP), which took effect 18 October 2013. The EIS does not state that consistency with the planning outcomes in the Regional Plan is required. The RPI Act gives effect to the policies contained in the regional plan.

Recommendation:

Conditions of the Environmental Authority should reflect the statutory CQRP and recognise that there are regional policies in the plan.

An assessment of the Project against the provisions of the CQRP will be required.

Response:

It should be noted that this section of the Draft EIS was largely complete and written before the CQRP came into effect. This section will be re-written with reference to the CQRP for

the final EIS document.

Per advice sought and received from DSDIP via email from EHP, the Proponent understands that specific assessment against the CQRP is no longer required, as it is understood by EHP that regional interests identified in the CQRP will be considered by the Proponent when responding to DSDIP's request to assess the potential impacts of the project on the Priority Agricultural Area and any Priority Agricultural Land Uses when determining whether a Regional Interests Development Approval would be required under the Regional Planning Interests Act 2014.

EIS Amendment:

Reference is now made to the CQRP within the new discussion on the RPI Act 2014 as indicated in the EIS Amendment in Sections 2.5 and State Planning Policy in Section 2.13 above.

2.15 Section 1.6.5.4, Page 1-61 – Potential Impacts upon Local Resources

Submitter:

Department of Environment and Heritage Protection

Submission:

No information has been included in the column about summary of potential project impacts and proposed management measures for Item Number 6 (Nutrients in aquatic environments) in Table 1.9.

Appropriate comments should be included for this item.

Response:

Comment about the potential impacts of nutrients in aquatic water systems as a result of the project, including proposed management measures, are included for Item 6 in Table 1.9 of the final EIS document.

EIS Amendment:

The entry for Item 6 in Table 1.9 has been updated as follows:

Resource Condition Target	Indicators	Potential Project Impacts and Management
6. Nutrients in aquatic environments.	Nitrogen in aquatic environments. Phosphorus in aquatic environments.	The most common effects of increased nitrogen and phosphorus levels in aquatic ecosystems are increases in the abundance of algae and aquatic plants which can lead to eutrophication. Management strategies include surface water management, restricting phosphate detergents, sewage treatment and monitoring.

Section 7.2.4 of Appendix 19 has been updated to read as follows:

Potential spills of chemicals and hydrocarbons that are used on the Project site may enter waterways. These chemicals are often toxic and can impact the integrity of watercourses.

Nitrogen and phosphorus are two nutrients that are found in fresh and marine waters and are considered essential to support biological life. These nutrients are found as natural sources in the soil and air and as by-products of human biological and industrial wastes. Nitrates are found in sewage and fertilisers, likewise, phosphates are also found in fertilizers in addition to detergents. Typically the amount of each source varies

according to the degree of human activity in the associated airshed and watershed.

Waters having relatively large supplies of nutrients are termed eutrophic (well nourished) and eutrophication is the process by which water bodies are made more eutrophic through an increase in their nutrient supply (Smith, Tilman, & Nekola., 1999). The most common effects of increased nitrogen and phosphorus supplies on aquatic ecosystems are typically perceived as increases in the abundance of algae and aquatic plants. The central issue is as algae and other plants die off the amount of oxygen declines in the water causing eutrophication. Excess nutrients can also lead to algae blooms which become toxic to both humans and aquatic life. This type of algae, blue-green algae, can acquire nitrogen from the air, and when provided with high concentrations of phosphorus (available in the water), the algae growth explodes and creates unhealthy and aesthetically unpleasing conditions. Furthermore, eutrophication has also been shown to cause the following impacts to in-stream ecosystems (Smith, Tilman, & Nekola., 1999):

Increased biomass and changes in species composition of suspended algae and periphyton;

- Reduced water clarity;
- Taste and odor problems;
- Blockage of intake screens and filters;
- Fouling of submerged lines and nets;
- Disruption of flocculation and chlorination processes at water treatment plants;
- Restriction of swimming and other water-based recreation;
- Harmful diel fluctuations in pH and in dissolved oxygen concentrations;
- Dense algal mats reduce habitat quality for macroinvertebrates and fish spawning; and
- Increased probability of fish kills.

Several pathways are associated with the uptake of nitrogen. Nitrogen that enters the environment, in excess of plant growth requirements, may either: (1) accumulate in soils; (2) move from the land into surface waters; (3) migrate into groundwater; or (4) enter the atmosphere via ammonia volatilization and nitrous oxide production. However, a significant fraction of nitrogen that enters the atmosphere subsequently returns to the land and surface waters via wet and dry deposition (Smith, Tilman, & Nekola., 1999).

Like nitrogen, phosphate fertilizers applied to soils have the ability to accumulate. This trend has important implications for eutrophication control because the total amount of phosphorus exported in runoff from the landscape to surface waters increases linearly with the soil phosphorus content (Smith, Tilman, & Nekola., 1999).

Smith, Tilman and Nekola (1999) articulate that different streams will vary in their response to nitrogen and phosphorus. These responses have been shown to vary depending on the watershed area, hydraulic flushing rate and hydraulic residence time of nutrients within the water body (Lohman & Jones, 1999). Several studies have found that high concentrations of inorganic suspended solids can reduce algal yields within waterbodies and observations indicate a combination of high levels of inorganic suspended solids and shorter hydraulic residence times can reduce phosphorus concentrations in mainstream systems.

A new Section 7.3.2 of Appendix 19 has been inserted to read as follows, with remaining sub-sections of Section 7.3 renumbered:

Nutrient limitation is a key concept in the management of eutrophication of waterways associated with the Project site. The concept of nutrient limitation implies: (1) that one key nutrient should be the primary limiting factor for plant growth in a given ecosystem; (2) that the growth of plants in a given ecosystem should be proportional to the rate of supply of this nutrient; and (3) that control of eutrophication should be accomplished by restricting the loading of this key nutrient to the ecosystem.

Previous studies have emphasised the significance of phosphorus as a water pollutant due to its ability to stimulate the growth of algae and other aquatic plants (Smith, Tilman, & Nekola., 1999). However, recent data suggest enrichment with both phosphorus and nitrogen together often produces higher algal yields than additions of these nutrients alone, therefore phosphorus and nitrogen are considered co-limiting to algal communities in streams.

The control of excessive nutrient loading requires an understanding of the loading of nutrients, their availability, and the quantification of the relationship between nutrient load and eutrophication response (Lee & Jones, 2005). Typically, simple concentration-based standards are unreliable for effective eutrophication control, therefore, the successful eutrophication management and control on the Project site is based primarily on the prevention of nitrogen and phosphorus escaping from the landscape into the receiving waters.

Nutrient restrictions will be achieved on the Project site by the following measures:

- Diversion of wastewater effluents as part of the surface water management system on the Project site which retains dirty water and diverts clean surface water;
- Restrict the use of phosphate-containing detergents where practical;
- Where possible, bioactive glyphosate shall be used for the treatment of weeds that are located in close proximity to watercourses;
- Installation of sewage treatment facilities with sufficient capacity to handle site waste; and
- Monitoring of receiving waters.

Monitoring of the receiving waters will identify any factors regulating internal sources of nutrients and within-stream nutrient dynamics and will assist in developing objective criteria used in judging acceptable versus non-acceptable water quality. Water quality monitoring is further discussed in Section 7.3.4.

2.16 Section 1.6.5.4, Page 1-60 to 1-62; Section 4.2.1.2, Page 4-33; Section 5.5, Page 5-13 – Agricultural Interests and Productivity

Submitter:

Department of Agriculture, Forestry and Fisheries – Resource, Planning and Skills

Submission:

The Proponent to detail its agriculture coexistence policy, including details on:

- how the Project will be mutually beneficial to both agricultural interests and resource activities;
- how the Project will not cause agricultural interests to pause then restart in order to fit in with the Project's resource development schedules;
- how the Project will recognise and ensure the continual and ongoing agricultural production in areas affected by development activities;
- how impacts to agriculture productivity (e.g. size of cattle herd, carrying capacity, cropping yields, strategic cropping land) will be minimised and mitigated during the Project;
- how impacts to agriculture productivity (e.g. size of cattle herd, carrying capacity, cropping yields, strategic cropping land) will be maintained and enhanced on an ongoing and continual basis from post completion of Project related activities;
- how rehabilitation will restore disturbed land back to its pre-development landform i.e. slope, soil profile, resulting in equivalent or higher levels of yield as land prior to development based on the same management techniques and inputs; and
- how the Project will provide positive flow-on benefits for the agricultural supply chains in and out of the local/regional community.

Response:

The Proponent will seek to minimise the impact on agricultural production during and after the life of the project. Cropping and grazing will continue on as much of the land as possible during mining. Where properties are purchased to enable the project to take place, the Proponent will seek to keep unaffected areas of those properties in production during the life of the project. Consideration will also be given to reticulation of excess water from mine dewatering for agricultural purposes, where possible, to improve productivity.

With a typical differential subsidence of 0.8m over 110m in the current cropping areas (and maximum of 1.1m over a distance of 130m), post-completion slope above the underground operations will remain fundamentally similar to the existing conditions, and appropriate mitigation measures (re-contouring drainage lines) will be undertaken to ensure drainage is unaffected, with the result that there should be no long-term impact on agricultural yields. Based on evidence and research at Crinum and Kestral mines (Hinchliffe, 2003) approximately 50km north-east of Taroborah, as well as in the Illinois Basin in the USA (Darmody, 1988), where incidentally the land in both areas is much flatter than at Taroborah, it is expected that all currently cropped land will return to production at 90% or greater of its existing yields at the completion of the project with little or no effect to soil fertility.

The Proponent has clarified with DAFF that while the opencut will unavoidably result in a final void being left behind, this will be on the least productive area of the tenement, and one which is not currently used for cropping, and has not been used for this purpose previously. The grazing characteristics of the land south and north of the highway will be largely unaffected on those tenements falling within the Project area. Careful consideration will be given to improving stocking rates on these properties through reticulation of excess water.

EIS Amendment:

Section 4.2.2.2 of the EIS discusses the impacts to land use suitability and proposes mitigation measures to minimise this impact. This section has been expanded to include the following paragraph as the fourth to last paragraph:

"With a typical differential subsidence of 0.8m over 110m in the current cropping areas (and maximum of 1.1m over a distance of 130m), post-completion slope above the underground operations will remain fundamentally similar to the existing conditions, and appropriate mitigation measures as discussed above will ensure drainage is unaffected, with the result that there should be no long-term impact on agricultural yields. Based on evidence and research at Crinum and Kestral mines, located approximately 50km north-east of Taroborah, as well as in the Illinois Basin in the USA, where incidentally the land in both areas is much flatter than at Taroborah, it is expected that all currently cropped land will return to production at 90% or greater of its existing yields at the completion of the project with little or no effect to soil fertility."

And two final paragraphs have been added as follows:

"While the opencut will unavoidably result in a final void being left behind, this will be on some of the least productive area of the tenement, and one which is not currently used for cropping, and has not been used for this purpose previously. The grazing characteristics of the land south and north of the highway will be largely unaffected on those tenements falling within the Project area. Careful consideration will be given to improving stocking rates on these properties through reticulation of excess water.

The Proponent will seek to minimise the impact of mining operations on agricultural production during and after the life of the Project. Cropping and grazing will continue on as much of the land as possible during mining. Where properties are purchased to enable the project to take place, the Proponent will seek to keep unaffected areas of those properties in production during the life of the project. Consideration will also be given to reticulation of excess water from mine dewatering for agricultural purposes, where possible, to improve productivity."

3. SECTION 2 – PROJECT NEEDS AND ALTERNATIVES

3.1 Section 2.1, Page 2-2 – Impact to Current Agricultural Land Uses

Submitter:

Department of Agriculture, Forestry and Fisheries – Resource, Planning and Skills

Submission:

The Proponent is requested to provide details on the impacts to existing agricultural activities undertaken from within all Project areas (e.g. size of cattle herd, carrying capacity, cropping yields). If the final MLA boundaries overlay any priority agricultural areas, the Proponent is requested to provide mapping of all priority agricultural land uses as identified in the Central Queensland Regional Plan undertaken within the MLA (both currently, and if possible, over the last 10 years).

Response:

As discussed in the response to the submission on EIS Sections 1.6.5.4, 4.2.1.2 and 5.5 (Section 2.16 of this response document), cropping and grazing will continue on as much of the land as possible during mining. Where properties are purchased to enable the project to take place, the Proponent will seek to keep unaffected areas of those properties in production during the life of the project.

No current or historic (last 10-20 years) areas of cropping land will be permanently impacted (i.e. excavated) by the mining operations or siting of mine infrastructure, and subsidence of cropping land from underground mining will only result in temporary impact of approximately 60-90ha of cropping land annually. Once subsided, drainage will be reestablished and the lands returned to cropping within an approximate one year period. History elsewhere has shown that cropping yields will not be significantly diminished (5-10% yield loss) from pre-disturbance levels.

The opencut is sited primarily on Class 4 and 5 cropping suitability land (i.e. land that is marginal to unsuitable for cropping), whilst the mine infrastructure area is located on Class 3 and 4 cropping suitability land (suitable to marginal) that has never been cropped and is used solely for grazing purposes. The approximately 250ha of affected land currently supports approximately 100-200 head of cattle intermittently, and will be returned to use following mine closure. The displaced cattle can easily be accommodated on adjoining land to the south and east of the mine during operating years.

The final ML area has not been determined, but will definitely avoid the small area of Priority Agricultural Area in the northeast portion of the MDL467 tenement as defined in the CQRP.

EIS Amendment:

The following sentence is added to the end of Section 2.1.

"In addition to the above benefits, current land uses of cattle grazing and dryland broadacre cropping can continue over most of the Project site while mining is undertaken, with only marginal reduction in the benefits these land uses currently provide. This is discussed further in the next section"

3.2 Section 2.2.6, Page 2-10 and elsewhere – Subsidence of Capricorn Highway

Submitter:

Department of Transport and Main Roads

Submission:

There are a number of mentions of the potential for subsidence of the Capricorn Hwy, and that they will have limited effect. However the EIS does not provide sufficient estimates of the potential for subsidence and recommended mitigation measures.

Further information about potential subsidence should be provided and discussion with Central Region officers about a Subsidence Management Plan as part of the Compensation Infrastructure Agreement with TMR should commence. This liaison should be undertaken in sufficient time to allow any amelioration works to be undertaken before undermining of the road takes effect.

Response:

The proponent would argue that, other than a cross-section along the length of the subsided section of the Capricorn Highway, sufficient characterisation and discussion on the subsidence potential of the Capricorn Highway is provided in Section 4.2.2.3 of the EIS document. A cross section has been undertaken, however, unless the vertical scale is highly exaggerated, the section tells little about the subsidence other than that it is very minor.

The proponent will certainly engage with DTMR regarding a Subsidence Management Plan and Compensation Infrastructure Agreement at the appropriate time, bearing in mind that any subsidence from the Project activities would be some 10 years from now.

EIS Amendment:

Next to last paragraph of Section 2.2.6 amended to read as follows:

"The Project was also designed to avoid major subsidence impacts from underground mining on the Central West rail system and Capricorn Highway. By developing underground longwall mining only to the north of, and parallel to, these transport systems, in consideration to assessed geological constraints, significant subsidence impacts shall be avoided. Prior to underground mining, a Subsidence Management Plan will be developed to monitor and mitigate subsidence of the infrastructure and elsewhere, and a compensation agreement will be developed with the DTMR to ensure the impacts are not a burden on the State or the public."

Last paragraph of Section 4.2.2.3 amended to read as follows:

"Prior to longwall mining, a comprehensive Subsidence Management Plan (SMP) will be developed and compensation agreements put in place with the DTMR to mitigate any damage from subsidence. As part of the SMP, During during extraction of the first longwall panel, suitable warning signage and speed limit reduction will be posted along the highway, and the highway will be monitored daily for significant cracking should it occur and repaired accordingly."

3.3 Section 2.2.10, Page 2-13 – Water Supply

Submitter:

Department of Natural Resources and Mines

Submission:

The report has identified that ongoing production will utilise water extracted through dewatering of the pits and underground workings. The report however, has not identified any intended sources of water for construction phase i.e. prior to pit excavation and dewatering.

Response:

It is considered likely that some form of dewatering in advance of opencut mining operations will be necessary in order to control inflows into the initial box cut, and these dewatering wells would be installed at the outset of mine construction and used as the supply of water for construction activities. The final EIS document will be amended to include the above comments.

EIS Amendment:

The fourth paragraph of Section 2.2.10 is amended as follows:

"The use of groundwater to supply the Project's water requirements during construction and operations reduces both the mine footprint (no off-lease water-supply network required) and the vegetation / ecosystem disturbance, thereby benefiting the local environment and assisting in social and economic goals."

A new paragraph is added after the fourth paragraph of Section 2.2.10 as follows:

"It is considered likely that some form of dewatering in advance of opencut mining operations will be necessary in order to control inflows into the initial box cut, and these dewatering wells would be installed at the outset of mine construction and used as the supply of water for construction activities."

The first sentence of the existing next to last paragraph in Section 2.2.10 is amended as follows:

"It is anticipated the initial opencut dewatering wells and the eventual mine water storage dam will be connected via a constructed pipeline to water treatment facilities and a 200 kL water storage tank, located in the MIA, to service the mine during construction and operations, respectively."

4. SECTION 3 – DESCRIPTION OF THE PROJECT

4.1 Section 3.2.7, Page 3-16 – Regulated Dams

Submitter:

Department of Environment and Heritage Protection

Submission:

Two water storages, known as the mine water dam (MWD) and the Coal Preparation Plant Waste Recycle Dam (CPPWRD), have been assessed against EHP's (EM635) Manual for Assessing Consequence Categories and Hydraulic Performance of Dams (EHP 2013) and determined to be regulated structures. However, Appendix A of the EHP guideline (EM634) Structures which are dams or levees constructed as part of environmentally relevant activities (EHP 2014), requires the consequence category of any structure to be assessed in accordance with EM635.

It is noted that flood protection levees associated with the project may be subject to regulation as they have important environmental objectives for minimising the risk of flood water inflows. Furthermore, some of the sediment dams that are proposed to capture runoff from the waste rock dumps that would be used to encapsulate the potential acid forming (PAF) waste rock and coal processing rejects material may also be subject to regulation.

An assessment of all water management structures, including levees and sediment dams needs to be conducted against EM635.

Response:

Acknowledged and this assessment has been undertaken and the results reported in the final EIS document.

It should be noted that there are no major flood protection levees associated with the project.

EIS Amendment:

The first paragraph of Section 3.2.7 of the EIS main body report has been amended to read as follows:

"Assessment of the proposed surface water management facilities for the Project, which are

described in Section 3.5.3.4, was undertaken against the guidelines contained in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Dams* (EHP Publication EM635, 2013). Based on this assessment, which can be found in Appendix 13, two regulated dams will be constructed on the Project site in order to collect and supply the Project with adequate water and are described below:"

A new Section 4.4 - Design Criteria for Site Water of Appendix 13 replaces the old Section 5.1 – Initial Storage Sizing and reads as follows:

"4.4 Design Criteria for Site Water

4.4.1 Performance Criteria for Site Water Management System

The performance of the stormwater management system identified above is based on the capacity of the proposed water dams Mine Wastewater Dam (MWD), CPP Water Recycle Dam (CPPWRD) and 7 sediment dams to contain site water with minimal discharge to the environment. Containment criteria for the storages are detailed below.

4.4.2 Performance criteria

According to the DEHP Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (2013) as well as the EA, key criteria relevant to regulated structures relates to accommodating a design storage (wet season containment) allowance, being referred to as DSA. The DSA is to be available for each storage as at 1st November of each year. Containment criteria for the structures identified in Section 4, are as follows:

- High Consequence - accommodate a 1 in 100 AEP event (wet season) as a minimum requirement, equivalent to a 1% spill probability.
- Significant Consequence - accommodate a 1 in 20 AEP event (wet season) as a minimum requirement, equivalent to a 5% spill probability.

Conservatively, containment criteria related to 'Significant' regulated structures in the Taroborah Coal Project site was based on the following design criterion:

Significant Consequence - accommodate a 1 in 100 AEP event (wet season) as a minimum requirement, equivalent to a 1% spill probability.

4.4.3 Regulatory Context

The basis for the determination of performance criteria for the Taroborah water management structures has been adopted from the DEHP guidelines: *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (2013). The purpose of the consequence assessment as detailed in DEHP (2013) is to assign to all structures a "consequence category" based on three failure scenarios, as follows:

- Failure to contain - overtopping scenario,
- Failure to contain – seepage scenario (it is noted that this scenario assessment is not relevant in the consequences assessment for the flood bunds/levees.
- Dam-Break scenario.

The consequence assessment based on DEHP (2013), provides an assessment category of High, Significant or Low for the scenarios identified above. An assessed category of High or Significant for a structure will result in the structure being classified as 'Regulated' with applicable performance criteria applied based on DEHP (2013).

4.4.4 Consequence Category Criteria

Based on the failure scenarios as outlined in Section 4.4.3, several modes of failure are possible and each failure mode has been considered separately. The scenarios and failure modes are discussed in greater detail in Appendix B.

A failure to contain scenario means a release from the structure that result from loss of containment

due to excessive seepage, overtopping of the structure and/or other deficiencies in water management of the structure. Although they are typically non-flood producing, failure to contain events may involve the release of contaminants, which could endanger environmental values or human life.

A dam break scenario encompasses the collapse of a dam due to any possible cause. A dam break is typically flood producing, involving the rapid release of significant volumes of contaminants, which could endanger environmental values or human life. An embankment dam break could take place via the following failure modes:

- Spillway failure;
- Erosion-induced stability failure of embankment from flooding;
- Piping failure of embankment; and
- Static or seismic stability failure.

The consequence category to be applied for a structure is the highest category determined under the failure event assessments. The consequence categories for the storage structures at Taroborah was assessed to be of 'High' and 'Low' consequence in accordance with the criteria outlined in DEHP (2013).

4.4.5 Consequence Assessment

A brief review of the potential harm, associated with failure-to-contain or dam break scenarios, for each of the proposed storage structures, has been assessed based on assumed/expected water quality conditions as advised by IMC , and summarised as follows:

- The MWD assessment was based on storage of groundwater inflows and in-pit spoil run- off pumped from the open-cut and underground mines, with major deterioration of the receiving environment expected to occur, subject to a release of contained site water runoff generated from the MWD.
- Waters stored in the CPPWRD are expected to comprise recovered process water from the CPP and site water runoff stored at sediment basins, with the release of contained site water from WRD having the potential to cause major deterioration of the receiving environment. The CPPWRD dam will also store site water transferred from the MWD (as capacity allows).
- Sediment Dam 1 (SED 01) is expected to receive runoff from the Product Coal stockpile area and some upstream catchment runoff. Sediment Dam 2 is located to the east of Sediment Dam 1 and is expected to receive runoff from the CPP area and OM coal pad which is expected to contain PAF material (EGI, 2012). Both dams will operate with continuous pumping into the CPPWRD and is expected to cause minor deterioration with the release of contained site water due to the minor storage volume contained.
- Storage in Sediment Dam 3 (SED 03) is expected to comprise surface runoff from the Mine Infrastructure Area (MIA), fuel bay and maintenance wash bay with continuous pumping for release into CPPWRD is expected to cause minor deterioration with the release of contained site water due to the minor storage volume contained.
- Sediment Dam 4 (SED 04), Sediment Dam 6 (SED 06) and Sediment Dam 7 (SED 07) are expected to comprise surface runoff from the out-of-pit spoil dumps at the Project site. These dams are expected to cause minor deterioration with the release of contained site water due indication that most of the overburden and interburden tested to date at Taroborah is likely to be NAF.(EGI,2013)
- Storage in Sediment Dam 5 (SED 05) is expected to comprise Underground ROM Stockpiles, fuel stores and wash down bay with continuous pumping to CPPWRD is expected to cause minor deterioration with the release of contained site water due to the minor storage volume contained.

Based on the above information, each proposed containment structure has therefore been assigned a consequence category as tabulated in Table 7. The detailed assessment for the storage

dams, as per the DEHP guidelines (2013), is attached in Appendix B.

Table 7
Consequence Assessment Summary

Structure	Assigned Consequence			Containment Criteria (based on overtopping consequence category)	Regulated Dam(Y/N)
	Failure To Contain-Seepage	Overtopping	Dambreak		
MWD	LOW	HIGH	SIGNIFICANT	1 in 100 year AEP	Y
CPPWRD	LOW	HIGH	HIGH	1 in 100 YEAR AEP	Y
Sediment Dam 1	LOW	LOW	LOW	N/A	N
Sediment Dam 2	LOW	LOW	LOW	N/A	N
Sediment Dam 3	LOW	LOW	LOW	N/A	N
Sediment Dam 4	LOW	LOW	LOW	N/A	N
Sediment Dam 5	LOW	LOW	LOW	N/A	N
Sediment Dam 6	LOW	LOW	LOW	N/A	N
Sediment Dam 7	LOW	LOW	LOW	N/A	N

4.4.6 Water Management Sizing/Containment Criteria

Based on the above assessment and in accordance with DEHP (2013), the determination of a Design Storage Allowance (DSA) is required for all regulated structures. Storage analysis based on 'high' consequence was adopted to calculate an approximate storage at site for containment to minimise the impact on the operations and environment to an acceptable risk as discussed with Shenhuo. In addition, and based on ANCOLD (DEHP, 2013), the considered appropriate design capacity for the emergency spillway is to pass a peak flood from the 1 in 1,000 year Annual Exceedance Probability (AEP).

4.4.7 Site Water Collection Drains

Site water collection drains/bunds will be formed to intercept site water generated from disturbed surfaces and facilitate their drainage to containment structures such that the risk of discharge to receiving water is minimal. As such, the design of all site water collection drains and bunds should be to accommodate a 100 year ARI event of critical duration. Site water drains are to be located around the perimeter of possible contaminant spillage (such as hydrocarbons), with effective capture and transport of site water to the proposed collection points required.

The target maximum flow velocity within bunds and channels of 1 m/s is proposed to minimise drain/bund armouring requirements.

And finally, Appendix B – Consequence Assessment to Appendix 13 of the EIS document provides an assessment of all water storage structures proposed for the Project using the EM635 guidelines, as follows:

"B1 Preface

The following section details the Consequence Category assessments carried out for the storage structures at the Taroborah Coal Project. These assessments have been completed in accordance with the published guideline, "Manual for Assessing Consequence Categories and Hydraulic Performance of Structures, November 2013" (Version 4).

B2 Consequence Category Assessment

In order to assess the storage structures' consequence category at the Taroborah Coal Project site, the DEHP (2013) requires the investigation of three failure event scenarios, namely:

- Failure to contain – seepage;
- Failure to contain - overtopping; and
- Dam break.

Under each of the above scenarios, several modes of failure are possible and each failure mode has

been considered separately.

A failure to contain scenario means a release from the structure that result from loss of containment due to excessive seepage, overtopping of the structure and/or other deficiencies in water management of the structure. Although they are typically non-flood producing, failure to contain events may involve the release of contaminants, which could endanger environmental values or human life.

A dam break scenario encompasses the collapse of a dam due to any possible cause. A dam break is typically flood producing, involving the rapid release of significant volumes of contaminants, which could endanger environmental values or human life. An embankment dam break could take place via the following failure modes:

- Spillway failure;
- Erosion-induced stability failure of embankment from flooding;
- Piping failure of embankment; and
- Static or seismic stability failure.

The consequence category to be applied for a structure is the highest category determined under the three failure event assessments and the contaminant concentration/dam volume assessment. The consequence category selected for each storage structure is described in greater detail in the sections that follow:

Mine Water Dam

Consequence category for the Mine Water Dam was assessed in accordance with the criteria outlined in Table 1 of the DEHP (2013). Table B1 is reproduced, and comments on selected categories are as follows:

Harm to humans

- The consequence category based on harm to humans based on Failure to contain due to seepage, overtopping, and dam break is 'Low' because human will not routinely be present in the failure path and human consumption is expected 20 km downstream of the Taroborah site where the health of less than 10 people being effected.
- Water released from the dams at the project site will be from the designated spillway or a structure failure would result in discharging into Taroborah creek. The nearest settlement along the Taroborah creek from the project site is almost approximately 20 km downstream, thus any contaminated waters released could result in the health of less than 10 people affected.

General environmental harm

- The Taroborah mine site is located upstream to the High Ecological Value Waters(Heva2041) wetlands as allocated in the (EPP,2009), WQ1303,Lower Nagoa River/Theresa Creek Sub-Basin. The Mine Water Dam is located approximately 10 km upstream of the Heva2041. Under a 'Dam Break' scenario and 'Failure to Contain – overtopping' scenario, these areas may undergo significant alteration to the existing ecosystem and therefore the Main Dam is classified as a "SIGNIFICANT" consequence category, based on general environmental harm.
- The release of this water through a 'Failure to Contain – Seepage' scenario, would be unlikely to meet any of the minimum thresholds specified for the Significant Consequence Category for adverse effects. The quantity of stormwater runoff stored within the Main Dam are from groundwater inflows and in-pit spoil run-off pumped from the open-cut and underground mines, with minor deterioration of the receiving environment expected to occur.

General Economic Loss

- The consequence category, based on general economic loss or property damage would be "significant" due the HEVa2041 in the potential impact area of a "Failure to Contain - overtopping" or "Dam Break" scenario and "low" for "Failure to Contain - seepage", The expected costs to third parties would be expected to cost less than $1 million in remedial works, rehabilitation, compensation and repairs.

The outcome of this assessment for the Mine water Dam under the 'Dam Break', 'Failure to Contain – seepage' scenarios, and 'Failure to Contain – overtopping' scenarios, covering the aspects as outlined above, is a "HIGH" consequence. Given the above assessment, the Mine Water Dam is a "Regulated Structure" in accordance with DEHP (2013).

Table B1
Consequence Category Assessment for Mine Water Dam

Environmental Harm	Consequence Category				Overall Rating	
	High	Significant	Low	Failure to contain - Seepage	Failure to contain - Overtopping	Dam Break
Harm to Humans	Location such that people are routinely present in the failure path and if present loss of life to greater than 10 people is expected[2]. Note: The requirement to consider the location of people in the failure path is only relevant to the 'dam break' scenario	Location such that people are routinely present in the failure path and if present loss of life to 1 person or greater but less than 10 people is expected[2]. Note: The requirement to consider the location of people in the failure path is only relevant to the 'dam break' scenario	Location such that people are not routinely present in the failure path and loss of life is not expected[2]. Note: The requirement to consider the location of people in the failure path is only relevant to the 'dam break' scenario	LOW	LOW	LOW
	Location such that contamination of waters (surface and/or groundwater[3]) used for human consumption could result in the health of 20 or more people being affected[4].	Location such that contamination of waters (surface and/or groundwater[3]) used for human consumption could result in the health of 10 or more people but less than 20 people being affected[4].	Location such that contamination of waters (surface and/or groundwater[3]) used for human consumption could result in the health of less than 10 people being affected[4].	LOW	LOW	LOW
General Environmental Harm	Location such that: a) Contaminants may be released to areas of MNES, MSES or HEV waters that are not already authorised to be disturbed to at least the same extent under other conditions of this authority subject to any applicable offset commitment (Significant Values); and b) Adverse effects5 on Significant Values are likely; and c) The adverse effects are likely to cause at least one of the following: i) Loss or damage or remedial costs greater than $50,000,000; or ii) Remediation of damage is likely to take 3 years or more; or iii) Permanent alteration to existing ecosystems; or iv) The area of damage (including downstream effects) is likely to be at least 5 km2.	Location such that contaminants may be released so that adverse effects (that are not already authorised to be disturbed to at least the same extent under other conditions of this authority subject to any applicable offset commitment) either: a) Would be likely to be caused to Significant Values but those adverse effects would not be likely to meet the thresholds for the High consequence category and instead would be likely to cause at least one of the following: i) Loss or damage or remedial costs greater than $10,000,000 but less than $50,000,000; or ii) Remediation of damage is likely to take more than 6 months but less than 3 years; or iii) Permanent alteration to existing ecosystems; or iv) The area of damage (including downstream effects) is likely to be at least 1 km2 but less than 5 km2. Or b) Would be likely to be caused to environmental values classed as slightly or moderately disturbed waters6, wetland of general ecological significance7, riverine areas, springs or lakes and associated flora and fauna (Moderate Values), and the adverse effects are likely to cause at least one of the following: i) Loss or damage or remedial costs greater than $20,000,000; or ii) Remediation of damage is likely to take more than 1 year; or iii) Significant alteration to existing ecosystems; or iv) The area of damage (including downstream effects) is likely to be at least 2 km2.	Location such that either: a) Contaminants are unlikely to be released to areas of Significant Values or Moderate Values; or b) Contaminants are likely to be released to those areas, but would be unlikely to meet any of the minimum thresholds specified for the Significant Consequence Category for adverse effects.	LOW	HIGH	SIGNIFICANT
General Economic Loss or Property Damage	Location such that harm (other than a different category of harm as specified above) to third party assets in the failure path would be expected to require $10 million or greater in rehabilitation, compensation, repair or rectification costs[8].	Location such that harm (other than a different category of harm as specified above) to third party assets in the failure path would be expected to require $1 million and greater but less than $10 million in rehabilitation, compensation, repair or rectification costs8.	Location such that harm (other than a different category of harm as specified above) to third party assets in the failure path would be expected to require less than $1 million in rehabilitation, compensation, repair or rectification costs[8].	LOW	LOW	LOW
			OVERALL	LOW	HIGH	SIGNIFICANT

Sediment Dams

Consequence category for the Sediment Dams were assessed in accordance with the criteria outlined in Table 1 of the DEHP (2013). Table B2 is reproduced, and comments on selected categories are as follows:

Harm to humans

- The consequence category based on harm to humans due Failure to contain due to seepage, overtopping, and dam break is 'Low' because human will not routinely be present in the failure path and human consumption is expected 20 km downstream of the Taroborah site where the health of less than 10 people being effected.
- Water released from the dams at the project site will be from the designated spillway or a structure failure would result in discharging into Taroborah creek. The nearest settlement along the Taroborah creek from the project site is almost approximately 20 km downstream, thus any contaminated waters released could result in the health of less than 10 people affected.

General environmental harm

- The Taroborah mine site is located immediately upstream to the High Ecological Value Waters (Heva2041) wetlands as allocated in the EPP (2009), WQ1303,Lower Nagoa River/Theresa Creek Sub-Basin. The sediment basins are located at a minimum 5 km upstream of the Heva2041. Under a 'Dam Break' scenario and 'Failure to Contain – overtopping' scenario, these areas may not undergo significant alteration to the existing ecosystem and therefore the storages are classified as a "low" consequence category, based on general environmental harm.
- The release of this water through a 'Failure to Contain – Seepage' scenario, would be unlikely to meet any of the minimum thresholds specified for the Significant Consequence Category for adverse effects due to the distance of the sediment dams from the Heva2041.

General Economic Loss

- The consequence category, based on general economic loss or property damage would be "Low" as there are no third party assets exist in the potential impact area of a "Failure to Contain - seepage", "Failure to Contain - overtopping" or "Dam Break" scenario. The expected costs to third parties would be expected to cost less than $1 million in remedial works, rehabilitation, compensation and repairs.

The outcome of this assessment for the Sediment dams for the 'Dam Break', 'Failure to Contain – seepage' scenarios, and 'Failure to Contain – overtopping' scenarios, covering the aspects as outlined above, is of "Low" consequence. Given the above assessment, the Dams are non - regulated structure in accordance with DEHP (2013).

Table B2
Consequence Category Assessment for Sediment Dams

Environmental Harm	Consequence Category			Overall Rating		
	High	Significant	Low	Failure to contain - Seepage	Failure to contain - Overtopping	Dam Break
Harm to Humans	Location such that people are routinely present in the failure path and if present loss of life to greater than 10 people is expected[2]. Note: The requirement to consider the location of people in the failure path is only relevant to the 'dam break' scenario	Location such that people are routinely present in the failure path and if present loss of life to 1 person or greater but less than 10 people is expected[2]. Note: The requirement to consider the location of people in the failure path is only relevant to the 'dam break' scenario	Location such that people are not routinely present in the failure path and loss of life is not expected[2]. Note: The requirement to consider the location of people in the failure path is only relevant to the 'dam break' scenario	LOW	LOW	LOW
	Location such that contamination of waters (surface and/or groundwater[3]) used for human consumption could result in the health of 20 or more people being affected[4].	Location such that contamination of waters (surface and/or groundwater[3]) used for human consumption could result in the health of 10 or more people but less than 20 people being affected[4].	Location such that contamination of waters (surface and/or groundwater[3]) used for human consumption could result in the health of less than 10 people being affected[4].	LOW	LOW	LOW
General Environmental Harm	Location such that: a) Contaminants may be released to areas of MNES, MSES or HEV waters that are not already authorised to be disturbed to at least the same extent under other conditions of this authority subject to any applicable offset commitment (Significant Values); and b) Adverse effects[5] on Significant Values are likely; and c) The adverse effects are likely to cause at least one of the following: i) Loss or damage or remedial costs greater than $50,000,000; or ii) Remediation of damage is likely to take 3 years or more; or iii) Permanent alteration to existing ecosystems; or iv) The area of damage (including downstream effects) is likely to be at least 5 km^2.	Location such that contaminants may be released so that adverse effects (that are not already authorised to be disturbed to at least the same extent under other conditions of this authority subject to any applicable offset commitment) either: a) Would be likely to be caused to Significant Values but those adverse effects would not be likely to meet the thresholds for the High consequence category and instead would be likely to cause at least one of the following: i) Loss or damage or remedial costs greater than $10,000,000 but less than $50,000,000; or ii) Remediation of damage is likely to take more than 6 months but less than 3 years; or iii) Permanent alteration to existing ecosystems; or iv) The area of damage (including downstream effects) is likely to be at least 1 km^2 but less than 5 km^2. Or b) Would be likely to be caused to environmental values classed as slightly or moderately disturbed waters[6], wetland of general ecological significance[7], riverine areas, springs or lakes and associated flora and fauna (Moderate Values), and the adverse effects are likely to cause at least one of the following: i) Loss or damage or remedial costs greater than $20,000,000; or ii) Remediation of damage is likely to take more than 1 year; or iii) Significant alteration to existing ecosystems; or iv) The area of damage (including downstream effects) is likely to be at least 2 km^2.	Location such that either: a) Contaminants are unlikely to be released to areas of Significant Values or Moderate Values; or b) Contaminants are likely to be released to those areas, but would be unlikely to meet any of the minimum thresholds specified for the Significant Consequence Category for adverse effects.	LOW	SIGNIFICANT	SIGNIFICANT
General Economic Loss or Property Damage	Location such that harm (other than a different category of harm as specified above) to third party assets in the failure path would be expected to require $10 million or greater in rehabilitation, compensation, repair or rectification costs[8].	Location such that harm (other than a different category of harm as specified above) to third party assets in the failure path would be expected to require $1 million and greater but less than $10 million in rehabilitation, compensation, repair or rectification costs[8].	Location such that harm (other than a different category of harm as specified above) to third party assets in the failure path would be expected to require less than $1 million in rehabilitation, compensation, repair or rectification costs[8].	LOW	LOW	LOW
			OVERALL	LOW	LOW	LOW

CPPWRD

Consequence category for the CPPWRD was assessed in accordance with the criteria outlined in Table 1 of the DEHP (2013). Table B3 is reproduced, and comments on selected categories are as follows:

Harm to humans

- The consequence category based on harm to humans due Failure to contain due to seepage, overtopping, and dam break is 'Low' because human will not routinely be present in the failure path and human consumption is expected 20 km downstream of the Taroborah site where the health of less than 10 people being effected.
- Water released from the dam at the project site will be from the designated spillway or a structure failure would result in discharging into Taroborah creek. The nearest settlement along the Taroborah creek from the project site is almost approximately 20 km downstream, thus any contaminated waters released could result in the health of less than 10 people affected.

General environmental harm

- The Taroborah mine site is located immediately upstream to the High Ecological Value Waters (Heva2041) wetlands as allocated in the (EPP,2009), WQ1303,Lower Nagoa River/Theresa Creek Sub-Basin. The CPPWRD is expected to contain is located approximately 8 km upstream of the Heva2041. Under a 'Dam Break' scenario and 'Failure to Contain – overtopping' scenario, these areas may undergo major alteration to the existing ecosystem and therefore the CPPWRD is classified as a "HIGH" consequence category, based on general environmental harm.
- The release of this water through a 'Failure to Contain – Seepage' scenario, would be unlikely to meet any of the minimum thresholds specified for the Significant Consequence Category for adverse effects. The quantity of stormwater runoff stored within the CPPWRD will be mainly recovered process water from the CPP and site water runoff stored at sediment basins, with the release of contained site water from CPPWRD having the potential to cause major deterioration of the receiving environment.

General Economic Loss

- The consequence category, based on general economic loss or property damage would be "Significant" due to HEVA2041 exist downstream in the potential impact area of a "Failure to Contain - seepage", "Failure to Contain - overtopping" or "Dam Break" scenario. The expected costs to third parties would be expected to cost less than $1 million in remedial works, rehabilitation, compensation and repairs.

The outcome of this assessment for the Mine water Dam under the 'Dam Break', 'Failure to Contain – seepage' scenarios, and 'Failure to Contain – overtopping' scenarios, covering the aspects as outlined above, is a "HIGH" consequence. Given the above assessment, the CPPWRD is a "Regulated Structure" in accordance with DEHP (2013)."

Table B3
Consequence Category Assessment for CPPWRD

Environmental Harm	Consequence Category				Overall Rating	
	High	**Significant**	**Low**	**Failure to contain - Seepage**	**Failure to contain - Overtopping**	**Dam Break**
Harm to Humans	Location such that people are routinely present in the failure path and if present loss of life to greater than 10 people is expected[2]. Note: The requirement to consider the location of people in the failure path is only relevant to the 'dam break' scenario	Location such that people are routinely present in the failure path and if present loss of life to 1 person or greater but less than 10 people is expected[2]. Note: The requirement to consider the location of people in the failure path is only relevant to the 'dam break' scenario	Location such that people are not routinely present in the failure path and loss of life is not expected[2]. Note: The requirement to consider the location of people in the failure path is only relevant to the 'dam break' scenario	**LOW**	**LOW**	**LOW**
	Location such that contamination of waters (surface and/or groundwater[3]) used for human consumption could result in the health of 20 or more people being affected[4].	Location such that contamination of waters (surface and/or groundwater[3]) used for human consumption could result in the health of 10 or more people but less than 20 people being affected[4].	Location such that contamination of waters (surface and/or groundwater[3]) used for human consumption could result in the health of less than 10 people being affected[4].	**LOW**	**LOW**	**LOW**
General Environmental Harm	Location such that: a) Contaminants may be released to areas of MNES, MSES or HEV waters that are not already authorised to be disturbed to at least the same extent under other conditions of this authority subject to any applicable offset commitment (Significant Values); and b) Adverse effects[5] on Significant Values are likely; and c) The adverse effects are likely to cause at least one of the following: i) Loss or damage or remedial costs greater than $50,000,000; or ii) Remediation of damage is likely to take 3 years or more; or iii) Permanent alteration to existing ecosystems; or iv) The area of damage (including downstream effects) is likely to be at least 5 km^2.	Location such that contaminants may be released so that adverse effects (that are not already authorised to be disturbed to at least the same extent under other conditions of this authority subject to any applicable offset commitment) either: a) Would be likely to be caused to Significant Values but those adverse effects would not be likely to meet the thresholds for the High consequence category and instead would be likely to cause at least one of the following: i) Loss or damage or remedial costs greater than $10,000,000 but less than $50,000,000; or ii) Remediation of damage is likely to take more than 6 months but less than 3 years; or iii) Permanent alteration to existing ecosystems; or iv) The area of damage (including downstream effects) is likely to be at least 1 km^2 but less than 5 km^2. Or b) Would be likely to be caused to environmental values classed as slightly or moderately disturbed waters[6], wetland of general ecological significance[7], riverine areas, springs or lakes and associated flora and fauna (Moderate Values), and the adverse effects are likely to cause at least one of the following: i) Loss or damage or remedial costs greater than $20,000,000; or ii) Remediation of damage is likely to take more than 1 year; or iii) Significant alteration to existing ecosystems; or iv) The area of damage (including downstream effects) is likely to be at least 2 km^2.	Location such that either: a) Contaminants are unlikely to be released to areas of Significant Values or Moderate Values; or b) Contaminants are likely to be released to those areas, but would be unlikely to meet any of the minimum thresholds specified for the Significant Consequence Category for adverse effects.	**LOW**	**HIGH**	**HIGH**
General Economic Loss or Property Damage	Location such that harm (other than a different category of harm as specified above) to third party assets in the failure path would be expected to require $10 million or greater in rehabilitation, compensation, repair or rectification costs[8].	Location such that harm (other than a different category of harm as specified above) to third party assets in the failure path would be expected to require $1 million and greater but less than $10 million in rehabilitation, compensation, repair or rectification costs[8].	Location such that harm (other than a different category of harm as specified above) to third party assets in the failure path would be expected to require less than $1 million in rehabilitation, compensation, repair or rectification costs[8].	**LOW**	**LOW**	**LOW**
			OVERALL	**LOW**	**HIGH**	**HIGH**

4.2 Section 3.2.7, 3.2.8 and 3.2.9, Page 3-15 to16 – Dams, Flood Protection Bunds and Visual Amenity Bund

Submitter:

Department of Environment and Heritage Protection

Submission:

A number of flood protection levees, visual amenity bunds and regulated dams are proposed to be built during the project's construction phase using non-acid forming (NAF) spoil and clay excavated from the surface of the open-cut pit, prior to the commencement of mining. However, it is not clear what volume of spoil and clay would be required to construct these structures and whether a suitable volume of NAF material will be available from the surface of the open-cut pit, prior to mining. This is particularly relevant, given that 65% of the spoil samples tested have a positive net acid producing potential (i.e. considered to be acid generating material) and only 35% of the samples tested exhibit acid neutralising capacity potential (Chapter 3, page 3-110). Furthermore, a significant amount of clay and NAF spoil material will also be required to construct the waste rock dumps (refer below to 'Issue: Volume 2, Section 4.4.2.6 Spoil – Construction' about the volume of materials required for waste rock dump design).

The following is recommended to be undertaken:

1. Outline the anticipated volume of NAF spoil and clay required to construct the flood protection levees, visual amenity bunds and regulated dams
2. Outline any potential deficit of suitable NAF spoil and clay materials from the surface of the open-cut pit, with reference to the findings of the waste rock characterisation assessment in Appendix 12
3. If there is a deficit of NAF spoil and clay materials from the surface of the open-cut pit, discuss any readily available alternative sources of suitable construction materials.

Response:

Firstly, it should be noted that there are no major flood protection levees required to be constructed for the Project site. There are a number of small diversion bunds to prevent overland flow from heavy rainfall inundating the opencut pit and MIA. The opencut pit and MIA will be unaffected by flooding in Taroborah Creek.

The results indeed indicate that 65% of samples tested have a positive NAPP, but this is not a true measure of the examined material's acid forming potential, as the samples are not representative of material volumes. Taking all of the various determined characteristics of the overburden material into account, including the proportionate length of drill hole represented by the various samples, EGi (Appendix 12) state in their Executive Summary that two-thirds of the overburden material is NAF and in the table in Section 5.11 on page 17 that 65% of overburden/interburden material can be classified as NAF.

IMC has undertaken modelling of the overburden material in the opencut pit that suggests that 56% of overburden/interburden material is NAF and 43% is PAF. The estimate is provided in Table 3.24, page 3-106 of the Draft EIS.

More detailed overburden modelling has recently been undertaken to identify the amount of clay and basalt material within the NAF total available in the initial opencut strips, and also the amount of material required for construction of the two water storage dams, the rail loop and the overland flow diversion bunds. The visual amenity bund requirements

have been determined previously as 1.09Mbcm of NAF and are already factored into the dumping design and schedule.

The material balance results for the design of the dams, rail loop and overland flow protection bunds are presented below. In undertaking this balance, it has been determined from examination of relevant exploration hole logs and the soil sampling descriptions that the immediate subsoil material in the area of the dams and rail loop is clay and highly weathered claystone, which is expected to provide for a suitably impermeable base for the dams once compacted, and also be suitable for construction of the dam embankments. Thus, as indicated below, there is more than sufficient excavated material between the two dams (excavated to a depth of 2m below the topographic surface to provide capacity) and the rail loop cut (to maintain negotiable grades for trains around the loop) to construct all necessary dam embankments and the diversion bunds. There is also ample NAF material in the initial opencut pit strips (see Section 5.17 below) should this material prove unsuitable for the bulk of the dam embankment construction.

The necessary armour material for the dam embankments will be sourced from either the more competent basalt or NAF sandstone material in the initial opencut excavations or from Shenhuo's proposed limestone quarry immediately south of Taroborah (EPM17924).

Material Type	**CPPWRD** Volume (m^3)	**MWD** Volume (m^3)	**Rail Loop Cut/Fill** Volume (m^3)	**Overland Flow Protection Bund** Volume (m^3)
Dam capacity	832,000	1,077,000		
Topsoil removal estimate	75,900	112,300	10,400	5,000
Clay material excavated during construction (to 2m depth)	148,700	274,800	42,200	
Clay material required to line the inner wall of the dam	5,400	3,800		
Armour material required to line the inner wall of the dam	6,400	5,000		
Embankment NAF/clay Material Required	280,600	140,200	6,810	2,625
Balance of NAF material required to clay material available	126,500	-138,400	-35,390	2,625

EIS Amendment:

Third to last paragraph in Section 3.2.7 amended to read as follows:

"The construction of regulated dams will coincide with the construction of the CPP and MIA and extend throughout the 12 months of the construction phase. Material volumes estimated from design of these structures indicates that ample construction materials can be sourced from excavation of the dam footprints themselves (clays to 2m depth) as well as cut material from the rail loop and the initial opencut surface in the form of NAF spoil and clays."

Section 3.2.8 amended to read as follows:

"Earthen bunds will be constructed along the perimeter boundary of mine associated infrastructure, diverting clean rainfall run-off water from the natural catchment to tributaries associated with

Taroborah Creek. Additionally, earthen bunds will be constructed around the perimeter of the opencut pit to protect against overland flow generated from heavy rainfall potentially flooding the opencut pit. These structures are considered pit protection bunds rather than clean water diversion drains as they do not normally receive water from the upstream catchment.

Three overland flow protection bunds will be required during the initial stages of opencut production, two protecting the northern and eastern perimeter of the opencut pit and one west of the MIA. It should be noted that flooding within the main channel of Taroborah Creek has been considered in the placement of the opencut pit and MIA such that flows from a 1 in 1000 year rainfall event will not inundate any of this infrastructure based on the existing topography. Therefore, no protection bunds or flood levies along Taroborah Creek have been considered in the design.

A hydrological model was developed to estimate peak flows and hydrographs for the drainage lines in the Taroborah Creek catchment and rainfall intensity data was used to calculate the design storms to size water diversion infrastructure. Overland flow protection bunds will be constructed to a nominal height of 0.5 m and will be designed to accommodate a 1 in 1,000 year peak flow event to protect the opencut pit and MIA from local flow inundation.

The construction of the overland flow protection bunds will take place during the initial construction phase and opencut pit development. Similar to the construction of regulated dams, sufficient material can be sourced from the rail loop cut material and the initial opencut surface in the form of NAF spoil and clays, and construction will require the use of various size dozers, front end loaders and excavators etc."

Section 3.2.9 amended to read as follows:

"A vegetated visual-amenity bund will be developed along the southern side of the rail line and Capricorn Highway within the first year of opencut mining (by end of 2018). This bund will be constructed from NAF spoil material excavated from the initial opencut pit with the aim of reducing the visual impacts of mine infrastructure upon users of both the rail line and highway (refer to Figure 3.7 for location details of this bund). Upon construction, the bund will be vegetated with native grasses and tree species to enhance the visual character of the structure and provide for long term stability and sustainability."

4.3 Section 3.5.2, Page 3-73 – Energy Supply and Safety during Construction

Submitter:

Ergon Energy

Submission:

The material submitted suggests that relocation of existing electricity infrastructure may be required as part of the project. Any changes to Ergon Energy infrastructure required as part of the proposal will require Ergon Energy's consent and be undertaken at the proponent's expense (unless otherwise agreed to by Ergon Energy). Any redesign of Ergon Energy infrastructure required as a result of the proposal must take into consideration servicing and maintenance access requirements for Ergon Energy personnel and equipment. Where fencing prohibits access to and along infrastructure, gates must be supplied and installed at the proponent's expense.

Ergon Energy must be contacted for safety advice prior to work commencing within close proximity of Ergon Energy infrastructure. The following legislation and code should be consulted for working in the vicinity of electricity infrastructure:

- Electrical Safety Act 2002
- Electrical Safety Regulation 2013

- Code of Practice - Working near Exposed Live Parts

Response:

The Proponent does not see how the material submitted suggests that relocation of existing electricity infrastructure may be required, but acknowledges that any changes to existing Ergon infrastructure required by the Project will require Ergon's consent and be at the Proponent's expense.

Further, the Proponent acknowledges the need to contact Ergon for safety advice prior to work commencing and this contact shall be instigated at the appropriate time.

EIS Amendment:

None required

4.4 Section 3.5.2, Page 3-73 & Appendix 2 – Energy Supply and Regulatory Approvals

Submitter:

Department of Energy and Water Supply

Submission:

The draft EIS describes the plan to construct a 66 kilovolt (kV) electricity supply line, 22 kilometres in length, from Ergon Energy's Emerald substation to a 66/11kV substation to be constructed at the mine site. The draft EIS states that the route of this line is yet to be finalised.

An application for a special approval under Section 209 of the *Electricity Act 1994* will need to be submitted to the Department of Energy and Water Supply, should the line's finalised route traverse property not owned by the operator of the line.

Further, Section 227 of the *Electricity Act 1994* requires that- "a person, other than an electricity entity or special approval holder, must not operate an electricity line beyond the person's property other than under a regulation".

Response:

The requirements for approvals of the Project's electricity supply are acknowledged and appropriate wording and reference will be included in the final EIS document.

It should be noted that the Proponent does not intend to operate the electrical power supply line outside the boundaries of the Project site.

EIS Amendment:

First paragraph of Section 3.5.2 amended to read as follows:

"During construction, an approximate 22 km long 66 kV electricity supply line from the Emerald sub-station to the Project site will be constructed. The route for this power line has not been finalised, but will likely run in close proximity to the Capricorn Highway. Should the final route not coincide with state owned property, then an application for a special approval under Section 209 of the Electricity Act 1994 will be submitted to the Department of Energy and Water Supply for consideration."

4.5 Section 3.5.3.4, Page 3-80 – Surface Water Management

Submitter:

Department of Environment and Heritage Protection

Submission:

Figure 3.33 does not show the location of sediment dam 7 and the visual amenity bunds and flood protection levees have not been labelled.

Response:

Figure 3.33 will be amended as recommended for the final EIS document. Note, there are no major levees that need to be constructed for flood protection of the Project site.

EIS Amendment:

Figure 3.33 amended to include labeling of the visual amenity bund and sediment dam 7.

4.6 Section 3.5.4, Page 3-81 – Surface Water Management

Submitter:

Department of Transport and Main Roads

Submission:

This section discusses diversion of storm water in proximity to the project site and near public roads.

Further information about changes to storm water generation near public roads as a result of the project should be provided, including assessing potential impacts and proposing mitigation strategies.

Response:

There should be no changes to storm water generation in relation to public roads as the diversions occur 2m downdip of the highway and do not interfere with Wilga Downs road.

EIS Amendment:

The following paragraph has been added to the Opencut Area sub-heading of Section 3.5.4.

"It should be noted that the main clean water overland flow diversion system incorporated as part of the visual amenity bund running parallel to the highway/railway line corridor is located approximately 50m to the south and 2m downhill of the railway line. Given the small catchment area (~344ha) that would report to this bund, and its being designed to handle a 1 in 1000 year peak flow event, there is a very low probability of impact to the transport corridor from storm waters due to this structure."

4.7 Section 3.5.5, Page 3-83 – Sewage

Submitter:

Department of Environment and Heritage Protection

Submission:

This section proposes to treat sewage effluent to a Class A standard and irrigate it onto 2.5ha of land set aside for irrigation. The hydraulic and nutrient loading characteristics of the proposed 2.5ha effluent irrigation area will need to be assessed using the Model for Effluent Disposal using Land Irrigation (MEDLI).

Response:

MEDLI modelling has recently been undertaken to assess the performance and potential environmental impact of the proposed 2.5ha effluent irrigation area and the final design and MEDLI input and output files are provided in the final EIS document as Appendix 27 and as Attachment A to this document.

EIS Amendment:

Fourth paragraph of Section 3.5.5 has been amended to read as follows:

"Since an underground mains sewerage system is not available locally, it is proposed that treated effluent from the STP is spray irrigated over a section of the Project site (2.5 ha in area) that has been assigned for this purpose, which is not located near drainage lines, surface water or human habitation (refer to Figure 3.35 for location details of the STP and associated spray irrigation area). MEDLI modelling analysis of the soil in this area is presented in Appendix 27 and indicates that the area of land required to irrigate the site's treated water is 0.9 ha. This corresponds to an average irrigation rate of 2.6 mm/d, which has been deemed as sustainable, with no detriment to the environment in relation to hydraulic, nutrient or salinity loadings."

First paragraph of Section 4.4.2.5 has been amended to read as follows:

"Sewage will be treated by an on-site sewage treatment plant (STP) and spray irrigated to a segregated section of the Project site. Sewage effluent will be maintained within quality parameters to reduce the risk of surface and groundwater contamination. MEDLI modelling analysis of the proposed irrigation site is presented in Appendix 27, and the results indicate that the area of land required to irrigate the site's treated water is 0.9 ha. This corresponds to an average irrigation rate of 2.6 mm/d, which has been deemed as sustainable, with no detriment to the environment in relation to hydraulic, nutrient or salinity loadings."

4.8 Section 3.6.3.1, Page 3-99 and Section 3.6.3.2, Page 3-101– Volume of Excavated Waste Spoil Disposal

Submitter:

Department of Environment and Heritage Protection

Submission:

According to Section 3.6.3.1 the overburden and interburden waste is expected to swell by a factor of 25% following excavation. However, the typical spoil dump design parameters in Table 3.23 on page 3-101 have been calculated based on a swell factor of 20%. The discrepancy in the swell factor could significantly alter the height and footprint of the waste rock dumps with implications on successful rehabilitation and final landform design, including potential long-term flooding impacts on waste rock dump erosion and stability.

Further information (including supporting references) about the anticipated swell factor of excavated spoil material and any implications on waste rock dump design and long-term erosion potential and stability needs to be provided.

Response:

The 20% swell in Table 3.23 is a misprint, and should be 25%. This will be corrected in the final EIS document.

A swell factor of 25% has been chosen based on the nature of the in situ material, which is predominantly clays, sands and weathered claystone, and will be able to be free dug, particularly in the initial years. Typically, this material will have a swell factor of around 17-20%. For the more competent fresh sandstone material that requires blasting, a swell factor of 30-35% is more typical, with the swell percentage based on the strength of the in situ rock and the powder factor used in blasting, which determines the ultimate fragmentation of the rock. For Taroborah, the sandstone material has a weak to moderate strength of around 20MPa, so should fragment fairly well with the powder factors proposed (0.35kg/bcm).

Therefore, based on the overall ratio of NAF to PAF material in the overburden of 56:44, which roughly correlates to the ratio of weathered to fresh material, an overall average

swell factor of 25% is considered appropriate, and may be conservative for the out-of-pit spoil dumps, which will have a higher percentage of weathered material.

As for the dump design and long term stability and erosion potential, the overall slope angle of 30 degrees is considered appropriate for the material involved, with an estimated slope stability factor of safety of 1.24 and adequate benching to control erosion prior to final shaping and revegetation.

As a comparison, a research paper completed by a University of Southern Queensland student indicates that the measured swell factor for the blasted only overburden at the Callide Mine, with blasted overburden that is predominately (95%) moderate strength sandstone and siltstone (16-20MPa material), ranged from 11-17% for a typical powder factor of 0.5kg/bcm (Heit, 2011).

EIS Amendment:

Stated swell factor in Table 3.23 corrected to read 25%.

4.9 Section 3.6.3.3, Page 3-102 – Spoil Dump Decommissioning

Submitter:

Department of Natural Resources and Mines

Submission:

The decommissioning process described in this section refers to the use of several types of extractive materials such as gravel and clay but does not mention the source/s of this material, estimates of the quantities required, or the effects project demands will have on regional reserves of this material.

Response:

A definitive estimate of the required quantities of these materials cannot be made at this time as final design has not been completed. However, preliminary estimates have been recently undertaken and are presented here.

The preliminary design parameters for the out-of-pit spoil dumps are as follows:

- A Gravel basal layer unit that is 0.5m in thickness at the base of the out of pit waste dump, followed by;
- A Clay unit that is 0.3m in thickness, followed by;
- A Gravel unit that is 0.5m, followed by;
- A Boulder unit that is 0.5m in thickness, followed by;
- A Limestone unit that is 0.5m in thickness, that will form the base of an encapsulation cell around the PAF material;
- Topsoil emplaced on the final landform of the out of pit waste dumps to a depth of 0.4m, underlain by;
- A Gravel unit that is 1m in thickness to assist with drainage of rainwater infiltrates the topsoil, underlain by;
- A Clay unit that is 0.4m in thickness that seals the out of pit waste dump, underlain by;
- A NAF unit that is at least 20m in thickness between the clay unit near the surface of the final land form design and the Limestone unit that encapsulates the PAF material.

The NAF unit will be at least 50m in thickness internally from the flitches and berms that form the final landform design of the out of pit waste dump;

- The Limestone unit underlies the NAF unit and encapsulates the PAF material with a unit thickness of 0.5m.

Using the above design parameters and the preliminary out-of-pit spoil design shapes required to contain the mined material that needs to be disposed of out-of-pit, the following table provides the "design" quantities of material required.

Out of Pit Dump Reference	Dump Design Volume (lcm)	Enclosed PAF Esimate - Volume (lcm)	Limestone - Volume (lcm)	Gravel within the Basal layers - Volume (lcm)	Clay within the Basal layers - Volume (lcm)	Boulders within the Basal layers - Volume (lcm)	Top Soil spread over the final landform - Volume (lcm)	Gravel below the surface of the final landform - Volume (lcm)	Clay below the surface of the final landform - Volume (lcm)	Remaining NAF Estimate - Volume (lcm)
SE dump	12,676,000	5,450,000	350,800	328,800	99,200	326,300	116,700	291,750	116,700	5,595,750
SW dump	5,385,200	2,137,200	87,400	168,000	56,000	167,900	77,800	194,500	77,800	2,418,600
NW dump	12,337,200	5,816,900	177,200	282,200	84,700	228,200	130,300	325,900	130,300	5,161,500
Totals	30,398,400	13,404,100	615,400	779,000	239,900	722,400	324,800	812,150	324,800	13,175,850

Based on geological modelling of the overburden material as indicated from relevant exploration boreholes, the following table presents the estimate of materials that are scheduled to be extracted and disposed of out-of pit in the first two and one-half years.

Open Pit Strip	PAF Volume (lcm)	Basalt Volume (lcm)	Tertiary Clay Volume (lcm)	Remaining NAF Volume (lcm)	Topsoil Volume (lcm)	Rejects Volume (lcm)	Total Volume (lcm)
R1_11*	3,367,586	597,267	618,701	4,015,769	135,483	60,258	8,795,064
R2_1	1,911,206	1,635	524,090	3,815,788	75,551	39,112	6,367,382
R3_1	813,154	-	646,736	2,215,012	75,438	17,012	3,767,352
R1_12	-	378,226	445,387	3,697,331	43,124	-	4,564,069
R2_2	-	2,883	306,149	2,047,652	50,673	39,106	2,446,463
R3_2	-	-	619,157	1,532,933	36,111	-	2,188,201
Totals	6,091,946	980,012	3,160,221	17,324,485	416,380	155,488	28,128,532

* Excludes the 1.89Mm3 of NAF waste that will be used to construct the visual amenity bund.

As indicated above, with the exception of the limestone layer in the base of the dump and the gravel layer that forms part of the capping, it is expected that the required volumes of clay and gravel (crushed basalt) material are available within the overburden to be excavated during initial mining operations. The required volume of limestone is available from the Proponent's adjoining limestone tenement (EPM 17924) to the south, while the gravel capping is available from basalt material in Strips R1_13 and R1_14 and can be placed during Year 3 and Year 4 of mining operations.

EIS Amendment:

The last two paragraphs of Section 3.6.3.3 are amended to read as follows:

"Based on the overburden geology, all of the necessary base and capping materials for the spoil dumps are expected to be available within the planned opencut excavation areas or in an adjacent mineral lease controlled by Shenhuo.

Spoil dump design and rehabilitation strategies applied to the spoil dumps are described further in Section 3.6.4 and Section 3.7, respectively"

4.10 Section 3.6.5, Page 3-121 – Solid Waste Disposal

Submitter:

Department of Environment and Heritage Protection

Submission:

The only licensed facility able to accept the wastes described in Section 3.6.5 is the Emerald

landfill operated by the Central Highlands Regional Council (CHRC). However, no information could be found about whether or not CHRC has been consulted about the expected project wastes proposed to be transported to the Emerald landfill, and whether the landfill has adequate capacity to accept project wastes for the life of the mine.

Details about the consultation undertaken with CHRC as to the projected waste volumes that would be generated by the project and the capacity of the Emerald landfill to accept the waste during the life of the project needs to be provided. If the CHRC is unable to accept the wastes generated by the project, discuss alternative disposal options, such as alternative locations or an on-site waste disposal facility.

Note: If an on-site landfill will be required, design and siting will need to be done in consultation with EHP.

Response:

The Proponent has discussed general waste disposal with CHRC's Mark Giebel (see Section 5.14 below). There is concern that the general waste volumes from the Project during construction and operations on an annual basis will be more than estimated, and additional landfill capacity may need to be permitted by council. The Proponent is mindful of this potential requirement and will work with the CHRC to arrive at a mutually beneficial solution, including the possibility of disposing the waste on site within the opencut.

EIS Amendment:

Tables 3.20, 3.21 and 4.32 have been amended to include additional annual volumes for scrap metal and general waste streams. Please see amended Table 4.32 included in the response in Section 5.14 of this document.

The following sentence has been added to the first paragraph in Section 3.6.5.1:

"Should commercial disposal facilities be inadequate or require upgrade, disposal on site may be considered as an alternative if deemed more beneficial to both parties."

4.11 Section 3.6.6.5, Page 3-124 & Section 4.5.2 and Appendix 13 – Water Balance – Release of Excess Water

Submitter:

Department of Natural Resources and Mines

Submission:

The EIS outlines the release of water directly into the irrigation channel downstream of the Fairbairn Dam that is located approximately 14 km east of the mine site as an option for beneficial use of the expected excess water make from the mining operations. The Proponent should clarify the proposed release location and the piping and pumping infrastructure necessary to transfer the water from the mine site to this location, and further, note that if this location is considered to be a watercourse as defined under the Water Act 2000, any additional take of water from this location may have to be authorised.

Response:

An appropriate illustration and description of the proposed pipeline route and pumping infrastructure will be included in the final EIS document as indicated below. With regard to the additional requirements that may be required for the taking of water from the proposed release location, the Proponent notes these requirements and also states that there is absolutely no intention of ever taking water from the irrigation channel such that the requirement for authorisation of this take will not be necessary.

EIS Amendment:

The following paragraph and figure have been inserted in Section 3.6.6.5 of the EIS main bady report.

"Two options for beneficial use are being considered. The first option would be to release the excess water directly into the irrigation channel downstream of the Fairbairn Dam that is located approximately 15.5 km east of the mine site. This would be accomplished via installation of a pumping station at the mine site and a pipeline run along the upgraded Central West Railway line as indicated in Figure 3.45. Preliminary design calculations indicate a 100 kW pump combined with a 250mm diameter pipeline would be capable of handling up to 5 ML/day of water along the proposed route."

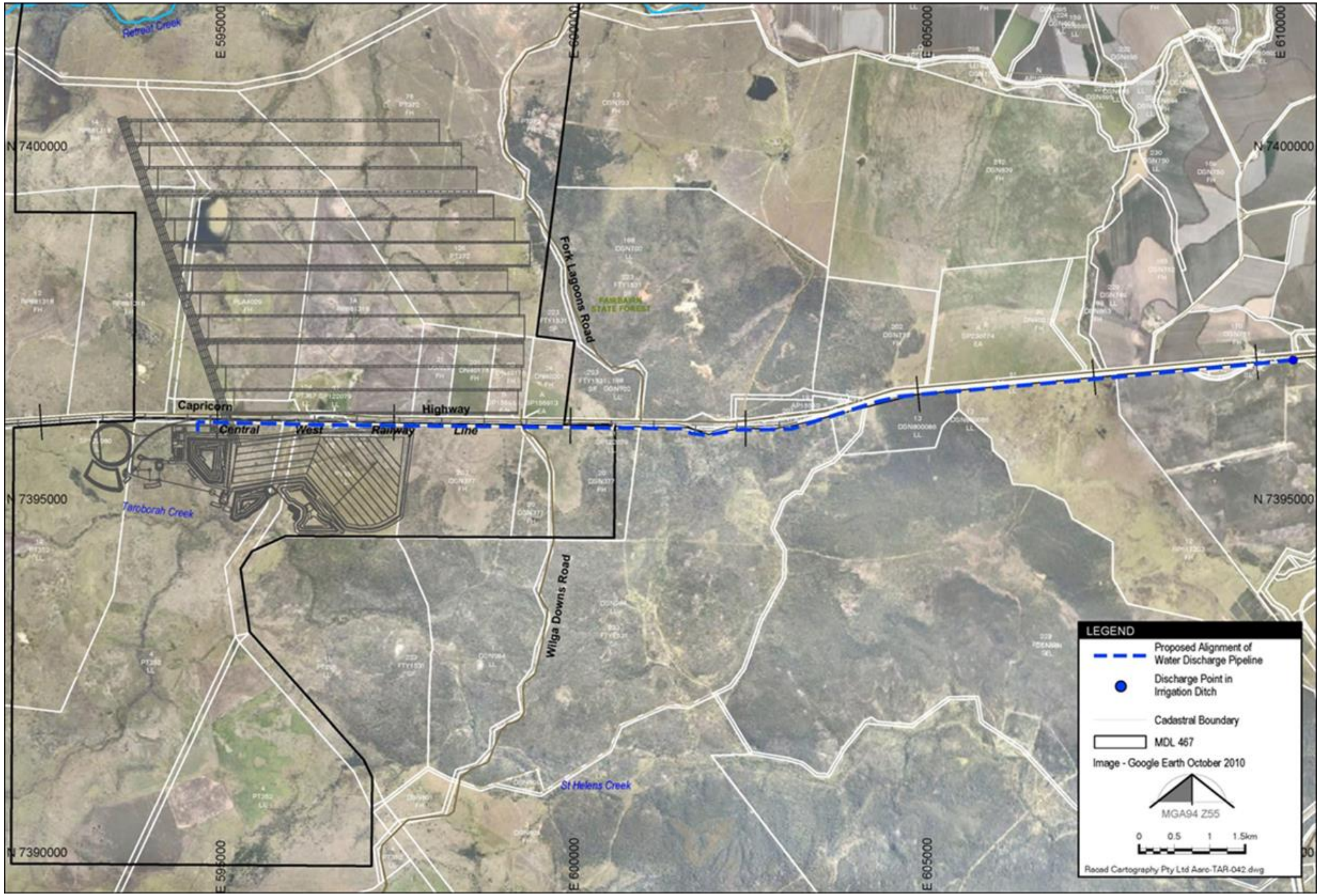


Figure 3.45 Proposed Excess Water Discharge System

4.12 Section 3.6.6.5, Page 3-124 & Section 4.5.2 and Appendix 13 – Water Balance – Release of Excess Water for Beneficial Use

Submitter:

SunWater

Submission:

SunWater has noted the proponent's beneficial use options for dealing with excess water. SunWater requests that these options be planned so as to minimise any adverse impacts on water quality in the receiving waters which have the potential to impact urban, industrial and agricultural customers.

Response:

This is acknowledged by the Proponent and as stated in the Draft EIS (Appendix 13, Section 5.7.2.1), water quality in the MWD, from which the excess water would be released, will be regularly monitored and treated if necessary prior to release to ensure suitable quality for the intended purpose (i.e. irrigation or industrial use). The planned release of water is discussed more fully in Section 4.11 of this document above.

EIS Amendment:

See response for Section 4.11 of this document above.

4.13 Section 3.7.7, Page 3-139 – Rehabilitation Methodology

Submitter:

Department of Environment and Heritage Protection

Submission:

Information about the proposed rehabilitation methodology is incomplete with regard to the source of the native species proposed to be used for rehabilitation, the staging of progressive rehabilitation and the anticipated financial cost.

The following information about the proposed rehabilitation strategy needs to be provided:

- details regarding the anticipated sources of native species and/or seed stock listed in Table 3.36 that are proposed to be used for rehabilitation
- the timing of implementing the rehabilitation methods having regard to the proposed mine plan
- the anticipated costs of implementing the rehabilitation methods to achieve the proposed final landform design.

Response:

The potential sources of native species have been identified through consultation with Cole Smith, who collects seeds for several native rehabilitation suppliers. Contact details of two potential suppliers of native rehabilitation species who already supply mine sites in Central Queensland are provided in the following table.

Name	Phone Number	Comment
Cole Smith	49741105	Collects seeds for several native rehab suppliers
Global Hardwood Plantations	49971072 or 49973304	Contact James Nile. Located in Moura Qld
Austrahort	38210745	Seed merchants – have a contract to supply Anglo Coal. Located in Brisbane Qld.

The native rehabilitation species required are as detailed in Table 3.36 in the EIS. The regional ecosystems to which these species belong are provided in the following table, which is included as Table 3.37 in the final EIS document.

Table 3.37 - Regional Ecosystem Suitability of Rehabilitation Species

Scientific Name	Common Name	Regional Ecosystem									
		11.3.3a	11.3.6	11.3.25	11.3.27h	11.4.8	11.4.9	11.5.3	11.9.1	11.9.10	11.10.3
Dichanthium sericeum	Queensland Bluegrass			x					x		
Themeda triandra	Kangaroo Grass	x				x		x			
Bothriochloa decipiens	Pitted Bluegrass			x		x				x	
Chloris truncata	Windmill Grass		x			x	x	x	x	x	x
Cymbopogon refractus	Barbed Wire Grass					x					
Heteropogon contortus	Black Speargrass		x				x	x	x		
Panicum decompositum	Native Millet		x	x	x						
Leptochloa digitata	Umbrella Canegrass	x		x							
Lomandra longifolia	Long-leaved Mat-rush	x	x	x							
Carissa ovata	Currant Bush		x	x		x	x	x	x	x	
Lysiphyllum hookeri	Queensland Ebony	x	x	x			x	x			
Terminalia oblongata subsp. *oblongata*	Yellowwood	x					x	x	x		
Diospyros humilis	Small-leaved Ebony			x							
Acacia holosericea	Soap Bush		x								
Eremophila mitchellii	False Sandalwood					x	x	x	x	x	
Melaleuca bracteata	Black Teatree	x	x	x							
Grevillea striata	Beefwood							x			x
Casuarina cristata	Belah			x			x			x	
Acacia harpophylla	Brigalow					x	x		x	x	
Acacia salicina	Native Willow			x							
Corymbia	Pink										x

Scientific Name	Common Name	Regional Ecosystem									
		11.3.3a	11.3.6	11.3.25	11.3.27h	11.4.8	11.4.9	11.5.3	11.9.1	11.9.10	11.10.3
intermedia	Bloodwood										
Eucalyptus cambageana	Blackbutt			x		x		x	x		x
Eucalyptus melanophloia	Silver-leaved Ironbark		x					x	x		
Eucalyptus populnea	Poplar Box	x	x					x		x	
Eucalyptus tereticornis	Forest Red Gum		x	x							
Alphitonia excelsa	Red Ash		x						x		x

As stated several times in the rehabilitation section of the report, rehabilitation will be completed as soon as practical, with rehab of the out-of-pit spoil dumps commencing in Year 2 and complete by Year 4, and the in-pit spoil rehab progressing once the final lift of waste is placed. This progression is more fully illustrated in the amended Figures 3.17 – 3.20 that are reproduced below and will replace the previous versions in the final EIS document.

The Proponent does not see the relevance of including the estimated rehabilitation costs in the EIS document, but the following rehabilitation costs are included in the Project financial analysis.

- General reshaping of spoil dumps included in the mine equipment operating and labour costs.
- Allowance for topsoil spreading, re-vegetation, seeding and maintenance included at $10,000/ha.

EIS Amendment:

As mentioned, the above Table 3.37 has been added to Section 3.7.7.1 of the final EIS document. And the following amended Figures 3.17 – 3.20 replace the previous versions in the final EIS document.

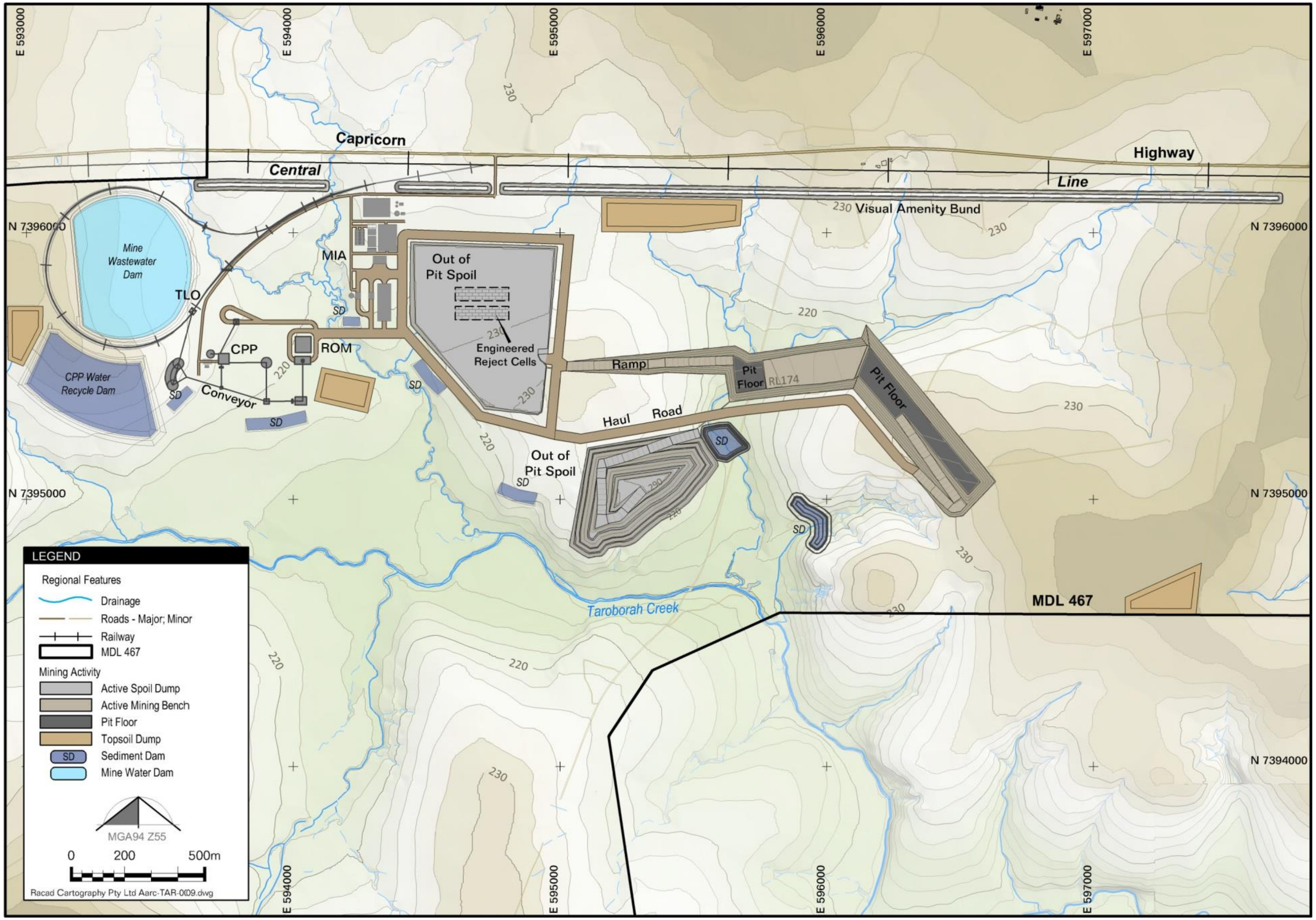


Figure 3.17 Mine Stage Plan – Year 1

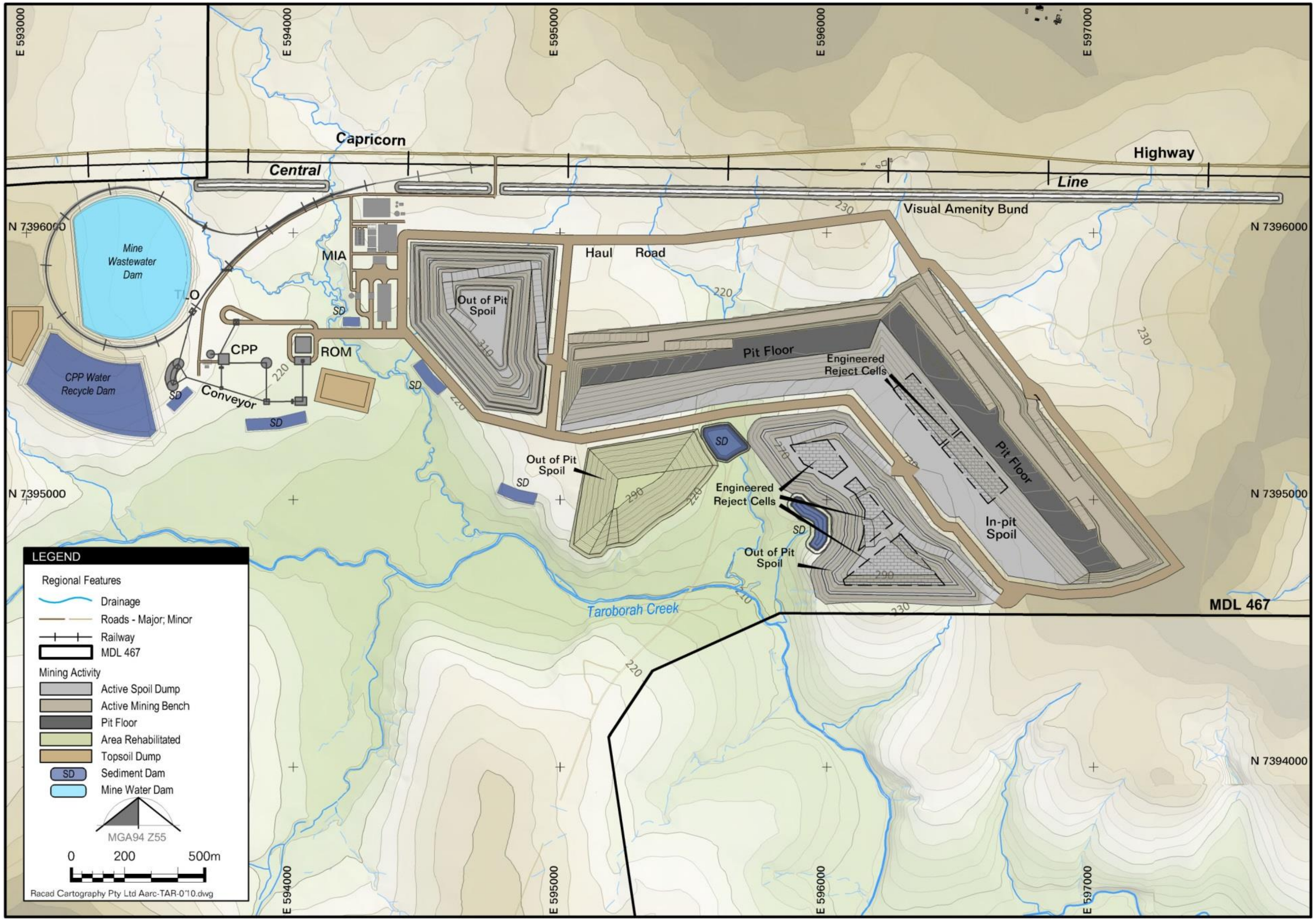


Figure 3.18 Mine Stage Plan – Year 3

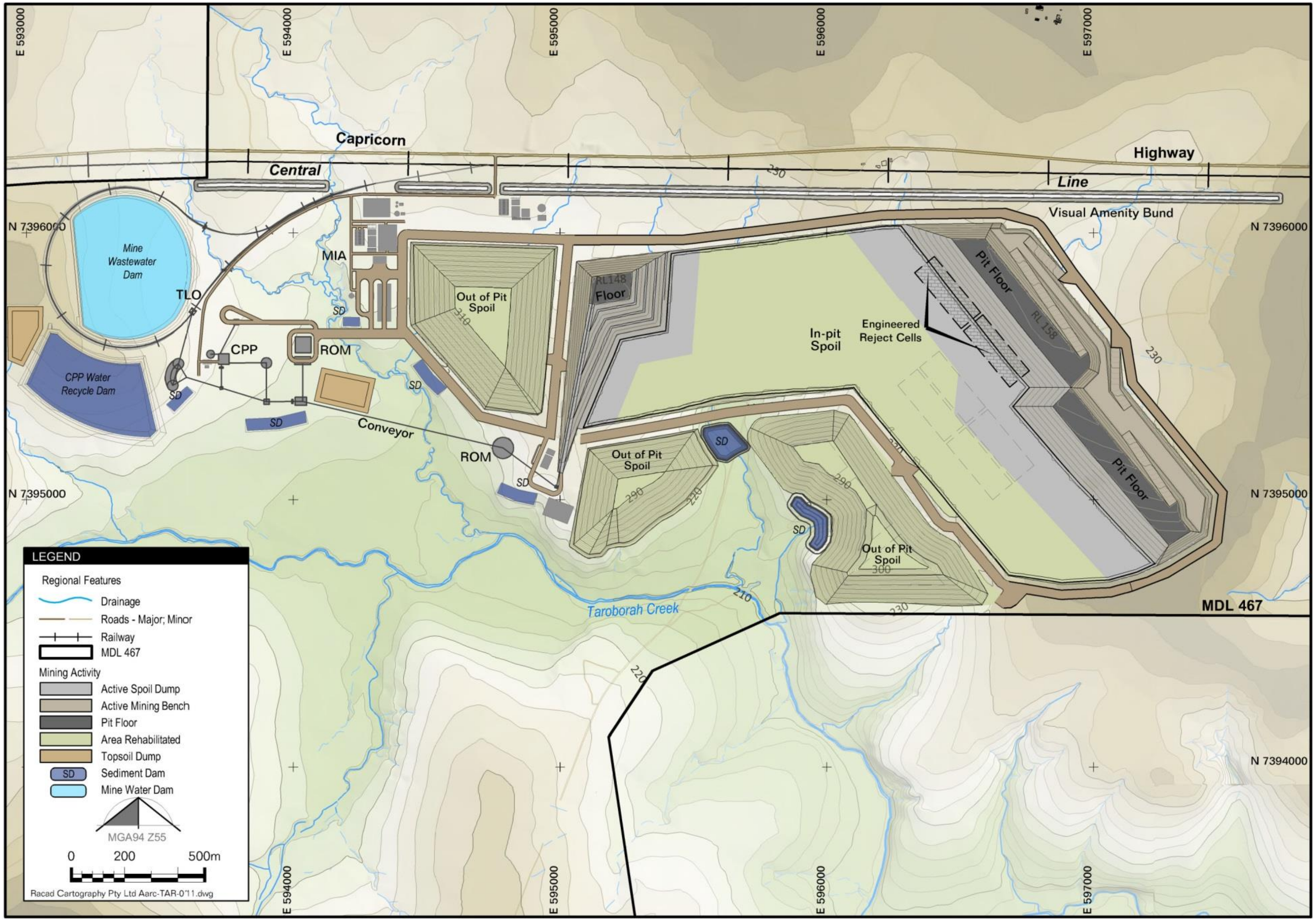


Figure 3.19 Mine Stage Plan – Year 5

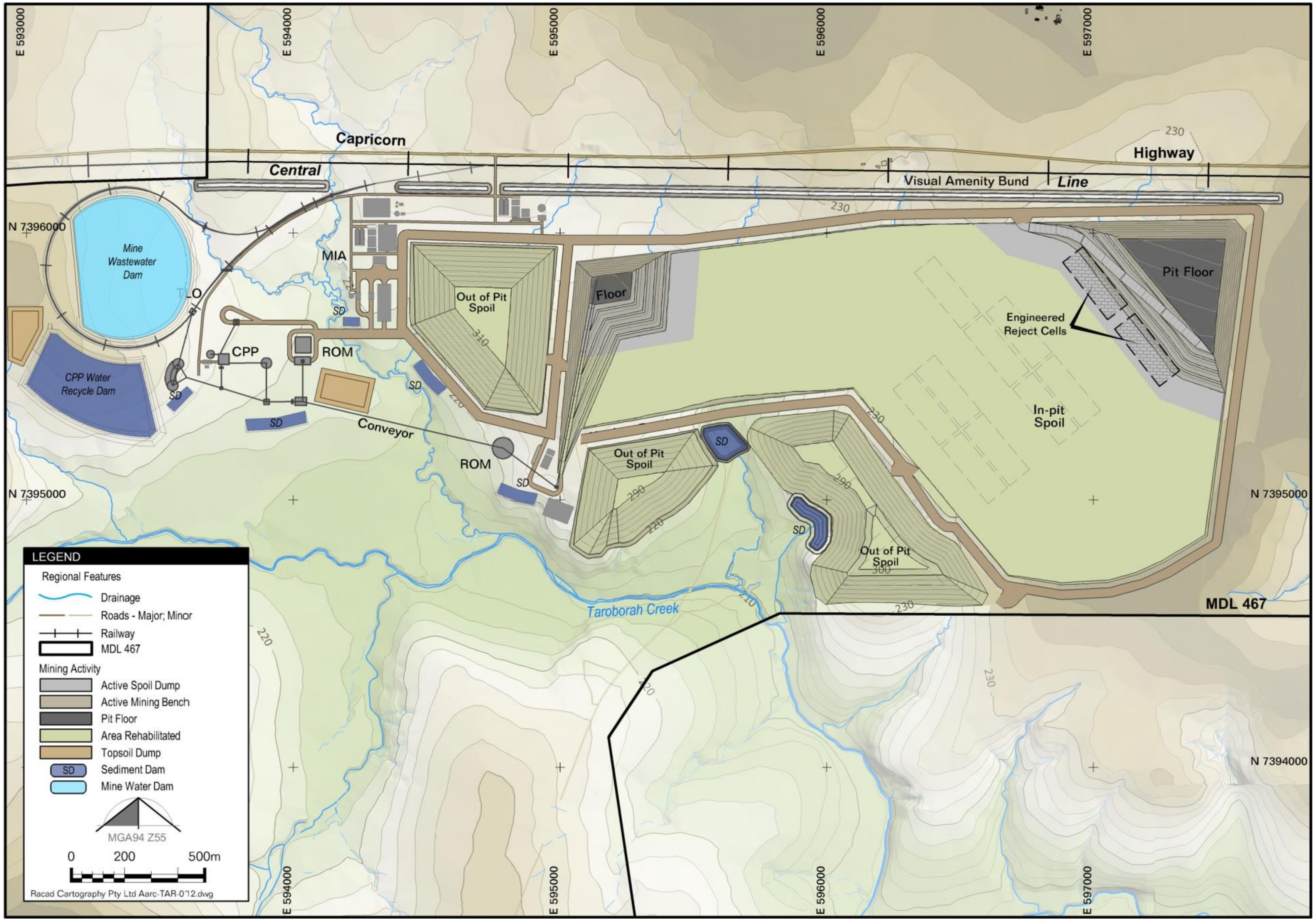


Figure 3.20 Mine Stage Plan – Year 7

5. SECTION 4 – ENVIRONMENTAL VALUES AND MANAGEMENT OF IMPACTS

5.1 Section 4.2.1.8, Page 4-76 – Infrastructure

Submitter:

Department of Natural Resources and Mines

Submission:

Figure 4.36 on page 4-78 shows the location of LW8 and LW9 below an existing storage that captures overland flow. The subsidence of existing storages that take overland flow cannot facilitate the take of a larger volume of water.

Response:

Given the location of the dam wall, the subsidence modelling shows that the area of the wall where the overflow outlet is located will experience maximum subsidence compared to the rest of the captured water area, and therefore, dam capacity will likely not increase as a result of subsidence.

EIS Amendment:

None required.

5.2 Section 4.2.2.3, Page 4-89 – Subsidence

Submitter:

Department of Natural Resources and Mines

Submission:

The EIS does not outline sources of water supply (such as farm dams) potentially affected by the project, (Section 4.5.1 of the Terms of Reference for the project).

Response:

There are two main water supplies that will be affected by the Project. One is the underground aquifers, which are addressed in Section 4.5 and Appendix 14 of the EIS. The other source of water supply is rainfall run-off, which is addressed in Section 4.5 and Appendix 13. What is not specifically addressed is the various landholder surface water catchment facilities that serve as a water supply to livestock. There are six small (<25ML) pastoral dams that will be impacted by subsidence from underground mining as well as the large dam/wetland in the central west portion of the Project area.

Regarding the smaller dam structures, some will be impacted positively (increased capacity) and some negatively (reduced capacity) by subsidence. However, as the level of subsidence is slight (<2m overall and ~1m differential), it is expected that any structures that are negatively impacted can be returned to pre-mining capacity with minimal effort. As discussed in Section 5.1 above, impact on the large dam/wetland is not expected to increase the capacity of the dam due to maximum subsidence of the outlet area. On the other hand, with the lake behind the dam spanning two longwall panels when full, and differential subsidence of only 0.7m, there should not be a significant decrease in capacity either, with the decreased capacity along the humps balanced by increased capacity in the troughs.

As part of the Subsidence Management Plan for the Project, the Proponent will outline all

sources of water supply potentially affected by subsidence from the project, including farm dams, and monitor these as mining progresses to identify any repairs to overland flow storages due to these impacts. Should repairs be indicated to be required, these would be carried out in accordance with the Water Resource (Fitzroy Basin) Plan 2011, or any subsequent legislation requirements in effect at the time of repairs. Further, the Proponent will liaise with DNRM if repairs are required.

EIS Amendment:

None required.

5.3 Section 4.2.2.8, Page 4-110 – Visual Amenity

Submitter:

Department of Environment and Heritage Protection (EHP)

Submission:

An earthen visual amenity bund is proposed to remain as part of the final landform design to provide a visual buffer between the Capricorn Highway and the final voids. However, retaining the bund is inconsistent with the rehabilitation goals for mine infrastructure (including visual amenity bunds) listed in Table 3.3.4, which include, amongst others, stable and self-sustaining. Furthermore, no information could be found about consideration of alternative visual amenity methods and why an earthen visual amenity bund was selected as the preferred method.

Recommendations:

1. Discuss the alternative visual amenity options considered for the project and explain the selection of the preferred method.
2. If an earthen visual amenity bund is the preferred method, provide information about the decommissioning and rehabilitation of the bund/s to achieve the rehabilitation goals in Table 3.3.4.

Response:

Options considered for visual screening of the surface works from the Capricorn Highway and the homesteads to the west and north included augmenting the existing trees with additional vegetation or construction of an earthen bund.

In considering the option of creating a vegetation screen, the required time to develop a screen with the necessary density and height to screen the surface infrastructure and the majority of the out-of-pit spoil dumps, as well as prevent light pollution and lessen dust impacts, precluded the use of seedlings or tube stock. And the use of mature trees was not considered feasible or cost effective due to the difficulty in maintaining the trees until they take root and the cost for some 4km of screen at around $5,000 per tree. Discussion with James Nile of Global Hardwoods suggested that mature trees suffer from becoming root bound in their pots and even with significant maintenance the success rate after replanting is probably less than 75%.

Alternatively, an earthen bund can be constructed from the mined spoil at a fraction of the cost and provides immediate screening. As discussed in the EIS, the bund would be shaped with moderate slopes (~30%) and immediately topsoiled and revegetated with grasses, shrubs and tube stock, so as to limit erosion and become self-sustaining in a relatively short time period. Further, it is expected that at the end of the 22-year mine life, the bunds will have developed a mature vegetation cover and be suitable for the pre-mining land use of low intensity cattle grazing, such that removing them and then re-vegetating will do more

harm than good.

EIS Amendment:

None required.

5.4 Section 4.3 – Increased Road Traffic

Submitter:

Queensland Fire and Emergency Services

Submission:

Due to the increased road traffic (both heavy and light vehicles), there is the potential for an increase in road traffic crashes (RTC). Although it is stated that the majority of the workforce will be bus-in bus-out (BIBO) from Emerald to site, there is still a larger volume of other traffic within this area. The QFES provides primary response to any RTC within this area and along the transport corridors. QFES relies on Auxiliary Brigades to attend RTC within this area with Emerald Auxiliary being the primary response and backed up by Capella Auxiliary as the next closest response.

The introduction of a Fatigue Management Plan to assist with the education and management of workers and contractors driving whilst fatigued.

Response:

Acknowledged, and development of a Fatigue Management Plan is already an action item in the Section 6.7 of the Social Impact Management Plan (Appendix 23 of the EIS). Development of a Fatigue Management Plan will also be mentioned in Section 4.3 of the EIS.

EIS Amendment:

First sentence of Section 4.3.2.3m – Driver Fatigue has been amended to read as follows:

"Driver fatigue for HV operators will be managed through a Fatigue Management Plan developed in accordance with the National Heavy Vehicle Regulator's fatigue management guidelines (NHVR, 2013)."

5.5 Section 4.3 and Appendix 11 – Increased Road Traffic

Submitter:

Central Highlands Regional Council

Submission:

The EIS indicates that increased road traffic volumes from the projects are relatively small. However, increased construction traffic through Emerald (Clermont Street) particularly oversize loads and even moderate increases in volumes of operational traffic on highway and through Emerald may have a noticeable impact on residents and businesses.

During construction, gravel is to be hauled on the Anakie – Sapphire Road. The proponent should engage with CHRC prior to construction to assess the need for a Road Infrastructure Agreement to mitigate impacts of increased heavy vehicle traffic.

Response:

As the study indicates, the total increase in traffic volumes along the Capricorn Highway as a result of Project construction is expected to be less than 1%. To put this in perspective, the number of additional heavy vehicles that are expected to travel through Emerald on a

daily basis during peak construction activities is 24 (12 movements each way).

The study estimates of gravel requirements during construction equates to a total of 630 B Double truckloads over a 90 day period, or an average of 7 truckloads per day. The Proponent is certainly willing to discuss the need for a Road Infrastructure Agreement with CHRC if it is deemed this volume (or other volumes that might arise after further design) warrants it.

EIS Amendment:

A final sentence has been added under the Local Road and Pavement Impacts heading of Section 4.3.2.1 of the EIS main body report and Section 5.3.1 of Appendix 11 to read as follows:

"Shenhuo will engage with CHRC prior to construction to assess the need for a Road Infrastructure Agreement to mitigate impacts of increased heavy vehicle traffic."

5.6 Section 4.3 – Increased Road Traffic

Submitter:

Central Highlands Regional Council

Submission:

QFES is the responsible agency in the response to RTC. With the increase of coal trains use and the number of level crossings in and around Emerald, this could have the potential for increased vehicle verses train crashes within the immediate area.

A public information campaign will need to be introduced to make the general public aware of the potential hazards level crossing have and the distances it takes a laden coal train to stop.

Response:

The above is acknowledged by the Proponent and an appropriate advertising campaign will be instigated by the Proponent utilising Radio/Newspaper ads, etc.

EIS Amendment:

None required

5.7 Section 4.3 – Rail and Road Traffic Interactions

Submitter:

Queensland Fire and Emergency Services

Submission:

Delays may be encountered by QFES personnel and appliances at level crossings when attending incidents because of the location of the rail corridor. Other factors which may cause a delay in response are the length of the trains and the speed that may be imposed on them over the river crossing and through the township.

Consideration may be given for widening the road network to alleviate these delays

Response:

Acknowledged, and the Proponent will consider alternatives to widen the road network around the rail crossings when upgrading the railway line.

EIS Amendment:

None required.

5.8 Ref Section 4.3 – Rail and Road Traffic Interactions

Submitter:

Central Highlands Regional Council

Submission:

The introduction of rail traffic (3 trains per day in each direction) through Emerald is addressed in the EIS, specifically:

1. Increased dust levels from coal
2. Safe operation of level crossings at Opal Street and Gregory Hwy to Springsure
3. Upgrade to Nogoa Rail bridge to accommodate 20t axle load and wider wagons

Each of these individually has raised concerns in the community and together pose a considerable amenity issue for residents and businesses in Emerald.

To address these issues, the Proponent is requested to engage with CHRC, DTMR and rail operators to:

1. Establish baseline and ongoing dust monitoring program in Emerald; and
2. Conduct traffic and/or other simulation modelling to assess the duration of road closures and queuing impacts at level crossings on the surrounding road network even though the report indicates that the project conforms to safe operations of the level crossings
3. The design of the Nogoa Rail Bridge upgrade be cognisant of the role the bridge plays in flood events and recent flood mitigation works carried out to reduce this impact

Response:

The Proponent is certainly willing to engage with CHRC, DTMR and rail operators to address these concerns.

With respect to coal dust from the train movements, the Proponent has already committed to employing dust suppression methods on the loaded rail cars in the form of low profiling and veneering of the coal surface in the wagons, and a dust (and noise) monitoring program will be established prior to project construction and continue as part of normal operations.

With respect to train/traffic interaction issues, the Proponent has undertaken the requested traffic modelling, which is included as Attachment B to this response. The results of the modelling indicate that minimal impact to road traffic will be experienced at all three level crossings in Emerald from the passing of the coal trains operating at 40km/hour at all times with the exception of projected future morning and evening peak hour traffic at the Opal Street crossing and at morning peak at Selma road, when moderate delays are expected.

As for the safe operation of the crossings, the introduction of the coal trains will have no impact on the safety of the existing crossings as the trains will be subject to the same operation restrictions as trains currently passing through Emerald, and the ALCAM assessment conducted for the proposed route indicates the crossings are currently safe enough.

With respect to the Nogoa Bridge upgrade, the required upgrades will be able to utilise the

existing basic bridge support structure (pilings and trestles), with only the decking and rail to be modified to accept wider carriages and slightly heavier axel loads. Therefore, the currently available area for waterflow under the bridge will not be altered. Further, the Proponent will investigate the feasibility of further increasing flow area as part of the detailed bridge upgrade design

EIS Amendment:

The rail crossing traffic study is included as Appendix B to Appendix 11 to the final EIS document.

A new sub-heading of *Traffic Assessment* under the **Level Crossing Assessment** heading in Section 4.3.2.6 of the EIS has been added as follows:

"An assessment of the operational impacts associated with the rail transport of coal at the three existing railway crossing locations within the township of Emerald has been undertaken (Appendix B). The following level crossing locations have been considered:

- Level crossing south of the Capricorn Highway / Gregory Highway intersection
- Level crossing south of the Capricorn Highway / Opal Street intersection
- Level crossing south of the Capricorn Highway / Selma Road intersection

Micro-simulation modelling and sensitivity analysis was undertaken in AIMSUN Transport Simulation Modelling software in order to identify any potential significant traffic congestion impacts as a result of the increased rail traffic. Three periods of traffic volumes (morning peak, off-peak and evening peak) were considered for both current road traffic counts and projected (2024) road traffic counts and three train speeds (40km/hour, 50km/hour and 60km/hour)

The results of the simulation indicate that the passing of the coal trains at the slowest 40km/hour speed require 128 seconds to clear a crossing (gates down, train pass, gates up) and result in worst case queues of 23 vehicles (123m) in the morning and evening peak hours at the Opal Street crossing for projected future 2024 traffic volumes, which are inflated from 2014 volumes at 2.5% per annum and considered conservative. Based on this queue length, an average delay of 2 seconds per vehicle passing through the intersection can be expected.

While the queue will not be as long at 12 vehicles (72m), the morning peak at the Selma Road crossing for projected 2024 traffic volumes will also experience moderate impact due to the number of north bound vehicles that turn right onto the Capricorn Highway at this non-signalled intersection.

The maximum queue lengths of 13-14 vehicles (84m) at the Gregory Highway occurs during both peak hours. However, these queue lengths are expected to provide minimal impact due to the low mean queue lengths of 3 vehicles.

For off-peak traffic volumes, all of the crossings show minimal impact from the proposed coal trains, which reinforce the plan to only operate the coal trains through Emerald during off-peak times."

5.9 Section 4.3 – Road Diversions

Submitter:

Queensland Ambulance Service

Submission:

Notification to the Queensland Ambulance Service (QAS) of any diversions, restrictions on road infrastructure that may impact on the delivery of ambulance operations from ambulance locations through road network locations within the project area; this should outline alternative routes to be utilised.

Response:

Acknowledged, and the Proponent will comply when appropriate.

EIS Amendment:

None required

5.10 Section 4.3.1.1, Page 4-129 & Appendix 11– Road Impact Assessment

Submitter:

Department of Natural Resources and Mines

Submission:

This section does not adequately describe the stock routes that will be impacted by the proposal nor does it acknowledge that, under the *Land Protection (Pest and Stock Route Management) Act 2002* (LP Act), the integrity of stock routes must be maintained to ensure the connectivity and useability of the network. It is important for the proponent to acknowledge that current usage classifications of stock routes have no bearing on whether consideration needs to be given to their replacement and or realignment

Response:

Impacted and affected stock routes, namely the route from Lake Maraboon in the south running northward to the Capricorn Highway, will be relocated as part of the design for the final EIS document. The DNRM has been consulted about the proposed relocated route, and will continue to be consulted along with CHRC to ensure the future connectivity and useability of this route.

EIS Amendment:

The following sentence has been added to paragraph has been added to the last paragraph of Section 3.1.1.4 of Appendix 11.

"Never the less, under the Land Protection (Pest and Stock Route Management) Act 2002 (LP Act), the integrity of stock routes must be maintained to ensure the connectivity and useability of the network."

And the following sentence has been added to the end of the Stock Route Network subheading of Section 4.3.1.1 of the EIS main body report.

"While these routes are not utilised currently or in the foreseeable future, under the *Land Protection (Pest and Stock Route Management) Act 2002* (LP Act), the integrity of stock routes must be maintained to ensure the connectivity and useability of the network."

A new heading entitled Stock Routes has been added to Section 4.3.2.1 of the EIS main body report that reads as follows:

"A stock route running northward from Lake Maraboon to the Capricorn Highway will need to be relocated approximately 3km to the west in order to accommodate the planned opencut pit and mine surface infrastructure. A route for the relocation has been proposed by Shenhuo as shown in Figure 4.56. The route has been preliminarily approved by the DNRM's Senior Lands Officer (Stock Routes), and both the DNRM and the CHRC stock route officer will be consulted in the detailed design stage to ensure the final suitability of the relocated route."

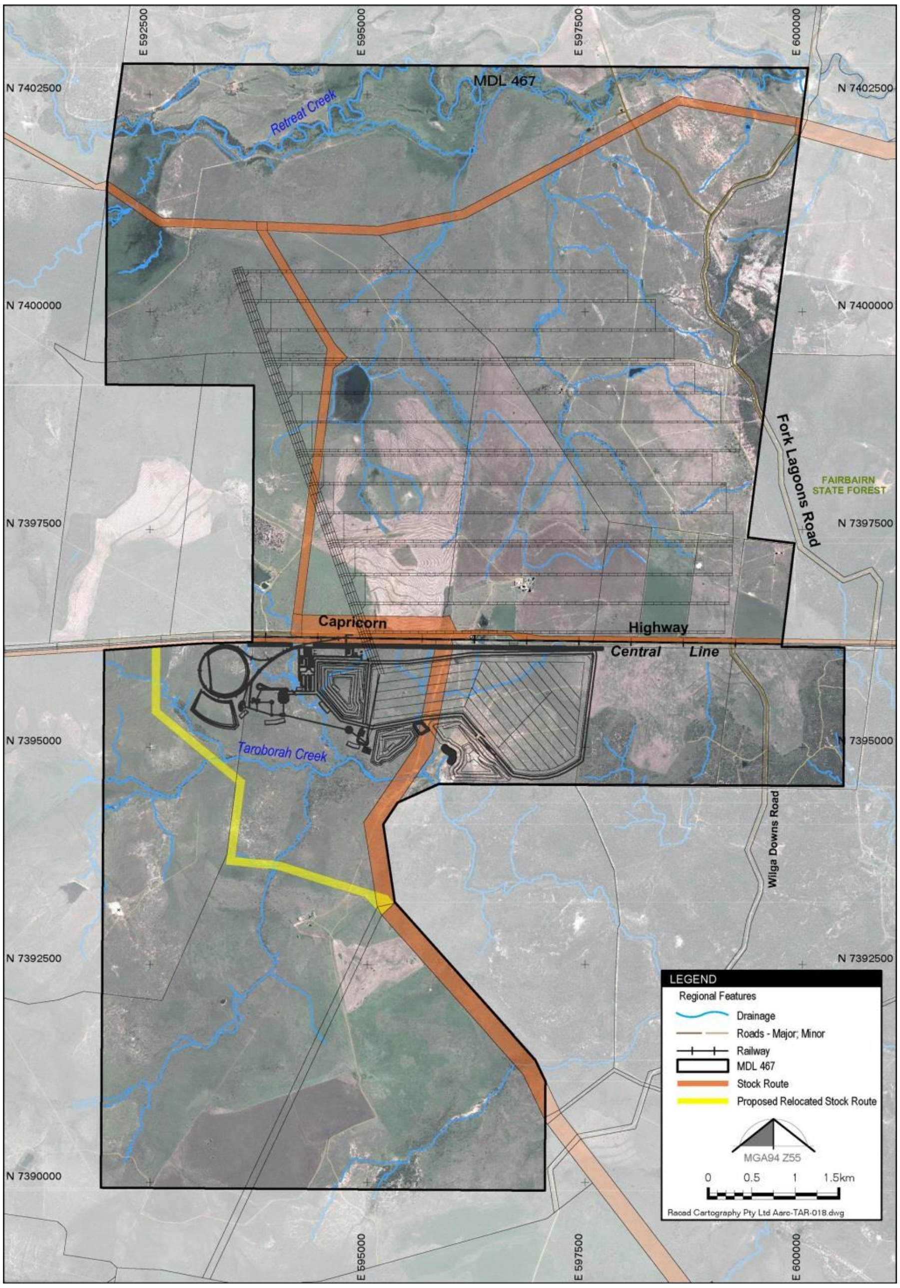


Figure 4.56 Proposed Relocated Stock Route

The above has also been added as Section 5.1.1.3 in Appendix 11.

5.11 Section 4.3.2.1, Page 4-134 & Appendix 11, Page 58 – Road and Rail Upgrades - Potential Impacts to Fisheries Resources

Submitter:

Department of Agriculture, Fisheries and Forestry – Fisheries Queensland

Submission:

Upgrades to the road and rail network may impact on fish resources. The project should commit that:

- Any new or upgrades to existing works including waterway diversions, culvert or

bed level crossings, rock armouring, or all and any other works within a waterway as defined under the Fisheries Act 1994 for both permanent and temporary works, or works resulting in the disturbance of marine plants or within a declared Fish Habitat Area, adequately provide for fish passage, and provide equal or enhanced habitat values and habitat complexity;

- Will not, either directly or indirectly, increase water velocities within waterways to a level that would prevent fish movement through the Project site or associated infrastructure.

Response:

Shenhuo has spoken with the Department of Agriculture, Fisheries and Forestry (DAFF) in relation to any potential impacts on fisheries. Shenhuo has clarified with DAFF that the project will not involve any new rail or road crossings of either the Nogoa River, Taroborah Creek or Retreat Creek, such that fish ladders or similar measures would be required.

EIS Amendment:

None required

5.12 Section 4.3.2.1, Page 4-135 – Road Impacts

Submitter:

Department of Transport and Main Roads

Submission:

Figure 4.55 shows a proposed Mine Site Access layout/standard- including rail crossing and storage lanes.

The form and standard of the proposed access to the mine site needs to be negotiated with TMR as part of the Compensation Infrastructure Agreement. (Note- Accelerations-type layouts are not the preferred treatment by TMR.)

Response:

Acknowledged, and the Proponent will liaise with DTMR during the final design stage to ensure the new mine access arrangements are satisfactory to all parties.

EIS Amendment:

Last sentence of the first bullet point in Section 4.3.2.1 amended to read as follows:

"Figure 4.55 illustrates the preliminarily proposed upgrades to the highway (note final design will be subject to discussion with and approval from DTMR); and"

5.13 Section 4.3.2.1, Page 4-137 and 4-141 & Appendix 11 – Road Impacts

Submitter:

Department of State Development, Infrastructure and Planning and Department of Main Roads

Submission:

Table 4.23 and Table 4.27 indicate construction loads will include 300 B Double trips carrying diesel fuel and another 900 trips during operation. The Central Queensland Resource Supply Chain study, undertaken by DSDIP, highlights the need for a modal shift of fuel transportation off road and on to rail to: (a) reduce heavy vehicle traffic on the Capricorn Highway (b) improve road safety. This future direction for fuel transportation is

consistent with Department of Transport and Main Road's (DTMR) Moving Freight Strategy.

Recommendation:

Proponent to work with DTMR to investigate options to transport project-related diesel fuel requirements by rail.

Response:

Acknowledged. It should be noted that the annual trips will maximise at around 700 (350 each way) with the open-cut and 200 (100 each way) for the underground. These trips are not concurrent and therefore don't relate to 900 trips annually, but rather, the open-cut will be winding down and the underground ramping-up such that total trips during the transition will be approximately 500 (250 each way).

Nonetheless, if the fuel becomes available in Emerald that has been delivered by rail at a competitive price, then the Proponent would most certainly look at that option as opposed to long hauls from Gladstone or elsewhere. The Proponent has contacted Mr Ray Merlehan of the DTMR to discuss their Moving Freight Strategy initiative and information on this was being sent. The Proponent will continue to liaise with DTMR as the project progresses to keep abreast of the advancement of this initiative.

EIS Amendment:

The first paragraph under Anticipated Traffic Volumes on page 4-136 in Section 4.3.2.1 has been amended to read as follows:

"The expected volumes and weights of all Project inputs and outputs including the types of vehicles used and the likely number and timing of trips, during the construction and operational phase of the Project are outlined throughout this section. It should be noted this assessment assumes all material movements to and from the mine site, with the exception of the product coal, will be undertaken via on-road means. The Department of Transport and Main Roads has recently instituted an initiative to increase freight movements via rail, with Emerald targeted as a potential rail freight depot. Should this come to fruition, it is expected that the Project would receive some materials via rail, and therefore, road movements of freight from the coast to Emerald would likely be reduced from that projected in this assessment."

5.14 Section 4.4 - Waste

Submitter:

Central Highlands Region al Council (Mark Giebel)

Submission:

The stipulation of tonnages of domestic waste in Table 4.32 are generally understated in comparison to what we observe coming through our facilities. There are often roll on – roll off bins of mixed general waste in addition to the front lift bins that are regularly disposed to landfill. These bins are usually poorly sorted mix of C&D waste. The figure quoted equates to less than 0.5 tonnes per week.

Further, there does not appear to be any recognition of waste generated from the construction phase. Large volumes of waste to landfill are traditionally generated through this phase. This waste is normally poorly sorted and the majority is sent to landfill.

Council is facing having to upgrade its licensed capacity on its

Lochlees Rd landfill that services Emerald. A contribution towards this MCU process could be made to assist Council meet this additional regulatory requirement.

Response:

The volumes of operational waste projected in the Draft EIS were based on an existing opencut mining operation of similar size to that planned at Taroborah. However, as a measure of conservatism, the amounts of waste to be generated, particularly domestic (or general) have been revisited, and compared with other project EIS estimates. Based on this comparison, the tonnages for general waste have been increased from 25tpa to 75tpa.

Wastes generated during construction are discussed and itemised in Table 3.20, Section 3.6.1.1 of the EIS main body report. However, the amount of waste generated is not addressed. For completeness, the amount of construction waste has now been estimated and included in the applicable EIS tables.

While it is acknowledged that there may be additional costs to CHRC with respect to disposing of wastes generated by Taroborah, there will also likely be other Projects coming on-line in the same time frame that will also generate wastes for disposal by CHRC facilities, and it is expected that the costs of any requirements of CHRC to upgrade licenced capacity of disposal facilities would be passed along to all customers in the normal course of business, not by separate contributions from specific customers.

EIS Amendment:

Table 3.20, Table 3.21 and Table 4.32 updated with new quantities of waste. The amended Table 4.32, which combines construction and operational waste estimates, is provided below.

	Estimated Waste Quantities	Waste Management					Potential Impacts	EIS Reference
		Minimise / Avoid	Re-use	Recycle	Disposal	Criteria		
Solid Wastes								
Excavated Waste (Spoil)	Open Cut: Estimated annual average quantity up to 22 million loose cubic metres (lcm) (Annual max. 33 million lcm)		Use where possible to support mine infrastructure		Disposal in out-of-pit spoil dumps will mainly occur in Years 1 and 2 of the mine life. In-pit dumping is expected to commence in earnest by Year 3 and will continue for the mine life. Waste which exhibits acid/neutral/alkaline mine drainage will be stored in engineered spoil dumps to ensure that this waste does not become oxidised or release acid and/or heavy metals.	Excavated waste must be characterised and selectively placed within out-of-pit and in-pit spoil dumps. Spoil characterised as PAF must be encapsulated with NAF material	Contamination of land, groundwater and/or surface water (e.g. acid mine drainage)	Land Section 4.2 Water Section 4.5
Coarse and Fine Coal Preparation Plant (CPP) Rejects	Open Cut: Estimated annual average quantity up to 212,000 tonnes (t) (Annual max. 280,000 t)			Process water will be recycled back through the CPP				
	Underground Longwall: Estimated annual average quantity up to 36,000 tonnes (Annual max. 72,000 t)			Process water will be recycled back through the CPP				

	Estimated Waste Quantities	Waste Management					Potential Impacts	EIS Reference
		Minimise / Avoid	Re-use	Recycle	Disposal	Criteria		
Cleared Vegetation	1000 cubic metres (m^3)/ 200t during construction, 100 m^3/20t per annum during opencut operations	Stands of timber avoided by design	Mulch, landscape borders, fence posts, natural habitat for rehabilitation	Native species may be replanted as part of landscaping following construction	Weeds managed and disposed of in accordance with Weeds and Pest Control Management Plan	Permit required to harvest State-owned timber resources	Fire hazard, Regional Ecosystem disturbance	Conservation Section 4.8
General	200t during construction, 75 tpa during operations,	Bulk supply ordered where available to reduce packaging	Re-use packaging where appropriate.	Recyclable materials will be segregated and collected for recycling by a licensed waste management contractor	Non-recyclables are stored in allocated refuse bins and collected by a licensed waste management contractor.	Refuse bins must be collected at regular intervals	Land disturbance	Conservation Section 4.8
Scrap Metal	100t during construction, 50 tpa during operations		Re-use where appropriate	Store in mine laydown area for recycling	Scrap is sold and removed by a licensed contractor.	Scrap metal will be segregated and stored prior to removal	Land disturbance	Conservation Section 4.8
Batteries	20 during construction, 40 per annum during operations	Generators are also used on-site	Re-use where appropriate	Collection for recycling by licensed waste management contractor		Batteries are to be stored in 250 kg bundles (maximum) prior to removal	Land contamination	Land Section 4.2 Conservation Section 4.8
Drums of oil, hydrocarbons and chemicals	10 drums per annum	Bulk supply ordered where available to reduce	Re-use absorbents	Recycle to supplier or another licensed waste management contractor	Disposal off-site by licensed contractor to a facility licensed to accept such waste.	Maximum volumes to comply with storage areas which are designed to contain at least 110% of a single storage tank or 100% of the largest	Land contamination	Land Section 4.2

	Estimated Waste Quantities	Waste Management					Potential Impacts	EIS Reference
		Minimise / Avoid	Re-use	Recycle	Disposal	Criteria		
		packaging				storage tank plus 10% of the second largest storage tank in multiple storage areas		
Tyres	20 tyres per annum		Re-use where appropriate	Segregated and stores for collection by licensed waste management contractor for recycling		Tyres are to be stockpiled in volumes less than 3 m in height and 200 m^2 and at least 10 m from any other tyre storage area awaiting collection	Fire hazard Visual amenity	Hazard and Risk Section 4.13 Land Section 4.2
Liquid Wastes								
Sewage	Up to 5ML produced during construction, and up to 10.15ML per annum during operations			Following construction of the sewage treatment plant,wastes will be treated and spray irrigated on site	Sewage wastes generated during initial construction will be removed from site and managed by a licensed waste management contractor.	Sewage effluent quality parameters as defined in Section 3.5.5, Table 3.17 must be within acceptable limits	Land, groundwater and surface water contamination	Land Section 4.2 Water Section 4.5
Mine Affected Water	Average of 2,400 ML produced per annum over the life of the Project		Dewater coarse and fine rejects and store in CPP Water Recycle Dam	Recycle through CPP	Temporarily stored in CPP Water Recycle Dam prior to recycling	Dam to meet Mandatory Reporting Level (MRL) during annual inspection	Land, groundwater and surface water contamination	Land Section 4.2 Water Section 4.5
Groundwater	Between 220 ML and 2,100 ML of		Excess groundwater is treated and	Recycle through mine operations use and CPPWRD make-up	Temporarily stored in MWD prior to recycling	Dam to meet Mandatory Reporting Level (MRL)	Land and surface water	Land Section 4.2

	Estimated Waste Quantities	Waste Management					Potential Impacts	EIS Reference
		Minimise / Avoid	Re-use	Recycle	Disposal	Criteria		
	groundwater will be captured per annum		released for Beneficial Use	supply		during annual inspection	contamination	Water Section 4.5
Waste oils, hydrocarbons and solvents	60,000 L per annum		Re-use where appropriate	Waste oils, hydrocarbons and solvents will be removed from site by a licensed waste disposal operator to a licensed waste storage facility	Waste oils etc. are to be collected and stored in clearly marked containers for recycling. Records to be kept.	Maximum volumes to comply with storage areas which are designed to contain at least 110% of a single storage tank or 100% of the largest storage tank plus 10% of the second largest storage tank in multiple storage areas	Land contamination	Land Section 4.2

5.15 Section 4.4.1.2, Page 4-163 - Waste Quantities and Treatment Methods

Submitter:

Department of Environment and Heritage Protection

Submission:

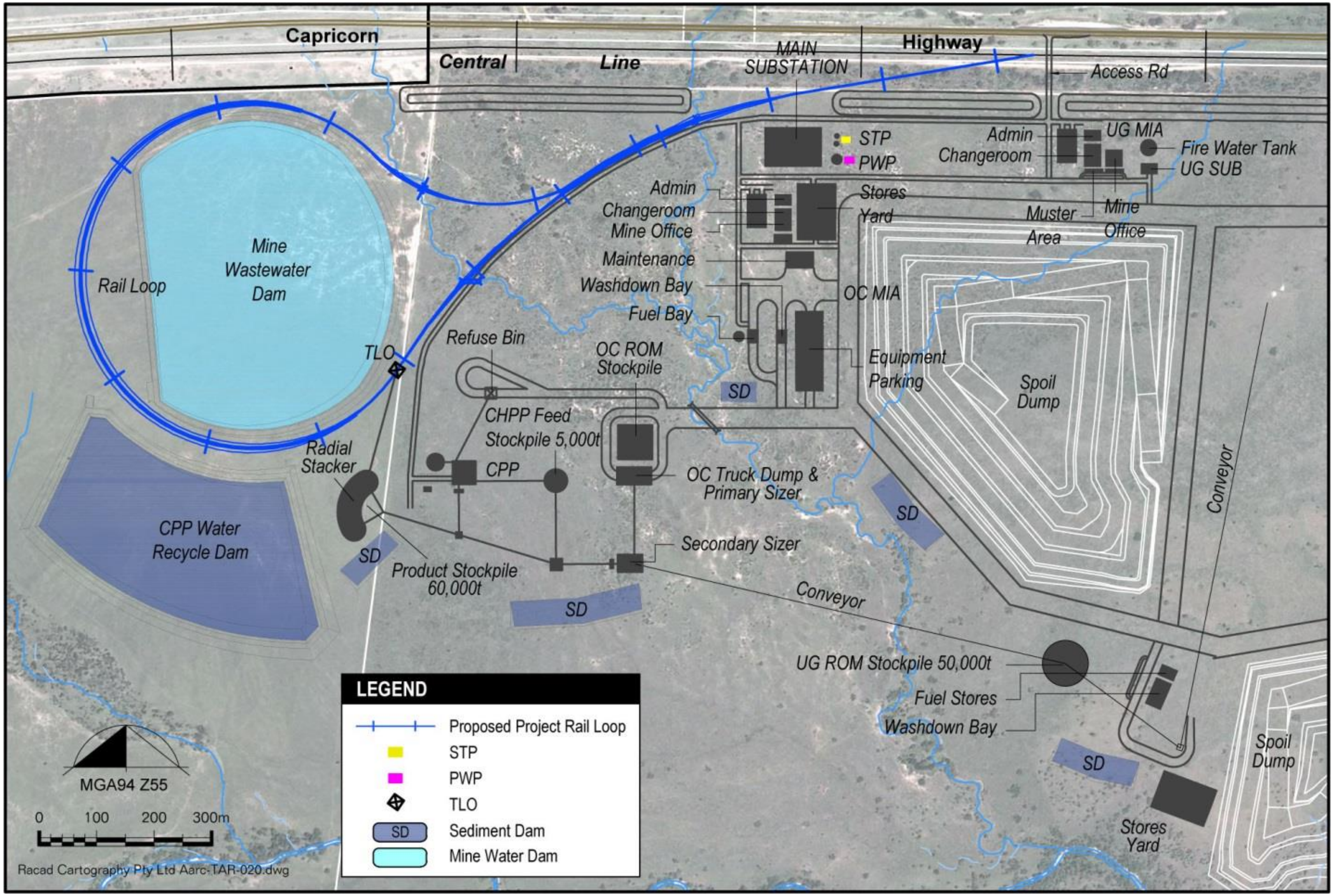
Table 4.3.2 does not include cleared vegetation as a waste that would be generated by project activities. Furthermore, Chapter 6, Condition C3 proposes burning of vegetation as a proposed disposal method. The burning of waste, including cleared vegetation, is not best practice and is discouraged by EHP. The reuse of cleared vegetation, including as habitat during progressive rehabilitation, mulching and landscaping borders, timber fence posts on farming properties, or provision to local landscapers for mulching is preferred to burning. Reuse of cleared vegetation, instead of burning, is also consistent with the principles of the waste management hierarchy and would achieve a greater environmental outcome.

Response:

Cleared vegetation is discussed as a waste stream in Table 3.20, Section 3.6.1.1 of the EIS main body report. The volumes of cleared vegetation were not estimated initially nor included as a waste stream during operations for the simple reason that there is not expected to be significant volumes, either during construction or opencut mine operation. This is because the area where the MIA and opencut mine are located has been almost completely cleared of trees and scrub, with only the drainage lines, which have largely been avoided in the design of the surface facilities, containing appreciable volumes of larger vegetation species. Please see the aerial photo below with the planned surface facilities overlain and the photograph, which was taken from St Helen's Road just south of the railway line and looking south over the area of the opencut.

Nonetheless, it is acknowledged that some volumes of cleared vegetation will arise during construction and opencut operation, and therefore Table 4.3.2 has been amended in the final EIS document to include cleared vegetation as a waste that would be generated during project activities and includes measures for reuse as the preferred treatment method for managing cleared vegetation.

Further, condition C3 in Section 6 has been amended to indicate the burning of waste vegetation is a last resort.


Capricorn
Central
Line
Highway
MAIN SUBSTATION
Access Rd
STP
PWP
Admin Changeroom
UG MIA
Fire Water Tank
UG SUB
Admin
Changeroom
Mine Office
Maintenance
Washdown Bay
Fuel Bay
Stores Yard
Muster Area
Mine Office
OC MIA
Mine Wastewater Dam
Rail Loop
TLO
Refuse Bin
OC ROM Stockpile
SD
Equipment Parking
Spoil Dump
CHPP Feed Stockpile 5,000t
CPP
Radial Stacker
OC Truck Dump & Primary Sizer
CPP Water Recycle Dam
Secondary Sizer
Product Stockpile 60,000t
Conveyor
UG ROM Stockpile 50,000t
Fuel Stores
Washdown Bay
Stores Yard
LEGEND
Proposed Project Rail Loop
Sediment Dam
Mine Water Dam
MGA94 Z55
0 100 200 300m
Racad Cartography Pty Ltd Aarc-TAR-020.dwg

Taroborah opencut mine area with State Forest in the background

EIS Amendment:

Table 4.32 in Section 4.4.1.2 of the EIS main body report now includes the following line item on cleared vegetation waste:

	Estimated Waste Quantities	Waste Management					Potential Impacts	EIS Reference
		Minimise / Avoid	Re-use	Recycle	Disposal	Criteria		
Solid Wastes								
Cleared Vegetation	1000 cubic metres (m^3)/ 200t during construction, 100 m^3/20t per annum during opencut operations	Stands of timber avoided by design	Mulch, landscape borders, fence posts, natural habitat for rehabilitation	Native species may be replanted as part of landscaping following construction	Weeds managed and disposed of in accordance with Weeds and Pest Control Management Plan	Permit required to harvest State-owned timber resources	Fire Hazard, Regional Ecosystem disturbance	Conservation Section 4.8

And condition C3 in Section 6 of the EIS main body report now reads as follows:

"The holder of this environmental authority may burn vegetation cleared in the course of carrying out extraction activities provided no other preferred method of reuse or disposal is feasible and the activity does not cause environmental harm at any sensitive place or commercial place."

5.16 Section 4.4.2.6, Page 4-168 - Geochemical classification of spoil materials

Submitter:

Department of Environment and Heritage Protection

Submission:

Table 4.33 provides a summary of NAF and potential acid forming (PAF) spoil based on the percentages of samples analysed for each lithological waste rock unit. However, the proportion of NAF and PAF spoil has not been linked to the estimated volumes of each waste rock unit in Table 3.24 on page 3-106 of Chapter 3 of the EIS. The volume of NAF and PAF is necessary to gain an understanding of the volume of waste with PAF properties and is essential information to guide the design of the waste rock dumps. This may have implications for the waste rock dump design because Section 3.6.3.4 on page 3-109 indicates that most of the sulphur present in the interburden and overburden is likely to be pyritic (ranging from 35% to 84% acid generating sulphur). However, both the proportion of NAF and the acid neutralising capacity of the waste has been estimated based on the percentage of samples analysed, rather than by the volume of each waste rock unit.

It is recommended that the proponent:

1. Amend Table 4.33 and Section 3.6.3.4 (Acid generation) to include the estimated volume of each waste rock unit with NAF and PAF properties.
2. Apply this information to the proposed design of the in-pit and out-of-pit waste rock dumps and provide amended designs, if required.

Response:

It is correct that the proportions in Table 4.33 are not linked to the mined volumes, but rather to the percentage of the samples from each of the lithologies that fall into the three AMD categories. There were considerably more samples per volume taken from the PAF interburden than any other lithology, which skews the sample proportion numbers. The statement that 66.6% of overburden and interburden material tested is likely to be non-acid forming is based on weighting each sample tested by the length of material in the borehole that sample represents.

On the other hand, the volume for each waste rock unit based on AMD category (not necessarily the lithology type) in Table 4.33 has been estimated using a geologic model developed for the AMD categories from each borehole and the opencut pit design, which is presented in Table 3.24. For example, the Weathered NAF – LOW ANC plus the Weathered NAF – High ANC in Table 3.24 represent the Basalt and Weathered sedimentary material of Table 4.33, and so on. If we link the sample percentages in each "lithology" to the respective waste volumes (excluding coal as it is not a waste), we get a volume percentage of 68% NAF/PAF-LC and 32% PAF, which confirms the characterisation of the overburden/interburden material stated in Section 4.4.2.6.

However, for AMD prevention design purposes, it has been assumed that 50% of the Mixed NAF and PAF-LC category material is NAF and 50% is PAF, which brings the volume percentage of NAF/PAF down to 56%/44%. This percentage has been used in the design of out-of-pit and in-pit spoil dumps as discussed above in Section 4.9 of this response document.

EIS Amendment:

To make things clearer with regard to Table 4.33, the second and third paragraphs of Section 4.4.2.6 have been amended to read as follows:

"The physical and chemical characteristics of overburden and interburden have been determined through geochemical testing of samples from exploration boreholes. Rock samples underwent Acid Base Accounting (ABA) assessment, allowing sampled geologies to be classified into non-acid forming (NAF), potentially acid forming (PAF) and uncertain (UC) categories. The results of this classification process are summarised in Table 4.33, which provides the number of samples tested for the different overburden lithologies and the percentage of the samples that fall into the three AMD categories.

The results indicate that, based on the length of borehole represented by the various samples tested, approximately 66.6% of the overburden and interburden material is likely to exhibit NAF characteristics, whilst the remainder (33.3%) is likely to be PAF and PAF-LC."

The last paragraph above also replaces the paragraph immediately following Table 3.27, which is a reproduction of Table 4.33.

To better illustrate the amount of overburden material that is likely to be NAF or PAF, Table 3.24 has been amended as follows:

Waste Rock Unit	Estimated Volume (bank m^3)	Number of Samples
Weathered NAF – Low ANC	40,700,000	43
Weathered NAF – High ANC	9,400,000	38
Fresh NAF	18,400,000	26
Subtotal - NAF	**68,500,000**	**107**
Fresh PAF-LC	18,400,000	26
Fresh PAF A Seam Roof	22,400,000	26
PAF/PAF-LC Interburden	17,600,000	70
Subtotal – PAF and PAF-LC	**58,400,000**	**122**

5.17 Section 4.4.2.6, Page 4-168 - Spoil Constructions

Submitter:

Department of Environment and Heritage Protection

Submission:

The spoil dumps are proposed to be engineered to encapsulate PAF material within a NAF horizon. This is expected to involve a 0.5m gravel foundation layer, a 0.3m clay liner, a 0.5m protective layer of sand and gravel and a 1m thick layer of boulder and crushed limestone. The outer faces of the dumps are proposed to consist of NAF and acid neutralising capacity waste and crushed limestone. However, the anticipated volumes of encapsulation materials required and availability of materials in the mined waste to achieve this design has not been provided.

It is recommended that the proponent:

1. Provide information about the anticipated volumes and availability of encapsulation materials required to achieve the proposed waste rock dump design.
2. Comment on any shortfall of encapsulation materials and associated implications on waste rock dump design.

Response:

This is a very similar submission to that presented above in Section 4.9 of this response document, and the response to this submission is the same.

EIS Amendment:

The following two paragraphs have been inserted as the last two paragraphs of Section 4.4.2.63:

"Based on the overburden geology, all of the necessary base and capping materials for the spoil dumps are expected to be available within the planned opencut excavation areas or in an adjacent mineral lease controlled by Shenhuo.

Spoil dump design and rehabilitation strategies applied to the spoil dumps are described further in Section 3.6.4 and Section 3.7, respectively"

5.18 Section 4.5.1.1, Page 4-185 - Surface Waterways - Wetlands

Submitter:

Department of Environment and Heritage Protection

Submission:

Figure 4.61 identifies a number of wetlands within the project site. However, an assessment of the potential environmental values (EVs) of these wetlands has not been presented. The Wetland Field Assessment Tool (WFAT) is an assessment approach that can be used to determine the EVs of the wetlands within the project site.

Response:

As the WFAT was not an available tool at the time of the aquatic field surveys, it could not be used to assess the values of the wetlands found on the project site. However, the environmental values of the various wetlands were assessed by the field ecologists using traditional methods and, as stated in the draft EIS, found to be generally low due to grazing pressures and the fact that no flora or fauna of conservation significance were identified at these locations. Nevertheless, to provide further clarification of this assessment, the assessment of the environmental value of the wetlands on the project site has been expanded as indicated below.

EIS Amendment:

The following discussion on EVs of the wetlands is included in Section 4.5.1.1 under the Wetland Values (formerly Wetlands) sub-heading, as Section 7.1.1 in Appendix 19.

"The *Environmental Protection Regulation 2008* (s81A) states that the environmental values of wetlands are the qualities that support and maintain:

(a) the health and biodiversity of the wetland's ecosystems;

(b) the wetland's natural state and biological integrity;

(c) the presence of distinct or unique features, plants or animals and their habitats, including threatened wildlife, near threatened wildlife and rare wildlife under the *Nature Conservation Act 1992*;

(d) the wetland's natural hydrological cycle;

(e) the natural interaction of the wetland with other ecosystems, including other wetlands.

The Project site is located in the Lower Nogoa / Theresa Creek Sub-basin of the Fitzroy River Basin. Wetland systems on the site have been noted by field ecologists for their Moderate to Good aquatic

habitat quality and their importance as permanent and semi-permanent water sources in a region characterised by ephemeral watercourses.

Lacustrine Wetlands

Two lacustrine wetlands (created by dams) were mapped on the Project site. Neither is consistent with any vegetation community under Queensland's Regional Ecosystem framework. The larger dam in the central west of the Project site was found to support substantial and complex habitat for fauna, with little evidence of erosion due to an abundance of vegetation both in and surrounding the dam.

Permanent waterbodies on the Project site are likely to provide important habitat for a number of common amphibian species, particularly given the ephemeral nature of watercourses and floodplain wetlands. The larger lacustrine wetland in the central west area of the site provides the only source of permanent water. This dam has been scored as Medium under the Aquatic Conservation Assessment (ACA).

Palustrine Wetlands

One large, ephemeral palustrine wetland was identified in the north-west of the Project site, incorporating two smaller palustrine wetlands mapped by EHP on wetlands mapping. These smaller wetlands have been scored as Medium under the ACA.

During the dry season survey, only a small quantity of water was evident. The wetland is considered to support good aquatic habitat by field ecologists, with evidence of variation in substrate and cover elements. Vegetation is dominated by grass species, which populate the banks of the wetland.

Some vegetation communities on the Project site have been noted by field ecologists for their potential to utilise groundwater. However, vegetation associated with palustrine wetlands on the site is limited to shrub and groundcover species, reducing the likelihood for groundwater dependence.

Remnant Regional Ecosystems Associated with Wetlands

A close association was noted between palustrine wetlands and REs along Retreat Creek in the north of the Project site. These REs are considered to be 51-80% wetland and are typically River Red Gum Riparian Woodland (RE 11.3.25 – *Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines) with a small segment (26.2 ha) of River Teatree Riparian Woodland (RE 11.3.3a – Riverine wetland or fringing riverine wetland/ *Melaleuca bracteata* woodland on alluvial plains).

While Retreat Creek itself is not considered likely to receive surface expressions of groundwater, measured groundwater levels in the vicinity of Retreat Creek are approximately 6-10 mbgl. Deep-rooted vegetation species, such as Eucalypt species of RE 11.3.25, therefore have the potential to utilise sub-surface groundwater.

Waterholes

A few semi-permanent waterholes exist within the Project site, although some of these may become dry at certain times of the year. These areas should be monitored pre- and post-wet season, with the emphasis upon water quality and invertebrate fauna. This is in recognition of their importance and high conservation value to the ecology of the region. These waterholes are vital refuges to the aquatic biota, and in the dry season, may be the only available watering points for wildlife.

Habitat Quality

Water bodies on the Project site, including watercourses and dams, hold both permanent and temporary aquatic habitats for native fish species, and may provide habitat for breeding and dispersal during periods of high flow. The habitat assessment revealed that most wetlands were characterised as providing relatively good aquatic habitat. Some wetlands and dams received lower scores, falling into the Moderate category. These sites were found to be ephemeral / not flowing, lacking in aquatic habitat variability, and exhibited indications of bank instability."

Further, a new Section 7.2.5 – Wetlands Impacts has been added to Appendix 19 of the EIS, which reads as follows:

"As the layout of mine infrastructure and associated mine-impacted surface water have been designed to avoid Taroborah Creek, it is expected that this infrastructure will have minimal impact upon aquatic habitats and the natural flow regime of this creek. The tributaries of Taroborah Creek are ephemeral in nature and drain quickly with no permanent waterholes. For the most part, these tributaries have been subject to previous clearing and cattle grazing activities as well as the introduction of pasture grasses and therefore, do not represent prime aquatic habitat.

Wetlands located within the area subject to subsidence are likely to experience tension cracking along the banks and potentially alterations to the depth and extent of water. The ephemeral nature of the watercourses and many of the wetlands reduce the likelihood of permanent hydrological and ecological impacts. The lacustrine wetland/dam located in the central region of the Project site, however, is a permanent source of water, and may exhibit changes to its depth and extent as a result of surface subsidence.

Further impacts of subsidence are detailed in the following section."

5.19 Section 4.5.1.1, Page 4-202 - Surface Water-Quality

Submitter:

Department of Environment and Heritage Protection

Submission:

Water quality within and in the vicinity of the proposed Taroborah Coal Project area has not been adequately characterised. Tables 4.41 to 4.48 include 5 sets of dry season data and 1 wet season data set over a sixteen month period (September 2011 to January 2013). In the absence of detailed flow data, this indicates that there was limited sampling performed during medium to high flows. Flow information at the time of sampling is necessary because water quality in permanent or semi-permanent waterholes is likely to be different from that in flowing streams, and hence, it may be necessary to characterise baseline water quality based on stream flow (i.e. electrical conductivity during high flow or base flow periods). Furthermore, percentiles can be biased by water quality data from the more extreme ends of the hydrograph (i.e. waterholes that have not been subjected to flow or rainfall for some time). Further, there are more dry season sampling events than wet season sampling events which can further bias the water quality results to times of no flow.

Note: The reference-based scheduled water quality objectives (WQOs) in the Environmental Protection (Water) Policy 2009 Nogoa River Sub-basin Environmental Values and Water Quality Objectives No. 130 (EHP 2013) are either derived from the Queensland Water Quality Guidelines Version 3 (EHP 2013), which are representative of waterway condition under base flow regimes, or from the Fitzroy basin regional water quality

guidelines, for low flows. Therefore, the WQOs should generally only be applied under base flow and low flow conditions.

Recommendations:

1. Where possible, provide quantitative flow information for the sampling done during dry and wet season surveys.
2. Separate water quality data according to flow (high, base or nil flow) and exclude from the summary statistics measurements taken from sites when there has been no flow.
3. Compare the results with the relevant WQOs for both base flow and low flow conditions.

Response:

WET AND DRY SEASONS

According to the Bureau of Meteorology, based on the key climate groups, Taroborah is located in a subtropical climate region which is characterised by distinct wet and dry seasons (Australia Government 2013 http://australia.gov.au/about-australia/australian-story/austn-weather-and-the-seasons).

Typically the 'dry' season occurs between April and October and the 'wet' season occurs between November and March (Australia Government 2013). In total seven sampling events took place from September 2011 to January 2013 to characterise the surface water quality on the Project site. Specifically three dry season sampling events (i.e. September 2011, June 2012 and October 2012) and four wet season sampling events (i.e. March 2012, November 2012, December 2012 and January 2013) took place.

SURFACE WATER QUALITY

Quantitative flow information for the sampling done during the wet and dry season surveys is not available as no stream flow gauging stations exist within the vicinity of the Project. Further, due to insufficient data, water quality data cannot be meaningfully separated according to stream flow.

Although not quantitative, stream flow information has been procured from notations taken at the time of sampling. The table below characterises the flow at each site during several sampling events. Flow characterisation ranges from standing, to slow flow, to rapid flow.

Flow Information for Each Site during Sampling Periods

Site	Survey Period						
	Sept 2011	Mar 2012	June 2012	Oct 2012	Nov 2012	Dec 2012	Jan 2013
TAS/AQ1	dry	rapid flow	rapid flow	standing	standing	standing, ns	dry
TAS/AQ2	dry	slow flow	standing	standing	standing	nd	standing
TAS/AQ3	standing	standing	standing	standing	standing	standing	standing
TAS/AQ4	standing	standing	nv	nv	standing	standing	standing
TAS/AQ5	standing	rapid flow	nv	nv	standing	standing	dry
TAS/AQ6	standing	rapid flow	nv	nv	standing	dry	standing
TAS/AQ7	dry	standing	slow flow	dry	dry	dry	dry
TAS/AQ8	dry	standing	slow flow	standing	standing	nv	dry
TAS/AQ10	standing	standing	slow flow	standing	standing	standing	standing
TAS/AQ11	slow flow	standing	nv	standing	standing	standing	standing
TAS/AQ12	dry	nv	dry	dry	standing	standing, ns	standing
AQ13	nv	standing	standing	nv	nv	nv	nv

nd = no flow data noted, ns = not sampled, nv = not visited
highlighted cells represent Retreat Creek and Taroborah Creek

Sites TAS/AQ3, TAS/AQ8, TAS/AQ12 and TAS/AQ13 represent wetland systems and are therefore classified naturally as standing water. These sites have now been compared against the appropriate WQOs in accordance with the Environmental Protection (Water) Policy 2009 Nogoa River Sub-basin Environmental Values and Water Quality Objectives No. 130 (EHP 2013) (i.e. Wetland WQOs derived from ANZECC (2000) 'chemical stressors for Tropical Australia'), as requested by EHP in the following submission (Section 5.20).

In addition, sites TAS/AQ4 and TAS/AQ6 represent dammed systems and are therefore also classified as naturally standing. These sites have now been compared against the appropriate WQOs in accordance with the Environmental Protection (Water) Policy 2009 Nogoa River Sub-basin Environmental Values and Water Quality Objectives No. 130 (EHP 2013) (i.e. Freshwater Lakes/Reservoirs WQOs), as requested by EHP in the following submission (Section 5.20).

As can be seen from the highlighted cells in the table above (which represent both Retreat and Taroborah Creeks), the majority of samples were taken from standing water. Section 4.5.1.1 (Surface Water Quality) of the EIS describes the rainfall in the four weeks prior to each sampling event. This data, sourced from the Bureau of Meteorology Emerald Airport Station (Station # 035264), provides an indication of the water quantities that may have been experienced during such sampling events.

Following review of meteorological data and the flow notations above it may not be reasonable to exclude water quality data that has been obtained from sites with no flow (as requested by EHP comment) as this data makes up the breadth of the water quality sampling results and is characteristic of the ephemeral nature of the creeks and associated drainage lines that were sampled.

Therefore, prior to the installation of stream flow gauges, it may not be possible to characterise water quality results based on stream flow (as per EHP comment), however, water quality results have been compared with the relevant WQOs for both base flow and low flow conditions where applicable i.e. within the Environmental Protection (Water) Policy 2009 Nogoa River Sub-basin Environmental Values and Water Quality Objectives No. 130 (EHP 2013), typically associated with electrical conductivity.

Results were analysed for variations between seasons (wet and dry), rather than flow. Three dry season surveys were conducted and four wet season surveys were undertaken. This analysis indicated comparable concentrations for the majority of toxicants with no distinguishable trends from one season to the next. This is likely due to consistently low flow throughout each season with few exceptions.

EIS Amendment:

None Required

5.20 Section 4.5.1.1, Page 4-202 to 4-215 - Surface Water-Quality

Submitter:

Department of Environment and Heritage Protection

Submission:

The water quality data for pastoral dams in Tables 4.41 to 4.44 has been combined with that of the creeks and palustrine wetlands. For example, water quality data for pastoral dams at sites AQ03/TAS03 and AQ08/TAS08 and palustrine wetland site AQ12/TAS12 was included with stream data for Retreat Creek and the pastoral dam site AQ13 was included

with water quality data for Taroborah Creek. Further, the WQOs listed in Tables 4.41 to 4.44 have not been matched to the water area or type. For example, the WQOs for physico-chemical water quality indicators for pastoral dams (presumably used for agricultural purposes) should be matched with the WQOs for lakes or reservoirs, and the palustrine wetland should be matched with the WQOs for wetlands. While Retreat and Taroborah creeks should be matched with the WQOs for streams in the lower Nogoa River and tributaries.

Note: The Queensland Water Quality Guidelines were developed recognising different water types because the variability in water quality between water types is expected to be significantly greater than within water types. It is inappropriate to pool water quality data from different water types due to the possibility of a non-representative characterisation of water quality for each water type.

Recommendations:

1. Separate water quality data in Tables 4.41 to 4.48 into the water area or type and match the data with the corresponding WQOs.
2. Amend the analysis of the water quality data so that the results for each water area or type is compared to the corresponding scheduled WQOs in the Environmental Protection (Water) Policy 2009 Nogoa River Sub-basin Environmental Values and Water Quality Objectives No. 130 (EHP 2013

Response:

Water quality data has been separated in water area or type and compared to the corresponding WQOs for these areas or types

EIS Amendment:

The last paragraph on page 4-181 (now page 4-182) has been deleted and replaced with the following two paragraphs.

“The EVs for the Nogoa River Sub-basin are presented in Table 4.35 while the physio-chemical WQOs are presented in Table 4.36 and Table 4.37 and are based upon Queensland Water Quality Guidelines Central Coast Region. The WQOs presented in Table 4.38 are based on the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council (ANZECC) 2000) default trigger values for physical and chemical stressors for tropical Australia for slightly disturbed ecosystems in accordance with the Environmental Protection (Water) Policy 2009 Nogoa River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Nogoa River Sub-basin (EHP 2011).

In addition, toxicant WQOs presented in Table 4.39 have also been derived from ANZECC (2000) guidelines in accordance with the Environmental Protection (Water) Policy 2009 Nogoa River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Nogoa River Sub-basin (EHP 2011). The ANZECC (2000) guidelines provide a framework for gauging water quality. They set out general levels for a range of different elements found in waterways which are considered to be safe levels for environmental protection, essentially defining the water quality needed to protect the environmental values.”

And the following two tables have been inserted following Table 4.36, with former Table 4.37 now becoming Table 4.39.

