GEMINI PROJECT
Site-Specific EA Application

MAGNETIC SOUTH PTY LTD
December 2020

VOLUME 1:

- Revised Supporting Information
- Appendix A: Traffic Impact Assessment
- Appendix B: Surface Water Assessment

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AARC Environmental Solutions Pty Ltd

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Site-specific EA Application: Revised Supporting Information

PREPARED FOR

MAGNETIC SOUTH PTY LTD

DECEMBER 2020

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GEMINI PROJECT
EA APPLICATION

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ABBREVIATIONS, ACRONYMS, AND GLOSSARY OF TERMS

<	less than
>	more than
AARC	AARC Environmental Solutions Pty Ltd
AEP	annual exceedance probability
AMD	acid mine drainage
ANFO	ammonium nitrate fuel oil
ANZG	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
ANZMEC	Australian and New Zealand Minerals and Energy Council
AQMP	*Air Quality Management Plan*
AS	Australian Standard
ASK	Trinity Consultants Australia Pty Ltd trading as ASK Consulting Engineers
ATP	authority to prospect
AusRivAS	Australian River Assessment System
AVH	The Australasian Virtual Herbarium
Biosecurity Act	*Biosecurity Act 2014* (Qld)
BoM	Bureau of Meteorology
BOYD	John T. Boyd Company
Cardno	Cardno (Qld) Pty Ltd
CEC	cation exchange capacity
CH_4	methane
CHPP	coal handling and preparation plant
CHRC	Central Highlands Regional Council
CMSH Act	*Coal Mining Safety and Health Act 1999*
CMSH Regulation	Coal Mining Safety and Health Regulation 2017
CO_2	carbon dioxide
CO_2-e	carbon dioxide equivalent
CSIRO	Commonwealth Scientific and Industrial Research Organisation

DA	former Department of Agriculture (WA)
DAF	Department of Agriculture and Fisheries (Qld)
DATSIP	Department of Aboriginal and Torres Strait Islander Partnerships (Qld)
DES	Department of Environment and Science (Qld)
DEWHA	former Department of the Environment, Water, Heritage and the Arts (Cth)
DFAT	Department of Foreign Affairs and Trade (Cth)
DME	former Department of Minerals and Energy (Qld)
DNRM	former Department of Natural Resources and Mines (Qld)
DNRME	Department of Natural Resources, Mines and Energy (Qld)
DoEE	Department of the Environment and Energy (Cth)
DSA	design storage allowance
DSITI	former Department of Science, Information Technology and Innovation (Qld)
E	east
e.g.	'*for example'*
EA Application	'*Site-specific application for a new environmental authority for a resource activity'*
EA	environmental authority
EC	electrical conductivity
EHP	former Department of Environment and Heritage Protection (Qld)
EIS	Environmental Impact Statement
EP Act	*Environmental Protection Act 1994* (Qld)
EP Regulation	*Environmental Protection Regulation 2019* (Qld)
EP	equivalent person
EPA Victoria	Environmental Protection Agency Victoria (Vic)
EPA	Environmental Protection Agency (US)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
EPC	exploration permit for coal
EPP (Air)	*Environmental Protection (Air) Policy 2019* (Qld)
EPP (Noise)	*Environmental Protection (Noise) Policy 2019* (Qld)
EPP (WWB)	*Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (Qld)
ERA	environmentally relevant activity
ERC	estimated rehabilitation cost
ESCP	*Erosion and Sediment Control Plan*
ESP	exchangeable sodium percentage
etc.	*'and other similar things'*

EV	environmental value
GDE	groundwater dependent ecosystem
GHG	greenhouse gas
HES	high ecological significance
i.e.	*'in other words'*
ICPMS	inductively coupled plasma mass spectrometry
IECA	International Erosion Control Association
INAP	International Network on Acid Prevention
JBT	JBT Consulting Pty Ltd
K	site and rock constant
Katestone	Katestone Environmental Pty Ltd
KLC	kinetic leach column
L_{90}	'A' weighted sound pressure level equalled or exceeded 90% of the time
$L_{Aeq,adj,T}$	the L_{eq} adjusted for tonal or impulsive noise characteristics and with a measurement interval of 'T' duration (e.g., 15 minutes, 1 hour).
LC	least concern
L_{eq}	equivalent continuous sound level
LGA	local government area
LOR	limit of reporting
Magnetic South	Magnetic South Pty Ltd (the Proponent)
MAW	mine affected water
MDL	mineral development licence
MERFP Act	*Mineral and Energy Resources (Financial Provisioning) Act 2018* (Qld)
MGA	Map Grid of Australia
MIA	mine infrastructure area
ML	mining lease
MLA	mining lease application
MRL	mandatory reporting level
MSES	Matter(s) of State Environmental Significance
N	north
n/a	not applicable
N_2O	nitrous oxide
NAF	non-acid forming

NATA	National Association of Testing Authorities
NC Act	*Nature Conservation Act 1992* (Qld)
NC	no concern at present
NE	northeast
NGER Act	*National Greenhouse and Energy Reporting Act 2007* (Cth)
NGER Determination	*National Greenhouse and Energy Reporting (Measurement) Determination 2008* (Cth)
NGER Guidelines	*National Greenhouse and Energy Reporting Guidelines*
NGER Scheme	*National Greenhouse and Energy Reporting Scheme*
No.	number
NPI	National Pollution Inventory
NPV	net present value
NT	near threatened
NUMA	non-use management area
OC	of concern
PAF	potentially acid forming
PCA	potential commercial area
PCI	pulverised coal injection
PET	Plecoptera, Ephemeroptera, Trichoptera
pH	'*scale used to specify how acidic or basic a water-based solution is'*
PM_{10}	particulate matter with equivalent aerodynamic diameters of 10 µm or less
$PM_{2.5}$	particulate matter with equivalent aerodynamic diameters of 2.5 µm or less
PMF	probable maximum flood
PMLU	post-mining land use
PPE	personal protective equipment
PPV	peak particle velocity
PRCP	*Progressive Rehabilitation and Closure Plan*
QGC	Queensland Gas Company
RE	regional ecosystem
REMP	*Receiving Environment Monitoring Program*
RGS	RGS Environmental Pty Ltd
RIS	restricted invasive species
RN	registration number

ROM	run-of-mine
SE	southeast
SILO	Scientific Information for Land Owners
SLC	special least concern
SMD	slightly to moderately disturbed
SMU	soil management unit
SQG	sediment quality guideline
STP	sewage treatment plant
SWL	surface water level
SWMS	Site Water Management System
TBA	'*to be assigned'*
TDS	total dissolved solids
TEC	threatened ecological community
the Project	Gemini Project
TLO	train load out
TSP	total suspended particulate matter
TSSC	Threatened Species Scientific Committee
V	vulnerable
V:H	vertical to horizontal ratio
VC	vegetation community
VM Act	*Vegetation Management Act 1999* (Qld)
W	west
Water Act	*Water Act 2000* (Qld)
WoNS	weed(s) of national significance
WQO	water quality objective
WRM	WRM Water and Environment Pty Ltd

UNITS OF MEASUREMENT

%	percent
°	degree(s)
°C	degree(s) Celsius
cm	centimetre(s)

dB	decibel(s)
dBA	‘A’ weighted decibel
dBZ	decibel relative to ‘Z’
dS/m	deciSiemens per metre
ha	hectare(s)
Hz	Hertz
kg/ha	kilogram(s) per hectare
kL	kilolitre(s)
km	kilometre(s)
km^2	square kilometre(s)
kt CO_2-e	kilotonne(s) of carbon dioxide equivalent
kt	kilotonne(s)
kV	kilovolt(s)
L	litre(s)
L/s	litre(s) per second
m	metre(s)
m/day	metre(s) per day
m/s	metre(s) per second
m^2	square metre(s)
m^3	cubic metre(s)
m^3/day	cubic metre(s) per day
mAHD	metre(s) in Australian Height Datum
Mbcm	million bank cubic metre(s)
mbgl	metre(s) below ground level
meq/100g	milliequivalent per 100 grams
mg/kg	milligram(s) per kilogram
mg/L	milligram(s) per litre
mg/m^2/day	milligram(s) per square metre per day
Ml	megalitre(s)
ml	millilitre(s)
Ml/a	megalitre(s) per annum
mm	millimetre(s)
mm/s	millimetre(s) per second

Mt	million tonne(s)
Mtpa	million tonne(s) per annum
NTU	Nephelometric Turbidity Unit
t	tonne(s)
t/a	tonne(s) per annum
TJ	terajoule(s)
µg/L	microgram(s) per litre
µg/m^3	microgram(s) per cubic metre
µm	micrometre(s)
µS/cm	microSiemens per centimetre

1.0 INTRODUCTION

AARC Environmental Solutions (AARC) was commissioned by Magnetic South Pty Ltd (Magnetic South; the Proponent) to prepare an environmental authority (EA) application for the Gemini Project (the Project). This report provides the supporting information to be considered as part of the EA Application to the Department of Environment and Science (DES) in consideration of Sections 125 and 126A of the *Environmental Protection Act 1994* (EP Act).

This document provides a description of the Project, environmentally relevant activities (ERAs), environmental values (EVs), potential impacts of the ERAs on the identified EVs, and mitigation measures and management commitments.

1.1 THE PROPONENT

The Proponent for the Gemini Project is:

Magnetic South Pty Ltd

Suite 302, Level 3, 102 Adelaide Street, Brisbane, Queensland, 4000

ABN: 95 122 465 749

ACN: 122 465 749

Magnetic South is a private Australian based company which was founded in 2006. The executive team of Magnetic South has some 60 years' experience in the development and operation of metallurgical coal assets and agribusiness in central Queensland.

Magnetic South is the registered entity proposing to carry out the Project, and all permits and licences are held and will be issued to that entity.

1.2 ENVIRONMENTAL IMPACT STATEMENT TRIGGERS

The proposed EA Application does not trigger the requirement for an Environmental Impact Statement (EIS) under the EP Act. The Project does not propose any petroleum or coal seam gas activities. EIS triggers for a new application for mining activities are summarised below in Table 1.

1.3 CONTENT OF SUPPORTING INFORMATION

In accordance with Section 125 and 126A of the EP Act, this document includes the information described in Table 2.

1.4 ENVIRONMENTALLY RELEVANT ACTIVITIES

ERAs include resource activities or specific agricultural activities or other activities as defined by the EP Act. Current prescribed ERAs and resource activities are specified in Schedules 2 and 3, respectively, of the *Environmental Protection Regulation 2019* (EP Regulation). The Project will include the resource activity of "mining black coal" as well as the ancillary activities outlined in Table 3 which require approval as part of the EA Application.

1.5 NOTIFIABLE ACTIVITIES

Notifiable activities are activities that have the potential to cause land contamination. The notifiable activities listed under Schedule 3 of the EP Act relevant to the Project are provided in Table 4.

Table 1 EIS Trigger Criteria

EIS Trigger	Yes / No
For greenfield (new) mine proposals	
Would the application involve the removal of two million tonnes per year or more of run-of-mine (ROM) ore or coal?	**No.** The Gemini Project is proposing the removal of up to 1.9 Mtpa of ROM coal, averaging 1.8 Mtpa over the production life of the Project.
Would the application involve the removal of one million tonnes per year or more of ROM ore or coal on or under a floodplain or in a coastal hazard area?	**No.** The Gemini Project is not proposing the removal of 1 Mtpa or more of ROM coal under a floodplain as defined by the *Water Act 2000*.The Gemini Project is not located in a coastal hazard area.
Would the application involve the introduction of a novel or unproven resource extraction process, technology or activity?	**No.** The Gemini Project is proposing a traditional truck and shovel operation, and proven processing approach.

Table 2 EP Act Requirements for Supporting Information

Component	Relevant Section
Section 125 – Requirements for applications generally	
Description of all environmentally relevant activities for the application.	Section 1.4 and Table 3
Description of any development permit under the Planning Act, or State Development Area approval under the State Development Act required for carrying out the environmentally relevant activities for the application.	No approvals are required under the *Planning Act 2016* or *State Development and Public Works Organisation Act 1971*.
Description of the land on which each activity will be carried out.	Section 5.0
Assessment of the likely impact of each relevant activity on environmental values, including: • a description of the environmental values likely to be affected by each relevant activity; • details of any emissions or releases likely to be generated by each relevant activity; • a description of the risk and likely magnitude of impacts on the environmental values; • details of the management practices proposed to be implemented to prevent or minimise adverse impacts; and • details of how the land, the subject of the application will be rehabilitated after each relevant activity ceases.	EVs, emissions or releases, risk and magnitude of impacts, and proposed management practices are detailed within each 'environmental' section. This constitutes Section 5.0 through to Section 13.0. Section 4.0
Description of the proposed measures for minimising and managing waste generated by each relevant activity.	Section 12.5 and Section 12.7
Details of any site management plan that relates to the application.	Details of relevant management plans are covered in the *Mitigation Measures, Management and Monitoring* subsection of each 'environmental' section (Section 5.0 through to Section 13.0).
Section 126A – Requirements for site-specific applications – particular resource projects and resource activities	
Any proposed exercise of underground water rights during the period in which resource activities will be carried out under the relevant tenure.	Section 8.3
The areas in which underground water rights are proposed to be exercised.	Pit AB and Pit C mining areas as specified in the conceptual layout (Figure 7) and mine stage plans (Figure 23 through to Figure 32).
For each aquifer affected, or likely to be affected, by the exercise of underground water rights: • a description of the aquifer; • an analysis of the movement of underground water to and from the aquifer, including how the aquifer interacts with other aquifers and surface water; • a description of the area of the aquifer where the water level is predicted to decline because of the exercise of underground water rights; and • the predicted quantities of water to be taken or interfered with because of the exercise of underground water rights during the period in which resource activities are carried out.	Section 8.2.1 Section 8.2.4 and Figure 71 Section 6.3.1 and Section 6.4.1 Section 8.3.3, Figure 74 and Figure 75 Table 12 and Table 13.
The environmental values that will, or may, be affected by the exercise of underground water rights and the nature and extent of the impacts on the environmental values.	Section 8.2 Section 8.3.3 and Section 8.3.4
Any impacts on the quality of groundwater that will, or may, happen because of the exercise of underground water rights during or after the period in which resource activities are carried out.	Section 8.3.3
Strategies for avoiding, mitigating or managing the predicted impacts on the environmental values or the impacts on the quality of groundwater.	Section 8.4

Table 3 Applicable ERAs for the Project

Environmentally Relevant Activity	Description
Schedule 2 (Prescribed ERAs)	
8 (1) (c) Chemical storage	Chemical storage (the relevant activity) consists of storing more than 500 m^3 of class C1 or C2 combustible liquids under AS1940 or dangerous goods class 3. Threshold 3) Storing more than 500 m^3 of chemicals of class C1 or C2 combustible liquids under AS1940 or dangerous goods class 3 under subsection (1)(c). *Aggregate Environmental Score: 85*
31 (1) Mineral processing	Mineral processing (the relevant activity) consists of processing, in a year, a total of 1,000t or more of coke or mineral products. Threshold 2) Processing, in a year, the following quantities of mineral products, other than coke (b) more than 100,000 t. *Aggregate Environmental Score: 280*
33 (1) Crushing, milling, grinding or screening	Crushing, milling, grinding or screening (the relevant activity) consists of crushing, grinding, milling or screening more than 5,000 t of material in a year. Threshold Crushing, grinding, milling or screening more than 5,000 t of material in a year. *Aggregate Environmental Score: no score*
60 (1)(ii)(A) Waste disposal	Waste disposal (the relevant activity) consists of operating a facility for disposing of general waste and a quantity of limited regulated waste that is no more than 10% of the total amount of waste received at the facility in a year. Threshold 2) Operating a facility for disposing of, in a year, (h) more than 200,000 t. *Aggregate Environmental Score: 107*
63 (1)(b)(i) Sewage treatment	Sewage treatment (the relevant activity) consists of operating 1 or more sewage treatment works at a site that have a total daily peak design capacity of at least 21EP. Threshold 1) Operating sewage treatment works, other than no-release works, with a total daily peak design capacity of (b) more than 100 but not more than 1500 EP (i) if treated effluent is discharged from the works to an infiltration trench or through an irrigation scheme. *Aggregate Environmental Score: 27*
Schedule 3 (Resource Activity)	
13 Mining black coal	*Aggregate Environmental Score: 128*

Table 4 Notifiable Activities For the Project

Notifiable Activities	Description
Schedule 3	
1 Abrasive Blasting	Carrying out abrasive blast cleaning (other than cleaning carried out in fully enclosed booths) or disposing of abrasive blasting material.
7 Chemical Storage	Storing more than 10 t of chemicals (other than compressed or liquefied gases) that are dangerous goods under the dangerous goods code.
15 Explosives production or storage	Operating an explosives factory under the *Explosives Act 1999.*
24 Mine Wastes	a) storing hazardous mine or exploration wastes, including, for example, tailing dams, overburden or waste rock dumps containing hazardous contaminants; or b) exploring for, or mining or process, minerals in a way that exposes faces, or releases groundwater, containing hazardous contaminants.
29 Petroleum Product or Oil Storage	Storing petroleum products or oil: a) in underground tanks with more than 200 litre (L) capacity; or b) in above ground tanks with: I. for petroleum products or oil in class 3 in packaging groups 1 and 2 of the dangerous goods code – more than 2,500 L capacity; or II. for petroleum products or oil in class 3 in packaging groups 3 of the dangerous goods code – more than 5,000 L capacity; or III. for petroleum products that are combustible liquids in class C1 or C2 in *Australian Standard AS1940 The storage and handling of flammable and combustible liquids* published by Standards Australia – more than 25,000 L capacity.
37 Waste Storage, treatment of disposal	Storing, treating, reprocessing or disposing of waste prescribed under a regulation to be regulated waste for this item (other than at the place it is generated), including operating a nightsoil disposal site or sewage treatment plant where the site or plant has a design capacity that is more than the equivalent of 50,000 persons having sludge drying beds or on-site disposal facilities.

2.0 PROJECT LOCATION, SETTING AND TENURE

2.1 LOCATION AND SETTING

The Project is situated within the Bowen Basin, approximately 110 km east of Emerald and 125 km southwest of Rockhampton, in central Queensland (Figure 1). Blackwater, a larger town serving mines in the region, is located approximately 34 km to the west (Figure 1). The small rural townships of Bluff and Dingo are located approximately 15 km west and 3 km east of the Project, respectively (Figure 1).

The Project is located within the Central Highlands Regional Council (CHRC) local government area (LGA), which covers approximately 60,000 km^2 and supports a population of more than 30,000 residents living in Arcadia Valley, Bauhinia, Blackwater, Bluff, Capella, Comet, Dingo, Duaringa, Emerald, Rolleston, Sapphire Gemfields, Springsure and Tieri.

Nearby mining operations include Bluff PCI Project (approximately 12 km to the west), Yarrabee Coal Mine (approximately 34 km to the northwest), Jellinbah Mine (approximately 32 km to the northwest), Curragh Coal Mine (approximately 33 km to the northwest), and the Blackwater Mine (approximately 36 km to the southwest) (Figure 2). It is noted the Bluff Mine is currently in care and maintenance with no certainty of return to operations.

Taunton National Park is situated to the north of the Project’s mining lease application (MLA) area, whilst Walton State Forest is approximately 6 km to the west and Blackdown Tablelands National Park is located approximately 9 km to the southwest of the MLA (Figure 2).

The Capricorn Highway, which is a state-controlled road, links Rockhampton with western Queensland (Figure 1). Capricorn Highway traverses the MLA and links the townships of Bluff and Dingo (Figure 2). The Aurizon Blackwater Rail System (Blackwater Railway) tracks along the northern side of the Capricorn Highway (Figure 1 and Figure 2). A stock route (ID: 413CENT) tracks alongside the Capricorn Highway and is currently open but classified as minor and unused.

Publicly gazetted roads including Sanders, Namoi, Charlevue, Cooinda, Red Hill, Normanby and Ellesmere roads provide local access (Figure 2).

The topography of the MLA varies from flat to gently undulating, with elevations ranging between approximately 120-150 metres in Australian Height Datum (mAHD). The MLA and surrounds are currently used for low intensity cattle grazing and resource exploration activities. Land ownership in the vicinity of the Project is described in Section 2.3.2. It is Magnetic South’s intention that the land continue to be used for agricultural purposes until such time that it is required for Project construction and/or operation. Land not required for mining activities will continue to be utilised for agricultural purposes throughout the life of the Project.

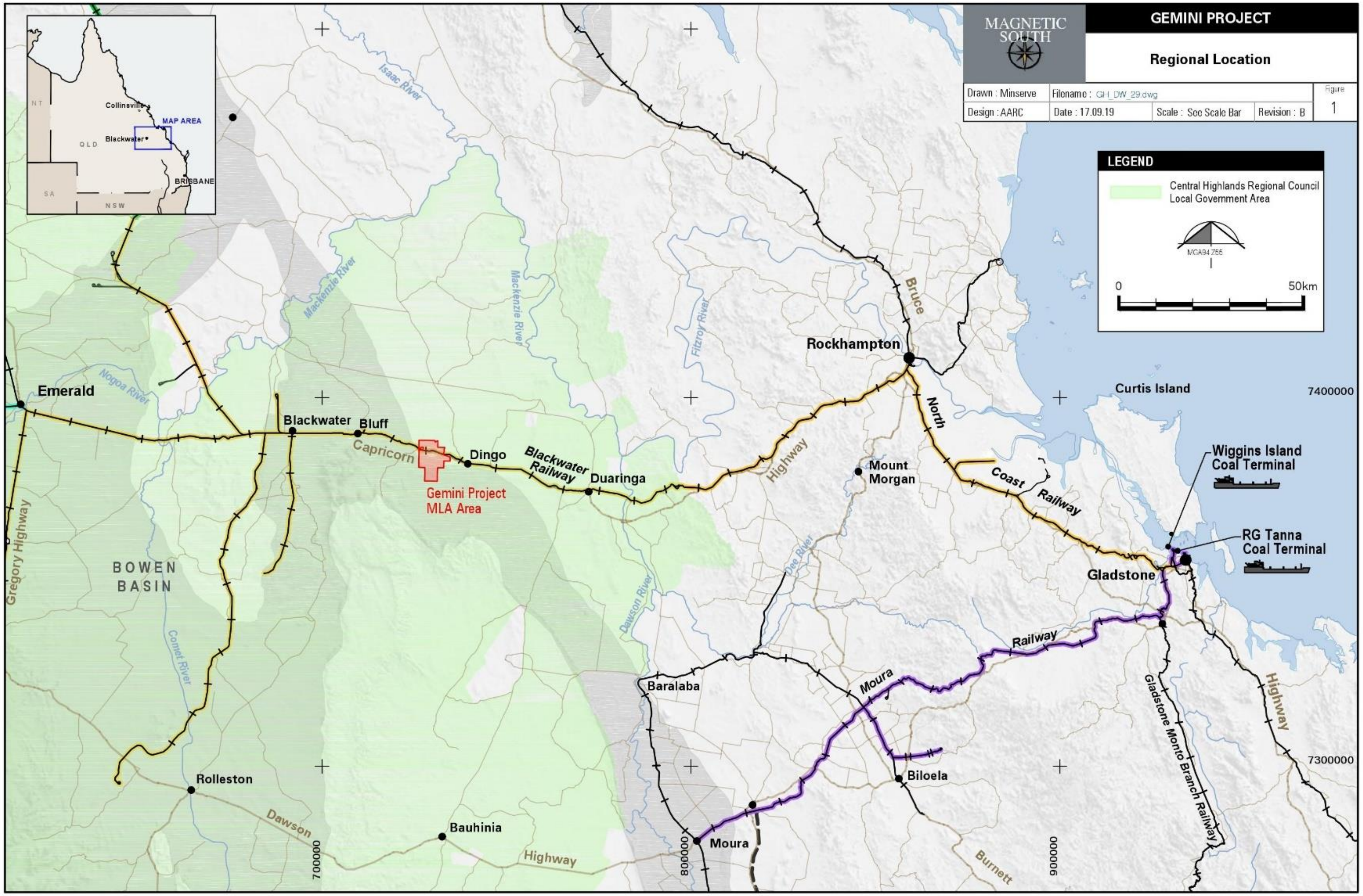


Figure 1 Regional Location

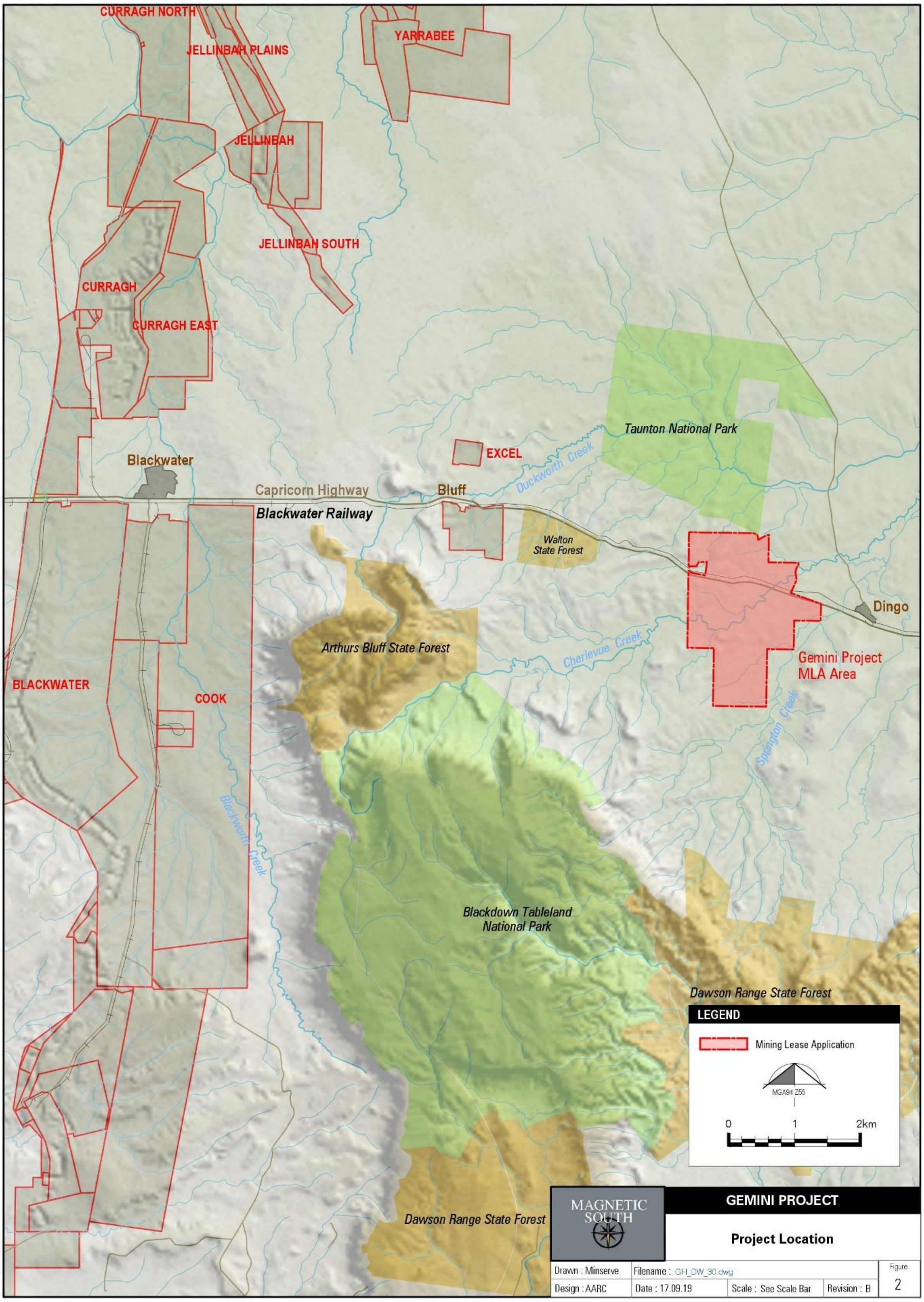


Figure 2 Project Location

2.2 LOCAL METEOROLOGICAL CONDITIONS

The Project area has a climate classification of 'subtropical' (moderately dry winter) using the Bureau of Meteorology's (BoM) modified Köppen climate classification system. The local region experiences a subtropical climate characterised by high variability seasonal rainfall subject to cyclic wet summer and dry winter seasons, with variable temperature and evaporation. Predominantly wind blows from the southeast and east in the region.

Local meteorological conditions have been compiled using data from the Scientific Information for Land Owners (SILO) Data Drill. The Data Drill accesses grids of climate data available from surrounding BoM point observations and then creates interpolated climate values for the requested location. The SILO climate data was obtained for coordinates that correspond to the approximate centre of the Project MLA. The data has been utilised to produce a climatograph for the Project (Figure 3).

The mean annual rainfall for the Project region is approximately 655 mm with average annual (pan) evaporation of 2,024 mm which exceeds rainfall for every month of the year (Table 5). Rainfall is highly seasonal, with November to March generally accepted as the 'wet season' and rainfall during this time accounting for approximately 68% of the region's total yearly rainfall. The 'dry season' usually occurs from April through to October with monthly rainfall totals below 45 mm consistently throughout this period. The rainfall data for this region is consistent with the Köppen classification of 'subtropical' (moderately dry winter).

The hottest months typically occur between October and March while the coolest months occur between May and September. The highest mean maximum temperature typically occurs in January (33.8°C) and the lowest mean minimum temperature in July (7.7°C).

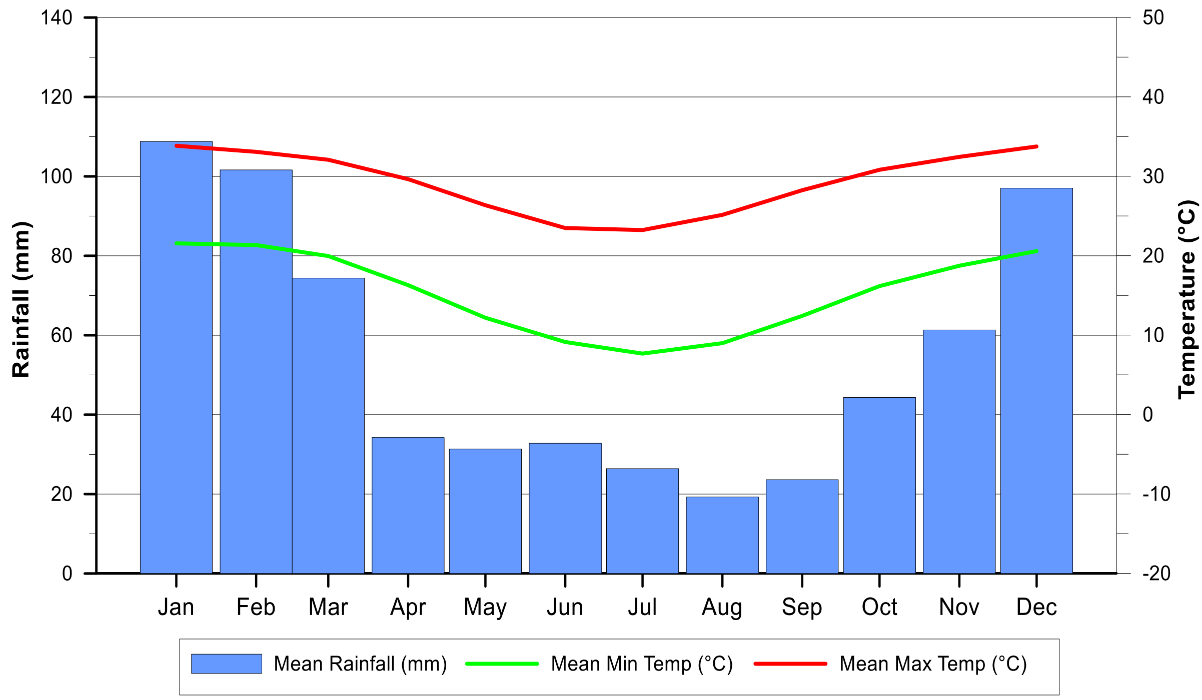


Figure 3 Climatograph

Table 5 Average Monthly Rainfall and Evaporation

Month	Average Rainfall (mm)	Average Evaporation (mm)
January	108.8	229.6
February	101.6	186.4
March	74.4	185.1
April	34.2	150.8
May	31.3	117.7
June	32.8	93.5
July	26.4	101.2
August	19.3	129.9
September	23.6	164.2
October	44.3	207.6
November	61.3	220.2
December	97	237.8
Total	**655.2**	**2,024.1**

2.3 TENURE AND LAND OWNERSHIP

2.3.1 Tenure

The Project is located entirely within the MLA, which is within exploration permit for coal (EPC) 881 held by Magnetic South (Figure 4). The surface rights held by Magnetic South within the MLA are also shown on Figure 4.

Petroleum tenements overlapping the MLA and surrounds include authority to prospect (ATP) 758, ATP 806 and potential commercial area (PCA) 163, PCA 165, and PCA 166 (Figure 5). All of the petroleum tenements are held by OME Resources Australia Pty Ltd, a subsidiary of Queensland Gas Company (QGC). Magnetic South and OME Resources Australia Pty Ltd are parties to a co-development agreement.

Other tenements proximal to the MLA include EPC 960 and mineral development licence (MDL) 505 held by Walton Coal Pty Ltd, EPC 769 held by Peabody Capricorn Pty Ltd, and EPC 1859 held by Area Coal Pty Ltd (Figure 4).