Table 4.37 Freshwater Lakes / Reservoirs Water Quality Objectives to Protect Aquatic Ecosystems

Parameter	Water Quality Objective
Ammonia Nitrogen	< 10 µg/L [a]
Oxidised Nitrogen	< 10 µg/L [a]
Organic Nitrogen	< 330 µg/L [a]
Total Nitrogen	< 350 µg/L [a]
Filterable Reactive Phosphorus	< 5 µg/L [a]
Total Phosphorus	< 10 µg/L [a]
Chlorophyll a	< 5 µg/L [a]
Dissolved Oxygen	90%–110% saturation [a]
Turbidity	1-20 NTU [a]
Suspended Solids	nd[a]
pH	pH: 6.5–8.0 [a]
Conductivity - baseflow	<250 µS/cm [b]

a) The values for these indicators are based on the QWQG Central Coast regional water quality guidelines.

b) The values for these indicators are based on sub-regional low flow water quality guidelines derived by the department as part of the process to establish EVs and WQOs in the Fitzroy Basin.

Table 4.38 Wetland Water Quality Objectives to Protect Aquatic Ecosystems

Parameter	Water Quality Objective
Ammonia Nitrogen	n/a
Oxidised Nitrogen	< 10 µg/L
Organic Nitrogen	n/a
Total Nitrogen	< 350-1200 µg/L
Filterable Reactive Phosphorus	< 5-25 µg/L
Total Phosphorus	< 10-50 µg/L
Chlorophyll a	< 10 µg/L
Dissolved Oxygen	90%–120% saturation
Turbidity	2-200 NTU
Suspended Solids	n/a
pH	pH: 6.0–8.0
Conductivity - baseflow	90-900 µS/cm

And the following paragraphs, tables and discussion on water quality have been inserted under the sub-heading Surface Water Quality to replace the draft EIS

Tables 4.41 thru 4.48 and discussion beginning at the eighth paragraph on page 4-200 (now page 4-202) and continuing through page 4-220 (now page 4-226).

"Physio-chemical and biological water quality results at each sampling location including the Wetlands (refer to **Table 4.43** and **Table 4.44**), the Pastoral Dams (refer to **Table 4.47** and **Table 4.48**), Retreat Creek (refer to **Table 4.51** and **Table 4.52**) and Taroborah Creek (refer to **Table 4.55** and **Table 4.56**) have been compared to the Lower Nogoa / Theresa Creek WQOs, including the Freshwater Lakes / Reservoirs and Wetland components where applicable, in accordance with the *Environmental Protection (Water) Policy 2009 Nogoa River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Nogoa River Sub-basin* (EHP 2011), in addition to both the ANZECC (2000) Aquatic Ecosystem Guidelines for 95% species protection and the ANZECC (2000) Livestock Drinking Water Guidelines.

In addition, the results for dissolved and total heavy metal analysis for the Wetlands (refer to **Table 4.45** and **Table 4.46** respectively), the Pastoral Dams (refer to **Table 4.49** and **Table 4.50** respectively), Retreat Creek (refer to **Table 4.53** and **Table 4.54** respectively) and Taroborah Creek (refer to **Table 4.57** and **Table 4.58** respectively) have been compared to the ANZECC (2000) Aquatic Ecosystem Guidelines for 95% species protection and the ANZECC (2000) Livestock Drinking Water Guidelines.

Where these WQOs and guideline values have been exceeded is highlighted within each table as follows:

- Bold red numeral / white background cell – indicates an exceedance of the Lower Nogoa / Theresa Creek WQOs, the Freshwater Lakes/ Reservoirs WQOs or the Wetland WQOs, derived from ANZECC (2000) guidelines (where applicable);
- Bold red numeral / pink background cell – indicates a value exceeding the ANZECC (2000) Aquatic Ecosystem Guidelines for 95% species protection; and
- Bold red numeral / blue background cell – indicates a value exceeding the ANZECC (2000) Livestock Drinking Water Guidelines.

Please note that not all water quality parameters were tested for each sampling event. However, each summary table provided below outlines the number of analyses undertaken for each quality parameter at each site.

Table 4.43 Wetlands – Summary of Surface Water Quality Chemical Analytical Results

Wetlands		Field pH	Field Temp (degrees Celsius)	Field Dissolved Oxygen (%)	Field Electrical Conductivity (µS/cm)	Field Turbidity (NTU)	Lab pH	Lab Turbidity (NTU)	Lab Electrical Conductivity (µS/cm)	Sulfate as SO4 (mg/L)	Total Recoverable Mercury (mg/L)
Wetland Water Quality Objectives[a]		6.0-8.0	n/a	90-120	90-900	2-200	6.0-8.0	2-200	90-900	n/a	n/a
ANZECC Aquatic Ecosystem Guideline		6.5-8.5	n/a	85-110	125-2200	n/a	6.5-8.5	n/a	125-2200	n/a	0.0006
ANZECC Livestock Drinking Water Guideline		n/a	n/a	n/a	n/a	1000	n/a	1000	n/a	1000	0.002
Site	Statistic										
AQ8 / TAS8	No. of Analyses	3	2	2	3	2	0	1	0	2	2
	Mean	7.46	24.45	90.00	581.67	529.17	-	165.00	-	1.00	0.0001
	Median	7.23	24.45	90.00	410.60	529.17	-	165.00	-	1.00	0.0001
	Min	6.94	17.10	51.00	224.40	150.35	-	165.00	-	1.00	0.0001
	Max	8.20	31.80	129.00	1110.00	908.00	-	165.00	-	1.00	0.0001
	80th Percentile	7.81	28.86	113.40	830.24	756.47	-	165.00	-	1.00	0.0001
	95th Percentile	8.10	31.07	125.10	1040.06	870.12	-	165.00	-	1.00	0.0001
AQ3 / TAS3	No. of Analyses	5	4	4	5	2	4	4	4	7	7
	Mean	9.14	24.40	80.15	249.82	146.03	9.22	178.50	266.25	1.57	0.0001
	Median	9.22	24.35	81.60	263.00	146.03	9.32	179.00	289.00	1.00	0.0001
	Min	8.47	17.10	67.90	175.40	115.05	8.69	167.00	158.00	1.00	0.0001
	Max	9.62	31.80	89.50	318.00	177.00	9.54	189.00	329.00	5.00	0.0001
	80th Percentile	9.35	27.48	85.12	284.40	164.61	9.50	186.00	313.40	1.00	0.0001
	95th Percentile	9.55	30.72	88.41	309.60	173.90	9.53	188.25	325.10	3.80	0.0001
AQ13 / TAS 13	No. of Analyses	2	2	2	2	1	0	1	0	2	2
	Mean	7.71	22.65	83.75	260.75	180.03	-	144.00	-	1.00	0.0001
	Median	7.71	22.65	83.75	260.75	180.03	-	144.00	-	1.00	0.0001
	Min	7.57	17.60	63.00	252.80	180.03	-	144.00	-	1.00	0.0001
	Max	7.84	27.70	104.50	268.70	180.03	-	144.00	-	1.00	0.0001
	80th Percentile	7.79	25.68	96.20	265.52	180.03	-	144.00	-	1.00	0.0001
	95th Percentile	7.83	27.20	102.43	267.91	180.03	-	144.00	-	1.00	0.0001
AQ12 / TAS12	No. of Analyses	1	0	0	1	1	1	1	1	2	2
	Mean	8.18	-	-	705.00	440.00	8.31	555.00	991.00	3.00	0.0001
	Median	8.18	-	-	705.00	440.00	8.31	555.00	991.00	1.00	0.0001
	Min	8.18	-	-	705.00	440.00	8.31	555.00	991.00	5.00	0.0001
	Max	8.18	-	-	705.00	440.00	8.31	555.00	991.00	4.20	0.0001
	80th Percentile	8.18	-	-	705.00	440.00	8.31	555.00	991.00	4.80	0.0001
	95th Percentile	8.18	-	-	705.00	440.00	8.31	555.00	991.00	3.00	0.0001

[a] derived from ANZECC (2000) default trigger values for physical and chemical stressors for tropical Australia for slightly disturbed ecosystems in accordance with the Environmental Protection (Water) Policy 2009 (EHP 2011).

Table 4.44 Wetlands – Summary of Surface Water Quality Chemical Analytical Results (continued)

Wetlands		Fluoride (mg/L)	Ammonia as N (µg/L)	Nitrite as N (mg/L)	Nitrate as N (mg/L)	Nitrite plus Nitrate as N (NOx) (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Nitrogen as N (TKN + NOx) (mg/L)	Total Phosphorus as P (mg/L)
Wetland Water Quality Objectives[a]		n/a	n/a	n/a	n/a	0.01	0.35-1.2	n/a	0.01-0.05
ANZECC Aquatic Ecosystem Values		n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.5
ANZECC Livestock Drinking Water Values		2	n/a	30	400	n/a	n/a	n/a	n/a
Site	**Statistic**								
AQ8 / TAS8	No. of Analyses	3	3	3	3	3	3	3	3
	Mean	0.20	0.13	0.01	0.02	0.02	4.43	4.43	0.58
	Median	0.20	0.13	0.01	0.02	0.02	1.40	1.40	0.29
	Min	0.10	0.09	0.01	0.02	0.02	1.30	1.30	0.24
	Max	0.30	0.16	0.01	0.02	0.02	10.60	10.60	1.22
	80th Percentile	0.26	0.15	0.01	0.02	0.02	6.92	6.92	0.85
	95th Percentile	0.29	0.16	0.01	0.02	0.02	9.68	9.68	1.13
AQ3 / TAS3	No. of Analyses	7	7	7	7	7	7	7	7
	Mean	0.19	0.07	0.01	0.03	0.03	1.06	1.07	0.04
	Median	0.20	0.06	0.01	0.03	0.03	1.10	1.10	0.04
	Min	0.10	0.04	0.01	0.01	0.01	0.60	0.70	0.01
	Max	0.30	0.15	0.01	0.08	0.08	1.60	1.60	0.08
	80th Percentile	0.20	0.08	0.01	0.04	0.04	1.20	1.20	0.04
	95th Percentile	0.28	0.13	0.01	0.07	0.07	1.48	1.48	0.07
AQ13 / TAS13	No. of Analyses	2	2	2	2	2	2	2	2
	Mean	0.15	0.07	0.01	0.01	0.01	1.15	1.15	0.56
	Median	0.15	0.07	0.01	0.01	0.01	1.15	1.15	0.56
	Min	0.10	0.04	0.01	0.01	0.01	1.10	1.10	0.06
	Max	0.20	0.10	0.01	0.01	0.01	1.20	1.20	1.05
	80th Percentile	0.18	0.09	0.01	0.01	0.01	1.18	1.18	0.85
	95th Percentile	0.20	0.10	0.01	0.01	0.01	1.20	1.20	1.00
AQ12 / TAS12	No. of Analyses	2	2	2	2	2	2	2	2
	Mean	0.35	0.08	0.01	0.03	0.03	1.55	1.55	0.05
	Median	0.35	0.08	0.01	0.03	0.03	1.55	1.55	0.05
	Min	0.30	0.06	0.01	0.02	0.02	1.40	1.40	0.03
	Max	0.40	0.09	0.01	0.03	0.03	1.70	1.70	0.07
	80th Percentile	0.38	0.08	0.01	0.03	0.03	1.64	1.64	0.06
	95th Percentile	0.40	0.09	0.01	0.03	0.03	1.69	1.69	0.07

[a]derived from ANZECC (2000) default trigger values for physical and chemical stressors for tropical Australia for slightly disturbed ecosystems in accordance with the Environmental Protection (Water) Policy 2009 (EHP 2011).

Table 4.45 Wetlands – Summary of Surface Water Quality Dissolved Metals Results

Wetlands		Dissolved Metals																	
		Al (mg/L)	As (mg/L)	Sb (mg/L)	Ba (mg/L)	Be (mg/L)	B (mg/L)	Cd (mg/L)	Cr (mg/L)	Co (mg/L)	Cu (mg/L)	Fe (mg/L)	Pb (mg/L)	Mn (mg/L)	Mo (mg/L)	Ni (mg/L)	Se (mg/L)	Ag (mg/L)	Zn (mg/L)
ANZECC Aquatic Ecosystem Values		**0.055**	**0.013**	**n/a**	**n/a**	**n/a**	**0.37**	**0.002**	**0.001**	**n/a**	**0.0014**	**n/a**	**0.0034**	**1.9**	**n/a**	**0.011**	**0.011**	**0.00005**	**0.008**
ANZECC Livestock Drinking Water Values		**5**	**0.5**	**n/a**	**n/a**	**n/a**	**5**	**0.01**	**1**	**1**	**1**	**n/a**	**1**	**n/a**	**0.15**	**1**	**0.02**	**n/a**	**20**
Site	**Statistic**																		
AQ8 / TAS8	No. of Analyses	2	2	2	1	2	1	2	2	1	2	1	2	3	3	3	2	1	3
	Mean	0.020	0.003	0.001	0.116	0.001	0.050	0.0001	0.001	0.002	0.001	0.210	0.001	0.015	0.001	0.003	0.005	**0.0001**	0.005
	Median	0.020	0.003	0.001	0.116	0.001	0.050	0.0001	0.001	0.002	0.001	0.210	0.001	0.016	0.001	0.004	0.005	**0.0001**	0.005
	Min	0.010	0.002	0.001	0.116	0.001	0.050	0.0001	0.000	0.002	0.001	0.210	0.001	0.006	0.001	0.002	0.000	**0.0001**	0.005
	Max	0.030	0.003	0.001	0.116	0.001	0.050	0.0001	0.001	0.002	0.001	0.210	0.001	0.022	0.002	0.004	0.010	**0.0001**	0.005
	80th Percentile	0.026	0.003	0.001	0.116	0.001	0.050	0.0001	0.001	0.002	0.001	0.210	0.001	0.020	0.002	0.004	0.008	**0.0001**	0.005
	95th Percentile	0.029	0.003	0.001	0.116	0.001	0.050	0.0001	0.001	0.002	0.001	0.210	0.001	0.021	0.002	0.004	0.010	**0.0001**	0.005
AQ3 / TAS3	No. of Analyses	5	5	6	5	6	4	6	6	4	6	5	5	6	6	6	6	3	6
	Mean	0.024	0.001	0.001	0.012	0.001	0.070	0.0001	0.001	0.001	0.001	0.054	0.001	0.009	0.001	0.003	0.002	**0.0004**	0.005
	Median	0.020	0.001	0.001	0.012	0.001	0.070	0.0001	0.000	0.001	0.001	0.050	0.001	0.007	0.001	0.003	0.000	**0.0001**	0.005
	Min	0.010	0.001	0.001	0.011	0.001	0.060	0.0001	0.000	0.001	0.001	0.050	0.001	0.004	0.001	0.002	0.000	**0.0001**	0.005
	Max	0.040	0.001	0.001	0.013	0.001	0.080	0.0001	0.001	0.001	**0.003**	0.070	0.001	0.021	0.003	0.003	0.010	**0.0010**	0.005
	80th Percentile	0.040	0.001	0.001	0.012	0.001	0.074	0.0001	0.001	0.001	**0.002**	0.054	0.001	0.010	0.001	0.003	0.000	**0.0006**	0.005
	95th Percentile	0.040	0.001	0.001	0.013	0.001	0.079	0.0001	0.001	0.001	**0.003**	0.066	0.001	0.018	0.003	0.003	0.008	**0.0009**	0.005
AQ13 / TAS 13	No. of Analyses	1	1	1	0	1	0	1	1	0	1	0	1	2	2	2	1	0	2
	Mean	0.010	0.001	0.001	-	0.001	-	0.0001	0.001	-	0.001	-	0.001	0.024	0.001	0.009	0.010	-	0.005
	Median	0.010	0.001	0.001	-	0.001	-	0.0001	0.001	-	0.001	-	0.001	0.024	0.001	0.009	0.010	-	0.005
	Min	0.010	0.001	0.001	-	0.001	-	0.0001	0.001	-	0.001	-	0.001	0.006	0.001	0.006	0.010	-	0.005
	Max	0.010	0.001	0.001	-	0.001	-	0.0001	0.001	-	0.001	-	0.001	0.042	0.001	0.012	0.010	-	0.005
	80th Percentile	0.010	0.001	0.001	-	0.001	-	0.0001	0.001	-	0.001	-	0.001	0.035	0.001	0.011	0.010	-	0.005
	95th Percentile	0.010	0.001	0.001	-	0.001	-	0.0001	0.001	-	0.001	-	0.001	0.040	0.001	0.012	0.010	-	0.005
AQ12 / TAS12	No. of Analyses	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2
	Mean	0.025	0.001	0.001	0.021	0.001	0.060	0.000	0.000	0.001	0.001	0.190	0.001	0.075	0.001	0.003	0.000	**0.0001**	0.005
	Median	0.025	0.001	0.001	0.021	0.001	0.060	0.0001	0.000	0.001	0.001	0.190	0.001	0.075	0.001	0.003	0.000	**0.0001**	0.005
	Min	0.010	0.001	0.001	0.014	0.001	0.050	0.0001	0.000	0.001	0.001	0.060	0.001	0.013	0.001	0.003	0.000	**0.0001**	0.005
	Max	0.040	0.001	0.001	0.028	0.001	0.070	0.0001	0.000	0.001	0.001	0.320	0.001	0.136	0.001	0.003	0.000	**0.0001**	0.005
	80th Percentile	0.034	0.001	0.001	0.025	0.001	0.066	0.0001	0.000	0.001	0.001	0.268	0.001	0.111	0.001	0.003	0.000	**0.0001**	0.005
	95th Percentile	0.039	0.001	0.001	0.027	0.001	0.069	0.0001	0.000	0.001	0.001	0.307	0.001	0.130	0.001	0.003	0.000	**0.0001**	0.005

Table 4.46 Wetlands – Summary of Surface Water Quality Total Metals Results

Wetlands		Total Metals																	
		Al (mg/L)	As (mg/L)	Sb (mg/L)	Ba (mg/L)	Be (mg/L)	B (mg/L)	Cd (mg/L)	Cr (mg/L)	Co (mg/L)	Cu (mg/L)	Fe (mg/L)	Pb (mg/L)	Mn (mg/L)	Mo (mg/L)	Ni (mg/L)	Se (mg/L)	Ag (mg/L)	Zn (mg/L)
ANZECC Aquatic Ecosystem Values		0.055	0.013	n/a	n/a	n/a	0.37	0.002	0.001	n/a	0.0014	n/a	0.0034	1.9	n/a	0.011	0.011	0.00005	0.008
ANZECC Livestock Drinking Water Values		5	0.5	n/a	n/a	n/a	5	0.01	1	1	1	n/a	1	n/a	0.15	1	0.02	n/a	20
Site	Statistic																		
AQ8 / TAS8	No. of Analyses	3	3	3	2	3	2	3	3	2	3	2	3	3	3	3	3	2	3
	Mean	1.887	0.003	0.001	0.100	0.001	0.050	0.0002	0.004	0.004	0.003	4.125	0.001	0.256	0.001	0.007	0.007	0.001	0.007
	Median	2.750	0.002	0.001	0.100	0.001	0.050	0.0002	0.003	0.004	0.003	4.125	0.001	0.065	0.001	0.005	0.010	0.001	0.007
	Min	0.030	0.001	0.001	0.054	0.001	0.050	0.0001	0.001	0.002	0.001	2.770	0.001	0.020	0.001	0.005	0.001	0.001	0.005
	Max	2.880	0.005	0.001	0.145	0.001	0.050	0.0002	0.008	0.006	0.006	5.480	0.001	0.684	0.002	0.011	0.010	0.001	0.009
	80th Percentile	2.828	0.004	0.001	0.127	0.001	0.050	0.0002	0.006	0.005	0.005	4.938	0.001	0.436	0.002	0.009	0.010	0.001	0.008
	95th Percentile	2.867	0.005	0.001	0.140	0.001	0.050	0.0002	0.008	0.006	0.006	5.345	0.001	0.622	0.002	0.010	0.010	0.001	0.009
AQ3 / TAS3	No. of Analyses	6	6	7	6	7	5	7	7	5	7	6	6	6	6	6	7	6	6
	Mean	0.943	0.002	0.001	0.017	0.001	0.076	0.0001	0.002	0.001	0.002	0.487	0.001	0.050	0.001	0.005	0.003	0.0004	0.006
	Median	0.335	0.002	0.001	0.016	0.001	0.080	0.0001	0.001	0.001	0.002	0.405	0.001	0.046	0.001	0.004	0.000	0.0001	0.005
	Min	0.130	0.001	0.001	0.012	0.001	0.050	0.0001	0.000	0.001	0.001	0.100	0.001	0.020	0.001	0.002	0.000	0.0001	0.005
	Max	3.670	0.002	0.001	0.024	0.001	0.100	0.0001	0.008	0.002	0.008	1.220	0.001	0.104	0.001	0.009	0.010	0.001	0.008
	80th Percentile	1.010	0.002	0.001	0.019	0.001	0.092	0.0001	0.003	0.001	0.002	0.580	0.001	0.062	0.001	0.006	0.008	0.001	0.006
	95th Percentile	3.005	0.002	0.001	0.023	0.001	0.098	0.0001	0.007	0.002	0.006	1.060	0.001	0.094	0.001	0.008	0.010	0.001	0.008
AQ13 / TAS13	No. of Analyses																		
	Mean	0.410	0.001	0.001	0.086	0.001	0.080	0.0002	0.001	0.001	0.003	0.370	0.001	0.062	0.001	0.008	0.010	0.001	0.008
	Median	0.410	0.001	0.001	0.086	0.001	0.080	0.0002	0.001	0.001	0.003	0.370	0.001	0.062	0.001	0.008	0.010	0.001	0.008
	Min	0.370	0.001	0.001	0.086	0.001	0.080	0.0001	0.001	0.001	0.002	0.370	0.001	0.007	0.001	0.007	0.010	0.001	0.005
	Max	0.450	0.001	0.001	0.086	0.001	0.080	0.0003	0.001	0.001	0.004	0.370	0.001	0.116	0.001	0.009	0.010	0.001	0.010
	80th Percentile	0.434	0.001	0.001	0.086	0.001	0.080	0.0003	0.001	0.001	0.004	0.370	0.001	0.094	0.001	0.009	0.010	0.001	0.009
	95th Percentile	0.446	0.001	0.001	0.086	0.001	0.080	0.0003	0.001	0.001	0.004	0.370	0.001	0.111	0.001	0.009	0.010	0.001	0.010
AQ12 / TAS12	No. of Analyses	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	Mean	5.045	0.001	0.001	0.094	0.001	0.095	0.0001	0.006	0.006	0.004	5.780	0.001	0.293	0.002	0.019	0.0002	0.0001	0.009
	Median	5.045	0.001	0.001	0.094	0.001	0.095	0.0001	0.006	0.006	0.004	5.780	0.001	0.293	0.002	0.019	0.0002	0.0001	0.009
	Min	4.940	0.001	0.001	0.050	0.001	0.060	0.0001	0.004	0.004	0.002	5.080	0.001	0.250	0.001	0.013	0.0002	0.0001	0.008
	Max	5.150	0.001	0.001	0.138	0.001	0.130	0.0001	0.008	0.008	0.005	6.480	0.001	0.336	0.002	0.024	0.0002	0.0001	0.010
	80th Percentile	5.108	0.001	0.001	0.120	0.001	0.116	0.0001	0.007	0.007	0.005	6.200	0.001	0.319	0.002	0.022	0.0002	0.0001	0.010
	95th Percentile	5.140	0.001	0.001	0.134	0.001	0.127	0.0001	0.008	0.008	0.005	6.410	0.001	0.332	0.002	0.023	0.0002	0.0001	0.010

Table 4.47 Pastoral Dams - Summary of Surface Water Quality Chemical Analytical Results

Pastoral Dams		Field pH	Field Temp (degrees Celsius)	Field Dissolved Oxygen (%)	Field Electrical Conductivity (µS/cm)	Field Turbidity (NTU)	Lab pH	Lab Turbidity (NTU)	Lab Electrical Conductivity (µS/cm)	Sulfate as SO4 (mg/L)	Total Recoverable Mercury (mg/L)
Nogoa River Water Quality Objectives – Freshwater Lakes/Reservoirs		6.5-8.0	n/a	90-110	<250	1-20	6.5-8.0	1-20	<250	n/a	n/a
ANZECC Aquatic Ecosystem Guideline		6.5-8.5	n/a	85-110	125-2200	n/a	6.5-8.5	n/a	125-2200	n/a	0.0006
ANZECC Livestock Drinking Water Guideline		n/a	n/a	n/a	n/a	1000	n/a	1000	n/a	1000	0.002
Site	**Statistic**										
AQ4 / TAS4	No. of Analyses	4	3	3	4	3	3	3	3	5	5
	Mean	8.25	26.87	78.57	856.75	548.79	7.83	480.67	1151.67	7.60	0.0001
	Median	8.30	24.90	66.00	917.50	543.00	8.11	603.00	1010.00	6.00	0.0001
	Min	8.05	21.60	65.80	211.00	141.37	7.26	170.00	995.00	1.00	0.0001
	Max	8.37	34.10	103.90	1381.00	962.00	8.13	669.00	1450.00	20.00	0.0001
	80th Percentile	8.33	30.42	88.74	1156.60	794.40	8.12	642.60	1274.00	9.60	0.0001
	95th Percentile	8.36	33.18	100.11	1324.90	920.10	8.13	662.40	1406.00	17.40	0.0001
AQ6 / TAS6	No. of Analyses	3	2	2	3	3	2	2	2	4	4
	Mean	8.07	24.10	64.55	1166.90	730.06	8.04	2349.50	3593.00	78.25	0.0001
	Median	8.15	24.10	64.55	290.80	194.84	8.04	2349.50	3593.00	55.50	0.0001
	Min	7.72	21.80	46.60	229.90	155.35	7.85	219.00	246.00	1.00	0.0001
	Max	8.34	26.40	82.50	2980.00	1840.00	8.23	4480.00	6940.00	201.00	0.0001
	80th Percentile	8.26	25.48	75.32	1904.32	1181.93	8.15	3627.80	5601.20	146.40	0.0001
	95th Percentile	8.32	26.17	80.71	2711.08	1675.48	8.21	4266.95	6605.30	187.35	0.0001

Table 4.48 Pastoral Dams - Summary of Surface Water Quality Chemical Analytical Results (continued)

Pastoral Dams		Fluoride (mg/L)	Ammonia as N (µg/L)	Nitrite as N (mg/L)	Nitrate as N (mg/L)	Nitrite plus Nitrate as N (NOx) (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Nitrogen as N (TKN + NOx) (mg/L)	Total Phosphorus as P (mg/L)
Nogoa River Water Quality Objectives – Freshwater Lakes/Reservoirs		n/a	<10	n/a	n/a	<0.01	<0.35	n/a	<0.01
ANZECC Aquatic Ecosystem Values		n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.5
ANZECC Livestock Drinking Water Values		2	n/a	30	400	n/a	n/a	n/a	n/a
Site	Statistic								
AQ4 / TAS4	No. of Analyses	5	5	5	5	5	5	5	5
	Mean	0.14	0.13	0.01	0.03	0.03	1.10	1.12	0.09
	Median	0.10	0.09	0.01	0.02	0.02	1.00	1.00	0.12
	Min	0.10	0.05	0.01	0.01	0.01	0.80	0.80	0.01
	Max	0.20	0.33	0.01	0.07	0.07	1.50	1.60	0.13
	80th Percentile	0.20	0.14	0.01	0.04	0.04	1.34	1.36	0.12
	95th Percentile	0.20	0.28	0.01	0.06	0.06	1.46	1.54	0.13
AQ6 / TAS6	No. of Analyses	4	4	4	4	4	4	4	4
	Mean	0.20	0.18	0.01	0.06	0.06	0.95	0.98	0.17
	Median	0.20	0.06	0.01	0.04	0.04	0.90	0.95	0.18
	Min	0.20	0.05	0.01	0.01	0.01	0.50	0.50	0.06
	Max	0.20	0.55	0.01	0.15	0.15	1.50	1.50	0.26
	80th Percentile	0.20	0.26	0.01	0.08	0.08	1.38	1.38	0.25
	95th Percentile	0.20	0.48	0.01	0.13	0.13	1.47	1.47	0.26

Table 4.49 Pastoral Dams - Summary of Surface Water Quality Dissolved Metals Results

Pastoral Dams		Dissolved Metals																	
		Al (mg/L)	As (mg/L)	Sb (mg/L)	Ba (mg/L)	Be (mg/L)	B (mg/L)	Cd (mg/L)	Cr (mg/L)	Co (mg/L)	Cu (mg/L)	Fe (mg/L)	Pb (mg/L)	Mn (mg/L)	Mo (mg/L)	Ni (mg/L)	Se (mg/L)	Ag (mg/L)	Zn (mg/L)
ANZECC Aquatic Ecosystem Values		**0.055**	**0.013**	**n/a**	**n/a**	**n/a**	**0.37**	**0.002**	**0.001**	**n/a**	**0.0014**	**n/a**	**0.0034**	**1.9**	**n/a**	**0.011**	**0.011**	**0.00005**	**0.008**
ANZECC Livestock Drinking Water Values		**5**	**0.5**	**n/a**	**n/a**	**n/a**	**5**	**0.01**	**1**	**1**	**1**	**n/a**	**1**	**n/a**	**0.15**	**1**	**0.02**	**n/a**	**20**
Site	**Statistic**																		
AQ4 / TAS4	No. of Analyses	4	4	5	4	5	3	**5**	5	3	**5**	4	4	4	4	4	**5**	**3**	4
	Mean	0.038	0.002	0.001	0.101	0.001	0.053	0.0001	0.000	0.001	0.001	0.075	0.001	0.252	0.001	0.003	0.002	**0.00040**	0.005
	Median	0.030	0.002	0.001	0.105	0.001	0.050	0.0001	0.000	0.001	0.001	0.055	0.001	0.211	0.001	0.004	0.000	**0.00010**	0.005
	Min	0.010	0.001	0.001	0.073	0.001	0.050	0.0001	0.000	0.001	0.001	0.050	0.001	0.161	0.001	0.002	0.000	**0.00010**	0.005
	Max	**0.080**	0.002	0.001	0.120	0.001	0.060	0.0001	0.001	0.001	**0.002**	0.140	0.001	0.426	0.002	0.004	0.010	**0.00100**	0.005
	80th Percentile	**0.062**	0.002	0.001	0.118	0.001	0.056	0.0001	0.000	0.001	**0.002**	0.092	0.001	0.301	0.001	0.004	0.002	**0.00064**	0.005
	95th Percentile	**0.076**	0.002	0.001	0.120	0.001	0.059	0.0001	0.001	0.001	**0.002**	0.128	0.001	0.395	0.002	0.004	0.008	**0.00091**	0.005
AQ6 / TAS6	No. of Analyses	3	3	4	3	4	2	4	4	2	4	3	3	3	3	3	4	2	3
	Mean	0.027	0.006	0.001	0.236	0.001	0.050	0.0001	0.000	0.002	0.001	0.140	0.001	1.052	0.001	0.002	0.003	**0.001**	0.005
	Median	0.010	0.006	0.001	0.215	0.001	0.050	0.0001	0.000	0.002	0.001	0.130	0.001	1.080	0.001	0.002	0.000	**0.001**	0.005
	Min	0.010	0.002	0.001	0.084	0.001	0.050	0.0001	0.000	0.002	0.001	0.050	0.001	0.006	0.001	0.001	0.000	**0.001**	0.005
	Max	**0.060**	0.010	0.001	0.408	0.001	0.050	0.0001	0.001	0.002	**0.003**	0.240	0.001	**2.070**	0.002	0.004	0.010	**0.001**	0.005
	80th Percentile	0.040	0.008	0.001	0.331	0.001	0.050	0.0001	0.001	0.002	**0.002**	0.196	0.001	1.674	0.002	0.003	0.004	**0.001**	0.005
	95th Percentile	0.055	0.010	0.001	0.389	0.001	0.050	0.0001	0.001	0.002	**0.003**	0.229	0.001	**1.971**	0.002	0.004	0.009	**0.001**	0.005

Table 4.50 Pastoral Dams - Summary of Surface Water Quality Total Metal Results

Pastoral Dams		Total Metals																	
		Al (mg/L)	As (mg/L)	Sb (mg/L)	Ba (mg/L)	Be (mg/L)	B (mg/L)	Cd (mg/L)	Cr (mg/L)	Co (mg/L)	Cu (mg/L)	Fe (mg/L)	Pb (mg/L)	Mn (mg/L)	Mo (mg/L)	Ni (mg/L)	Se (mg/L)	Ag (mg/L)	Zn (mg/L)
ANZECC Aquatic Ecosystem Values		**0.055**	**0.013**	**n/a**	**n/a**	**n/a**	**0.37**	**0.002**	**0.001**	**n/a**	**0.0014**	**n/a**	**0.0034**	**1.9**	**n/a**	**0.011**	**0.011**	**0.00005**	**0.008**
ANZECC Livestock Drinking Water Values		**5**	**0.5**	**n/a**	**n/a**	**n/a**	**5**	**0.01**	**1**	**1**	**1**	**n/a**	**1**	**n/a**	**0.15**	**1**	**0.02**	**n/a**	**20**
Site	**Statistic**																		
AQ4 / TAS4	No. of Analyses	4	4	5	4	5	3	5	5	3	5	4	4	4	4	4	5	4	4
	Mean	**0.590**	0.003	0.001	0.111	0.001	0.053	**0.0141**	**0.101**	0.002	**0.362**	1.108	0.001	0.421	0.002	0.005	0.002	**0.0003**	0.005
	Median	**0.405**	0.002	0.001	0.110	0.001	0.050	0.0001	**0.001**	0.002	**0.002**	0.995	0.001	0.402	0.002	0.004	0.000	**0.0001**	0.005
	Min	**0.210**	0.002	0.001	0.084	0.001	0.050	0.0001	0.001	0.001	**0.001**	0.720	0.001	0.256	0.001	0.003	0.000	**0.0001**	0.005
	Max	**1.340**	0.004	0.001	0.141	0.001	0.060	**0.0700**	**0.500**	0.003	**1.800**	1.720	0.001	0.624	0.002	0.008	0.010	**0.0010**	0.006
	80th Percentile	**0.860**	0.003	0.001	0.133	0.001	0.056	**0.0141**	**0.102**	0.003	**0.363**	1.330	0.001	0.512	0.002	0.006	0.002	**0.0004**	0.005
	95th Percentile	**1.220**	0.004	0.001	0.139	0.001	0.059	**0.0560**	**0.400**	0.003	**1.441**	1.623	0.001	0.596	0.002	0.007	0.008	**0.00087**	0.006
AQ6 / TAS6	No. of Analyses	3	3	4	3	4	2	4	4	2	4	3	3	3	3	3	4	3	3
	Mean	**0.610**	0.006	0.001	0.250	0.001	0.050	0.0001	0.0007	0.002	**0.002**	0.673	0.001	1.100	0.001	0.001	0.003	**0.0004**	0.007
	Median	**0.060**	0.006	0.001	0.207	0.001	0.050	0.0001	0.0003	0.002	0.001	0.050	0.001	1.180	0.001	0.001	0.000	**0.0001**	0.006
	Min	0.030	0.002	0.001	0.116	0.001	0.050	0.0001	0.0002	0.001	0.001	0.050	0.001	0.051	0.001	0.001	0.000	**0.0001**	0.005
	Max	**1.740**	0.010	0.001	0.427	0.001	0.050	0.0001	**0.002**	0.002	**0.004**	1.920	0.001	**2.070**	0.002	0.002	0.010	**0.0010**	**0.009**
	80th Percentile	**1.068**	0.008	0.001	0.339	0.001	0.050	0.0001	0.001	0.002	**0.003**	1.172	0.001	1.714	0.002	0.002	0.004	**0.0006**	0.008
	95th Percentile	**1.572**	0.010	0.001	0.405	0.001	0.050	0.0001	**0.002**	0.002	**0.004**	1.733	0.001	**1.981**	0.002	0.002	0.009	**0.0009**	**0.009**

Table 4.51 Retreat Creek and Tributaries - Summary of Surface Water Quality Chemical Analytical Results

Retreat Creek		Field pH	Field Temp (degrees Celsius)	Field Dissolved Oxygen (%)	Field Electrical Conductivity (µS/cm)	Field Turbidity (NTU)	Lab pH	Lab Turbidity (NTU)	Lab Electrical Conductivity (µS/cm)	Sulfate as SO4 (mg/L)	Total Recoverable Mercury (mg/L)
Nogoa River Water Quality Objectives		6.5-8.5	n/a	85-110	250-340	50	6.5-8.5	50	250-340	25	n/a
ANZECC Aquatic Ecosystem Guideline		6.5-8.5	n/a	85-110	125-2200	n/a	6.5-8.5	n/a	125-2200	n/a	0.0006
ANZECC Livestock Drinking Water Guideline		n/a	n/a	n/a	n/a	1000	n/a	1000	n/a	1000	0.002
Site	Statistic										
AQ1 / TAS1	No. of Analyses	4	3	3	4	2	1	2	1	4	4
	Mean	8.01	21.33	74.73	880.15	475.13	8.14	476.00	1150.00	54.00	0.0001
	Median	7.94	21.20	68.30	951.00	475.13	8.14	476.00	1150.00	64.00	0.0001
	Min	7.78	15.50	48.90	358.60	240.26	8.14	242.00	1150.00	1.00	0.0001
	Max	8.39	27.30	107.00	1260.00	710.00	8.14	710.00	1150.00	87.00	0.0001
	80th Percentile	8.16	24.86	91.52	1207.80	616.05	8.14	616.40	1150.00	73.80	0.0001
	95th Percentile	8.33	26.69	103.13	1246.95	686.51	8.14	686.60	1150.00	83.70	0.0001
AQ2 / TAS2	No. of Analyses	5	4	4	5	2	3	4	3	6	6
	Mean	7.73	23.48	57.15	1196.58	658.06	7.91	907.25	1448.00	5.00	0.0001
	Median	7.60	23.65	51.80	1670.00	658.06	7.92	900.00	1690.00	2.50	0.0001
	Min	7.39	16.60	9.70	233.30	156.11	7.80	159.00	814.00	1.00	0.0001
	Max	8.23	30.00	115.30	1875.00	1160.00	8.00	1670.00	1840.00	17.00	0.0001
	80th Percentile	8.01	28.08	91.18	1758.20	959.22	7.97	1376.00	1780.00	6.00	0.0001
	95th Percentile	8.18	29.52	109.27	1845.80	1109.81	7.99	1596.50	1825.00	14.25	0.0001
AQ5 / TAS5	No. of Analyses	4	3	3	4	3	2	2	2	4	4
	Mean	8.17	27.00	93.57	768.08	430.95	8.08	418.50	902.50	16.00	0.0001
	Median	8.12	26.60	78.70	857.00	468.00	8.08	418.50	902.50	17.50	0.0001
	Min	7.83	20.30	56.70	298.30	199.86	7.95	220.00	735.00	1.00	0.0001
	Max	8.61	34.10	145.30	1060.00	625.00	8.20	617.00	1070.00	28.00	0.0001
	80th Percentile	8.38	31.10	118.66	1057.00	562.20	8.15	537.60	1003.00	25.00	0.0001
	95th Percentile	8.55	33.35	138.64	1059.25	609.30	8.19	597.15	1053.25	27.25	0.0001
AQ11 / TAS11	No. of Analyses	5	4	4	5	3	4	4	4	6	6
	Mean	8.89	25.95	72.20	2302.20	1666.10	9.04	1430.00	2022.50	20.50	0.0001
	Median	8.95	27.10	56.30	2008.00	1417.00	8.98	1190.00	2050.00	20.50	0.0001
	Min	8.64	20.80	51.20	1797.00	1040.00	8.90	1040.00	1760.00	16.00	0.0001
	Max	9.08	28.80	125.00	3793.00	2541.31	9.31	2300.00	2230.00	24.00	0.0001
	80th Percentile	8.98	28.38	86.30	2385.00	2091.59	9.12	1652.00	2164.00	24.00	0.0001
	95th Percentile	9.06	28.70	115.33	3441.00	2428.88	9.26	2138.00	2213.50	24.00	0.0001

Table 4.52 Retreat Creek and Tributaries - Summary of Surface Water Quality Chemical Analytical Results (continued)

Retreat Creek		Fluoride (mg/L)	Ammonia as N (µg/L)	Nitrite as N (mg/L)	Nitrate as N (mg/L)	Nitrite plus Nitrate as N (NOx) (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Nitrogen as N (TKN + NOx) (mg/L)	Total Phosphorus as P (mg/L)
Nogoa River Water Quality Objectives		**n/a**	**10**	**0.06**	**0.06**	**n/a**	**0.5**	**n/a**	**0.05**
ANZECC Aquatic Ecosystem Values		**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**0.5**
ANZECC Livestock Drinking Water Values		**2**	**n/a**	**30**	**400**	**n/a**	**n/a**	**n/a**	**n/a**
Site	**Statistic**								
AQ1 / TAS1	No. of Analyses	4	4	4	4	4	4	4	4
	Mean	0.23	0.06	0.01	0.03	0.03	**0.68**	0.68	**0.17**
	Median	0.20	0.06	0.01	0.02	0.02	0.50	0.50	**0.17**
	Min	0.20	0.04	0.01	0.01	0.01	0.30	0.30	**0.09**
	Max	0.30	0.09	0.01	0.05	0.05	**1.40**	1.40	**0.24**
	80th Percentile	0.24	0.07	0.01	0.03	0.03	**0.92**	0.92	**0.22**
	95th Percentile	0.29	0.09	0.01	0.05	0.05	**1.28**	1.28	**0.24**
AQ2 / TAS2	No. of Analyses	6	6	6	6	6	6	6	6
	Mean	0.12	0.06	0.01	0.02	0.02	**1.20**	1.20	**0.31**
	Median	0.10	0.06	0.01	0.01	0.01	**0.95**	0.95	**0.19**
	Min	0.10	0.05	0.01	0.01	0.01	**0.70**	0.70	**0.07**
	Max	0.20	0.07	0.01	0.03	0.03	**2.60**	2.60	**0.90**
	80th Percentile	0.10	0.06	0.01	0.02	0.02	**1.20**	1.20	**0.37**
	95th Percentile	0.18	0.07	0.01	0.03	0.03	**2.25**	2.25	**0.77**
AQ5 / TAS5	No. of Analyses	4	4	4	4	4	4	4	4
	Mean	0.25	0.08	0.01	0.04	0.04	**1.50**	1.53	**0.19**
	Median	0.20	0.08	0.01	0.03	0.03	**0.75**	0.75	**0.12**
	Min	0.20	0.05	0.01	0.01	0.01	0.50	0.50	**0.08**
	Max	0.40	0.09	0.01	**0.07**	0.07	**4.00**	4.10	**0.43**
	80th Percentile	0.28	0.08	0.01	0.05	0.05	**2.08**	2.12	**0.24**
	95th Percentile	0.37	0.09	0.01	**0.07**	0.07	**3.52**	3.61	**0.38**
AQ11 / TAS11	No. of Analyses	6	6	6	6	6	6	6	6
	Mean	0.25	0.09	0.02	**0.12**	0.13	**1.27**	1.37	**0.11**
	Median	0.25	0.08	0.01	0.04	0.04	**1.15**	1.30	**0.12**
	Min	0.20	0.06	0.01	0.02	0.02	**0.80**	1.00	0.01
	Max	0.30	0.12	**0.08**	**0.56**	0.64	**1.80**	1.80	**0.22**
	80th Percentile	0.30	0.11	0.01	0.04	0.04	**1.70**	1.70	**0.19**
	95th Percentile	0.30	0.12	0.06	**0.43**	0.49	**1.78**	1.78	**0.21**

Table 4.53 Retreat Creek and Tributaries - Summary of Surface Water Quality Dissolved Metals Results

Retreat Creek		Dissolved Metals																	
		Al (mg/L)	As (mg/L)	Sb (mg/L)	Ba (mg/L)	Be (mg/L)	B (mg/L)	Cd (mg/L)	Cr (mg/L)	Co (mg/L)	Cu (mg/L)	Fe (mg/L)	Pb (mg/L)	Mn (mg/L)	Mo (mg/L)	Ni (mg/L)	Se (mg/L)	Ag (mg/L)	Zn (mg/L)
ANZECC Aquatic Ecosystem Values		**0.055**	**0.013**	**n/a**	**n/a**	**n/a**	**0.37**	**0.002**	**0.001**	**n/a**	**0.0014**	**n/a**	**0.0034**	**1.9**	**n/a**	**0.011**	**0.011**	**0.00005**	**0.008**
ANZECC Livestock Drinking Water Values		**5**	**0.5**	**n/a**	**n/a**	**n/a**	**5**	**0.01**	**1**	**1**	**1**	**n/a**	**1**	**n/a**	**0.15**	**1**	**0.02**	**n/a**	**20**
Site	**Statistic**																		
AQ1 / TAS1	No. of Analyses	3	3	3	2	3	2	3	3	2	3	2	3	4	4	4	3	0	4
	Mean	0.017	0.002	0.001	0.080	0.001	0.050	0.0001	0.000	0.001	0.001	0.050	0.001	0.034	0.001	0.001	0.003	-	**0.009**
	Median	0.010	0.001	0.001	0.080	0.001	0.050	0.0001	0.000	0.001	0.001	0.050	0.001	0.015	0.001	0.001	0.000	-	0.007
	Min	0.010	0.001	0.001	0.061	0.001	0.050	0.0001	0.000	0.001	0.001	0.050	0.001	0.009	0.001	0.001	0.000	-	0.005
	Max	0.030	0.004	0.001	0.099	0.001	0.050	0.0001	0.001	0.001	0.001	0.050	0.001	0.098	0.001	0.001	0.010	-	**0.018**
	80th Percentile	0.022	0.003	0.001	0.091	0.001	0.050	0.0001	0.001	0.001	0.001	0.050	0.001	0.050	0.001	0.001	0.006	-	**0.012**
	95th Percentile	0.028	0.004	0.001	0.097	0.001	0.050	0.0001	0.001	0.001	0.001	0.050	0.001	0.086	0.001	0.001	0.009	-	**0.017**
AQ2 / TAS2	No. of Analyses	5	5	5	4	5	4	5	5	4	5	4	5	6	6	6	5	2	6
	Mean	0.028	0.003	0.001	0.141	0.001	0.053	0.0001	0.0005	0.001	0.001	0.123	0.001	0.443	0.001	0.002	0.002	**0.00010**	0.006
	Median	0.010	0.004	0.001	0.147	0.001	0.050	0.0001	0.0002	0.001	0.001	0.075	0.001	0.358	0.001	0.002	0.000	**0.00010**	0.005
	Min	0.010	0.001	0.001	0.102	0.001	0.050	0.0001	0.0002	0.001	0.001	0.060	0.001	0.014	0.001	0.001	0.000	**0.00010**	0.005
	Max	**0.100**	0.005	0.001	0.167	0.001	0.060	0.0001	0.0010	0.002	0.001	0.280	0.001	0.953	0.001	0.004	0.010	**0.00010**	**0.010**
	80th Percentile	0.028	0.004	0.001	0.160	0.001	0.054	0.0001	0.0008	0.001	0.001	0.166	0.001	0.919	0.001	0.002	0.002	**0.00010**	0.007
	95th Percentile	**0.082**	0.005	0.001	0.165	0.001	0.059	0.0001	0.0009	0.002	0.001	0.252	0.001	0.945	0.001	0.004	0.008	**0.00010**	**0.009**
AQ5 / TAS5	No. of Analyses	3	3	4	3	4	2	4	4	2	4	3	3	3	3	3	3	3	3
	Mean	0.033	0.004	0.001	0.117	0.001	0.060	0.0001	0.000	0.002	**0.002**	0.090	0.001	1.256	0.003	0.003	0.003	**0.0004**	0.005
	Median	0.020	0.004	0.001	0.125	0.001	0.060	0.0001	0.000	0.002	**0.002**	0.050	0.001	1.310	0.001	0.002	0.000	**0.0001**	0.005
	Min	0.010	0.001	0.001	0.055	0.001	0.050	0.0001	0.000	0.002	0.001	0.050	0.001	0.007	0.001	0.001	0.000	**0.0001**	0.005
	Max	**0.070**	0.008	0.001	0.170	0.001	0.070	0.0001	0.001	0.002	**0.003**	0.170	0.001	**2.450**	0.006	0.005	0.010	**0.0010**	0.005
	80th Percentile	0.050	0.006	0.001	0.152	0.001	0.066	0.0001	0.001	0.002	**0.002**	0.122	0.001	**1.994**	0.004	0.004	0.004	**0.0006**	0.005
	95th Percentile	**0.065**	0.008	0.001	0.166	0.001	0.069	0.0001	0.001	0.002	**0.002**	0.158	0.001	**2.336**	0.006	0.005	0.009	**0.0009**	0.005
AQ11 / TAS11	No. of Analyses	5	5	6	5	6	4	6	6	4	6	5	5	5	5	5	6	3	5
	Mean	0.012	0.002	0.001	0.081	0.001	0.340	0.0001	0.001	0.001	**0.003**	0.050	0.001	0.010	0.001	0.004	0.002	0.0004	0.007
	Median	0.010	0.002	0.001	0.076	0.001	0.340	0.0001	0.001	0.001	**0.002**	0.050	0.001	0.004	0.001	0.004	0.000	0.0001	0.005
	Min	0.010	0.001	0.001	0.046	0.001	0.320	0.0001	0.000	0.001	0.001	0.050	0.001	0.002	0.001	0.003	0.000	0.0001	0.005
	Max	0.020	0.003	0.002	0.114	0.001	0.360	0.0001	0.001	0.001	**0.007**	0.050	0.001	0.025	0.002	0.005	0.010	0.0010	**0.013**
	80th Percentile	0.012	0.002	0.001	0.101	0.001	0.354	0.0001	0.001	0.001	**0.003**	0.050	0.001	0.019	0.001	0.005	0.001	0.0006	0.007
	95th Percentile	0.018	0.003	0.002	0.111	0.001	0.359	0.0001	0.001	0.001	**0.006**	0.050	0.001	0.023	0.002	0.005	0.008	0.0009	**0.012**

Table 4.54 Retreat Creek - Summary of Surface Water Quality Total Metals Results

Retreat Creek		Total Metals																	
		Al (mg/L)	As (mg/L)	Sb (mg/L)	Ba (mg/L)	Be (mg/L)	B (mg/L)	Cd (mg/L)	Cr (mg/L)	Co (mg/L)	Cu (mg/L)	Fe (mg/L)	Pb (mg/L)	Mn (mg/L)	Mo (mg/L)	Ni (mg/L)	Se (mg/L)	Ag (mg/L)	Zn (mg/L)
ANZECC Aquatic Ecosystem Values		0.055	0.013	n/a	n/a	n/a	0.37	0.002	0.001	n/a	0.0014	n/a	0.0034	1.9	n/a	0.011	0.011	0.00005	0.008
ANZECC Livestock Drinking Water Values		5	0.5	n/a	n/a	n/a	5	0.01	1	1	1	n/a	1	n/a	0.15	1	0.02	n/a	20
Site	Statistic																		
AQ1 / TAS1	No. of Analyses	4	4	4	3	4	3	4	4	3	4	3	4	4	4	4	4	3	4
	Mean	0.570	0.003	0.001	0.093	0.001	0.050	0.0001	0.001	0.001	0.002	0.667	0.001	0.120	0.001	0.002	0.005	0.0004	0.005
	Median	0.540	0.002	0.001	0.096	0.001	0.050	0.0001	0.001	0.001	0.002	0.620	0.001	0.075	0.001	0.002	0.005	0.0001	0.005
	Min	0.480	0.002	0.001	0.078	0.001	0.050	0.0001	0.001	0.001	0.001	0.610	0.001	0.044	0.001	0.001	0.000	0.0001	0.005
	Max	0.720	0.004	0.001	0.105	0.001	0.050	0.0001	0.001	0.001	0.002	0.770	0.001	0.285	0.002	0.002	0.010	0.0010	0.005
	80th Percentile	0.636	0.003	0.001	0.101	0.001	0.050	0.0001	0.001	0.001	0.002	0.710	0.001	0.174	0.001	0.002	0.010	0.0006	0.005
	95th Percentile	0.699	0.004	0.001	0.104	0.001	0.050	0.0001	0.001	0.001	0.002	0.755	0.001	0.257	0.002	0.002	0.010	0.0009	0.005
AQ2 / TAS2	No. of Analyses	5	6	6	5	6	5	6	6	5	6	5	6	6	6	6	6	5	6
	Mean	0.347	0.004	0.001	0.141	0.001	0.054	0.0001	0.002	0.001	0.001	1.412	0.001	0.832	0.001	0.003	0.003	0.0003	0.007
	Median	0.200	0.004	0.001	0.131	0.001	0.050	0.0001	0.001	0.001	0.001	0.880	0.001	0.856	0.001	0.003	0.000	0.0001	0.006
	Min	0.040	0.001	0.001	0.092	0.001	0.050	0.0001	0.000	0.001	0.001	0.210	0.001	0.105	0.001	0.002	0.000	0.0001	0.005
	Max	1.210	0.006	0.001	0.204	0.001	0.070	0.0002	0.006	0.002	0.004	3.990	0.003	1.380	0.001	0.006	0.010	0.0010	0.014
	80th Percentile	0.340	0.006	0.001	0.183	0.001	0.054	0.0001	0.002	0.002	0.002	1.902	0.001	1.150	0.001	0.004	0.010	0.0003	0.009
	95th Percentile	0.993	0.006	0.001	0.199	0.001	0.066	0.0002	0.005	0.002	0.004	3.468	0.003	1.323	0.001	0.006	0.010	0.0008	0.013
AQ5 / TAS5	No. of Analyses	3	3	4	3	4	2	4	4	2	4	3	3	3	3	3	4	3	3
	Mean	1.460	0.007	0.001	0.155	0.001	0.060	0.0001	0.001	0.004	0.002	1.803	0.002	2.039	0.003	0.004	0.003	0.0004	0.009
	Median	1.700	0.004	0.001	0.119	0.001	0.060	0.0001	0.001	0.004	0.002	0.720	0.001	2.190	0.001	0.002	0.000	0.0001	0.011
	Min	0.100	0.002	0.001	0.088	0.001	0.050	0.0001	0.000	0.001	0.001	0.380	0.001	0.066	0.001	0.001	0.000	0.0001	0.005
	Max	2.580	0.014	0.001	0.258	0.001	0.070	0.0001	0.003	0.006	0.005	4.310	0.004	3.860	0.006	0.009	0.010	0.0010	0.012
	80th Percentile	2.228	0.010	0.001	0.202	0.001	0.066	0.0001	0.002	0.005	0.003	2.874	0.003	3.192	0.004	0.006	0.004	0.0006	0.012
	95th Percentile	2.492	0.013	0.001	0.244	0.001	0.069	0.0001	0.003	0.006	0.004	3.951	0.004	3.693	0.006	0.008	0.009	0.0009	0.012
AQ11 / TAS11	No. of Analyses	5	5	6	5	6	4	6	6	4	6	5	5	5	5	5	6	5	5
	Mean	1.710	0.002	0.001	0.088	0.001	0.340	0.0001	0.003	0.003	0.004	1.918	0.001	0.054	0.001	0.008	0.002	0.0003	0.009
	Median	1.650	0.002	0.001	0.098	0.001	0.345	0.0001	0.002	0.002	0.004	1.340	0.001	0.042	0.001	0.007	0.000	0.0001	0.007
	Min	0.120	0.001	0.001	0.048	0.001	0.270	0.0001	0.001	0.002	0.002	0.760	0.001	0.024	0.001	0.004	0.000	0.0001	0.005
	Max	4.310	0.003	0.001	0.113	0.001	0.400	0.0001	0.008	0.004	0.007	4.580	0.001	0.106	0.002	0.013	0.010	0.0010	0.019
	80th Percentile	2.214	0.002	0.001	0.111	0.001	0.382	0.0001	0.004	0.003	0.005	2.292	0.001	0.068	0.002	0.010	0.001	0.0003	0.010
	95th Percentile	3.786	0.003	0.001	0.113	0.001	0.396	0.0001	0.007	0.004	0.007	4.008	0.001	0.097	0.002	0.012	0.008	0.0008	0.017

Table 4.55 Taroborah Creek and Tributaries - Summary of Surface Water Quality Chemical Analytical Results

Taroborah Creek		Field pH	Field Temp (degrees Celsius)	Field Dissolved Oxygen (%)	Field Electrical Conductivity (µS/cm)	Field Turbidity (NTU)	Lab pH	Lab Turbidity (NTU)	Lab Electrical Conductivity (µS/cm)	Sulfate as SO_4 (mg/L)	Total Recoverable Mercury (mg/L)
Nogoa River Water Quality Objectives		6.5-8.5	n/a	85-110	250-340	50	6.5-8.5	50	250-340	25	n/a
ANZECC Aquatic Ecosystem Values		6.5-8.5	n/a	85-110	125-2200	n/a	6.5-8.5	n/a	125-2200	n/a	0.0006
ANZECC Livestock Drinking Water Values		n/a	n/a	n/a	n/a	1000	n/a	1000	n/a	1000	0.002
Site	Statistic										
AQ7 / TAS7	No. of Analyses	2	2	2	2	1	0	1	0	2	2
	Mean	8.66	22.05	67.40	988.50	491.11	-	432.00	-	1.00	0.0001
	Median	8.66	22.05	67.40	988.50	491.11	-	432.00	-	1.00	0.0001
	Min	8.19	13.20	9.60	733.00	491.11	-	432.00	-	1.00	0.0001
	Max	9.13	30.90	125.20	1244.00	491.11	-	432.00	-	1.00	0.0001
	80th Percentile	8.94	27.36	102.08	1141.80	491.11	-	432.00	-	1.00	0.0001
	95th Percentile	9.08	30.02	119.42	1218.45	491.11	-	432.00	-	1.00	0.0001
AQ10 / TAS10	No. of Analyses	6	5	5	6	3	4	4	4	7	7
	Mean	8.89	24.56	140.16	2285.00	1787.53	8.85	918.50	2168.50	30.14	0.0001
	Median	8.97	23.90	111.30	1982.50	1980.00	8.99	895.50	1870.00	23.00	0.0001
	Min	8.23	16.80	70.00	877.00	587.59	8.21	513.00	664.00	1.00	0.0001
	Max	9.29	32.10	221.60	4206.00	2795.00	9.20	1370.00	4270.00	82.00	0.0001
	80th Percentile	9.17	27.70	210.08	3090.00	2469.00	9.12	1274.00	2884.00	48.20	0.0001
	95th Percentile	9.26	31.00	218.72	3927.00	2713.50	9.18	1346.00	3923.50	73.30	0.0001

Table 4.56 Taroborah Creek - Summary of Surface Water Quality Chemical Analytical Results (continued)

Taroborah Creek		Fluoride (mg/L)	Ammonia as N (µg/L)	Nitrite as N (mg/L)	Nitrate as N (mg/L)	Nitrite plus Nitrate as N (NOx) (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Nitrogen as N (TKN + NOx) (mg/L)	Total Phosphorus as P (mg/L)
Nogoa River Water Quality Objectives		n/a	10	0.06	0.06	n/a	0.5	n/a	0.05
ANZECC Aquatic Ecosystem Values		n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.5
ANZECC Livestock Drinking Water Values		2	n/a	30	400	n/a	n/a	n/a	n/a
Site	Statistic								
AQ7 / TAS7	No. of Analyses	2	2	2	2	2	2	2	2
	Mean	0.30	0.06	0.18	1.71	1.88	0.70	2.55	0.10
	Median	0.30	0.06	0.18	1.71	1.88	0.70	2.55	0.10
	Min	0.30	0.05	0.01	0.01	0.01	0.60	0.60	0.09
	Max	0.30	0.07	0.34	3.40	3.74	0.80	4.50	0.11
	80th Percentile	0.30	0.07	0.27	2.72	2.99	0.76	3.72	0.11
	95th Percentile	0.30	0.07	0.32	3.23	3.55	0.79	4.31	0.11
AQ10 / TAS10	No. of Analyses	7	7	7	7	7	7	7	7
	Mean	0.49	0.07	0.07	0.35	0.41	4.07	4.47	0.75
	Median	0.50	0.08	0.01	0.02	0.02	2.00	3.00	0.10
	Min	0.30	0.02	0.01	0.01	0.01	0.60	0.60	0.02
	Max	0.60	0.13	0.44	2.33	2.77	13.80	13.80	3.28
	80th Percentile	0.58	0.10	0.01	0.03	0.03	6.04	6.22	0.93
	95th Percentile	0.60	0.12	0.31	1.64	1.95	11.70	11.70	2.59

Table 4.57 Taroborah Creek and Tributaries - Summary of Surface Water Quality Dissolved Metals Results

Taroborah Creek		Dissolved Metals																	
		Al (mg/L)	Sb (mg/L)	As (mg/L)	Ba (mg/L)	Be (mg/L)	B (mg/L)	Cd (mg/L)	Cr (mg/L)	Co (mg/L)	Cu (mg/L)	Fe (mg/L)	Pb (mg/L)	Mn (mg/L)	Mo (mg/L)	Ni (mg/L)	Se (mg/L)	Ag (mg/L)	Zn (mg/L)
ANZECC Aquatic Ecosystem Values		0.055	n/a	0.013	n/a	n/a	0.37	0.002	0.001	n/a	0.0014	n/a	0.0034	1.9	n/a	0.011	0.011	0.00005	0.008
ANZECC Livestock Drinking Water Values		5	n/a	0.5	n/a	n/a	5	0.01	1	1	1	n/a	1	n/a	0.15	1	0.02	n/a	20
Site	Statistic																		
AQ7 / TAS7	No. of Analyses	1	1	1	0	1	0	1	1	0	1	0	1	2	2	2	1	0	2
	Mean	0.010	0.001	0.001	-	0.001	-	0.0001	0.001	-	0.002	-	0.001	0.003	0.001	0.002	0.010	-	0.005
	Median	0.010	0.001	0.001	-	0.001	-	0.0001	0.001	-	0.002	-	0.001	0.003	0.001	0.002	0.010	-	0.005
	Min	0.010	0.001	0.001	-	0.001	-	0.0001	0.001	-	0.002	-	0.001	0.002	0.001	0.001	0.010	-	0.005
	Max	0.010	0.001	0.001	-	0.001	-	0.0001	0.001	-	0.002	-	0.001	0.004	0.001	0.002	0.010	-	0.005
	80th Percentile	0.010	0.001	0.001	-	0.001	-	0.0001	0.001	-	0.002	-	0.001	0.004	0.001	0.002	0.010	-	0.005
	95th Percentile	0.010	0.001	0.001	-	0.001	-	0.0001	0.001	-	0.002	-	0.001	0.004	0.001	0.002	0.010	-	0.005
AQ10 / TAS10	No. of Analyses	5	6	5	5	6	4	6	6	4	6	5	5	6	6	6	5	3	6
	Mean	0.022	0.001	0.003	0.092	0.001	0.288	0.0001	0.001	0.006	0.005	0.132	0.001	0.018	0.004	0.011	0.002	0.0004	0.005
	Median	0.010	0.001	0.002	0.086	0.001	0.310	0.0001	0.000	0.005	0.005	0.060	0.001	0.008	0.002	0.008	0.000	0.0001	0.005
	Min	0.010	0.001	0.001	0.041	0.001	0.150	0.0001	0.000	0.002	0.002	0.050	0.001	0.005	0.001	0.002	0.000	0.0001	0.005
	Max	0.050	0.001	0.006	0.162	0.001	0.380	0.0001	0.001	0.010	0.007	0.300	0.001	0.047	0.008	0.030	0.010	0.0010	0.005
	80th Percentile	0.034	0.001	0.004	0.104	0.001	0.350	0.0001	0.001	0.008	0.007	0.220	0.001	0.032	0.007	0.017	0.001	0.0006	0.005
	95th Percentile	0.046	0.001	0.006	0.147	0.001	0.373	0.0001	0.001	0.010	0.007	0.280	0.001	0.043	0.008	0.027	0.008	0.0009	0.005

Table 4.58 Taroborah Creek and Tributaries - Summary of Surface Water Quality Total Metals Results

Taroborah Creek		Total Metals																	
		Al (mg/L)	Sb (mg/L)	As (mg/L)	Ba (mg/L)	Be (mg/L)	B (mg/L)	Cd (mg/L)	Cr (mg/L)	Co (mg/L)	Cu (mg/L)	Fe (mg/L)	Pb (mg/L)	Mn (mg/L)	Mo (mg/L)	Ni (mg/L)	Se (mg/L)	Ag (mg/L)	Zn (mg/L)
ANZECC Aquatic Ecosystem Values		**0.055**	**n/a**	**0.013**	**n/a**	**n/a**	**0.37**	**0.002**	**0.001**	**n/a**	**0.0014**	**n/a**	**0.0034**	**1.9**	**n/a**	**0.011**	**0.011**	**0.00005**	**0.008**
ANZECC Livestock Drinking Water Values		**5**	**n/a**	**0.5**	**n/a**	**n/a**	**5**	**0.01**	**1**	**1**	**1**	**n/a**	**1**	**n/a**	**0.15**	**1**	**0.02**	**n/a**	**20**
Site	**Statistic**																		
AQ7 / TAS7	No. of Analyses	2	2	2	1	2	1	2	2	1	2	1	2	2	2	2	2	1	2
	Mean	**1.090**	0.001	0.001	0.177	0.001	0.090	0.002	0.0004	0.003	**0.004**	2.070	0.002	0.035	0.001	0.003	0.010	**0.001**	0.007
	Median	**1.090**	0.001	0.001	0.177	0.001	0.090	0.000	0.0001	0.003	**0.004**	2.070	0.002	0.035	0.001	0.003	0.010	**0.001**	0.007
	Min	**0.180**	0.001	0.001	0.177	0.001	0.090	0.000	0.0001	0.003	**0.002**	2.070	0.001	0.006	0.001	0.001	0.010	**0.001**	0.005
	Max	**2.000**	0.001	0.001	0.177	0.001	0.090	**0.010**	0.0010	0.003	**0.005**	2.070	0.002	0.064	0.001	0.004	0.010	**0.001**	**0.009**
	80th Percentile	**1.636**	0.001	0.001	0.177	0.001	0.090	0.001	0.0006	0.003	**0.004**	2.070	0.002	0.052	0.001	0.003	0.010	**0.001**	0.008
	95th Percentile	**1.909**	0.001	0.001	0.177	0.001	0.090	**0.008**	0.0009	0.003	**0.005**	2.070	0.002	0.061	0.001	0.004	0.010	**0.001**	**0.009**
AQ10 / TAS10	No. of Analyses	6	7	6	6	7	5	7	7	5	7	6	6	6	6	6	7	6	6
	Mean	**1.953**	0.001	0.003	0.108	0.001	0.254	0.0001	**0.003**	0.007	**0.006**	1.967	0.001	0.084	0.004	**0.016**	0.003	**0.0004**	**0.014**
	Median	**0.445**	0.001	0.002	0.110	0.001	0.280	0.0001	0.001	0.009	**0.003**	0.760	0.001	0.051	0.002	**0.012**	0.001	**0.0001**	0.007
	Min	**0.070**	0.001	0.001	0.079	0.001	0.160	0.0001	0.001	0.001	**0.003**	0.250	0.001	0.021	0.001	0.002	0.000	**0.0001**	0.005
	Max	**9.120**	0.001	0.006	0.144	0.001	0.350	0.0002	**0.014**	0.015	**0.012**	8.090	0.001	0.186	0.010	**0.042**	0.010	**0.0010**	**0.039**
	80th Percentile	**1.300**	0.001	0.004	0.120	0.001	0.326	0.0001	**0.002**	0.011	**0.008**	1.560	0.001	0.172	0.008	**0.025**	0.008	**0.0010**	**0.018**
	95th Percentile	**7.165**	0.001	0.006	0.138	0.001	0.344	0.0002	**0.010**	0.014	**0.011**	6.458	0.001	0.183	0.010	**0.038**	0.010	**0.0010**	**0.034**

"Wetlands – Physio- chemical Analysis Results

The physio-chemical and biological monitoring results for several wetlands represented by sites AQ/TAS3, AQ/TAS8, AQ/TAS12 and AQ/TAS13, indicate that water exceeds the trigger values for physical and chemical stressors for tropical Australia provided in ANZECC (2000), in accordance with the Wetland WQOs (EHP 2011), and the specified guidelines for Aquatic Ecosystems (ANZECC 2000) for pH, DO, EC, TDS, oxides of Nitrogen, total Nitrogen and total Phosphorus (refer to Table 4.43and Table 4.44).

Livestock Drinking Water Guidelines were not exceeded at any wetland sites.

The pH of water determines the solubility and biological availability of chemical constituents such as nutrients (phosphorus, nitrogen, and carbon) and heavy metals (lead, copper, cadmium, etc.). The pH also determines whether aquatic life can use it. In the case of heavy metals, the degree to which they are soluble determines their toxicity. Metals tend to be more toxic at lower pH because they are more soluble.

Results indicate water bodies associated with sampling sites AQ/TAS3, AQ/TAS8, AQ/TAS12 and AQ/TAS13 are basic in nature with an average pH between these sites of 8.1, only marginally above the Wetland WQO (6.00-8.0) with a maximum pH 9.62 recorded at site AQ/TAS3.

DO levels were generally recorded outside both the ANZECC (2000) Aquatic Ecosystems Guideline (85-110%) and the Wetland WQO (90-120%). Among sites, AQ/TAS8 recorded a maximum DO gas pressure of 129%. AQ/TAS3 and AQ/TAS13 averaged 80% and 84% respectively.
Total dissolved gas pressures exceeding 115% over a period of a few hours can cause the death of any fish exposed to these conditions (Boulton and Brock 1999). This condition is termed 'gas bubble disease' and is caused by the formation of bubbles in the tissues, which eventually accumulate in the gill capillaries, killing the fish (Boulton and Brock 1999). However, DO can change considerably over a daily or diurnal period (ANZECC 2000).

Electrical Conductivity is one way to measure the inorganic materials including calcium, bicarbonate, nitrogen, phosphorus, iron, sulphur and other ions dissolved in a water body. Salinity is the component of conductivity that is critical to the survival of some aquatic plants and animals. Many species can survive only within certain salinity ranges so changes in salinity levels can result in changes to the variety and types of species found. The Wetland WQO for EC is between 90-900 µS/cm. All sites were within the Wetland WQO for EC with the exception of site AQ/TAS8, which recorded a maximum of 1110 µS/cm, but had a mean value of 582 µS/cm. All sites were within the ANZECC (2000) Aquatic Ecosystem Guideline for EC.

Nitrogen and phosphorus are two essential nutrients that are found in fresh and marine waters and are considered essential to support biological life. Eutrophication of a water body may occur during an increase of nutrient supply which can in turn lead to an abundance of algae (including toxic algal blooms) and aquatic plants. Total Nitrogen at wetland sites AQ/TAS8 and AQ/TAS12 exceeded the Wetlands WQO for total Nitrogen (0.35-1.2 mg/L). Site AQ/TAS8 recorded the highest maximum concentration of total Nitrogen of 10.6 mg/L and an average of 4.43 mg/L. The average concentration of total Nitrogen at site AQ/TAS12 was 1.55 mg/L. In addition, results indicate that total Phosphorus exceeds the Wetland WQO (0.01-0.05 mg/L) and the ANZECC (2000) Aquatic Ecosystem Guideline value of 0.5 mg/L at site AQ/TAS8 and AQ/TAS 13, maximums of 1.22 mg/L and 1.05 mg/L recorded respectively. Site AQ/TAS12 also exceedes the Wetland WQO for total Phosphorus with a maximum of 0.07 mg/L recorded.

Wetlands – Dissolved Heavy Metals

According to ANZECC (2000), the major toxic effect of metals comes from the dissolved fraction and comparison of total heavy metal concentrations are likely to overestimate the fraction that is

bioavailable in the environment. Therefore, throughout this section we discuss the filtered (dissolved) results of heavy metal concentrations and the comparisons made against the applicable trigger values.

Heavy metal analysis results for the wetlands indicate that water exceeds the ANZECC (2000) Aquatic Ecosystem Guidelines for Cu and Ag (refer to Table 4.45).

Copper

Copper (Cu) was found to exceed the ANZECC (2000) Aquatic Ecosystem Guidelines at site AQ/TAS 3. The recorded maximum of Cu was 0.003 mg/L, over twice the Aquatic Ecosystem trigger value of 0.0014 mg/L.

The observed Cu concentrations in surface waters are considered to be naturally elevated and may be due to windblown dust, decaying vegetation and forest fires, processes which are known to naturally release Cu to the environment.

Silver

The concentration of Ag was exceeded at sites AQ/TAS 3, AQ/TAS 8 and AQ/TAS 12 when compared against the ANZECC (2000) Aquatic Ecosystem Guideline of 0.00005 mg/L. No Livestock Drinking Water Guideline value has been specified for Ag.

The highest average concentration of Ag was approximately 0.0004 mg/L with a maximum concentration of 0.001 mg/L at site AQ/TAS 3 approximately 20 times higher than the ANZECC (2000) Aquatic Ecosystem Guideline.

The levels of Ag are likely to be naturally occurring or may emanate from the upstream gemstone mining operations.

Pastoral Dams – Physio- chemical Analysis Results

The Pastoral Dams are located at sampling sites AQ/TAS 4 and AQ/TAS 6. Results indicate the average pH of these sites to be 8.16 with a maximum pH of 8.37 at site AQ/TAS 4. These results indicate site AQ/TAS 4 is basic in nature and these values exceed the Nogoa River Water Quality Objectives for Freshwater Lakes / Reservoirs (pH 6.5-8.0). However, pH did not exceeded either the ANZECC (2000) aquatic ecosystem guideline values or the ANZECC (2000) Livestock Drinking Water guideline values.

DO levels were generally below the Freshwater Lakes / Reservoirs trigger value (90-110%) with an average DO concentration of 71.56% and a minimum of 46.6% at site AQ/TAS 6. The highest recorded maximum for DO was 103.9% which is within the acceptable trigger value range. The average concentration of DO was also below the ANZECC (2000) aquatic ecosystem guideline value (85-110%); however livestock drinking water guideline values have not been specified for DO.

The Freshwater Lakes / Reservoirs WQO for EC is <250 µS/cm. Results indicate that the majority of sampling rounds exceeded this value with an averaged EC of 856.75 µS/cm at site AQ/TAS 4 and 1166.90 µS/cm at site AQ/TAS 6. EC was, however, within the acceptable range specified by the ANZECC (2000) Aquatic Ecosystem Guideline (125-2200 µS/cm).

Total Nitrogen at site AQ/TAS 4 and AQ/TAS 6 exceeds the Freshwater Lakes / Reservoirs WQO for total Nitrogen (<0.35 mg/L) with an average concentration of 1.10 mg/L and 0.95 mg/L respectively. A minimum concentration of 0.5 mg/L was recorded at site AQ/TAS 6. Aquatic ecosystem guideline values and livestock drinking water guideline values have not been specified for total Nitrogen. In addition, results indicate that total Phosphorus exceeds the Freshwater Lakes / Reservoirs WQO (<0.01) with an average concentration of 0.09 mg/L at site AQ/TAS 4 and 0.17 mg/L at site AQ/TAS 6.

This WQO is considerably more stringent than the ANZECC (2000) Aquatic Ecosystem Guideline value of 0.5 mg/L which was not exceeded during any sampling event.

Pastoral Dam – Dissolved Heavy Metals

Dissolved metal analysis results for the Pastoral Dam (refer to Table 4.49) indicate that water exceeds either the ANZECC (2000) Aquatic Ecosystem Guidelines for Al, Cu, Mn and Ag.

Aluminium

Results indicate the average level of aluminium (Al) concentration at each site to be within the ANZECC (2000) Aquatic Ecosystem guideline value which is 0.055 mg/L. The maximum concentration of Al at site AQ/TAS 4 was 0.08 mg/L and 0.06 mg/L at site AQ/TAS 6, only marginally above the ANZECC (2000) trigger value for Aquatic Ecosystems. This value does not exceed the ANZECC (2000) Livestock Drinking Water trigger value of 5 mg/L.

Observed levels of Al are likely to be naturally occurring.

Copper

Copper (Cu) was found to exceed the ANZECC (2000) Aquatic Ecosystem Guidelines of 0.0014 mg/L at site AQ/TAS 4 and AQ/TAS 6.

The maximum recorded concentration of Cu was 0.002 mg/L at AQ/TAS 4 and 0.003 at AQ/TAS 6, twice the Aquatic Ecosystem Guideline. However, the average concentration of Cu at each site was below the ANZECC (2000) Aquatic Ecosystem Guideline.

The observed Cu concentrations in surface waters are considered to be naturally elevated and may be due to windblown dust, decaying vegetation and forest fires, processes which are known to naturally release Cu to the environment.

Manganese

Mn exceeded the ANZECC (2000) Aquatic Ecosystem Guideline value of 1.9 mg/L only marginally at site AQ/TAS 6. The maximum concentration of Mn recorded at this site was 2.07 mg/L. No Livestock Drinking Water Guideline value has been specified for Mn.

Observed levels of Mn are likely to be naturally occurring.

Silver

The concentration of Ag was exceeded at site AQ/TAS 4 and site AQ/TAS 6 when compared against the ANZECC (2000) Aquatic Ecosystem Guideline of 0.00005 mg/L. No Livestock Drinking Water Guideline value has been specified for Ag.

The average concentration of Ag was approximately 0.0004 mg/L at site AQ/TAS 4 with a maximum concentration of 0.001 mg/L, approximately 20 times higher than the ANZECC (2000) Aquatic Ecosystem Guideline. The average and maximum concentration of Ag at site AQ/TAS 6 was 0.001 mg/L.

Although Ag occurs naturally in it's pure free form, as an alloy with other metals and in minerals. However, most silver is produced as a by-product of copper, lead, gold and zinc refining. The levels of Ag are likely to be naturally occurring or may emanate from the upstream gemstone mining operations.

Retreat Creek – Physio- chemical Analysis Results

The physio-chemical and biological monitoring results for Retreat Creek, traversing the northern portion of the Project site, indicate that water exceeds the trigger values provided in the Lower Nogoa / Theresa Creek WQOs (EHP 2011) at several sites for pH, DO, EC, TDS, Sulfate, Nitrite,

Nitrate, total Nitrogen and total Phosphorus. The ANZECC (2000) Aquatic Ecosystem Guidelines were exceeded at several sites for pH, DO, EC and total Phosphorus and the ANZECC (2000) Livestock Drinking Water Guidelines were exceeded at several sites for TDS (refer to Table 4.51 and Table 4.52).

Results indicate water bodies associated with sampling sites AQ/TAS 5 and AQ/TAS 11 are basic in nature with an average pH between these sites of 8.53 with a maximum pH 9.08 recorded at site AQ/TAS 11.

Alkalinity is also important for fish and aquatic life because it protects or buffers against rapid pH changes. Higher alkalinity levels in surface waters will buffer acid rain and other acid wastes and prevent pH changes that are harmful to aquatic life (U.S. Geological Survey 2011). In addition, aquatic life reportedly function best in a pH range of 6.0 to 9.0, consistent with the majority of samples (Water Research Centre for Environmental Quality 2004).

DO is one of the primary determinants of fish presence in waterways located in arid regions (Glover 1982). DO levels were generally recorded within the ANZECC (2000) Aquatic Ecosystems Guideline and Lower Nogoa / Theresa Creek trigger values (85 – 110%), with the exception of several sites (AQ/TAS 1, AQ/TAS 2, and AQ/TAS 11) which exhibited low DO concentrations with an average concentration between these sites of approximately 68 %. The highest recorded maximum for DO was 145 % at site AQ/TAS 5. Total dissolved gas pressures exceeding 115% over a period of a few hours can cause the death of any fish exposed to these conditions (Boulton and Brock 1999). This condition is termed 'gas bubble disease' and is caused by the formation of bubbles in the tissues, which eventually accumulate in the gill capillaries, killing the fish (Boulton and Brock 1999). However, DO can change considerably, over a daily or diurnal period (ANZECC 2000).

Electrical Conductivity is one way to measure the inorganic materials including calcium, bicarbonate, nitrogen, phosphorus, iron, sulphur and other ions dissolved in a water body. Salinity is the component of conductivity that is critical to the survival of some aquatic plants and animals. Many species can survive only within certain salinity ranges so changes in salinity levels can result in changes to the variety and types of species found. The Lower Nogoa / Theresa Creek WQOs for EC are 250-340 µS/cm which are considerably more stringent than the ANZECC (2000) Aquatic Ecosystem Guidelines of 125-2,200 µS/cm. All sites were outside the Lower Nogoa / Theresa Creek WQO for EC with the average EC ranging between 768 µS/cm (AQ/TAS 5) and 2,302 µS/cm (AQ/TAS 11). One site, AQ/TAS 11 also exceeded the ANZECC (2000) Aquatic Ecosystem Guideline with a maximum of 3,793 µS/cm.

Retreat Creek – Heavy Metals

Heavy metal analysis results for Retreat Creek indicate that water exceeds either the ANZECC (2000) Aquatic Ecosystem Guidelines, the ANZECC (2000) Livestock Drinking Water Guidelines or both for Al, Cu, Mn, Ag and Zn (refer to Table 4.53).

Aluminium

Results from the metal analysis indicate locations AQ/TAS 2 and AQ/TAS 5 to be experiencing elevated levels of dissolved Al, exceeding the trigger values outlined in the ANZECC (2000) Guidelines for Aquatic Ecosystems Values.

Results indicate levels of Al to be up to 1.8 times higher than Aquatic Ecosystems guideline value of 0.055 mg/L, with site AQ/TAS 2 experiencing the highest level of Al returning a result of 0.1 mg/L.

These sampling sites occur within Retreat Creek, which flows in an easterly direction and has the potential to affect Theresa Creek and Nogoa River.

In the absence of industrial or mining disturbance, with no known history of or reason for contamination, the levels of Al are likely to be naturally occurring or may emanate from the upstream gemstone mining operations.

Copper

Copper (Cu) was found to exceed the ANZECC (2000) Aquatic Ecosystem Guidelines of 0.0014 mg/L at site AQ/TAS 11 and site AQ/TAS 5.

The average concentration of Cu at site AQ/TAS 5 was 0.002 mg/L (1.4 times higher than ANZECC (2000) Aquatic Ecosystem Guideline). Between sites AQ/TAS 5 and AQ/TAS 11 the average concentration of Cu was 0.0025 mg/L with a recorded maximum of 0.007 mg/L at site AQ/TAS 5, five times the ANZECC (2000) Aquatic Ecosystem Guideline for Cu.

The observed Cu concentrations in surface waters are considered to be naturally elevated and may be due to windblown dust, decaying vegetation and forest fires, processes which are known to naturally release Cu to the environment.

Manganese

Manganese (Mn) was elevated at site AQ/TAS 5, in comparison to the ANZECC (2000) Aquatic Ecosystem Guideline trigger value of 1.9 mg/L. The maximum concentration of Mn at AQ/TAS 5 was 2.45 mg/L.

A total of three samples were collected between 2011 and 2013 at this site and average concentrations were found to be lower than the ANZECC (2000) Aquatic Ecosystem Guideline trigger value with the highest average concentration of only 1.25 mg/L recorded.

Mn is considered to be naturally elevated.

Silver

Silver (Ag) exceeded the ANZECC (2000) Aquatic Ecosystem Guidelines of 0.00005 mg/L at sites AQ/TAS2 and AQ/TAS 5. Each of these sites recorded a maximum concentration of 0.0001 mg/L, 20 times higher than the guideline value.

Zinc

Zinc (Zn) concentrations were found to be elevated at three sites AQ/TAS 1, AQ/TAS 2 and AQ/TAS 11 in comparison to the ANZECC (2000) Aquatic Ecosystem Guideline of 0.008 mg/L. The average concentration of Zn across the three sites was 0.007 mg/L which is lower than the trigger value. The maximum concentration of Zn was recorded at site AQ/TAS 1 (0.018 mg/L), approximately twice the guideline value.

<u>*Taroborah Creek – Physio- chemical Analysis Results*</u>

The physio-chemical and biological monitoring results for Taroborah Creek, traversing the southern proportion of the Project site, are similar to the results observed for Retreat Creek and indicate that water exceeds the trigger values provided in either the Lower Nogoa / Theresa Creek WQOs (EHP 2011), the ANZECC (2000) Aquatic Ecosystem 95% species protection Guidelines, or both at sites AQ/TAS 7 and AQ/TAS 10 for one or more of the following parameters: pH, DO, EC, TDS, Sulfate, Nitrite, Nitrate, total Nitrogen and total Phosphorus (refer to Table 4.55and Table 4.56). The ANZECC (2000) Livestock Drinking Water Guidelines were exceeded at AQ/TAS 10 for TDS (refer to Table 4.55)

Results indicate water bodies associated with sampling sites AQ/TAS 7 and AQ/TAS 10 are basic in nature with an average pH between these sites of 8.78 with a maximum pH of 9.29 recorded at site AQ/TAS 10.

DO levels varied across each site with average concentrations of 67% at site AQ/TAS 7 and 140% at AQ/TAS 10 both outside the WQOs for both the ANZECC (2000) Aquatic Ecosystems Guideline and Lower Nogoa / Theresa Creek trigger values (85 – 110%).

EC values for sites AQ/TAS 7 and AQ/TAS 10 were also outside the Lower Nogoa / Theresa Creek WQO for EC (250-340 µS/cm) with average measurements of 988 µS/c and 2,285 µS/cm recorded respectively. It can be seen from these results that the average measured EC value recorded at site AQ/TAS 10 exceeded the ANZECC (2000) Aquatic Ecosystem Guideline of 125-2,200 µS/cm by 85 µS/cm.

TDS was exceeded at both sites on Taroborah Creek however; one site AQ/TAS 10 also exceeded the ANZECC (2000) Livestock Drinking Water Guideline of 1,000 NTU with a maximum NTU of 2,795 recorded and an average of 1,787 NTU.

Taroborah Creek – Dissolved Heavy Metals

Results from the heavy metal analysis indicated elevated levels of B, Cu, Ni, and Ag at site AQ/TAS 10 with exceedances of Cu only experienced at site AQ/TAS 7 in comparison to the ANZECC (2000) Aquatic Ecosystem 95% species protection Guidelines (refer to Table 4.57).

Boron

Results indicate site AQ/TAS 10 had marginally elevated levels of Boron (B) when compared to the ANZECC (2000) Aquatic Ecosystem Guideline of 0.37 mg/L with a maximum recording of 0.38 mg/L. However, the average concentration of B was found to be only 0.28 mg/L which is within guideline trigger values.

Copper

The ANZECC (2000) Aquatic Ecosystem Guideline for Cu is 0.0014 mg/L and was exceeded at site AQ/TAS 7 which recorded a concentration of 0.002 mg/L during the single sampling event which took place. In addition, site AQ/TAS 10 also exceeded the ANZECC (2000) Aquatic Ecosystem Guideline for Cu with an average concentration of 0.005 mg/L and a maximum of 0.007 mg/L recorded, five times the guideline value.

Nickel

Although the average concentration of dissolved Nickel at site AQ/TAS10 was within the ANZECC (2000) Aquatic Ecosystem Guideline of 0.011 mg/L, the maximum concentration recorded at this site was 0.03 mg/L, almost three times the guideline limit.

Nickel occurs naturally in soils and is released to the atmosphere by windblown dust, combustion of fuel, municipal incineration and industries involved in steel production. In consideration to the rural setting of the Project and the absence of smelting and other nickel refining processes it is determined elevated levels of Nickel may be naturally occurring.

Silver

Elevated levels of Ag were also recorded at site AQ/TAS 10 consistent with the majority of results at various sampling sites. The maximum concentration of Ag recorded was 0.0006 mg/L, 12 times the guideline limit of 0.00005 mg/L.

Statistical Significance

The range of samples collected from the Pastoral Dam, the Wetlands, Retreat Creek and Taroborah Creek spans from one to seven samples per site.

It is currently understood that sample sizes less than about five tend to give rise to very inaccurate results and in practice, percentiles based on small numbers of samples would give rise to more stringent guidelines (QWQG 2009).

As error values tend to level off at around 15–20 data values, it is suggested this number of samples is sufficient to provide a reasonable estimate of the true percentile value (QWQG 2009). Research suggests 15–20 data values are applicable to most water quality indicators in accordance with the QWQG (2009).

The interpretation of data provided from wet and dry season surveys indicates a likely baseline condition for the Project site, however, in accordance with the QWQG this database is not absolute and may not be indicative of the reference condition of water ways associated with the Project site.

Although four sites (AQ/TAS 2, AQ/TAS 3, AQ/TAS 4 and AQ/TAS 11) have been sampled in excess of five times each, and thus these results should be considered statistically significant, further sampling will be required before a complete statistically significant database can be considered representative of the Project site."

5.21 Section 4.5.1.2, Page 4-229 – Groundwater - Quality

Submitter:

Department of Environment and Heritage Protection

Submission:

The groundwater in the region of the mine has been insufficiently characterised. Apart from the Aldebaran Sandstone geology with course grained lithology (with six samples) all other geologies/lithologies are poorly represented (one or two samples). For example, there are only two groundwater samples taken from the coal seam B and only one from coal seam A. Given that groundwater quality would differ across different geologies, as well as over time, one or two samples to represent a geological area at one point in time is inadequate to capture the potential variability in water quality within the geological area of the mine. Furthermore, there was only one sample per site so potential temporal variability at the site was not captured by the current background sampling presented in the EIS.

Groundwater should continue to be monitored prior to mine construction and operation in order to characterise the potential temporal and spatial variability of groundwater quality at the site. As a guide, the same data requirements for deriving local surface water quality guidelines should be applied when characterising background groundwater quality (see Table 4.4.2, page 78 of the Queensland Water Quality Guidelines (EHP 2013)).

Response:

Groundwater quality will continue to be sampled and monitored through the existing 19 bore network. There are earlier water quality tests that have now been included in the data set from the TAR boreholes, and another round of quality testing for the monitoring bore network that was completed in May 2014 has been included. And the results from a recently completed round of testing in September 2014 are provided as Attachment C to this response document

The preponderance of sampling has been taken from the coarse grained Aldebaran sandstone unit because that is the major aquifer in the Project area and the aquifer that will contribute to groundwater make in the mining operations. As the investigations to date have determined, the A seam is generally the same aquifer as the Aldebaran due to their close stratigraphic proximity and similar potentiometric water levels and water quality. On the other hand, the B seam may or may not be interconnected depending on the geology of

the interval between them.

EIS Amendment:

Table 4.57 (now Table 4-67) has been amended to include the average groundwater quality of the various aquifer units based on the expanded sampling database, as shown below.

Parameter	Statistic	Aldebaran Sandstone			Tertiary Regolith	Tertiary Basalt	Alluvium
		CG	FG	Coal			
Field EC @ 25 ^{0}C (µS/cm)	Avg.	1,435	1,765	2,301	2,059	1,354	1,431
	Min.	546	782	1,570	1,430	1,315	917
	Max.	2,572	3,130	3,180	2,533	1,380	1,775
Field Total Dissolved Solids (mg/L)	Avg.	848	1,060	1,415	1,186	793	853
	Min.	471	403	1,010	789	676	605
	Max.	1,590	1,990	2,000	1,410	910	1,010
Field pH (pH units)	Avg.	8	9	8	8	7	7
	Min.	7	7	7	7	7	6
	Max.	9	11	8	8	7	8
Calcium (mg/L)	Avg.	56	36	66	58	77	52
	Min.	17	2	37	30	71	34
	Max.	128	58	97	70	85	77
Magnesium (mg/L)	Avg.	55	25	81	116	107	52
	Min.	3	1	47	81	98	29
	Max.	89	47	129	163	116	78
Sodium (mg/L)	Avg.	167	253	273	213	72	186
	Min.	66	101	151	122	69	123
	Max.	494	482	354	257	74	262
Bicarbonate (mg/L)	Avg.	442	150	301	512	687	389
	Min.	21	1	245	398	629	225
	Max.	1,180	276	416	620	778	641
Chloride (mg/L)	Avg.	231	329	490	324	65	216
	Min.	48	124	291	129	52	134
	Max.	903	560	718	497	73	338
Sulfate (mg/L)	Avg.	41	131	125	81	22	64
	Min.	6	37	66	7	20	37
	Max.	156	293	198	131	25	84
Number of Samples		17	5	6	5	3	4

Note: CG – coarse grained sandstone
FG – fine grained sandstone

See other amendments regarding groundwater quality under Section 13.7 of this response document.

5.22 Section 4.5.1.2, Page 4-250 & Appendix 14, Page 26 – Groundwater - Quality

Submitter:

Department of Environment and Heritage Protection

Submission:

The text on page 4-250 of Chapter 4.5 and page 26 of Appendix 14 refers to electrical conductivity in mg/L, which is incorrect.

For electrical conductivity the preferred unit should be µS/cm which corresponds with the units for water quality objectives in the Environmental Protection (Water) Policy 2009 Nogoa River Sub-basin Environmental Values and Water Quality Objectives No. 130 (EHP 2013) and Queensland Water Quality Guidelines (EHP 2013a).

The units in the referenced text should be amended to show the correct units.

Response:

The reference to EC in the draft EIS in this instance was a typographical error and should have been TDS, consistent with the rest of the discussion on salinity. Nonetheless, all discussion on the salinity of groundwater in Section 4.5.1.2 and in Section 7.1 of Appendix 14 now refers to salinity in terms of EC as measured in µS/cm.

EIS Amendment:

Discussion on the salinity of groundwater in Section 4.5.1.2 of the final EIS, beginning with the sixth paragraph under the Groundwater Quality sub-heading, reads as follows:

"Salinity is a key constraint to water management and groundwater use, and can be categorised by electrical conductivity (EC)..

The results for field salinity indicate that groundwater within the Quaternary alluvium is slightly brackish to brackish, with an average EC of 1,400 µS/cm. The coarse grained sandstone is generally less saline than the alluvium, with fresh water quality recorded at TAR249_C in 2014, and a larger number of samples classified as slightly brackish.

The A and B coal seams have brackish water quality, with an average EC of 2,300 µS/cm. EC of the coal seams is comparatively low for the Bowen Basin, which can typically vary from 5000 µS/cm to over 50,000 µS/cm. The lower EC of the A and B seams is likely related to leakage of 'fresher groundwater' from the immediately overlying pebbly coarse sandstone unit and from rainfall infiltration where it occurs at sub-crop to the south."

And Section 7.1 of Appendix 14 has been retitled "Electrical Conductivity" and now reads as follows:

"Table 6 summaries the major ion concentrations for the groundwater units. Data represented is derived from three sampling events in late 2009, March / April 2013 and May 2014. The data provides a period of baseline groundwater quality and captures some seasonal or temporal variation.

The results indicate that the groundwater within the alluvium and Tertiary basalt are generally fresher than the regolith and Aldebaran Sandstone units, with lower major ion concentrations.

Salinity is a key constraint to water management and groundwater use and can be determined indirectly by measuring Electrical conductivity (EC) of water samples. The following EC ranges (µS/cm) are commonly used to categorise salinity:

- Fresh 0 µS/cm to 750 µS/cm;
- Slightly brackish 750 µS/cm to 1,500 µS/cm;

- Brackish 1,500 µS/cm to 4,550 µS/cm;
- Moderately saline 4,550 µS/cm to 10,600 µS/cm;
- Saline 10,600 µS/cm to 21,200 µS/cm; and
- Highly saline 21,200 µS/cm to 53,000 µS/cm.

Figure 14 presents a histogram of the available EC data classified according to this system. The distribution of EC values shows that groundwater quality across the Project area generally varies from slightly brackish to brackish.

Table 6: SUMMARY OF WATER QUALITY RESULTS – ALL GEOLOGICAL UNITS

Parameter	Statistic	Aldebaran Sandstone			Tertiary regolith	Tertiary basalt	Alluvium
		CG	FG	Coal			
Field EC @ 25°C (µS/cm)	Avg.	1,435	1,765	2,301	2,059	1,354	1,431
	Min.	546	782	1,570	1,430	1,315	917
	Max.	2,572	3,130	3,180	2,533	1,380	1,775
Total Dissolved Solids (mg/L)	Avg.	848	1,060	1,415	1,186	793	853
	Min.	471	403	1,010	789	676	605
	Max.	1,590	1,990	2,000	1,410	910	1,010
Field pH (pH units)	Avg.	8	9	8	8	7	7
	Min.	7	7	7	7	7	6
	Max.	9	11	8	8	7	8
Calcium (mg/L)	Avg.	56	36	66	58	77	52
	Min.	17	2	37	30	71	34
	Max.	128	58	97	70	85	77
Magnesium (mg/L)	Avg.	55	25	81	116	107	52
	Min.	3	1	47	81	98	29
	Max.	89	47	129	163	116	78
Sodium (mg/L)	Avg.	167	253	273	213	72	186
	Min.	66	101	151	122	69	123
	Max.	494	482	354	257	74	262
Bicarbonate (mg/L)	Avg.	442	150	301	512	687	389
	Min.	21	1	245	398	629	225
	Max.	1,180	276	416	620	778	641
Chloride (mg/L)	Avg.	231	329	490	324	65	216
	Min.	48	124	291	129	52	134
	Max.	903	560	718	497	73	338
Sulfate (mg/L)	Avg.	41	131	125	81	22	64
	Min.	6	37	66	7	20	37
	Max.	156	293	198	131	25	84
Number of Samples		17	5	6	5	3	4

Note: *CG – coarse grained sandstone*
FG – fine grained sandstone

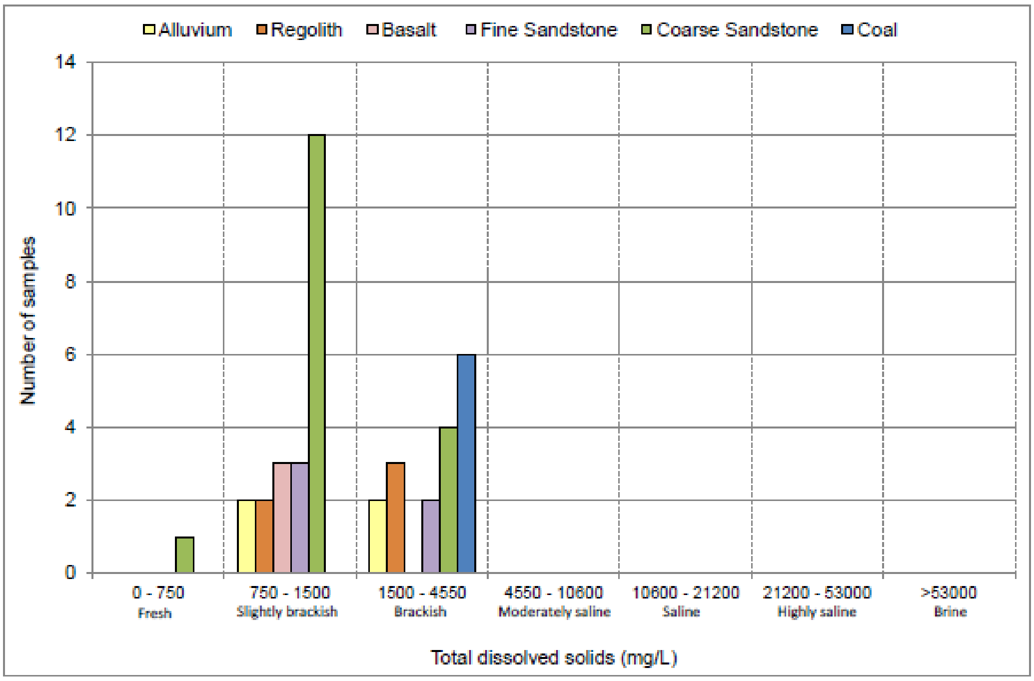


Figure 14: EC Histogram – All Geological Units

The results for field EC shown in Figure 14 indicate that groundwater within the Quaternary alluvium is slightly brackish to brackish, with an average EC of 1,400 µS/cm. The coarse grained sandstone is generally less saline than the alluvium, with fresh water quality recorded at TAR249_C in 2014, and a larger number of samples classified as slightly brackish.

The A and B coal seams have brackish water quality with an average EC of 2,300 µS/cm. EC of the coal seams is comparatively low for the Bowen Basin, which can typically vary from 5000 µS/cm to over 50,000 µS/cm. The lower EC of the A and B seams is likely related to leakage of 'fresher groundwater' from the immediately overlying pebbly coarse sandstone unit and from rainfall infiltration where it occurs at sub-crop to the south.

A significant portion of the EC dataset exceeds the 80th percentile limit that is specified for deep (> 30 m) groundwater quality objectives in the Nogoa River / Theresa Creek sub-basin (see Section 9.1). Major ion exceedances include Na, Ca, Mg, HCO3, Cl and SO4. A number of minor ions and metals also exceed the water quality objectives defined in Section 9.1. This assessment indicates that future assessment of the groundwater quality should be undertaken based on baseline (pre-mining) data and not the specified water quality objectives."

5.23 Section 4.5.2.1 & Appendix 13 - Surface Water - Quality Impact

Submitter:

SunWater

Submission:

Due to the proximity of the project area to Taroborah Creek which eventually flows into the Nogoa River, SunWater has concerns with the potential impacts on water quality. Immediately downstream of the St Helens Creek confluence is the intake for the Selma pipeline and town water supply system of Emerald. As you may be aware, any adverse impacts on water quality due to discharges of mine affected water from the project site have the potential to impact urban, industrial and agricultural customers.

Response:

The sensitivity of water quality emanating from Taroborah Creek that could enter the Emerald water supply is understood by the Proponent and has factored into the planned

water management system for the Project from the outset. This is why no release of potentially mine affected water is planned to occur within Taroborah Creek and why the major water containment structures will be designed to withstand at least 1 in 100 ARI storm events.

EIS Amendment:

None Required

5.24 Section 4.5.2.2, Page 4-276 & Section 6.5, Page 6-8 - Groundwater Monitoring

Submitter:

Department Natural Resources and Mines

Submission

Table 4.62 in Section 4.5.2.2 and Table 6.6 in Section 6.5 of the EIS indicate that 12 bores are proposed to be monitored. This differs to the proposed 19 monitoring bore network presented in Table 8 page 40 of Appendix 14:

Response:

The network of 19 monitoring bores included in Table 8 of Appendix 14 is not the final proposed network, but rather, a listing of all of the bores where piezometers have been installed. The proposed monitoring network in the body of the report are those bores that are considered relevant for long term monitoring, as MB06 and MB07 did not encounter water when installed and still remain dry to date, MB05 is adjacent to TAR189C and they are considered to be hydraulically connected, MB02C and MB04C are adjacent to MB02S and MB04S, respectively, and are considered to be hydraulically connected, and TAR053 and TAR016C will be interfered with during initial mining operations and most likely become unusable. Nonetheless, data from all of the installed monitoring bores has been collected to date and the proposed network will be increased to include all monitoring bores within the project area, and the relevant tables and figures in the final EIS report will be updated accordingly. Further, it is acknowledged by the Proponent that a monitoring network will need to be approved by DNRM and incorporated into the conditions of any future water licence.

EIS Amendment:

The following paragraph has been added in Appendix 14 in front of Table 8 (now Table 9):

"The network of 19 monitoring bores summarised below is not the final proposed monitoring network for the mine, but a list of all sites where monitoring bores have been installed. These bores are considered relevant for long term monitoring. It is acknowledged by the Proponent that a monitoring network will need to be approved by DNRM and incorporated into the conditions of any future water licence or environmental authority. The monitoring plan will be designed in accordance with ANZECC and DEHP guidelines to consider the risk to the environment and the environmental value of the groundwater resources."

And Table 4.62 (now Table 4.74) in Section 4.5.2.2 and Table 6.4 in Section 6.5 have been amended to include all 19 monitoring bores.

5.25 Section 4.5.2.3, Page 4-281 - Site Water Management – Site Water

Submitter:

Department of Environment and Heritage Protection

Submission:

One of the assumptions of the Goldsim water balance model on page 4-281 was:

"The groundwater dewatering system will cease (i.e. groundwater will be transferred to beneficial farm users) when the accumulation of storage in the MWD reaches 900 ML and resume when the storage is below 900 ML."

However, there was no assessment of whether the excess groundwater is suitable for irrigation use (e.g. a comparison of groundwater quality with the irrigation WQOs), or if there is a demonstrated demand for the water over the mines' lifetime. This issue is further compounded by the lack of groundwater data in the EIS to adequately characterise the variability in groundwater quality.

Recommendation: Either re-run the Goldsim model without the above assumption or conduct an impact assessment with more up-to-date groundwater monitoring data that considers irrigation as an EV.

Response:

An additional two rounds of groundwater quality test results has been completed and both sets of results are compared to ANZECC 2000 irrigation WQOs in Table A-4 and Table A-5 in Appendix A of EIS Appendix 14. A third set of water quality results are included as Attachment C to this response and provide similar quality parameters.

What the comparison indicates is that quality of the deeper groundwater emanating from the Permian aquifers, which will be the groundwater reporting to the mine workings and pumped to the MWD, is generally suitable in terms of pH, salinity, sodicity, and trace elements for both stock watering purposes and also for the normal flood irrigation systems utilised in the Emerald area. While isolated bores indicate minor exceedances of certain WQOs for irrigation, the exceedances are not consistent from bore to bore (i.e. widespread), and the expected release volume levels (2-4ML/day) are such that, when mixed with the normal volumes of water flowing in the Selma (western) irrigation system at the release point (165-180ML/day), the release of the excess groundwater will not result in contamination of the irrigation water system.

EIS Amendment:

Second sentence of last paragraph on page 4-281 (now second paragraph on page 4-290) of Section 4.5.2.3 amended to include:

"The quality of the groundwater is suitable for both stock watering and crop irrigation purposes (when mixed in proportionately small quantities with normal irrigation water from Fairbairn Dam) as indicated in Appendix 14…"

A fourth sentence is added to the following paragraph to the above that reads:

"Maximum discharge rates of approximately 2-4ML/day would not affect the quality of the typical 165-180ML/day of Fairbairn Dam water already flowing in the channel."

A new set of water quality data is added as Table A-5 in Appendix A of EIS Appendix 14, and both Table A-4 and Table A-5 include WQOs for irrigation and stock watering for comparison.

5.26 Section 4.7.2.1, Page 4-346 to 4-348 - Predicted Noise Emissions

Submitter:

Department of Environment and Heritage Protection

Submission:

The predicted noise levels in Figures 4.109 to 4.111 exceed the proposed noise limits at a number of sensitive receptors.

Provide further information about how the proponent intends to address the predicted noise exceedances.

Response:

As discussed in section 4.7.2.2 of the report, the most sensitive noise receptors (Donelley, Iona and St Helens) will be bought out or otherwise compensated. Walther is only affected at night time under adverse meteorological conditions, and it is expected that adjustment of mining methods during these adverse times and/or further noise barrier solutions will be able to reduce the approximate 10% exceedance projected.

EIS Amendment:

None required

5.27 Section 4.8.2.1, Page 4-402, Section 5.7 3.1, Page 5-66 & Appendix 18, Page 87 - Impacts to Threatened Ecological Communities

Submitter:

Federal Department of the Environment

Submission:

Clarification is sought on potential impacts to Brigalow (Acacia harpophylla dominant and co- dominant) threatened ecological community. In particular, Table 4.95 indicates the total disturbance area including subsidence to the described Brigalow / Belah Low Open Woodland (Vegetation Community 10) would be 8.5 hectares, however Table 5.12 indicates total disturbance area would be 0 hectares

Response:

The disturbance of 8.5ha to Community 10 in Table 4.95 is incorrect and needs to be corrected. Community 10 is not disturbed by subsidence or any other mining activities in any way.

Table 19 in Appendix 18 also needs correcting.

EIS Amendment:

Table 4.95 on page 4-402 (now Table 4.113 on page 4-424) in Section 4.8.3.1 in the EIS main body report and Table 19 on page 87 (now page 86) in Appendix 18 of the EIS report are amended to read as follows:

	Vegetation Community	Regional Ecosystem Equivalents	VM Act Status	EHP Biodiversity Status	EPBC Act Status	Total Area (ha)	Total Disturbance Area including Subsidence (ha)	Total Area to be Cleared (ha)
1	River Red Gum Riparian Woodland	RE 11.3.25	Least Concern	Of Concern	-	190.1	0	0
2	River Teatree Riparian Woodland	RE 11.3.3a	Of Concern	Of Concern	-	143.0	0	0
3	Lancewood Woodland	RE 11.10.3	Least Concern	No Concern	-	95.2	11.2	0
4	Brigalow Woodland	RE 11.9.1	Endangered	Endangered	Endangered	72.6	2.76	2.76
5	Dawson Gum Open Woodland	RE 11.4.8	Endangered	Endangered	Endangered	31.2	0	0
6	Silver-leaved Ironbark Open Woodland	RE 11.5.3	Least Concern	No Concern	-	191.2	31.9	0
7	Silver-leaved Ironbark Open Woodland	RE 11.3.6	Least Concern	Of Concern	-	33.2	33.2	0
8	Poplar Box Open Woodland	RE11.9.10	Of Concern	Endangered	-	130.9	67.0	0
9	Belah Low Open Woodland	RE 11.4.9*	-	-	-	4.1	4.1	0
10	Brigalow / Belah Low Open Woodland	RE 11.4.9	Endangered	Endangered	Endangered	8.5	0	0
11	Non-remnant Grassland	-	-	-	-	5,632.5	1701.6	314.11
12	Palustrine Wetlands	RE 11.3.27h	Least Concern	Of Concern	-	112.5	0	0
13	Lacustrine Wetlands	-	-	-	-	32.2	27.41	0
n/a	Potential Natural Grassland	RE 11.8.11	Of Concern	Of Concern	Endangered	163.5	0	149.43

5.28 Section 4.8.3.3, Page 4-405 – Management of Aquatic Values

Submitter:

Federal Department of the Environment

Submission:

Section 52 of the Environmental Protection Regulation 2008 requires adequate buffer zones between site activities and sensitive areas. The management strategies proposed in Section 4.8.3.3 to minimise the impacts on aquatic flora and fauna include a 50m buffer zone around sensitive regional ecosystems. However, proposed buffer zones between the work area and the adjacent State forest, wetlands and riparian areas have not been discussed or shown on maps.

Recommendation: Amend the management measures to include proposed buffer zones around the State forest, wetlands and riparian areas, including maps at a suitable scale.

Response:

A buffer zone of 50m is now proposed along the Project boundary with the State forest and the other sensitive regional ecosystems. Except for endangered brigalow woodland, all mine infrastructure has been designed (or will be in the final design) to honour these buffer zones.

EIS Amendment:

The fifth bullet point on page 4-405 (now page 4-428) in Section 4.8.3.3 of the EIS main body report has been amended to read as follows:

- "Project disturbances will be progressively rehabilitated on completion of work. Where possible, a 50m buffer zone has been be implemented around sensitive aquatic ecosystems as illustrated in Figure 4.122; and"

And the following figure has been added as Figure 4.126 in Section 4.8.3.3.

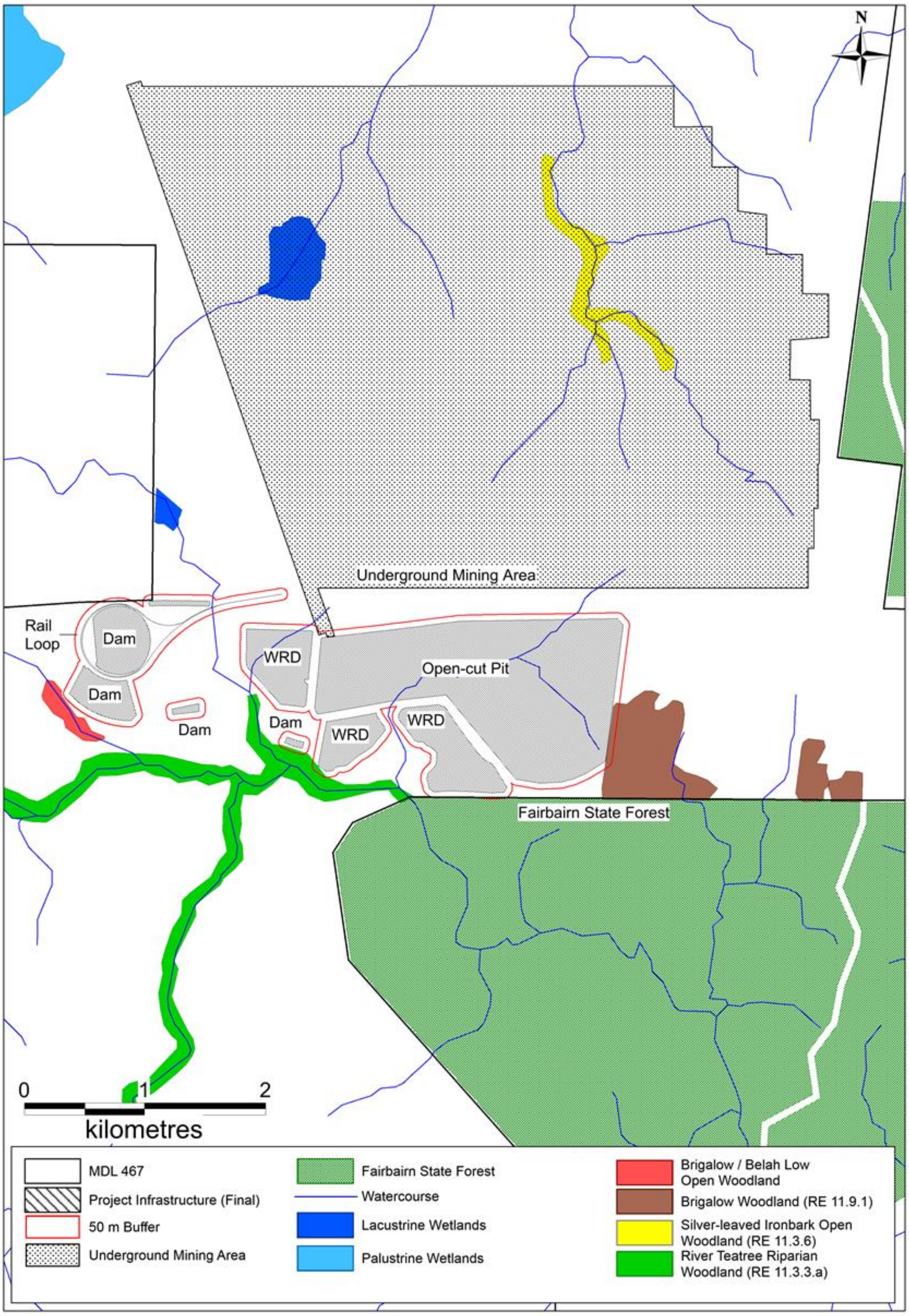


Figure 4.122 Infrastructure Buffer Zone (50 m)

5.29 Section 4.10.2, Page 4-482 & Appendix 23, SIMP Section 6.5, Page 33 - Social Impact Assessment and Management - Business and Enterprises

Submitter:

Department of State Development, Infrastructure and Planning (DSDIP)

Submission:

The proponent has elected to adopt the Queensland Resources and Energy Sector Code of Practice and stated it will encourage local businesses to supply to the project through liaison with ICN, Chamber of Commerce and Central Highlands Development Corporation. Regional Services, DSDIP, works with proponents to develop local industry plans, local buy programs and works with potential local suppliers to, for example, build their capability, develop capability statements, management systems and/or identify compliance requirements. In the experience of Regional Services, DSDIP, the ICN Gateway is difficult for small and medium-sized enterprises (SMEs) to navigate and has limited application in relation to work packages of the size for which local SMEs could bid. Regional Services, DSDIP, can work in partnership with the proponent to deliver the Accessing Supply Chain Opportunities (ASCO) program which would be tailored to the specific supply chain needs of the project and provide capacity building for local and regional companies to ensure SMEs have fair and reasonable access to tender for work packages.

Regional Services, DSDIP, can host Opportunity Forums for the proponent and connect with businesses in the region to ensure a good coverage of tier 3 to 5 or 6.

Recommendation:

Identify Regional Services, DSDIP, as a stakeholder in developing a local content plan including engagement mechanisms to disseminate opportunities, identify local business capability and work with businesses on capability development including capability statements to maximise opportunities for local suppliers.

Response:

The Proponent, by reference to Qld govt as a stakeholder under Business and Enterprise in Section 4.10.2, surely intended this to include DSDIP, and this reference will be changed to DSDIP in the final EIS document.

EIS Amendment:

The first action item under Section 6.5 in Appendix 23 – Social Impact Management Plan has been amended to read as follows.

Action	Performance Indicator	Timeframe*	Responsible Party
Develop and implement a detailed Local Content Plan for Taroborah, with support from ICN, the Central Highlands Development Corporation (CHDC), Regional Services of the Department of State Development and Infrastructure planning (DSDIP) and other key industry and employment organisations. The plan will include the following actions:	Plan developed and implemented	Before project start-up Ongoing	Shenhuo, ICN, CHDC, DSDIP

And the Business and Enterprise entry in Table 4.123 (now Table 4.142) in Section 4.10.2 of the EIS main body report has been amended to read as follows:

Impact	Pre-mitigation: Nature (P/N)	Pre-mitigation: Probability (H/M/L)	Pre-mitigation: Consequence (H/M/L)	Stakeholder	Mitigation/ Opportunity	Post mitigation: Long-term risk (H/M/L)
BUSINESS AND ENTERPRISE Local businesses have been under pressure since the Global Financial Crisis and subsequent mining industry downturn, so are actively seeking commercial opportunities. The Project will encourage local businesses to tender for supplies and services during both construction and operation. The Project will liaise with the Industry Capability Network (ICN), Regional Services of the Department of State Development and Infrastructure Planning and local business groups, such as the local Chamber of Commerce and Central Highlands Development Corporation (CHDC), in order to facilitate participation by local suppliers.	P	H	H	• DSDIP, Regional Services • ICN • CHRC • COC • CHDC • Local businesses • Indigenous businesses	• Work with ICN and local business groups to maximise local business skills for project participation • Communicate clear prequalification requirements to local businesses and provide mentoring/training where required	L

5.30 Section 4.10.2, Social Impact Assessment and Management Community Engagement

Submitter:

Queensland Ambulance Services

Submission:

The QAS will provide a representative for future key stakeholder meetings when operationally convenient. Details of meetings can be sent to the Officer-in-Charge, Emerald via email: QASEmerald.OIC.@ambulance.qld.gov.au.

Response:

Acknowledged

EIS Amendment:

None required

5.31 Section 4.10 & Section 4.12 - Social Impact & Economic Impact

Submitter:

Department of Aboriginal and Torres Strait Islander and Multicultural Affairs (DATSIMA)

Submissions:

Within Sections 4.10 and 4.12 there is no mention of any face to face contact with Aboriginal People in a culturally safe environment and manner.

DATSIMA recommends that such contact be incorporated within these Sections.

Response:

Acknowledged, and discussion on personal contact with Aboriginal People is included in Section 4.10 of the final EIS. Note that there is no reference to stakeholder consultation of any kind in Section 4.12, so the reference to Section 4.12 in this submission is not considered relevant to this recommendation.

EIS Amendment:

The following has been added as an additional paragraph in Section 4.10.1.2 of the EIS main body report.

"In addition to regular liaison with Traditional Owner groups, consultation was undertaken with a range of local Indigenous stakeholders – including the Queensland Department of Aboriginal and Torres Strait Islander and Multicultural Affairs (DATSIMA), the Central Highlands Aboriginal Corporation and local health service providers - to understand Indigenous health, education and employment issues across the region. All communication with Indigenous stakeholders was carried out in a respectful and welcoming manner, an approach that is reinforced in the Project's Indigenous Participation Plan outline (refer to Appendix B of Appendix 23 - Taroborah Social Impact Management Plan)."

5.32 Section 4.12.1.2, Page 4-506 - Socio Economic Profile

Submitter:

Department of Aboriginal and Torres Strait Islander and Multicultural Affairs

Submission:

There is no mention of Aboriginal employment or unemployment rates;

There is no mention of Aboriginal employment classifications;

DATSIMA recommends the development of an Aboriginal and Torres Strait Islander Action Plan that:

- Identifies opportunities for Training and employment supported by funding for training to up skill.
- Identifies traineeships and apprenticeships fulltime, part time and school based.
- Identifies opportunities for cadetships.
- Identifies business development and contracting opportunities and the support to ensure ongoing development.
- Identifies and manage potential barriers to success and initiatives necessary to support success.

Aligns with existing programs and resources that enhance Aboriginal and Torres Strait Islander employment opportunities.

Response:

There is no mention of employment or unemployment rates nor employment classification for any particular culture or ethnic background in Section 4.12.1.2, as the discussion in this section is related to the Central Highlands as a whole. However, there is mention of Aboriginal employment and unemployment rates, education and other demographics in Section 4.10.1.11 and in Appendix 23 - Taroborah Social Impact Assessment. This will be referred to in Section 4.12.1.2.

Further, as recommended, an Indigenous Participation Plan outline has been developed and is now an Appendix to the Taroborah Social Impact Management Plan.

EIS Amendment:

The following sentence has been added to the first paragraph in Section 4.12.1.2 of the EIS main body report.

“Further detail on social and cultural values and demographics can be found in Section 4.10 and Appendix 23.”

Under the Demographic Impacts section of Table 4.123 (now Table 4-142) in Section 4.10.2 (formerly page 4-476, now page 4-502), the following has been added to the third bullet point in the Mitigation/Opportunity column

“(see Appendix B of Appendix 23 for the outline of an Indigenous Participation Plan as an example)”

Appendix 23 – Social Impact Management Plan amended to include Appendix B – Outline for an Indigenous Participation Plan.

5.33 Section 4.12.2.11, Page 4-523 - Local Industry Participation Plan

Submitter:

Department of State Development, Infrastructure and Planning

Submission:

The proponent has referenced the requirement to prepare a Local Industry Participation Plan in accordance with the Local Industry Policy. The Local Industry Policy does not apply

to private sector resource projects.

Proponent to contact the Queensland Resources Council (QRC) and seek guidance on adoption of the QRC Code of Practice for Local Content.

Response:

The Proponent is unsure where this issue arises from, as discussion in EIS Section 4.12.2.11 on development of a Local Industry Participation Plan clearly states that *"The Proponent has elected to adopt the Queensland Resources and Energy Sector Code of Practice for Local Content rather than a LIPP."*

To avoid any confusion, this sub-section will be retitled Local Content Plan.

EIS Amendment:

Section 4.12.2.11 is now titled "Local Content Plan" in the final EIS document.

5.34 Section 4.11 & Section 4.13 - Safety and Health and Hazard and Risk

Submitter:

Queensland Fire and Emergency Services

Submission:

Due to the distance from QFES urban support, the site-based emergency personnel MUST be sufficiently trained and equipped with adequate PPE and equipment to be self-sufficient to manage and control any incident until QFES response arrives. This arrival could take several hours due to the distance from a permanently manned station and/or equipment required for the incident involved.

QFES acknowledges that there is an Auxiliary fire station in Emerald, however QFES recommends consultation occurs between parties to form a collaborative agreement where both Taroborah Coal and QFES work together in a unified approach to deal with emergency incidents.

We note the proponent should comply where necessary with relevant Queensland statutory legislation and should implement safety and health management systems so as to mitigate hazard and risk. We also advise the following:

- Hazard analysis and risk assessment undertaken in accordance with *AS/NZS ISO 31000:2009 Risk Management – Principles and guidelines*; and *with HB203:2006 Environmental Risk Management Principles and Processes.*
- Implementation or emergency response plans detailing mitigation strategies to achieve specific outcomes as outlined in the *State Planning Policy (SPP) 1/03 – Guideline for Mitigating the Adverse Impacts of Flood, Bushfire and Landslide;* and maintain adequate separation of vegetation from exposures to prevent wildfire events threatening infrastructure in isolated areas;
- All dangerous goods, explosives and hazardous substances transported, stored and managed in accordance with relevant legislation;
- Development of safety management plans and emergency response procedures in consultation with the state and regional emergency service providers and provide an adequate level of training to staff who will be tasked with emergency management activities;
- Compliance where necessary with the *Fire and Emergency Services Act 1990.*

Response:

The Proponent will commit to this collaborative agreement process at the appropriate time.

The Proponent notes the hazard analysis and risk assessment guidelines referenced above, and will undertake to utilise these guidelines in future hazard and risk analysis and assessment for the Project.

The safety and health initiatives mentioned above have been added to the relevant Health and Safety sections of the final EIS document as appropriate.

EIS Amendment:

The following sentence has been added to the end of Section 4.11.2.6 - Transport of the EIS main body report.

"All dangerous goods, explosives and hazardous substances will be transported, stored and managed in accordance with relevant legislation."

The following has been added as the fourth paragraph in Section 4.11.2.7 - Protecting Health, Safety and Community Values of the EIS main body report.

"Safety management plans and emergency response procedures will be developed in consultation with the state and regional emergency service providers and in compliance with the *Fire and Emergency Services Act 1990* where appropriate. The emergency response plans will detail mitigation strategies to achieve specific outcomes as outlined in the *State Planning Policy (SPP) 1/03 – Guideline for Mitigating the Adverse Impacts of Flood, Bushfire and Landslide*. An adequate level of training will be provided to staff that will be tasked with emergency management activities. Adequate separation of vegetation from exposures to prevent wildfire events threatening infrastructure in isolated areas will be maintained."

5.35 Section 4.13 - Hazard and Risk

Submitter:

Queensland Ambulance Service

Submission:

Provide a copy of the Emergency Response plan to QAS, which should include contact details for key stakeholders in case of a disaster or emergency.

Provide notification of planned exercises, either practical or table-top, for information, attendance or participation by QAS.

Identify possible landing sites for both the rescue helicopter service and fixed wing aircraft services if required. This should include coordinates of landing zones, flight paths, lighting and wind sock.

Consult with the Director, Clinical Quality and Patient Safety is available in relation to treatment plans for injured workers due to methane gas extraction or chemical injuries.

Provide a visible sign from the roadside that clearly identifies QAS entry to the site in the event of an emergency.

Response:

Acknowledged, and the Proponent will comply at the appropriate time.

EIS Amendment:

None required

5.36 Section 4.13.2.5 - Hazard Prevention and Management

Submitter:

Queensland Police Service (QPS)

Submission:

Section 4.13.25 Hazard Prevention and Management indicates that an Emergency Response Plan is required to be developed, and that in developing this plan it must address 'liaising with, and using, local or state emergency services'. Further to this, Section 8.1 Emergency Response Plan of the Project Integrated Risk Management Plan indicates that the project proponent must consult with local emergency services having regard to their advice for incorporation in the ERP.

The Queensland Police Service is not specifically identified in the EIS as an Emergency Service. The QPS would like to highlight the importance of consultation in relation to the development of the ERP.

The QPS request that they be specifically included in this consultation so that the strategies and responses to emergencies developed within the ERP are consistent with the response that will be provided by the QPS in the event that the project ERP needs to be activated

Response:

There are no specific organisations identified as an Emergency Service in the EIS, however, the QPS is identified as having been consulted in developing the Hazard and Risk Assessment section of the EIS (S 4.13.2.1, p 4-527).

Nonetheless, the Proponent acknowledges the need to further consult with various Emergency Services organisations when developing the Emergency Response Plan, and will certainly consult with the QPS as one of those organisations at the appropriate time.

EIS Amendment:

None required

6. SECTION 5 – MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

6.1 Section 5.9.3, Page 5-76 and 5-78 - Available offset areas

Submitter:

Department of Agriculture, Fisheries and Forestry – Resource, Planning and Skills

Submission:

The Proponent is requested to identify all existing and potential agricultural areas (as identified by the Agricultural Land Audit) within the 100km buffer of the MLA and then exclude these areas as potential biodiversity offset areas

Response:

Due to the new offsets legislation that came into effect in July 2014, the consideration of potential offset areas has been undertaken within the entire Brigalow Belt Bioregion rather than just a 100 km radius of the Project. And in this assessment, all potential agricultural areas have been excluded from the available area consideration.

EIS Amendment:

Section 5.9 of the EIS main body report has been amended to read as follows:

"The Project was declared a controlled action under Section 75 of the EPBC Act due to anticipated impacts upon the following MNES:

- Listed threatened species and communities (sections 18 and 18A) – identified on site as the endangered ecological communities of Brigalow (*Acacia harpophylla* dominant and co-dominant) and Potential Natural Grassland (Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin); and
- Listed migratory species (sections 20 and 20A) – identified on site as Cattle Egret, Latham's Snipe and the Glossy Ibis.

Ground-truthed RE assessments and seasonal surveys conducted by qualified and experienced ecologists have identified particular on-site MNES that will be impacted by Project activities. Such residual (post rehabilitation) impacts were found to be significant following assessment via the *Significant Impact Guidelines: 1.1 Matters of National Environmental Significance* (DEWHA 2009) refer to Section 5.0 of this chapter of the EIS for details of the impact assessment results.

The *EPBC Environmental Offset Policy* (DoE 2012a) therefore applies to the Project, since some impact upon the Brigalow (*Acacia harpophylla* dominant and co-dominant) and Natural Grassland (Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin) threatened ecological communities will occur, even after all reasonable measures have been taken to avoid and mitigate impacts upon the protected matter.

Significant Project impacts upon EPBC Act listed migratory species are considered to be unlikely and therefore, their habitat does not require offsetting.

An initial offset strategy has been developed in consideration of the requirements of the Commonwealth *EPBC Environmental Offset Policy 2012* (DoE 2012a) and the *Queensland Environmental Offset Policy*[1] *– Version 1* (EHP 2014). In addition, the Australian Government guide *How to Use the Offsets Assessment Guide* (DoE 2012c) will be referenced when offsets are to be calculated.

5.91 Mapping Potential Environmental Offset Locations

A desktop assessment was undertaken in order to locate potential environmental offset locations within the Brigalow Belt Bioregion. Ideally, offsets will be located on properties accessible by Shenhuo, outside of the resource area and away from significant mine development areas in order to avoid the potential for future offset disturbance.

Broad Vegetation Groups (BVG) were employed to identify off-site habitats which are similar in value and ecological structure to those REs which will be impacted on the Project site and would prove suitable as offset areas.

This assessment was undertaken via analysis and combination of the following GIS data sets, in order to generate BVGs (refer to Figure 5.13 for potential offset supply for each BVG):

- RE mapping version 8.0;
- Pre-clear (vegetation present before European clearing) mapping;
- Mining leases, protected areas and nature refuges, to remove conflicting land uses;
- Areas identified as Class A Agricultural Land in the Agricultural Land Audit, to ensure areas most suitable for agriculture are excluded in identification of potential offset supply. Class A Agricultural Land is land that is considered suitable for most agricultural uses, with few limitations; and
- Regulated Vegetation Management Map, with Category A and R land removed. Category B (remnant), C (high value regrowth) and X (unregulated) vegetation is available for use as environmental offsets.

5.9.2 Calculating Environmental Offsets

[1] The *Queensland Environmental Offset Policy 2014* came into effect on the 1 July 2014 and applies to where significant residual impacts remain from activities requiring an Environmental Authority.

The *EPBC Act Offset Policy* (DoE 2012g) requires the offset site to meet, as a minimum, the quality of the habitat at the impact site. Where a proposed offset site has a lower habitat quality than that of the impact site, the offset must be managed over a defined period of time so that its habitat quality is improved to meet the quality of habitat originally impacted.

Since the offsets required under the *Queensland Environmental; Offset Policy* (EHP 2014) will contribute toward those required under the EPBC Act, it is proposed that State environmental offsets will be calculated first by applying the habitat quality analysis in accordance with EHP's *Guide to Determining Terrestrial Habitat Quality* which forms part of the *Queensland Environmental Offset Policy* (EHP 2014). The *Offset Assessment Guide* (DoE 2012b) provided under the *EPBC Act Offset Policy* (DoE 2012a), will then be employed to ensure offset requirements have been met for EPBC Act purposes.

The following areas of MNES threatened ecological communities will be impacted by Project:

- Community 4 – Brigalow Woodland (RE 11.9.1) – disturbance area = 2.76 ha; and
- Potential Natural Grassland (RE 11.8.1) – disturbance area = 145.13 ha.

The quality of each threatened ecological community disturbed by the Project will be determined via the habitat quality indicators provided in the *Guide to Determining Terrestrial Habitat Quality*, in conjunction with the *EPBC Act Offset Policy* (2012a) *Offset Assessment Guide* (DoE 2012c). These guidelines take into account the site condition, site context and species stocking rates as required.

The following ecological characteristics of the threatened ecological communities Brigalow (*Acacia harpophylla* dominant and co-dominant) and Potential Natural Grassland (Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin) will be defined in accordance with the *EPBC Act Offset Policy* (DoE 2012a):

- Vegetation condition and structure;
- Diversity of habitat species present;
- Number of relevant habitat features;
- The importance of the site in relation to the overall occurrence of the community;
- Threats which occur on or near the site;
- Presence of species on the site;
- Density of species known to utilise the site; and
- Role of the site population(s) in regards to the overall community population.

Habitat Quality assessments will be determined using the Queensland Government's assessment framework which is yet to be released. The assessments will be conducted on both the impact site and offset area in order to ensure that the environmental offset site will deliver a 'conservation outcome'.

Data from the site-based assessment will also be used in conjunction with the *Offset Assessment Guide* (DoE 2012c) 'impact calculator' to ensure the proposed environmental offset is adequate, in accordance with the *EPBC Act Offset Policy* (2012a).

5.9.3 Available Offsets

An assessment of the various local ecological communities that could be employed for offsetting has been conducted within the Brigalow Belt Bioregion, and excludes land classified as Class A Agricultural Land as identified by the Agricultural Land Audit). BVG25a provides equivalent ecosystems to the Brigalow community and BVG30b provides equivalent ecosystems to the Potential Natural Grassland ecological community that will be impacted by the Project. Figure 5.13 indicates the potential offset supply areas within the Bioregion for BVGs 25a and 30b.

Table 5.15 identifies the area of relevant EPBC listed community that will be impacted by the Project and the anticipated area of suitable environmental offset sectors that are available.

Table 5.15 Required Offsets and Potentially Available Offsets within the Brigalow Belt Bioregion.

Required Offset	Description	TEC Area to be Offset	BVG Area Available
BVG 25a	Brigalow (*Acacia harpophylla* dominant and co-dominant)	6.86 ha	1,625,900 ha
BVG 30b	Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin	145.13 ha	219,688 ha

5.9.4 Securing Offsets

All direct offset sites will be secured using one of the following mechanisms:

- An environmental offset protection area in accordance with the *Environmental Offsets Act 2014*;
- An area of high nature conservation value in accordance with the VM Act 1999, secured for the purposes of an offset;
- A nature refuge under the *Nature Conservation Act 1992* (NC Act 1992), secured for the purposes of an offset;
- A protected area under the NC Act 1992, secured for the purposes of an offset; or
- Covered by a statutory covenant for environmental purposes under the *Land Act 1994* or *Land Title Act 1994*.

These mechanisms ensure offset protection and assist in the implementation of offset management strategies.

Note that the mechanisms adopted to secure offsets will ultimately depend upon the options that are available and agreed to by the relevant parties.

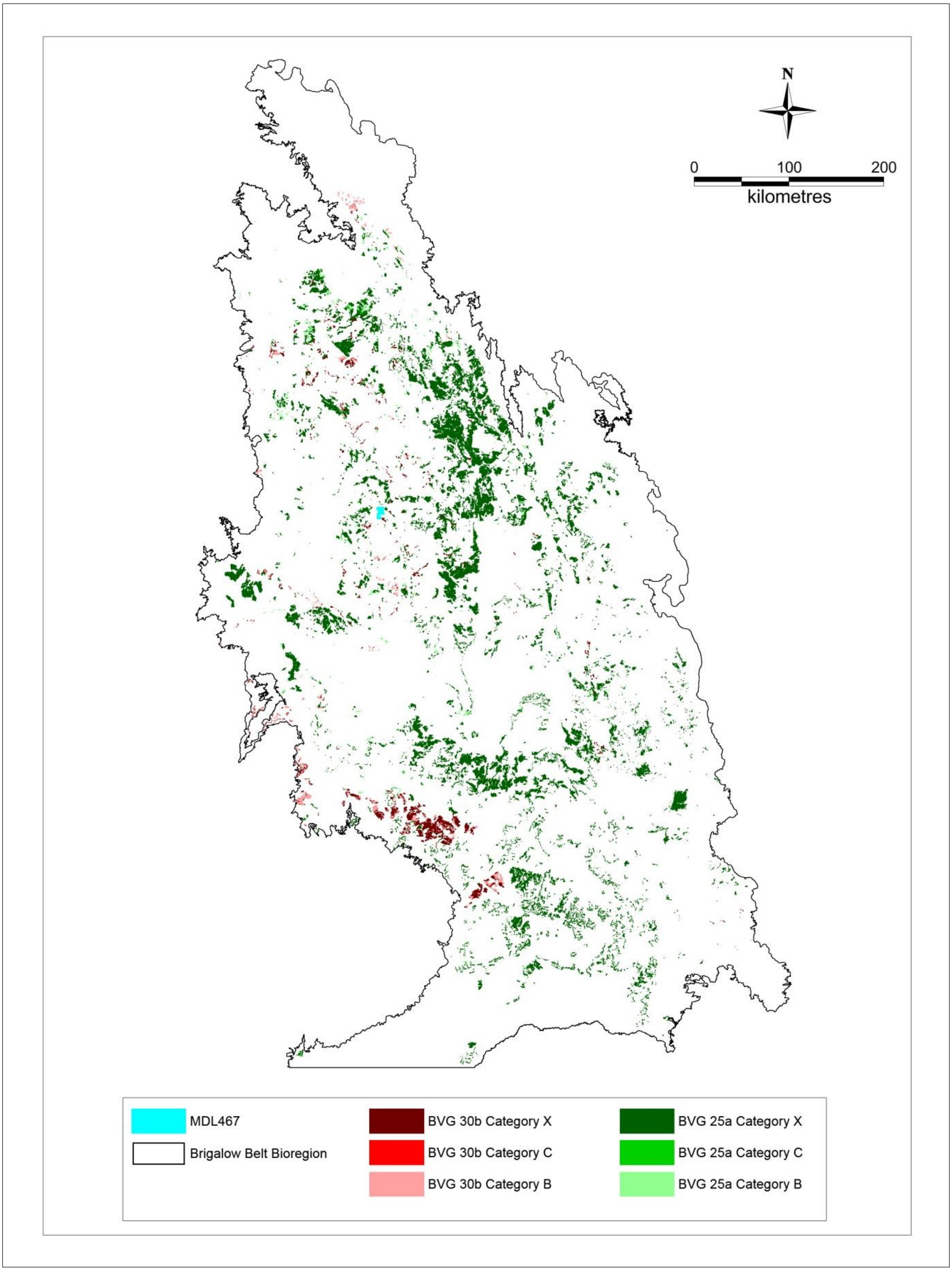


Figure 5.13 Potential Land Available for Offset within Brigalow Belt Bioregion

5.9.5 Management of Offsets

Offset management plans will be prepared to provide information on the ecological threats for each offset site and the associated actions that will be required in order to manage these threats. Each management plan will contain an estimate of the costs of offset management, reporting and monitoring program that will be required until the desired management outcomes are achieved.

Offset management actions recommended could include:

- Management of grazing;
- Weed management;
- Feral pest management; and
- Management of fire.

The duration of the active management period will be influenced by the condition of vegetation, type of habitat and vegetation on site, as well as existing management issues.

5.9.6 Monitoring and Reporting

The following offset monitoring and reporting actions will be required in order to generate a record of ecological community comparability over the term of the offset and overall progress for returning the offset to remnant vegetation status:

- Provision of regular Project offset monitoring and management reports to the regulator,
- Biannual photo point monitoring conducted every two years; and
- Habitat Quality assessments conducted at the same locations as the photo point monitoring."

7. SECTION 6 – ENVIRONMENTAL COMMITMENTS

7.1 Section 6 - Model Conditions for Regulated Structures

Submitter:

Department of Environment and Heritage Protection

Submission:

The model mining conditions for regulated structures have not been included in the proposed EA conditions in Chapter 6.

Response:

Chapter 6 has been amended to include the relevant conditions for regulated structures found in Appendix B of the EHP Guideline, Structures which are dams or levees constructed as part of environmentally relevant activities (EHP 2013).

EIS Amendment:

The relevant conditions for regulated structures now constitute Section 6.9 – Schedule I of the EIS main body report.

7.2 Section 6, Schedule F – Water, Receiving Environment Monitoring Program

Submitter:

Department of Environment and Heritage Protection

Submission:

This section includes a commitment to develop a receiving environment monitoring program (REMP). However, the timing of when this document will be developed has not been included. It would be useful if the proponent prepared a framework for the REMP for review during the EIS process. A comprehensive REMP would need to be prepared and submitted to the administering authority prior to the commencement of mining activities.

Recommendation: Provide a framework for the REMP and include a timeframe in Section 6 for submitting the completed REMP to the administering authority.

Response:

A REMP framework has been developed and provided as Appendix 28 to the EIS document.

EIS Amendment:

The new Appendix 28 to the EIS document is reproduced in this document as Attachment C.

7.3 Section 6.6, Page 6-22 - Schedule F – Water, Temporary Interference with Watercourses

Submitter:

Department of Natural Resources and Mines

Submission:

The EIS includes "*F25 Temporarily destroying native vegetation, excavating, or placing fill in a watercourse, lake or spring necessary for and associated with mining operations must be undertaken in accordance with Department of Environment and Heritage Protection's Guideline-Activities in a Watercourse, Lake or Spring associated with Mining Activities.*"

The proponent to note that the guideline referred to has been replaced by Riverine Protection Permit exemption requirements and changes to the Water Act 2000 have removed the riverine protection permit provision for destroying vegetation in a watercourse.

Response:

Noted by the Proponent and this Schedule has been updated accordingly in the final EIS document.

EIS Amendment:

Condition F25 in Section 6.6 of the EIS main body report is amended to read as follows:

"Excavating or placing fill in a watercourse, lake or spring necessary for and associated with mining operations must be undertaken in accordance with the provisions of a Riverine Protection Permit issued by the Department of Natural Resources and Mines, unless they meet the Riverine Protection Permit exemption requirements."

8. APPENDIX 7 – SOIL AND LAND SUITABILITY ASSESSMENT REPORT

8.1 Appendix 7, Page 14 - Soil and Land Suitability Assessment Methodology

Submitter:

Department of Natural Resources and Mines

Submission:

Inadequate mapping intensity and separation of soil units. The Terms of Reference (TOR) Section 4.2.1.5 requires a soil survey mapping intensity of I :25 000 scale not I :50 000 scale as conducted. The TOR refer to DME 1995 and McKenzie et al 2008 for the required site intensity. The required site intensity is likely to have provided a more detailed soil map with separation of the units identified at soil type level. The soil map (Figure 8) contains less detail than the broadscale Geological map (Figure 4). Proponent needs to provide justification for the reduced mapping intensity.

Response:

The intensity of soil sampling undertaken (62 pits in the 1595 ha study area) is within the recommended range in accordance with the Guidelines for Surveying Soil and Land Resources (Mckenzie et al 2008) for mapping at a high intensity of 1:25 000. Mapping observations were taken in the field at regular intervals by the soil scientist undertaking the primary sampling program while traversing from sample site to sample site. Although not always formally annotated, these observations served to confirm mapping boundaries, soil-type distributions and areas subject to cultivation. These observations contributed to completing the 1:25 000 scale requirements. This results in an approximate area of 25 ha or less per observation.

EIS Amendment:

The third and fourth paragraphs of Section 3.2 of Appendix 7 have been amended to read as follows:

"Sampling strategies and survey plans were developed in accordance with the Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques (herein referred to as the Technical Guidelines) (DME 1995) and the Guidelines for Surveying Soil and Land Resources (Mckenzie et al 2008) (herein referred to as the Blue Book).

The survey effort involved the undertaking of detailed profile descriptions with profiles sampled at 62 locations within the 5195 ha study area (see Figure 7 for details). The location of each site was recorded using a Global Positioning System (GPS) with an accuracy of +/- 10m. This intensity of test pits is within the recommended range in accordance with the Blue Book for mapping at a high intensity of 1:25 000. Mapping observations were taken in the field at regular intervals by the soil scientist undertaking the primary sampling program while traversing from sample site to sample site. Although not always formally annotated, these observations served to confirm mapping boundaries, soil-type distributions and areas subject to cultivation. These observations contributed to completing the 1:25 000 scale requirements. This results in an approximate area of 25 ha or less per observation."

8.2 Appendix 7, Page 18 - Soil and Land Suitability Assessment Results

Submitter:

Department of Natural Resources and Mines

Submission:

Confirmation of the Soil Management Unit "Eden. This soil management unit does not appear in the *Central/ Highlands Land Management Manual* (Bourne and Tuck 1993), the *Land Management Field Manual Wandoan District* (Gray and Macnish 1985) or in the *Dawson/Callide Districts Land Management Manual* (Shields and Gillespie 1991). Proponent needs to provide source of the Eden Soil Management Unit**.**

Response:

The Eden Soil Management Unit had been described as such under the incorrect interpretation of sub-surface sodicity data. The Eden SMU had been described as having a sodic subsoil and, therefore, did not match any of the profile descriptions provided in existing land management field manuals relevant to the area.

Review of the data has indicated the sub-surface soils of this management unit are not sodic; with an exchangeable sodium percentage of <2% throughout the profile. Subsequently, the soil management unit was redefined and is considered to match the characteristics of the Glen Idol Agricultural Management Unit as described in the publication Understanding and Managing Soils in the Central Highlands (Thwaites & Maher, 1993).

References to the Eden SMU have been amended to refer to the Glen Idol SMU, and discussions regarding the sodicity of the sub-surface soils and potential management implications have been amended.

EIS Amendment:

All references to the Eden soil management unit in the entire EIS documents have been replaced by Glen Idol.

8.3 Appendix 7, Page 60 - Soil and Land Suitability Assessment - GQAL

Submitter:

Department of Natural Resources and Mines

Submission:

Inaccurate reproduction of Agricultural Land Classification contained in Attachment I of the Planning Guidelines (DPI/DHLGP 1993) as required to be used by the Terms of Reference Section 4.2.1.6. Proponent to reproduce**.**

Response:

It is acknowledged that the descriptions for the Agricultural Land Classification classes do not exactly match those in Attachment 1 of the guidelines. This has been corrected in the final EIS document.

EIS Amendment:

The agricultural land classification descriptions in Section 6.5 of Appendix 7 have been amended to read as follows:

"Class A CROP LAND

Land suitable for current and potential crops

Limitations to production range from none up to moderate levels.

All crop land is considered to be good quality agricultural land.

Class B LIMITED CROP LAND

Land marginal for current and potential crops; and suitable for pastures

Land which is marginal or unsuitable for most current and potential crops due to severe limitations. Further engineering and/or agronomic improvements may be required before land would be considered suitable for cropping.

Land marginal for particular crops of local significance is considered to be good quality agricultural land.

Class C PASTURE LAND

Land suitable only for improved or native pastures

Limitations preclude continuous cultivation for crop production but some areas may tolerate a short period of ground disturbance for pasture establishment.

In areas where pastoral industries are the major primary industry, land suitable for improved or high quality native pastures may be considered to be good quality agricultural land.

Class D NON-AGRICULTURAL LAND

Land not suitable for agricultural uses

This may be undisturbed land with significant habitat, conservation and/or catchment values. Severe limitations preclude any interference with land or biological resources for the production of agricultural goods."

8.4 Appendix 7, Page 60 - Soil and Land Suitability Assessment - GQAL

Submitter:

Department of Natural Resources and Mines

Submission:

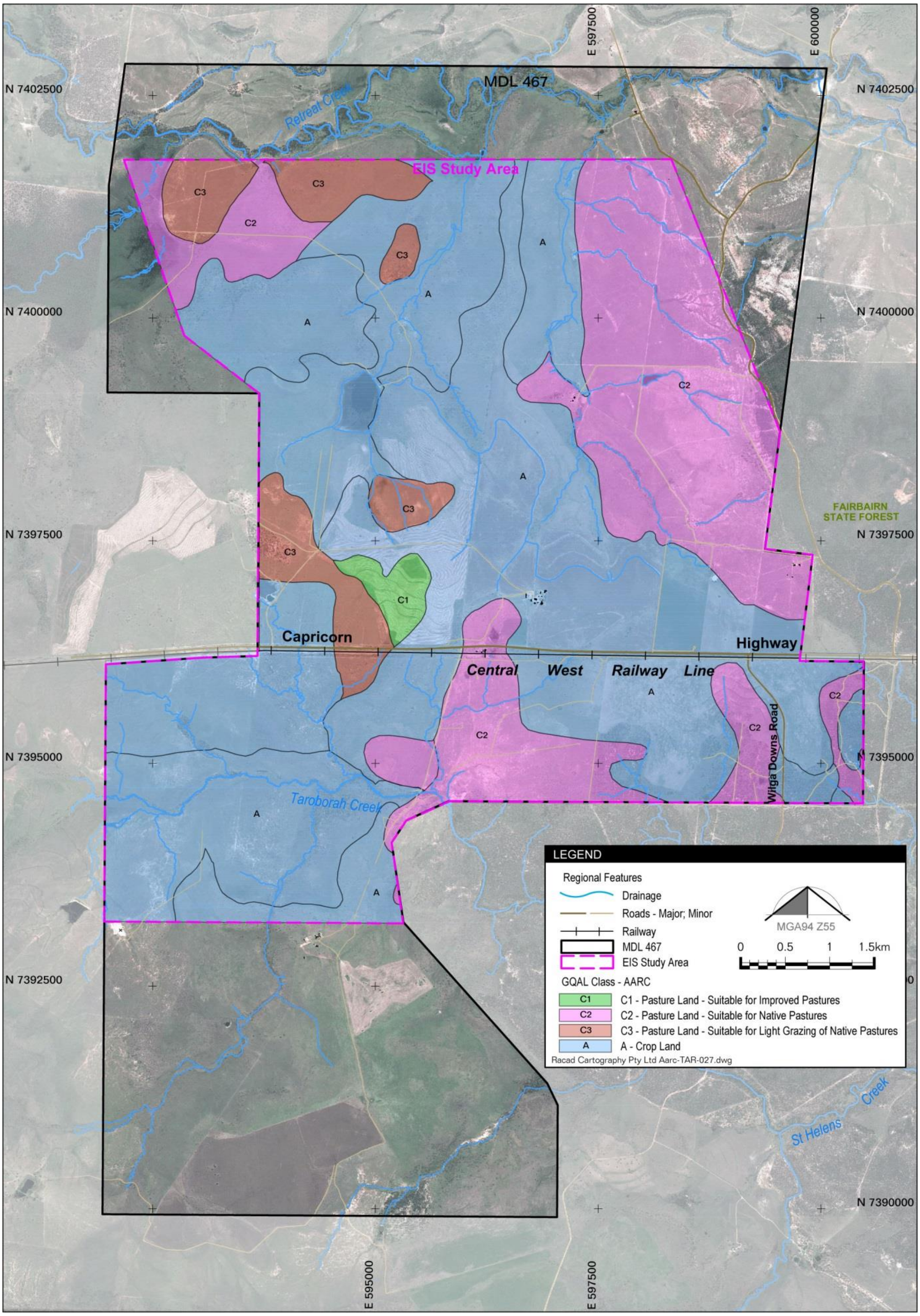
Incorrect allocation of Land Suitability Classes of the Soil Management Units of the project area to the Agricultural Land Classification scheme (DPI/DHLGP 1993). For example the land suitability assessment for the Orion/Jimbaroo soil management unit determined an overall Land Suitability Class of 3 for rainfed broadacre cropping (Table 27). According to the Agricultural Land Classification scheme (DPI/DHLGP 1993) the Orion/Jimbaroo units would be allocated to Class A CROP LAND: Land Suitable for current and potential crops. Limitations to production range from none up to moderate levels. All crop land is considered to be good quality agricultural land. Proponent to amend all soil management units assessed as Land Suitability Class 3 to read Agricultural Land Class A (GQAL). Amend Figure 12.