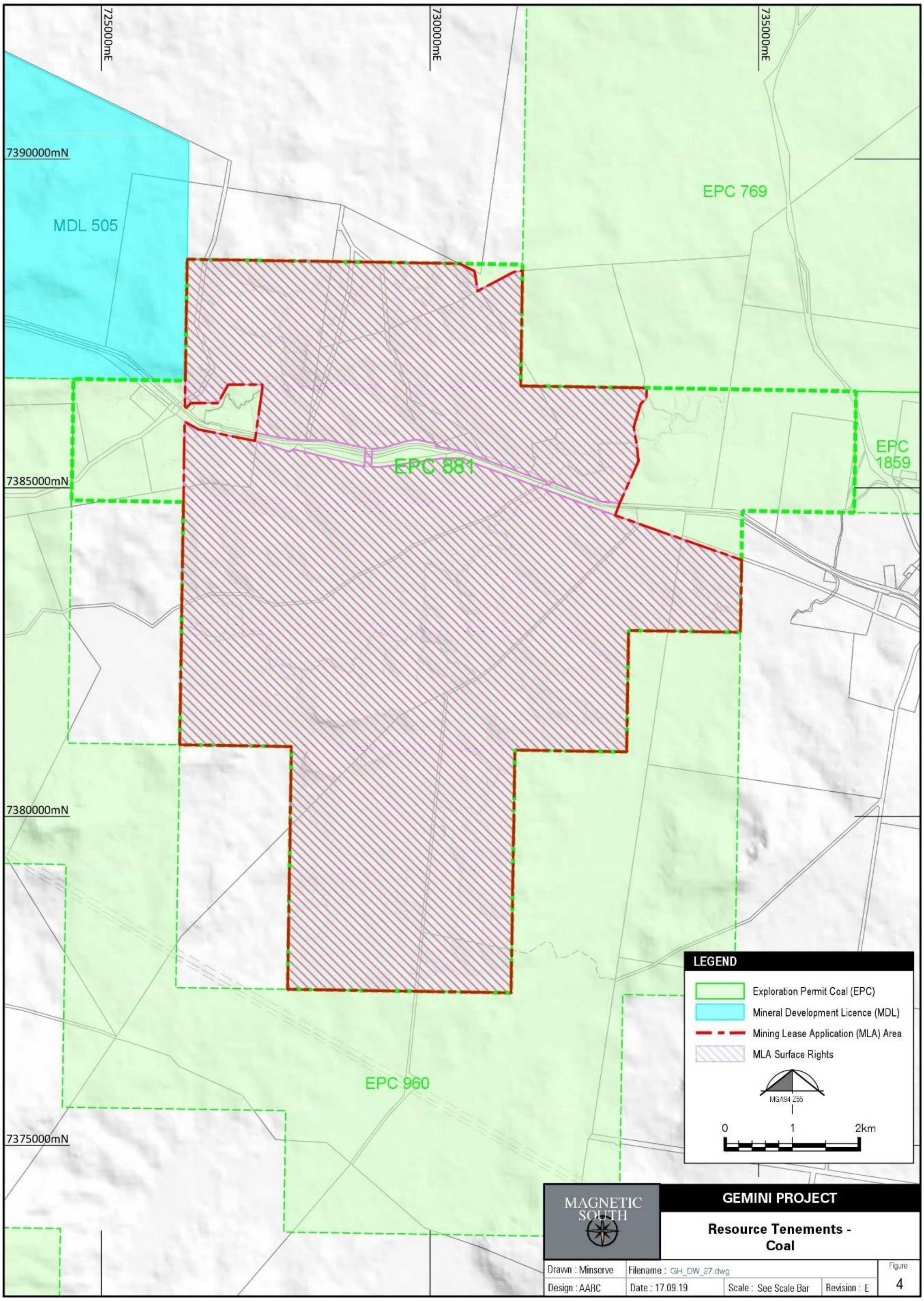


Figure 4 Resource Tenements – Coal

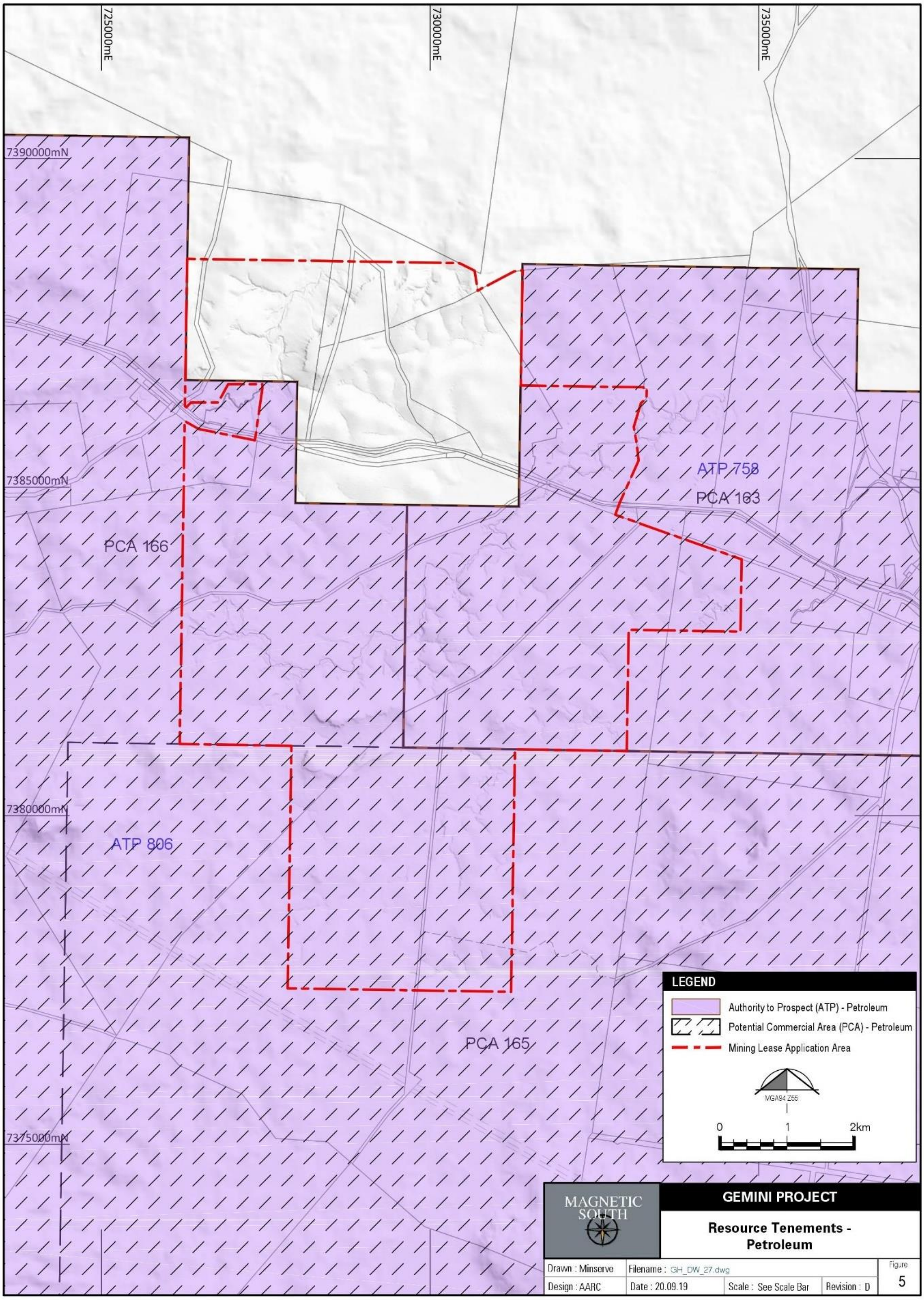


Figure 5 Resource Tenements – Petroleum

2.3.2 Land Ownership

The subject land within the MLA is held as freehold, leasehold or road reserve. Land ownership within the MLA is outlined in Table 6 and shown in Figure 6.

The Project's infrastructure is located on Lot 1 on Plan HT424 (freehold), Lot 2 on Plan HT138 (leasehold), Lot 100 on Plan RP882349 (freehold), and Lot 1 on Plan RP904099.

A number of publicly gazetted road reserves occur within the MLA; including the Capricorn Highway. The Blackwater Railway occurs within leasehold land along the northern side of the Capricorn Highway.

Consultation with private landholders within the MLA has been conducted by Magnetic South and discussions continue in relation to consent.

Table 6 Land Ownership

<table>
<tr><th>Registered Owner/s</th><th>Lot / Plan</th><th>Tenure</th><th>Property Name</th></tr>
<tr><td>AW, HJ, & LWG Vaughan</td><td>100 / RP882349</td><td>Freehold</td><td>Redrock Park</td></tr>
<tr><td rowspan="9">Magnetic South Pty Ltd</td><td>47 / H406</td><td>Freehold</td><td>Rubina</td></tr>
<tr><td>2 / HT181</td><td>Freehold</td><td>Rubina</td></tr>
<tr><td>3 / HT181</td><td>Freehold</td><td>Rubina</td></tr>
<tr><td>2 / HT138</td><td>Lands Lease</td><td>-</td></tr>
<tr><td>1 / HT424</td><td>Freehold</td><td>Yarrawonga / Longdale / St Helen's</td></tr>
<tr><td>4 / RP801280</td><td>Freehold</td><td>-</td></tr>
<tr><td>1 / RP904099</td><td>Freehold</td><td rowspan="2">Gum Flat</td></tr>
<tr><td>4 / HT165</td><td>Freehold</td></tr>
<tr><td>2 / RP904099</td><td>Freehold</td><td>Ellesmere</td></tr>
<tr><td rowspan="3">The State of Queensland (Department of Transport and Main Roads)</td><td>643 / SP260475</td><td>Lands Lease</td><td rowspan="2">Rail corridor</td></tr>
<tr><td>624 / SP260477</td><td>Lands Lease</td></tr>
<tr><td>25 / HT655</td><td>Lands Lease</td><td>-</td></tr>
</table>

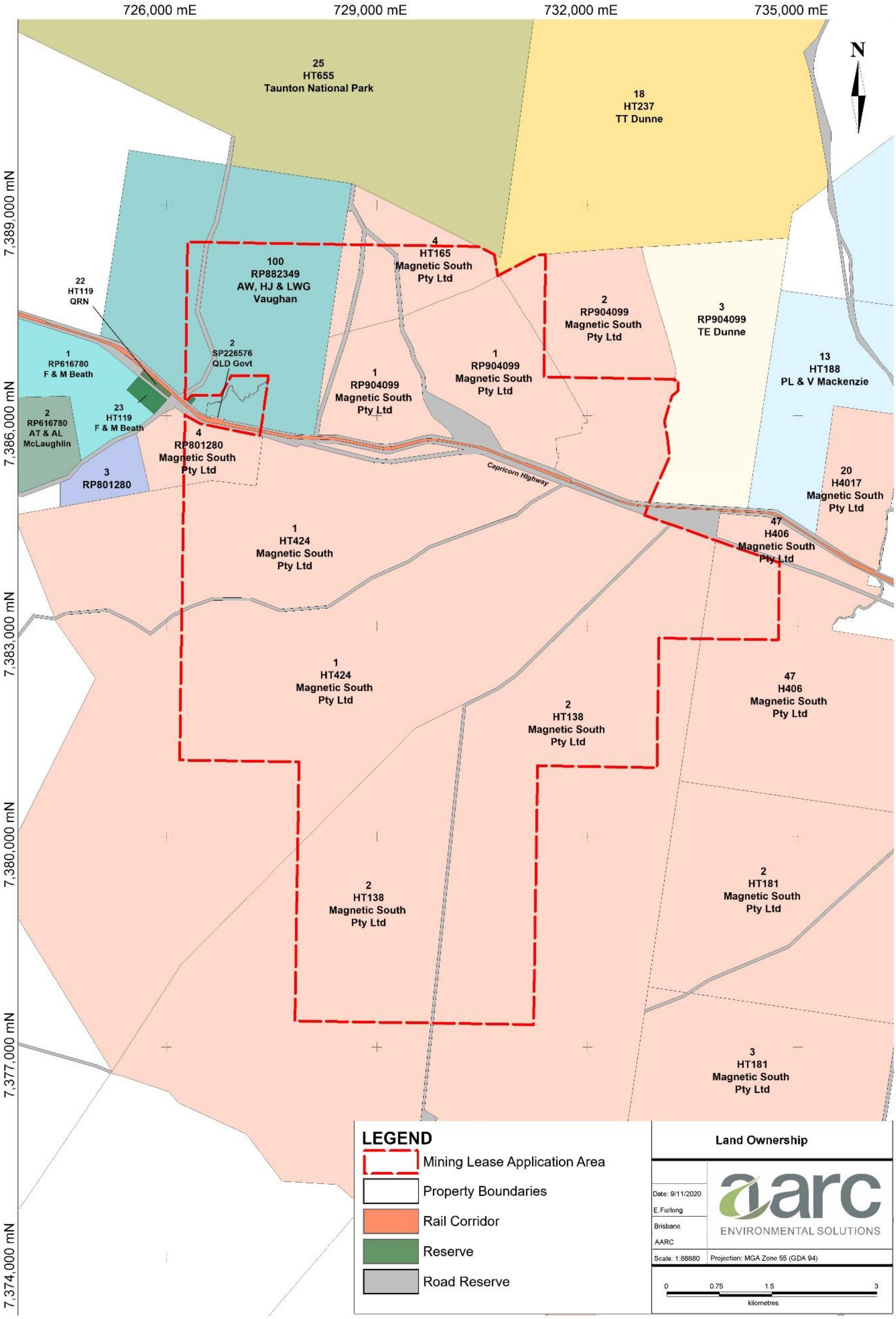


Figure 6 Land Ownership

3.0 PROJECT DESCRIPTION

3.1 PROJECT OVERVIEW

The Gemini Project is a greenfield, open-cut metallurgical coal mine producing pulverised coal injection (PCI) coal and coking coal for export to the international steel making industry.

The Project is located in the Bowen Basin, a well-established coal mining area with existing transport infrastructure. The Project will bring benefits to the local community, region, Queensland and the Commonwealth through direct employment opportunities, royalties and taxes. The Project will also utilise the services of regional suppliers of rail, power, water, communications, contractors, service providers and local businesses, which will have a positive economic impact beyond direct employment.

The Project term is anticipated to be 37 years from grant of the mining lease (ML); with this term including initial construction, mine operation and rehabilitation activities.

Mine construction activities are scheduled to commence in July 2021; subject to granting of the Project ML and EA. It is anticipated that it will take approximately six months to establish the necessary infrastructure to commence overburden removal and 18 months to commence coal production.

The main activities associated with the Project include:

- exploration activities continuing in order to support mine planning;
- development of a mine infrastructure area (MIA) including mine offices, bathhouse, crib rooms, warehouse/stores, workshop, fuel storage, refuelling facilities, wash bay, laydown area, sewage, effluent and liquid waste storage, and a helipad;
- construction and operation of a coal handling and preparation plant (CHPP) and coal handling facilities adjacent to the MIA, including run-of-mine (ROM) coal and product coal stockpiles and rejects bin/overflow (coarse and fine rejects);
- construction and operation of a surface conveyor from the product stockpiles to a train load out (TLO) facility and rail loop connecting to the Blackwater Railway to transport product coal to coal terminals at Gladstone for export.
- construction of an accommodation facility, sewage treatment plant and effluent irrigation area within the northwest bounds of the MLA;
- construction of access roads from the Capricorn Highway to the MIA, and from the Capricorn Highway to the TLO facility;
- installation of a raw water supply pipeline to connect to the Blackwater Pipeline network;
- construction of a 66 kV transmission line and switching/substation to connect to the existing regional network;
- other associated minor infrastructure, plant, equipment and activities;
- development of mine areas (open-cut pits) and out-of-pit waste rock emplacements;
- drilling and blasting of competent waste material;

- mine operations using conventional surface mining equipment (excavators, front end loaders, rear dump trucks, dozers);
- mining up to 1.9 Mtpa ROM coal (average of 1.8 Mtpa) for a construction/production period of approximately 20 years;
- progressive placement of waste rock in:
  - emplacements, adjacent to and near the open-cut voids; and
  - mine voids, behind the advancing open-cut mining operations;
- progressive rehabilitation of waste rock emplacement areas and mined voids;
- progressive establishment of soil stockpiles, laydown area and borrow pits (for road base and civil works; material will be sourced from local quarries where required);
- disposal of CHPP rejects (coarse and fine rejects) in out-of-pit spoil dumps, and in-pit behind the mining void;
- progressive development of internal roads and haul roads including a causeway over Charlevue Creek to enable coal haulage and pit access;
- development of water storage dams and sediment dams, and the installation of pumps, pipelines, and other water management equipment and structures including temporary levees, diversions and drains.

Existing local and regional infrastructure, facilities and services would be used to support Project activities. These include the SunWater water distribution network, the Aurizon rail network, Ergon's electricity network, the Capricorn Highway, and Gladstone export coal terminals.

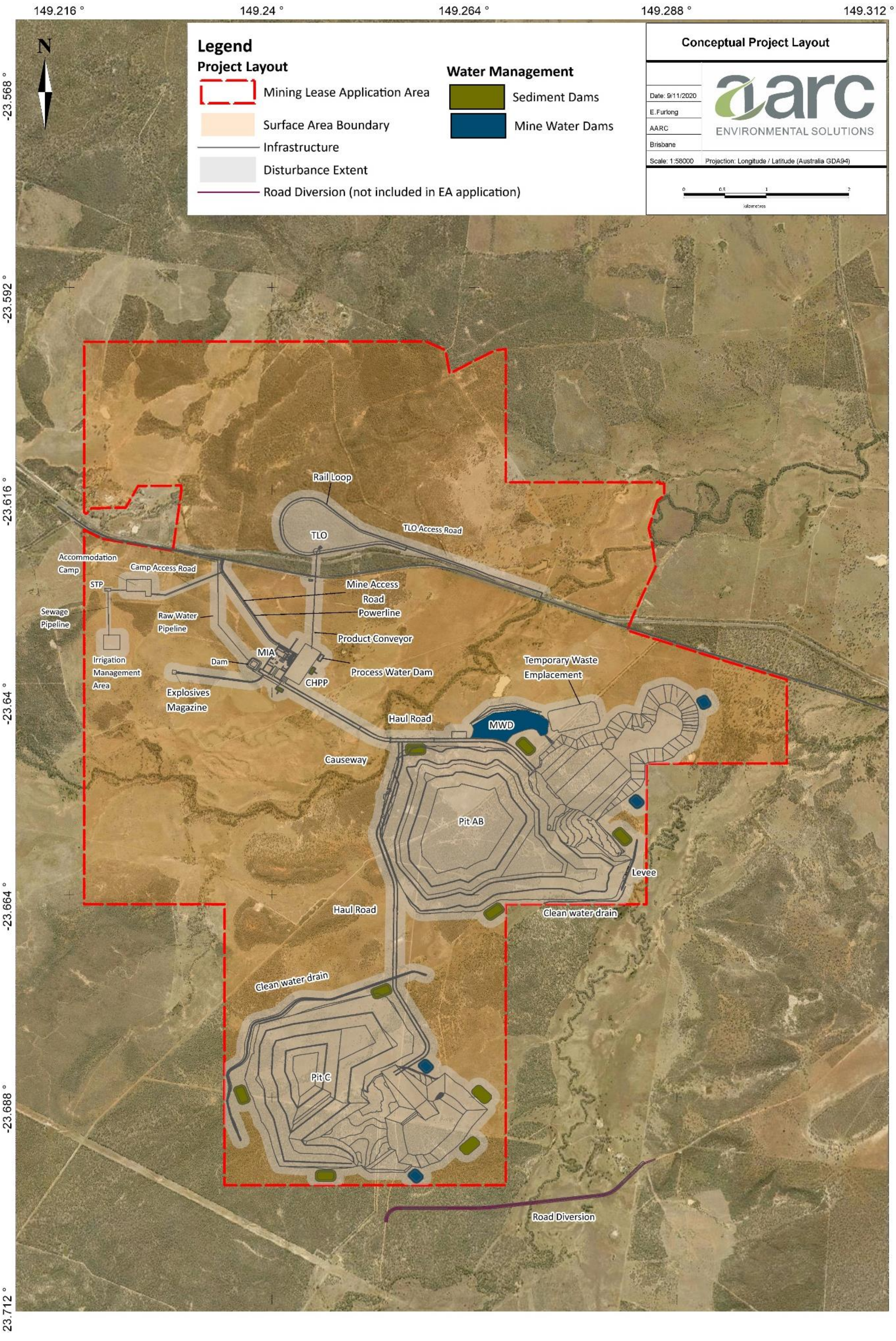


Figure 7 Conceptual Layout - Gemini Project

3.2 PROJECT DISTURBANCE AREA

A conceptual Project layout is provided in Figure 7 which represents the total area disturbed by mine operations only and does not equate to the disturbance footprint at any one point in time. Open-cut mining areas will be developed and rehabilitated progressively. The total disturbance footprint for the Project is 1,953.5 ha which incorporates all mining and infrastructure components as described in Table 7.

Table 7 Total Disturbance Area

Proposed Disturbance	Approximate Area (ha)
In-pit and out-of-pit waste emplacements, including dry rejects disposal areas	722.4
Temporary waste emplacements	17.5
Residual void lakes	76.5
Residual void high walls	133.1
Residual void low walls	187.2
Water management infrastructure1	85
Mine infrastructure areas	731.8
Total	**1,953.5**

* Infrastructure disturbance area includes a 100 m buffer around the perimeter of the disturbance footprint.

3.3 CONSTRUCTION

Proposed infrastructure and other development activities for the Project during the construction phase will include:

- mine access road from the Capricorn Highway to the MIA, associated Capricorn Highway intersection, site access security infrastructure and car parking at the MIA;
- MIA;
- explosives magazine;
- CHPP and associated coal handling infrastructure;
- TLO facility and access road;
- haul road to Pit AB including a low-level causeway across Charlevue Creek;
- construction of the haul road to Pit C (anticipated to commence in Year 11 of the Project); and
- accommodation facility and camp access road adjoining the mine access road.

These infrastructure components are described in Section 3.3.1 through to Section 3.3.5.

Water management infrastructure for the Project will include a temporary flood protection levee, clean water diversions for drainage features, mine water dams, sediment dams, raw water dam and process water dam. The water management components are described in Section 3.4.3.

Supporting infrastructure required for the Project includes an electrical power transmission line (refer Section 3.5.1) and raw water supply pipeline (refer Section 3.5.2).

Site preparation will include the clearance of vegetation, topsoil removal and stockpiling, bulk earthworks and temporary drainage works. Initial site preparation works will be focused on the rail infrastructure, mine access road, MIA, CHPP, accommodation facilities and haul road. Site clearance will be staged throughout the construction phases on an “as needs” basis to coincide with infrastructure installation and development to minimise the extent and duration of disturbance.

Quarry materials will be sourced from onsite deposits, where available, for use as road base, select fill, rail ballast, rock protection, and other construction materials. It is expected that waste rock from pit excavation will provide the majority of construction and bulk fill materials, however, some material may also be sourced from the onsite Project disturbance footprint or from quarries in the region.

The majority of infrastructure components (e.g., CHPP, buildings, pipelines, etc.) will be manufactured offsite and transported to site for assembly and installation.

3.3.1 Mine Access Road

Vehicle access for mine personnel, contractors, suppliers and deliveries to the Project will be via a new mine access road from the Capricorn Highway. The concept design of the mine access road is shown in Figure 8. The proposed mine access road intersection will be located approximately 2.7 km east of the Capricorn Highway/Charlevue Road intersection. The concept design of the proposed intersection is shown in Figure 9. The design includes an auxiliary left turn treatment – short turn lane and a channelised right turn treatment with reduced length of right turn slots, which has been designed in accordance with the *Guide to Road Design Part 4A: Unsignalised and Signalised Intersections* (Austroads Ltd 2017).

The mine access road intersection will be sealed, while the remainder of the mine access road to the MIA will be unsealed. Just beyond the mine access road intersection, access to the accommodation facilities will occur via an adjoining camp access road to the west of the MIA. A *Traffic Impact Assessment* (Cardno 2019) has been prepared for the Project and is included as Appendix A.

A MIA will be constructed in the northwest of the MLA (Figure 7). An indicative layout of the MIA is shown in Figure 10. A security gate will be established at the entrance to the mine on the mine access road (Figure 10) to prevent inadvertent access to the mine site operations. The security gate will be positioned to direct visitors to the MIA and associated car park (Figure 10).

The MIA will include the mine offices, bathhouse, crib rooms, warehouses and storage areas, workshops, potable water storage, fuel storage and refuelling facilities, sewage, effluent and liquid waste storage, tyre bay, laydown area, Go-line, wash bay, and other associated amenities (Figure 10).

Personnel, visitors and deliveries will access the MIA and associated mine offices via the mine access road. Access from the MIA to the mining operations is via internal light vehicle access roads and the mine haul roads.

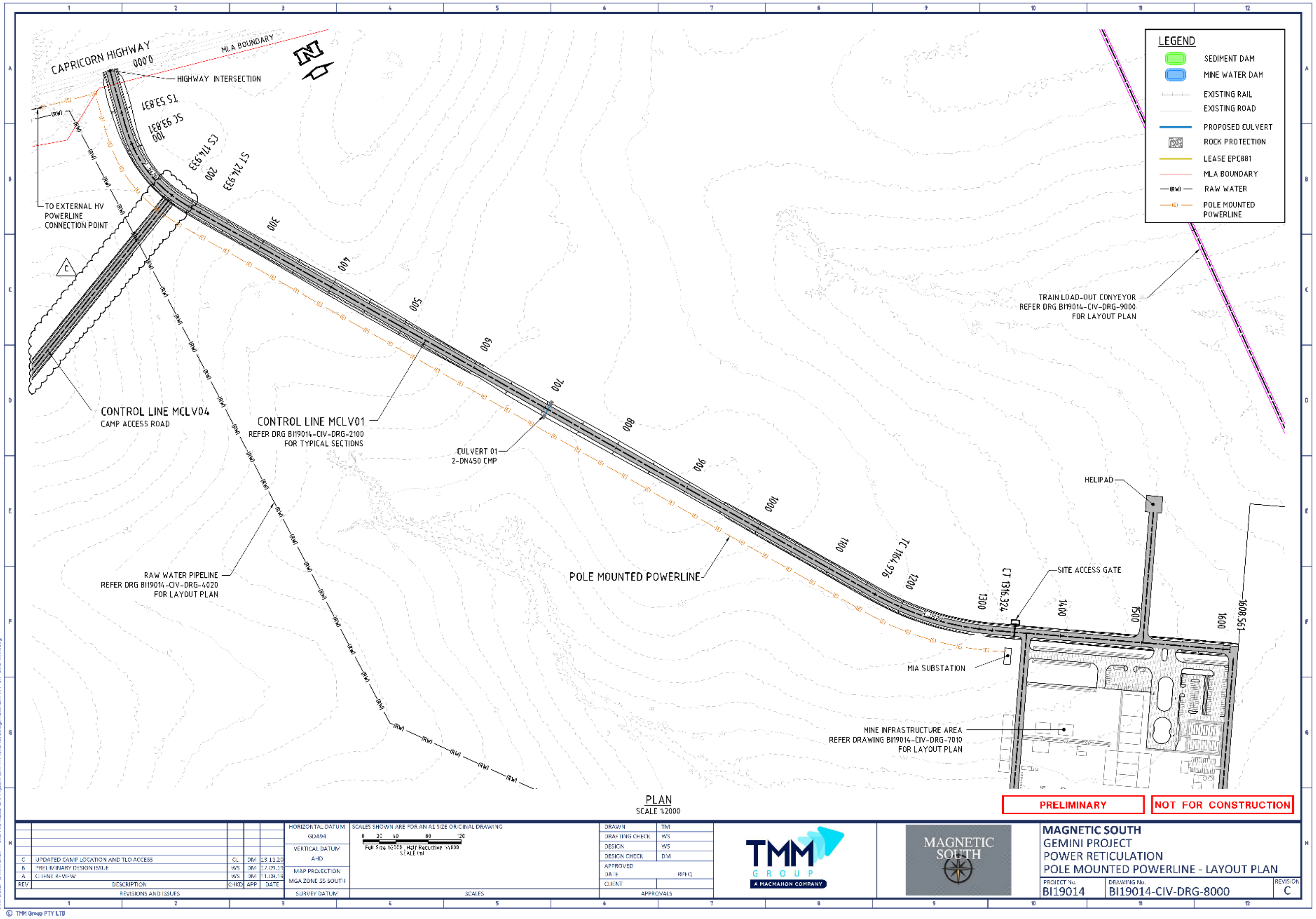
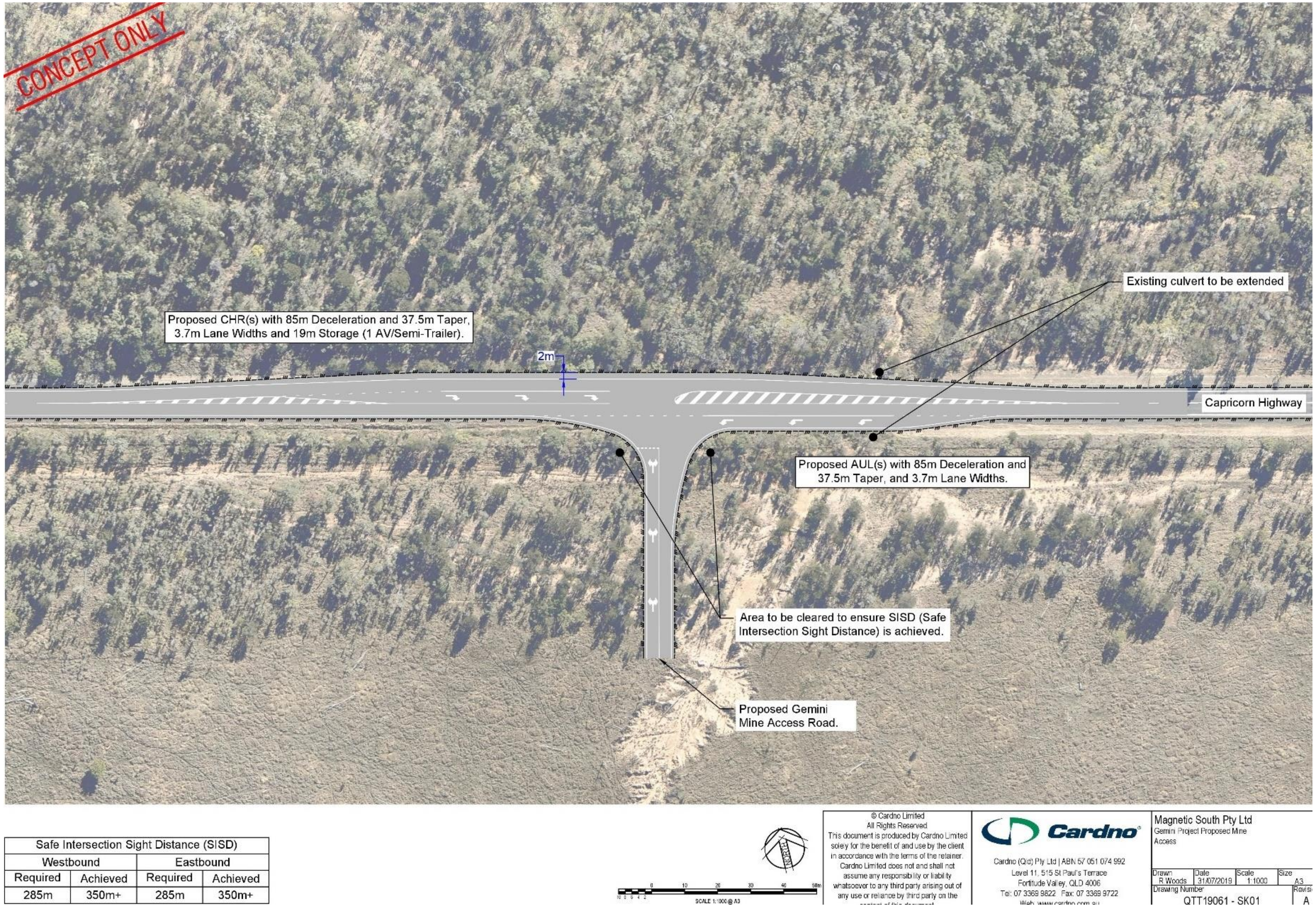


Figure 8 Conceptual Design - Mine Access Road



Safe Intersection Sight Distance (SISD)			
Westbound		Eastbound	
Required	Achieved	Required	Achieved
285m	350m+	285m	350m+

Figure 9 Conceptual Design - Mine Access Road Intersection

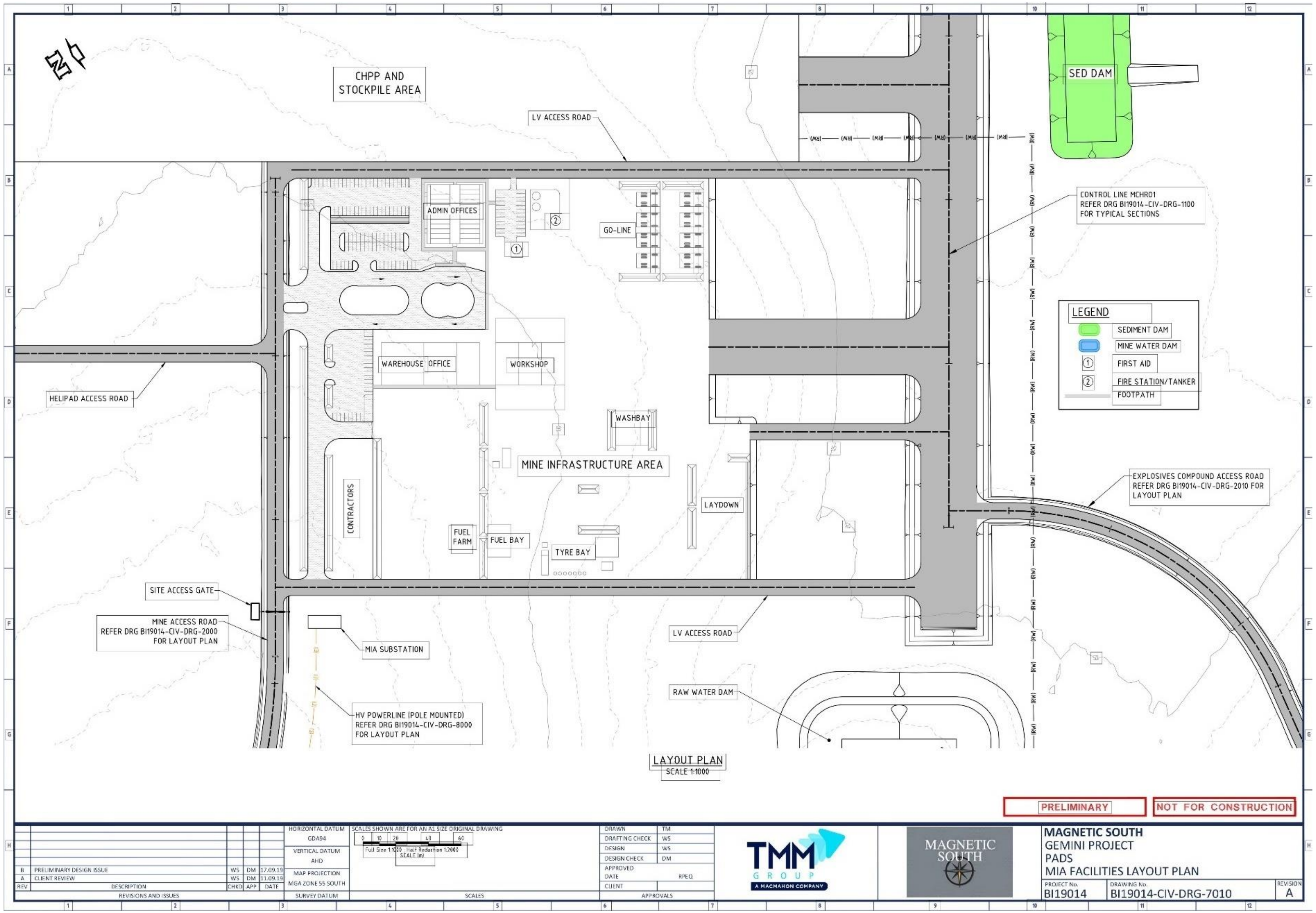


Figure 10 Conceptual Layout - MIA

3.3.2 Explosives Storage

An explosives compound will be established to the west of the MIA (Figure 7 and Figure 11). Explosives magazines will be fenced, signed and maintained in accordance with *AS2187.2-2006: Explosives – Storage and use (Part 2: Use of explosives).*

3.3.3 CHPP, Stockpiles and Overland Conveyor

A CHPP and associated coal handling facilities will be constructed adjacent to the MIA (Figure 7 and Figure 11) and will include:

- CHPP;
- ROM coal stockpile;
- product stockpile;
- rejects bin and overflow (coarse and fine rejects); and
- coal handling facilities including an overland conveyor to transport product coal to the TLO.

It is anticipated that construction of the CHPP and associated coal handling facilities will take approximately 18 months. The CHPP will operate 24 hours per day, 7 days a week.

Product coal will be direct fed to the train loading bin by conveyor from the product coal stockpile adjacent to the CHPP. The conveyor will be constructed to pass over both the Capricorn Highway and the Blackwater Railway (Figure 12). Concept design of the Capricorn Highway conveyor crossing is shown in Figure 13, and the Blackwater Railway conveyor crossing in Figure 14.

3.3.4 Train Load Out Facility and Access Road

A TLO facility comprising a rail spur, rail loop and train loading bin will be constructed adjacent to the Blackwater Railway (Figure 7). The rail spur and loop will be approximately 6 km in length and will connect to the Blackwater Railway west of the existing Charlevue Creek rail bridge.

Access to the TLO facility will utilise an existing access road off the Capricorn Highway via Red Hill Road at Lot 2 on Plan RP904099 (Figure 7). The TLO access road is unsealed and runs beneath the rail bridge proximal to Charlevue Creek and will continue around the perimeter of the TLO rail loop. This access road will be used for TLO construction activities and for operations.

3.3.5 Haul Roads

The alignment of the haul roads from the MIA to Pit AB and Pit C is shown in Figure 7. Construction of the haul road to Pit C is anticipated to commence in Year 11 of the Project.

The haul road to Pit AB will include a causeway to cross Charlevue Creek. The causeway will be designed for a 1 in 2 year rainfall event, with the capacity to carry a 540 t class excavator on a float.