Response:

The SLSA has been revised to align with the directive of DNRM that Class 3 land, classified under the land suitability assessment (DME 1995), should be considered Class A Crop Land under the Planning Guidelines: Identification of Good Quality Agricultural Land (DHLGP 1993).

EIS Amendment:

Figure 12 of Appendix 7 has been amended to look as follows:


MDL 467
EIS Study Area
Retreat Creek
Taroborah Creek
St Helens Creek
Capricorn Highway
Central West Railway Line
Wiga Downs Road
FAIRBAIRN STATE FOREST
N 7402500
N 7400000
N 7397500
N 7395000
N 7392500
N 7390000
E 595000
E 597500
E 600000
C1
C2
C3
A
LEGEND
Regional Features
Drainage
Roads - Major; Minor
Railway
MDL 467
EIS Study Area
MGA94 Z55
0 0.5 1 1.5km
GQAL Class - AARC
C1 - Pasture Land - Suitable for Improved Pastures
C2 - Pasture Land - Suitable for Native Pastures
C3 - Pasture Land - Suitable for Light Grazing of Native Pastures
A - Crop Land
Racad Cartography Pty Ltd Aarc-TAR-027.dwg

9. APPENDIX 9 – VISUAL AMENITY ASSESSMENT REPORT

9.1 Appendix 9 - Visual Amenity

Submitter:

Department of Transport and Main Roads

Submission:

This section briefly indicates light spillage matters will be considered at a later date, when project design details have advanced.

The EIS should consider and propose mitigation measure to be put in place to avoid night-time glare with the resulting increase in road safety risk to passing road-users.

Response:

The EIS has considered night-time glare and deemed it to be insignificant in relation to motorists on the Capricorn Highway for the following reasons.

1. The visual amenity bund will restrict line of site from the highway to some 30-40m above ground level in mine infrastructure areas where flood lights that could cause glare would be located.
2. Flood lights will generally be aimed southward, away from the direction of the highway.

The final EIS document will be updated to include discussion on potential glare to motorists on the Capricorn Highway.

EIS Amendment:

Section 4.2 of Appendix 9, which discusses the artificial lighting aspects of the Project, has been amended to read as follows:

"Artificial lighting will be used at night on the Project site, particularly around the MIA, haul roads, CHPP, train load out facilities, power generating sites and by both light and heavy vehicles. The majority of these light sources will not be directly visible from either the Capricorn Highway or the surrounding residences once the mine is constructed and operating due to the presence of the visual amenity bund. However, potential visual amenity impacts will also be influenced by the prevailing climatic conditions, such as the intensity of moonlight and presence of fog or haze, such that a lit up sky will be prevalent at times. It is likely that such a lit up sky will be visible from surrounding residences and the Capricorn Highway and therefore, while not a risk of causing glare, will impose some visual amenity impacts.

The presence of artificial lighting will be the main source of visual impacts at night time. While it is likely that most of the artificial lighting will be directed southward, since the Project's lighting layout plans have yet to be developed, night time images of the Project site and potential visual amenity impacts of the Project at night were not developed for this visual amenity assessment."

A second paragraph has been added to Section 6.8 – Lighting of Appendix 9 to address the issue of potential glare to motorists on the Capricorn Highway, which reads as follows:

"The potential for artificial lighting to cause a risk of glare to motorists on the Capricorn highway is considered very low due to the visual amenity bund, which will screen all but the highest portions of the northwest spoil dump from direct line of site to light sources."

10. APPENDIX 11 – TRANSPORT IMPACT ASSESSMENT

10.1 Appendix 11, Section 5.1.1.1, Page 58 - Transport Impact Assessment – Road Closures

Submitter:

Department of Transport and Main Roads and Queensland Police Service

Submission:

This section discusses the need for closures of public roads during blasting.

While the 4th paragraph in S 6.0: Mitigation Strategies & Recommendations, page 89 generally discusses advising the public of road closures, it is unclear whether this refers to closures during blasting or for other reasons. The EIS should provide more information about road closures for blasting e.g. if 20 times, how will closures be spaced (which times of day/ days apart) to ensure minimal impact on freight movements and other traffic. More specifically, how will road closures be practically managed?

A detailed Closure Management Plan for state- controlled roads will be required, including how traffic managed from a control point of view.

Details of how traffic delays are intended to be minimised in the event that the highway is affected by flyrock, requiring the roadway to be cleaned/cleared should also be provided

Response:

Acknowledged, and further discussion on the nature and management of road closures is provided in the final EIS document as discussed below.

A detailed Traffic and Road Closure Management Plan will be developed in due course and this is mentioned in the EIS (note: closures not anticipated until around 2023)

Note: As mentioned in Section 5.1.1.1, the risk of flyrock reaching the Capricorn Highway is considered very low and the actual requirement to have road closures may never eventuate with proper planning.

EIS Amendment:

Last sentence of Section 5.1.1.1 of Appendix 11 amended to read as follows:

"These closures might occur 2-3 times a week for approximately 2 months of the year, or less than 20 times per year in total."

A new Section 6.2 – Road Diversion/Closures in the Mitigation Strategy section of Appendix 11 has been developed as follows:

"To limit the impact of local road diversions and closures as a result of the Project, these will be developed in accordance with the Road Planning and Design Manual (DTMR 2004) and signed in accordance with the Manual of Uniform Traffic Control Devices (DTMR 2011). The public will be notified prior to the closure or diversion of any public road, and a Closure Management Plan will be developed in consultation with the DTMR that will include details on the traffic management controls to be implemented to ensure safety. While the diversion of local roads is designed to create minimum disruption to existing patterns of movements, consultation with locals is imperative to ensure transparency, minimise impacts and foster community understanding. Shenhuo will commit to the dissemination of relevant information and consultation, where appropriate, to minimise community and safety impacts.

During the access intersection construction period, partial closure and diversion of the Capricorn Highway will likely be required and will be conducted in accordance with appropriate traffic management techniques developed as part of the Closure Management Plan. This will ensure the

safety of construction workers and the public, and minimise disruptions to affected traffic movements.

Because of the orientation of the pit to the Capricorn highway, the potential temporary closures for blasting are likely to occur only two months of the year at a frequency of 2-3 times per week during the last 2 years of the opencut mine life. To minimise disruptions to both mine operations as well as traffic along the highway, the blasts would likely occur in the afternoon just prior to shift change. It is expected that closures would last no more than approximately 20-30 minutes, which allows for the blast to take place and inspection/clean-up of large debris if required. To minimise this time, road cleaning equipment would be on hand to effect immediate removal of the debris."

10.2 Appendix 11, Section 5.1.4 - Transport Impact Assessment – Road Safety

Submitter:

Department of Transport and Main Roads

Submission:

This section provides some useful discussion about road safety issues, but could do so in a more prioritised, systematic way. For example, it discusses hazardous material transport as the first issue and only driver fatigue as another. While road safety at the access from the Capricorn Hwy to the project site has been canvassed, road safety issues at other intersections eg Cap. Hwy/ Anakie-Sapphire Rd should also be considered.

While driver fatigue is an important issue, reference to Appendix B, Checklist 3 "Safety issues checklist for all developments", pg B4 of TMR's Guideline for Assessing Road Impacts of Development" (GARID) will ensure a more complete assessment and mitigation of road safety issues from project traffic, especially from heavy vehicles during the project construction phase.

Response:

Acknowledged, and the Proponent has redrafted this section in the final EIS document, taking into account the DTMR's guidelines.

EIS Amendment:

Firstly, reference to the GARID checklist is included as the second introductory paragraph of Section 5.1.4 as follows:

Appendix B of the GARID provides a checklist of potential safety issues that should be addressed for all developments. These issues pertain to intersections, site access, road links, and other road users. The following sections address potential road safety concerns associated with development and operation of the Project.

Table 30 Road Safety Issues Checklist

Safety Aspects	
Intersections and Access	On and off-site queuing
	Access location and layout / sight distance
	Bus stops
	Lighting
	Pavement marking & signage
	Speed environment
	Intersection operation & acceleration / deceleration lane
	Auxiliary turn lanes / lengths / weaving
	Heavy vehicle and bus turnpaths

Safety Aspects	
	Utilities (hardware / services)
	Location of poles / traffic signal
Road Links	Road width
	Shoulder seals
	Vertical / horizontal alignment
	Bridges and approaches
	Clearance to obstructions
	Overtaking opportunities
Pedestrians	Road crossing facilities
	Footpaths
	Disabled provision
Cyclists	Cycle lanes / paths
	Road crossing facilities
	Intersection provision
Motorcyclists	Road surface
	Warning of hazards
	Barrier kerbs
	Visibility at intersections
	Drainage pits and culverts

Source: Department of Main Roads (DMR) (2006)

Secondly, a new Section 5.1.4.1 – Heavy Vehicles is added to address heavy vehicle traffic as follows:

"Road safety impacts typically associated with increased HV usage of the road network, particularly secondary or local roads, include visibility issues for other road users, increased risk of collision due to an increased number of road users, and driver fatigue. The greatest road safety risks associated with the Project's heavy vehicle usage will occur during the construction phases, primarily to transport materials and equipment to the site.

Heavy vehicles proposed to be used for Project construction include Six Axle Articulated and Four Axle trucks, and B-Double Road Trains. The Anakie – Sapphire Road (a local major road) will primarily be utilised during the open-cut construction phase for the Project for the transport of road materials and a proportion of rail, ballast and bridge steel materials. An estimated total of 2,202 HV trips with a total of 7,456.88 HV ESAs will be required along the Anakie – Sapphire Road during the construction periods. However, safety risks associated with heavy vehicle use of this route will be short-term; following open-cut construction, this route is only proposed to be used for the transport of approximately 35 loads of gravel material per annum from Sapphire in a B-Double Road Train.

The remainder of materials required during construction and production of the Project will be sourced from Gladstone, Mackay, Emerald, and Brisbane (in some cases), and will be transported via the Bruce and Capricorn Highways. An estimated total of 5,768 HV trips from Mackay / Gladstone and Emerald with a total of 15,437.78 HV ESAs will be required for the open-cut and underground construction periods. However, the Traffic Impact Assessment determined that the construction period would not generate any increases along the relevant SCR routes considered to be significant under the GARID. Traffic increases along Section #16A – 16C are estimated to be up to 0.871%.

A total of 116 trucks have been involved in road accidents along the Capricorn Highway between 2002 and 2013. During this period, a further 94 trucks have been involved in accidents on the Peak Downs Highway and another 39 on the Gregory Highway. The upgrades to the Capricorn Highway to facilitate Project access will reduce the risk of collisions resulting from heavy vehicles turning off onto the Project access road. The intersection of the Anakie-Sapphire Road with the Capricorn

Highway has pavement markings indicating traffic turning onto the Capricorn Highway to give-way. Visibility is not a significant concern; there are few physical obstructions impeding visibility and the road is relatively straight and level at this intersection."

The sub-section on Driver Fatigue has been amended as discussed below in the response in Section 11.3 of this document.

A new Section 5.1.4.4 - Intersections, Access and Road Links has been added to address applicable portions of the GARID Appendix B checklist as follows:

"Access to the Project will be via a new access road adjoining the Capricorn Highway. The Project access design incorporates dedicated turning lanes to safely access the Project, acceleration / deceleration lane and appropriate pavement markings to minimise the risks associated with turning off the Capricorn Highway into the Project area. A T-intersection will be constructed where the access road intersects the Capricorn Highway, allowing vehicles exiting the site to merge onto the Highway. All State road standards will be adhered to in the design of intersections and access roads.

Lighting is not considered to be a key safety concern for the Project. All anticipated access to the Project site, including material deliveries and workforce shift changeovers will occur during daylight periods.

The CHRC's Strategic Framework states that development that significantly increases the volume of traffic on rural roads may necessitate improvements to the road design to maintain operational efficiency and road users' safety. Although a significant increase in traffic is not anticipated, opportunities to minimise road safety risks, particularly at key intersections and routes, will be investigated prior to Project development, in consultation with the CHRC and DTMR. Prior to construction of the Project, a comprehensive RIA will be undertaken, addressing specific and detailed design requirements, such as enhanced lighting, signage and pavement markings on routes utilised by the Project, to ensure compliance with the Road Planning and Design Manual (2nd edition) (DTMR 2013).

The intersection of the Anakie-Sapphire Road with the Capricorn Highway has 'give-way' pavement markings for traffic turning onto the Capricorn Highway. Visibility is not a significant concern; there are few physical obstructions impeding visibility, and the road is relatively straight and level at this intersection. Queensland road crash statistics from 2002 – 2013 indicate that three road accidents have occurred at the intersection of the Anakie – Sapphire Road and Capricorn Highway. No fatalities resulted from these incidents.

As described above, upgrades to the proposed access road intersection with the Capricorn Highway will minimise the risk of collisions due to vehicles turning to and from the Project site. A total of 42 fatalities have been recorded along the Capricorn Highway between 2002 and 2013, the majority of which occurred during daylight hours on clear days on a dry sealed road surface. Most did not occur at intersections, although the data indicate a lack of traffic control (e.g. give way / stop signage) at T- and Cross-intersections. Of all these fatalities, a total seven trucks, four motorcycles, five pedestrians, and 44 cars were involved."

The Driver Safety Practices sub-section has been removed and placed in Section 6 of Appendix 11 as discussed in the response in Section 11.4 of this document.

The sub-section on Public Transport has been retitled as Section 5.1.4.5 – Other Road Users and amended to read as follows:

"There are no known public transport services in the area of the Project. Given the nature of the location, there are no identifiable designated cycle ways or pedestrian networks present. Similarly, the nature of the rural location dominated by mining and agriculture means that motorcyclists and pedestrians are infrequent."

10.3 Appendix 11, Section 5.1.4.2, Page 80 - Transport Impact Assessment – Driver Fatigue

Submitter:

Queensland Police Service

Submission:

Section 5.1.4.2 of the Transport Impact Assessment indicates that Driver Fatigue has been identified as a risk and outlines a number of intended strategies to mitigate this risk. This section is however, relatively silent on this issue of Driver Fatigue of DIDO workers whilst they are travelling between Emerald and their home base (i.e Gladstone, Rockhampton etc) before and at the end of their shift rotation.

The QPS considers that it is essential that the issue of driver fatigue regarding DIDO workers travelling to and from their home base (as opposed to travelling from their temporary accommodation to the mine site, which is already covered in this section) is a significant issue that needs to be considered and addressed with the same level of concern as has other areas of fatigue. The management of these issues should be incorporated into a fatigue risk management plan, and behavioural code.

Response:

Acknowledged, and the Proponent will include mention of DIDO workers in the redraft of this section for the final EIS document.

Further, the last paragraph in this section will be revised to indicate that a Fatigue Risk Management Plan will be developed for the Project, rather than may be developed if determined prudent from risk assessment outcomes

EIS Amendment:

A new fourth paragraph has been inserted into Section 5.1.4.2 (now Section 5.4.1.3) that reads as follows:

"Management strategies to address driver fatigue of the DIDO worker's as they travel to and from their home base and Emerald at the beginning and end of their roster periods will also be implemented. Strategies to be considered will include shorter shift lengths at the beginning and end of the roster periods, mandatory rest periods at the end of rosters, etc."

The last paragraph of Section 5.1.4.2 has been amended to read as follows:

"A fatigue risk assessment will be conducted during the detailed design phase prior to construction in order to determine the major issues to be addressed in the development of the site's Fatigue Risk Management Plan. The commuting times to and from the Project site will be considered in this assessment process, as will the fatigue of DIDO workers."

10.4 Appendix 11, Section 5.1.4.3, Page 84 - Transport Impact Assessment – Road Safety Practices

Submitter:

Department of Transport and Main Roads

Submission:

This section provides some worthwhile practices about upholding road safety. However, further mitigation strategies to manage road safety risks of increased project traffic could be added, following a more thorough road safety review as recommended above.

Response:

Acknowledged, and the Proponent will redraft this section in the final EIS document, taking into account the DTMR's suggested mitigation strategies.

EIS Amendment:

As the Road Safety Practices sub-section relates more to mitigation strategies than impacts, it has been removed from Section 5.1.4 – Transport Impact Assessment and placed into Section 6 – Mitigation Strategies and Recommendations as a new Section 6.3 – Road Safety and Heavy Vehicles. The new Section 6.3 of Appendix 11 reads as follows:

"While the increase in traffic resulting from Project development and operation is estimated to be minimal, a number of management and mitigation practices will be employed to ensure the safety of all road users is maintained, both on and off the Project site. The following practices will be implemented to ensure driver safety is upheld at all times:

- All personnel who are required to operate and drive company vehicles or equipment shall be in possession of a current valid licence or certificate of competency for that class of vehicle or machinery;
- All drivers will receive training in the handling of heavy vehicles or vehicles transporting over-sized loads;
- Personnel are to notify the Site Manager immediately of any changes to the conditions of their drivers or operation licences (i.e. cancellation, suspension or special conditions);
- Personnel will always drive vehicles at a safe speed for the prevailing road conditions and pay attention to other hazards (vehicles, pedestrians, stock and wildlife, flooded roads);
- Seat belts must always be worn when driving or travelling in vehicles;
- Before commencing a trip in a field vehicle, the driver should conduct an inspection and check tyres, lights, fluids and brakes;
- A vehicle shall never be employed for any purpose other than its intended use;
- Appropriate signage identifying Project site roads, haul roads and Project boundaries, indicating access restrictions where applicable;
- On the Project site, road safety management will include strict enforcement of zero alcohol and illicit drugs tolerance and enforcement of appropriate vehicle speeds; and
- The Project's Emergency Response and Contingency Plan will incorporate and address road safety impacts and management strategies discussed above.

Driver fatigue for heavy vehicle operators will be managed in accordance with The National Heavy Vehicle Regulator's fatigue management guidelines (NHVR, 2013) and incorporated into the Project's Health and Safety Management System. This includes the following practices:

- Counting work and rest time;
- Record keeping – including driver work diaries, schedules and rosters, health assessments and fatigue incident records. Maintaining work diaries to ensure rest and work hours are compliant with relevant laws (e.g. HVNL Act) and minimise risks associated with driver fatigue is particularly important for drivers of heavy vehicles; and
- Risk identification, assessment and control.

Other potential safety risks, particularly those related to visibility issues, may be mitigated with further design considerations and traffic management controls. Considerations of upgrades or installation of lighting, signage and/or pavement markings, or other design options to improve safety concerns, particularly at intersections, will be addressed at the RIA stage of the Project, prior to commencement of construction."

10.5 Appendix 11, Section 5.2.1, Page 84 - Transport Impact Assessment – Rail

Submitter:

Department of Transport and Main Roads

Submission:

Table 31 provides ALCAM scores for level crossings along or off the Capricorn Hwy and the last sentence on pg 83 refers the reader to Appendix A. However, the location of Appendix A does not appear to be listed in the overall Table of Contents.

Clarify location of Appendix A and include further discussion of impacts and any proposed impact mitigation strategies which may be required for road/rail crossings and intersections between Emerald and the Mine Site.

Particular attention should be paid to the traffic impacts of coal train operations on the following intersections:

- Capricorn Highway / Gregory Highway and the impacts of this on other intersections on the State controlled Network.
- Capricorn Highway / Opal St and the impacts of this on other intersections on the State controlled Network.
- Capricorn Highway /Selma Road

Response:

Appendix A was to be included at the end of the Appendix 11 document, but was inadvertently left out.

Any impacts to these intersections and mitigation strategies have been addressed in a rail crossing traffic modelling study conducted by Brown Consulting, which is included as Attachment B to this document (see response to CHRC under Section 5.8 above).

EIS Amendment:

The attached Brown Consulting rail crossing traffic assessment is included as Appendix B to Appendix 11 of the EIS report.

And a new Section 5.2.2 – Level Crossing Traffic Impact Assessment has been added to Appendix 11 that reads as follows:

"Brown Consulting were engaged to undertake an assessment of the impacts on traffic flow at the three level railway line crossings in Emerald as a result of the coal product transport by rail from the Project. The assessment consisted of traffic simulation modelling and sensitivity analysis using AIMSUN transport simulation modelling software in order to identify any potential significant congestion impacts as a result of the proposed coal transport rail traffic. The following provides a synopsis of the results of the assessment, while the full Brown Consulting report is provided as Appendix B.

Modelling of the base year 2014 and ten year design horizon year 2024 conditions for each of the following three sites was undertaken in AIMSUN transport simulation software.

- Level crossing south of the Capricorn Highway / Gregory Highway intersection
- Level crossing south of the Capricorn Highway / Opal Street intersection
- Level crossing south of the Capricorn Highway / Selma Road intersection

Traffic survey information for the simulation was obtained from DTMR and used as the 2014 base year case, while an moderate to high anticipated growth rate across the Emerald road network of 2.5% p.a. was assumed for the 2024 future year case. While proposed rail traffic is anticipated to

occur during times that do not coincide with the peak periods of the existing road network (i.e. off-peak), modelling has been conducted assuming the worst-case AM peak traffic data, the worst-case off-peak traffic data and the worst-case PM peak traffic data scenarios to provide a conservative assessment. Further, the scenarios of no trains, a slowest train speed 40km/h, and a fastest train speed of 60km/h were modelled for each location.

The results of the AIMSUN simulations are provided in Table 33 through Table 35, and illustrated in Figure 9 through Figure 11 for the worst case queuing for each time period for each crossing assuming the slowest train speed.

In order to achieve an objective evaluation of the simulation, the results were then assessed against Level of Service (LOS) rating derived from the *RTA Guide to Traffic Generating Developments*. The LOS rating, from A to F, provides a measure of the impact of delay per vehicle across the crossing.

Based on the LOS rating, minimal impact (LOS of A or B) to road traffic will be experienced at all three level crossings in Emerald from the passing of the coal trains operating at a slowest speed of 40km/hour at all times with the exception of projected future morning and evening peak hour traffic at the Gregory Highway crossing and evening peak hour traffic at the Opal Street crossing, when moderate delays (LOS of C) are expected.

A LOS rating of A is considered good operation for a crossing. A LOS rating of B indicates satisfactory operations of the crossing with spare capacity. A LOS rating of C is deemed to be satisfactory under the guidelines, although further study may be required in the future, if the predicted traffic volumes do occur.

Table 33 Summary of impacts at level crossing adjacent to Capricorn Highway / Gregory Highway intersection

Scenario	Maximum Queue Length – No Trains (veh)	Mean Queue Length – With Trains (veh)	Maximum Queue Length – With Trains* (veh)	Maximum LOS^ at Railway Crossing – With Trains	Maximum Queue Length – With Fastest Train (veh)
AM Peak (8:00 – 9:00am)					
Base year 2014	5 [30m] at south approach	8	28 [168m]	B	23 [138m]
Future year 2024	12 [72m] at south approach	9	33 [198m]	C	32 [192m]
Off-Peak (12:30 – 1:30pm)					
Base year 2014	4 [24m] at south approach	2	13 [78m]	B	11 [66m]
Future year 2024	6 [36m] at south approach	2	10 [60m]	B	12 [72m]
PM Peak (4:45 – 5:45pm)					
Base year 2014	4 [24m] at west approach	6	22 [132m]	B	12 [72m]
Future year 2024	7 [42m] at west approach	9	26 [156m]	C	24 [144m]

*Refer Figure 9 showing indicative location of maximum queues for the year 2024 scenario

^LOS = Level of Service, presented on a scale A – F where A represents free-flowing conditions with minimal delays, F represents heavy congestion

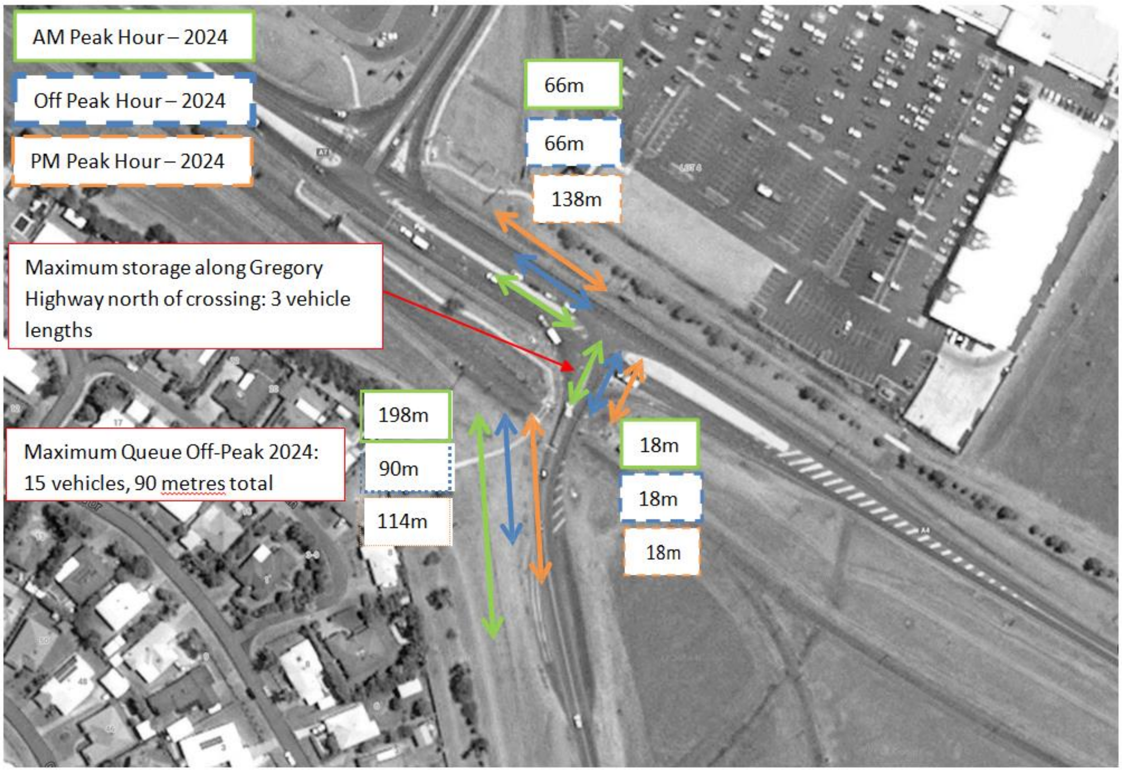


Figure 9 Indicative location of maximum queues obtained from modelling future year 2024 – Capricorn Highway / Gregory Highway intersection

Table 34 Summary of impacts at level crossing adjacent to Capricorn Highway / Opal Street intersection

Scenario	Maximum Queue Length – No Trains (veh)	Mean Queue Length – With Trains (veh)	Maximum Queue Length – With Trains* (veh)	Maximum LOS^ at Railway Crossing – With Trains	Maximum Queue Length – With Fastest Train (veh)
AM Peak (8:00 – 9:00am)					
Base year 2014	5 [30m] at south approach	9	34 [204m]	B	33 [198m]
Future year 2024	8 [48m] at south approach	15	50 [300m]	C	48 [288m]
Off-Peak (10:15 – 11:15am)					
Base year 2014	3 [18m] at west approach	10	19 [114m]	B	15 [90m]
Future year 2024	4 [24m] at west approach	15	22 [132m]	B	20 [120m]
PM Peak (5:00 – 6:00pm)					
Base year 2014	7 [42m] at west approach	12	50 [300m]	B	18 [108m]
Future year 2024	10 [60m] at west approach	34	59 [354m]	B	37 [222m]

*Refer Figure 10 showing indicative location of maximum queues for the year 2024 scenario
^LOS = Level of Service, presented on a scale A – F where A represents free-flowing conditions with minimal delays, F represents heavy congestion

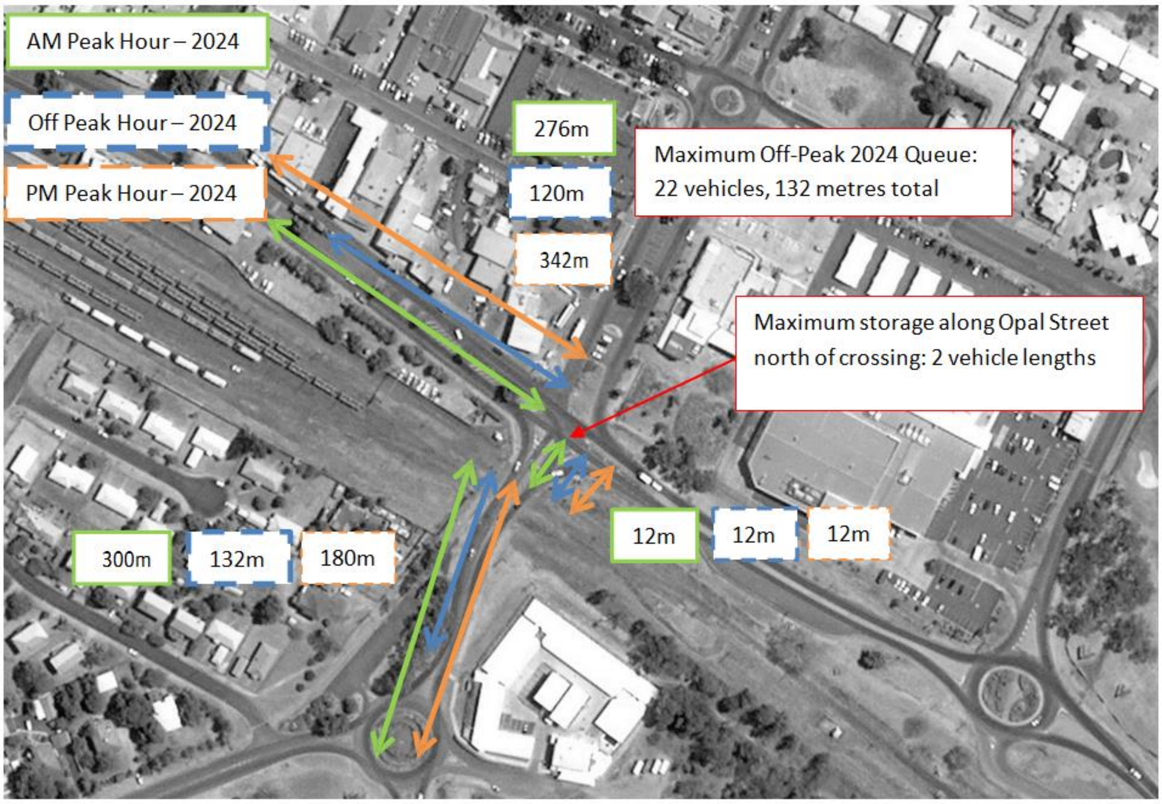


Figure 10 Indicative location of maximum queues obtained from modelling future year 2024 – Capricorn Highway / Opal Street intersection

Table 35 Summary of impacts at level crossing adjacent to Capricorn Highway / Selma Road intersection

Scenario	Maximum Queue Length – No Trains	Mean Queue Length – With	Maximum Que ue	Maximum LOS^ at Ra	Maximum Queue Length – Wit
AM Peak (7:45 – 8:45am)					
Base year 2014	3 [18m] at south approach	2	12 [72m]	A	10 [60m]
Future year 2024	6 [36m] at south approach	3	13 [78m]	A	11 [66m]
Off-Peak (12:00 – 1:00pm)					
Base year 2014	3 [18m] at south approach	1	6 [36m]	A	6 [36m]
Future year 2024	5 [30m] at south approach	8	12 [72m]	A	11 [66m]
PM Peak (4:45 – 5:45pm)					
Base year 2014	3 [18m] at south approach	2	10 [60m]	A	6 [36m]
Future year 2024	6 [36m] at south approach	3	12 [72m]	A	8 [48m]

*Refer Figure 11 showing indicative location of maximum queues for the year 2024 scenario

^LOS = Level of Service, presented on a scale A – F where A represents free-flowing conditions with minimal delays, F represents heavy congestion

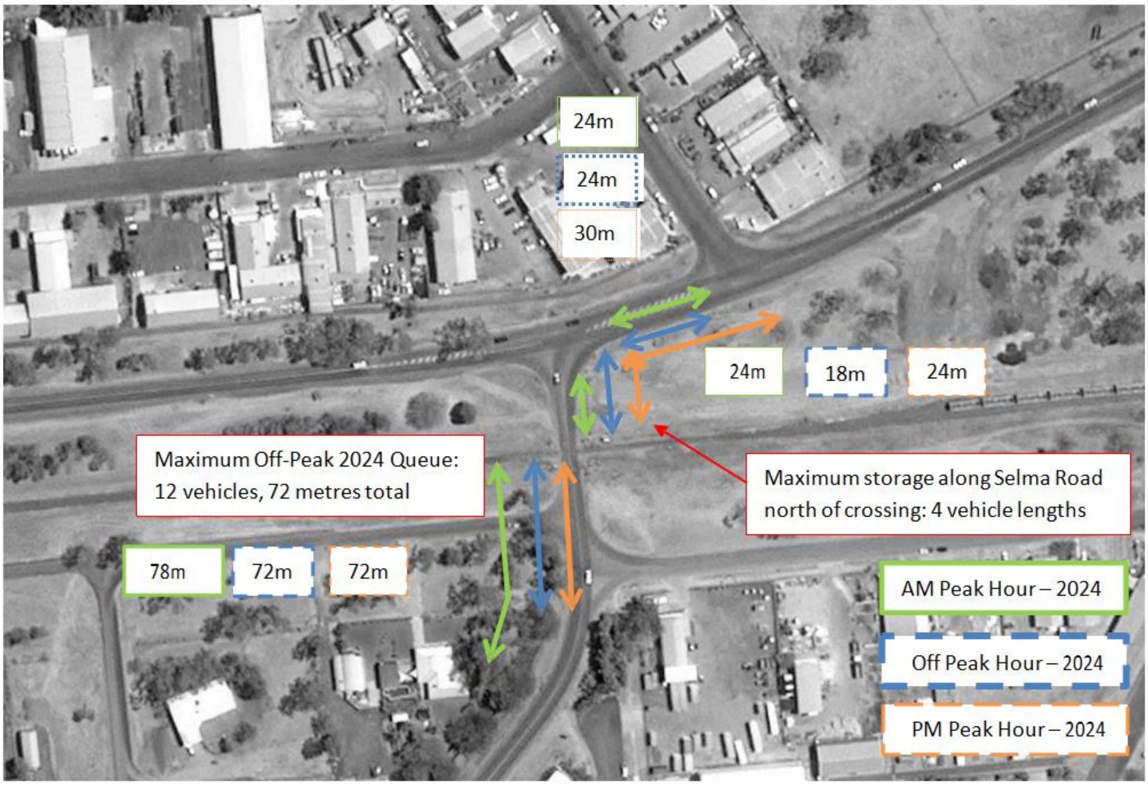


Figure 11 Indicative location of maximum queues obtained from modelling future year 2024 – Capricorn Highway / Selma Road intersection

Maximum queues at the adjoining Capricorn Highway intersections are such that no disruption to through traffic on the highway is expected with the exception of eastbound traffic through the Opal Street intersection, where the queues waiting to turn south eventually build to the point where they exceed the capacity of the turning lane and block the single lane prior to the turning lane.

It should be noted that the predicted queues at the Opal Street intersection in the future year 2024 scenario are principally attributable to the increase in base load traffic. With the assumed 2.5% annual growth rate in traffic volumes, the projected year 2024 traffic volumes will exceed the capacity of the current single lane configuration of the Capricorn Highway in terms of vehicles per hour by some 40%, which will cause traffic delays in and of itself. Therefore, it is likely that upgrades to the Capricorn Highway infrastructure in this area will be required in future that will positively affect the queue lengths and delays projected in this assessment.

Despite the somewhat lengthy queues that are projected to eventuate at the Opal Street and Gregory Highway crossings, the modelling indicates the congestion clears within 90 seconds or less following the passing of the train under current intersection configurations, which is considered acceptable and of moderate impact. As suggested above, it is quite possible that upgrades to these intersections to handle the projected increase in future base load vehicle traffic may eventuate regardless of the presence of the coal trains, which would act to lessen the increased rail traffic impact projected in this assessment.

10.6 Appendix 11, Section 5.5, Page 88 - Transport Impact Assessment – Cumulative Impacts

Submitter:

Department of Transport and Main Roads

Submission:

The first paragraph provides very brief discussion on the cumulative impacts of the many major development projects (mainly other coal mines) in the region. However, the summary is too vague. It provides no information about which projects may commence construction or operation in the same timeframe as this project or discussion about which key roads may then be cumulatively affected.

A comprehensive analysis of the potential cumulative road impacts of existing projects is not warranted. However, further information about which projects may commence construction or operation in the same timeframe as this project or discussion about which key roads may then be cumulatively affected is required as a minimum

Response:

Acknowledged, and the Proponent has redrafted this section in the final EIS document.

EIS Amendment:

Section 5.5 of Appendix 11 has been expanded to include the following additions starting as paragraph five.

"A review of coal resource areas and existing mines in the Bowen Basin revealed that there is a concentration of mining activity further north, in the Isaac-Connors sub-catchment if the Fitzroy River Basin. Mines and developments in this area most likely utilise the Peak Downs Highway, Suttor Developmental Road, and Gregory Highway. The section of the Capricorn Highway in proximity to the Project site (Section #16C) is not heavily utilised by other mining projects or large developments.

Materials transport from Mackay or Gladstone will make a greater contribution to cumulative road and traffic impacts than materials transport from Sapphire. However, as revealed by the traffic and pavement impact assessments, the predicted increases are not considered to be significant, reducing the overall contribution of the Taroborah Project to cumulative impacts.

Table 32 provides an overview of operational projects in the region and their location relative to the Project. The operational phases of these projects may overlap with the construction and operational phases of the Taroborah Project.

Table 32 Operational Projects

Name of Development	Principal Proponent	Status	Location Relative to Taroborah Project
Baralaba	Cockatoo Coal Limited	Operational	202 km SE, Dawson sub-catchment
Blackwater	BHP Coal Pty Ltd	Operational	93 km SE, Mackenzie sub-catchment
Broadlea North	Vale Australia Pty Ltd	Operational	186 km N, Isaac / Connors sub-catchment
Burton	Peabody Energy	Operational	218 km N, Isaac / Connors sub-catchment
Callide Mine & Boundary Hill South	Anglo American Metallurgical Coal	Operational	286 km SE, Dawson sub-catchment

Name of Development	Principal Proponent	Status	Location Relative to Taroborah Project
expansion			
Carborough Downs	Vale Australia Pty Ltd	Operational	179 km N, Isaac / Connors sub-catchment
Caval Ridge	BHP Billiton Mitsubishi Alliance	Operational (2010)	Isaac / Connors sub-catchment
Clermont	Rio Tinto Coal Australia	Operational	100 km NW, Nogoa sub-catchment
Coppabella	Peabody Energy	Operational	195 N, Isaac / Connors sub-catchment
Cook / Eldorado Hill	Cook Resource Mining Pty Ltd	Operational	101 km ESE, Mackenzie sub-catchment
Cracow	Newcrest Operations Limited	Operational	306 km SE, Dawson sub-catchment
Curragh	Wesfarmers Resources	Operational	93 km E, Mackenzie sub-catchment
Curragh North	Wesfarmers Resources	Operational	109 km NE, Mackenzie sub-catchment
Daunia	BHP Billiton Mitsubishi Alliance	Operational (2009)	Isaac / Connors sub-catchment
Dawson Central	Anglo American Metallurgical Coal	Operational	246 km SE, Dawson sub-catchment
Dawson South	Anglo American Metallurgical Coal	Operational	259 km SE, Dawson sub-catchment
Dawson North	Anglo American Metallurgical Coal	Operational	227 km SE, Dawson sub-catchment
Ensham	Ensham Resources Pty Limited	Operational	58 km ENE, Nogoa sub-catchment
Foxleigh	Anglo American Metallurgical Coal	Operational	108 km NE, Mackenzie sub-catchment
German Creek & German Creek East	Anglo American Metallurgical Coal	Operational	96 km NE, Mackenzie sub-catchment
Goonyella Riverside and Broadmeadow	BHP Billiton Mitsubishi Alliance	Operational	193 N, Isaac / Connors sub-catchment
North Goonyella	Peabody Energy	Operational	210 km N, Isaac / Connors sub-catchment
Gregory Crinum	BHP Billiton Mitsubishi Alliance	Operational	59 km NE, Nogoa sub-catchment
Grosvenor Coal Mine	Anglo American Metallurgical Coal	Operational	Isaac / Connors sub-catchment
Hail Creek	Rio Tinto Coal Australia	Operational	231 km N, Isaac / Connors sub-catchment
Isaac Plains	Vale Australia Pty Ltd	Operational	173 km N, Isaac / Connors sub-catchment
Jellinbah East	Jellinbah Group Pty Ltd	Operational	104 km ENE, Mackenzie sub-

Name of Development	Principal Proponent	Status	Location Relative to Taroborah Project
			catchment
Kestrel	Rio Tinto Coal Australia	Operational	55 km NE, Nogoa sub-catchment
Lake Lindsay	Anglo American Metallurgical Coal	Operational	100 km NE, Mackenzie sub-catchment
Lake Vermont	Jellinbah Group Pty Ltd	Operational	137 km NE, Isaac / Connors sub-catchment
Middlemount	Yancoal and Peabody Energy	Operational	104 km NE, Mackenzie sub-catchment
Millennium	Peabody Energy	Operational	172 km N, Isaac / Connors sub-catchment
Minerva	Sojitz Coal Mining	Operational	44 km S, Comet sub-catchment
Moorvale	Peabody Energy	Operational	177 N, Isaac / Connors sub-catchment
Moranbah Ammonium Nitrate Project	Dyno Nobel Asia Pacific Ltd	Operational	-
Moranbah Gas Project	Arrow Energy Limited	Operational (2004)	-
Moranbah North	Anglo American Metallurgical Coal	Operational	184 N, Isaac / Connors sub-catchment
Northern Missing Link Project	Queensland Rail	Operational (2005)	-
Norwich Park	BHP Billiton Mitsubishi Alliance	Operational	114 km NNE, Isaac / Connors sub-catchment
Oaky Creek	Xstrata Coal	Operational	79 km NE, Mackenzie sub-catchment
Peak Downs	BHP Coal Pty Ltd	Operational	147 km N, Isaac / Connors sub-catchment
Poitrel	BHP Billiton Mitsui Coal	Operational	169 km N, Isaac / Connors sub-catchment
Rolleston	Xstrata Coal	Operational	112 km SSE, Comet sub-catchment
Saraji	BHP Coal Pty Ltd	Operational	135 km N, Isaac / Connors sub-catchment
South Blackwater	South Blackwater Coal Pty Limited	Operational	99 km SE, Comet sub-catchment
South Walker Creek	BHP Billiton Mitsui Coal	Operational	205 km NNE, Isaac / Connors sub-catchment
Yarrabee	Yancoal	Operational	113 km ENE, Mackenzie sub-catchment

Table 33 details proposed developments in the region and their current status. The construction and operational phases of these developments may overlap with Taroborah construction and / or operations."

Table 33 Proposed Projects

Name of Development	Principal Proponent	Status	Location
Baralaba North Continued Operations (expansion of Baralaba)	Cockatoo Coal Limited	Proposed (EIS underway)	Dawson sub-catchment
Baralaba South Coal Project	Wonbindi Coal Pty Limited	Proposed (EIS underway)	Dawson sub-catchment
Carborough Downs Mine Expansion	Vale Australia Pty Ltd	Proposed (EIS complete)	Isaac / Connors sub-catchment
Central Queensland Gas Pipeline	Central Queensland Pipeline Pty Ltd	(EIS complete – 2007)	-
Central Queensland Integrated Rail	Aurizon Holdings Limited	Proposed	-
Connors River Dam and Pipelines	SunWater Ltd	Proposed (EIS complete – 2012)	Isaac / Connors sub-catchment
Elimatta	New Hope Coal	Proposed (EIS complete)	Dawson sub-catchment
Ensham Underground	Ensham Resources Pty Limited	Proposed (EIS complete)	Nogoa sub-catchment
Foxleigh Plains (extension of Foxleigh)	Anglo American Metallurgical Coal	Proposed (EIS complete)	Mackenzie sub-catchment
Red Hill (expansion of Goonyella Riverside and Broadmeadow)	BM Alliance Coal Operations Pty Ltd	Proposed	Isaac / Connors sub-catchment
Grosvenor West Project	Carabella Resources Limited	Proposed (EIS underway)	Isaac / Connors sub-catchment
Lower Fitzroy River Infrastructure Project	Gladstone Area Water Board & SunWater Ltd	Proposed (EIS underway)	-
Meteor Downs South	U&D Mining Industry Australia Pty Ltd	Proposed	Comet sub-catchment
Millennium Expansion Project	Peabody Energy	Proposed (EIS complete)	Isaac / Connors sub-catchment
Minyango	Blackwater Coal Pty Ltd	Proposed (EIS complete)	Mackenzie sub-catchment
Moranbah South	Anglo American Metallurgical Coal	Proposed (EIS complete)	Isaac / Connors sub-catchment
New Lenton	New Hope Group	Proposed (EIS underway)	Isaac / Connors sub-catchment
Olive Downs	Peabody Energy	Proposed	Isaac / Connors sub-catchment
Red Mountain Joint Venture	Peabody Energy	Proposed	Isaac / Connors sub-catchment
Rolleston Coal Mine Expansion	Xstrata Coal	Proposed (EIS underway)	Comet sub-catchment
Teresa Coal Project	New Emerald Coal (Linc Energy)	Proposed (EIS underway)	Nogoa sub-catchment

Name of Development	Principal Proponent	Status	Location
West Emerald	Cuesta Coal	Proposed	Nogoa sub-catchment
Wandoan	Xstrata Coal	Proposed (EIS complete)	Dawson sub-catchment
Washpool	Washpool Coal Pty Ltd	Proposed (EIS complete)	Mackenzie sub-catchment

10.7 Appendix 11, Section 6.0, Page 89 - Transport Impact Assessment – Mitigation Strategies and Recommendations

Submitter:

Department of Transport and Main Roads

Submission:

This section provides some important mitigation strategies including:

1. Road upgrades as required
2. Contributions to pavement maintenance and rehabilitation
3. Local diversions and road closures
4. Managing dust emissions
5. Managing spills during transport.

However, they don't adequately deal with increased road safety risk from additional project traffic. There appears little discussion about potential heavy vehicle traffic impacts and the adequacy of intersections during the construction phase along key freight delivery routes eg from routes other than the Capricorn Hwy eg from Townsville or Mackay.

The fourth paragraph mentions road closure and diversions, however, doesn't specify what may trigger these (whether blasting near public roads or another reason).

As mentioned elsewhere, some further consideration of potential road safety risks from project traffic during the construction phase (including any other projects whose development timelines may significantly coincide with this project) should be examined and reported.

This section should clarify reasons for possible road closure to help TMR and other stakeholders understand what mitigation.

Response:

Acknowledged, and the Proponent has redrafted this section in the final EIS document. Also, many of the issues raised in this submission are impacts rather than mitigation strategies, and therefore, are more appropriately discussed in various sub-sections of Section 5.0 – Potential Impacts.

It should be noted that significant concern is being shown regarding the increase in construction traffic for this project. To put this into perspective, the estimated construction traffic that will travel though Emerald, whether from the east or from the north, and out to the mine site will peak at 24 heavy vehicles movements per day from 1Q thru 2Q 2018, and average 8 heavy vehicles movements per day over the 12 month mine construction period, with these movements split fairly evenly between Mackay, Gladstone, Emerald and Sapphire.

Therefore, impacts from increased heavy vehicle traffic at intersections along the various travel routes, except for the Sapphire road-Capricorn Highway intersection would be minimal and unnoticeable.

EIS Amendments:

Section 6 of Appendix 11 has been redrafted to include expanded discussion on road safety mitigation strategies. Please see the EIS Amendment in Section 11.4 of this document.

Section 6 also includes expanded discussion on road closures. Please see the EIS Amendments in Section 11.1 of this document.

Discussion on heavy vehicle impacts is included in Section 5.1.4.4 as discussed in the EIS Amendment in Section 11.2 of this document.

Finally, a new Section 6.6 – Road Use Management Plan has been added that reads as follows:

"Prior to Project construction, a Road Use Management Plan will be prepared and implemented by both Project employees and contractors involved in the transportation of goods and materials for the Project.

The Road Use Management Plan will facilitate the safe operation of vehicles and use of transport routes. The Plan will also provide for recording and addressing any road or traffic related incidents and complaints."

11. APPENDIX 13 – SURFACE WATER MANAGEMENT PLAN

11.1 Appendix 13 – Subsidence Impacts

Submitter:

Department of Environment and Heritage Protection

Submission:

The subsidence impact assessment is focused around potential impacts on irrigation, stock watering or drinking water supply. However, the assessment does not consider the potential impacts to aquatic ecosystems.

Recommendation: Incorporate ecological outcomes into the subsidence impact assessment. The modelling would need to include flow parameters that are relevant to aquatic ecosystems and show how subsidence is predicted to affect waterhole connectivity, water level in streams and stable low flows.

Response:

Firstly, it should be noted that all of the watercourses and drainage lines in the Project area are ephemeral and only flow in response to prolonged rainfall. And the major watercourses that can be defined as creeks or streams are unaffected by direct subsidence. Further, the modelled loss of overland flow from rainfall events that would normally report to Retreat Creek and downstream aquatic ecosystems is considered insignificant at <1% of the estimated average annual overland flow in the Retreat Creek catchment system.

Secondly, the purpose of the Subsidence Assessment contained in Appendix 13 was to define the impacts of the expected subsidence as it relates to water quantity and flow, not its environmental impacts. In fact, there is no assessment of the potential impacts on irrigation, stock watering or drinking water supply mentioned in this submission for that matter.

However, there is discussion on the effect of subsidence on drainage lines and aquatic ecosystems in Section 4.5.2.1, Section 4.8.3.1, Appendix 19 and Appendix 26 of the Draft EIS report, and this assessment has been expanded in response to another submission on impacts from subsidence (please see response in Section 20.2 of this document).

Finally, monitoring of the subsidence impacts on overland flow from the affected drainages will be an important aspect of both the Subsidence Management Plan and the Receiving Environment Monitoring Plan that will be developed for the Project.

EIS Amendment:

None required

11.2 Appendix 13, Section 2.5, Page 9 - Environmental Values and Beneficial Uses

Submitter:

Department of Environment and Heritage Protection

Submission:

The baseflow WQO for electrical conductivity (EC) for the Lower Nogoa (340 µS/cm) has been omitted from Table 1.

The baseflow WQO for EC for the Lower Nogoa of 340 µS/cm should be included in Table 1 of the Surface Water Management Plan

Response:

Acknowledged, and this has been included in Table 1 of the final Appendix 13 document

EIS Amendment:

Table 1 of Appendix 13 now reads as follows:

Table 1
Lower Nogoa/Theresa Creek Water Quality Objectives

Parameter	Water Quality Objectives to Protect Aquatic Ecosystem EVs
Ammonia (N)	<10 µg/L[a]
Oxidised (N)	<60 µg/L[a]
Organic(N)	<420 µg/L[a]
Total Nitrogen(TN)	<500 µg/L[a]
Filterable Reactive Phosphorus (FRP)	<20 µg/L[a]
Total Phosphorus(TP)	<50 µg/L[a]
Chlorophyll a	<5.0 µg/L[a]
Dissolved Oxygen	85%–110% saturation
Turbidity	<50 NTUa
Suspended Solids	<10 mg/L[b]
pH	6.5–8.5 [b]
Conductivity (EC) baseflow	<720 µS/cm (Theresa Creek)
	<340 µS/cm (Lower Nogoa)

Conductivity (EC) high flow	<250 µS/cm[b]
Sulfate	<25 mg/L[b]

Note: As per Table 2 in the EPP (WATER) 2009 for the Nogoa River WQO's

11.3 Appendix 13, Section 4, Page 16 - Stormwater Management System Development

Submitter:

Department of Environment and Heritage Protection

Submission:

It is stated on page 16 that:

"(ii) Site water runoff from mining areas including non-acid forming (NAF) waste rock material and groundwater inflows "……."is to be managed such that it is captured in the first instance and subject to long term water quality testing, subsequent release to the receiving environment may occur, with the expected water quality issue related to suspended sediment."

Limited information could be found in various parts of the EIS about the characterisation of mine affected water in the MWD, CPPWRD and sediment dams to suggest that expected water quality issues will relate to suspended sediment only, or any detail on the long term water quality testing to be conducted on the site water.

While the most recognisable contaminant of potential concern is suspended solids, there are likely to be others, such as EC and some metals and metalloids.

Recommendations:

1. Clarify the expected water quality (including a list of potential contaminants) in the MWD, CPPWRD and sediment dams (based on both the waste characterisation and up-to-date groundwater quality information) into the site water management plan. This information should be used to help identify the potential hazards the dams pose to the environment under any conditions (i.e. during high stream flow, no stream flow, etc.) or if mine affected water from these dams is likely to be suitable for beneficial use. This information should be used to guide the management of surface water and to develop the ongoing surface water quality monitoring program.
2. Provide information about the long term water quality monitoring program to be applied to runoff from waste rock dumps and groundwater inflows. Details on the long term water testing should include the timing and frequency of testing, which water quality indicators will be included in the testing suite, etc. This information would need to be incorporated into the release conditions of the EA pertaining to mine affected waters.

Response:

Response to 1

The water quality expected in the MWD can be characterised by a combination of the quality projection for the final pit void in the first year of inundation (the opencut contribution)and the average quality of the groundwater in the Aldebaran sandstone aquifer (the underground mine contribution). The details can be found in Table 6 of Attachment E to this document and the response in Section 12.14 of this document, respectively. There will also be some hydrocarbons contained in this water that have emanated from contact with grease and oil residues left by mining machinery, however, given the volumes of diluting water involved, the hydrocarbon levels will be negligible.

Water quality in the sediment dams and the CPPWRD will be similar to the quality of the surface water run-off from spoil material as characterised in Table 5 of Attachment E to this document. Additionally, the CPPWRD water quality will likely have increased levels of SO_4 and magnetite as it will be affected by recycling water to the CPP, and will also contain low

levels of hydrocarbons as run-off from the MIA areas will also report to here.

It should be noted that the site water management system has been designed such that release of mine affected water will only occur from the MWD in a controlled manner for irrigation, except in the circumstances of extreme storm events (i.e. > 200 year ARI), when water from the various sediments dams wioll also likely be released. All sediment dams have been assessed as a low consequence risk due to their limited size and therefore designed for a 1 in 10 year ARI event, with pumping capabilities to handle a 100 year ARI event to transfer water to the CPPWRD to ensure they maintain this design capacity. Due to its High consequence rating, the design storage allowance for the CPPWRD has been designated for a 1 in 100 year ARI rainfall event (i.e. <1% spill risk) as 392ML, however, the storage volume as designed will be over 800ML and the dam operated to have the capability to pump water to the MWD if necessary to maintain the DSA capacity at all times, such that the actual spill risk is <0.5%.

Response to 2

The proposed long term water quality monitoring program is outlined in the Receiving Environment Monitoring Program (REMP) framework document that has been developed for the project.

EIS Amendment:

None required for Response A. The long term water quality monitoring program (or REMP) is outlined in Appendix 28 to the final EIS document and reproduced in this document as Attachment E.

11.4 Appendix 13, Section 5.1.3, Page 20 & Section 5.7.2.2, Page 28 - Stormwater Management System - Hazard Assessment Summary and CPPWRD

Submitter:

Department of Environment and Heritage Protection

Submission:

The CPPWRD has been classified as a high hazard regulated dam requiring a 1:100 AEP design storage allowance (i.e. less than 1% spill probability). However, the modelled spill probability for the CPPWRD presented in Section 5.7.2.2, based on a storage capacity of 750ML, is less than 2%. This does not meet the 1% spill probability for high hazard dams required by EHP's Manual for Assessing Consequence Categories and Hydraulic Performance of Dams (EHP 2013).

Recommendation: Amend the design of the CPPWRD to show compliance with EHP's *Manual for Assessing Consequence Categories and Hydraulic Performance of Dams* (EHP 2013)

Response:

The 750 ML design volume of the CPPWRD does exceed the <1% probability DSA of 540 ML, as discussed in Section 5.1 of the Draft EIS and illustrated in Table 7. However, the operating philosophy of transferring water from the MWD to the CPPWRD used in the draft water balance model assumed maximum use of the 750 ML storage volume to limit release of any excess groundwater make stored in the MWD, which allowed the spill risk of the CPPWRD to increase to < 2%. As discussed in the previous response above, the water balance model has been rerun to reduce the operational spill risk of the CPPWRD to below 0.5%.

EIS Amendment:

Table 7 (now Table 8 in Section 5.1) of Appendix 13 of the final EIS has been amended based on redesign of the surface facilities to read as follows:

Table 8
Minimum Design Storage Requirement for Regulated Structures

Regulated Structure	Containment Criteria	Equivalent Rainfall(mm)	Contributing Catchment (ha)	Minimum Design Storage Allowance (ML)
MWD	1 in 100 year AEP	841	22.1	497#
CPPWRD	1 in 100 year AEP	1,200	32.7	392*

This value includes 312 ML of groundwater inflow that will be concurrently transferred to this dam from mine workings.
* The direct contributing catchment for the CPPWRD is 11.9 ha. The current evaluation of DSA for CPPWRD includes the process plant catchment area of 20.8 ha which is proposed to be captured within SED01 and SED02 and subsequently pumped into CPPWRD to ensure full containment of significantly contaminated water.

And the discussion on the performance of the water management system (including the CPPWRD) based on the new operational philosophy in the water balance model, which is contained in Section 5.3 of the amended Appendix 13, reads as follows:

"5.3 Water Balance Modelling Results and Interpretation

5.3.1 Model Output

Outputs from the water balance model are summarised in Plate 10 for the MWD and Plate 11 for the CPPWRD in the form of storage volume percentiles, over the respective modelling period, with the maximum, mean and minimum conditions also shown.

Plate 10
MWD Water Balance Model Output
(Storage Capacity by Volume)

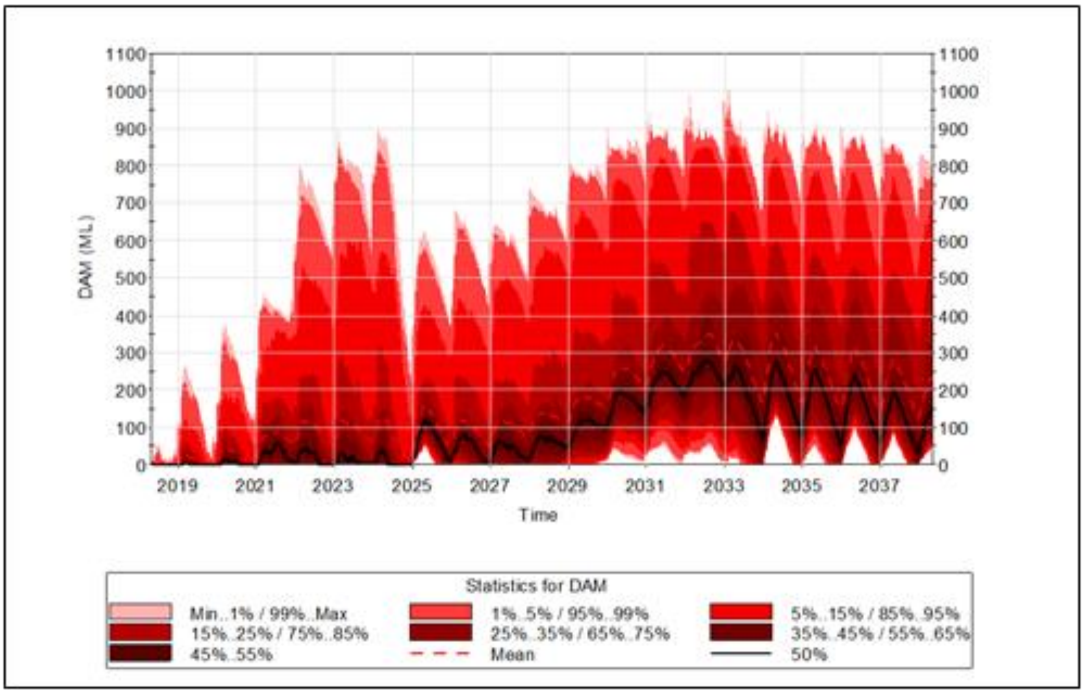


Plate 11
CPPWRD Water Balance Model Output
(Storage Capacity by Volume)

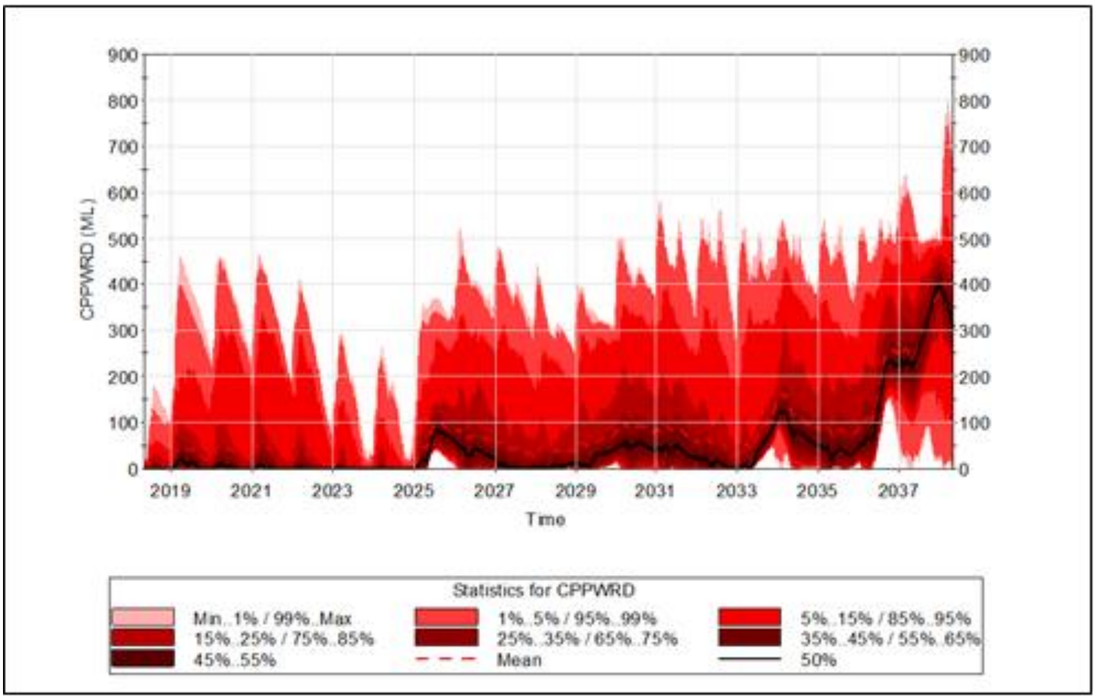
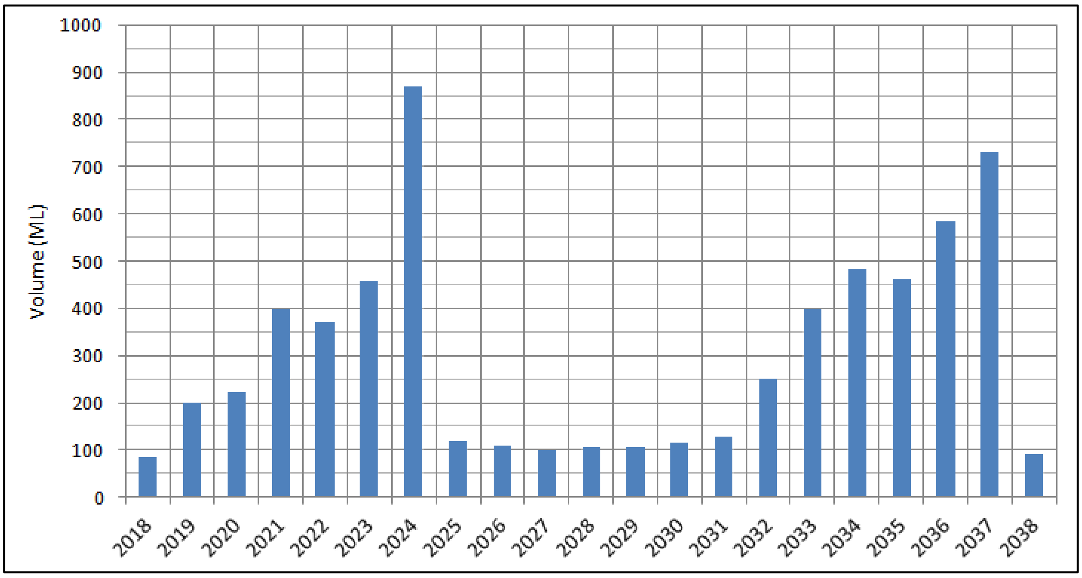


Plate 12 shows the excess ground water discharged when the MWD had a storage volume greater than 900ML.

Plate 12
Mean Excess Water at Site



5.3.2 Model Results Interpretation

5.3.2.1 Mine Wastewater Dam

Plate 10 in Section 5.3.1 indicates maximum accumulation within the MWD based on the simulated 123 year rainfall record of 1077ML, with a spill risk of less than 1% using a full storage capacity of 1,077ML and with the operational conditions in place. Plate 12 shows that the groundwater excess

from dewatering will range on average between 80ML to 880 ML per annum.

As the water balance model indicates excess of groundwater inflow at site, it is proposed (by Shenhuo) to perform controlled releases of the excess water from the MWD subject to testing and necessary treatment into the irrigation system downstream of Fairbairn Dam for beneficial use. Additional monitoring and testing is proposed as necessary before release. The modelled spill risk for the MWD is less than 1% under proposed operational conditions which achieves the spill risk criteria of less than 1% for High consequence structure.

5.3.2.2 CPP Water Recycle Dam

Plate 11 in Section 5.3.1 indicates accumulation within the CPPWRD based on the simulated 123 year rainfall record exceeds the full supply capacity of 832ML only for the final year being less than 1% of modelled conditions. The mean storage volume ranges from 50ML during the dry season to 400ML in the wet season with the higher storage levels occurring in the final 3 years of operation. The modelled spill risks for the CPPWRD is less than 0.5% which is less and achieves the spill risk criteria of less than 1% for a High consequence structure.

5.3.3 Additional Operational Conditions

For the purposes of conceptual modelling, a pit sump capacity of some 20 ML was adopted based on consultation with IMC, notwithstanding that the pit sumps will be designed based on the requirement of the site during the operational period."

11.5 Ref 93 Appendix 13, Section 5.1.4, Page 20 & Section 5.8, Page 29 - Stormwater Management System - Containment Requirement for Regulated Structures and Summary

Submitter:

Department of Environment and Heritage Protection

Submission:

"Other process inputs" is mentioned in the water balance modelling section on pages 20 and 29. These inputs are currently unidentified and were excluded from the modelling, which states:

"…the exclusion of the sediment dam inflow and other process inputs which have been shown in the water balance model to be highly variable inputs."

However, it is not clear how significant the other process inputs are to the water balance model.

Recommendation: Provide an explanation of the significance of the "Other process inputs" (where possible), in the context of the water balance modelling with regard to any limitations these inputs have on the level of accuracy, certainty and interpretation of the modelling results.

Response:

The Proponent acknowledges the confusion and concern about the statements in both sections that arises more from somewhat ambiguous wording than it does from a lack of consideration of all of the water balance inputs that go into the estimation of the Design Storage Allowance (DSA). Both of the snippets identified above relate to the estimation of the DSA rather than the water balance model in general. In this respect, the DSA determination includes nothing but inputs (i.e. mine dewatering and rainfall run-off) and no outputs. The "other process inputs" actually relates to mining processes inputs (i.e. water usage), which is an output and not considered in the DSA determination. Therefore, with no operational outputs included in the DSA determination, the results could be considered conservative.

Despite the “exclusion of sediment dam inflow” statement, the CPPWRD DSA determination does include some inputs from sediment dams, as evidenced by the catchment area used in the DSA determination (44 ha as indicated on Table 7) compared to the actual direct catchment area (19 ha as indicated on Table 9). This relates to the water from Sediment Dam 2, which catches the run-off from the CHPP area and is considered the highest risk sediment dam in terms of quality on the proposed mine site.

As for the other sediment dams, the inflow to these are indeed somewhat undefined and variable. For example, the run-off from the out-of-pit spoil will be higher risk during the first 2-3 years of the mine operation than for the remaining 18 years due to the fact that rehabilitation has not been effected and some PAF material could be exposed to a high rainfall event. However, with proper design of the spoil dump drainage system, there should be no significant flushing effect of PAF affected water from heavy rainfall, and the major concern will be sediment. And following rehabilitation, the proposed capping design will negate the exposure of harmful contaminants in the spoil dumps to the rainfall run-off altogether. Therefore, the catchment area of the out-of-pit spoil dumps has not been included in the long term DSA determination for the CPPWRD.

EIS Amendment:

To eliminate the ambiguity of the snippets raised in this submission, the following amendments have been made to Appendix 13 to the final EIS document.

The first paragraph of Section 5.1 – Initial Storage Sizing (formerly Section 5.1.4 - Containment Requirement for Regulated Structures (Method of Deciles, not including process inputs)) has been amended to read as follows:

“Initial Design Storage Allowance requirements were assessed based on the consequence assessment criteria in Section 4.4, using the Method of Deciles inclusive of mean groundwater inflow to the MWD and higher risk sediment dam inflows to the CPPWRD. The DSAs for each regulated structure are outlined in Table 8.”

And the first three paragraphs of Section 5.4 - Proposed Operational Conditions (formerly Section 5.8 – Summary of Results) has been amended to read as follows

“The proposed regulated structures’ storage capacities were selected based on the larger capacity evaluated based on the Method of Deciles method and the Operational Simulation Un-calibrated method. The proposed storage capacity for each regulated structure is outlined in Table 13.

Table 13
Proposed Storage Capacities for Regulated Structures

Regulated Structure	Design Storage Allowance (ML)	Operational Simulation Un-calibrated (ML)	Proposed Storage Capacity (ML)
MWD	497	1,077	1,077
CPPWRD	392	832	832

As shown above, the proposed DSA from the Method of Deciles (including average captured groundwater inflow to the MWD and excluding inflows from most sediment dams to the CPPQWRD) is lower than the Operational Simulation results for the MWD and CPPWRD. The difference in storage volume estimation for the CPPWRD is due to the exclusion of all the sediment dam inflows in the DSA calculation except SED 1 and SED 2, as the inflows to the other sediment dams have been shown in the water balance model to be highly variable inputs in terms of quantity and potential deteriorated quality. The difference in storage volume estimation for the MWD is due to the variability of the captured groundwater inflow volumes with time, which will vary the DSA volume calculated using the Method Of Deciles for each year of the project. Therefore the mean groundwater inflow volume of 312ML per annum has been used in the Method of Deciles DSA

estimation, noting that for maximum modelled groundwater inflow volumes, the Method Of Deciles volume increases to approximately 900ML.

To provide the most conservative estimate for the volume requirements for the two regulated storages, the Operational Simulation results have been selected. Therefore, the proposed storages for the MWD and the CPPWRD are 1,077 ML and 832 ML, respectively."

11.6 Appendix 13 - Water Balance Model Development - Relevance

Submitter:

Independent Expert Scientific Committee (IESC)

Submission:

There is uncertainty surrounding the Taroborah Coal project's mine water requirements under a range of climatic conditions, which may result in the potential risk of uncontrolled discharges and requirements for supplementary water supplies. Specifically, the water balance has been modelled under mean rainfall conditions, does not identify mine water requirements during dry or wet conditions and under-represents early and recent climatic data, including significant flood events in 2008 and 2011.

A listing of all inputs and outputs for the site water balance including their seasonal and annual variation are necessary to improve confidence in predicted water availability onsite, the spill risk for mine water storages and the proposed mine site water management system's performance under wet and dry conditions.

A complete site water balance should be presented, showing all inputs and outputs and stores of water in the system over the whole mine life. The water management system performance under a variety of conditions, including seasonal wet/dry and long-term climate trends, should be provided and the potential for water excesses or shortages assessed. If additional sources of water supply could be required, they should be clearly identified. The preferred discharge option for excess water from site should be confirmed and appropriate infrastructure designed, for example, location and sizing of pumps. Ongoing monitoring of climate (rainfall and evaporation), groundwater inflows and onsite water use should be carried out, and the results used to verify and, if necessary, update the water balance during the mine life.

Response:

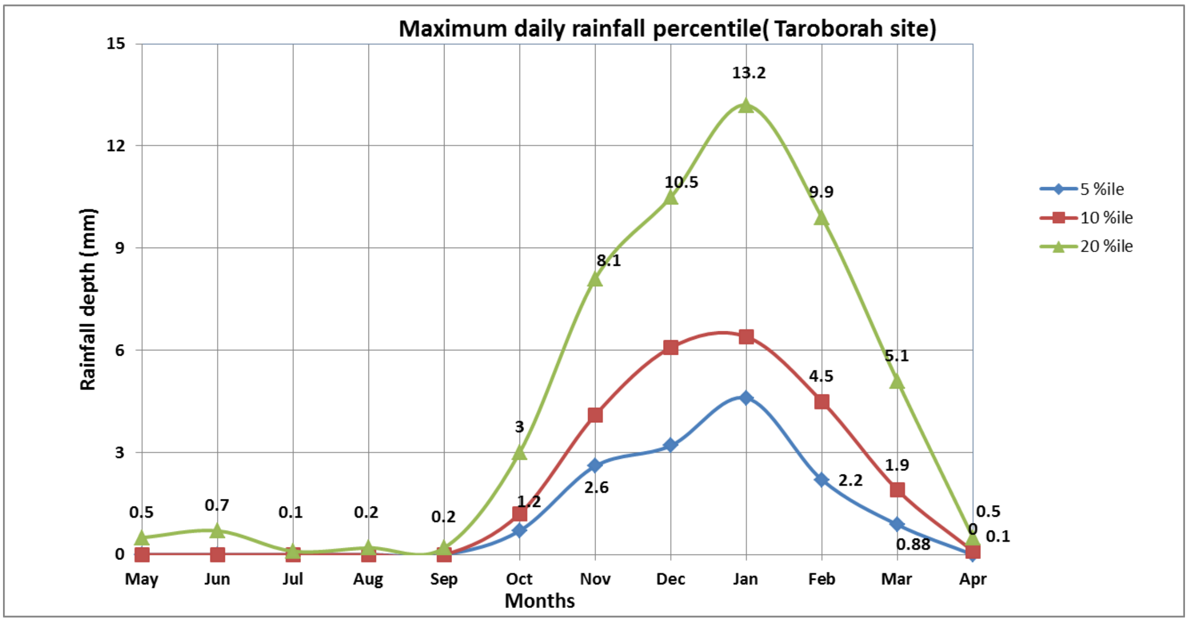
The adopted water balance model for the Taroborah project site is based on a daily climatic record for the Emerald area comprising some 124 years of data as detailed below, including the 2008 and 2011 flood events.

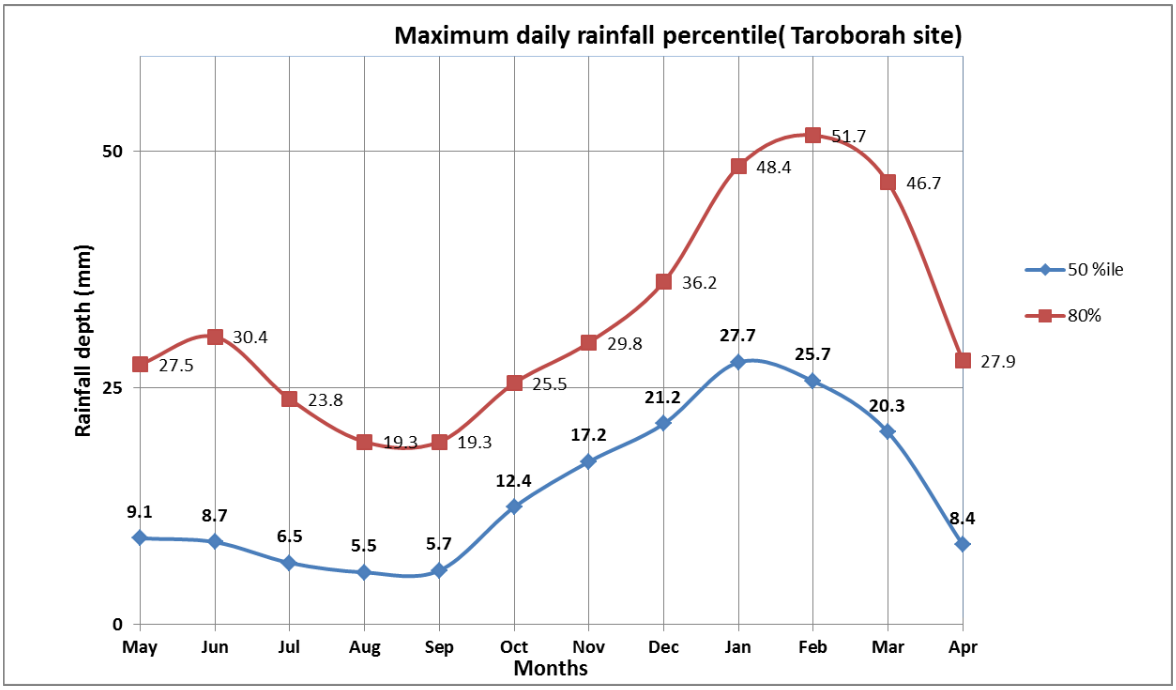
Climatic Input to Water Balance Model

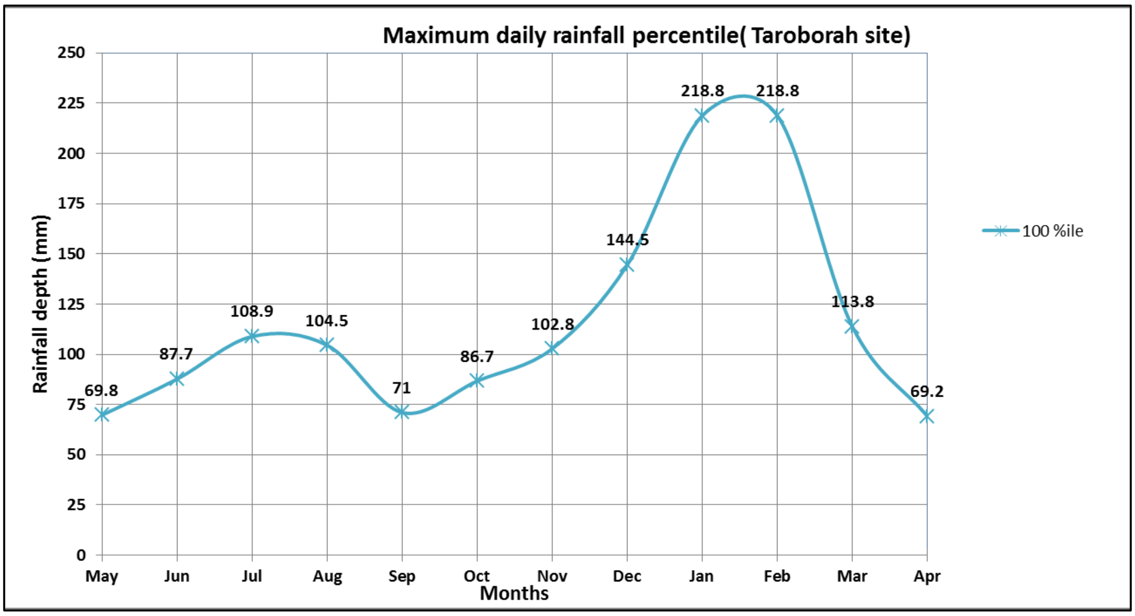
Model Parameter	Available Data	Data Source	Comments
Rainfall	Daily rainfall for period 1889 to 2013	SILO Data drill for Emerald site location.	
Evaporation	Average monthly Class A Pan evaporation data.	SILO Data drill for Emerald site location.	Evapotranspiration data based on Class A Pan. Evaporation data, taken as representative of open-water evaporation.

The water balance model was carried out using the Gold Sim modelling software and

applying a dynamic probabilistic simulation modelling approach whereby the model includes all climatic conditions ranging from minimum, to mean, to maximum in the form or percentiles ranging from 5% to 95%. The 20th percentile year represents a dry year, the 50th an average year and the 80th a wet year. The following graphs present the maximum daily rainfall of 5%, 20%, 50%,80% and 100% percentile that has been applied to the Water Balance Model.







The mine water balance model for the project also receives input from groundwater discharge. This groundwater discharge is a product of mining through the Permian coal measures in the opencut and underground mine developments. The numerical groundwater model has been used to simulate mine development and allows for the prediction of this discharge.

The numerical groundwater model has been calibrated to a steady state condition with the assumption of constant surface recharge to the groundwater system. This application of constant recharge has been applied in the predictive model and, as a result, the model does not simulate seasonal variations in recharge. Measured groundwater level data over the last 15 months has shown that the groundwater systems (in particular the Permian coal measures) are unaffected by seasonal rainfall, with immeasurable hydraulic response during rainfall events. Therefore, the model assumption not to simulate seasonal recharge variation in the predictive model scenarios is appropriate at this stage in the project.

As groundwater inflow occurs from the Permian coal measures, any short-term fluctuations (increases or decreases) in recharge to the outcrop or subcrop of the Permian coal measures will not be observed in the groundwater discharge to the mine. The modelled recharge rate is low and groundwater travel times are long enough for the strata to buffer any additional water that may be accepted into the groundwater system as recharge. Therefore, the predicted groundwater inflow from the Permian coal measures will be unaffected by any seasonal changes in rainfall or recharge.

With regards to any longer term increase in groundwater recharge (climate change), the sensitivity analysis in the EIS (Section 11.8 within Appendix 14) currently includes a scenario whereby recharge (excluding recharge to the void and spoil) was increased and decreased by an order of magnitude. The results (shown below) demonstrate that with an order of magnitude change over the full life of the mine (open cut and underground) the average daily inflows would increase and decrease by 28% and 4% respectively.

Recharge Sensitivity on Groundwater Inflows

Parameter	Average Daily Inflow		Maximum Daily Inflow	
	ML/day	%	ML/day	%
Baseline	2.6	100	5.7	100
RCH + 1 x OM	3.3	128%	6.5	114%
RCH – 1 x OM	2.5	96%	6.6	115%

To manage water levels in the various sediment basins and pit sumps, each basin and sump will include a discharge pumping system to transfer water to the Coal Preparation Plant Water Recycle Dam (CPPWRD) and the Mine Wastewater Dam (MWD), respectively. The approximate pump sizes required based on a 10 year ARI event for the less sensitive sediment basins and a 100 year ARI event for the more sensitive sediment basins are indicated in the following table.

Site Water Management System Pump Capacities

Transfer System	Catchment Area	Pumping Capacity
Open Cut Pit to MWD	varies	100 L/s
MWD to CPPWRD	na	50 L/s
Sediment Basin 1 to CPPWRD – Captures run-off from Product Stockpile area – more sensitive	3.6 ha	10 L/s
Sediment Basin 2 to CPPWRD - Captures run-off from the CHPP area – more sensitive	16.9 ha	50 L/s
Sediment Basin 3 to CPPWRD - Captures run-off from the MIA, including wash down and fuel stores – more sensitive	18.9 ha	50 L/s
Sediment Basin 4 to CPPWRD - Captures run-off from the northwest spoil dump area – less sensitive	40.3 ha	10 L/s
Sediment Basin 5 to CPPWRD - Captures run-off from the underground ROM stockpile and fuel stores/ wash down area – more sensitive	7.6 ha	20 L/s
Sediment Basin 6 to CPPWRD - Captures run-off from the southwest spoil dump area – less sensitive	16.9 ha	10 L/s
Sediment Basin 7 to CPPWRD - Captures run-off from the southeast spoil dump area – less sensitive	38.6 ha	10 L/s

Based on the probabilistic site water balance model, there is expected to be a surplus of water even in the driest conditions. Therefore, external water sources for mine operations supply are not expected to be required.

At this point in time, the modeled surplus of water, which will be suitable for irrigation and livestock watering needs, is anticipated to be released to the local landholders (where those water supplies are impacted by the mining operations) in the first instance and then in a controlled manner off site into the Selma irrigation channel system downstream of Fairburn dam. To minimise fluctuations in release volumes and eliminate the need for emergency release of large volumes in a short time frame, water will be released in a

steady state manner year around to provide for maximum irrigation needs during the dry season and ensure adequate volumes in the dams for storage of seasonal rain events. Design of each release system will be undertaken as part of the detailed engineering study for the Project.

A third option being investigated for disposal of surplus water is sale of the water to a third party interest proposing to construct an industrial water supply line from the Fairburn Dam to the Galilee Basin. Should this eventuate, it would become the preferred option following release to local landholders.

Ongoing monitoring of the climate (rainfall and evaporation) and onsite water use will be undertaken as suggested as the operations progress. Monitoring of groundwater inflows is already recommended as part of the impact assessment report in the EIS (Appendix 14, Section 12.3). This data would be used to verify the groundwater model and provide confidence in its predictive capacity.

EIS Amendment:

The above detail on the water balance model inputs and outputs is now included in an expanded Appendix A to Appendix 13 in the final EIS document.

11.7 Appendix 13, Section 5.2, Page 20 - Water Balance Model Development

Submitter:

Department of Natural Resources and Mines

Submission:

The EIS states "Additionally, water balance modelling has been conducted to estimate the extent to which the capture of overland flow from clean water catchments can meet construction and operational water demands for the Project site." The report does not estimate the water demand for the construction phase or identify where the water will be sourced from. The Proponent is requested to estimate the average and maximum rates of water supply from each source for each phase of the project's life (Section 3.5.3 of the Terms of Reference for the Project**).**

Response:

Firstly, it should be noted that the statement of "capture overland flow from clean water catchments" is erroneous, as clean overland flow is proposed to be diverted around the mining activities rather than captured. The only capture of overland flow will be rainfall run-off from mining disturbance areas (i.e. the spoil dumps, opencut pit, CHPP facilities and MIA), which will be stored the various sediment dams and the CPPWRD and MWD.

It is considered likely that some form of dewatering in advance of opencut mining operations will be necessary in order to control inflows into the active pit voids, and these dewatering wells would be installed in the initial stage of mine construction and used as the supply of water for construction activities. Estimated water supply requirements for the construction and operational phases of the Project are shown in the following table.

As stated in the draft EIS, water for mining operations (primarily dust suppression) will be supplied from the MWD and water for coal processing will be sourced from the CPPWRD. And potable water will also be supplied from the MWD via the on-site water treatment plant.

Taroborah Coal Project
Estimated Water Usage - ML/day

		Surface Dust Suppression							CHPP			
Project Activities	Year	Area for MIA/Pit (ha)	Area for Haul Roads Length (m)	width (m)	Area (ha)	Total Area (ha)	Usage [1] @ 0.33 ML/ha (ML/day)	Equip Washdown (ML/day)	ROM tonnes/yr	Usage @ 240L/t (ML/day)	UG Mine (ML/day)	Total Water Usage (ML/day)
Construction	2017	10	-	35	-	10	0.33	0.030				0.33
Construction/OC Ops	2018	20	8,700	35	30.45	50.45	1.66	0.030	215,314	0.15		1.81
OC Ops	2019	10	8,700	35	30.45	40.45	1.33	0.030	588,506	0.40		1.74
OC Ops	2020	10	7,400	35	25.90	35.9	1.18	0.030	812,142	0.56		1.74
OC Ops	2021	10	7,900	35	27.65	37.65	1.24	0.030	896,461	0.61		1.86
OC Ops + UG dev	2022	10	8,400	35	29.40	39.4	1.30	0.030	829,808	0.57	0.38	2.24
OC Ops + UG dev	2023	10	8,900	35	31.15	41.15	1.36	0.035	831,460	0.57	0.75	2.68
OC Ops + UG ops	2024	10	7,900	35	27.65	37.65	1.24	0.045	440,508	0.30	1.00	2.54
UG Ops Only	2025	3	5,600	35	19.60	22.6	0.34	0.015	52,378	0.04	1.20	1.57
UG Ops Only	2026	3	5,600	35	19.60	22.6	0.34	0.015	250,745	0.17	1.20	1.71
UG Ops Only	2027	3	5,600	35	19.60	22.6	0.34	0.015	614,651	0.42	1.20	1.96
UG Ops Only	2028	3	5,600	35	19.60	22.6	0.34	0.015	561,056	0.38	1.20	1.92
UG Ops Only	2029	3	5,600	35	19.60	22.6	0.34	0.015	181,038	0.12	1.20	1.66
UG Ops Only	2030	3	5,600	35	19.60	22.6	0.34	0.015	91,675	0.06	1.20	1.60
UG Ops Only	2031	3	5,600	35	19.60	22.6	0.34	0.015	371,846	0.25	1.20	1.79
UG Ops Only	2032	3	5,600	35	19.60	22.6	0.34	0.015	352,071	0.24	1.20	1.78
UG Ops Only	2033	3	5,600	35	19.60	22.6	0.34	0.015	523,314	0.36	1.10	1.80
UG Ops Only	2034	3	5,600	35	19.60	22.6	0.34	0.015	796,539	0.55	1.00	1.89
UG Ops Only	2035	3	5,600	35	19.60	22.6	0.34	0.015	778,688	0.53	1.00	1.87
UG Ops Only	2036	3	5,600	35	19.60	22.6	0.34	0.015	-	-	1.00	1.34
UG Ops Only	2037	3	5,600	35	19.60	22.6	0.34	0.010	-	-	1.00	1.34
UG Ops Only	2038	3	5,600	35	19.60	22.6	0.34	0.010	-	-	1.00	1.34

Note: (1) Usage on surface mine roads halved during underground operations due to significantly reduced traffic

EIS Amendment:

Sections 5.2 through 5.6 of Appendix 13 to the Draft EIS have been incorporated into a new Section 5.2 of Appendix 13. Sections 5.2 and 5.3 of the draft EIS, which discussed water supply sources and operational water needs have been replaced by the following first two sub-sections of Section 5.2.

"5.2 Water Balance Model

5.2.1 Preface

The specific objective of the modelling was to assess containment capacity and minimise release of potentially mine-impacted site water, complying with the criteria as outlined in Section 4.0, by the appropriate sizing of site water management elements, as well as to manage the quantity of water captured on the project site. Additionally, water balance modelling was conducted to estimate the extent to which the required mine dewatering and the capture of overland flow from related catchments can meet construction and operational water demands for the Taroborah Coal Project site.

5.2.2 Site Water Requirements

Water requirements on the mine site will vary over the life of the operation. Water use during construction and for open-cut operations will mainly comprise dust suppression and coal preparation. Ablutions will be produced from a potable water treatment plant. Climatic factors will also play a significant role in water requirements for dust suppression and will be assessed on a year to year basis. Water use for underground operations will mainly comprise equipment operational needs and dust suppression. Operational water needs will be preferentially sourced from the on-site storages (dirty), as well as surface and groundwater flows reporting to the open cut pit and underground workings. Groundwater inflow based on the groundwater report by AGE (AGE, 2014), dust suppression demand and operation water input is shown in Appendix A, Table 2. A 200 kL water storage tank and Potable Water Treatment Plant for the generation of potable water on site has been included in this assessment."

And the above table providing the estimate of mine operational water needs is including in the expanded Appendix A to Appendix 13 of the final EIS document.

11.8 Appendix 13, Section 6.2, Page 32 - Site Water Collection Drains

Submitter:

Department of Environment and Heritage Protection

Submission:

Section 6.2 states: "The site water drains extend around the perimeter of the out of pit spoil dumps on each side and are designed to report towards the sediments basin which then flows into the MWD."

However, elsewhere in the Surface Water Management Plan (e.g. Plate 6 on page 21) and in other EIS documents, the sediment dams (also called sediment basins) are shown reporting to the CPPWRD.

Revise the relevant sections of the EIS to ensure consistency of the design of the surface water management system

Response:

The above highlighted wording on Page 32 of Appendix 13 is incorrect and has been corrected in the final EIS document to be consistent with the other areas of the report.

EIS Amendment:

The first paragraphs of Section 6.2 in Appendix 13 have been amended to read as follows:

"Site water collection drains will be formed around the infrastructure area to capture site water. The locations of these are shown on Figure 4, 5, 6 and 7.A description of these drains, drain sizes and relevant construction/engineering aspects, is provided below:

Out of Pit Spoil Dump	The site water drains extend around the perimeter of the out of pit spoil dumps on each side and are designed to report towards the sediment basin for each dump, which is then pumped into the CPPWRD. A total catchment of approximately 95.8 ha is estimated for the three out of pit spoil dumps.
Pit	Drainage lines are proposed along the northern and eastern boundary of the pit based on the pit sequencing. The contributing catchment runoff will be captured and subsequently flow into the sump and pump arrangement and discharged to the MWD.
Infrastructure area	Extending around the perimeter of the infrastructure area with discharge to Sediment Basins 1, 2, 3 and 5, which are then pumped into the CPPWRD.

These drains are to be formed by excavation."

11.9 Appendix 13, Section 6.3.5, Page 35 - Summary of Subsidence Trough Mapping

Submitter:

Department of Natural Resources and Mines

Submission:

The Potential Ponding areas in the EIS (illustrated in Plate 13-p38 and detailed in Table 16-p36) were estimated from cross sections developed for two major drainage lines (illustrated in Plate 12-p 37) in order to assess the pre and post underground mining impact

upon drainage line topography. The proponent does not estimate any ponding that may occur in areas away from the two drainage lines. The Proponent should estimate the surface ponding for the entire area to be subsided and estimate volumes of all ponding likely to occur. Further, a detailed Subsidence Management Plan is required to address the impacts of subsidence on water resources.

Response:

The entire area impacted by subsidence was assessed for ponding, and the assessment showed that ponding would only occur within the two major drainage lines that are oriented sub-perpendicular to the subsidence troughs. Therefore the identified ponding areas and volumes are considered accurate for the level of subsidence predicted.

A Subsidence Management Plan that details monitoring of impacts to water resources and proposed remediation strategies will be developed as required prior to mining and once the mine layout is finalised.

EIS Amendment:

Section 7.4 (formerly Section 6.3.5) of Appendix 13 has been amended to read a sfollows:

"The level of subsidence and the post-mining topography within the Project extent were provided by IMC. The subsided topography contours received from IMC were reviewed to identify ponding locations. This review revealed that, because of the orientation of the extracted panels being roughly perpendicular to the slope of the land, the two major drainage lines were the only areas where significant ponding would occur. Cross sections along these drainage lines were then prepared to estimate ponding locations, pond geometry and the storage capacity of the ponds to the level at which the ponds would overflow.

The mapping of potential subsidence ponding extents and volumes within the proposed Taroborah underground mine area identified 10 ponding areas. The subsidence pond volumes are estimated to range between 3 ML and 12.5 ML. The average capacity would be approximately 7.1 ML. The total identified ponding area is some 28.2 hectares. The two drainage line's long sections in comparison of existing topography against post-mining topography is illustrated on Plate 15 with the identified ponding areas shown on Plate 16."

11.10 Appendix 13 and Section 4.5 - Subsidence Impacts to Surface Water

Submitter:

Independent Expert Scientific Committee

Submission:

Subsidence modelling predicts surface depressions will develop and will form ponds with volumes up to 12.5 ML, covering approximately 28.8 ha of the proposed project area. When at full capacity, combined pond volumes are predicted to total 53 ML, or a surface runoff capture of six per cent across the project area. The proponent's assessment of subsidence impacts does not include consideration of scouring of subsided surface drainages; storage within surface tension cracks; increased capacity within surface water infrastructure; and surface water runoff reductions from drainage lines impacted by subsidence. Given the above, there is low confidence in the assessment of subsidence impacts to Retreat Creek as impacts may be underestimated. Further, the assessment does not consider the potential for scouring to cause increased sedimentation and a deterioration of water quality.

Response:

The above statement on predicted ponding volumes is partly mistaken.

The total ponding volume from subsidence depressions, assuming no progressive mitigation efforts to reduce pond volume over the 17 years of underground mine operation, is 71ML and has no relation to percentage of run-off capture. The 53ML quoted is the average run-off capture per annum over the life of the underground mine, and again, assumes that no mitigation to reduce ponding over the 17 years of mine life is undertaken. While it is true that the full 53ML capture per annum is 6% of annual run-off into Retreat Creek from the project site, this is only 3ML over the prescribed 50ML limit in the Fitzroy River Water Resources Plan and represents only 0.1% of the total 41,233ML of modeled annual rainwater run-off in the Retreat Creek catchment area. In actuality, the subsidence depressions that could form ponding of rain water runoff will be progressively rehabilitated to reestablish drainage shortly after subsidence such that the annual flow capture will be a fraction of the 53ML total mentioned here, and therefore, will be insignificant.

As shown in the figures below, even though the site runoff flows perpendicular to the proposed length of the underlying longwall panels (Figure 1), the subsidence model completed for the project predicts that the changes in grade along the drainage pathways due to subsidence are small when compared with the natural gradients and, therefore, are unlikely to have a significant impact on the surface water flows. Thus, depths of any formed subsidence troughs are predicted to be 1m or less.

Given that the site will remain vegetated, the increases in velocity of run-off, if there is any, are considered to be non-scouring. Therefore, the potential for increased instability along the identified water ways sections shown in Plate 13 subject to gradient increase is considered to be low.

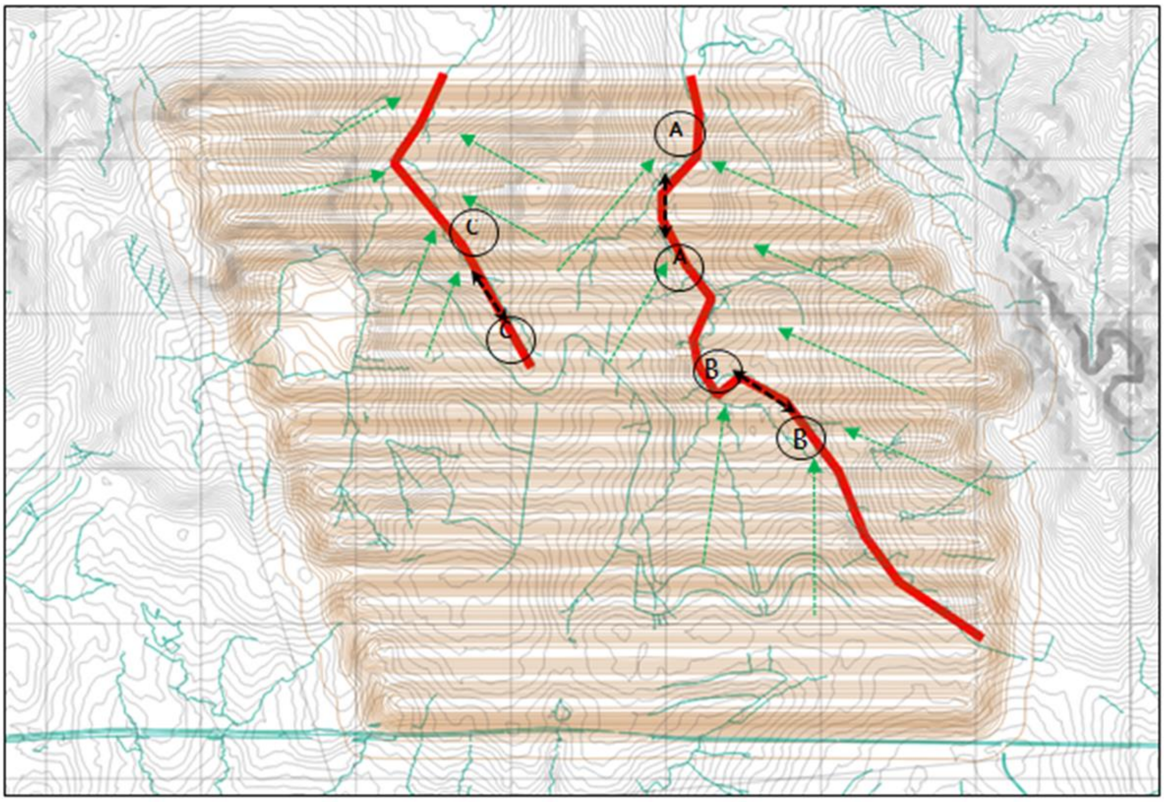


Figure 1 : Surface Drainage Direction (N-S) in relation to Longwall Panel Orientation (E-W)

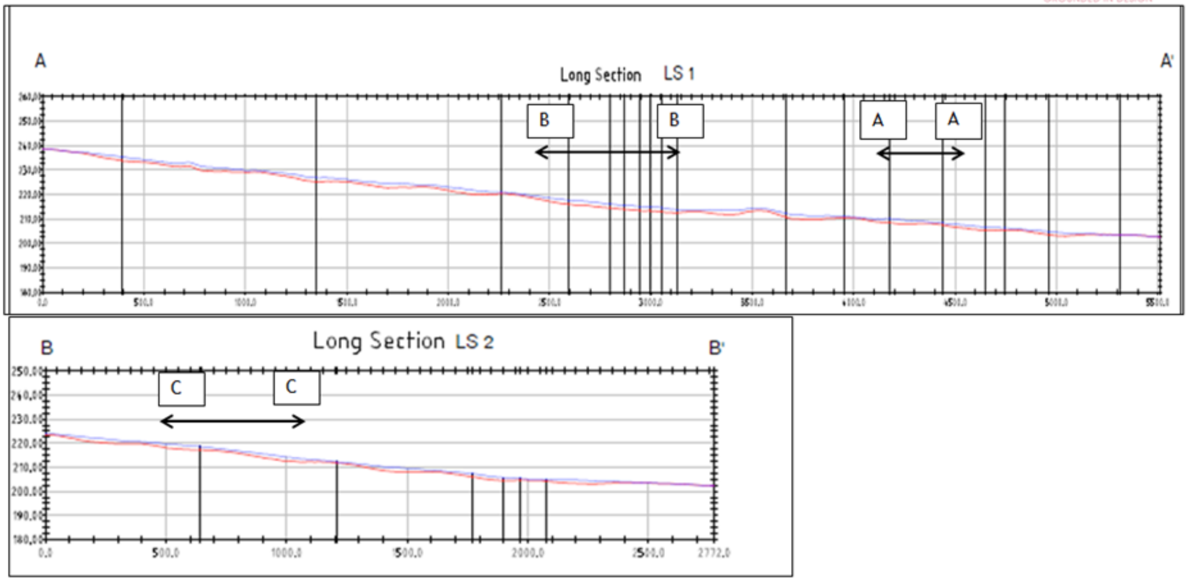


Figure 2 : Long Sections along Main Drainage Pathways

Three longitudinal sections for both natural drainages were selected, shown on Figure 2, to represent the difference between the pre and post underground mining impact upon drainage line topography shown on Figure 1. The post mining changes in grade along the drainage lines are small and less than 1 % compared to the natural gradient of the pre-mining topography. Therefore, the velocity increases along the drainage lines will be small and the subsided surface will experience minimal erosional effect. With minimal additional erosion, it is anticipated that the water quality of the run-off water will not be significantly affected. Monitoring and inspection programmes will be implemented and detailed in the updated WMP to ensure the regulatory requirement of the Project site's water quality is met.

Localised surface cracking will occur due to tensile strain on the ground surface above the underground mine workings. Tension cracks are predicted to occur along the edges of the subsidence troughs formed from the extraction of the longwall panels and along the tops of topographic high points. This surface cracking will be the greatest at the start of each chain pillar between panels and most obvious on hard surfaces. The following information on the likely nature of surface cracking at Taroborah was provided in the subsidence assessment.

- The cracks are predicted to extend approximately 35m either side of the pillars into the panels (i.e. a zone of ~100m on 300m centres).
- Cracks will be in the order of a maximum width of 0.2 - 0.3m and a maximum depth of 5m in the worst case instances.
- In most areas, the surface cracking is anticipated to be less severe.

Most surface fractures will be temporary, with many closing during natural deposition of sediment after rainfall events. The surface soil cover will have an influence on the cracking that is actually visible at the surface. Unconsolidated deposits of alluvium, colluvium, and soil tend to obscure surface cracks. Therefore, the tension cracks will be filled over time and can be considered negligible for long term storage of surface runoff. To limit the time the cracks remain open, mitigation measures such as ripping and grading to smooth surface profile and re-vegetating the cracked areas are proposed. With the implementation of these measures, it is anticipated that the losses of surface water through surface tension cracks will be insignificant.

With respect to increased storage volumes in existing pastoral dam structures as a result of subsidence, this is predicted to be negligible as the dam structures themselves will generally be subsided along with the storage basin, and therefore, there will be minimal (0.5m or less) or no net increase in water depth within the storage structures. Further, once any increase in volume is initially filled, these dams will then continue to act as they currently do in terms of average annual capture capacity in the long term.

EIS Amendment:

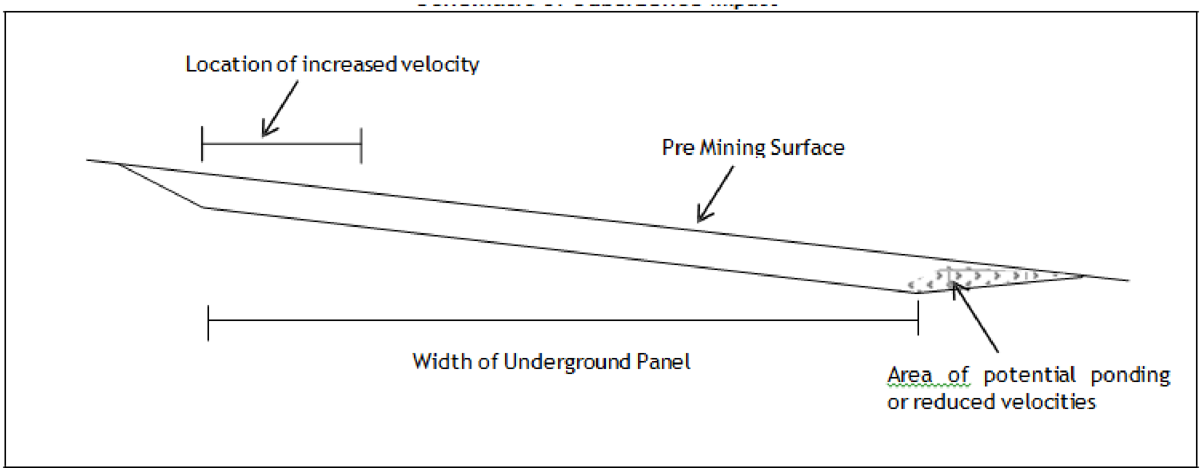
To address the scouring and tension crack issues mentioned above, the following two sections have been included in Appendix 13 of the final EIS document.

"7.6 Scouring of Subsided Surface Drainage and Water Quality Impact

The subsidence model completed by IMC indicates that the changes in grade will be minor (maximum of 1.2%) when compared with the existing gradients as shown on Plate 15 in Section 7.4.

The change in gradient due to subsidence will be most notable within the primary drainage paths which are represented as the long sections on Plate 15 in Section 7.4. Subsidence in areas outside the drainage paths would only marginally change the overland flow direction with maximum gradients within the order of the existing topography. A schematic of the subsidence along the drainage path is provided on Plate 19 and shows the impact of ponding due to subsidence localised to areas of the upslope associated with the chain pillars between the extraction panels.

Plate 19
Schematic of Subsidence Impact



*Schematic is Not to Scale (Vertically Exagerated). For visual purposes only.

In relation to the 10 identified ponding locations, increased velocities will be encountered. Peak velocities (namely V1 to V10) were evaluated based on the locations as shown on Plate 20.

The peak velocities were evaluated using the Rational Method to assess existing topographical conditions against post-mining topographical conditions. The evaluated peak velocities were based on critical durations using ARIs of 2 year, 10 year, 20 year and 50 year with results presented in Table 21.

Plate 20
Evaluated Peak Velocity Locations

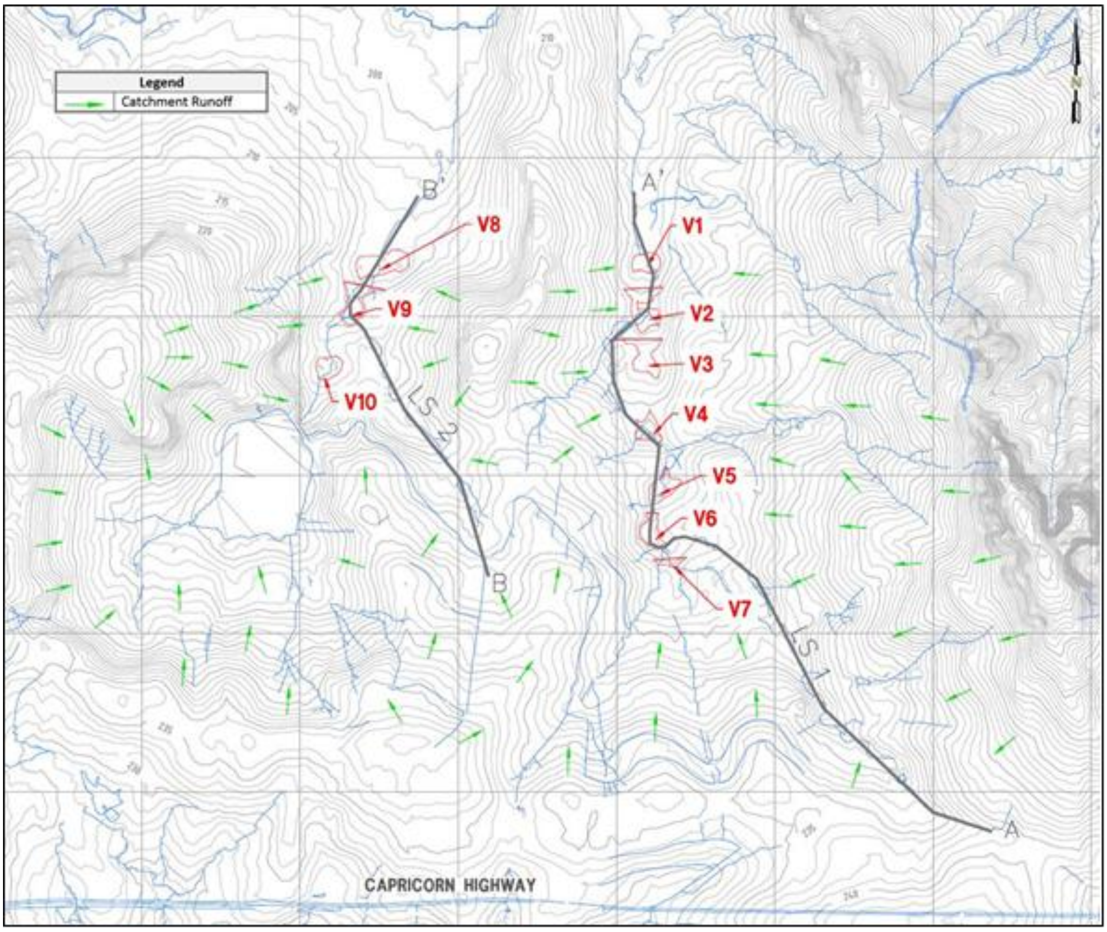


Table 21
Flow Velocities for Existing and Post-Mining Conditions

Location	Existing Flow Velocities Flow Velocity (m/sec)				Post-Mining Flow Velocities Flow Velocity (m/sec)			
	ARI							
	2 Year	10 Year	20 Year	50 Year	2 Year	10 Year	20 Year	50 Year
P1	1.46	1.67	1.75	1.85	1.48	1.68	1.77	1.88
P2	1.45	1.64	1.72	1.83	1.46	1.67	1.75	1.85
P3	1.41	1.60	1.67	1.78	1.42	1.61	1.71	1.80
P4	1.29	1.44	1.51	1.60	1.30	1.46	1.55	1.62
P5	1.19	1.31	1.36	1.42	1.22	1.34	1.38	1.45
P6	1.19	1.31	1.35	1.42	1.22	1.33	1.38	1.44
P7	1.03	1.13	1.18	1.22	1.06	1.15	1.20	1.25
P8	1.29	1.45	1.52	1.61	1.29	1.46	1.54	1.61
P9	1.15	1.28	1.35	1.42	1.15	1.30	1.37	1.44
P10	1.53	1.69	1.76	1.84	1.54	1.71	1.78	1.87

7.7 Mitigation of Potential Water Losses

7.7.1 Surface Tension Cracks

Localised surface cracking may occur due to tensile strain on ground surface. Tension cracks are predicted on the edges of long wall panels and along the tops of topographic high points. This surface cracking will be the greatest at the start and end of each panel and most obvious on hard/brittle surfaces. The following information was provided by IMC

- The cracks are predicted to extend approximately 35m either side of the pillars into the panels (i.e. a zone of ~100m on 300m centres);
- Cracks will be in the order of a maximum width of 0.2 - 0.3m and a maximum depth of 5m in the worst case instances; and
- In most areas, the surface cracking is anticipated to be less severe.

It is considered that most surface fractures may be temporary, with many closing during natural swelling and deposition of sediment from rainfall events. The surface soil cover will have an influence on the cracking that is actually visible at the surface. Unconsolidated deposits of alluvium, colluvium, and soil tend to obscure surface cracks. Therefore, the tension cracks will be filled over time and can be considered negligible for storage of surface runoff. In cases where the cracks remain open over time, mitigation measures such as ripping, re-grading to smooth surface profile and re-vegetating the cracked areas are proposed. With the implementation of these measures, it is anticipated that the losses of surface water through surface tension cracks will be insignificant."

11.11 Appendix 13, Section 6.4.1, Page 40 - Assessment of Hydrological Impacts

Submitter:

Department of Environment and Heritage Protection

Submission:

The following issues have been identified in Section 6.4.1 of the Surface Water Management Plan, including:

1. Based on the Fitzroy River Water Resources Plan the limit of overland flow that can be taken from a surface runoff in any particular catchment due to works should be not more than 50 ML/km^2. For this site, the predicted yield that will be lost due to subsidence is approximately 53 ML/km^2.
2. Sections 6.5 and 6.5.3 (referenced in Section 6.4.1) could not be found.
3. The number, "40 ML/km^2" quoted in Section 6.4.1 differs to the "50 ML/km^2" quoted in Section 6.3.4 on page 35. This may significantly affect the outcomes of the subsidence impact assessment with a loss of 32% on average runoff rather than the quoted "6 % on average of runoff."

Recommendation: The proponent should demonstrate how the results of the hydrological impacts of the subsidence impact assessment met the requirements of the Fitzroy River Water Resources Plan.

Response:

<u>Response to 1</u>

This statement suggests misinterpretation of the material presented, and is mistaken. The capture is estimated at 53 ML in total per annum. The capture per km^2 is only 2 ML/km^2 (i.e. 38 ML/km^2 post subsidence versus 40 ML/km^2 pre subsidence)

<u>Response to 2</u>

This was a typographical error, and should have been 6.3 and 6.3.3. This has been corrected

in final EIS document.

Response to 3

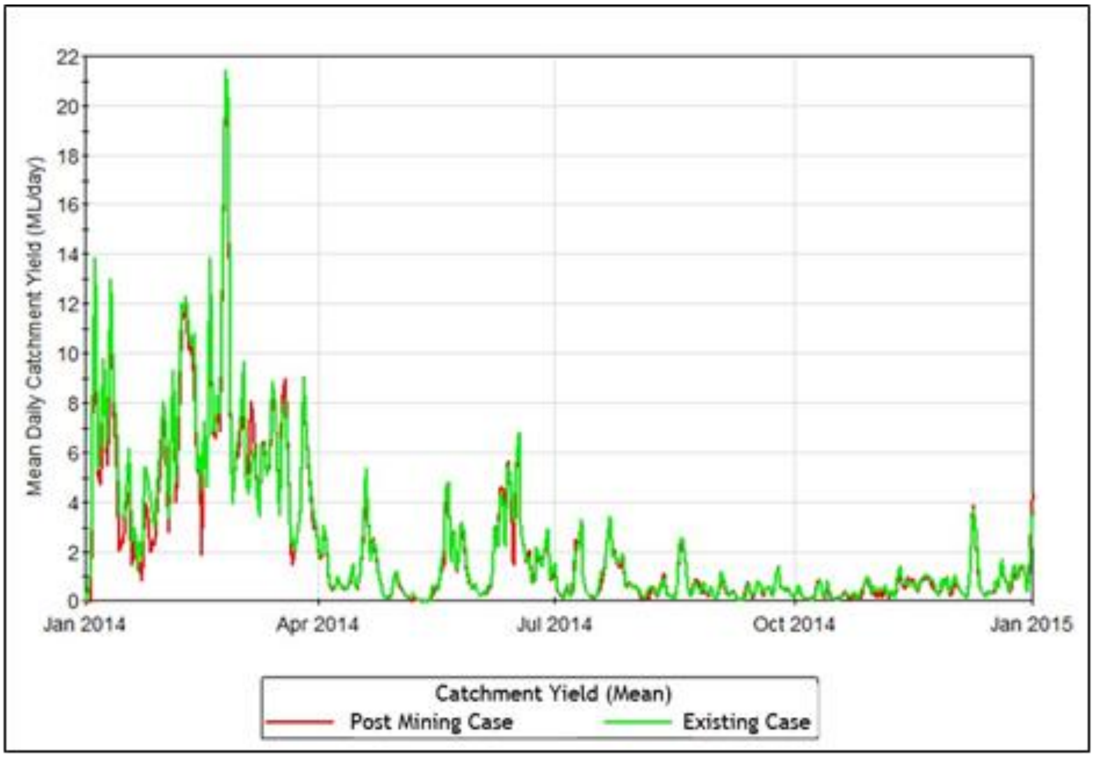
The 40 ML/km^2 is the average run-off after an assumed 20% evaporation figure (i.e. 80% of 50ML) as mentioned in Section 6.3.3, which is what the model assumes in the post-development scenario. If we compare the loss before evaporation to the 50 ML/km^2 limit, then the 38 ML/km^2 run-off post development becomes 45.5 ML/km^2 and the loss is about 8% of the 50ML/km^2 limit.

EIS Amendment:

To clarify the estimated water capture resulting from mine subsidence, Section 6.4 – Model Results (now Section 7.5.2) of Appendix 13 has been reworded as follows.

"Based on the model as described above, the results presented as mean daily runoff for the existing and post mining conditions are presented in **Plate 18**.

Plate 18
Mean Daily Runoff for the Project Site Subsidence Area



The sum of the mean daily runoff as shown on **Plate 18** in **Section 7.5.2** indicates the following:

- Mean annual runoff for the existing conditions is some 852 ML/pa;
- Mean annual runoff for post-mining conditions is some 799 ML/pa; and
- The difference between the existing and post-mining runoff volumes indicate that the annual average losses due to the subsidence ponds is some 53ML."

12. APPENDIX 14 – GROUNDWATER IMPACT ASSESSMENT REPORT

12.1 Appendix 14 - Groundwater Impact Assessment

Submitter:

Department of environment and Heritage Protection

Submission:

Throughout the Groundwater Impact Assessment the terms “domestic purposes”, “domestic supply” and “domestic use” are used interchangeably to define the use of groundwater from bores including use for drinking water supply. For example, Section 13 Conclusions on page 42 of the Groundwater Impact Assessment states:

“Overall the groundwater is generally not suitable for domestic supply (human consumption); however, groundwater within the alluvium, fresh Tertiary basalts and Aldebaran Sandstone is considerable for stock water supply (ANZECC, 2000).”

However, in Schedule 4 Dictionary of the Water Act 2000, the term, “domestic purposes” does not include drinking water supply and is defined as follows:

“irrigating a garden, not exceeding .25ha, being a garden cultivated for domestic use and not for the sale, barter or exchange of goods produced in the garden.”

Consequently, the inconsistent use of the terms in the Groundwater Impact Assessment to represent “domestic use” makes it difficult to determine what the groundwater EVs are for the project and which WQOs should be applied to the project to protect or enhance the EVs.

Recommendation: Amend Appendix 14 Groundwater Impact Assessment to include the following definitions from the Nogoa River Sub-basin Environmental Values and Water Quality Objectives to make it clear what the EVs are for groundwater:

1. Farm water supply/use - Suitability of domestic farm water supply, other than drinking water. For example, water used for laundry and produce preparation.
2. Drinking water supply - Suitability of raw drinking water supply. This assumes minimal treatment of water is required, for example, coarse screening and/or disinfection.ion**:**

Response:

The above definitions are acknowledged and these will be used in describing water use in Appendix 14.

EIS Amendment:

The terms “farm water supply” and “drinking water” (where appropriate) have replaced “domestic use” throughout Appendix 14.

12.2 Appendix 14, Section 4.1, Page 12 & Section 6 3.3, Page 35 - Groundwater Monitoring Network

Submitter:

Department of Natural Resources and Mines

Submission:

This section highlights that only one round of groundwater levels and quality monitoring was undertaken (April 2013) and further notes on page 24 that there is insufficient

historical data to describe season flows. A minimum of 12 months of data is required to show any trends or seasonal variation in levels or quality. The proponent is to supply monitoring data collected since April 2013 (as there should now be 12 months of data available) and provide discussion and analysis on whether the additional data supports the initial assumptions in the report or whether the model requires recalibration

Response:

A second and third groundwater monitoring event were undertaken in May and September 2014, with water samples taken at 17 of the 19 monitoring bore locations (two were still dry) and water level data downloaded from level loggers that had been installed in April 2013 and May 2014 (one bore). This additional 17 months of groundwater level monitoring data has been analysed and no significant change in levels was recorded over the 17 month period.

Further, water quality was also fairly consistent between data sets, with recorded variations in pH, EC, SAR and TDS of generally <10% between the data sets.

Based on the additional monitoring results, there appears to be little seasonal variation in the groundwater regime, and the model assumptions regarding this are still considered valid. Therefore, no recalibration of the model is required at this time.

EIS Amendment:

Appendix 14 has been amended to include the May 2014 groundwater monitoring results in Section 4.1, Section 6 and Appendix A, and discusses the lack of seasonal variability in the data in Sections 6.1.3, 6.2.3 and 6.3.3.

12.3 Appendix 14, Groundwater Model – Geological Conceptualisation

Submitter:

Independent Expert Scientific Committee

Submission:

The following uncertainties reduce confidence in the groundwater model predictions:

- The proponent's groundwater model is based on a groundwater conceptualisation that prevents lateral groundwater flow across the eastern and western bounding faults, which restricts groundwater drawdown extent. The draft Environmental Impact Statement (EIS) does not contain any pre-existing or recent exploration data to justify that there is no hydraulic connectivity across the faults. The effect of "turning off" cells may result in an unrealistic lack of connectivity between upper (layers one and two) and lower (three to ten) layers, resulting in an under-estimation of groundwater drawdown extent.
- It is unclear how the fault boundary conditions have been incorporated into the groundwater model and there is no description of any groundwater flow boundaries throughout the model domain, or their influence on model predictions.

Confidence in groundwater model predictions is reduced by the low number (three listed within the EIS) of hydraulic conductivity measurements within the coal seams. Confidence in the model is further reduced by the prescription of calibrated horizontal hydraulic conductivity values for the coal seams that are an order of magnitude lower than the values identified during the field study. Significantly lower calibrated hydraulic conductivity values than those measured in the field may result in an underestimation of the drawdown extent and groundwater mine inflow predictions.

Recommendations:

The following measures would aid in addressing these uncertainties and improve confidence with the model predictions:

A. Evidence to support the proponent's approach to modelling large basin scale faults by "turning off" cells on the far side (relative to the project area) of faults. Evidence to support this groundwater modelling approach would include:

   - A geological conceptualisation that identifies groundwater flow, connectivity, and key geological structures in an east to west direction.
   - Groundwater and hydrogeological data from either side of the faults, including water table depth and groundwater head for hydrogeological units.
   - Evidence from comparable fault zones that have been analysed, to explain the assumptions made in representing the influence of faults within the numerical groundwater model.
   - A full description of flow boundaries, and boundary conditions used to parameterise faults, within the groundwater model.
   - Sensitivity of the model to variations in fault representation.
   - Peer review of the model construction and geological conceptualisation.

B. Further field measurements of hydraulic conductivity within the target coal seams. These would be beneficial calibration targets for future versions of the model, given hydraulic conductivity for the coal seams was estimated using only three permeability tests (one from the A seam and two from the B seam).

C. Ongoing transient calibration of the groundwater model, utilising seasonal groundwater data gathered from recently installed monitoring bores. This is needed to enable the model to predict impacts to, and variations in, seasonal groundwater levels and baseflows to surface water systems. Following commencement of mining, groundwater mine inflow monitoring data could be used as a transient calibration target.

D. Improved resolution of river cells would provide finer scale impact predictions, therefore aiding the assessment of potential impacts to individual GDEs and springs.

Response:

<u>Response to A</u>

The statement that the proponent's groundwater model is based on a groundwater conceptualisation that prevents lateral groundwater flow across the eastern and western bounding faults is incorrect. The numerical model presented by Australasian Groundwater and Environmental Consultants (AGE) in Appendix 14 of the EIS has used regional scale faults and structural domains to provide the basis for the model extent (EIS Appendix 14, Appendix B, Section 1.3.1). These are based upon referenced and publically available reports and mapping. As these regional scale faults and structural domains are at the boundary extents of the model domain (see EIS Appendix 14, Appendix B, Section 1.3.1) these are discussed briefly in terms of model development. Section 3.4 of EIS Appendix 14 discusses the structural geology as follows:

"Seismic surveys and exploration drilling have identified several NW-SE trending faults to the east and west of the Project area (Figure 4). Coal measures have been documented outside of the fault zones; however, no coal was intersected along the hinge zone of the

inferred anticline (Veevers et al., 1962). Overall, geological investigations and mapping show that the region has undergone extensive periods of deformation, resulting in disconnection of the coal seams from stratigraphy east of the Veevers et al. (1962) inferred anticline."

Within the project area, IMC have defined a graben (fault bounded) structure in which the coal measures are to be mined. These faults have been defined through project specific seismic data, detailed exploration drilling by the proponent and State government drilling and mapping. AGE has developed a conservative approach to simulate this graben structure. Rather than defining linear fault features in the model, AGE has assumed a drape feature with hydraulic continuity on either side of the fault. Therefore, there is modelled hydraulic connectivity on either side of these faults rather than simulating them as impermeable barriers. The coal seams have then been simulated to pinch out where the strata gets shallower to the east and west. This pinching out of the strata is based upon regional drilling data. A schematic east west cross section through the model domain is being developed to show this geological representation and will be included in the amended report.

AGE have applied a conservative approach by assuming local continuity. As the faults have not been represented in the model there is consequently no justification regarding assumptions, boundary conditions, parameterisation nor sensitivity on the presence of faults. This approach has been implemented given the limited hydrogeological data on the nature of the fault (permeable or impermeable). The worst case assumption of lateral continuity has been presented for impact prediction.

Peer review has not been carried out. AGE would welcome a technical peer review of the model by a third party in accordance with the Australian modelling guidelines (Barnett et al., 2012).

<u>Response to B</u>

To date, further field measurements within the coal seam have not been collected. AGE believe that for the current purposes of impact assessment, the amount of hydraulic data collected from the coal seam is commensurate with the level of risk to the Permian coal measures. AGE agree that additional hydraulic data from the coal seams would be beneficial to include in any future variants of the numerical model to provide additional calibration targets.

EIS Appendix 14, Appendix B, Section 4.1 reports the sensitivity analysis carried out on horizontal and vertical hydraulic conductivity (± 50%) of all model layers. This shows that the total predicted inflows increase by 20% when compared against the base case model. Greater sensitivity is demonstrated with the specific storage of the model layers.

<u>Response to C</u>

Ongoing transient water level data is being captured for the project. The existing data (see Attachment F to this response document) shows little seasonal variation in the water level data, and a transient calibration of the current groundwater model is not considered appropriate at this point in time (see Point 5 below for further comment on this). AGE agree that once mining commences and mine inflow data is available, this should be coupled with the transient water level data to conduct a transient calibration of the groundwater model.

<u>Response to D</u>

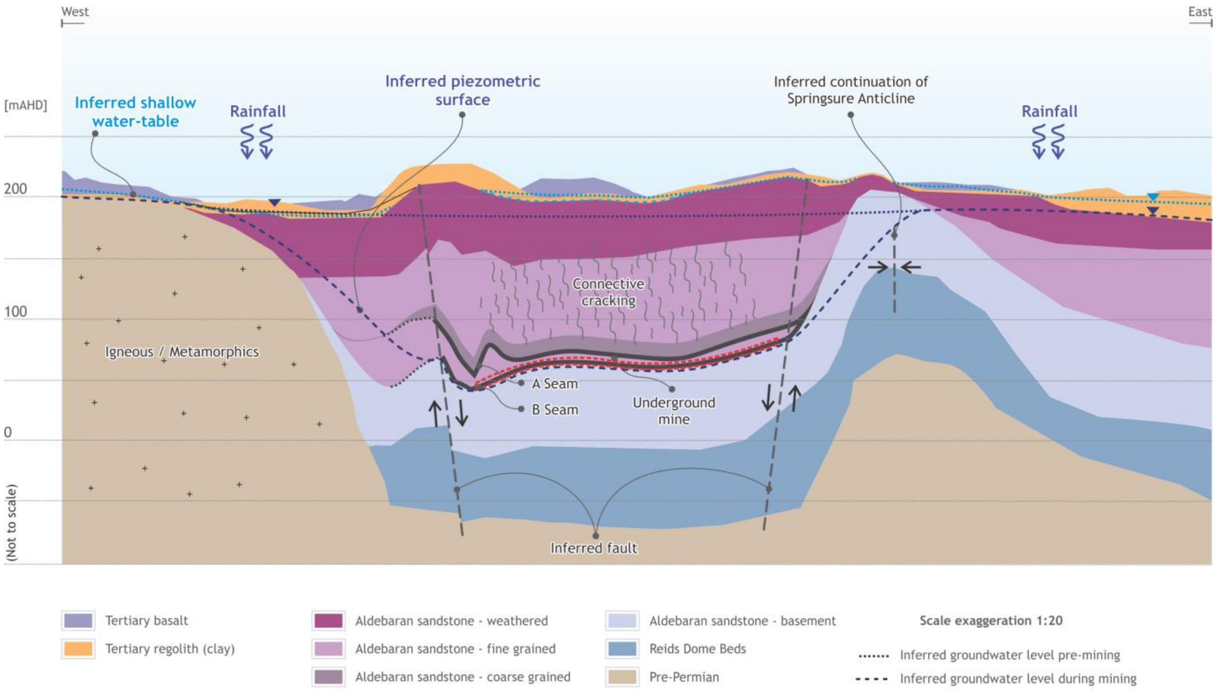
Improved resolution of the river cells would certainly provide finer scale impact predictions. However, the model has been developed as a regional impact assessment tool and the

practicalities of providing detailed definition along creeks is unrealistic and outside the objective of the current numerical model. The level of detail provided by the predicted drawdown and depressurisation contours is considered more than adequate to assess the magnitude of water level change and impact to the environment. Furthermore, the predicted changes in regional fluxes (changes to river leakage and baseflow) are appropriate for the scale of the model.

In future, the model mesh may be refined in areas where environmental receptors are thought to be potentially at risk of harm. This would, however, not be required for several years due to the timing of underground mining and potential impact, and require additional hydrogeological data to substantiate the model refinement.

EIS Amendment:

The following East-West cross section of the geological conceptualisation has been added to Section 8 of Appendix 14:



Conceptual Groundwater Model Cross Section (West to East)

Figure 7

Taroborah (G1588)

The following two paragraphs have been added to the end of Section 8 of Appendix 14:

"Within the project area, the Proponent has defined a graben (fault bound) structure in which the coal measures are to be mined. These faults have been defined through project specific seismic data, detailed exploration drilling and State government drilling and mapping. However, aside from the physical location of these structures and the vertical offset, there is no hydrogeological information available on these faults to assess whether they are barriers or conduits to groundwater flow.

Therefore a conservative approach has been developed to represent these faults (graben structure) in the impact assessment model. Rather than defining linear fault features in the model, drape features are inferred, with hydraulic continuity on either side of the mapped fault. As detailed above, drilling has identified that the coal seams do not extend immediately east of the project area. This is possibly due to the presence of an anticline structure, where the coal seams have been eroded away and the basal units of the Aldebaran Sandstone are exposed."

Section 11.1 of Appendix 14 has been amended to include the following in paragraph 3:

"Consideration was given to carrying out a transient calibration, however, the existing water level

data (Sections 6.1.3, 6.2.3 and 6.3.3) shows little seasonal variation, and a transient calibration of the groundwater model was not considered appropriate. There are no reliable recharge or discharge processes evident in the water level hydrographs with which to calibrate the model against."

And the fifth paragraph of Section 11.1 of Appendix 14 has been amended to include the following sentence:

"Detail in the regional model domain was applied to those areas considered to have the greatest influence in the impact assessment (the mine area). The model mesh has been generated in accordance with the Australian guidelines. No faults have been represented in the model domain."

And the following two paragraphs have been added to Section 1.3.2 of Appendix B of Appendix 14:

"The numerical model has used regional scale faults and structural domains to provide the basis for the model extent. These are based upon the above referenced and publically available reports and mapping. As these regional scale faults and structural domains are at the boundary extents of the model domain, these are discussed briefly in terms of model development.

Within the project area, the Proponent has defined a graben (fault bound) structure in which the coal measures are to be mined. These faults have been defined through project specific seismic data, detailed exploration drilling and State Government drilling and mapping. A conservative approach has been developed to simulate this graben structure. Rather than defining linear fault features in the model, drape features have been implemented with layer hydraulic continuity on either side of the mapped fault. Therefore, there is modelled hydraulic connectivity on either side of these faults rather than simulating them as impermeable barriers. The coal seams have then been simulated to pinch out to the east and west of the respective bounding faults, as they do not exist in this region. The basis for pinching out the coal strata (model layers) is based upon regional drilling data. This approach was adopted as it is expected to provide a conservative overestimate of the extent of depressurisation outside the fault bounded blocks, and therefore represents a likely worst case scenario."

And the following paragraph has been added to the end of Section 1.3.5 of Appendix B of Appendix 14:

"It is important to note that no faults or structures have been represented in the model domain. The model layers assume lateral continuity."

And Section 2 of Appendix B of Appendix 14 has the following added as the second paragraph:

"The existing water level hydrographs show no seasonal variation and hence no recharge or discharge responses against which to calibrate. As a result, a transient calibration of the groundwater model was not considered appropriate or necessary. Once mining commences and mine inflow data is available, a transient calibration of the groundwater model should be carried out."

12.4 Appendix 14, Groundwater Model – Geological Model Subsidence Induced Fracturing

Submitter:

Independent Expert Scientific Committee

Submission:

The proponent's approach to modelling subsidence induced fracturing and deformations in the strata overlying longwall panels presents the following concerns:

A. The influence of subsidence cracking on groundwater flow is likely to be under represented in the groundwater model. Fracturing induced by subsidence has been represented up to 90 m above the base of layer eight. However, evidence from

other longwall mines and research (Kendorski, 2006) suggests that subsidence induced deformations above longwall panels can extend up to 60 times the mined longwall panel height towards the surface, which in this case would be up to 210 m.

B. The proponent has not provided an assessment of the impact of fracturing within the Tertiary clay/mud units which act as an aquitard between the Tertiary Basalt and Aldebaran Sandstone. These units have been mapped with opposing flow directions. An increase in connectivity between the Tertiary Basalt and the Aldebraran Sandstone may result in changes to groundwater flow, quality and quantity within these hydrogeological units.

C. Groundwater flow within the Aldebaran Sandstone is predicted to be in a southward direction, which is attributed to recharge by leakage from the Quaternary Alluvium associated with Retreat Creek. Subsidence induced fracturing may increase recharge rates within the Aldebaran Sandstone and subsequently increase mine water inflows beyond those predicted by the groundwater model.

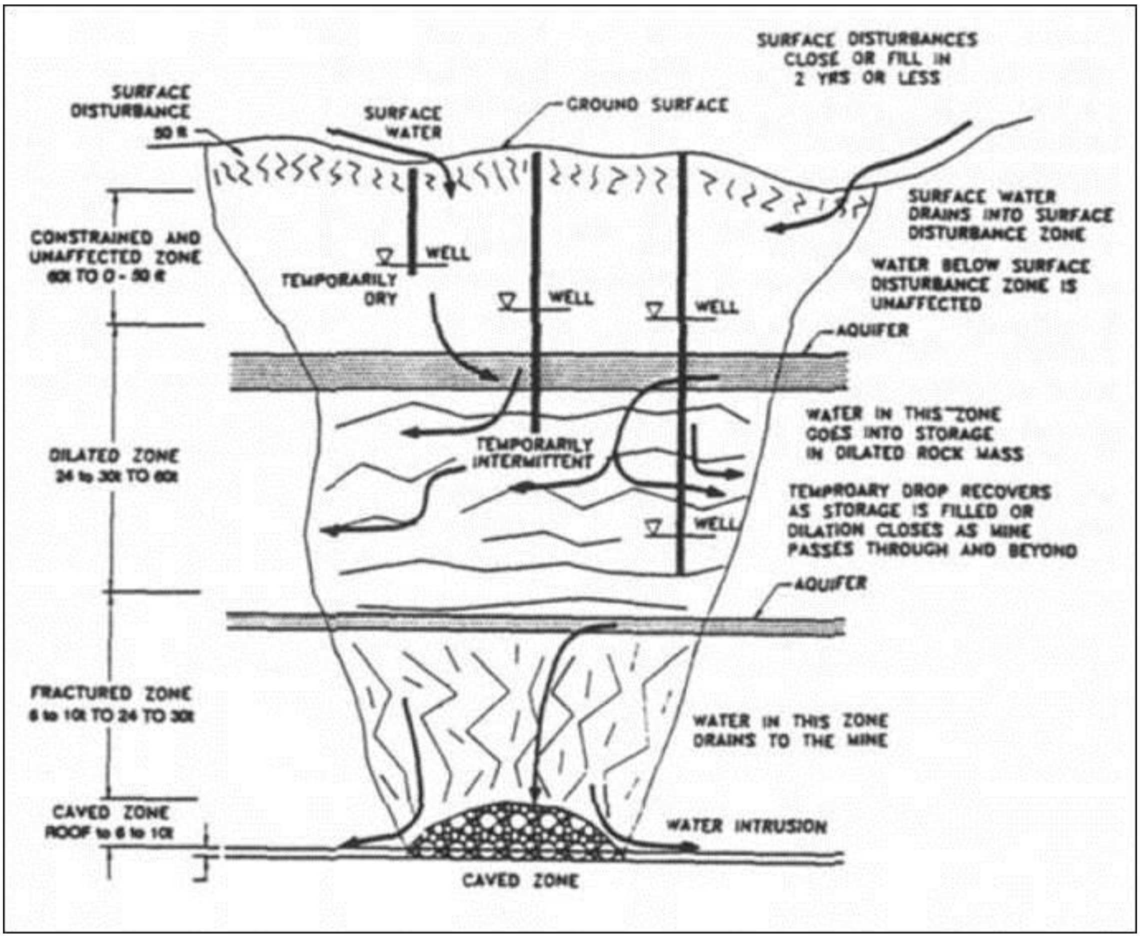
Recommendations:

A variety of potential subsidence induced fracturing scenarios and parameters should be considered for the layers above longwall panels. These scenarios should be supported by evidence and an assessment provided of the resulting changes to recharge, mine inflows and river baseflows.

Response:

Response to A - Height of Fracturing

With respect to concern A above, suggesting that the Taroborah groundwater model under represents the influence of subsidence cracking on groundwater flow needs to be put in context, as the reference to subsidence induced deformations extending up to 60 times the mining height above the workings as cited from Kendorski (2006) relates to two different "strata behavior models" as presented therein. In what Kendorski (2006) terms his 1979 model of strata behavior above full-extraction mining panels, the "Fractured" zone extends from the caving zone to 30-58 times the mining height (30-58t), and consists of continuous open fractures that form pathways for downward flow of water. In this context, the Taroborah assumption of 30t could be perceived as optimistic and not representing a possible worst case scenario. However, further research and historic mining experience in the US and elsewhere resulted in a 1993 update of the 1979 model. In the 1993 model of strata behavior above longwall workings, Kendorski defines an additional zone of subsidence induced deformation above the "Fractured" zone as the "Dilated" zone. In the Fractured zone in the 1993 model, the deformations result in connected vertical fractures that form downward flow paths for water occurring in and immediately overlying this zone. Conversely, in the overlying Dilated zone, the strata bend and are subject to bed separation, or dilation, but vertical cracking is limited and does not provide an effective vertical connection to the lower strata. This results in an increase in horizontal permeability and storage capacity of the strata in this zone but with no resultant increase in vertical permeability. Further, the filling of the increased storage created in the Dilated zone results in only a temporary drawdown of overlying groundwater and pre-mining levels return once the increased storage is filled. In the 1993 model, the typical heights of the Fractured and Dilated zones are from 6-10t to 24-30t and 24-30t to 60t, respectively, as indicated in the figure below. Finally, Kendorski (2006) concludes *"Recent investigations have consistently borne out the validity of the 1993 Model for strata behavior and characterization above full-extraction mining such as longwall mines first developed more than 25 years ago"*, which supports the Taroborah groundwater model assumption of a 30t fracturing height, or 90m for the typical 3m extraction height.



Kendorski 1993 Model of Strata Behaviour Above Full-extraction Mining Panels

Investigations of Australian experience, as well as groundwater modelling of other Bowen Basin longwall proposals, tend to support the Kendorski 1993 model of strata behavior and the assumption made for Taroborah. For example:

- Adhikary and Wilkins (2012): Extensive monitoring of longwall caving at Springvale and Dendrobium in NSW indicate the height of the Fractured zone extends to 100-105m (~30t) above the mine workings.
- MSEC (2012) : This subsidence modelling report for Moranbah South sites experience of undermining surface waters (Isaac River) at Moranbah North, where longwall extraction at 4.5m height showed no discernible increased inflow into the mine workings at depths from 110m to 200m (i.e. 25t-50t).
- Guo et al. (2007) : provides a summary of practical hydrogeological models of longwall mining proposed by various authors, and concludes that the Fractured/disturbed zone, where the strata sag downwards resulting in bending, fracturing, joint opening and bed separation, is indicated to be 15 to 40 times the seam thickness.
- Gale (2008): In the Hunter Valley, at Wollombi Creek Mine, stream flow was lost when mining occurred at a depth of approximately 90m but not at depths greater than 120m. Subsidence was estimated to be approximately 1.4-1.6m. The site at Wambo under Wollombi Creek also indicated stream loss at depths of 90-95m but not at depths of 110-210m. The Proponent notes that subsidence of 1.4-1.6m at

Wollombi Creek suggests an extraction thickness of 2.3-2.7m, or a thickness of the Fractured zone of 33-39t.

Gale goes on to suggest that the height of fracturing is more a function of extraction width rather than extraction height, with a typical ratio of height of fractures forming being 1-1.5 times the extraction width. However, the creation of these fractures alone does not necessarily imply that a direct hydraulic connection exists over this zone. In order for mine inflow to occur, the fractures created must form a connected and conductive network to allow significant volumes of inflow.

- Frith (2003) : Investigation of subsurface fracturing above longwall panels using vertical boreholes at a number of QLD and NSW mines indicated that the height above the workings where total loss of drilling fluid occurred (which is considered analogous to the Fractured zone) ranged from 18-63m (6.4-31.5t) as shown in the following table.

Mine No. (refer to Appendix D for Mine details)	W (m)	H (m)	T (m)	S_{max} (m)	Predicted Smooth Profile Strain, E_{max} (mm/m)	a* (m)	b* (m)	A (a/H) (m)	B (b/H) (m)	a/T	S_{max}/W^2 **
1-NSW	170	185	2.0	0.99	2.8	63	163	0.34	0.88	31.5	0.034
2-NSW	250	210	3.1	1.9	2.5	40	170	0.20	0.85	12.5	0.030
3-NSW	105	75	2.8	1.27	9.4	58	64	0.77	0.85	20.7	0.115
4- QLD	205	132	2.4	1.28	3.1	21	117	0.16	0.89	8.9	0.038
5- QLD	200	142	2.8	1.40	2.9	18	127	0.13	0.89	6.4	0.035
6- QLD	205	95	3.2	1.86	9.4	55	85	0.58	0.89	17.2	0.099
7-NSW	150	350	2.7	0.28	1.0	n/m	150	n/m	0.43	n/m	0.018

Note : *- a = Distance to total drilling fluid loss above workings.
*- b = Distance to partial drilling fluid loss above workings.
**- S_{max}/W^2 = a new robust term (i.e. Overburden Curvature Index) to plot A and B against instead of tensile strain (see below for further explanation).
n/m – not measured as drilling terminated before depth was reached.

- Teresa Creek EIS (2013) : The Groundwater section of this study discusses experience at other Australian mines as follows:
  - A paper published for the 2008 Coal Operators' Conference for Crinum Mine reported that, typical of the Bowen Basin, less than 90 m of overburden cover from the overlying aquifer was generally the start of water percolation.
  - The Environmental Assessment Report Addendum – Kestrel Mine Extension Project (Matrix, 2007) indicated that the longwall panel design ensured an overburden thickness greater than 120 m below the sand aquifer, thereby avoiding the loss of groundwater within the basal sands to the underground mine.

On the basis of the above discussion, a height of fracturing of 30t above the floor of the workings, as assumed in the current model, is assessed as being appropriate for the base case. A sensitivity of a 40t fracturing height has also been undertaken and the results are presented in the final EIS report.

<u>Response to B - Fracturing within Tertiary Clays</u>

The preponderance of experience of subsurface fracturing with regard to weak sediments (i.e. mudstones, claystones and weathered siltstones) and clays is that these units do not generally form continuous open fractures due to their plasticity, and the fractures that do form tend to be self-healing over a relatively short period of time due to swelling from

moisture. Gale (2008) states *"the presence of clay in the overburden is considered to constrain the fracture network through fracture healing by expansion or its ability to strain without fracturing"*.

Seedsman and Dawkins (ACARP C13009, 2006) provide the following observations of the experience at the nearby Bowen Basin mines of Crinum and Gordonstone/Kestrel as reported by Gale (2008).

"*The impact of geology was apparent at Crinum Mine whereby a pervasive clay layer acted as an aquiclude between fractured strata above a longwall panel and saturated basalt. In this case, the clay created a barrier to flow to the cracked strata below. In situations where the clay barrier was breached, high water inflow occurred (Seedsman, 2006). Subsidence at this site is typically in the range of 2-2.5m.*

A similar situation was noted at Gordonstone and Kestrel Mine whereby clay rich units exist under the Tertiary sands and form hydraulic barrier to the Permian strata below. This information is based on piezometer measurements which show significant depressurisation within the Permian strata and no obvious impacts within the overlying Tertiary sediments. These mines abut onto the Crinum Lease area."

The overburden geology at Taroborah includes a significantly thick sequence of weak Tertiary strata and weathered Permian, ranging from 45-90m in thickness. Included are numerous, oftentimes thick, layers of clay and weathered claystone which lie beneath the scattered basalt occurrences and alluvial gravels in the north near Retreat Creek. Based on experience elsewhere, it is expected that these units will not be highly fractured from subsidence where they occur more than 60-70m above the mine workings and therefore, will continue to act as an aquiclude to the overlying groundwater and surface waters.

With respect to vertical hydraulic conductivity, the base case methodology presented in the EIS applies multipliers to the vertical hydraulic conductivity (see EIS Appendix 14, Appendix B, Table B-5) of each model layer (dependent upon the height of connective cracking). In light of a recent paper by Tammetta (2014), an additional sensitivity model is currently being carried out assuming greater vertical hydraulic conductivity in the subsidence induced fracture zone. The results of this sensitivity are presented in the final EIS report.

<u>Response to C - Increased recharge rates</u>

Groundwater flow within the Aldebaran Sandstone is predicted to be southward in the northern portion of the Project area and westward in the central portion of the Project area. Recharge to the Aldebaran Sandstone may occur via rainfall percolation from mapped outcrop and subcrop, although the presence of thick sequences of shallow silts and clays overlying the Aldebaran in places would inhibit recharge in these areas and likely reduces the amount of recharge from this mechanism. Recharge from either downward percolation from Quaternary alluvium associated with Retreat Creek or graben related fault leakage from the western fault zone may also be occurring.

The conceptual hydrogeological understanding of the site (including the basic recharge processes and interconnectivity of geological units) has been translated into an appropriate impact assessment model. The model has been calibrated against the measured groundwater level data within the groundwater units observed at site. Connective cracking has also been simulated within the predictive model. However, the potential for an increase in surficial groundwater recharge to the Aldebaran Sandstone as a result of subsidence induced fracturing has not been simulated.

Whilst subsidence may occur at the surface, subsidence induced fracturing (that is an increase in the vertical hydraulic conductivity of the strata) is not predicted to extend to the ground surface. As a result, surficial groundwater recharge mechanisms are unlikely to be

affected by subsidence induced fracturing. The potential changes in flow as a result of changes to vertical interconnectivity are currently simulated in the model and the results presented in EIS Appendix 14.

EIS Amendment:

The following has been added as the second and third paragraphs of Section 3.5 of Appendix B of EIS Appendix 14:

"In the underground extraction areas for the Project, the fracturing will depressurise the strata overlying the coal seam. The extent of the connective cracking typically varies depending on the coal seam thickness, the longwall panel width and the nature and strength of the overlying strata.