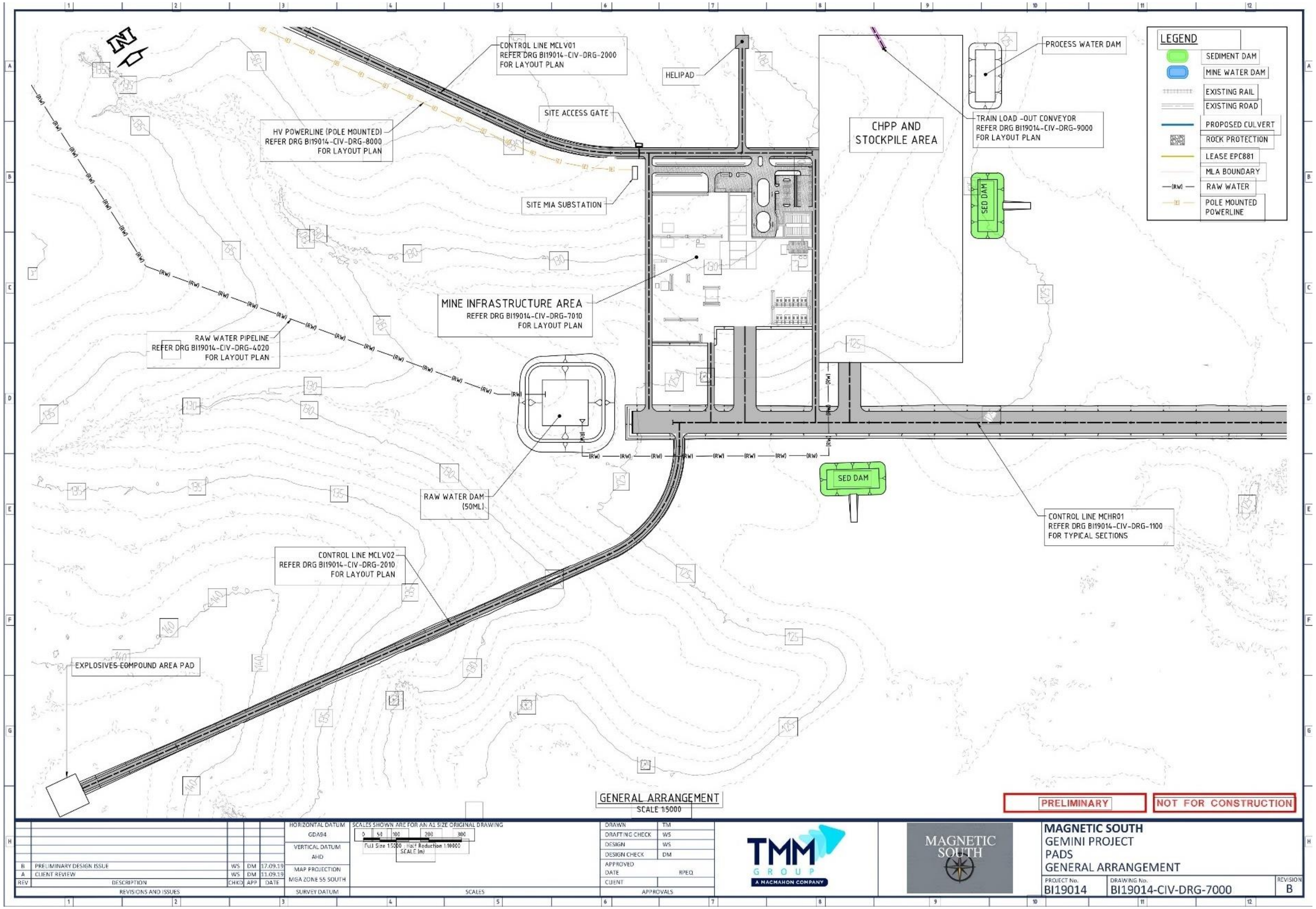


Figure 11 Conceptual Layout - MIA and Associated Infrastructure

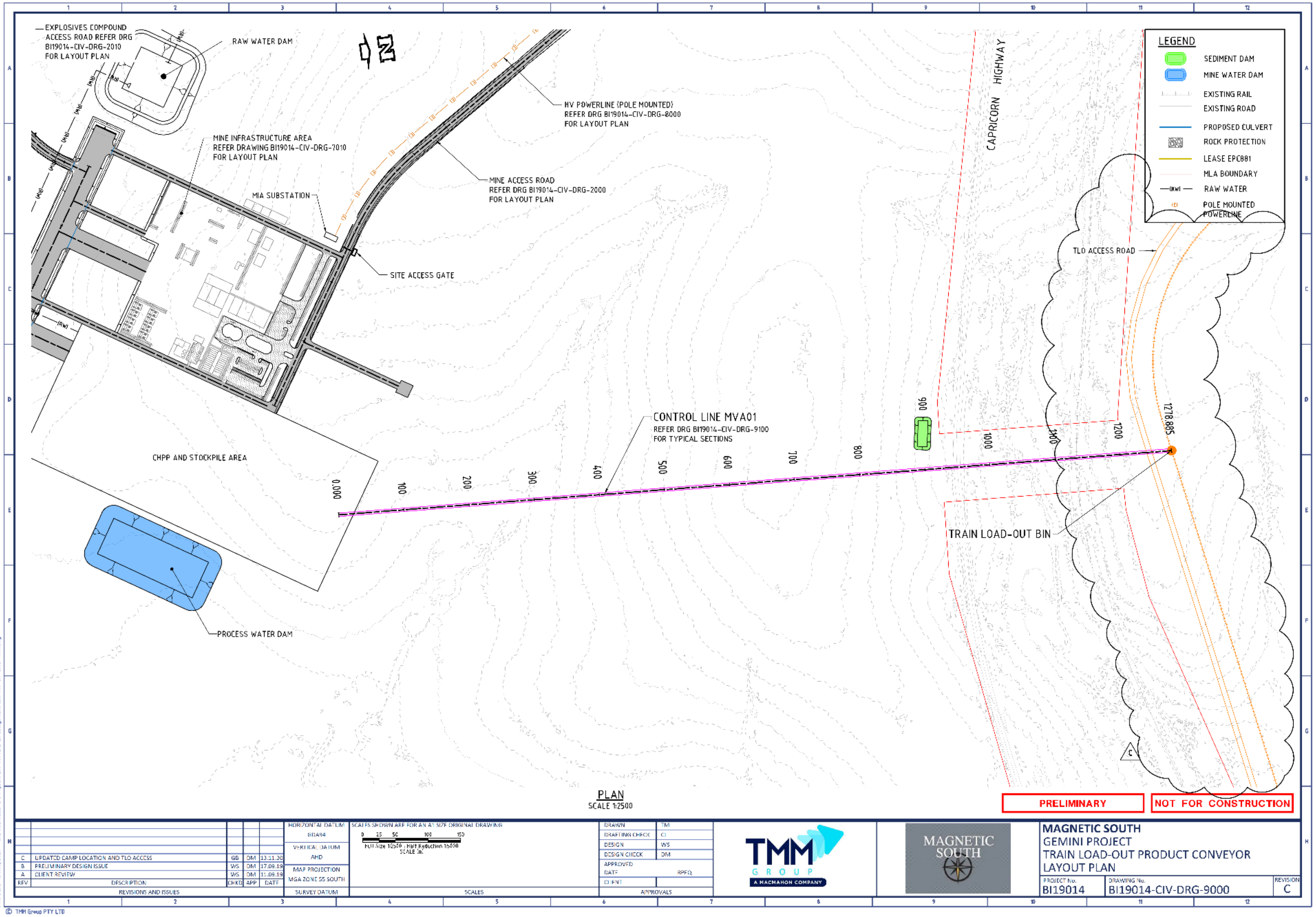


Figure 12 Conceptual Layout - Product Coal Overland Conveyor

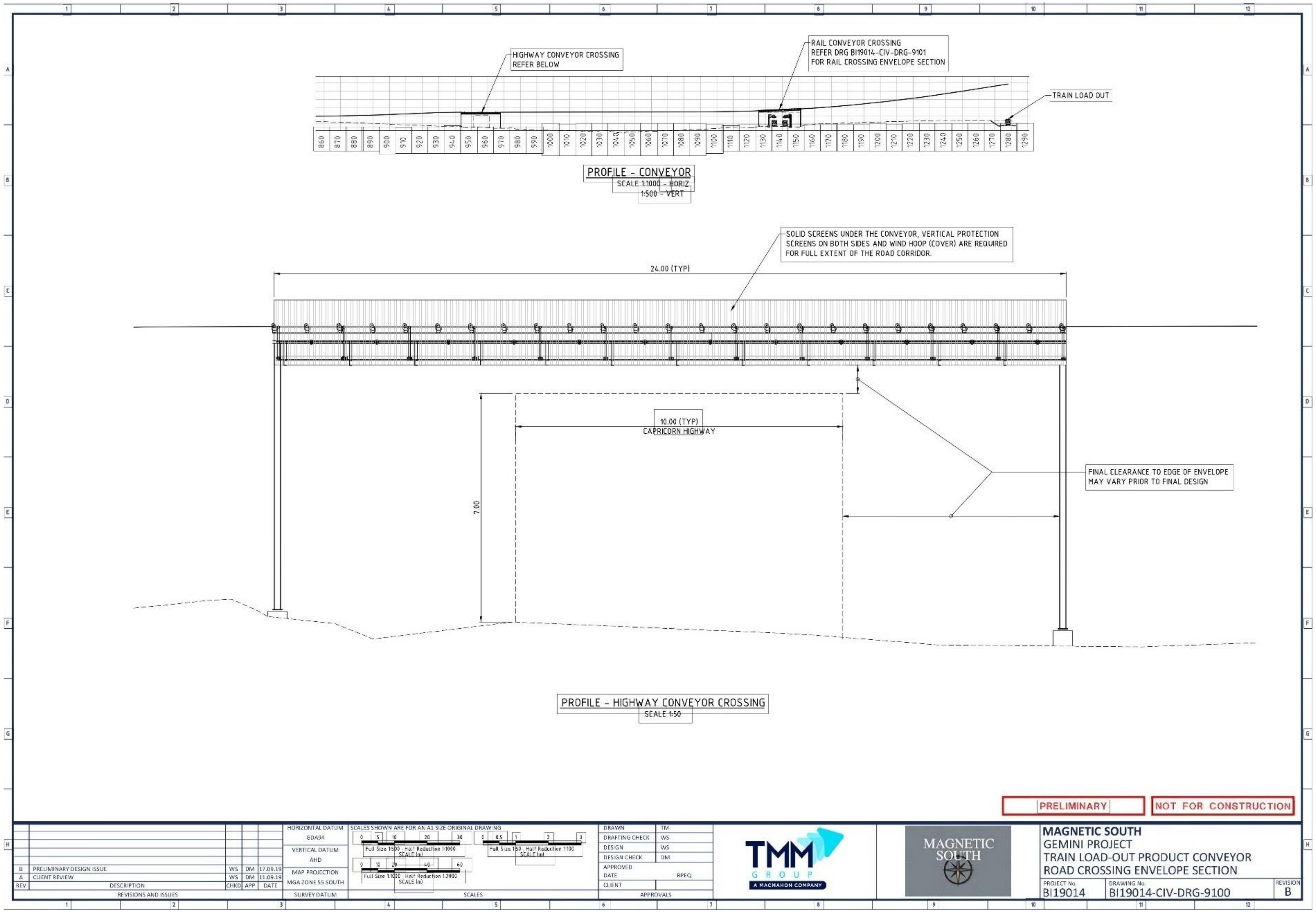


Figure 13 Conceptual Design - Conveyor Crossing (Capricorn Highway)

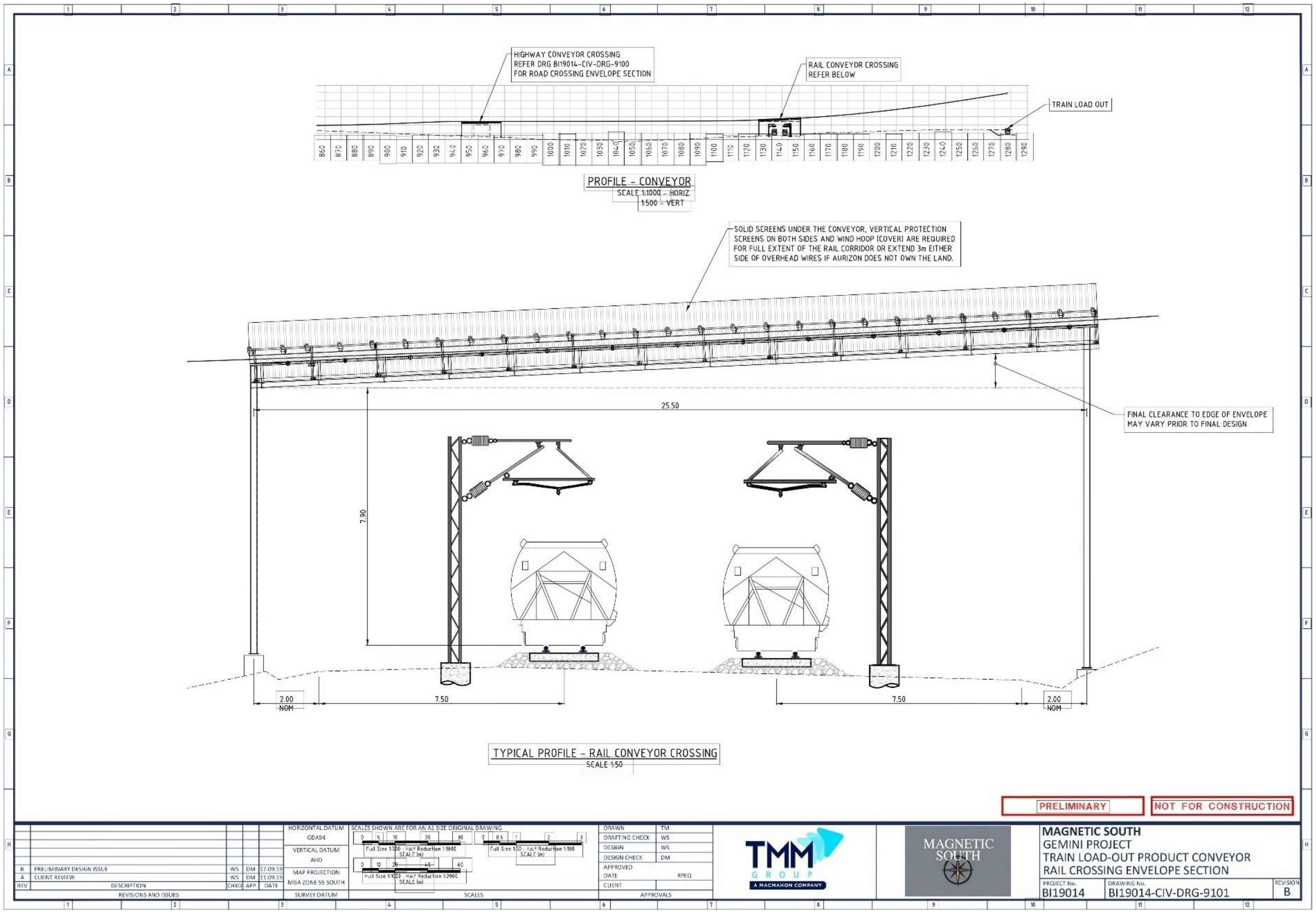


Figure 14 Conceptual Design - Conveyor Crossing (Blackwater Railway)

3.4 SITE WATER MANAGEMENT

3.4.1 Water Management Principles

The 'Site Water Management System' (SWMS) for the Gemini Project is based on the following key principles:

- divert clean catchment water around mining works to the extent practicable;
- use/recycle lesser quality water in preference to higher quality water;
- use potentially contaminated water in preference to imported raw water or uncontaminated water;
- release water from site only in accordance with the conditions of the EA, such that the released water will not significantly impact on the values of the receiving waters or downstream properties;
- manage water storages and transfers within the site in order to:
  - maximise onsite storage to meet reasonably anticipated periods of wet and dry weather; and
  - minimise disruption to mining operations.

3.4.2 Site Water Management System

For the purpose of site water management, site water has been classified into the types shown in Table 8 on the basis of the likely water quality characteristics.

The proposed strategy for the management of surface water at the Project is based on the separation of water from different sources based on anticipated water quality.

A conceptual SWMS was developed for the Project by WRM Water and Environment Pty Ltd (WRM) as a part of the *Surface Water Assessment* (WRM 2020b) (Appendix B). On the basis of the expected runoff and groundwater inflow quality, the SWMS separates water into two segregated management systems:

1. **Mine affected water (MAW) system:** will manage runoff and seepage from the mine pits, CHPP, coal stockpiles, and MIA. This is a closed system designed to prevent releases of MAW to the environment.

2. **Sediment water system:** runoff from overburden dumps will be managed under an *Erosion and Sediment Control Plan* (ESCP) which is to be implemented throughout the Project, such that sediment generated and transported by runoff will be settled in a sediment dam. As overburden runoff quality is expected to be relatively benign (refer Section 13.0), the sediment dams will potentially discharge directly into the environment (after the settlement of suspended sediment), and as such, will not affect the mine water balance. However, the water balance assessment has assumed sediment dams will be pumped back to the CHPP for reuse.

Clean water flows from undisturbed areas are generally diverted around the areas of disturbance. A raw water supply pipeline is proposed to supply all site water requirements prior to dam construction, and supplement site water supplies throughout the life of the Project. Raw water will be delivered to a dedicated raw water dam (located adjacent to the MIA), which will also intercept clean water from its local upstream catchment.

A site water balance model has been developed by WRM (2020b) to determine the most appropriate design of the SWMS. The site water balance forms the basis of impact assessment and infrastructure design for the site. Details of the site water balance are provided in Section 3.4.5.

A schematic of the integrated SWMS configuration for the Project is shown in Figure 15.

Table 8 Site Water Types

Water Type	Definition
Mine affected water	In accordance with the *Model mining conditions* (DES 2017e), MAW means the following types of water: i) pit water, tailings dam water, processing plant water; ii) water contaminated by a mining activity which would have been an ERA under Schedule 2 of the EP Regulation if it had not formed part of the mining activity; iii) rainfall runoff which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated, excluding rainfall runoff discharging through release points associated with erosion and sediment control structures that have been installed in accordance with the standards and requirements of an ESCP to manage such runoff, provided that this water has not been mixed with pit water, tailings dam water, processing plant water or workshop water; iv) groundwater which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated; v) groundwater from the mine dewatering activities; vi) a mix of MAW (under any of paragraphs i to v) and other water.
Sediment water	Surface water runoff from areas that are disturbed by mining operations (including out-of-pit waste rock emplacements). This runoff does not come into contact with coal or other carbonaceous material and may contain high sediment loads but does not contain elevated level of other water quality parameters (e.g., electrical conductivity (EC), pH, metals, metalloids, non-metals). This runoff must be managed to ensure adequate sediment removal prior to release to receiving waters.
Clean catchment water	Surface runoff from areas unaffected by mining operations. Clean catchment water includes runoff from undisturbed areas and fully rehabilitated areas.
Raw water	Untreated water, generally from an external water supply, that has not been contaminated by mining activities.
Potable water	Treated water suitable for human consumption.

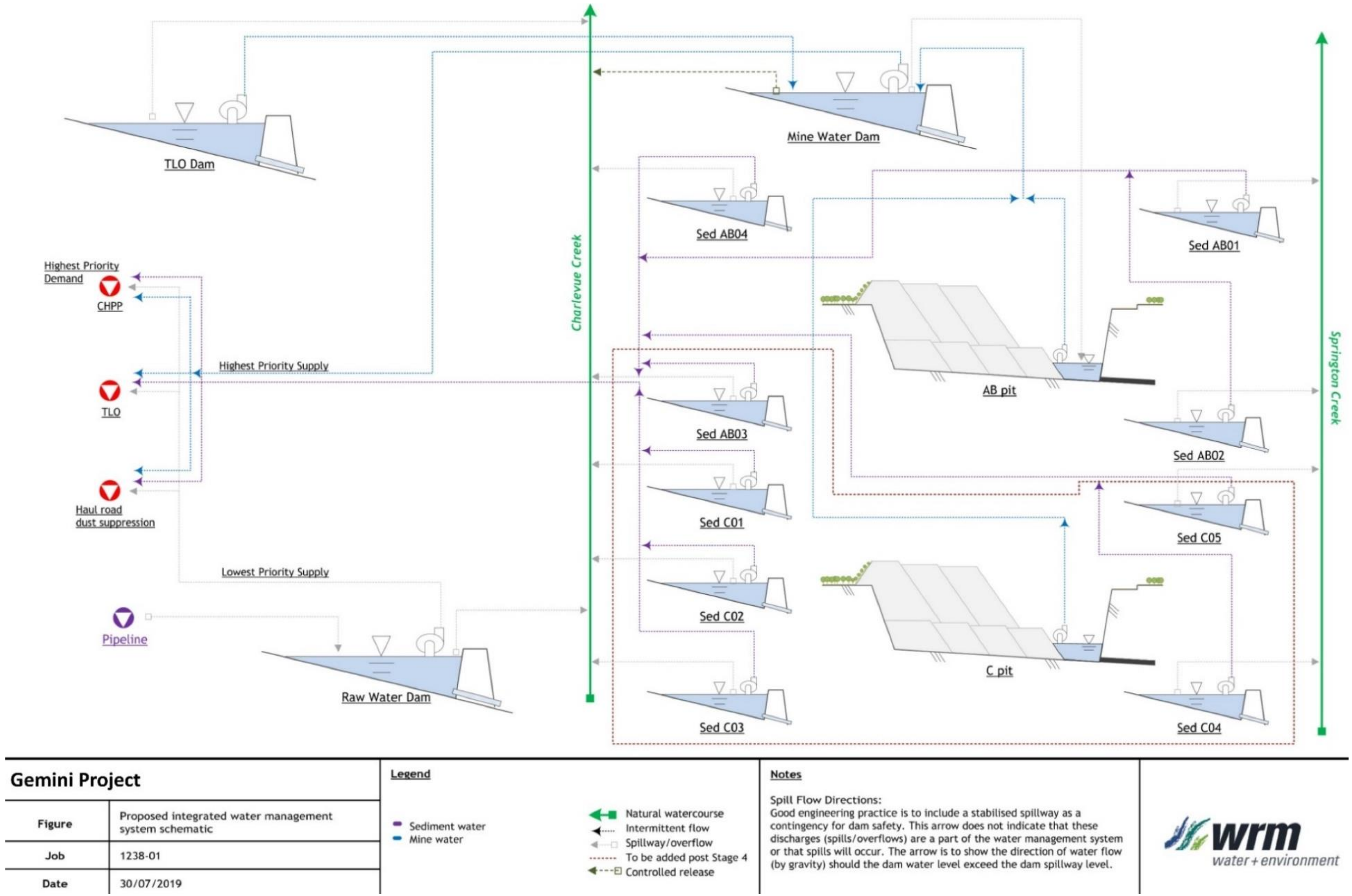


Figure 15 Proposed Integrated SWMS Schematic

3.4.3 Water Management Infrastructure

The SWMS consists of infrastructure to provide catchment separation and manage water quality and quantity onsite. Infrastructure for the Project's SWMS includes:

- temporary flood protection levee to protect Pit AB from potential flood waters;
- clean water drains to divert runoff from undisturbed catchments around areas disturbed by mining activities;
- sediment water drains to divert water from waste rock emplacements, and areas yet to be rehabilitated;
- sediment water dams to store water from waste rock emplacements and allow settlement of sediment loads before discharging treated water or recycling back to the CHPP;
- mine water drains to divert water from MIA, CHPP and coal stockpile areas into the MAW system; and
- mine water dams to store water pumped out of the pit, and collect water from the MIA, CHPP and coal stockpile areas.

Figure 7 provides a schematic layout of proposed water management infrastructure for the Project.

3.4.3.1 Temporary Flood Protection Levee

A temporary flood levee designed to provide protection from a 0.1% annual exceedance probability (AEP) flood event will be constructed adjacent to Pit AB (Figure 7). The levee will be required to reduce the risk of ingress of clean floodwaters into operational areas where they may become contaminated with possible adverse impact on water management operations and containment performance. The levee will be constructed prior to the commencement of waste stripping within Pit AB.

The levee will be a 'regulated structure' and will be designed, constructed and decommissioned in accordance with the '*Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933)*' and *'Structures which are dams or levees constructed as part of environmentally relevant activities (ESR/2016/1934)*'. The design height of the levee ranges from 1.21 m to 2.37 m, determined by the modelled flood height, plus 0.5 m freeboard. A plan and longitudinal section of the levee is provided in Figure 16, with a typical cross-section provided in Figure 21. The levee will be reinforced by in-pit rock dumps as mining progresses.

These levee structures would be temporary, required only until the final overburden profile is achieved and the associated permanent drainage systems commissioned. The final voids are located and designed such that they are not inundated by flooding in the probable maximum flood. Accordingly, no flood levee will be required to prevent inundation of the final void. The levee constructed to protect the operational pit would not be required post-mining and therefore has been designed to form part of the rehabilitated dump.

3.4.3.2 Clean Water Drains

The Project will require two sections of a 'drainage feature' (as determined under the *Water Act 2000* (Water Act) to be diverted around surface disturbance areas associated with Pit AB and Pit C (Figure 7). This will allow the runoff from undisturbed upslope catchments to flow around the operations, minimising the impact on the downstream environment, while also minimising the potential volume of water captured into the MAW system. The drainage feature is a tributary of Springton Creek and is not considered to be a 'watercourse' as defined by the Water Act.

The engineered drainage features will be required throughout operations at each mine pit and will become permanent features at mine closure.

Runoff and seepage from the mine pits will be contained within the MAW system. The mine pits and MAW dams are located such that it would not be possible for this MAW water to enter the engineered drainage features.

The overburden dumps will be initially placed within the levees, and (in accordance with the erosion and sediment control plan) sediment-laden runoff would be directed to sediment dams via drains designed to prevent overflow into the engineered drainage features.

As the final overburden dump profile is developed, a series of contour drains would direct runoff away from the engineered drainage structures and to sediment dams. Overflows to "engineered 'drainage features'" would only occur after treatment in a sediment dam.

The preliminary channel designs included in the assessment have the following design features:

- Pit AB:
    - compound trapezoidal channel shape:
        - 1m deep low flow channel with 5 m base width;
        - Base width of high flow channel 15 m;
        - side slopes 1V in 3H;
    - longitudinal slope: 0.4% (the existing channel has a slope of approximately 0.3%);
    - design 1 in 50 AEP depths are up to 3.7 m, and peak velocities range up to 2.5 m/s;
- Pit C:
    - compound trapezoidal channel shape:
        - 1m deep low flow channel with 4 m base width;
        - width of high flow channel 15 m;
        - side slopes 1V in 3H;
    - longitudinal slope varies between 0.25% and 0.4%; and
    - design 1 in 50 AEP depths are up to 1.3 m, and peak velocities range between 1.0 m/s and 2.0 m/s.

A plan and longitudinal section of the channels is provided in Figure 17 (Pit AB) and Figure 18 to Figure 20 (Pit C), with a typical cross-section provided in Figure 21.

While the engineered drainage channels themselves would not be regulated structures, they are designed to ensure they do not interfere with the functioning of the levees in the design flood event (for example by inducing scour which could affect the integrity of the levee).

Based on the flood model results, flow velocities in the Pit AB drainage feature would generally be non-erosive, however, there may be a requirement for scour protection near the channel outlet where velocities are highest.

The permanent channels will be designed to be self-sustaining features of the local surface water environment. It is therefore proposed that the design of the drains will take into account key design principles and requirements for the functionality of permanent diversions, including for operations, maintenance, monitoring and revegetation.

Magnetic South will investigate the potential to realign the proposed diversion further south at mine closure to improve the geomorphological characteristics and reduce the need for erosion protection.