The model assumed the highly connective fracturing (goaf) above the coal seam extended to a height of 10 times the coal seam thickness, which was equivalent to a height of 40 m within these areas. The model also simulated the connective fracturing extending to a height of 30 times the coal seam thickness, which was equivalent to a height of 90 m. These heights were based on typical fracturing signatures observed in longwall mines in the Bowen Basin."

A new Section 4.2 has been added to Appendix B of EIS Appendix 14 which includes the above discussion on subsidence induced fracturing and hydraulic conductivity and the results of the sensitivity modelling as follows.

"4.2 Subsidence Induced Fracturing

The sensitivity of the model output was explored in relation to the conceptual approach used to represent subsidence induced fracturing and the parameters used in the method.

4.2.1 Representation of Subsidence Induced Fracturing

Within the basecase model, the longwall mine was represented by applying a series of drains to each longwall panel. These drains remained active for the entire mining strip of the longwall panel. Once mining of the longwall panel is complete, the drains were then switched off and the material above the mined coal seam was simulated to be goafed or affected by subsidence induced fracturing (see Table B-8).

An alternative method of representing the longwall panel was explored as a sensitivity analysis. In the alternative approach, the drains are not active for the entire mining strip of the longwall panel but switched off progressively in conjunction with the active mining face. The overburden material above and behind the mined strip is also progressively goafed or fractured.

Whilst neither conceptual approach is perfectly representing physical reality, it provides an alternative approach to compare against the baseline.

4.2.2 Height of Subsidence Induced Fracturing

The height of fracturing in the baseline model used a 30 times multiplier (30 t) above the mined B seam (equivalent to 90 m) as postulated by the 1993 model of Kendorski (2006) and commonly used in the industry. In this context, the assumption of 30 t could be perceived as optimistic and not representing a possible worst case scenario.

Investigations of Australian experience, as well as groundwater modelling of other Bowen Basin longwall proposals, support the 1993 Kendorski model of strata behaviour and the assumption made for the project. For example:

- Adhikary and Wilkins (ACARP C18016, 2012): Extensive monitoring of longwall caving at Springvale and Dendrobium in NSW indicate the height of the fractured zone extends 100 m to 105 m (~30 t) above the mine workings.
- MESC (2012): This subsidence modelling report for Moranbah South sites experience of undermining surface waters (Isaac River) at Moranbah North, where longwall extraction at 4.5 m height showed no discernible increased inflow into the mine workings at depths from 110 m to 200 m (i.e. 25 t - 50 t).
- Guo et al. (ACARP C14033, 2007): Provides a summary of practical hydrogeological models

of longwall mining proposed by various authors, and concludes that the fractured / disturbed zone, where the strata sag downwards resulting in bending, fracturing, joint opening and bed separation, is indicated to be 15 to 40 times the seam thickness.

- Gale (ACARP C13013, 2008): In the Hunter Valley, at Wollombi Creek Mine, stream flow was lost when mining occurred at a depth of approximately 90 m but not at depths greater than 120 m. Subsidence was estimated to be approximately 1.4 m to 1.6 m. The site at Wambo under Wollombi Creek also indicated stream loss at depths of 90 m to 95 m but not at depths of 110 m to 210 m. It is noted that subsidence of 1.4 m to 1.6 m at Wollombi Creek suggests an extraction thickness of 2.3 m to 2.7 m, or a thickness of the fractured zone of 33 t to 39 t.

  Gale goes on to suggest that the height of fracturing is more a function of extraction width rather than extraction height, with a typical ratio of height of fractures forming being 1 to1.5 times the extraction width. However, the creation of these fractures alone does not necessarily imply that a direct hydraulic connection exists over this zone. In order for mine inflow to occur, the fractures created must form a connected and conductive network to allow significant volumes of inflow.

- Frith (ACARP C10023, 2003): Investigation of subsurface fracturing above longwall panels using vertical boreholes at a number of Queensland and NSW mines indicated that the height above the workings where total loss of drilling fluid occurred (which is considered analogous to the fractured zone) ranged from 18 m to 63 m (6.4 to 31.5 t).

With this information, the sensitivity model was generated with the assumption that the height of fracturing is equivalent to 40 times the thickness of the B coal seam (equivalent to 120 m). This multiplier would appear to be at the upper end of predictions. This height extends the fractured zone to the base of layer 3, which represents the base of weathering in the Aldebaran Sandstone and base of Tertiary in some parts of the model.

4.2.3 Vertical Hydraulic Conductivity of the Goaf

Model sensitivity was also explored in terms of the vertical hydraulic conductivity values applied to the strata impacted by subsidence induced fracturing. The vertical hydraulic conductivity values applied to the fractured strata representing layers 4 to 9 were increased in comparison with the baseline model. Table B-8 shows the changes to the vertical hydrualic conducitivty within the goaf/fracture zone.

Table B-8: Sensitivity of longwall induced changes to Kz

Layer	Baseline fractured Kz (m/day)	Sensitivity fractured Kz (m/day)	Percent change
4	6.02×10^{-3}	1.09×10^{-2}	82%
5	7.70×10^{-3}	3.50×10^{-2}	355%
6	1.00×10^{-1}	1.00	900%
7	2.30×10^{-2}	4.60×10^{-2}	100%
8	5.0×10^{-4}	1.00×10^{-3}	100%
9	8.4×10^{-3}	2.12×10^{-2}	150%

4.2.4 Summary

The predicted inflows from the sensitivity analyses are shown in Figure B- 23. The analyses show that by modifying the representation of the longwall mine and by increasing the height of subsidence induced fracturing (from 30 t to 40 t), the inflows are generally higher, in the order of 4 ML/day to 5 ML/day. There are two peaks of short duration toward the end of mining in the order of 8 ML/day.

By also modifying the vertical hydraulic conductivity of layers 7, 8 and 9, the predicted inflows increase between 0.5 ML/day and 2 ML/day. The inflows are generally between 4 ML/day and 6 ML/day. The two inflow peaks of short duration toward the end of mining increase up to 10 ML/day.

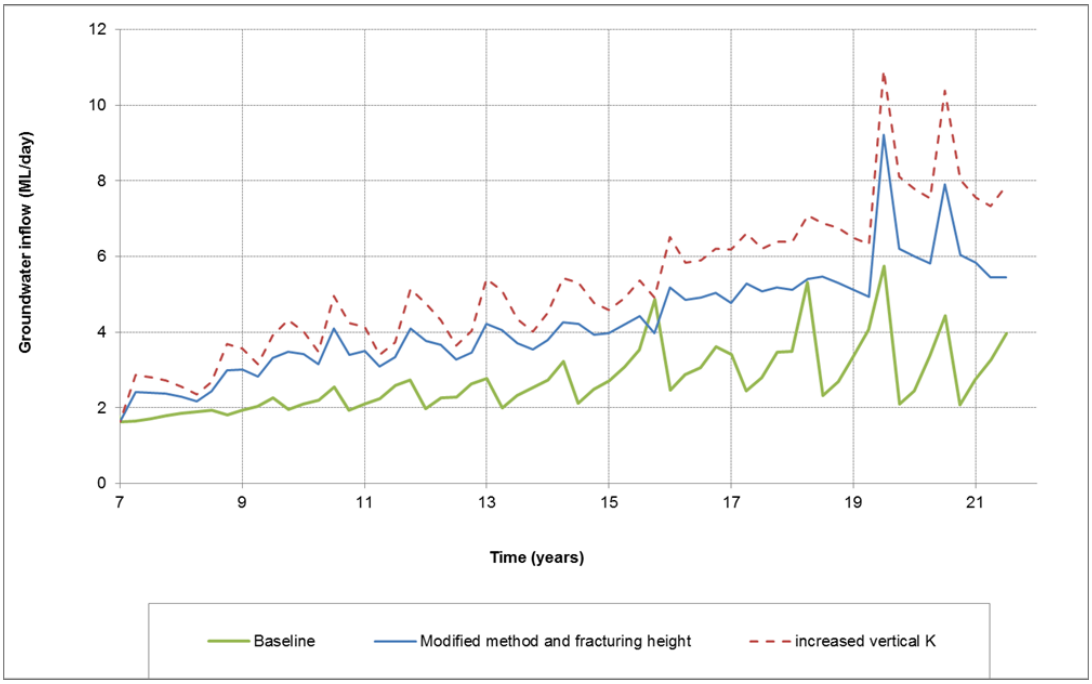


Figure B-23: Subsidence induced fracturing sensitivity analysis – predicted inflows

The sensitivity analysis shows that during the later stages of mining, groundwater inflows in the order of 8 ML/day to 10 ML/day are predicted. This inflow occurs when the longwall mine progression is in the northern portion of the mine, directly under a thick sequence of Tertiary material, which in the model is represented as having relatively high hydraulic conductivity and direct connection via the increased subsidence fracturing. This predicted high inflow is not considered realistic for the reasons outlined below.

The experience of subsurface fracturing with regard to weak sediments (i.e. mudstones, claystones and weathered siltstones) and clays is that these units do not generally form continuous open fractures due to their plasticity, and the fractures that do form tend to be self-healing over a relatively short period of time due to swelling from moisture. Gale (2008) states “the presence of clay in the overburden is considered to constrain the fracture network through fracture healing by expansion or its ability to strain without fracturing”.

The overburden in the project area includes a significantly thick sequence of weak Tertiary strata and weathered Permian, ranging in thickness from 45 m to 90 m. Included are numerous, often times thick, layers of clay and weathered claystone, which lie beneath the scattered basalt occurrences and alluvial gravels in the north near Retreat Creek. Based on experience elsewhere, it is expected that these units will not be highly fractured from subsidence where they occur more than 60 m to 70 m above the mine workings and therefore, will continue to act as an aquiclude to the overlying groundwater and surface waters.

Therefore, whilst the sensitivity analysis predicts high inflows to the underground mine, it is unlikely that these flow rates would eventuate due to the nature of the overlying sediments.

Figure B-24 shows the 1 m drawdown extent for the subsidence sensitivity analysis. Figure B- 24 indicates that the extent of drawdown predicted by the sensitivity model is comparable to the other sensitivities presented in Figure B- 22.

Table B-9 shows that by changing the representation of the goaf and increasing the height of fracturing from 30 t to 40 t, it increases the average predicted inflow by 41%. By further increasing the vertical hydraulic conductivities, the inflows increase by 67%. As discussed above, the maximum inflows are considered unlikely due to the nature of the weathered Permian and Tertiary material above the longwall mine.

Table B-9: Summary of Subsidence Sensitivity Analysis

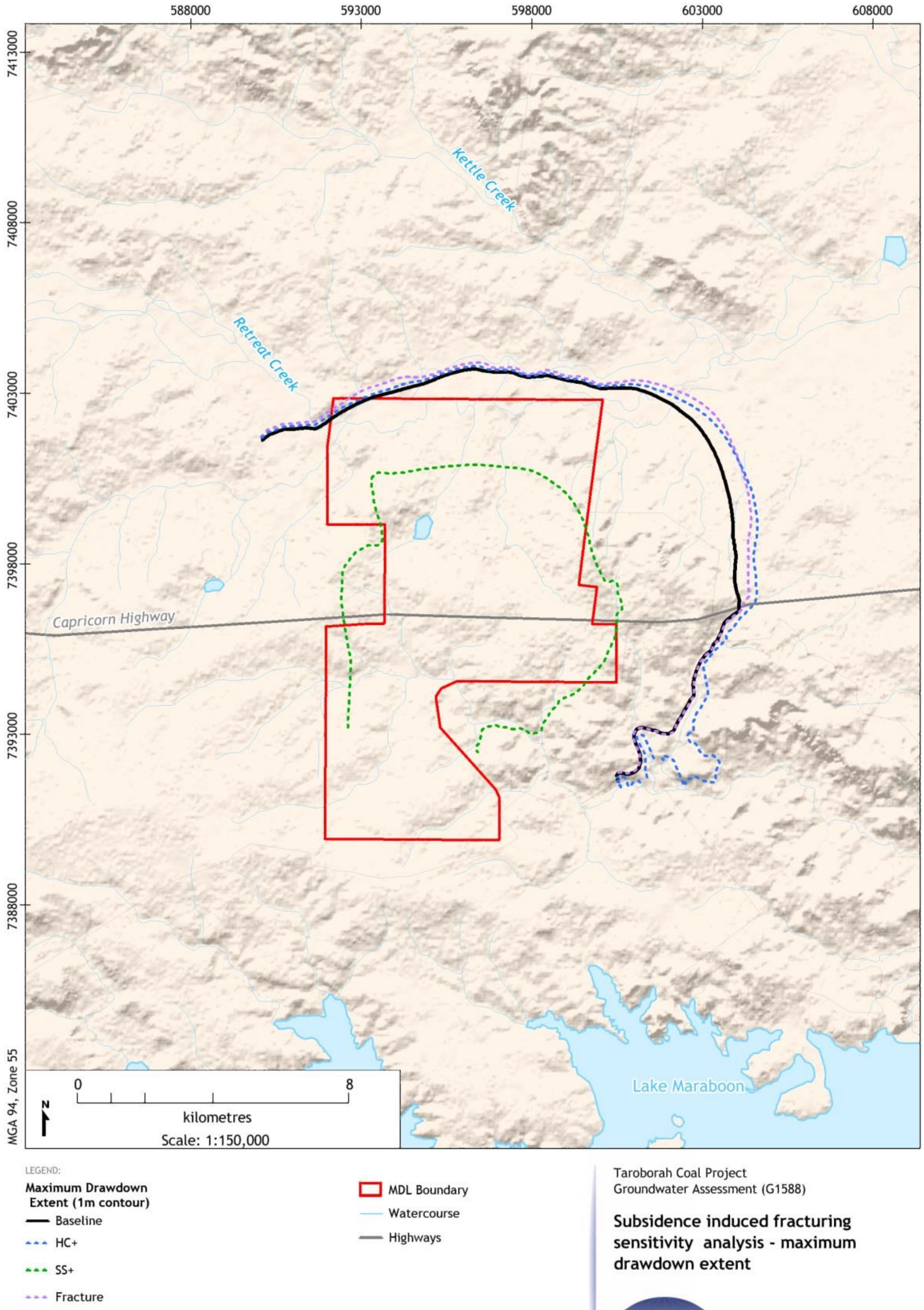
Parameter	Average Daily Inflow		Maximum Daily Inflow	
Unit	**ML/day**	**%**	**ML/day**	**%**
Baseline	2.6	100	5.7	100
Modified method and fracturing height	3.6	141	9.2	161
Increased vertical K	4.3	167	10.9	190

Figure B-25 shows the predicted drawdown for the subsidence sensitivity analysis within layer 9 after 21 years. The figure shows that with the change in longwall representation, the predicted depressurisation within the model layers is sustained and is of greater magnitude. This magnitude is greatest within layer 9 and decreases with height above the underground mine.

The greater drawdown as a result of this change in the modelling approach is only present during mining. Post mining, the recovery within the underground and open pit will be comparable to the baseline model.

Groundwater drawdown caused by underground mining in the layers overlying the longwall panel is more extensive in this scenario. This is because the vertical hydraulic conductivity of the fracture zone is increased, which further enhances hydraulic connection to the overlying groundwater system when compared to the baseline model presented in the EIS. The model results show water levels depressurise by up to 30m within the Aldebaran Sandstone, immediately above the active underground mining.

Whilst this scenario increased the hydraulic connection between the longwall mining area and the Aldebaran sandstone, the results show the majority of the Aldebaran Sandstone is not fully desaturated. Following the completion of each longwall mining area, groundwater levels in Layer 9 (rubble zone) respond similar to the basecase (see Section 3.7); however, residual drawdown occurs in the overlying layers for approximately six months following longwall completion."

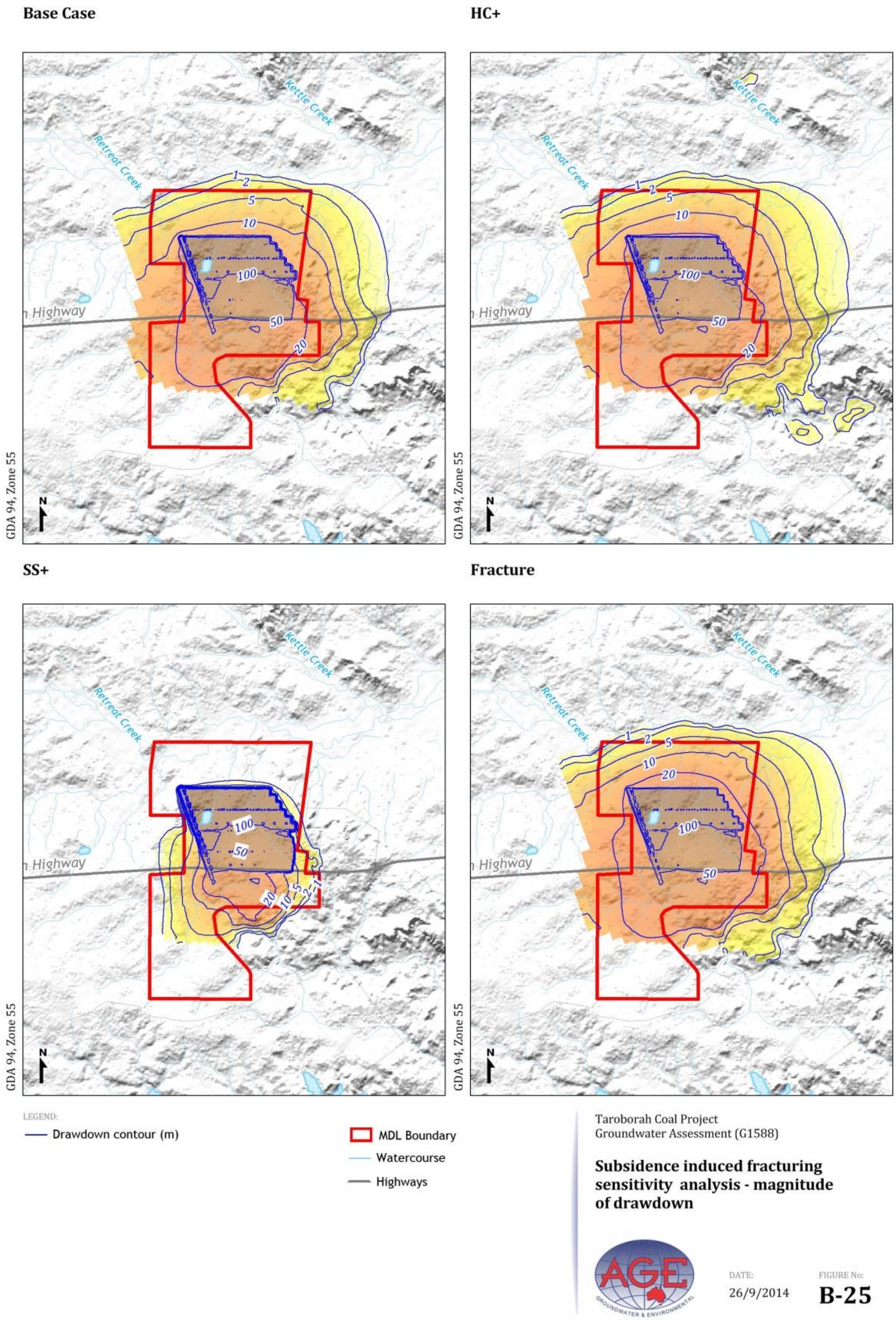


Taroborah Coal Project
Groundwater Assessment (G1588)

Subsidence induced fracturing sensitivity analysis - maximum drawdown extent

DATE: 14/10/2014

FIGURE No: **B-24**


Base Case
HC+
SS+
Fracture
Kettle Creek
Retreat Creek
Highway
GDA 94, Zone 55
N
1
2
5
10
20
50
100
LEGEND:
Drawdown contour (m)
MDL Boundary
Watercourse
Highways
Taroborah Coal Project
Groundwater Assessment (G1588)
Subsidence induced fracturing sensitivity analysis - magnitude of drawdown
DATE:
26/9/2014
FIGURE No:
B-25

12.5 Appendix 14 - Surface Water and Groundwater Interaction

Submitter:

Independent Expert Scientific Committee

Submission:

There is a low level of confidence in the proponent's prediction of impacts to surface water and groundwater interactions. The groundwater model is unable to predict impacts to seasonal variations in surface and groundwater interactions. Additionally, the EIS presents conflicting evidence as to whether creeks within the model domain are ephemeral or perennial. Confidence in the groundwater model's ability to characterise surface and groundwater interactions is further reduced by the uncertainties surrounding groundwater flow boundaries and the size of river cells. In particular, cells representing Retreat Creek and a large proportion of Taroborah Creek have grid sizes of up to 500m in proximity to the project area.

The groundwater model predicts that the Taroborah Coal project will result in a reduction in baseflow to rivers across the model domain of approximately 0.9 ML/day and will result in an increased leakage from rivers in the model domain of 0.9 ML/day. Both of these functions will result in a decrease of 657.44 ML/year of water provided to downstream reaches of surface water systems. However, the scale of this impact cannot be quantified because surface water flow or baseflow data for surface water courses has not been provided within the EIS.

Response:

As per Section 11.1 of EIS Appendix 14, the objective of the impact assessment model was to produce a tool that suitably represents the current understanding of the groundwater environment and can predict changes in groundwater conditions due to future activities within the model domain, including but not limited to the development of the Project.

The design, construction and calibration of the model were all tailored to meet these objectives as well as providing a framework for future iterations of the model following the addition of new data.

The objectives of the modelling, based on Australian modelling guidelines, were to:

- replicate measured groundwater levels at each observation bore (steady state), with an overall scaled root square mean error of less than 10% for all observation points;
- produce water budgets with a numerical error of less than 1% at each time step and on a cumulative basis;
- estimate groundwater seepages to the open-cut and underground mining areas over the Project life;
- predict the zone of depressurisation in alluvial and other aquifers from mining activities and the level and rate of drawdown at specific locations;
- predict the changes in groundwater drawdown to surface flows and other groundwater users due to Project operations; and
- identify areas of potential risk where groundwater impact mitigation/control measures may be necessary.

The original model objectives have been addressed in EIS Appendix and it is considered fit for purpose.

Recent transient water level data is available for the site, however, there is no seasonal variation in this data. Consideration was given to convert the model to a transient calibration, yet because there was no seasonal variation in the groundwater levels to calibrate against, it was assessed as unnecessary. Therefore, with the data available it would appear that the groundwater systems (in particular the deeper Permian coal measures in which mining will occur) are insensitive to seasonal climatic effects.

Detail in the regional model domain was applied to those areas considered to have the greatest influence in the impact assessment, namely the mine area. The model mesh has been generated in accordance with the Australian guidelines and in this regard, the 500m cell size at the model margins is considered appropriate.

There are numerous model cells in which the SURFACT river package is used as described in Section 1.3.4 of Appendix B of EIS Appendix 14. The use of the SURFACT river package within 500m grid cells is considered appropriate for a regional impact assessment model. A finer grid resolution over a larger area would result in a model that is impractical to run and use as an impact assessment tool. The model was not designed to be an aquifer simulator and this is the inference when applying fine grid resolution over a large area to simulate seasonal variation in stream flow.

The model does not predict 657 ML/yr loss of flow to downstream reaches of surface water systems. Figure 16 in EIS Appendix 14 shows that during the mining period, the model predicts the following:

- 0.9 ML/day increase in water entering the model through the SURFACT river package as leakage through the river bed. This occurs where there is a greater hydraulic gradient beneath the streams;
- 0.9 ML/day increase in water leaving the model through the SURFACT river package as baseflow or drains. This occurs in the lower lying areas where there is a greater hydraulic gradient beneath the streams; and
- these changes in the mining water budget effectively cancel each other out so that the net change in flow that mining has on the cells representing streams or rivers is close to 0 ML/day.

The baseflow component for Retreat Creek has not been established as there are no gauging stations established on it and the creek is ephemeral and only flows in response to sustained rainfall. Therefore, the above assumption of a 0% change in the baseflow of Retreat Creek is appropriate.

Total run-off flow within the Retreat Creek catchment has been estimated at 41,223 ML/yr as discussed in Appendix 13 to the Draft EIS. On this basis, and assuming there is only leakage to the groundwater system from this flow and no input to Retreat Creek flow from groundwater release, a 0.9 ML/day (328.5 ML/yr) reduction in flow from leakage into the groundwater is less than 1% of the estimated total flow component of Retreat Creek.

EIS Amendment:

The last paragraph of Section 1.3.4 of Appendix B of Appendix 14 has been amended to read as follows:

"The inlet and outlet of the main creeks and drainage lines were assigned with fixed head cells, within Layer 1 of the numerical model (Figure B-3). Outside of the mine area, the SURFACT river package was applied to 500 m grid cells. This application is considered appropriate for a regional impact assessment model. A finer grid resolution over a larger area would result in a model that is impractical to run and use as an impact assessment tool. The use of the SURFACT river package within 500 m grid cells allows the model objectives to be met and does not reduce the confidence or

reliability of the model predictions."

12.6 Appendix 14, Section 6.1.3, Page20 & Appendix B, Section 1.3.4, Page B-4 and B-5 - Potentiometric Surface, Recharge, Flow and Discharge

Submitter:

Department of Natural Resources and Mines

Submission:

Section 6.1.3 discusses potential recharge mechanisms. Page 20 and page 28 notes the possibility of increased recharge rates and interactions with faults. The effects of these faults in relation to recharge do not appear to be incorporated in the model. The report should discuss how this has been incorporated into the numerical groundwater model, or provide discussion why it was not considered.

Appendix B, Section 1.3.4 also discusses recharge rates for alluvium, regolith and weathered basalt. The section does not indicate if recharge was applied to outcropping Permian, and what values were assigned to that recharge. It is assumed that possibly the regolith recharge rate was applied over that area.

Recommendation: Discussion, and ideally a figure should be provided on how recharge was applied to the model**.**

Response:

Recharge was applied to the alluvium, regolith and weathered basalt layers of the model as was discussed in Section 1.3.4 of Appendix B. There was no specific recharge mechanism applied to the Permian layers from the bounding faults as there is no hydrogeological data to support this assumption, however, there was some degree of recharge applied from downward percolation of overlying alluvial groundwater through application of vertical hydraulic conductivity to the various model layers.

Rainfall recharge was applied across the model domain – as shown in Figure B-9 below. Bore logs to the east indicate the presence of thick sequences of shallow silts and clays overlying the Aldebaran Sandstone that would inhibit recharge, and therefore zones of recharge for the Aldebaran were not applied. Irrespective of this, the sensitivity analysis showed that a decline in recharge had little impact on the predicted extent of drawdowns and mine inflows, and an increase in recharge visibly reduced the extent of impacts. Therefore, the approach used is considered conservative and suitable based on the information available for recharge at the site.

EIS Amendment:

Section 1.3.4 of Appendix B of EIS Appendix 14 has been amended to include a discussion on recharge to the Aldebaran sandstone aquifer as follows:

"The potentiometric contours from the Permian Aldebaran Sandstone indicate potential recharge from either of the following two sources:

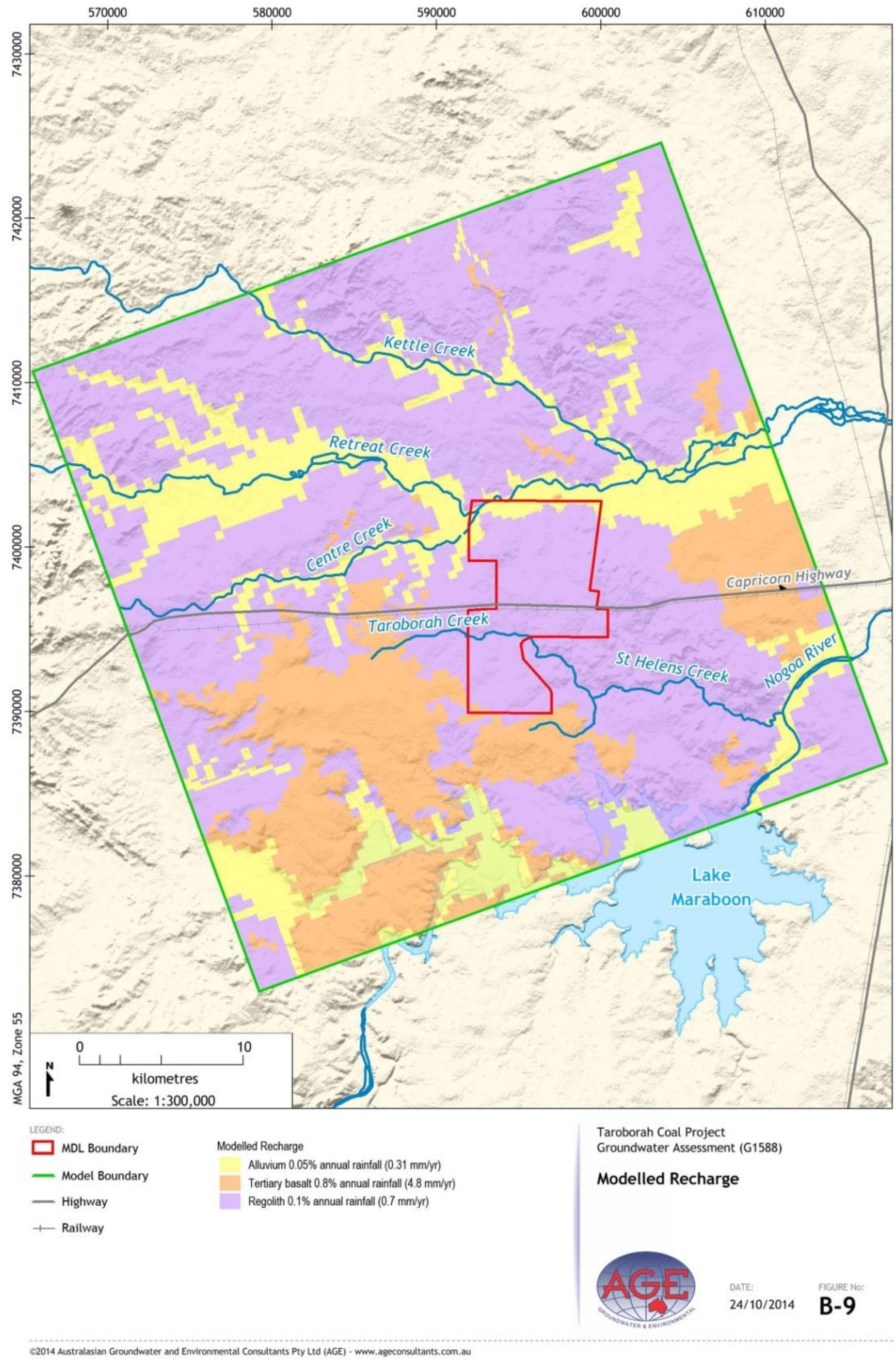
- downward percolation from Quaternary alluvium associated with Retreat Creek; or
- graben related fault leakage from the western fault zone.

Specific recharge zones for these potential processes were not included in the model development. Aside from geological mapping of the fault and the potentiometric contours, there is no hydrogeological data to support the assumption of additional recharge occurring at the surface expression of the fault. Furthermore, the model does not specifically represent any fault within the

model domain and infers lateral connectivity in these areas.

With regards to downward percolation from the Quaternary alluvium to the Permian strata, the model layers represent some degree of hydraulic connection between these units via the application of vertical hydraulic conductivity."

A new Figure B-9 referenced above and included below and illustrating the influence area of the recharge mechanisms has been added to Section 3.3 of Appendix B of EIS Appendix 14.



And the two paragraph discussion on potentiometric surface and recharge of the Aldebaran sandstone in Section 6.1.3 of Appendix 14 has been replaced by the following:

"Figure 8 shows the potentiometric surface of the pebbly coarse sandstone unit inferred from groundwater levels measured in monitoring bores during May 2014. The contours indicate that groundwater flow within the pebbly coarse sandstone reflects topography flows towards the south. Pumping from bore RN90064 appears to locally influence groundwater levels in the coarse sandstone creating a local zone of drawdown.

Recharge potentially occurs via rainfall percolation from mapped sub-crops of the Aldebaran Sandstone, shown on the 1:250,000 surface geology map (Figure 5). However, review of lithology east of the project area (MB03_S), where the Aldebaran Sandstone subcrops, indicates the presence of thick sequences of shallow silts and clays that would inhibit recharge. Therefore, recharge predominantly occurs via more permeable zones within the regolith and Tertiary basalt, as well as downward percolation from Quaternary alluvium associated with Retreat Creek."

12.7 Appendix 14, Section 9.1, Page 32 - Environmental Protection (Water Policy) 2009

Submitter:

Department of Environment and Heritage Protection

Submission:

The proponent has stated that:

"The groundwater chemistry data relevant to the project is summarised in Table A-4 of Appendix A. Comparison of this data with the WQOs indicates that all bores exceed at least one of the 80th percentile criteria for deep and shallow groundwater listed in Table 7. This indicates that if the project proceeded, future assessment of groundwater should be undertaken based on baseline (pre-mining) data and not the specified WQOs."

There is insufficient background data presented in the EIS to derive local water quality guidelines for groundwater. As the groundwater data in the EIS dates back to April 2013 there should now be another twelve months of groundwater monitoring data available.

Recommendations:

1. Provide any additional groundwater monitoring data since the EIS was submitted.
2. Consider any additional background groundwater quality results and groundwater WQOs (Fitzroy groundwater: water quality objectives (aquatic ecosystem) according to water chemistry zone 13) in the groundwater data analysis. The reference data requirements for estimating 20th, 50th and 80th percentiles are the same as those for surface water and are included in Table 4.4.2 (page 78) of the Queensland Water Quality Guidelines (EHP 2013).

Response:

Groundwater quality from a 2009 sampling event in the TAR monitoring bores as well as a May 2014 sampling event have now been included in the EIS. An additional sampling event was completed in September 2014, and the results are provided as Attachment C to this response document. All of the additional results support the original assumption that site specific WQOs will need to be established for the groundwater at Taroborah.

It is acknowledged that current data is insufficient to set site specific WQOs, and to this end, the Proponent will continue its quarterly sampling regime for at least the next 18 months in order to collect the additional relevant data.

EIS Amendment:

Table 6 and Figure 11 (now Figure 14) in Section 7 of Appendix 14 of the EIS have been updated to include the 2009 and May 2014 groundwater quality data sets. A new Table A-5 has been added to Appendix A of Appendix 14 containing the detailed May 2014 groundwater quality data set.

Discussion on the groundwater quality in Section 7.1 of Appendix 14 of the EIS has been amended to read as follows:

"The results for field EC shown in Figure 14 indicate that groundwater within the Quaternary alluvium is slightly brackish to brackish, with an average EC of 1,400 µS/cm. The coarse grained sandstone is generally less saline than the alluvium, with fresh water quality recorded at TAR249_C in 2014, and a larger number of samples classified as slightly brackish.

The A and B coal seams have brackish water quality with an average EC of 2,300 µS/cm. EC of the coal seams is comparatively low for the Bowen Basin, which can typically vary from 5000 µS/cm to over 50,000 µS/cm. The lower EC of the A and B seams is likely related to leakage of 'fresher groundwater' from the immediately overlying pebbly coarse sandstone unit, and from rainfall infiltration where it occurs at sub-crop to the south.

A significant portion of the EC dataset exceeds the 80th percentile limit that is specified for deep (> 30 m) groundwater quality objectives in the Nogoa River / Theresa Creek sub-basin (see Section 9.1). Major ion exceedances include Na, Ca, Mg, HCO3, Cl and SO4. A number of minor ions and metals also exceed the water quality objectives defined in Section 9.1. This assessment indicates that future assessment of the groundwater quality should be undertaken based on baseline (pre-mining) data and not the specified water quality objectives."

12.8 Appendix 14, Section 11.1, Page 35 - Overview of Groundwater Modelling

Submitter:

Department of Environmental and Heritage Protection

Submission:

The groundwater impact assessment includes a sensitivity analysis using wet years for catchment runoff. However, it would be useful if the groundwater modelling included a worst case groundwater inflow scenario, considering that groundwater inflow is expected to be a significant contributor to the volume of mine affected water in surface water storages.

Recommendation: Amend the water balance model to include maximum groundwater inflow to produce a worst-case scenario output and propose any additional mitigation measures, if required.

Response:

An additional sensitivity of groundwater inflow has been run assuming a "worst" case scenario of increased fracture height due to subsidence effects (increased to 40 times mining height from 30 times based on investigation for Section 13.4 above) plus increased vertical hydraulic conductivity within the various fracture zones as indicated in the following table.

The results indicated that a worst case groundwater inflow based on the above parameters might be a 0.5-2.5ML/day increase over the base case on average, with a maximum inflow of 10.9ML/day (versus 5.7ML/day in the base case) in the later years.

Using the worst case groundwater inflow, the site water balance model has been run to determine the impacts on required release of excess water. The results indicate that excess water make on site increases from an average of 0.9 ML/day and maximum of 3.3 ML/day

for the conservative expected case to an average of 1.7 ML/day and maximum of 5.0 ML/day with the worst case fracturing sensitivity.

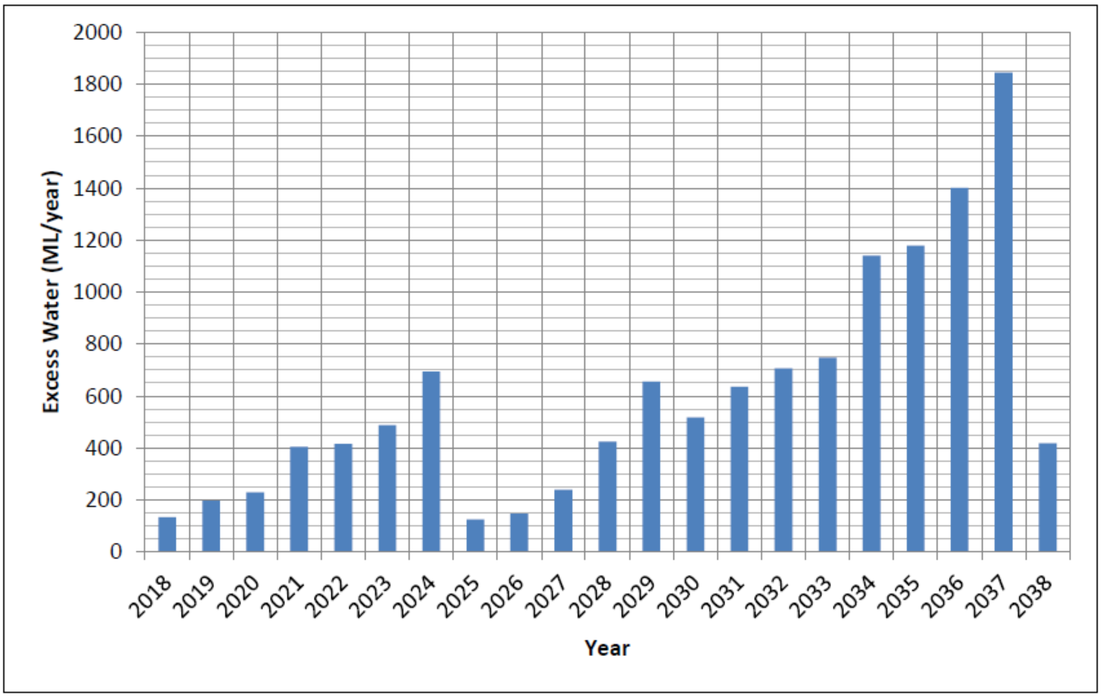
EIS Amendment:

A new Section 4.2 has been added to Appendix B of EIS Appendix 14 to cover the worst case sensitivity analysis of increased fracturing height and increased hydraulic conductivity as presented above in Section 12.4 of this response document.

And Section 4.2.1 of EIS Appendix 13 presents the results of the water balance model assuming the worst case inlflows as follows

"A sensitivity analysis was conducted to determine the effects of increased groundwater inflow of some 20-50% to the Taroborah Coal Project site. Results of excess groundwater is presented on Plate 13 and shows the annual excess varies from 110 ML/year to 1850 ML/year. The groundwater inflow was provided by AGE as shown in Appendix A as an input into the water balance model. Management of the groundwater inflow was varied to achieve a spill risk of less than 1% for the MWD and the CPPWRD."

Plate 13
Excess Water at Site under Predicted Maximum Groundwater Inflow Conditions



12.9 Appendix 14, Section 11.5, Page 33 - Water Act 2000 and Water Regulation 2002

Submitter:

Department of Environment and Heritage Protection

Submission:

There are no units for ions, salts and metals in Table 7.

Units for these values need to be included in Table 7.

Response:

This was an oversight. Units now included in Table 7.

EIS Amendment:

Units of mg/L have been added to the trace elements and compounds in Table 7.

12.10 Appendix 14 - Impact on Groundwater Users

Submitter:

Department and Natural Resources and Mines

Submission:

This section outlines the impacts on surrounding bores. The report does not outline any mitigation measures or likely alternative sources of water to affected users. The report should provide possible mitigation measures to potentially effected bores. This should include some detail on whether the alternative source is physically present and available. The proponent should also provide a commitment to enter into make good agreements to provide alternative water supplies to landholders whose bore are predicted to be impacted by the mine dewatering**.**

Response:

The mitigation measures will be discussed in Appendix 14 and in Section 4.5.2.2 of the main body of the EIS report as required by the TOR. The Proponent will likely enter into make good agreements with potentially affected landholders, and potential mitigation methods for any significant loss of water in affected bores will be replacement by the Proponent, either through the deepening of the existing bores (if feasible) or through its mine dewatering scheme. Details of the mitigation agreements and method of delivery will be developed with the individual landholders at the appropriate time.

EIS Amendment:

The following has been added to Section 11.5 of Appendix 14 and Section 4.5.2.2 of the main body of the EIS report:

"Table 8 summarises these eight bores and provides an assessment of the reduction in available drawdown in the bore.

Table 1: PREDICTED DRAWDOWN IN PRIVATE BORES

Bore ID	Stratigraphy	Use	Bore Depth (mbgl)	SWL mbgl (Dec 2011)	Predicted Drawdown (m)	Head Available (m)	Reduction in available drawdown*
57603	Aldebaran Sandstone	Stock	80.0	5.5*	-2.5	77.5	3%
67349	Tertiary Basalt	Stock	32.0	7.83	-7.2	24.8	29%
Twin Bore	Tertiary Basalt / Aldebaran Sandstone	Stock - Not currently in use	46	19	-8.5	37.5	23%
Census Bore 2	Aldebaran Sandstone	Exploration Hole - used for stock	137	10.6*	-20.3	116.7	17%
84184	Aldebaran Sandstone	Stock	76.5	30.7*	-17.3	59.2	29%

Table 1: PREDICTED DRAWDOWN IN PRIVATE BORES							
Bore ID	**Stratigraphy**	**Use**	**Bore Depth (mbgl)**	**SWL mbgl (Dec 2011)**	**Predicted Drawdown (m)**	**Head Available (m)**	**Reduction in available drawdown***
90064	Aldebaran Sandstone / Coal	Stock & farm water	92.0	42.0*	-29.7	62.3	48%
103729	Aldebaran Sandstone	Stock	121.5	33.7*	-10.1	111.4	9%
Census Bore 3	Aldebaran Sandstone	Stock, farm & drinking water	123	47.8*	-23.6	99.4	24%

**SWL estimated from groundwater model.*

Table 8 shows that, as a result of the Project, one bore is predicted to have a nearly 50% reduction in available drawdown, two bores are predicted to have their available drawdown reduced between 25% and 50%, and five bores are predicted to have their available drawdown reduced by <25%.

Those bores with a reduction of greater than 50% are likely to be significantly impacted and are likely to require an alternative source of water to replace this supply. This may be a replacement bore or supplementation of the supply. Bores with a reduction of between 25% and 50% are likely to be impacted and may require to be deepened, replaced or supplemented with an alternative supply. Those bores with a reduction of available drawdown of less than 25% may be impacted by the project. These bores may require deepening or supplementation with an alternative supply.

Any significant loss of groundwater supply in affected bores will be replaced by the Proponent. Mitigation measures may entail deepening of the bore, deepening of the pump, constructing a replacement bore or supplementation of supply with alternative water. Details of the mitigation measures will be developed in agreement with the landholder at the appropriate time."

The following has been added to Section 3.8 of Appendix B of EIS Appendix 14:

"Any loss of groundwater supply in affected bores will be compensated by the Proponent. Mitigation measures may entail:

- deepening of the bore;
- deepening of the pump;
- constructing a replacement bore; or supplementation of supply with the groundwater extracted as a requirement of the mining process.

Details of the mitigation measures will be developed in agreement with the landholder at the appropriate time."

12.11 Appendix 14 - Impact on Groundwater Users

Submitter:

Independent Expert Scientific Committee

Submission:

The project poses a risk to private users of groundwater. Drawdown within privately owned bores is predicted to reach a maximum of 29.7 m below the existing water table, which includes bores that are utilised as domestic, stock and irrigation water sources.

Recommendations:

Features of a monitoring and management framework, not including measures already

committed to by the proponent, should include commitments to monitor, mitigate and manage impacts to private groundwater users resulting from bore drawdown.

Response:

Firstly, it should be noted that there are no potentially impacted groundwater bores within or nearby the Project that are used for irrigation. The only uses of groundwater in the Project area are for stock watering, farm supply and one instance of drinking water supply.

The groundwater bores that incur the greatest amount of drawdown are those located within the Project boundary, and the Proponent has already stated their intent to either purchase or lease the properties within which these occur from the current owners, such that the significant drawdown impacts will be felt only by the Proponent. Further, there will be an excess of water from mine operations, and this excess will be supplied to any affected landowners in the first instance to compensate for any drawdown losses.

Finally, the Proponent has notified the neighbouring landowners that they are proposing to enter into voluntary but binding water make good agreements with them to ensure any potential impacts from the Project to their groundwater supplies are remedied. These agreements will include a monitoring program for each bore and a mitigation scheme to prevent impacts in the first instance.

EIS Amendment:

Provided in Section 12.10 of this response document.

12.12 Appendix 14 - Final Landform

Submitter:

Independent Expert Scientific Committee

Submission:

The proponent has not detailed the proposed measures to manage and mitigate the risks posed by the final landform following the completion of the proposed project. The proponent should demonstrate that the legacy issues and risks to water resources as a result of the final landform have been assessed, will be mitigated and managed, including:

- Design of a monitoring bore network within emplacement areas surrounding the final pit lakes to provide a representative indication of groundwater quality and identify any leaching of highly saline or acidic material.
- Modelling of salt stratification and contaminant enrichment within the final void lakes.
- Water quality criteria for the final void lake.

Development of a final void management plan, prior to the completion of open cut mining, which incorporates the above measures.

Response:

Pit water quality modelling has been undertaken and is provided in Attachment E to this response document.

The hydrogeochemical model for the Taroborah open pit voids was based around Microsoft Excel and the Phreeqc chemical speciation program. The use of Phreeqc means the calculations of pH and void water chemistry were based on fundamental chemical principals. By using thermodynamic principals rather than empirical relationships, it is possible to predict pH and full water chemistry for different scenarios with respect to void

dimensions, wall rock types (including NAF and PAF characteristics), runoff chemistries from individual rock types, different inflow regimes for surface and ground waters, and development of water bodies within the voids through time.

The Excel component of the hydrogeochemical model contains data relevant to the void shell (lithology, NAF/PAF distribution), water balance information, and the chemistries assigned to runoffs from different wall rock units, and ground water inflows. The Excel component also has embedded macros that produce an input file that feeds into the Phreeqc computer program which predicts the pH and water quality of the combined pit water.

The inputs considered in the water quality model of the Taroborah final void include ground waters from the high wall and from the in-pit spoil, as well as rainfall runoff from different geological surfaces. The model calculated pit lake water quality on a one-year time step, and for each step the model input file included data for the flow and chemistry of each source of water inflow. The only output was a loss of water via evaporation. There was no water overflow from the void.

Although rejects will be placed on the pit floor during underground mining operations, the rejects will be placed in a manner that minimises the potential for sulphide oxidation to occur. This will involve blending with limestone and encapsulation of rejects within engineered isolation cells that are lined with geosynthetic clay to restrict oxygen ingress and to minimise leaching. Such measures will limit the exposure of rejects to conditions that are conducive to ARD generation. It was therefore assumed that any reject cells constructed within the void will be geochemically secure prior to and post flooding of the void, and consequently will not contribute significantly to pit lake water quality.

The following water quality parameters were included as input to the hydrogeochemical model: pH, redox, alkalinity, Ag, Al, As, B, Ba, Ca, Cd, Cl, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Sn, SO4, U, and Zn.

Year-by-year predictions of pit lake quality for the eastern void were made for a period of 100 years. The western void was not modelled as it is considered that, because the western void has essentially the same stratigraphy and will be subject to inflows of the same surface and ground waters, it is expected that the quality of the pit lake that develops in the western void will be comparable to that predicted for the eastern void.

The pit floor and lower strata of the high wall (roof, coal seams and interburden) will comprise PAF materials and have the potential to generate ARD. However, the model predicts that inflows of alkaline groundwater, together with alkaline runoff from in-pit spoil and upper weathered strata of the high wall, should be sufficient to neutralise acidity produced by the PAF rock units.

Based on the assumptions made in the model, pit water is predicted to be circum-neutral throughout the 100 year period modelled. It is also predicted that salinity will gradually increase due to the inflow of slightly saline ground water and the concentrating effect of evaporative water loss. The predicted water quality by decade is provided in the following table.

Parameter	Unit	Year after Start of Filling										
		1	10	20	30	40	50	60	70	80	90	100
pH		7.5	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.8	7.8
Major anions												
Cl	mg/L	359	527	619	714	815	909	1008	1093	1195	1274	1350
SO4	mg/L	451	475	537	611	686	774	858	939	1021	1057	1125
Major cations												
Ca	mg/L	78	62	60	59	58	60	62	64	65	57	58
Mg	mg/L	108	143	167	194	220	247	273	298	324	346	368
Na	mg/L	200	292	341	392	447	497	550	596	650	692	733
K	mg/L	2	2	3	3	3	4	4	5	5	6	6
Trace elements												
Ag	mg/L	0.001	0.001	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.003
Al	mg/L	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3
As	mg/L	0.00003	0.00003	0.00004	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.001	0.002
Ba	mg/L	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.6
B	mg/L	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3
Cd	mg/L	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002
Co	mg/L	0.1	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.05	0.04	0.04
Cr	mg/L	0.006	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.005	0.004	0.004
Cu	mg/L	0.003	0.002	0.002	0.003	0.002	0.003	0.003	0.003	0.003	0.003	0.004
Fe	mg/L	0.006	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Hg	mg/L	0.0001	0.0001	0.0002	0.0002	0.0002	0.0002	0.0003	0.0003	0.0003	0.0003	0.0003
Mn	mg/L	2	2	2	2	3	3	3	4	4	4	4
Mo	mg/L	0.005	0.007	0.008	0.009	0.01	0.01	0.01	0.01	0.02	0.02	0.02
Ni	mg/L	0.19	0.08	0.08	0.08	0.08	0.09	0.10	0.11	0.12	0.11	0.12
Pb	mg/L	0.00003	0.00003	0.00004	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0004	0.0004
Sb	mg/L	0.001	0.001	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.003
Se	mg/L	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02
Sn	mg/L	0.001	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.004	0.004
U	mg/L	0.011	0.005	0.005	0.004	0.004	0.005	0.005	0.006	0.006	0.004	0.004
Zn	mg/L	0.5	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2

The design of the post closure groundwater monitoring network will be carried out a later date. The network however is unlikely to maintain bores within the spoil or emplacement areas as there is no perceived level of environmental risk within the spoil or pit void. The pit void is assessed to be a groundwater sink post mining. The network is more likely to be installed to monitor groundwater within shallower, fresher groundwater systems from which local groundwater supplies are extracted. Hence, with the objective of monitoring and maintaining the environmental value of the resource.

The water quality criteria for the final void lake will be determined following the final void salinity modelling. However, as the final void is predicted to be a groundwater sink post mining, the level of risk to the environment is assessed to be low. Rather than monitoring the quality of a groundwater sink, the focus for post closure monitoring should relate to the protection of the environmental value of the resource.

A final void management plan will be developed prior to the completion of open cut mining and will incorporate groundwater and surface water quality monitoring.

EIS Amendment:

The memo report on the final void water quality modelling provided as Attachment E of this document is included as a new Appendix 14a to the final EIS document.

The following paragraph has been added following the first paragraph under Final Void Hydrology (formerly Final Void Drainage) in Section 3.7.8.1 of the final EIS document:

"A hydrochemical model developed to predict the water quality during the filling of the final opencut voids is detailed in Appendix 14a and has indicated that the pit water will be circum-neutral throughout the 100 year period modelled. It is also predicted that salinity will gradually increase due to the inflow of slightly saline ground water and the concentrating effect of evaporative water loss. The concentration of sulfates, cations and trace elements should not be toxic to livestock. As the pit will act as a groundwater sink, there is little chance of regional contamination of the groundwater

system post mining, and any contamination will be confined to the pit itself and the immediate area around the pit walls."

The second paragraph under Rejects Storage Leachate and Final Void Water Quality (formerly Rejects Storage Leachate) in Section 4.5.2.3 – Site Water Management of the final EIS document has been amended to read as follows:

"To assess the effectiveness of the rejects storage system on final void water quality and potential groundwater contamination, a final void management plan will be developed prior to the completion of open cut mining. The Project's surface water and groundwater monitoring programmes will include assessment of surface and groundwater pH, salinity, sulphate and heavy metals, as indicators of potential rejects leachate. The post closure groundwater monitoring network is unlikely to maintain bores within the spoil or emplacement areas as there is no perceived level of environmental risk within the spoil or pit void. The pit void is assessed to be a sink post mining and the network is more likely to be installed to monitor groundwater within groundwater systems around the void, from which local groundwater supplies are extracted, hence, with the objective of monitoring and maintaining the environmental value of the resource."

The following paragraph has been added to Section 12 of Appendix 14.

"A final void management plan will be developed prior to the completion of open cut mining and will incorporate groundwater and surface water quality monitoring. The post closure groundwater monitoring network is unlikely to maintain bores within the spoil or emplacement areas as there is no perceived level of environmental risk within the spoil or pit void. The pit void is assessed to be a sink post mining and the network is more likely to be installed to monitor groundwater within groundwater systems around the void, from which local groundwater supplies are extracted, hence, with the objective of monitoring and maintaining the environmental value of the resource."

12.13 Appendix 14, Section 12.1, Page 41 - Water Level Monitoring Plan

Submitter:

Department of Natural Resources and Mines

Submission:

The report notes that water levels and water quality will be monitored for an initial period of 2 years out of a 21 year mine life, and does not indicate frequency of longer term monitoring. Monitoring is required to be carried for the life of the mine. Typically water licence conditions will require water levels and groundwater extraction data to be recorded at least quarterly and reported annually

Response:

Certainly, the report indicates that monitoring will be carried out for the life of mine through comments such as the first sentence of the second paragraph of Section 12 (page 40) which states "The groundwater monitoring program … will continue throughout the life of the mine." As stated in the report, the frequency of manual sampling (currently proposed as quarterly) will be reviewed after the initial 24 month (2 year) period, but this does not mean that it will be stopped at that time, but rather that the frequency may be adjusted if deemed warranted. And as for water levels, these will continue to be recorded through the electronic data loggers at daily intervals at least (currently set at 6-hour intervals).

EIS Amendment:

None required.

12.14 Appendix 14, Appendix A, Page A-6 - Laboratory Water Quality Results

Submitter:

Department of Environment and Heritage Protection

Submission:

Irrigation is an EV for the region and the proponent has indicated that water collected at the MWD (including groundwater inflows) may be added to the irrigation system downstream of Fairbairn dam (Appendix 13 Surface Water Management Plan, Page 28). Therefore, it may be necessary for scheduled WQOs for irrigation (or irrigation water quality guidelines) to be included for comparison with groundwater quality in Table A-4 of Appendix A of the Groundwater Impact Assessment.

Recommendation: Consider the proposed disposal method and end use of mine affected water (e.g. release to surface waters or reuse) and determine whether it is necessary to include in Table A-4 of Appendix A of the Groundwater Impact Assessment the irrigation WQOs from the Environmental Protection (Water) Policy 2009 Nogoa River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (EHP 2013), and irrigation water quality guidelines from the Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Volume 1: The Guidelines (ANZECC & ARMCANZ 2000).

Response:

The ANZECC 2000 Irrigation WQOs have been added to the Table A-4 and the new Table A-5 in Appendix A of EIS Appendix 14, and a new section has been added to Appendix 13 that compares these WQO's to the quality of the groundwater expected to be released. The Short Term Limit (STL) values have been used in the comparisons as the release of water is expected to occur for a maximum of 20 years only.

What the comparison indicates is that the groundwater quality as measured to date at Taroborah is suitable for the planned beneficial use of crop irrigation via flood techniques, particularly when the dilution effect of the water already in the irrigation system is considered (i.e. up to 2 ML/day released into a 160 ML/day system). Only two samples in two boreholes exceeded any of the STLs for flood irrigation, and these came from tertiary aquifers that will not be drained through the mining activities. And the salinity and sodium levels of the groundwater are suitable for all crops grown in the Emerald area without dilution effects with the exception of the salinity in regards to citrus crops, which is some 50% higher in about 30% of the bores.

EIS Amendment:

The amended Table A-4 and new Table A-5 contained in Appendix A of Appendix 14 are as follows:

Table A-4: LABORATORY WATER QUALITY RESULTS – APRIL 2013

Analytes	Units	LOR	ANZECC 2000		ADWG (2011)		MB01_B	MB02_C	MB02_S	MB03_S	MB04_C	MB04_S	MB05_C	MB08_B	MB09_T	MB10_T	TAR016_CR	TAR053	TAR176_C	TAR177_C	TAR249_C
Aquifer	-	-	Irrigation Water	Livestock Drinking	Aesthetic	Health	Tertiary Clay, Silt	Aldebaran Sandstone - B seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Fine Sandstone	Aldebaran Sandstone - B seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - A seam	Tertiary Clay, Gravel	Quaternary Alluvium	Quaternary Alluvium	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Fine Sandstone	Tertiary Basalt	Aldebaran Sandstone - Coarse Sandstone
Date Sampled	-	-					12/3/2013	13/3/2013	12/3/2013	13/3/2013	12/3/2013	12/3/2013	13/3/2013	21/2/2013	11/3/2013	11/3/2013	23/4/2013	22/4/2013	18/4/2013	18/4/2013	22/4/2013
Field - Physical Parameters																					
pH Value	pH Unit	-	-	-	6.5 - 8.5	-	8.26	8.35	8.24	7.95	8.39	8.34	8.37	8.47	8.21	7.92	6.75	7.24	8.66	7.06	7.68
Electrical Conductivity @ 25°C	µS/cm	-	-	-	-	-	2,450	3,180	1,395	3,130	2,760	2,570	1,570	1,434	917	1,679	1,328	956	893	1,368	797
Total Dissolved Solids	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	864	624	-	-	520
Temperature	°C	-	-	-	-	-	-	24.1	25.4	26.8	25.3	24.5	26.9	-	-	-	26.6	26.2	26.7	26.0	25.7
Laboratory - Physical Parameters																					
pH Value	pH Unit	0.01	-	-	6.5 - 8.5	-	8.35	8.23	8.16	8.36	8.24	8.20	8.45	-	8.33	8.36	7.59	7.93	8.65	7.40	8.56
Electrical Conductivity @ 25°C	µS/cm	1	-	-	-	-	2,170	3,070	1,370	3,060	2,630	2,440	1,590	1,450	931	1,560	1,290	980	930	1,400	783
Sodium Adsorption Ratio	-	0.01	-	-	-	-	4.3	4.5	2.7	11.8	6.32	8.98	3.52	-	3.74	6.32	1.97	1.51	3.73	1.24	3.79
Total Dissolved Solids (Calc.)	mg/L	10	-	3,000-13,000*	600	-	1,410	2,000	890	1,990	1,710	1,590	1,030	942	605	1,010	838	637	604	910	509
Total Suspended Solids	mg/L	5	-	-	-	-	49,700	270	126	8,020	3,470	163	240	313	390	54,400	11	7	<5	5	85
Total Hardness as $CaCO_3$	mg/L	1	-	-	200	-	674	773	446	318	583	385	348	-	204	326	459	371	186	655	137
Alkalinity																					
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	-	-	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity as $CaCO_3$	mg/L	1	-	-	-	-	15	<1	<1	11	<1	<1	20	17	5	16	<1	<1	28	<1	14
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	-	-	-	-	398	248	472	276	245	376	260	559	225	454	537	445	157	778	75
Total Alkalinity as $CaCO_3$	mg/L	1	-	-	-	-	413	248	472	288	245	376	280	576	231	470	537	445	186	778	90
Major Ions																					
Calcium	mg/L	1	-	1,000	-	-	59	97	60	58	77	57	39	30	34	43	75	58	53	71	17
Chloride	mg/L	1	refer to guideline	-	250	-	428	718	154	540	594	488	291	129	134	191	117	48	199	73	179
Fluoride	mg/L	0.1	2.0	2	-	1.5	<4.0	0.4	0.6	0.6	0.5	0.8	0.4	-	0.2	<0.4	0.5	0.5	0.2	0.2	0.4
Magnesium	mg/L	1	-	-	-	-	128	129	72	42	95	59	61	81	29	53	66	55	13	116	23

Table A-4: LABORATORY WATER QUALITY RESULTS – APRIL 2013

Analytes	Units	LOR	ANZECC 2000		ADWG (2011)		MB01_B	MB02_C	MB02_S	MB03_S	MB04_C	MB04_S	MB05_C	MB08_B	MB09_T	MB10_T	TAR016_CR	TAR053	TAR176_C	TAR177_C	TAR249_C
Aquifer	-	-	Irrigation Water	Livestock Drinking	Aesthetic	Health	Tertiary Clay, Silt	Aldebaran Sandstone - B seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Fine Sandstone	Aldebaran Sandstone - B seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - A seam	Tertiary Clay, Gravel	Quaternary Alluvium	Quaternary Alluvium	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Fine Sandstone	Tertiary Basalt	Aldebaran Sandstone - Coarse Sandstone
Date Sampled	-	-					12/3/2013	13/3/2013	12/3/2013	13/3/2013	12/3/2013	12/3/2013	13/3/2013	21/2/2013	11/3/2013	11/3/2013	23/4/2013	22/4/2013	18/4/2013	18/4/2013	22/4/2013
Potassium	mg/L	1	-	-	-	-	10	13	5	83	18	44	12	2	2	3	3	5	16	3	10
Sodium	mg/L	1		-	180	-	257	288	131	482	351	405	151	193	123	262	97	67	117	73	102
Sulfate as SO_4	mg/L	1	-	1,000 - 2000	250	500	131	67	36	293	185	156	66	45	37	84	22	13	37	20	42
Dissolved Metals																					
Aluminium	mg/L	0.01	-	-	0.2	-	<0.01	0.02	<0.01	<0.01	<0.01	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	0.01
Antimony	mg/L	0.001	-	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	0.001
Arsenic	mg/L	0.001	-	-	-	-	0.002	<0.001	0.004	0.002	<0.001	0.003	0.002	<0.001	0.001	0.013	0.001	0.005	0.002	<0.001	<0.001
Barium	mg/L	0.001	-	-	-	-	0.091	0.146	0.047	0.093	0.082	0.163	0.108	0.117	0.018	0.087	0.121	0.388	0.078	0.096	0.031
Beryllium	mg/L	0.001	-	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	mg/L	0.05	-	-	-	-	0.07	0.13	0.09	0.28	0.14	0.08	0.11	0.12	0.06	0.09	0.1	0.06	0.1	0.07	0.05
Cadmium	mg/L	0.0001	-	-	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	-	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	0.001	-	-	-	-	0.009	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.003	0.002	0.003	<0.001	<0.001	<0.001
Copper	mg/L	0.001	-	-	-	-	0.002	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Ferrous Iron	mg/L	0.05	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	0.22	1.29	<0.05	0.44	<0.05
Lead	mg/L	0.001	-	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	-	-	-	-	0.076	0.022	0.008	0.029	0.016	0.01	0.017	0.006	0.073	0.031	0.051	0.029	0.001	0.077	0.003
Mercury	mg/L	0.0001	-	-	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	-	-	-	-	0.034	0.002	0.009	0.015	0.007	0.003	0.002	0.01	<0.001	0.039	0.002	0.003	0.011	0.005	0.011
Nickel	mg/L	0.001	-	-	-	-	0.009	<0.001	<0.001	0.001	0.001	<0.001	0.002	0.001	<0.001	0.002	0.002	0.004	<0.001	0.003	0.001
Selenium	mg/L	0.01	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	mg/L	0.001	-	-	-	-	0.005	<0.001	0.008	0.012	0.005	<0.001	0.001	0.013	<0.001	0.007	0.01	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	0.01	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.005	-	-	-	-	0.012	0.005	<0.005	0.006	<0.005	0.005	0.007	<0.005	<0.005	<0.005	0.005	<0.005	<0.005	0.008	0.008
Total Metals																					

Table A-4: LABORATORY WATER QUALITY RESULTS – APRIL 2013

Analytes	Units	LOR	ANZECC 2000		ADWG (2011)		MB01_B	MB02_C	MB02_S	MB03_S	MB04_C	MB04_S	MB05_C	MB08_B	MB09_T	MB10_T	TAR016_CR	TAR053	TAR176_C	TAR177_C	TAR249_C
Aquifer	-	-	Irrigation Water	Livestock Drinking	Aesthetic	Health	Tertiary Clay, Silt	Aldebaran Sandstone - B seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Fine Sandstone	Aldebaran Sandstone - B seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - A seam	Tertiary Clay, Gravel	Quaternary Alluvium	Quaternary Alluvium	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Fine Sandstone	Tertiary Basalt	Aldebaran Sandstone - Coarse Sandstone
Date Sampled	-	-					12/3/2013	13/3/2013	12/3/2013	13/3/2013	12/3/2013	12/3/2013	13/3/2013	21/2/2013	11/3/2013	11/3/2013	23/4/2013	22/4/2013	18/4/2013	18/4/2013	22/4/2013
Aluminium	mg/L	0.01	20	5	-	-	183	0.51	0.5	1.01	17.4	46.7	0.21	2.59	1.07	116	0.26	0.04	0.02	0.02	1.88
Antimony	mg/L	0.001	-	-	-	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.001	<0.001	<0.001	<0.001	0.001
Arsenic	mg/L	0.001	2	0.5	-	0.01	0.022	0.002	0.002	0.003	0.004	0.01	0.002	<0.001	0.003	0.115	0.002	0.004	0.001	<0.001	0.002
Barium	mg/L	0.001	-	-	-	2	1.49	0.14	0.176	0.131	0.237	0.446	0.097	0.144	0.03	2.12	0.125	0.343	0.078	0.109	0.052
Beryllium	mg/L	0.001	0.5	-	-	0.06	0.016	0.001	<0.001	0.003	0.004	0.012	<0.001	<0.001	<0.001	<0.010	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	mg/L	0.05	refer to guideline	5	-	4	0.05	0.14	0.06	0.3	0.13	0.12	0.11	0.1	0.06	0.54	0.1	0.06	0.09	0.05	0.07
Cadmium	mg/L	0.0001	0.05	0.01	-	0.002	0.0061	<0.0001	<0.0001	0.0002	0.0002	0.0004	<0.0001	<0.0001	<0.0001	0.0012	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	1	1	-	0.05	0.238	<0.001	<0.001	0.001	0.004	0.004	<0.001	0.002	0.006	0.264	<0.001	<0.001	<0.001	<0.001	0.016
Cobalt	mg/L	0.001	0.1	1	-	-	0.354	0.001	<0.001	0.003	0.003	0.006	<0.001	0.001	0.003	0.154	0.002	0.003	<0.001	<0.001	0.002
Copper	mg/L	0.001	5	0.5	1	2	0.645	0.008	0.001	0.004	0.013	0.022	<0.001	0.002	0.004	0.266	<0.001	<0.001	<0.001	<0.001	0.017
Ferrous Iron	mg/L	0.05	10	-	0.3	-	<0.05	0.08	<0.05	0.1	<0.05	<0.05	<0.05	-	<0.05	<0.05	0.2	-	-	-	-
Lead	mg/L	0.001	5	0.1	-	0.01	0.234	0.009	0.001	0.024	0.026	0.074	<0.001	0.002	0.002	0.213	0.001	<0.001	<0.001	<0.001	0.008
Manganese	mg/L	0.001	10	-	0.1	0.5	45.9	0.085	0.02	0.375	0.274	0.727	0.024	0.029	0.088	13.4	0.052	0.03	0.001	0.092	0.067
Mercury	mg/L	0.0001	0.002	0.002	-	0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0008	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	0.05	0.15	-	0.05	0.004	0.002	0.003	0.015	0.006	0.007	0.002	0.007	<0.001	<0.010	0.002	0.004	0.012	0.005	0.014
Nickel	mg/L	0.001	2	1	-	0.02	0.798	0.002	0.002	0.003	0.009	0.009	0.003	0.003	0.003	0.081	0.002	0.004	<0.001	0.003	0.019
Selenium	mg/L	0.01	0.5	0.02	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	mg/L	0.001	0.1	0.2	-	0.017	0.045	0.001	<0.001	0.015	0.011	0.027	0.002	0.015	<0.001	0.152	0.01	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	0.01	0.5	-	-	-	0.41	<0.01	<0.01	<0.01	0.01	0.02	<0.01	<0.01	0.02	0.38	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.005	5	20	3	-	1.38	0.015	0.009	0.038	0.074	0.069	0.006	0.02	0.022	0.459	0.01	<0.005	<0.005	0.005	0.16
Nutrients																					
Ammonia	mg/L	0.01	-	-	0.5	-	0.08	0.14	0.08	0.92	0.22	0.13	0.17	-	0.1	0.05	0.02	0.38	0.54	0.03	0.26
Nitrate as N	mg/L	0.01	-	-	-	50	0.01	0.02	<0.01	0.02	<0.01	<0.01	0.03	-	0.02	0.02	0.02	<0.01	<0.01	0.02	0.02
Nitrite as N	mg/L	0.01	-	30	-	3	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrite + Nitrate as N	mg/L	0.01	-	400	-	-	0.01	0.02	<0.01	0.04	<0.01	<0.01	0.03	0.18	0.02	0.02	0.02	<0.01	<0.01	0.02	0.02

Table A-4: LABORATORY WATER QUALITY RESULTS – APRIL 2013

Analytes	Units	LOR	ANZECC 2000		ADWG (2011)		MB01_B	MB02_C	MB02_S	MB03_S	MB04_C	MB04_S	MB05_C	MB08_B	MB09_T	MB10_T	TAR016_CR	TAR053	TAR176_C	TAR177_C	TAR249_C
Aquifer	-	-	Irrigation Water	Livestock Drinking	Aesthetic	Health	Tertiary Clay, Silt	Aldebaran Sandstone - B seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Fine Sandstone	Aldebaran Sandstone - B seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - A seam	Tertiary Clay, Gravel	Quaternary Alluvium	Quaternary Alluvium	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Fine Sandstone	Tertiary Basalt	Aldebaran Sandstone - Coarse Sandstone
Date Sampled	-	-					12/3/2013	13/3/2013	12/3/2013	13/3/2013	12/3/2013	12/3/2013	13/3/2013	21/2/2013	11/3/2013	11/3/2013	23/4/2013	22/4/2013	18/4/2013	18/4/2013	22/4/2013
Total Kjeldahl Nitrogen as N	mg/L	0.1	-	-	-	-	3	0.4	<0.1	0.8	0.7	0.2	<0.1	<0.1	<0.1	1.7	0.2	0.5	0.6	0.2	1
Total Nitrogen as N	mg/L	0.1	-	-	-	-	3	0.4	<0.1	0.8	0.7	0.2	<0.1	0.2	<0.1	1.7	0.2	0.5	0.6	0.2	1
Reactive Phosphorus as P	mg/L	0.01	refer to guideline	-	-	-	0.04	0.04	0.02	<0.01	<0.01	0.01	0.02	-	<0.01	0.04	<0.01	<0.01	<0.01	0.02	<0.01
Total Phosphorus as P	mg/L	0.01	-	-	-	-	31.7	0.44	0.1	0.42	0.17	0.43	0.63	0.17	0.06	41.5	<0.01	0.08	<0.01	0.02	0.08
Ion Balance																					
Total Anions	meq/L	0.01	-	-	-	-	23	26.6	14.5	27.1	25.5	24.5	15.2	16.1	9.17	16.5	14.5	10.5	10.1	18	7.72
Total Cations	meq/L	0.01	-	-	-	-	24.9	28.3	14.8	29.4	27.4	26.4	13.8	16.6	9.48	18	13.5	10.5	9.21	16.3	7.43
Ionic Balance	%	0.01	-	-	-	-	3.86	3.12	0.74	4.15	3.56	3.74	4.62	1.57	1.69	4.18	3.65	0.27	4.59	4.91	1.91

* Guideline Value depends on type of livestock.

- (yellow) Exceeds ANZECC (2000) short term irrigation water guideline value.
- (green) Exceeds Australian Drinking Water Guidelines (2011) aesthetic guideline value.
- (red) Exceeds Australian Drinking Water Guidelines (2011) health guideline value.
- 1000 Exceeds ANZECC (2000) livestock drinking water guideline value.

Table A-5: LABORATORY WATER QUALITY RESULTS – MAY 2014																							
Analytes	**Units**	**LOR**	**ANZECC 2000**		**ADWG (2011)**		**MB01_B**	**MB02_C**	**MB02_S**	**MB03_S**	**MB04_C**	**MB04_S**	**MB05_C**	**MB08_B**	**MB09_T**	**MB10_T**	**TAR016_CR**	**TAR040_C**	**TAR053**	**TAR176_C**	**TAR177_C**	**TAR189_C**	**TAR249_C**
Aquifer	-	-	**Irrigation Water**	**Livestock Drinking**	**Aesthetic**	**Health**	Tertiary Clay, Silt	Aldebaran Sandstone - B seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Fine Sandstone	Aldebaran Sandstone - B seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - A seam	Tertiary Clay, Gravel	Quaternary Alluvium	Quaternary Alluvium	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Fine Sandstone	Tertiary Basalt	Aldebaran Sandstone	Aldebaran Sandstone - Coarse Sandstone
Date Sampled	-	-					15/5/2014	16/5/2014	16/5/2014	14/5/2014	15/5/2014	15/5/2014	14/5/2014	16/5/2014	15/5/2014	14/5/2014	16/5/2014	15/5/2014	16/5/2014	15/5/2014	15/5/2014	14/5/2014	15/5/2014
Field - Physical Parameters																							
pH Value	pH Unit	-	-	-	6.5 - 8.5	-	6.63	6.98	7.04	11.05	7.14	9.07	8.45	7.10	6.46	6.79	6.89	7.05	6.96	7.25	6.94	7.84	9.06
Electrical Conductivity @ 25°C	µS/cm	-	-	-	-	-	2,533	2,153	1,463	2,850	2,377	2,313	1,767	1,430	1,351	1,775	1,236	1,194	973	1,170	1,315	2,267	546
Total Dissolved Solids	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Temperature	°C	-	-	-	-	-	26.6	24.5	26.8	27.7	26.9	25.7	29.3	27.2	26.2	26.4	27.0	21.7	27.0	26.0	26.8	29.0	24.4
Laboratory - Physical Parameters																							
pH Value	pH Unit	0.01	-	-	6.5 - 8.5	-	7.85	8.36	8.28	10.4	8.21	8.82	8.54	8.17	8.03	8.15	8.19	8.26	8.26	8.4	8.25	8.48	8.91
Electrical Conductivity @ 25°C	µS/cm	1	-	-	-	-	2,460	2,030	1,380	2,640	2,460	2,250	1,720	1,310	1,390	1,680	1,180	1,050	904	1,130	1,240	2,150	521
Sodium Adsorption Ratio	-	0.01	-	-	-	-	3.5	8.53	2.69	40.8	5.12	11.4	4.74	2.34	4.23	3.53	1.98	1.74	1.53	2.41	1.21	6.1	3.66
Total Dissolved Solids (Calc.)	mg/L	10	-	3,000-13,000*	600	-	1,380	1,220	783	1,660	1,520	1,380	1,010	789	869	928	604	559	471	645	676	1,170	1,000
Total Suspended Solids	mg/L	5	-	-	-	-	915	103	5	759	67	111	52	7,390	14	813	256	223	327	114	53	49	10,500
Total Hardness as $CaCO_3$	mg/L	1	-	-	200	-	846	326	436	22	582	215	364	512	324	513	491	378	351	333	616	439	67
Alkalinity																							
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	-	-	-	-	<1	<1	<1	72	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity as $CaCO_3$	mg/L	1	-	-	-	-	<1	18	<1	194	<1	70	34	<1	<1	<1	<1	<1	<1	20	<1	38	31
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	-	-	-	-	620	416	492	<1	358	322	279	587	237	641	520	442	444	254	653	450	1180
Total Alkalinity as $CaCO_3$	mg/L	1	-	-	-	-	620	434	492	267	358	392	313	587	237	641	520	442	444	274	653	488	1210
Major Ions																							
Calcium	mg/L	1	-	1,000	-	-	70	53	64	9	93	25	37	70	54	77	78	51	55	56	85	29	22
Chloride	mg/L	1	-	-	250	-	497	370	185	560	589	502	377	136	338	202	114	108	57	220	69	501	146
Fluoride	mg/L	0.1	2.0	2	-	1.5	0.2	0.9	0.8	0.5	0.5	0.9	0.3	0.7	0.2	0.4	0.6	0.2	0.5	0.2	0.1	0.3	<0.5#
Magnesium	mg/L	1	-	-	-	-	163	47	67	<1	85	37	66	82	46	78	72	61	52	47	98	89	3
Sodium	mg/L	1	-	-	180	-	234	354	129	445	284	385	208	122	175	184	101	78	66	101	69	294	69
Potassium	mg/L	1		-	-	-	8	8	6	175	13	57	44	2	3	16	3	9	5	15	4	10	6
Sulfate as SO_4	mg/L	1	-	1,000 - 2000	250	500	93	198	42	225	141	108	94	7	55	78	18	12	12	42	20	8	26

Table A-5: LABORATORY WATER QUALITY RESULTS – MAY 2014

Analytes	Units	LOR	ANZECC 2000		ADWG (2011)		MB01_B	MB02_C	MB02_S	MB03_S	MB04_C	MB04_S	MB05_C	MB08_B	MB09_T	MB10_T	TAR016_CR	TAR040_C	TAR053	TAR176_C	TAR177_C	TAR189_C	TAR249_C
Aquifer	-	-	Irrigation Water	Livestock Drinking	Aesthetic	Health	Tertiary Clay, Silt	Aldebaran Sandstone - B seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Fine Sandstone	Aldebaran Sandstone - B seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - A seam	Tertiary Clay, Gravel	Quaternary Alluvium	Quaternary Alluvium	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Fine Sandstone	Tertiary Basalt	Aldebaran Sandstone	Aldebaran Sandstone - Coarse Sandstone
Date Sampled	-	-					15/5/2014	16/5/2014	16/5/2014	14/5/2014	15/5/2014	15/5/2014	14/5/2014	16/5/2014	15/5/2014	14/5/2014	16/5/2014	15/5/2014	16/5/2014	15/5/2014	15/5/2014	14/5/2014	15/5/2014
Dissolved Metals																							
Aluminium	mg/L	0.01	-	-	0.2	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Antimony	mg/L	0.001	-	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	mg/L	0.001	-	-	-	-	<0.001	0.003	<0.001	0.006	<0.001	0.002	<0.001	<0.001	<0.001	0.004	<0.001	0.002	0.004	<0.001	<0.001	<0.001	0.002
Barium	mg/L	0.001	-	-	-	-	0.098	0.096	0.125	0.052	0.122	0.066	0.102	0.233	0.03	0.108	0.214	0.233	0.398	0.113	0.116	0.154	0.034
Beryllium	mg/L	0.001	-	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	mg/L	0.05	-	-	-	-	0.09	0.12	0.09	0.07	0.1	0.1	0.08	0.07	0.05	0.08	0.08	0.11	0.06	0.1	0.05	0.13	0.05
Cadmium	mg/L	0.0001	-	-	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	-	-	-	-	<0.001	<0.001	0.002	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	0.001	-	-	-	-	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.002	<0.001	0.002	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.001	-	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ferrous Iron	mg/L	0.05	-	-	-	-	<0.05	<0.05	<0.05	<0.05	0.09	<0.05	<0.05	<0.05	<0.05	0.33	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Lead	mg/L	0.001	-	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	-	-	-	-	0.159	0.296	0.029	<0.001	0.125	0.009	0.036	0.049	0.032	0.125	0.039	0.102	0.028	0.032	0.07	0.017	<0.001
Mercury	mg/L	0.0001	-	-	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	-	-	-	-	0.006	0.012	0.006	0.042	0.002	0.013	0.036	0.003	<0.001	0.008	0.003	0.008	0.003	0.004	0.006	0.004	0.01
Nickel	mg/L	0.001	-	-	-	-	0.008	0.002	0.003	<0.001	0.004	<0.001	0.004	0.003	0.004	0.006	0.007	0.002	0.008	0.003	0.002	0.001	<0.001
Selenium	mg/L	0.01	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	mg/L	0.001	-	-	-	-	<0.001	0.001	<0.001	<0.001	0.001	0.001	<0.001	0.008	<0.001	0.002	0.008	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	0.01	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.005	-	-	-	-	0.007	0.007	0.017	<0.005	<0.005	<0.005	<0.005	<0.005	0.042	0.02	0.039	0.016	0.021	<0.005	0.013	<0.005	<0.005
Total Metals																							
Aluminium	mg/L	0.01	20	5	-	-	9.96	0.29	0.08	3.62	0.11	0.17	0.63	13.2	0.03	2.82	1.14	1.3	1.27	1.93	0.11	0.32	101
Antimony	mg/L	0.001	-	-	-	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	mg/L	0.001	2	0.5	-	0.01	0.004	0.004	<0.001	0.007	<0.001	0.009	0.001	0.002	<0.001	0.005	0.002	0.003	0.007	0.002	<0.001	<0.001	0.101

Table A-5: LABORATORY WATER QUALITY RESULTS – MAY 2014

Analytes	Units	LOR	ANZECC 2000		ADWG (2011)		MB01_B	MB02_C	MB02_S	MB03_S	MB04_C	MB04_S	MB05_C	MB08_B	MB09_T	MB10_T	TAR016_CR	TAR040_C	TAR053	TAR176_C	TAR177_C	TAR189_C	TAR249_C
Aquifer	-	-	Irrigation Water	Livestock Drinking	Aesthetic	Health	Tertiary Clay, Silt	Aldebaran Sandstone - B seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Fine Sandstone	Aldebaran Sandstone - B seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - A seam	Tertiary Clay, Gravel	Quaternary Alluvium	Quaternary Alluvium	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Fine Sandstone	Tertiary Basalt	Aldebaran Sandstone	Aldebaran Sandstone - Coarse Sandstone
Date Sampled	-	-					15/5/2014	16/5/2014	16/5/2014	14/5/2014	15/5/2014	15/5/2014	14/5/2014	16/5/2014	15/5/2014	14/5/2014	16/5/2014	15/5/2014	16/5/2014	15/5/2014	15/5/2014	14/5/2014	15/5/2014
Barium	mg/L	0.001	-	-	-	2	0.136	0.105	0.134	0.207	0.122	0.084	0.124	0.331	0.034	0.203	0.238	0.272	0.454	0.14	0.124	0.172	2.07
Beryllium	mg/L	0.001	0.5	-	-	0.06	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.02
Boron	mg/L	0.05	-	5	-	4	0.09	0.12	0.1	0.13	0.13	0.15	0.12	0.09	0.07	0.08	0.1	0.12	0.08	0.11	0.09	0.15	0.2
Cadmium	mg/L	0.0001	0.05	0.01	-	0.002	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0042
Chromium	mg/L	0.001	1	1	-	0.05	0.034	0.001	0.004	0.038	<0.001	0.002	0.012	0.011	0.042	0.013	0.002	0.002	0.002	0.005	0.001	<0.001	0.103
Cobalt	mg/L	0.001	0.1	1	-	-	0.013	<0.001	<0.001	0.003	<0.001	<0.001	0.001	0.004	<0.001	0.005	0.005	<0.001	0.011	0.001	<0.001	<0.001	0.072
Copper	mg/L	0.001	5	0.5	1	2	0.024	0.001	0.002	0.006	<0.001	<0.001	0.004	0.009	0.006	0.013	0.003	0.002	0.002	0.005	0.001	0.014	0.397
Ferrous Iron	mg/L	0.05	10	-	0.3	-	2.32	<0.05	<0.05	0.88	0.19	<0.05	0.06	<2.50#	<0.05	0.45	<0.25#	<1.25#	<1.25#	<0.05	0.24	0.1	31.5
Lead	mg/L	0.001	5	0.1	-	0.01	0.006	0.001	<0.001	0.005	<0.001	<0.001	0.001	0.013	<0.001	0.004	0.01	0.005	0.009	0.004	0.004	0.001	0.479
Manganese	mg/L	0.001	10	-	0.1	0.5	1.24	0.325	0.042	0.079	0.144	0.027	0.055	0.262	0.035	0.601	0.061	0.117	0.05	0.078	0.192	0.024	5.74
Mercury	mg/L	0.0001	0.002	0.002	-	0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	0.05	0.15	-	0.05	0.004	0.013	0.006	0.042	0.002	0.019	0.038	<0.001	0.001	0.005	0.003	0.009	0.003	0.004	0.005	0.004	0.01
Nickel	mg/L	0.001	2	1	-	0.02	0.03	0.002	0.004	0.006	0.005	0.002	0.032	0.012	0.006	0.017	0.013	0.005	0.024	0.007	0.003	0.003	0.272
Selenium	mg/L	0.01	0.5	0.02	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.07
Uranium	mg/L	0.001	0.1	0.2	-	0.017	0.002	0.002	<0.001	0.002	0.001	0.003	<0.001	0.014	<0.001	0.004	0.008	<0.001	0.001	<0.001	<0.001	<0.001	0.074
Vanadium	mg/L	0.01	0.5	-	-	-	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	0.02	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.11
Zinc	mg/L	0.005	5	20	3	-	0.053	0.009	0.023	0.023	0.009	<0.005	0.024	0.039	0.047	0.034	0.084	0.093	0.037	0.036	0.008	0.013	1.26
Nutrients																							
Ammonia	mg/L	0.01	-	-	0.5	-	0.05	0.09	0.04	2.7	0.12	0.17	0.22	1.22	0.08	0.01	0.02	8.19	0.11	0.3	0.1	0.56	0.47
Nitrate as N	mg/L	0.01	-	-	-	50	<0.01	<0.01	<0.01	0.04	<0.01	<0.01	0.03	0.14	0.04	0.05	<0.01	<0.01	<0.01	0.13	0.04	<0.01	<0.01
Nitrite as N	mg/L	0.01	-	30	-	3	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrite + Nitrate as N	mg/L	0.01	-	400	-	-	<0.01	<0.01	<0.01	0.04	<0.01	<0.01	0.03	0.14	0.04	0.05	<0.01	<0.01	<0.01	0.13	0.04	<0.01	<0.01
Total Kjeldahl Nitrogen as N	mg/L	0.1	-	-	-	-	0.3	0.1	<0.1	3.2	0.2	0.2	0.3	1.3	<0.1	0.2	<0.1	8.3	0.2	0.3	0.1	0.6	9.2
Total Nitrogen as N	mg/L	0.1	-	-	-	-	0.3	0.1	<0.1	3.2	0.2	0.2	0.3	1.4	<0.1	0.2	<0.1	8.3	0.2	0.4	0.1	0.6	9.2
Reactive Phosphorus as P	mg/L	0.01	-	-	-	-	0.02	<0.01	0.01	0.03	<0.01	<0.01	0.01	0.03	<0.01	0.04	<0.01	<0.01	<0.01	<0.01	0.01	0.04	<0.01

Table A-5: LABORATORY WATER QUALITY RESULTS – MAY 2014

Analytes	Units	LOR	ANZECC 2000		ADWG (2011)		MB01_B	MB02_C	MB02_S	MB03_S	MB04_C	MB04_S	MB05_C	MB08_B	MB09_T	MB10_T	TAR016_CR	TAR040_C	TAR053	TAR176_C	TAR177_C	TAR189_C	TAR249_C
Aquifer	-	-	**Irrigation Water**	**Livestock Drinking**	**Aesthetic**	**Health**	Tertiary Clay, Silt	Aldebaran Sandstone - B seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Fine Sandstone	Aldebaran Sandstone - B seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - A seam	Tertiary Clay, Gravel	Quaternary Alluvium	Quaternary Alluvium	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Fine Sandstone	Tertiary Basalt	Aldebaran Sandstone	Aldebaran Sandstone - Coarse Sandstone
Date Sampled	-	-					15/5/2014	16/5/2014	16/5/2014	14/5/2014	15/5/2014	15/5/2014	14/5/2014	16/5/2014	15/5/2014	14/5/2014	16/5/2014	15/5/2014	16/5/2014	15/5/2014	15/5/2014	14/5/2014	15/5/2014
Total Phosphorus as P	mg/L	0.01	-	-	-	-	0.56	0.06	0.01	0.11	0.06	0.02	0.08	0.42	*<0.01*	0.64	0.07	0.21	0.08	0.02	0.04	0.07	3.45
Ion Balance																							
Total Anions	meq/L	0.01	-	-	-	-	28.3	23.2	15.9	25.8	26.7	24.2	18.8	15.7	15.4	20.1	14	12.1	10.7	12.6	15.4	24	28.8
Total Cations	meq/L	0.01	-	-	-	-	27.3	22.1	14.5	24.3	24.3	22.5	17.4	15.6	14.2	18.7	14.3	11.2	10	11.4	15.4	21.8	4.5
Ionic Balance	%	0.01	-	-	-	-	1.91	2.48	4.79	3.07	4.67	3.75	3.85	0.38	4.22	3.77	1.07	4.04	3.42	4.65	0.02	4.89	73

*	Guideline Value depends on type of livestock
#	Anomalous LOR reported by laboratory
(yellow)	Exceeds ANZECC (2000) short term irrigation water guideline value.
(green)	Exceeds Australian Drinking Water Guidelines (2011) aesthetic guideline value.
(red)	Exceeds Australian Drinking Water Guidelines (2011) health guideline value.
100 **0**	Exceeds ANZECC (2000) livestock drinking water guideline value.

And Appendix 13 has a new Section 2.5.1 that compares the quality of the groundwater to the ANZECC 2000 irrigation guidelines that reads as follows:

"A groundwater impact assessment was conducted by AGE to develop a conceptual understanding of the local groundwater level and water quality of the site. The assessment was carried out using groundwater quality conditions that is currently being monitored from 19 groundwater monitoring boreholes located at 16 separate sites as shown on Plate 5. AGE (2014) reported that the monitoring boreholes within the project area intersects three major aquifers as described below.

Aldebaran Sandstone	The main source of groundwater within the Project area is from the Aldebaran Sandstone. Ten bores inferred to be screened across Aldebaran Sandstone are located either within the Project area, or immediately to the east of the Project boundary (Plate 5). Observations have shown groundwater to be present under confined conditions throughout a number of different horizons within the Aldebaran Sandstone including: o A and B coal seams; o pebbly coarse-grained sandstone unit directly overlying A Seam; o shallower, predominantly fine-grained, sandstones.
Tertiary Basalt	The Tertiary basalts are commonly weathered within the Project area, with only localised, dissected areas of fresh basalt. The Tertiary basalts are relatively thin and occurs sporadically across the Project area, with thick sequences of fresh basalt mapped to the south-west of the Project area. Groundwater within basalt typically occurs within fractured and vesicular horizons. It is expected that the amount of flow within the basalts is dependent on the extent and intensity of the fractures. The presence of thick impermeable Tertiary clays throughout the Project area suggests the Tertiary units are likely to be confined and hydraulically disconnected from the underlying Aldebaran Sandstone. Groundwater flows were too low to be measured by air lift tests for monitoring bores
Quaternary Alluvium	Alluvium within the Project area has limited groundwater potential, as drilling shows it is typically thin (<30 m) and has limited lateral extent. Observations during drilling of a borehole located approximately 20 m from Taroborah Creek, show that alluvial sands adjacent to the creek are dry in that location. No users of alluvium where identified within the Project area during the bore census. Where groundwater is present in the alluvium it is likely to be unconfined.

As part of the groundwater impact assessment carried out for the EIS, three sampling events were undertaken as follows:

- Event 1: Sampled on the March/April 2013;
- Event 2: Sampled on the May 2014; and
- Event 3 Sampled on September 2014

Water quality results from the above sampling for bores monitoring the Aldebaran Sandstone aquifer are presented in Table 2 representing the highest parameters readings for the three events. Also included in Table 2 are the guideline values for irrigation taken from the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ, 2000) and, commonly referred to as the ANZECC (2000) guidelines and the surface water quality objects for the

Lower Nogoa River as described in Table 1. The above guidelines were selected for comparison to assess if groundwater released into the Selma channel from the Taroborah Coal Project site meets the regulatory guidelines for irrigation and is suitable for release into the existing environment. For the purpose of this assessment to reflect the potential dewatering water quality, 12 monitoring bores located within the Aldebaran Sandstones were considered as shown in Table 2.

Plate 5
Monitoring Borehole Locations

(Source: G1588 Taroborah_EIS_Final)

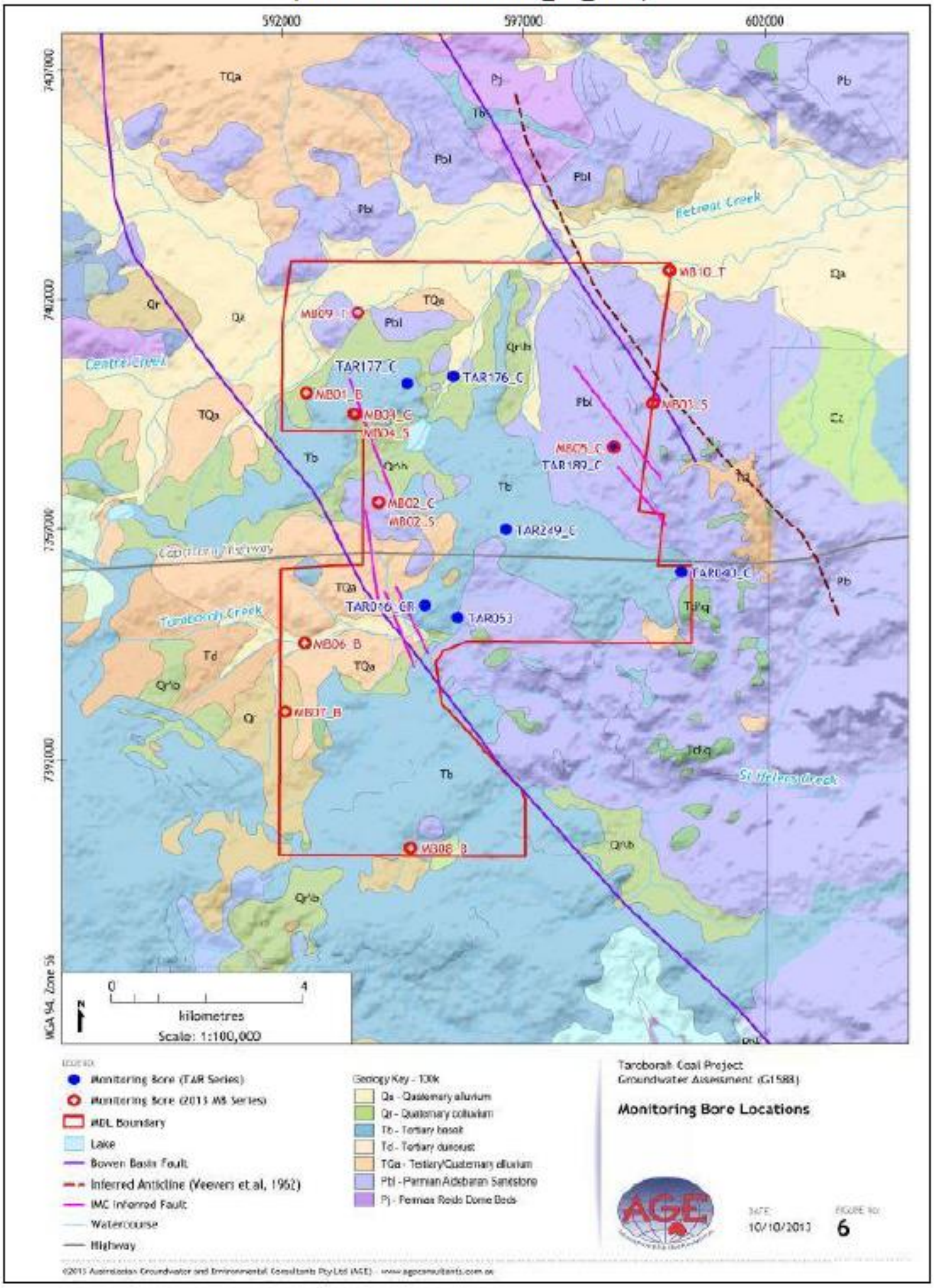


Table 2
Groundwater Quality Results from the Aldebaran Sandstone Aquifer (Source: AGE,IMC)

Analytes	Units	Limit of Reporting (LOR)	Guideline Value - Surface Water Quality	Guideline Value - Short Term Irrigation	Groundwater Monitoring Borehole											
					MB02_C	MB02_S	MB03_S	MB04_C	MB04_S	MB05_C	TAR016_CR	TAR053	TAR176_C	TAR249_C	TAR040_C	TAR189C
Aquifer	-				Aldebaran Sandstone - B seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Fine Sandstone	Aldebaran Sandstone - B seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - A seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Fine Sandstone	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone	Aldebaran Sandstone
Date Sampled	-	-			13/03/2013	12/03/2013	13/03/2013	12/03/2013	12/03/2013	13/03/2013	23/04/2013	22/04/2013	18/04/2013	22/04/2013	15/5/2014	15/5/2014
Field - Physical Parameters																
pH Value	pH Unit		6.5-8.5	4.5-9.0	8.35	8.24	7.95	8.39	8.34	8.37	6.75	7.24	8.66	7.68	7.05	7.84
Electrical Conductivity @ 25°C	µS/cm	-	720(baseflow) 250(highflow)	1500-7700	**3180**	**1395**	**3130**	**2760**	**2570**	**1570**	**1328**	**956**	**893**	**797**	**1,194**	**2,267**
Total Dissolved Solids	mg/L	-	-	-	-	-	-	-	-	-	864	624	-	520	-	-
Temperature	°C	-	-	-	24.1	25.4	26.8	25.3	24.5	26.9	26.6	26.2	26.7	25.7	21.7	29.0
Laboratory - Physical Parameters																
pH Value	pH Unit	0.01	-	-	8.23	8.16	8.36	8.24	8.2	8.45	7.59	7.93	8.65	8.56	8.26	8.48
Electrical Conductivity @ 25°C	µS/cm	1	-	-	3070	1370	3060	2630	2440	1590	1290	980	930	783	1,050	2,150
Sodium Adsorption Ratio	-	0.01	-	9	4.5	2.7	**11.8**	6.32	8.98	3.52	1.97	1.51	3.73	3.79	1.74	6.1
Total Dissolved Solids (Calc.)	mg/L	10	-	-	2000	890	1990	1710	1590	1030	838	637	604	509	559	1,170
Total Suspended Solids	mg/L	5	10	-	**270**	**126**	**8020**	**3470**	**163**	**240**	**11**	7	<5	**85**	223	49
Total Hardness as $CaCO_3$	mg/L	1	-	-	773	446	318	583	385	348	459	371	186	137	378	439
Alkalinity																
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity as $CaCO_3$	mg/L	1	-	-	<1	<1	11	<1	<1	20	<1	<1	28	14	<1	38
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	-	-	248	472	276	245	376	260	537	445	157	75	442	450
Total Alkalinity as $CaCO_3$	mg/L	1	-	-	248	472	288	245	376	280	537	445	186	90	442	488
Major Ions																
Calcium	mg/L	1	-	-	97	60	58	77	57	39	75	58	53	17	51	29
Chloride	mg/L	1	-	30-700	**718**	154	540	594	488	291	117	48	199	179	108	501
Fluoride	mg/L	0.1	-	2	0.4	0.6	0.6	0.5	0.8	0.4	0.5	0.5	0.2	0.4	0.2	0.3
Magnesium	mg/L	1	-	-	129	72	42	95	59	61	66	55	13	23	61	89
Potassium	mg/L	1	-	-	13	5	83	18	44	12	3	5	16	10	78	294
Sodium	mg/L	1	-	-	288	131	482	351	405	151	97	67	117	102	9	10
Sulfate as SO_4	mg/L	1	25	-	**67**	**36**	**293**	**185**	**156**	**66**	22	13	**37**	**42**	12	8

1. Guideline values for irrigation beneficial use (identified as the only beneficial use for the connected groundwater aquifers.) are based on Australian and New Zealand Guidelines for Fresh & Marine Water Quality - October 2000 (ANZECC) values which are the maximum concentration (mg/L) or contaminant in the irrigation water which can be tolerated assuming 20 yrs. of irrigation.
2. Exceedences to guideline values are bolded.
3. 718 for groundwater quality criteria
4. 0.05 inidcates exceedance for surface water quality criteria

Table 2 (Cont'd)
Groundwater Quality Results from the Aldebaran Sandstone Aquifer (Source: AGE,IMC)

Analytes	Units	Limit of Reporting (LOR)	Guideline Value - Surface Water Quality	Guideline Value - Irrigation	Groundwater Monitoring Borehole											
					MB02_C	MB02_S	MB03_S	MB04_C	MB04_S	MB05_C	TAR016_CR	TAR053	TAR176_C	TAR249_C	TAR040_C	TAR189C
Dissolved Metals																
Aluminium	mg/L	0.01	-	20	0.02	<0.01	<0.01	<0.01	0.05	<0.01	<0.01	<0.01	0.02	0.01	<0.01	<0.01
Antimony	mg/L	0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001
Arsenic	mg/L	0.001	-	-	<0.001	0.004	0.002	<0.001	0.003	0.002	0.001	0.005	0.002	<0.001	0.002	<0.001
Barium	mg/L	0.001	--	-	0.146	0.047	0.093	0.082	0.163	0.108	0.121	0.388	0.078	0.031	0.233	0.154
Beryllium	mg/L	0.001	-	0.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	mg/L	0.05	-	0.5-6.0	0.13	0.09	0.28	0.14	0.08	0.11	0.1	0.06	0.1	0.05	0.11	0.13
Cadmium	mg/L	0.0001	-	0.05	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001		1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	0.001	-	0.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.003	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.001	-	5	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001
Ferrous Iron	mg/L	0.05	-	10	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.22	1.29	<0.05	<0.05	<0.05	<0.05
Lead	mg/L	0.001	-	5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	-	10	0.022	0.008	0.029	0.016	0.01	0.017	0.051	0.029	0.001	0.003	0.102	0.017
Mercury	mg/L	0.0001	-	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	-	0.05	0.002	0.009	0.015	0.007	0.003	0.002	0.002	0.003	0.011	0.011	0.008	0.004
Nickel	mg/L	0.001	-	2	<0.001	<0.001	0.001	0.001	<0.001	0.002	0.002	0.004	<0.001	0.001	0.002	0.001
Selenium	mg/L	0.01	-	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	mg/L	0.001	-	0.1	<0.001	0.008	0.012	0.005	<0.001	0.001	0.01	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	0.01	-	0.5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.005	-	5	0.005	<0.005	0.006	<0.005	0.005	0.007	0.005	<0.005	<0.005	0.008	0.016	<0.005
Nutrients																
Ammonia	mg/L	0.01	0.01	-	0.14	0.08	0.92	0.22	0.13	0.17	0.02	0.38	0.54	0.26	8.19	0.56
Nitrate as N	mg/L	0.01	0.05	-	0.02	<0.01	0.02	<0.01	<0.01	0.03	0.02	<0.01	<0.01	0.02	<0.01	<0.01
Nitrite as N	mg/L	0.01	-	-	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrite + Nitrate as N	mg/L	0.01	--	-	0.02	<0.01	0.04	<0.01	<0.01	0.03	0.02	<0.01	<0.01	0.02	<0.01	<0.01
Total Kjeldahl Nitrogen as N	mg/L	0.1	-	-	0.4	<0.1	0.8	0.7	0.2	<0.1	0.2	0.5	0.6	1	8.3	0.6
Total Nitrogen as N	mg/L	0.1	0.5	-	0.4	<0.1	0.8	0.7	0.2	<0.1	0.2	0.5	0.6	1	8.3	0.6
Reactive Phosphorus as P	mg/L	0.01		-	0.04	0.02	<0.01	<0.01	0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.04
Total Phosphorus as P	mg/L	0.01	0.05	-	0.44	0.1	0.42	0.17	0.43	0.63	<0.01	0.08	<0.01	0.08	0.21	0.07
Ion Balance																
Total Anions	meq/L	0.01	-	-	26.6	14.5	27.1	25.5	24.5	15.2	14.5	10.5	10.1	7.72	12.1	24
Total Cations	meq/L	0.01	-	-	28.3	14.8	29.4	27.4	26.4	13.8	13.5	10.5	9.21	7.43	11.2	21.8
Ionic Balance	%	0.01	-	-	3.12	0.74	4.15	3.56	3.74	4.62	3.65	0.27	4.59	1.91	4.04	4.89

1. Guideline values for irrigation beneficial use (identified as the only beneficial use for the connected groundwater aquifers.) are based on Australian Water Quality Guidelines for Fresh & Marine Waters - November 1992 (ANZECC) values which are the maximum concentration (mg/L) or contaminant in the irrigation water which can be tolerated assuming 100 yrs. of irrigation.
2. Exceedences to guideline values are bolded.
3. 718 for groundwater quality criteria
4. 0.05 inidcates exceedance for surface water quality criteria

Review of the groundwater quality results in comparison to the ANZECC (2000) agricultural guidelines, indicates that:

- pH from the collected samples ranges from 6.75 to 8.6 with all results within both guidelines limits;
- The Sodium Adsorption Ratio (SAR) is used to predict the potential for sodium to accumulate in the soil, if sodic water was in constant use. Majority of the site samples shows SAR level within the range of 3-9 which is suitable for irrigation with the exception of BH MB03_S which has shown elevated levels of SAR(Sodium Absorption Ratio).This result was not replicated in the adjacent boreholes and the cause of the elevated levels is not clear;
- All total dissolved metals concentrations measured are below guideline values; and
- Salinity, being a key constraint to water management and groundwater use, and can be categorised by Electrical Conductivity (EC). The EC obtained from the laboratory and field results for the three events were compared against the ANZECC (2000) Table 4.2.5 guideline for the main irrigated crops supplied by the Nogoa Mackenzie Water Supply Scheme based on Sunwater (2014) and cereal crops as advised by IMC. It is considered that wheat, sorghum, corn (grain and sweet) are the main constituents for cereal crops based on the ANZECC (2000) Table 4.2.5 guideline. The Average Root Zone Salinity Threshold was chosen to compare against the groundwater quality results. The main irrigated crops based on Sunwater (2014) are as follows:
  - Cotton;
  - Grape; and
  - Citrus comprising
  - Mandarin and Lemon (No salinity tolerance requirement provided in Table 4.2.5 ANZECC (2000) guidelines therefore was not included);
  - Orange ; and
  - Grapefruit (Not a main crop provided by Sunwater (2014) but has been considered from Table 4.2.5 ANZECC (2000) guidelines as it being a Citrus crop as requested by IMC).

  The Average Root Zone Salinity Threshold requirements for each crop based on ANZECC (2000) Table 4.2.5 guideline is as follows:

  - Cotton 7,700 µS/cm
  - Orange 1,700 µS/cm
  - Grape 1,500 µS/cm
  - Grapefruit 1,800 µS/cm
  - Wheat 6,000 µS/cm
  - Sorghum 6,800 µS/cm
  - Corn (Grain and Sweet) 1,700 µS/cm

The comparisons were plotted accordingly and are provided on Plates 6-a and 6-b;

A summary of the groundwater salinity levels in comparison against the Average Root Zone Salinity Threshold requirements provided by the ANZECC (2000) guideline show tolerable levels for boreholes MB02_S, TAR016_CR, TAR053, TAR176_C, TAR249_C and TAR040_C for laboratory and field testing results. The remaining boreholes being MB02_C, MB03_S, MB04_C, MB04_S, MB05_C and TAR189C show tolerable levels with respect to Cotton, Wheat and Sorghum threshold requirements but exceed threshold requirements for Orange, Grape, Grapefruit and Corn (Grain and Sweet) for laboratory and field testing results.

To address the above exceeded threshold requirements, it is proposed to release the groundwater from the Taroborah Coal Project site at a maximum rate of 2ML/day and diluted with some 160ML/day (supply rate) of water from Lake Maraboon. The dilution process will reduce the groundwater's salinity levels released from the site to lower levels allowing the Selma Channel to remain within threshold requirements. This analysis however does not take into consideration the integrity of the irrigation channel or existing crops along the channel or receiving environment, nor the quality and dilution from stormwater captured in the MWD before release.

Plate 6
Groundwater Salinity Test Results

a) Laboratory Test Results: Salinity Level at Taroborah Coal Project Site

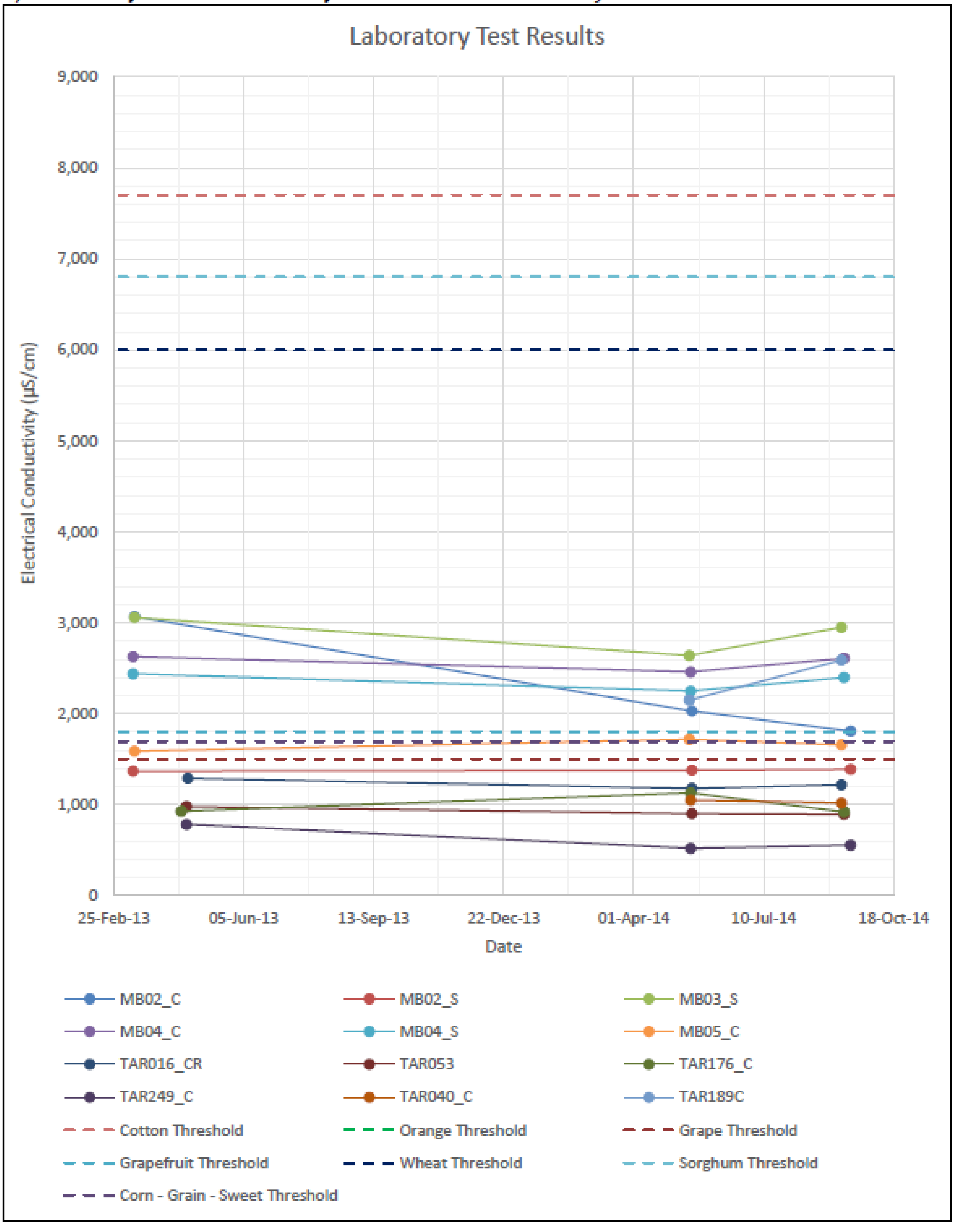
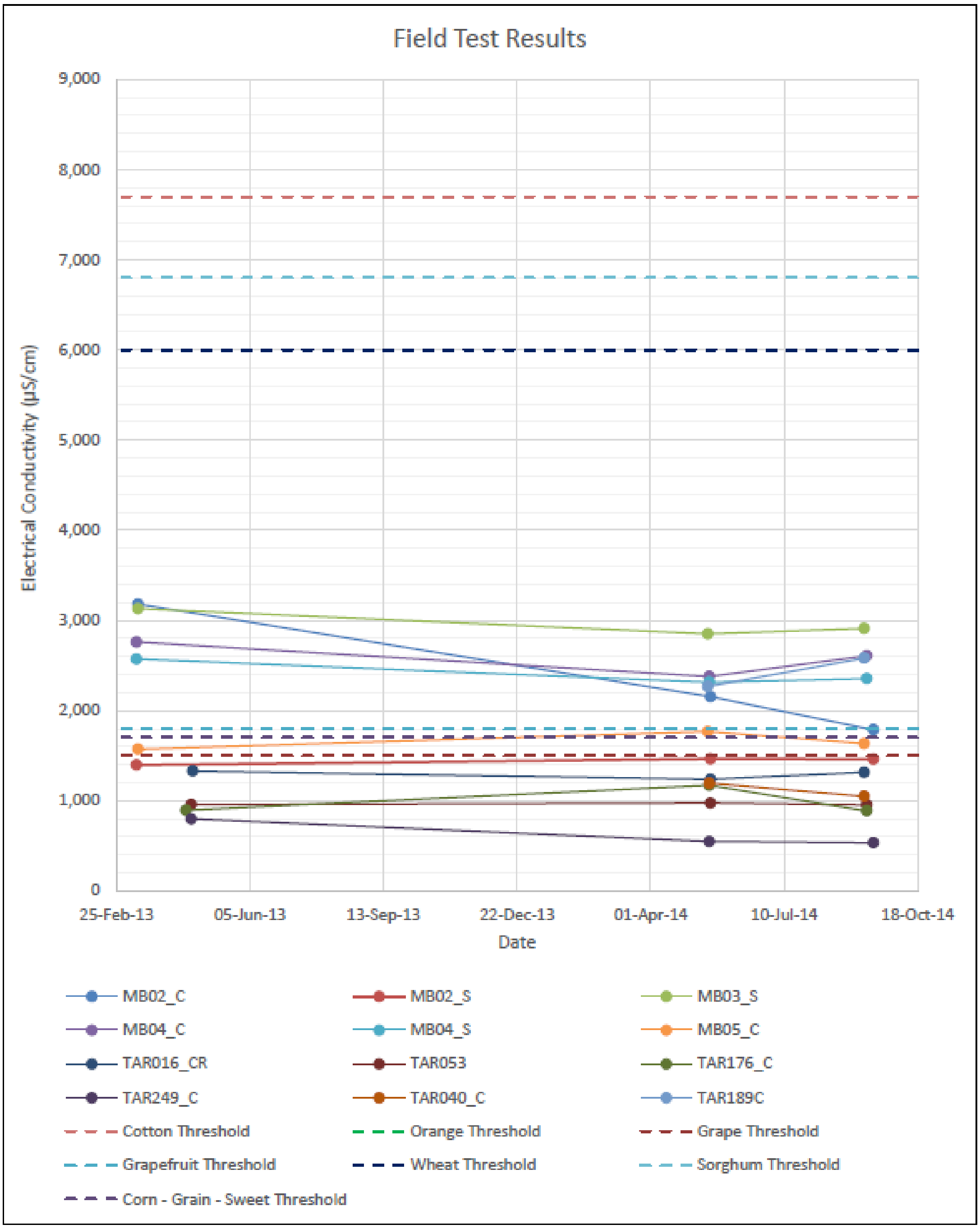


Plate 6 (Cont'd)
Groundwater Salinity Test Results

b) Field Test Results: Salinity Level at Taroborah Coal Project Site



12.15 Appendix 14, Appendix B, Section 2.1.2, Page B-13 - Calibrated Steady State Water Budget

Submitter:

Department of Natural Resources and Mines

Submission:

The report indicates that the long term average of water entering the groundwater system

is 29 ML/day, with recharge being approximately 6.5ML/day. This seems to be different to Section 11.3 Page 37, which indicates 0.3ML/day recharge contribution. Clarification should be provided.

Response:

The 0.3ML/day recharge contribution from groundwater mentioned in Section 11.3 is additional recharge to the calibrated steady state of 6.5ML/day from the opencut void, such that total recharge is 6.8ML/day.

EIS Amendment:

The third bullet point in Section 11.3 of Appendix 14 has been amended to read as follows:

"Recharge contributes an additional 0.3 ML/day to the groundwater system as a result of the proposed mine, on top of the 6.5 ML/day predicted for the baseline water budget. This additional recharge occurs after mining of the open cut and occurs as additional recharge to the void and spoil;"

12.16 Appendix 14, Appendix B, Section 3.6.1, Page B-19 - Predicted Mine Inflows

Submitter:

Department of Natural Resources and Mines

Submission:

This section discusses predicted inflow into the final void post mine life. The report does not address the issue of long term water quality in the final void. The proponent should provide details on the long term water quality expected in the void and what potential affects this may have on local groundwater systems.

Response:

Please see response above in Section 12.12.

EIS Amendment:

Please see amendment above in Section 12.12.

12.17 Appendix 14, Appendix B, Section 3.7, Pages B-20 to B-24 - Groundwater Drawdown

Submitter:

Department of Natural Resources and Mines

Submission:

Figures B-11 to B 14 show the predicted drawdown in Seam B. The sudden depressurisation ('cliff effect') immediately above the working longwall sections appears unusual (for example, in Figure B-14). It would be expected that there would still be residual drawdown effects from previous longwall sections, whereas the contours appear to indicate healthy recovery in a short period. It is recommended that the model assumptions be checked, particularly how effects of previous longwall sections are modelled.

Additionally, Figures B-11 to B 14 show the predicted drawdown in Seam B and note that "coal seam is not present where no drawdown colourfill". These figures would indicate that the B seam does not extend further north than roughly N. 7402500. The report does not provide any evidence supporting this. Discussion of any evidence supporting this assumption should be provided. It is acknowledged that the model has modelled

drawdowns past this northern point.

Response:

Cliff Effect

At the completion of each longwall panel, drain cells are removed from the simulation and water levels are allowed to recover. Unconfined storage properties of the mined longwall panel are increased to reflect additional void space in the rubble left behind following goafing due to the removal of the coal. The numerical model predicts groundwater levels recover to within 80% of their pre-mining levels after just 91 days. This is primarily due to the high storage within the Aldebaran sandstone overlying the longwall mining area, which is not completely de-saturated and allows rapid drainage of groundwater into the mined out areas. This high storage effectively buffers the groundwater systems adjacent to the Aldebaran sandstone aquifer from impacts. Steep vertical hydraulic gradients form in the model and result in high groundwater flows towards the de-saturated area within the coal seam, which causes groundwater levels to recover quickly. This occurs in the model because depressurisation is not extensive above the longwall mining area, and a high yielding aquifer exists adjacent to active mining.

AGE explored a scenario whereby the permeability of the fracture zone was increased to allow the vertical depressurisation to extend further above the longwall. Groundwater drawdown caused by underground mining in the layers overlying the longwall panel is more extensive in this scenario. This is because the vertical hydraulic conductivity of the fracture zone is increased, which further enhances hydraulic connection to the overlying groundwater system when compared to the baseline model presented in the EIS. The model results show water levels depressurise by up to 30m within the Aldebaran Sandstone, immediately above the active underground mining.

Whilst this scenario increased the hydraulic connection between the longwall mining area and the Aldebaran sandstone, the results show the majority of the Aldebaran Sandstone is not fully de-saturated. Following the completion of each longwall mining area, groundwater levels in Layer 9 (rubble zone) respond similar to the base case above, however, residual drawdown occurs in the overlying layers for approximately six months following longwall completion.

Extent of B seam

Regarding the colouring of B seam extent to the north, IMC drilling in the north indicates the B seam splits and thins as it approaches Retreat Creek, and historic drilling by previous tenement holders indicates that the area to the north of Retreat Creek contains only thin, poor quality coal seams similar to the seams that occur beneath the B seam in the mining area, and may be due to a northern "boundary fault". In any event, the colouring is considered immaterial as the B seam is essentially the same aquifer as the coarse grained Aldebaran sandstone unit, and, as modelled, will experience some drawdown north of the "illustrated" B seam extents.

EIS Amendment:

None required

13. APPENDIX 15 – AIR QUALITY

13.1 Appendix 15, Page 37 & Appendix B, Page 9 - Air Quality Impact Assessment

Submitter:

Department of Environment and Heritage Protection

Submission:

In order to determine the air impacts, operations in years 2 and 5 were modelled. It appears from Table 27 in Appendix 15 and Table B3 in Appendix B that in year 5, "overburden to in pit" will be the major contributor of dust emissions and it will be responsible for the highest impact on the receiving environment. Section 3.2.2.1 "Overburden Stripping" in Volume 1 of the EIS indicates that year 6 will see the greatest quantity of overburden stripped with approximately 32,568,000 cubic metres of loose excavated material backfilled into the open-cut pit. Consequently, the worst case scenario of dust emissions is likely to be in year 6 which has not been modelled.

Recommendation: Provide the results of modelling the worst case air impacts and justify the selection of the worst case scenario.

Response:

The emission rates of dust associated with the Taroborah Coal Project were estimated in Section 6 of the technical air quality impact assessment report (Katestone, 2014). Section 6 and the associated appendices describe in detail the methodologies used to calculate emissions and the mine activity data that was used for mining Years 2 and 5.

The emission rates of dust associated with Year 6 have been estimated using the same methodologies as were applied in the technical air quality impact assessment report. Activity data and dust emission rates estimated for Years 5 and 6 are compared below.

The rates of ROM coal, washed coal, total product coal and overburden removal for Year 5 and Year 6 are provided in the following Table 1.

Table 1 Annual Production Rates for Year 5 and Year 6.

Coal Type and Source		Year 5	Year 6
ROM Coal (t)	Open cut	2,177,615	1,988,289
	Underground	98,460	370,905
	Total	2,276,076	2,359,194
Coal Washing (t)	Bypassed	1,446,268	1,527,734
	Washed	829,808	831,460
	Rejects	245,728	291,150
Total Product (t)	Open Cut	1,932,892	1,708,827
	Underground	97,456	359,217
	Total	2,030,348	2,068,044
Overburden removal	Total	29,962,033	32,742,873

The emission rates for Year 5 and Year 6 are presented in Table 2.

Table 2 Estimated Dust Emission Rates for Year 5 and Year 6

Activity	Total dust emission rate (g/s)					
	Year 5			Year 6		
	TSP	PM10	PM2.5	TSP	PM10	PM2.5
In-Pit Activities including drilling, blasting and truck	4.7	2.5	0.4	4.7	2.5	0.4
Haul Roads	79.2	27.9	2.9	86.5	30.5	3.1
Conveyors	1.6	0.4	0.05	1.5	0.4	0.05
CHPP	10.3	1.8	0.2	10.6	1.9	0.2
Wind Erosion of stockpiles	3.4	1.7	0.3	3.4	1.7	0.3
Train loading	2.9	0.5	0.1	3.0	0.5	0.1
Rail line	0.01	0.004	0.001	0.01	0.004	0.001
Total	**102.1**	**34.8**	**3.9**	**109.6**	**37.4**	**4.1**

From the emission rates estimated in Table 2, it can be seen that:

- The overburden tonnage is 9% greater in Year 6 than in Year 5
- The emission rates due to haul roads are estimated to be 9% higher in Year 6 than in Year 5
- Overall project emissions for Year 6 are estimated to be 7 % higher for TSP, 8% higher for PM_{10} and 6% higher for $PM_{2.5}$ than for Year 5

With the change in emission rates from Year 5 to Year 6 and based on the modelling results for Year 5, the following has been inferred for Year 6.

- Concentrations of TSP, PM_{10} and $PM_{2.5}$ as well as dust deposition rate are likely to increase; however, the increase would not be greater than 9% at any receptor.
- The annual average concentrations of TSP would not exceed the objective at any additional receptors.
- The 6th highest 24-hour average concentrations of PM_{10} would not exceed the objective at any additional receptors.
- The maximum 24-hour average concentrations of $PM_{2.5}$ may exceed the objective at one additional receptor in Year 6 compared with Year 5. This receptor is the Walther residence. The concentration for Year 5 was predicted to be marginally below the objective of 25 µg/m³ at the Walther residence (24.9 µg/m³). Consequently, the estimated higher dust emission rates for Year 6 would likely result in a predicted exceedance of the objective in Year 6. The PM_{10} concentrations at this receptor were predicted to exceed the objective in Year 5; consequently, the marginally higher prediction at the Walther residence for Year 6 does not alter the outcome of the air quality assessment of the Taroborah Coal Project in this regard.
- The annual average concentrations of $PM_{2.5}$ would not exceed the objective at any additional receptors.
- The maximum monthly and annual average dust deposition rates would not exceed the guidelines at any additional receptors.

EIS Amendment:

A memorandum containing the above response is included as Appendix 15a to the EIS report.

Additionally, the above discussion has been incorporated into a Year 6 sub-heading in Section 4.6.2.1 of the EIS main body report.

13.2 Appendix 15, Page 55 & 61 - Dust Deposition

Submitter:

Department of Environment and Heritage Protection

Submission:

Figures 13 and 19 demonstrate that dust deposition rates of greater than 120 mg/m^2/day will be experienced in areas of State forest adjacent to the mining lease. The impact of dust deposition on the forest was not discussed in the EIS.

Note: Some independent assessments of dust deposition impacts on vegetation have been commissioned for other projects (e.g. Gold Coast Quarry – refer to: www.goldcoastquarry.com/assets/Additional-Documents/3.-Attachment-A-Air-Quality.pdf) that may be useful.

Recommendation: Assess the potential impacts of predicted dust deposition levels on the health of ecologically sensitive vegetation in the State forest adjacent to the mine site.

Response:

There is no statutory limit for the deposition of dust for vegetation protection. EHP provides design guidance for dust deposition for the avoidance of dust nuisance, which is related to human perception. The effect of dusts on vegetation is principally through interception of light by leaves and the consequential effects on the rates of photosynthesis and plant health and growth. However, there are no prescribed assessment criteria for dust loads on vegetation associated with reduced physiological activity.

Fairbairn Forest Reserve is located to the immediate south and east of the Project site and encompasses approximately 10,000 ha of remnant vegetation (Section 4.8 of the Taroborah Coal Project EIS). The EIS did not include a detailed statement of the vegetation species in the Fairbairn Forest Reserve. The EIS did identify several vegetation communities that would extend into the Fairbairn forest. The flora and fauna assessment contained in the EIS details the vegetation of the canopy, scrub and ground layers. The flora type has been identified and the relative dominance of the species. The vegetation communities are:

- Community 2 - River Teatree Riparian Woodland
- Community 4 - Brigalow Woodland
- Community 6 - Silver-leaved Ironbark Open Woodland

The following table presents the highest maximum monthly dust deposition rates predicted to occur in Year 2 and Year 5 within the Fairbairn Forest Reserve.

The movement of air and the progressive interception of dust within the vegetation canopy will result in a decrease in concentration and therefore dust deposition rate (Raupach et al., 2011), which is not accounted for in the dispersion modelling. Therefore the modelled dust deposition rates overestimate dust levels beyond the leading edge of the woodland nearest the mine.

Highest dust deposition rate predicted within the State Forest

Mine Year	Maximum monthly dust deposition rate ($mg/m^2/day$)	Annual dust deposition rate ($mg/m^2/day$)
Year 2	389	244
Year 5	360	187

A review of literature has found that the most important factor in the assessment of dust effects on vegetation is the dust load on the leaf surface. This is affected by:

- Rate of dust deposition;
- Duration of deposition;
- Frequency of heavy rain events (e.g. > 100 mm);
- Functional life of the leaf;
- Structural features of the plant that may lead to shedding or retention of dust such as:
  - branching habit of the tree or shrub (erect growth and sparse branching minimise deposition in low winds);
  - foliage density (dense foliage increases particle impaction);
  - leaf orientation (horizontal display maximises dust retention, vertical display minimises retention in a low wind environment); and
  - stiffness of display of branches and leaves (stiff branches and leaves retain their profile in wind; flexible branches and leaves stream in wind, greatly reducing the surface area presented for deposition);
- Structural features of the leaf that may lead to shedding or retention of dust such as:
  - smoothness of leaf surface (this may differ between upper and lower surfaces);
  - presence of long, branched or expanded hairs on the leaf surface; and
  - presence of salt secreting glands on the leaf surface that may increase leaf surface wetness; and
- Mean particle diameter. The interception of particles is affected by their diameter in relation to the size and density of the leaves (Raupach et al., 2001). Light interception by the dust on plant canopies is also affected by particle diameter (Doley, 2006) and the effects on photosynthesis can be described quantitatively (Doley and Rossato, 2010). It is also important to recognise that the shading effect of dust increases exponentially with decreasing particle diameter.

A detailed study of the potential effects of quarry dust on vegetation communities was prepared by Dr David Doley for Boral's Gold Coast Quarry Project (Doley D., 2013). The study assessed the potential impact of dust deposition on a Eucalyptus pilularis (blackbutt) dominated forest and on an area proposed to be used for ecological offsets. The study considered dust deposition rates of up to 400 $mg/m^2/day$ (as a maximum monthly rate), which is similar to the worst-case dust deposition rates predicted for the Taroborah Coal Project and presented in the table above. The study used conservative assumptions that

would likely overestimate the actual impact.

The study of the Gold Coast Quarry found the following.

- The overstorey Eucalyptus pilularis would be relatively unaffected by dust deposition at the maximum mean monthly rate.
- The understorey layer (small trees and large shrubs) may lose approximately 10% of their dry matter production potential – a reduction that was considered "...not likely to be deleterious for the species within this vegetation layer."
- A greater effect on ground species was predicted, with a possible loss of about one quarter of dry matter production potential in the proposed offset area (Imperata cylindrica-dominated cover). Within the Eucalyptus pilularis forest, a reduction of dry matter production potential of 50% was estimated, which could be detrimental for small ground cover species with horizontally displayed leaves.

In Communities 2, 4 and 6, it would appear that ground species are dominated by grasses similar to the offset areas in the Gold Coast Quarry Study. Consequently, the Gold Coast Quarry study would suggest that dust deposition is unlikely to cause a significant impact on the Fairbairn Forest Reserve.

The Gold Coast Quarry study recommended planting a windbreak of Casuarina species at the edge of a nearby area of native vegetation to reduce the concentration of dust in air moving laterally into the native vegetation.

EIS Amendment:

A memorandum containing the above response is included as Appendix 15a to the EIS report.

A new sub-heading has been added to Section 4.6.2.1 of the EIS main body report that reads as follows:

"Potential Impacts on Vegetation

The Fairbairn State Forest is classified as a Category C Environmentally Sensitive Area. The State Forest is located to the east and south of the Project site, in proximity to the open-cut pit and other infrastructure which have the potential to generate dust. The effect of dust on vegetation is principally through interception of light by leaves and the consequential effects on the rates of photosynthesis and plant health and growth. However, there is no prescribed assessment criteria for dust loads on vegetation associated with reduced physiological activity.

A number of factors may influence the impacts of dust deposition on vegetation. These factors have been outlined in Appendix 15a and are described in Table 4.92 below.

Table 4.92 Factors influencing dust deposition and impacts on vegetation

Factors influencing the deposition of dust on the surface of leaves

• Rate of dust deposition;
• Duration of deposition;
• Particle diameter class distribution;
• Frequency of heavy rain events (e.g. > 5 mm);
• Frequency of strong wind events (e.g. > 5 m/s);
• Functional life of the leaf;
• Structural features of the plant that may lead to shedding or retention of particles:
    o Branching habit of the tree or shrub (erect or pendant leaf disposition and sparse branching minimise deposition in low winds);
    o Foliage density (dense foliage increases particle impaction);

Factors influencing the deposition of dust on the surface of leaves
○ Foliage element size (small cylindrical elements intercept particles more effectively per unit surface area than large flat elements); ○ Leaf orientation (horizontal display maximises particle retention, vertical display minimises retention in a low wind environment); ○ Stiffness of display of branches and leaves (stiff branches and leaves retain their profile in wind; flexible branches and leaves stream in wind, greatly reducing the surface area presented for deposition, and flapping with resulting dislodgment of particles); • Structural features of the leaf that may lead to shedding or retention of particles: ○ Smoothness of leaf surface (this may differ between upper and lower surfaces, with the upper surface generally being smoother); ○ Presence of long, branched or expanded hairs on the leaf surface (more common on lower than on upper surfaces); and ○ Presence of salt or resin secreting glands on the leaf surface that may increase leaf surface wetness. • Mean particle diameter. The interception of particles is affected by their diameter in relation to the size and density of the leaves (Raupach et al., 2001). Light interception by the dust on plant canopies is also affected by particle diameter (Doley, 2006) and the effects on photosynthesis can be described quantitatively (Doley and Rossato, 2010). It is also important to recognise that the shading effect of dust increases exponentially with decreasing particle diameter

Limited research has been conducted investigating the impact of dust from coal mining activities on vegetation. However, recently a detailed study of the potential effects of quarry dust on vegetation communities was prepared by Doley (2013) for Boral's Gold Coast Quarry Project. The study assessed the potential impact of dust deposition on a Eucalyptus pilularis (blackbutt) dominated forest and on an area proposed to be used for ecological offsets. The study considered dust deposition rates of up to 400 mg/m²/day (as a maximum monthly rate), which is similar to the worst-case dust deposition rates predicted for the Project (refer to Table 4.93). The study used conservative assumptions that would likely overestimate the actual impact.

The study of the Gold Coast Quarry found the following (Doley, 2013):

- The overstorey Eucalyptus pilularis would be relatively unaffected by dust deposition at the maximum mean monthly rate;
- The understorey layer (small trees and large shrubs) may lose approximately 10% of their dry matter production potential – a reduction that was considered "...not likely to be deleterious for the species within this vegetation layer."; and
- A greater effect on ground species was predicted, with a possible loss of about one quarter of dry matter production potential in the proposed offset area (Imperata cylindrica-dominated cover). Within the Eucalyptus pilularis forest, a reduction of dry matter production potential of 50% was estimated, which could be detrimental for small ground cover species with horizontally displayed leaves.

The Fairbairn Forest Reserve encompasses approximately 10,000 ha of remnant vegetation. Several vegetation communities found on the Project site also extend into the Fairbairn State Forest. These communities are discussed in detail in Section 4.8 of the EIS and are outlined below:

- River Teatree Riparian Woodland;
- Brigalow Woodland; and
- Silver-leaved Ironbark Open Woodland

Research confirms that ground species within these communities are dominated by grasses similar to the offsets areas in the Gold Coast Quarry Study (Doley, 2013). Consequently, the Gold Coast Quarry study would suggest that dust deposition is unlikely to cause a significant impact on the Fairbairn Forest Reserve.

Within the Project boundary areas of Brigalow/Belah Low Open Woodland are also within close proximity to the open-cut pit and other infrastructure and therefore may potentially experience dust deposition impacts. However, Raupach et al. (2011) suggests that the movement of air and the progressive interception of dust within the vegetation canopy will result in a decrease in concentration and therefore dust deposition rate.

Table 4.93 presents the highest predicted maximum monthly dust deposition rates within the Fairbairn State Forest for Years 2 and 5 of the Project. As previously described, these rates are considered to be an over-estimation beyond the forest edge nearest to the mine, as the various layers of forest canopy will intercept the dust, decreasing the concentration and deposition rate of dust (Katestone 2014).

Doley (2003) reports chemically inert dust (or dust which does not substantially alter substrate pH) will typically adversely affect plant growth where the dust load exceeds 5 g/m2. These results suggest that plant growth will not be affected within the State Forest as 5 g/m2 is far greater than the highest modelled dust deposition rates predicted for the Fairbairn State Forest (refer to Table 4.79).

Table 4.93 Highest Dust Deposition Rates Predicted within the State Forest

Mine Year	Max. Monthly Dust Deposition Rate ($mg/m^2/day$)	Annual Dust Deposition Rate ($mg/m^2/day$)
Year 2	389	244
Year 5	360	187

Source: Katestone 2014

In addition, as noted in Section 4.6.1.1, the prevailing winds in the region of the Project originate from the north-northeast through to the east to the southeast, influencing the prevailing direction of dust dispersal. Due to the location of the Fairbairn State Forest to the east/southeast of the Project site, prevailing winds will minimise potential impacts of dust on vegetation. Furthermore, a rain event of >5 mm may be assumed adequate to remove accumulated dust from plants."

13.3 Not Specified but fits in with Appendix 15 and Appendix 18 - Indirect Impacts to Brigalow ERE's

Submitter:

Federal Department of the Environment

Submission:

Further information should be provided about the likelihood and significance of indirect impacts to the described Brigalow Woodland (Vegetation Community 4) and Brigalow / Belah Low Open Woodland (Vegetation Community 10) given the proximity to the proposed open cut pit and waste and recycle water dam respectively.

Response:

The potential impacts to Vegetation Community 4 are discussed in the above response in Section 13.2 of this document. Similar impacts from dust deposition could be expected to occur to Vegetation Community 10.

The presence of the waste and recycle water dams will have no impact on Vegetation Community 10 as they are, firstly, designed with a very low spill risk, and secondly, any spill would report to the east of the dams, not the west.

EIS Amendment:

As provided above in Section 13.2 of this document.

13.4 Appendix 15, Appendix B, Section B1, Page 1 & Section B4, Page 3 - Conveyor Emissions and Wind Erosion of Stockpiles

Submitter:

Department of Environment and Heritage Protection

Submission:

The equations used for the estimation of emission factors from the wind erosion of stockpile and exposed areas and from the conveyors have been taken from the US EPA guidelines. However, it is not clear why the equations specified in the Australian National Pollution Inventory (NPI) were not selected, as these have been developed to represent Australian conditions. Consequently, it is not clear how accurate/conservative the estimated emission factors are for conveyor and wind erosion emissions.

Recommendation: Explain why equations other than recommended by the NPI were selected for wind erosion of stockpile and exposed areas and the conveyors and discuss the accuracy and conservativeness in determining emission factors by using the alternative equations.

Response:

The NPI emission factor for wind erosion from exposed areas has been used for all active stockpiles and other active exposed areas, which is consistent with the NPI recommendations. The AP-42 emission factor has been used to quantify emissions from exposed inactive areas. The NPI wind erosion factor will overestimate dust emissions from inactive areas.

Emissions associated with material transfers to conveyors have been estimated using the AP-42 emission factor because this factor is considered to be the most representative in the circumstances. In this instance, the AP-42 emission factor provides a higher estimate of dust emissions than would be obtained using the equivalent NPI emission factor. However, dust emissions from material transfers are a relatively small component of overall emissions and, hence, the adoption of an alternative factor would not change the outcomes of the assessment.

EIS Amendment:

A memorandum containing the above response is included as Appendix 15a to the EIS report.

None other required

13.5 Appendix 15, Appendix B, Section B1 to B8, Pages 1 to 8 - Emission Parameters

Submitter:

Department of Environment and Heritage Protection

Submission:

A number of emission parameters were utilised in the dust emission equations specified in Appendix B. However, it is not clear how a number of these parameters (e.g. soil and coal be selected from the mine's site-specific data. If the selected values do not represent the actual site conditions the predicted dust emission impacts can be under or over predicted.

Recommendation: Discuss how representative of site conditions the emission parameters are for soil and coal moisture content and silt content.

Response:

The moisture and silt content for both soil and coal are summarised in the table below. The source of the value selected for use in the assessment has been referenced in the table. In summary, project specific data was used where it was available. In the absence of project specific data, the mid-point of the range of applicability of the emission factor equations was used.

Moisture and silt contents used in the assessment

Material	Silt content (%)	Moisture content (%)
ROM coal	8.6[1]	12[2]
Product	8.6[1]	15[2]
Overburden	6.9[1]	7.9[1]

[1] AP-42 Emission factors for Western Surface Coal Mining Chapter 11.9 Table 11.9-3

[2] Pre-feasibility study for the Taroborah Coal Project

EIS Amendment:

A memorandum containing the above response is included as Appendix 15a to the EIS report.

None other required

13.6 Appendix 15, Appendix B, Section B1 to B8, Pages 1 to 8 - Emission Sources

Submitter:

Department of Environment and Heritage Protection

Submission:

It is not clear how the emission sources were modelled. If these were modelled as a series of volume sources, then the assumed heights of individual volume sources needs to be discussed in the report, as well as how the source heights were selected.

Recommendation: Discuss how the emission sources were modelled. If these were modelled as a series of volume sources, provide the heights of individual volume sources and discuss the process used to determine source heights.

Response:

Dispersion modelling was conducted using the model CALPUFF. The sources were represented as a combination of area and volume sources, with a total of 181 area sources and nine volume sources modelled for Year 2 and a total of 147 area sources and 12 volume sources modelled in Year 5.

The source parameters for the modelling of Year 2 are provided in Table 1 and Table 2 below for the area and volume sources, respectively. The source parameters for the modelling of Year 5 are provided Table 3 and Table 4 for the area and volume sources, respectively.

An area source is defined by an effective release height (above ground level), an initial vertical spread and a release area. A volume source is defined by an effective release

height (above ground level), an initial vertical spread and an initial horizontal spread.

The effective height of an area or volume source is the height at which emissions are likely to occur above ground level. The effective height will be dependent on the mining operations, pit depth and type of equipment. The effective heights have been selected by source type considering the following:

- The height of the waste dumps
- The depth of the pits
- The size of the haul trucks
- The height of the coal wagons
- The height of the conveyors
- The height of the CHPP

The vertical spread of an area or volume source has been determined as one-quarter of the height of the emission source in accordance with modeling guidelines (e.g. National Institute of Water and Atmospheric Research, 2004 and Vic EPA, 2000).

The horizontal spread of a volume source has been determined as one-half of the height of the emission source in accordance with modelling guidelines (e.g. the ISC user manual (US EPA, 2004)).

Table 1 Year 2 model configuration parameters for area sources

Description	Number of Sources	Effective Height	Vertical Spread (σ_z)	Area Modelled
		m	*m*	*m^2*
ExPit Waste Dump Northwest	2	8	2.0	292803.8
ExPit Waste Dump Southeast	3	8	2.0	371718.1
ExPit Waste Dump Southwest - Inactive	3	8	2.0	167962.7
Overburden Haul road A	5	11	2.8	26252.4
Overburden Haul road B	15	11	2.8	95034.1
Open-Cut Pit	4	8	2.0	307156.6
Open-Cut Pit - Duplicate for blasting emissions	4	8	2.0	307156.6
InPit Dump West - Active	4	8	2.0	285768.6
InPit Dump - Inactive	4	2	0.5	281532.4
Rail - straight section	38	6	1.5	275372.9
Rail loop	31	6	1.5	69739.8
Rejects haul road from CHPP	14	11	2.8	74255.8
ROM Haul road A	8	11	2.8	47395.5
ROM Haul road B	15	11	2.8	96648.6
Screen Dump	13	8	2.0	154132.7
ROM stockpile	1	8	2.0	3769.4
Topsoil stockpile	5	8	2.0	170316.5
CHPP feed stockpile	1	8	2.0	1420.2
Product stockpile	1	8	2.0	9632.1

Description	Number of Sources	Effective Height	Vertical Spread (σz)	Area Modelled
		m	*m*	*m*^{2}
Train loading conveyor	1	10	2.5	5424.9
CHPP bypass conveyor	2	10	2.5	9169.4
CHPP feed conveyor	2	10	2.5	8422.4
Conveyor from CHPP to product stockpile	2	10	2.5	6615.2
Conveyor from OC ROM SP to secondary sizer	1	10	2.5	4494.0
Conveyor from secondary sizer	1	10	2.5	4139.5
Conveyor from CHPP to rejects SP	1	10	2.5	3922.9

Table 2 Year 2 model configuration parameters for volume sources

Description	Coordinates		Elev (m)	Release ht (m)	Initial σy	Initial σz
	Easting	Northing				
Open cut mine ROM stockpile (transfer)	594036	7395520	221.5	10	5.00	2.50
Secondary sizing plant	594036	7395368	220.7	10	5.00	2.50
Transfer between conveyor from sizing plant and CHPP feed or bypass conveyors	593899	7395368	221.6	10	5.00	2.50
Transfer to and from CHPP feed stockpile	593899	7395513	222.4	10	5.00	2.50
Transfer on product conveyor from CHPP to product stockpile	593731	7395418	223.4	10	5.00	2.50
Transfer to and from product stockpile	593599	7395459	224.8	10	5.00	2.50
Coal handling and processing plant	593739	7395526	223.9	30	15.00	7.50
Drop into reject bin	593786	7395666	224.3	10	5.00	2.50
Train loading	593622	7395706	226.1	10	5.00	2.50

Table 3 Year 5 model configuration parameters for area sources

Description	Number of Sources	Effective Height	Vertical Spread (σz)	Area Modelled
		m	*m*	*m*^{2}
ExPit Waste Dump Southeast	3	8	2.0	371718.1
ExPit Waste Dump Northwest	2	8	2.0	292803.8
ExPit Waste Dump Southwest - Inactive	3	8	2.0	167962.7
Open-Cut Pit	2	8	2.0	285521.4
InPit Dump - Inactive	4	2	0.5	575150.0
InPit Dump - Active	2	8	2.0	156605.0
Open-Cut Pit - Duplicate for blasting emissions	2	8	2.0	285429.2
Rehabbed in-pit dump	2	2	0.5	550673.1
ROM Haul road B	18	11	2.8	104484.1
Rejects haul road from CHPP	1	11	2.8	7973.7
Rail loop	31	6	1.5	69739.8

Description	Number of Sources	Effective Height	Vertical Spread (σz)	Area Modelled
		m	*m*	*m²*
Rail - straight section	38	6	1.5	275372.9
Screen Dump	13	8	2.0	154132.7
ROM stockpile	1	8	2.0	3769.4
Underground ROM stockpile	1	8	2.0	7120.9
Product stockpile	1	8	2.0	9632.1
Topsoil stockpile	5	8	2.0	170316.5
CHPP feed stockpile	1	8	2.0	1420.2
Conveyor from open cut ROM SP to secondary	1	10	2.5	4494.0
Conveyor from secondary sizer	1	10	2.5	4139.5
Conveyor from CHPP to rejects SP	1	10	2.5	3922.9
CHPP feed conveyor	2	10	2.5	8422.4
CHPP bypass conveyor	2	10	2.5	9169.4
Train loading conveyor	1	10	2.5	5424.9
Conveyor from CHPP to product stockpile	2	10	2.5	6615.2
Conveyor from ROM from underground	7	10	2.5	54542.2

Table 4 Year 5 model configuration parameters for volume sources

Description	Coordinates		Elev (m)	Release ht (m)	Initial σy	Initial σz
	Easting	Northing				
Open cut mine ROM stockpile (transfer)	594036	7395520	221.5	10	5.0	2.5
Secondary sizing plant	594036	7395368	220.7	10	5.0	2.5
Transfer between conveyor from sizing plant and CHPP feed or bypass conveyors	593899	7395368	221.6	10	5.0	2.5
Transfer to and from CHPP feed stockpile	593899	7395513	222.4	10	5.0	2.5
Transfer on product conveyor from CHPP to product stockpile	593731	7395418	223.4	10	5.0	2.5
Transfer to and from product stockpile	593555	7395482	225.4	10	5.0	2.5
Coal handling and processing plant	593739	7395526	223.9	30	15.0	7.5
Drop into reject bin	593786	7395666	224.3	10	5.0	2.5
Train loading	593622	7395706	226.1	10	5.0	2.5
Transfer of underground ROM at portal	595137	7395833	226.1	10	5.0	2.5
Conveyor transfer for underground ROM	594983	7395055	224.3	10	5.0	2.5
Underground mine ROM stockpile (transfer)	594786	7395195	223.5	10	5.0	2.5

EIS Amendment:

A memorandum containing the above response is included as Appendix 15a to the EIS report.

None other required

14. APPENDIX 17 – NOISE ASSESSMENT

14.1 Appendix 17, Section 5.4.1.2, Pages 19 to 20 - Sleep Disturbance Criteria

Submitter:

Department of Environment and Heritage Protection

Submission:

Sleep disturbance has been referenced to WHO 1999, as opposed to the latest publication, WHO 2009. Within the WHO 2009 publication, the transient value for sleep disturbance was lowered from LAmax 45dBA to LAmax 42dBA. An indoor to outdoor value of 5-7dB is acceptable for sound attenuation with windows open for outdoor to indoor.

Recommendation: The sleep disturbance criteria should be amended to 42dBA with an indoor to outdoor sound attenuation of 5 to 7dB. A maximum criterion of 49dBA is therefore more accurate than 55dBA used in the report. Furthermore, the proposed sleep disturbance mitigation measures should be amended to reflect compliance with the revised criteria**.**

Response:

The recommendation is acknowledged and the Appendix 17 report has been amended.