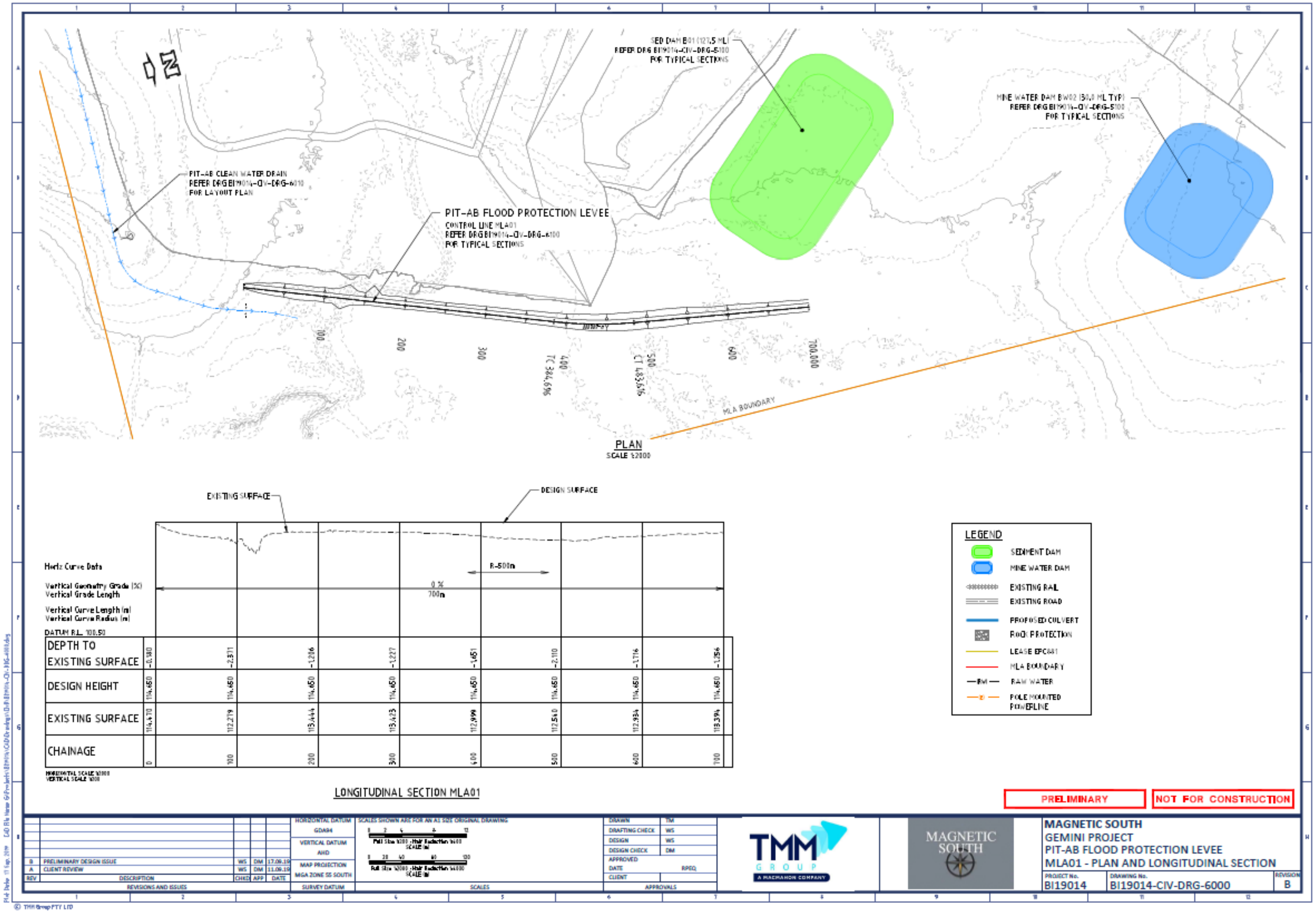


Figure 16 Flood Protection Levee Plan and Longitudinal Section

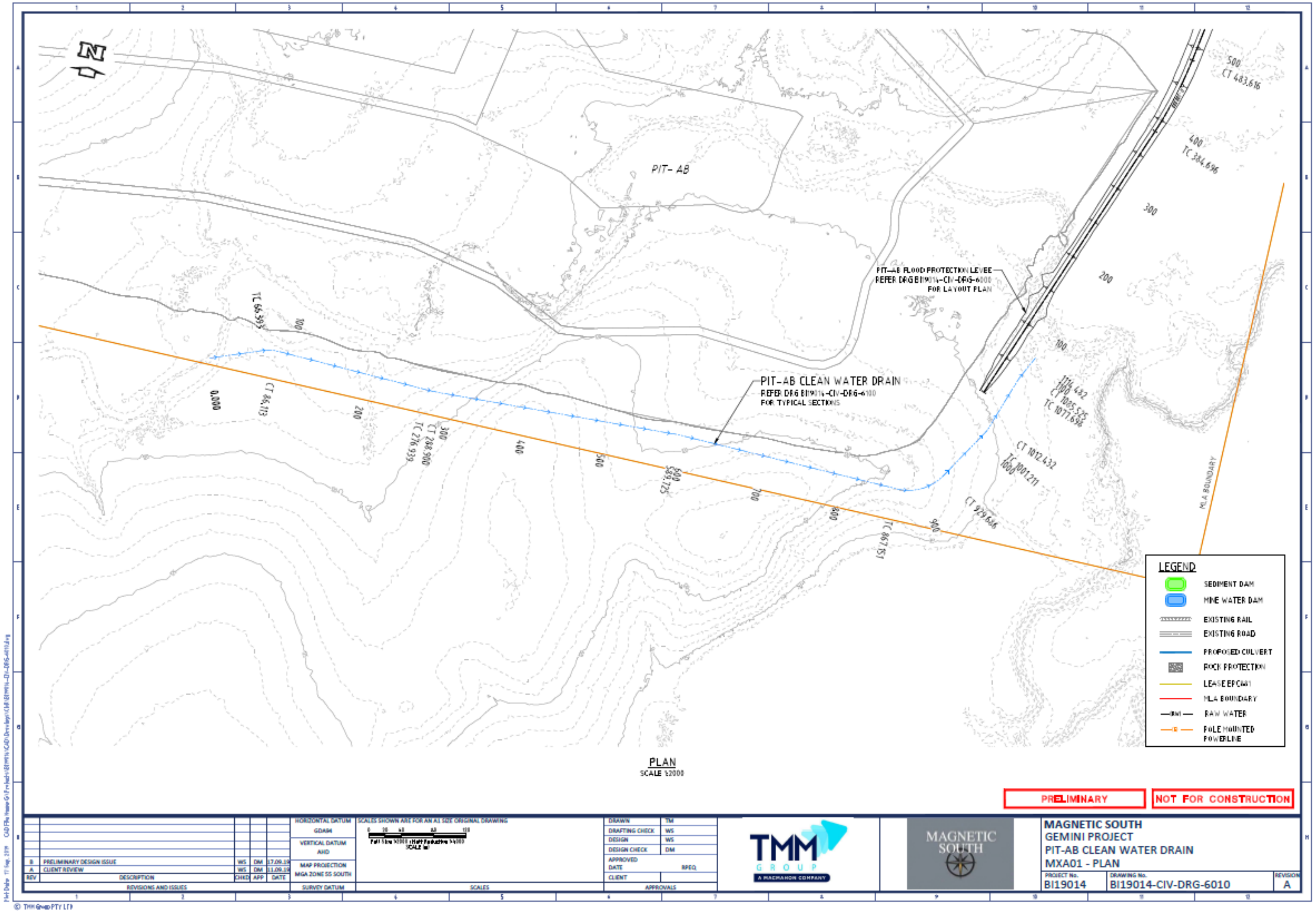


Figure 17 Pit AB Clean Water Drain Conceptual Design

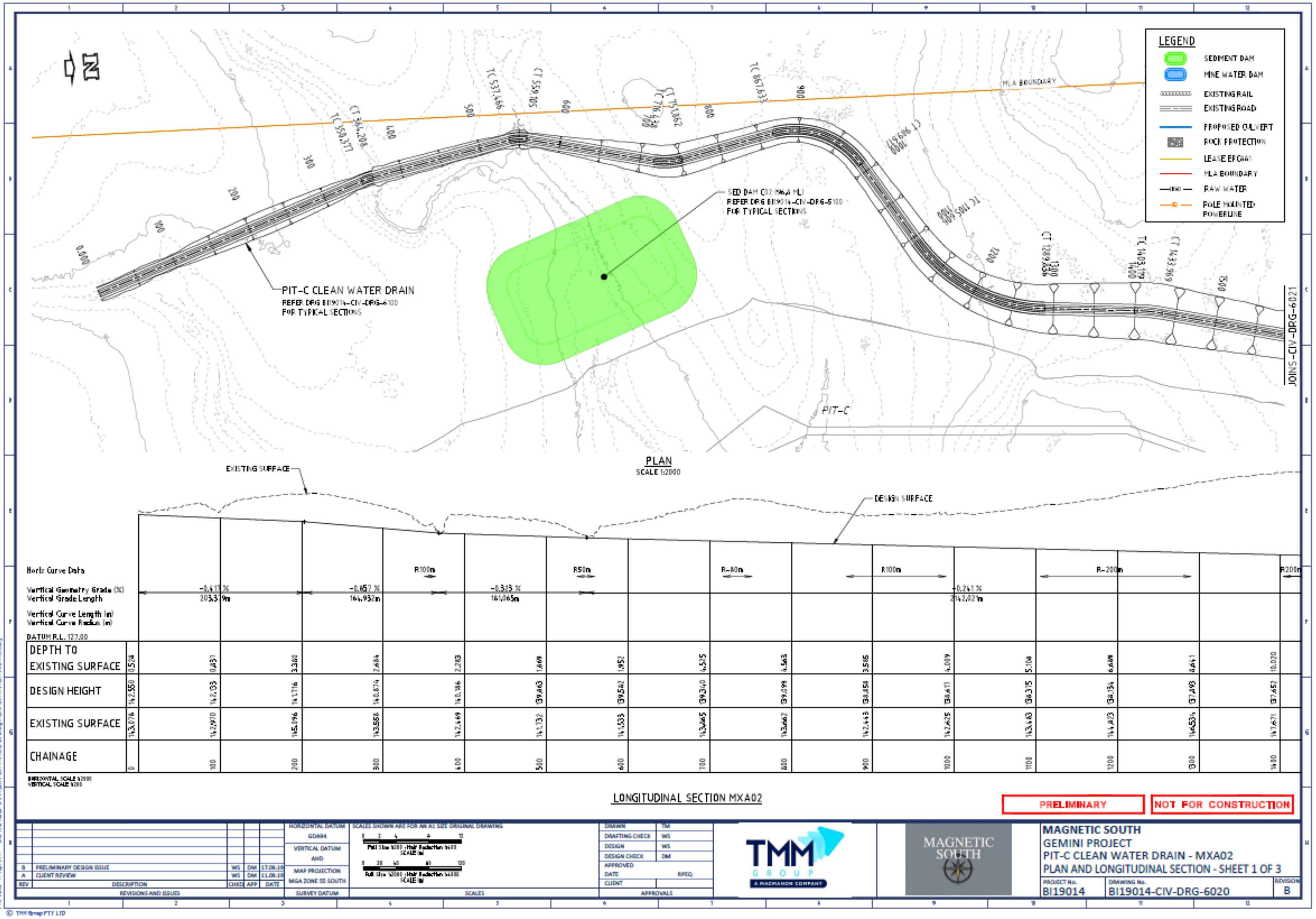


Figure 18 Pit C Clean Water Drain Conceptual Design

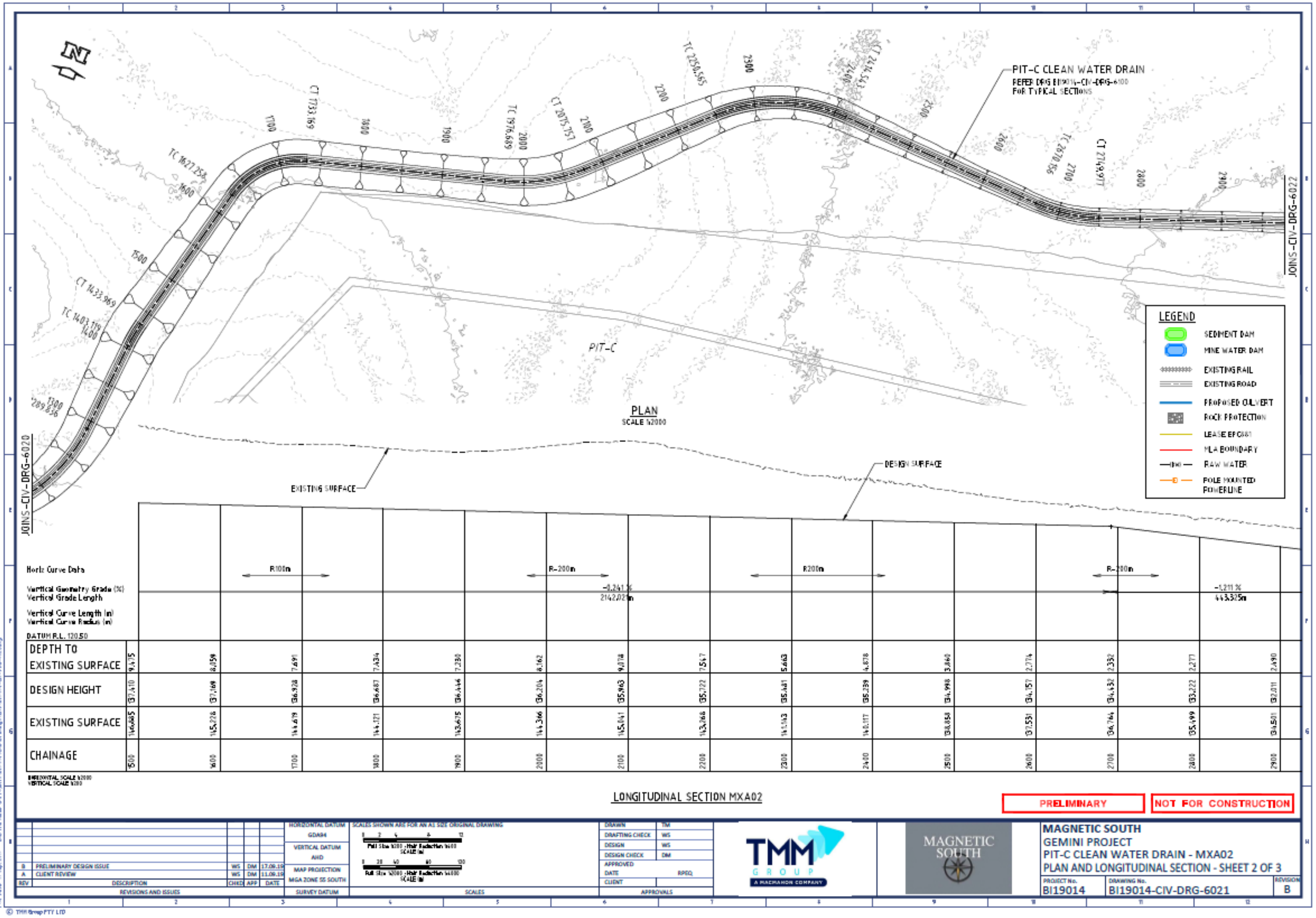


Figure 19 Pit C Clean Water Drain Conceptual Design

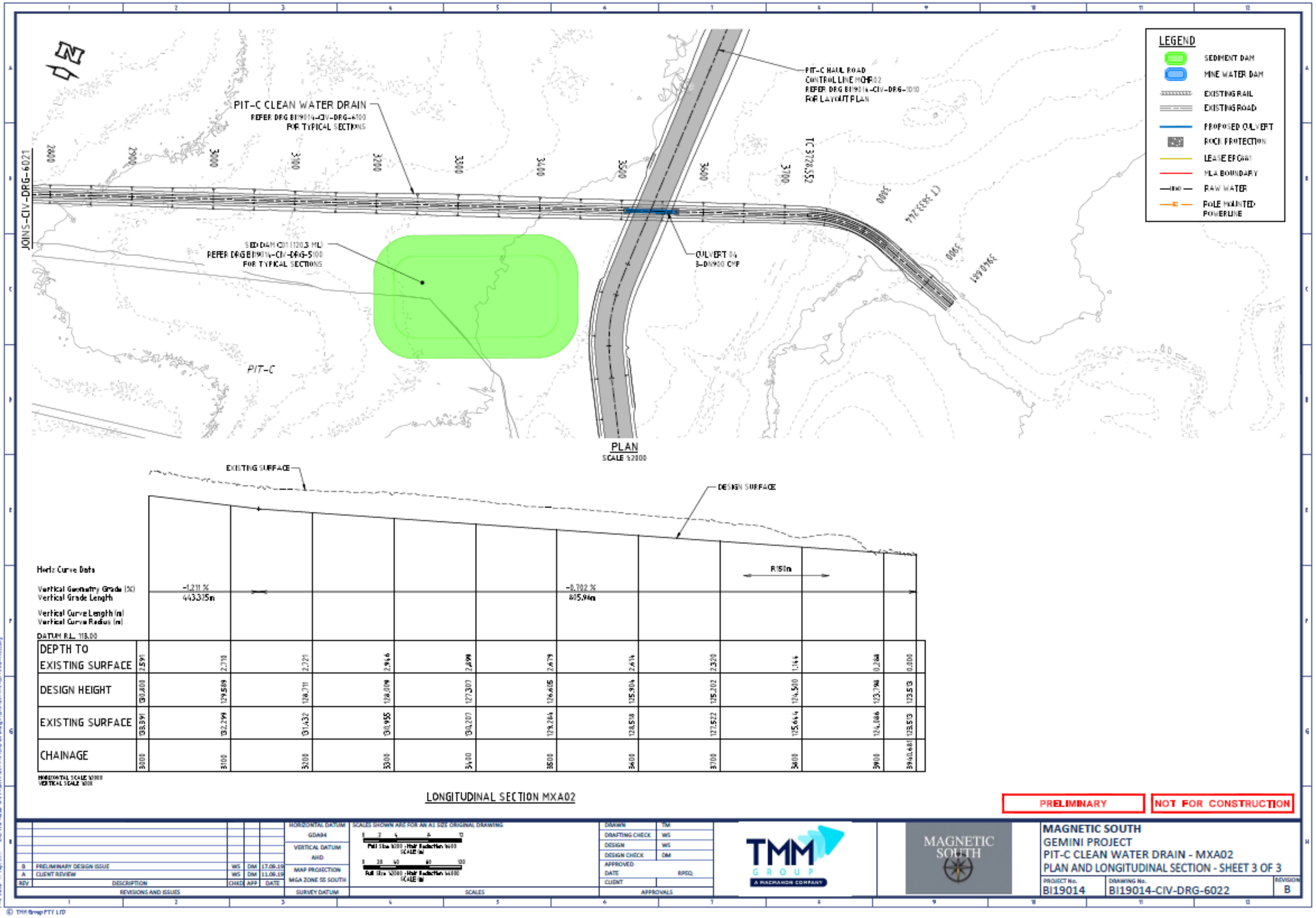


Figure 20 Pit C Clean Water Drain Conceptual Design

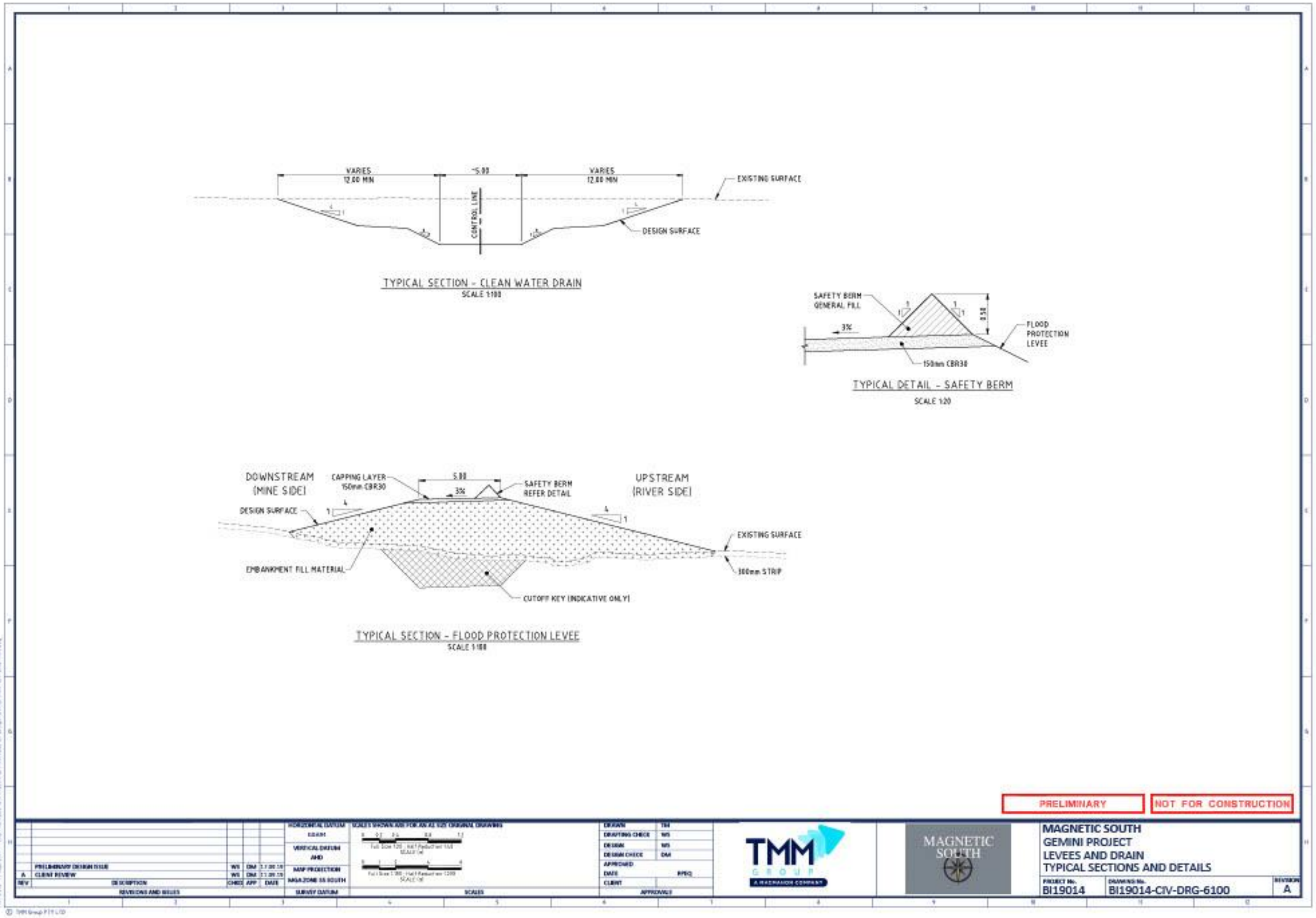


Figure 21 Levees and Drains - Typical Sections and Details

3.4.3.3 Water Storages

Water storages will include mine water dams, sediment dams, raw water dam, and process water dam. All storages will be located such that they are above the 0.1% AEP flood level.

All water storage dams, structures and facilities will be designed, constructed and managed in accordance with the *Manual for assessing consequence categories and hydraulic performance of structures [ESR/2016/1933]* (DES 2016).

Water collected in sediment dams will be captured and retained for reuse on-site and/or controlled release off-site to the receiving environment in accordance with *Model water conditions for coal mines in the Fitzroy basin [ESR/2015/1561]* (EHP 2013a).

Process Water Dam

Water is used in the CHPP for the sizing and removal of waste material. Water recovered from the CHPP during processing will be recycled through a closed loop circuit whereby any wastewater from the CHPP is temporarily stored in the process water dam and reused in the CHPP.

Mine Water Dams

Water that accumulates in the pits will be transferred to contained water storages (i.e., mine water dams) for beneficial use (i.e., dust suppression and/or CHPP water supply). Pit AB will be used as a supplementary mine water storage after commencement of mining in Pit C. A number of small staging dams may be used to collect water pumped from the mine pits before transferring to the mine water dam. These ancillary dams are designed to overtop back into the pits. The main mine water dam is located to the north of Pit AB and offsite discharge of mine water will be avoided by operating below a maximum operating level and directing emergency overflows from the mine water dam via a spillway to the Pit AB.

MIA dams will capture and contain runoff from the MIA and coal stockpiles. Oil/water separators are proposed for vehicle wash and workshop areas to treat hydrocarbon contaminated runoff prior to capture. These dams will be sized to ensure full containment of MIA and coal stockpile runoff.

A series of sediment traps and small drainage dams will be used to capture washdown and overflow from trains and sumps before it is directed to the TLO dam. Water collected in this small dam will be pumped to the mine water dam.

Haul Road Dams

Two small dams will be used to manage runoff from disturbed catchments. One dam (between Pit AB and Pit C) will be used to contain runoff from the Pit C haul road, while the other dam will be used to collect runoff from the haul road on the western side of Charlevue Creek.

Raw Water Dam

A raw water dam will be located adjacent to the MIA (Figure 7 and Figure 11) and will be sized to hold approximately 50 megalitres (Ml). The raw water dam will store water transported to site via the raw water pipeline from Blackwater, described in Section 3.5.2.

Sediment Dams

Sediment dams will be constructed to contain runoff from the waste rock emplacements and haul roads. The sediment dams allow for gravity settling of sediment prior to re-use of the water onsite or release offsite. The sediment dams will be designed and operated in accordance with *Best Practice Erosion and Sediment Control* (IECA Australasia 2008) and the Department of Environment and Heritage Protection guideline for *Stormwater and environmentally relevant activities [ESR/2015/1653]* (DES 2017f). A consequence category assessment will be undertaken by a suitably qualified person during the final design process. However, sediment dams are unlikely to have a significant consequence category due to their locality from the floodplain, climate modelling and the preliminary design parameters.

The sediment dams have been sized as follows:

- water storage capacity 0.1% AEP 24-hour storm event with an adopted volumetric event runoff coefficient for disturbed catchments of 0.5;
- *total sediment basin volume = settling zone capacity + sediment storage volume.*
  The sediment storage volume is the portion of the basin storage volume that progressively fills with sediment until the basin is de-silted; and
- *solids storage volume = 25% of water storage volume.*

If required, water captured in sediment dams will be pumped back into the MAW system.

Table 9 summarises the sediment dam design criteria in accordance with the abovementioned guidelines.

The sediment dams will be maintained until the vegetation within the catchment area of the sediment dams is successfully established; and whereby surface water runoff achieves similar water quality characteristics to background sites of areas undisturbed by mining activities. Sediment dams may be maintained during rehabilitation to augment site water requirements.

Table 9 Gemini Project Sediment Dam Design

Storage	Catchment Areas (ha)	10-year 24-hour Water Storage capacity (ML)	Solids Storage Volume (ML)	Total Storage Capacity (ML)
AB01	146.1	105.9	26.5	132
AB02	155.5	112.7	28.2	141
AB03	121.8	88.3	22.1	110
AB04	114.9	83.3	20.8	104
C01	132.7	96.2	24.1	120
C02	106.8	77.4	19.4	97
C03	32.4	23.5	5.9	29
C04	76.0	55.1	13.8	69
C05	64.8	47	11.7	59

Source: Appendix B - Surface Water Assessment

3.4.4 Preliminary Consequence Category Assessment

3.4.4.1 Consequence Assessment – Dams

A consequence assessment has been completed for the dams making up the proposed water management system, in accordance with the *Manual for assessing consequence categories and hydraulic performance of structures* (DES 2016) (the Manual). Details of the assessment protocols and criteria are provided in the *Surface Water Assessment* (WRM 2020b), with results of the assessment summarised in Table 10.

Table 10 Summary of Consequence Assessment - Dams

	Main Water Dam	CHPP and MIA Dams	Raw Water Dam	Sediment Dams
Failure to contain - seepage				
Harm to humans	L	L	L	L
General environmental harm	S	L	L	L
General economic loss/damages	L	L	L	L
Failure to contain - overtopping				
Harm to humans	L	L	L	L
General environmental harm	S	L	L	L
General economic loss/damages	L	L	L	L
Dam break				
Harm to humans	L	L	L	L
General environmental harm	L	L	L	L
General economic loss/damages	S	L	L	L
OVERALL CCA RATING	**S**	**L**	**L**	**L**
Requires DSA/MRL	Y*	N	N	L
Requires engineered spillway	Y	Y	Y	Y
Requires lining (unless detailed groundwater investigation indicates risks are low)	Y	Y	N	N

L = Low consequence
S = Significant consequence
*DSA for Mine Water Dam – no DSA required if spills are directed to the Mine Pit via an appropriately robust overflow system (the Mine Pit provides the DSA)

3.4.4.2 Consequence Assessment – Levee

A consequence assessment has also been completed for the proposed levee protecting the mine pit from flood inundation. The Manual includes specific considerations for the assessment of levee. Details of the assessment protocols and criteria are provided in the *Surface Water Assessment* (WRM 2020b), with results of the assessment summarised in Table 11.

Table 11 Overall Consequence Categories

Criteria	Consequence Category
Harm to humans	L
General environmental harm	S
General economic loss/damages	L
OVERALL CCA RATING	**S**

3.4.5 Site Water Balance Model

The operating life mine stage plans were used to determine progressive catchment areas and land use types for each mine water storage. These 'snapshots' of mine operations were adopted for the site water balance modelling. OPSIM, a computer-based operational simulation model was used to assess the dynamics of the mine water balance under conditions of varying rainfall and catchment conditions throughout the development of the Project, based on the SWMS described in Section 3.4.2. The model was configured to simulate the operations of all major components of the water management system. Detailed water balance modelling methodology is provided in Appendix B.

Water Demand

Water demands calculated for the operational life include CHPP coal washing and conveyor dust suppression, haul road dust suppression, and TLO dust suppression demands. The estimated annual demands (WRM 2020b) (Appendix B) considered the Project from the basis of full production levels (Project Year 2). Year 1 demands are estimated based on construction activities only; including infrastructure establishment and early works on Pit AB excavation. The CHPP and TLO will not be processing coal to contribute to water demand, with the only Project water demand during Year 1 would be dust suppression for construction activities. Site water demands are summarised in Table 12.

Groundwater Inflows

As indicated, there will be small 'pumpable' inflows of groundwater to mining pits at the end of operations. Current active pits do not indicate any groundwater inflows. Groundwater inflows to the pits have been assumed to increase in a linear manner over time.

Groundwater inflows were estimated in the *Groundwater Impact Assessment* (JBT 2019), which is discussed further in Section 8.0 and attached as Appendix C. The estimates provided by JBT (2019) are based on net inflows to the pit after evaporation losses from the pit faces and the entrained moisture losses due to mining.

Groundwater inflows are expected to increase over time and eventually the net inflow would exceed the total site water demand. Water is therefore expected to accumulate in the mine water dam over the long term. The relatively large capacity of the mine water dam has been provided specifically for this purpose.

The net inflow rates adopted for the site waster balance model are provided in Table 12.

Overall Water Balance

The overall average annual site water balance is summarised in Table 13. The results demonstrate the adaptive capacity of the SWMS to changing mine stages and climatic variability.

Over the life of the Project, the results of the site water balance indicate that small volumes of external water supply will be required at each stage of the Project, with the exception of Stage 1 (first four years of Project). Haul road dust suppression forms the greatest demand for water on the site, while the greatest loss of water is caused by evaporation.

Total average inflows increase steadily during the first three stages (13 years) of the Project from approximately 1,000 Ml/a to approximately 1,500 Ml/a. A larger increase is evident in Stages 4 and 5, with the commencement of Pit C adding a greater runoff catchment area which increases total average inflows to around 2,300 Ml/a over the final five years of the Project.

Total average outflows, steadily increase over the operational life of the Project from approximately 1,000 Ml/a to approximately 2,000 Ml/a.

The model of the SWMS has been configured to ensure MAW is contained within the system. Hence, the modelled results show no spills of MAW from the mine water dams (not including sediment dams).

When the sediment dams exceed their maximum operating volumes, sediment dams are allowed to discharge offsite. Note that sizing of the proposed sediment dams is in accordance with *Best Practice Erosion and Sediment Control* (IECA Australasia 2008).

Table 12 Summary of Site Water Demands and Expected Groundwater Inflows

Year	Demand (Ml/a)				Net Groundwater Inflow (Ml/a)
	CHPP	Haul Road	TLO	Total	
1	0.0	250.0	0.0	250.0	0.0
2	162.0	314.6	0.72	477.3	31.5
3	162.0	314.6	0.73	477.3	31.5
4	162.0	314.6	0.73	477.3	31.5
5	162.0	314.6	0.73	477.3	31.5
6	162.0	333.4	0.73	496.1	31.5
7	162.0	333.4	0.72	496.1	31.5
8	162.0	333.4	0.72	496.1	31.5
9	162.0	333.4	0.71	496.1	31.5
10	162.0	333.4	0.72	496.1	31.5
11	162.0	333.4	0.72	496.1	31.5
12	162.0	401.5	0.70	564.2	220.8
13	162.0	401.5	0.74	564.2	220.8
14	162.0	401.5	0.74	564.2	189.2
15	162.0	464.9	0.74	627.6	205.0
16	162.0	464.9	0.74	627.6	31.6
17	162.0	511.8	0.72	674.5	31.6
18	162.0	511.8	0.74	674.5	31.6
19	143.4	511.8	0.65	655.9	47.3
Total	**2,897.4**	**7,178.5**	**13.00**	**10,088.9**	**1,292.6**

External Water Supply

Site water requirements are preferentially sourced from the MAW system and supplemented as required by the sediment water system. However, in the event that both systems are not sufficient to meet operational water requirements, external raw water will be supplied by a spur pipeline from the Blackwater Pipeline (refer Section 3.5.2) and transferred to the raw water dam.

'External supply pipeline' refers to the quantity of raw water imported from external sources (i.e., SunWater) which is then transferred to the raw water dam.

Potential imported water requirements have been assessed using forecast simulation. The results show that:

1. imported water requirements from the external pipeline are highest in the early Project stages;
2. under very dry conditions, the demand could reach 500 Ml/a, but median Year 1 demand is less than 100 Ml/a; and
3. during later years, accumulated stored water in the MAW system and sediment water system is sufficient to supply demands in all but the driest years.

The external raw water supply contract will be sufficient to ensure continued operation even in the driest of years.

Table 13 Average Annual Site Water Balance

Process	Stage 1 Y1-Y4	Stage 2 Y5-Y10	Stage 3 Y11-Y13	Stage 4 Y14-Y15	Stage 5 Y16-Y18	Total
Inflows (Ml/a)						
Rainfall and runoff	973	1,052	1,215	2,148	2,214	7,602
Net groundwater inflow	32	32	210	118	37	428
External supply pipeline	89	51	29	17	11	196
Total Inflows	**1,093**	**1,135**	**1,454**	**2,283**	**2,261**	**8,226**
Outflows (Ml/a)						
Evaporation	250	317	386	629	762	2,344
Haul road dust suppression	315	336	405	469	515	2,040
CHPP usage	162	162	162	162	162	810
Spill from raw water dam	37	41	41	43	44	206
Spill from sediment dams	223	245	398	669	652	2,187
Spill from mine water dams	0	0	0	0	0	0
Total Outflows	**988**	**1,102**	**1,392**	**1,972**	**2,135**	**7,587**
Change in Site Water Inventory (Ml/a)	**102**	**29**	**59**	**308**	**122**	**619**

3.5 SUPPORTING INFRASTRUCTURE

3.5.1 Power Supply

Electricity supply to the region is provided by a Powerlink 275 kV/132 kV substation at Blackwater (Rangal Substation). Electricity is currently supplied to properties within the local area from a 132 kV/66 kV substation at Blackwater, as well as Ergon substations at Dingo and Bluff. Ergon Energy distributes electricity from these substations to local customers.

Power to the mine and all mining infrastructure (i.e., accommodation facilities, CHPP and MIA) will be supplied by the construction of a 66 kV transmission line and an onsite switching/substation located adjacent to the MIA. The transmission line will be connected to the regional network and be installed along the alignment of the mine access road to the MIA (Figure 8). Diesel power generation will be used for construction activities and until the transmission line is completed.

3.5.2 Water Supply

SunWater operates the Blackwater Pipeline network, which supplies water from the Bedford Weir (part of the Nogoa-Mackenzie River pipeline network) to the town of Blackwater and a number of nearby coal mines.

A spur pipeline from the Blackwater Pipeline will be constructed for the Project by SunWater with the take-off point located near the Blackwater Treatment Plant. SunWater has advised there is sufficient availability of water within the Mackenzie Nogoa River network to provide the Project's estimated water requirements, including in the driest of years. Within the MLA the water supply pipeline will be installed proximal to the mine access road corridor and connect to the raw water dam near the MIA (Figure 22).

During construction water will be required for dust suppression and civil works, as well as potable water for drinking. Water will be sourced from regional suppliers and transported to site by tanker and stored at the MIA until the permanent supply is established. Potable water may also be supplied by truck from Blackwater.

3.5.3 Sewage

A *Land-Based Disposal Effluent Disposal Assessment* (Cardno 2020) for the Project's effluent disposal is attached as Appendix N. During both construction and operation phases, workers will generate domestic wastewater from accommodation, offices, and facilities. The wastewater will include material which is generated from the following:

- toilets (often classed as black water); and
- showers, kitchen facilities and laundry (often classed as grey water).

In accordance with the EP Regulation, wastewater has been estimated using each worker as an equivalent person (EP) with each EP generating 200 L/day. During construction, a total of 280 workers will be onsite and generate their total maximum volume of 56,000 L/day. During operations, only 140 workers will be present onsite and will generate their total maximum volume of 28,000 L/day.

All domestic wastewater will be channelled to a single sewage treatment plant (STP) located at the accommodation facilities towards the northwest of the MLA, as shown in Figure 7. The STP has been designed for a 280 EP maximum capacity (56,000 L/day). A closed wet weather storage tank will be located at the STP and designed in accordance with the *QLD Government Technical Guideline for Disposal of Effluent via Irrigation*. The closed wet weather storage tank will have a 3-day capacity of 168m^3 suitable for both construction and operations to account for times when the ground is showing signs of saturation (such as surface water pooling) during substantial rain events. The tank will have a length of 19.48m, width of 19.48m, and an overflow outlet depth of 3m.

A membrane bioreactor will be operated at the STP with an appropriately sized pump station to minimise the retention of raw sewage to less than eight hours and reduce the potential for odour and volatile organic compounds.

The treated effluent from the STP will be irrigated in a suitable irrigation management area, while the remaining sewage sludge will be removed by a licensed regulated waste contractor for offsite disposal. During the initial site preparation phase, prior to installation of the STP, all sewage will be contained at the MIA and transferred by a certified third-party contractor to an appropriately licensed regional waste disposal facility.

3.5.3.1 Irrigation Management Area

The proposed irrigation management area is located south of the Capricorn Highway towards the northwest of the MLA and is shown in Figure 7. It is located within reasonable proximity to the primary source of wastewater (accommodation facilities) and is accessible from the proposed camp access road.

The reasonably flat nature of the designated area and distance from significant watercourses is ideal for irrigation. The topography falls in a north to south direction. The irrigation area lacks any significant drainage lines / watercourses and sits on the divide between the catchment of Stanley Creek towards the north and the catchment of Charlevue Creek to the south. Two minor drainage lines off Charlevue Creek are present to the east and west of the irrigation management area. Stanley Creek and Charlevue Creek are highly ephemeral flowing only after substantial rainfall events. The management area has already been cleared and therefore contains limited ecological value.

The irrigation management area (approximately 195m x 195m, 3.8 ha) will maintain sufficient buffers from sensitive receivers such as waterways, ecosystems, and the residents/mining camp (refer to Figure 12-1 of Appendix N). The following buffer zones for the irrigation management area will be adopted in accordance with the *QLD Government Technical Guideline For Disposal of Effluent via Irrigation* to ensure environmental care and exposure to all sensitive receptors is negligible:

- natural waterways >100 m;
- residential facility or public amenities >50 m;
- domestic water bore > 250 m;
- drinking water catchment and aquatic ecosystems with high ecological value > 250 m;
- town water supply bore > 1000 m;
- groundwater bore used for potable water supply >250 m; and
- groundwater table at a depth >3 m.

A review of the Central Highlands Regional Council Flood Hazard Overlay indicates that the irrigation management area and the greater proposed mine are located a substantial distance away from Q100 floodplain based on the 1% AEP + climate change allowance. Therefore, inundation within the irrigation area is not considered to be high-risk.

Site specific soil data was unavailable from the selected irrigation management area and therefore soil characteristics have been interpolated from the Soil and *Land Suitability Assessment* (AARC 2019) (Appendix I). As a result, the irrigation management area has been characterised by the Soil Management Unit (SMU) Geoffrey which covers approximately two thirds of the mining lease (refer to Section 5.2.5). The Geoffrey SMU consists of texture contrast soils (loamy sands to sandy light clays) with soft surface conditions, associated with undulating plains and rises. The chemical and physical properties of the soil profile pH are described as moderately acidic in the upper loamy profile (5.8-6), with a sudden shift to weakly alkaline in the underlying clay profile (8.1). An increased cation exchange capacity (CEC) was observed at greater depths (0.4 – 8.8 meq / 100g) and also a general increase in salts, as is evident in the higher EC (0.004 – 0.137), chloride and sodicity in the bottom clay layer. Exchange sodium percentage (ESP) ranges from non-sodic in the upper profile (1 – 1.8%) to strongly sodic in the lower profile (22.1%).

Topsoil nutrients are generally quite limited with nitrate (3 mg/kg), phosphorous (8 mg/kg) and potassium (<200 mg/kg) below desirable levels. Boron (0.2 mg/kg) and sulphate (<10 mg/kg) are also lower than guideline recommendations for suitable plant growth medium. For extractable metals, manganese (16.0 mg/kg) and zinc (2.16 mg/kg) are within the desirable range, though iron (166 mg/kg) is elevated, and copper (<1.0 mg/kg) is below reportable levels. The nature of the soil is generally supportive of spray irrigation, though the sodicity in the lower soil profile will need to be managed to ensure the soil does not become dispersive.

3.5.3.2 Irrigation Regime

The irrigation regime will be undertaken in accordance with *AS/NZS 1547:2012 On-Site Domestic Wastewater Management.* The infrastructure required will include a STP, wet weather storage tank, closed pond, pump system, pump chamber, pipeline, flush and release valve, supply header and secondary treatment unit. The irrigation layout is illustrated in Appendix N. The pump system and pipeline will contain a separate effluent chamber with storage volume to match the electrical starting requirements of the irrigation pump motor. The irrigation system will have a discharge capability of at least 50% more than the maximum 30-minute flow rate and capacity to withstand at least 150% of the shut-off head of the pump. The selected spray-irrigation system will evenly distribute effluent and control the droplet size, throw, and plume through the use of coarse spray heads suitable for effluent application.

Given the designated irrigation site is isolated and significant in size, management would only warrant a secondary treatment quality to contain negligible risk of human exposure, aerosol drift and odour nuisance to offsite locations. The following management measures will be implemented to ensure the limits identified in the *National Guidelines for Water Recycling* (Table 9-1, Appendix N) are achieved:

- no access during and after irrigation, until dry (1-4 hours);
- spray drift control (low-throw sprinklers - 180º inward throw);
- restricted irrigation when wind direction is not favourable, or temperature inversions present; and
- irrigation timing during the day when residents are not localised.

Magnetic South will also operate and manage an onsite septic system, which will be located at the MIA to service the office area. Waste from the septic system will be regularly pumped out and removed by a regulated waste contractor for disposal as required. Servicing or maintenance of the system will be contracted to a licensed plumber to undertake the works, as required.

Specific details and requirements regarding the sewage management system will be addressed in a *Non-Mineral Waste Management Plan* for the Project (Section 12.8.1).