EIS Amendment:

The third paragraph of Section 5.3.3 of Appendix 17 has been amended to reflect the 5-7db sound attenuation for outdoor to indoor as follows:

"In the EHP EcoAccess Guideline "Planning For Noise Control" documentation, it is proposed that the noise reduction provided by a typical residential building façade is 5 to 7 dBA assuming open windows. That is, with an external noise source, a 5 to 7 dBA reduction in noise levels from outside a house to inside a house is expected when windows are fully open. Thus the indoor noise objectives noted above could be considered as the following external objectives (with windows open):

- Daytime and Evening: 40 to 42 dBA $L_{Aeq,adj,1hr}$, 45 to 47 dBA $L_{A10,adj,1hr}$ and 50 to 52 dBA $L_{A1,adj,1hr}$
- Night: 35 to 37 dBA $L_{Aeq,adj,1hr}$, 40 to 42 dBA $L^{A10,adj,1hr}$ and 45 to 47 dBA $L_{A1,adj,1hr}$"

The first paragraph of Section 5.4.1.2 of Appendix 17 has been amended to reflect the WHO2009 guidelines as follows:

"The World Health Organization (WHO) issued its "Night Noise Guidelines for Europe" in 2009. This guideline is written specifically for the European environment and may not be applicable for Australian conditions. However, it has been adopted as it is the most recent WHO publication which addresses sleep disturbance. The WHO guideline states that in regard to sleep disturbance from continuous noise from activities, such as mining operations, the equivalent sound pressure level should not exceed 30 dBA indoors, if negative effects on sleep are to be avoided. The WHO guideline states that the threshold for sleep awakening and sleep disturbance is 42 dBA L_{max} indoors."

Further, the fourth paragraph of Section 5.4.1.2, which discussed the maximum 55dbA noise level, has been deleted, and the remainder of Section 5.4.1.2 has been amended to read as follows:

"As noted previously, EHP propose that the noise reduction provided by a typical residential building façade is 5 to 7 dBA assuming open windows. Thus the indoor noise objectives noted above could be converted to external objectives (with windows open) with the appropriate correction.

Comparison of the nominated noise limits indicates that the WHO criteria for short duration events are more stringent and therefore have been adopted for this assessment. The recommended sleep disturbance noise limits which have been adopted for this assessment are summarised in Table 5.1.

Table 5.1 Summary of WHO Sleep Disturbance and Annoyance Criteria

Descriptor	Number of Noise Events	Indoor Criterion in dBA	Outdoor Criterion, dBA
Sleep Disturbance (Short Duration Events)	Not Specified	L_{max} 42	L_{max} 47 to 49
Sleep Disturbance (Continuous Noise)	Continuous	L_{eq} 30	L_{eq} 35 to 37
Annoyance (Night Time)	Continuous	L_{eq} 35	L_{eq} 40 to 42

Note: The outdoor criteria are based on a EHP EcoAccess nominated outdoor-to-indoor noise reduction of 5 to 7 dBA for open windows.

Similar amendments have been applied to Section 4.7.1.3 of the EIS main body report.

14.2 Appendix 17, Section 5.5, Page 20 - Proposed External Noise Limits

Submitter:

Department of Environment and Heritage Protection

Submission:

The proposed external sleep disturbance noise limits presented in Table 5.3 are averages. However, it is the loudest noises which are most likely to result in sleep disturbance. Consequently, a maximum noise limit is also required.

Recommendation: Amend Table 5.3 to include a maximum noise limit.

Response:

Acknowledged, and Table 5.3 has been amended in the Appendix 17 report.

EIS Amendment:

A third paragraph has been inserted in Section 5.5 of Appendix 17 that reads as follows:

"An external limit of 47 dBA L_{max} is also recommended for the night-time for sleep disturbance, based on the WHO guideline as discussed in Section 5.4.1.2."

And Table 5.3 in Appendix 17 has been amended as follows:

Table 5.3 Proposed External Noise Limits

Recommended Noise Limits	Time Period		
	Daytime	Evening	Night-time
$L_{eq,adj,T}$ (T= 15 minutes to 1 hour), dBA*	40	40	35
L_{max} dBA*	N/A	N/A	47

And the last sentence in Section 5.5 of Appendix 17 has been amended to reads as follows:

"From ASK's experience, the difference between the average Lmax noise events and the Leq due to the variable noise from equipment is typically 5 dBA to 8 dBA. Therefore, in compliance with the external 35 dBA Leq criteria, it is predicted that the external 47 dBA Lmax sleep disturbance limit will also be met."

Similar amendments have been applied to Section 4.7.1.4 of the EIS main body report.

15. APPENDIX 18 – TERRESTRIAL FLORA AND FAUNA ASSESSMENT

15.1 Appendix 18, Section 6.3.11, Page 66 - Non-remnant Grassland

Submitter:

Department of Environment and Heritage Protection

Submission:

Areas of Natural Grassland Threatened Ecological Community are mapped within the mine impact area south and north of the Capricorn Highway. However, according to Figure 5 (Flora transect locations within the site) no flora survey sites were located within the areas mapped as Natural Grassland within the mining lease. During the site visit on the 2nd June 2014, small areas of heavily grazed and poor condition Natural Grassland, as well as three indicator grassland species (Astrebla spp, Aristida latifolia and Dichanthium sericeum), were observed south of the highway in the location of the eastern most polygon.

Recommendation: Carry out grassland surveys within the areas that have been mapped as non-remnant grassland during good growing conditions (e.g. wet season) to determine the extent and condition of Natural Grasslands on-site**.**

Response:

The Proponent acknowledges that some natural grassland species do exist within the areas mapped by the EHP as RE 11.8.1, however, maintains that these areas no longer represent that RE due to overall grass species consist as mentioned in Section 6.3.14 of Appendix 18 of the Draft EIS . While a specific transect location was not established within the heart of the mapped RE in question, the review of aerial photos and visual observations along the edges of the RE made by the experienced botanist conducting the field survey confirmed this assessment and it was deemed that a transect within this mapped RE was not necessary.

Nevertheless, the Proponent acknowledges that further field observations would probably be prudent to ensure the initial assessment of this area as no longer being an RE is valid. In this regard, waiting for the wet season and then conducting the requisite field survey was deemed an unattractive delay in the EIS process at this point in time, and therefore, EHP was contacted to discuss the options for progressing the EIS forward. From these discussions, it has been decided that the mapped RE 11.8.1 in question will be acknowledged as such in the EIS document and assessed for impacts in this context, with further reassessment conducted in the future prior to Project development.

EIS Amendment:

A new Section 6.3.14 has been inserted into Appendix 18 to address the natural grasslands as follows:

"Several areas of Community 11 are mapped by DEHP as Natural Grassland REs (e.g. RE 11.8.11 – 'Dichanthium sericeum grassland on Cainozoic igneous rocks'). These areas are now dominated by buffel grass and, generally, are no longer considered to be representative of the mapped RE. One area of DEHP-mapped Natural Grassland that coincides with the proposed infrastructure area, will be treated as consistent with RE 11.8.11 for the purpose of this Flora and Fauna Assessment, despite being considered to constitute Non-remant Grassland following field surveys. This approach has been adopted to account for potential impacts to Potential Natural Grassland prior to further ground-truthing to determine its presence on the Project site. These areas will be referred to as 'Potential Natural Grassland'. Consequently, these areas are classified as Of Concern under the VM Act and DEHP Biodiversity Status, and Endangered under the EPBC Act. Offsets to these areas of Potential Natural Grassland are detailed in Section 8.3."

And the reference to natural grasslands in the first paragraph of Section 6.3.15 (previously 6.3.14) of Appendix 18 has been removed and the amended paragraph reads as follows:

"Site surveys and ground-truthing of Regional Ecosystem mapping has revealed inconsistencies in relation to current remnant vegetation mapping over the Project site. The majority of the Project site has been subject to anthropogenic disturbances such as vegetation clearing, cropping and cattle grazing. Large areas mapped as woodland or open forest remnant vegetation (e.g. RE 11.8.5 'Eucalyptus orgadophila open woodland on Cainozoic igneous rocks', RE 11.4.9 'Acacia harpophylla shrubby open forest to woodland with Terminalia oblongata on Cainozoic clay plains', etc.) have been reduced to grasslands with scattered shrubs and trees."

Finally, offset provisions for the disturbed area of RE 11.8.1 have been included in Section 8.3 of Appendix 18 of the final EIS, Sections 3.3 and 3.4 of Appendix 21 of the final EIS and Section 4.8.3.8 of the EIS main body report.

16. APPENDIX 19 – AQUATIC ECOLOGY ASSESSMENT

16.1 Appendix 19 - Aquatic Ecology Assessment

Submitter:

Department of Environment and Heritage Protection

Submission:

In some instances the aquatic sampling site names and descriptions are different in different chapters of the EIS. For example, site AQ02 in the Aquatic Ecology Assessment Report is labelled AQ2 in Appendix 26 IESC Report. Site names and descriptions need to be consistent throughout the EIS to avoid confusion and for ease of interpretation when preparing the environmental authority (EA) conditions

Response:

The Proponent will amend the final EIS document to ensure that site names and descriptions for water quality, sediment and aquatic ecology surveys are consistent throughout the EIS and appendices.

EIS Amendment:

Throughout the final EIS documents, the surface water quality sampling points have been referred to as AQX/TASX for consistency, with AQ designating wet season samples (taken in the November thru March time period), TAS designating dry season sampling, and X being the sampling site (1-13).

16.2 Appendix 19 - Surface Water Quality Sampling Sites

Submitter:

Department of Environment and Heritage Protection

Submission:

It is not clear what sites prefixed with "AARCTSW" (See Table – Summary of surface water data, Event No. 3) are and how they fit in to the water quality surveys.

The sites prefixed with "AARCTSW" need to be defined and described as to how they fit into the water quality surveys**.**

Response:

The AARCTSW designation was used once by a sampler from AARC who was not familiar

with the Taroborah sample designation as discussed in the response above. The site numbers are consistent with all of the other sampling, and as the samples were taken in June the AARCTSW should have been TAS.

EIS Amendment:

All references to AARCTSW in Appendix 19 and elsewhere in the EIS documents has been amended to TAS.

16.3 Appendix 19, Section 3.0, Page 13 - Relevant Legislation Reference

Submitter:

Department of Agriculture, Fisheries and Forestry – Fisheries Queensland

Submission:

The project document should make reference to the Fisheries Act 1994 to assess current fisheries resources and the potential impacts to fisheries resources

Response:

This legislation is not considered relevant because there are no suitable fish in abundant quantities so as to consider any of the water occurrences within the Project area or nearby downstream as fisheries or fishery resources within the intent of the legislation. This is due to the highly ephemeral nature of the surface watercourses and drainage lines and the lack of access for the general public to fish in these or the pastoral dams.

EIS Amendment:

None required

16.4 Appendix 19, Sections 5.2.4, 5.2.5 & 5.2.6, Page 28 - Aquatic and Riparian Vegetation Identification, Macro-invertebrate Sampling & Aquatic Vertebrate Fauna Sampling

Submitter:

Department of Environment and Heritage Protection

Submission:

According to the report, the pastoral dams have been included in the aquatic condition analysis. However, where the intent is to provide a clear picture of upstream and downstream condition prior to development, including the pastoral dams in the assessment can bias the data so that the baseline conditions may look worse than they are. In intermittent or ephemeral systems, the focus is on locating refugia, and sampling those because they represent the most persistent water bodies in the system where aquatic organisms will seek refuge and migrate from to recolonise rewetted areas when flows resume.

Recommendations:

1. The baseline condition analysis will need to separate Retreat and Taroborah Creeks (and tributaries) survey sites from the pastoral dam sites for the data analysis in Section 5.3 of Appendix 19.
2. Further aquatic surveys will need to be committed to and carried out prior to the commencement of construction activities so that a baseline condition can be established and project impacts on aquatic ecology can be effectively identified

by the REMP. The survey sites should be reviewed to remove dam sites and replace them with semi-permanent and permanent waterholes for refugia, where possible.

Response:

Data analysis in Appendix 19 has been separated as recommended, to identify particular ecosystem types (dams, wetlands, creeks/tributaries). The results are presented in Section 6.2 of Appendix 19 and Section 4.5.1.1 of the EIS main body report.

Sampling sites detailed in the Aquatic Flora and Fauna Assessment (Appendix 19) were those sites assessed during field surveys in 2011 - 2013. These sites will continue to be monitored over the next 24 months (on a quarterly basis) to further enhance the background water quality data set.

The sites selected for future monitoring and assessment are presented in Section 4.5 and Section 6 of the EIS. These sites were selected with the following considerations:

- Representation of both upstream (background) and downstream (impact) sites;
- Representation of both of the main creek systems of the Project site (Taroborah Creek and Retreat Creek);
- Includes applicable creek locations from the existing data set that have exhibited, or are most likely to exhibit, flowing water (wet periods) or allow assessment of refugia (dry periods); and
- Located on the Project site, or at locations where public access is safe and permitted.

The seven proposed, long-term monitoring points are indicated in the following table.

Monitoring Points	Receiving Waters Location Description	Latitude (GDA94)	Longitude (GDA94)
Upstream Background Monitoring Points			
MP 1 – New site	Taroborah Creek upstream of Project impact area	592460	7394520
MP 2 – Survey site AQ/TAS10	Tributary south of Taroborah Creek	593875	7392625
MP3 – Survey site AQ/TAS5	Retreat Creek	594555	7402037
Downstream Monitoring Points			
MP4 – Survey site AQ/TAS7	Taroborah Creek	595695	7394650
MP5 - Survey site AQ/TAS2	Confluence of unnamed drainage and Retreat Creek	597840	7402650
MP6 – Survey site AQ/TAS 1	Retreat Creek	600070	7402480
MP7 – new site	Taroborah Creek	598685	7391555

EIS Amendment:

Surface water quality testing results presented in Section 6.2 of Appendix 19 and Section 4.5.1.1 of the EIS main body report are as presented previously in Section 5.20 of this document.

The proposed ongoing aquatic monitoring sites as presented in the table above are presented as Table 4.68 in Section 4.5.2.1 of the EIS main body report and as Table 6.12 in Section 6.6 of the EIS main body report.

16.5 Appendix 19, Appendix C - Surface Water Quality Results

Submitter:

Department of Environment and Heritage Protection

Submission:

The water quality data in Appendix C of the Aquatic Ecology Assessment for chromium in Retreat and Taroborah Creeks and wetlands (including dams) within and local to the mining lease appear to be in incorrect units for some sampling events. For example, the chromium data from survey 2 is ten-fold lower than for the other surveys. Consequently, the water quality survey data, particularly for metals, may need to be reviewed and amended. The same water quality data also appears in Appendix 26 IESC Report and Chapter 4.5 Water of the EIS main report.

All water quality data in Appendix C of the Aquatic Ecology Assessment, Appendix 26 IESC Report and Chapter 4.5 of the EIS main report needs to be reviewed to ensure that all of the data is in the correct units and amended, if necessary.

Response:

Acknowledged, the results for survey 2 are reported in Mg/L, with a limit of reporting of 0.001. All of the other results are reported in ug/L, with a limit of reporting of 0.2. Thus, by virtue of the reporting limits, the result for survey 2 when converted to ug/L will naturally be approximately 10 fold lower.

EIS Amendment:

The line indicating the reporting units for the survey 1 results has no longer been repeated for each page of the tables in Appendix C of Appendix 19.

16.6 Appendix 19, Section 6.2, Page 36 - Surface Water Quality

Submitter:

Department of Environment and Heritage Protection

Submission:

The water quality assessment compared the total metal or metalloid levels at monitoring sites to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality toxicity trigger values (TTVs) for 95 percent species protection (ANZECC & ARMCANZ 2000). It is stated in section 3.4.3.2 of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality that:

"Comparison of total concentrations will, at best, overestimate the fraction that is bioavailable. The major toxic effect of metals comes from the dissolved fraction, so it is valid

to filter samples (e.g. to 0.45 µm) and compare the filtered concentration against the trigger value."

Consequently, the proponent's use of total concentrations in the comparison with the TTVs has likely overestimated what is bioavailable in the environment.

Note: The Australian and New Zealand Guidelines for Fresh and Marine Water Quality TTV for 95 percent species protection are the WQOs for the Lower Nogoa/Theresa Creek Sub-basin waters (WQ1303) Aquatic ecosystem—moderately disturbed aquatic ecosystems (EHP 2013) and do not include livestock, irrigation or drinking water TTVs.

Recommendations:

1. Compare the 95th percentile of the field-filtered metals and metalloid concentrations sampling results with the ANZECC & ARMCANZ TTVs for 95 percent species protection.
2. Compare the total metal concentration sampling data with the Australian and New Zealand Guidelines for Fresh and Marine Water Quality - livestock watering and irrigation trigger values (ANZECC & ARMCANZ 2000) and the Australian Drinking Water Guidelines (NHMRC 2011).

Response:

Acknowledged, and the tables have been updated to reflect these different comparisons. This has resulted in an additional table to compare dissolved metals as well as the original total metals table.

EIS Amendment:

A new Table 9 has been inserted into Section 6.2 of Appendix 19 that compares the dissolved metals testing results with the ANZECC & ARMCANZ TTVs for 95 percent species protection. The previous Table 9 is now renumbered Table 10 and compares the total metals testing results with recommended guidelines.

16.7 Appendix 19, Section 6.2, Page 42 - Surface Water Quality Results - Chromium

Submitter:

Department of Environment and Heritage Protection

Submission:

Chromium (total and dissolved) appears to be high at some sites on Retreat Creek (AQ5/TAS5, AQ2/TAS2 and AQ11/TAS11) and farm dams (AQ4/TAS4 & AQ3/TAS3). The proponent concluded that:

"*Given that there has been no known industrial or mining disturbance or history of contamination on the Project site, it can be concluded that the Chromium levels are naturally occurring or may emanate from the upstream gemstone mining operations."*

However, the sites with significantly high chromium, when compared to scheduled WQOs, are AQ11/TAS11 (a tributary of Retreat Creek fed by a spring) and further downstream of this point at AQ02/TAS on the Retreat Creek main channel. If the gemfields were a source of the chromium contamination higher levels of chromium would be expected further upstream on Retreat Creek and closer to the gemfields at AQ06/TAS06 with a concentration gradient decreasing downstream of this point. Furthermore, the significantly high chromium levels at site AQ10 (on a Taroborah Creek tributary) is not downstream of the gemfileds. Therefore, the source of chromium at the above mentioned sites is still unclear.

The levels of chromium found at these three sites are up to 1000 times the aquatic ecosystem trigger value for 95% species protection and may well be attributable to an anthropogenic source rather than a natural source. However, it should be noted that, chromium concentrations in sediments have been observed to be much higher in the Fitzroy catchment than to other areas of Queensland (Semple and Williams, 1998).

Recommendations:

1. Further investigate the source of chromium in pastoral dams and in Retreat and Taroborah Creeks (and their tributaries), particularly at sites AQ11/TAS11, AQ02/TAS and AQ06/TAS06.
2. Assess the relationship (if any) between the sediment sampling survey results in Section 6.3 and the water quality monitoring results in Section 6.2 of Appendix 19 to provide further evidence for explaining the high chromium concentrations.
3. If the source of contamination cannot be identified and managed, treat sites AQ11/TAS11, AQ02/TAS and AQ06/TAS06 as 'existing contaminated sites due to actual contamination' and propose management measures as per Section 4.2.1.7 of the TOR.

Response:

The exceedances of Chromium noted in the Draft EIS are a result of the incorrect reporting of the units in Table 9. All of the results are reported in ug/L instead of the indicated mg/L, which accounts for the 1000 fold exceedances. When we compare the results with the guidelines using the same units, there are no issues with chromium in any of the samples.

EIS Amendment:

The results for chromium have been converted from ug/L to mg/L in Table 9 and Table 10 in Appendix 19 (and elsewhere in the EIS documents) to provide a like for like comparison with the guidelines.

16.8 Appendix 19, Section 6.3.1, Page 42 - Surface Sediment Quality Results - Metals

Submitter:

Department of Environment and Heritage Protection

Submission:

Not all, if any, of the sites surveyed for sediment metal concentrations fulfil the reference site requirements (particularly the pastoral dams) in order to derive local sediment quality guidelines. Therefore, in the interim, the proponent should refer to the ISQG-low trigger values default guidelines in Table 3.5.1 of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

Note: Section 3.5.4.3 Absence of guidelines (page 3.5-5) of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality state:

"The approach suggested is to derive a value on the basis of natural background (reference) concentration multiplied by an appropriate factor."

If developing locally derived sediment quality guidelines is the preferred approach in the longer term, then reference to Section 3.5.4.3 of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality should be included in Section 6.3.1.

Recommendations:

1. Amend Section 6.3.1 to include a reference to the ISQG-low trigger values default

guidelines in Table 3.5.1 of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

2. Amend Section 6.3.1 to include a reference to Section 3.5.4.3 of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality with regard to deriving local sediment quality guidelines
3. Ensure that all reference sites selected to collect data to derive local water quality guidelines for sediment fulfil the reference site criteria in the Queensland Water Quality Guidelines (DEHP 2013).

Response:

According the *Queensland Water Quality Guidelines* (2013) a reference site is a site whose condition is considered to be a suitable baseline or benchmark for assessment and management of sites in similar water bodies. The condition of the site is 'reference condition' and values of individual indicators at that site are the 'reference values'.

Most commonly, reference condition refers to sites that are subject to minimal/limited disturbance. The criteria adopted by the *Queensland Water Quality Guidelines* (2013) for minimally disturbed reference sites are shown in Table 4.4.1 of the guidelines and are replicated in the table below.

Table 4.4.1 Derived from the *Queensland Water Quality Guidelines* (2013) - Criteria for Reference Sites for Physico-Chemical Indicators

	Freshwaters
1	No intensive agriculture within 20km upstream. Intensive agriculture is that which involves irrigation, widespread soil disturbance, use of agrochemicals and pine plantations. Dry-land grazing does not fall into this category.
2	No major extractive industry (current or historical) within 20km upstream. This includes mines, quarries and sand/gravel extraction.
3	No major urban area (>5000 population) within 20km upstream. If the urban area is small and the river large this criterion can be relaxed.
4	No significant point source wastewater discharge within 20km upstream. Exceptions can again be made for small discharges into large rivers.
5	Seasonal flow regime not greatly altered. This may be by abstraction or regulation further upstream than 20km. Includes either an increase or decrease in seasonal flow

Originally the comment provided by EHP stated that not all of the sites surveyed for sediment metal concentrations fulfil the reference site requirements (particularly the pastoral dams) in order to derive local sediment quality guidelines.

EHP therefore recommends, in the interim, the proponent should refer to the ISQG-low trigger values default guidelines in Table 3.5.1 of the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* and to ensure that all reference sites selected to collect data to derive local water quality guidelines for sediment fulfil the reference site criteria in the *Queensland Water Quality Guidelines* (refer to Table 4.4.1).

Appendix 19 has been amended to include further references to the ISQG-low trigger values for the interim as required by EHP comment.

Table 6.12 of Section 6 of the EIS main body report, which is provided below with additional annotation for the monitoring points, outlines the proposed upstream and downstream monitoring points which are suitable for determining the reference condition of the receiving waters in accordance with the *Queensland Water Quality Guidelines* (refer to Table 4.4.1). It should be noted that these sites are for the most part the same as those

sites surveyed during baseline surveys. All proposed reference sites are located in either Retreat Creek or Taroborah Creek i.e. no sites are located within pastoral dams.

Table 6.12 in Section 6 of the EIS: Receiving Water Upstream Background Sites and Downstream Monitoring Points

Monitoring Points	Receiving Waters Location Description	Latitude (GDA94)	Longitude (GDA94)
Upstream Background Monitoring Points			
MP 1 – New site	Taroborah Creek	592460	7394520
MP 2 – Survey site AQ/TAS10	Tributary south of Taroborah Creek	593875	7392625
MP3 – Survey site AQ/TAS5	Retreat Creek	594555	7402037
Downstream Monitoring Points			
MP4 – Survey site AQ/TAS7	Taroborah Creek	595695	7394650
MP5 - Survey site AQ/TAS2	Retreat Creek	597840	7402650
MP6 – Survey site AQ/TAS 1	Retreat Creek	600070	7402480
MP7 – new site	Taroborah Creek	598685	7391555

EIS Amendment:

The last paragraph of Section 6.3.1 of Appendix 19 is amended to read as follows:

"The guidelines state that in some areas natural mineralisation of stream sediments will mean that levels of some metals will be higher than the default low trigger values, or even the high trigger values, without any human interference. In these cases, site specific stream sediment low and high trigger levels should be determined from background data. In the interim, monitoring should continue to compare sediment metal concentrations to the low ISQG trigger values found in Table 3.5.1 of the ANZECC (2000) guidelines. In the absence of guidelines, Section 3.5.4.3 of the ANZECC (2000) guidelines recommend to derive a trigger value on the basis of natural background concentrations multiplied by a factor of two. Another alternative is to apply the water quality guideline values to sediment pore waters (ANZECC 2000)."

16.9 Appendix 19, Section 6.5, Page 67 - Macro-invertebrates

Submitter:

Department of Environment and Heritage Protection

Submission:

For the SIGNAL 2 analysis a description for each of the 4 quadrants on the SIGNAL 2 score plot has been included so that results can be interpreted in Figure 12. However, apart from

indicating toxic pollution or harsh physical environments, the results in quadrant 3 could also indicate inadequate sampling. Furthermore, it is probably premature to conduct a SIGNAL 2 analysis based on single surveys in the wet and dry seasons. It is also not appropriate to apply this assessment methodology to non-permanent streams (or water holes) unless equivalent reference sites are available.

Recommendations:

1. Add the following text (underlined) to dot point three on page 67: *"Quadrant 3 - Often indicates toxic pollution or harsh physical environments (or inadequate sampling)"*.
2. Commit to conducting ongoing background surveys, prior to construction, to represent and recognise a fuller-scope of community population dynamics, and then conduct a SIGNAL 2 analysis.

Response:

The suggested wording for Quadrant 3 has been added to the report for the final EIS document.

The proponent has committed to continue monitoring both Retreat Creek and Taroborah Creek on a quarterly basis over the next 24 months for the purposes of collecting water quality data. At the moment, due to the highly ephemeral nature of both creek systems and the lack of rainfall, there has been no water in any of the pools and water holes that are being monitored for at least the last 6 months. However, should water be encountered next dry season, then certainly macroinvertebrate sampling will be undertaken in order to conduct further Signal 2 analyses.

EIS Amendment:

Dot point 3 on page 67 (now page 91) of Appendix 19 has been amended to read as follows:

"• Quadrant 3 – Often indicates toxic pollution or harsh physical environments (or inadequate sampling); and"

16.10 Appendix 19, Section 7, Page 87 _ Habitat Values

Submitter:

Department of Environment and Heritage Protection

Submission:

Taroborah Creek flows into a high ecological value (HEV) ecosystem area (HEVa 2041), just outside the mining lease boundary, as indicated on the lower Nogoa Plan. Within area HEVa 2041, the management intent (level of protection) for water is to achieve 'no change' through an effectively unmodified waterway condition. However, there is no characterisation of the receiving environment in the HEV area in the Aquatic Ecology Assessment. If there is a chance of impacts to the HEVa 2041 as a result of the mine from construction or operational activities (including a release of mine affected water into Taroborah Creek) then the proponent would need to establish WQOs (an unmodified condition) to achieve the management intent of the HEV area.

Even if waters within HEVa 2041 are currently slightly or moderately disturbed they are to be progressively improved to achieve effectively unmodified water quality in the 20th, 50th and 80th percentiles of HEV waters, habitat, biota, flow and riparian areas.

Recommendation: Establish WQOs (an unmodified condition) to achieve the management

intent of 'no change' for the HEV area (HEVa 2041) located adjacent to the mine site. As there is currently insufficient information available to establish effectively unmodified or 'no change' water quality for these waters the proponent should refer to Section 4.4.6 of the Queensland Water Quality Guidelines (DERM 2013) for details on how to establish a minimum water quality data set for deriving local 20th, 50th and 80th percentiles, noting that all data quality and quantity requirements must be fulfilled.

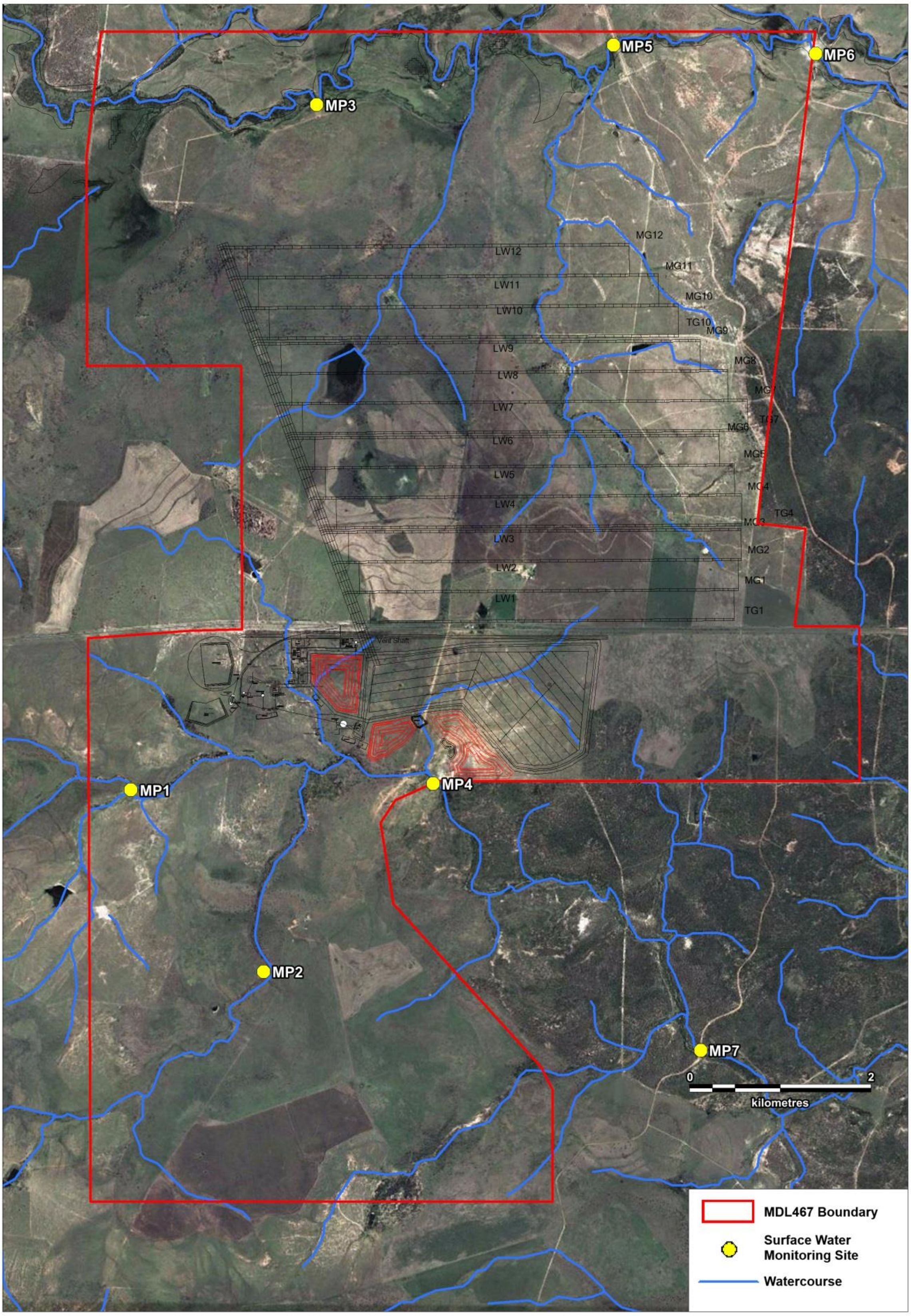
Response:

There is limited characterisation of the receiving environment of HEVa 2041 as determined by survey site AQ/TAS7, which is located in Taroborah Creek immediately upstream of HEVa 2041. The fact that there was only two sampling events where water was available at this site (one wet season with standing water and one dry season with slow flowing water) is more to do with the highly ephemeral nature of Taroborah Creek rather than a lack of intent to characterise the background environment.

The Proponent is conversant with the requirements in the Queensland Water Quality Guidelines (DERM 2013) for establishing a minimum water quality data set for deriving local 20th, 50th and 80th percentiles for this area, and has committed to continue the monitoring of Taroborah Creek in the HEVa 2041 area by including the EIS survey site AQ/TAS7 in the long term monitoring program for the mine (location MP4 in Table 6.12 of Section 6.6), as well as establishing a second monitoring point downstream within HEVa 2014 (location MP7 in Table 6.12 of Section 6.6). Both of these sites will continue to be monitored quarterly for the next 24 months, than at least bi-annually thereafter.

EIS Amendment:

As indicated above, monitoring sites MP4 and MP7 have been maintained and included, respectively, in Table 6.12 and Figure 6.3 of Section 6.6 of the EIS main body report. Table 6.12 is shown in the response in Section 16.8 of this document and Figure 6.3 is replicated below.


MP1
MP2
MP3
MP4
MP5
MP6
MP7
LW1
LW2
LW3
LW4
LW5
LW6
LW7
LW8
LW9
LW10
LW11
LW12
MG12
MG11
MG10
TG10
TG1
TG4
0
2
kilometres
MDL467 Boundary
Surface Water Monitoring Site
Watercourse

16.11 Appendix 19 & EIS Section 4.2, Section 5 and Section 6 - Water Related Ecological Assets – Ongoing Monitoring and Management Framework

Submitter:

Independent Expert Scientific Committee

Submission:

Many of the ecological water related assets within the project area and surrounding region are not clearly identified and therefore the full suite of potential ecological impacts cannot be determined. Total existing and post mining baseflow provision to Retreat, Centre and Taroborah Creeks has not been estimated or measured. Given the groundwater model is unable to predict seasonal reductions in groundwater availability, baseflow related impacts to riparian vegetation and groundwater dependent ecosystems (GDEs) associated with the alluvium of Retreat, Centre and Taroborah Creeks cannot be determined.

The location of springs and semi-permanent pools has not been identified within the EIS, and therefore impacts to these water related assets and ecosystems are unknown. The EIS (Appendix 19, p. 97) indicates that springs and semi-permanent pools occurring on the tributary to Retreat Creek provide refugia for macro-invertebrates, amphibians and fish. This tributary also supports the riparian Silver-leaved Ironbark Woodland community which may be dependent on groundwater. Impacts would be expected to include, a reduction in groundwater availability for springs due to drawdown; changes to the surface flow regime and timing of flows for semi- permanent pool replenishment; increased periods of drying out within semi-permanent pools; and scouring of surface drainage flow channels leading to increased sedimentation within semi- permanent pools.

Recommendations:

1. Features of a monitoring and management framework, not including measures already committed to by the proponent, should include:
    a. Revision of the proposed surface water monitoring locations to un-impacted surface water course reaches. This would improve the suitability of baseline surface water quality data.
    b. Installation of surface water flow meters within Retreat Creek and Taroborah Creek to determine existing seasonal flow dynamics and baseflow estimates.
    c. Continued water quality and quantity monitoring for a period that will provide a comprehensive baseline (24 months) prior to the commencement of construction activities, to provide representative existing surface water and groundwater quality and quantity conditions.
    d. Regular surface water sampling for physicochemical properties, for example, pH, dissolved oxygen, suspended and dissolved sediments. Monitoring should be conducted in accordance with published guidelines (ANZECC and ARMCANZ (2000) Australian Guidelines for Water Quality Monitoring and Reporting. National Water Quality Management Strategy (NWQMS). Document 4 and 7. Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council for Australia and New Zealand, Canberra.)
    e. Implementation of a regular schedule for monitoring of groundwater quality and quantity parameters throughout the life of the project.
    f. Identification of surface water and groundwater quality trigger levels with associated remedial actions to be undertaken should these triggers be

exceeded.

g. Ongoing visual and photographic monitoring of subsidence within and in the vicinity of surface drainages, semi-permanent pools, springs and the large dam located within the predicted extent of subsidence. Subsidence monitoring is needed to identify any necessary mitigation or remediation, confirm that land subsidence does not appreciably increase with time and that the proposed remedial works are effective. Monitoring should be conducted in accordance with the requirements of a subsidence management plan.

2. Details of ongoing GDE and/or spring monitoring locations, and monitoring frequency, have not been provided. A GDE and spring monitoring programme would need to include regular groundwater and surface water monitoring, including flow and water persistence within semi- permanent pools, to aid an assessment of the importance of seasonal water variations to these assets. A programme such as this would allow the development of stress indicators and trigger values to determine when impact mitigation and management measures should be introduced.

3. A systematic approach to identification of GDEs should be taken in which the hydrogeological conceptualisation is used to identify areas of shallow groundwater (less than 20 metres below ground level) and groundwater discharge. The location of springs needs to be incorporated in future assessment documentation or management plans.

4. Stygofaunal sampling carried out in 2011 did not identify stygofauna. However, these samples were taken from deeper, consolidated, hydrogeological units and did not include sampling from likely stygofauna habitat in alluvium. Recent bores have been installed within the alluvium which should be sampled to determine the presence of stygofauna.

5. The use of groundwater by riparian vegetation should be evaluated using techniques from the Australian Groundwater Dependent Ecosystem Toolbox (AGDET). Use of the AGDET would allow an improved assessment of the impacts of groundwater drawdown and subsidence on any identified vegetation GDEs. For example, the assessment of GDEs within the EIS only considered surface expressions of groundwater as potential GDEs. However, vegetation within and in proximity to the proposed project area contains deep rooted species that have the potential to use groundwater and should be considered as potential GDEs.

6. The location, size and the ecosystems supported by semi-permanent pools and springs within the Taroborah Coal project area should be identified. Pools should be monitored for their duration of persistence and for water quality pre and post wet season

7. A number of streams across the proposed project area appear to be supported by shallow groundwater. A depth to water table map is needed to inform the hydrological conceptualisation for the surface water catchments of Retreat Creek and Taroborah Creek.

Response:

<u>Response to 1</u>

The planned interim surface water and groundwater monitoring locations for Taroborah that will be sampled over the next 24 months are illustrated in the following Figure A.

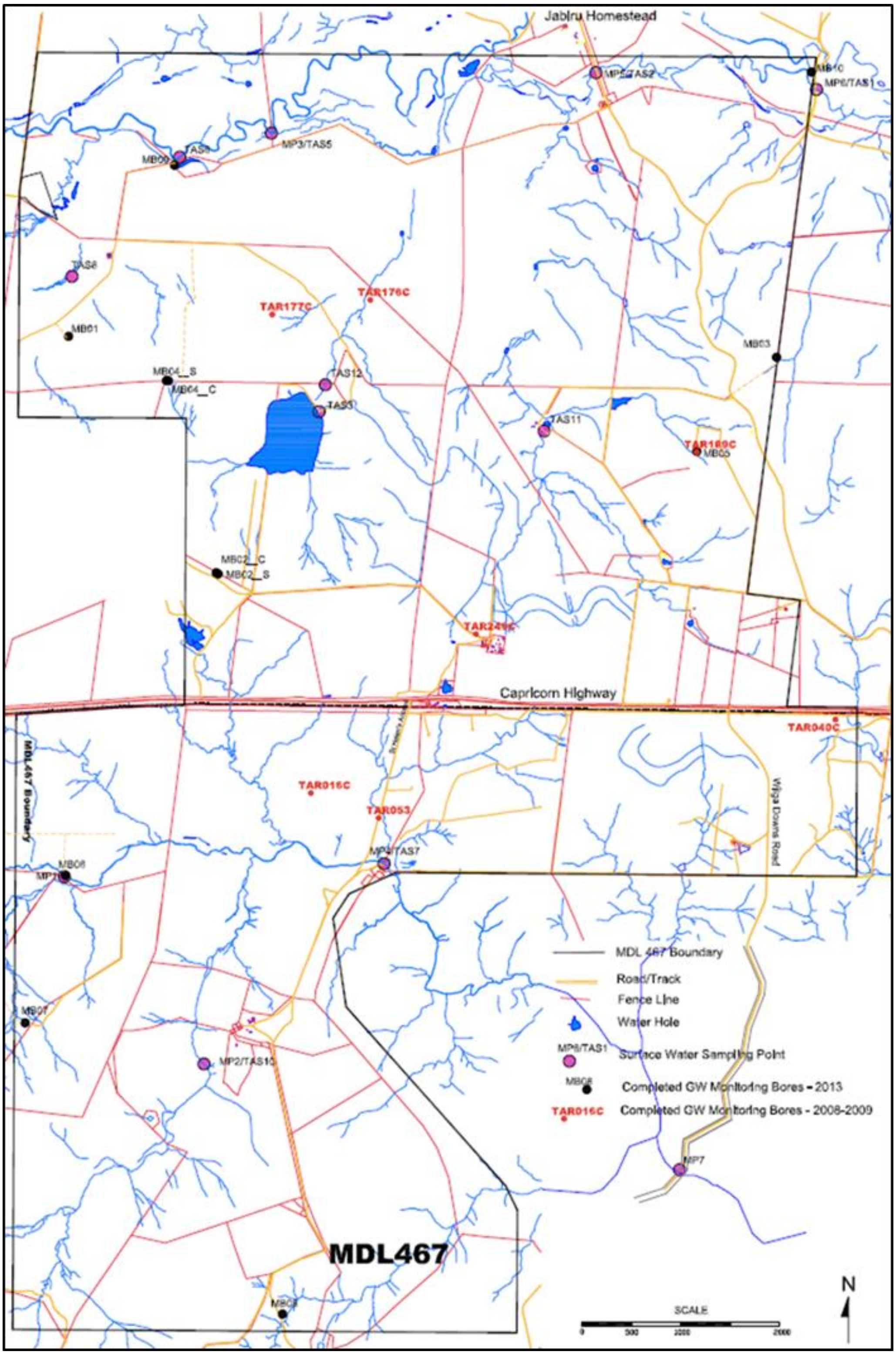


Figure A : Planned Interim Surface Water and Groundwater Monitoring Points

The surface water monitoring locations have been revised slightly from those in the Draft EIS to cater for a more direct measuring location on Taroborah Creek downstream of the project site (MP7) as well as add monitoring points for the major Lacustrine wetland system (TAS3) and Palustrine wetland (TAS12) resulting from the Lacustrine wetland in the central west area of the project, the Paulstrine wetlands system in the northwest of the project

area adjacent to Centre Creek(TAS8), and the intermittent spring system feeding the drainage line to Retreat Creek in the central portion of the project area (TAS11). The monitoring points at MP1 and MP3/TAS5 have remained as previous as they are considered sufficiently far upstream from potential impact sources so as to be suitable for baseline quality data. Further, by maintaining the sampling positions in as many of the same locations as possible to the EIS survey locations, this previous information can be combined with future information to more readily establish appropriate "background" quality parameters against which to compare future impacts.

For the groundwater monitoring system, all currently installed monitoring bores are included in the revised network to provide maximum data coverage, including the near pit TAR016C and TAR053 bores to monitor groundwater impacts from opencut mining and surface operations.

Although both Retreat Creek and Taroborah Creek are ephemeral, flow meters are planned to be installed at the MP1 and MP3 monitoring locations to provide measurement of flows following storm events.

The quarterly water sampling frequency at all surface water and groundwater monitoring points was always planned to be maintained for a further 12 months to provide at least 24 months of data as discussed in the Draft EIS, and another round of samples was recently taken in early September of this year. At the conclusion of the 24 month period, the sample results will be reviewed to ascertain the adequacy of the sampling interval and the necessity to decrease the intervals at some locations or opportunity to increase the interval at others. Each sample obtained is sent to ALS laboratories for undertaking the complete suite of testing as recommended in the various guidelines and as has been reported in the Draft EIS.

Appropriate quality trigger levels will be established prior to mining after sufficient background data has been obtained.

Both visual and physical (surveying) monitoring of subsidence will be undertaken as part of the standard Subsidence Management Plan for longwall mining that will be developed in due course.

<u>Response to 2, 3, and 6</u>

The Bureau of Meteorology's (BoM) Atlas of Groundwater Dependent Ecosystems identifies the potential for groundwater interaction, through surface expression, sub-surface interaction, or the presence of aquifer/cave ecosystems. Mapping of likely aquifer/cave ecosystems in Queensland is currently not available. GDEs are ecosystems that depend to some degree on the surface expression of groundwater or the sub-surface presence of groundwater.

The BoM Atlas of GDEs revealed a number of areas on and around the Project site that have moderate or high potential for sub-surface groundwater interaction or surface expression of groundwater. Field surveys conducted for the Aquatic Ecology Assessment noted the potential for some vegetation communities on the Project site (e.g. Silver Leaved Ironbark Open Woodland) to be dependent on groundwater to some degree. Deep-rooted vegetation of the Silver Leaved Ironbark Open Woodland community (RE 11.3.6) occurring along the riparian zone of one of the more substantial tributaries of Retreat Creek may be dependent on subsurface groundwater. Their dependence on groundwater may be permanent or intermittent to meet their water requirements. Due to the ephemeral nature of many of the watercourses in the region, it is possible that groundwater resources may be utilised to supplement water requirements. Depth to groundwater in the vicinity of Retreat Creek is approximately 6-10 mbgl. Shallower-rooting vegetation, such as shrubs and

groundcover, are not thought to be reliant on groundwater. Elsewhere within the Project boundaries, only a few, isolated instances of shallower (15-20 mbgl) groundwater occurrence where encountered during exploration drilling.

Retreat Creek and Taroborah Creek, which traverse the northern and southern portions of the Project site, respectively, do not appear to receive surface expressions of groundwater, as these watercourses were found to be dry during dry season surveys. The Atlas of GDEs indicates that Retreat Creek has a moderate potential to interact with groundwater as a surface expression. Vegetation communities on the Project site have been noted for their potential to utilise groundwater. However, vegetation associated with palustrine wetlands on the site is limited to shrub and groundcover species, reducing the likelihood for groundwater dependence.

Figure B and Figure C indicate the likelihood of groundwater interaction in relation to water related assets.

- Springs

  The Project site is located in the vicinity of the Great Artesian Basin (GAB) and consequently, there are a number of springs associated with the GAB in the catchments surrounding the site. Figure D indicates the location of these regional springs. As indicated, no springs have been mapped within the immediate vicinity of the Project site, on both the Queensland Springs Database and the BoM GDE Atlas. The GDE Atlas does not indicate the presence of any spring-fed wetlands in the vicinity.

  Despite the lack of mapped springs within the Project, aquatic ecology field assessments noted that the drainage line into Retreat Creek on which the Silver-leaved Ironbark Woodland (RE 11.3.6) occurs is likely to be fed by a local spring (monitoring site TAS11 on Figure A), although the drainage was dry when visited in May and September 2014. Some sections of the Nogoa River are also known to be partially spring-fed from the Precipice Sandstone (Queensland Water Commission 2012). While there are a number of mapped springs within the Nogoa River and Comet River catchments, no springs are mapped on watercourses associated with the Project, either upstream or downstream.

  As mentioned above, a number of semi-permanent pools of conservation value to the region were identified during the 2011 and 2012 field surveys on a drainage line feeding Taroborah Creek from the south (monitoring site MP2/TAS10 on Figure A). These waterholes will be assessed to determine their potential for groundwater interaction. However, there was no water evident during sampling exercises in May and September 2014.

- Inflow Dependent Ecosystems

  Inflow dependent ecosystems (IDEs) are ecosystems that rely on water in addition to rainfall. These additional water sources may be surface runoff, soil moisture, or groundwater. IDE mapping (Figure E) indicates that the lacustrine wetlands in the central west and west of the Project site coincides with an areas of high likelihood for dependence on additional water sources. A substantial portion of RE 11.3.3a (River Teatree Riparian Woodland) fringing Taroborah Creek also coincides with an area mapped as being likely to be dependent on water other than rainfall. Areas with particularly high likelihood of utilising additional water sources also include:

  - Retreat Creek;
  - The palustrine wetland in the northwest of the project site along Centre

Creek;

- The central west dam / lacustrine wetland; and
- Taroborah Creek and the pools identified during field surveys along a contributing drainage line from the south (Site TAS10/AQ10).

As indicated in the Figure A above, most all of the above described assets are included in the planned surface water monitoring programme for Taroborah.

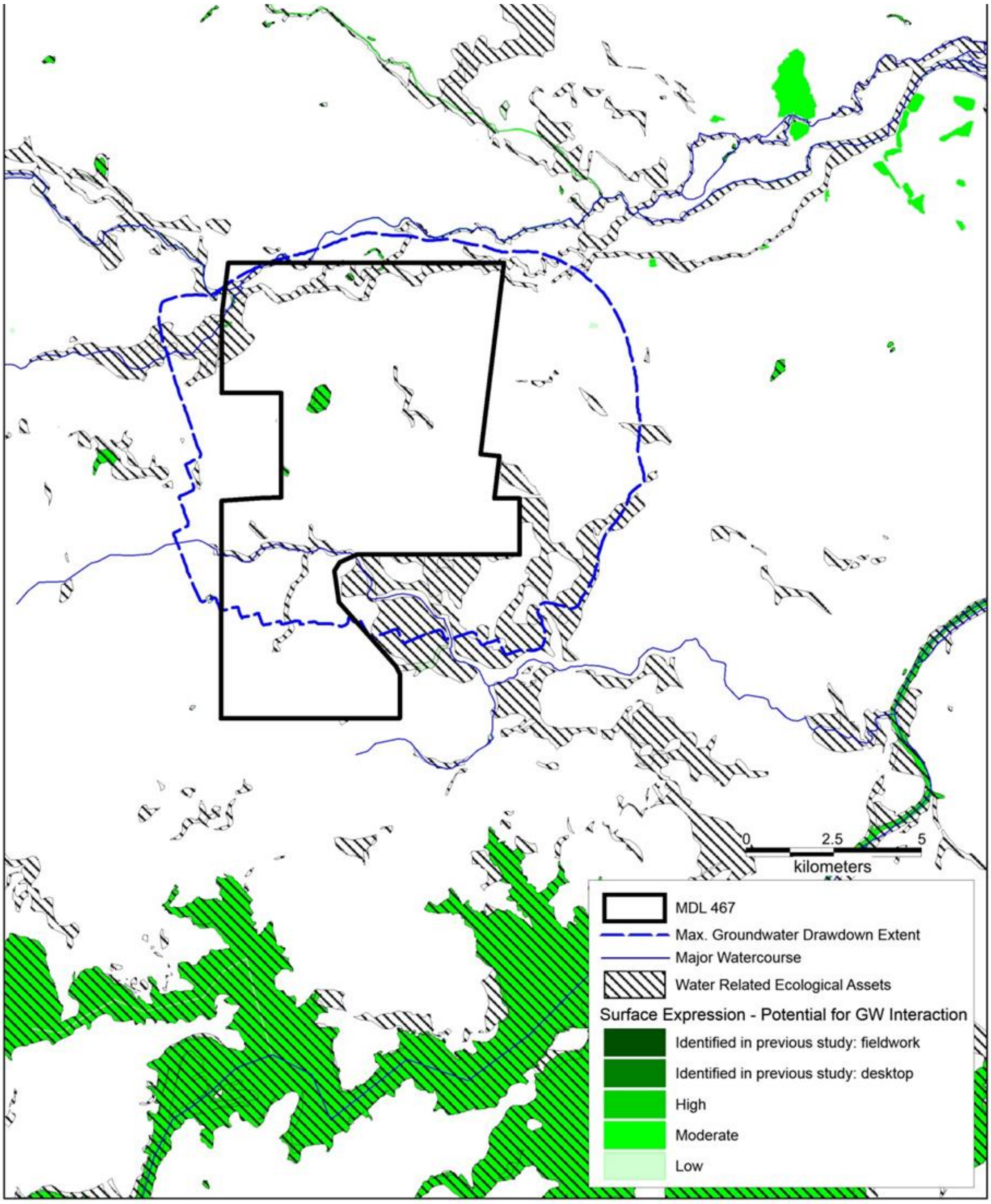


Figure B : Likelihood of Interaction with Groundwater – Surface Expression of Groundwater

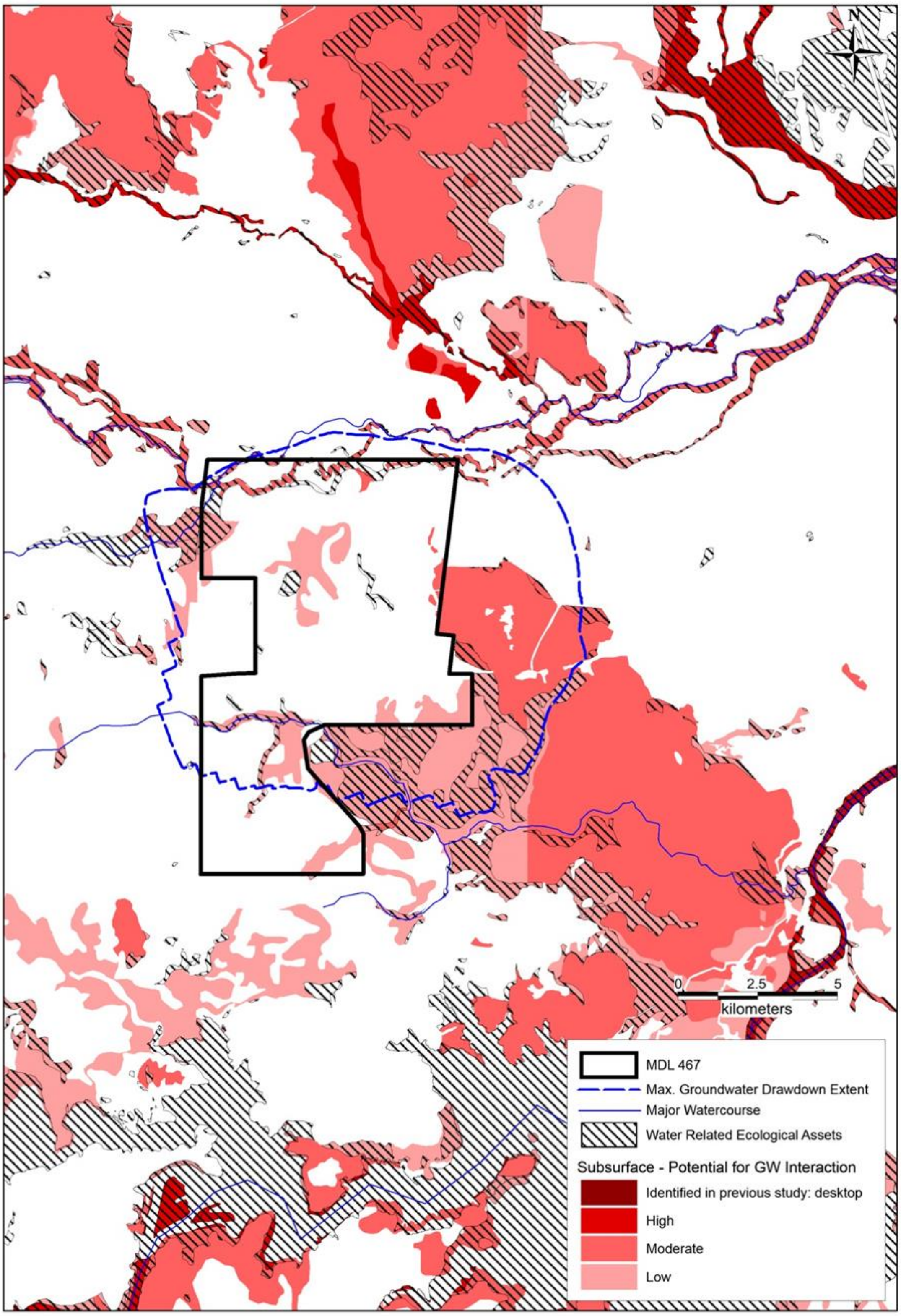


Figure C : Likelihood of Interaction with Groundwater – Sub-surface Expression of Groundwater

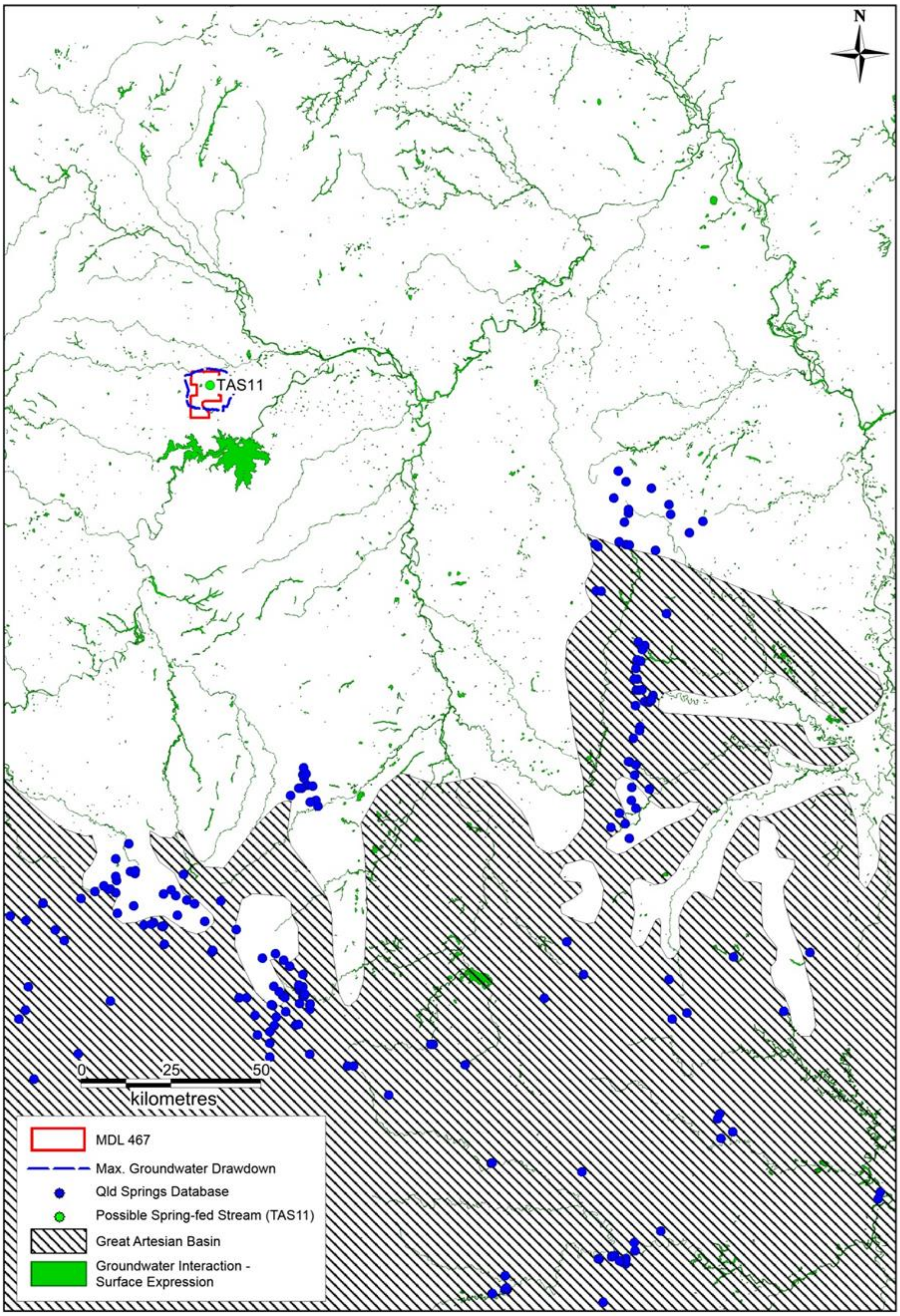


Figure D : Springs Associated with the Great Artesian Basin

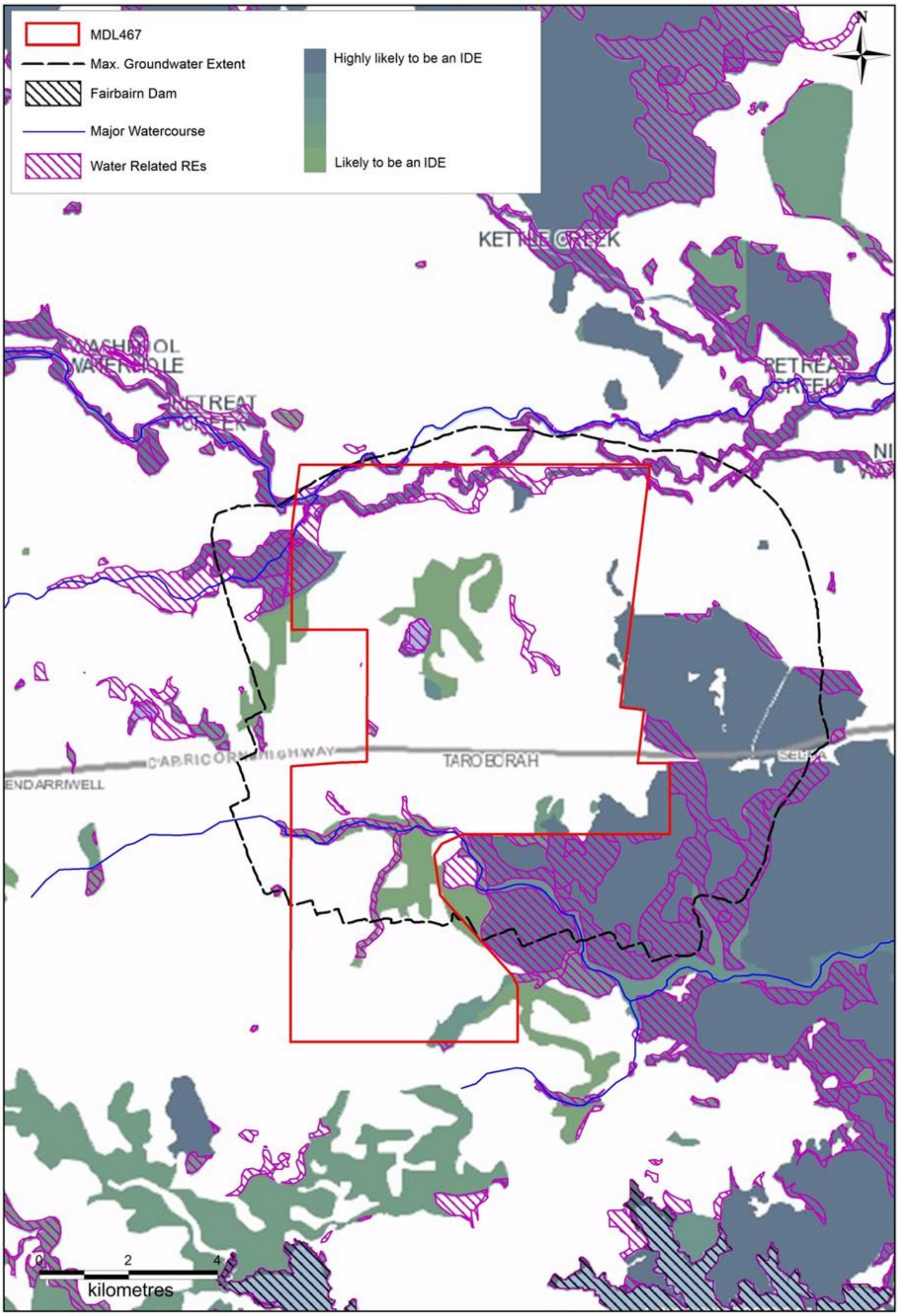


Figure E : Mapped Inflow Dependent Ecosystems

Response to 4

The pilot stygofauna sampling program conducted in September 2011 at seven monitoring bores located on the Project site did include one bore screened within Tertiary basalt (Tb),

with the rest located in the deeper lying Aldebaran sandstone. No stygofauna were identified in any of the groundwater samples collected during the pilot program. An additional sampling program is proposed to be undertaken in future to specifically target the alluvium. The survey will include the alluvial groundwater monitoring bores on the Project site installed in 2013 (MB09 and MB10) as well as additional private bores in the surrounding area if access can be gained.

Response to 5

In conducting the initial field surveys, the Australian Groundwater Dependent Ecosystem Toolbox (AGDET) evaluation framework was not used, as suggested above by the IESC, simply because it was not available at that time. The National Water Commission (2011) did not develop AGDET until 2011.

Now that AGDET is available, additional potential sites located outside the project boundary but within a conceivable impact distance (i.e. 3-5 km from the Project boundary) that are mapped within or adjacent to publicly accessible land will be surveyed for groundwater dependency as suggested by the IESC and added to the monitoring program if suitable.

In order to understand the ecological water requirements (EWRs) of these assets with potential groundwater dependence, AGDET will be utilised as it provides a framework for evaluating GDEs and their EWRs. EWRs represent:

- The likely responses of ecosystems (or ecosystem components) to changes in the quality and/or quantity of groundwater;
- The hydrological conditions necessary for persistence of the ecosystem; and
- The thresholds that represent the hydrological limits beyond which an ecosystem is not resilient or cannot persist (National Water Commission 2011).

The use of the AGDET framework will allow characterisation of the groundwater dependence of these ecosystems to determine whether they are indeed GDEs, and understanding of the importance of seasonal variations in water quantity, quality and flow. Characterisation of hydrological ranges and critical thresholds will assist in developing trigger values to indicate when mitigation and management strategies are necessary.

The AGDET outlines the following three-step approach:

1. Identify the location, classification and conceptualisation of GDEs:
    a. Identify the location of ecosystems that have the potential to utilise groundwater.
    b. Determine the GDE type/functional grouping.
2. Characterise dependence on groundwater:
    a. Determine the role of groundwater in the ecosystem.
    b. Determine the degree of reliance on groundwater.
3. Characterise the ecological response to changes in groundwater quantity/quality/flow:
    a. Identify potential threats to groundwater and the ecosystem.
    b. Determine how changes to groundwater may result in changes to the ecosystem.
    c. Determine how these potential changes may impact the long-term presence/viability of the ecosystem.

The AGDET framework recommends a range of ecological and biological indicators for assessment and monitoring of GDEs. The table below details the indicators and variables to be monitored, based on those presented in the AGDET.

Recommended Indicators and Variables

Indicators	Variables
Ecosystem Structure	
Hydrology / Hydrogeology	– Groundwater levels – Groundwater pressures, amount of abstraction – Surface water levels and flow
Water Quality	– See Table 3 (surface water) and Table 5 (groundwater)
Vegetation	– Species diversity of plant and algal communities – Cover and abundance of indicator plant and algal species – Species evenness over time – Weed index over time – Regeneration index over time – Canopy fullness/density of indicator species – Community distribution and/or zonation change or distribution of indicator plant species along a gradient – Size (height) and age structure of a local population – Canopy health
Fauna	– Presence/absence of indicator species – Community composition – Stygofauna species, abundance and/or community composition – Microbial species, abundance and/or community composition – Macroinvertebrate species, abundance and/or community composition – Fish species, abundance and/or community composition
Climate	– Rainfall – Maximum temperatures – Evaporation
Ecosystem Processes	
Biogeochemistry and Ecosystem Function	– Rates of community respiration – Rates of primary production – Rates of nutrient cycling – Rates of acid generation

Adapted from: National Water Commission 2011

<u>Response to 7</u>

As discussed above, there is only one "stream" identified across the Project site that is supported by shallow groundwater. This stream is the drainage line occurring in the central portion of the property running northward to Retreat Creek that is fed by an intermittent spring, which is currently dry. No other "shallow" groundwater (<10 mbgl) has been encountered in the 130 plus exploration boreholes drilled across the property and located away from Retreat Creek. And only the two monitoring bores drilled in 2013 and located adjacent to Retreat Creek encountered shallow groundwater. Therefore, a depth to water table map to inform the hydrological conceptualisation for the surface water catchments of Retreat Creek and Taroborah Creek can be developed but will likely not reveal anything new with regard to shallow groundwater dependent ecosystems.

EIS Amendments:

A new Section 7.1.1 – Wetland Values in Appendix 19 and in Section 4.5.1.1 – Surface Waterways in the EIS main body report addresses, among other things, the importance of semi-permanent pools in point 6 above by including a sub-heading as follows:

"**Waterholes**

A few semi-permanent waterholes exist within the Project site, although some of these may become dry at certain times of the year. These areas should be monitored pre- and post-wet season, with the emphasis upon water quality and invertebrate fauna. This is in recognition of their importance and high conservation value to the ecology of the region. These waterholes are vital refuges to the aquatic biota, and in the dry season, may be the only available watering points for wildlife."

The discussion on Groundwater Dependent Ecosystems in Section 4.8.2.3 of the EIS main body report has been expanded to read as follows:

"The Bureau of Meteorology's (BoM) Atlas of Groundwater Dependent Ecosystems (GDEs) identifies the potential for groundwater interaction, through surface expression, sub-surface interaction, or the presence of aquifer/cave ecosystems. Mapping of likely aquifer/cave ecosystems in Queensland is currently not available. GDEs are ecosystems that depend to some degree on the surface expression of groundwater or the sub-surface presence of groundwater. The BoM Atlas of GDEs revealed a number of areas on and around the Project site that have moderate or high potential for sub-surface groundwater interaction or surface expression of groundwater.

No ecosystems were encountered on the Project site which exhibited a high potential for interaction with the surface expression of groundwater (groundwater dependent ecosystems (GDEs)), except for a creek which flows northward towards Retreat Creek that is fed by a local spring (sampling location TAS11 – refer to Figure 4.114). During the dry season, Retreat Creek and Taroborah Creek were not found to be flowing, implying that these watercourses do not receive flows from surface expressed groundwater. Field surveys conducted for the Aquatic Ecology Assessment noted the potential for some vegetation communities on the Project site (e.g. Silver Leaved Ironbark Open Woodland) to be dependent on groundwater to some degree. Deep-rooted vegetation of the Silver Leaved Ironbark Open Woodland community (RE 11.3.6) occurring along the riparian zone of one of the more substantial tributaries of Retreat Creek may be dependent on subsurface groundwater. Their dependence on groundwater may be permanent or intermittent to meet their water requirements. Due to the ephemeral nature of many of the watercourses in the region, it is possible that groundwater resources may be utilised to supplement water requirements.

Since groundwater levels in the vicinity of Retreat Creek have been recorded approximately six metres below ground level, only deep-rooted vegetation (such as the Eucalypt trees which form the dominant canopy) may use subsurface groundwater as a water supply."

And two new sub-sections have been added to Section 4.8.2.3 – Aquatic Biology Results of the EIS main body report following the above discussion that read as follows:

"Springs

The Project site is located in the vicinity of the Great Artesian Basin (GAB) and consequently, there are a number of springs associated with the GAB in the catchments surrounding the site. No springs have been mapped within the immediate vicinity of the Project site, on both the Queensland Springs Database and the BoM GDE Atlas. The GDE Atlas does not indicate the presence of any spring-fed wetlands in the vicinity.

Despite the lack of mapped springs within the Project, aquatic ecology field assessments noted that the drainage line of Retreat Creek on which the Silver-leaved Ironbark Woodland (RE 11.3.6) is located is likely to be fed by a local spring (aquatic sampling site TAS11). It is also possible that some of the wetlands mapped may represent springs/surface expressions of groundwater emanating from the GAB. Some sections of the Nogoa River are also known to be partially spring-fed from the Precipice Sandstone (Queensland Water Commission 2012). While there are a number of mapped

springs within the Nogoa River and Comet River catchments, no springs are located on watercourses associated with the Project, either upstream or downstream. As mentioned above, a number of semi-permanent pools of conservation value to the region were identified on a drainage line of Taroborah Creek during field surveys. These waterholes will be assessed to determine their potential for groundwater interaction.

Inflow Dependent Ecosystems

Inflow dependent ecosystems (IDEs) are ecosystems that rely on water in addition to rainfall. These additional water sources may be surface runoff, soil moisture, or groundwater. IDE mapping (Figure 5) indicates that the lacustrine wetland in the central west of the Project site coincides with an area of high likelihood for dependence on additional water sources. A substantial portion of RE 11.3.3a (River Teatree Riparian Woodland) fringing Taroborah Creek also coincides with an area mapped as being likely to be dependent on water other than rainfall. Areas with particularly high likelihood of utilising additional water sources also include:

- Retreat Creek;
- The palustrine wetland in the north-west of the site;
- The central dam / lacustrine wetland; and
- Taroborah Creek and the pools identified during field surveys along its tributaries (aquatic site TAS10/AQ10)."

And the following sub-section has been added to Section 4.8.3.1 - Potential Impacts of the Project of the EIS main body report following the above discussion that read as follows:

"**Impacts to Groundwater Dependent Ecosystems**

Dewatering of aquifers is a typical requirement for open-cut mining operations where the open-cut pit is lower than the water table. This results in lowering of the water table, known as groundwater drawdown. Groundwater drawdown may cause salinisation and/or contamination of aquifers, altering the chemistry and quality of groundwater (Eberhard et al. 2004). Drawdown of the water table may cause desiccation of sediments, altering the balance of aerobic and anaerobic processes and influencing the microbial composition within populations (Tomlinson and Boulton 2008). Mortality of subterranean fauna may occur as a result of stranding due to drawdown of the water table (Stumpp and Hose 2013).

Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) modelled groundwater drawdown for the Project (AGE 2013). The maximum extent of groundwater drawdown extends up to approximately 3.5 km beyond the Project site, predominantly to the east (AGE 2013). Within this extent of drawdown, vegetation communities or flora species that depend to some degree on access to sub-surface groundwater may be impacted if the groundwater level falls lower than the root zone.

Groundwater levels in the vicinity of Retreat Creek have been recorded at approximately 6 mgbl; only deep-rooted vegetation (such as the Eucalypt trees) may use subsurface groundwater as a water supply. A groundwater reduction of approximately 5 m has been modelled around Retreat Creek, while a 30 m reduction has been modelled around Taroborah Creek. This will result in impacts to vegetation that utilise groundwater, such as deep-rooted Eucalypt species associated with RE 11.3.25, 11.3.3a or 11.3.6. Vegetation lacking deep-roots (i.e. shrubs and groundcover species) is not anticipated to be impacted by operational groundwater drawdown.

Mining activities may disturb groundwater flow regimes, spatially and/or temporally. For example, disturbance to hydrological connectivity patterns may alter the quality, flow and/or flux of groundwater, potentially affecting nutrient cycling (Tomlinson and Boulton 2008). More broadly, changes to the groundwater regime may "alter the rate and nature of subsurface ecological processes, resulting in reduced availability of carbon, nitrogen and phosphorous, with flow-on effects for biodiversity and ecosystem services" (Tomlinson and Boulton 2008, p.20), particularly those that rely directly on access to groundwater. Figure 5 indicates the potential changes to the water table during the operations phase of the Project. Changes to the groundwater level will mostly affect the area south of Retreat Creek and north of Taroborah Creek."

Section 3.3 of Appendix 26 – Independent Expert Scientific Committee Report has had several amendments as provided below.

A new third paragraph has been added to the introduction of Section 3.3 that reads as follows:

"The IESC defines a water-dependent asset as: "an entity…where the characteristics can be ascribed a defined value and which can be clearly linked, either directly or indirectly, to a dependency on groundwater or surface water quantity or quality" (IESC 2013, p.38). Water related ecological assets were identified within the vicinity of the Taroborah Project by reviewing the following datasets:

- Aquatic Ecology Report and ground-truthed vegetation mapping based on ecological field surveys of the Project site;
- Aquatic Conservation Assessment (ACA) for the Great Barrier Reef region. The most recent version of the non-riverine ACA incorporates springs in addition to other wetlands;
- Bureau of Meteorology's Groundwater Dependent Ecosystem (GDE) Atlas, used to determine the likelihood of GDEs and Inflow Dependent Ecosystems (IDEs) (BoM 2012);
- Regional Ecosystem (RE) Mapping;
- Wetland Protection Area Mapping;
- Wetland Management Area Mapping;
- Vegetation Management Watercourse Map;
- Vegetation Management Wetlands Map; and
- Queensland Springs Register.

Data relating to wetlands, REs and springs were obtained from the Queensland Government Information Service (QGIS).

A summary of key water related ecological assets is provided in Table 26.

Table 26 Summary of Key Water Related Ecological Assets

Asset	Easting*	Northing*	Area (ha)	Description
Watercourses				
Nogoa River	593867	7380107	-	ACA score of Medium with a score of High in some sections. RE 11.3.25 (*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines) along riparian zone. Non-perennial watercourse.
Taroborah Creek	595854	7394367	-	ACA score of Medium. Non-perennial watercourse. Considered unlikely to receive surface expressions of groundwater.
Retreat Creek	553498	7408100	-	ACA score of Medium. Non-perennial watercourse. Considered unlikely to receive surface expressions of groundwater.
Centre Creek	583234	7398275	-	ACA score of Medium. Non-perennial watercourse.
St Helens Creek	604160	7391835	-	ACA score of Medium. Non-perennial watercourse.
Riverine Wetlands				
Riverine Wetland (Nogoa R.)	611059	7390054	414.8	Riverine Wetland Management Area (WMA) under Vegetation Management Act (VM Act) located south-east of the site along the Nogoa River. RE

Asset	Easting*	Northing*	Area (ha)	Description
				11.3.25 associated with riverine wetland.
Lacustrine				
Fairbairn Dam	612837	7376884	16,700	ACA score of High. Listed on the Directory of Nationally Important Wetlands.
Small Dam (Lacustrine Wetland)	593786	7396960	4.8	Located in the west of the Project site. Mapped during field surveys. Not consistent with any REs.
Dam (Lacustrine Wetland)	594795	7,99063	27.4	Located in the central-west of the Project site. ACA score of Medium. Mapped during field surveys. Not consistent with any REs.
Palustrine Wetlands				
Large Palustrine Wetland	592461	7400821	109.5	Mapped during field surveys in the north-west of the site. However, ground truthing revealed that the extent of the wetland in the NW corner of the site is larger than the EHP mapped wetlands, incorporating 2 palustrine wetlands occurring in close proximity to each other. Wetland encompasses two smaller wetland areas mapped on ACA mapping with scores of Medium. Corresponds to RE 11.3.27 (Freshwater wetlands).
HES Wetland	600099	7407137	7.8	ACA score of High. Shown as a Wetland Protection Area (WPA) and a wetland of High Ecological Significance (HES) under the VM Act. Corresponds to RE 11.3.27 (Freshwater wetlands).
Lakes				
Nine Mile Waterhole	606433	7402943	2.3	Perennial lake associated with RE 11.3.1/11.3.37 (50%/50%). RE 11.3.1 (*A. harpophylla* and/or *Casuarina cristata* open forest on alluvial plains) is listed as Endangered under the VM Act. RE 11.3.37 (Eucalyptus coolabah fringing woodland on alluvial plains) is not of conservation significance.
Washpool Waterhole	588245	7405256	3.02	Perennial lake associated with RE11.3.2/11.3.25/11.3.3/11.3.1 (45%/35%/15%/5%). RE 11.3.2 (*E. populnea* woodland on alluvial plains) is listed as Of Concern under the VM Act.
Riparian Vegetation Communities				
Silver Leaved Ironbark Open Woodland	597314	7399020	5.927	Corresponds to RE 11.3.6 (*Eucalyptus melanophloia* woodland on alluvial plains), which is not considered to be of conservation significance. Aquatic Ecology Assessment noted that deep-rooting species may utilise groundwater. Drainage line may be spring-fed.
River Red Gum Riparian Woodland	592323	7402227	190	Corresponds to RE 11.3.25 (*E. tereticornis* or *E. camaldulensis* woodland fringing drainage lines), which is not considered to be of conservation significance.

Asset	Easting*	Northing*	Area (ha)	Description
River Teatree Riparian Woodland along watercourse lines in north and south of site	595493	7402078	26.2	Corresponds to RE 11.3.3.a (Riverine wetland or fringing riverine wetland/ *M. bracteata* woodland on alluvial plains), which is listed as Of Concern under the VM Act.
	593853	7393379	116.8	
Brigalow / Belah Low Open Woodland	592951	7395235	8.5	Consistent with RE 11.4.9 (*A. harpophylla* shrubby woodland with Terminalia oblongata on Cainozoic clay plains). RE 11.4.9 is listed as Endangered under both the VM Act and EPBC Act.

* MGA GDA 94, Zone 55"

Two new paragraphs have been added to the beginning of the first bullet point – River Red Gum Riaparian Woodland of Section 3.3.1 – Aquatic and Riparian Vegetation in Appendix 26 that read as follows:

"A close association was noted between palustrine wetlands and REs in the north of the Project site. These REs are considered to be 51-80% wetland and are typically River Red Gum Riparian Woodland (RE 11.3.25 – Eucalyptus tereticornis or Eucalyptus camaldulensis woodland fringing drainage lines) with a small segment (26.2 ha) of River Teatree Riparian Woodland (RE 11.3.3a – Riverine wetland or fringing riverine wetland/ Melaleuca bracteata woodland on alluvial plains).

While Retreat Creek itself is not considered likely to receive surface expressions of groundwater, groundwater levels in the vicinity of Retreat Creek are approximately 7-10 mbgl. Deep-rooted vegetation species, such as Eucalypt species of RE 11.3.25, therefore have the potential to utilise sub-surface groundwater."

The following discussion has been added to Section 3.3.2 – Wetlands in Appendix 26:

"Other water-related features in the vicinity of the Project are shown in Figure 11 and discussed below.

- *Watercourses*

The major watercourses in the vicinity of the Taroborah Project are: Retreat Creek, Centre Creek, Taroborah Creek, St Helens Creek and the Nogoa River. The ACA for riverine systems classified these non-perennial watercourses as Medium ecological significance, however, one section of the Nogoa River to the south-west of the site is classed as High significance. The Nogoa River is primarily associated with RE 11.3.25 (E. tereticornis or E. camaldulensis woodland fringing drainage lines).

- *Riverine Wetlands*

Two riverine wetlands identified as Wetland Management Areas are located in proximity to the Project site, including one wetland occurring along the Nogoa River. Both wetlands are associated with RE 11.3.25. Most riverine systems in the area receive a Medium ACA Score, as do many non-riverine systems.

- *Lacustrine Wetlands*

Fairbairn Dam is a major lacustrine wetland located south of the Project site. The ACA concluded that the Dam has a High ecological significance and it is listed on the Directory of Nationally Important Wetlands. Although artificial, it provides important equivalent natural lake/swamp habitat and dry season refuge for waterbirds (Department of Environment 2010).

Two artificial lacustrine wetlands were mapped on the Project site during field surveys. These included a large dam (lacustrine wetland) in the central portion of the site, and a small dam (lacustrine wetland) in the west of the site. Both received scores of Medium under the ACA. These wetlands were found to be associated with sparse canopies of regrowth Brigalow with shrub layers dominated by exotic species. Neither wetland is consistent with any RE.

Permanent waterbodies on the Project site are likely to provide important habitat for a number of common amphibian species, particularly given the ephemeral nature of watercourses and floodplain wetlands. The larger dam (lacustrine wetland) in the central area of the site provides the only source of permanent water and was found to support substantial and complex habitat for fauna, with little evidence of erosion due to an abundance of vegetation both in and surrounding the dam.

- *Palustrine Wetlands*

One large, ephemeral palustrine wetland associated with Centre Creek was mapped in the north-west of the Project site during field surveys. Ground-truthing determined that the extent of this palustrine wetland community is larger than EHP mapped wetlands, incorporating two palustrine wetlands occurring in close proximity to one another. These two EHP mapped wetlands received Medium ACA Scores.

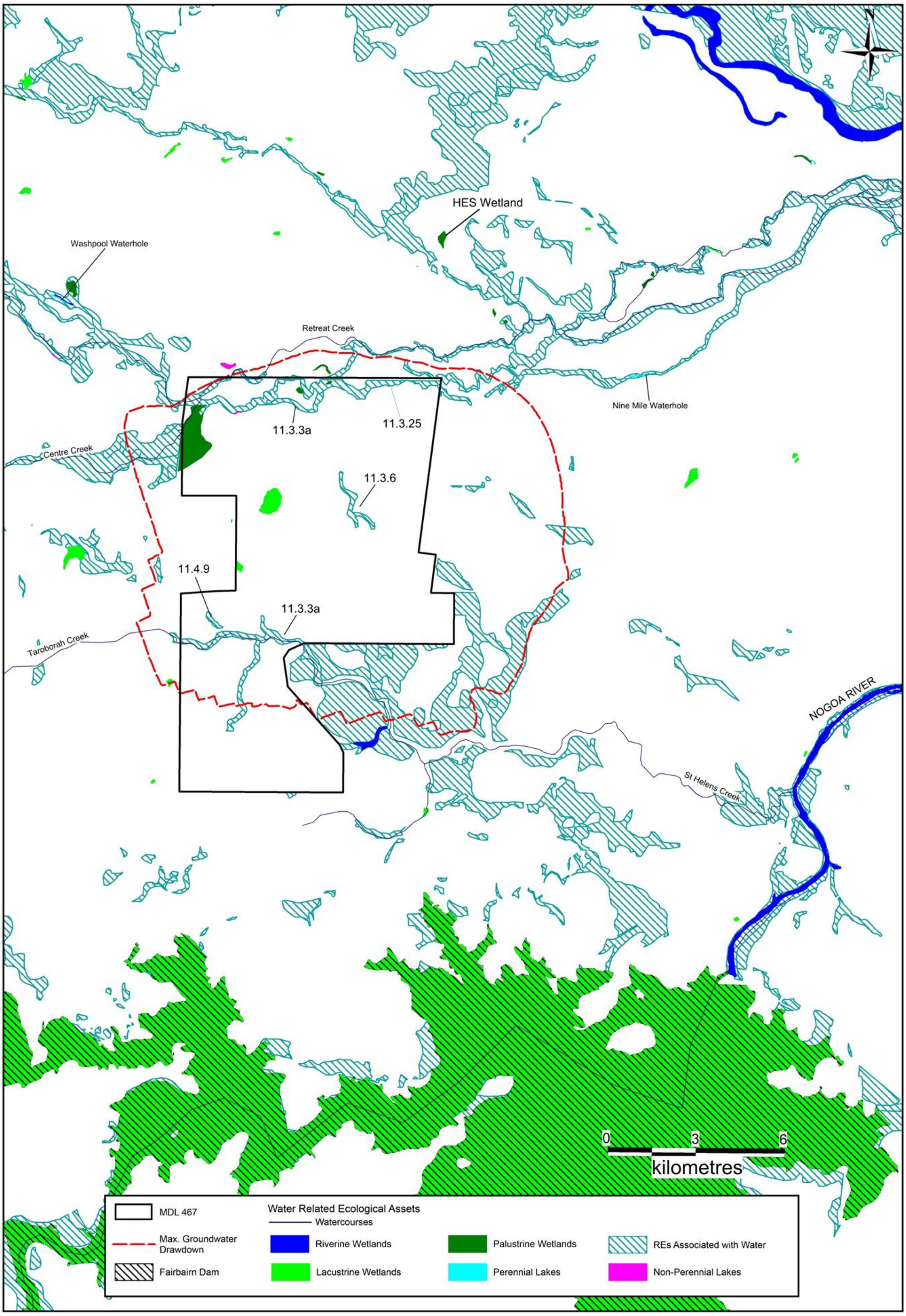
During the dry season survey, only a small quantity of water was evident. The wetland is considered to support good aquatic habitat, with evidence of variation in substrate and cover elements. Vegetation is dominated by grass species, which vegetate the banks of the wetland.

Three palustrine wetlands of High Ecological Significance and High ACA scores are located to the east and north-east of the Project site. One is classified under EHP mapping as RE 11.3.27b (Freshwater Lacustrine Wetland), while the other two are RE 11.3.3.c (Eucalyptus coolabah woodland on alluvial plains).

- *Lakes*

A number of perennial lakes and waterholes are present in the region, including Washpool Waterhole to the north-west of the Project site, and Nine Mile Waterhole, located to the east. Washpool waterhole is associated with RE 11.3.1/11.3.37, and Nine Mile Waterhole is associated with mixed REs dominated by RE 11.3.2 (Eucalyptus populnea woodland on alluvial plains). Various non-perennial lakes also occur within the region.

The Aquatic Ecology Assessment noted the presence of a number of semi-permanent pools located along the southern-most drainage line into Taroborah Creek (Sites TAS10/AQ10). These pools may become dry at certain points throughout the year. These pools are considered to be of high conservation value to the ecology of the region, providing vital refuges to the aquatic biota, and in the dry season, may be the only available watering points for wildlife."



Source: GIS Data sourced from Queensland Government Information Service 2014. RE Mapping on Project site ground-truthed during flora surveys.

Figure 11 Water Related Ecological Assets Associated with the Taroborah Project

And Section 3.3.4 – Groundwater Dependent Ecosystems in Appendix 26 has been rewritten to read as follows:

"The Bureau of Meteorology's (BoM) Atlas of Groundwater Dependent Ecosystems identifies the potential for groundwater interaction, through surface expression, sub-surface interaction, or the presence of aquifer/cave ecosystems. Mapping of likely aquifer/cave ecosystems in Queensland is currently not available. GDEs are ecosystems that depend to some degree on the surface expression of groundwater or the sub-surface presence of groundwater.

The BoM Atlas of GDEs revealed a number of areas on and around the Project site that have moderate or high potential for sub-surface groundwater interaction or surface expression of groundwater. Field surveys conducted for the Aquatic Ecology Assessment noted the potential for some vegetation communities on the Project site (e.g. Silver Leaved Ironbark Open Woodland) to be dependent on groundwater to some degree. Deep-rooted vegetation of the Silver Leaved Ironbark Open Woodland community (RE 11.3.6) occurring along the riparian zone of one of the more substantial drainage lines associated with Retreat Creek may be dependent on subsurface groundwater. Their dependence on groundwater may be permanent or intermittent to meet their water requirements. Due to the ephemeral nature of many of the watercourses in the region, it is possible that groundwater resources may be utilised to supplement water requirements. Depth to groundwater in the vicinity of Retreat Creek is approximately 7 mbgl. Shallower-rooting vegetation, such as shrubs and groundcover, are not thought to be reliant on groundwater.

Retreat Creek and Taroborah Creek, which traverse the northern and southern portions of the Project site, respectively, do not appear to receive surface expressions of groundwater, as these watercourses were found to be dry during dry season surveys. The Atlas of GDEs indicates that Retreat Creek has a moderate potential to interact with groundwater as a surface expression. Vegetation communities on the Project site have been noted for their potential to utilise groundwater. However, vegetation associated with palustrine wetlands on the site is limited to shrub and groundcover species, reducing the likelihood for groundwater dependence.

The lacustrine wetlands on the Project site (located in the central area and along the western boundary) are shown as having a moderate potential for groundwater interaction. It should be noted that this is considered unlikely as the wetlands are artificial.

Figure 12 and Figure 13 indicate the likelihood of groundwater interaction in relation to water related assets.

- Springs

The Project site is located in the vicinity of the Great Artesian Basin (GAB) and consequently, there are a number of springs associated with the GAB in the catchments surrounding the site. No springs have been mapped within the immediate vicinity of the Project site, on both the Queensland Springs Database and the BoM GDE Atlas. The GDE Atlas does not indicate the presence of any spring-fed wetlands in the vicinity.

Despite the lack of mapped springs within the Project, aquatic ecology field assessments noted that the drainage line into Retreat Creek on which the Silver-leaved Ironbark Woodland (RE 11.3.6) occurs is likely to be fed by a local spring (aquatic sampling site TAS11), although the drainage was dry when visited in May and September 2014. Some sections of the Nogoa River are also known to be partially spring-fed from the Precipice Sandstone (Queensland Water Commission 2012). While there are a number of mapped springs within the Nogoa River and Comet River catchments, no springs are mapped on watercourses associated with the Project, either upstream or downstream.

As mentioned above, a few semi-permanent pools of conservation value to the region were identified on a drainage line associated with Taroborah Creek during the 2011 and 2012 field surveys (site TAS10/AQ10). However, there was no water evident during sampling exercises in May and September 2014.

Figure 14 indicates the location of regional springs.

- Inflow Dependent Ecosystems

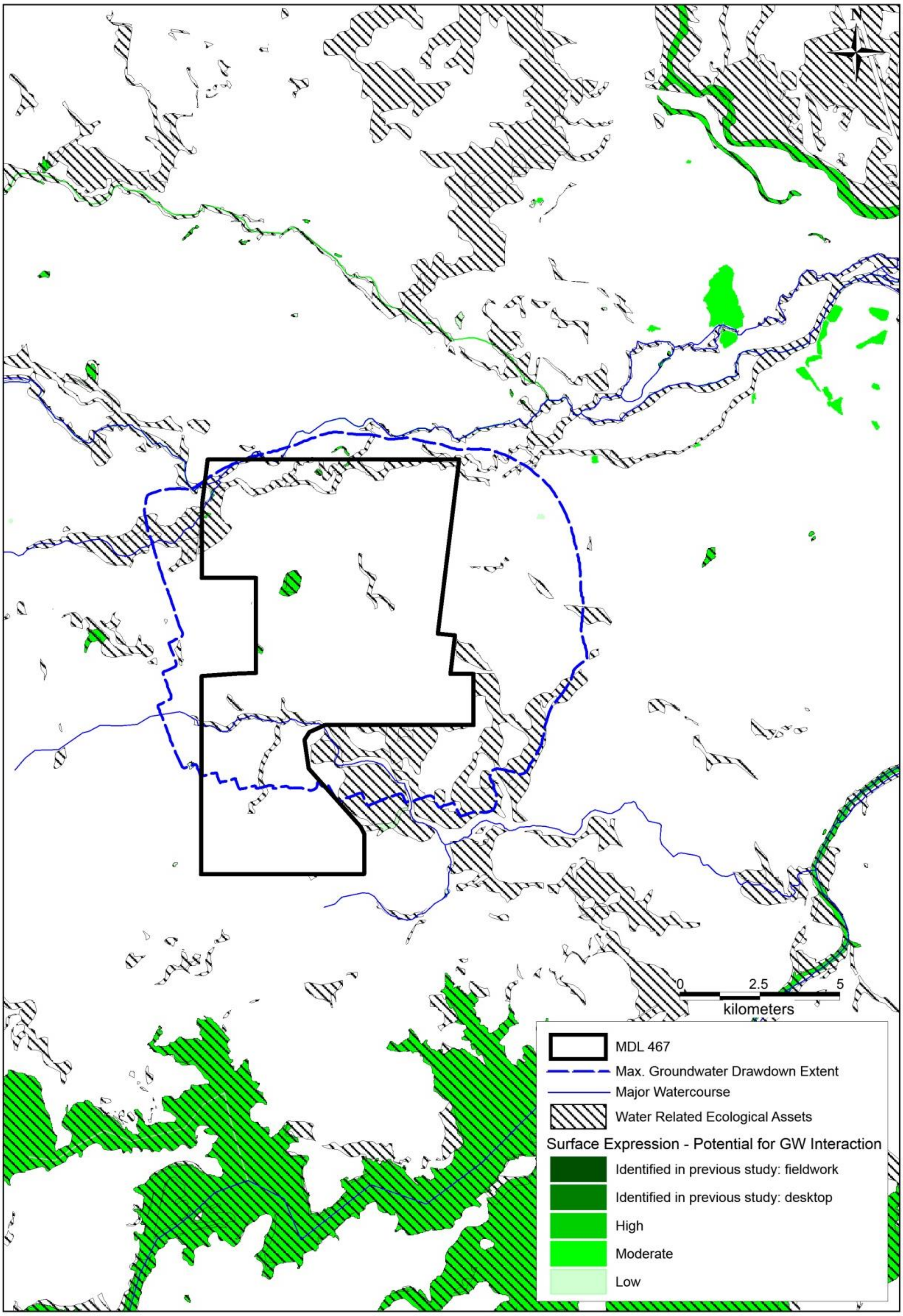
Inflow dependent ecosystems (IDEs) are ecosystems that rely on water in addition to rainfall. These

additional water sources may be surface runoff, soil moisture, or groundwater. IDE mapping (Figure 15) indicates that the lacustrine wetlands in the central west and west of the Project site coincide with areas of high likelihood for dependence on additional water sources. A substantial portion of RE 11.3.3a (River Teatree Riparian Woodland) fringing Taroborah Creek also coincides with an area mapped as being likely to be dependent on water other than rainfall. Areas with particularly high likelihood of 257tilizing additional water sources also include:

- Retreat Creek;
- The palustrine wetland in the north-west of the site;
- The central dam / lacustrine wetland; and
- Taroborah Creek and the pools identified during field surveys along its tributaries (Aquatic site TAS10/AQ10).

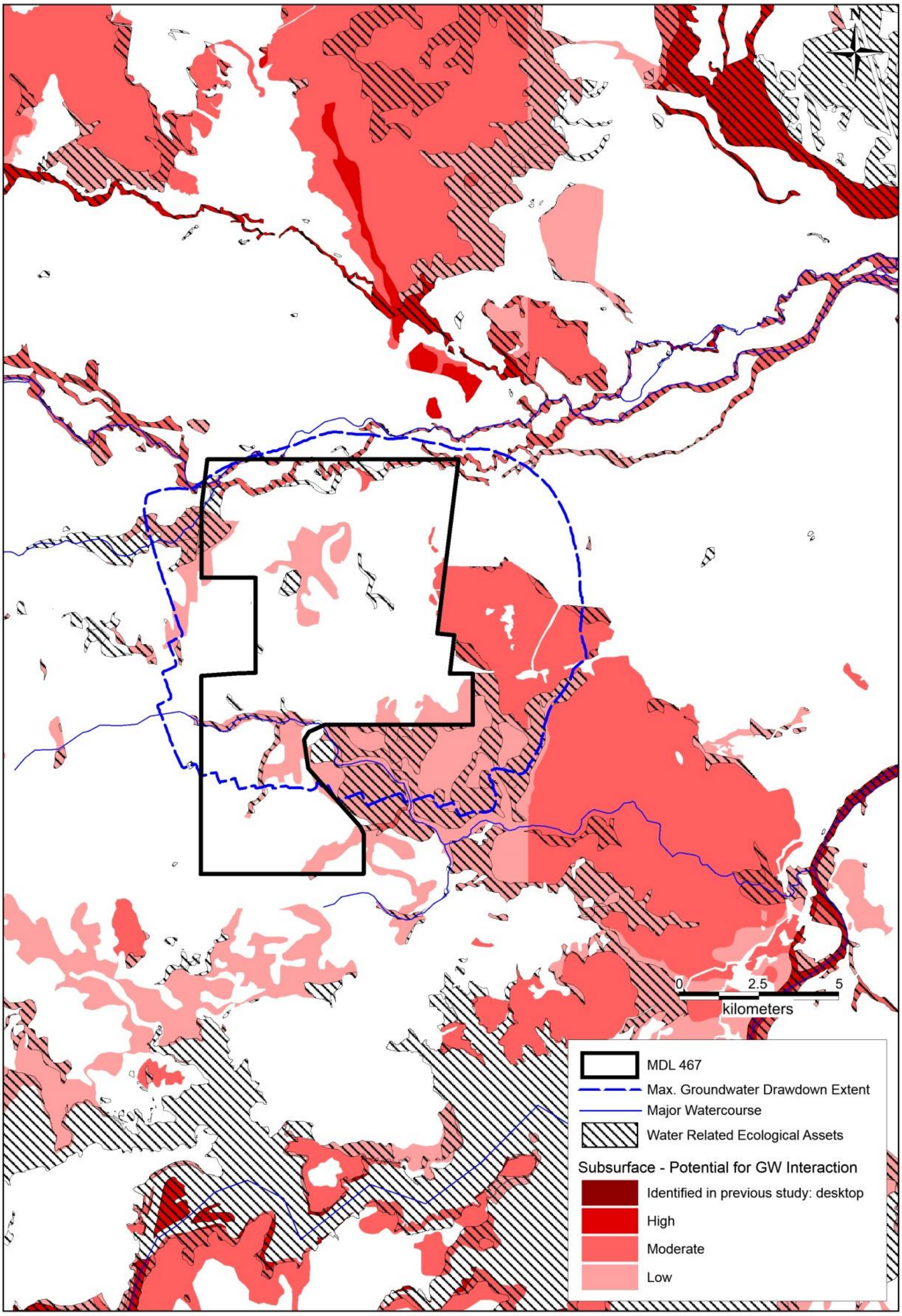
- Stygofauna

A pilot stygofauna sampling program was conducted in September 2011 at seven bores located on the Project site, six located within Tertiary basalt (Tb), and one located within the Quaternary colluvium/basalt (Qr\b). No stygofauna were identified in the groundwater samples collected during the pilot program. An additional sampling program is proposed in Section 9.2 to specifically target the alluvium.



Source: GDE Mapping obtained from BoM (2012).

Figure 12 Likelihood of Interaction with Groundwater – Surface Expression of Groundwater



Source: GDE Mapping obtained from BoM (2012).

Figure 13 Likelihood of Interaction with Groundwater – Subsurface Groundwater

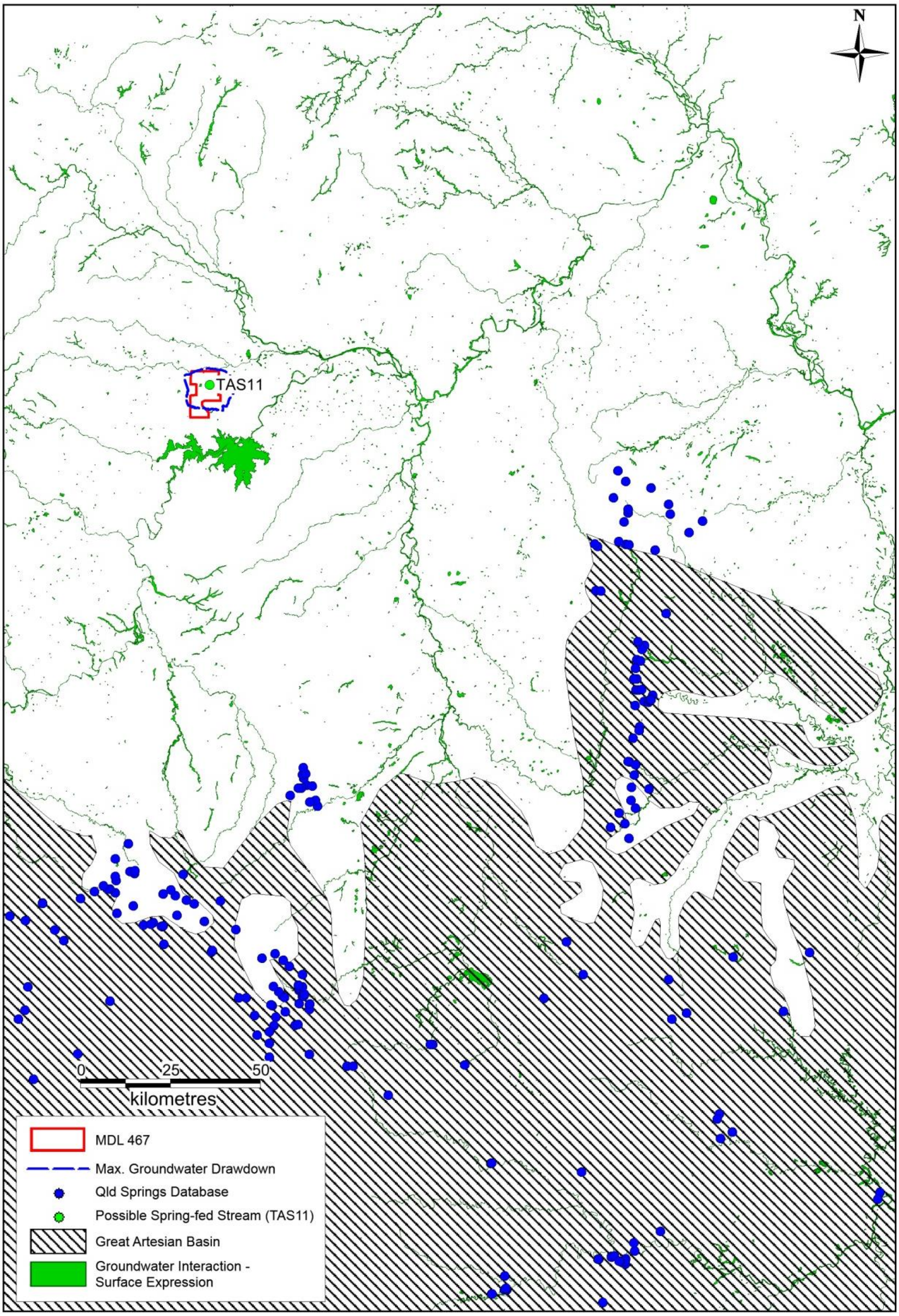
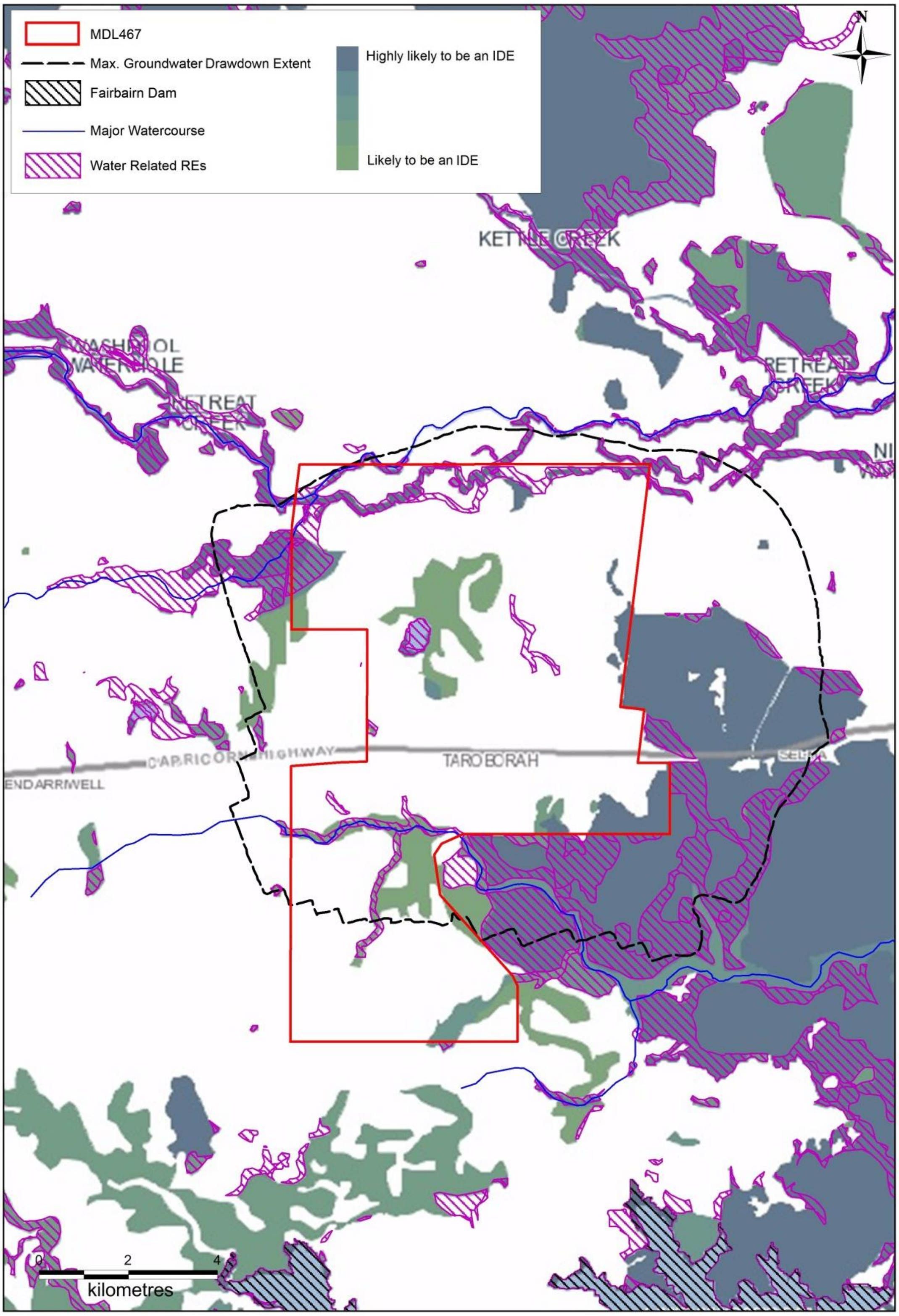


Figure 14 Springs Associated with the Great Artesian Basin



Source: IDE mapping obtained from BoM (2012)

Figure 15 Inflow Dependent Ecosystems

17. APPENDIX 23 – SOCIAL IMPACT ASSESSMENT

17.1 Appendix 23, Section 4.1.2, page 20, Section 4.1.7, page 25 & Section 4.1.15, page 36 - Social Impact Assessment - Local Community

Submitter:

Central Highlands Regional Council, Community and Development Services

Submission:

CHRC acknowledges Shenhuo International Group Pty Ltd (Shenhuo) references to Central Highlands 2022 Community Plan.

- Community Values - regional
- Emerald and Gemfields priorities (only those as nominated by Shenhuo)
- Regional key infrastructure and community services goals (only those nominated by Shenhuo)

CHRC request Shenhuo partner with key stakeholders and through the Taroborah Community Consultation Committee (CCC) support the Central Highlands 2022 Community Plan five regional outcomes and goals; Emerald 2022 Community Plan priorities and Gemfields 2022 Community Plan priorities.

CHRC recommends Shenhuo consider participating in the Emerald 2022 and Gemfields 2022 Community Reference Groups when they are established

Response:

Shenhuo is supportive of the objectives of the Central Highlands 2022 Community Plan, and is committed to working with the local community reference groups when establishing the project Community Consultative Committee.

EIS Amendment:

None required

17.2 Appendix 23, Section 5.1 - Social Impact

Submitter:

Central Highlands Regional Council, Community and Development Services

Submission:

CHRC acknowledges Shenhuo Project team will include the role of Community Liaison Officer (CLO) to oversee all stakeholder integration, communication processes, enquiries/complaints management and conflict resolution processes. That the incumbent will reside in Emerald and will be responsible for implementing, monitoring, and evaluation and reporting on SIMP performance.

CHRC recommend the Taroborah CLO attend the Emerald Interagency meetings.

Response:

Acknowledged, and the Proponent will look to have the CLO involved in the Emerald Interagency meetings around the time of construction start-up.

EIS Amendment:

None required

17.3 Appendix 23, Section 5.2 - Social Impact Management Plan - Community Consultative Committee

Submitter:

Central Highlands Regional Council, Community and Development Services

Submission:

CHRC acknowledges Shenhuo will establish and facilitate the Taroborah Community Consultation Committee (CCC) to be made up of a number of key stakeholders. Council would request a CHRC representative (ex officio) participate as part of the group

Response:

Shenhuo would welcome the participation of a CHRC representative on the Taroborah CCC.

EIS Amendment:

None required

17.4 Appendix 23, Section 5.2 - Social Impact Management Plan - Community Investment Program

Submitter:

Central Highlands Regional Council, Community and Development Services

Submission:

CHRC acknowledges Shenhuo will set up the Taroborah Community Investment Program (CIP) which will fund opportunities for community groups and charitable organisations in the region.

CHRC requests the Taroborah Community Investment Program (CIP) be focused on supporting Emerald and Gemfields communities.

Response:

CHRC's request is noted and will be considered at the appropriate time.

EIS Amendment:

None required

17.5 Appendix 23, Section 5.4 - Social Impact Management Plan - General Communication

Submitter:

Central Highlands Regional Council, Community and Development Services

Submission:

CHRC encourage Shenhuo's ongoing stakeholder engagement strategy and maintaining a variety of communication mediums to regularly update and communicate information to the local communities about the development, impacts and opportunities at all stages of the project – especially the quarterly community newsletter

Response:

Acknowledged

EIS Amendment:

None required

17.6 Appendix 23, Section 5.4 - Social Impact Management Plan - Targeted Communication

Submitter:

Central Highlands Regional Council, Community and Development Services

Submission:

CHRC acknowledge Shenhuo's approach to tailoring a specific engagement strategy for each key stakeholder group including government, landholders, community, Indigenous communities, business & industry

Response:

No response required

17.7 Appendix 23, Section 5.4.6 - Social Impact Management Plan - Employees and Contractors

Submitter:

Central Highlands Regional Council, Community and Development Services

Submission:

CHRC acknowledges Shenhuo will encourage employees and contractors to undertake a comprehensive induction process comprising a strict code of conduct (in line with community values). Also, noted employees and contractors will be requested to participate in community safety, land access and enquiries/complaints management training.

CHRC acknowledge Shenhuo will encourage staff to participate in community life and integrate with local residents through community service organisations (e.g. school Parents and Citizens Associations, Country Women's Association, Lions, Rotary Clubs, etc) and sporting organisations. Additionally, that the site management team will be encouraged to reside in the community.

Response:

No response required

17.8 Appendix 23 Section 6.1, Page 27 - Social Impact Management Plan - Cumulative Impacts/Regional Development

Submitter:

Department of State Development, Infrastructure and Planning

Submission:

The proponent should refer to DSDIP's 'Managing the impacts of major projects in resource communities July 2013' in relation to cumulative impacts, particularly the Royalties for Regions program and the Local Area Infrastructure Program

Response:

Acknowledge and will amend this table in the final EIS document. Note that Royalties for

Regions is already mentioned in Section 6.3.

EIS Amendment:

Section 6.1 has been updated to reflect reference to the DSDIP guidelines and the Royalties for Regions program with two new entries as follows.

Action	Performance Indicator	Timeframe*	Responsible Party
6.1 CUMULATIVE IMPACTS/REGIONAL DEVELOPMENT The regional study areas have been impacted by intensive coal mining, construction and exploration since the mid-1970s. There are many operating mines in the region, along with many more proposed operations. Combined, these projects will potentially put strain on local roads, community infrastructure and housing affordability and availability. While the recent mining industry downtown has created uncertainty around both existing and potential mining projects, there is still a requirement for long-term management of cumulative impacts and regional growth. A key role of the Taroborah Community Consultation Committee (CCC) will be to identify and where possible contribute to addressing cumulative impacts jointly with other CCC members, such as key government, business and community stakeholders.			
CCC to assist Shenhuo to contribute to managing cumulative impacts in line with the Qld Department of State Development and Infrastructure Planning's guide to *Managing the impacts of major projects in resource communities*, July 2013.	Joint industry, government and community approach to managing local cumulative impacts	1 year Ongoing	Shenhuo, DSDIP, other proponents
Through the CCC, investigate opportunities to access government funding (e.g. Royalties for Regions) to address cumulative impacts.	Funding submissions produced Funding secured	1 year Ongoing	Shenhuo

17.9 Appendix 23, Section 6.1 - Social Impact Management Plan - Cumulative Impacts/Regional Development

Submitter:

Central Highlands Regional Council, Community and Development Services

Submission:

CHRC acknowledge Shenhuo's involvement and contribution to Central Queensland (CQ Regional Plan) and Central Highlands (CH2022 Community Plan) regional development projects through the Taroborah CCC.

CHRC invite Shenhuo to consider the significance of the Capricorn Highway especially between Emerald and the Gemfields for locals and tourists visiting the region.

CHRC notes cumulative impacts happen at the regional level and community level and asks that Shenhuo consider Emerald and the communities of the Gemfields to be included in the geographical area of the Taroborah Mine Project footprint.

Response:

Shenhuo notes CHRC's invitation and does recognise the significance of the Capricorn Highway between Emerald and the Gemfields. Further, Emerald and the Gemfields are considered as being in the project footprint for cumulative impact purposes.

EIS Amendment:

None required

17.10 Appendix 23, Section 6.2 - Social Impact Management Plan - Community Safety and Wellbeing, Community Investment

Submitter:

Central Highlands Regional Council, Community and Development Services

Submission:

CHRC acknowledge Shenhuo's commitment to a Community Safety and Wellbeing Strategy.

CHRC note Shenhuo's intension to encourage Taroborah employees to relocate to the local area, assess and implement incentive initiatives, such as high-quality family friendly accommodation and housing, salary incentives, Employee Assistance Program, etc.

Also noted is Shenhuo's encouragement of project personnel (staff and contractors) to integrate with the local community through participating in community and sporting organisations, volunteer programs and support not-for-profit organisations during work hours.

SES volunteers in Emerald and Gemfields provide a valued service.

CHRC encourage Taroborah Community Investment Program and invite a meeting with Council's Community Development Unit to assist with information on local grants programs, other community investment programs and access up to date information on community development opportunities.

CHRC notes areas worthy of community investment are:

- Healthy eating and active lifestyle programs and initiatives in the Central Highlands region
- Youth Community Development Programs (12 – 24 years) in Emerald and Gemfields
- Multicultural programs and annual festival
- Support Arts programs and initiatives in Emerald and the Gemfields
- Junior sporting and recreation initiatives in Emerald and Gemfields

Council invites Shenhuo CCC to consider supporting and partnering with CHRC to roll out community and economic development resources and programs.

CHRC acknowledge Shenhuo will implement a comprehensive Traffic Management Plan.

CHRC recommend the Traffic Management Plan be agreed on by key stakeholders and reviewed quarterly by CHRC, Shenhuo, DTMR, Aurizon and QR.

Response:

Shenhuo note the above comments from CHRC.

Shenhuo acknowledges that SES volunteers provide a valued service and assistance in this regard will certainly be considered.

The suggested meeting with CHRC regarding the CIP will be set-up when appropriate.

Community and economic development programs will be determined by Shenhuo in consultations.

The Proponent acknowledges this recommendation and will update the planned Traffic Management Plan review to quarterly in the final EIS document.

EIS Amendment:

None required

17.11 Appendix 23, Section 6.3 - Social Impact Management Plan - Community Infrastructure and Services

Submitter:

Central Highlands Regional Council, Community and Development Services

Submission:

CHRC request the Taroborah CCC communicate with CHRC when accessing government funding including Royalties for the Regions to improve local services and infrastructure as a key stakeholder in regional development.

Response:

Acknowledged, and CHRC has been added to the Responsible Party column.

EIS Amendment:

CHRC has been added as a responsible party under the first action item for Section 6.3 of Appendix 23 – SIMP.

17.12 Appendix 23, Section 6.3 - Social Impact Management Plan - Community Infrastructure and Services, Childcare

Submitter:

Central Highlands Regional Council, Community and Development Services

Submission:

CHRC recommend engaging with C&K Association to plan for childcare needs and services

Response

Shenhuo will discuss the implications of its employment strategy with all relevant child care providers, and all local schools at the appropriate time.

EIS Amendment:

None required

17.13 Appendix 23, Section 6.3 - Social Impact Management Plan - Community Infrastructure and Services, Health and Emergency Services

Submitter:

Central Highlands Regional Council, Community and Development Services

Submission:

CHRC recommend:

- Queensland Health and other allied health professionals and service provider representatives be considered as partners for identifying and mitigating any impacts of health infrastructure.
- The Gemfields area be considered in the 'Adopt a Doctor' program as well as allied health agencies and programs.
- There is potential to use local pharmacies and other health businesses to support business development
- Consider supporting the local Ambulance Service (noted in SIMP page 12 as 'grossly undermanned'

Response:

Acknowledged and the Responsible Party column of the table will be updated in the final EIS document.

In selecting medical practitioners and other allied health services under its 'Adopt a Doctor' program, Shenhuo will seek professionals with the best and most appropriate qualifications, as well as having regard to the normal residences of its staff who will use those services.

The potential to use local pharmacies is acknowledged.

Consideration of supporting the local Ambulance Service is acknowledged and the local Ambulance Service will be added to the list of potential supportees in a major emergency.

EIS Amendment:

Queensland Health and the Queensland Ambulance Service have been added as Responsible Parties where appropriate as noted above.

17.14 Appendix 23, Section 6.3 - Social Impact Management Plan - Community Infrastructure and Services, Highways and Roads

Submitter:

Central Highlands Regional Council, Community and Development Services

Submission:

CHRC strongly recommend Shenhuo work collaboratively with CHRC, DTMR, Aurizon and QR to implement road traffic and coal train management strategies with full and honest community engagement and communications.

The key stakeholders meeting regularly and are in agreement with strategies.

Shenhuo ensure effective and earnest public education programs are provided for road and rail safety due to Taroborah coal train activities and impacts to road traffic.

Response:

Full and honest community engagement and communication has been undertaken throughout the EIS process to date. And road and train management strategies are planned to be undertaken at the appropriate time.

Once the initial strategies have been agreed upon by the relevant parties and are put in place, regular meetings of the relevant parties will be held to review the performance of these strategies and revise them as necessary.

The Proponent does not believe that the addition of coal trains will necessarily increase the

road safety risk, as the trains will not operate any differently than any other trains that currently pass through Emerald, other than create slightly longer delays at the road crossings. However, the Proponent will regularly place safety messages in the local media to reinforce the safety precautions to be taken by motorists when any trains are present.

EIS Amendment:

None required

17.15 Appendix 23, Section 6.3 - Social Impact Management Plan - Community Infrastructure and Services, Utilities

Submitter:

Central Highlands Regional Council, Community and Development Services

Submission:

CHRC encourage regular communication to the community on dust monitoring stations along railway corridor through Emerald.

When planning for telecommunications, water and energy to the mine that Shenhuo consider opportunities to assist with improve services to landholders and Gemfields community

Response:

All results of the noise and dust monitoring program along the rail corridor through Emerald that the Proponent has agreed to establish will be published regularly on the Project website and in Project newsletters.

The proponent will consider this during the planning stages, and it is expected that any required upgrades to these services to the mine site will necessarily improve these services to the local area.

EIS Amendment:

None required

17.16 Appendix 23, Section 6.4 - Social Impact Management Plan - Land Access and Use

Submitter:

Central Highlands Regional Council, Community and Development Services

Submission:

CHRC recommend it is a priority to liaise and meet with directly impacted landholders and near neighbours as well as offer personal support and counselling support – telephone and face to face through local service providers.

Additionally, provide information on water, dust, noise, vibration and light to directly impacted landholders and near neighbours relating to mining and transport activities.

Regular communication and information sharing can support impacted landholders anxious about future uncertainty.

Response:

This has been the policy of the Proponent throughout the term of their tenancy and will continue to be the primary process of community liaison.

All results of required environmental monitoring programs for the Project will be published

regularly on the Project website and in Project newsletters.

The importance of regular communication and information sharing with impacted landholders is acknowledged.

EIS Amendment:

None required

17.17 Appendix 23, Section 6.4 - Social Impact Management Plan, Land Use

Submitter:

Central Highlands Regional Council, Community and Development Services

Submission:

CHRC recommend Taroborah Cultural Heritage Management Plan be developed and implemented.

Along with indigenous projects, the Emerald Heritage Village and Sapphire Gemfields Interpretative Trail Projects should be considered for the Cultural Heritage Management Plan.

Response

The CHMP development process is currently ongoing with the relevant Traditional Owners and will be implemented when completed.

The Proponent fails to see the relevance of these initiatives to Cultural Heritage Management on the Project site.

EIS Amendment:

None required

17.18 Appendix 23, Section 6.5 - Social Impact Management Plan - Local Content, Business Participation

Submitter:

Central Highlands Regional Council, Community and Development Services

Submission:

CHRC recommends Shenhuo source their employees locally with a preference to Emerald and Gemfields communities, other Central Highlands' residents and then Central Queensland and beyond.

CHRC recommend Shenhuo, DSDIP, ICN and Central Highlands Development Corporation (CHDC) partner with local businesses in Emerald and the Gemfields to develop and implement the Taroborah Local Content Strategy.

CHRC encourages Shenhuo to support local businesses by buying locally and educating them about Taroborah Coal Project procurement requirements.

CHRC encourage Shenhuo to link with Central Highlands Development Corporation to facilitate initiatives to enhance local supply chain business opportunities as well as business improvement programs.

Developing tourism in the Central Highlands region is a priority for CHRC and invites Shenhuo to participate in supporting the Sapphire Gemfields Interpretative Trail Project. This project is listed as a core tourism project in the Central Queensland Tourism Strategy.

The Gemfields is recognised as an important tourism destination for Queensland**.**

Response:

This has always been the Proponent's stated preferred strategy, and Shenhuo's commitment to local employment is already clearly highlighted in the SIMP.

The inclusion of ICN and CHDC as partners in developing a Local Content Strategy is acknowledged and they will be added to the Responsible Party column of the plan in the final EIS document. Shenhuo is currently discussing with CHDC the best way to implement local procurement plans, and believes CHDC will likely be the most experienced and informed partner.

Linking with CHDC to facilitate initiatives to enhance local supply chain business opportunities is acknowledged as already referenced in Section 6.5, and will be undertaken at the appropriate time.

The invitation to participate in supporting the Sapphire Gemfields Interpretative Trail Project is acknowledged, and will be considered by the Taroborah CCC at the appropriate time.

EIS Amendment:

Section 6.5 – Business Participation has been updated to include CHDC as a potential contributor to the Local Content Plan.

CHDC has been added as a Responsible Party to the relevant Section 6.5- Business Participation action items.

17.19 Appendix 23, Section 6.5- Social Impact Management Plan - Local Content, Training and Employment

Submitter:

Department of State Development, Infrastructure and Planning

Submission:

DSDIP is identified as a stakeholder in identifying opportunities for women. The Department of Education, Training and Employment (DETE) is the appropriate department to assist.

Response:

Acknowledged and will amend the table accordingly in the final EIS document.

EIS Amendment:

DSDIP and has been replaced by DETE in the relevant item of Section 6.5 - Training and Employment.

17.20 Appendix 23, Section 6.5 - Social Impact Management Plan - Local Content, Training and Employment

Submitter:

Central Highlands Regional Council, Community and Development Services

Submission:

CHRC acknowledge Shenhuo's support for the training programs with providers and high schools (Emerald State High School, Emerald Christian College and Marist College). Also support for the

tertiary sector CQ University and TAFE College as well as Emerald Agricultural College.

Response:

No response required

17.21 Appendix 23, Section 6.5 - Social Impact Management Plan - Local Content, Indigenous Participation

Submitter:

Central Highlands Regional Council, Community and Development Services

Submission:

Acknowledge Shenhuo's commitment to Indigenous community, employment and cultural awareness programs

Response:

No response required. Note an Indigenous Participation Plan outline has been developed and included in the final EIS document.

17.22 Appendix 23, Section 6.6 - Social Impact Management Plan - Housing and Accommodation, Local

Submitter:

Central Highlands Regional Council, Community and Development Services

Submission:

CHRC acknowledges improved emergency and seniors housing availability is identified for the CCC.

Additionally, crisis and youth accommodation and support can be noted for Emerald and Gemfields.

Response:

It is acknowledged that crisis and youth accommodation and youth support are important aspects of social impact management, and the Proponent will add this initiative in the Action column of the plan in the final EIS document.

EIS Amendment:

The first action item of Section 6.5 has been updated to include crisis and youth accommodation support.

17.23 Appendix 23, Section 6.6 - Social Impact Management Plan - Housing and Accommodation, Workforce

Submitter:

Central Highlands Regional Council, Community and Development Services

Submission:

CHRC notes the development of Taroborah Mine Project Workforce Accommodation Strategy, especially placement of key management roles in Emerald and encouraging all employees not already resident in Emerald to settle in the local district. CHRC request input to the development of the short-term accommodation program for the construction

workforce and DIDO workforce during construction and operation phases.

Response:

Acknowledged, and the Proponent will add CHRC in the Responsible Party column of the plan in the final EIS document.

EIS Amendment:

CHRC has been added as a Responsible Party in developing the Workforce Accommodation Strategy for Taroborah.

17.24 Appendix 23, Section 6.7 - Social Impact Management Plan - Employee Engagement, Employee Support

Submitter:

Central Highlands Regional Council, Community and Development Services

Submission:

Shenhuo consider using local qualified psychologists and service providers for the Employee Assistance Programme to support local business and employment opportunities.

CHRC encourages Shenhuo to promote local community events and celebrations to their workforce.

Response:

Acknowledged, and Shenhuo will add the suggested entities in the Responsible Party column of the plan in the final EIS document.

The promotion of local community events and celebrations is noted and will be included in the SIMP.

EIS Amendment:

Section 6.7 has been updated to flag the potential to source local psychologists and social workers in support of its Employee Assistance Programme.

A new action item has been added to Section 6.7with regard to local community events and celebrations as follows:

Action	Performance Indicator	Timeframe*	Responsible Party
Encourage employees to participate in local community life through attendance at Central Highlands events and celebrations.	Promotion of key local events to employees	Project start-up Ongoing	Shenhuo

17.25 Appendix 23, Section 7.1, Page 387 - Social Impact Management Plan, Monitoring Framework

Submitter:

Department of State Development, Infrastructure and Planning

Submission:

A monitoring framework should be provided with each of the action plans. As per the Social

Impact Monitoring Framework Example Social Impact Assessment guideline July 2013 (DSDIP), the framework should include:

- Targets and outcomes sought
- An explanation of how management of the impact will be monitored e.g. Regular communication with state government agencies or local governments
- The names of each party responsible for implementation of each monitoring strategy

Response:

The Section 6 action plans all have objectives, performance indicators, timeframes and responsible parties. Section 7 provides an overview of the Taroborah monitoring framework, with an example. A similar line item for each action item has not been developed yet, but will be at the appropriate time prior to Project start-up.

However, following discussions with DSDIP, the likely sources of providing monitoring data and the responsible agencies for reporting the data to are to be expounded on in Section 7. Therefore, an example under each of the main areas of the SIMP is now provided in Section 7.1, and Section 7.2 has been amended to indicate who monitoring reports are to be distributed to.

EIS Amendment:

Section 7.1 of Appendix 23 – Social Impact Management Plan has been amended to read as follows:

"A framework has been developed to provide structure and integrity to the Project monitoring and evaluation processes. The monitoring framework will measure key performance indicators (refer to Section 6.0 for details) against baseline SIA data and progressive data. The latter will be sourced with support from the Queensland Government and CHRC, as well as via ongoing project evaluation tools, including:

- CHRC's Central Highlands Community Wellbeing Indicators
- CHRC's biannual Community Satisfaction Surveys
- CCC meeting minutes; and
- Enquiries and complaints reports (refer to Section 8.0 for details), including close-out performance.

A full monitoring framework (an example is presented in Table 4) will be developed prior to Project start-up and reviewed quarterly thereafter.

Table 4 : Social Impact Monitoring Framework Example

Mitigation strategy	Performance indicator/target	Resp	Monitoring tools
Cumulative Impacts/ Regional Development			
CCC to assist Shenhuo to contribute to managing cumulative impacts in line with the Qld Department of State Development and Infrastructure Planning's guide to *Managing the impacts of major projects in resource communities*, July 2013.	Joint industry, government and community approach to managing local cumulative impacts	CCC/ CLO	Baseline SIA data CHRC Wellbeing Indicators and Community Satisfaction Surveys Regular liaison with DSDIP and CHRC
Community Safety and Wellbeing			
Encourage Taroborah employees to relocate to the local area. Assess and then implement incentive initiatives, such as high-quality, family friendly accommodation and housing, salary incentives, Employee Assistance Program, etc.	Maximised numbers of employees residing locally	CLO	Baseline SIA data Number of employees living locally CHRC Wellbeing Indicators and Community Satisfaction Surveys Regular liaison with CHRC Taroborah Enquiries Register
Community Infrastructure and Services			
Within the CCC, consider current childcare needs and if appropriate, support community strategies to attract childcare services to the region	Appropriate number of providers in Emerald	CCC/ CLO	Baseline SIA data Number of childcare centres CHRC Wellbeing Indicators and Community Satisfaction Surveys Regular liaison with CHRC
Land Access and Use			
In conjunction with local landholders, agree and implement a full Land Access Management Plan. This will include weed and pest management, gate and fence access protocols, and landholder contact. Key aspects of the plan will be incorporated into the employee induction program.	Plan implemented Landholder satisfaction with access procedures and how they are adhered to by project employees 100% employees and contractors inducted in landholder-related protocols	CLO	Baseline SIA data CHRC Wellbeing Indicators and Community Satisfaction Surveys Taroborah Enquiries Register
Local Content			

Mitigation strategy	Performance indicator/target	Resp	Monitoring tools
Develop and implement a detailed Local Content Plan for Taroborah, with support from ICN, the Central Highlands Development Corporation (CHDC) and other key industry and employment organisations.	Plan developed and implemented	CLO	Baseline SIA data CHRC Wellbeing Indicators and Community Satisfaction Surveys Regular liaison with ICN, CHDC and other key industry and employment organisations
Housing and Accommodation			
Through the CCC, identify opportunities to support improved emergency, seniors, crisis and youth housing availability and youth support.	Reduced emergency, seniors, crisis/youth accommodation waiting lists	CCC/ CLO	Baseline SIA data CHRC Wellbeing Indicators and Community Satisfaction Surveys Regular liaison with DCCSDS, DHPW, CHRC
Employee Engagement			
Implement and enforce employee and contractor Code of Conduct, both for the Project site and within the community.	Assessment of employees' code awareness level Demonstrated analysis of cause of stakeholder enquiries / complaints Structured community satisfaction assessment of employee/contractor behaviour	CLO	Baseline SIA data CHRC Wellbeing Indicators and Community Satisfaction Surveys Regular liaison with CHRC Taroborah Enquiries Register

And a new sentence has been added to the end of Section 7.2 to read as follows:

"Outcomes of these reviews, along with a compilation of quarterly social monitoring results, will be detailed in a report for DSDIP and other relevant agencies."

17.26 Appendix 23, Section 7.1 Social Impact Management Plan, Monitoring Framework

Submitter:

Central Highlands Regional Council, Community and Development Services

Submission:

CHRC suggests Shenhuo representatives meet with Council representatives to link with Central Highlands Community Wellbeing Indicators Project. Additionally, Council conducts a bi-annual Community Satisfaction Survey. Council is mindful of consultation fatigue levels with the communities in the Central Highlands region.

Response:

Acknowledged, and the Proponent will revise this section of the EIS report accordingly by adding consultation with the appropriate CHRC representatives and removing the separate Stakeholder Satisfaction Surveys.

EIS Amendment:

Section 7.1 has been updated to include CHRC community monitoring tools as noted in the amendment above.

18. APPENDIX 26 – IESC REPORT

18.1 Appendix 26, Section 7.1 – Cumulative Impacts

Submitter:

Independent Expert Scientific Committee

Submission:

The cumulative impact assessment does not adequately consider local scale cumulative impacts to water resources from coal mines located within the Nogoa River Catchment.

Six projects at varying stages of development are located within 50 km of the Taroborah Coal project (in order of proximity): Teresa, Valeria, West Emerald, Athena, Kestrel and Minerva. Other than the Teresa Coal project, the proponent has not provided an assessment of whether impacts from these mines are likely to contribute to cumulative impacts associated with the Taroborah Coal project.

The consideration of cumulative impacts between the proposed project and the Teresa Coal project is limited to a statement of distances between drawdown extents that are not substantiated by documented evidence or reference to the Teresa Coal EIS. This approach does not consider cumulative losses, or seasonal losses, in baseflow to surface water systems of the Nogoa River Catchment, which are likely to be most noticeable during the dry season.

The groundwater model for the Taroborah Coal project is 40 km by 40 km and is oriented such that the Teresa Coal project area does not fall within the model domain. However, based on the Teresa Coal project's existing publicly available groundwater model report, groundwater drawdown caused by that project extends into the Taroborah Coal project's groundwater model domain and should therefore be represented in the Taroborah Coal project's groundwater model.

Given the above, cumulative groundwater drawdown impacts of the two projects are unable to be quantified unless the Taroborah groundwater model takes into account the Teresa Coal project.

Recommendations:

The following features would enable a more comprehensive cumulative impact assessment within the Nogoa River catchment:

a. Identification of the regional geology, hydrogeological regime and hydrogeological connectivity between project areas.

b. Collection of data from other projects in relation to groundwater drawdown, water tables, surface water hydrology and surface and groundwater interactions.

c. Utilisation of appropriately robust and repeatable methodologies to determine the significance of impacts.

d. Determination of monitoring, mitigation and management measures to avoid or minimise and report on potential cumulative impacts.

Response:

The contribution of Taroborah Project on cumulative impacts from surrounding mines has not been considered simply because they are expected to be insignificant.

In terms of cumulative losses of surface water caused by Taroborah impacts to baseflows of the Nogoa River flow systems, there will be no loss because both Retreat Creek and Taroborah Creek are ephemeral and have no baseflow contribution in the first instance. If anything, the expected requirement to release excess site water, and the plan to release this water into the irrigation system emanating from Lake Maraboon, could be seen as a positive contribution to the baseflows of the Nogoa River.

With respect to Retreat Creek, the projected 328ML/year of river leakage into the groundwater system at Taroborah coupled with the potential maximum 53ML/year of storm water run-off capture due to subsidence ponding, represents only 0.9% of the estimated annual contribution of flows to the Nogoa River system from Retreat Creek. The Retreat Creek catchment, in turn, represents only 13% of the measured contribution to the overall flow into the Nogoa River system from Theresa Creek (which is 319,500 ML/year on average as determined from Appendix F1 of the Teresa Creek EIS) into which it flows. By comparison, the capture of storm water run-off from subsidence ponding at the Teresa Creek Project is not estimated in their EIS, however, discussion in Appendix F1 on the ponding in subsidence troughs is as follows:

"Significant ponding is modelled to occur during runoff events. A preliminary rainfall-runoff model calculated the 1 year ARI flood flow into this area from the local upstream catchment to be about 25 m^3/s, which is likely to result in ponding depths of up to 1.8 metres within the main subsidence impact area. Average ponding depths are in the vicinity of 0.7 m. Under existing conditions there is a marshy area within the southern boundary of the subsidence impacted area which is known to pond and experience prolonged inundation following significant rainfall events. Ponding in this area is expected to worsen with the impact of subsidence. Modelling shows depths around a maximum of 2.5 m in this area under a 1 year ARI runoff design storm event."

Clearly, the Teresa Creek project will have significantly more impact on flows in the Nogoa River system than Taroborah.

In terms of groundwater drawdown interaction, the discussion in the Taroborah EIS clearly indicates that the drawdown from each mine (3.5km to the northeast from Taroborah and 10km to the southwest from Teresa Creek) will not interact with each other due to their distance of separation of 19km, which was determined directly from AGE's modelling for Taroborah and discussion contained in the Teresa Creek EIS, and hence the reference to GHD, 2013. Clearly both the Taroborah and Teresa Creek EIS reports provide substantiating evidence of the lack of drawdown interaction between the proposed projects.

In terms of hydrogeologic connectivity between Taroborah and Teresa Creek, it is noted that the primary stratigraphic unit at Taroborah is the Aldebaran sandstone, which lies beneath the German Creek formation that hosts the Teresa Creek project. It is highly unlikely, therefore, that the two projects would be hydrogeologically connected.

In terms of cumulative impacts with respect to the other projects mentioned, Taroborah is sufficiently distant from the operating mines and proposed projects, and located on different sub-catchment systems to the Nogoa River, such that any hydrogeological interaction is extremely remote and cumulative impacts on surface flows would be even less significant than with Teresa Creek.

The currently proposed monitoring regimes for both surface water and groundwater impacts for Taroborah (see response in Section 16.11 of this report) are considered

sufficiently robust so as to cater for determining and managing both local impacts and more regional cumulative impacts.

EIS Amendment:

Section 7.1 of Appendix 26 has been amended to include a Section 7.1.1 – Groundwater Impacts and Section 7.1.2 – Surface Water Impacts.

Section 7.1.1 now reads as follows:

"The greatest potential for any impact to groundwater is in the vicinity of shallow alluvial aquifers, mostly found near major creeks and rivers. The nearest, advanced coal resource project is the Teresa Coal Project, approximately 25 km to the north-east. This project has a worst-case scenario model drawdown extent of 2.5 km to the north and west of the project boundary and 10 km to the south and southeast of the project boundary (GHD, 2013). Groundwater drawdown for the Taroborah Coal Project is modelled to be up to 3.5 km outside of the western Project boundary. Therefore, as the two closest boundaries are some 19 km apart, it is highly unlikely that the Teresa Coal Project and the Taroborah Coal Project will have a cumulative impact on the groundwater aquifer(s) as the modelled drawdown extents are some 5.5 km apart."

And Section 7.1.2 contains the original three paragraphs and figure on surface water impacts plus a new Section 7.1.2.1 - Impact of Uncontrolled Releases, which reads as follows:

"While the Taroborah Project is not anticipated to cause impacts to the receiving environment, the potential exists for the Project to contribute to catchment-wide downstream cumulative impacts resulting from uncontrolled discharges of mine affected water. The potential impacts associated with the release of mine affected waters include:

- Toxicity related to the release of sulphate, salinity, acid or alkaline solutions, metals or metalloids;
- Changes in the bioavailability of metals caused by changes to pH of receiving waters, impacting flora and fauna;
- Detrimental impacts to the structure and function of ecosystems; and
- Impacts to the suitability of water for drinking, stock water, or irrigation.

While it is inevitable that all developments will contribute to some extent to cumulative impacts, the degree and severity of this contribution is dependent on a number of factors, including:

- Quality and quantity of mine discharge water;
- Time of release;
- Weather conditions at the time of release;
- Existing quality and flow of the receiving catchments.

For example, it has been noted that northern sub-catchments such as the Isaac / Connors sub-basin typically has naturally higher EC than the Nogoa sub-catchment (DERM 2009);

- The number and type of other developments in the area; and
- Whether the release coincides with releases from other mines.

In order to determine the potential for the Project to contribute to cumulative impacts with respect to water quality, the following section provides an overview of the other resource and infrastructure developments located, or proposed to be located, in the Fitzroy River Basin. These developments are detailed in Table 35, with operational mines shown in Figure 26.

Table 35 Coal mines and projects operational / completed / under construction within the Fitzroy River Basin

Company	Name of Development	Type of Development	Size (ha) / Resource (Mt)	Status	Sub-Catchment
Coal Mines					
Cockatoo Coal Limited	Baralaba	Open-cut coal	-	Operational	Dawson
	Baralaba North Continued Operations	Open-cut coal	2,498	Proposed	Dawson
Wonbindi Coal Pty Limited	Baralaba South Coal Project	Open-cut coal	2,214 / 10-100	Proposed	Dawson
BHP Coal Pty Ltd	Blackwater	Coal	13,686	Operational	Mackenzie
Vale Australia Pty Ltd	Broadlea North	Coal	1,635	Operational	Isaac / Connors
Peabody Energy	Burton	Coal	5,099	Operational	Isaac / Connors
Anglo American Metallurgical Coal	Callide Mine	Coal	-	Operational	Dawson
	Boundary Hill South	Open-cut coal	630	Operational	Dawson
Vale Australia Pty Ltd	Carborough Downs	Underground coal	2,657	Operational	Isaac/Connor
	Carborough Downs Mine Expansion	Underground coal	-	Proposed	Isaac / Connors
BHP Billiton Mitsubishi Alliance	Caval Ridge	Open-cut coal	3534 / 100-500	Operational	Isaac / Connors
Rio Tinto Coal Australia	Clermont	Open-cut coal	-	Operational	Nogoa
Peabody Energy	Coppabella	Open-cut coal	930	Operational	Isaac / Connors
Cook Resource Mining Pty Ltd	Cook / Eldorado Hill	Coal	16,970	Operational	Mackenzie
Wesfarmers Resources	Curragh	Coal	4,455.6	Operational	Mackenzie
Wesfarmers Resources	Curragh North	Coal	4,859.11	Operational	Mackenzie
BHP Billiton Mitsubishi Alliance	Daunia	Open-cut coal	2,234 / 10-100	Operational	Isaac / Connors
Anglo American Metallurgical Coal	Dawson Central	Coal	-	Operational	Dawson
	Dawson South	Coal	-	Operational	Dawson
	Dawson North	Coal	-	Operational	Dawson
Bandanna Energy	Dingo West	Coal	4,646	Proposed	Mackenzie
New Hope Coal	Elimatta	Open-cut coal	3,975 / 100-500	Proposed	Dawson
Ensham Resources Pty Limited	Ensham	Open-cut coal	6,928	Operational	Nogoa
	Ensham Underground	Underground coal	- / 100-500	Proposed	Nogoa
Anglo American Metallurgical Coal	Foxleigh	Open-cut coal	3,097	Operational	Mackenzie
	Foxleigh Plains (extension of Foxleigh)	Open-cut coal	3,798 / 10-100	Proposed	Mackenzie

Company	Name of Development	Type of Development	Size (ha) / Resource (Mt)	Status	Sub-Catchment
Anglo American Metallurgical Coal	German Creek	Coal	24,660	Operational	Mackenzie
	German Creek East	Coal	2,106	Operational	Mackenzie
BHP Billiton Mitsubishi Alliance	Goonyella Riverside & Broadmeadow	Open-cut coal	-	Operational	Isaac / Connors
	Red Hill	Underground coal	8,841 / 100-500	Proposed	Isaac / Connors
Peabody Energy	North Goonyella	Open-cut coal	3,554	Operational	Isaac / Connors
BHP Billiton Mitsubishi Alliance	Gregory Crinum	-	-	Operational	Nogoa
Anglo American Metallurgical Coal	Grosvenor Coal Mine	Underground coal	- / 100-500	Operational	Isaac / Connors
Carabella Resources Limited	Grosvenor West Project	Coal	3,817 / 10-100	Proposed	Isaac / Connors
Rio Tinto Coal Australia	Hail Creek	Coal	20,380	Operational	Isaac/Connor
Vale Australia Pty Ltd	Isaac Plains	Coal	2,142	Operational	Isaac/Connor
Jellinbah Group Pty Ltd	Jellinbah East	Coal	-	Operational	Mackenzie
Rio Tinto Coal Australia	Kestrel	Underground coal	5,839 / 100-500	Operational	Nogoa
Anglo American Metallurgical Coal	Lake Lindsay	Open-cut coal	4,171	Operational	Mackenzie
Jellinbah Group Pty Ltd	Lake Vermont	Coal	-	Operational	Isaac / Connors
	Lake Vermont West	Coal	453	Proposed	Isaac / Connors
U&D Mining Industry Australia Pty Ltd	Meteor Downs South	Open-cut coal	- / 10-100	Proposed	Comet
Yancoal and Peabody Energy	Middlemount	Open-cut coal	1,586 / 100-500	Operational	Mackenzie
Peabody Energy	Millennium	Coal	2,245	Operational	Isaac / Connors
	Millennium Expansion Project	Open-cut coal	- / 10-100	Proposed	Isaac / Connors
Sojitz Coal Mining	Minerva	Coal	1,558	Operational	Comet
Blackwater Coal Pty Ltd	Minyango	Coal	3,324 / 100-500	Proposed	Mackenzie
Peabody Energy	Moorvale	Open-cut coal	4,372	Operational	Isaac / Connors
Anglo American Metallurgical Coal	Moranbah North	Underground coal	6,761	Operational	Isaac / Connors
	Moranbah South	Underground coal	- / 100-500	Proposed	Isaac / Connors
New Hope Group	New Lenton	Open-cut coal	4,905 / 10-100	Proposed	Isaac / Connors
BHP Billiton Mitsubishi Alliance	Norwich Park	Open-cut coal	13,641	Operational	Isaac / Connors
Xstrata Coal	Oaky Creek	Coal	-	Operational	Mackenzie
Peabody Energy	Olive Downs	Open-cut coal	1,739 / 10-100	Proposed	Isaac / Connors

Company	Name of Development	Type of Development	Size (ha) / Resource (Mt)	Status	Sub-Catchment
BHP Coal Pty Ltd	Peak Downs	Open-cut coal	-	Operational	Isaac / Connors
BHP Billiton Mitsui Coal	Poitrel	Open-cut coal	3,369	Operational	Isaac / Connors
Peabody Energy	Red Mountain Joint Venture	Coal	754	Proposed	Isaac / Connors
Xstrata Coal	Rolleston	Open-cut coal	4,863	Operational	Comet
	Rolleston Coal Mine Expansion	Open-cut coal	- / 100-500	Proposed	Comet
BHP Coal Pty Ltd	Saraji	Open-cut coal	-	Operational	Isaac / Connors
South Blackwater Coal Pty Limited	South Blackwater	Coal	8,465	Operational	Comet
BHP Billiton Mitsui Coal	South Walker Creek	Coal	-	Operational	Isaac / Connors
New Emerald Coal (Linc Energy)	Teresa Coal Project	Coal	- / 100-500	Proposed	Nogoa
Cuesta Coal	West Emerald	Coal	55,800	Proposed	Nogoa
Xstrata Coal	Wandoan	Open-cut coal	- / >1000	Proposed	Dawson
Washpool Coal Pty Ltd	Washpool	Coal	3,937 / 100-500	Proposed	Mackenzie
Cockatoo Coal (Taroom) Pty Limited	Woori (Guluguba)	Coal	911 / 10-100	Proposed	Dawson
Yancoal	Yarrabee	Coal	-	Operational	Mackenzie
Other Resource Developments					
Newcrest Operations Limited	Cracow	Zn, Ag, Au, Cu, Pb	1,409	Operational	Dawson
Dyno Nobel Asia Pacific Ltd	Moranbah Ammonium Nitrate Project	Ammonium Nitrate Manufacturing Facility	-	Operational	-
Arrow Energy Limited	Moranbah Gas Project	Coal Seam Gas	508.3 PJ	Operational	-
Infrastructure Projects					
Aurizon Holdings Limited	Central Queensland Integrated Rail	Rail	-	-	-
SunWater Ltd	Connors River Dam and Pipelines	Dam and pipeline	373,662 ML Rail: 133 km	-	-
Queensland Rail	Northern Missing Link Project	Rail Link	69 km	-	-
Gladstone Area Water Board and SunWater Ltd	Lower Fitzroy River Infrastructure Project	Weir Raising and Construction	-	-	-
Central Queensland Pipeline Pty Ltd	Central Queensland Gas Pipeline	U/g gas pipeline	450 km	-	-

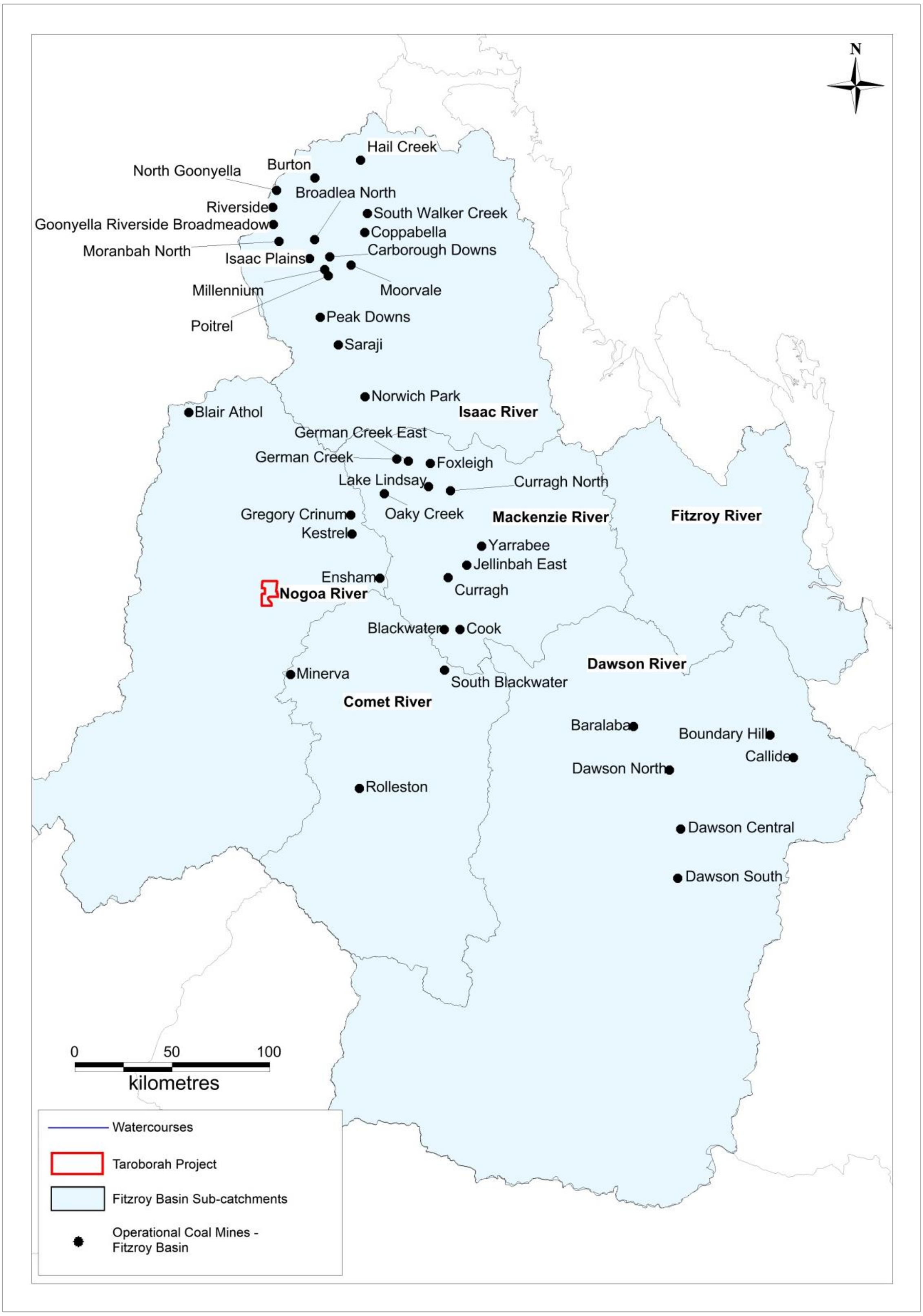


Figure 26 Major Operational Mines in the Fitzroy Basin

Water Management Strategy

The likelihood of uncontrolled discharges to the receiving environment is considered to be minimal. Site water collection drains and bunds will be designed to accommodate a 100 year ARI event. Clean water (i.e. stormwater occurring around the Project site that does not come into contact with

disturbed areas) will be intercepted by diversion drains that will be constructed around site infrastructure. Clean water will then be transported away from disturbed areas, ultimately connecting with downstream tributaries (ATC Williams 2013).