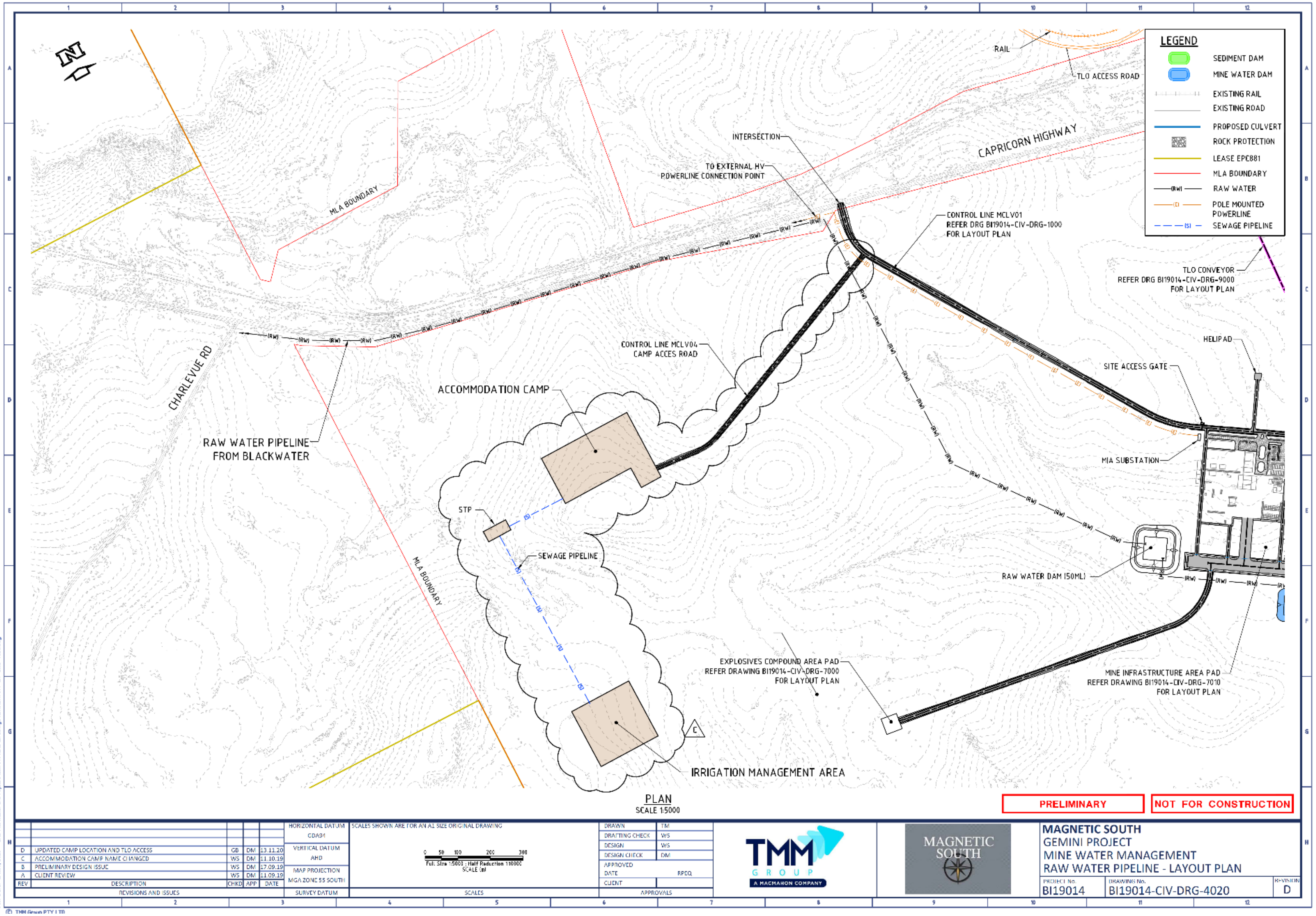


Figure 22 Conceptual Layout - Raw Water Supply Pipeline

3.5.4 Telecommunications

High speed telecommunication services are available in the region via an existing fibre optic network. Connection to this network will be undertaken utilising either microwave or fibre optic cable. A cable connection will be established in the mine access road and power supply corridor.

3.5.5 Fuel Supply

Fuels will be stored within the MIA, with additional self-bunded tanks located as required in the mining area, depending the current location of the main fleet and advancing mine face.

Fuels (including diesel) will be delivered to the Project by contractors. The transport, storage and handling of fuels (including diesel) will be undertaken in accordance with relevant legislation and guidelines.

All equipment and vehicle operators will be trained in the safe operation of the equipment (including operating procedures for the refilling and maintenance of fuel storage tanks and mine vehicles) and the relevant emergency response and spill management procedures in the event of an incident.

Regular inspection programs will be undertaken to monitor the structural integrity of fuel tanks and bunds.

3.6 MINING OPERATIONS

3.6.1 Open-cut Mining Method and Activities

The Project includes two mining areas referred to as Pit AB and Pit C. The open-cut mining areas will be mined using a conventional truck and shovel mining method with excavators and haul trucks.

Mining of Pit AB will be undertaken over a period of approximately 12 years. Out-of-pit waste rock emplacements are required until mine operations advance sufficiently to allow backfilling of the mine void. Out-of-pit waste rock emplacement for Pit AB will be conducted over a period of approximately eight years. In-pit waste rock emplacement will occur from Year 5. Following the completion of coal extraction from Pit AB, final backfilling of the Pit AB void will occur through the rehandling of out-of-pit waste rock emplacements from Year 12.

The development of Pit C is scheduled to commence in Year 12 (one year prior to the completion of mining in Pit AB) and mining will be undertaken over a period of approximately seven years. Out-of-pit waste rock emplacement will be undertaken for Pit C over a period of approximately four years. Once operations have advanced sufficiently, backfilling of the mine void will commence and continue as the mining face advances. Following the completion of coal extraction from Pit C in Year 19, final backfilling of the Pit C void will occur through the rehandling of the out-of-pit waste rock emplacement.

A summary of the open-cut mining activities is provided below.

Vegetation Clearing and Topsoil Stripping and Handling

Vegetation will be progressively cleared over the life of the Project ahead of the active mining and waste rock emplacement areas. Specific vegetation clearance procedures will be developed for the Project as described in Section 5.0.

Topsoil from disturbed areas will be stripped and stockpiled for use in rehabilitation of the final landform. Where stripped topsoils cannot be used directly for progressive rehabilitation, the topsoil will be stockpiled separately. Specific soil management, stockpiling and re-application procedures will be developed for the Project as described in Section 4.0.

Waste Rock Management

Some weathered or friable overburden (e.g., clays and alluvium) will be pre-stripped using excavators and haul trucks, with supporting dozers.

Drilling and blasting of competent overburden and interburden material (waste rock) will be undertaken within the open-cut pit areas. Standard commercial products will be used, with the principal blasting agent being ammonium nitrate fuel oil (ANFO).

The removal of waste rock will be undertaken by excavator and haul truck, with supporting dozers to expose the underlying coal seams. The waste rock will be placed in out-of-pit waste rock emplacements, or as infill in the mine void, behind the advancing mining operations.

The permanent waste rock emplacements are located to the west of Pit AB and Pit C. The waste rock emplacements will be developed progressively during the operational life of each pit and will have a maximum elevation of approximately 190 mAHD high. As mining advances, sufficient void space will be created within the mined-out areas to enable waste rock to be placed in the in-pit waste rock emplacements.

A small temporary waste rock emplacement will also be established to the north of Pit AB. Waste material will be re-handled from each waste rock emplacement and from the temporary waste rock emplacement to backfill the final voids of each of the respective pits following the completion of coal mining activities.

ROM Coal Handling

Excavators will load the ROM coal into haul trucks for haulage to the ROM stockpile area located at the MIA. Haulage of ROM coal from Pit AB and Pit C will be conducted during day and evening hours (i.e., 7 am to 10 pm), to minimise air quality and noise impacts at sensitive receptors during the night. Noise and dust levels would be monitored for compliance management. To achieve increased Project production rate efficiencies; ROM coal haulage during night hours (i.e., 10 pm to 7 am) would be considered, providing monitoring shows that compliance can be achieved at sensitive receptors.

Landform Profiling and Rehabilitation

Re-shaping of the waste rock emplacements, re-application of topsoil and revegetation of the final landform surfaces will be undertaken progressively over the life of the Project. The rehabilitation strategy for the Project is described in Section 4.0.

3.6.2 Mine Schedule

The total quantity of coal to be mined is approximately 32 Mt ROM. The indicative mine schedule is provided in Table 14. The life of mine waste rock material handled is estimated to be approximately 475 Mbcm for the Project. The annual volumes of waste rock handled during the various mining stages of the Project are provided in Table 14.

Subject to granting of the Project ML and EA, mine construction activities are scheduled to commence in July 2021. It is anticipated that it will take approximately six months to establish the necessary infrastructure to commence overburden removal and 18 months to commence coal production.

Indicative general arrangements for various stages of the Project are shown in Figure 23 to Figure 32. The stage plans show the mine's progression over time and are based on the present schedules and production plans. The layout and mining sequence may vary from that shown to account for localised geological features, detailed engineering design, mining economics and variations in market tonnages and quality requirements.

Table 14 Indicative Mine Schedule

Year	Waste Rock (Mbcm)	ROM Coal Mined (Mtpa)	Coal Rejects (Mtpa)	Product Coal (Mtpa)[1]
Y1	13.0	0	0	0
Y2	26.1	0.9	0.83	0.07
Y3	22.1	1.9	0.54	1.36
Y4	24.4	1.9	0.53	1.37
Y5	27.8	1.9	0.54	1.36
Y6	22.5	1.9	0.54	1.36
Y7	26.8	1.9	0.56	1.34
Y8	29.9	1.9	0.55	1.35
Y9	24.0	1.9	0.57	1.33
Y10	24.2	1.9	0.55	1.35
Y11	23.4	1.9	0.56	1.34
Y12	26.2	1.9	0.60	1.30
Y13	27.5	1.8	0.41	1.39
Y14	28.2	1.8	0.41	1.39
Y15	28.7	1.8	0.42	1.38
Y16	28.1	1.8	0.41	1.39
Y17	27.4	1.8	0.45	1.35
Y18	28.9	1.8	0.42	1.38
Y19	14.3	1.6	0.38	1.22
Total	473.4 Mbcm	32.3 Mt	9.27 Mt	23.03 Mt

Notes: Mbcm million bank cubic metres
1 values represent the air-dried tonnage

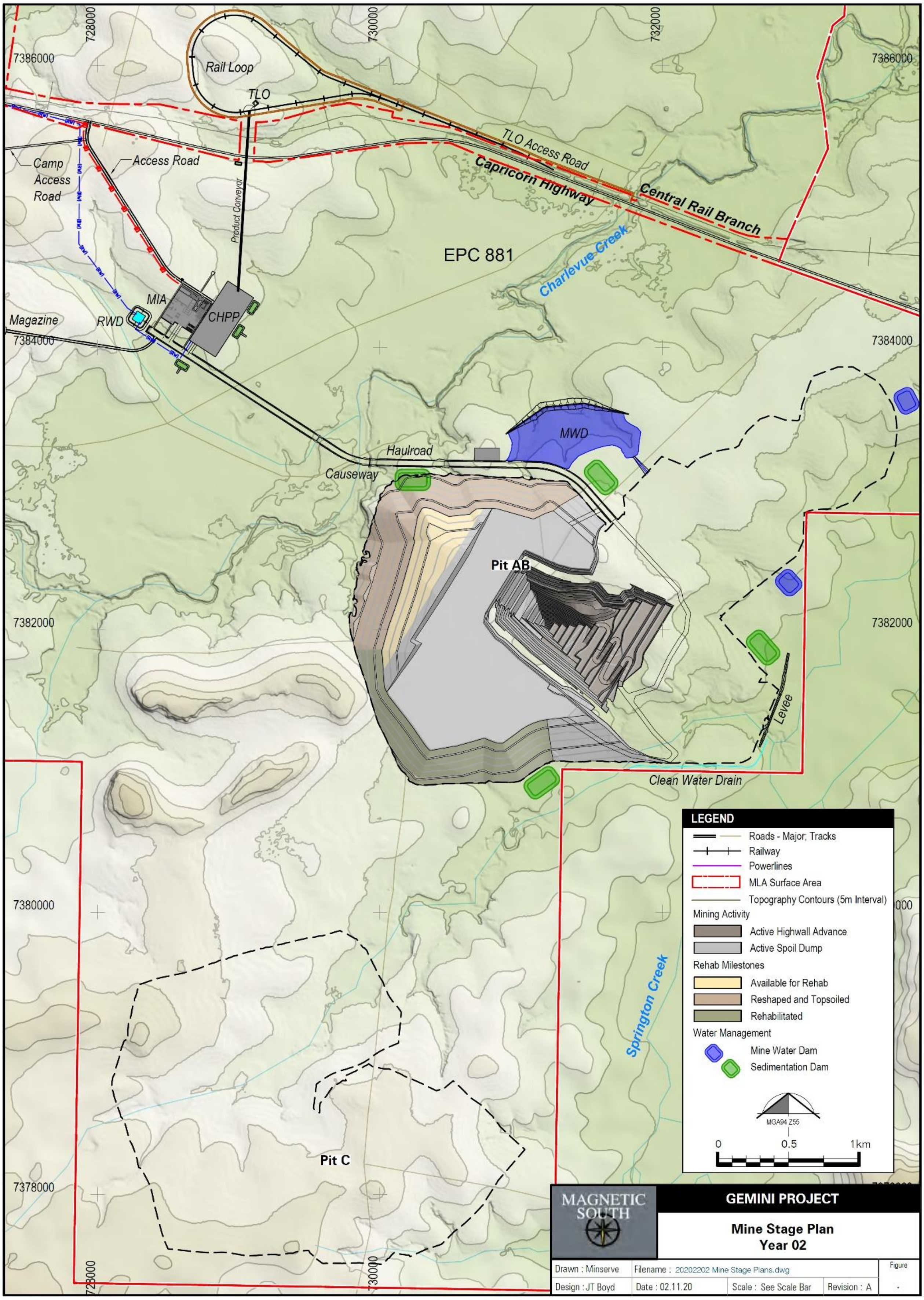


Figure 23 Mine Stage Plan - Year 02

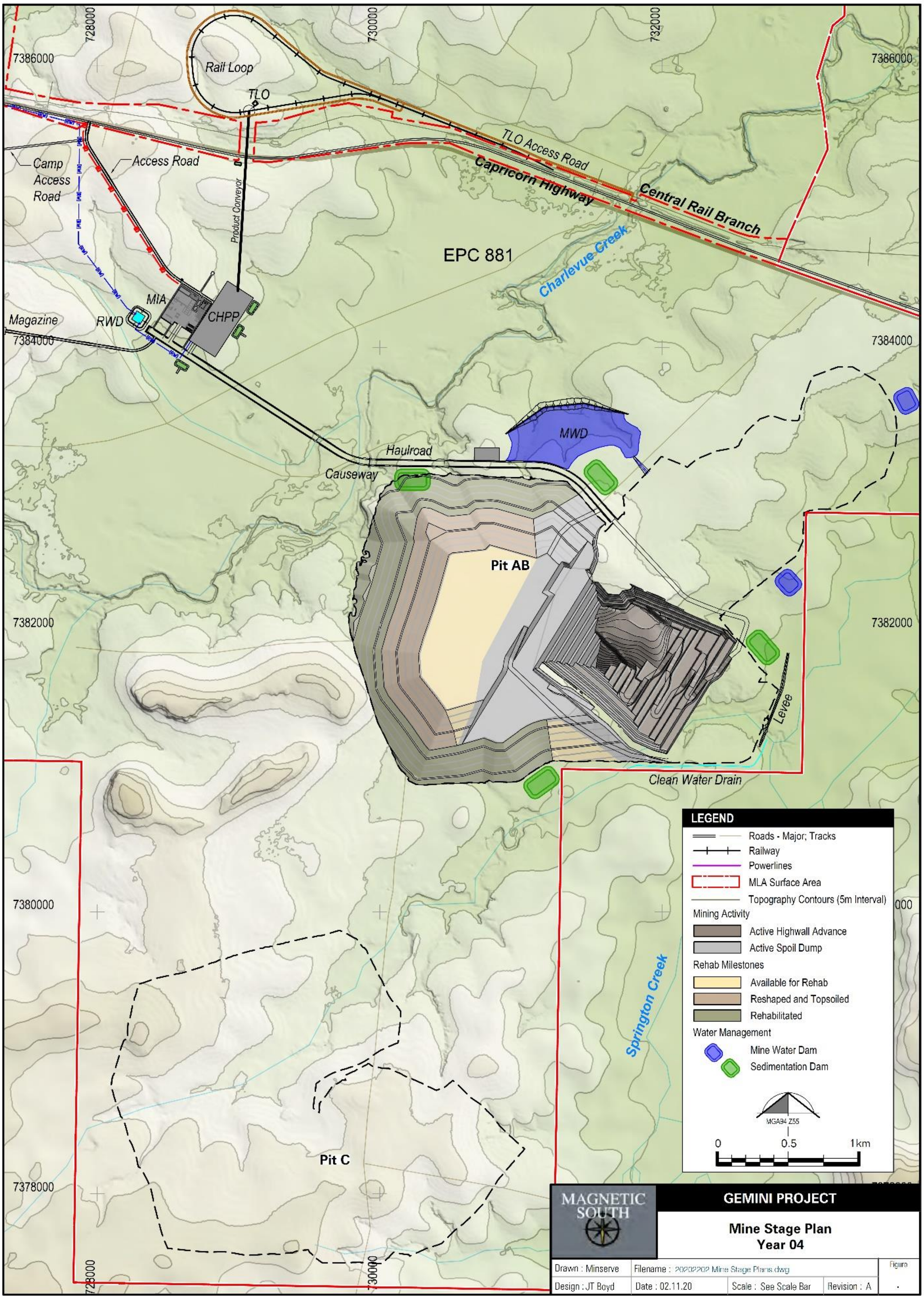


Figure 24 Mine Stage Plan - Year 04

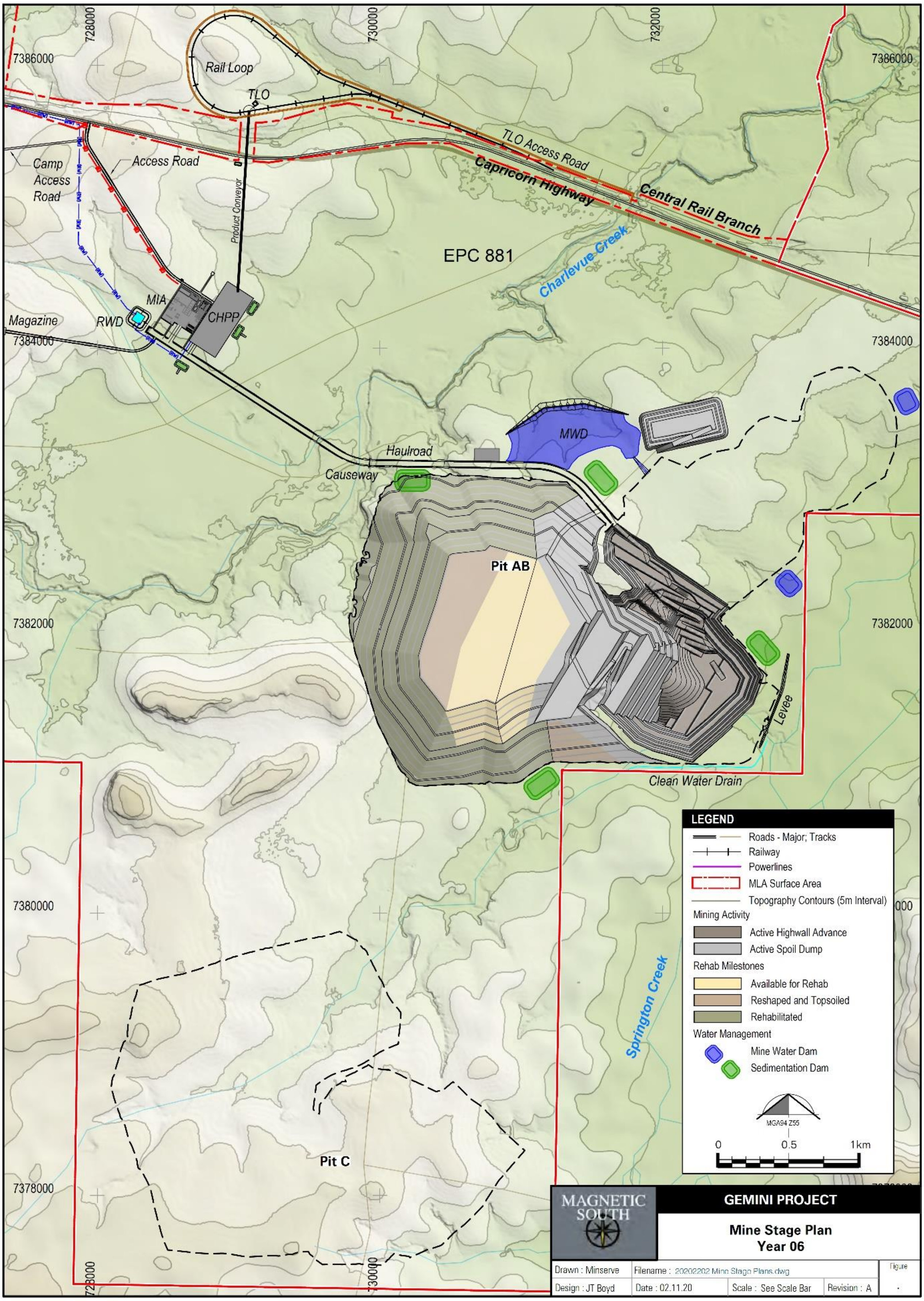


Figure 25 Mine Stage Plan - Year 06

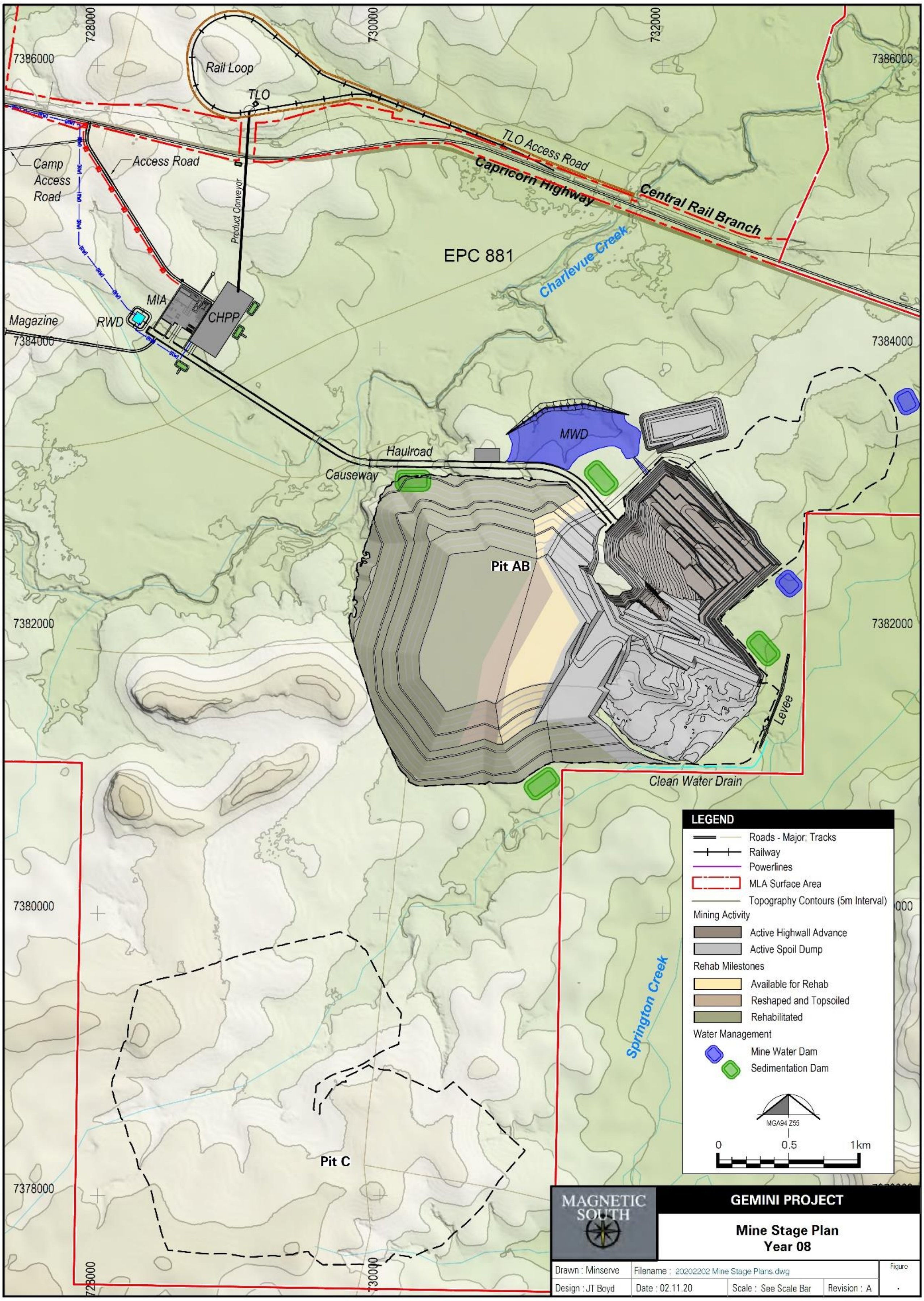


Figure 26 Mine Stage Plan - Year 08

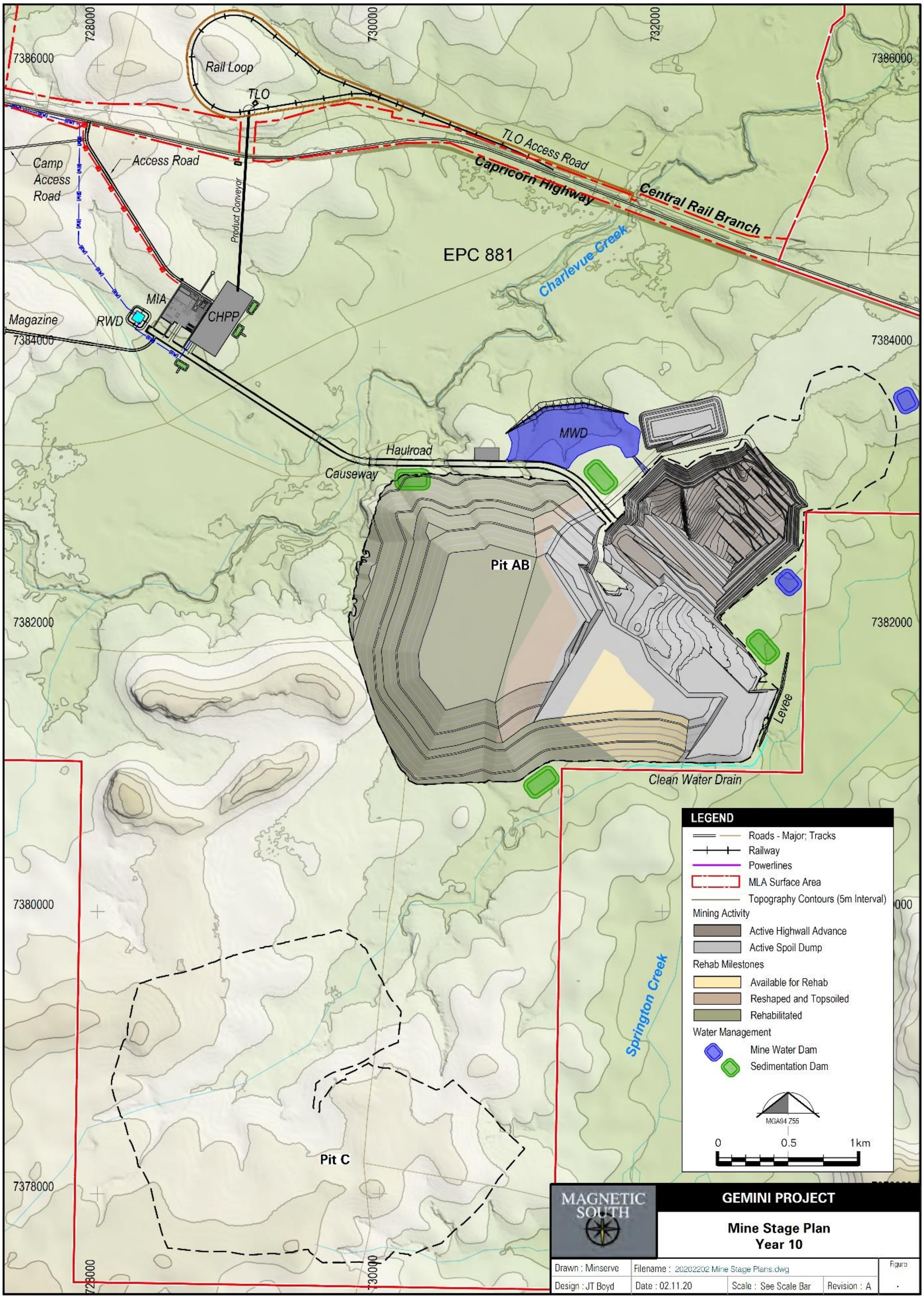


Figure 27 Mine Stage Plan - Year 10

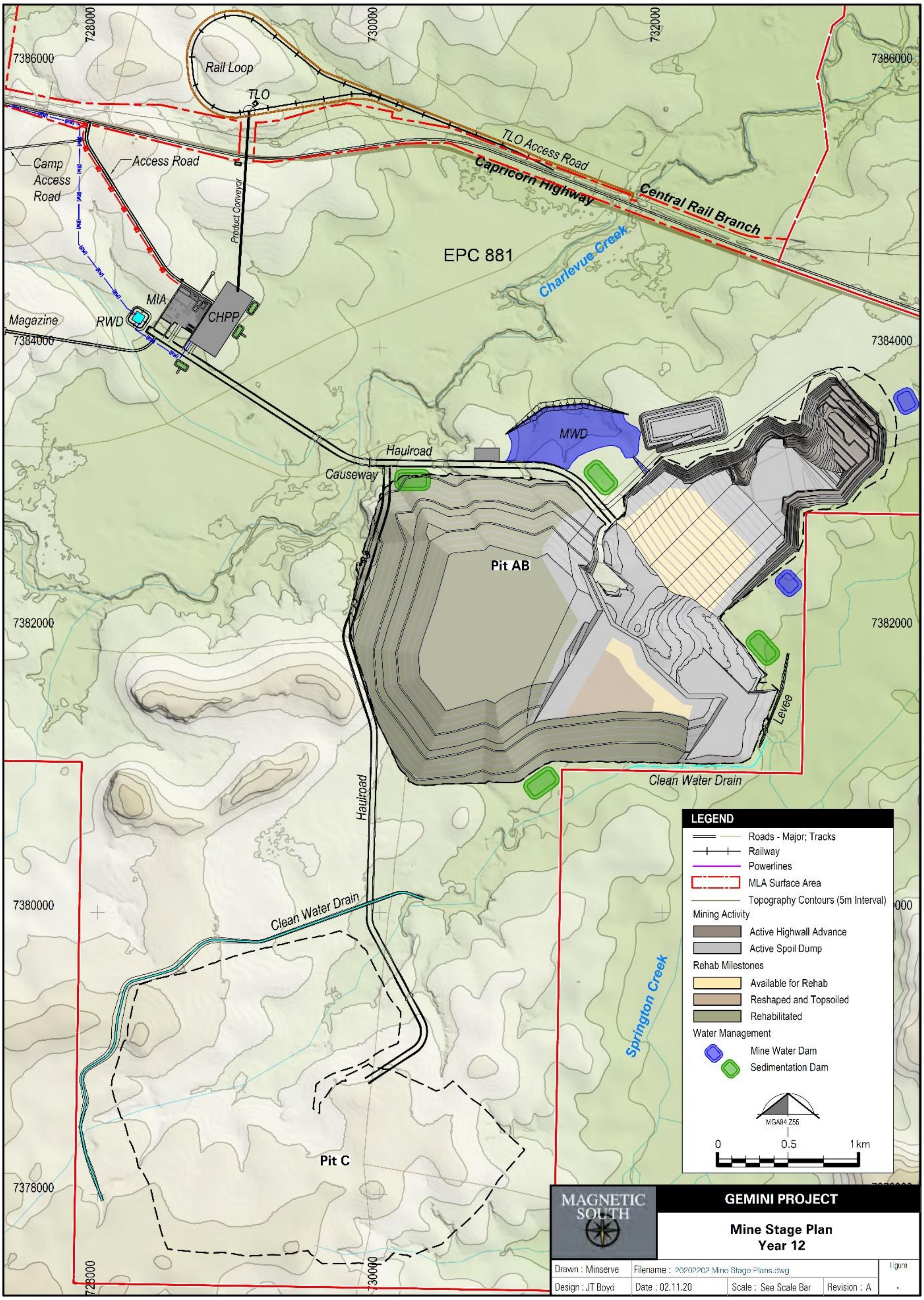


Figure 28 Mine Stage Plan - Year 12

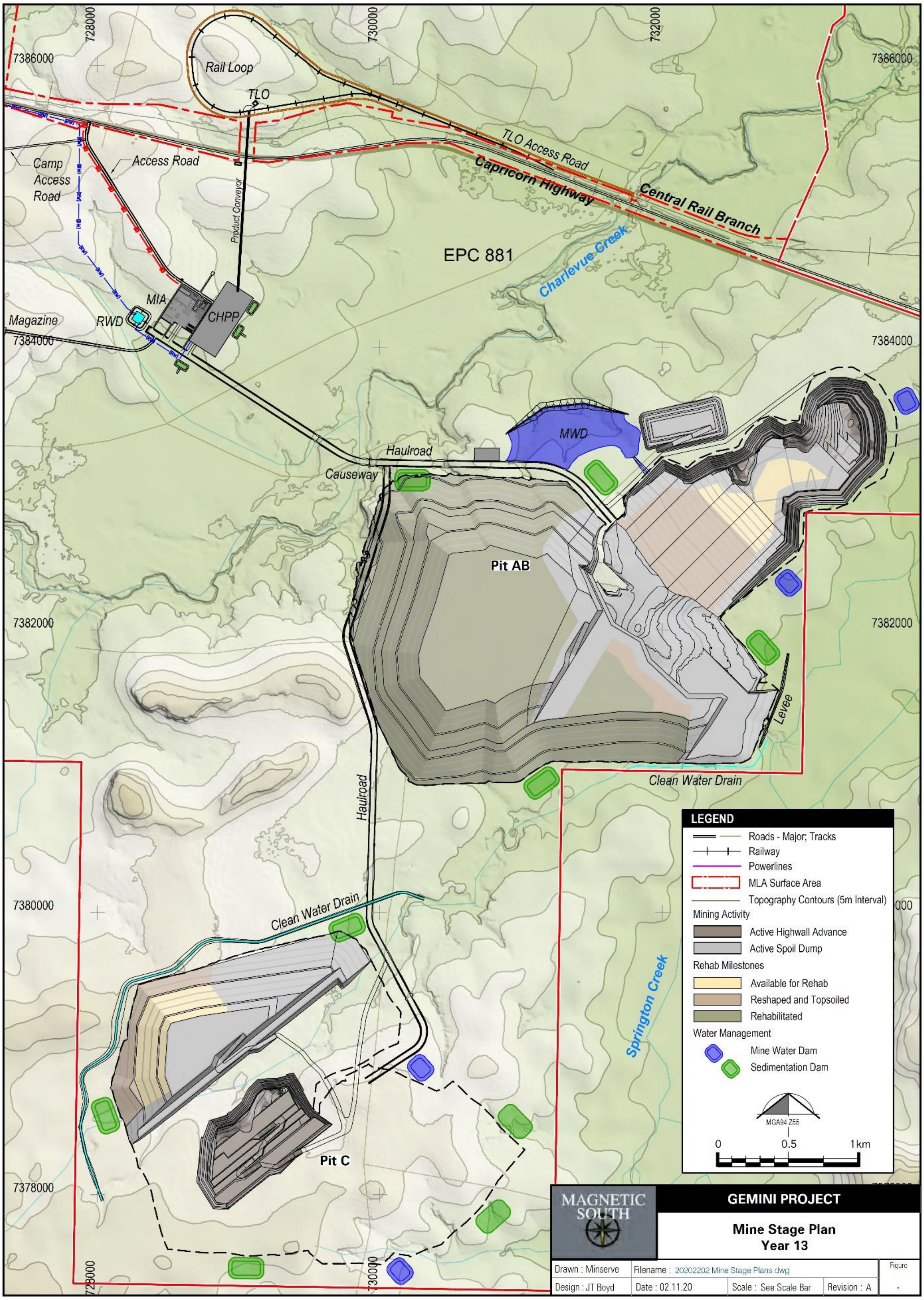


Figure 29 Mine Stage Plan - Year 13

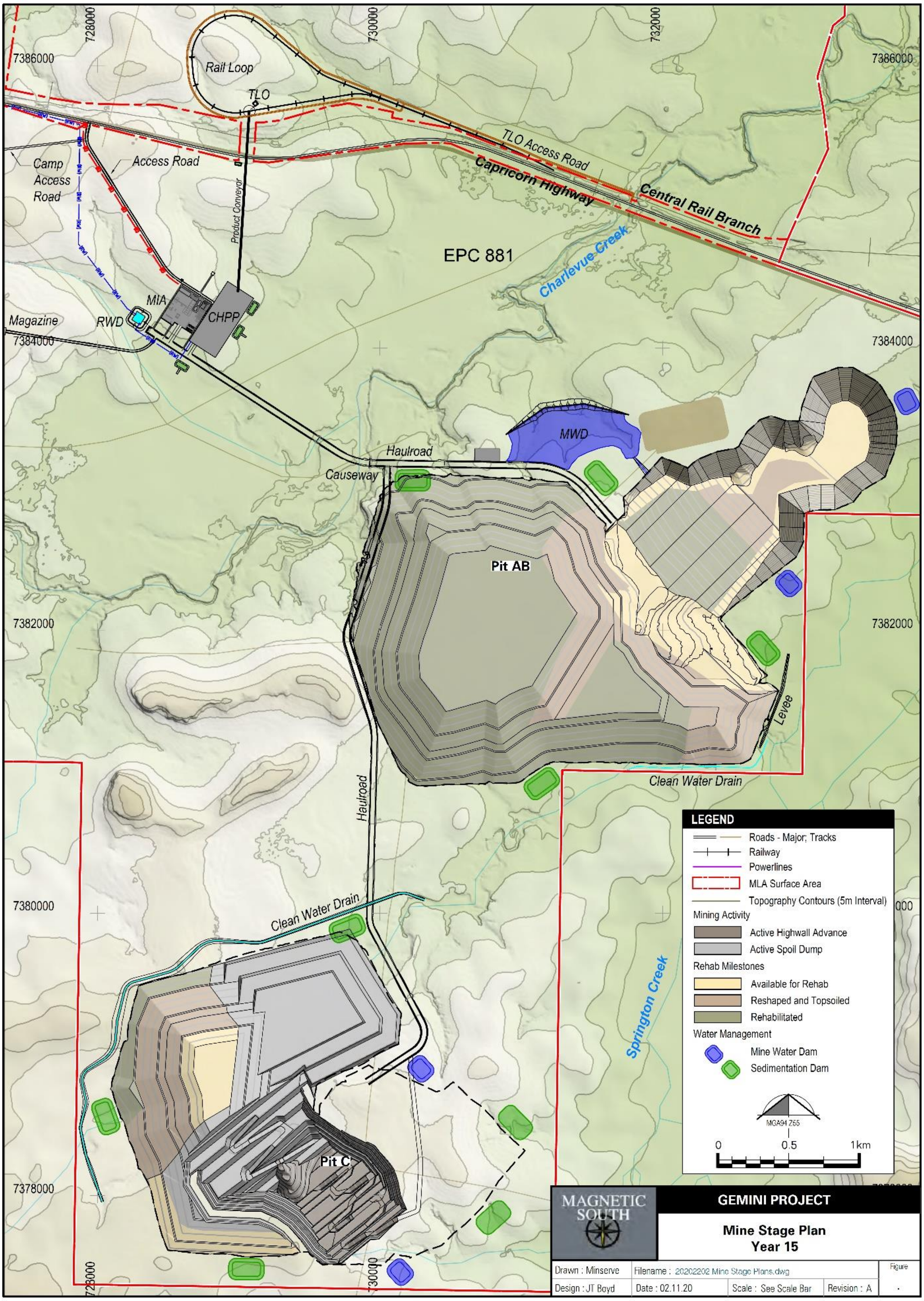


Figure 30 Mine Stage Plan - Year 15

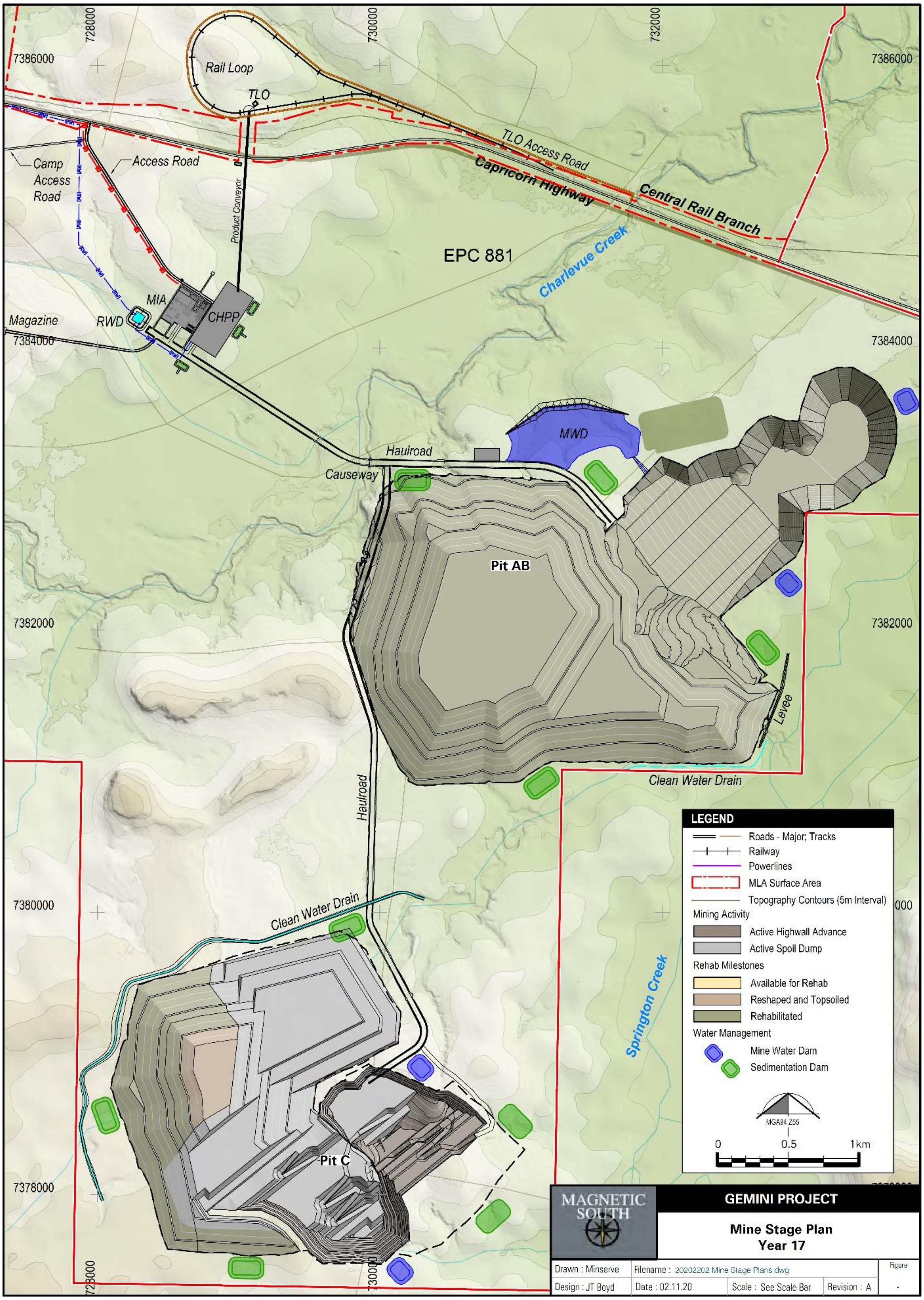


Figure 31 Mine Stage Plan - Year 17

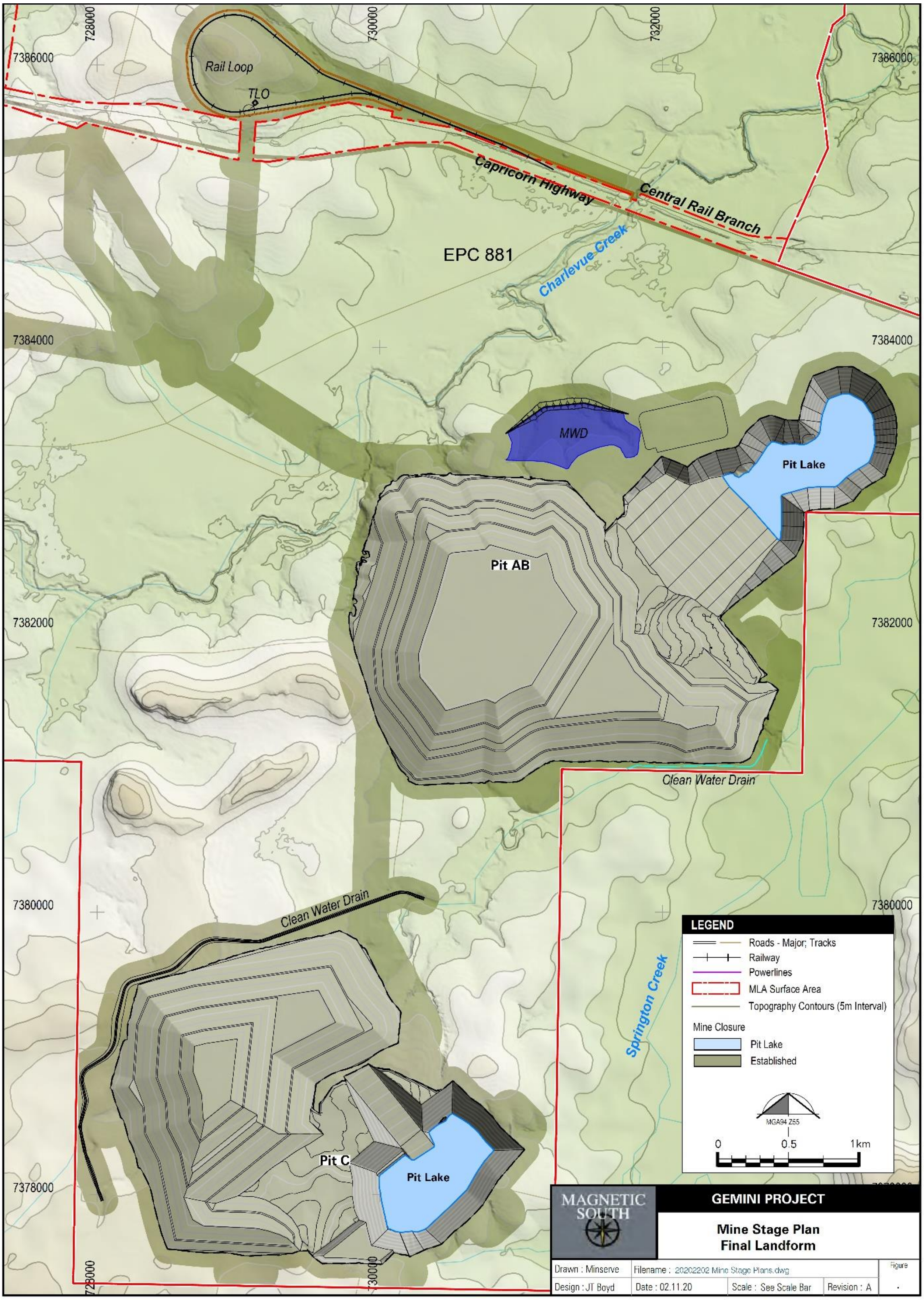


Figure 32 Mine Stage Plan – Final Landform

3.6.3 ROM Coal Processing

ROM coal from the ROM stockpile area will be crushed and screened and conveyed to the CHPP for beneficiation. A portion of mined coal may be screened and crushed and bypass the CHPP, direct to the product stockpiles.

Primary sizing will break the coal down to a maximum of 250 mm diameter. Secondary and tertiary sizing will then reduce the top size coal below 50 mm diameter.

The coarse coal circuit will comprise dense medium cyclones and centrifuges to separate the coarse rejects from the washed product coal. The fine coal circuit will comprise cyclones and sieve bends, flotation cells and thickeners, and reflux classifier and screens. Product coal will be conveyed to the product stockpiles for blending to meet customer specifications. The product coal will be conveyed to the TLO facility to be loaded onto trains.

Coarse rejects will be conveyed to the rejects bin. Fine rejects and slimes will be dewatered and conveyed to the rejects bin to be combined with the coarse reject material. The combined rejects will be loaded onto trucks for placement in out of pit spoil dumps, or in-pit behind the mining void.

The conceptual materials handling flowsheet is shown in Figure 33.

3.6.4 Rail Transport and Port Operations

The PCI coal or coking coal from the Project will be transported via the Blackwater Railway to the RG Tanna Coal Terminal or Wiggins Island Export Coal in Gladstone (Figure 1) for export to the international steel making market. Both of these terminals form part of the existing Port of Gladstone.

There will be approximately four train movements per week on average, subject to train and shipping schedules.

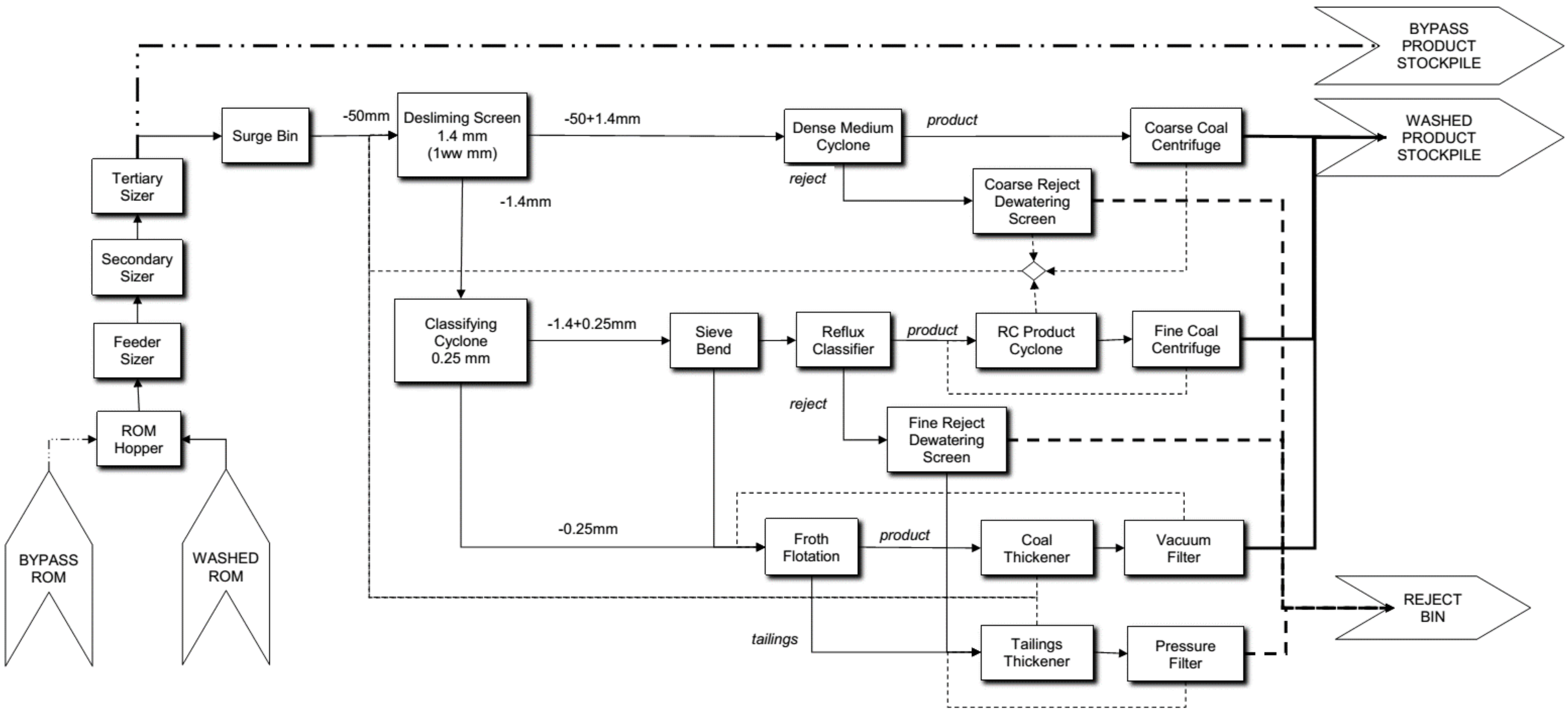


Figure 33 Conceptual Materials Handling Flowchart

3.7 EQUIPMENT FLEET

Equipment used to construct the Project will include excavators, haul trucks, dozers, drills, graders, front end loaders, cranes and water trucks. The mine fleet for the Project is forecast to vary according to the production rates and equipment requirements associated with the open-cut mining operations.

The mining equipment required for the Project includes large (540 t class) hydraulic excavators to remove the bulk of the waste rock material, supplemented by smaller 350 t and 200 t class hydraulic excavators and front-end loaders to remove interburden and partings, and to mine coal. Haul trucks will transport coal (100 t class) and waste rock (240 t class).

A fleet of ancillary equipment will be used to support the mining equipment, including dozers, graders and water trucks. Rotary drills will also be used to drill the waste rock material and coal as required.

The forecast equipment list at full development will include:

- up to four excavators;
- up to 20 haul trucks;
- up to nine dozers;
- up to two graders;
- up to four front end loaders; and
- up to two water trucks.

A small fleet of ancillary equipment will be used to service and maintain mine equipment and infrastructure and CHPP, ROM and product coal stockpiles and manage warehouse storage. This will include fuel trucks, service trucks tyre changer, forklift, mobile cranes, light trucks, loaders and light vehicles.

3.8 ROAD TRANSPORT

The Capricorn Highway traverses the MLA, providing a convenient regional link to Blackwater, Emerald and Rockhampton. As described in Section 3.3.1, an intersection with the Capricorn Highway will be constructed for the mine access road.

A number of local Council roads traverse the MLA and are located to the north and south of the Capricorn Highway. Local roads to the north of the Capricorn Highway within the MLA include Red Hill Road and Ellesmere Road.

Local roads within the MLA to the south of the Capricorn Highway include Cooinda Road and an un-named road. Cooinda Road traverses the MLA from the south and connects to the Capricorn Highway. The un-named road traverses the centre of the MLA through Lot 1 on Plan HT424 (Figure 6) and connects to the Capricorn Highway. To the east of the MLA, Sanders Road originates from Namoi Road and extends to the property boundary of Lot 2 on Plan HT138. From the property boundary, Sanders Road becomes an access track within the property and connects to Cooinda Road within the MLA. These local roads and tracks will be temporarily closed to the public for the Project.

To maintain the connection of Cooinda Road to the Capricorn Highway (via Sanders Road and Namoi Road), the access track extending from Sanders Road is proposed to be diverted. The diversion will be approximately 2 km in length and will connect onto Cooinda Road approximately 1.0-1.2 km south of its current connection. The diversion works are located outside of the MLA and will be subject to a separate approval from the CHRC (i.e., approval is not being sought by this EA application). Notwithstanding, the approximate location of the proposed diversion is shown on Figure 7.

A *Traffic Impact Assessment* (Cardno 2019) for the Project's roads and intersections is attached as Appendix A. This assessment concluded that all proposed intersections, including the mine access intersection, successfully meet the safe intersection sight distance requirements. Modelling and analysis of the mine access intersection was conducted for a three-way priority-controlled arrangement showing that these intersections can accommodate the anticipated traffic network.

A link capacity assessment was developed for the worst-case traffic scenario anticipated in 2040. This assessment concluded that the Project's road network operates at the highest level of service under baseline traffic conditions. The status of the traffic environment with additional Project related traffic is described as "*stable flow where drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream*".

The overall impacts to the existing traffic network are not expected to be significant based on an increase in mobilisation of Project vehicles on local and State roads.

3.9 WORKFORCE

Employment opportunities that will be generated by the Project include:

- peak construction workforce of up to 260 personnel; including approximately 230 persons servicing the mine development and 30 persons servicing the rail development; and
- peak operations workforce of up to 330 personnel.

The construction workforce roster will typically be 12-hour day shifts, on a 10 days on and four days off rotation. The majority of work will be conducted during the day; however, some construction activities may require night work. For these activities continuous 24-hour activities may be undertaken, scheduled over two 12-hour shifts in a 24-hour cycle.

The operational workforce roster will be 12-hour day/night shifts, on a seven days on and seven days off rotation. The senior management and technical staff roster will be 10-hour day shifts, on a five days on and two days off rotation.

3.10 WORKFORCE ACCOMMODATION

During site preparation and construction, temporary accommodation would be available for non-resident workers within the local region in towns such as Blackwater, Dingo and Bluff and in the accommodation facility, once constructed. The accommodation facility will be constructed towards the northwest of the MLA and will have capacity to accommodate up to 280 persons, but under normal conditions will only be occupied by up to 140 persons. Access to the accommodation facility will occur off the mine access road just beyond the intersection off the Capricorn Highway.

It is anticipated that 80% of the operational workforce will be drive-in-drive-out from the surrounding region, staying at the accommodation facility and bussed to site daily. The remaining 20% of the workforce would reside locally in Dingo, Bluff or Blackwater, with daily light vehicle travel to site and carpooling where practicable.

4.0 REHABILITATION AND CLOSURE

4.1 LEGISLATIVE FRAMEWORK

4.1.1 Environmental Protection Act 1994

In Queensland, mine rehabilitation is required under the EP Act. Amendments to the EP Act in late 2018 implemented key elements of the State Government's *Mined Land Rehabilitation Policy* (State of Queensland 2018) which intends to ensure that land disturbed by mining activities is rehabilitated to a safe and stable landform that does not cause environmental harm and is able to sustain an approved post-mining land use (PMLU).

A key component of the amended Act is the requirement (clause 125 (1)(n)) for a site-specific application for a mining activity related to a ML to be accompanied by a proposed *Progressive Rehabilitation and Closure Plan* (PRCP) complying with Division 3 of Part 2 of Chapter 5. Under this Division, a PRCP must include a PRCP schedule providing rehabilitation milestones for each proposed PMLU, and management milestones for each non-use management area (NUMA) proposed; as well as stating when each milestone is to be achieved. In accordance with the *Environmental Protection (Rehabilitation Reform) Amendment Regulation 2019*, the PRCP start date is 1 November 2019.

The timing of the EA application for the Gemini Project means that it is a transitional project under the amended EP Act. If the EA application is approved, a transition notice from the regulator will be issued to the holder, requiring transition into the PRCP framework. Where practical this rehabilitation and closure section has been prepared to provide information that will ultimately be required in the PRCP.

4.1.2 Mineral and Energy Resources (Financial Provisioning) Act 2018

The *Mineral and Energy Resources (Financial Provisioning) Act 2018* (MERFP Act) was assented to on 30th November 2018 and, apart from amending the EP Act to implement key elements of the *Mined Land Rehabilitation Policy* (State of Queensland 2018), introduces a new financial provisioning scheme, and changes the method for estimating the rehabilitation cost for a resource activity. The new financial provisioning scheme:

- provides for holders of an EA for a resource activity, to pay financial provision contributions to a scheme fund, or provide a surety;

- provides a way to manage the financial risk to the State, as well as the State's costs and expenses, where a resource activity EA holder does not comply with their obligations in relation to rehabilitation; and

- provides a source of funds to the State, for the rehabilitation and/or remediation of lands impacted by abandoned mines, as well as for research contributing to the rehabilitation of land on which resource activities have been carried out.

In accordance with Section 297 of the EP Act, it will be a condition of a resource activity EA that the holder must not carry out a resource activity unless an estimated rehabilitation cost (ERC) decision is in effect and the holder has made the relevant contribution to the scheme fund. Given this, it is anticipated that at the time of issue of an EA for the Project, the proponent will determine the ERC and apply to DES for an ERC decision for the resource activity in accordance with Section 298 of the EP Act.

4.1.3 Policies, Subordinate Legislation and Guidelines

As outlined in Section 4.1.1, the *Mined Land Rehabilitation Policy* (State of Queensland 2018) is the principal and current policy relevant to mine land rehabilitation.

At the time of writing, the following relevant subordinate legislation and guidelines were available:

- *Guideline (Resource Activities): Rehabilitation requirements for mining resource activities [ESR/2016/1875]* (DES 2014a).

The EP Act is supported by the EP Regulation.

4.2 KEY INFLUENCING ECOSYSTEM PROCESSES AND FUNCTIONS

4.2.1 Climate

Rehabilitation methods, particularly surface preparation activities, revegetation species selection, and revegetation timing need to consider the climatic aspects of the region.

The climate of the Project area is characterised as semi-arid with hot humid summers and dry mild winters. Temperatures range between 15°C and 30°C, with mean daily maximum temperatures ranging between 24°C in June and 34°C in January; and mean minimum temperatures ranging between 8°C in July and 22°C in January. The average annual rainfall is 655 mm and evaporation typically exceeds 2,040 mm per annum.

The climatic aspects of the Project site of most relevance to rehabilitation outcomes and erosional impacts can be summarised as:

- **Rainfall:** records depict a typical wet season between November and March of each year, approximately coinciding with the hotter summer months. Figure 34 highlights the significant variation of wet year average rainfall that exists in the region.

- **Evaporation:** average evaporation rates are typically three times greater than the average annual rainfall which, with the variation in annual rainfall commonly experienced is indicative that significant moisture stress can regularly occur, with a consequent potential impact on revegetation success rates and/or failure events.

- **Rainfall intensity:** the central Queensland area can experience high intensity rainfall events. Analysis of BoM 2016 Design Rainfall Data System indicates that short (less than five-minute) duration, high intensity storms of greater than 100 mm per hour would be expected in the Bluff area of central Queensland typically once or twice each year (BoM 2019a).

4.2.2 Landscape, Landform and Hydrology

The Project area is described as gently undulating with elevations ranging between 120-150 mAHD. The physiography of the area is characterised by a dissected tableland having a general relief variation of about 80 m with slopes within the MLA area well less than 5°. The topography of the Project is representative of the surrounding region. The viewscape, some 15-18 km distant to the southwest and west respectively is to the elevated Blackdown Tableland National Park and Arthurs Bluff State Forest which rise approximately 450 m above the elevation of the Project site. There is little relief to the north and east with the land falling gently toward the Mackenzie River valley.

The landscape is influenced by the presence of Charlevue Creek which bisects the MLA from west to east and Springton Creek which flows alongside the southeast boundary of the MLA. The associated

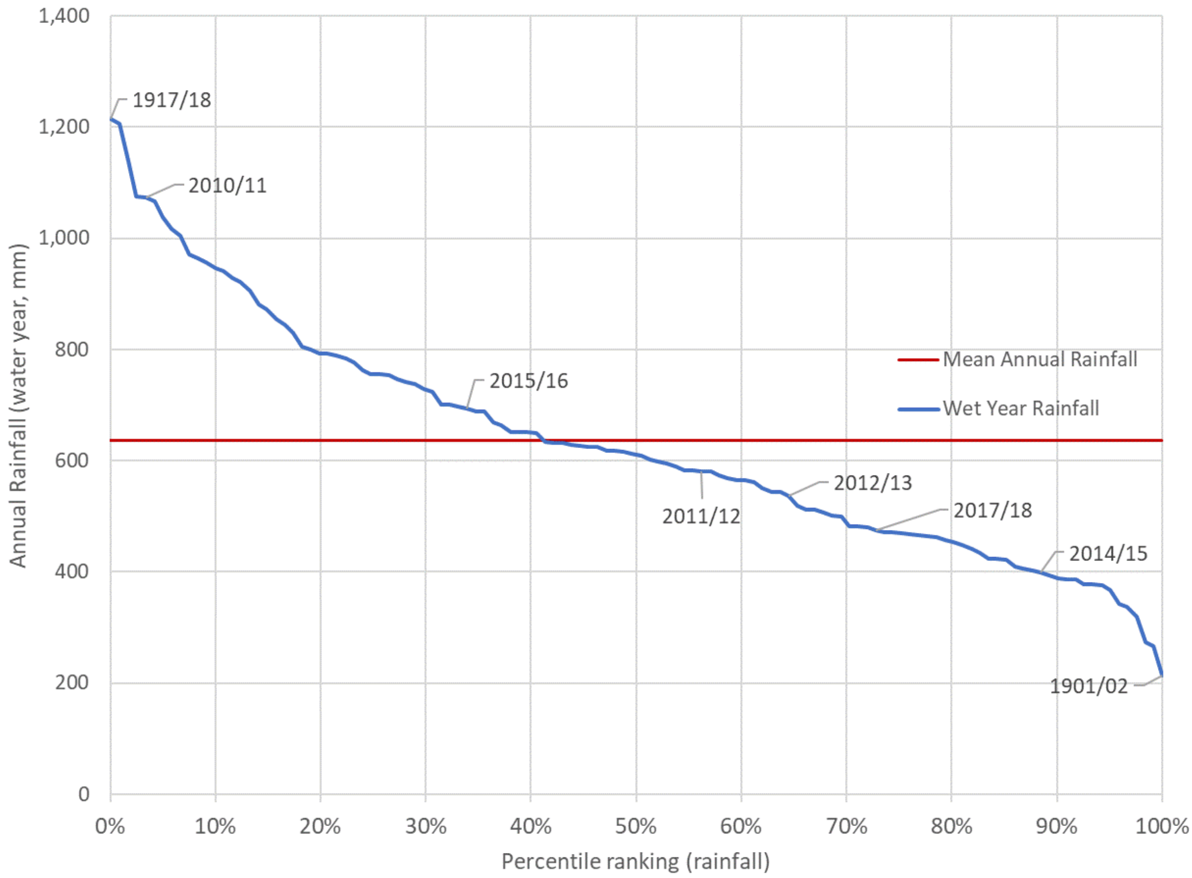


Figure 34 Percentile Ranking of Water Years

floodplains of these two watercourses result in localised lower elevations within the surrounding landscape.

The Project lies within the Mackenzie River sub-catchment, which covers a total area of 12,985 km^2, and is situated in the centre of the Fitzroy River catchment. The major water body associated with the Project site is Charlevue Creek. This creek begins within the boundaries of Blackdown Tablelands National Park, flowing to the northeast before joining Springton Creek. Springton Creek flows to the Fitzroy River eventually reaching the Pacific Ocean approximately 46 km north of Gladstone. A significantly smaller tributary, Stanley Creek crosses the northwest corner of the MLA boundary eventually converging with Springton Creek downstream of the MLA. Minor associated tributaries, dams and drainage features also exist across the site.

4.2.3 Spoil Geochemistry

A detailed *Geochemical Assessment of Mining Waste Materials* associated with the Project was undertaken by RGS Environmental Pty Ltd (RGS 2019) (Appendix G). Geochemical test work undertaken was based on industry recognised procedures for the geochemical characterisation and assessment of mine materials. Seventy samples representative of the main overburden, inter-burden and potential coal reject materials likely to be encountered during development of the Project were assessed.

Samples were subjected to a range of static and kinetic geochemical tests to assess the presence and degree of environmental risk from the oxidation of reactive sulphides, the potential for acid generation, and leaching of soluble metals/metalloids and salts. While these geochemical risks were determined to be low, the assessment recommended the placement of any carbonaceous mining waste material in locations not near the surface or outer batters of waste rock emplacements.

The assessment identified that while most mining materials would be amenable to revegetation, they are likely to be susceptible to dispersion and erosion and may require amelioration for example, through the addition of gypsum and fertiliser. The assessment recommended additional testing of materials and field trials to assist in determining the most appropriate management options to ensure effective rehabilitation.

Geochemistry is discussed in further detail in Section 13.0.

4.2.4 Topsoil Resources

SMUs are detailed within Section 5.2.5. In general, the surface soils to be reclaimed for use in rehabilitation topsoiling activities are of variable pH (between 4.6 and 8), very low to medium salinity, non-sodic (with the exception of the Charlevue SMU), and of very low to high fertility (based on CEC analysis results). The majority of topsoil reclaimed will originate from the Geoffrey SMU which, while not dispersive in the A horizon, has a sandy texture and low nutrient status and may require amelioration to ensure successful revegetation.

A practical topsoil stripping depth of 30 cm has been adopted to capture the entire seed bank, although shallower topsoil stripping depths are recommended where soil chemistry changes occur at less than 30 cm below surface. Subsoil stripping depths are also provided to demarcate the subsoils of a suitable chemical nature for reuse in rehabilitation where desirable (Table 15).

The volume of topsoil and subsoil that can be reclaimed across the disturbance footprint has been calculated using the disturbance area and recommended stripping depth for topsoils and subsoils (refer Table 15). The assessment of soil and land suitability concluded that the topsoils within the disturbance area from Charlevue and Nigel are not suitable for use in rehabilitation activities due to soil limiting properties and have been excluded from the calculation of topsoil reserves (Appendix I).

The volume of topsoil able to be reclaimed across the disturbance footprint of the Project site is 4,953,748 m^3. In addition, 3,832,237 m^3 of subsoil material may also be reclaimed to supplement the topsoil resource. Based on a recommended minimum topsoil respreading depth of 0.3 m, approximately 5,231,820 m^3 of soil will be required for rehabilitation efforts over the life of the Project.

Generally, only topsoil from the A horizon/shallow B horizon will be stripped. Where subsoils are required to supplement topsoil resources, subsoils with high clay content and low erosivity risk will be preferentially selected. A review of the available SMUs has identified James and Barry as having preferred subsoils.

Delineation of topsoils and subsoils during stripping and stockpiling is proposed to prevent dilution of the seedbank. It is recommended that subsoils are placed below topsoil during rehabilitation to increase germination, provide a suitable medium for root development and to aid in water storage within the soil profile. Mixing of topsoils and subsoils is also possible at a recommended ratio of 2:1 but may lead to additional nutrient and seed input requirements to successfully establish vegetation.

Topsoil and subsoil volumes available for use in rehabilitation activities will be maintained in a topsoil inventory in accordance with a *Topsoil Management Plan* to be developed upon approval of the EA conditions and prior to the commencement of construction activities (refer to Section 4.4.2).

Soils are discussed in further detail in Section 5.0.

Table 15 Estimated Topsoil Volumes Available for Rehabilitation

Soil Management Unit	Surface Area to be Disturbed (m^2)	Topsoil Stripping Depth (m)	Maximum Subsoil Stripping Depth (m)	Estimated Volume of Recoverable Topsoil (m^3)	Estimated Volume of Recoverable Subsoil (m^3)
Anderson*	0.0	0.0	0.00	0	0
Barry	78,510.0	0.2	0.90	15702	54957
Charlevue*	2,183,000.0	0.0	0.00	0	0
Cooinda	349,400.0	0.3	0.60	104820	104820
Ellesmere*	0.0	0.0	0.00	0	0
Geoffrey	14,707,000.0	0.3	0.50	4412100	2941400
James	117,200.0	0.3	0.60	35160	35160
Kosh	549,000.0	0.2	0.50	109800	164700
Namoi	1,328,000.0	0.2	0.60	265600	531200
Nigel*	165,300.0	0.0	0.00	0	0
Normanby	0.0	0.3	0.90	0	0
Wallace	52,830.0	0.2	-	10566	0
Total	**19,530,240.0**	**-**	**-**	**4,953,748**	**3,832,237**

Note: - denotes areas outside the disturbance footprint that will not be used as a topsoil resource for rehabilitation
* soil properties limit plant growth and are unsuitable for use in revegetation activities

4.2.5 Terrestrial Ecology

The Project area falls within the Brigalow Belt bioregion, characterised by brigalow (*Acacia harpophylla*) woodland but presenting other vegetation such as semi evergreen vine thickets, dry eucalypt woodlands and native Bluegrass (*Dichanthium sp.*) grasslands. Due to the size of Brigalow Belt bioregion, it covers a broad climatic gradient as well as a diversity of soils and topography. As a result of agricultural and development activities, most of the relatively undisturbed areas are confined to the rugged parts of the landscape.

Consistent with the surrounding country, the MLA is predominantly non-remnant and subject to low intensity cattle grazing. Remnant vegetation includes patches of eucalypt woodland within riparian areas and on flat plains. These communities are mapped as riverine wetlands where they are associated with a major watercourse or floodplain. *Acacia sp.* closed woodlands are present on higher ground. The Project proposes clearing of 720 ha of remnant vegetation over the life of the Project.