Site water (i.e. water generated from disturbed areas on the Project site, associated with operational surfaces) will be captured and contained in storage dams or sediment ponds and reused in mining and processing water circuits (ATC Williams 2013).

Fitzroy Basin Cumulative Impacts

A study conducted by the Department of Environment and Resource Management (DERM) in 2009 investigated the cumulative impacts of mining activities on water quality in the Fitzroy River Basin. The study concluded that the limits and conditions imposed on coal mines were inconsistent and not necessarily effective in protecting downstream environmental values, and insufficient data are available to provide a quantitative assessment of the cumulative impacts of mine water discharges (DERM 2009).

It is considered that salinity presents the most significant risk to water quality in the Fitzroy Basin due to discharges from coal mines. As part of the study, a risk assessment was conducted using electrical conductivity, discharge data (i.e. duration, frequency, volume, water quality and receiving waters) and geographic location within the basin. The matrix shown in Table 36 was used to determine the risk rating for each mine.

Table 36 Cumulative Risk Assessment Matrix for Mine Discharges in the Fitzroy Basin

Frequency/Volume (ML/year)			EC (µS/cm)			
			Very Low	**Low**	**Medium**	**High**
			<720	**<1,250**	**<2,500**	**>2,500**
Very Low	**Zero/small**	**<100**	Very Low	Low	Low	Medium
Low	**Few releases, infrequent**	**<1,000**	Low	Low	Medium	Medium
Medium	**Frequent**	**<10,000**	Low	Medium	Medium	High
High	**Continuous, some dry weather**	**<100,000**	Medium	Medium	High	Very High
Very High	**Continuous, months**	**>100,000**	Medium	High	Very High	Very High

Source: DERM 2009

The assessment found that the greatest contributors to potential downstream cumulative impacts on water quality were:

- Coppabella (Peabody Energy);
- North Goonyella (Peabody Energy);
- Goonyella Riverside (BHP Billiton Mitsubishi Alliance);
- Millennium (Peabody Energy);
- Peak Downs (BHP Coal Pty Ltd); and
- Ensham (Ensham Resources Pty Limited).

The results of the risk assessment are illustrated in Figure 27. With the exception of Ensham (located in the Nogoa sub-catchment), these mines are located in the Isaac-Connors sub-catchment. An additional six mines in the northern sub-catchments were found to present a medium cumulative risk. Most mines in the southern sub-catchments (i.e. Dawson, Nogoa and Mackenzie), however, presented only a low cumulative risk to water quality impacts based on EC. Coal mine development in the northern sub-catchments of the Fitzroy Basin is considered to pose a greater risk of

downstream cumulative impacts than mines in the southern sub-catchments, in which the Taroborah Project is located.

Three main recommendations were proposed based on the conclusions of the study:

1. Development of appropriate standardised environmental authority conditions relating to mine water discharges;
2. Development of locally-relevant water quality guidelines; and
3. Development of a cumulative impact assessment model for the region.

These recommendations have culminated in the establishment of an Integrated Quantity and Quality Model (IQQM) for the Fitzroy Basin, the Model Water Conditions for Coal Mines in the Fitzroy Basin and Environmental Values and Water Quality Objectives at localised sub-basin scales across the Fitzroy River Basin. The IQQM simulates stream flows, releases, in-stream infrastructure and diversions, and was used to inform the Water Resource Plan development process.

It is anticipated that the Model Water Conditions will be applied to the Taroborah Project, located in the lower Fitzroy Basin (Zone 3). The Model Water Conditions were developed specifically for improving water management in relation to coal mines in the Fitzroy Basin, particularly in terms of improving the cumulative impact of multiple mine discharges, and achieving consistency in Environmental Authority conditions between mining developments. The model conditions consider the spatial location of a project within the catchment when determining appropriate trigger levels and contaminant limits applicable to its mine discharges.

Using the risk matrix provided above, the Taroborah Project is anticipated to have a low risk of cumulative impacts to the receiving environment, within the context of the Fitzroy Basin. The Project will have a ‘very low’ volume of <100 ML/year and a ‘medium’ EC of <2,500 µS/cm, resulting in a risk of ‘low’.

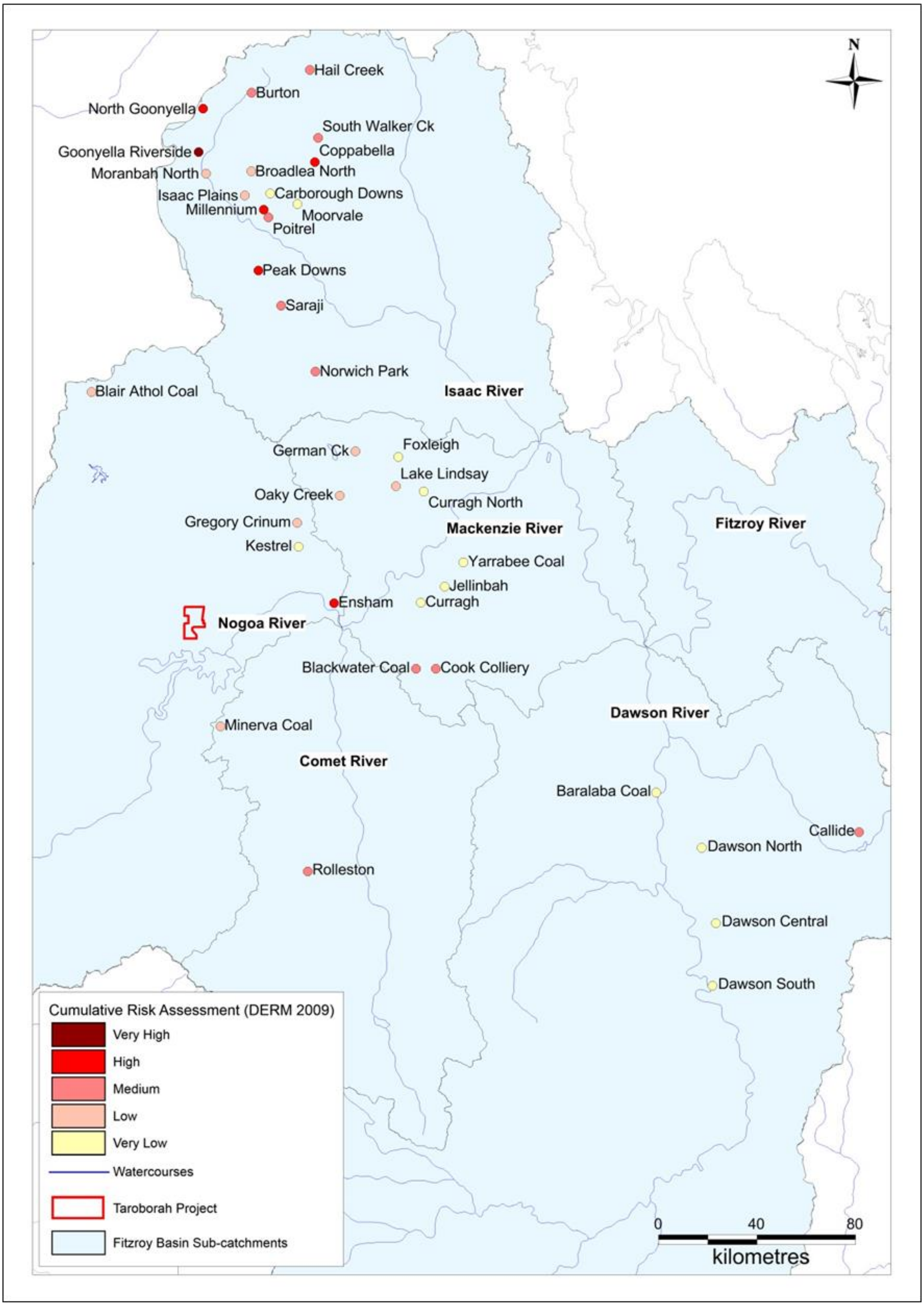


Figure 27 Cumulative Risk Assessment of Major Operational Mines in the Fitzroy Basin

19. GENERAL COOMENT SUBMISSIONS

19.1 NA Additional Comments

Submitter:

Central Highlands Regional Council, Community and Development Services

Submission:

NB: Since writing this SIA and SIMP the Sustainable Resource Community Policy is no longer current. CHRC acknowledge the Taroborah Mine Project Social Impact Management Plan included cumulative impacts.

Response:

No response required.

19.2 NA General Comments on Indigenous Issues

Submitter:

Department of Aboriginal and Torres Strait Islander and Multicultural Affairs

Submission:

As a demonstration of support for the Native Title Agreement, the proponent:

- Undertake to establish and participate in a Liaison Committee whose role is to monitor compliance with the Native Title Agreement or the interests of Aboriginal and Torres Strait Islander people.
- Develop an Aboriginal and Torres Strait Islander Participation Plan.
- Commit to employing Aboriginal and Torres Strait Islander personnel during construction and in operational, either directly or through contractors.
- Provide training that will equip Aboriginal and Torres Strait Islander people with the skills required to secure long term sustainable employment.
- Seeks to develop and retain locally-based skilled workforce.
- Develop detailed strategies and targets in consultation with relevant government agencies, Aboriginal and Torres Strait Islander communities and registered native title applicants.

Engage in culturally appropriate recruitment policies and strategies to attract and retain Aboriginal and Torres Strait Islander people.

DATSIMA recommends that the Proponent develop strategies that supports the development of a general agreement regarding training and employment opportunities for Aboriginal and Torres Strait Islander peoples which includes:

- Monitoring and measuring success.
- Reviews and adjusts as necessary to changing circumstances.
- Work with the local Aboriginal and Torres Strait Islander communities to build skills, competence and programs that enhance opportunities through education and training through to sustainable employment.
- An Aboriginal and Torres Strait Islander procurement policy in all tendering documentations.

Response:

The Taroborah Indigenous Participation Plan (IPP) outline now included as Appendix B to Appendix 23 of the EIS document addresses these recommendations, as does Shenhuo's commitment to working with DATSIMA (Rockhampton) to achieve its IPP objectives. Note that the project's Community Liaison Officer will be charged with monitoring Indigenous participation (rather than a committee) and will report regularly as part of the SIMP monitoring programme.

EIS Amendment:

None required

20. GENERAL PUBLIC SUBMISSIONS

20.1 Section 1.3.3.4, Page 1-16 & Section 2.2.1, Page 2-3 - Consequences for not Proceeding with the Project

Submitter:

Fitzroy Basin Association

Submission:

The proponent describes the economic implications of not proceeding with the project, however the avoidance of environmental and land production impacts (e.g. to Strategic Cropping Land) are not discussed**.**

Recommendation:

The proponent amends this section to include a description of environmental and production impacts that will be avoided should the project not proceed.

Response:

Acknowledged, and this will be included in a re-draft of this section for the final EIS document.

EIS Amendment:

A final sentence has been added to Section 1.3.3.4 and Section 2.2.1 of the EIS main body report that reads as follows:

"By not undertaking the Project, the temporary disturbance of approximately 461 ha of Class 3 and Class 4 grazing land and permanent disturbance of 35 ha of Class 4 grazing land and 3 ha of an endangered brigalow community will be avoided."

20.2 Section 2.2.4.1, Page 2-6 - Mining and Processing - Extraction

Submitter:

Fitzroy Basin Association

Submission:

The proponent states "*With consideration to the principles of ESD, to responsibly extract the resource in as an efficient manner as possible, the preferred scenario was based on Case 1b [longwall mining vs. bard and pillar mining] with slight modifications applied [open cut mining in the south of the project area] to further harness the resource available in the Taroborah area.*" Ecologically Sustainable Development principles encompass more than economic considerations as detailed by the proponent; other principles include a

requirement to minimise environmental and production impacts (as would occur under a bord & pillar mining scenario, since subsidence of the above landscape will affect both ecological and agricultural production values).

Recommendation:

The proponent should review this section to consider all aspects of Ecologically Sustainable Development, instead of only those relating to economic values

Response:

The assumption that “subsidence of the above landscape will affect both ecological and agricultural production values” is very broad and not necessarily true in this case. Affects to both agricultural production and ecological values will likely be minimal.

Agricultural Production

As discussed in response to submissions elsewhere in this document (Section 2.16 and Section 3.1), the Proponent will seek to minimise the impact on agricultural production during and after the life of the project. Cropping and grazing will continue on as much of the land as possible during mining. Where properties are purchased to enable the project to take place, the Proponent will seek to keep unaffected areas of those properties in production during the life of the project. Consideration will also be given to reticulation of excess water from mine dewatering for agricultural purposes, where possible, to improve productivity.

With a typical differential subsidence of 0.8m over 110m in the current cropping areas (and maximum of 1.1m over a distance of 130m), post-completion slope above the underground operations will remain fundamentally similar to the existing conditions, and appropriate mitigation measures (re-contouring drainage lines) will be undertaken to ensure drainage is unaffected, with the result that there should be no long-term impact on agricultural yields. Based on evidence and research at Crinum and Kestral mines approximately 50km north-east of Taroborah, as well as in the Illinois Basin in the USA , where incidentally the land in both areas is much flatter than at Taroborah, it is expected that all currently cropped land will return to production at 90% or greater of its existing yields at the completion of the project with little or no effect to soil fertility.

No current or historic (last 10-20 years) areas of cropping land will be permanently impacted (i.e. excavated) by the mining operations or siting of mine infrastructure, and subsidence of cropping land from underground mining will only result in temporary impact of approximately 60-90ha of cropping land annually. Once subsided, drainage will be re-established and the lands returned to cropping within an approximate one year period. History elsewhere has shown that cropping yields will not be significantly diminished (5-10% yield loss) from pre-disturbance levels.

The opencut is sited primarily on Class 4 and 5 cropping suitability land (i.e. land that is marginal to unsuitable for cropping), whilst the mine infrastructure area is located on Class 3 and 4 cropping suitability land (suitable to marginal) that has never been cropped and is used solely for grazing purposes. The approximately 250ha of affected land currently supports approximately 100-200 head of cattle intermittently, and will be returned to use following mine closure. The displaced cattle can easily be accommodated on adjoining land to the south and east of the mine during operating years.

Ecological Values

Potential impacts to ecological values include subsidence of both endangered regional ecosystems and aquatic ecosystems. Because of clearing for cropping and grazing, only isolated areas of remnant vegetation of ecological value will be impacted by subsidence

from underground longwall mining. The land subsidence which will occur as a result of underground mining has the potential to impact only approximately 114 ha of regional ecosystems and 33 ha of ephemeral aquatic habitat associated with one drainage line of Retreat Creek.

As reported in Australia Mining magazine in April 2010, an extensive three year ACARP project was conducted by Dr Paul Frazier, the Hunter and New England regional manager for environmental services firm Eco Logical Australia, to study the impact of subsidence on the surface environment at three longwall minesites; the Kestrel mine in the Bowen Basin, the Beltana mine the Hunter Valley and the Dendrobium operation in the Illawarra region. At the conclusion of the study, the team had not found any major changes to the vegetation or the agricultural production at the selected study sites. And studies (monitoring) conducted at Metropolitan as reported in their 2008 EIS also indicated that adverse impacts to riparian and ridge top vegetation as a result of subsidence has been minor.

Given the level and nature of subsidence at Taroborah (strains of 12mm/m or less and tilts of 1% or less) will be less severe than at Kestrel and Beltana, and similar to that at Dendrobium and Metropolitan, it is not expected that any major adverse impacts to the root systems of the established vegetation will occur. Nor will altered drainage patterns and cracking result in significant ponding or loss of water as discussed in Section 4.8 of the EIS report.

EIS Amendment:

None required

20.3 Section 3.7.7.1, Table 3.36, Page 3-140 - Native Species Suitable for Rehabilitation

Submitter:

Fitzroy Basin Association

Submission:

The proponent lists species considered suitable for rehabilitation. Rehabilitation should be focussed on re-establishing vegetation communities that originally existed on the project site.

Recommendation:

The species listed in Table 3.36 should be grouped according to which rehabilitated regional ecosystem they will contribute to. This will also provide a checklist to ensure that ecological diversity proposed for rehabilitation is commensurate with regional ecosystem descriptions

Response:

This has been addressed in the final EIS document.

EIS Amendment:

Table 3.36 in the EIS main body report has been amended as follows.

Scientific Name	Common Name	Regional Ecosystem									
		11.3.3a	11.3.6	11.3.25	11.3.27h	11.4.8	11.4.9	11.5.3	11.9.1	11.9.10	11.10.3
Dichanthium sericeum	Queensland Bluegrass			x					x		
Themeda triandra	Kangaroo Grass	x				x		x			
Bothriochloa decipiens	Pitted Bluegrass			x		x				x	
Chloris truncata	Windmill Grass		x			x	x	x	x	x	x
Cymbopogon refractus	Barbed Wire Grass					x					
Heteropogon contortus	Black Speargrass		x				x	x	x		
Panicum decompositum	Native Millet		x	x	x						
Leptochloa digitata	Umbrella Canegrass	x		x							
Lomandra longifolia	Long-leaved Mat-rush	x	x	x							
Carissa ovata	Currant Bush		x	x		x	x	x	x	x	
Lysiphyllum hookeri	Queensland Ebony	x	x	x			x	x			
Terminalia oblongata subsp. *oblongata*	Yellowwood	x					x	x	x		
Diospyros humilis	Small-leaved Ebony			x							
Acacia holosericea	Soap Bush		x								
Eremophila mitchellii	False Sandalwood					x	x	x	x	x	
Melaleuca bracteata	Black Teatree	x	x	x							
Grevillea striata	Beefwood							x			x
Casuarina cristata	Belah			x			x			x	
Acacia harpophylla	Brigalow					x	x		x	x	
Acacia salicina	Native Willow			x							
Corymbia intermedia	Pink Bloodwood										x
Eucalyptus cambageana	Blackbutt			x		x		x	x		x
Eucalyptus melanophloia	Silver-leaved Ironbark		x					x	x		
Eucalyptus populnea	Poplar Box	x	x					x		x	
Eucalyptus tereticornis	Forest Red Gum		x	x							
Alphitonia excelsa	Red Ash		x						x		x

20.4 Section 4.2.2.9 - Lights

Submitters:

Frances Sypher and Cameron Backus

Submission:

Sypher

Bright lights of concern to us and our cattle.

Suggest dimming the lights between 7pm and 6am

Backus

Light pollution impacting on quality of life is a concern

Response:

Studies undertaken to date do not indicate the prospect that light pollution will affect the properties in question, due to both the presence of the visual amenity bund and the location of the properties in question in relation to the mining operations. However, if this proves to be otherwise once mining commences, then Shenhuo will undertake appropriate mitigation measures.

EIS Amendment:

None required

20.5 Section 4.3 and Appendix 11 - Train Transport thru Emerald

Submitters:

Kathleen Murray and Mike Featherstone

Submission:

Murray

It is with great angst that I have learnt that 6 Coal Trains per day will be travelling through Emerald (where now there is none) once this project is finalized.

I wish to protest in the most strenuous terms about this proposal and hope the Coal Trains are in fact diverted around Town to either the Minerva line or the Blair Athol Line to prevent adverse impact on residential back yards, businesses along the Capricorn HWY and potential traffic chaos at three main intersections.

I also note that the train shunting area was moved some years ago from the centre of town to opposite the Agriculture college- some 2 kilometres out of town for just the same reasons. A precedent has been set and should be followed.

Some seventy concerned residents in the Moodewarra Estate share my views and hope common sense prevails.

Featherstone

It has been most distressing to hear that should the Taroborah Coal Development proceed, up to six coal trains will be passing through the centre of Emerald causing disruption to daily routines, noise pollution, spreading dust and filth and lowering property values.

I would respectfully ask and draw your attention to;

1. When residential properties were purchased no coal trains were running

adjacent to said backyards.

2. Property values have already dropped substantially with the mining down turn and further drops in asset values would cause a panic and be political suicide.
3. Is the CHRC ready to compensate effected home owners?
4. The existing rail corridor through Emerald takes trains the closest to the backyards of hundreds of homes all along the length of the track to Gladstone. Even Blackwater and Bluff are not affected to the extend Emerald will be! How is this proper?
5. Do you want to create another Gladstone with hazardous air quality?
6. Do you want to drive residents out?
7. I would expect the CHRC to be working on attracting and keeping residential workers not punishing them by poisoning their back yards.
8. The existing Vince Lester Bridge will require some $900,000.00 in upgrades to accommodate trains nobody wants on it!
9. What effects are to be borne by businesses along the Capricorn HWY and Hospital RD?
10. How will the dust and noise effect the Flora and Fauna in the Botanic gardens- to say nothing of the play area under the bridge?

Mr Maguire please stop the trains coming through Emerald and spend the CHRC money marked for infrastructure upgrades on making the trains go around the Town like the Minerva line.

Response:

The Proponent is mindful of the resident’s concerns regarding increased train movements through Emerald. We note that only 12 properties in the Moodewarra Estate where Ms Murray lives back-up to the rail line, and some 20 elsewhere along the line within town and west of the river. The modelling of train noise contained in the EIS indicates that noise will only exceed the statutory limits within 60m of the tracks, in adverse meteorological conditions. And this distance can easily and effectively be reduced through the erection of sound barriers if required, as is done throughout more densely populated areas where trains operate.

As for the dust issue, and noted in the response below in Section 20.10, the Proponent has stated that the moisture content of the product coal that will be transported is expected to be 15% and all of the loaded coal wagons will be veneered, both of which will effectively limit the release of dust from the passing trains.

With regard to running the coal around town on a new bypass rail route, the Proponent notes that as well as being financially unviable, rerouting the line around the town would adversely impact on priority agricultural land, and likely increase the number of residents impacted, not decrease them. Running the trains around the town to the Minerva line would impact the residential developments along the Gregory Highway. The number of existing houses impacted would be notably greater than the number of houses impacted under current plans. Moreover, there would still be some noise experienced in the Moodewarra Estate, near the intersection of the Gregory Highway and Capricorn Highway, so this would likely not make an appreciable difference to the residents there.

EIS Amendment:

None required

20.6 Section 4.3.2.1 - Road Impacts

Submitter:

Craig McCamley, Cameron Backus and Frances Sypher

Submission:

McCamley

During the construction and operation of the proposed mine there will be significant increases in traffic on the Capricorn Hwy between Emerald and the turn off. The report states that no upgrades are required to this section of road as it assesses impacts to be minimal. I disagree with this assessment. The section of highway is built predominantly on a black soil plain and has deteriorated a number of times over the recent decade with existing traffic. The section of highway in question has actually had a speed limit of 80 kph for at least 4 years (201 0 to 2013) that I know of due to the highway breaking up and being unsafe to use at 100 kph. The recent CHRC works have simply resealed the surface. This highway will break up and fail with increased volume and weight over it. This will make it unsafe and cost the CHRC (read ratepayers) to repair.

Upgrade the section of highway from Emerald to the proposed operations turn off to provide infrastructure which will withstand mine site traffic increases. This is consistent with commitments made by other mining companies in the Emerald area when starting a new operation.

Backus

I am concerned with how …. The Increased traffic in general will impact on our quality of life.

Sypher

Increased traffic on Gregory highway - no provisions for cars overtaking while we are turning into our private property road.

Suggested solution is an overtaking lane put in as per regulations.

Response:

Firstly, it is the Proponent’s understanding that the Capricorn Highway is a State Controlled Road, and therefore, the State has the responsibility to maintain it. It is acknowledged that the poor condition of the highway is primarily due to a poorly constructed roadbase established on swelling clay soil. The heavy volume of coal trucks from the Alpha Mine test pit did not help matters. The cost to upgrade this section of highway to withstand the heavy traffic volumes that would be required to likely impact it would be extensive and is not considered warranted by the small increase in traffic that will occur from Taroborah (< 1% increase on existing levels or a maximum of 12 heavy vehicles per day over a 6 month period), which is considered insignificant under legislation and therefore, has raised no concern from DTMR or CHRC and does not require a specific compensation agreement under legislation. Nor does legislation require a mine or any other specific user to upgrade a road prior to their operating on it.

Other than upgrades to intersections for mine access, the Proponent is unaware of any other mines in the area that have upgraded roads prior to operation.

The Proponent assumes that Ms Sypher meant the Capricorn Highway in her submission, as the Project will have negligible impact on the Gregory Highway. The increased traffic from the Project should have no impact on any landholders turning into their property access roads, as it is the other vehicles on the highway that will need to slow down to avoid a

collision. Further, the Proponent is unaware of any legislation that requires other road users to construct a bypass lane for landholders turning into their private road.

EIS Amendment:

None required

20.7 Section 3.6 and Section 4.4 – Litter along highway

Submitter:

Frances Sypher

Submission:

The submitter is concerned about an Increase in rubbish along highway and in their paddock. Suggested solution is talking to employees regarding waste management and the effects on the environment and the importance of putting rubbish in appropriate places.

Response:

This concern is noted, but should not be a big problem as the Proponent is proposing BIBO to the mine site as the primary means of employee transport. However, this solution will be incorporated into employee and contractor site inductions and training.

EIS Amendment:

None required

20.8 Section 4.5.1.2 and Section 5.7.4.3 - Groundwater Drawdown

Submitter

Craig McCamley, Frances Sypher, William Crowther and Cameron Backus

Submission:

<u>McCamley</u>

We live on the property "Selma" which is situated to the east of the proposed mine. We use a water bore (DNRM # 47238) for domestic water and for stock water. My objection with the groundwater section is this. Groundwater modelling is a helpful guide but far from an exact science. If the modelling is correct then our water supply is unlikely to be badly affected. However, if the modelling is incorrect and our water supply is affected by the operation of the mine then we will be without sufficient water for stock or for domestic use. This is not an acceptable outcome for us. We rely on this water supply and have invested money in pumping infrastructure from this bore. To obtain water of sufficient quality for domestic use would be very expensive and inconvenient for us if the bore was to deteriorate as a result of mining nearby. This is a serious and genuine concern I have regarding the proposed operation.

Recommendation:

I would like to see the operator of the mine commit to entering into "make good" agreements with all neighbouring landholders (including us) regarding the groundwater supply. The agreements should provide assurance that if a bore water supply is affected by the operating mine then the situation will be resolved, in consultation and agreement, with the near neighbours at no cost to the affected landholders. This is a very common form of agreement throughout the Bowen Basin between landholders and mine operators. To be effective, more accurate quantity testing would need to be undertaken of all bores in the area and routine monitoring conducted to determine any changes in the water table or

flows to bores. Measure it and manage it. The proposed operation must assure near neighbours that it will make good any impacts they cause to local bore water supplies.

Sypher

Concerned about the loss of water from our bore, water quality and contamination to water. Suggested solution is to gauge water levels and water monitoring on a regular basis.

Crowther

I am the owner of the property Sweetwater, Lot 96SP227975 which is on the north western boundary of the Taroborah mining lease.

The property Sweetwater, Lot 96 is highly dependent upon groundwater taken from a bore which is in a 3 -5 km radius of the Taroborah mining lease. This water is required for the watering of 1500 head of cattle throughout the year.

I understand that Taroborah is planning to utilise groundwater supplies for the watering of the mine. It is our concern that the ground water supplying the bore for Sweetwater will be negatively impacted. I realise that the EIS is stating that there will not be a significant impact on this bore however I am aware that there are cases where unforseen impacts occur and that it is most difficult if not impossible to accurately ascertain the flow of groundwater. This water is of utmost importance to the successful operation of the propefi Sweetwater, a cattle property which runs in excess of 1500 head of cattle. Without this water this cattle operation would become unviable and the value of the property would be severely impacted upon.

I request that there be a monitoring bore installed and that this be independently monitored at regular intervals to ascertain any effect on this groundwater.

I request that there be a "make good agreement' reached between Taraborah and myself in the event of this groundwater being compromised or impacted upon in any way or form, from the supply that is currently available.

Backus

I am writing to you to express my concerns as a potentially effected nearby landholder. We operate a beef grazing enterprise just to the west of the proposed Taroborah Project and rely on the alluvial underground water table for stock and domestic water supply. We currently have two bores, one drilled in 1972, and the other drilled in 1993 that we pump from daily without fail in more than 40 years, enabling us to carry on a beef grazing enterprise year in year out through wet and dry years. We have put in a large amount of infrastructure such as pipelines, tanks, and troughs that connect to the two bores and allow us to utilise the entire property for grazing regardless of whether dams have dried up. We currently have not run water into dams for the past three years and would not be able to operate without these bores.

It is evident that mining does impact on the underground water tables and thus impacts severely on those that rely on them for commercial business purposes, irrigation, stock and domestic purposes. This can be seen nearby in the Lillyvale Mining Area.

I am concerned that as a small family business we would not have the financial means to go up against a mine legal department to prove that it was the mining that caused a potential and likely failure of our evidently secure underground water supply. I would like it to be a condition of the Environmental Authority that it be mandatory for the miner to make good any impact on quality or quantity to nearby bores, rather than the land holder having to pay prohibitively large legal costs to determine guilt.

I would like it to be a condition that the miner compensate the nearby landholders for all

costs associated with the monitoring of water quality and quantity of nearby bores or have an independent body monitor these and provide the landholder with documentation of results.

Response:

The Proponent is certainly cognizant of the importance of groundwater to the livelihood of the landholders that currently live within the Project boundaries as well as those on surrounding tenements. While "make good" agreements are not required under current legislation, it is the intention of Shenhuo to enter into some form of agreement of this nature with all potentially affected landholders. Potentially affected landholders (including those who have provided the above submissions) have already been contacted in regard to this, as have the State and Federal government regulators.

A groundwater monitoring regime is already established for the Project site as detailed in the Draft EIS. This monitoring regime has been expanded to include all 19 existing monitoring bores, and landholder bores that are subject to a make good agreement will be included in the monitoring network upon the agreement being finalised.

EIS Amendment:

Please see amendments as detailed in the response in Section 12.10 above.

20.9 Section 4.5.2.3, Page 4-288 - Uncontrolled Discharges - Cumulative Impacts

Submitter:

Fitzroy Basin Association

Submission:

The proponent states that "as no other mining projects or industrial activities are located close to the Project site and the local catchment is not associated with any other mines /industry, the cumulative impacts of discharges from multiple sources is not considered to pose a risk to the local receiving environment." FBA submits that cumulative impacts to downstream environments (e.g. Nogoa, Mackenzie and Fitzroy river systems and the Great Barrier Reef) have not been considered.

Recommendation:

The proponent conducts an assessment of the cumulative impacts of its operation and other mining developments within the catchment of the downstream receiving environment, including cumulative impacts to the Great Barrier Reef.

Response:

While the Taroborah Project is not anticipated to cause impacts to the receiving environment, the potential exists for the Project to contribute to catchment-wide downstream cumulative impacts resulting from uncontrolled discharges of mine affected water. The potential impacts associated with the release of mine affected waters include:

- Toxicity related to the release of sulphate, salinity, acid or alkaline solutions, metals or metalloids;
- Changes in the bioavailability of metals caused by changes to pH of receiving waters, impacting flora and fauna;
- Detrimental impacts to the structure and function of ecosystems; and

- Impacts to the suitability of water for drinking, stock water, or irrigation.

While it is inevitable that all developments will contribute to some extent to cumulative impacts, the degree and severity of this contribution is dependent on a number of factors, including:

- Quality and quantity of mine discharge water;
- Time of release;
- Weather conditions at the time of release;
- Existing quality and flow of the receiving catchments. For example, it has been noted that northern sub-catchments such as Isaac/Connors typically has naturally higher EC than the Nogoa sub-catchment (DERM 2009);
- The number and type of other developments in the area; and
- Whether the release coincides with releases from other mines.

In order to determine the potential for the Project to contribute to cumulative impacts, the following section provides an overview of the other resource and infrastructure developments located, or proposed to be located, in the Fitzroy River Basin.

A study conducted by the Department of Environment and Resource Management (DERM) in 2009 investigated the cumulative impacts of mining activities on water quality in the Fitzroy River Basin. The study concluded that the limits and conditions imposed on coal mines were inconsistent and not necessarily effective in protecting downstream environmental values, and insufficient data are available to provide a quantitative assessment of the cumulative impacts of mine water discharges (DERM 2009).

It is considered that salinity presents the most significant risk to water quality in the Fitzroy Basin due to discharges from coal mines. As part of the study, a risk assessment was conducted using electrical conductivity, discharge data (i.e. duration, frequency, volume, water quality and receiving waters) and geographic location within the basin. The matrix shown in Table 4.79 was used to determine the risk rating for each mine.

Table 4.79 Cumulative Risk Assessment Matrix for Mine Discharges in the Fitzroy Basin

Frequency/Volume (ML/year)			EC (µS/cm)			
			Very Low	Low	Medium	High
			<720	<1,250	<2,500	>2,500
Very Low	Zero/small	<100	Very Low	Low	Low	Medium
Low	Few releases, infrequent	<1,000	Low	Low	Medium	Medium
Medium	Frequent	<10,000	Low	Medium	Medium	High
High	Continuous, some dry weather	<100,000	Medium	Medium	High	Very High
Very High	Continuous, months	>100,000	Medium	High	Very High	Very High

Source: DERM 2009

The assessment found that the greatest contributors to potential downstream cumulative impacts on water quality were:

- Coppabella (Peabody Energy);
- North Goonyella (Peabody Energy);
- Goonyella Riverside (BHP Billiton Mitsubishi Alliance);
- Millennium (Peabody Energy);
- Peak Downs (BHP Coal Pty Ltd); and
- Ensham (Ensham Resources Pty Limited).

The results of the risk assessment are illustrated in Figure 4.95. With the exception of Ensham (located in the Nogoa sub-catchment), these mines are located in the Isaac-Connors sub-catchment. An additional six mines in the northern sub-catchments were found to present a medium cumulative risk. Most mines in the southern sub-catchments (i.e. Dawson, Nogoa and Mackenzie), however, presented only a low cumulative risk to water quality impacts based on EC. Coal mine development in the northern sub-catchments of the Fitzroy Basin is considered to pose a greater risk of downstream cumulative impacts than mines in the southern sub-catchments, in which the Taroborah Project is located.

Three main recommendations were proposed based on the conclusions of the study:

1. Development of appropriate standardised environmental authority conditions relating to mine water discharges;
2. Development of locally-relevant water quality guidelines; and
3. Development of a cumulative impact assessment model for the region.

These recommendations have culminated in the establishment of an Integrated Quantity and Quality Model (IQQM) for the Fitzroy Basin, the Model Water Conditions for Coal Mines in the Fitzroy Basin and Environmental Values and Water Quality Objectives at localised sub-basin scales across the Fitzroy River Basin. The IQQM simulates stream flows, releases, in-stream infrastructure and diversions, and was used to inform the Water Resource Plan development process.

It is anticipated that the Model Water Conditions will be applied to the Taroborah Project, located in the lower Fitzroy Basin (Zone 3). The Model Water Conditions were developed specifically for improving water management in relation to coal mines in the Fitzroy Basin, particularly in terms of improving the cumulative impact of multiple mine discharges, and achieving consistency in Environmental Authority conditions between mining developments. The model conditions consider the spatial location of a project within the catchment when determining appropriate trigger levels and contaminant limits applicable to its mine discharges.

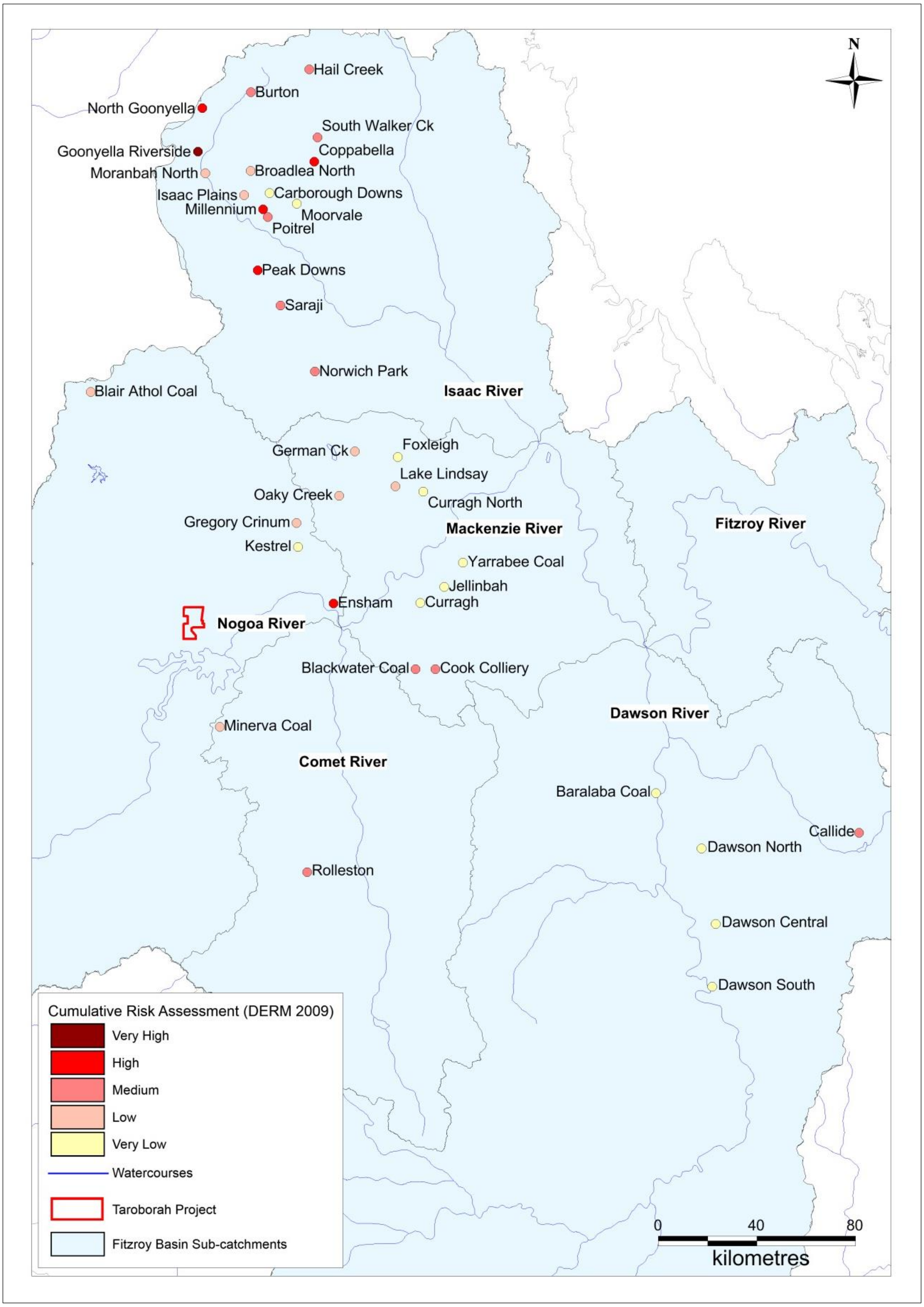


Figure 4.95 Cumulative Risk Assessment of Major Operational Mines in the Fitzroy Basin

EIS Amendment:

The above discussion is included verbatim at the end of the Uncontrolled Discharges sub-section of Section 4.5.2.3 of the EIS main body report.

20.10 Section 4.6 - Air Quality – Coal Dust from Trains

Submitter:

Craig McCamley and Cameron Backus

Submission:

McCamley

The modelling shows "Selma" is unlikely to be badly affected by dust. Open Cut mines and open coal stockpiles are notoriously dusty unless well managed. One source of dust which is not addressed is the dust blowing off open coal wagons attached to trains. My concern is the dust created in this way can be considerable if the coal is dry and this dust would blow off the trains and across the dwellings north of the rail line and also in Emerald. It is interesting to note that China does not allow open stockpiles of coal and all coal mined (from the larger operations at least) is stored in large bins and storage structures. This is the law in China. It is important for Taroborah to recognise that dust generation is a significant community concern.

Recommendation:

Ensure coal is wet when it is loaded on to trains. This has the added benefit of weighing heavy when the coal is loaded into the ships. Often coal is marketed around 8% moisture. If the coal is loaded so that it is at maximum moisture content then dust make near Emerald and off the trains will be minimised. Dust generated at the mine and from open coal stockpiles can be managed by efficient road watering (also ample watering at coal dumps) and good blast design. Instead of simply using a radial stacker to stockpile the coal a luffing linear stacker could be used or a telescopic chute fitted to a radial stacker to prevent fines blowing off the product as it is stacked. The cost benefit to the operation is that it does not lose the fine portion of the product over the life of the mine. The fines (as you would be aware) often consist of the higher volatile portion of the coal so spreading them over the surrounding properties is losing value from the product. My point is there are several options and strategies readily available to reduce the dust made from an operation. It is important that Taroborah implement strategies that deliver a result as this is an important community relations concern. Dust pollution impacting on quality of life is a concern.

Backus

I am concerned with how the …. dust pollution, … will impact on our quality of life.

Response:

Product coal will have significant moisture as a matter of its properties (estimated at 15%). The Taroborah Coal Project will mitigate potential dust emissions from coal wagons by profiling wagon loads and applying a treatment to the coal surface (veneering) that ensures that wind erosion of coal dust is minimised. These features have been demonstrated to be effective in minimising emissions of coal dust from rail wagons and will ensure that there are no adverse impacts on residents.

A recent review of dust from coal trains in Queensland presented in a report to the Senate Standing Committee on Community Affairs Inquiry: *The Impacts on health of air quality in Australia* (Katestone, 2013) found the following in relation to likely dust levels from trains and dust management measures:

- A review of studies that have conducted air quality monitoring in the corridor and around rail systems has shown that whilst coal dust and the influence of coal trains on dust levels has been detected, the levels of coal dust were found to be well below the air quality objectives for the protection of human health and amenity

impacts. The studies showed that outside of the rail corridor, defined as approximately 10 metres from the tracks, coal dust concentrations were much lower than within the corridor and were below air quality objectives for the protection of human health and amenity.

- One of the main actions to date is the implementation of veneering stations at loadout facilities of central Queensland coal mines. Application of a veneer to the coal surface of a loaded wagon ensures coal dust lift-off is reduced. The degree of reduction will depend on a range of conditions, but wind tunnel studies suggest that a reduction in coal dust lift-off of better than 85% is achievable.

EIS Amendment:

None required

20.11 Section 4.7 - Noise and Vibration

Submitter:

Craig McCamley and Cameron Backus

Submission:

McCamley

My concern regarding noise and vibration is this: The area is a quiet rural community with some infrequent highway noise from the Capricorn Highway. If the proposed mine was to commence operations significant noise would be added to the area. In particular these noise sources are of concern to me:

1. Trains accelerating away from the mine
2. Blasting and machine operations from the Open Cut
3. Noise from the CHPP
4. Tack dozers operating on open stock piles
5. Coal moving through coal clearance infrastructure (bins, chutes conveyors etc).

It is one thing to recognise that noise will be made and to work in noisy environments. It is another to live and sleep next to a noisy operation. This is a serious concern I have regarding the operation. I understand that if the proposed mine is established it will not be able to eliminate noise but it has a responsibility to make every effort to reduce noise created with readily available and proven noise reduction techniques.

Recommendation:

I would suggest the operation commit to noise reduction measures that will reduce the noise generated at the source to a level as low as reasonably possible. Suggestions for the noise sources listed:

1. Upgrade/electrify the rail line to allow electric locos or limit the power applied to diesel locos as they pull away from the mine. Another option would be to limit loading of trains to business hours.
2. No blasting between 4pm and 8am. Blast design controls.
3. Noise barriers at source ie around crushers, pumps and other noise sources.
4. Fit low noise running gear on dozers. No stockpile pushing between 4pm and 8am
5. Noise barriers at source

Engineering solutions should be included in the design of the mine as they are more effective/sustainable and much more cost effective over the life of the mine. I am aware of mining operations which have implemented some of these measures already to minimise noise generation from their sites so what is being suggested here is simply industry best practice. Taroborah could establish itself as an industry leader in the area of stakeholder engagement and community relations by being proactive in this area.

Backus

I am concerned with how the noise, … will impact on our quality of life.

Response:

The predicted noise levels at Mr McCamley's (Selma) and Mr Backus' properties are well within guideline limits.

The Proponent acknowledges the various noise limiting measures suggested by Mr McCamley and note that most of these methods are already mentioned in the EIS document.

The noise that will be generated by loading trains is not a high contributor to the overall noise emission levels, and some of the suggestions on limiting noise from the trains (i.e. electrification and day light loading only) are not financially feasible or operationally controllable by the mine.

The erection of specific fixed plant sound barriers and alternative train opersating methods are noted as a potential mitigation method, and will be considered if noise levels generated by the Project warrant it.

EIS Amendment:

The additional mitigation measure of fixed plant sound barriers and reduced locomotive power on start-up are included as mitigation measures bullet points in Section 4.7.2.2 of the EIS main body report.

20.12 Section 4.7 - Noise and Vibration

Submitter:

Frances Sypher

Submission:

Concerned with noise and vibration from blasting frightening cattle, causing them to congregate around the homestead.

Request notification when blasting to occur.

Response:

The above request is acknowledged, and while noise and vibration levels from blasting are predicted to be very minor at the Sypher's location, the Proponent is certainly willing to set-up a blasting notification protocol with the Syphers and any other potentially affected landholders.

EIS Amendment:

None required

20.13 Section 4.8 - Ecology – Weed borne diseases

Submitter:

Frances Sypher

Submission:

There is potential for new pests and diseases to be brought to the area.

Suggest monitoring.

Response:

This monitoring is already covered in Section 4.8.3.7 of the Draft EIS as follows.

Introduced Flora

The risks posed by weeds in mining areas include the introduction of new species, the spread of weeds to adjacent areas, and increases in weed abundance in disturbed areas. Weeds can also diminish rehabilitation efforts by outcompeting species selected for revegetation and reduce overall land productivity.

The best form of weed control is the prevention of their establishment on site. Small infestations can often be treated efficiently; however, the large-scale eradication of established infestations can incur significant management costs.

Threat mitigation plans will be developed and included in a Weed Management Plan (WMP) developed for the Project to prevent the spread of weeds throughout the site, thereby reducing the liability costs associated with the eradication of infestations.

Control measures to be included in the WMP include:

- Risk assessment of high biosecurity risk species and their sites;
- Restricting vehicles to designated roads where practical;
- Preventing water and fertilisers (when used) from running into bushland;
- Managing buffers or windbreaks around disused revegetated areas (when applicable); and
- Cleaning of machinery and off-road vehicles (including visitors).

Biosecurity Queensland promotes a number of wash-down procedures, enabling industry to meet these requirements, which will be implemented on the Project site. Weed eradication and management strategies will be developed in consultation with Pest Fact Sheets (made available by DAFF) to ensure the most effective methods of eradication are employed on the Project site.

Weed management will also be addressed during the Site Induction Program for the Project to inform staff of the weed species likely to be encountered on the Project site, the locations of known weed infestations, and how to report the presence of new infestations.

Introduced Fauna

Six introduced pest fauna species were recorded during the field surveys, four of which are defined as Class 2 Pests under the Queensland LP Act.

Pest animal control methods employed on the Project site will use scientific information and informed judgment to implement the most humane method that is effective in a given situation to reduce the negative impacts that a method has on an animal's welfare (DAFF 2011).

In accordance with the Australian Animal Welfare Strategy (2008), taking into account changes in whole of community standards, the objectives of pest animal control on the Project site are to:

1) Meet the statutory requirements of the LP Act;
2) Promote and use only humane and effective methods of pest animal control; and
3) Undertake best practice standards in all situations where there is potential for human to animal interaction.

When choosing a control technique, it is the aim of the Project to balance the effectiveness of the technique, its humaneness, and public safety. The Project shall only undertake pest animal control methods that are scientifically proven to remove or destroy the animal with next to no pain, suffering or mental anguish. No biological or chemical methods of control will be used to control pest animal species on the Project site.

Measures that will be considered in the management of Class 2 pest species on the Project site include:

- Effective dingo control methods include shooting and fencing in combination with current land management practices;
- Feral Cat control measures include trapping;
- European Rabbit control measures include ripping warrens and shooting; and
- A combination of physical controls will be employed where practical to control the Feral Pig, including shooting and/or barrier construction.

In addition, food scraps will not be left out as these attract pests. Food scraps will be disposed of in appropriately sealed containers / bins and collected by a suitably qualified contractor.

EIS Amendment:

None required

20.14 Section 4.8.2.2, Page 4-386 - Terrestrial Fauna

Submitter:

Fitzroy Basin Association

Submission:

The proponent reports that no species of national conservation significance (EPBC Act) and only one species of state conservation significance (NC Act) were located during the project's fauna surveys.

A total of 24 threatened species are known to occur in the region and are listed in an appendix document (App. 13), along with an assessment of the likelihood of their occurrence at the project site.

Recommendation:

FBA submits that the Appendix 13 information relating to threatened species and their likelihood of occurrence at the project site is presented in the main body of the report.

Response:

Clearly, the reference to Appendix 13 is incorrect, and was meant to be Appendix 18.

The above request is acknowledged and the Proponent will include the requested

information in Section 4.8 of the report.

EIS Amendment:

The following has been inserted after the 4th paragraph of Section 4.8.1 – Description of Environmental Values of the EIS main body report.

"The EPBC Act Protected Matters Search Tool and the Wildlife Online Database were used to search for historical records of fauna species within an area, defined by a 100 km x 100 km square centred on a central point within the Survey Area (23° 32' 7.0794" S, 147° 56' 8.016" E).

Review of the database searches indicated the potential presence of 24 threatened species in the region of the Project site. These species are listed in 0 below.

Table 4.90 Threatened Fauna Species, their Habitats and Likelihood of Occurrence on the Project Site

Scientific Name Common Name	Conservation Status EPBC Act 1999	 NCA 1992	Habitat	Notes
Birds				
Accipiter novaehollandiae Grey Goshawk	Not listed	Near Threatened	The grey goshawk inhabits rainforests, forested gullies and valleys, taller woodlands, timber on watercourses and open country during dispersal (Pizzey & Knight 2007).	Suitable habitat for this species occurs on the Project site and surrounding lands. Due to the abundance of similar habitat type surrounding the Project Site, if the species was present in the region, the Project is unlikely to impact on the species.
Anseranas semipalmata Magpie Goose	Marine	Not Listed	The magpie goose occupies large seasonal wetlands and well vegetated dams with rushes and sedges; wet grasslands and floodplains (Pizzey & Knight 2006).	Suitable habitat for this species occurs on the Project site. However, this species is not at its distributional range and the area is not known to be a significant foraging or breeding ground.
Apus pacificus Fork-tailed Swift	Migratory/Marine	Least Concern	Fork-tailed Swift breeds from central Siberia eastwards through Asia, spending boreal winter in northern Australia. Known to appear and forage for aerial insects over any habitat. They are strictly aerial when visiting Australia during the austral summer (Morcombe 2002).	May potentially occur over site but was not observed during the survey period. Development on site is unlikely to affect this species as it is strictly aerial remaining high above ground. Rarely if ever comes into contact with vegetation or land.
Ardea alba Great Egret, White Egret	Migratory/Marine	Least Concern	Common throughout Australia, with the exception of the most arid areas. Known to prefer shallow water, particularly when flowing, but may be seen on any watered area, including damp grasslands (Morcombe 2012).	Suitable habitat for this species occurs on Site. Given the abundance of similar habitat type surrounding the Project Site, if the species was present in the region, the Project is unlikely to impact on the species.
Ardea ibis Cattle Egret	Migratory/Marine	Least Concern	Widespread and common in north, north-eastern and south-eastern Australia. The species is found in grasslands, woodlands and wetlands, and is not common in arid areas. Utilises pastures and croplands, especially where drainage is poor. Will also forage in garbage dumps, and often associates with livestock (Morcombe 2012).	Suitable habitat occurs on Site, and surrounding lands. Given the presence of major watercourses and wetlands in the region, it is likely the species would prefer these sites. May benefit from human waste and livestock in the region. Overall, it is unlikely that the project would impact on this species.
Ephippiorhynchus asiaticus Black-necked Stork	Not Listed	Near Threatened	Prefers open freshwater environments, including the margins of swamps, shallow floodwaters over grasslands, wet shorelines, margins of mangroves, mudflats and estuaries (Morcombe 2002).	Limited habitat occurs on Project Site. Given the habitat associated with major watercourses and wetlands in the region, it is likely the species would prefer these sites.

Scientific Name Common Name	Conservation Status		Habitat	Notes
	EPBC Act 1999	NCA 1992		
Erythrotriorchis radiatus Red Goshawk	Vulnerable	Endangered	Inhabits undisturbed forest/woodland especially those adjacent to water bodies with large populations of birds. Hunts from a perch in dense foliage. Breeds in large eucalypts or melaleucas (Morcombe 2002).	Limited habitat occurs on Project Site. Due to the presence of large forest/woodland habitats occurring in association with Lake Maraboon to the south-east of the Project Site, it is considered unlikely that the project would impact on the species if it does occur in the region.
Gallinago hardwickii Latham's Snipe, Japanese Snipe	Migratory/Marine	Least Concern	Prefers low vegetation in swamps, salt marsh, heath, creek lines and irrigated cropland (Morcombe 2002).	The Project site provides limited areas of suitable habitat for this species. Given the abundance of suitable habitat in the region, the Project is not likely to impact on the species.
Geophaps scripta scripta Squatter Pigeon (southern)	Vulnerable	Vulnerable	This species occurs in dry grassy eucalypt woodlands and open forests, mostly in sandy sites near permanent water (Curtis et al. 2012)	The Project site lacks any permanent watercourses required to support a population in the long-term. The Project site may provide suitable habitat for this species during the wet season.
Haliaeetus leucogaster White-bellied Sea-eagle	Migratory/Marine	Least Concern	This species inhabits coastal and near coastal areas of northern and eastern Australia. Sometimes occur around inland drainages and large dams or lakes where sufficient prey (medium sized birds and fish) is available (Morcombe 2002).	Limited habitat on the Project Site. It is more likely that the species would occur in association with larger water bodies occurring in the region such as Nogoa river or Lake Maraboon where water and prey are readily available.
Hirundapus caudacutus White-throated Needletail	Migratory/Marine	Least Concern	This species occupies airspace over forests, woodlands, farmlands, plains, lakes, coasts, hilltops and timbered ranges (Pizzey & Knight 2006).	The subject site provides limited habitat for this species. It is more likely that this species occurs over the vast woodland habitats and the major wetland (i.e. Lake Maraboon) located to the south-east of the Project site.
Melithreptus gularis Black-chinned Honeyeater	Not Listed	Near Threatened	The black-chinned honeyeater occupies dry eucalypt woodland, particularly containing ironbark and box eucalypts as well as river red gum (Garnett *et al.* 2011).	Some suitable habitat may occur on the Project site however given the species range and the availability of similar habitat in the region it is unlikely the Project will adversely affect this species at a regional scale.
Merops ornatus Rainbow Bee-eater	Migratory/Marine	Least Concern	Common across mainland Australia. Seasonal movements from north to south during austral summer. Open woodland, forest clearings, semi-arid shrub land and grassland. Nests in long tunnel built into sandy soil or river bank (Morcombe 2002).	The Project site provides limited habitat for this species. It is highly likely that this species would occupy more suitable habitats in the region such as the banks of the Nogoa River.

Scientific Name Common Name	Conservation Status		Habitat	Notes
	EPBC Act 1999	NCA 1992		
Myiagra cyanoleuca Satin Flycatcher	Migratory/Marine	Least Concern	This species tends to inhabit heavily vegetated gullies in forests, taller woodlands. During migration, the satin flycatcher can be found in coastal forests, woodlands, mangroves, gardens and trees in open country (Pizzey & Knight 2006).	No suitable habitat occurs on the Project Site. Although individuals may occur sporadically along densely vegetated watercourses in region, the Project is not likely to impact on the species.
Neochmia ruficauda ruficauda Star Finch (eastern), Star Finch (southern)	Endangered	Endangered	The star finch is a very rare and nomadic granivore. Sightings have reduced significantly since white settlement. Found in rank vegetation along watercourses and swamps (Morcombe 2002).	Suitable habitat occurs in the region. While potential habitat for this species is present, the Project site lacks permanent watercourses. The project is unlikely to impact the species if it does occur in the region.
Nettapus coromandelianus Cotton Pygmy-goose	Not Listed	Near Threatened	Uncommon to rare vagrant across north-east Australia. Inhabits deep, permanent water bodies but may occupy floodplain pools during the wet season (Morcombe 2002).	Suitable habitat for this species occurs on the Project site and surrounding lands. Due to the abundance of similar habitat type surrounding the Project Site, if the species was present in the region, the Project is unlikely to impact on the species.
Phaethon rubricauda Red-tailed Tropicbird	Marine	Vulnerable	The red-tailed tropicbird is restricted to marine environments and breeds on offshore islands.	Individuals may be blown inland after periodical cyclone events but there is no suitable habitat available on the Project Site.
Rostratula australis Australian Painted Snipe	Vulnerable/ Migratory/Marine	Vulnerable	This species inhabits shallow inland wetlands, either permanent or temporary (Marchant and Higgins 1993).	Suitable habitat for this species occurs on the Project site. Due to the abundance of similar habitat type surrounding the Project Site, if the species was present in the region, the Project is unlikely to impact on the species.
Tadorna radjah Radjah Shelduck	Not Listed	Near Threatened	During the wet season the Radjah shelduck will occupy most shall waters including freshwater, saltwater and brackish swamps, mangrove lined coastal creeks and shallow river margins. During the dry season, the species tends to populate around larger permanent lagoons, paperbark swamps, man-made wetlands, mangroves, tidal flats and estuaries (Pizzey & Knight 2006).	Although suitable habitat for this species occurs on the Project site, the site occurs beyond the limit of the species distribution and it is therefore considered unlikely that this species occurs on the Project site.
Mammals				

Scientific Name Common Name	Conservation Status		Habitat	Notes
	EPBC Act 1999	NCA 1992		
Dasyurus hallucatus Northern Quoll	Endangered	Least Concern	Declined over range, now restricted to isolated populations across the north. Locally common in the Carnarvon range-Bowen area in rocky *Eucalyptus* woodland. May occur in other woodland and forest types (Menkhorst and Knight 2011).	Due to the current high disturbance and fragmentation of the Project Site, little suitable habitat is present. Targeted searches were carried out for this species but no evidence was found.
Nyctophilus timoriensis Greater Long-eared Bat, South-eastern Long-eared Bat (south-eastern form)	Vulnerable	Vulnerable	South-eastern form found through inland NSW and inland southern QLD. Roosts in tree hollows or decorticating bark. Forages in vegetation below canopy.	The Project site provides limited habitat as a result of previous disturbances that have led to a lack of roosting habitat.
Reptiles				
Acanthophis antarcticus Common Death Adder	Not Listed	Near Threatened	Death adders occur where intact shrub and leaf litter layers are present (Wilson 2009).	The Project site lacks areas of deep leaf litter, a habitat value that this species depends on. Lands to the south-east of the Project site may provide suitable habitat in association with existing woodland habitats. However, it is unlikely that the project will impact on this species.
Delma torquata Collared Delma	Vulnerable	Vulnerable	Restricted to south-east Queensland, north-west to Blackdown tableland and inland to Roma. Shelters in leaf litter and beneath logs and rocks. Occurs in rocky areas within dry open forest and brigalow (Wilson & Swan 2008).	As a result of previous clearing and agricultural disturbances, the Project site now contains small fragmented areas of potential habitat for this species.
Denisonia maculata Ornamental Snake	Vulnerable	Vulnerable	This species occurs in Brigalow woodlands growing on clay and sandy soils, riverside woodland, and open forest growing on natural levees (Shine 1983), showing a preference for moist areas (Wilson and Knowles 1988).	The Project site provides suitable habitat for this species. However, given the presence of Lake Maraboon and associated woodlands to the south-east of the Project site, it is highly likely that this species would prefer these habitats. In the event that the species does occur in the region, it is unlikely that the project would impact on the species.
Egernia rugosa Yakka Skink	Vulnerable	Vulnerable	Occurs in south-eastern, central and north-east Queensland. Lives communally in logs, rock crevices, beneath rocks and in burrows. Inhabits dry open forests, woodlands and rocky areas.	Previous activities on the Project site have resulted in extensive disturbance, fragmentation, and a subsequent lack suitable habitat for this species. It is possible this species may inhabit the Project site. The Project site is not expected to have any impacts on this species or its habitat.

Scientific Name Common Name	Conservation Status EPBC Act 1999	NCA 1992	Habitat	Notes
Furina dunmalli Dunmall's Snake	Vulnerable	Vulnerable	Restricted to central south-eastern QLD. Inhabits Brigalow but has suffered decline across its range, possibly because of decline in brigalow. Prey on *Egernia striata* (Wilson and Swan 2008).	Restricted areas of suitable habitat occur in association with watercourses on the Project site. Due to the abundance of similar habitat type surrounding the Project site, if the species was present in the region, the Project is unlikely to impact on the species.
Hemiaspis damelii Grey Snake	Not Listed	Endangered	This species shows preference for cracking flood-prone soils in the Brigalow Belt, extending to Lockyer Valley in Southeast Queensland and the north-east interior of NSW. It shelters in soil cavities and beneath well-insulated debris (Wilson 2005).	Suitable habitat for this species occurs on the Project site. Due to the abundance of similar habitat type surrounding the Project Site, if the species was present in the region, the Project is unlikely to impact on the species.
Lerista allanae Allan's Lerista	Endangered	Endangered	This species' distribution is restricted to the area between Clermont and Capella (Couper & Ingram 1992). It occurs in grass tussocks on heavy-clay soil. There are no recent records despite thorough searches throughout range (Wilson & Swan 2008)	It is unlikely that this species occurs on the Project site.
Paradelma orientalis Brigalow Scaly-foot	Vulnerable	Vulnerable	Restricted to SE Queensland. Shelters in grass tussocks and leaf litter and beneath logs and sandstone. Occurs on sandstone ridges and in woodlands, brigalow and vine thickets (Wilson & Swan 2008).	Due to high disturbance, fragmentation, and a lack of rocky habitat or fallen debris there is limited suitable habitat for this species on the Project Site.
Rheodytes leukops Fitzroy River Turtle	Vulnerable	Vulnerable	This species is found in rivers within the Fitzroy Catchment with large deep pools with rocky, gravelly or sandy substrates, connected by shallow riffles. Preferred areas have high water clarity, and are often associated with Ribbonweed (*Vallisneria* sp.) beds (Cogger et al. 2000).	Suitable habitat for this species does not occur on the Project site. This species is not considered likely to occur on site.

Scientific Name Common Name	Conservation Status		Habitat	Notes
	EPBC Act 1999	NCA 1992		
Strophurus taenicauda Golden-tailed Gecko	Not Listed	Near Threatened	The golden-tailed gecko is endemic to the brigalow belt region and occupies dry sclerophyll forests comprising ironbark eucalypts, cypress pine and brigalow. This arboreal species shelters behind loose bark and in tree hollows (Wilson 2009).	Due to the extent of disturbance and fragmentation across the Project site, there is limited habitat available for this species. Given the abundance of similar habitat type surrounding the Project Site, if the species was present in the region, the Project is unlikely to impact on the species.
Amphibians				
Cyclorana verrucosa Rough Collared Frog	Not Listed	Near Threatened	The rough-collared frog occurs near seasonal ponds, creeks, and claypans in open country (Tyler & Knight 2011)	Suitable habitat for this species occurs on the Project site and surrounding lands. Given the abundance of ponds and creeks on lands surrounding the Project Site, the Project is unlikely to have a significant impact on the species.

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ATTACHMENT A

MEDLI Analysis Report

ACN: 108 153 242

Process Engineering, Process Management, Project Management and Environmental Management Solutions

PO Box 2055, Gladstone Qld 4680 Telephone: 07 4979 4001
Facsimile: 07 4979 3009

Shenhuo International Group Pty Ltd
Taroborah treated effluent irrigation – MEDLI analysis

On-Site Wastewater Assessment:
Development Approval for ERA 63 1 (b) (i)

By: Darrin Marxsen
BE (Chem), Grad Dip Mgt, Grad Cert Env Mgt, MProject Mment (Trans)
MIEAust CPEng, CEnv CSci CEng MIChemE, RPEQ 6953
Principal Resource
Alpha Concepts Pty Ltd

Document No: M/TCoal/0914/0
Monday, 8 September 2014

Executive Summary

A sewage treatment plant rated for 200 EP is to be commissioned as part of the Taroborah Coal Project to process wastewater generated by onsite offices, toilet blocks and associated facilities.

The site is not serviced by a sewer and therefore requires on-site sewerage treatment with treated effluent to be discharged through an irrigation scheme. As the peak design capacity is between 100 – 1500 EP, this is an Environmentally Relevant Activity under Schedule 2, section 63, 1 (b) (i) of the Environmental Protection Regulation, 2008.

The proposed treatment plant is rated at 29, 000 litres per day peak capacity, with a treated water quality analogous to Class A.

MEDLI analysis has shown the area of land required to irrigate the site's treated water is 0.9 ha. This corresponds to an average irrigation rate of 2.6 mm/d, which has been deemed as sustainable (no detriment to the environment in relation to hydraulic, nutrient or salinity loadings). Preliminarily Taroborah Coal has set aside 2.5 ha of land available for irrigation purposes at the site.

The selected irrigation method is surface irrigation by fixed sprinklers, generating a large droplet, non-aerosol, low plume irrigation profile. Buffer zones to limit potential human contact have been specified in relation to the property boundaries and other structures.

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List of Tables and Figures

1 Introduction

IMC Mining Pty Ltd (IMC), on behalf of Shenhuo International Group Pty Ltd (Shenhuo), is seeking approval to conduct an Environmentally Relevant Activity at a proposed development at Taroborah, central-west Queensland. Alpha Concepts has been enlisted to gather supporting information and perform MEDLI analysis to facilitate this process.

The proposed development requires on-site sewerage treatment corresponding to Environmentally Relevant Activity 63, 1 (b) (i). This activity is regulated by the Environmental Protection Act 1994, Environmental Guidelines and Regulations, and Local Government Guidelines and Regulations.

The Client therefore has a commitment to adhere to the requirements of both the Department of Environment Heritage Protection and the respective Regional Council within regards to managing and operating the site as an ERA.

This document details the MEDLI modelling results developed to determine the required irrigation area based on climatic conditions, local soil characteristics and treated wastewater quality characteristics.

2 Development location and building plans

The proposed irrigation area is shown in yellow in Figure 1 below.

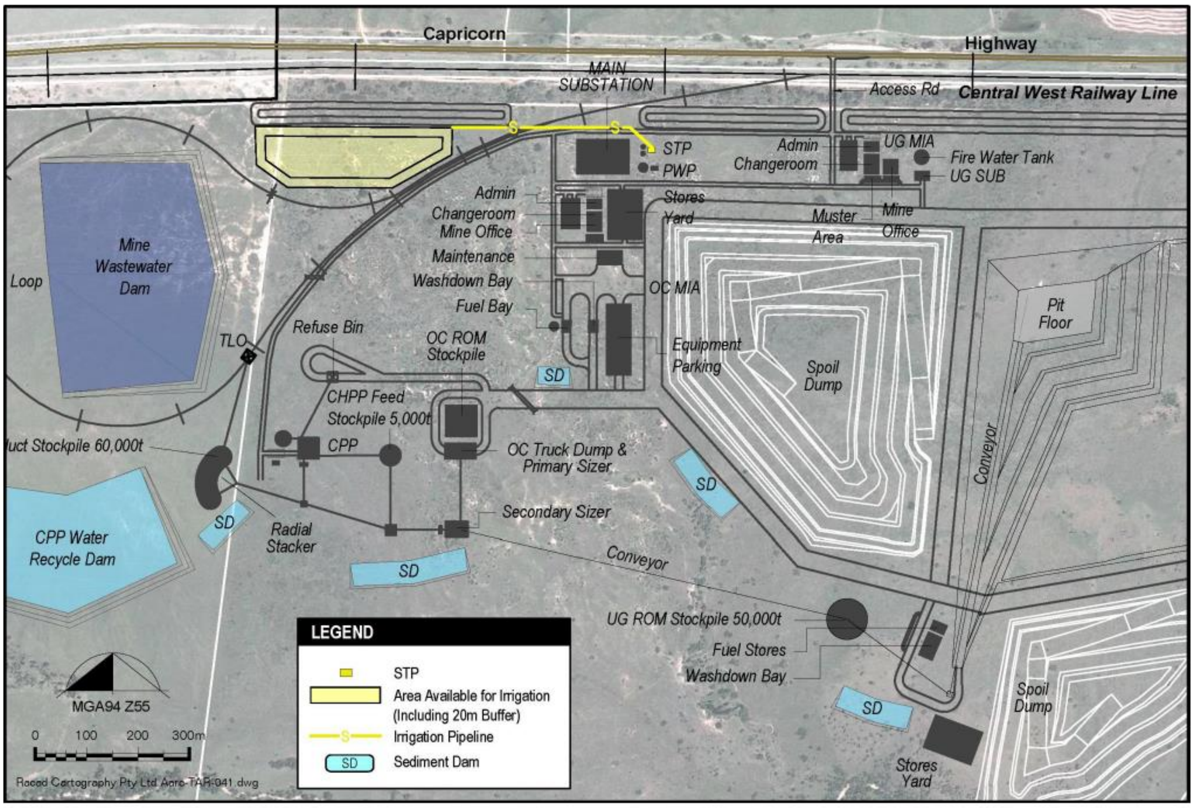


Figure 1: STP and irrigation area location

3 MEDLI analysis

The 'Model for Effluent Disposal Using Land Irrigation' (MEDLI), version 1.3, was used to determine the area required for sustainable application of treated water to land. The wastewater generation rate, effluent quality and wet weather storage volume and soil characteristics were the basis of modelling. Details of the site activity and modelling results are explained in the following sections, and the summary input and output reports for the model runs are included in the appendix.

3.1 Model inputs and assumptions

The philosophy of design and MEDLI modelling will be to demonstrate that average loads of 23.2m^3/d treated effluent can be irrigated to land with no identified detriment to environment. The discharge rate has been chosen to optimise land required and minimise nutrient impact and minimise runoff generated by irrigation. The site soil characteristics of low hydraulic permeability reduces relative infiltration rate and the risk of nutrients on ground water.

Irrigating at 2.6 mm/d over 0.9 ha of land is sufficient to assimilate the wastewater generated. The model was run using the average wastewater generation rate of the development.

The following table shows the effluent water parameters entered into MEDLI.

Table 1: MEDLI input data- irrigated water characteristics

Parameter	Value
Suspended solids, mg/L	5
Phosphate, mg/L P	5
Total Nitrogen, mg/L N	10
Conductivity, µS/cm	1600

The following additional inputs were used:

- Soil type: grey clay
- Vegetation cover: Pasture (Rhodes grass pasture)
- Irrigation method: Fixed sprinkler irrigation

Once the inputs were finalised, the model was run several times using different irrigation rates. Two runs are reported here: the first is a baseline run which shows site conditions with no irrigation. The second run shows the model iteration with the most acceptable level of impact to land. The results are given in the table below.

Table 2: MEDLI results- with and without irrigation

Parameter	Baseline (no irrigation)	Average irrigation of 2.6 mm/d over 0.9 ha
Model rationale	Determine site characteristics without irrigation	Irrigation at sustainable rate over 0.9 ha
Wastewater generation rate (l/day)	0	23,200 (average)
Irrigation rate (l/day)	0	23,200
Average Irrigation Application Rate (mm/day)	0	2.60
Irrigation Method	Nil	Fixed sprinkler
Irrigation Trigger	n/a	Every day
Vegetation	Rhodes Grass	Rhodes grass
Irrigation Area	9,000 m^2	9,000 m^2
Rainfall mm/yr	631.9	631.9
Irrigation mm/yr	0	949.6
Soil Evaporation mm/yr	339.7	126.1
Transpiration mm/yr	214.6	1154.7
Drainage mm/yr	23.2	164.4
Runoff mm/yr	55.6	138.0
Average N03-N conc. of deep drainage mg/L	0.3	0.0
Average P conc. Below root zone mg/L	0.0	0.0
Maximum monthly Water logging factor (0.0 to 1.0)	0.0	0.2
Reduction in crop yield due to salinity %	0.0	0.0
MEDLI Summary Input File Name	iTarb9	iTarb8
MEDLI Summary Output File Name	oTarb9	oTarb8

3.2 Guidelines for land application of effluent

MEDLI Modelling has indicated that 9,000 m^2 of land is required for the application of 23,200 litres per day of treated effluent; equating to an average irrigation rate of 2.60 mm/day.

Irrigation will be managed according to a detailed Irrigation Management Plan, to be developed concurrently with site construction. Key design aspects and accepted practices for irrigation of treated water are:

- No irrigation during days where rain events are over 1 mm.
- No irrigation during high wind periods.
- Irrigation of water to be predominantly between the hours of 22:00 and 03:00 to avoid human contact.
- No irrigation within 12 meters of property boundary where large droplet spray irrigation is used. Alternate fine irrigation will require increased set-back distances from irrigation edge to border of irrigation field.
- Use of surface spray irrigation via low angle, large droplet non aerosol type irrigation. The setback and separation / buffer distances proposed are based on an irrigation plume height of 3 meters. Variation in this height necessitates review of set-back distances.
- Personnel are to avoid contact with effluent.
- No roof rainwater catchment for drinking purposes within 50 meters of edge of irrigation field using spray irrigation.
- No bore use for drinking water purposes within 200 meters of irrigation field.
- Irrigation area fully fenced to prevent access.
- No livestock grazing of irrigation field.
- No edible crops within irrigation field.
- Signage must be installed notifying public and site personnel that treated water is in use and advising to avoid contact and not drink.
- Regular maintenance and monitoring of the irrigation field.
- Mowing of irrigation field at prudent harvest times, modelled as being at least twice per year.
- Regular review of irrigation field to ensure no pooling, stress to vegetation or identifiable degradation to soil.

As MEDLI modelling has been performed on the basis of irrigation irrespective of rain events; which will not be the case in practice, it is proposed to set irrigation average and maximum targets as part of the approval.

As stated, irrigation will not occur if there is a rain event in excess of 1 mm in any one day. During periods of rainfall, wastewater is accumulated in the Wet Weather Storage facility. As a result of the accumulated inventory will need to be irrigated when there is no rainfall. To this respect a maximum irrigation rate has been set relative to the average rate so as to ensure no net long-term accumulation of treated water, the proposed irrigation volume terms are as follows:

1. The maximum irrigation rate for any one day is set at 33.0 m^3/d.
2. The fortnight average irrigation rate will not exceed 23.2 m^3/d.

3.3 Wet Weather Storage

Viewing the number of days where rainfall exceeds 1 mm, and utilising the peak wastewater generation rate a minimum wet weather storage volume of 100 m^3 has been selected. This volume yields a storage time of 3.45 days at peak wastewater generation rates and 4.3 days at expected average wastewater generation rates. The wet weather storage has been based on sealed tank

storage. If use of pond or dam irrigation, rainfall influences will need to be taken into consideration in setting wet weather storage volume.

4 Conclusions and recommendations

As the site is un-sewered, there is the need to implement an onsite wastewater treatment system and hence the need to raise an ERA 63 1(b) (i) for the onsite sewage treatment and disposal of treated water. A sewage treatment plant of 29 kL/day peak capacity has been sized for the site. The treated water quality from the proposed design is analogous to Class A.

MEDLI modelling has been performed and the results indicate that an irrigation application area of 0.9 ha is required for the average site loading conditions. Irrigation of 0.9 ha with an average irrigation rate of 2.6 mm/d is believed to be sustainable as the MEDLI modelling for these values indicates no nutrient or salt impacts.

Appendices

Appendix 1: Hydraulic calculations
Appendix 2: Emerald BOM Climate Data
Appendix 3: MEDLI input/output files

- MEDLI input file: no irrigation (iTarb9)
- MEDLI output file: no irrigation (oTarb9)
- MEDLI input file: irrigation (iTarb8)
- MEDLI output file: irrigation (oTarb8)

Wastewater Generation Calculations

Wastewater volume - Peak		
Site capacity	200	persons
Wastewater generation per person	145	l/person/day
Peak flow	29000	litres / day

Wastewater volume - Average		
Site capacity (80% of peak)	160	persons
Wastewater generation per person	145	l/person/day
Average flow	23200	litres / day

Treated Water Quality
Analogous to Class A
Low risk and low proximity to sensitive environmental receptors

Table: Loading rates for wastewater release limits

Irrigation area 0.6 ha

Parameter	Release limits		Loading rate		
	Minimum	Maximum	kg/d	kg/yr	kg/ha/yr
pH	6.5	8			
BOD_5 mg/l		20			
Suspended Solids mg/l		5			
Phosphate as P mg/l		5	0.15	52.96	88.20
Total Nitrogen as N mg/l		10	0.29	105.92	176.40
Nitrate/ Nitrite as N mg/l		5	0.15	52.96	88.20
TKN as N mg/l		5	0.15	52.96	88.20
Conductivity µS/cm		1600			
Free Chlorine mg/l	0.5	3			
Dissolved Oxygen mg/l	2				

Land Application Estimate

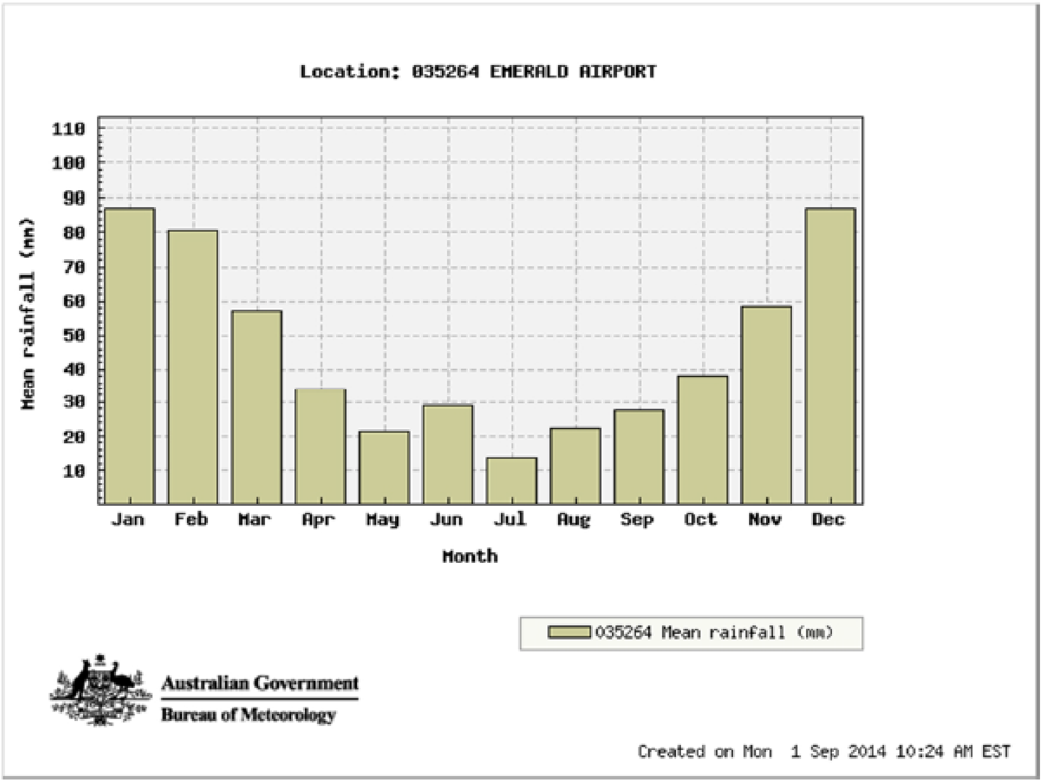
Parameter	Value	Units	Data source
Effluent generation			
Peak Flow	29000	l/d	*Waste generation estimates*
	29.00	m3/d	
	10.6	ML/yr	0.02900
Person rating -EP	128.8888889	persons	
Average Flow	23200	l/d	*Waste generation estimates*
	23.2	m3/d	
	8.5	ML/yr	0.02320
Person rating -EP	116	persons	
Water losses			
Mean Daily Evaporation	5.84	mm/d	*MEDLI Climate Data- 'no irrigation run', 50th percentile*
Mean Rainfall	1.54	mm/d	
% of net evaporation for vegitation assimmilaton	90%		
Irrigation Rate	3.86	mm/d	
MEDLI Derived irrigation rate - average 365 days	2.6	mm/d	
Irrigation days			
Days of rainfall > 1 mm	44.9	days	*BOM Climate Data*
Wet days in year	12%		
Dry days in year	88%		
Irrigation days/fortnight	12.3	d/fortnight	
Irrigation rate			
Average irrigation volume	23.2	m3/d	
	0.0232	ML/d	
	8	ML/y	
Area required	6004.7	m2	
	0.60	ha	
MEDLI Derived irrigation area	0.9	ha	
Peak irrigation volume	26.5	m3/d	
	0.026	ML/d	
	10	ML/y	
Irrigation area	6004.7	m2	
Peak irrigation rate	4.4	mm/d	
MEDLI Derived irrigation rate - dry days	2.94	mm/d	

For irrigation rate at 3.9 mm, required area is 0.59 ha.	3.86	mm
	23.2	m3
	0.60	**ha**
To irrigate over 2.5 ha, irrigation rate required is maximum 1.16 mm.	2.5	ha
	29	m3
	1.16	**mm**
MEDLI output	2.5	ha
	1607	mm/y
	110.0	m3/d

Wet Weather Storage Calculations

Note: The DEHP requires 3 days storage minimum.

Parameter	Value	Units	Notes
Storage volume required			
Month of Highest Mean Rainfall	January		
Number of days of Rain > 1 mm/d	5.8		
Number of days of Rain > 10 mm/d	2.5		
Ratio of > 1mm rainfall in month	0.21		
Days per week storage required	1.44		
Peak Flowrate	29.00	m3/d	
Required Storage Volume	73	m3	
Equivalent storage volume			
Selected storage volume	100	m3	
Peak flowrate	29	m3/d	
Equivalent peak flow storage	3.45	days	
Average wastewater generation	23.2	m3/d	
Equivalent average flow storage	4.31	days	



Appendix 2

Monthly Climate Statistics for 'EMERALD AIRPORT' [035264] http://www.bom.gov.au/climate/averages/tables/cw_035264.shtml
Created on [27 Aug 2014 14:56:17 GMT+00:00]

035264 EMERALD AIRPORT
Commenced: 1981
Last Record: 2014
Latitude: 23.57 Degrees South
Longitude: 148.18 Degrees East
Elevation: 189 m
State: QLD

Statistic Element	January	February	March	April	May	June	July	August	September	October	November	December	Annual	Number of Y	Start Year	End Year
Mean maximum temperature (Degrees C) for years 1992 to 2014	34.4	33.3	32.6	29.8	26.2	23.2	23.2	25.4	29.1	31.7	33.2	34.2	29.7	22	1992	2014
Highest temperature (Degrees C) for years 1992 to 2014	45.6	41.5	40.8	36.7	34.3	31.3	31	35.2	39.9	42.4	42.9	43	45.6	22	1992	2014
Date of Highest temperature for years 1992 to 2014	6-Jan-94	2-Feb-05	12-Mar-07	3-Apr-06	4-May-07	29-Jun-03	13-Jul-95	23-Aug-09	26-Sep-13	31-Oct-03	30-Nov-06	26-Dec-01	6-Jan-94	N/A	1992	2014
Lowest maximum temperature (Degrees C) for years 1992 to 2014	23.1	20.9	21.9	17.2	16	9.7	13.6	12.6	15.7	19.1	20.7	19	9.7	22	1992	2014
Date of Lowest maximum temperature for years 1992 to 2014	31-Jan-14	15-Feb-00	28-Mar-08	27-Apr-12	25-May-12	20-Jun-07	23-Jul-08	9-Aug-96	23-Sep-93	28-Oct-12	19-Nov-97	27-Dec-06	20-Jun-07	N/A	1992	2014
Decile 1 maximum temperature (Degrees C) for years 1992 to 2014	30.4	29.2	29.5	26.6	22.8	19	19.9	21.5	24.6	27.8	29	29.5		23	1992	2014
Decile 9 maximum temperature (Degrees C) for years 1992 to 2014	38.5	36.9	35.9	33	29	26.9	26.3	29	33	36.1	37	38.6		23	1992	2014
Mean number of days >= 30 Degrees C for years 1992 to 2014	28.3	24.4	26.7	15.7	1.4	0.1	0.1	2.1	11.9	22.1	25	27.2	185	22	1992	2014
Mean number of days >= 35 Degrees C for years 1992 to 2014	13.3	8.5	5.5	0.5	0	0	0	0.1	1.5	5.3	9.1	13.4	57.2	22	1992	2014
Mean number of days >= 40 Degrees C for years 1992 to 2014	1.3	0.4	0.2	0	0	0	0	0	0	0.5	0.6	1.3	4.3	22	1992	2014
Mean minimum temperature (Degrees C) for years 1992 to 2014	22.2	21.9	20.2	16.9	12.9	10.1	8.9	9.9	13.5	17	19.4	21.3	16.2	22	1992	2014
Lowest temperature (Degrees C) for years 1992 to 2014	17	16.1	12.1	6.5	2	1.4	0.5	0.8	3	8.2	10.7	12.3	0.5	22	1992	2014
Date of Lowest temperature for years 1992 to 2014	4-Jan-01	3-Feb-13	31-Mar-08	13-Apr-94	29-May-00	13-Jun-09	12-Jul-14	11-Aug-12	22-Sep-96	13-Oct-12	17-Nov-06	27-Dec-06	12-Jul-14	N/A	1992	2014
Highest minimum temperature (Degrees C) for years 1992 to 2014	32.9	28.8	27.6	24	22	20	18.2	19.4	22.2	26.8	25.5	28.2	32.9	22	1992	2014
Date of Highest minimum temperature for years 1992 to 2014	7-Jan-94	1-Feb-95	12-Mar-07	2-Apr-00	2-May-98	8-Jun-02	3-Jul-04	27-Aug-11	28-Sep-13	29-Oct-03	14-Nov-04	14-Dec-05	7-Jan-94	N/A	1992	2014
Decile 1 minimum temperature (Degrees C) for years 1992 to 2014	19.9	19.5	17.3	13.6	8.3	5.2	4.5	5.8	9.5	13.5	16.5	18.5		23	1992	2014
Decile 9 minimum temperature (Degrees C) for years 1992 to 2014	24.4	24.3	22.9	20.3	17	14.7	13.8	14.4	17.6	20.4	22.3	24		23	1992	2014
Mean number of days <= 2 Degrees C for years 1992 to 2014	0	0	0	0	0	0.1	0.1	0.2	0	0	0	0	0.4	22	1992	2014
Mean number of days <= 0 Degrees C for years 1992 to 2014	0	0	0	0	0	0	0	0	0	0	0	0	0	22	1992	2014
Mean daily ground minimum temperature Degrees C for years 2009 to 2009														0	2009	2009
Lowest ground temperature Degrees C for years 2009 to 2009														0	2009	2009
Date of Lowest ground temperature for years 2009 to 2009														N/A	2009	2009
Mean number of days ground min. temp. <= -1 Degrees C for years 2009 to 2009														0	2009	2009
Mean rainfall (mm) for years 1992 to 2014	87	80.8	57	33.7	21.3	29.2	13.8	22.2	27.9	38	58.5	86.8	555.7	22	1992	2014
Highest rainfall (mm) for years 1992 to 2014	231.6	216.2	335.2	130.1	66.6	143.4	76.4	128.2	167.6	213.4	143.6	263.8	1099.2	22	1992	2014
Date of Highest rainfall for years 1992 to 2014	2004	2010	1994	1998	2005	2007	2008	1998	2010	1998	2008	2010	2010	N/A	1992	2014
Lowest rainfall (mm) for years 1992 to 2014	6.2	3.7	1.4	0	0	0	0	0	0	0.2	2.8	10.2	284.1	22	1992	2014
Date of Lowest rainfall for years 1992 to 2014	1998	1993	2004	1993	2004	2004	2009	2013	2011	2002	2003	1994	2001	N/A	1992	2014
Decile 1 monthly rainfall (mm) for years 1992 to 2014	17.9	19	4.1	2	0.3	1.2	0	0	0	3.7	6.6	16.5	370.4	22	1992	2014
Decile 5 (median) monthly rainfall (mm) for years 1992 to 2014	69.1	69.1	25.7	25.2	15.1	12.7	6.8	9.4	6.2	23.8	56.6	79.6	475.3	22	1992	2014
Decile 9 monthly rainfall (mm) for years 1992 to 2014	168.6	163.8	158.2	82.8	44.2	57.8	42.5	61.1	77.6	92.6	109.6	155.9	883.2	22	1992	2014
Highest daily rainfall (mm) for years 1992 to 2014	132	112.8	140	90.5	49.2	36	60.2	51.5	48.2	72.8	56.8	119.8	140	22	1992	2014
Date of Highest daily rainfall for years 1992 to 2014	9-Jan-96	11-Feb-09	2-Mar-94	23-Apr-98	11-May-05	2-Jun-08	24-Jul-08	29-Aug-93	30-Sep-96	25-Oct-98	1-Nov-13	3-Dec-10	2-Mar-94	N/A	1992	2014
Mean number of days of rain for years 1800 to 3000	7.8	8.7	5.6	4.4	3.8	4.2	2.6	2.9	3.4	5.4	7.5	8.2	64.5	22	1992	2014
Mean number of days of rain >= 1 mm for years 1992 to 2014	5.8	5.9	3.8	3	2.4	3	1.4	2	2.3	3.8	5.5	6	44.9	22	1992	2014
Mean number of days of rain >= 10 mm for years 1992 to 2014	2.5	2.3	1.5	1.1	0.7	1	0.5	0.7	1	1.2	1.9	2.7	17.1	22	1992	2014
Mean number of days of rain >= 25 mm for years 1992 to 2014	1.1	1	0.9	0.4	0.1	0.4	0.1	0.3	0.3	0.4	0.7	1	6.7	22	1992	2014
Mean daily wind run (km) for years 1998 to 2014	305	286	287	256	238	247	251	244	261	299	307	308	274	13	1998	2014
Maximum wind gust speed (km/h) for years 1998 to 2014	78	87	72	61	63	68	59	70	76	144	106	106	144	13	1998	2014
Date of Maximum wind gust speed for years 1998 to 2014	31-Jan-10	21-Feb-12	21-Mar-05	16-Apr-11	18-May-07	9-Jun-06	28-Jul-08	23-Aug-10	11-Sep-99	29-Oct-07	3-Nov-04	28-Dec-98	29-Oct-07	N/A	1998	2014
Mean daily sunshine (hours) for years null to null																
Mean daily solar exposure (MJ/(m*m)) for years 1990 to 2014	24.8	22.8	22.1	18.8	15.9	14.1	15.3	18.3	21.6	24.1	25.4	25.8	20.8	25	1990	2014
Mean number of clear days for years 1992 to 2010	4.7	2.6	7.9	8.6	9.1	11.2	10.2	13.9	10.7	9.7	7.8	5.1	101.5	11	1992	2010
Mean number of cloudy days for years 1992 to 2010	8.6	10.1	6.1	4.5	5.3	4	5.3	5.3	5.1	5.8	7.4	7.6	75.1	11	1992	2010
Mean daily evaporation (mm) for years null to null																
Mean 9am temperature (Degrees C) for years 1992 to 2010	27.3	26.6	25.7	23	19.1	15.8	15.1	17.1	20.9	24	25.8	27.2	22.3	18	1992	2010
Mean 9am wet bulb temperature (Degrees C) for years 1992 to 2010	22	22.3	20.4	17.9	15	12.1	11.2	12.5	15.1	17.9	19.6	21.3	17.3	15	1992	2010
Mean 9am dew point temperature (Degrees C) for years 1992 to 2010	19.2	19.7	17.3	14.1	10.6	8.5	6.9	7.7	10.3	13.1	15.4	17.6	13.4	18	1992	2010
Mean 9am relative humidity (%) for years 1992 to 2010	63	68	61	60	60	64	60	57	54	53	55	58	59	18	1992	2010
Mean 9am cloud cover (okas) for years 1992 to 2010	4.6	4.7	4.3	3.8	3.7	3.8	3.9	3.5	3.8	3.6	3.9	4.5	4	12	1992	2010
Mean 9am wind speed (km/h) for years 1992 to 2010	15	15.2	16.1	15.4	14.9	15.6	14.6	15.3	15.4	16.3	15.1	15.1	15.3	18	1992	2010
Mean 3pm temperature (Degrees C) for years 1992 to 2010	33.1	32.3	31.9	29.2	25.6	22.6	22.5	24.4	28	30.6	32.1	33.2	28.8	18	1992	2010
Mean 3pm wet bulb temperature (Degrees C) for years 1992 to 2010	22.9	23.1	21.4	19	16.8	14.8	14.1	15.1	16.8	19.1	20.5	21.9	18.8	15	1992	2010
Mean 3pm dew point temperature (Degrees C) for years 1992 to 2010	17	17.7	14.5	11.5	8.9	7.5	5.7	5.7	6.9	9.5	12	14.5	11	18	1992	2010
Mean 3pm relative humidity (%) for years 1992 to 2010	41	45	37	36	37	41	36	32	30	31	33	36	36	18	1992	2010
Mean 3pm cloud cover (oktas) for years 1992 to 2010	4.8	5.3	3.8	4.3	3.9	3.5	3.7	3.6	3.7	3.3	4	4	4	12	1992	2010
Mean 3pm wind speed (km/h) for years 1992 to 2010	15.4	15	15.6	14.6	13.7	13.9	13.7	14.5	14.4	14.7	15.1	15	14.6	18	1992	2010

```
Version 1.30 : GENERAL INFORMATION - CONTROL.PRM
Taroborah Coal Project
200 EP STP
Shenhuo International Group Pty Ltd
E Terry
Fri Sep 05 08:41:33 2014
MEDLI analysis for treated effluent irrigation at Taroborah.
Tarob00
-
Version 1.30 :  ITER.PRM
~Grid Type (1=full grid,2=selected), Increm (side 1) ,Increm (side 2)
1 5 5
~Grid range (if full, max[area, vol], if not, co-ords for corners A[area,vol], B[area,vol], C[area,vol} x0y0, x1y1, x2y2)
0 0
~Costings Fixed, Units/ML, Units/ha
0 10 70
~Append results? (0 = no, other = yes)
0
---------------------------------------
Version 1.30 : CLIMATE.PRM
^Site name
Taroborah
^Latitude (°S)
23.55
^Longitude (°E)
147.95
^Climate station
                Tarb
^Run start date^ Run end date
   1   1  1950  31  12  2013
^Report start date^ Report end date
   1   1  1950   1   1  1950
---------------------------------------
Version 1.30 : CROP.PRM - PASTURE OPTION
^Pan coefficient
1
^Model option (1=monthly covers, 2=pasture, 3=crop, 4=seasonal rotation)
2
^Species
Rhodes grass pasture
^Salt tolerance
tolerant
GROWTH:^Max. crop coefficient^Max.root depth(mm)^Radiation use efficiency(kg/Ha)/(MJ/m2)^min Yield for Full Cover (kg/ha)
0.9 1.2e+03 11 5.5e+03
^Max. shoot nitrogen(%dwt)^max. shoot phosphorus(%dwt)
3.8 0.6
```

HARVEST:^Residual green cover(%)^Residual dead cover(%)^Residual shoot biomass(kg/ha)^Harvest trigger yield (kg/ha)
40 60 300 6e+03
^Leaf water interception store(mm)
0.5
TEMPERATURE:^Ct0(°C)^Ct1(°C)^Ct2(°C)^Ct3(°C)^Ct4(°C)^TT(degree days)
-1 11 21 30 45 320
NITROGEN:^BN1 cover(%dwt)^BN2 cover(%dwt)^BN1 growth(%dwt)^BN2 growth(%dwt)
1 2 1 2
SALINITY: ^salinity threshold(dS/m saturated ext.)^Yield reduction rate(% per dS/m)^No. years for averaging
7 3.2 10

Version 1.30 : GROUNDWATER.PRM
spare line
spare line
^Distance from irrigation area to property boundary in direction of ground water flow (m) N.B. Minimum distance = 2*radius of (circular) irrigation area
250
^Aquifer thickness(m)^Depth between aquifer and surface (m)
10 3
^Specific flux (mm/hr)^Porosity of aquifer (mm/mm)^Longitudinal dispersion coefficient (m2/d)^Lateral dispersion coefficient (m2/d)^Adsorption retardation (m2/d)
0.4 0.1 100 0.1 1

Version 1.30 : IRRIGATION.PRM
^Irrigation area (ha)
0.9000
^Irrigation method
Fixed Sprinkler
^Maximum Irrigation Option (1=ML/ha/d, 2= ML/d, 3 = full requirement) ^ rate
1 27.77778
^Minimum Irrigation Option (1=ML/ha/d, 2= ML/d, 3 = full requirement) ^ rate
1 0.000000
^Irrigation Trigger Option (1=%PAWC, 2= mm SWD, 3 = every X days) ^ irrTrigValue
3 1.0
^Irrigation Application Option (1=up to FC + x (mm), 2= mm, 3 = % USL) ^ irrAppValue
2 0.0
^Minimum number of days skipped between irrigation events
0
^Apply annual fresh (or bore) water allocation(0=FALSE; 1= TRUE)
0

Version 1.30 : NITROGEN.PRM
^Soil profile type
Grey Clay
Kinetic rate coefficients (%/day @ 35°C):^Ammonium adsorption^Ammonium desorption^Ammonification of organic N^Immobilisation of ammonium^Denitrification

```
0.00 0.00 0.000350 0.00 0.10
^Initial Nitrate N (mg/kg)^Initial Organic N (mg/kg)
2.5 800.0
---------------------------------------
Version 1.30 : PHOSPHORUS.PRM
^Soil profile type
Grey Clay
^Freundlich Ads. Coeff.^Freundlich ads. exponent^Freundlich Desorp. Exp.^Initial Soil Solution P (mg/L)
Layer 1
73.0 0.39 0.25 0.010
Layer 2
73.0 0.39 0.25 0.010
Layer 3
73.0 0.39 0.25 0.010
Layer 4
73.0 0.39 0.25 0.010
---------------------------------------
Version 1.30 : SOIL.PRM
^Soil profile type
Grey Clay
^No. of layers
4
^Layer thickness (mm)^Air dry (%v/v)^Lower storage limit (%v/v)^Upper storage limit (%v/v)^Sat. water capacity
(%v/v)^Sat.Hyd.Conductivity (mm/hr)^Bulk density (g/cm3)
  100  4.2  26.7  42.0  47.0  10.000  1.39
  500  0.1  27.5  43.6  48.6  1.000  1.35
  600  0.1  30.7  42.4  47.4  0.500  1.38
  300  0.1  32.8  42.7  48.2  0.100  1.36
^Curve number
75
Slope of Stage II drying (mm/day^0.5)^Stage I drying max.(mm)
3.5 6
Scalars: Lag^Wet day factor^albedo
0.73 0.49 0.23
---------------------------------------
Version 1.30 : Pond parameters for up to 4 ponds.
Number of Ponds
 1
Volume at outlet (m^3): Ponds 1..n
99994.28125
Max. length of wetted surface (m): Ponds 1..n
 162.09
Max. width of wetted surface (m): Ponds 1..n
 162.09
Max water depth (m): Ponds 1..n
   4
```

Depth of freeboard (m): Ponds 1..n
0.5
Side slope (radians from horizontal): Ponds 1..n (N.B.radians = degrees*11/630)
0.785714
Leakage rate (mm/day): Ponds 1..n
0.1
Evaporation coefficient: Ponds 1..n
0.7
Classification: Ponds 1..n
anaerobic
Drawdown (depth removable for irrigation) (m): Ponds 1..n
3.6
N transfer coefficient (aka nitrogen proportionality constant)
0.013714286
Nitrogen settling fraction: Ponds 1..n
0
Phosphorus settling fraction: Ponds 1..n
0
Potassium settling fraction: Ponds 1..n
0
Required (design) hydraulic retention time (days): Ponds 1..n
40
Actual hydraulic retention time (days): Ponds 1..n
3.455
spare line
spare line
Sludge accumulation rate (m^3/kg TS): Ponds 1..n
0
Pond efficiency factor (K value of an anaerobic pond in this area)
1.16418
Maximum design loading rate of Volatile Solids into first pond (kg/m3/day) at K=1.0
0.067
Daily amount drawn from last pond for recirculation (m3)
0
Starting depth (2=half full,1=full,0=empty)
1
Daily non-effluent inflow volume (m3) assuming no recycling occurs^Total dissolved salts (mg/l) in fresh water^total N (mg/L)
0 0 0
Length/Width ratio: Ponds 1..n
1
Desludging protocol option
4 No desludging required
Conductivity (1st pond) (dS/m) at which use of recycled flushing water (from last pond) ceases &^resumes (N.B. Input under Piggery Technical Water Details)
12 8
Recycling Pond

```
1
Rain catchment as a % of max surface area: Ponds 1..n
 100
Area exposed to evaporation as a % of surface area: Ponds 1..n
 100
User-specified starting pond concentrations (0 = FALSE; 1 = TRUE)
1
initial [N] mg/L: Ponds 1..n
     10
initial [P] mg/L: Ponds 1..n
      5
initial [K] mg/L: Ponds 1..n
      0
initial [TDS] mg/L: Ponds 1..n
  1e+03
```

```
Version 1.30 : Effluent pretreatment parameter file
Treatment type
None
Amounts Removed (%):^Vol^Nitrogen^Phosphorus^Potassium^TDS^Total Solids^Volatile Solids^E.coli^Salmonella^Virus^Helminth
0 0 0 0 0 0 0 0 0 0 0
```

```
INDUSTRY=OTHER
  dummy line
  dummy line
  Nature of Industry
other
Number of livestock
0
```

```
Version 1.30 : SHANDY.PRM for Shandying water
spare line
spare line
^Fresh water available (1=YES, other=no)
0
^Shandying water salinity (dS/m)
0.5
^Shandying water nitrogen conc.(mg/L)
1
^Max. allowable salinity of irrigation water (dS/m)
0
^Max. allowable nitrogen conc. of irrigation water (mg/L)
0
^Maximum daily supply of shandying water (ML/day)
0
^Use minimal dilution i.e. shandy primarily for effluent disposal (0=NO;1=YES)
```

```
0
max dam Vol^max dam Depth^dam Coeff^dam Exponent
0 0 1 0
---------------------------------------
Version 1.30 : NBREAKUP.PRM
spare line
spare line
Nitrogen Components in Irrigation Effluent (%):^Nitrate N^Ammonium N^organic N
20 80 0
^Ammonium loss in irrigation (%)
20
---------------------------------------
Version 1.30 : BUGS.PRM
^Bug group, ^Bug sp, ^units, ^a coef, ^b coef
bact E.coli     (countsx10^6Per100mL) 2.60000 1.09000
bact Salmonella      (countsPer100mL) 1.04000 1.09000
viru Virus      (countsx10^6Per100mL) 0.08718 0.02840
helm Helminth        (countsPerLitre) 0.20000 0.50000
^Influent temp (oC) (-1 if same as ambient air temp),^ off-set
0.0 2.0
^Pond Shortcircuiting % (0=none 100=full))
0.0 0.0 0.0 0.0
^ adjustor (Max No. days daily temperature averaged for pond 1)
90.0
---------------------------------------
Version 1.30 : WASTE.PRM  Waste stream parameter file
Industry Type (Feedlot=1;Piggery=2;Abattoir=3;SewageTP: Leaky = 4 1, Avg = 4 2, non-Leaky = 4 3; Other=5,Dairy=6)
5  20
 Parameters and units:
 Daily waste characteristics for calendar leap year (366 days)
 Effluent      TN         TP         K         TDS         TS         VS         E.coli^Salmonella^Virus^Helminth
  ML          mg/L       mg/L       mg/L       mg/L       mg/L       mg/L        (countsx10^6Per100mL) (countsPer100mL)
(countsx10^6Per100mL) (countsPerLitre)
 29.0000       10.0        5.0        0.0     1024.0          5          3        0.0          0          0        0.0
 29.0000       10.0        5.0        0.0     1024.0          5          3        0.0          0          0        0.0
 29.0000       10.0        5.0        0.0     1024.0          5          3        0.0          0          0        0.0
 29.0000       10.0        5.0        0.0     1024.0          5          3        0.0          0          0        0.0
 29.0000       10.0        5.0        0.0     1024.0          5          3        0.0          0          0        0.0
 29.0000       10.0        5.0        0.0     1024.0          5          3        0.0          0          0        0.0
 29.0000       10.0        5.0        0.0     1024.0          5          3        0.0          0          0        0.0
 29.0000       10.0        5.0        0.0     1024.0          5          3        0.0          0          0        0.0
 29.0000       10.0        5.0        0.0     1024.0          5          3        0.0          0          0        0.0
 29.0000       10.0        5.0        0.0     1024.0          5          3        0.0          0          0        0.0
 29.0000       10.0        5.0        0.0     1024.0          5          3        0.0          0          0        0.0
 29.0000       10.0        5.0        0.0     1024.0          5          3        0.0          0          0        0.0
 29.0000       10.0        5.0        0.0     1024.0          5          3        0.0          0          0        0.0
```

29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0

29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
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29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
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29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0

29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0

29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0

29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0

29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0

29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0

29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0

Water usage: drinking^hosedown^flushing (L)
0 0 0
Annual Effluent Volume (ML)
10592.299805
Last entry for workDays.SelectedString
7 days/week
Last entry for months.SelectedString
All year
Last day loaded to screen
1

→

****

SUMMARY OUTPUT
MEDLI Version 1.30

Data Set: Tarob00
Run Date: 05/09/14 Time:11:15:09.03

****

GENERAL INFORMATION

Title: Taroborah Coal Project
Subject: 200 EP STP
Client: Shenhuo International Group Pty
User: E Terry
Time: Fri Sep 05 08:41:33 2014
Comments: MEDLI analysis for treated effluent irrigation at Taroborah.

RUN PERIOD

Starting Date 1/ 1/1950
Ending Date 31/12/2013
Run Length 64 years 0 days

CLIMATE INFORMATION

Enterprise site: Taroborah -23.5 deg S 147.9 deg E
Weather station: Taraborah_23.55S_147.95E

ANNUAL TOTALS	10 Percentile	50 percentile	90 Percentile
Rainfall mm/year	394.	564.	992.
Pan Evap mm/year	1887.	2132.	2311.

MONTHLY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall (mm)	105	110	61	37	37	27	25	22	18	39	60	92	631
Pan Evap (mm)	236	190	193	152	117	91	101	134	178	224	238	254	2108
Ave Max Temp DegC	34	34	32	30	26	23	23	25	29	32	34	35	29
Ave Min Temp DegC	22	22	20	16	12	9	8	9	12	16	19	21	15
Rad (MJ/m2/day)	22	21	20	18	15	14	16	19	22	24	25	24	19

MONTHLY IRRIGATION

Irrigation (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0

SOIL PROPERTIES

Soil type: Grey Clay

SOIL WATER PROPERTIES

		Layer 1	Layer 2	Layer 3	Layer 4
Bulk Density	(g/cm3)	1.4	1.4	1.4	1.4
Porosity	(mm/layer)	47.5	245.3	287.5	146.0
Saturated Water Content	(mm/layer)	47.0	243.0	284.4	144.6
Drained Upper Limit	(mm/layer)	42.0	218.0	254.4	128.1
Lower Storage Limit	(mm/layer)	26.7	137.5	184.2	98.4
Air Dry Moisture Content	(mm/layer)	4.2			
Layer Thickness	(mm)	100.0	500.0	600.0	300.0

		Profile	Max Rootzone
Total Saturated Water Content	(mm)	719.0	574.4
Total Drained Upper Limit	(mm)	642.5	514.4
Total Lower Storage Limit	(mm)	446.8	348.4

Total Air Dry Moisture Content	(mm)	5.6	5.3
Total Depth	(mm)	1500.0	1200.0

Maximum Plant Available Water Capacity		166.0
Saturated Hydraulic Conductivity		
At Surface	(mm/hr)	10.0
Limiting	(mm/hr)	0.1

RUNOFF

Runoff curve No II 75.0

SOIL EVAPORATION

CONA	(mm/day^0.5)	3.5
URITCH	(mm)	6.0

AVERAGE WASTE STREAM
****

Other waste stream
(All values relate to influent after any screening and recycling, if applicable).

Inflow Volume	(ML/year)	10592.3
Nitrogen	(tonne/year)	105.9
Phosphorus	(tonne/year)	53.0
Salinity	(tonne/year)	10846.5

Nitrogen Concentration	(mg/L)	10.0
Phosphorus Concentration	(mg/L)	5.0
Salinity	(mg/L)	1024.0
Salinity	(dS/m)	1.6

WASTE STREAM DETAILS (for last inflow event):

Nitrogen Concentration	(mg/L)	10.0
Phosphorus Concentration	(mg/L)	5.0
TDS Concentration	(mg/L)	1024.0
Salinity	(dS/m)	1.6

IRRIGATION WATER
****

Irrigation triggered every 1 days
Irrigating a fixed amount of 0 mm

AREA

Total Irrigation Area (ha) 0.9

VOLUMES

Total Irrigation	(ML/year)	0.0
Minimum Volume Irrigated by Pump	(ML/ha/day)	0.0
Maximum Volume Irrigated by Pump	(ML/ha/day)	27.8
Maximum Vol. Available For Shandying	(ML/yr)	0.0

IRRIGATION CONCENTRATIONS

Average salinity of Irrigation	(dS/m)	0.0
Average salinity of Irrigation	(mg/L)	0.0
Average Nitrogen Conc of Irrigation		
Before ammonia loss	(mg/L)	0.0
After ammonia loss	(mg/L)	0.0
Average Phosphorus Conc of Irrigation	(mg/L)	0.0

FRESH WATER USAGE
****

Irrigation (shandying) water	(ML/yr)	0.00
Avg volume of fresh water used	(ML/yr)	0.00
Annual allocation	(ML/yr)	N/A

POND INFORMATION
****

POND GEOMETRY

		Pond 1
Final pond volume	(ML)	100.0
Final liquid volume	(ML)	100.0
Final sludge volume	(ML)	0.0
Average pond volume	(ML)	100.0
Average active volume	(ML)	100.0
Maximum pond volume	(ML)	100.0
Minimum allowable pond volume	(ML)	9.5
Average pond depth	(m)	4.0
Pond depth at outlet	(m)	4.0
Maximum water surface area	(m2 x1000)	26.3
Pond catchment area	(m2 x1000)	26.9
Pond footprint length	(m)	164.1
Pond footprint width	(m)	164.1

POND WATER BALANCE

Inflow of Effluent to pond system	(ML/yr)	10592.3
Recycle Volume from pond system	(ML/yr)	0.0
Rain water added to pond system	(ML/yr)	17.0
Evaporation loss from pond system	(ML/yr)	38.8
Seepage loss from pond system	(ML/yr)	1.0
Irrigation from last pond	(ML/yr)	0.0
Volume of overtopping	(ML/yr)	10569.5
Sludge accumulated	(ML/yr)	0.0
Sludge accumulated	(t DM/yr)	0.0
Sludge removed	(ML/yr)	0.0
No of desludging events every 10 years		0.0
Increase in pond water volume	(ML/yr)	0.0

OVERTOPPING EVENTS

Volume of overtopping	(ML/yr)	10569.53
No. of days pond overtops per 10 years		3652.50
Average Length of overtopping events	(days)	23376.00
% Reuse		0.00

No. of overtopping events every 10 years

> 0.000 ML	0.16
> 0.026 ML*	0.00
> 1.000 ML	0.00
> 2.000 ML	0.00
> 5.000 ML	0.00
> 10.000 ML	0.00
> 20.000 ML	0.00
> 50.000 ML	0.00

* Volume equivalent to 1 mm depth of water

No. periods/year without irrigable effluent		0.0
Average Length of such periods	(days)	0.0

POND NITROGEN BALANCE

Nitrogen Added by Effluent	(tonne/yr)	105.9	Irrig. from pond (ML/yr)	0.0
Nitrogen removed by Irrigation	(tonne/yr)	0.0		
Nitrogen removed by Volatilisation	(tonne/yr)	1.3		
Nitrogen removed by Seepage	(tonne/yr)	0.0		
Nitrogen accumulated in Sludge	(tonne/yr)	0.0		

Nitrogen lost by Overtopping	(tonne/yr)	104.6		
Nitrogen involved in Recycling	(tonne/yr)	0.0		
Increase in pond Nitrogen	(tonne/yr)	0.0		

POND PHOSPHORUS BALANCE

Phosphorus Added by Effluent	(tonne/yr)	53.0	Irrig. from pond (ML/yr)	0.0
Phosphorus removed by Irrigation	(tonne/yr)	0.0		
Phosphorus removed by Seepage	(tonne/yr)	0.0		
Phosphorus accumulated in Sludge	(tonne/yr)	0.0		
Phosphorus lost by Overtopping	(tonne/yr)	53.0		
Phosphorus involved in Recycling	(tonne/yr)	0.0		
Increase in pond Phosphorus	(tonne/yr)	0.0		

POND SALINITY BALANCE

Salinity Added by Effluent	(tonne/yr)	10846.5
Salinity removed by Irrigation	(tonne/yr)	0.0
Salinity removed by Seepage	(tonne/yr)	1.0
Salinity lost by Overtopping	(tonne/yr)	10845.4
Salinity involved in Recycling	(tonne/yr)	0.0
Increase in pond Salinity	(tonne/yr)	0.0

POND CONCENTRATIONS

		Pond 1
Average Nitrogen Conc of Pond Liquid	(mg/L)	9.9
Average Phosphorus Conc of Pond Liquid	(mg/L)	5.0
Average TDS Conc of Pond Liquid	(mg/L)	1026.1
Average Salinity of Pond Liquid	(dS/m)	1.6
Average Potassium Conc of Pond Liquid	(mg/L)	0.0

(On final day of simulation)

Nitrogen Conc of Pond Liquid	(mg/L)	9.9
Phosphorus Conc of Pond Liquid	(mg/L)	5.0
TDS Conc of Pond Liquid	(mg/L)	1030.4
EC of Pond Liquid	(dS/m)	1.6
Potassium Conc of Pond Liquid	(mg/L)	0.0

REMOVED SLUDGE - NUTRIENT & SALT CONCENTRATIONS

Nitrogen in removed Sludge (db)	(kg/tonne)	0.0
Phosphorus in removed Sludge (db)	(kg/tonne)	0.0
Salt in removed Sludge (db)	(kg/tonne)	0.0
Potassium in removed Sludge (db)	(kg/tonne)	0.0

REMOVED SLUDGE - NUTRIENT & SALT MASSES

Nitrogen in removed Sludge	(tonne/yr)	0.0
Phosphorus in removed Sludge	(tonne/yr)	0.0
Salt in removed Sludge (mass bal.)	(tonne/yr)	0.0
Salt in removed Sludge	(tonne/yr)	0.0
Potm. in removed Sludge (mass bal.)	(tonne/yr	0.0
Potassium in removed Sludge	(tonne/yr)	0.0

LAND DISPOSAL AREA
****

WATER BALANCE

(Initial soil water assumed to be at field capacity)
(Irrigated up to 0.00% of field capacity)

Rainfall	(mm/year)	631.9	Irrigation Area	(ha)	0.9
Irrigation	(mm/year)	0.0			
Soil Evaporation	(mm/year)	339.7			
Transpiration	(mm/year)	214.6			
Runoff	(mm/year)	55.6			
Drainage	(mm/year)	23.2			
Change in soil moisture	(mm/year)	-1.3			

ANNUAL TOTALS

Year	Rain (mm)	Irrig (mm)	Sevap (mm)	Trans (mm)	Runoff (mm)	Drain (mm)	Change (mm)
1950	1197.0	0.0	82.5	1044.4	110.2	125.9	-166.0
1951	399.0	0.0	140.0	237.5	27.9	7.6	-14.1
1952	475.0	0.0	317.9	105.0	19.4	0.0	32.8
1953	591.0	0.0	273.7	277.3	58.0	0.0	-18.0
1954	1151.0	0.0	246.8	536.5	306.7	70.9	-9.9
1955	893.0	0.0	287.6	411.6	69.2	60.4	64.1
1956	1482.0	0.0	348.5	541.2	297.3	165.8	129.3
1957	443.0	0.0	196.8	420.0	6.0	22.3	-202.0
1958	755.0	0.0	295.2	387.8	40.3	0.0	31.8
1959	760.0	0.0	293.5	366.2	46.1	0.0	54.2
1960	538.0	0.0	253.9	322.2	2.3	0.0	-40.4
1961	736.0	0.0	400.5	306.8	46.9	0.0	-18.3
1962	567.0	0.0	146.7	414.7	2.0	0.0	3.6
1963	634.0	0.0	369.8	226.5	54.2	0.0	-16.5
1964	452.0	0.0	366.3	88.3	0.4	0.0	-3.0
1965	417.0	0.0	304.1	89.5	5.4	0.0	18.0
1966	514.0	0.0	335.6	176.0	16.6	0.0	-14.1
1967	522.0	0.0	364.8	159.3	6.6	0.0	-8.7
1968	602.0	0.0	281.0	276.2	24.4	0.0	20.4
1969	420.0	0.0	291.0	114.0	2.9	0.0	12.2
1970	504.0	0.0	345.9	135.8	11.4	0.0	10.9
1971	617.0	0.0	329.5	191.5	78.7	0.0	17.4
1972	425.0	0.0	253.5	180.4	40.1	0.0	-49.1
1973	818.0	0.0	495.0	152.1	48.0	0.0	122.9
1974	856.0	0.0	385.0	320.5	162.3	65.3	-77.1
1975	1073.0	0.0	394.5	421.1	168.1	0.0	89.2
1976	596.0	0.0	428.1	274.2	8.2	0.0	-114.5
1977	514.0	0.0	336.0	162.1	15.7	0.0	0.3
1978	974.0	0.0	412.5	348.9	215.2	0.0	-2.7
1979	406.0	0.0	312.3	97.1	3.1	0.0	-6.5
1980	561.0	0.0	315.3	218.6	26.7	0.0	0.4
1981	733.0	0.0	409.3	276.3	39.0	0.0	8.4
1982	301.0	0.0	223.0	108.1	1.3	0.0	-31.5
1983	960.0	0.0	451.9	316.3	133.9	52.2	5.6
1984	735.0	0.0	428.5	233.8	24.7	0.0	48.0
1985	503.0	0.0	396.3	146.2	16.0	0.0	-55.6
1986	469.0	0.0	392.7	71.1	9.5	0.0	-4.3
1987	575.0	0.0	446.2	89.8	0.0	0.0	39.1
1988	780.0	0.0	469.5	152.3	48.0	0.0	110.2
1989	745.0	0.0	432.9	433.3	23.6	0.0	-144.8
1990	640.0	0.0	309.0	117.3	85.0	0.0	128.7
1991	430.0	0.0	320.4	223.6	13.4	0.0	-127.4
1992	390.0	0.0	300.8	38.5	13.9	0.0	36.8
1993	379.0	0.0	284.1	129.0	3.5	0.0	-37.6
1994	403.0	0.0	234.7	40.0	48.0	0.0	80.3
1995	471.0	0.0	352.0	190.7	0.6	0.0	-72.3
1996	657.0	0.0	363.5	141.7	102.4	0.0	49.4
1997	466.0	0.0	378.6	126.1	0.2	0.0	-38.9
1998	823.0	0.0	452.9	217.6	41.9	0.0	110.6
1999	364.0	0.0	313.3	99.0	7.3	0.0	-55.5
2000	855.0	0.0	407.0	202.0	77.3	62.9	105.7
2001	360.0	0.0	316.7	119.2	5.8	11.5	-93.2
2002	351.0	0.0	288.7	59.6	10.9	0.0	-8.1
2003	364.0	0.0	286.6	44.6	25.3	0.0	7.5
2004	446.0	0.0	281.1	128.0	18.4	0.0	18.6
2005	531.0	0.0	396.4	154.5	16.3	0.0	-36.2
2006	508.0	0.0	370.3	55.1	16.2	0.0	66.4
2007	722.0	0.0	459.7	168.5	31.5	38.7	23.6
2008	1010.0	0.0	414.5	122.3	318.7	133.6	20.9
2009	408.0	0.0	273.7	84.7	42.3	75.8	-68.6
2010	1300.0	0.0	526.1	149.8	279.2	215.3	129.6
2011	652.0	0.0	407.2	111.1	58.3	166.4	-90.9
2012	820.0	0.0	413.5	108.0	110.6	193.9	-6.0
2013	398.0	0.0	338.8	75.4	13.2	17.2	-46.6

NUTRIENT BALANCE

NITROGEN

Total N irrigated from ponds	(kg/ha/year)	0.0	% of Total as ammonium	80.0
Nitrogn lost by ammonia volat.	(kg/ha/year)	0.0	Deep Drainage (mm/year)	23.2
Nitrogen added in irrigation	(kg/ha/year)	0.0		
Nitrogen added in seed	(kg/ha/year)	2.4		
Nitrogen removed by crop	(kg/ha/year)	52.3		
Denitrification	(kg/ha/year)	0.9		
Leached NO3-N	(kg/ha/year)	0.1		
Change in soil organic-N	(kg/ha/year)	-50.1		
Change in soil solution NH4-N	(kg/ha/year)	0.0		
Change in soil solution NO3-N	(kg/ha/year)	-0.8		
Change in adsorbed NH4-N	(kg/ha/year)	0.0		
Initial soil organic-N	(kg/ha)	3272.0		
Final soil organic-N	(kg/ha)	64.7		
Initial soil inorganic-N	(kg/ha)	51.3		
Final soil inorganic-N	(kg/ha)	0.6		
Average N03-N conc in the root zone	(mg/L)	2.7		
Average N03-N conc below root zone	(mg/L)	0.8		
Average N03-N conc of deep drainage	(mg/L)	0.3		

PHOSPHORUS

Phosphorus added in irrigatn	(kg/ha/year)	0.0	% of Total as phosphate	100.0
Phosphorus added in seed	(kg/ha/year)	0.4		
Phosphorus removed by crop	(kg/ha/year)	0.4		
Leached PO4-P	(kg/ha/year)	0.0		
Change in dissolved PO4-P	(kg/ha/year)	0.0		
Change in adsorbed PO4-P	(kg/ha/year)	0.0		
Average P04-P conc in the root zone	(mg/L)	0.0		
Average P04-P conc below root zone	(mg/L)	0.0		

SOIL P STORAGE LIFE

Year	YearNo.	Tot P stored kg/ha	P leached in year kg/ha
1950	1	248.2	0.0
1951	2	248.2	0.0
1952	3	248.9	0.0
1953	4	248.2	0.0
1954	5	248.2	0.0
1955	6	248.2	0.0
1956	7	248.9	0.0
1957	8	248.2	0.0
1958	9	248.2	0.0
1959	10	248.2	0.0
1960	11	248.8	0.0
1961	12	248.1	0.0
1962	13	248.1	0.0
1963	14	248.1	0.0
1964	15	248.8	0.0
1965	16	248.1	0.0
1966	17	248.1	0.0
1967	18	248.1	0.0
1968	19	248.8	0.0
1969	20	248.1	0.0
1970	21	248.1	0.0
1971	22	248.1	0.0
1972	23	248.8	0.0
1973	24	248.1	0.0
1974	25	248.1	0.0
1975	26	248.1	0.0
1976	27	248.7	0.0
1977	28	248.0	0.0
1978	29	248.0	0.0

1979	30	248.0	0.0
1980	31	248.7	0.0
1981	32	248.0	0.0
1982	33	248.0	0.0
1983	34	248.0	0.0
1984	35	248.7	0.0
1985	36	248.0	0.0
1986	37	248.0	0.0
1987	38	248.0	0.0
1988	39	248.6	0.0
1989	40	247.9	0.0
1990	41	247.9	0.0
1991	42	247.9	0.0
1992	43	248.6	0.0
1993	44	247.9	0.0
1994	45	247.9	0.0
1995	46	247.9	0.0
1996	47	248.6	0.0
1997	48	247.9	0.0
1998	49	247.9	0.0
1999	50	247.9	0.0
2000	51	248.6	0.0
2001	52	247.9	0.0
2002	53	247.9	0.0
2003	54	247.9	0.0
2004	55	248.5	0.0
2005	56	247.9	0.0
2006	57	247.9	0.0
2007	58	247.8	0.0
2008	59	248.5	0.0
2009	60	247.8	0.0
2010	61	247.8	0.0
2011	62	247.8	0.0
2012	63	248.4	0.0
2013	64	247.7	0.0

PLANT

Plant species: Rhodes grass pasture

PLANT WATER USE

Irrigation	(mm/year)	0.	Totl Irrigation Area(ha)	0.9
Pan coefficient	(%)	1.0		
Maximum crop coefficient	(%)	0.9		
Average Plant Cover	(%)	18.		
Average Plant Total Cover	(%)	35.		
Average Plant Rootdepth	(mm)	269.		
Average Plant Available Water Capacity	(mm)	103.		
Average Plant Available Water	(mm)	34.		
Yield produced per unit transp.	(kg/ha/mm)	18.		

PLANT NUTRIENT UPTAKE

Dry Matter Yield (Shoots)	(kg/ha/yr)	3945.			
Net nitrogen removed by plant	(kg/ha/yr)	50.	Shoot Concn	(%DM)	1.27
Net phosphorus removed by plant	(kg/ha/yr)	0.	Shoot Concn	(%DM)	0.00

AVERAGE MONTHLY GROWTH STRESS (0=no stress, 1=full stress)

Month	Yield kg/ha	Nitr	Temp	Water Defic	Water Logging
1	700.	0.4	0.0	0.4	0.0
2	646.	0.4	0.0	0.3	0.0
3	668.	0.4	0.0	0.3	0.0

4	315.	0.3	0.0	0.4	0.0
5	214.	0.3	0.2	0.3	0.0
6	151.	0.3	0.5	0.4	0.0
7	111.	0.2	0.6	0.4	0.0
8	97.	0.2	0.4	0.4	0.0
9	124.	0.2	0.1	0.3	0.0
10	133.	0.1	0.0	0.3	0.0
11	314.	0.2	0.0	0.4	0.0
12	472.	0.3	0.0	0.4	0.0

>>> NO-PLANT EVENTS <<<

%Days due to temperature stress 0.9
%Days due to frosting 0.2
%Days due to water stress 50.8
%Days due to nitrogen stress 0.0
No. of forced harvests per year 3.2
No. of normal harvests per year 0.2

SALINITY

Salt tolerance - plant species: tolerant

Average EC of Irrigation Water (dS/m) 0.0 Irrigation (mm/year) 0.0
Average EC of Rainwater (dS/m x10) 0.3 Rainfall (mm/year) 631.9

>>>No salinity calculations<<<
No. of years chosen for running averages 10

GROUNDWATER
****

Average Groundwater Recharge (m3/day) 0.6
Average Nitrate-N Conc of Recharge (mg/L) 0.3

Thickness of the Aquifer (m) 10.0
Distance (m) from Irrigation Area to where
Nitrate-N Conc in Groundwater is Calculated 250.0

Concentration of NITRATE-N in Groundwater (mg/L)

	Year	Depth Below Water Table Surface 0.0 m	5.0 m	9.0 m
	1954	0.0	0.0	0.0
	1959	0.0	0.0	0.0
	1964	0.0	0.0	0.0
	1969	0.0	0.0	0.0
	1974	0.0	0.0	0.0
	1979	0.0	0.0	0.0
	1984	0.0	0.0	0.0
	1989	0.0	0.0	0.0
	1994	0.0	0.0	0.0
	1999	0.0	0.0	0.0
	2004	0.0	0.0	0.0
	2009	0.0	0.0	0.0
Last	2013	0.0	0.0	0.0

ACKNOWLEDGMENTS
****
This run brought to you courtesy of:

MEDLIEXE.EXE : 1300468 bytes Mon Jun 23 06:20:34 2008

CRCPROJ.EXE : 1286656 bytes Mon Jun 23 06:20:38 2008

GRAPHS.EXE   :   439296 bytes Mon Jun 23 06:20:36 2008

OTHER INDUSTRY INPUT PARAMETERS - DATA SUMMARY

Nature of Industry: other

>>> Dryland run! <<<   1 file(s) copied

UNCONDITIONAL FINISH

```
Version 1.30 : GENERAL INFORMATION - CONTROL.PRM
Taroborah Coal Project
200 EP STP
Shenhuo International Group Pty Ltd
E Terry
Fri Sep 05 11:38:15 2014
MEDLI analysis for treated effluent irrigation at Taroborah.
Tarob8
-
Version 1.30 :  ITER.PRM
~Grid Type (1=full grid,2=selected), Increm (side 1) ,Increm (side 2)
1 5 5
~Grid range (if full, max[area, vol], if not, co-ords for corners A[area,vol], B[area,vol], C[area,vol} x0y0, x1y1, x2y2)
0 0
~Costings Fixed, Units/ML, Units/ha
0 10 70
~Append results? (0 = no, other = yes)
0
---------------------------------------
Version 1.30 : CLIMATE.PRM
^Site name
Taroborah
^Latitude (°S)
23.55
^Longitude (°E)
147.95
^Climate station
                Tarb
^Run start date^ Run end date
   1   1  1950  31  12  2013
^Report start date^ Report end date
   1   1  1950   1   1  1950
---------------------------------------
Version 1.30 : CROP.PRM - PASTURE OPTION
^Pan coefficient
1
^Model option (1=monthly covers, 2=pasture, 3=crop, 4=seasonal rotation)
2
^Species
Rhodes grass pasture
^Salt tolerance
tolerant
GROWTH:^Max. crop coefficient^Max.root depth(mm)^Radiation use efficiency(kg/Ha)/(MJ/m2)^min Yield for Full Cover (kg/ha)
0.9 1.2e+03 11 5.5e+03
^Max. shoot nitrogen(%dwt)^max. shoot phosphorus(%dwt)
3.8 0.6
```

HARVEST:^Residual green cover(%)^Residual dead cover(%)^Residual shoot biomass(kg/ha)^Harvest trigger yield (kg/ha)
40 60 300 6e+03
^Leaf water interception store(mm)
0.5
TEMPERATURE:^Ct0(°C)^Ct1(°C)^Ct2(°C)^Ct3(°C)^Ct4(°C)^TT(degree days)
-1 11 21 30 45 320
NITROGEN:^BN1 cover(%dwt)^BN2 cover(%dwt)^BN1 growth(%dwt)^BN2 growth(%dwt)
1 2 1 2
SALINITY: ^salinity threshold(dS/m saturated ext.)^Yield reduction rate(% per dS/m)^No. years for averaging
7 3.2 10

Version 1.30 : GROUNDWATER.PRM
spare line
spare line
^Distance from irrigation area to property boundary in direction of ground water flow (m) N.B. Minimum distance = 2*radius of (circular) irrigation area
250
^Aquifer thickness(m)^Depth between aquifer and surface (m)
10 3
^Specific flux (mm/hr)^Porosity of aquifer (mm/mm)^Longitudinal dispersion coefficient (m2/d)^Lateral dispersion coefficient (m2/d)^Adsorption retardation (m2/d)
0.4 0.1 100 0.1 1

Version 1.30 : IRRIGATION.PRM
^Irrigation area (ha)
0.9000
^Irrigation method
Fixed Sprinkler
^Maximum Irrigation Option (1=ML/ha/d, 2= ML/d, 3 = full requirement) ^ rate
1 27.77778
^Minimum Irrigation Option (1=ML/ha/d, 2= ML/d, 3 = full requirement) ^ rate
1 0.000000
^Irrigation Trigger Option (1=%PAWC, 2= mm SWD, 3 = every X days) ^ irrTrigValue
3 1.0
^Irrigation Application Option (1=up to FC + x (mm), 2= mm, 3 = % USL) ^ irrAppValue
2 2.6
^Minimum number of days skipped between irrigation events
0
^Apply annual fresh (or bore) water allocation(0=FALSE; 1= TRUE)
0

Version 1.30 : NITROGEN.PRM
^Soil profile type
Grey Clay
Kinetic rate coefficients (%/day @ 35°C):^Ammonium adsorption^Ammonium desorption^Ammonification of organic N^Immobilisation of ammonium^Denitrification

```
0.00 0.00 0.000350 0.00 0.10
^Initial Nitrate N (mg/kg)^Initial Organic N (mg/kg)
2.5 800.0
---------------------------------------
Version 1.30 : PHOSPHORUS.PRM
^Soil profile type
Grey Clay
^Freundlich Ads. Coeff.^Freundlich ads. exponent^Freundlich Desorp. Exp.^Initial Soil Solution P (mg/L)
Layer 1
73.0 0.39 0.25 0.010
Layer 2
73.0 0.39 0.25 0.010
Layer 3
73.0 0.39 0.25 0.010
Layer 4
73.0 0.39 0.25 0.010
---------------------------------------
Version 1.30 : SOIL.PRM
^Soil profile type
Grey Clay
^No. of layers
4
^Layer thickness (mm)^Air dry (%v/v)^Lower storage limit (%v/v)^Upper storage limit (%v/v)^Sat. water capacity
(%v/v)^Sat.Hyd.Conductivity (mm/hr)^Bulk density (g/cm3)
  100  4.2  26.7  42.0  47.0  10.000  1.39
  500  0.1  27.5  43.6  48.6  1.000  1.35
  600  0.1  30.7  42.4  47.4  0.500  1.38
  300  0.1  32.8  42.7  48.2  0.100  1.36
^Curve number
75
Slope of Stage II drying (mm/day^0.5)^Stage I drying max.(mm)
3.5 6
Scalars: Lag^Wet day factor^albedo
0.73 0.49 0.23
---------------------------------------
Version 1.30 : Pond parameters for up to 4 ponds.
Number of Ponds
 1
Volume at outlet (m^3): Ponds 1..n
99994.28125
Max. length of wetted surface (m): Ponds 1..n
 162.09
Max. width of wetted surface (m): Ponds 1..n
 162.09
Max water depth (m): Ponds 1..n
   4
```

Depth of freeboard (m): Ponds 1..n
0.5
Side slope (radians from horizontal): Ponds 1..n (N.B.radians = degrees*11/630)
0.785714
Leakage rate (mm/day): Ponds 1..n
 0.1
Evaporation coefficient: Ponds 1..n
 0.7
Classification: Ponds 1..n
anaerobic
Drawdown (depth removable for irrigation) (m): Ponds 1..n
 3.6
N transfer coefficient (aka nitrogen proportionality constant)
 0.013714286
Nitrogen settling fraction: Ponds 1..n
     0
Phosphorus settling fraction: Ponds 1..n
     0
Potassium settling fraction: Ponds 1..n
     0
Required (design) hydraulic retention time (days): Ponds 1..n
    40
Actual hydraulic retention time (days): Ponds 1..n
 3.455
spare line
spare line
Sludge accumulation rate (m^3/kg TS): Ponds 1..n
      0
Pond efficiency factor (K value of an anaerobic pond in this area)
1.16418
Maximum design loading rate of Volatile Solids into first pond (kg/m3/day) at K=1.0
0.067
Daily amount drawn from last pond for recirculation (m3)
0
Starting depth (2=half full,1=full,0=empty)
 1
Daily non-effluent inflow volume (m3) assuming no recycling occurs^Total dissolved salts (mg/l) in fresh water^total N (mg/L)
0 0 0
Length/Width ratio: Ponds 1..n
    1
Desludging protocol option
4 No desludging required
Conductivity (1st pond) (dS/m) at which use of recycled flushing water (from last pond) ceases &^resumes (N.B. Input under Piggery Technical Water Details)
12 8
Recycling Pond

```
1
Rain catchment as a % of max surface area: Ponds 1..n
 100
Area exposed to evaporation as a % of surface area: Ponds 1..n
 100
User-specified starting pond concentrations (0 = FALSE; 1 = TRUE)
1
initial [N] mg/L: Ponds 1..n
     10
initial [P] mg/L: Ponds 1..n
      5
initial [K] mg/L: Ponds 1..n
      0
initial [TDS] mg/L: Ponds 1..n
  1e+03
_______________________________________________________
Version 1.30 : Effluent pretreatment parameter file
Treatment type
None
Amounts Removed (%):^Vol^Nitrogen^Phosphorus^Potassium^TDS^Total Solids^Volatile Solids^E.coli^Salmonella^Virus^Helminth
0 0 0 0 0 0 0 0 0 0 0
_______________________________________________________
INDUSTRY=OTHER
  dummy line
  dummy line
  Nature of Industry
other
Number of livestock
0
__________________________________________
Version 1.30 : SHANDY.PRM for Shandying water
spare line
spare line
^Fresh water available (1=YES, other=no)
0
^Shandying water salinity (dS/m)
0.5
^Shandying water nitrogen conc.(mg/L)
1
^Max. allowable salinity of irrigation water (dS/m)
0
^Max. allowable nitrogen conc. of irrigation water (mg/L)
0
^Maximum daily supply of shandying water (ML/day)
0
^Use minimal dilution i.e. shandy primarily for effluent disposal (0=NO;1=YES)
```

0
max dam Vol^max dam Depth^dam Coeff^dam Exponent
0 0 1 0

Version 1.30 : NBREAKUP.PRM
spare line
spare line
Nitrogen Components in Irrigation Effluent (%):^Nitrate N^Ammonium N^organic N
20 80 0
^Ammonium loss in irrigation (%)
20

Version 1.30 : BUGS.PRM
^Bug group, ^Bug sp, ^units, ^a coef, ^b coef
bact E.coli (countsx10^6Per100mL) 2.60000 1.09000
bact Salmonella (countsPer100mL) 1.04000 1.09000
viru Virus (countsx10^6Per100mL) 0.08718 0.02840
helm Helminth (countsPerLitre) 0.20000 0.50000
^Influent temp (oC) (-1 if same as ambient air temp),^ off-set
0.0 2.0
^Pond Shortcircuiting % (0=none 100=full))
0.0 0.0 0.0 0.0
^ adjustor (Max No. days daily temperature averaged for pond 1)
90.0

Version 1.30 : WASTE.PRM Waste stream parameter file
Industry Type (Feedlot=1;Piggery=2;Abattoir=3;SewageTP: Leaky = 4 1, Avg = 4 2, non-Leaky = 4 3; Other=5,Dairy=6)
5 20
Parameters and units:
Daily waste characteristics for calendar leap year (366 days)
Effluent TN TP K TDS TS VS E.coli^Salmonella^Virus^Helminth
ML mg/L mg/L mg/L mg/L mg/L mg/L (countsx10^6Per100mL) (countsPer100mL)
(countsx10^6Per100mL) (countsPerLitre)

29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0

29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
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29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
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29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
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29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
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29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
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29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0

29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0

29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0

29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0

29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0

29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0

29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0

29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0
29.0000	10.0	5.0	0.0	1024.0	5	3	0.0	0	0	0.0

Water usage: drinking^hosedown^flushing (L)
0 0 0
Annual Effluent Volume (ML)
10592.299805
Last entry for workDays.SelectedString
7 days/week
Last entry for months.SelectedString
All year
Last day loaded to screen
1

→

****

SUMMARY OUTPUT
MEDLI Version 1.30

Data Set: Tarob8
Run Date: 05/09/14 Time:11:38:47.43

****

GENERAL INFORMATION

Title: Taroborah Coal Project
Subject: 200 EP STP
Client: Shenhuo International Group Pty
User: E Terry
Time: Fri Sep 05 11:38:15 2014
Comments: MEDLI analysis for treated effluent irrigation at Taroborah.

RUN PERIOD

Starting Date 1/ 1/1950
Ending Date 31/12/2013
Run Length 64 years 0 days

CLIMATE INFORMATION

Enterprise site: Taroborah -23.5 deg S 147.9 deg E
Weather station: Taraborah_23.55S_147.95E

ANNUAL TOTALS	10 Percentile	50 percentile	90 Percentile
Rainfall mm/year	394.	564.	992.
Pan Evap mm/year	1887.	2132.	2311.

MONTHLY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall (mm)	105	110	61	37	37	27	25	22	18	39	60	92	631
Pan Evap (mm)	236	190	193	152	117	91	101	134	178	224	238	254	2108
Ave Max Temp DegC	34	34	32	30	26	23	23	25	29	32	34	35	29
Ave Min Temp DegC	22	22	20	16	12	9	8	9	12	16	19	21	15
Rad (MJ/m2/day)	22	21	20	18	15	14	16	19	22	24	25	24	19

MONTHLY IRRIGATION

Irrigation (mm)	81	73	81	78	81	78	81	81	78	81	78	81	949

SOIL PROPERTIES

Soil type: Grey Clay

SOIL WATER PROPERTIES

		Layer 1	Layer 2	Layer 3	Layer 4
Bulk Density	(g/cm3)	1.4	1.4	1.4	1.4
Porosity	(mm/layer)	47.5	245.3	287.5	146.0
Saturated Water Content	(mm/layer)	47.0	243.0	284.4	144.6
Drained Upper Limit	(mm/layer)	42.0	218.0	254.4	128.1
Lower Storage Limit	(mm/layer)	26.7	137.5	184.2	98.4
Air Dry Moisture Content	(mm/layer)	4.2			
Layer Thickness	(mm)	100.0	500.0	600.0	300.0

		Profile	Max Rootzone
Total Saturated Water Content	(mm)	719.0	574.4
Total Drained Upper Limit	(mm)	642.5	514.4
Total Lower Storage Limit	(mm)	446.8	348.4

Total Air Dry Moisture Content	(mm)	5.6	5.3
Total Depth	(mm)	1500.0	1200.0

Maximum Plant Available Water Capacity		166.0
Saturated Hydraulic Conductivity		
At Surface	(mm/hr)	10.0
Limiting	(mm/hr)	0.1

RUNOFF

Runoff curve No II 75.0

SOIL EVAPORATION

CONA	(mm/day^0.5)	3.5
URITCH	(mm)	6.0

AVERAGE WASTE STREAM
****

Other waste stream
(All values relate to influent after any screening and recycling, if applicable).