Five weeds of national significance (WoNS) and/or restricted invasive species (RIS) under the *Biosecurity Act 2014* (Biosecurity Act) (DAF 2018a) were identified on the MLA. The near threatened plant species *Cerbera dumicola* was identified in two rocky areas to the central west of the MLA. Impacts to these populations were avoided in the Project design.

Four fauna species of conservation significance; the southern squatter pigeon (*Geophaps scripta scripta*), the greater glider (*Petauroides volans*) and the short-beaked echidna (*Tachyglossus aculeatus*) and the rufous fantail (*Rhipidura rufifrons*) were identified on the Project. The rufous fantail (*Rhipidura rufifrons*) is a listed migratory bird species under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). All fauna species are regionally abundant, having been recorded outside of the study area on numerous occasions. Ample equivalent or improved habitat is available for these species in the surrounding area. The Project proposes no significant impact to the species.

Flora, fauna and aquatic ecological systems are discussed in further detail in Section 6.0.

4.2.6 Current Land Use and Land Suitability

Under the CHRC 2016 planning scheme, the land within the Project boundary is mapped as 'rural'. This zone provides for various rural uses, opportunities for non-rural uses compatible with agriculture and the environmental features and landscape of the areas, and the protection and/or management of significant natural resources and processes related to primary production. The current use is best described as low intensity cattle grazing and resource exploration activities.

SMUs are detailed at Section 5.2.5 along with a determination of land suitability for cattle grazing (refer Section 5.2.6). The land suitability assessment identified grazing land suitability within the Project area as being of Classes 2, 3 and 4 as detailed in Table 16.

Table 16 Land Suitability Assessment

Land Suitability Class	Area Occupied	Description
Class 2	1,080.5 ha (17.49%)	Suitable land with minor limitations which either reduce production or require more than the simple management practices of Class 1 land to maintain economic production.
Class 3	4,338 ha (70.20%)	Suitable land with moderate limitations which either further lower production or require more than those management practices of Class 2 land to maintain economic production.
Class 4	750.84 ha (12.31%)	Marginal land, which is presently considered unsuitable due to severe limitations. The long-term significance of these limitations on the proposed land use is unknown or not quantified. The use of this land is dependent upon undertaking additional studies to determine whether the effect of the limitations can be reduced to achieve sustained economic production.

4.3 REHABILITATION OBJECTIVES

The overarching objective of mined land rehabilitation for the Gemini Project is to conform to the State government policy of returning disturbed lands to a safe and stable landform that does not cause environmental harm and is able to sustain an approved PMLU.

PMLUs for the mine were developed based on pre-mining land suitability, landholder/stakeholder preferences, technical studies and the existing land use and environmental values of the surrounding landscape. Magnetic South is an active member in the local community and is responsible for managing an extensive area of local cattle grazing land. Community consultation has been undertaken by Magnetic South over the past two years and has covered all relevant aspects of mine operations and closure. This Consultation included, but was not limited to:

- underlying landholders;
- surrounding community members with an interest in the Project;
- the Gaangalu Nation People;

- local council representatives; and
- state government representatives.

A meeting was held with members of the Central Highlands Regional Council on the 26 November 2019. Options for rehabilitation and final land uses were specifically addressed in this discussion. The continuation of grazing interests was a key outcome of the consultation, incorporated into the development of PMLUs.

Further consultation will be undertaken as part of the ongoing consultation strategy for the Project, including in the development phase of the PRCP. Local knowledge of graziers is highly valued by Magnetic South in all aspects of land management and is seen as essential for ensuring successful and sustainable rehabilitation of the Gemini Project.

4.3.1 Rehabilitation Areas

The disturbance areas identified in the final site design have been divided into rehabilitation areas, which have a common PMLU and rehabilitation methodology, these include:

- RA1: in-pit and out-of-pit waste emplacements, including dry rejects disposal areas;
- RA2: temporary waste emplacements;
- RA3: residual void lakes;
- RA4: residual void high walls;
- RA5: residual void low walls;
- RA6: water management infrastructure; and
- RA7: mine infrastructure areas.

These rehabilitation areas are shown below in Figure 35.

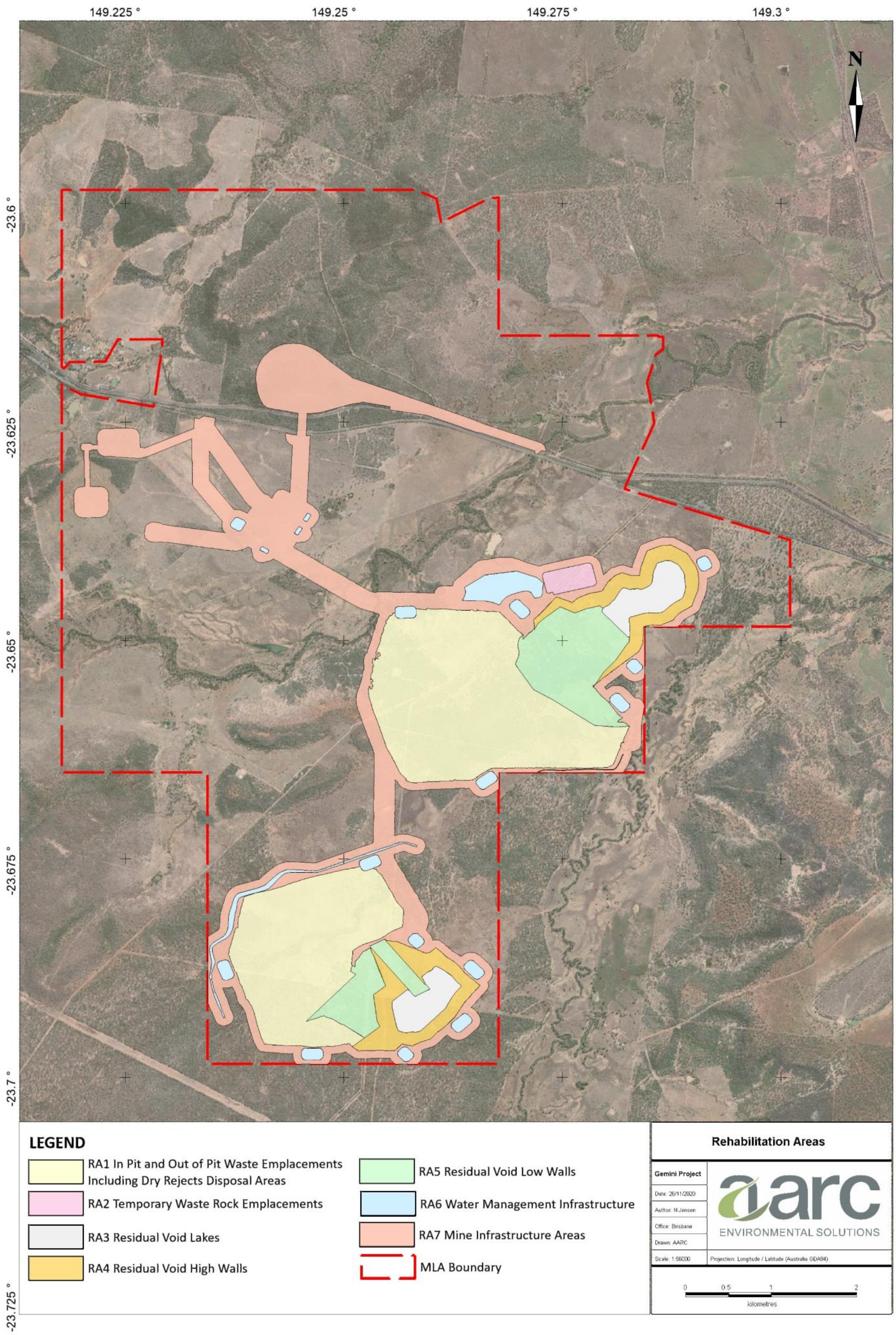


Figure 35 Rehabilitation Areas

4.3.2 Post-mining Land Use

In the short term, Project activities will disturb and alter the current land use of low intensity cattle grazing. The overarching objective is to return the majority of disturbed land to future landowners with a land use capacity conforming to existing local government planning instruments, and that enables a sustainable future value to be derived. Areas disturbed by mining activities will largely be returned to a grazing landscape, with the introduction of some areas of native ecosystem habitat suitable for native flora and fauna. These PMLUs have been determined based on pre-mining land suitability, landholder/stakeholder preferences, and the existing land use and environmental values of the surrounding landscape.

The development of the rehabilitation strategy for the Project has been informed by the rehabilitation hierarchy. Minimisation of disturbance has been a focus of design phase mine planning work, and a key land use objective being reinstatement of a land use at least equivalent or compatible to that existing previously. Given the existing land use of the area, reinstatement of grazing as a PMLU will be adopted for all areas apart from the proposed residual voids and any retained water management or other infrastructure where the latter supports accepted PMLUs and/or adds to the economic value of the land to be relinquished. With appropriate management of the higher sodicity topsoils identified, it is anticipated that rehabilitated landforms will be capable of sustaining improved and native pastures equivalent to those currently existing.

Two residual voids will remain post-mining and are anticipated to accumulate water over time to an equilibrium water level. The pit lakes and surrounding highwalls are proposed to support a PMLU of fauna habitat comprised of the water body itself and its surrounding inwardly draining slopes which will be rehabilitated to sustain a native ecosystem able to support native fauna. The air/waterbody interface is expected to support a range of waterborne and flying insects, as well as avifauna and various bat and microbat species. The waterbody itself is expected to support a range of freshwater aquatic plants and invertebrates in shallower edge areas and over time transition to brackish water species as water quality changes. Rehabilitated low wall slopes will be capable of supporting a grazing land use and native flora and fauna. The proposed PMLU for each of the rehabilitation areas is summarised below in Table 17 and shown in Figure 36.

Table 17 Nominated PMLUs

Rehabilitation Area	Post-mining Land Use	Approximate Footprint Area (ha)	Approximate Proportion of Total Disturbance
RA1: In-pit and out-of-pit waste emplacements, including dry rejects disposal areas	Grazing	722.4	37%
RA2: Temporary waste emplacements	Grazing	17.5	1%
RA3: Residual void lakes	Fauna habitat	76.5	4%
RA4: Residual void high walls	Native vegetation supporting fauna habitat	133.1	7%
RA5: Residual void low walls	Grazing	187.2	9%
RA6: Water management infrastructure[1]	Grazing/native vegetation	85	4%
RA7: Mine infrastructure areas[1]	Grazing	731.8	38%

Notes: 1 Where not retained under a landholder agreement allocating infrastructure responsibility.

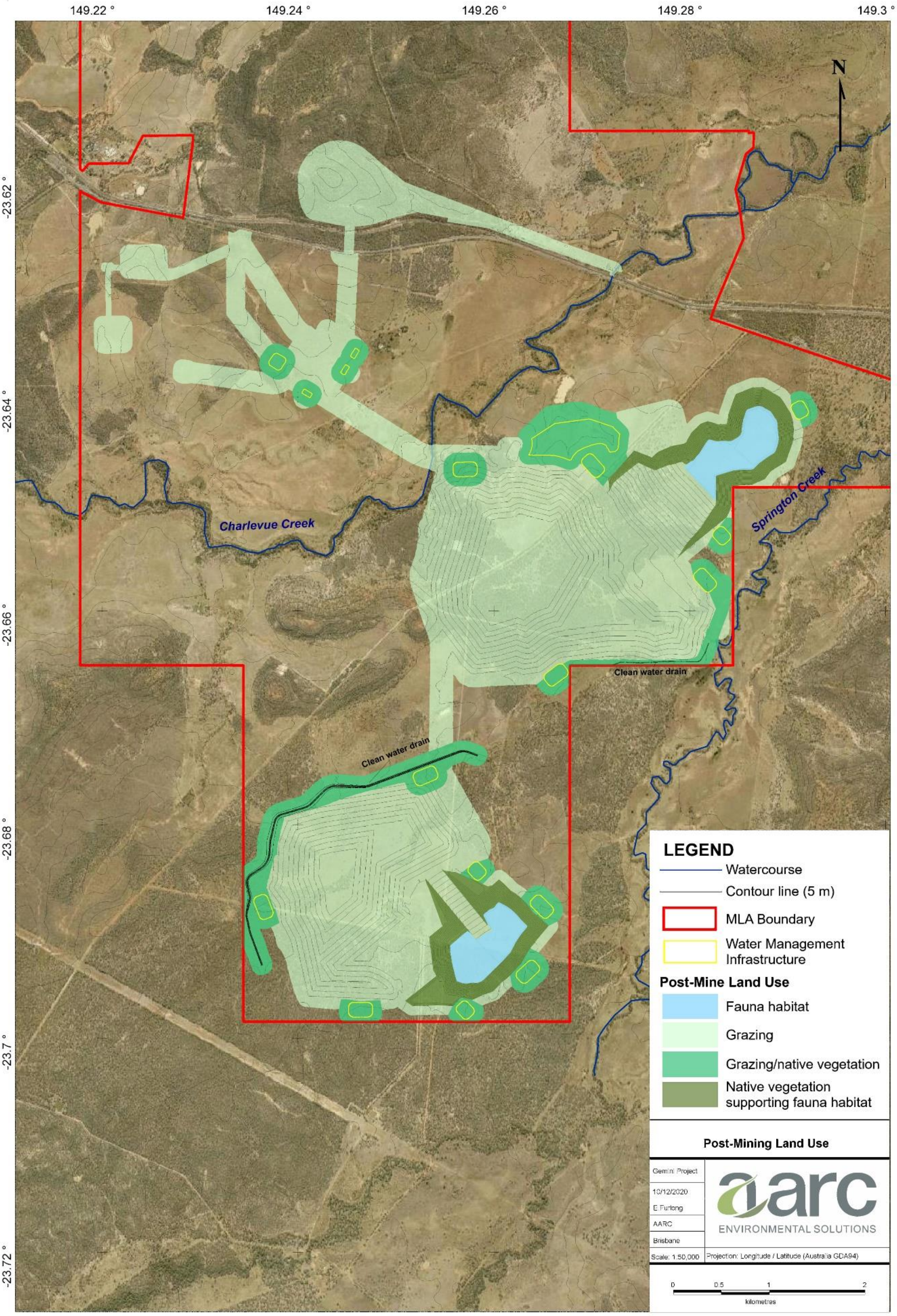


Figure 36 Post Mining Land Uses

The following subsections describe how progressive rehabilitation will be undertaken to achieve PMLUs for each rehabilitation functional area.

4.3.2.1 Alternative Post-Mine Closure Options Analysed

Mine planning assessed a number of options to manage and reduce final landform residual risk including backfilling the pits to a modified pre-mining topography, backfill of pits to about 80 m below the pre-mining topography and no backfilling of pits. All options required the rehandle of spoil material, the reduction of remnant highwall angles by dozer push, the reshaping of waste rock emplacements, and normal rehabilitation techniques related to topsoiling, surface preparation and revegetation. Options were evaluated on the relative basis of cost, overall project value and relative reduction in environmental risk.

The modified pre-mining topography option was based on backfilling voids to a level slightly higher than the original topography to allow for settlement over time. Once a sufficient period has been allowed for settlement, the area would be shaped and drained to manage erosion and then topsoiled and revegetated. Advantages with this option include negation of the need to stabilise highwall slopes or make safe the final void itself. The primary disadvantages with this option are:

- the significant cost of rehandling extremely large volumes of spoil at the end of mine production;
- the significant limitation on being able to undertake progressive rehabilitation given the need to rehandle a majority of waste rock material at the end of mine life; and
- the ongoing settlement of the final landform surface potentially resulting in long term stability issues.

The modified pre-mining topography option resulted in the net present value (NPV) of the project being so low that the Project could not proceed. In consideration of the margins of error within the financial model assumptions, the risk of a negative return was far too high for development. This option was therefore not considered further.

The preferred option (proposed in this application) is to backfill to 80 m below topography, based on the findings of the *Groundwater Impact Assessment* (JBT 2019) (Appendix C). This study indicated that, with controls to limit surface water draining to the pits, saline inflows would be significantly reduced if the pit was backfilled to 80 mbgl. For this option, in-pit backfill would be reshaped to 6° in line with other slopes with a corresponding grazing land use. Highwall slope management requirements would be reduced, and additional areas would be available for grazing. Only minor restrictions on progressive rehabilitation arise. While still resulting in a partially backfilled void at completion of mining, a key advantage is that water quality within the pit lakes will increase in salinity at a lower rate than otherwise.

The residual voids will comprise three principal ‘rehabilitation areas’ having differing landforms and characteristics and, as a result, differing PMLUs. These areas are described as:

- Regraded, topsoiled and revegetated low wall slopes draining to the pit water lakes and able to support a grazing PMLU.
- Two water bodies with a surface level which has been modelled to gradually increase to an equilibrium level of between 70-80 mAHD; acting as a groundwater sink and having a gradually increasing salinity. A key rehabilitation objective for this rehabilitation area is to reduce the rate of predicted water salinity present in the void primarily to allow the ecology of the residual void waterbody sufficient time to adapt to salinity changes. Backfilling the voids to 42 mAHD for Pit AB and 65 mAHD for Pit C reduces saline groundwater inflows and surface water drainage,

resulting in a significant reduction in the rate of salinity development within the pit water body. This is due to the water level adjacent the final void equal to the groundwater level within the spoil as illustrated in Figure 37.

Final void modelling suggests that during the first 200 years after closure, lake salinities will be less than 10,000 mg/L. After 500 years, salinity is conservatively modelled to increase to 30,000 mg/L. It should be noted that modelling inherently overestimates the rate of salinity increase in residual void water bodies by assuming that the source of mobile salts in overburden is infinite. Recent research is challenging this assumption, but there is little currently available data on the long-term behaviour of water bodies resident in Bowen Basin coal mine overburdens, particularly the rate of approaching a long-term equilibrium salinity level. The backfilling option adopted is intended to seal the poorer quality remnant coal seam aquifers and limit salt inputs to the pit lake from groundwater.

- Residual void high walls will be regraded to moderate slopes of approximately 22°, made safe and rehabilitated to a native ecosystem able to support native fauna as a PMLU.

Figure 37 provides progressive cross-sections depicting the proposed backfilling of spoil within AB Pit.

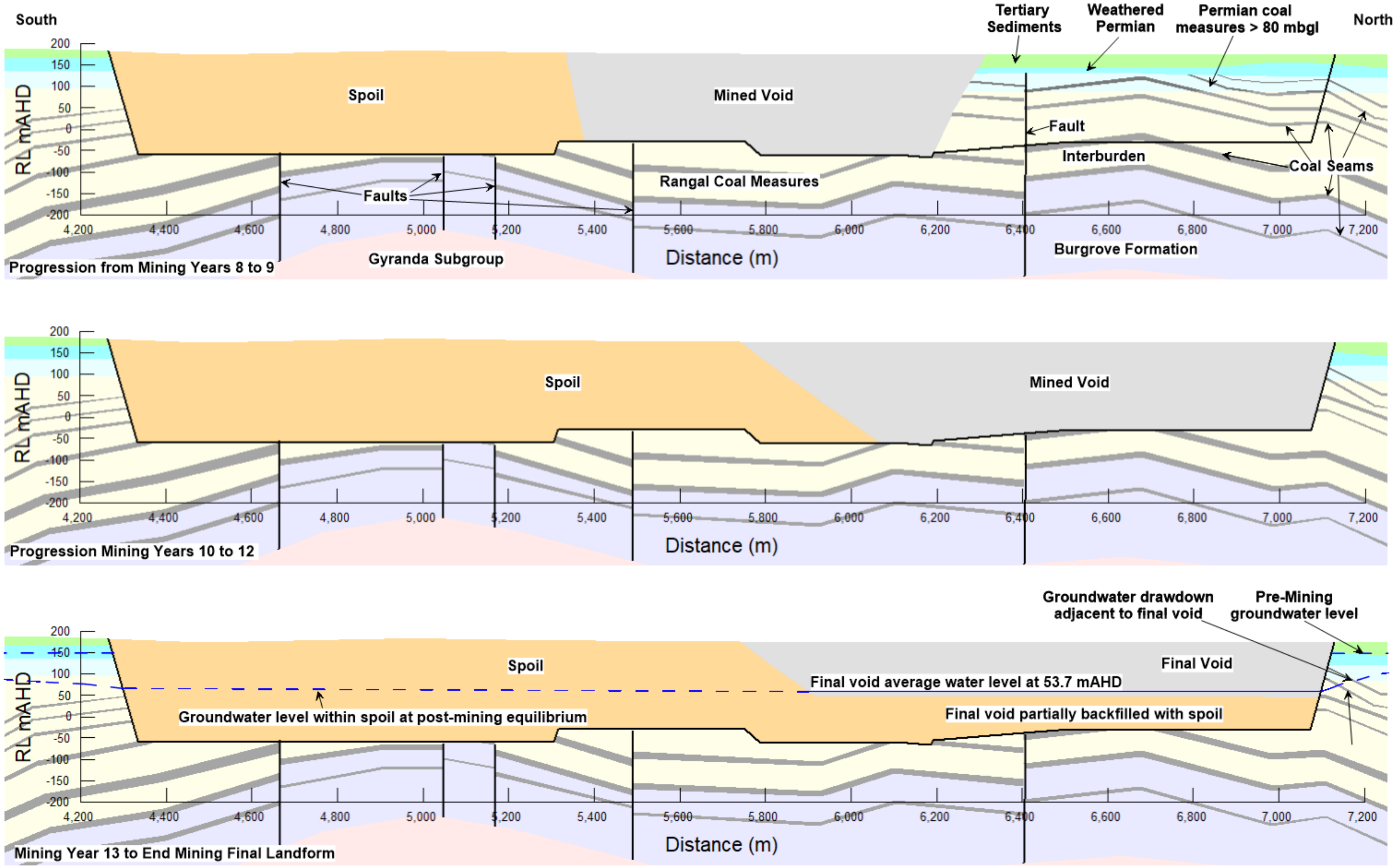


Figure 37 Conceptual Layout of Pit AB Groundwater Levels

4.4 REHABILITATION METHODS AND CONTROLS

Rehabilitation activities will be carried out in accordance with the following subsections. Rehabilitation activities will be subject to adaptive management where the rehabilitation methods and controls are continually improved and updated based on the results of site-specific rehabilitation trials, further land assessment (where applicable) and revisions of legislative requirements.

4.4.1 Reshaping/Landform Development

As a general guide, waste rock emplacements are constructed as benches with external faces formed from upper benches set back sufficiently from the prior bench to facilitate regrading to the design final rehabilitation slope.

Overburden placement will be undertaken using rear dump trucks in accordance with mine planning schedules and as per dump designs informed by geotechnical assessments. Standard mine survey controls will be utilised to ensure that disturbance footprints are not exceeded and that design slopes will be attained. Regrading to final landform will be undertaken using bulldozers to push to grade utilising standard survey controls.

Landform design will utilise concave slopes and terraced profiles to reduce the requirement for engineered drains. Where proposed to be utilised, and in conformance with a proposed *Master Waste Rock Emplacement Surface Drainage Plan* (discussed further in Section 4.4.6), graded banks and rock-protected spine drains will be installed to allow drainage from long rehabilitated slopes to be conveyed to natural ground level. All surface runoff from newly rehabilitated slopes will be directed into sediment dams until revegetation uptake is stable and adequate to control soil erosion. Further discussion on sediment design details and parameters is detailed in Section 3.4.3.3.

Final trimming of reshaped areas will be undertaken as required to remove excess rock and ensure correct graded bank slopes.

Topsoil spreading will then be undertaken to achieve the designated topsoil depth followed by surface preparation including at a minimum contour ripping to retain moisture and control erosion.

4.4.2 Topsoil Management

A *Topsoil Management Plan* will be developed for the Project. The overarching principle of the *Topsoil Management Plan* will be to reduce the risk of topsoil degradation and improve the chances of rehabilitation success. The objectives of the Project's *Topsoil Management Plan* are to:

- maintain a soil balance that will achieve the rehabilitation requirements throughout the life of the mine;
- maintain topsoil viability through the utilisation of best practices in soil stripping, stockpiling and application activities; and
- provide a standard practice for the Project's storage and handling of topsoil resources.

The *Topsoil Management Plan* will include the following components:

- identification and delineation of topsoil and subsoil resources including amelioration requirements;
- standard practices for topsoil and subsoil stripping;

- a topsoil and subsoil stockpiling strategy which outlines the methodologies and standard practices for the stockpiling of topsoil resources;
- procedures and methodologies used for the application of topsoil and subsoil resources;
- a topsoil and subsoil inventory which is maintained for the life of the Project;
- details of erosion and sediment controls for practices relating to topsoiling activities such as the use of sediment dams to minimise the release of water and suspended sediments into the receiving environment; and
- roles and responsibilities for the supervision of soil management.

The *Topsoil Management Plan* will reduce the risk of topsoil degradation and improve the chances of rehabilitation success through a series of management measures customised for each topsoil activity, these are described in further detail below.

4.4.2.1 Identification of Topsoil Resources

The identification and delineation of topsoil and subsoil resources will be undertaken based on the soil assessments already undertaken (AARC 2019) (Appendix I) including indicative stripping depths and topsoil qualities as summarised in Table 15.

The *Topsoil Management Plan* will detail the methods used for the further assessments of topsoil resources, where required, to confirm the topsoil stripping depth and dispersion characteristics of soils. Deficiencies in soil requirements will be identified and procedures for the amelioration of topsoils will be provided. Topsoil resources will be mapped, and GIS shapefiles will be retained for reporting purposes.

4.4.2.2 Topsoil Stripping

The *Topsoil Management Plan* will include standard methodologies for topsoil and subsoil stripping which will consider the equipment used, soil and climatic conditions under which topsoil stripping should occur, the removal of vegetation and the treatment of machinery for weeds.

4.4.2.3 Topsoil Stockpiling

A topsoil and subsoil stockpiling strategy will be developed with consideration to the management recommendations provided in the *Soil and Land Suitability Assessment* (Appendix I). To assist in maintaining a viable seedbank and promote vegetation growth, where possible, topsoil will be directly placed in prepared rehabilitation areas rather than stockpiled. Topsoil will also be planted over as soon as possible after being placed in prepared rehabilitation areas. This will assist in preventing erosion of the topsoil and making the best use of the soil's available nutrients.

Delineation of topsoils and subsoils during stripping and stockpiling is proposed to prevent dilution of the seedbank. It is recommended that subsoils are placed below topsoil during rehabilitation to increase germination, provide a suitable medium for root development and to aid in water storage within the soil profile. Mixing of topsoils and subsoils is also possible at a recommended ratio of 2:1, but may lead to additional nutrient and seed inputs to successfully establish vegetation

The topsoil and subsoil stockpiling strategy will:

- optimise the placement of topsoil stockpiles as much as practicable to:
    - exclude grazing and vehicle access;

    - minimise topsoil and subsoil handling;

    - consider climatic conditions, surface water flow and erosion controls such as the diversion of overland flow/runoff around disturbed areas;

- set stockpile design parameters including height (typically up to 3 m), shape and batter angles (no greater than 1:3) and limiting side slopes to a maximum slope of 1V:6H to reduce erosion and sediment run-off;

- describe the applicable construction equipment and practices;

- describe standard practices for the long-term storage of soil stockpiles including recommendations for soil testing and the application of fertilisers, soil ameliorants and seeding application relevant to long term stockpiling of topsoil resources;

- describe the sterile seeding for the long-term storage of stockpiles. Briefly, if the stockpiles require grass cover, they will be ripped and seeded with a quick establishment pasture, to limit erosion and maintain a viable seed bank. This will be done if the period of stockpiling is greater than one growing season or six months. In accordance with the findings of research undertaken in the Hunter Valley (Keipert et al 2005), and in order to avoid the significant deterioration that commonly occurs in the first year, topsoil will ideally be stockpiled for as short a period as possible; and

- establishment of a stockpile monitoring frequency for the control of weeds on stockpiles.

4.4.2.4 Topsoil Application

Where possible, placement of topsoil at a thickness of approximately 0.3 m is recommended across the rehabilitated area to create a growth medium of sufficient depth to hold water and support revegetation. If available, subsoils that have been identified as having a high clay content with low erosivity risk can be returned first at a depth of up to 0.5 m, prior to the addition of sandier topsoil. This may assist in providing a more suitable growth medium that holds water for long periods of time.

For the Geoffrey SMU, it is recommended that soil horizons in the natural landscape are restored during rehabilitation. The clay rich subsoils should be placed first on the rehabilitated landform, followed by the sandy A horizon over the top to recreate the A and B horizons. Placement of the subsoil layer is expected to retain soil moisture necessary for successful revegetation.

Stripping depths have accounted for the dispersive nature of the SMUs sodic subsoils. Topsoil estimates exclude any sodic subsoil material from the topsoil resource, therefore the topsoil resource is not considered sodic and dispersive. The rehabilitated landform is thus at low risk of the dispersive impacts associated with sodic soils and mitigation measures that target sodic and dispersive soils are not considered necessary.

Topsoiled areas will be ripped into the underlying spoil surface to reduce compaction from heavy machinery and to encourage surface water infiltration and minimise soil loss due to erosion. On the slopes of spoil dumps, ripping will be undertaken along the contour.

Grass and woody vegetation remaining after land clearing can be incorporated into the rehabilitation design at strategic locations to help limit runoff and erosion (by slowing down overland flow), retain active biological activity, and provide habitat for returning fauna. Additionally, mulched organic material incorporated into the soil (particularly the topsoil) will increase organic carbon levels over time, further stabilising the soil and landscape.

4.4.2.5 Topsoil Inventory

A topsoil and subsoil inventory will be maintained during the life of the Project, which accounts for the volumes and locations of topsoil as it is progressively stripped, stockpiled, and reapplied. The inventory will also address the delineation of stockpiled topsoil, protection from unplanned use or disruption and prioritisation of re-use. The soil inventory will allow early identification of potential issues such as soil balance deficits or poorer quality soils; enabling remedial actions to be planned in advance of mining operations.

4.4.3 Revegetation Program

Vegetation is generally established in rehabilitated areas through topsoil application, by direct seeding or by planting using nursery-raised tube-stock of target species. Revegetation efforts will be directed towards creating a stable and self-sustaining system, in accordance with the defined land use; that is for each defined land use the system can support the survival and reproduction of all organisms living within it, without outside intervention. Data collected from baseline assessments and relevant analogue sites will be used in a comparative analysis to determine if revegetation has achieved a self-sustaining and stable ecosystem. Species selected for rehabilitation efforts to support a self-sustaining ecosystem will provide microhabitat and cover for fauna, a natural mulch system and nutrient input from the breakdown of plant waste, stabilise soils through provision of vegetative cover and soil binding root systems to prevent erosion and promote soil aeration.

Areas identified as returning to a grazing PMLU including waste rock emplacements, mine infrastructure areas and water management areas will likely utilise grass seed mixes for the Project area that include Rhodes grass (*Chloris gayana*), Creeping bluegrass (*Bothriochloa insculpta*), Desmanthus (*Desmanthus virgatus*), Forest bluegrass (*Bothriochloa decipiens*), Queensland bluegrass (*Dichanthium sericeum*), Barbed wire grass (*Cymbopogon refractus*), Black speargrass (*Heteropogon contortus)* and Curly windmill grass (*Enteropogon acicularis*) as well as other species native to the area. Application rates are anticipated to range between 6-10 kg/ha.

For areas to be restored to native vegetation including pit low walls, species will be based on the rehabilitation objectives and will generally target species relevant to nearby remnant vegetation associations, soil types, and site conditions. Revegetation of native woodland areas for example, will include the planting of endemic species which are characteristic of pre-mining conditions, as identified through flora assessments undertaken for the Project.

Seeding will typically be scheduled to occur prior to the wet season to maximise the benefits of subsequent rainfall.

Topsoil stockpiles will be revegetated to assist in stabilisation and erosion control. Similarly, drainage lines, berms and other erosion control and stabilisation works will require revegetation with an appropriate seed mix. Application rates will vary depending on the circumstance as well as the rehabilitation species sensitivity, the growth media and the PMLU.

4.4.4 Rehabilitation Maintenance and Repair

Significant rainfall events, floods, fire, drought, pest species outbreaks or other factors may also result in a requirement to undertake additional maintenance on rehabilitated areas. Maintenance of rehabilitated areas or reparation may also be required where visual observations of rehabilitation and or rehabilitation monitoring results (refer Section 4.8) indicate that the expected trajectory towards achieving successful rehabilitation is not being met. Depending on the underlying cause of failed rehabilitation, rectification activities may include:

- earthworks repair of erosion areas;
- re-seeding / replanting failed or unsatisfactory areas;
- supplementary planting of tube-stock;
- pest and weed control;
- irrigation of plants;
- additional fertiliser or other ameliorant application to control pH and improve soil structure; and
- repair or alteration of drainage structures.

In the event that maintenance is required, a maintenance plan will be developed that properly assesses the risks of re-entering a rehabilitated area with earthmoving equipment, the sourcing of soils and topsoil, impacts on planned drainage of the site, erosion controls and revegetation methods.

4.4.5 Rehabilitation Trials

Revegetation techniques will continually be developed and refined over the life of the Project through a continual process of research, trialling, monitoring and improvement. It is common practice within mine sites to undertake site–specific rehabilitation trials to inform rehabilitation efforts and practices. Rehabilitation trials may involve refining soil preparation procedures, seed mix type, rate and application, surface cover treatment, irrigation requirements and repair methods. As such, rehabilitation trials will be used as part of adaptive management of rehabilitation and will commence as identified during mining operations.

The performance of rehabilitation trials will be assessed against the methodology outlined in Section 4.8 and dependent on the underlying principle of the trial further performance indicators may be identified on a case-by-case basis.

Subject to onsite resource capacity and availability of external research opportunities, Magnetic South may engage with external research programs such as those undertaken by ACARP and research institutions.

4.4.6 Waste Rock Landform Development and Rehabilitation

The commencement of mining necessarily sees overburden being initially placed out-of-pit to provide sufficient working space for operations to proceed. A single out-of-pit waste rock emplacement is associated with each of Pit AB and Pit C. In-pit placement of overburden will occur in Year 2 for Pit AB and about Year 15 for Pit C.

The out-of-pit waste rock emplacement for Pit AB is located to the west and south of the pit with construction coinciding with the commencement of mining. By Year 4, the full footprint of out-of-pit dumping will be reached with waste rock being placed both in-pit and within the extents of the out-of-pit waste rock emplacement. In Year 6, a small temporary out-of-pit waste rock emplacement will be constructed to the north of the pit for the purpose of providing additional pit backfilling later in the mine life.

Beyond Year 6, the majority of waste rock is placed in-pit, progressively refiling the pit from south to north as the pit progresses in the same direction. By about Year 12/13 the maximum extents of Pit AB are reached and the development of infrastructure to support Pit C commences.

Mining of Pit C commences in Year 12, again with waste rock being placed in an out-of-pit waste rock emplacement located to the west of the pit. By Year 15, waste rock from Pit C is being placed both in-pit and out-of-pit and the full disturbance footprint of the out-of-pit waste rock emplacement has been reached. Pit AB is continuing to be progressively rehabilitated, including the rehandling of spoil from the temporary out-of-pit waste rock emplacement back in-pit and all areas having been reshaped including the highwalls of Pit AB.

By Year 19, the rehabilitation of Pit AB has been completed and mining is at or near completion at Pit C, with progressive rehabilitation of the Pit C waste rock emplacements ongoing.

Figure 23 through to Figure 32 conceptually visualise the progression of the mine, including location and extent of waste rock emplacements and rehabilitation. A preliminary schedule of progressive rehabilitation milestones per rehabilitation area is provided in Section 4.6.

Minor drainage works and a pit levee are required to the southeast of Pit AB during operations to ensure high flows from an unnamed second order tributary of Springton Creek do not access the pit. In addition, a permanent drain is required to divert clean runoff from the upper reaches of an unnamed second order tributary of Springton Creek around the out-of-pit waste rock emplacement associated with Pit C. Neither of these tributaries are defined as watercourses under the Water Act.

The *Geochemical Assessment of Mining Waste Materials* (RGS 2019) (Appendix G) and *Geochemical Assessment of Coal Reject Material* (RGS 2020) (Appendix H) for the Project identified that waste rock materials have a low risk of acid generation and a high factor of safety with respect to potential for acid mine drainage (AMD).