Inflow Volume	(ML/year)	10592.3
Nitrogen	(tonne/year)	105.9
Phosphorus	(tonne/year)	53.0
Salinity	(tonne/year)	10846.5

Nitrogen Concentration	(mg/L)	10.0
Phosphorus Concentration	(mg/L)	5.0
Salinity	(mg/L)	1024.0
Salinity	(dS/m)	1.6

WASTE STREAM DETAILS (for last inflow event):

Nitrogen Concentration	(mg/L)	10.0
Phosphorus Concentration	(mg/L)	5.0
TDS Concentration	(mg/L)	1024.0
Salinity	(dS/m)	1.6

IRRIGATION WATER
****

Irrigation triggered every 1 days
Irrigating a fixed amount of 2 mm

AREA

Total Irrigation Area (ha) 0.9

VOLUMES

Total Irrigation	(ML/year)	8.5
Minimum Volume Irrigated by Pump	(ML/ha/day)	0.0
Maximum Volume Irrigated by Pump	(ML/ha/day)	27.8
Maximum Vol. Available For Shandying	(ML/yr)	0.0

IRRIGATION CONCENTRATIONS

Average salinity of Irrigation	(dS/m)	1.6
Average salinity of Irrigation	(mg/L)	1026.1
Average Nitrogen Conc of Irrigation		
Before ammonia loss	(mg/L)	9.9
After ammonia loss	(mg/L)	8.3
Average Phosphorus Conc of Irrigation	(mg/L)	5.0

FRESH WATER USAGE
****

Irrigation (shandying) water	(ML/yr)	0.00
Avg volume of fresh water used	(ML/yr)	0.00
Annual allocation	(ML/yr)	N/A

POND INFORMATION
****

POND GEOMETRY

		Pond 1
Final pond volume	(ML)	100.0
Final liquid volume	(ML)	100.0
Final sludge volume	(ML)	0.0
Average pond volume	(ML)	100.0
Average active volume	(ML)	100.0
Maximum pond volume	(ML)	100.0
Minimum allowable pond volume	(ML)	9.5
Average pond depth	(m)	4.0
Pond depth at outlet	(m)	4.0
Maximum water surface area	(m2 x1000)	26.3
Pond catchment area	(m2 x1000)	26.9
Pond footprint length	(m)	164.1
Pond footprint width	(m)	164.1

POND WATER BALANCE

Inflow of Effluent to pond system	(ML/yr)	10592.3
Recycle Volume from pond system	(ML/yr)	0.0
Rain water added to pond system	(ML/yr)	17.0
Evaporation loss from pond system	(ML/yr)	38.8
Seepage loss from pond system	(ML/yr)	1.0
Irrigation from last pond	(ML/yr)	8.5
Volume of overtopping	(ML/yr)	10561.0
Sludge accumulated	(ML/yr)	0.0
Sludge accumulated	(t DM/yr)	0.0
Sludge removed	(ML/yr)	0.0
No of desludging events every 10 years		0.0
Increase in pond water volume	(ML/yr)	0.0

OVERTOPPING EVENTS

Volume of overtopping	(ML/yr)	10560.99
No. of days pond overtops per 10 years		3652.50
Average Length of overtopping events	(days)	23376.00
% Reuse		0.08

No. of overtopping events every 10 years

> 0.000 ML	0.16
> 0.026 ML*	0.00
> 1.000 ML	0.00
> 2.000 ML	0.00
> 5.000 ML	0.00
> 10.000 ML	0.00
> 20.000 ML	0.00
> 50.000 ML	0.00

* Volume equivalent to 1 mm depth of water

No. periods/year without irrigable effluent		0.0
Average Length of such periods	(days)	0.0

POND NITROGEN BALANCE

Nitrogen Added by Effluent	(tonne/yr)	105.9	Irrig. from pond (ML/yr)	8.5
Nitrogen removed by Irrigation	(tonne/yr)	0.1		
Nitrogen removed by Volatilisation	(tonne/yr)	1.3		
Nitrogen removed by Seepage	(tonne/yr)	0.0		
Nitrogen accumulated in Sludge	(tonne/yr)	0.0		

Nitrogen lost by Overtopping	(tonne/yr)	104.5			
Nitrogen involved in Recycling	(tonne/yr)	0.0			
Increase in pond Nitrogen	(tonne/yr)	0.0			

POND PHOSPHORUS BALANCE

Phosphorus Added by Effluent	(tonne/yr)	53.0	Irrig. from pond (ML/yr)		8.5
Phosphorus removed by Irrigation	(tonne/yr)	0.0			
Phosphorus removed by Seepage	(tonne/yr)	0.0			
Phosphorus accumulated in Sludge	(tonne/yr)	0.0			
Phosphorus lost by Overtopping	(tonne/yr)	52.9			
Phosphorus involved in Recycling	(tonne/yr)	0.0			
Increase in pond Phosphorus	(tonne/yr)	0.0			

POND SALINITY BALANCE

Salinity Added by Effluent	(tonne/yr)	10846.5
Salinity removed by Irrigation	(tonne/yr)	8.8
Salinity removed by Seepage	(tonne/yr)	1.0
Salinity lost by Overtopping	(tonne/yr)	10836.7
Salinity involved in Recycling	(tonne/yr)	0.0
Increase in pond Salinity	(tonne/yr)	0.0

POND CONCENTRATIONS

		Pond 1
Average Nitrogen Conc of Pond Liquid	(mg/L)	9.9
Average Phosphorus Conc of Pond Liquid	(mg/L)	5.0
Average TDS Conc of Pond Liquid	(mg/L)	1026.1
Average Salinity of Pond Liquid	(dS/m)	1.6
Average Potassium Conc of Pond Liquid	(mg/L)	0.0

(On final day of simulation)

Nitrogen Conc of Pond Liquid	(mg/L)	9.9
Phosphorus Conc of Pond Liquid	(mg/L)	5.0
TDS Conc of Pond Liquid	(mg/L)	1030.4
EC of Pond Liquid	(dS/m)	1.6
Potassium Conc of Pond Liquid	(mg/L)	0.0

REMOVED SLUDGE - NUTRIENT & SALT CONCENTRATIONS

Nitrogen in removed Sludge (db)	(kg/tonne)	0.0
Phosphorus in removed Sludge (db)	(kg/tonne)	0.0
Salt in removed Sludge (db)	(kg/tonne)	0.0
Potassium in removed Sludge (db)	(kg/tonne)	0.0

REMOVED SLUDGE - NUTRIENT & SALT MASSES

Nitrogen in removed Sludge	(tonne/yr)	0.0
Phosphorus in removed Sludge	(tonne/yr)	0.0
Salt in removed Sludge (mass bal.)	(tonne/yr)	0.0
Salt in removed Sludge	(tonne/yr)	0.0
Potm. in removed Sludge (mass bal.)	(tonne/yr	0.0
Potassium in removed Sludge	(tonne/yr)	0.0

LAND DISPOSAL AREA
****

WATER BALANCE

(Initial soil water assumed to be at field capacity)
(Irrigated up to 1.59% of field capacity)

Rainfall	(mm/year)	631.9	Irrigation Area	(ha)	0.9
Irrigation	(mm/year)	949.6			
Soil Evaporation	(mm/year)	126.1			
Transpiration	(mm/year)	1154.7			
Runoff	(mm/year)	138.0	>>> irrigation portion		2.6
Drainage	(mm/year)	164.4			
Change in soil moisture	(mm/year)	-1.7			

ANNUAL TOTALS

Year	Rain (mm)	Irrig (mm)	Sevap (mm)	Trans (mm)	Runoff (mm)	Drain (mm)	Change (mm)
1950	1197.0	949.0	123.7	1067.9	604.1	379.4	-29.0
1951	399.0	949.0	231.7	1069.2	69.0	75.4	-97.3
1952	475.0	951.6	201.4	1062.7	58.6	137.7	-33.8
1953	591.0	949.0	318.5	1006.0	59.5	97.8	58.1
1954	1151.0	949.0	0.0	1196.7	555.2	281.2	66.9
1955	893.0	949.0	170.3	1062.7	423.1	265.8	-79.8
1956	1482.0	951.6	274.2	995.9	720.6	268.1	174.7
1957	443.0	949.0	0.0	1318.2	99.6	164.7	-190.6
1958	755.0	949.0	297.3	1026.7	97.8	218.1	64.2
1959	760.0	949.0	0.0	1308.9	116.4	176.8	106.9
1960	538.0	951.6	273.5	1037.2	53.1	234.4	-108.7
1961	736.0	949.0	308.0	1020.2	137.5	156.9	62.3
1962	567.0	949.0	0.0	1325.3	26.3	261.0	-96.5
1963	634.0	949.0	332.7	933.6	181.3	163.6	-28.2
1964	452.0	951.6	0.0	1197.4	16.5	73.3	116.4
1965	417.0	949.0	357.3	1023.3	16.0	57.3	-87.9
1966	514.0	949.0	308.1	1003.7	95.2	104.2	-48.3
1967	522.0	949.0	0.3	1281.1	11.7	126.0	51.9
1968	602.0	951.6	249.8	975.3	136.6	248.6	-56.7
1969	420.0	949.0	0.0	1241.4	13.2	0.0	114.4
1970	504.0	949.0	328.5	1180.1	10.2	12.5	-78.4
1971	617.0	949.0	377.4	927.9	70.4	137.1	53.3
1972	425.0	951.6	471.7	845.8	65.6	80.4	-86.9
1973	818.0	949.0	276.8	1082.8	79.0	124.7	203.7
1974	856.0	949.0	312.8	888.1	441.1	312.4	-149.4
1975	1073.0	949.0	4.3	1147.7	361.3	338.3	170.5
1976	596.0	951.6	367.8	1035.1	65.8	244.3	-165.4
1977	514.0	949.0	0.3	1148.9	71.5	222.1	20.1
1978	974.0	949.0	0.0	1135.4	335.5	325.6	126.5
1979	406.0	949.0	444.9	894.0	13.8	193.3	-191.0
1980	561.0	951.6	295.1	1137.7	28.1	42.6	9.1
1981	733.0	949.0	402.3	970.6	128.9	175.5	4.7
1982	301.0	949.0	496.4	765.5	0.7	28.3	-40.8
1983	960.0	949.0	441.8	922.0	202.1	197.4	145.8
1984	735.0	951.6	379.7	1183.7	101.3	111.1	-89.2
1985	503.0	949.0	25.9	1158.5	35.0	142.8	89.8
1986	469.0	949.0	0.0	1410.3	16.8	131.6	-140.6
1987	575.0	949.0	0.0	1218.1	5.0	148.1	152.9
1988	780.0	951.6	0.0	1449.4	170.2	205.7	-93.6
1989	745.0	949.0	0.0	1047.1	262.1	328.2	56.7
1990	640.0	949.0	0.0	1289.1	99.6	191.7	8.6
1991	430.0	949.0	0.0	1200.2	17.0	178.7	-16.9
1992	390.0	951.6	0.0	1362.3	16.3	56.9	-93.8
1993	379.0	949.0	0.0	1182.2	19.7	14.5	111.6
1994	403.0	949.0	0.0	1345.6	58.7	77.3	-129.6
1995	471.0	949.0	0.0	1263.3	4.8	47.8	104.1
1996	657.0	951.6	0.0	1343.2	108.2	121.3	35.9
1997	466.0	949.0	0.0	1374.5	8.2	128.4	-96.1
1998	823.0	949.0	0.0	1054.8	298.9	223.1	195.1
1999	364.0	949.0	0.0	1349.6	49.9	104.4	-190.9
2000	855.0	951.6	0.0	1202.6	202.8	224.8	176.4
2001	360.0	949.0	0.0	1309.2	22.4	113.3	-135.8
2002	351.0	949.0	0.0	1321.0	16.9	32.8	-70.7
2003	364.0	949.0	0.0	1187.1	16.1	54.1	55.7
2004	446.0	951.6	0.0	1297.1	20.5	36.1	43.9
2005	531.0	949.0	0.0	1468.5	20.8	105.0	-114.3
2006	508.0	949.0	0.0	1225.7	17.3	89.5	124.6
2007	722.0	949.0	0.0	1352.0	39.3	208.6	71.1
2008	1010.0	951.6	0.0	1360.5	448.0	261.1	-107.9
2009	408.0	949.0	0.0	1163.0	57.0	141.7	-4.7
2010	1300.0	949.0	0.0	1008.9	731.0	362.3	146.8
2011	652.0	949.0	0.0	1164.5	193.4	335.7	-92.5
2012	820.0	951.6	0.0	1137.9	406.0	289.1	-61.4
2013	398.0	949.0	0.0	1234.2	5.1	129.5	-21.8

NUTRIENT BALANCE

NITROGEN

Total N irrigated from ponds	(kg/ha/year)	94.0	% of Total as ammonium	80.0
Nitrogn lost by ammonia volat.	(kg/ha/year)	15.0	Deep Drainage (mm/year)	164.4
Nitrogen irrigated	(kg/ha/year)	79.0		
Nitrogen added to runoff	(kg/ha/year)	0.2		
Nitrogen added in irrigation	(kg/ha/year)	78.7		
Nitrogen added in seed	(kg/ha/year)	0.3		
Nitrogen removed by crop	(kg/ha/year)	129.4		
Denitrification	(kg/ha/year)	0.6		
Leached NO3-N	(kg/ha/year)	0.0		
Change in soil organic-N	(kg/ha/year)	-50.2		
Change in soil solution NH4-N	(kg/ha/year)	0.0		
Change in soil solution NO3-N	(kg/ha/year)	-0.8		
Change in adsorbed NH4-N	(kg/ha/year)	0.0		
Initial soil organic-N	(kg/ha)	3272.0		
Final soil organic-N	(kg/ha)	60.7		
Initial soil inorganic-N	(kg/ha)	51.3		
Final soil inorganic-N	(kg/ha)	0.0		
Average N03-N conc in the root zone	(mg/L)	0.1		
Average N03-N conc below root zone	(mg/L)	0.1		
Average N03-N conc of deep drainage	(mg/L)	0.0		

PHOSPHORUS

Phosphorus irrigated	(kg/ha/year)	47.6		
Phosphorus added to runoff	(kg/ha/year)	0.1		
Phosphorus added in irrigatn	(kg/ha/year)	47.5	% of Total as phosphate	100.0
Phosphorus added in seed	(kg/ha/year)	0.1		
Phosphorus removed by crop	(kg/ha/year)	32.5		
Leached PO4-P	(kg/ha/year)	0.0		
Change in dissolved PO4-P	(kg/ha/year)	0.1		
Change in adsorbed PO4-P	(kg/ha/year)	14.9		
Average P04-P conc in the root zone	(mg/L)	0.5		
Average P04-P conc below root zone	(mg/L)	0.0		

SOIL P STORAGE LIFE

Year	YearNo.	Tot P stored kg/ha	P leached in year kg/ha
1950	1	268.6	0.0
1951	2	293.8	0.0
1952	3	304.7	0.0
1953	4	308.8	0.0
1954	5	309.9	0.0
1955	6	313.0	0.0
1956	7	319.8	0.0
1957	8	317.7	0.0
1958	9	317.9	0.0
1959	10	320.1	0.0
1960	11	324.2	0.0
1961	12	329.4	0.0
1962	13	331.6	0.0
1963	14	337.7	0.0
1964	15	345.0	0.0
1965	16	352.4	0.0
1966	17	362.5	0.0
1967	18	372.4	0.0
1968	19	384.8	0.0
1969	20	394.2	0.0
1970	21	406.2	0.0
1971	22	421.7	0.0
1972	23	438.6	0.0
1973	24	452.8	0.0
1974	25	468.0	0.0

1975	26	483.2	0.0
1976	27	501.8	0.0
1977	28	517.3	0.0
1978	29	534.6	0.0
1979	30	552.9	0.0
1980	31	574.8	0.0
1981	32	593.7	0.0
1982	33	614.8	0.0
1983	34	634.9	0.0
1984	35	655.8	0.0
1985	36	672.5	0.0
1986	37	692.0	0.0
1987	38	710.6	0.0
1988	39	733.9	0.0
1989	40	752.0	0.0
1990	41	773.1	0.0
1991	42	793.2	0.0
1992	43	815.2	0.0
1993	44	829.6	0.0
1994	45	851.6	0.0
1995	46	867.1	0.0
1996	47	888.9	0.0
1997	48	905.9	0.0
1998	49	924.5	0.0
1999	50	947.5	0.0
2000	51	968.7	0.0
2001	52	987.3	0.0
2002	53	1003.4	0.0
2003	54	1018.9	0.0
2004	55	1037.5	0.0
2005	56	1045.8	0.0
2006	57	1060.7	0.0
2007	58	1076.5	0.0
2008	59	1099.3	0.0
2009	60	1113.7	0.0
2010	61	1133.9	0.0
2011	62	1158.3	0.0
2012	63	1181.3	0.0
2013	64	1196.5	0.0

PLANT

Plant species: Rhodes grass pasture

PLANT WATER USE

Irrigation	(mm/year)	950.	Totl Irrigation Area(ha)	0.9
Pan coefficient	(%)	1.0		
Maximum crop coefficient	(%)	0.9		
Average Plant Cover	(%)	66.		
Average Plant Total Cover	(%)	93.		
Average Plant Rootdepth	(mm)	1104.		
Average Plant Available Water Capacity	(mm)	158.		
Average Plant Available Water	(mm)	125.		
Yield produced per unit transp.	(kg/ha/mm)	9.		

PLANT NUTRIENT UPTAKE

Dry Matter Yield (Shoots)	(kg/ha/yr)	10768.			
Net nitrogen removed by plant	(kg/ha/yr)	129.	Shoot Concn	(%DM)	1.20
Net phosphorus removed by plant	(kg/ha/yr)	32.	Shoot Concn	(%DM)	0.30

AVERAGE MONTHLY GROWTH STRESS (0=no stress, 1=full stress)

Month	Yield kg/ha	Nitr	Temp	Water Defic	Water Logging

1	1053.	0.8	0.0	0.1	0.0
2	884.	0.8	0.0	0.1	0.1
3	969.	0.7	0.0	0.1	0.1
4	905.	0.8	0.0	0.1	0.0
5	807.	0.7	0.2	0.0	0.1
6	613.	0.6	0.5	0.0	0.1
7	512.	0.5	0.6	0.0	0.2
8	826.	0.5	0.4	0.0	0.1
9	1210.	0.7	0.1	0.0	0.0
10	1012.	0.8	0.0	0.1	0.0
11	960.	0.8	0.0	0.2	0.0
12	1017.	0.8	0.0	0.2	0.0

>>> NO-PLANT EVENTS <<<

%Days due to temperature stress	0.4
%Days due to frosting	0.2
%Days due to water stress	0.4
%Days due to nitrogen stress	0.1
No. of forced harvests per year	0.5
No. of normal harvests per year	1.7

SALINITY

Salt tolerance - plant species: tolerant

Average EC of Irrigation Water	(dS/m)	1.6	Irrigation	(mm/year)	949.6
Average EC of Rainwater	(dS/m x10)	0.3	Rainfall	(mm/year)	631.9
Average EC of Infiltrated water	(dS/m)	1.1			
Av. water-upt-weightd rootzone EC	(dS/m s.e.)	1.6			
EC soil soln (FC) at base of rootzone	(dS/m)	10.4	Deep Drainage	(mm/year)	164.4
Reduction in Crop yield due to Salinity	(%)	0.0			
Percentage of yrs that crop yld falls below 90% of potential because of soil salinity		0.0			

Period	ECrootzone sat ext (dS/m)	ECbase in situ (dS/m)	Rel Yield (%)
1950 - 1959	1.35	7.35	100.
1951 - 1960	1.43	7.99	100.
1952 - 1961	1.37	7.64	100.
1953 - 1962	1.32	7.22	100.
1954 - 1963	1.31	7.00	100.
1955 - 1964	1.38	7.73	100.
1956 - 1965	1.46	8.67	100.
1957 - 1966	1.56	9.65	100.
1958 - 1967	1.54	9.79	100.
1959 - 1968	1.53	9.56	100.
1960 - 1969	1.66	10.87	100.
1961 - 1970	1.73	12.73	100.
1962 - 1971	1.78	12.96	100.
1963 - 1972	1.90	15.27	100.
1964 - 1973	1.86	15.62	100.
1965 - 1974	1.80	12.74	100.
1966 - 1975	1.58	10.21	100.
1967 - 1976	1.54	9.43	100.
1968 - 1977	1.51	8.90	100.
1969 - 1978	1.44	8.47	100.
1970 - 1979	1.42	7.72	100.
1971 - 1980	1.41	7.61	100.
1972 - 1981	1.39	7.46	100.
1973 - 1982	1.41	7.65	100.
1974 - 1983	1.40	7.42	100.
1975 - 1984	1.44	8.19	100.
1976 - 1985	1.54	9.20	100.
1977 - 1986	1.56	9.79	100.

1978 - 1987	1.57	10.27	100.
1979 - 1988	1.66	11.31	100.
1980 - 1989	1.55	10.17	100.
1981 - 1990	1.48	9.25	100.
1982 - 1991	1.47	9.23	100.
1983 - 1992	1.45	9.08	100.
1984 - 1993	1.53	10.22	100.
1985 - 1994	1.55	10.40	100.
1986 - 1995	1.59	11.15	100.
1987 - 1996	1.56	11.15	100.
1988 - 1997	1.60	11.37	100.
1989 - 1998	1.57	11.08	100.
1990 - 1999	1.71	13.41	100.
1991 - 2000	1.64	12.86	100.
1992 - 2001	1.70	13.80	100.
1993 - 2002	1.72	14.10	100.
1994 - 2003	1.70	13.61	100.
1995 - 2004	1.72	14.13	100.
1996 - 2005	1.70	13.43	100.
1997 - 2006	1.73	13.88	100.
1998 - 2007	1.64	12.71	100.
1999 - 2008	1.67	12.66	100.
2000 - 2009	1.63	12.12	100.
2001 - 2010	1.58	10.94	100.
2002 - 2011	1.48	9.41	100.
2003 - 2012	1.39	8.13	100.
2004 - 2013	1.36	7.81	100.

GROUNDWATER
****

Average Groundwater Recharge	(m3/day)	4.1
Average Nitrate-N Conc of Recharge	(mg/L)	0.0
Thickness of the Aquifer	(m)	10.0
Distance (m) from Irrigation Area to where Nitrate-N Conc in Groundwater is Calculated		250.0

Concentration of NITRATE-N in Groundwater (mg/L)

Year	Depth Below Water Table Surface 0.0 m	5.0 m	9.0 m
1954	0.0	0.0	0.0
1959	0.0	0.0	0.0
1964	0.0	0.0	0.0
1969	0.0	0.0	0.0
1974	0.0	0.0	0.0
1979	0.0	0.0	0.0
1984	0.0	0.0	0.0
1989	0.0	0.0	0.0
1994	0.0	0.0	0.0
1999	0.0	0.0	0.0
2004	0.0	0.0	0.0
2009	0.0	0.0	0.0
Last 2013	0.0	0.0	0.0

ACKNOWLEDGMENTS
****
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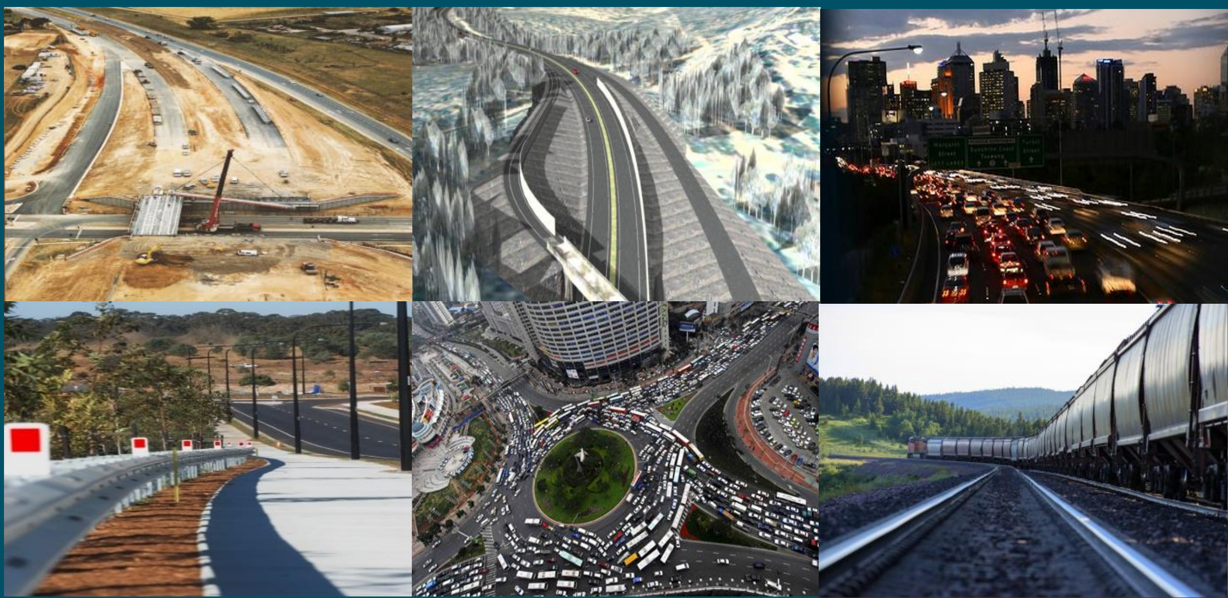
ATTACHMENT B

Level Rail Crossing Traffic Assessment

BROWN



Emerald Rail Crossing Assessment

Final Report

Taroborah Coal Project SEIS

B14343ER01

November 2014

IMC
GLOBAL EXPERTISE, LOCAL MINING SOLUTIONS

Prepared for IMC Mining Pty Ltd
on behalf of Shenhuo International Group Pty Ltd

Smart Consulting

COMMERCIAL IN CONFIDENCE

DOCUMENT CONTROL

REFERENCE NUMBER: B14343ER01

Revision	Date	Details	Author	Reviewed	Approved
8	20/11/2014	Rail Crossing Assessment Final Report	AK	JvP	JvP (RPEQ 7280)

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Appendices

1. Introduction and Context

Brown Consulting have prepared the following report for IMC Mining Pty Ltd on behalf of Shenhuo International Group Pty Ltd.

Shenhuo International Group Pty Ltd (the proponent) commenced an Environmental Impact Statement (EIS) process for the Taroborah Coal Project (TCP) in 2011. On 20th February 2012, the Commonwealth Department of Sustainability, Environment, Water, Population and Communities determined the proposed project to be a controlled action under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). The controlling provisions are:

- Listed threatened species and communities (sections 18 & 18A)
- Listed migratory species (sections 20 & 20A)
- Water resources (sections 24D & 24E)

The EIS will be prepared pursuant to the bilateral agreement (section 45 of the EPBC Act) between the Commonwealth and Queensland governments for the purposes of the Commonwealth Government's assessment under part 8 of the EPBC Act. The Proponent is preparing an EIS in accordance with the Terms of Reference (ToR) issued by the Department of Environment and Heritage Protection in August 2012.

The Taroborah Coal Project is located approximately 22km due west of Emerald, and the major activities proposed are.

- open-cut mining,
- underground mining,
- processing of mined coal, and
- transport of the coal to the port of Gladstone via the Central West and Blackwater rail systems.

The proposed rail traffic is to transport coal as part of the Taroborah Coal Project. Brown Consulting have undertaken an assessment of the operational impacts associated with the proposed development rail traffic at three existing railway crossing locations within the township of Emerald. Each of the three crossing locations within Emerald are within close proximity of road intersections. Traffic simulation modelling and sensitivity analysis has been undertaken in AIMSUN transport simulation modelling software in order to identify any potential significant congestion impacts as a result of the proposed development rail traffic.

The following level crossing locations have been considered:

- Level crossing south of the Capricorn Highway / Gregory Highway intersection
- Level crossing south of the Capricorn Highway / Opal Street intersection
- Level crossing south of the Capricorn Highway / Selma Road intersection

Refer to Figure 1.1 showing the regional context of the existing railway and the level rail crossings sites.

It is understood that an Australian Level Crossing Assessment Model (ALCAM) and assessment of the safety impacts associated with the rail traffic is being undertaken by others.

Figure 1.1 Regional Context of Emerald Transport Network (Image: Google Earth)

The indicative locations of the three rail crossing locations are circled

2. Development Traffic Conditions

The development traffic consists of rail movements travelling to and from the proposed mine that is situated west of Emerald. The proposed rail traffic is understood to consist of three additional trains in each direction, or six trains per day total two-way along the existing Central West railway system in Emerald. It is understood that this rail traffic is anticipated to occur during times that do not coincide with the peak periods of the existing road network, ie: off-peak periods, to minimise potential impacts to the existing road network.

The train vehicle has the following parameters:

- Train length: 1,425m
- Speed: 50km/h proposed, with 40km/h minimum to 60km/h maximum

The following report examines the impact of rail traffic occurring at any time of the day (peak and off-peak), and any potential for congestion within the vicinity of three railway crossings. Do note that since it is proposed that all rail traffic operate during off-peak periods, that modelling rail traffic during peak hours is a “worst-case” scenario that is unlikely to eventuate. The peak hour and off-peak hour scenarios are modelled using AIMSUN transport simulation software.

The assessment adopts the slowest train speed (40km/h), resulting in the maximum total event time of 167 seconds for a train to clear the crossing. This is inclusive of 9 seconds warning time, 10 seconds delay to ensure vehicles clear the crossing, 20 seconds boom gate operation time and 128 seconds train clearance time. This is considered conservative.

The AIMSUN simulation models the base year 2014 traffic volumes, as well as the projected traffic volumes in the future design horizon year of 2024. Traffic survey information obtained from DTMR is provided in Appendix A. The anticipated growth rate across the Emerald road network is anticipated to be 2.5% p.a. given the moderate rate of development in the surrounding area. The anticipated annual growth rate of 2.5% per annum for the traffic volumes is considered to be a medium to high growth rate, and is considered to be appropriate for the purposes of the traffic operations assessment in the following section.

The background traffic volumes for an average weekday at each of the three intersection sites are shown graphically in Figure 2.1 to Figure 2.3 below. For each site the base year 2014 conditions and design horizon year 2024 conditions were modelled. The traffic operations were assessed for the worst recorded AM peak traffic data, the worst recorded PM peak traffic and the worst recorded off-peak hour traffic obtained in the traffic surveys in order to assess the most severe potential impacts. In this regard, the change in directionality of all trips across the existing intersection sites is captured by the models. Thus the impact of the development rail traffic at each of the three railway crossing sites during all periods of the day has been captured by the following assessment.

Figure 2.1 Base Year 2014 Traffic Volume – Gregory Highway / Capricorn Highway intersection

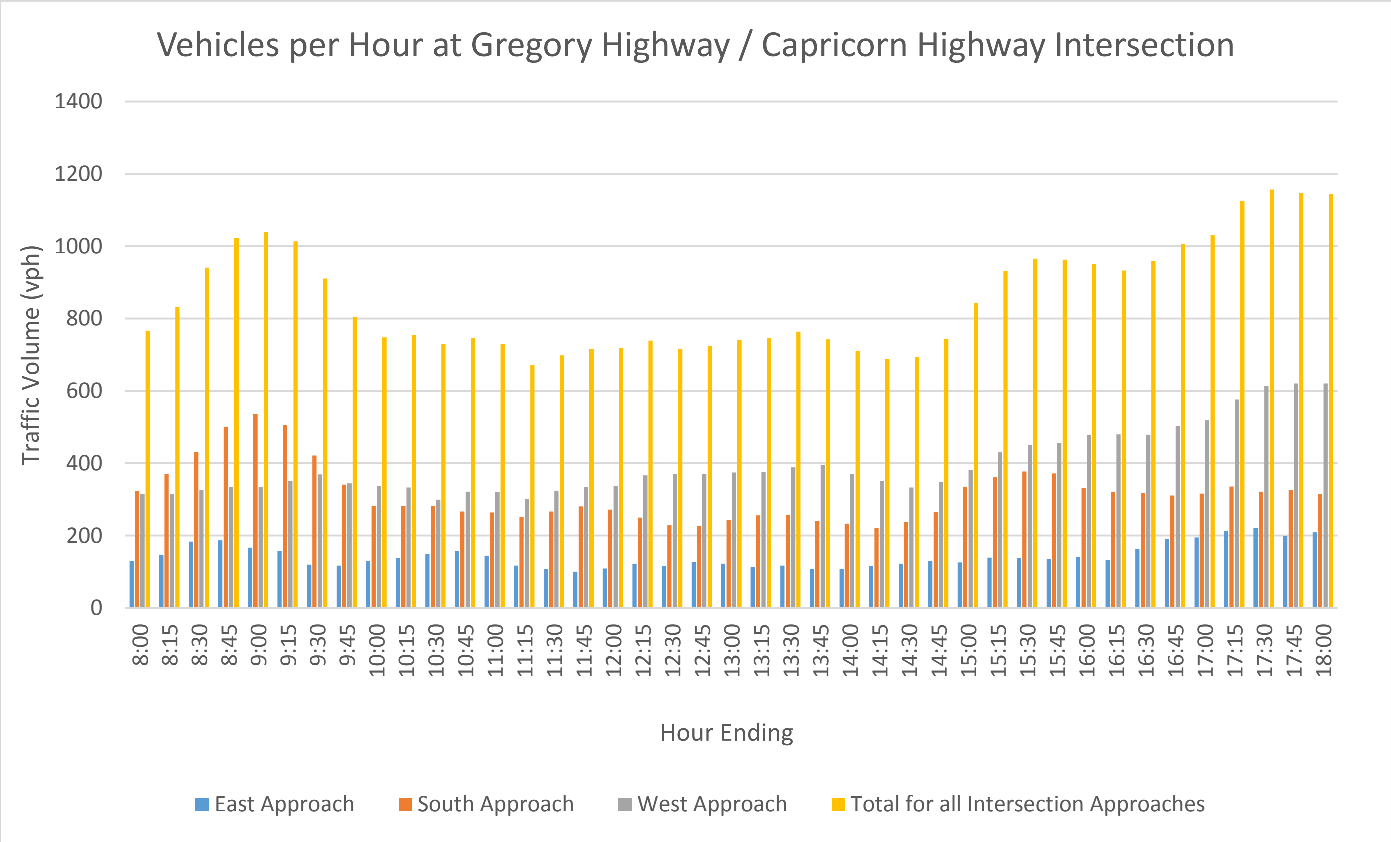


Figure 2.2 Base Year 2014 Traffic Volume – Capricorn Highway / Opal Street intersection

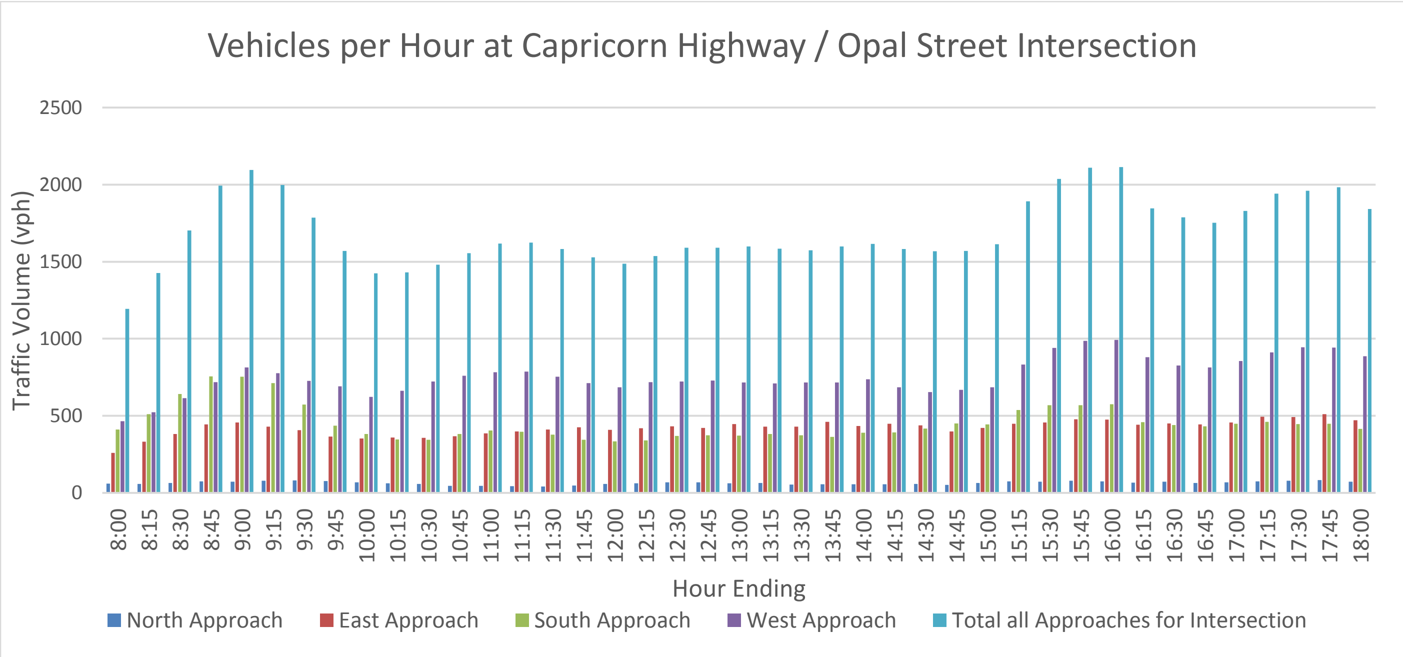
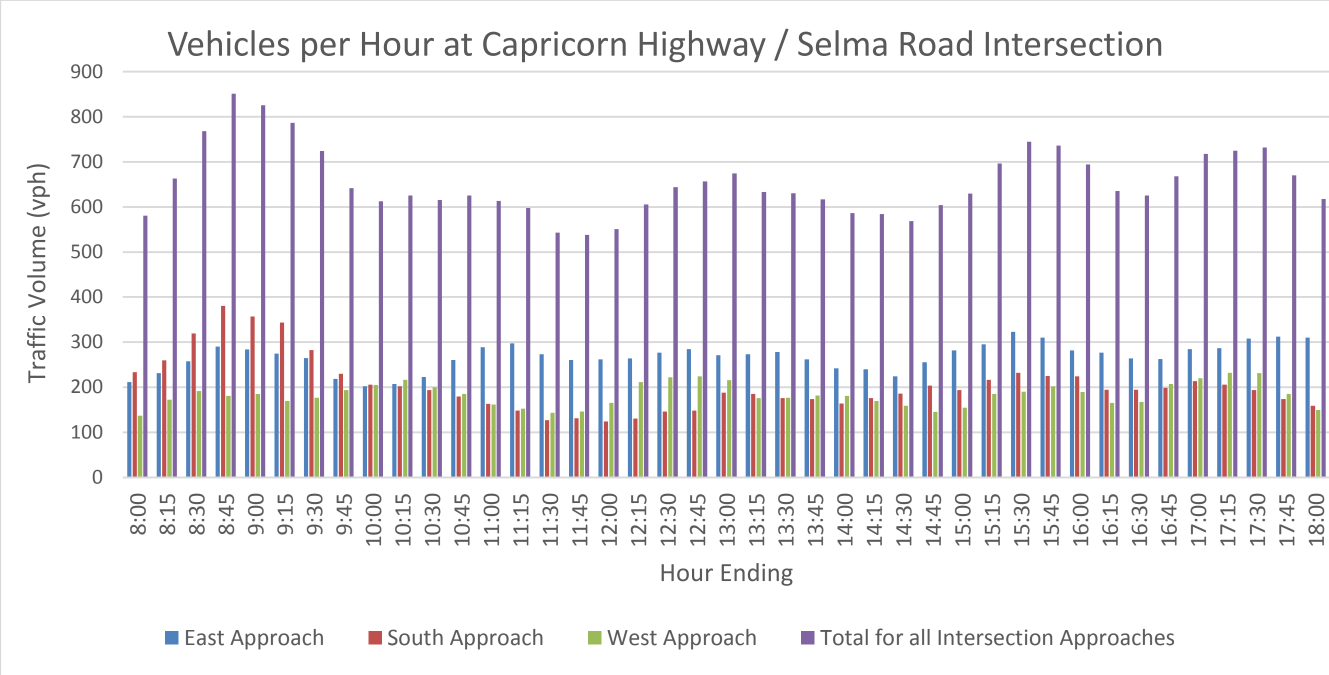


Figure 2.3 Base Year 2014 Traffic Volume – Capricorn Highway / Selma Road intersection



3. Traffic Assessment

Modelling of the base year 2014 and ten year design horizon year 2024 conditions for each of the following three sites was undertaken in AIMSUN transport simulation software.

- Level crossing south of the Capricorn Highway / Gregory Highway intersection
- Level crossing south of the Capricorn Highway / Opal Street intersection
- Level crossing south of the Capricorn Highway / Selma Road intersection

The models were run five times with five of the standard RTA seeds (28, 560, 2849, 7771 and 86524). The model is considered to be stable due to limited variation between each seed.

The following assessments provide a summary of the modelling results and overview of the resulting traffic operations at each of the three intersection sites. The AIMSUN modelling results for three models are provided: the scenario of no trains, the scenario with the slowest 40km/h speed trains, and the scenario with the fastest 60km/h speed trains. In each location, the maximum queue results were similar despite the speed of the train modelled. Hence detailed output results including mean queue, level of service at the railway crossing and average time delay per vehicle have been reported for the worst case 40km/h speed train only.

The level of service at the railway crossing is a measure of the average delay per vehicle across the intersection. The level of service has been calculated in accordance with the Roads and Transport Authority (RTA) Level of Service Criteria for Intersections, refer Table 3.1 below.

Table 3.1 Level of Service Criteria for Intersections

(adapted from *RTA Guide to Traffic Generating Developments, Table 4.2*)

Level of Service	Average Delay per Vehicle (secs/veh)	Intersection Service – for Give Way & Stop Signs
A	< 14	Good operation
B	15 to 28	Acceptable delays & spare capacity
C	29 to 42	Satisfactory, but incident study required
D	43 to 56	Near capacity & incident study required
E	56 to 70	At capacity, requires other control mode
F	> 70	Heavily congested flow with traffic demand exceeding capacity

The level of service provides an indication of the traffic conditions in terms of speed, travel time, freedom to manoeuvre, comfort, convenience, traffic interruptions and safety. The following assessment considers the level of service at each intersection location in combination with other site-specific factors including maximum queue lengths (and their effect on lane blocking), the influence of nearby intersections and the ability of the intersection to recover to a level of service following a train event.

3.1 Level crossing south of the Capricorn Highway / Gregory Highway intersection

The AIMSUN traffic simulation results for this site are summarised in Table 3.2.

Table 3.2 Summary of impacts at level crossing adjacent to Capricorn Highway / Gregory Highway intersection

Scenario	Maximum Queue Length – No Trains (veh)	Mean Queue Length – With 40km/h Train (veh)	Maximum Queue Length – With 40km/h Train* (veh)	Maximum LOS^ With 40km/h Train	Maximum Queue Length – With 60km/h Train (veh)
AM Peak (8:00 – 9:00am)					
Base year 2014	5 [30m] at south approach	8	28 [168m]	B	23 [138m]
Future year 2024	12 [72m] at south approach	9	33 [198m]	C	32 [192m]
Off-Peak (12:30 – 1:30pm)					
Base year 2014	4 [24m] at south approach	2	13 [78m]	B	11 [66m]
Future year 2024	6 [36m] at south approach	2	15 [90m]	B	12 [72m]
PM Peak (4:45 – 5:45pm)					
Base year 2014	4 [24m] at west approach	6	22 [132m]	B	21 [126m]
Future year 2024	7 [42m] at west approach	9	26 [156m]	C	24 [144m]

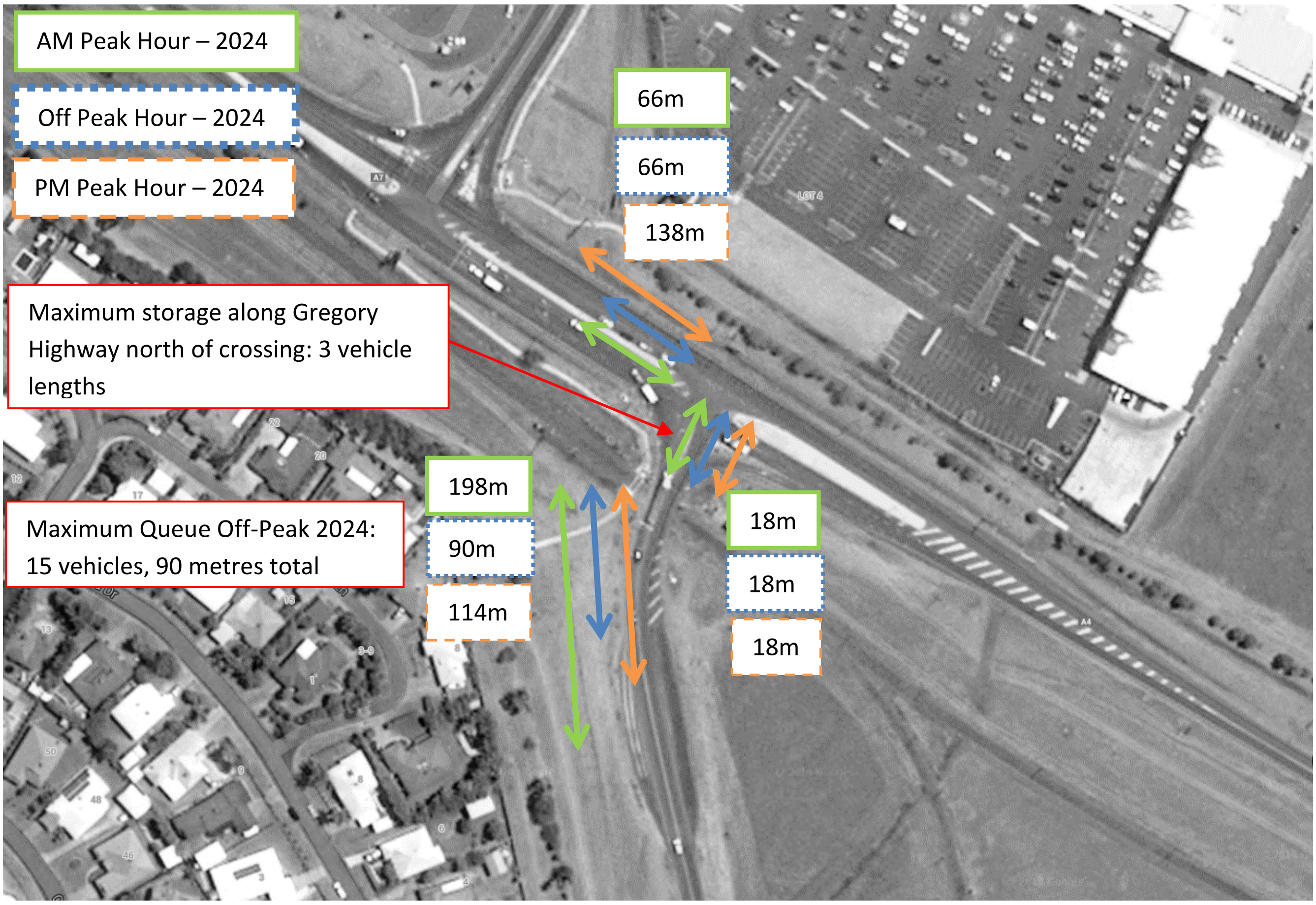
*Refer Figure 3.1 showing indicative location of maximum queues for the year 2024 scenario

^LOS = Level of Service, presented on a scale A – F where A represents free-flowing conditions with minimal delays, F represents heavy congestion

The AIMSUN modelling results show that for the slowest train speed there are significant queues anticipated during the morning and evening peak periods of the future design horizon year 2024. The maximum queue lengths for year 2024 traffic conditions are shown indicatively in Figure 3.1. The queue length north of the railway crossing is 18m maximum along the Gregory Highway, with the additional queues continuing along Capricorn Highway, refer Figure 3.1. The maximum queue length of 198 metres was observed during the morning peak hour of 2024 along the southern approach of the intersection. The maximum queue length during the evening peak hour of 2024 was 156 metres along the west approach. In each morning and evening peak hour model, the maximum queue lengths along the southern approach of the intersection site did not appear to impact any intersections to the south.

The queues during the off-peak period are moderate. The maximum queue length during the off peak period occurs on the southern approach and is 15 vehicle lengths or 90 metres in the design horizon year 2024. The queues on the western approach along the Capricorn Highway during the off-peak hour are approximately 14 vehicle lengths or 84 metres in total. The mean queue length during the future year 2024 off-peak hour was 2 vehicle lengths or 12 metres. The intersection appears to recover quickly following the departure of the train from the crossing. Following the worst-case train event (for slowest 40km/h speed train), the time taken for vehicles to return to average travel speed is 80 seconds during the off-peak hour of future year 2024. Refer to Figure 3.2 and Figure 3.3 showing the change in speed of vehicles travelling through the intersection with and without the train event in the future year 2024 off-peak scenario. Given that the average flow of vehicles travelling through the intersection is restored within 80 seconds of the train departure under worst-case off-peak hour traffic conditions, the 'recovery time' of the intersection is good. Hence it is not expected that additional rail movements during off-peak periods at this site will significantly impact upon the road network.

Figure 3.1 Aerial Image showing indicative location of maximum queues obtained from modelling future year 2024 – Capricorn Highway / Gregory Highway (Image: Google Earth)



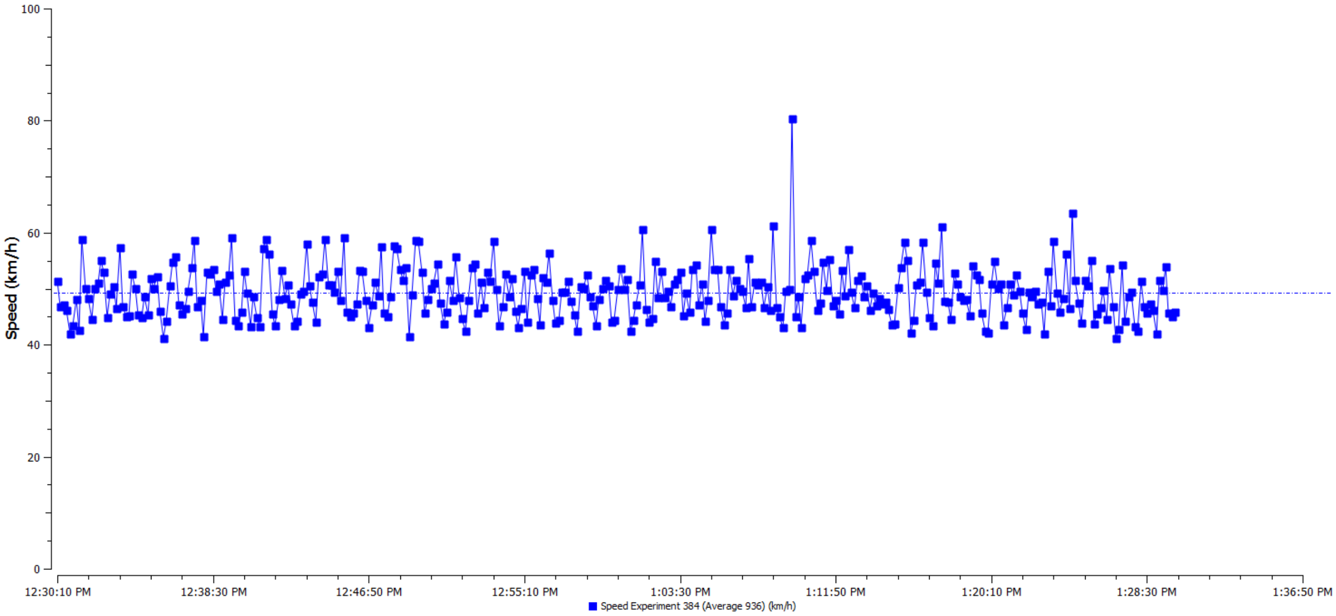


Figure 3.2 Change in Speed of Vehicles Travelling through Capricorn Highway / Gregory Highway intersection – No Train, Future Year 2024 Off-Peak Hour

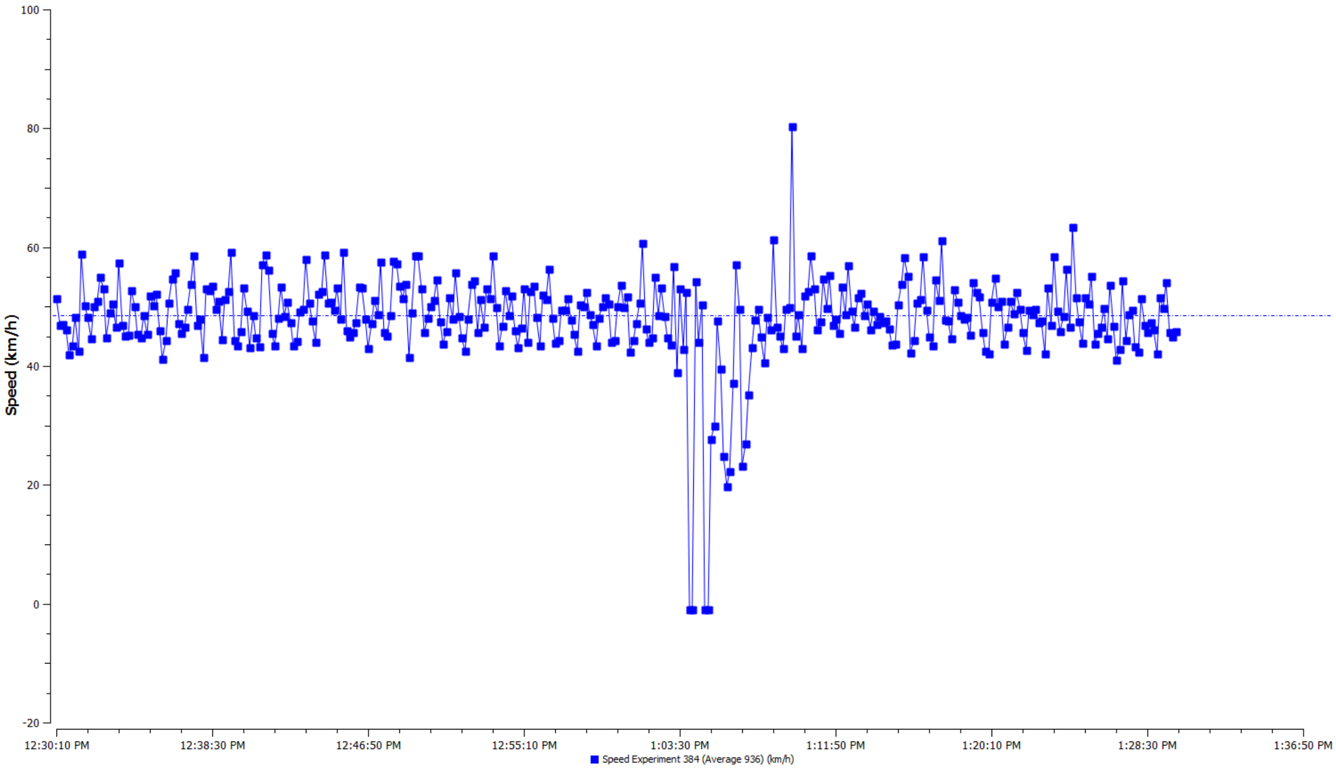


Figure 3.3 Change in Speed of Vehicles Travelling through Capricorn Highway / Gregory Highway intersection – With 40km/h Train, Future Year 2024 Off-Peak Hour

3.2 Level crossing south of the Capricorn Highway / Opal Street intersection

The AIMSUN traffic simulation results for this site are summarised in Table 3.3.

Table 3.3 Summary of impacts at level crossing adjacent to Capricorn Highway / Opal Street intersection

Scenario	Maximum Queue Length – Without Trains (veh)	Mean Queue Length – With 40km/h Train (veh)	Maximum Queue Length – With 40km/h Train* (veh)	Maximum LOS^ With 40km/h Train	Maximum Queue Length – With 60km/h Train (veh)
AM Peak (8:00 – 9:00am)					
Base year 2014	5 [30m] at south approach	9	34 [204m]	B	33 [198m]
Future year 2024	8 [48m] at south approach	15	50 [300m]	C	48 [288m]
Off-Peak (10:15 – 11:15am)					
Base year 2014	3 [18m] at west approach	10	19 [114m]	B	15 [90m]
Future year 2024	4 [24m] at west approach	15	22 [132m]	B	20 [120m]
PM Peak (5:00 – 6:00pm)					
Base year 2014	7 [42m] at west approach	12	50 [300m]	B	18 [108m]
Future year 2024	10 [60m] at west approach	34	59 [354m]	B	37 [222m]

*Refer Figure 3.4 showing indicative location of maximum queues for the year 2024 scenario

^LOS = Level of Service, presented on a scale A – F where A represents free-flowing conditions with minimal delays, F represents heavy congestion

The maximum queue lengths at the slowest train speed obtained in the AIMSUN model for year 2024 conditions are shown indicatively in Figure 3.4. There is queue storage of 2 vehicle lengths (approximately 12m) north of the railway crossing along Opal Street. Additional vehicles entering the railway crossing from the north queue along the Capricorn Highway.

The maximum queue length observed was approximately 354 metres at the west approach in the evening peak hour of 2024. During the evening peak hour, the most severe queue length was observed to extend beyond the right turn lane to the single lane on the western approach of the intersection, blocking through movements from the west. During the morning peak hour periods there were significant queues at the southern approach due to the high volume of left turning vehicles from the southern approach travelling towards the town centre of Emerald during the morning peak hour. The maximum morning queue length in year 2024 extended approximately 50 vehicle lengths (300m) along the southern approach of Opal Street to the roundabout intersection located further south. The AIMSUN models show that during the morning and evening peak hours a large proportion of trips travel between the south and west intersection approaches, travelling against the east-west priority at the intersection. The queue lengths during all time periods did not block the through lane on the eastern leg of the intersection.

The decline in performance of the intersection in year 2024 across all time periods is largely due to the high background traffic volumes. For example, the projected volume of eastbound traffic along the Capricorn Highway in year 2024 is 1,426 vehicles per hour, which exceeds the traffic capacity of 900 – 1,200 vehicles per hour per lane.

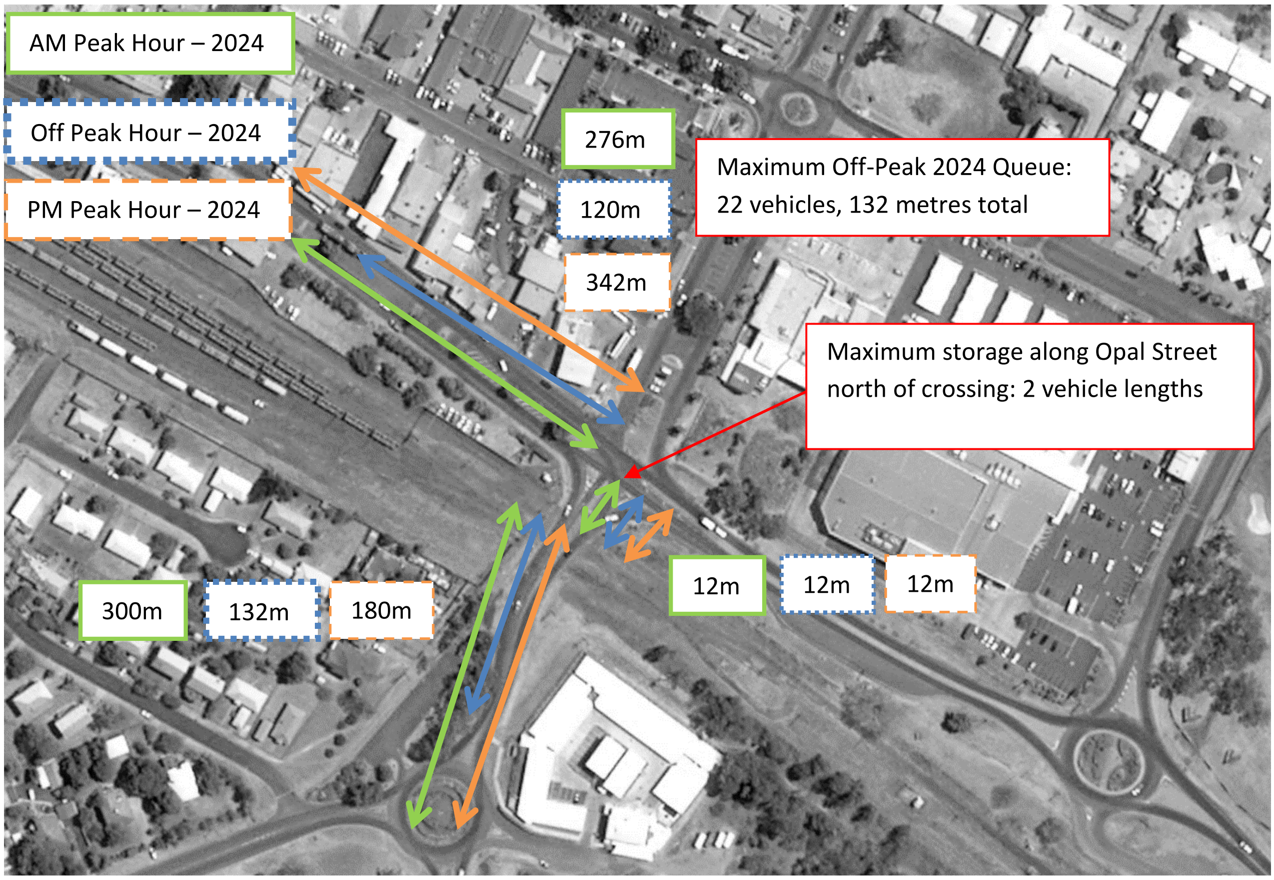
The high traffic volumes during year 2024 conditions likely explains the high queue lengths obtained in the 2024 models and the decline of the intersection performance following a train event. It is likely that the existing infrastructure at this location in year 2024 will need to be improved, as the existing intersection capacity will begin to erode even without the additional rail movements.

The queue lengths during the worst off-peak hours ranged up to 22 vehicle lengths (132m) maximum in year 2024 traffic conditions. The mean queue length over the off-peak hour was 15 vehicle lengths (90m) for the future year 2024 slowest train speed scenario. As per the queueing results in Table 3.3, the presence of the train event during the off-peak hour in future year 2024 is anticipated to result in an additional 18 vehicles (108 metres) queued at the western approach of the intersection as compared to the scenario without any train event. The Capricorn Highway / Opal Street intersection site showed the most severe maximum queue length for any off-peak period across all three intersection sites modelled.

However it is important to note that the modelling of the off-peak hour is conservative, as the traffic volumes inputted were the “worst-case” off-peak volumes, and that the future horizon year 2024 volumes were factored by 2.5% p.a. growth which is a medium to high rate of growth in background traffic volume. Sensitivity testing of the future year 2024 off-peak hour with decreased traffic volumes along Opal Street showed that if traffic volumes are decreased by a third along Opal Street the maximum queue length at the southern approach decreased to 13 vehicle lengths (78 metres), which is a reduction of 9 vehicle lengths (54 metres) of anticipated queueing as compared to the results in Table 3.3.

The traffic simulation models show that the operation of trains during the worst off-peak hour are anticipated to cause delays to the traffic movements from the southern approach, as well as delays to the west approach right and through movements. Do note that the model is conservative in regards to lane blocking, as in practice it is likely that vehicles travelling from the western approach wishing to continue through or wishing to turn left would utilise the wide road shoulder to pass any stationery vehicles that are queued to turn right. On average, the recovery time taken for vehicles travelling through the Opal Street intersection to return to average travel speed following the departure of the train event was approximately 90 seconds. Refer Figure 3.5 and Figure 3.6. This was the longest recovery time of the three intersection sites. However the intersection recovers well following a train event during the off-peak hour, with traffic flow conditions completely returning to normal within 90 seconds. From a traffic operations perspective, it is recommended that rail traffic be restricted to operate during off-peak periods only, resulting in minimal impacts per train event anticipated at this intersection.

Figure 3.4 Aerial Image showing indicative location of maximum queues obtained from modelling future year 2024 – Capricorn Highway / Opal Street (Image: Google Earth)



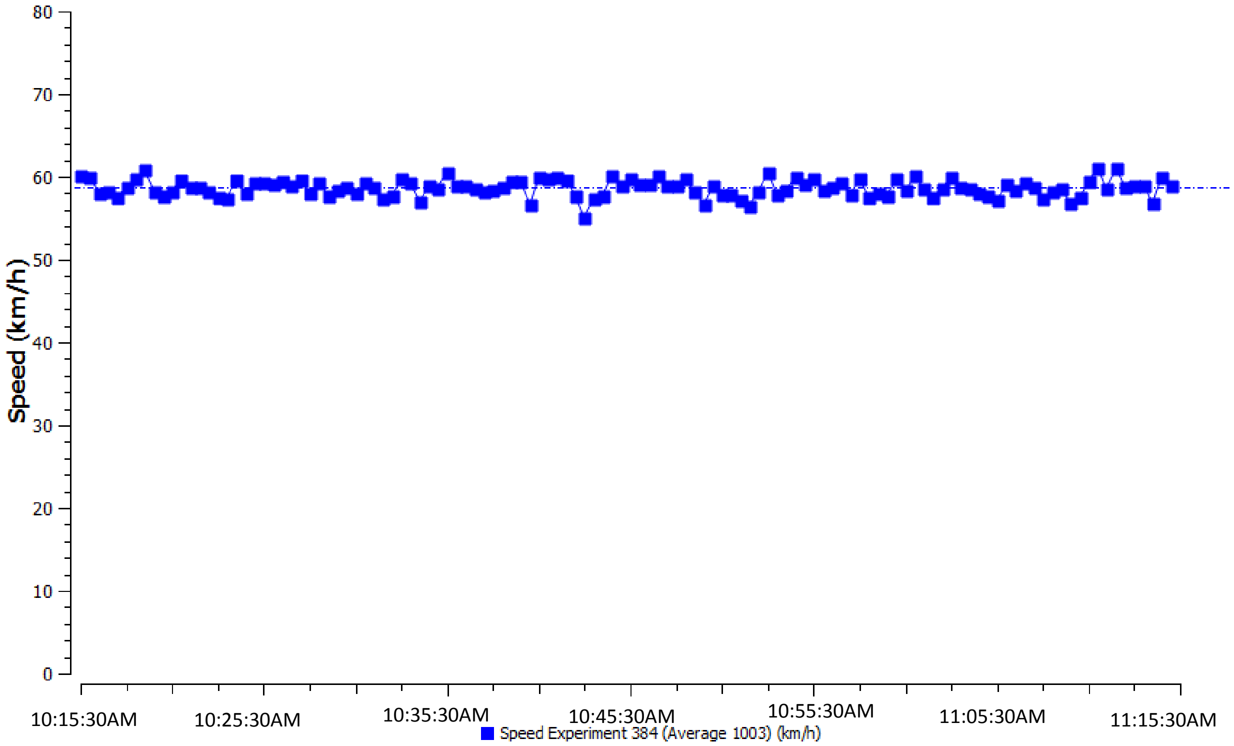


Figure 3.5 Change in Speed of Vehicles Travelling through Capricorn Highway / Opal Street intersection – No Train, Future Year 2024 Off-Peak Hour

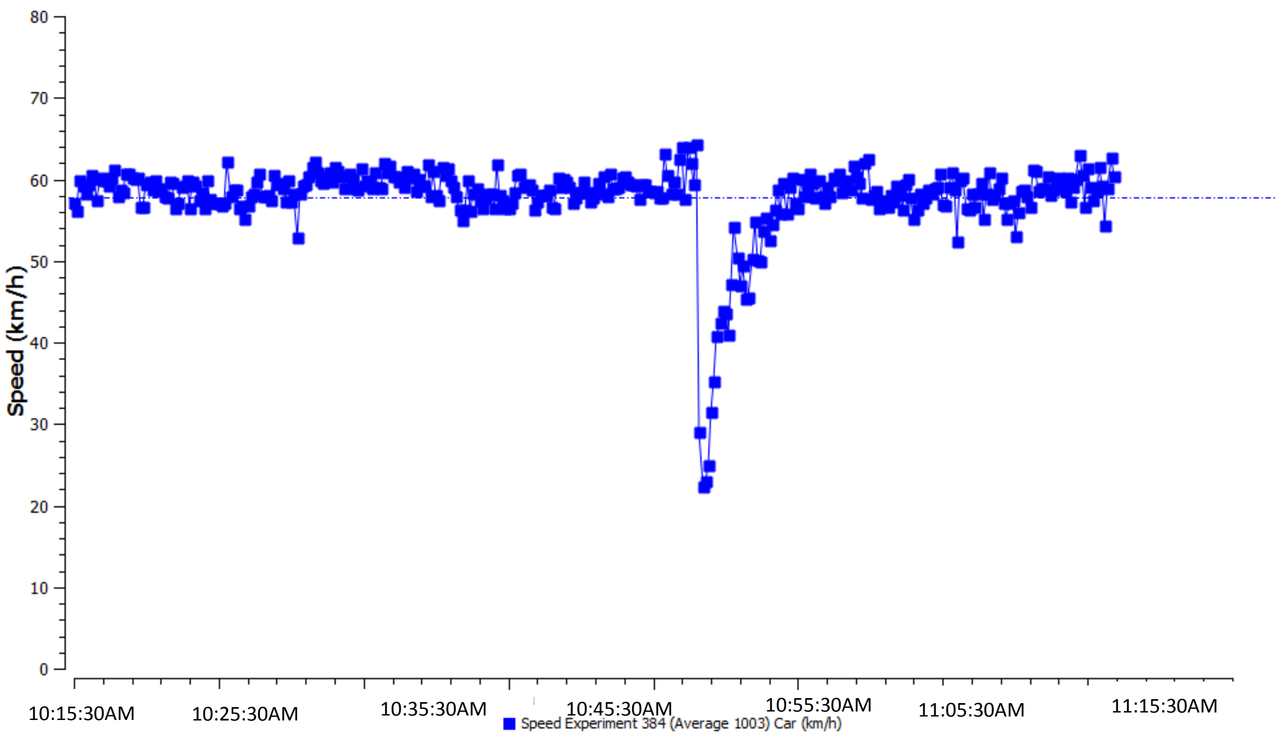


Figure 3.6 Change in Speed of Vehicles Travelling through Capricorn Highway / Opal Street intersection – With 40km/h Train, Future Year 2024 Off-Peak Hour

3.3 Level crossing south of the Capricorn Highway / Selma Road intersection

The AIMSUN traffic simulation results for this site are summarised in Table 3.4.

Table 3.4 Summary of impacts at level crossing adjacent to Capricorn Highway / Selma Road intersection

Scenario	Maximum Queue Length – Without Trains (veh)	Mean Queue Length – With 40km/h Train (veh)	Maximum Queue Length – With 40km/h Train* (veh)	Maximum LOS^ With 40km/h Train	Maximum Queue Length – With 60km/h Train (veh)
AM Peak (7:45 – 8:45am)					
Base year 2014	3 [18m] at south approach	2	12 [72m]	A	10 [60m]
Future year 2024	6 [36m] at south approach	3	13 [78m]	A	11 [66m]
Off-Peak (12:00 – 1:00pm)					
Base year 2014	3 [18m] at south approach	1	6 [36m]	A	6 [36m]
Future year 2024	5 [30m] at south approach	8	12 [72m]	A	11 [66m]
PM Peak (3:30 – 4:30pm)					
Base year 2014	3 [18m] at south approach	2	10 [60m]	A	6 [36m]
Future year 2024	6 [36m] at south approach	3	12 [72m]	A	8 [48m]

*Refer Figure 3.7 showing indicative location of maximum queues for the year 2024 scenario

^LOS = Level of Service, presented on a scale A – F where A represents free-flowing conditions with minimal delays, F represents heavy congestion

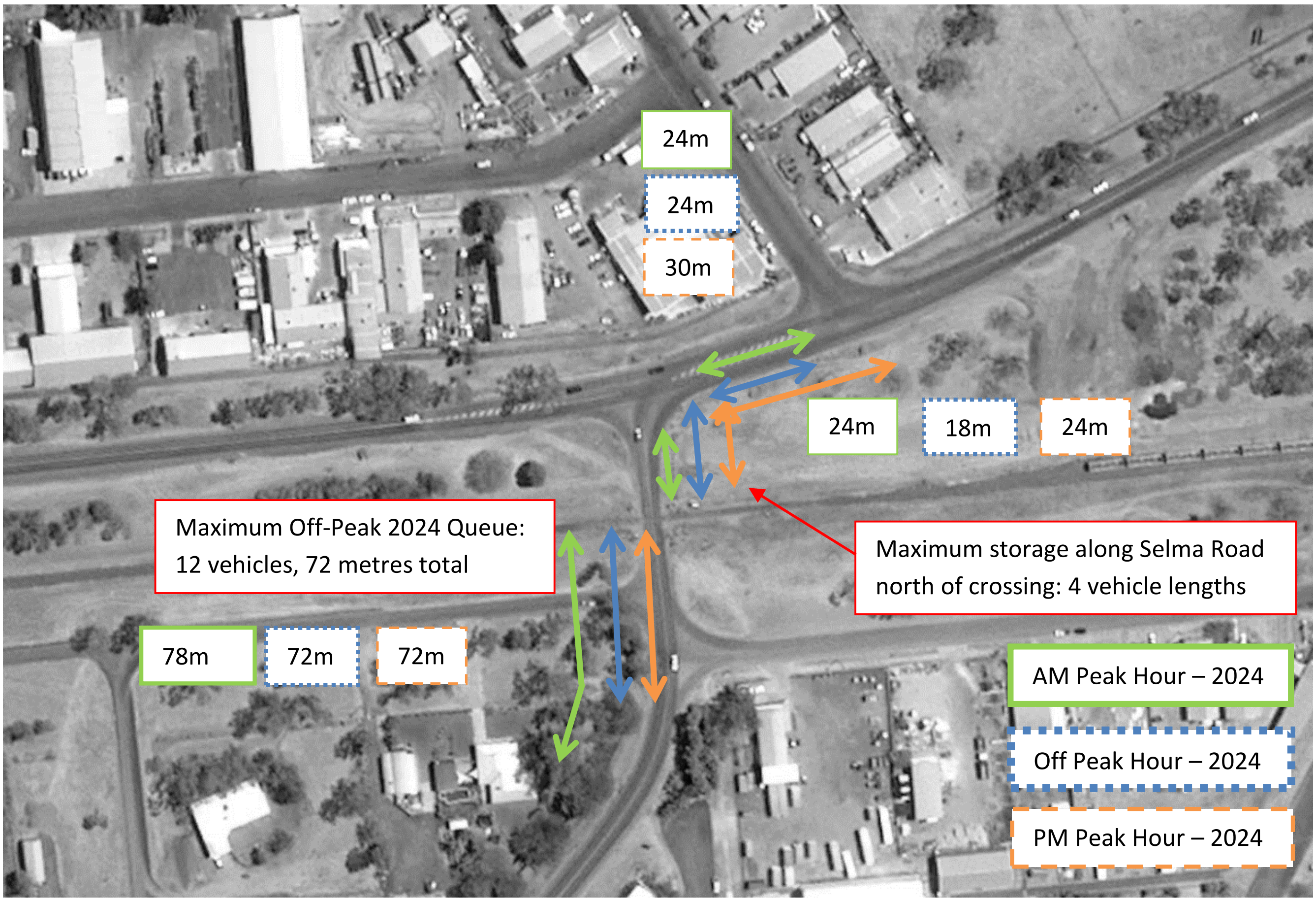
Figure 3.7 below indicatively represents the maximum queues observed under year 2024 conditions for the slowest train speed of 40km/h. As per Figure 3.7, up to 4 vehicle storage lengths are able to queue immediately north of the railway crossing along Selma Road without impact to traffic movements along the Capricorn Highway. Queues longer than 4 vehicle lengths however continue to queue along the Capricorn Highway, generally within the turn lanes along the Capricorn Highway.

The AIMSUN modelling shows that the worst queues at the intersection are anticipated to occur at the southern approach of the intersection site. This is due to the high volume of cars turning right from Selma Road towards the town centre of Emerald during all time periods. The results from sensitivity testing show that the southern approach of the intersection is particularly sensitive to the presence of rail traffic due to the high proportion of right turning vehicles from Selma Road. The queueing of vehicles along the southern intersection approach during all time periods modelled in future year 2024 extends through the intersection located further to the south. Further, the results also indicate that there is anticipated to be queueing back along the northern section of Selma Road and within the westbound lane of the Capricorn Highway (refer Figure 3.7). However queuing along the east approach of the Capricorn Highway is not anticipated to have any negative impact on the intersection located further east. The disruption to through-flowing traffic along the Capricorn Highway is not anticipated to be very significant as the eastern approach of the intersection is flared which allows through-traffic to safely overtake queued left-turning vehicles.

The off-peak queues are not significant. The maximum queue length during the future year 2024 off-peak hour was 12 vehicle lengths of 72 metres. The mean queue length during the future year 2024 off-peak hour was 8 vehicle lengths or 48 metres. Following a train event the intersection recovers quickly, within 60 seconds of the train departing the site. Refer Figure 3.8 and Figure 3.9 below. The traffic simulation models show that the operation of trains during the worst off-peak hour are not anticipated to cause unreasonable queues at the intersection. From a

traffic operations perspective, it is recommended that rail traffic be restricted to operate during off-peak periods only, as this will result in no significant impacts at this intersection.

Figure 3.7 Aerial Image showing indicative location of maximum queues obtained from modelling future year 2024 – Capricorn Highway / Selma Road (Image: Google Earth)



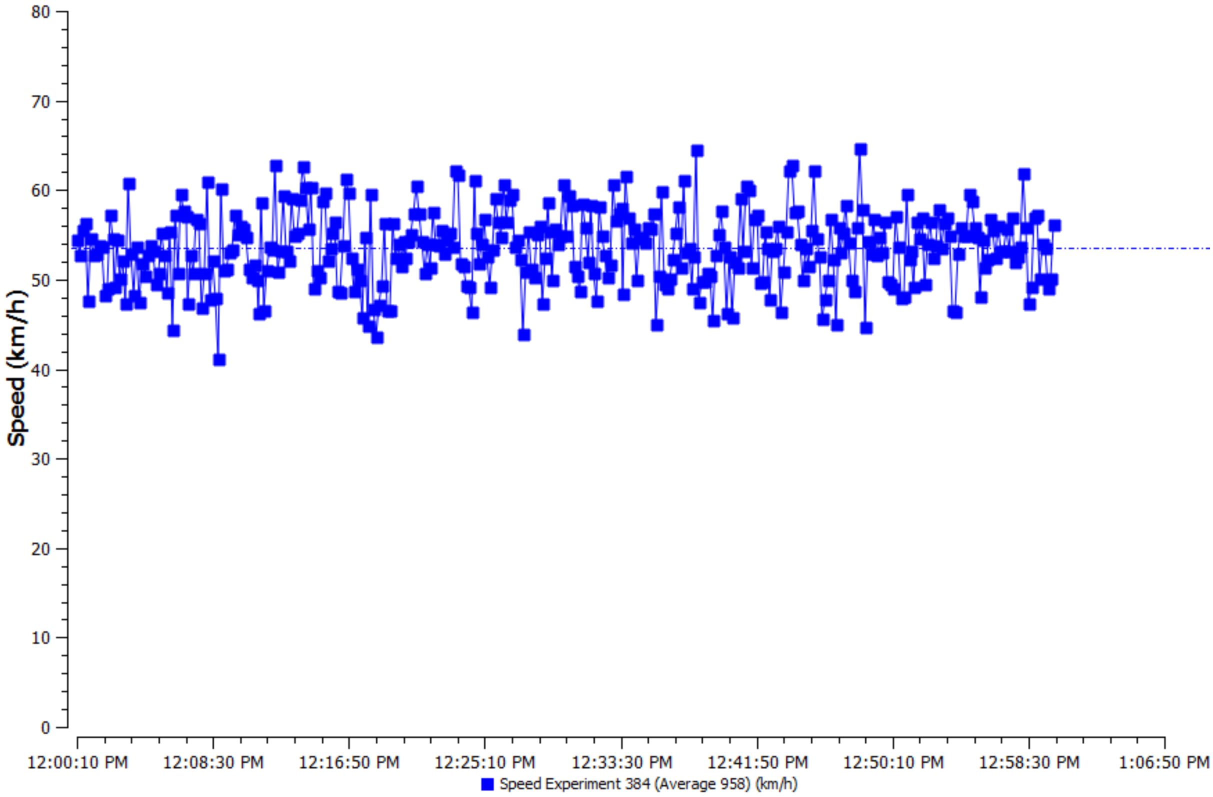


Figure 3.8 Change in Speed of Vehicles Travelling through Capricorn Highway / Selma Road intersection – No Train, Future Year 2024 Off-Peak Hour

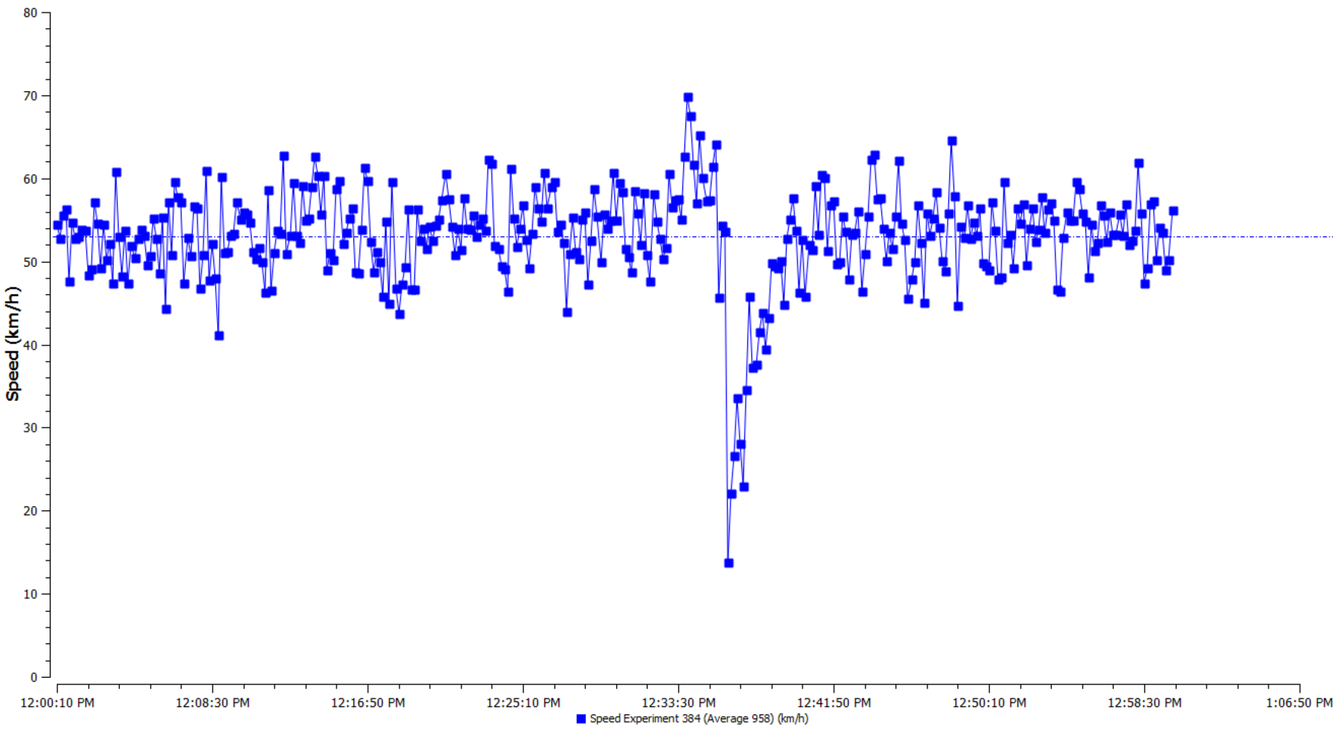


Figure 3.9 Change in Speed of Vehicles Travelling through Capricorn Highway / Selma Road intersection – With 40km/h Train, Future Year 2024 Off-Peak Hour

4. Recommendations

It is recommended that all rail traffic operate outside of the morning and evening peak hours of the existing road network. The operation of rail traffic during off-peak periods only (between 9am to 2.30pm, and between 6pm to 6am) is anticipated to result in minimal impact per train event. AIMSUN simulation modelling shows that at the worst location, the intersection recovers from a train event within 90 seconds of the train departure. This occurs at the Opal Street rail crossing. The worst-case off-peak queueing is also anticipated to occur at the Opal Street rail crossing, estimated at around 22 vehicle lengths or 132 metres. This is the worst anticipated impact across all of the three existing railway crossings examined. The off-peak results are also considered to be conservative, since the "highest" off-peak hour traffic volumes and slowest train speed were utilised in the AIMSUN simulation models.

5. Disclaimer

This report has been prepared on behalf of and for the exclusive use of IMC Mining and is subject to and issued in accordance with the agreement between Brown Consulting (QLD) Pty Ltd.

Our investigation and analysis has been specifically catered for the particular requirements of IMC Mining may not be applicable beyond this scope. For this reason, any other third parties are not authorised to utilise this report without further input and advice from Brown Consulting (QLD) Pty Ltd.

Brown Consulting (QLD) Pty Ltd accepts no liability or responsibility whatsoever for the report in respect of any use of or reliance upon this report by any third party.

The investigation and analysis has relied on information provided by others. We accept no responsibility for accuracy of material supplied by others. The accuracy of the investigation, analysis and report is dependent upon the accuracy of this information.

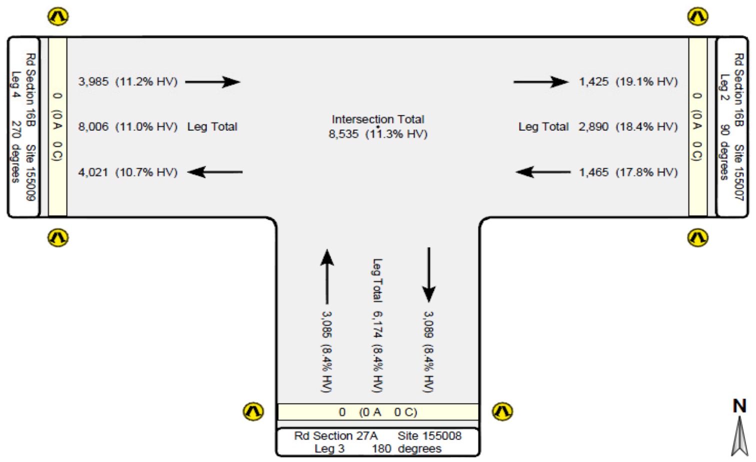
Appendix A Traffic Survey Information

Gregory Highway & Capricorn Highway   1 years growth
Wednesday 18-Sep-2013   2.50% growth pa

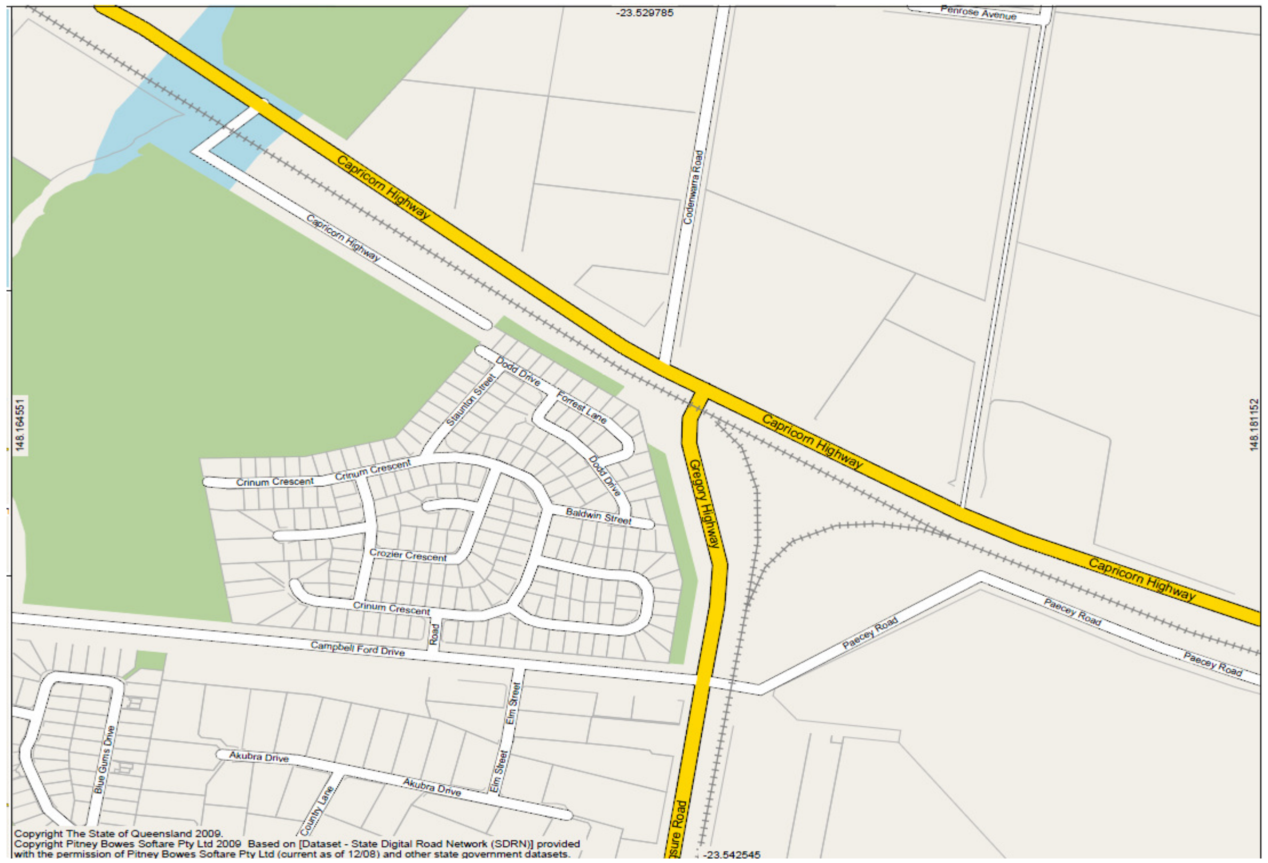
Time	Leg 2 Left	Leg 2 Through		Leg 3 Left	Leg 3 Right		Leg 4 Through	Leg 4 Right		Total
06:00-06:15	8	11		22	10		31	20		
06:15-06:30	2	9		22	11		27	15		
06:30-06:45	4	8		40	13		26	25		
06:45-07:00	5	22		29	1		28	37		
07:00-07:15	5	9		24	11		21	21		
07:15-07:30	6	11		37	14		18	36		
07:30-07:45	2	29		49	9		25	36		
07:45-08:00	7	22	93	66	6	221	24	44	231	545
08:00-08:15	7	38	125	92	4	284	30	29	248	657
08:15-08:30	4	28	140	122	5	362	28	69	292	794
08:30-08:45	10	29	149	122	10	438	23	51	305	892
08:45-09:00	3	18	140	103	9	479	28	64	330	**949**
09:00-09:15	7	23	125	42	3	426	17	36	324	875
09:15-09:30	1	23	117	39	2	338	23	45	294	749
09:30-09:45	3	23	104	48	6	258	20	50	290	652
09:45-10:00	2	36	121	50	5	200	14	60	272	592
10:00-10:15	2	29	122	44	4	203	22	46	287	612
10:15-10:30	1	28	127	55	4	221	20	56	295	644
10:30-10:45	3	15	119	53	5	226	21	41	287	631
10:45-11:00	4	27	112	44	5	219	30	56	299	630
11:00-11:15	5	26	112	62	4	238	20	53	304	654
11:15-11:30	2	31	116	47	5	231	31	61	321	667
11:30-11:45	3	33	134	50	9	232	28	55	342	708
11:45-12:00	6	27	136	50	2	235	19	68	343	714
12:00-12:15	2	23	130	53	2	223	14	67	352	705
12:15-12:30	3	28	128	36	2	209	27	59	345	683
12:30-12:45	7	27	126	54	2	206	17	48	327	659
12:45-13:00	4	19	116	49	2	205	30	76	346	667
13:00-13:15	5	21	117	62	8	220	24	67	357	694
13:15-13:30	8	14	108	50	4	237	33	58	362	706
13:30-13:45	5	20	98	57	4	242	30	74	402	742
13:45-14:00	5	19	99	95	3	290	20	67	382	**772**
14:00-14:15	1	28	103	48	5	273	24	55	370	745
14:15-14:30	10	30	121	59	4	282	31	61	371	774
14:30-14:45	8	26	130	64	2	287	30	63	360	777
14:45-15:00	2	27	135	74	5	268	21	66	360	763
15:00-15:15	5	28	139	96	5	317	28	73	382	838
15:15-15:30	7	29	135	82	7	343	32	78	401	879
15:30-15:45	7	27	135	80	4	362	31	94	434	**931**
15:45-16:00	9	33	149	55	3	340	20	61	427	916
16:00-16:15	14	36	166	87	6	332	22	81	429	928
16:15-16:30	9	23	162	67	6	316	20	69	408	886
16:30-16:45	7	36	171	64	4	299	23	86	392	862
16:45-17:00	10	26	165	61	2	304	33	79	423	893
17:00-17:15	6	30	151	60	6	277	18	111	450	877
17:15-17:30	12	34	165	46	6	255	23	80	464	885
17:30-17:45	9	23	154	58	1	246	26	74	455	855
17:45-18:00	17	29	164	61	5	249	19	94	456	869

Traffic Analysis and Reporting System
Intersection Analysis Report
Region 204 - Fitzroy   Road Section 16B - Capricorn Highway (Duaringa - Emerald)
Intersection 36 - Capricorn Hwy 16B & Gregory Hwy 27A (L)
Wednesday 18-Sep-2013 06:00 - 18:00

Summary



Leg	Angle	Road Section	Site	TDist	Site Description
2	90	16B	155007	157.560	Cap Hwy to Duaringa @ Gregory Hwy 27A
3	180	27A	155008	65.711	Gregory Hwy to Springsure @ Cap Hwy
4	270	16B	155009	157.560	Cap Hwy to Emerald @ Gregory Hwy 27A



Gregory Highway & Capricorn Highway — 2 years growth
Tuesday 16-Oct-2012 — 2.50% growth pa

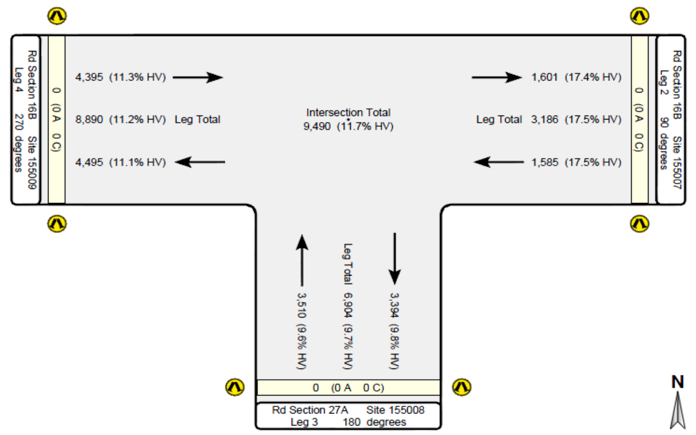
		Leg 2			Leg 3			Leg 4			Total
Time starting	Time ending	Left	Through		Left	Right		Through	Right		
6:00	6:15	0	9		46	5		24	25		
6:15	6:30	4	14		26	15		28	27		
6:30	6:45	9	20		56	7		19	30		
6:45	7:00	5	19		63	8		22	41		
7:00	7:15	9	13		55	11		22	47		
7:15	7:30	2	24		73	10		25	49		
7:30	7:45	1	26		67	11		39	31		
7:45	8:00	10	38	129	75	6	324	38	48	314	767
8:00	8:15	5	34	147	101	10	371	27	42	314	832
8:15	8:30	10	51	184	135	6	432	30	55	326	941
8:30	8:45	4	26	187	137	7	501	16	62	334	1022
8:45	9:00	3	26	167	107	8	537	27	60	335	**1039**
9:00	9:15	5	25	158	71	10	505	33	51	351	1014
9:15	9:30	4	21	120	59	2	421	34	69	370	911
9:30	9:45	6	22	118	57	11	341	19	35	345	804
9:45	10:00	5	35	129	53	5	282	22	58	337	748
10:00	10:15	5	34	139	78	4	283	20	60	333	754
10:15	10:30	6	29	149	57	3	282	19	52	299	730
10:30	10:45	6	30	158	50	4	267	19	56	321	746
10:45	11:00	3	25	145	50	5	264	22	57	320	729
11:00	11:15	2	11	118	65	6	252	27	36	303	672
11:15	11:30	4	21	107	68	6	267	24	68	325	699
11:30	11:45	5	25	101	63	4	281	25	59	334	715
11:45	12:00	3	33	109	44	3	272	25	57	337	719
12:00	12:15	2	24	123	46	4	250	24	67	367	740
12:15	12:30	7	12	117	50	4	229	26	70	371	717
12:30	12:45	6	34	127	59	5	226	27	57	371	724
12:45	13:00	4	28	123	59	4	243	21	65	375	741
13:00	13:15	1	16	113	62	1	256	39	53	376	746
13:15	13:30	6	17	118	51	4	257	39	69	389	**764**
13:30	13:45	7	23	107	42	6	241	27	63	395	743
13:45	14:00	10	22	107	50	6	233	14	49	371	711
14:00	14:15	7	18	116	49	3	222	19	54	351	688
14:15	14:30	5	25	123	62	8	237	31	60	333	693
14:30	14:45	10	26	129	72	3	266	21	84	349	744
14:45	15:00	8	21	126	117	5	335	24	70	381	843
15:00	15:15	4	34	140	67	10	361	29	91	431	932
15:15	15:30	7	21	138	78	7	377	38	72	451	966
15:30	15:45	8	26	136	66	4	372	30	80	456	963
15:45	16:00	5	29	141	76	7	331	31	85	479	951
16:00	16:15	8	22	132	61	6	320	31	90	480	933
16:15	16:30	11	46	163	80	2	317	27	82	479	959
16:30	16:45	15	46	191	60	4	311	31	102	503	1005
16:45	17:00	9	29	195	80	8	316	37	94	519	1031
17:00	17:15	10	37	213	77	9	336	44	132	577	1126
17:15	17:30	21	43	221	64	4	321	38	107	615	**1157**
17:30	17:45	11	30	200	66	3	327	28	111	621	1147
17:45	18:00	11	36	209	69	7	314	28	103	621	1144

Queensland Government
26-Aug-2014 09:41

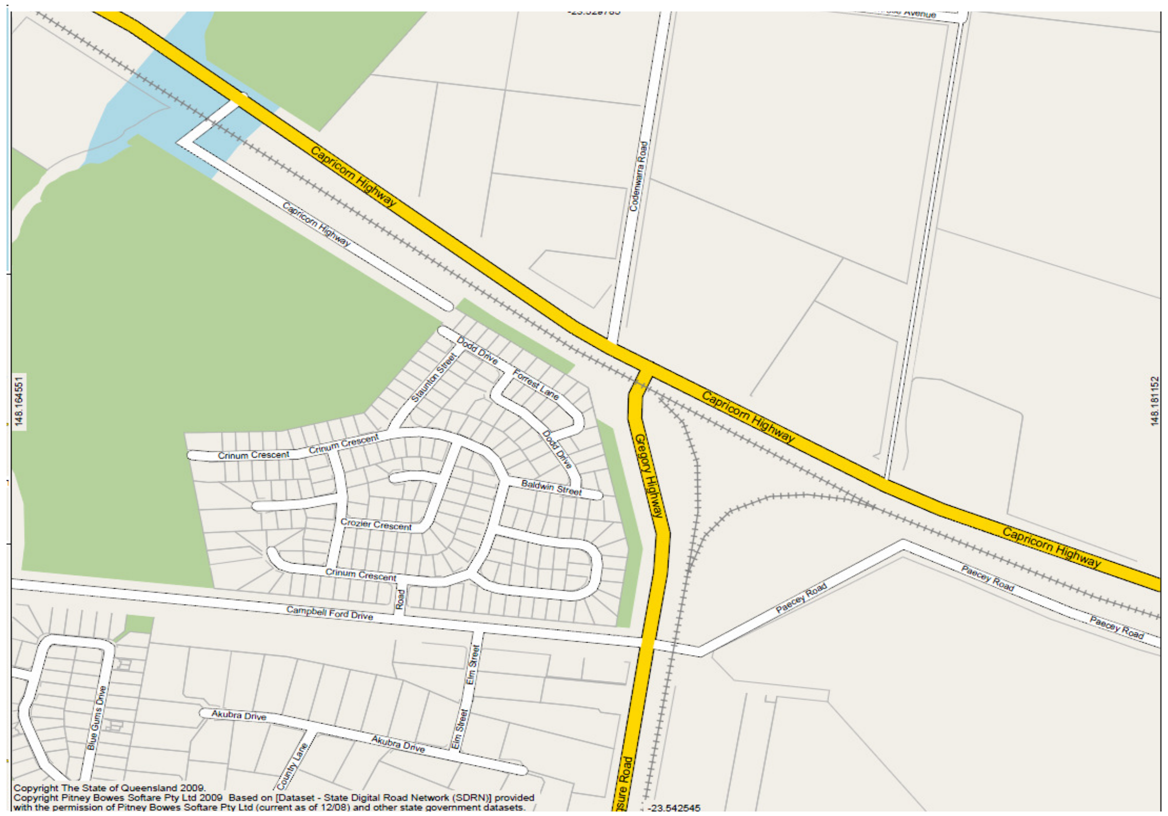
Traffic Analysis and Reporting System
Intersection Analysis Report
Region 204 - Fitzroy — Road Section 16B - Capricorn Highway (Duaringa - Emerald)
Intersection 36 - Capricorn Hwy 16B & Gregory Hwy 27A (L)
Tuesday 16-Oct-2012 06:00 - 18:00

TARS

Summary



Leg	Angle	Road Section	Site	TDist	Site Description
2	90	16B	155007	157.560	Cap Hwy to Duaringa @ Gregory Hwy 27A
3	180	27A	155008	65.711	Gregory Hwy to Springsure @ Cap Hwy
4	270	16B	155009	157.560	Cap Hwy to Emerald @ Gregory Hwy 27A



Gregory Highway & Capricorn Highway — 2 years growth

Wednesday 20-Jun-2012 — 2.50% growth pa

Time	Leg 2 Left	Leg 2 Through		Leg 3 Left	Leg 3 Right		Leg 4 Through	Leg 4 Right		Total
06:00-06:15										
06:15-06:30										
06:30-06:45										
06:45-07:00										
07:00-07:15	13	38		36	6		32	45		
07:15-07:30	6	22		42	9		40	42		
07:30-07:45	6	32		59	7		26	33		
07:45-08:00	6	48	180	83	18	273	27	37	296	749
08:00-08:15	8	41	178	72	25	331	34	55	309	817
08:15-08:30	10	37	198	132	7	423	31	58	316	937
08:30-08:45	4	41	205	127	4	492	18	65	341	1038
08:45-09:00	8	36	194	114	10	516	25	67	371	**1081**
09:00-09:15			143			414			277	834
09:15-09:30			94			268			184	545
09:30-09:45			46			130			97	273
09:45-10:00			0			0			0	0
10:00-10:15			0			0			0	0
10:15-10:30			0			0			0	0
10:30-10:45			0			0			0	0
10:45-11:00			0			0			0	0
11:00-11:15			0			0			0	0
11:15-11:30			0			0			0	0
11:30-11:45			0			0			0	0
11:45-12:00			0			0			0	0
12:00-12:15			0			0			0	0
12:15-12:30			0			0			0	0
12:30-12:45			0			0			0	0
12:45-13:00			0			0			0	0
13:00-13:15			0			0			0	0
13:15-13:30			0			0			0	0
13:30-13:45			0			0			0	0
13:45-14:00			0			0			0	0
14:00-14:15			0			0			0	0
14:15-14:30			0			0			0	0
14:30-14:45			0			0			0	0
14:45-15:00			0			0			0	0
15:00-15:15	6	40	48	72	10	86	29	72	106	241
15:15-15:30	7	38	96	58	5	152	41	89	243	491
15:30-15:45	10	31	139	58	5	219	33	72	353	710
15:45-16:00	10	25	175	60	11	293	39	69	466	935
16:00-16:15	12	33	174	77	14	303	47	76	490	967
16:15-16:30	12	49	191	66	8	314	28	80	466	972
16:30-16:45	14	42	207	19	6	274	40	84	486	968
16:45-17:00	17	50	241	68	8	279	33	103	516	1036
17:00-17:15	22	50	269	60	11	258	34	95	522	1050
17:15-17:30	14	34	255	73	5	263	32	117	565	1083
17:30-17:45	23	39	**262**	88	8	**337**	39	115	**597**	1196
17:45-18:00	25	41	261	61	3	325	21	121	603	1188

Queensland Government

26-Aug-2014 09:41

Traffic Analysis and Reporting System

Intersection Analysis Report

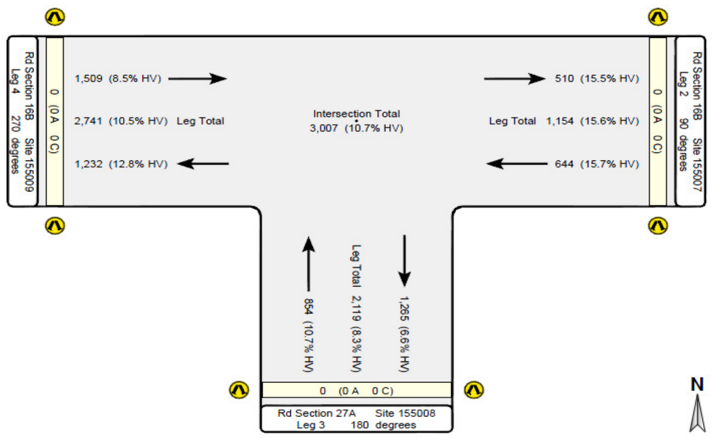
Region 204 - Fitzroy — Road Section 16B - Capricorn Highway (Duaringa - Emerald)

Intersection 36 - Capricorn Hwy 16B & Gregory Hwy 27A (L)

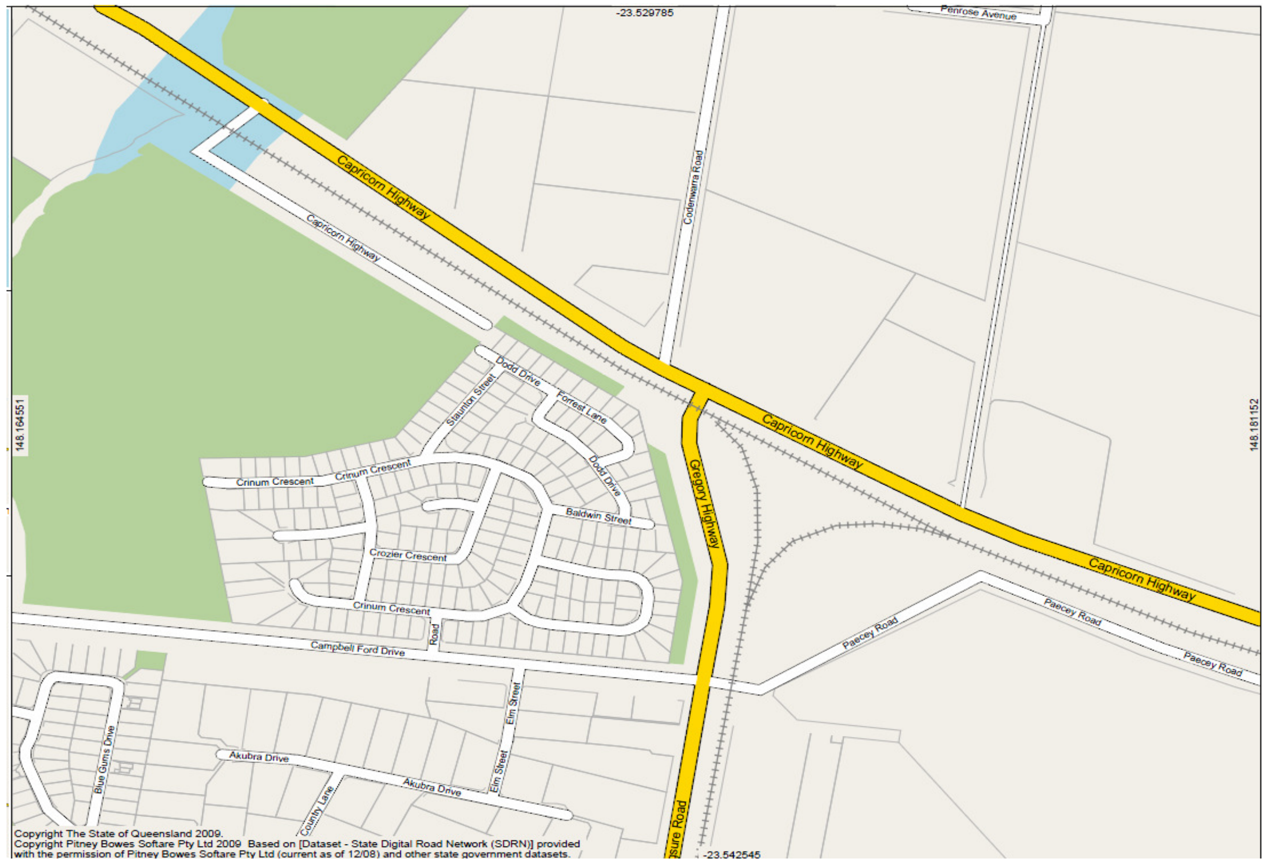
Wednesday 20-Jun-2012 15:00 - 18:00

TARS

Summary



Leg	Angle	Road Section	Site	TDist	Site Description
2	90	16B	155007	157.560	Cap Hwy to Duaringa @ Gregory Hwy 27A
3	180	27A	155008	65.711	Gregory Hwy to Springsure @ Cap Hwy
4	270	16B	155009	157.560	Cap Hwy to Emerald @ Gregory Hwy 27A



Capricorn Highway & Opal Street
Thursday 12-Sept-2013

1 years growth
2.50% growth pa

Start	Time End	Leg 1 Left		Leg 2 Left	Leg 2 Through	Leg 2 Right		Leg 3 Left	Leg 3 Right		Leg 4 Left	Leg 4 Through	Leg 4 Right		Total
6:00	6:15	8		0	16	3		77	6		8	35	35		
6:15	6:30	8		7	27	3		72	8		8	35	30		
6:30	6:45	12		5	33	1		74	2		9	33	27		
6:45	7:00	7		9	50	3		96	7		9	53	58		
7:00	7:15	12		10	28	2		68	2		14	61	45		
7:15	7:30	15		4	48	3		89	2		14	45	35		
7:30	7:45	12		3	54	3		92	7		22	32	36		
7:45	8:00	19	59	28	63	7	259	136	4	410	25	51	74	465	1194
8:00	8:15	11	58	14	86	11	332	164	5	511	25	59	93	524	1426
8:15	8:30	20	64	28	69	7	382	211	7	642	24	73	86	615	1703
8:30	8:45	22	74	26	89	6	445	205	5	755	39	61	91	719	1993
8:45	9:00	17	72	18	86	6	457	131	8	754	36	94	112	813	2096
9:00	9:15	18	79	17	57	10	429	121	7	712	16	57	68	776	1997
9:15	9:30	22	81	13	64	4	406	77	5	573	18	74	43	727	1787
9:30	9:45	18	77	21	55	5	365	70	6	436	26	77	54	692	**1569**
9:45	10:00	9	69	21	71	5	352	79	7	381	27	79	68	622	1424
10:00	10:15	12	63	26	61	4	359	89	5	346	24	73	83	662	1430
10:15	10:30	17	57	20	49	10	357	73	7	344	23	82	88	722	1480
10:30	10:45	7	46	17	63	11	367	97	16	382	23	87	85	761	1556
10:45	11:00	8	45	30	83	2	385	101	7	405	31	76	88	782	1617
11:00	**11:15**	**11**	**44**	**23**	**76**	**4**	**398**	**75**	**10**	**396**	**28**	**75**	**81**	**786**	**1624**
11:15	11:30	14	41	24	63	5	411	56	6	377	25	62	74	753	1583
11:30	11:45	14	48	24	73	7	424	75	6	344	17	70	67	711	1528
11:45	12:00	18	58	35	58	7	409	87	10	333	27	64	79	686	1486
12:00	12:15	14	62	27	83	3	419	82	9	339	32	82	101	718	1538
12:15	12:30	20	68	20	76	8	432	87	5	370	18	74	73	722	1591
12:30	12:45	15	69	20	71	2	420	79	5	373	28	53	79	728	1590
12:45	13:00	12	63	27	87	12	447	91	5	372	18	71	70	716	1598
13:00	13:15	15	64	25	65	5	428	92	8	381	29	82	98	710	1584
13:15	13:30	11	54	27	64	13	428	79	6	374	25	80	66	716	1573
13:30	13:45	17	56	36	85	4	461	70	4	364	17	66	77	716	1598
13:45	14:00	11	55	23	70	6	434	109	12	390	37	63	79	737	1615
14:00	14:15	15	55	26	77	6	448	95	8	393	26	72	61	686	1582
14:15	14:30	13	57	23	66	6	439	106	3	417	28	58	54	654	1567
14:30	14:45	12	52	25	59	2	399	106	1	451	20	78	76	668	1570
14:45	15:00	22	64	39	78	4	421	115	0	445	21	57	117	685	1614
15:00	15:15	25	74	38	88	9	448	186	7	537	41	81	182	833	1892
15:15	15:30	11	72	35	65	4	457	129	10	568	38	73	134	941	2038
15:30	15:45	18	78	35	66	5	478	100	7	568	23	96	100	987	2110
15:45	16:00	18	74	45	67	6	475	116	5	574	21	78	101	992	2115
16:00	16:15	18	67	37	63	3	442	72	9	459	14	70	110	879	1847
16:15	16:30	16	72	44	62	6	450	116	4	440	18	65	111	827	1789
16:30	16:45	10	64	32	64	5	445	95	3	431	17	74	115	814	1753
16:45	17:00	23	69	57	70	2	456	133	6	449	15	88	138	856	**1830**
17:00	17:15	24	75	68	58	13	493	91	2	461	17	90	142	912	1941
17:15	17:30	19	78	51	55	5	492	102	4	447	17	69	139	944	1961
17:30	17:45	15	83	39	73	6	509	97	2	448	13	77	114	942	1982
17:45	18:00	13	73	20	62	9	470	103	3	414	22	54	110	886	1843

Queensland Government
26-Aug-2014 09:02

Traffic Analysis and Reporting System
Intersection Analysis Report
Region 204 - Fitzroy Road Section 16B - Capricorn Highway (Duaringa - Emerald)
Intersection 86 - Capricorn Hwy & Opal St (L&RHS)
Thursday 12-Sep-2013 06:00 - 18:00

TARS
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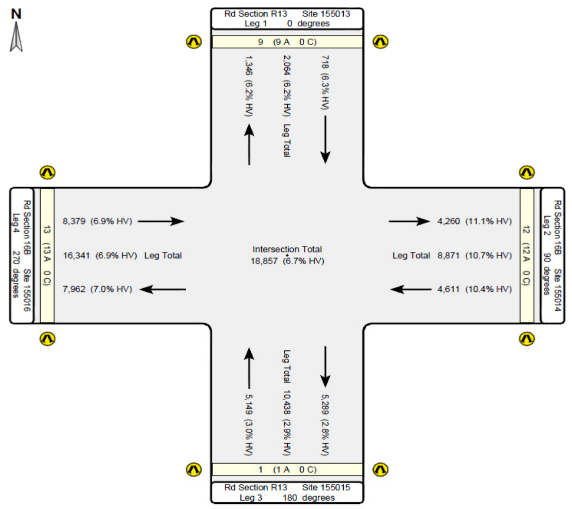
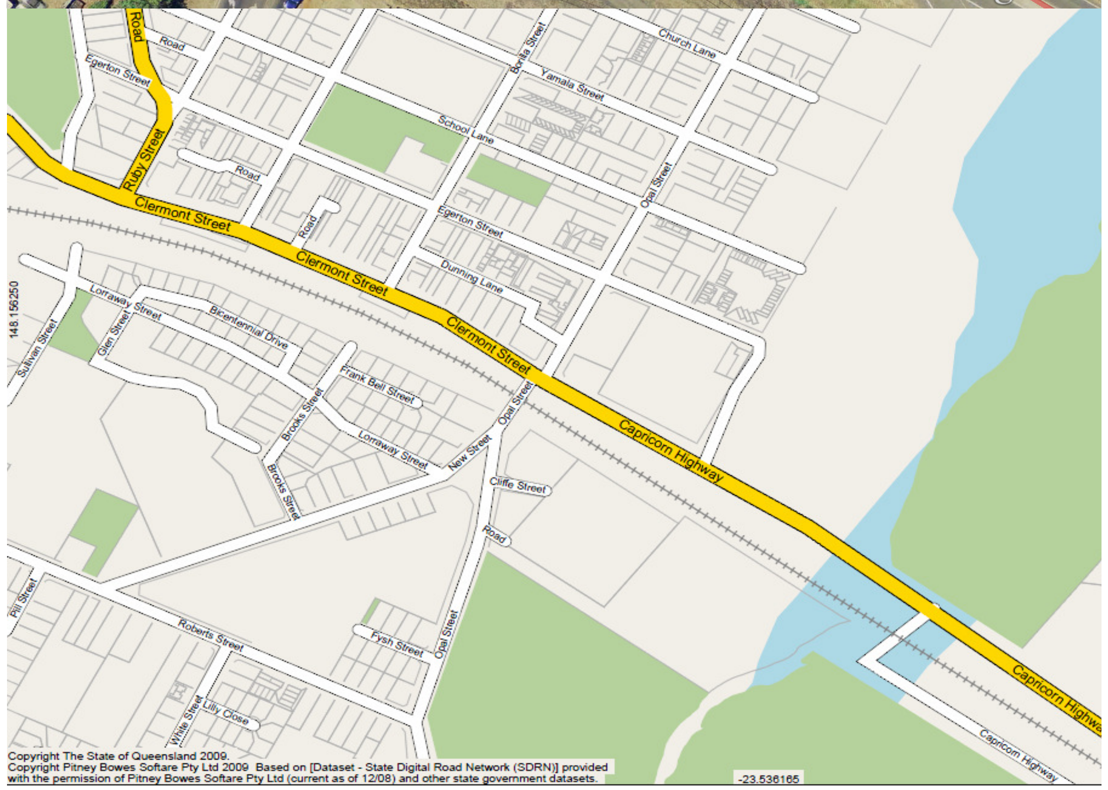
Summary



Leg	Angle	Road Section	Site	TDist	Site Description
1	0	R13	155013	0.000	Opal St @ Capricorn Hwy
2	90	16B	155014	158.950	Capricorn Hwy to Duaringa @ Opal St
3	180	R13	155015	0.000	Opal St @ Capricorn Hwy
4	270	16B	155016	158.950	Capricorn Hwy to Emerald @ Opal St

Capricorn Highway & Opal Street 2 years growth
Wednesday 20-Jun-2012 2.50% growth pa

	Leg 1		Leg 2				Leg 3				Leg 4			Total
Time	Left		Left	Through	Right		Left	Right		Left	Through	Right		
06:00-06:15														
06:15-06:30														
06:30-06:45														
06:45-07:00	74	269	91	368	38	1812	624	19	2338	126	296	296	2498	
07:00-07:15	12		55	4	0		73	4		15	48	42		
07:15-07:30	12		9	39	6		74	2		14	43	43		
07:30-07:45	6		7	65	6		82	2		22	29	43		
07:45-08:00	20	53	15	85	5	311	121	6	382	22	52	48	442	1188
08:00-08:15	15	56	16	59	13	341	121	2	431	28	56	49	472	1300
08:15-08:30	14	58	30	83	7	411	172	6	538	32	70	74	552	1558
08:30-08:45	17	69	21	112	7	476	152	4	614	22	76	76	636	1794
08:45-09:00	24	**74**	20	96	9	**497**	149	6	**643**	38	80	83	**719**	**1932**
09:00-09:15		58				404			514				579	1555
09:15-09:30		43				278			327				394	1042
09:30-09:45		25				131			163				211	531
09:45-10:00		0				0			0				0	0
10:00-10:15		0				0			0				0	0
10:15-10:30		0				0			0				0	0
10:30-10:45		0				0			0				0	0
10:45-11:00		0				0			0				0	0
11:00-11:15		0				0			0				0	0
11:15-11:30		0				0			0				0	0
11:30-11:45		0				0			0				0	0
11:45-12:00		0				0			0				0	0
12:00-12:15		0				0			0				0	0
12:15-12:30		0				0			0				0	0
12:30-12:45		0				0			0				0	0
12:45-13:00		0				0			0				0	0
13:00-13:15		0				0			0				0	0
13:15-13:30		0				0			0				0	0
13:30-13:45		0				0			0				0	0
13:45-14:00		0				0			0				0	0
14:00-14:15		0				0			0				0	0
14:15-14:30		0				0			0				0	0
14:30-14:45		0				0			0				0	0
14:45-15:00		0				0			0				0	0
15:00-15:15	23	24	52	96	4	160	99	2	106	22	81	152	268	558
15:15-15:30	23	48	35	75	15	291	131	6	250	35	95	143	555	1144
15:30-15:45	22	71	33	71	3	403	86	9	350	28	69	110	772	1597
15:45-16:00	17	89	53	74	3	540	102	5	462	40	78	92	993	2084
16:00-16:15	15	81	38	77	7	509	86	9	456	34	91	85	946	1991
16:15-16:30	16	74	36	73	6	498	106	7	431	25	64	101	858	1861
16:30-16:45	14	65	45	57	4	497	101	8	445	20	87	97	855	1863
16:45-17:00	18	66	48	65	11	491	125	8	473	30	78	103	856	1886
17:00-17:15	28	80	54	81	8	513	105	2	485	42	95	151	938	2016
17:15-17:30	22	86	58	61	5	522	113	6	492	31	95	143	1021	2121
17:30-17:45	23	96	65	73	7	563	113	3	499	24	105	127	1076	2234
17:45-18:00	18	96	57	70	2	568	111	4	480	18	86	143	1114	**2258**



Capricorn Highway & Selma Road — 1 years growth

Thursday 18-Jul-2013 — 2.50% growth pa

Time	Leg 2 Left	Leg 2 Through		Leg 3 Left	Leg 3 Right		Leg 4 Through	Leg 4 Right		Total
06:00-06:15	7	21		3	21		0	2		
06:15-06:30	10	12		4	16		7	0		
06:30-06:45	16	10		4	15		14	3		
06:45-07:00	14	16		18	40		11	8		
07:00-07:15	14	11		11	23		16	5		
07:15-07:30	18	10		4	40		16	0		
07:30-07:45	29	32		16	29		21	3		
07:45-08:00	30	43	191.7	27	45	200	28	9	100	492
08:00-08:15	29	20	216.3	12	47	226	27	12	119	561
08:15-08:30	46	22	257.3	11	78	272	36	9	149	678
08:30-08:45	30	13	238.8	17	91	336	31	9	165	**740**
08:45-09:00	31	29	225.5	9	59	332	27	6	161	719
09:00-09:15	20	21	217.3	12	44	329	36	9	167	713
09:15-09:30	23	25	196.8	6	35	280	39	6	167	644
09:30-09:45	29	30	213.2	6	41	217	46	3	176	607
09:45-10:00	30	24	207.1	7	37	193	39	10	193	592
10:00-10:15	25	29	220.4	5	36	177	34	1	182	580
10:15-10:30	34	33	239.9	10	33	179	38	7	182	602
10:30-10:45	35	24	239.9	3	44	179	35	5	173	592
10:45-11:00	24	26	235.8	2	28	165	30	4	158	559
11:00-11:15	31	29	241.9	6	32	162	19	6	148	551
11:15-11:30	28	24	226.5	3	31	153	24	5	131	510
11:30-11:45	27	26	220.4	3	31	139	28	4	123	483
11:45-12:00	41	28	239.9	10	27	147	25	4	118	504
12:00-12:15	42	31	253.2	9	31	149	51	22	167	569
12:15-12:30	30	30	261.4	8	34	157	26	10	174	592
12:30-12:45	33	32	273.7	11	47	181	23	10	175	**630**
12:45-13:00	32	21	257.3	11	33	189	31	6	183	629
13:00-13:15	37	36	257.3	6	33	188	20	12	141	586
13:15-13:30	32	40	269.6	9	31	186	24	9	138	593
13:30-13:45	36	22	262.4	9	40	176	24	7	136	575
13:45-14:00	23	34	266.5	13	42	188	22	10	131	585
14:00-14:15	33	24	250.1	7	45	201	21	10	130	581
14:15-14:30	29	33	239.9	5	35	201	31	5	133	574
14:30-14:45	42	40	264.5	10	46	208	23	7	132	605
14:45-15:00	59	32	299.3	7	29	189	22	12	134	622
15:00-15:15	47	24	313.7	6	48	191	35	9	148	652
15:15-15:30	30	35	316.7	14	41	206	31	8	151	**673**
15:30-15:45	33	23	290.1	7	29	186	22	10	153	628
15:45-16:00	40	16	254.2	7	36	193	24	13	156	603
16:00-16:15	34	13	229.6	9	32	179	27	20	159	568
16:15-16:30	37	26	227.6	2	39	165	18	15	153	545
16:30-16:45	58	21	251.1	7	37	173	41	13	175	600
16:45-17:00	36	23	254.2	4	40	174	24	29	192	620
17:00-17:15	75	14	297.3	9	36	178	28	17	190	665
17:15-17:30	58	15	307.5	7	23	167	14	7	177	652
17:30-17:45	32	17	276.8	2	32	157	23	12	158	591
17:45-18:00	36	27	280.9	3	40	156	16	5	125	562

Queensland Government

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Traffic Analysis and Reporting System

Intersection Analysis Report

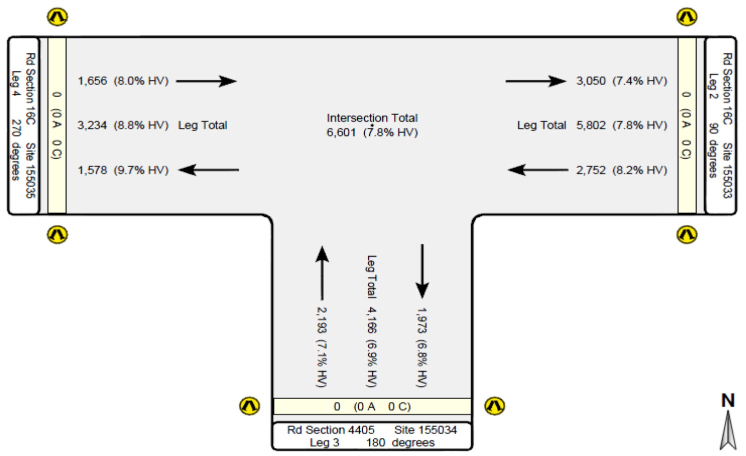
Region 204 - Fitzroy — Road Section 16C - Capricorn Highway (Emerald - Alpha)

Intersection 65 - Capricorn Hwy & Selma Rd (LHS)

Thursday 18-Jul-2013 06:00 - 18:00

TARS

Summary



Leg	Angle	Road Section	Site	TDist	Site Description
2	90	16C	155033	1.080	Capricorn Hwy to Emerald @ Selma Rd
3	180	4405	155034	0.000	Selma Rd to Fairbairn Dam @ Cap Hwy
4	270	16C	155035	1.080	Capricorn Hwy to Alpha @ Selma Rd

Queensland Government

26-Aug-2014 09:18

Traffic Analysis and Reporting System

Intersection Analysis Report

Region 204 - Fitzroy — Road Section 16C - Capricorn Highway (Emerald - Alpha)

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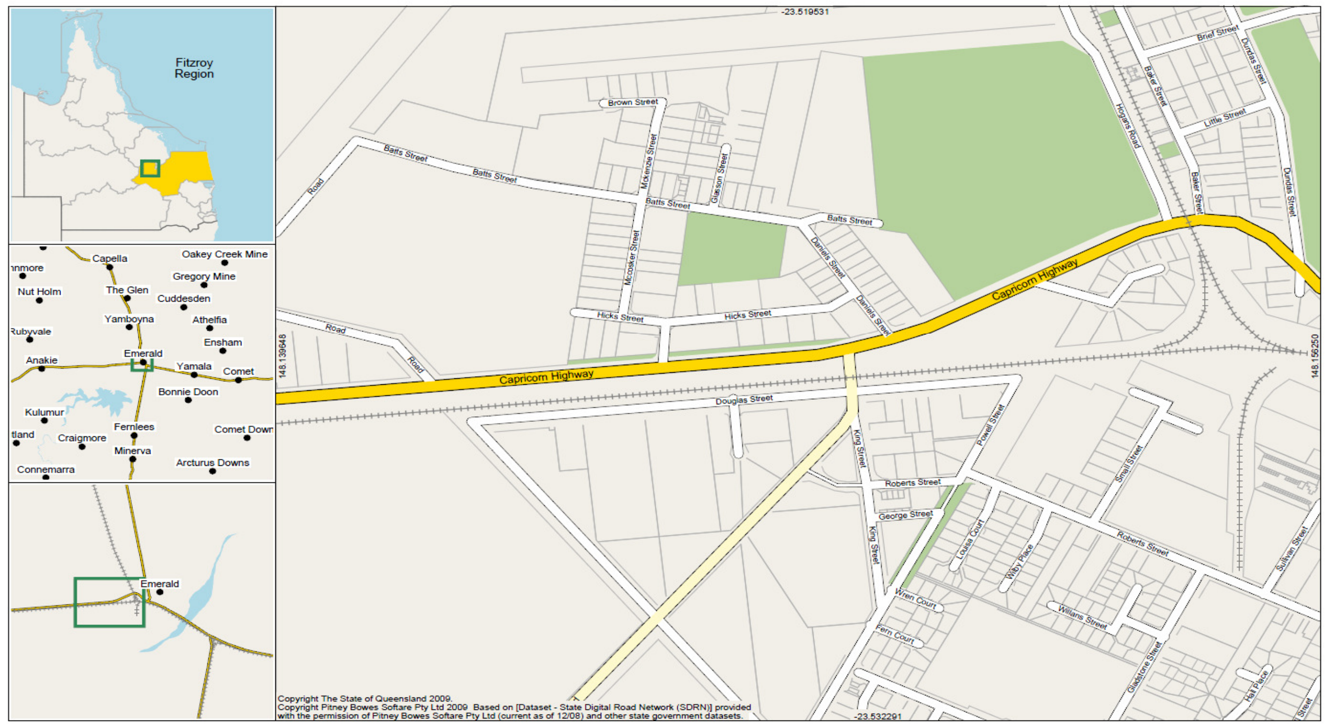
TARS



Capricorn Highway & Selma Road | 2 years growth
Thursday 20-Sept-2012 | 2.50% growth pa

Time		Leg 2			Leg 3			Leg 4			Total
Starting	Ending	Left	Through		Left	Right		Through	Right		
6:00	6:15	8	8		7	24		18	1		
6:15	6:30	17	13		4	18		12	4		
6:30	6:45	16	14		11	22		14	2		
6:45	7:00	20	21		12	42		19	6		
7:00	7:15	20	17		16	29		12	4		
7:15	7:30	15	29		22	30		24	9		
7:30	7:45	15	31		9	29		34	7		
7:45	8:00	30	44	211	32	55	233	33	7	137	581
8:00	8:15	31	25	231	30	40	260	40	10	172	663
8:15	8:30	38	31	257	28	81	319	35	16	191	768
8:30	8:45	47	30	290	9	87	380	28	3	181	**851**
8:45	9:00	39	29	284	18	47	357	30	14	185	826
9:00	9:15	31	16	274	10	47	344	27	8	169	787
9:15	9:30	31	29	265	9	42	283	41	17	177	724
9:30	9:45	19	14	219	9	37	230	43	4	193	642
9:45	10:00	27	25	202	7	35	206	46	9	205	613
10:00	10:15	21	31	207	11	42	202	41	5	216	625
10:15	10:30	39	36	223	6	37	193	40	2	200	616
10:30	10:45	30	39	261	8	25	180	25	8	185	625
10:45	11:00	44	35	289	4	22	163	30	3	162	614
11:00	11:15	30	30	297	10	29	148	35	2	152	598
11:15	11:30	27	25	273	4	19	127	26	7	143	543
11:30	11:45	20	37	261	8	29	131	29	7	146	538
11:45	12:00	38	42	262	3	16	124	32	19	165	551
12:00	12:15	33	29	264	9	36	130	52	29	211	605
12:15	12:30	30	34	276	5	33	146	29	14	222	644
12:30	12:45	34	31	285	15	24	148	30	8	224	657
12:45	13:00	31	36	271	21	36	188	35	8	215	**675**
13:00	13:15	33	31	273	7	35	185	30	13	175	634
13:15	13:30	36	33	278	6	23	175	33	11	177	630
13:30	13:45	19	30	262	11	26	173	29	14	182	617
13:45	14:00	26	22	242	11	37	164	34	8	181	586
14:00	14:15	30	32	240	12	41	175	24	8	169	584
14:15	14:30	29	25	224	6	33	186	24	10	159	568
14:30	14:45	40	39	255	13	41	204	21	9	145	604
14:45	15:00	45	28	282	6	32	193	32	19	154	629
15:00	15:15	38	37	295	11	64	216	37	24	185	697
15:15	15:30	43	37	323	15	39	232	31	8	190	**745**
15:30	15:45	30	37	310	9	38	225	35	6	202	736
15:45	16:00	23	23	282	5	32	224	31	8	189	694
16:00	16:15	37	33	276	15	32	194	31	7	165	636
16:15	16:30	33	35	264	8	46	194	28	13	167	625
16:30	16:45	50	16	263	7	44	199	55	24	207	668
16:45	17:00	39	28	285	11	40	213	33	18	220	718
17:00	17:15	48	24	287	8	32	206	32	18	232	725
17:15	17:30	61	27	308	8	34	193	33	7	231	732
17:30	17:45	56	14	312	2	30	173	20	15	185	670
17:45	18:00	42	23	310	3	34	159	14	3	149	618

Queensland Government
26-Aug-2014 09:18

Traffic Analysis and Reporting System
Intersection Analysis Report
Region 204 - Fitzroy   Road Section 16C - Capricorn Highway (Emerald - Alpha)
Intersection 65 - Capricorn Hwy & Selma Rd (LHS)
Thursday 18-Jul-2013 06:00 - 18:00

TARS
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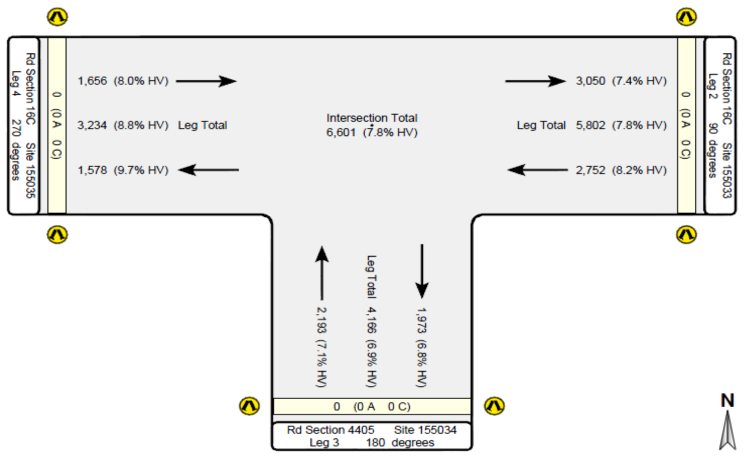
Summary

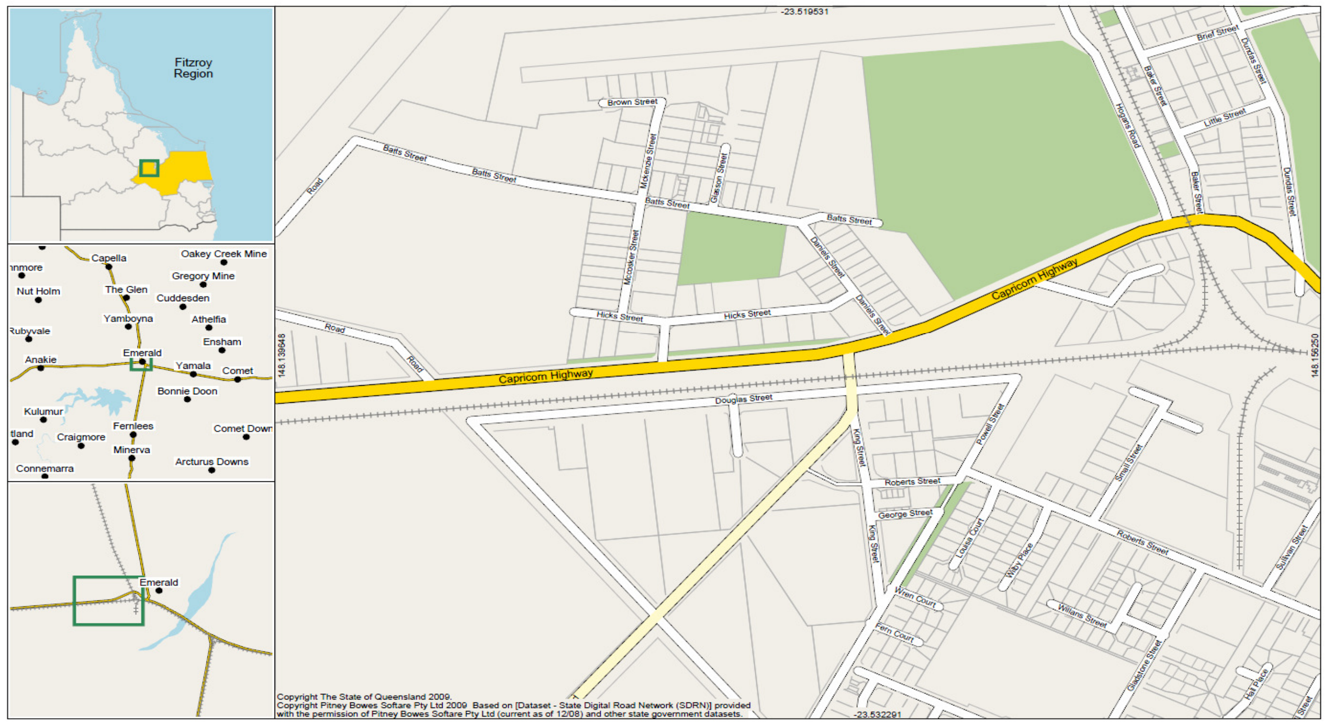


Leg	Angle	Road Section	Site	TDist	Site Description
2	90	16C	155033	1.080	Capricorn Hwy to Emerald @ Selma Rd
3	180	4405	155034	0.000	Selma Rd to Fairbairn Dam @ Cap Hwy
4	270	16C	155035	1.080	Capricorn Hwy to Alpha @ Selma Rd

Queensland Government
26-Aug-2014 09:18

Traffic Analysis and Reporting System
Intersection Analysis Report
Region 204 - Fitzroy   Road Section 16C - Capricorn Highway (Emerald - Alpha)
Intersection 65 - Capricorn Hwy & Selma Rd (LHS)
Thursday 18-Jul-2013 06:00 - 18:00

TARS
Page 1 of 20 (1 of 21)



One Hour Peak Periods
Base year 2014 volumes shown
Yellow highlighted counts represent "peak of the peak" hours used for modelling purposes

	AM PEAK	COUNT	PM PEAK	COUNT	OFF PEAK	COUNT
Gregory Highway & Capricorn Highway						
Wednesday 18-Sep-2013	8:00 - 9:00	949	2:45- 3:45	931	13:45-14:00	772
Tuesday 16-Oct-2012	8:00 - 9:00	1039	4:30 - 5:30	1157	12:30-13:30	764
Wednesday 20-Jun-2012	8:00 - 9:00	1081	4:45 - 5:45	1196	Data not available	
Capricorn Highway & Opal Street						
Thursday 12-Sept-2013	8:00 - 9:00	2096	3:00 - 4:00	2115	10:15-11:15	1624
Wednesday 20-Jun-2012	8:00 - 9:00	1932	5:00 - 6:00	2258	Data not available	
Capricorn Highway & Selma Road						
Thursday 18-Jul-2013	7:45 - 8:45	740	4:15 - 5:15	673	12:30-12:45	630
Thursday 20-Sept-2012	7:45 - 8:45	851	3:30 - 4:30	745	12:00-13:00	675

ATTACHMENT C

Groundwater Quality Test Results – September 2014

LABORATORY WATER QUALITY RESULTS – SEPTEMBER 2014																							
Analytes	**Units**	**LOR**	**ANZECC 2000**		**ADWG (2011)**		**MB01_B**	**MB02_C**	**MB02_S**	**MB03_S**	**MB04_C**	**MB04_S**	**MB05_C**	**MB08_B**	**MB09_T**	**MB10_T**	**TAR016_CR**	**TAR040_C**	**TAR053**	**TAR176_C**	**TAR177_C**	**TAR189_C**	**TAR249_C**
Aquifer	-	-	**Irrigation Water**	**Livestock Drinking**	**Aesthetic**	**Health**	Tertiary Clay, Silt	Aldebaran Sandstone - B seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Fine Sandstone	Aldebaran Sandstone - B seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - A seam	Tertiary Clay, Gravel	Quaternary Alluvium	Quaternary Alluvium	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Fine Sandstone	Tertiary Basalt	Aldebaran Sandstone	Aldebaran Sandstone - Coarse Sandstone
Date Sampled	-	-					15/9/2014	15/9/2014	15/9/2014	08/9/2014	10/9/2014	10/9/2014	08/9/2014	08/9/2014	10/9/2014	10/9/2014	08/9/2014	08/9/2014	10/9/2014	10/9/2014	10/9/2014	08/9/2014	15/9/2014
Field - Physical Parameters																							
pH Value	pH Unit	-	-	-	6.5 - 8.5	-	7.90	7.62	7.72	10.49	7.35	9.58	8.44	8.00	6.46	6.74	6.92	7.02	7.46	8.28	7.59	7.79	8.74
Electrical Conductivity @ 25°C	µS/cm	-	-	-	-	-	2596	1787	1460	2910	2607	2353	1633	1528	1140	1785	1313	1049	953	886	1355	2580	532
Total Dissolved Solids	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Temperature	°C	-	-	-	-	-	24.1	26.5	25.5	22.5	29.7	29.7	21.6	25.4	27.8	19.3	25.7	24.7	25.1	28.3	27.8	22.3	26.9
Laboratory - Physical Parameters																							
pH Value	pH Unit	0.01	-	-	6.5 - 8.5	-	8.27	8.51	8.31	10.4	7.64	9.62	8.46	8.26	6.89	7.13	7.42	7.71	7.85	8.22	7.79	8.09	7.60
Electrical Conductivity @ 25°C	µS/cm	1	-	-	-	-	2520	1810	1390	2950	2610	2400	1660	1490	1180	1670	1220	1020	896	923	1200	2590	556
Sodium Adsorption Ratio	-	0.01	-	-	-	-	3.70	6.10	2.63	64.7	5.62	28.4	4.93	3.06	4.01	2.85	2.23	1.35	1.62	4.09	1.28	6.36	4.30
Total Dissolved Solids (Calc.)	mg/L	10	-	3,000-13,000*	600	-	1640	1180	904	1920	1700	1560	1080	968	767	1080	793	663	582	600	780	1680	361
Total Suspended Solids	mg/L	5	-	-	-	-	60	18	13	82	16	34	6	23	7	317	17	58	12	7	17	12	17
Total Hardness as $CaCO_3$	mg/L	1	-	-	200	-	890	338	493	12	599	43	302	456	258	635	487	387	365	157	596	550	66
Alkalinity																							
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	-	-	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity as $CaCO_3$	mg/L	1	-	-	-	-	<1	32	7	186	<1	142	48	31	47	<1	<1	35	21	12	<1	68	<1
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	-	-	-	-	570	368	464	57	359	205	292	475	232	622	507	428	415	161	619	506	21
Total Alkalinity as $CaCO_3$	mg/L	1	-	-	-	-	570	400	471	243	359	347	341	506	279	622	507	463	435	174	619	574	21
Major Ions																							
Calcium	mg/L	1	-	1,000	-	-	73	53	72	3	85	4	17	49	44	106	78	51	54	35	59	39	18
Chloride	mg/L	1	-	-	250	-	490	293	176	631	624	505	310	186	214	175	109	72	40	185	43	570	140
Fluoride	mg/L	0.1	2.0	2	-	1.5	0.2	0.9	0.5	0.4	0.5	0.8	0.3	0.5	0.1	0.3	0.5	0.2	0.4	0.2	0.1	0.3	0.3
Magnesium	mg/L	1	-	-	-	-	172	50	76	1	94	8	63	81	36	90	71	63	56	17	109	110	5
Sodium	mg/L	1	-	-	180	-	254	258	134	507	316	427	197	150	148	165	113	61	71	118	72	343	80
Potassium	mg/L	1		-	-	-	9	8	7	173	22	92	46	6	2	4	3	7	7	21	4	11	7

LABORATORY WATER QUALITY RESULTS – SEPTEMBER 2014

Analytes	Units	LOR	ANZECC 2000		ADWG (2011)		MB01_B	MB02_C	MB02_S	MB03_S	MB04_C	MB04_S	MB05_C	MB08_B	MB09_T	MB10_T	TAR016_CR	TAR040_C	TAR053	TAR176_C	TAR177_C	TAR189_C	TAR249_C
Aquifer	-	-	Irrigation Water	Livestock Drinking	Aesthetic	Health	Tertiary Clay, Silt	Aldebaran Sandstone - B seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Fine Sandstone	Aldebaran Sandstone - B seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - A seam	Tertiary Clay, Gravel	Quaternary Alluvium	Quaternary Alluvium	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Fine Sandstone	Tertiary Basalt	Aldebaran Sandstone	Aldebaran Sandstone - Coarse Sandstone
Date Sampled	-	-					15/9/2014	15/9/2014	15/9/2014	08/9/2014	10/9/2014	10/9/2014	08/9/2014	08/9/2014	10/9/2014	10/9/2014	08/9/2014	08/9/2014	10/9/2014	10/9/2014	10/9/2014	08/9/2014	15/9/2014
Sulfate as SO_4	mg/L	1	-	1,000 - 2000	250	500	85	126	38	237	110	117	73	44	39	59	20	4	9	14	20	<1	22
Dissolved Metals																							
Aluminium	mg/L	0.01	-	-	0.2	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Antimony	mg/L	0.001	-	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	mg/L	0.001	-	-	-	-	<0.001	0.001	<0.001	0.001	0.001	0.002	<0.001	<0.001	<0.001	0.004	<0.001	0.002	0.003	0.001	<0.001	<0.001	<0.001
Barium	mg/L	0.001	-	-	-	-	0.072	0.168	0.112	0.032	0.133	0.019	0.039	0.125	0.036	0.087	0.181	0.240	0.407	0.071	0.092	0.274	0.031
Beryllium	mg/L	0.001	-	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	mg/L	0.05	-	-	-	-	0.12	0.08	0.07	0.11	0.09	0.06	0.09	0.08	0.06	<0.05	0.10	0.11	<0.05	0.09	0.06	0.13	<0.05
Cadmium	mg/L	0.0001	-	-	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	-	-	-	-	<0.001	0.002	<0.001	0.001	<0.001	<0.001	<0.001	0.019	<0.001	<0.001	0.002	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	0.001	-	-	-	-	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.002	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.001	-	-	-	-	0.002	<0.001	0.002	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ferrous Iron	mg/L	0.05	-	-	-	-	<0.05	0.05	<0.05	<0.05	0.16	<0.05	<0.05	<0.05	<0.05	0.21	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Lead	mg/L	0.001	-	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	-	-	-	-	0.111	0.166	0.027	<0.001	0.045	0.001	0.022	0.003	0.047	0.128	0.030	0.089	0.027	0.007	0.053	0.051	0.005
Mercury	mg/L	0.0001	-	-	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	-	-	-	-	0.005	0.040	0.010	0.019	<0.001	0.022	0.053	0.009	<0.001	0.005	0.008	0.005	0.003	0.004	0.006	0.002	0.010
Nickel	mg/L	0.001	-	-	-	-	0.006	0.003	0.012	<0.001	<0.001	<0.001	0.001	0.002	0.004	0.004	0.009	0.001	0.007	<0.001	<0.001	<0.001	<0.001
Selenium	mg/L	0.01	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	mg/L	0.001	-	-	-	-	<0.001	0.003	<0.001	<0.001	0.001	<0.001	<0.001	0.009	<0.001	0.004	0.010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	0.01	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.005	-	-	-	-	0.008	0.011	0.007	<0.005	<0.005	<0.005	<0.005	<0.005	0.038	0.036	0.021	0.006	0.009	<0.005	<0.005	<0.005	<0.005
Total Metals																							
Aluminium	mg/L	0.01	20	5	-	-	0.31	0.02	2.38	0.17	0.04	0.22	0.06	0.05	<0.01	0.95	0.33	0.11	0.05	0.01	0.06	0.03	0.10

LABORATORY WATER QUALITY RESULTS – SEPTEMBER 2014

Analytes	Units	LOR	ANZECC 2000		ADWG (2011)		MB01_B	MB02_C	MB02_S	MB03_S	MB04_C	MB04_S	MB05_C	MB08_B	MB09_T	MB10_T	TAR016_CR	TAR040_C	TAR053	TAR176_C	TAR177_C	TAR189_C	TAR249_C
Aquifer	-	-	Irrigation Water	Livestock Drinking	Aesthetic	Health	Tertiary Clay, Silt	Aldebaran Sandstone - B seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Fine Sandstone	Aldebaran Sandstone - B seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - A seam	Tertiary Clay, Gravel	Quaternary Alluvium	Quaternary Alluvium	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Fine Sandstone	Tertiary Basalt	Aldebaran Sandstone	Aldebaran Sandstone - Coarse Sandstone
Date Sampled	-	-					15/9/2014	15/9/2014	15/9/2014	08/9/2014	10/9/2014	10/9/2014	08/9/2014	08/9/2014	10/9/2014	10/9/2014	08/9/2014	08/9/2014	10/9/2014	10/9/2014	10/9/2014	08/9/2014	15/9/2014
Antimony	mg/L	0.001	-	-	-	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	mg/L	0.001	2	0.5	-	0.01	0.001	0.002	0.007	0.002	0.001	0.002	<0.001	<0.001	<0.001	0.004	<0.001	0.002	0.003	0.001	<0.001	<0.001	<0.001
Barium	mg/L	0.001	-	-	-	2	0.085	0.176	0.160	0.062	0.147	0.024	0.044	0.143	0.040	0.113	0.192	0.299	0.454	0.078	0.114	0.321	0.032
Beryllium	mg/L	0.001	0.5	-	-	0.06	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	mg/L	0.05	-	5	-	4	0.11	0.10	0.63	0.14	0.10	0.08	0.12	0.10	0.05	0.08	0.09	0.10	0.06	0.11	0.06	0.15	0.08
Cadmium	mg/L	0.0001	0.05	0.01	-	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	1	1	-	0.05	0.006	0.002	0.005	0.007	0.001	0.002	0.028	0.023	0.002	0.003	0.003	0.002	0.003	<0.001	0.001	0.001	0.001
Cobalt	mg/L	0.001	0.1	1	-	-	0.005	<0.001	0.008	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.003	<0.001	<0.001	0.004	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.001	5	0.5	1	2	0.010	0.002	0.015	0.003	<0.001	0.001	0.002	0.002	0.002	0.007	0.002	0.002	0.002	<0.001	0.002	0.001	<0.001
Ferrous Iron	mg/L	0.05	10	-	0.3	-	0.46	0.20	0.08	0.09	0.62	0.25	<0.05	<0.05	<0.05	0.08	0.10	1.39	0.18	0.15	0.27	0.11	0.14
Lead	mg/L	0.001	5	0.1	-	0.01	0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.002	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	10	-	0.1	0.5	0.156	0.168	0.579	0.011	0.050	0.006	0.024	0.010	0.050	0.233	0.033	0.104	0.032	0.008	0.080	0.059	0.009
Mercury	mg/L	0.0001	0.002	0.002	-	0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	0.05	0.15	-	0.05	0.006	0.042	0.010	0.020	0.001	0.020	0.055	0.009	<0.001	0.002	0.009	0.005	0.003	0.004	0.006	0.002	0.010
Nickel	mg/L	0.001	2	1	-	0.02	0.009	0.017	0.064	0.002	0.001	0.002	0.013	0.004	0.004	0.006	0.013	0.002	0.010	0.002	0.002	0.002	<0.001
Selenium	mg/L	0.01	0.5	0.02	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	mg/L	0.001	0.1	0.2	-	0.017	<0.001	0.004	0.002	<0.001	0.001	<0.001	<0.001	0.008	<0.001	0.004	0.010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	0.01	0.5	-	-	-	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.005	5	20	3	-	0.020	0.014	0.017	0.009	0.019	0.011	0.010	0.010	0.040	0.047	0.024	0.028	0.016	0.007	0.010	0.009	0.006
Nutrients																							
Ammonia	mg/L	0.01	-	-	0.5	-	0.03	0.10	<0.01	1.39	0.16	0.20	0.16	0.01	<0.01	<0.01	0.04	----	0.09	0.84	0.01	0.35	0.14
Nitrate as N	mg/L	0.01	-	-	-	50	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.21	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrite as N	mg/L	0.01	-	30	-	3	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrite + Nitrate as N	mg/L	0.01	-	400	-	-	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.21	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Kjeldahl Nitrogen as N	mg/L	0.1	-	-	-	-	0.1	0.2	0.1	----	----	----	0.3	0.2	0.1	0.2	0.1	----	0.2	----	0.1	0.4	0.2

LABORATORY WATER QUALITY RESULTS – SEPTEMBER 2014

Analytes	Units	LOR	ANZECC 2000		ADWG (2011)		MB01_B	MB02_C	MB02_S	MB03_S	MB04_C	MB04_S	MB05_C	MB08_B	MB09_T	MB10_T	TAR016_CR	TAR040_C	TAR053	TAR176_C	TAR177_C	TAR189_C	TAR249_C
Aquifer	-	-	**Irrigation Water**	**Livestock Drinking**	**Aesthetic**	**Health**	Tertiary Clay, Silt	Aldebaran Sandstone - B seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Fine Sandstone	Aldebaran Sandstone - B seam	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - A seam	Tertiary Clay, Gravel	Quaternary Alluvium	Quaternary Alluvium	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone	Aldebaran Sandstone - Coarse Sandstone	Aldebaran Sandstone - Fine Sandstone	Tertiary Basalt	Aldebaran Sandstone	Aldebaran Sandstone - Coarse Sandstone
Date Sampled	-	-					15/9/2014	15/9/2014	15/9/2014	08/9/2014	10/9/2014	10/9/2014	08/9/2014	08/9/2014	10/9/2014	10/9/2014	08/9/2014	08/9/2014	10/9/2014	10/9/2014	10/9/2014	08/9/2014	15/9/2014
Total Nitrogen as N	mg/L	0.1	-	-	-	-	0.1	0.2	0.1	----	----	----	0.3	0.4	0.1	0.2	0.1	----	0.2	----	0.1	0.4	0.2
Reactive Phosphorus as P	mg/L	0.01	-	-	-	-	0.02	0.01	<0.01	0.04	0.01	0.03	<0.01	0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Phosphorus as P	mg/L	0.01	-	-	-	-	0.05	0.01	0.02	----	----	----	0.02	0.02	0.02	0.27	<0.01	----	0.03	----	0.08	0.04	<0.01
Ion Balance																							
Total Anions	meq/L	0.01	-	-	-	-	27.0	18.9	15.2	27.6	27.1	23.6	17.1	16.3	12.4	18.6	13.6	11.4	10.0	8.99	14.0	27.5	4.83
Total Cations	meq/L	0.01	-	-	-	-	29.1	18.2	15.8	26.7	26.3	21.8	15.8	15.8	11.6	20.0	14.7	10.6	10.6	8.82	15.1	26.2	4.97
Ionic Balance	%	0.01	-	-	-	-	3.72	1.89	2.20	1.63	1.47	4.05	3.97	1.53	3.24	3.57	3.88	3.68	2.72	0.97	3.92	2.53	1.45

*	Guideline Value depends on type of livestock
#	Anomalous LOR reported by laboratory
(yellow)	Exceeds ANZECC (2000) short term irrigation water guideline value.
(green)	Exceeds Australian Drinking Water Guidelines (2011) aesthetic guideline value.
(red)	Exceeds Australian Drinking Water Guidelines (2011) health guideline value.
100 0	Exceeds ANZECC (2000) livestock drinking water guideline value.

ATTACHMENT D

Receiving Environment Monitoring Program Framework




Taroborah Coal Project

Receiving Environment Monitoring Program framework

Prepared for:

Shenhuo International Group Pty Ltd

November 2014

AustralAsian Resource Consultants

Document History and Status

Issue	Issued To	Qty	Date	Reviewed	Approved
1	IMC	1	13/11/14	AGP	ABP
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Document Version:	Draft

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LIST OF ABBREVIATIONS

AARC	-	AustralAsian Resource Consultants Pty Ltd
ANZECC	-	Australian and New Zealand Environment and Conservation Council
DO	-	dissolved oxygen
EC	-	electrical conductivity
EHP	-	(Department of) Environment and Heritage Protection
EPT	-	Ephemeroptera, Plecoptera, Trichoptera
ISQG	-	Interim Sediment Quality Guidelines
km	-	kilometre
MDL	-	Mineral Development Licence
Mtpa	-	Million tonnes per annum
QR	-	Queensland Rail
REMP	-	Receiving Environment Monitoring Program
ROM	-	run of mine
SIGNAL	-	Stream Invertebrate Grade Number – Average Level
TDS	-	total dissolved solids

1.0 INTRODUCTION

The Taroborah Coal Project proposes to utilise underground and open-cut methods to extract thermal coal for export. The Project is located entirely within Mineral Development Licence (MDL) 467.

AustralAsian Resource Consultants Pty Ltd (AARC) has been commissioned by Shenhuo International Group Pty Ltd to prepare a Receiving Environment Monitoring Program (REMP) framework for the proposed Taroborah Coal Project (the Project). The framework is based on existing data collated for the preparation of the Project Environmental Impact Statement, and proposed Environmental Authority (EA) conditions put forward by the proponent. It is noted that a refined REMP will be required prior to the commencement of mining activities.

1.1 PROJECT DESCRIPTION

The Project site is located in the Central Highlands District of Central Queensland, within the Bowen Basin region, approximately 22 kilometres (km) west of Emerald and 258 km east of Rockhampton. Figure 1 and Figure 2 indicate the location of the Project within the broader and local regions, respectively.

The Taroborah Coal Project includes both open-cut and underground mining operations, with an onsite coal processing plant to process run of mine (ROM) coal. Coal processing will involve crushing, screening and partial washing to separate product coal from waste materials. Waste rejects will be co-disposed of with spoil material in spoil dumps.

The open-cut mine plan is based upon excavator and truck operations to remove overburden and interburden and extract coal. Open-cut overburden and interburden will be hauled to out-of-pit spoil dumps located adjacent to the open-cut pit, and as mining progresses, in-pit dumping will be utilised. Topsoil which is stripped prior to mining will be segregated for later use in rehabilitation.

The underground mine will employ longwall mining techniques and is expected to produce up to 5.75 Million tonnes per annum (Mtpa) of ROM coal when running at full production. Mined coal will be transported via an underground connection to the open-cut highwall, with three entries providing man and materials, belt conveyor access and ventilation.

A rail load-out facility and rail balloon loop will transport product coal to the Queensland Rail (QR) Central West rail system. Product coal will then be transported via the QR Central West and Aurizon Blackwater rail systems to the Wiggins Island Coal Export Terminal at Gladstone.

The Project is expected to have an operational life of 22 years, including periods of construction, decommissioning and rehabilitation. The Project will initially be based solely upon open-cut operations south of the Capricorn Highway, until underground operations commence in Year 5.

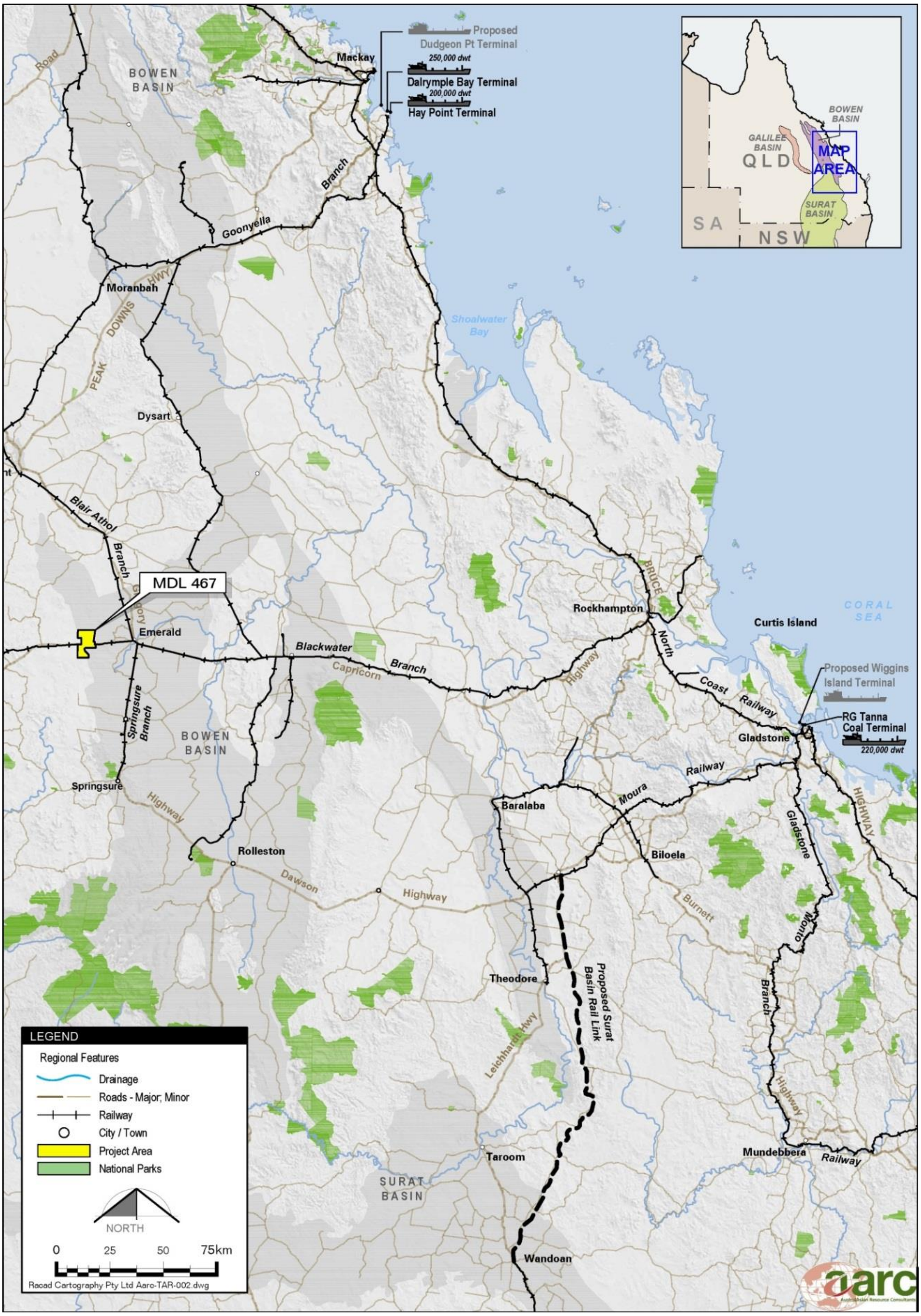


Figure 1 Regional Project Location

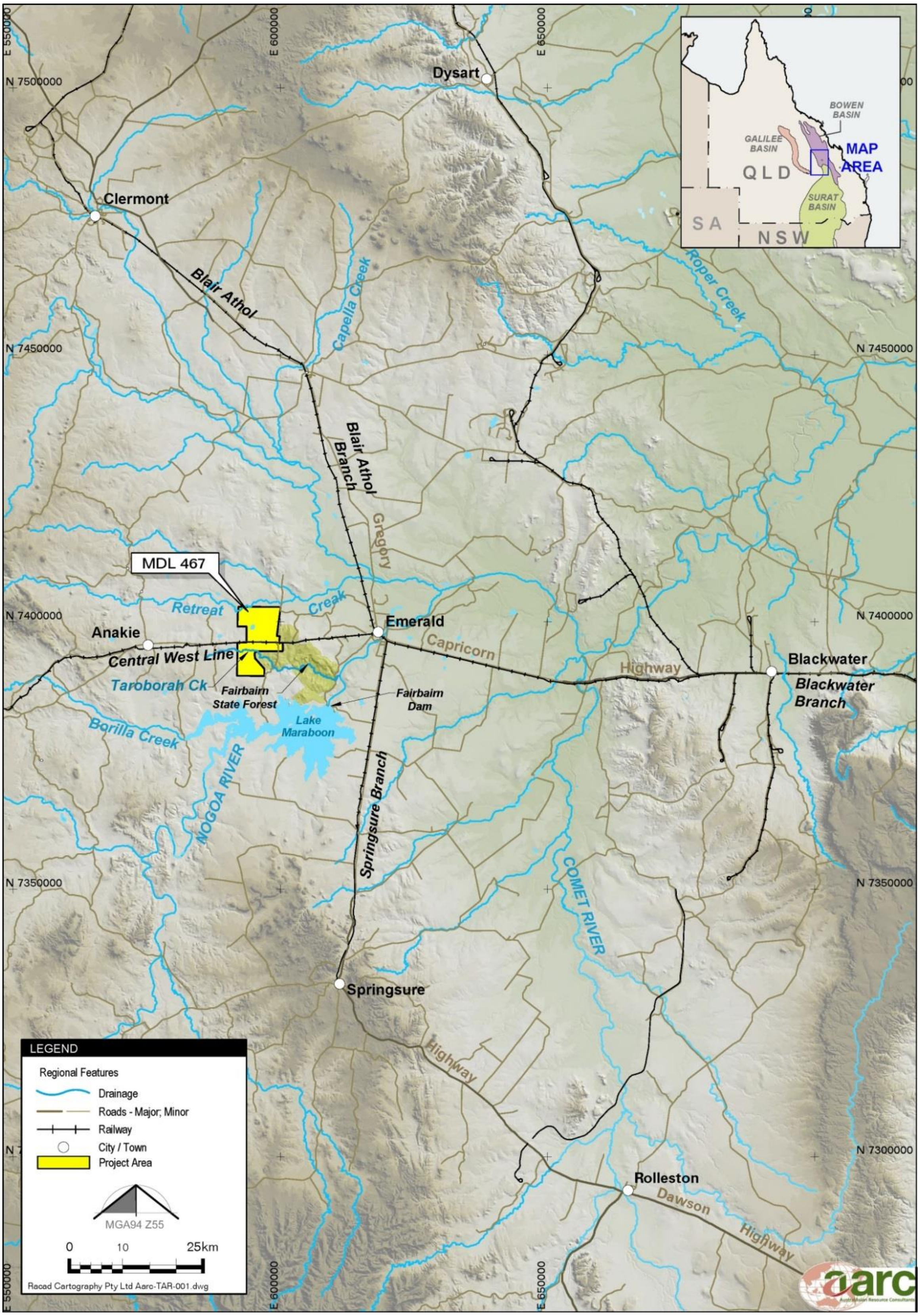


Figure 2 Local Project Location

1.2 PURPOSE

The purpose of this REMP framework is to provide an overview of the characteristics of the receiving environment and outline the monitoring locations, frequencies, parameters and methods to be employed to monitor the receiving environment. It is recognised that further sampling of the receiving waters is required in order to adequately characterise the background quality against which to monitor, and therefore, a formal REMP will not be available for some 18-24 months.

For the purpose of this REMP framework, the receiving environment is defined as the downstream waters of Taroborah and Retreat Creeks within 10 km of the Project site. The receiving environment will be monitored by focusing on the following aspects: receiving waters, stream sediment, macroinvertebrates, and riparian flora.

1.3 PROPOSED ENVIRONMENTAL AUTHORITY CONDITIONS

The proposed Environmental Authority conditions as relates to the monitoring of the receiving environment are as follows.

Contaminant Release

F4 The release of mine affected water to waters in accordance with condition F2 must not exceed the release limits stated in Table 6.8 Mine Affected Water Release Limits when measured at the monitoring points specified in Table 6.7 for each quality characteristic.

F5 The release of mine affected water to waters from the release points must be monitored at the locations specified in Table 6.7 Mine Affected Water Release Points, Sources and Receiving Waters for each quality characteristic and at the frequency specified in Table 6.8 Mine Affected Water Release Limits and Table 6.9 Release Contaminant Trigger Investigation Levels Potential Contaminants.

Mine Affected Water Release Events

F8 The holder must ensure a stream flow gauging station/s is installed, operated and maintained to determine and record stream flows at the locations and flow recording frequency specified in Table 6.10 Mine Affected Water Release during Flow Events.

F9 Notwithstanding any other condition of this environmental authority, the release of mine affected water to waters in accordance with condition F2 must only take place in accordance with the receiving water flow criteria for discharge specified in Table 6.10 Mine Affected Water Release during Flow Events for the release point(s) specified in Table 6.7 Mine Affected Water Release Points, Sources and Receiving Waters.

F10 The release of mine affected water to waters in accordance with condition F2 must not exceed the Electrical Conductivity and Sulphate release limits or the Maximum Release Rate (for all combined release point flows) for each receiving water flow criteria for discharge specified in Table 6.10 Mine Affected Water Release during Flow Events when measured at the monitoring points specified in Table 6.7 Mine Affected Water Release Points, Sources and Receiving Waters.

F11 The daily quantity of mine affected water released from each release point must be measured and recorded at the monitoring points in Table 6.7 Mine Affected Water Release Points, Sources and Receiving Waters.

Receiving Environment Monitoring and Contaminant Trigger Levels

F17 The quality of the receiving waters must be monitored at the locations specified in Table 6.12 Receiving Water Upstream Background Sites and Downstream Monitoring Points and depicted in Schedule K – Figure 3 – Receiving Water Monitoring Locations for each quality characteristic and at the monitoring frequency stated in Table 6.11 Receiving Water Contaminant Trigger Levels.

Receiving Environment Monitoring Program (REMP)

F20 The environmental authority holder must develop and implement a Receiving Environment Monitoring Program (REMP) to monitor, identify and describe any adverse impacts to surface water environmental values, quality and flows due to the authorised mining activity. This must include monitoring the effects of the mine on the receiving environment periodically (under natural flow conditions) and while mine affected water is being discharged from the site. For the purposes of the REMP, the receiving environment is Taroborah Creek and Retreat Creek within 10 km downstream of the release points. The REMP should encompass any sensitive receiving waters or environmental values downstream of the authorised mining activity that will potentially be directly affected by an authorised release of mine affected water.

F21 A REMP Design Document that addresses the requirements of the REMP must be prepared and made available to the administering authority upon request.

F22 A report outlining the findings of the REMP, including all monitoring results and interpretations must be prepared annually and made available on request to the administrating authority. This must include an assessment of background reference water quality, the condition of downstream water quality compared against water quality objectives, and the suitability of current discharge limits to protect downstream environmental values.

Note: the administering authority will take into consideration any extenuating circumstances prior to determining an appropriate enforcement response in the event condition F5 is contravened due to a temporary lack of safe or practical access. The administering authority expects the environmental authority holder to take all reasonable and practicable measures to maintain safe and practical access to designated monitoring locations.

2.0 REMP CONTENT REQUIREMENTS

2.1 DESCRIPTION OF RECEIVING ENVIRONMENT

The Project site is predominantly located on undulating plains and hills, with a sandstone plateau to the far west. The Project site lies within the Fitzroy River Basin and is traversed by two primary ephemeral creeks – Retreat Creek in the north and Taroborah Creek in the south – and a number of associated drainage lines. Both major creeks flow in an easterly direction and ultimately flow into the Nogoa River, downstream of Fairbairn Dam (Lake Maraboon). Consequently, both watercourses have the potential to affect the Nogoa River and other associated downstream tributaries. Watercourses occurring on the Project site are shown in Figure 3. Surface water within the Project site is used for stock drinking water.

The following sections describe the existing quality of the receiving environment, based on existing field studies conducted in preparation of the Project's Environmental Impact Statement (EIS). Locations of sample sites used for field assessments are shown in Figure 4. It should be noted that, based on the highly ephemeral nature of the creek systems within and around the Project site, the sampling data for water quality ranges from 2 – 7 samples per site, with the highest sampling occurring at locations where semi-permanent water holes exist (AQ/TAS2, AQ/TAS10) or the drainage line is spring fed (AQ/TAS11).

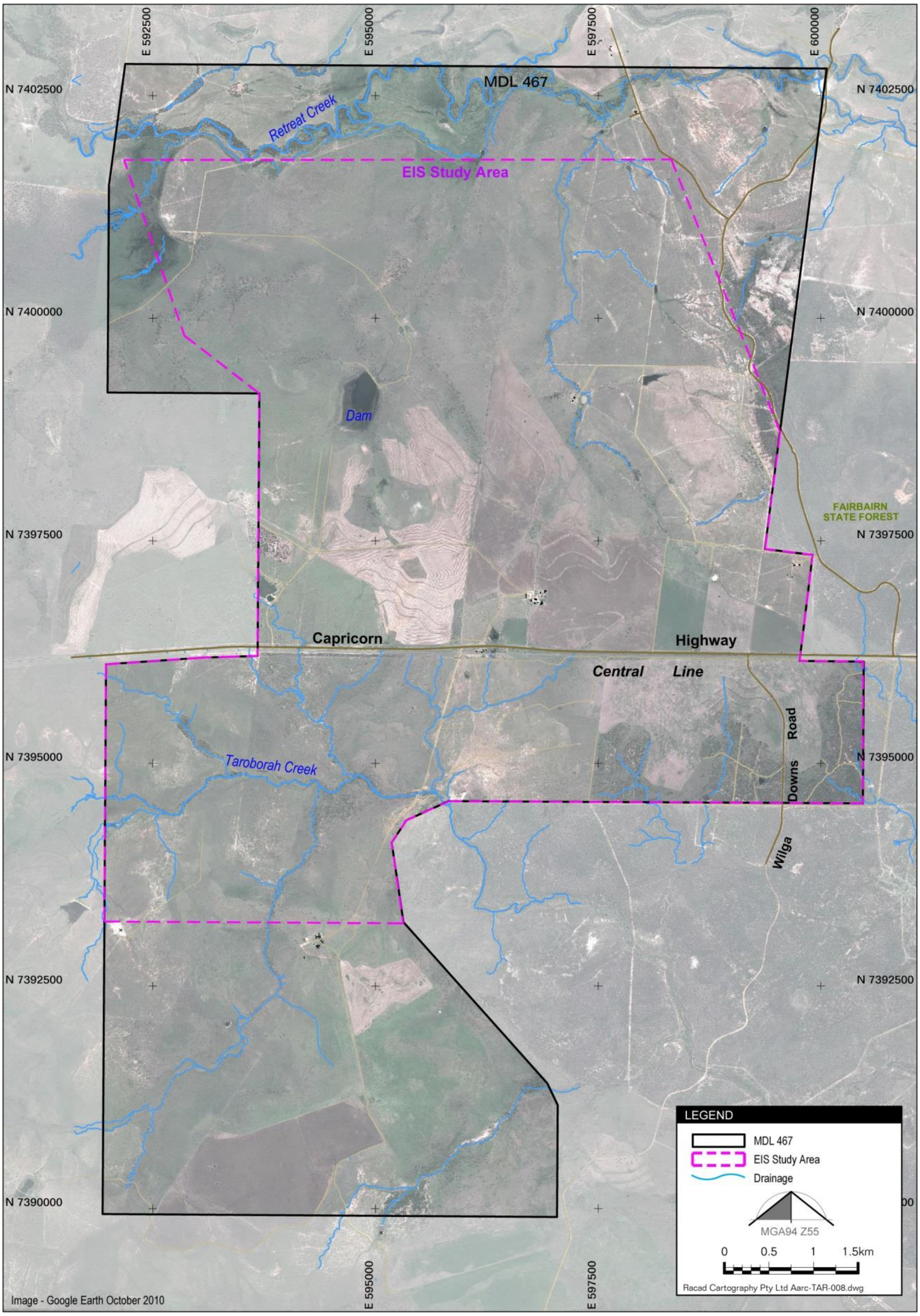


Figure 3 Watercourses on the Project Site

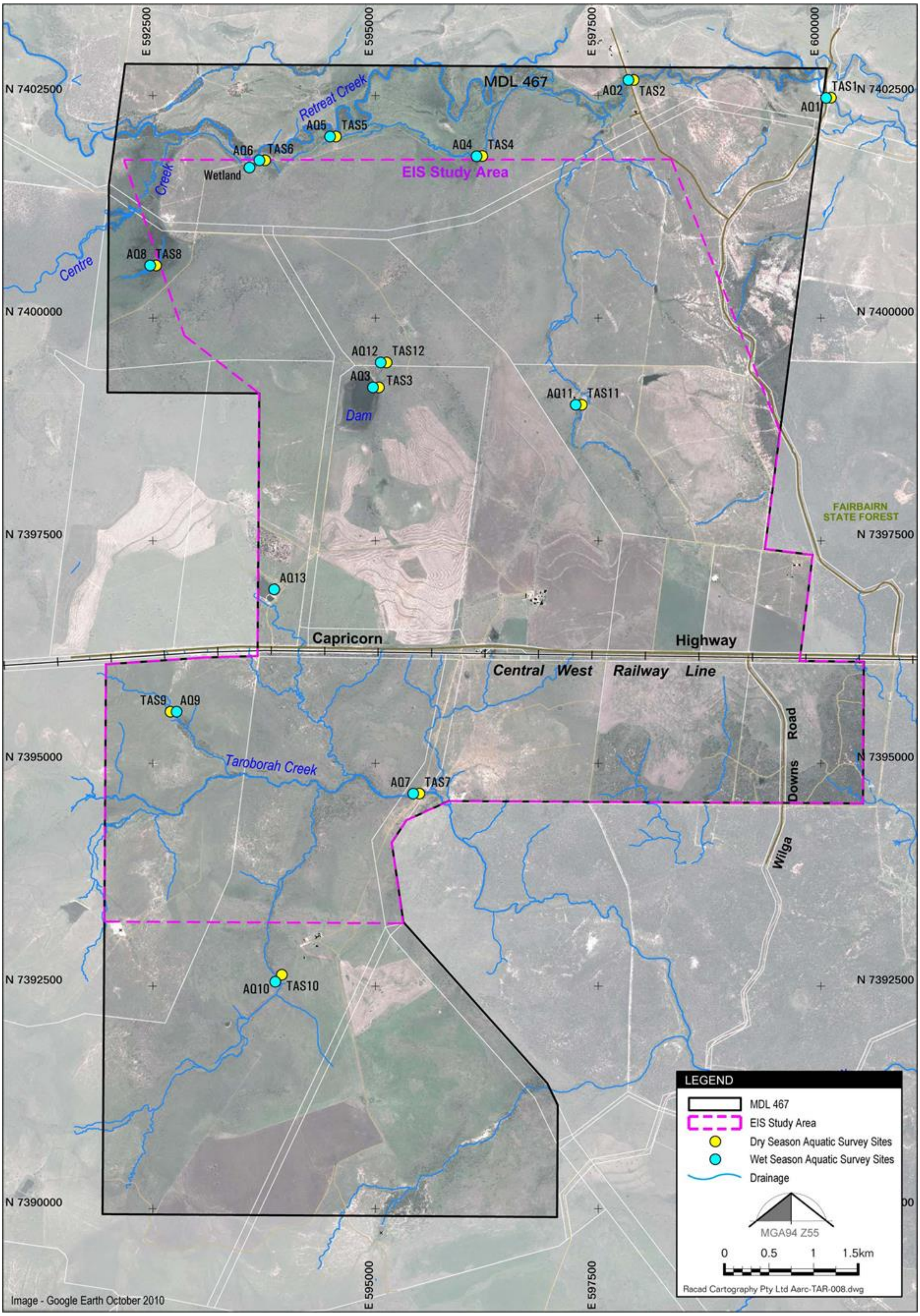


Figure 4 Aquatic Survey Sampling Locations

2.1.1 Water Quality

2.1.1.1 Retreat Creek and Tributaries

Physico-chemical Analysis Results

The physico-chemical monitoring results for Retreat Creek and its tributaries indicate that water exceeds the trigger values provided in the Australian and New Zealand Environment and Conservation Council (ANZECC) (2000) Aquatic Ecosystem Guidelines at several sites for pH, dissolved oxygen (DO), electrical conductivity (EC) and total Phosphorus, and the ANZECC (2000) Livestock Drinking Water Guidelines at several sites for total dissolved solids (TDS).

Results indicate water bodies associated with Retreat Creek sampling sites AQ/TAS5 and AQ/TAS11 are basic in nature with an average pH between these sites of 8.53 with a maximum pH 9.08 recorded at site AQ/TAS11. Average EC ranged between 768 µS/cm (AQ/TAS5) and 2,302 µS/cm (AQ/TAS11). AQ/TAS11 also exceeded the ANZECC (2000) Aquatic Ecosystem Guideline, with a maximum of 3,793 µS/cm.

DO levels were generally recorded within the ANZECC (2000) Aquatic Ecosystems Guideline values, with the exception of three sites (AQ/TAS1, AQ/TAS2, and AQ/TAS11) which exhibited low DO concentrations with an average concentration between these sites of approximately 68%. The highest recorded maximum for DO was 145% at site AQ/TAS5.

Heavy Metals

Heavy metal analysis results for Retreat Creek and its tributaries indicate that water exceeds either the ANZECC (2000) Aquatic Ecosystem Guidelines or the ANZECC (2000) Livestock Drinking Water Guidelines (or both) for aluminium, copper, manganese, silver and zinc. Aluminium, copper and manganese, in particular, are considered to be naturally elevated in the environment.

Elevated levels of dissolved aluminium, typically in excess of ANZECC (2000) Aquatic Ecosystems trigger levels, were identified at two sites along Retreat Creek. In the absence of industrial or mining disturbance, with no known history of or reason for contamination, the levels of aluminium are likely to be naturally occurring or may emanate from the upstream gemstone mining operations.

The observed copper concentrations in surface waters are considered to be naturally elevated and may be due to windblown dust, decaying vegetation and forest fires, processes which are known to naturally release copper to the environment.

2.1.1.2 Taroborah Creek and Tributaries

Physico-chemical Analysis Results

Results from Taroborah Creek and a tributary, traversing the southern portion of the Project site, were similar to those for Retreat Creek, with exceedances of trigger values provided in the ANZECC (2000) Aquatic Ecosystem Guideline (95% species protection), at sites AQ/TAS7 and AQ/TAS10, for one or more of the following parameters: pH, DO, EC, TDS, Sulphate, Nitrite, Nitrate, total Nitrogen and total Phosphorus. The ANZECC (2000) Livestock Drinking Water Guidelines were exceeded at AQ/TAS10 for TDS.

Sites along Taroborah Creek (AQ/TAS7) and a tributary (AQ/TAS10) were also basic, with an average pH between these sites of 8.78, and a maximum pH of 9.29 recorded at site AQ/TAS10. EC values for sites AQ/TAS7 and AQ/TAS10 recorded average measurements of 988 µS/cm and 2,285

µS/cm, respectively. The average measured EC value recorded at site AQ/TAS10 exceeded the ANZECC (2000) Aquatic Ecosystem Guideline. TDS was exceeded at both sites on Taroborah Creek; however, AQ/TAS10 also exceeded the ANZECC (2000) Livestock Drinking Water Guideline with a maximum NTU of 2,795 and an average of 1,787 NTU.

Heavy Metals

Results from the heavy metal analysis indicated elevated levels of boron, copper, nickel and silver at site AQ/TAS10, with exceedances of Cu only experienced at site AQ/TAS7 in comparison to the ANZECC (2000) Aquatic Ecosystem 95% species protection Guidelines.

Results indicate site AQ/TAS10 had marginally elevated levels of boron, with a maximum recording of 0.38 mg/L. However, the average concentration of boron was found to be within guideline trigger value. The ANZECC (2000) Aquatic Ecosystem Guideline was exceeded at site AQ/TAS7 with a concentration of 0.002 mg/L. In addition, site AQ/TAS10 also exceeded the ANZECC (2000) Aquatic Ecosystem Guideline with an average concentration of 0.005 mg/L and a maximum of 0.007 mg/L.

Although the average concentration of dissolved nickel at site AQ/TAS10 was within the ANZECC (2000) Aquatic Ecosystem Guideline, the maximum concentration recorded at this site was 0.03 mg/L, almost three times the guideline limit. Nickel occurs naturally in soils and is released to the atmosphere by windblown dust, combustion of fuel, municipal incineration and industries involved in steel production. In consideration to the rural setting of the Project and the absence of smelting and other nickel refining processes it is determined elevated levels of nickel may be naturally occurring.

Elevated levels of silver were also recorded at site AQ/TAS10, consistent with the majority of results at various sampling sites.

2.1.2 Stream Sediment

2.1.2.1 Retreat Creek and Tributaries

Heavy metal analysis indicates chromium and nickel are in exceedance of the ANZECC (2000) stream sediment quality trigger values at several sites.

The results of metal analysis indicated chromium was exceeded at three sites (AQ/TAS3, AQ/TAS4 and AQ/TAS12) when compared to the ANZECC (2000) stream sediment quality trigger values. The average concentration at each site, however, was within the ANZECC (2000) stream sediment quality trigger values with a mean concentration of 70.8 mg/kg recorded between sites. Chromium is known to naturally exist in soils and rocks and the slightly elevated levels found in Retreat Creek may be due to the catchment runoff passing over these soils entering the waterway.

Nickel was found to exceed the ISQG Low trigger value at seven sites, three of which also exceeded the ISQG High trigger value. The highest recorded maximum of 135 mg/kg was recorded at site AQ3 together with the highest recorded average of 124 mg/kg. In consideration to the rural setting of the Project and the absence of smelting and other nickel refining processes it is determined elevated levels of Ni may be naturally occurring.

2.1.2.2 Taroborah Creek and Tributaries

Heavy metal analysis indicates nickel is in exceedance of the ANZECC (2000) stream sediment quality trigger values at two sites. Similar to Retreat Creek, Ni may be naturally elevated in Taroborah Creek due to natural weathering processes.

2.1.3 Macroinvertebrates

A total of 47 macroinvertebrate taxa were identified during the aquatic surveys. Some of the more commonly encountered macroinvertebrates included True Fly (Diptera: Tanypodinae), Backswimmers (Hemiptera: Notonectidae), Water Boatmen (Hemiptera: Corixidae), and Diving Beetles (Coleoptera: Dytiscidae). Hemiptera: Corixidae were the most commonly encountered taxa, with specimens recorded from twelve of the sixteen aquatic sites where macroinvertebrate sampling was conducted.

It is generally accepted that three orders of macroinvertebrates, the Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) (EPT) are most sensitive to disturbance (Marshall et al. 2001). Ephemeroptera and Trichoptera taxa were identified at the majority of the sites. Trichopteran individuals were more commonly encountered during the dry season survey.

2.2 MONITORING LOCATIONS

In accordance with the monitoring locations proposed in the EIS for the Project, Table 1 details the proposed receiving environment monitoring sites. Figure 5 illustrates the location of these monitoring sites. Event-based sampling should be carried out during a release, from release point locations defined within Table 2.

Table 1 Receiving Environment Upstream and Downstream Monitoring Points

Monitoring Point	Receiving Environment Description	Easting (MGA94)	Northing (MGA94)
Upstream Background Monitoring Points			
MP1	Taroborah Creek, approx. 2.6km upstream of RP1	592460	7394520
MP2	Tributary south of Taroborah Creek, approximately 3.7km upstream of RP1 and RP2	593875	7392625
MP3	Retreat Creek	594555	7402037
Downstream Monitoring Points			
MP4	Taroborah Creek	595695	7394650
MP5	Retreat Creek	597840	7402650
MP6	Retreat Creek	600070	7402480
MP7	Taroborah Creek	598685	7391555

Table 2 Mine Affected Water Release Points, Sources and Receiving Waters

Release Point	Latitude (GDA94)	Longitude (GDA94)	Mine Affected Water Source & Location	Monitoring Point	Receiving Waters Description
RP 1	TBC	TBC	CPP Water Recycle Dam	Pipe or drain	Taroborah Creek
RP 2	TBC	TBC	Mine Wastewater Dam	Pipe or drain	Taroborah Creek
RP 3	TBC	TBC	Sediment Dam 03	Pipe or drain	Taroborah Creek
RP 4	TBC	TBC	Sediment Dam 04	Pipe or drain	Taroborah Creek
RP 5*	TBC	TBC	Mine Wastewater Dam	Intake pipe to pumping system	Selma Irrigation System – main channel adjacent to Capricorn Hwy underpass

Note – Release point coordinates will be confirmed with the administering authority once construction of dams and spillways has been finalised.

** For the purpose of controlled release of excess groundwater to irrigation, to be confirmed.*

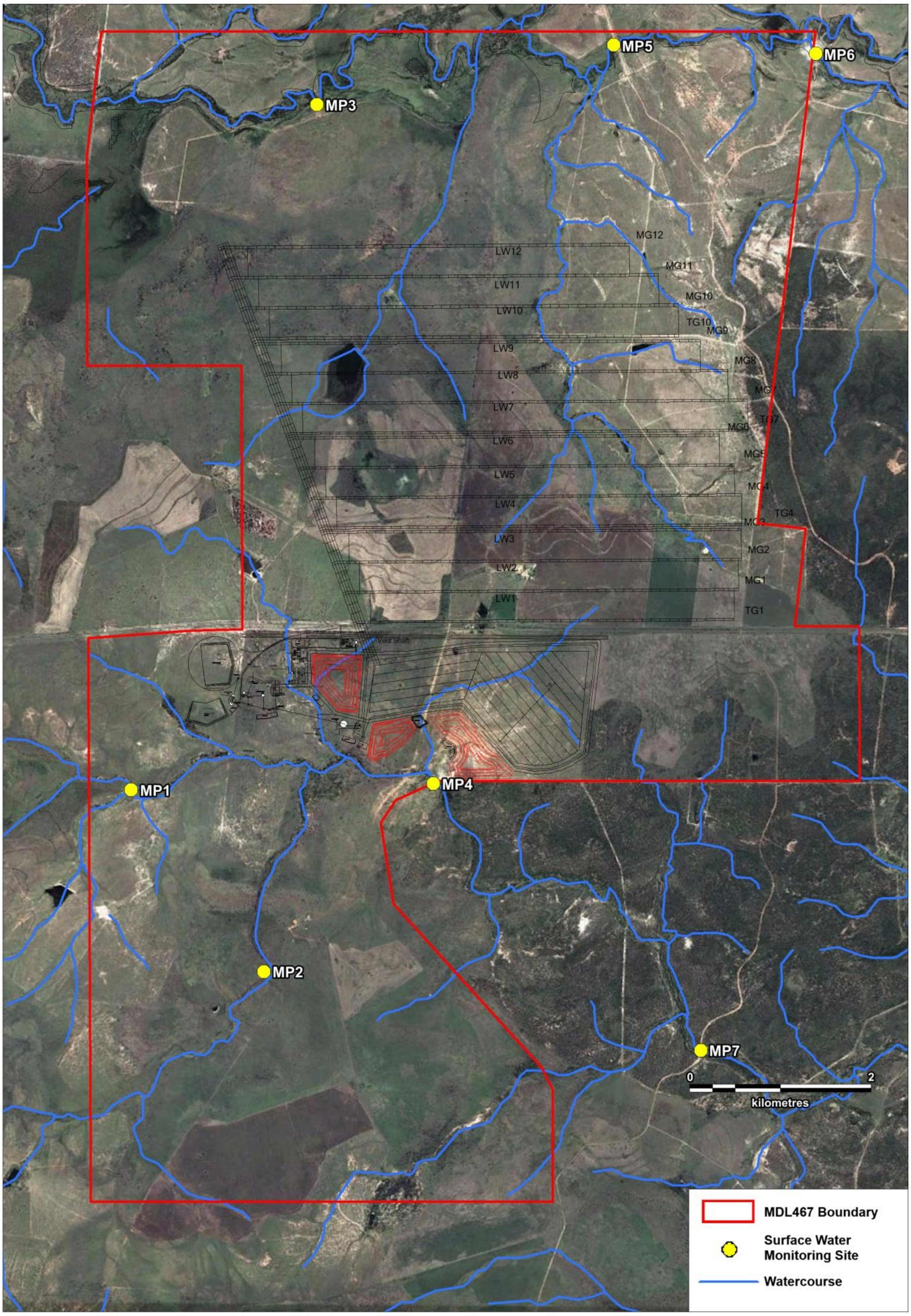


Figure 5 Receiving Environment Upstream and Downstream Monitoring Sites

2.3 MONITORING FREQUENCY

Typically the frequency of monitoring should be undertaken routinely and during an event. Specifically, receiving water quality data should be collected routinely on a monthly basis and daily during a release or weekly during each stream flow event. Monitoring of all other receiving environment aspects should be routinely conducted on a twice-yearly basis – once during the wet season and once during the dry season.

EC, pH, suspended solids, sulphate and sodium of downstream surface water will be monitored daily during a release event and the first sample must be collected within 2 hours of commencement of the release. All other surface water parameters will be monitored on the commencement of the release and weekly thereafter.

2.4 MONITORING PARAMETERS AND TRIGGER VALUES

2.4.1 Surface Water

Table 3 details the surface water parameters to be monitored and their associated ANZECC (2000) trigger levels.

In addition to the parameters listed in Table 3, monitoring of stream flow is recommended. Monitoring of flow data will allow detection of abnormal flow patterns within the receiving environment, as well as quantification of discharge volumes and calculation of contaminant loads from dams, in the case of an extreme rainfall or a release event.

Stream flow monitoring will take place upstream of the Taroborah Creek release point via a stream flow gauging station which will determine and record natural stream flows. During a natural flow event, stream flow monitoring will be undertaken daily, at both the gauging station and release points for the parameters outlined in Table 4 and Table 5.

Table 3 Release Contaminant Trigger Investigation Levels and Contaminant Trigger Levels

Quality Characteristic	Units	Trigger Levels
Receiving Waters Contaminant Trigger Levels		
pH	pH units	6.5 – 8.0
EC	µS/cm	1000
Suspended Solids	mg/L	1500
Sulphate (SO_4^{2-})	mg/L	300
Sodium	mg/L	180
Release Contaminant Trigger Investigation Levels		
Aluminium	µg/L	5000
Arsenic	µg/L	13
Cadmium	µg/L	10
Chromium	µg/L	1000
Copper	µg/L	500
Iron	µg/L	300
Lead	µg/L	4
Mercury	µg/L	0.2
Nickel	µg/L	1000
Zinc	µg/L	8
Boron	µg/L	370
Cobalt	µg/L	90
Manganese	µg/L	1900

Quality Characteristic	Units	Trigger Levels
Molybdenum	µg/L	34
Selenium	µg/L	10
Silver	µg/L	1
Uranium	µg/L	1
Vanadium	µg/L	10
Ammonia	µg/L	900
Nitrate	µg/L	1100
Petroleum hydrocarbons (C6-C9)	µg/L	20
Petroleum hydrocarbons (C10-C36)	µg/L	100
Fluoride (total)	µg/L	2000
Sodium	mg/L	180

Note: *1. All metals and metalloids must be measured as total (unfiltered) and dissolved (filtered). Trigger levels for metal/metalloids apply if dissolved results exceed trigger.*

2. The quality characteristics required to be monitored as per Table 3 can be reviewed once the results of two years monitoring data is available, or if sufficient data is available to adequately demonstrate negligible environmental risk, and it may be determined that a reduced monitoring frequency is appropriate or that certain quality characteristics can be removed from Table 3 by amendment.

3. SMD – slightly moderately disturbed level of protection, guideline refers ANZECC & ARMCANZ (2000).

4. LOR – typical reporting for method stated. ICPMS/CV FIMS – analytical method required to achieve LOR.

5. Stock drinking water guidelines (ANZECC & ARMCANZ (2000)) have been used where the aquatic ecosystem protection guideline has been exceeded on a number of times during background surface water sampling.

**Samples shall not be collected where access to monitoring points presents a serious health and safety risk.*

Table 4 Mine Affected Water Release Limits

Quality Characteristic	Release Limits*	Monitoring Frequency	Comment
Electrical conductivity (µS/cm)	Release limits specified in Table 5 for variable flow	Daily during release (the first sample must be taken within 2 hours of commencement of release)	-
pH (pH Unit)	6.5 (minimum) 9.0 (maximum)	Daily during release (the first sample must be taken within 2 hours of commencement of release)	-
Suspended Solids (mg/L)	1,500*	Daily during release (first sample within 2 hours of commencement of release)	Suspended solids are required to measure the performance of sediment and erosion control measures.
Sulphate (SO_4^{2-}) (mg/L)	Release limits specified in Table 5 for variable flow criteria	Daily during release (first sample within 2 hours of commencement of release)	-

Table 5 Mine Affected Water Release during Flow Events

Receiving Waters / Stream	Release Point	Gauging Station	Gauging Station Latitude (GDA94)	Gauging Station Longitude (GDA94)	Receiving Water Flow Recording Frequency	Receiving Water Flow Criteria for discharge (m^3/s)	Maximum release rate (for all combined RP flows)	Electrical Conductivity Release Limits
Taroborah Creek	RP1 – RP4	Taroborah Creek upstream (TBC)	TBC	TBC	Continuous (minimum daily)	Low/No Flow 28 days after natural flow events that exceed 0.15 m^3/s at Nogoa River	0.05 m^3/s	Electrical conductivity (µS/cm): <488 (Maximum, based on 80th percentile of historic data) Sulphate (mg/L): <300
						Medium Flow ≥ 0.15 m^3/s in the Nogoa River	0.08 m^3/s 0.02 m^3/s	Electrical conductivity (µS/cm) <1,500 Electrical conductivity (µS/cm) <3,500 Sulphate (mg/L): <600

2.4.2 Stream Sediment

Table 6 details the stream sediment parameters to be monitored and their associated ANZECC (2000) Interim Sediment Quality Guidelines (ISQG).

Table 6 ANZECC (2000) Sediment Quality Guideline Values

Parameter	Units	ANZECC (2000) ISQG Triggers	
		Low	High
Arsenic (As)	mg/kg	20	70
Silver (Ag)	mg/kg	1.0	3.7
Barium (Ba)	mg/kg	n/a	n/a
Beryllium (Be)	mg/kg	n/a	n/a
Cadmium (Cd)	mg/kg	1.5	10
Cobalt (Co)	mg/kg	n/a	n/a
Chromium (Cr)	mg/kg	80	370
Copper (Cu)	mg/kg	65	270
Iron (Fe)	mg/kg	n/a	n/a
Mercury (Hg)	mg/kg	0.15	1.0
Manganese (Mn)	mg/kg	n/a	n/a
Molybdenum (Mo)	mg/kg	n/a	n/a
Nickel (Ni)	mg/kg	21	52
Lead (Pb)	mg/kg	50	220
Selenium (Se)	mg/kg	n/a	n/a
Zinc (Zn)	mg/kg	200	410

2.4.3 Macroinvertebrates

Monitoring macroinvertebrates as biological indicators should involve assessment of the following:

- Presence and abundance of the EPT group of macroinvertebrates. These orders are particularly sensitive to disturbance;

- Taxonomic composition of macroinvertebrate assemblages using the Stream Invertebrate Grade Number – Average Level (SIGNAL) Index, developed by the National River Health Program.

2.5 MONITORING AND SAMPLING METHODS

2.5.1 Surface Water

Water quality monitoring should be undertaken in accordance with the *Monitoring and Sampling Manual 2009* (EHP 2013) which provides common techniques, methods and standards for sample collection, handling and data management.

At each site where surface water is available, in situ recordings of pH, EC, and temperature within the water body will be taken.

Equipment

The equipment required to obtain water quality samples from waterways, water storages and regulated structures is outlined below:

- An adequate number of clean laboratory sample bottles – 500 mL unpreserved plastic bottles and 250 mL acid-preserved plastic bottles;
- Hand-operated syringes with a supply of 0.45 µm filters (for dissolved metal analysis);
- Permanent marker pen and writing pen/pencil;
- Surface Data Record Sheet and clipboard; or
- Esky with ice bricks to keep water samples cool;
- Water Quality Meter calibrated for pH and EC;
- Separate Water Quality Meter calibrated for DO Saturation;
- Deionised water, disposable plastic cups and paper towels for use with and cleaning of the Water Quality Meter probes;
- Sampling beaker (if necessary); and
- Map of sampling locations and a GPS if required.

Procedure

It is desirable to collect the sample directly into the sample bottle, holding it either by hand or by means of a sampling rod. If this is not practical, collect the sample with a clean sampling beaker (intermediate container) and transfer it promptly into the sample bottle. In accordance with the *Monitoring and Sampling Manual 2009* (EHP 2013) intermediate containers should be washed with existing site water, being used for final collection of samples.

When collecting each water sample, it is important to avoid disturbing the edge of the waterway/dam or sediment if sampling in shallow water, as the presence of sediment will produce an invalid sample.

The method employed for sampling these water bodies is as follows:

1. Complete details of the sampling location, date and time on the label of each appropriate sample bottle (supplied by laboratory) prior to commencing sampling;
2. Record sampling on Water Storage Data Record Sheet; and
3. Carefully approach the water's edge, so as not to disturb sediments near the sampling site.

If collecting the sample directly into the laboratory sampling bottles:

1. Gently dip each bottle (both big and small bottles) into the water and fill completely;

Note: Always hold the acid-preserved bottle (smaller bottle) upright and do not tip it out once full because it contains acid.

2. Gently squeeze the sides of the two sample bottles to expel any air and cap tightly; and
3. Collect a third sample in a clean beaker to be used for field water quality measurements (as described below);
4. Place the two bottles upright in the esky with ice bricks, in order to keep the samples cool until you return to the site office.

Note: DO NOT reopen the acid-preserved bottle (smaller bottle).

If collecting the sample using a sampling beaker:

1. Collect a sufficient quantity of water to fill the sampling bottles and obtain field water quality measurements (a minimum of 750mL will be required);
2. Carefully transfer the sample into the appropriate sampling bottles and fill completely;
3. Gently squeeze the sides of each bottle to expel any air and cap tightly;
4. Place the sample bottle upright in the esky with ice bricks, in order to keep the sample cool until you return to the site office; and
5. Keep the remainder of the sample and perform field water-quality measurements as described below.

Note: DO NOT reopen the acid-preserved bottle (smaller bottle).

2.5.2 Stream Sediment

Sediment samples will be obtained during the dry season and wet season. At least 10 sub-samples of the stream–bed substrate will be taken at different locations along a 50 m stretch of each creek or river bed. The sub-samples will then be mixed to obtain a composite sample, sealed in sterilised glass jars and sent to a National Association of Testing Authorities (NATA) accredited laboratory for analysis of the parameters outlined above. Results were compared to the ANZECC Guidelines (2000) for Fresh and Marine Water Quality Trigger Values.

Equipment

- Sampling bags and labels;
- Bucket;
- GPS;
- Camera; and
- Pens / pencils / permanent markers.

Procedure

At each site three samples should be taken from different sections of the stream and mixed in the bucket to create a composite sample. Place approximately 1 kilogram (kg) of the composite sample in a sample bag, ensuring to label with the project name, sample site number, and sample date.

Sediment samples should be sent to a NATA laboratory and tested for the necessary parameters.

2.5.3 Macroinvertebrates

Macroinvertebrates are invertebrates that can be seen with the naked eye. The macroinvertebrate assemblage of an aquatic environment can be used as a biological indicator of the health of that environment.

Due to the ephemeral nature of the creeks and tributaries of the Project site, macroinvertebrate sampling should be undertaken at least annually when sufficient water is present at sampling sites.

Equipment

- 100 micro-metre (µm) macroinvertebrate D-frame sampling net;
- Sorting trays;
- Tweezers and pipettes;
- Vials, vial labels and clip-lock bags;
- Waders / reef walkers;
- 70% methylated spirits;
- Squirt bottles;
- Macroinvertebrate sampling pro-forma;
- GPS;
- Camera; and
- Pens / pencils / permanent markers.

Procedure

The shallows of the waterbody should be targeted, with samples collected from each micro-habitat, including edge and bed habitat). Sampling macroinvertebrates involves kick-sampling, in which the stream bed (or edge) is disturbed and the D-frame net passed through the resulting plume, along 5 – 10 m sections of the water body.

The macroinvertebrates collected should be live-picked for a 20 – 30 minute period using tweezers and pipettes. Half fill a vial with 70% alcohol (methylated spirits). Ensure the container you use is large enough. If the animals you collect take up more than 30% of the volume, use a larger container. Use alcohol stable vials to avoid vial cracking and sample loss. Use tweezers and pipettes to pick macroinvertebrates.

Samples should then be sent to an appropriately qualified person or facility for identification to family or sub-family level.

3.0 DATA ANALYSIS AND REPORTING

Results for surface water and stream sediment should be compared to the relevant trigger values to determine the quality of the receiving environment.

Macroinvertebrate species identified during sampling will be analysed for the presence / absence of EPT taxa. The EPT group of macroinvertebrates are three orders of insects that are especially sensitive to disturbance. Generally, there are more EPT species in areas of higher water quality and available habitat than in degraded water bodies. Examining this information in conjunction with other data such as SIGNAL Scores, water quality measurements, etc., a basic estimate of river health can be determined. The SIGNAL method uses pre-assigned 'grade numbers' which reflect their sensitivity to various pollutants (Chessman 2003).

Once the SIGNAL 2 scores have been calculated for each sampling site, the scores are plotted against the number of families found at that site. The position of a particular site on the bi-plot can provide an indication of the level of pollution and other physical and chemical factors that affect macroinvertebrate communities (Chessman 2003) (refer to Figure 6 for bi-plot interpretation).

Quadrant 3 Often indicating toxic pollution or harsh physical environments	**Quadrant 1** Indicates favourable habitat or chemically dilute water
Quadrant 4 Usually indicating urban, industrial, or agricultural pollution	**Quadrant 2** Often indicating high salinity or nutrient levels (may be natural)

Source: SIGNAL Index 2003

Figure 6 SIGNAL 2 Bi-Plot Interpretation

4.0 QUALITY ASSURANCE / QUALITY CONTROL

All sampling and sample identification will be undertaken by appropriately qualified and experienced persons. Field blanks should be taken each sampling round and duplicates taken for every 10% of samples. Blanks and duplicates should be labelled such that the laboratory cannot identify them as QA / QC samples.

Surface water and stream sediment samples will be sent to the NATA-accredited ALS for analysis within the relevant holding times. Accreditations for ALS Environmental Division labs are based on the requirements of ISO/IEC 17025:2005. Accreditations are held for specific tests as related on each laboratory Scope of Accreditation.

ALS employs stringent QA / QC procedures, including:

- Certified Reference Materials;
- Laboratory Duplicates;
- Laboratory Control Spikes;
- Matrix Spikes;
- Surrogates;
- Secondary and project Standards; and
- Inter Laboratory (Proficiency) Testing.

5.0 REFERENCES

Chessman B (2003). *SIGNAL 2 – A Scoring System for Macro-invertebrate ('Water Bugs') in Australian Rivers.* Monitoring River Health Initiative Technical Report no 31, Commonwealth of Australia, Canberra.

Department of Environment and Heritage Protection (EHP) 2013, *Monitoring and Sampling Manual 2009*, version 2, Queensland Government. Available from: https://www.ehp.qld.gov.au/water/pdf/monitoring-man-2009-v2.pdf

Marshall, Christopher, Harch Bronwyn D., Choy, Satish C. and Smith, Michael J (2001). *Chapter 8 Aquatic Macroinvertebrates as Indicators of Ecosystem Health*. QNRM Rocklea, Qld.

ATTACHMENT E

Final Pit Void Water Quality Assessment

EGi ENVIRONMENTAL GEOCHEMISTRY INTERNATIONAL

TO: **IMC Mining**

ATTENTION: **Dave Thomas**

DATE: 27 October 2014

SUBJECT: Modelling of Water Quality in Final Voids - Taroborah Coal Project

1. Background

Two voids will remain at the completion of the open cut mining stage of the Taroborah Coal Project (Figure 1). At completion of the project the voids will be allowed to fill by natural inflows of ground water and rainfall within the void. Over the long term the water levels in the voids will stabilise at around RL 195 m, and when filled the volumes will be approximately 6.4 Mm^3 for the void on the eastern side of the open cut, and 2.1 Mm^3 for the western void.

Geochemical studies carried out by EGi for the EIS indicated that the majority of overburden and spoil that will be produced during mining of the open cut will be non-acid forming (NAF). However some rock units within the stratigraphy that will be intersected by the open cut are sulphidic and will be potentially acid forming (PAF) and have the capacity to generate acidic rock drainage (ARD) if exposed to atmospheric conditions. In addition to the two coal seams, it is expected that the interburden between the two seams will be PAF, as will floor material below Seam B. The occurrence of PAF material is a potential concern in relation to the quality of water that will collect within the final voids.

Monitoring of ground waters across the Project area indicates that ground waters within the Quaternary alluvium, Tertiary gravel, and the Aldebaran sandstone are alkaline, and hence ground water inflows to the voids at closure will serve to neutralise acid that is produced from PAF materials exposed around the final surfaces of the voids. Monitoring of local ground water bores indicates pHs typically around 7 to 8 and alkalinities typically in the range 200 to 500 mg/L. Monitoring also indicates that ground water inflows will be slightly brackish (or saline), predominantly due to elevated concentrations of sodium and chloride. The total dissolved salts (TDS) in ground water will likely average around 400 to 600 mg/L.

This memorandum presents the results and findings of hydrogeochemical modelling of the Taroborah open cut voids carried out by EGi to predict the quality of water within the voids through time as water level rises. The modelling was carried out in association with ATC Williams (who provided data on surface water inflows) and also AGE Consultants (who provided data on ground water inflows). To date, modelling of water quality has focused on the larger eastern void. As the western void has essentially the same stratigraphy and will be subject to inflows of the same surface and ground waters, it is expected that the quality of the pit lake that develops in the western void will be comparable to that predicted for the eastern void.

81a College Street Balmain NSW 2041 Australia
T 61 2) 9810 8100 F 61 2) 98105542 E egi@geochemistry.com.au W www.geochemistry.com.au
Environmental Geochemistry International Pty Ltd ABN 12003 793 486

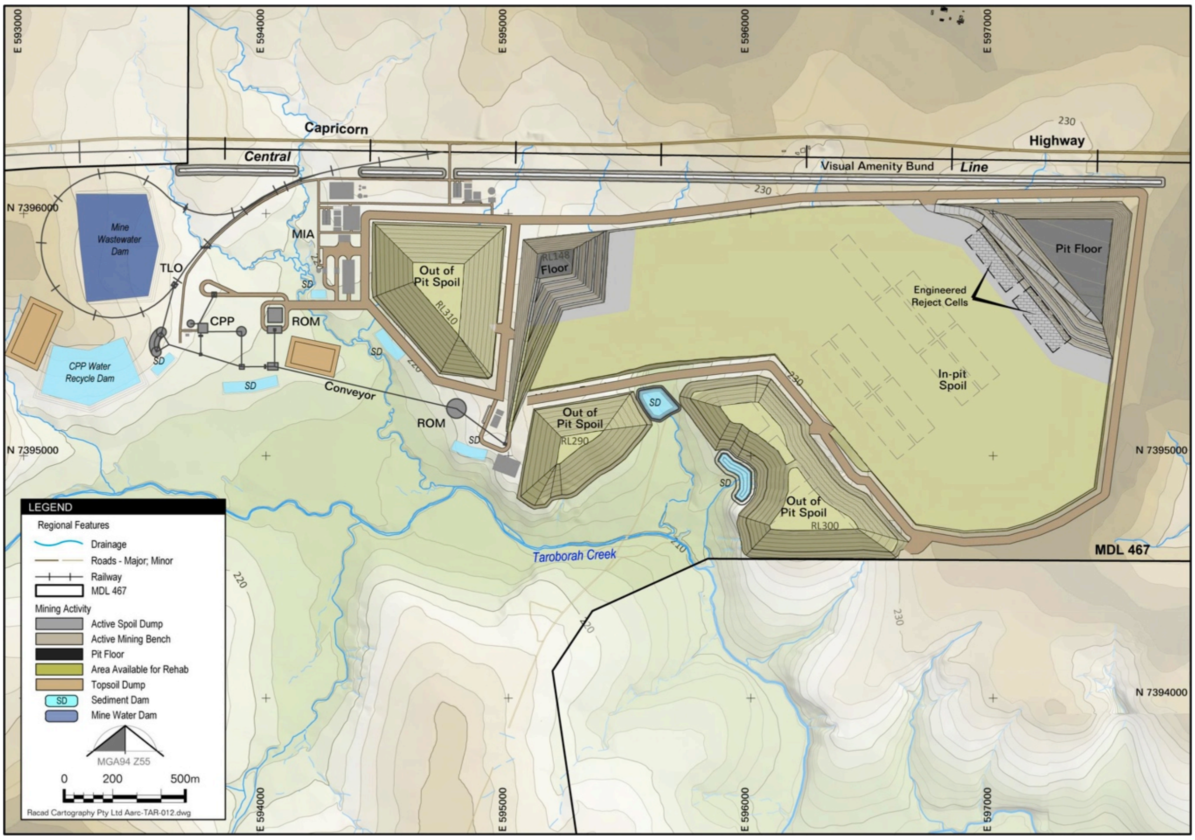


Figure 1: *Plan of Taroborah open cut at closure*

2. Model Software

The hydrochemical model for the Taroborah open pit voids was based around Microsoft *Excel* and the *Phreeqc* chemical speciation program. The use of Phreeqc means the calculations of pH and void water chemistry were based on fundamental chemical principals. By using thermodynamic principals rather than empirical relationships, it is possible to predict pH and full water chemistry for different scenarios with respect to void dimensions, wall rock types (including NAF and PAF characteristics), runoff chemistries from individual rock types, different inflow regimes for surface and ground waters, and development of water bodies within the voids through time.

The *Excel* component of the hydrogeochemical model contains data relevant to the void shell (lithology, NAF/PAF distribution), water balance information, and the chemistries assigned to runoffs from different wall rock units, and ground water inflows. The *Excel* component also has embedded macros that produce an input file that feeds into the *Phreeqc* computer program which predicts the pH and water quality of the combined pit water.

Phreeqc was developed and released for public use by the US Geological Survey (USGS), and is generally regarded as one of the leading hydrogeochemical programs currently available for simulating chemical reactions and transport processes in natural or contaminated water. *Phreeqc* has the capability to model the pH and chemical speciation reactions including solubility, redox, ion-exchange, and surface complexation for a

single solution or mixes of two or more solutions. Consequently, the output from *Phreeqc* provides an indication of the distribution of elements between dissolved and solid phases, which in the latter case may be a precipitate that is predicted to form due to a solubility constraint when different waters mix, or when an element is predicted to be adsorbed onto some colloidal surface such as iron oxide.

3. Modelling Approach

For modelling purposes the final void was partitioned into three main surfaces, namely the spoil slope, the high wall, and the void floor. These areas are illustrated in Figure 2. The highwall represents the original stratigraphic profile whereas the spoil represents a mixture of overburden and interburden materials that will be mined to access the coal seams and replaced in-pit.

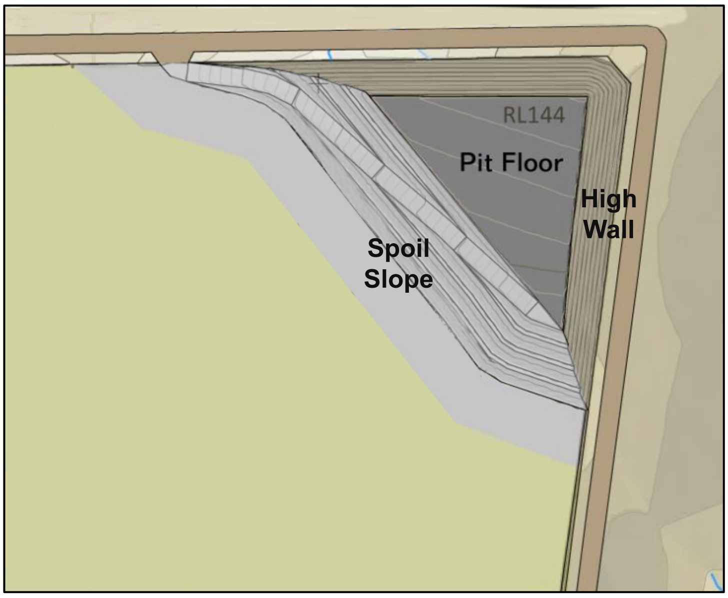


Figure 2: *Plan of Eastern void showing areas designated as spoil slope (light grey), high wall (lined olive) and pit floor (dark grey)*

The inputs considered in the water quality model of the Taroborah final void are illustrated in Figure 3. They include ground waters from the high wall and from the in-pit spoil, as well as runoffs from different geological surfaces. The model calculated pit lake water quality on a one-year time step, and for each step the model input file included data for the flow and chemistry of each source of water inflow. The only output was a loss of water via evaporation. There was no water overflow from the void.

It is understood that rejects may be placed within the void. Should this occur, the rejects will be placed in a manner that minimises the potential for sulphide oxidation to occur. This will involve blending with limestone and encapsulation of rejects within engineered isolation cells that are lined with geosynthetic clay to restrict oxygen ingress and to minimise leaching. Such measures will limit the exposure of rejects to conditions that are conducive to ARD generation. It was therefore assumed that any reject cells constructed within the void will be geochemically secure prior to and post flooding of the void, and consequently will not contribute significantly to pit lake water quality.

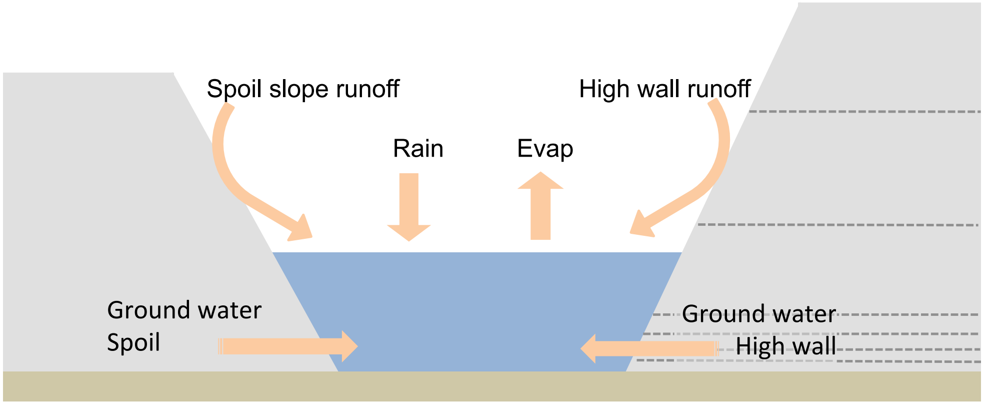


Figure 3: *Schematic of input/outputs considered in the hydrogeochemical model of the pit lake in the Taroborah final void*

4. Void Dimensions

The total surface area of the eastern void is 346,505 m^2. The spoil slope was assumed to be comprised of a homogenous material whereas the high wall was sub-divided into a number of strata representing the different rock units exposed on the wall at the completion of mining. A schematic of the layers within the high wall is given in Figure 4.

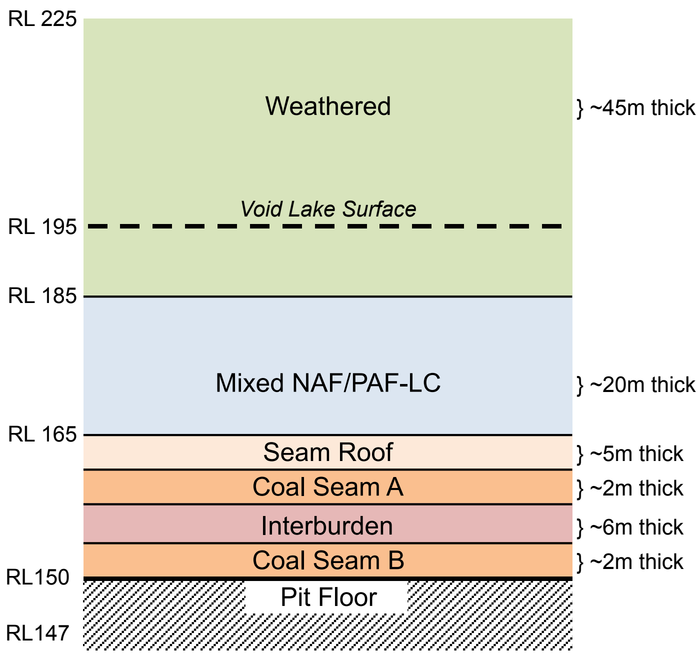


Figure 4: *Schematic of high wall stratigraphy (not to scale)*

The slope areas of different material surfaces within the Eastern void were provided by IMC and are summarised in Table 1. Plan areas for each material surface were also calculated by multiplying the spoil and high wall slope areas by a factor of 0.66.

Table 1: *Surface areas for the Eastern pit void*

Void Surface	Slope Area (m^2)	Plan Area (m^2)
Pit Floor	86,274	86,274
Spoil Slope	140,007	92,405
High Wall	120,224	79,348
Total	**346,505**	**258,026**
High Wall Strata		
HW Weathered	75,857	50,066
HW Mixed	18,435	12,167
HW Seam Roof	11,771	7,769
HW Coal Seam A	1,575	1,040
HW Interburden	10,233	6,754
HW Coal Seam B	2,353	1,553

The lowest point of the floor is at RL 147 m. It was assumed that the entire area of the floor will be exposed during the first year of filling, and thereafter entirely covered by water. The water level in the pit void was allowed to increase with inflows from ground water and surface runoff, based on staged storage capacities provided by IMC which are summarised in Table 2. It is understood from previous hydrologic modelling of the project area that the water level will rise to a maximum of RL 195 m.

Table 2: *Volume and surface areas versus RL for the Eastern pit void*

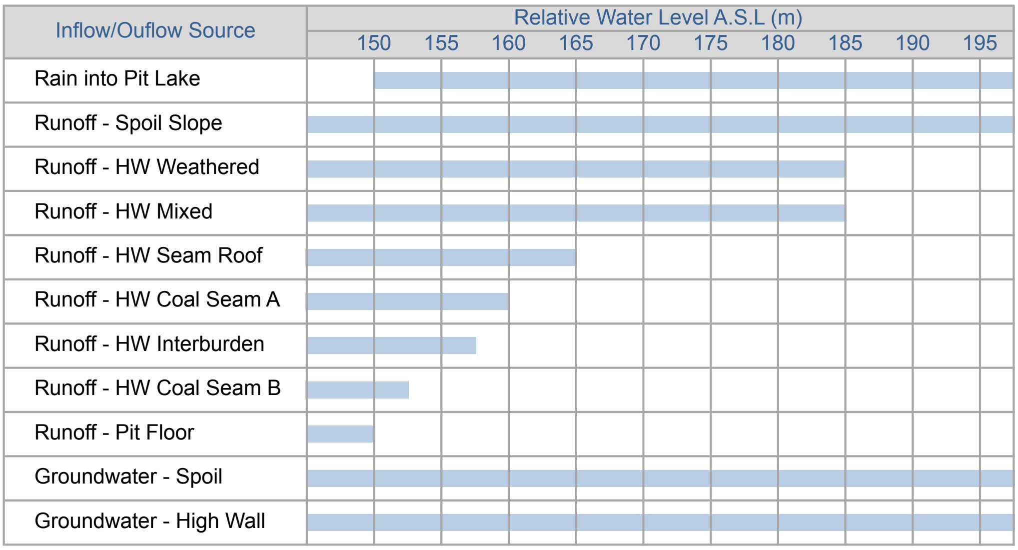
Relative Water Level A.S.L (m)	Volume (m^3)	Surface Area (m^2)
150	365,452	85,154
155	828,847	99,054
160	1,345,494	107,641
165	1,905,613	116,442
170	2,510,241	125,441
175	3,179,744	138,959
180	3,900,173	149,250
185	4,672,628	159,770
190	5,523,845	176,370
195	6,399,712	185,906

5. Ground Water and Surface Water Inflows

The rates of ground water inflow to the void were based on data provided by AGE Consultants. Rates were staged during filling using 5 m RL increments. Rates of surface runoff were calculated from exposed plan areas of spoil slope or high wall assuming an annual rainfall of 610 mm and an average runoff factor for the year of 0.3. The surface inflows based on this approach were comparable to estimates provided by ATC Williams using more sophisticated hydrologic modelling methods. Evaporation loss from the pit lake surface was based on an annual pan evaporation rate of 2100 mm and a pan coefficient of 1.3 (*i.e.* actual evaporation from pit lake surface of approximately 1600 mm per year).

Table 3 provides a schematic of inflows that contribute to pit water volume and quality as the void fills. The rates of inflow of ground water progressively decrease with increasing RL, as do the inflows of surface waters running off the spoil slope and the high wall as the void walls are progressively inundated. Conversely, the rate of inflow of rain directly into the pit lake, and the loss of pit lake water via evaporation, increase directly with increasing surface area of the lake. It should be noted that only wall rock above the water surface contributes to, or has any effect on, pit water chemistry (*i.e.* there is no chemical diffusion into or out of wall rock or the pit floor).

Table 3: *Inflows contributing to pit lake volume and chemistry with increasing water level*



The actual staged inflow rates for each input source are given in Table 4.

Table 4: *Inflow rates for surface and ground waters versus relative water level*

Inflow Source	Inflow Rates (m^3/year)										
	150 RL	155 RL	160 RL	165 RL	170 RL	175 RL	180 RL	185 RL	190 RL	195 RL	
Pit Lake	0	53,490	61,413	66,737	72,194	77,773	86,155	92,535	99,057	109,349	115,262
Runoff - Pit Floor	16,047	0	0	0	0	0	0	0	0	0	0
Runoff - Spoil Slope	17,187	17,187	15,908	15,049	14,168	13,268	11,915	10,885	9,832	8,171	7,217
Runoff - HW Weathered	9,312	9,313	9,131	9,215	9,904	9,696	9,100	8,782	8,444	7,017	6,198
Runoff - HW Mixed	2,263	2,263	2,263	2,263	2,263	1,697	1,132	566	0	0	0
Runoff - HW Seam Roof	1,445	1,445	1,445	1,445	0	0	0	0	0	0	0
Runoff - HW Coal Seam A	193	193	193	0	0	0	0	0	0	0	0
Runoff - HW Interburden	1,256	1,256	628	0	0	0	0	0	0	0	0
Runoff - HW Coal Seam B	289	289	0	0	0	0	0	0	0	0	0
SubTotal Runoff	47,993	85,436	90,983	94,709	98,529	102,435	108,301	112,768	117,333	124,538	128,676
Groundwater - Spoil	143,445	143,445	187,975	189,070	175,200	156,585	136,875	115,340	87,965	84,315	83,950
Groundwater - HW	109,135	109,135	113,150	104,025	91,250	77,015	62,415	46,355	27,010	24,455	23,725
SubTotal Groundwater	252,580	252,580	301,125	293,095	266,450	233,600	199,290	161,695	114,975	108,770	107,675
TOTAL	300,573	338,016	392,108	387,804	364,979	336,035	307,591	274,463	232,308	233,308	236,351

6. Chemistries of Input Water

Table 5 gives the chemistries assigned to ground water inflows and to surface runoffs from different material types. The input chemistries for runoff were based on results of column leach tests carried out by EGi for the Taroborah EIS. The chemistries assigned to ground water inputs were based on field monitoring data as summarised in the EIS. An input chemistry was also assigned to rainfall directly falling into the void lake once it begins to form.

The following water quality parameters are currently included as input to the hydrogeochemical model: pH, redox, alkalinity, Ag, Al, As, B, Ba, Ca, Cd, Cl, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Sn, SO_4, U, and Zn.

The initial water falling directly onto the pit floor during Year 1 was assumed to be acidic, as were runoffs associated with the coal seams, roof and interburden layers. Conversely, surface runoffs from spoil slope and the upper two layers of the high wall were assumed to be alkaline, as were ground water inflows.

It should also be noted that the chemistries currently assigned to input sources are independent of the flow conditions being modeled. In reality, the chemistries of runoff could change depending on climatic conditions (intensity and duration of rainfall event) and also into the long term as freshly mined surfaces weather and become depleted with respect some elements. However, there is currently insufficient background data to quantify such changes.

***Table 5:** Chemistries of input waters included in the hydrogeochemical model (mg/L except pH)*

Parameter	Groundwaters		Surface Runoff								Rain to Lake
	Spoil	High Wall	Spoil Slope	HW Weathered	HW Mixed	HW Seam Roof	HW Coal Seam A	HW Interburden	HW Coal Seam B	Pit Floor	
pH	8.4	7.7	7.4	8.2	7.4	2.3	2.2	2.3	2.2	2.5	6.5
Ag	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0
Al	0.01	0.01	2	0.3	2	337	1,000	135	1,000	54	0
As	0.003	0.003	0.04	0.1	0.0	2	3	0.3	3	0.09	0
B	0.07	0.07	0.08	0.2	0.08	0.05	0.1	0.05	0.1	0.05	0
Ba	0.18	0.18	0.03	0.02	0.03	0.005	0.01	0.01	0.01	0.01	0
Ca	71	53	314	40	314	102	100	66	100	71	0
Cd	0.0001	0.0001	0.006	0.0002	0.006	0.04	0.08	0.02	0.08	0.02	0
Cl	534	197	22	180	22	6.7	500	7	500	3	0
Co	0.002	0.002	0.2	0.002	0.2	2	4	1	4	2	0
Cr	0.001	0.001	0.002	0.001	0.002	0.5	1	0.2	1	0.08	0
Cu	0.001	0.001	0.03	0.01	0.03	2.0	4	1.11	4	1	0
Fe	1	1	7	0.1	7	2154	3000	648	3,000	190	0
Hg	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0
K	6	6	26	3	26	1	5	4	5	3	0
Mg	95	55	492	61	492	100	800	77	800	168	0.1
Mn	0.03	0.03	20	0.03	20	5	20	6	20	28	0
Mo	0.005	0.005	0.001	0.009	0.001	0.05	0.1	0.008	0.1	0.001	0
Na	263	160	27	144	27	3	250	5	250	3	0
Ni	0.002	0.002	0.5	0.01	0.5	5	10	2	10	3	0
Pb	0.001	0.001	0.002	0.001	0.002	0.002	0.003	0.01	0.003	0.01	0
Sb	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.001	0
Se	0.001	0.001	0.09	0.02	0.09	0.2	0.5	0.09	0.5	0.03	0
Sn	0.001	0.001	0.001	0.003	0.001	0.007	0.01	0.004	0.01	0.004	0
SO4	150	100	2,871	243	2,871	8,618	15,000	3,202	15,000	1,922	0.1
U	0.001	0.001	0.003	0.001	0.003	1	1	0.2	1	0.09	0
Zn	0.005	0.005	0.8	0.008	1	12	24	12	24	10	0
Alkalinity	251	381	50	120	50	-	-	-	-	-	1

7. Model Settings

Thermodynamic Database

The *Phreeqc* component of the model includes a selection of thermodynamic databases that define the various reactions that can occur, such as the precipitation of mineral phases. For the model runs reported in this memorandum, the thermodynamic database known as *Minteq.v4* was utilised in its existing form[1], with the exception that some mineral phases were excluded because they are unlikely to exist under the environmental conditions that will prevail in a setting such as exists within the final voids.

pH Determination

The pHs of source waters are specified as inputs to the model but the *Phreeqc* component of the model computes the pH of the combined pit water mix. This capability is essential as the solubilities of many elements (and especially metals) are pH-dependent, and therefore the model can compute concentrations of dissolved and solid phases. In the latter case, solid-phases of elements will occur when the total concentration in the mix exceeds the solubility product of one or more of the compounds included in the thermodynamic database.

O_2 Constraint

It was assumed that the pit lake was equilibrated with atmospheric oxygen (*i.e.* pO_2 set to -0.67)

CO_2 Constraint

Based on past experience, it is generally the case that pit waters that result from a combination of acid and alkaline waters are not fully equilibrated with atmospheric carbon dioxide (*i.e.* defined as pCO_2=3.5). Therefore, a pCO_2 of 2.5 was used.

8. Prediction of Pit Water Quality

Year-by-year predictions of pit lake quality for the eastern void were made for a period of 100 years. Figure 5 shows the predicted volume of water within the void during filling, and Figure 6 shows the cumulative inflows of ground water and surface runoff from different sources. Table 6 gives a summary of water quality predictions at the end of each decade during the 100 year period, and time series plots for pH and major elements are also given in Figure 7.

The pit water is predicted to be circum-neutral throughout the 100 year period, with salinity gradually increasing due primarily to the inflow of slightly saline ground water and the concentrating effect of evaporative water loss.

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[1] Some of the thermodynamic values included in the database may need to be modified to more accurately reflect the system being modelled. As a general rule, the precipitates that tend to form under field conditions tend to be somewhat impure and amorphous and typically have solubilities that are higher than those included in the thermodynamic database which are based on pure mineral phases. Assessment of the need for changes to the thermodynamic database will require additional laboratory experimentation (*e.g.* a series mixing tests) to provide experimental data against which the model can be calibrated.

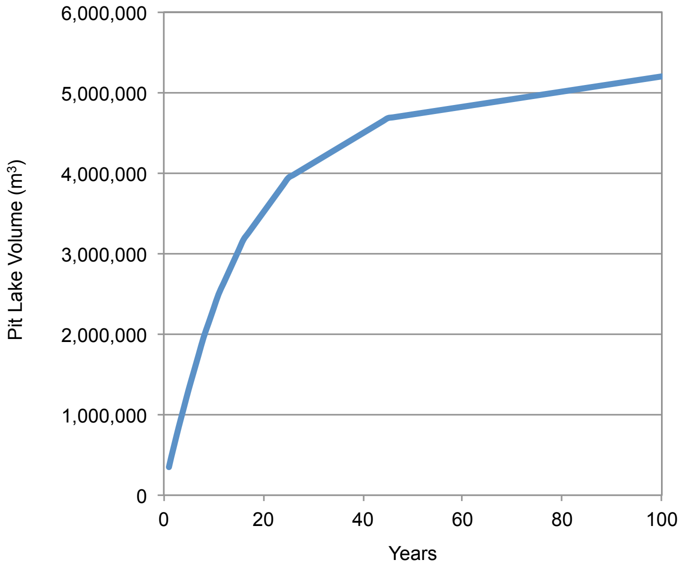


Figure 5: *Predicted volume of water within Eastern void*

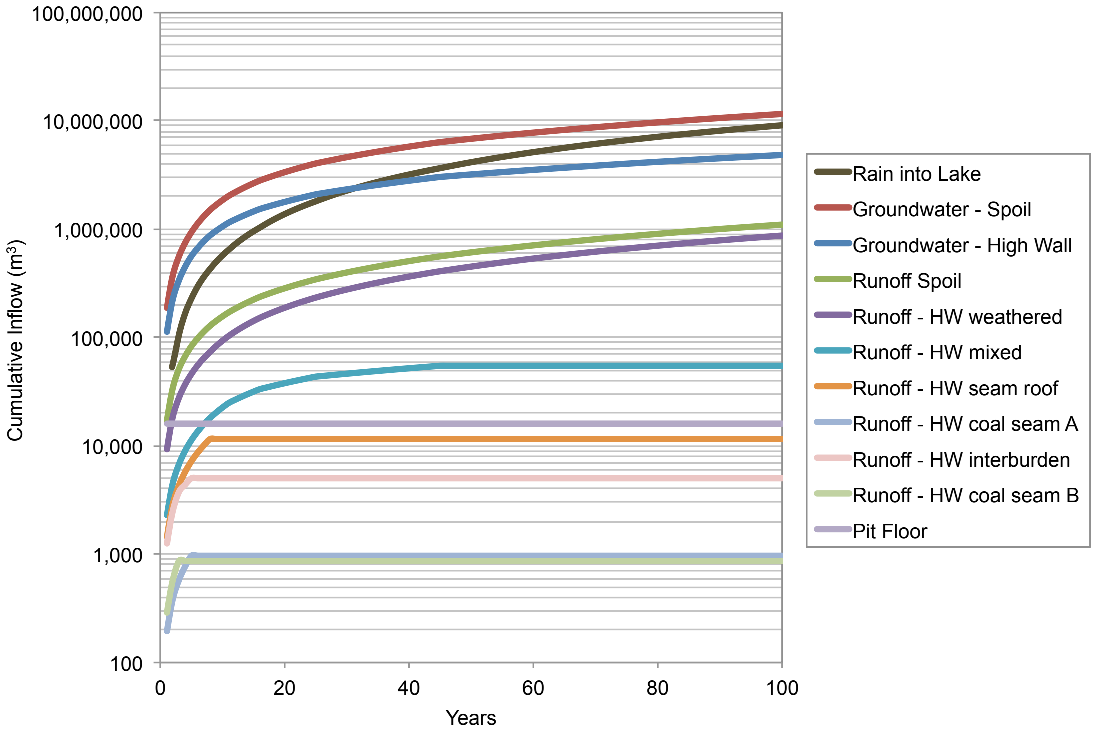


Figure 6: *Cumulative inflows of ground and surface waters from different sources for the Eastern void (note: logarithmic scale)*

***Table 6:** Predictions of pit water quality in the Eastern void during pit lake development*

Parameter	Unit	Year after Start of Filling										
		1	10	20	30	40	50	60	70	80	90	100
pH		7.5	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.8	7.8
Major anions												
Cl	mg/L	359	527	619	714	815	909	1008	1093	1195	1274	1350
SO4	mg/L	451	475	537	611	686	774	858	939	1021	1057	1125
Major cations												
Ca	mg/L	78	62	60	59	58	60	62	64	65	57	58
Mg	mg/L	108	143	167	194	220	247	273	298	324	346	368
Na	mg/L	200	292	341	392	447	497	550	596	650	692	733
K	mg/L	2	2	3	3	3	4	4	5	5	6	6
Trace elements												
Ag	mg/L	0.001	0.001	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.003
Al	mg/L	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3
As	mg/L	0.00003	0.00003	0.00004	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.001	0.002
Ba	mg/L	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.6
B	mg/L	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3
Cd	mg/L	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002
Co	mg/L	0.1	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.05	0.04	0.04
Cr	mg/L	0.006	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.005	0.004	0.004
Cu	mg/L	0.003	0.002	0.002	0.003	0.002	0.003	0.003	0.003	0.003	0.003	0.004
Fe	mg/L	0.006	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Hg	mg/L	0.0001	0.0001	0.0002	0.0002	0.0002	0.0002	0.0003	0.0003	0.0003	0.0003	0.0003
Mn	mg/L	2	2	2	2	3	3	3	4	4	4	4
Mo	mg/L	0.005	0.007	0.008	0.009	0.01	0.01	0.01	0.01	0.02	0.02	0.02
Ni	mg/L	0.19	0.08	0.08	0.08	0.08	0.09	0.10	0.11	0.12	0.11	0.12
Pb	mg/L	0.00003	0.00003	0.00004	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0004	0.0004
Sb	mg/L	0.001	0.001	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.003
Se	mg/L	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02
Sn	mg/L	0.001	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.004	0.004
U	mg/L	0.011	0.005	0.005	0.004	0.004	0.005	0.005	0.006	0.006	0.004	0.004
Zn	mg/L	0.5	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2

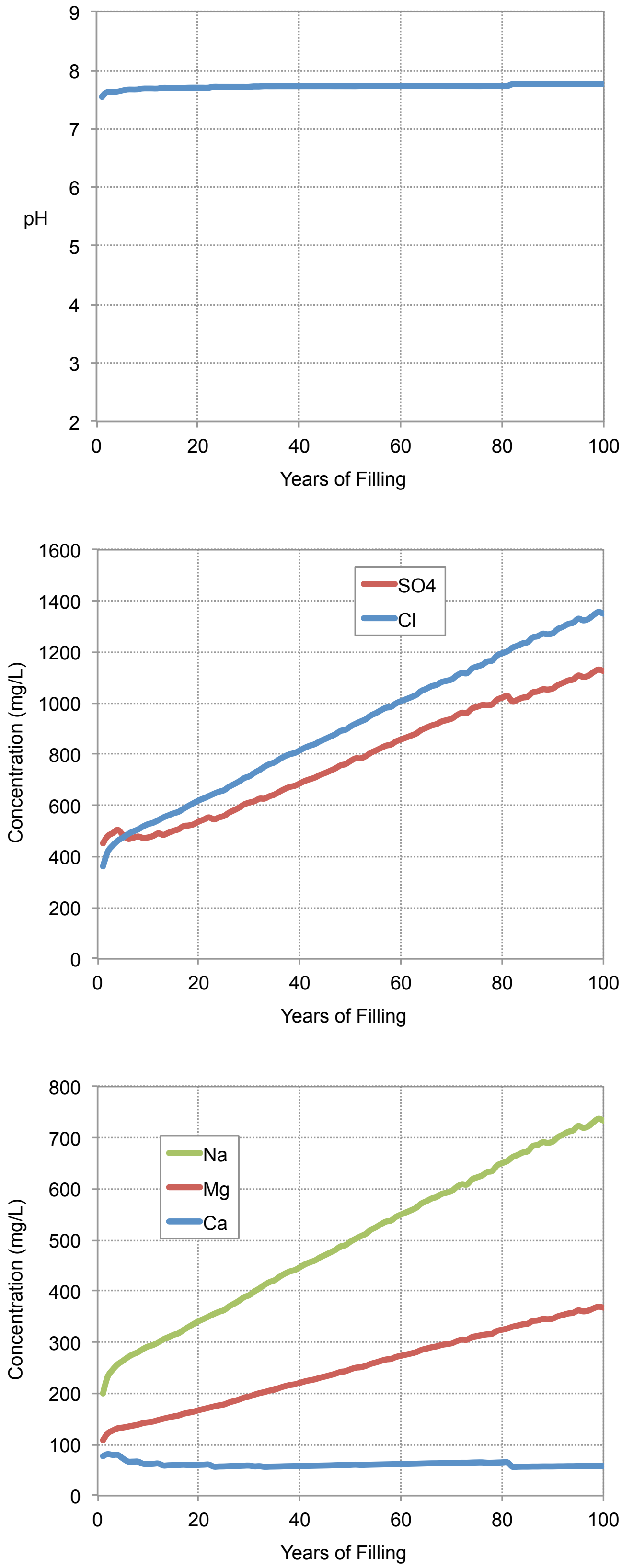


Figure 7: *Time series plots of predicted pH and concentrations of major anions and captions*

9. Sensitivity of Pit Water pH to Runoff from PAF Strata

The first few years will be of greatest concern in relation to ARD as this is when PAF floor rock and high wall strata will be exposed. Based on current assumptions, the model predicts that at the end of the first year there will be sufficient inflow of alkaline ground water and alkaline runoff from the spoil slope and weathered portion of the high wall to negate the acidity of surface runoff from PAF rock exposed around the base of the void. The model predicts that in Year 1, the inflows from PAF units represents less than 6% of total inflow, and in Years 2 and 3 when the pit floor is fully submerged the percentage of inflows from PAF units decreases to less than 1%. From Year 9 onward all PAF units are fully submerged.

In the event that surface runoff during the first few years is higher than currently assumed relative to the inflow of ground water inflow, then the pH of the developing pit lake could initially be lower than the base case shown in Figure 7. Figure 8 shows the effect of increasing the percentage of total inflow from PAF strata runoff on the pH of pit water for Year 1. The pH under the base case is marked as Point A in Figure 8. If the relative contribution of runoff from PAF strata was double in comparison to the base case then pit water at the end of the first year would be approximately pH 5 (Point B). At thee-times higher the pH would be less than 4 (Point C).

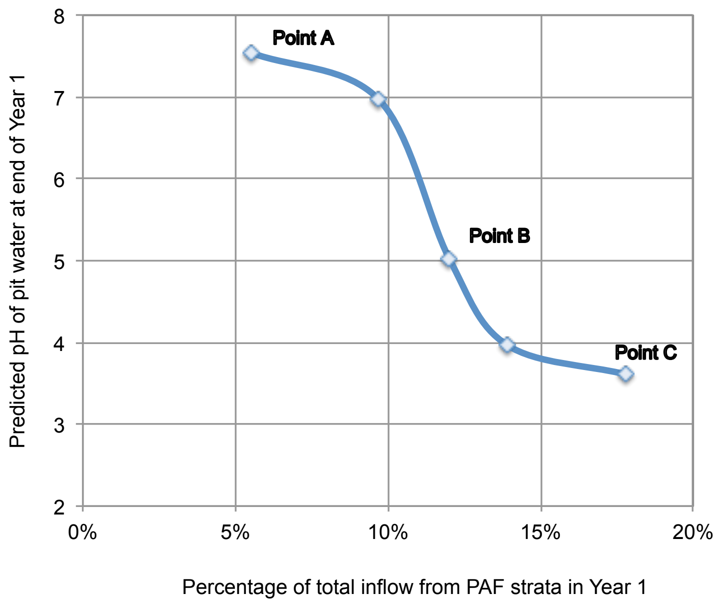


***Figure 8:** Effect of the relative percentage of inflow from PAF strata on the predicted pH of pit water in Year 1.*

However, it can be assumed that floor rock and PAF strata in the high wall will only contribute acidic runoff when they occur above the water level in the pit. This is based on the premise that a water cover, whilst not always preventing sulphide oxidation, will invariably decrease the availability of oxygen to submerged material to a level where the rates of sulphide oxidation and acid generation are unlikely to be inconsequential to the surrounding environment. Therefore, even if the relative contribution of surface runoff from PAF strata is much higher than expected during the first few years, it is expected that the amount of acid generation within the void

will be markedly lower once the void floor is fully inundated, and will effectively cease once the water level rises above the seam roof (around Year 7). The pH of the pit lake will then trend higher due to dilution and neutralisation by ongoing inflows of alkaline ground water and surface runoff from NAF spoil and the weathered portion of the high wall. Figure 9 shows the predicted change in pit water pH for a scenario where the proportion of inflow from surface runoff is about three times higher than for the base case. The pH of the pit water is predicted to be moderately acidic for the first six years, then increase markedly in Year 7, and remain circum-neutral thereafter.

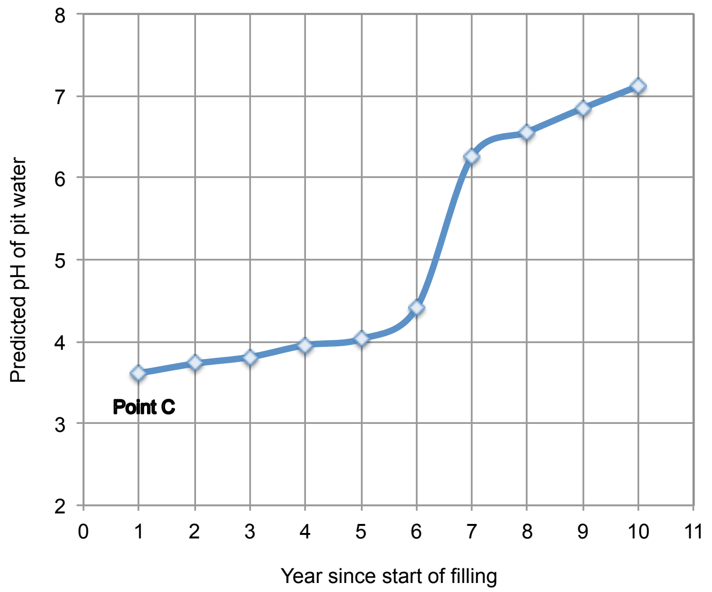


Figure 8: *Effect of the relative percentage of inflow from PAF strata on the predicted pH of pit water in Year 1.*

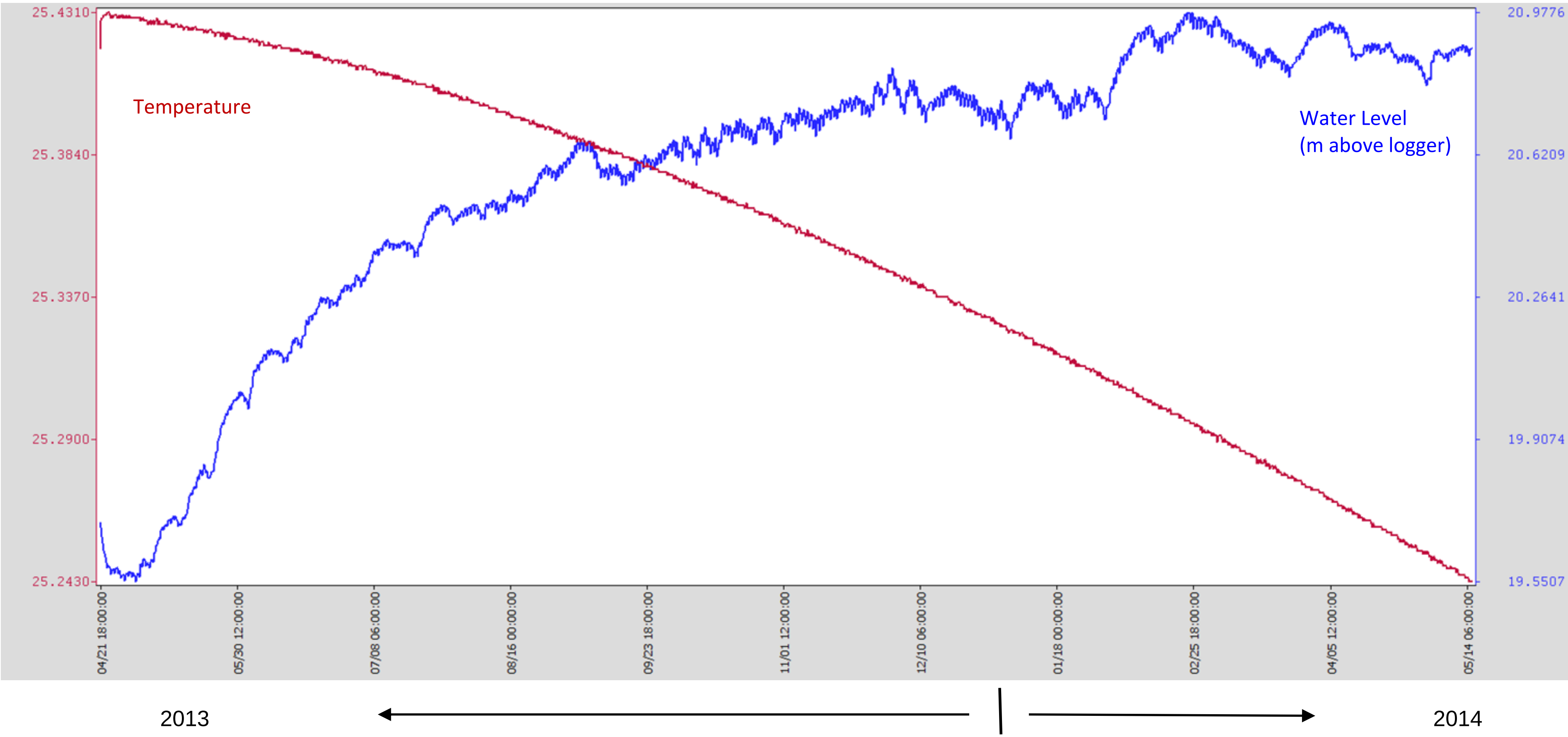
10. Summary

This memorandum provides predictions of pit lake quality for the final voids within the proposed Taroborah open cut. The predictions were based on a hydrogeochemical model developed for the eastern void that combined a mass-balance component for water and chemical inflows from a number of ground water and surface runoff sources, and a chemical speciation component (*Phreeqc*) for computation of the pH and chemical composition of the pit lake through time.

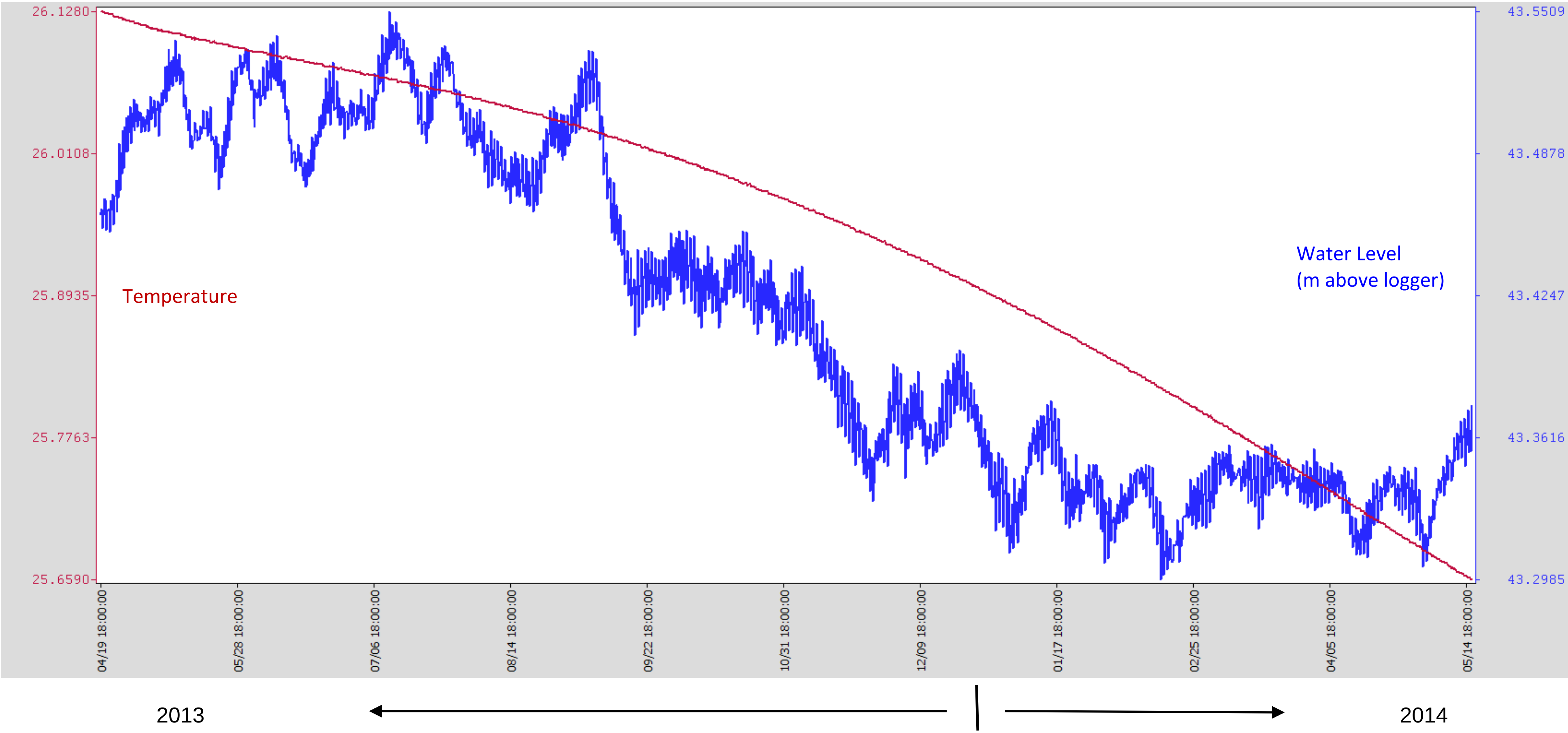
The pit floor and lower strata of the high wall (roof, coal seams and interburden) will comprise PAF materials and have the potential to generate ARD. However, the model predicts that inflows of alkaline ground water, together with alkaline runoff from in-pit spoil and upper weathered strata of the high wall, should be sufficient to neutralise acidity produced by the PAF rock units. Based on the assumptions made in the model, pit water is predicted to be circum-neutral throughout the 100 year period modelled. It is also predicted that salinity will gradually increase due to the inflow of slightly saline ground water and the concentrating effect of evaporative water loss.

ATTACHMENT F
Groundwater Level Hydrographs

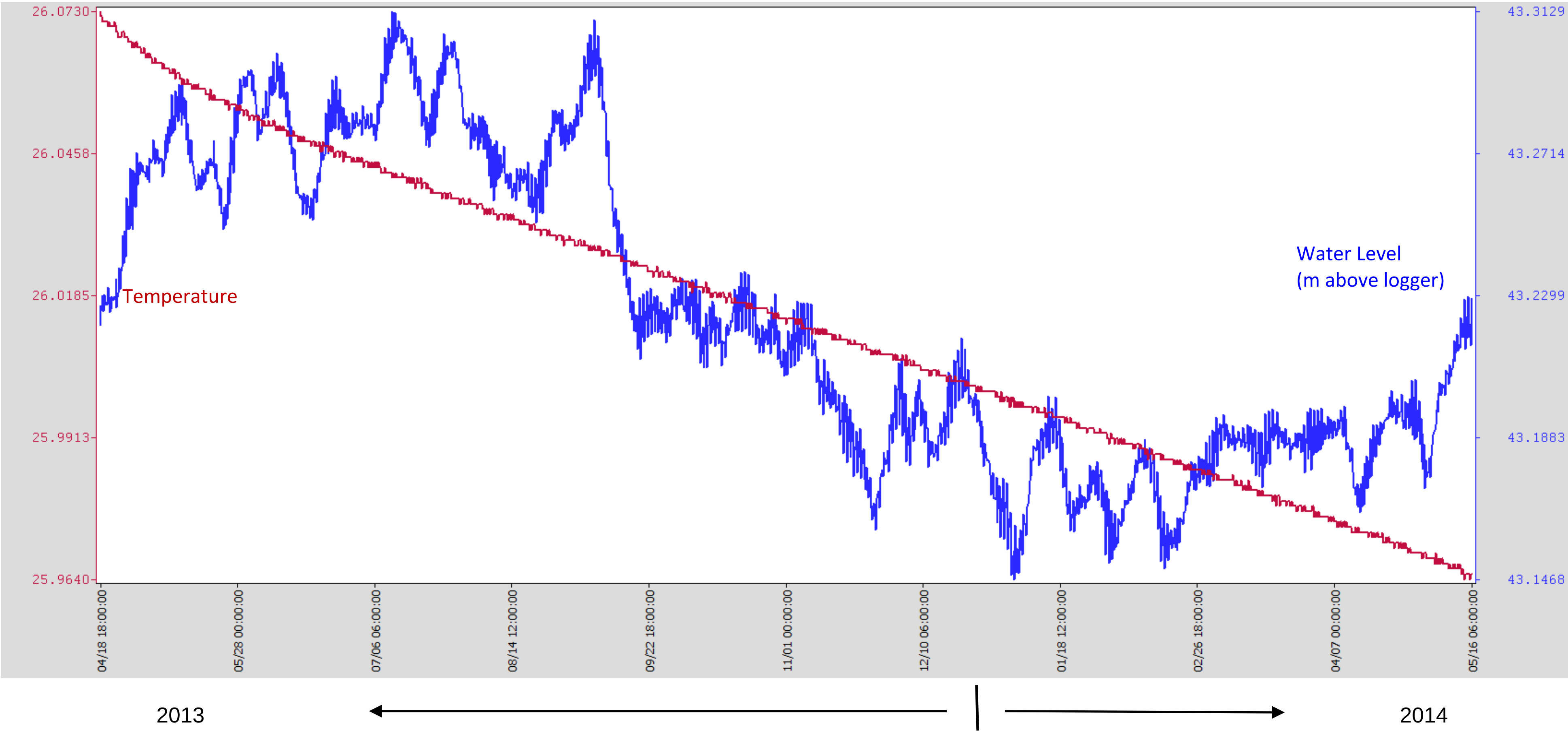
MB01


Temperature
Water Level
(m above logger)
25.4310
25.3840
25.3370
25.2900
25.2430
20.9776
20.6209
20.2641
19.9074
19.5507
04/21 18:00:00
05/30 12:00:00
07/08 06:00:00
08/16 00:00:00
09/23 18:00:00
11/01 12:00:00
12/10 06:00:00
01/18 00:00:00
02/25 18:00:00
04/05 12:00:00
05/14 06:00:00
2013
2014

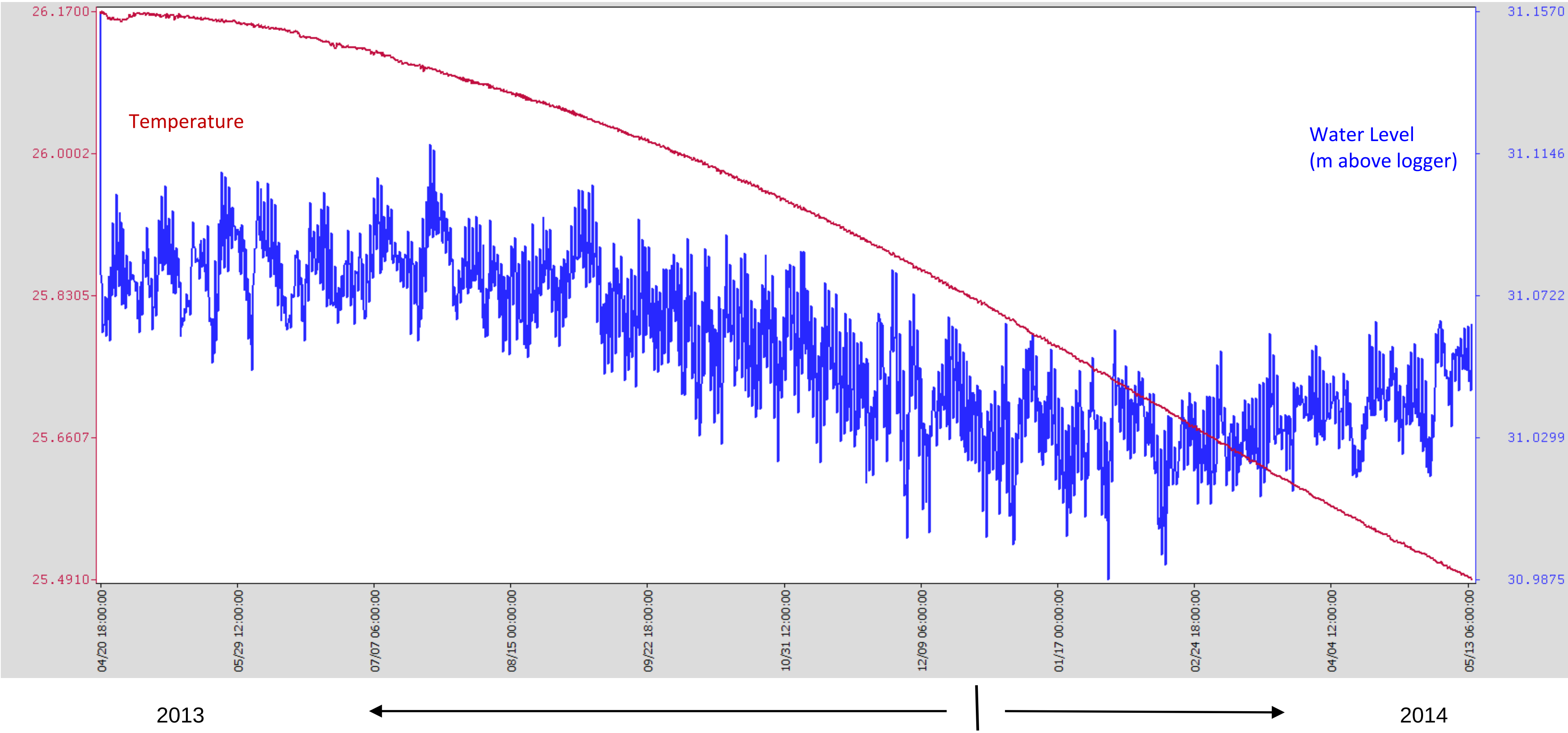
MB02C


26.1280
26.0108
25.8935
25.7763
25.6590
43.5509
43.4878
43.4247
43.3616
43.2985
Temperature
Water Level
(m above logger)
04/19 18:00:00
05/28 18:00:00
07/06 18:00:00
08/14 18:00:00
09/22 18:00:00
10/31 18:00:00
12/09 18:00:00
01/17 18:00:00
02/25 18:00:00
04/05 18:00:00
05/14 18:00:00
2013
2014

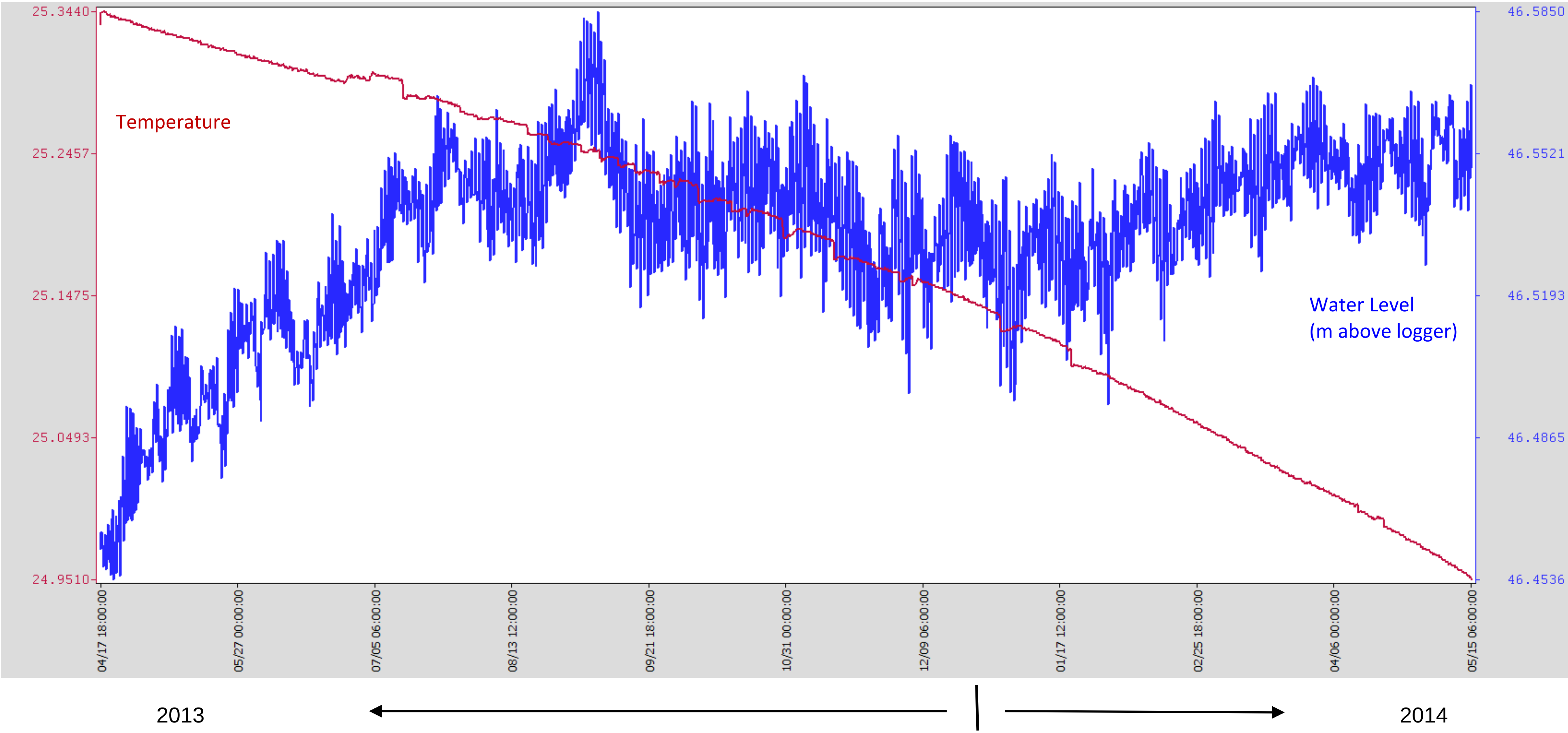
MB02S


26.0730
26.0458
26.0185
25.9913
25.9640
43.3129
43.2714
43.2299
43.1883
43.1468
Temperature
Water Level
(m above logger)
04/18 18:00:00
05/28 00:00:00
07/06 06:00:00
08/14 12:00:00
09/22 18:00:00
11/01 00:00:00
12/10 06:00:00
01/18 12:00:00
02/26 18:00:00
04/07 00:00:00
05/16 06:00:00
2013
2014

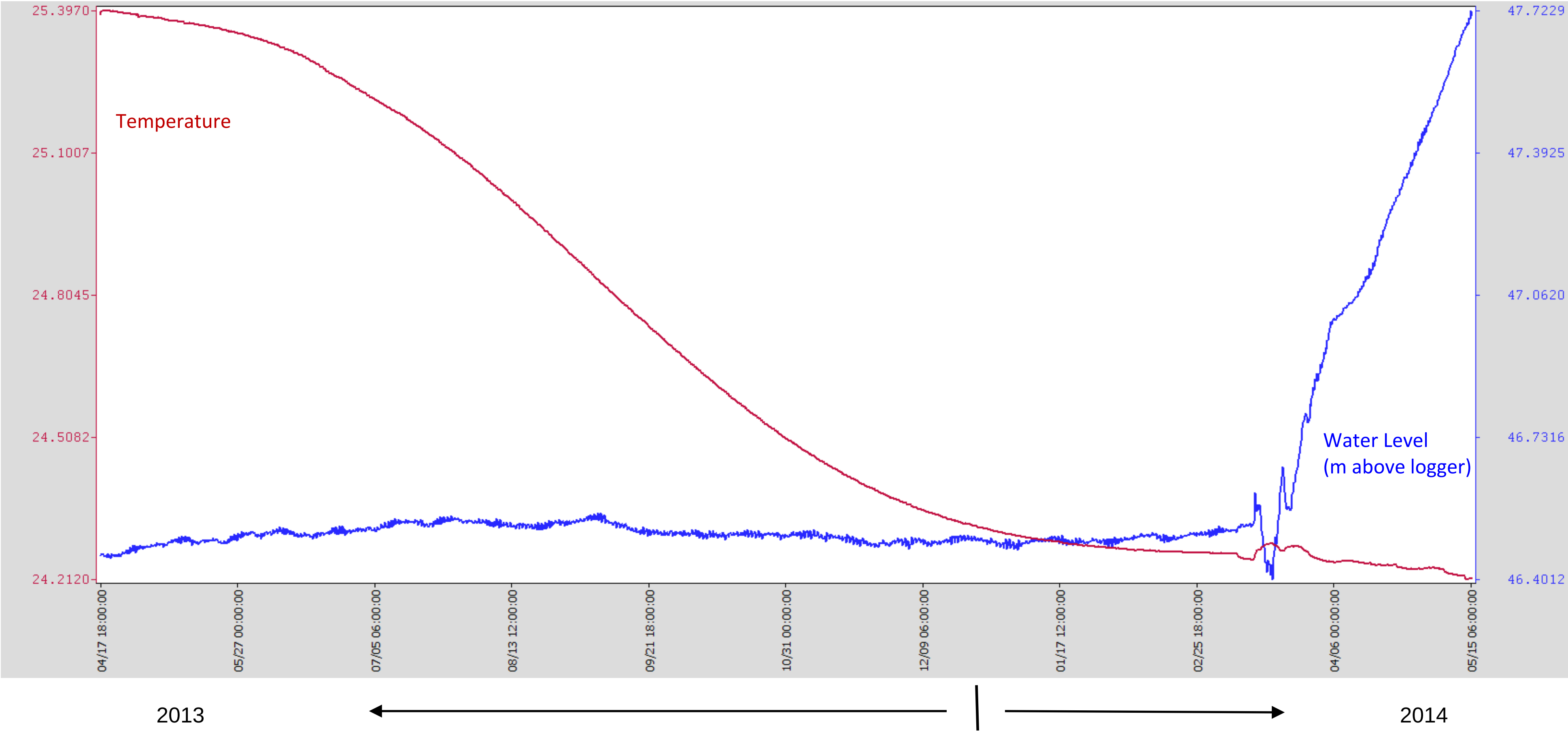
MB03S


26.1700
26.0002
25.8305
25.6607
25.4910
31.1570
31.1146
31.0722
31.0299
30.9875
Temperature
Water Level
(m above logger)
04/20 18:00:00
05/29 12:00:00
07/07 06:00:00
08/15 00:00:00
09/22 18:00:00
10/31 12:00:00
12/09 06:00:00
01/17 00:00:00
02/24 18:00:00
04/04 12:00:00
05/13 06:00:00
2013
2014

MB04C

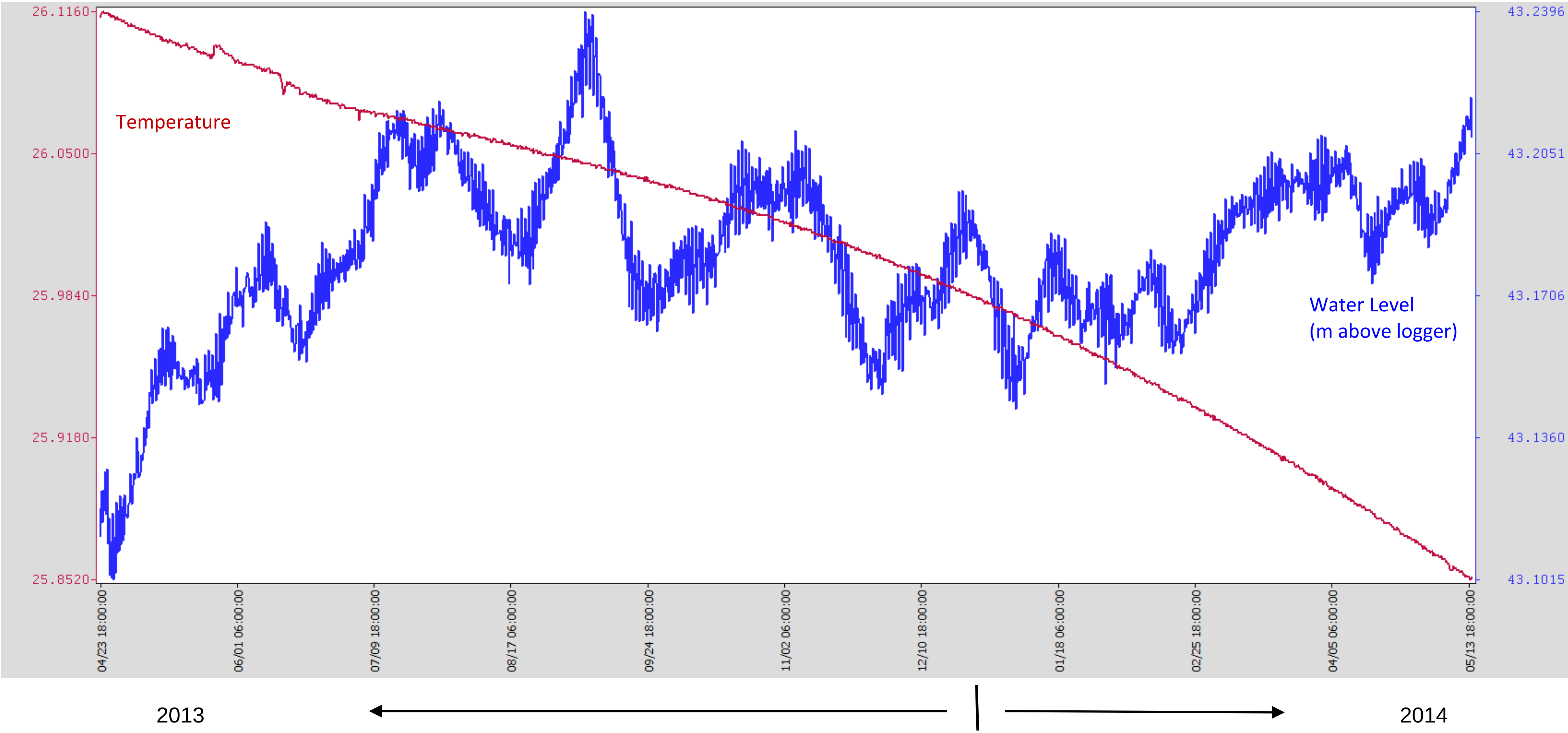

Temperature
Water Level
(m above logger)
25.3440
25.2457
25.1475
25.0493
24.9510
46.5850
46.5521
46.5193
46.4865
46.4536
04/17 18:00:00
05/27 00:00:00
07/05 06:00:00
08/13 12:00:00
09/21 18:00:00
10/31 00:00:00
12/09 06:00:00
01/17 12:00:00
02/25 18:00:00
04/06 00:00:00
05/15 06:00:00
2013
2014

MB04S

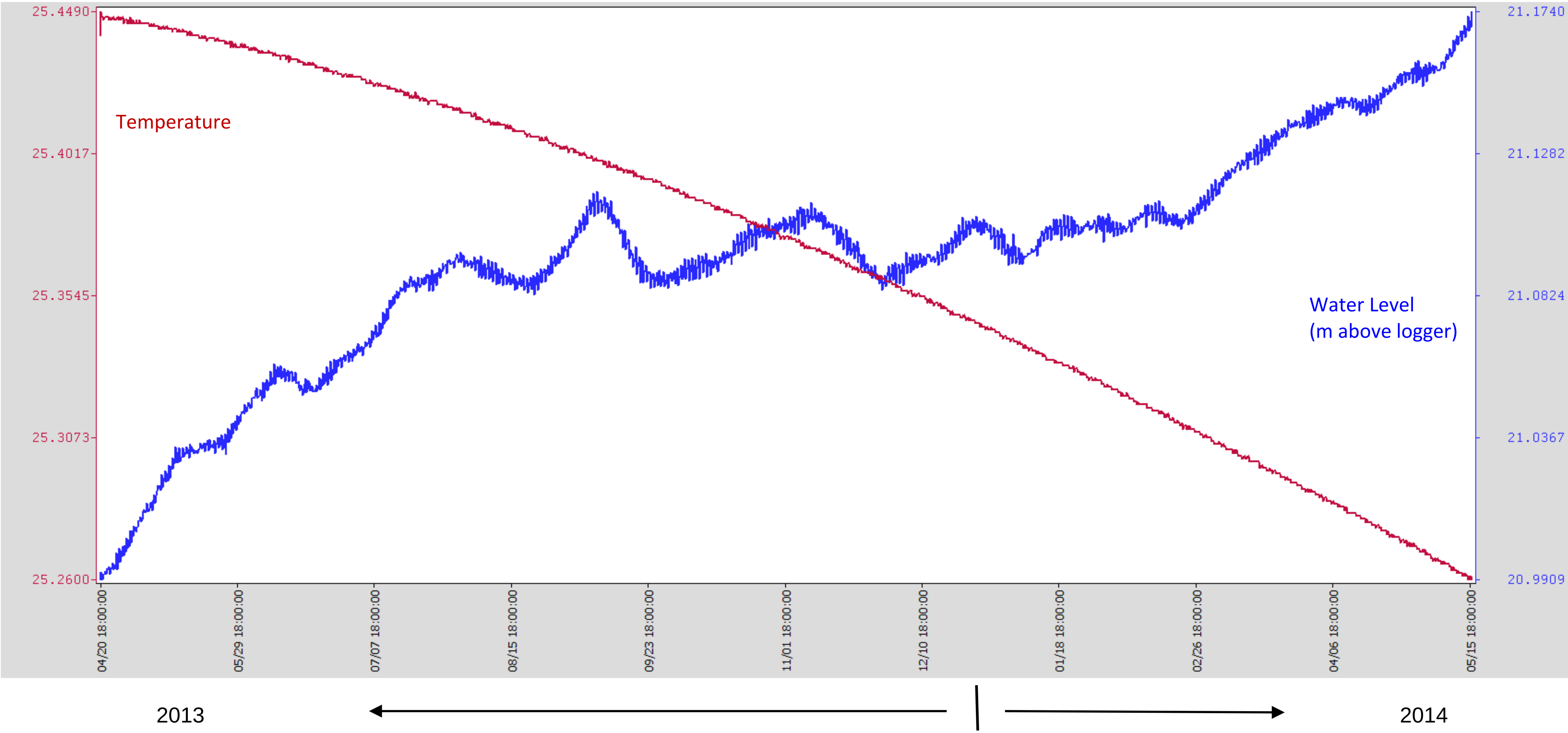


Note: This logger was not readable when visited in September 2014, which suggests that the large spike beginning in March 2014 is an aberration. This is also confirmed from the measurements made of standing water level below the collar, which were 43.85m in April 2013, 43.80m in May 2014, and 43.73m in September 2014.

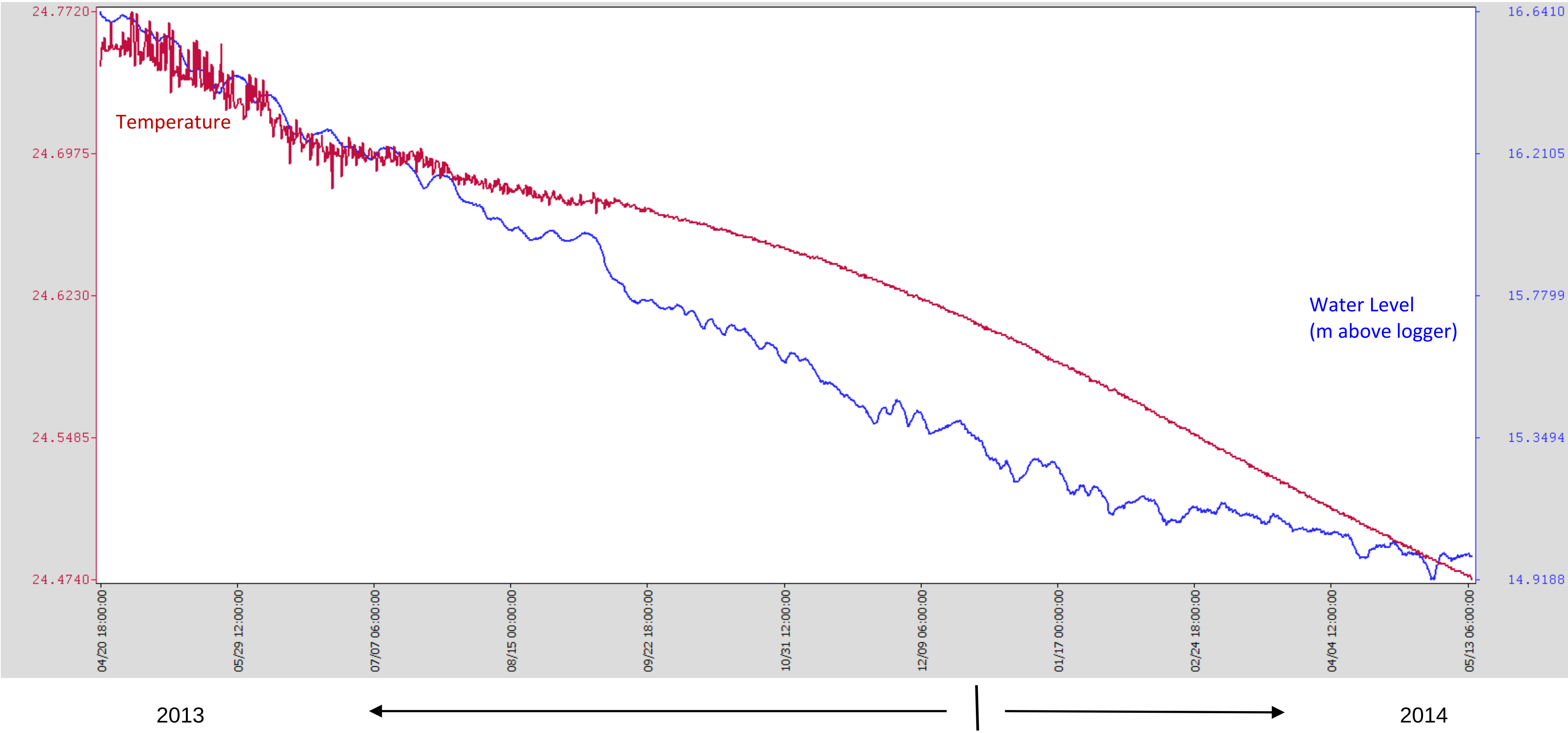
MB05C


26.1160
26.0500
25.9840
25.9180
25.8520
43.2396
43.2051
43.1706
43.1360
43.1015
Temperature
Water Level
(m above logger)
04/23 18:00:00
06/01 06:00:00
07/09 18:00:00
08/17 06:00:00
09/24 18:00:00
11/02 06:00:00
12/10 18:00:00
01/18 06:00:00
02/25 18:00:00
04/05 06:00:00
05/13 18:00:00
2013
2014

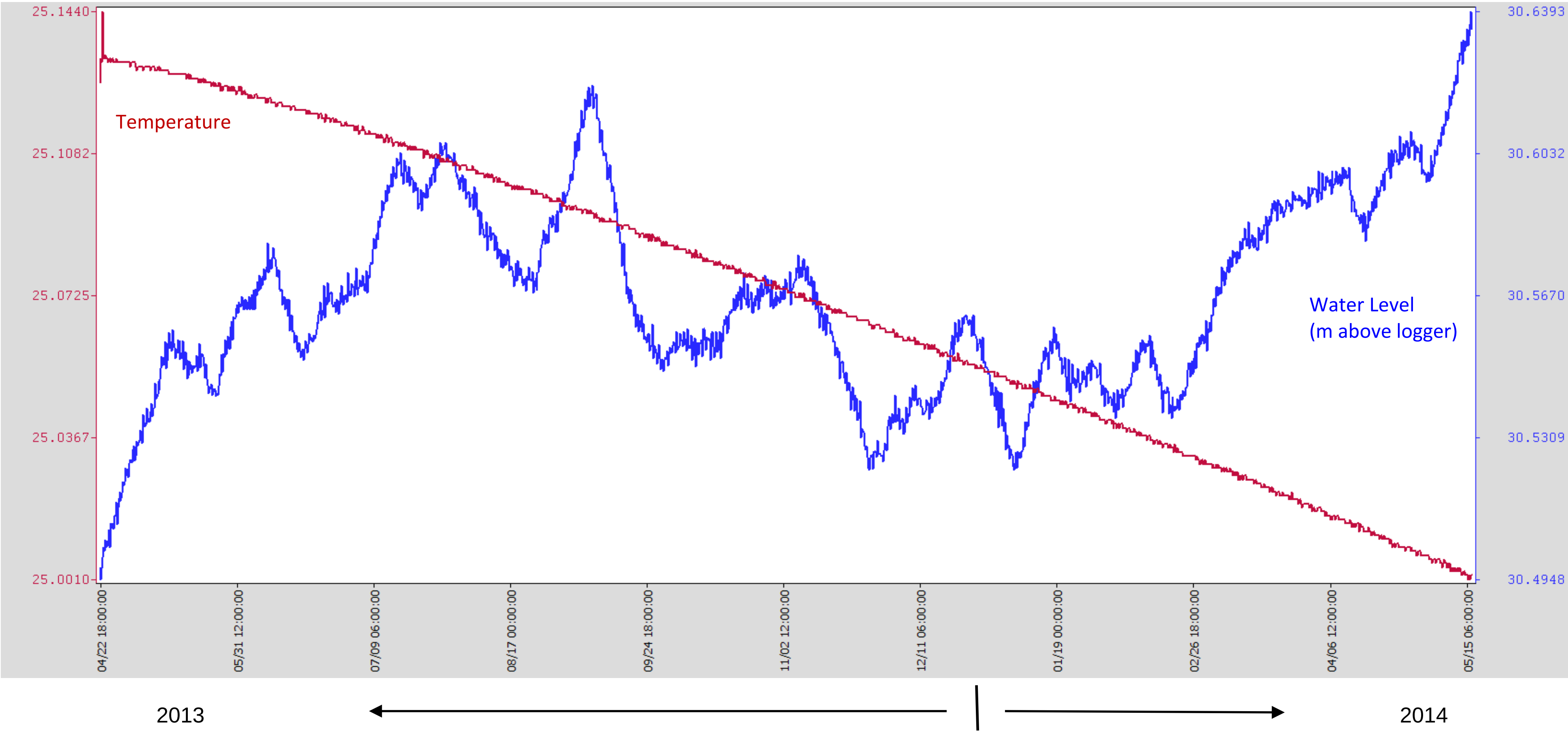
MB08B


25.4490
25.4017
25.3545
25.3073
25.2600
21.1740
21.1282
21.0824
21.0367
20.9909
Temperature
Water Level
(m above logger)
04/20 18:00:00
05/29 18:00:00
07/07 18:00:00
08/15 18:00:00
09/23 18:00:00
11/01 18:00:00
12/10 18:00:00
01/18 18:00:00
02/26 18:00:00
04/06 18:00:00
05/15 18:00:00
2013
2014

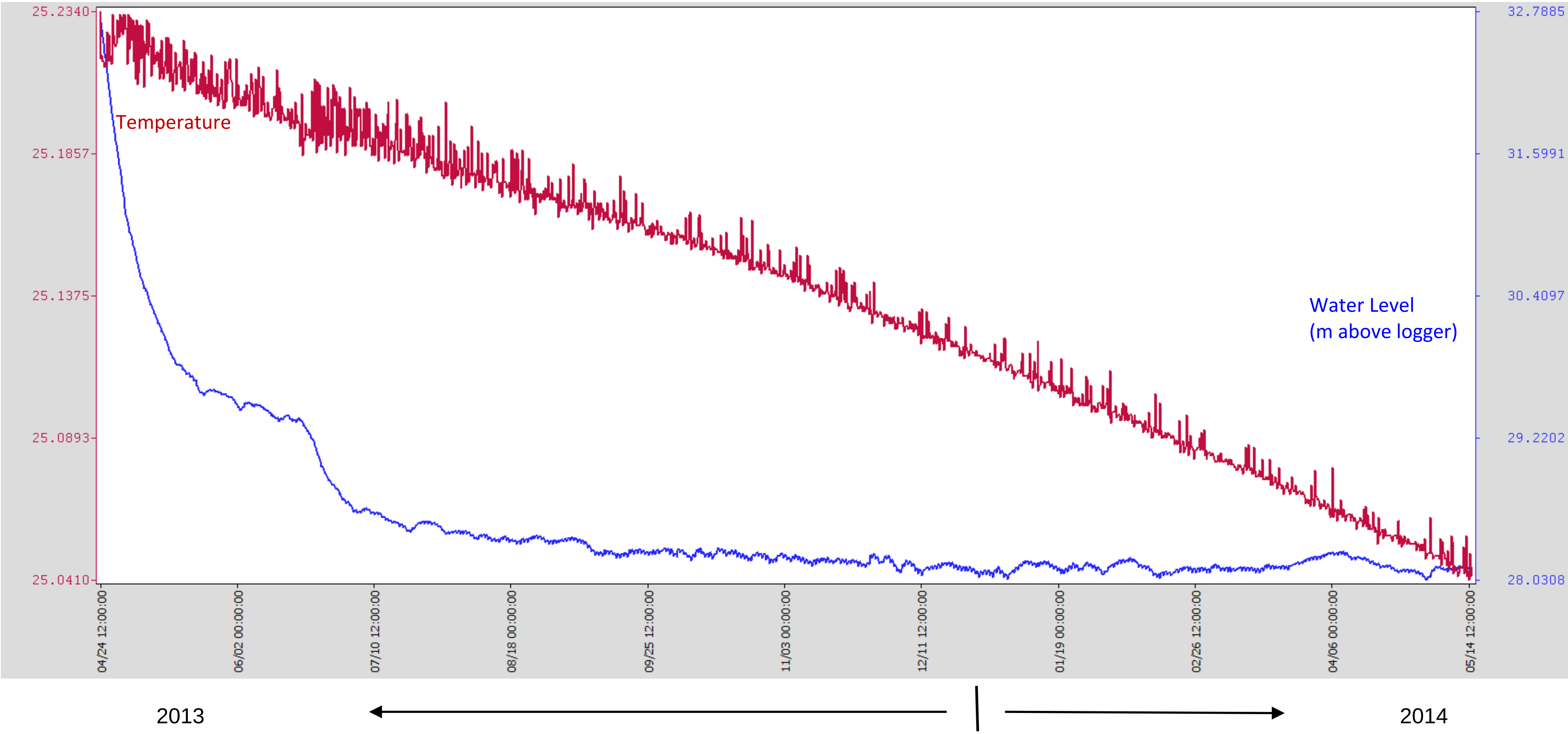
MB10T


24.7720
24.6975
24.6230
24.5485
24.4740
16.6410
16.2105
15.7799
15.3494
14.9188
Temperature
Water Level
(m above logger)
04/20 18:00:00
05/29 12:00:00
07/07 06:00:00
08/15 00:00:00
09/22 18:00:00
10/31 12:00:00
12/09 06:00:00
01/17 00:00:00
02/24 18:00:00
04/04 12:00:00
05/13 06:00:00
2013
2014

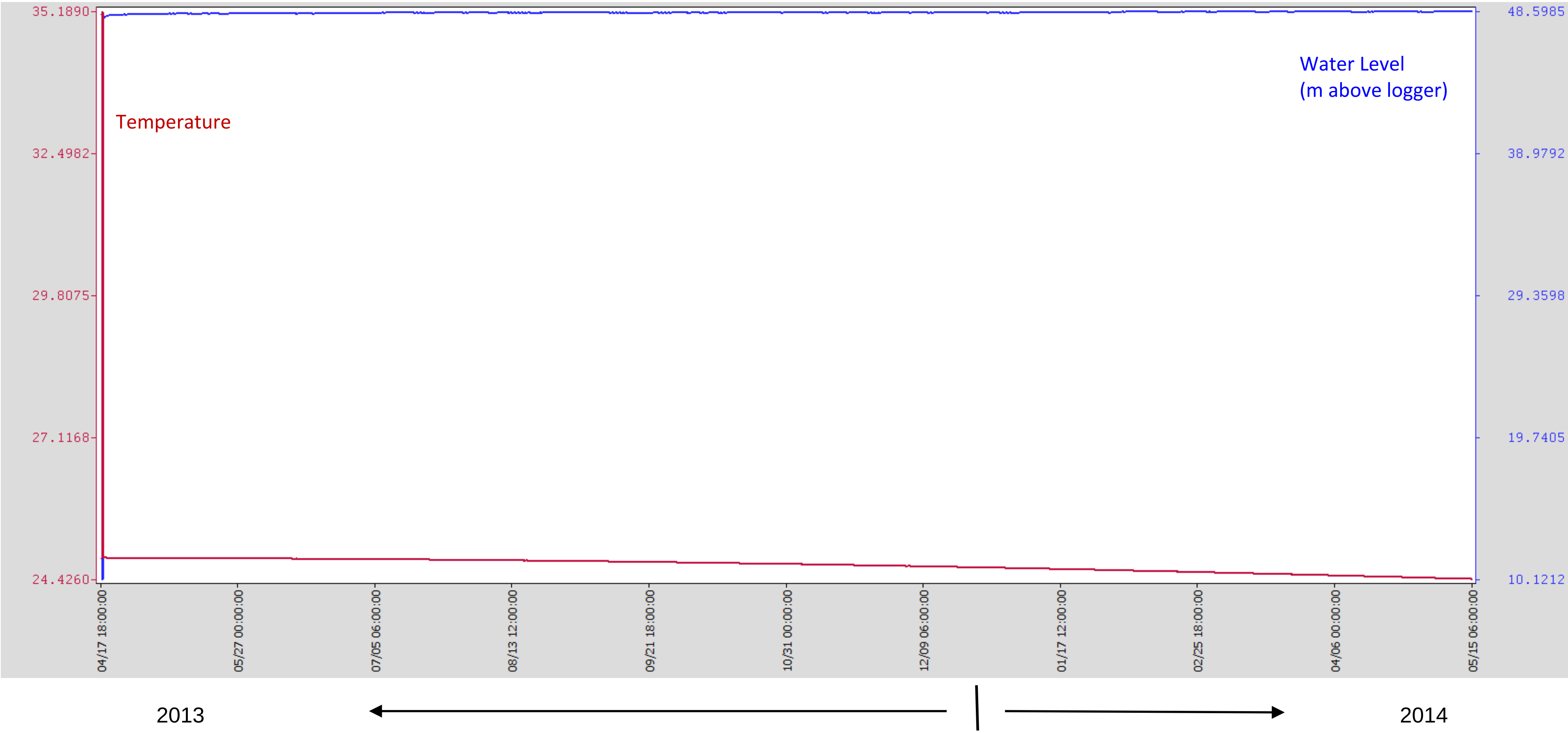
TAR016C


25.1440
25.1082
25.0725
25.0367
25.0010
30.6393
30.6032
30.5670
30.5309
30.4948
Temperature
Water Level
(m above logger)
04/22 18:00:00
05/31 12:00:00
07/09 06:00:00
08/17 00:00:00
09/24 18:00:00
11/02 12:00:00
12/11 06:00:00
01/19 00:00:00
02/26 18:00:00
04/06 12:00:00
05/15 06:00:00
2013
2014

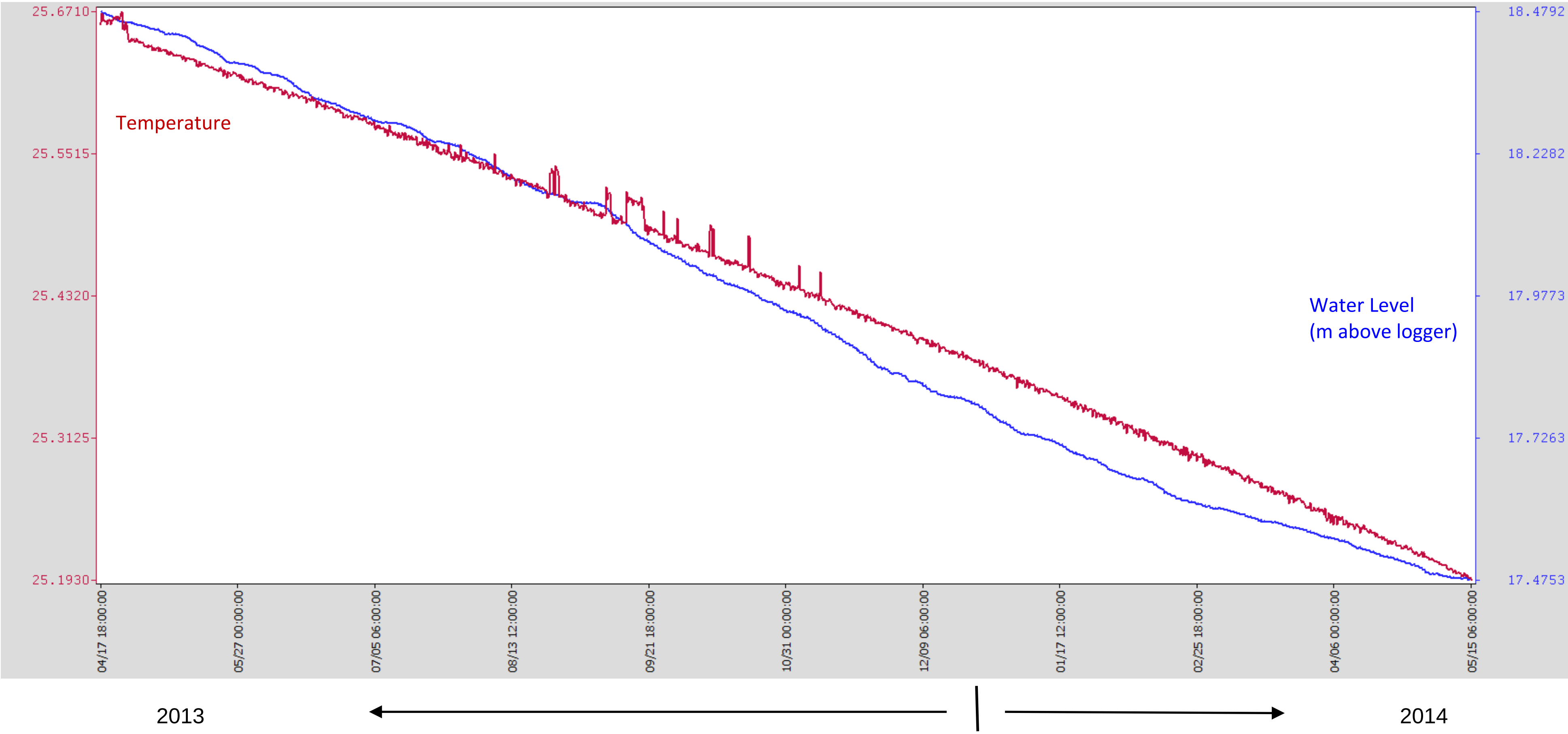
TAR040C


25.2340
25.1857
25.1375
25.0893
25.0410
32.7885
31.5991
30.4097
29.2202
28.0308
Temperature
Water Level
(m above logger)
04/24 12:00:00
06/02 00:00:00
07/10 12:00:00
08/18 00:00:00
09/25 12:00:00
11/03 00:00:00
12/11 12:00:00
01/19 00:00:00
02/26 12:00:00
04/06 00:00:00
05/14 12:00:00
2013
2014

TAR176C


35.1890
32.4982
29.8075
27.1168
24.4260
48.5985
38.9792
29.3598
19.7405
10.1212
Temperature
Water Level
(m above logger)
04/17 18:00:00
05/27 00:00:00
07/05 06:00:00
08/13 12:00:00
09/21 18:00:00
10/31 00:00:00
12/09 06:00:00
01/17 12:00:00
02/25 18:00:00
04/06 00:00:00
05/15 06:00:00
2013
2014

TAR177B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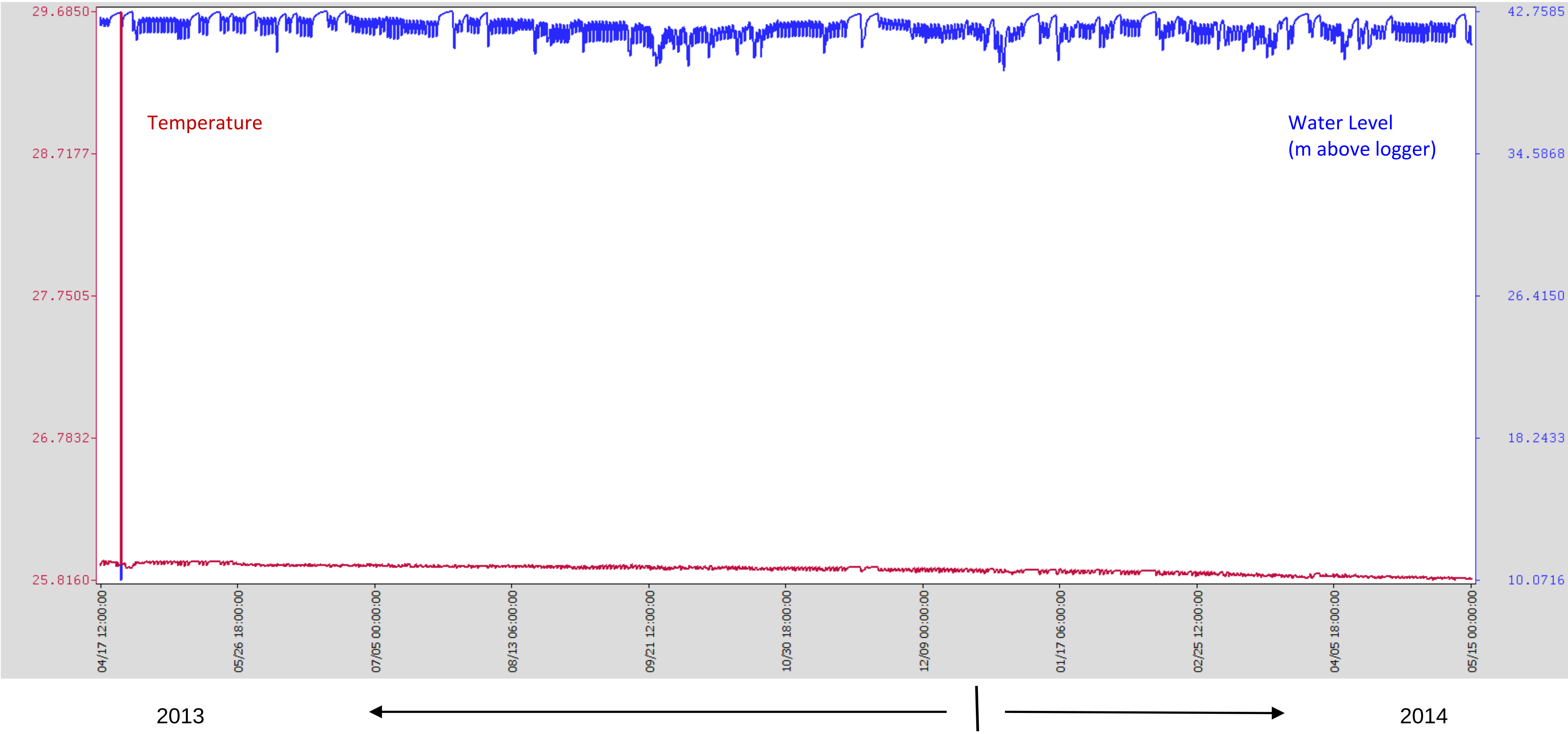
25.5515
25.4320
25.3125
25.1930
18.4792
18.2282
17.9773
17.7263
17.4753
Temperature
Water Level
(m above logger)
04/17 18:00:00
05/27 00:00:00
07/05 06:00:00
08/13 12:00:00
09/21 18:00:00
10/31 00:00:00
12/09 06:00:00
01/17 12:00:00
02/25 18:00:00
04/06 00:00:00
05/15 06:00:00
2013
2014

TAR249C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28.7177
27.7505
26.7832
25.8160
Temperature
Water Level
(m above logger)
42.7585
34.5868
26.4150
18.2433
10.0716
04/17 12:00:00
05/26 18:00:00
07/05 00:00:00
08/13 06:00:00
09/21 12:00:00
10/30 18:00:00
12/09 00:00:00
01/17 06:00:00
02/25 12:00:00
04/05 18:00:00
05/15 00:00:00
2013
2014