Validation test work will be undertaken on potential spoil materials as the Project develops to enable appropriate spoil management measures to be planned and implemented as required. Where highly sodic and/or dispersive spoil is identified, this material would not be placed in final landform surfaces and would not be used in construction activities. Regardless of the spoil type, especially where engineering or geotechnical stability is required, testing would be undertaken during construction to determine the propensity of such materials to erode. Surface runoff and seepage from spoil piles, including any rehabilitated areas, would be monitored for ‘standard’ water quality parameters including, but not limited to, pH, EC, major anions (sulphate, chloride and alkalinity), major cations (sodium, calcium, magnesium and potassium), TDS and a broad suite of soluble metals/metalloids.

Landform reshaping will occur progressively, as land is deemed available for rehabilitation, resources are available, and the mining activities do not prohibit the rehabilitation activities. As indicated in Table 18, waste rock emplacements have been designed to have externally draining slopes of a 1V:10H ratio and a maximum height of 190 mAHD (where maximum slopes adhere to 6°) constructed from rear dump truck-tipped dumps. While detailed geotechnical assessments are yet to be undertaken, the slopes proposed are at the lower end of typical design practice for waste rock emplacements in the Bowen Basin. The locations of waste rock emplacements showing proposed PMLUs are illustrated at Figure 36.

The top surfaces of both waste rock emplacements are limited in area and, given the relatively low geochemical risk currently identified, it is considered preferable to internally drain the upper surfaces of waste rock emplacements rather than increase flows down rehabilitated slopes. The practice of surface water drainage on waste rock emplacements via internal drainage is favourable on soils that have self-sealing properties, which have been recorded on site and has a low risk of failure. Internal drainage involves natural depressions or graded banks constructed with a relatively minimal slope cross section with vegetative cover which will blend into the landscape over time. Natural depressions promote internal drainage on the waste rock top surfaces without creating permanent ponding during normal and heavy rainfall events. Further, vegetative cover will aid in the absorption of surface water and will support a cattle grazing PMLU.

Geochemical assessments indicated that there will be no detrimental impacts on water quality and therefore, if used for stock watering, water ponding on waste rock emplacements does not pose a risk to cattle (RGS 2019 and RGS 2020). If deemed necessary from the results of rehabilitation monitoring (i.e., erosion rates, habitat structure), reshaping on the top surfaces of waste rock emplacements will be conducted and land prepared for vegetative surface cover with plans developed upon consultation with a suitably qualified person.

Additionally, rehabilitated slopes will be constructed to a relatively low slope (6°) to reduce the risk of erosional instability. Given these mitigation measures, drainage from regraded rehabilitation slopes is intended to be managed with limited use of graded banks; principally by targeting sufficient surface roughness through contour cultivation and appropriate revegetation rates. However, this approach will ultimately depend on the results of further topsoil testing and the performance of early rehabilitation works. If erosion is observed in early rehabilitation efforts, graded banks and spine drains will be incorporated into the rehabilitation design, as a temporary erosion control measure.

The surface of waste rock emplacements will be progressively revegetated with a pasture crop cover mix, consistent with the proposed revegetation program.

A master *Waste Rock Emplacement Surface Drainage Plan* is proposed to be developed to detail the design and methodologies for the development of natural surface drainage depressions on waste rock emplacements and to prevent erosion on the waste rock slopes. If required, graded banks will be designed in accordance with industry recommendations (Witheridge et al. 1996), they should achieve a minimum width of 5 m and height of 500mm high (Appendix I). Larger contour drains are generally more stable and longer lasting. Rock-lined spine drains will utilise rock of between 300 – 450 mm in diameter where required. Graded banks and rock-protected spine drains are designed to blend into the landscape over time, with a relative minimal cross section to minimise the risk of failure. If necessary, these structures will be removed, and remediation activities will be undertaken. Given the overburden and topsoil materials available, the rehabilitation design parameters to be observed, and the mitigation measures and actions nominated, no significant risks associated with the rehabilitation of waste rock emplacements have been identified.

Table 18 Waste Rock Emplacement Parameters

Emplacement	PMLU	Max. Elevation (mAHD)	Typical/ Max Slope	Approx. Max. Slope Length (m)
Pit AB waste rock emplacement (in-pit and out-of-pit)	Grazing	175	6°	540
Pit AB temporary (out-of-pit)	Grazing	n/a	n/a	n/a
Pit C waste rock emplacement (in-pit and out-of-pit)	Grazing	190	6°	530

4.4.7 Rejects Placement

Coal processing is described in Section 3.6.3. Coarse rejects will be conveyed to the rejects bin. Fine rejects and slimes will be dewatered and conveyed to the rejects bin to be combined with the coarse reject material. The combined rejects will be loaded onto trucks for placement in out-of-pit spoil dumps, or in-pit behind the mining void.

Over the life of the mine, just over 9 Mt of rejects is estimated to be generated for disposal. Most coal reject materials have a relatively low risk of acid generation. While the risk of environmental harm arising from the geochemical characteristics of materials to be handled is low, it is proposed that coal reject materials are selectively handled and encapsulated within waste rock emplacements and well away from the outside surface of rehabilitated landforms.

As such, no separate rejects facility is proposed for the Project. Representative samples of coal reject materials will be further assessed at the operational stage to ensure that the findings of the geochemical assessment (RGS 2020) (Appendix H) remain applicable.

4.4.7.1 Final Voids

Mine planning for the Project results in the northeast end of Pit AB and the east end of Pit C remaining as residual voids. Both voids will be partially backfilled with waste rock to elevate the void floor above the level of significant groundwater inflows, and to limit the potential for pit water to recharge any aquifers.

The void low wall will be rehabilitated to a gradual slope, safe for access and grazing by cattle. Small pit lakes will form on the pit floor reaching a steady state level where water losses through evaporation are equal to water inputs from rainfall, runoff and groundwater inflows. While water levels in the voids will vary over time dependent on the prevailing climatic conditions, the results of modelling indicate that an equilibrium level of approximately 70 mAHD in C Pit and 53 m AHD in AB Pit will be reached after 200 years. The steady state water level is well below the base of Tertiary aquifers negating any risk of contamination.

Perimeter drainage will be provided to limit the volume of surface water runoff, including modelled 1:1,000 storm event flows, from entering the void. The *Surface Water Assessment* (WRM 2020b) (Appendix B) confirms that pit lake water levels will not exceed 50 mbgl and that there is therefore no risk of overflow to surface waters.

Physical void characteristics are summarised in Table 19.

Table 19 Final Void Physical Characteristics

Mining Area	Approx. Pit Lake Area (ha)	Low Wall Slope	High Wall Slope
Pit AB	43	<6°	<22°
Pit C	37	<6°	<22°

Areas of the low wall capable of supporting pasture crop will be utilised as cattle grazing PMLU. The low walls may be subject to further assessment of low wall soil characteristics, stability, rehabilitation trials and stakeholder consultation to determine the final designation of land. Pit highwalls will be throw blasted and/or shaped to achieve a stable slope of 22°. Inward draining highwalls will support native vegetation post mining land use, consistent with pit lakes.

Two pit lakes with a total footprint area of approximately 81 ha will be formed as part of the final Project landform. Pit lakes have demonstrated capacity for the development of ecosystems able to behave similarly to natural wetlands (Lund and Blanchette, 2014). The underlying biophysical processes facilitating primary production are critical in allowing pit lakes to evolve into valuable ecosystems (Luek and Rasmussen, 2017; Marszelewski *et al.*, 2017; Lund and Blanchette 2014). Variables that influence primary production include bankside vegetation, nutrient concentrations in the water column (nitrogen, phosphorus and carbon), hydrology and bathymetry (Lund and Blanchette 2014).

Miguell-Chinchilla *et al.* (2014) studied the succession of macroinvertebrates in 19 pit lakes of approximately 22 years of age, that were formed as part of the reclamation process of an open cut coal mine in Spain. Miguell-Chinchilla *et al* (2014) recorded that macroinvertebrates inhabited pit lakes along a primary succession gradient whereby the environmental conditions, including nutrient and habitat resources, determined the community structure.

The salinity of water can be classified by the level of TDS, and the following classification was used for the purpose of this EA application (DSEWPAC 2012b and Environmental Protection Agency 2020):

- freshwater up to 3,000 mg/L;
- brackish 3,000 mg/L – 5,000 mg/L;
- saline 5,000 mg/L – 35,000 mg/L; and
- hypersaline > 35,000 mg/L.

Typically, pit lakes are modelled to become increasingly saline over time (i.e., waters having a TDS greater than 5,000 mg/L). This modelling is inherently conservative as it assumes an eternal, constant, source of salinity to the void lake from spoil seepage. Water quality modelling for the Project by WRM (2019) indicates salinity of both pit voids will gradually increase over time. Salinity is predicted to remain below 5,000 mg/L in the first 100 years following mining and will remain below 10,000 mg/L for the first 200 years. The pit lake will, therefore, be classified as brackish for approximately the first 100 years and is not predicted to reach hypersaline conditions until after approximately 500 years following mining (WRM 2020b). Biodiversity generally decreases as salinity increases, however, salinity of up to 10,000 µs/cm (~6,410 mg/L) can support noteworthy ecological systems and provide a valuable refuge for species (pers comms. M.Lund December 2019).

Research indicates that pit lakes with a TDS up to ~4,500 mg/L can provide ecological value for regional species in Central Queensland (Proctor and Grigg 2006). Further, pit lakes may act as a water refuge during periods of low rainfall for mobile species such as the Grey Teal Duck (Hart 1991) has previously been recorded within the Project surrounds (AARC 2020b). Species of ducks and swans have been observed in saline pit lakes of open cut coal mines in central Queensland (pers comms. C.Cote March 2020).

Macroinvertebrates are well-adapted to brackish and brackish-saline conditions; however, species diversity typically decreases with increasing salinity. A study of pit lakes aged from 1-22 years and ranging from 330 µs/cm – 4,416 µs/cm, associated with a nearby open cut coal mine in Moura, indicated that the diversity of aquatic invertebrates was similar to nearby natural waterbodies (Proctor and Grigg 2006). The pit lakes studied by Proctor and Grigg (2006) were reported to support orders of macroinvertebrates that were also recorded on the Project site, including Diptera, Hemiptera, Odonata and Coleoptera (AARC 2020a).

In an open-cut coal mine located within the Fitzroy Basin, native fish including the Spangled Perch (a species recorded on site) have been documented to have pioneered pit lakes with TDS of up to 7,600 µs/cm region (AARC 2020a).

Proctor and Grigg (2006) concluded that in Central Queensland, final void waterbodies have the potential to provide habitat for many invertebrate taxa typical of still inland water bodies. The ability for macroinvertebrates in freshwater systems to adapt to changes in salinity is dependent on the period of acclimation where the ability to adapt to new conditions improves when changes are incremental over time (Hart 1991).

The high walls associated with pit lakes can also provide suitable refuge and brooding habitat for several mobile fauna species. In periods of low rainfall, birds, including the Grey Teal, have been recorded using saline waters as refuges over both short- and long-term periods by drinking freshwater elsewhere (Lavery 1972). Several species of birds prefer to breed in saline conditions (Goodsell 1990). For example, the Grey Teal, Pacific Black Duck, White Faced Heron, Little Black Cormorant and Little Pied Cormorant were found by Goodsell (1990) to breed in saline conditions with TDS of up to between 14,600 mg/L (Pacific Black Duck) and 37,600 mg/L (Grey Teal). All of these species have been recorded either within the Project site or surrounds (AARC 2020b). Further, the Black Swan, a species known to inhabit the wider Project surrounds, was reported by Goodsell (1990) to breed in saline water with a TDS of up to 43,500 mg/L.

The residual high wall offers potential to provide steeper slope habitat that can be used by native nesting birds. For example, a resident Peregrine Falcon pair has been recorded successfully breeding in nests created in the high walls of an open cut mining pit in the Northern Territory (Potts and Donato 2008). Additional individual Peregrine Falcons were observed utilising the various open pit high walls for roosting. Birds documented to nest on inland, flat land or slopes may utilise the high-wall pit slopes as nesting habitat (O'Donnell and Debus 2012). Anecdotally, birds of prey have been reported to utilise the high wall as refuges in an open cut coal mine located in central Queensland (pers comms. J. Fittler March 2020); the Wedgetail Eagle, a species that has been recorded on the Project site is one example such species of bird of prey.

Insectivorous bats have been documented feeding on insects in the airspace above pit lakes in both Western Australia and central New South Wales (Griffiths *et a*l. 2014a; Griffiths *et al*. 2014b). A number of insectivorous bats have been identified on the Project Site by ANABAT surveys including the Chocolate Wattled Bat, Eastern Bent-winged Bat, Eastern Cave Bat, Goulds Wattled Bat, Inland Forest Bat, Little Pied Bat, Northern Free-tailed Bat, Troughton's Sheathtail Bat, White-striped Free-tailed Bat and the Yellow-bellied Sheath-tailed Bat (AARC 2020b).

The rock fissures and crevices present in the high-wall pit slopes provide potential refuge habitat for various cave-dwelling microbats identified within the Project Site. For example, the Little Broad-nosed Bat which roosts in hollows but which has been found in fence posts and under the metal caps of telegraph poles (Churchill 2009), Gould's Wattled Bat which has been found roosting in stumps, hollow trees and urban settings such as ceilings (ALA 2020) and the Troughton's Sheathtail Bat which has been recorded in cracks and crevices in rocky escarpments (DES 2011)), as well as species previously recorded within the Project region (e.g. the Eastern Horseshoe Bat which is known to roost in caves but also in holes and cracks in rocks (Australian Museum 2020).

Native vegetation proposed to rehabilitate the high-wall slopes will provide additional refuge for ground-dwelling fauna, including small mammals and reptiles. For example, the Delicate Mouse (*Pseudomys delicatulus*) feeds on native grass seeds and uses grass tussocks as refuges (Diete *et al*. 2015). Similarly, grass tussocks provide nature refuges for a number of mammals and reptile species found on the Project site during the fauna survey, including the Delicate Mouse, Short Beaked Echidna, Rakalie Bynoes Gecko, Elegant Snake-Eyed Skink, Prickly Knob-tailed Gecko, Eastern Stone Gecko and Box-patterned Gecko (AARC 2020b). The use of high-wall vegetation by goats, cattle, small mammals and reptiles has been observed in open-cut mines of Queensland (pers comms. C.Cote March 2020).

The ecological value of pit lakes and adjacent high-wall features can be facilitated through effective rehabilitation of the pit walls. For example, a review of the ecological processes associated with nutrient webs of natural lakes, wetlands and pit lakes, van Etten (2011) concluded that rehabilitating vegetation along the low walls can assist with improving water quality, primary production and provide suitable habitat for aquatic and terrestrial fauna. Aquatic plants along the littoral fringe have been reported to inhabit areas with consistent water levels in pit lakes with salinity less than 10,000 µs/cm, in Queensland (pers comms. J. Fittler March 2020). Further, habitat complexity including the development of microclimates (van Etten 2011) and additional habitat could be created through the addition of cleared vegetation (i.e., tree trunks) to both the low walls and the waterbody (Luek and Rassmussen 2017).

Given that salinity is predicted to remain below 5,000 mg/L during the first 100 years of post-mining operations, the pit lake and surrounding high-wall features is predicted to provide suitable habitat for a range of native fauna, including a number of species recorded within the Project site and surrounds.

4.4.8 Mine Infrastructure Areas

Mine infrastructure areas will not be rehabilitated until mining operations have ceased. These areas will have all infrastructure removed and be regraded to their approximate original contour to ensure they are stable and sound. Footings will be either completely removed or removed to at least a depth of 1 m below surface level. Where possible infrastructure will be on-sold or sold for scrap. Clean construction and demolition waste will either be removed from site or placed within one of the final waste rock emplacements and covered. Any land identified to be subject to contamination will be subject to notification and a site investigation and either excavated and contaminated material removed to a licensed facility or, or risk assessed and listed on the Environmental Management Register.

Once reshaped, mine infrastructure areas will be subjected to rehabilitation practices including topsoiling and revegetation as described in Section 4.4.2 and Section 4.4.3. The land disturbance and other controls detailed at Section 4.7 will be implemented as appropriate. In addition, controls to address specific demolition and closure risks will be implemented.

If consultation with neighbours or other potential post-mining land users identifies any infrastructure of value to the PMLU, a written agreement will be established that transfers liability in the structure and its use to the new owner.

Haul roads will be constructed utilising spoil material sourced from initial mining operations. At closure, haul roads will have road base materials removed and be reshaped to create a stable landform that blends in with the surroundings. Minor site access roads and tracks will be rehabilitated where they are no longer required.

4.4.9 Water Management Infrastructure

Unless water storage facilities are identified by the post-mining landholder as of value to their future use of the land, and an agreement is entered into, all water storages will be drained and de-silted, and re-profiled to ensure the area is free-draining and blends in with the surrounding landscape. Disturbed areas will be seeded with a seed mix suitable for grazing / native ecosystems. Raw water dams, once no longer required, will be emptied by pumping to the final void. Dam liners will be removed and appropriately disposed of.

The temporary levee for Pit AB would be incorporated into the final landform profile on closure.

The installed clean water drains will remain post-mining. The revegetation of permanent drainage structures will incorporate geomorphic and riparian vegetation features that are consistent with the pre-mining environment. A key objective of the revegetation of permanent drainage structures will be to ensure that self-sustaining vegetation communities are achieved. Additionally, revegetation along permanent drainage structures will aim to restore habitat connectivity within the remaining portions of Springton Creek.

4.5 REHABILITATION MILESTONES

4.5.1 Schedule of Land Available for Rehabilitation

Land will become progressively available for rehabilitation throughout the life of the Project. Land is considered available for rehabilitation when:

- the land is no longer required for operating infrastructure or machinery for mining, including, for example, a dam or water storage facility;
- the land is no longer being mined and there is no plan to return to mining within 10 years after the land would otherwise have become available for rehabilitation (assuming a probable or proven ore reserve remains); and
- the land does not contain permanent infrastructure remaining on the land for a PMLU.

A preliminary schedule of when land will become available for rehabilitation is provided below in Table 20.

Table 20 Preliminary Schedule of Land Available for Rehabilitation

Rehabilitation Area	Land Available (ha)				
	Year 4	Year 8	Year 12	Year 17	Year 21
RA1: In-pit and out-of-pit waste emplacements, including dry rejects disposal areas	231.0	59.5	97.0	148.2	186.7
RA2: Temporary waste emplacements				17.5	0
RA3: Residual void lakes				40.6	35.9
RA4: Residual void high walls				64.0	69.1
RA5: Residual void low walls				127.1	60.4
RA6: Water management infrastructure					85.0
RA7: Mine infrastructure areas					731.8

4.5.1.1 Milestone 1: Infrastructure Decommissioning and Removal

Infrastructure decommissioning and removal will involve the following processes:

- disconnection and removal (or sale and removal if appropriate) of all infrastructure including pipelines, fences not a part of the PMLU, buildings, machinery, equipment, road base, water management structures;
- all wastes and temporary stockpiles will be removed.

Rehabilitation milestone 1 is applicable to all rehabilitation areas.

4.5.1.2 Milestone 2: Remediation of Contaminated Land

A contaminated land investigation of the Project site will be undertaken by a suitably qualified person. The contaminated land investigation will determine the presence of contaminated land. Remediation activities will be undertaken and where required, consultation on appropriate remediation activities of contaminated land will be sought.

A validation report will detail the remediation of contaminated land and a site suitability statement prepared by a suitably qualified person which states that the land is suitable for the PMLU.

Rehabilitation areas for which milestone 2 is applicable include: RA6 and RA7.

4.5.1.3 Milestone 3: Landform Development and Reshaping / Profiling

On completion of construction and reprofiling of the final landform, inspection and reporting will be undertaken to provide assurance that landform development and reshaping has been undertaken in accordance with the accepted final landform design criteria.

Residual voids backfilled to 80 mbgl, necessary to support a native ecosystem land use for the final pit lake.

The geotechnical stability of landforms, including pit walls and spoil dumps, will be assessed by a suitably qualified person.

Rehabilitation areas for which milestone 3 is applicable include: RA1, RA2, RA4, RA5, RA6, RA7.

4.5.1.4 Milestone 4: Surface Preparation

Completion of earthworks associated with placement of the topsoil material on final landforms. A minimum of 0.3 m of topsoil is required on areas of land to be returned to a grazing PMLU. Deep ripping of the surfaces has been undertaken. Surface drainage features have been installed. If required, soil ameliorants have been applied. Topsoil spreading or select placement

An assessment of soil health will be completed by a suitably qualified person to verify the growth medium is suitable for achieving the intended PMLU.

Rehabilitation areas for which milestone 4 is applicable include: RA1, RA2 RA4, RA5, RA6 and RA7.

4.5.1.5 Milestone 5: Revegetation

Completed seeding of areas that have achieved milestone 4. Records of revegetation activities will be maintained, documentation of the below details will indicate completion of the milestone:

- GIS files of the areas where seeding and planting have occurred, where areas with different SMUs, seed mixes or dates of planting are mapped separately;
- date the seed mix was applied, or planting of tube stock was carried out;
- if seeding, the seed mix and rate of seeding applied;
- if planting, the number of tube stock planted;

Rehabilitation areas for which milestone 5 is applicable include: RA1, RA2, RA4, RA5, RA6 and RA7.

4.5.1.6 Milestone 6: Establishment of Target Vegetation

A minimum of 5 years of rehabilitation monitoring data will confirm that rehabilitated areas have, or are on a trajectory to, achieve a self-sustaining ecosystem. Rehabilitated areas will be assessed against target criteria and compared to analogue sites of similar characteristics and land use.

Rehabilitation areas for which milestone 6 is applicable include: RA1, RA2, RA4, RA5, RA6 and RA7.

4.5.1.7 Milestone 7: Residual Void Lake

Water level in the final void is less than 74 mAHD for C Pit and 58 mAHD for AB Pit. Water in void lakes will have a TDS of less than 10,000 mg/L when measured at the surface.

Rehabilitation areas for which milestone 7 is applicable include: RA3.

4.5.1.8 Milestone 8: Achievement of Stable PMLU

Monitoring determines that that the land is safe, structurally stable, does not cause environmental harm and is able to sustain the PMLU.

Rehabilitation areas for which milestone 8 is applicable include: RA1, RA2, RA3, RA4, RA5, RA6 and RA7.

4.5.2 Rehabilitation Indicators and Completion Criteria

The *Guideline (Resource Activities): Rehabilitation requirements for mining resource activities [ESR/2016/1875]* (DES 2014a) requires the nomination of rehabilitation performance indicators for mining resource activities. Rehabilitation performance indicators are intended to provide defensible measurements of progress towards rehabilitation targets – referred to as completion criteria.

Principles for the development of rehabilitation performance indicators are preferably specific, measurable, achievable, realistic and timely. They should be outcome-based (linked to the end land use); flexible to adapt to changing circumstances; able to evolve as the mine life progresses; subject to periodic review; and include a measurement approach that details how the criterion will have been met (DFAT 2016b; ANZMEC and MCA 2000). Baseline data described in this application has been used to inform the development of site-specific performance indicators to protect the environmental values of the Project area.

Completion criteria are the threshold values, which when met, are deemed to demonstrate that a given indicator requirement has been achieved. Completion criteria may be established through technical or engineering studies or by assessing analogue or comparative sites that are considered to represent the desired rehabilitation outcome. In many cases, completion criteria need to be developed on the basis of ongoing monitoring of analogue sites to determine seasonal behaviours or variation over time.

Milestone completion criteria relevant to each designated rehabilitation area are listed in Table 21.

Table 21 Rehabilitation Milestone Completion Criteria

Code	Milestone	Indicators	Criteria	Applicable Rehabilitation Areas
RM1	Milestone 1: Infrastructure Decommissioning and Removal	• presence of mine infrastructure equipment and materials.	• all unrequired services disconnected and removed; • all concrete, bitumen and gravel removed; • all pipelines drained and removed; • all fencing that is not part of the PMLU removed; • all buildings demolished and/or removed; • all machinery and equipment removed; • all surface water drainage infrastructure that is not retained in the final landform removed; and • all rubbish removed.	RA1, RA2, RA3, RA4, RA5, RA6, RA7
RM2	Milestone 2: Remediation of Contaminated Land	• presence of contaminated materials; and • contaminated land assessment.	• all contamination is remediated or removed; and • site investigation report prepared by a suitable qualified person which states that the site is safe for its intended use.	RA6, RA7
RM3	Milestone 3: Landform Development and Reshaping/Profiling	• landform maximum slope of spoil and voids; • void backfill depth; and • geotechnical study completed by a suitably qualified person assessing the factor of safety for all final landforms.	• all landform earthworks (excluding topsoil cover) completed; • slopes of spoil dumps conform to maximum angle of 6°; • backfilling of voids to a minimum of 80 mbgl; • highwalls of voids shaped to achieve a maximum angle of 22°; and • landform (pits and spoil dumps) assessed to be geotechnically stable by a suitably qualified person, modelled to achieve a factor of safety of ≥ 1.5.	RA1, RA2, RA4, RA5, RA6, RA7
RM4	Milestone 4: Surface Preparation	• evidence of landform surface treatment; and • soil health assessment.	• all surface drainage features installed; • topsoil placed over all reshaped surfaces to a depth of 0.3 m and deep ripped; and • soil health assessment confirms soil is suitable for target vegetation establishment. If required ameliorants have been applied.	RA1, RA2, RA4, RA5, RA6, RA7
RM5	Milestone 5: Revegetation	• rehabilitation monitoring by a suitably qualified person.	• complete seeding of all topsoiled surfaces using recommended seed mix; and • evidence of successful seed germination in rehabilitation monitoring report.	RA1, RA2, RA4, RA5, RA6, RA7
RM6	Milestone 6: Establishment of Target Vegetation	• rehabilitation monitoring by a suitably qualified person.	• average vegetation ground cover is within 2 standard deviations of equivalent analogue sites; • species richness is within 2 standard deviations of equivalent analogue sites; • weed abundance is consistent with equivalent analogue sites;	RA1, RA2, RA4, RA5, RA6, RA7

Code	Milestone	Indicators	Criteria	Applicable Rehabilitation Areas
			• for grazing areas, pasture mass, the standard unit of measuring pasture productivity (Cayley and Bird 1996) is within 2 standard deviations of analogue sites for pasture on the same SMU; and • validation by a suitably qualified person that the target PMLU is achieved.	
RM7	Residual Void Lake	• water level monitoring; • water quality monitoring; and • fauna monitoring.	• water level in the final void has achieved an Rl of less than 74 mAHD for C Pit and 58 mAHD for AB Pit. Water in void lakes will have a TDS of less than 10,000 mg/L when measured at the surface.	RA3
RM8	Milestone 8: Achievement of Stable PMLU	• rehabilitation monitoring; • geotechnical study; completed by a suitably qualified person assessing the factor of safety for all final landforms; • erosion analysis completed by a suitably qualified person; • fauna surveys including camera trapping, echolocation detection, scat analysis, aquatic and terrestrial trapping and target species surveys; • surface water quality monitoring; and • groundwater quality monitoring.	• report prepared by a suitably qualified person confirming the target PMLU has been achieved and the ecosystem is self-sustaining (with required land management inputs not significantly greater than the surrounding equivalent land use); • landform (pits and spoil dumps) assessed to be geotechnically stable by a suitably qualified person, modelled to achieve a factor of safety of ≥ 1.5; • predictive analysis of erosion confirming that soil loss rates are acceptable and require land management inputs not significantly greater than the surrounding equivalent land use; • fauna survey report provides evidence of native species inhabiting or utilising pit lake / highwall ecosystems including macroinvertebrates, aquatic vertebrates, avian species, bats, and other mammals; • surface water on the site and in the receiving environment is not significantly poorer in any parameter than equivalent reference sites and the baseline quality data for the Project; • groundwater on the site and in the receiving environment is not significantly poorer in any parameter than reference sites and the baseline quality data for the Project; and • predictive modelling undertaken by a suitably qualified person, confirming that the void lake will remain a groundwater sink and that there is no risk of contamination post mining.	RA1, RA2, RA3, RA4, RA5, RA6, RA7

4.6 PRELIMINARY REHABILITATION MILESTONE SCHEDULE

A preliminary rehabilitation milestone schedule has been developed on the basis of the mine schedule described in Section 3.6.2.

Cumulative areas of rehabilitation have been calculated using geospatial data of the mining stage plans which identify the conceptual sequence of mining and rehabilitation activities particularly with respect to the functional operational steps of waste rock emplacement construction, the point at which disturbed areas become available for rehabilitation, and then completion of the activities of reshaping/topsoiling and revegetation (refer to Figure 23 - Figure 32). Variations to the mining rate will likely result in discrepancies with the predicted timing of rehabilitation activities.

A summary of the milestone schedule for each rehabilitation area is provided below (Table 22 - Table 28), and illustrated in Figure 38 to Figure 46.

Table 22 Milestone Schedule Rehabilitation Area 1

Post-Mining Land Uses (PMLU)									
Rehabilitation Area:	RA1								
Relevant Activities:	In pit and out of pit waste emplacements (including dry rejects disposal)								
Total Rehabilitation Area Size (ha):	722.4								
Commencement of First Milestone: (RM1)	Year 2								
PMLU:	Grazing								
Project Year:	**Year 4**	**Year 8**	**Year 12**	**Year 17**	**Year 21**	**Year 25**	**Year 29**	**Year 33**	**Year 37**
Cumulative Area Available (Ha):	231.0	290.5	387.5	535.7	722.4	722.4	722.4	722.4	722.4
Milestone Completed By:	10 Dec Year 4	10 Dec Year 8	10 Dec Year 12	10 Dec Year 17	10 Dec Year 21	10 Dec Year 25	10 Dec Year 29	10 Dec Year 33	10 Dec Year 37
Milestone Reference	**Cumulative area achieved (ha)**								
RM1	231.0	290.5	387.5	535.7	722.4				
RM3	231.0	290.5	387.5	535.7	722.4				
RM4	231.0	257.8	330.3	535.7	722.4				
RM5	231.0	231.0	314.6	513.5	722.4	722.4			
RM6			165.7	206.0	330.6	493.0	722.4	722.4	
RM8							425.7	425.7	722.4

Table 23 Milestone Schedule Rehabilitation Area 2

Post-Mining Land Uses (PMLU)									
Rehabilitation Area:	RA2								
Relevant Activities:	Temporary Waste Rock Emplacement								
Total Rehabilitation Area Size (ha):	17.5								
Commencement of First Milestone: (RM1)	Year 15								
PMLU:	Grazing								
Project Year:	**Year 4**	**Year 8**	**Year 12**	**Year 17**	**Year 21**	**Year 25**	**Year 29**	**Year 33**	**Year 37**
Cumulative Area Available (Ha):				17.5	17.5	17.5	17.5		
Milestone Completed By:				10 Dec Year 17	10 Dec Year 21	10 Dec Year 25	10 Dec Year 29		
Milestone Reference	**Cumulative area achieved (ha)**								
RM1				17.5					
RM3				17.5					
RM4				17.5					
RM5				17.5					
RM6					17.5	17.5			
RM8							17.5		

Table 24 Milestone Schedule Rehabilitation Area 3

Post-Mining Land Uses (PMLU)									
Rehabilitation Area:	RA3								
Relevant Activities:	Residual Void Lakes								
Total Rehabilitation Area Size (ha):	76.5								
Commencement of First Milestone: (RM1)	Year 15								
PMLU:	Fauna Habitat								
Project Year:	**Year 4**	**Year 8**	**Year 12**	**Year 17**	**Year 21**	**Year 25**	**Year 29**	**Year 33**	**Year 37**
Cumulative Area Available (Ha):				40.6	76.5	76.5	76.5	76.5	76.5
Milestone Completed By:				10 Dec Year 17	10 Dec Year 21	10 Dec Year 25	10 Dec Year 29	10 Dec Year 33	10 Dec Year 37
Milestone Reference	**Cumulative area achieved (ha)**								
RM1				40.6	76.5	76.5			
RM7						40.6	76.5	76.5	
RM8								40.6	76.5

Table 25 Milestone Schedule Rehabilitation Area 4

Post-Mining Land Uses (PMLU)									
Rehabilitation Area:	RA4								
Relevant Activities:	Residual Void High Walls								
Total Rehabilitation Area Size (ha):	133.1								
Commencement of First Milestone: (RM1)	Year 13								
PMLU:	Native Vegetation Supporting Fauna Habitat								
Project Year:	**Year 4**	**Year 8**	**Year 12**	**Year 17**	**Year 21**	**Year 25**	**Year 29**	**Year 33**	**Year 37**
Cumulative Area Available (Ha):				64.0	133.1	133.1	133.1	133.1	133.1
Milestone Completed By:				10 Dec Year 17	10 Dec Year 21	10 Dec Year 25	10 Dec Year 29	10 Dec Year 33	10 Dec Year 37
Milestone Reference	**Cumulative area achieved (ha)**								
RM1				64.0	133.1				
RM3				64.0	133.1				
RM4				64.0	133.1				
RM5				64.0	133.1	133.1			
RM6						64.0	133.1	133.1	
RM8							64.0	64.0	133.1

Table 26 Milestone Schedule Rehabilitation Area 5

Post-Mining Land Uses (PMLU)									
Rehabilitation Area:	RA5								
Relevant Activities:	Residual Void Low Walls								
Total Rehabilitation Area Size (ha):	187.2								
Commencement of First Milestone: (RM1)	Year 12								
PMLU:	Grazing								
Project Year:	**Year 4**	**Year 8**	**Year 12**	**Year 17**	**Year 21**	**Year 25**	**Year 29**	**Year 33**	**Year 37**
Cumulative Area Available (Ha):				127.1	187.2	187.2	187.2	187.2	187.2
Milestone Completed By:				10 Dec Year 17	10 Dec Year 21	10 Dec Year 25	10 Dec Year 29	10 Dec Year 33	10 Dec Year 37
Milestone Reference	**Cumulative area achieved (ha)**								
RM1				127.1	187.2				
RM3				127.1	187.2				
RM4				127.1	187.2				
RM5				127.1	187.2	187.2			
RM6						127.1	187.2	187.2	
RM8							127.1	127.1	187.2

Table 27 Milestone Schedule Rehabilitation Area 6

Post-Mining Land Uses (PMLU)									
Rehabilitation Area:	RA6								
Relevant Activities:	Water Management Infrastructure								
Total Rehabilitation Area Size (ha):	85.0								
Commencement of First Milestone: (RM1)	Year 20								
PMLU:	Grazing								
Project Year:	**Year 4**	**Year 8**	**Year 12**	**Year 17**	**Year 21**	**Year 25**	**Year 29**	**Year 33**	**Year 37**
Cumulative Area Available (Ha):					85.0	85.0	85.0	85.0	85.0
Milestone Completed By:					10 Dec Year 21	10 Dec Year 25	10 Dec Year 29	10 Dec Year 33	10 Dec Year 37
Milestone Reference	**Cumulative area achieved (ha)**								
RM1					85.0				
RM2					85.0				
RM3					85.0				
RM4						85.0			
RM5						85.0			
RM6							85.0	85.0	
RM8									85.0

Table 28 Milestone Schedule Rehabilitation Area 7

Post-Mining Land Uses (PMLU)									
Rehabilitation Area:	RA7								
Relevant Activities:	Mine Infrastructure Area								
Total Rehabilitation Area Size (ha):	731.8								
Commencement of First Milestone: (RM1)	Year 20								
PMLU:	Grazing								
Project Year:	**Year 4**	**Year 8**	**Year 12**	**Year 17**	**Year 21**	**Year 25**	**Year 29**	**Year 33**	**Year 37**
Cumulative Area Available (Ha):					731.8	731.8	731.8	731.8	731.8
Milestone Completed By:					10 Dec Year 21	10 Dec Year 25	10 Dec Year 29	10 Dec Year 33	10 Dec Year 37
Milestone Reference	**Cumulative area achieved (ha)**								
RM1					731.8				
RM2					731.8				
RM3					731.8				
RM4						731.8			
RM5						731.8			
RM6							731.8	731.8	
RM8									731.8

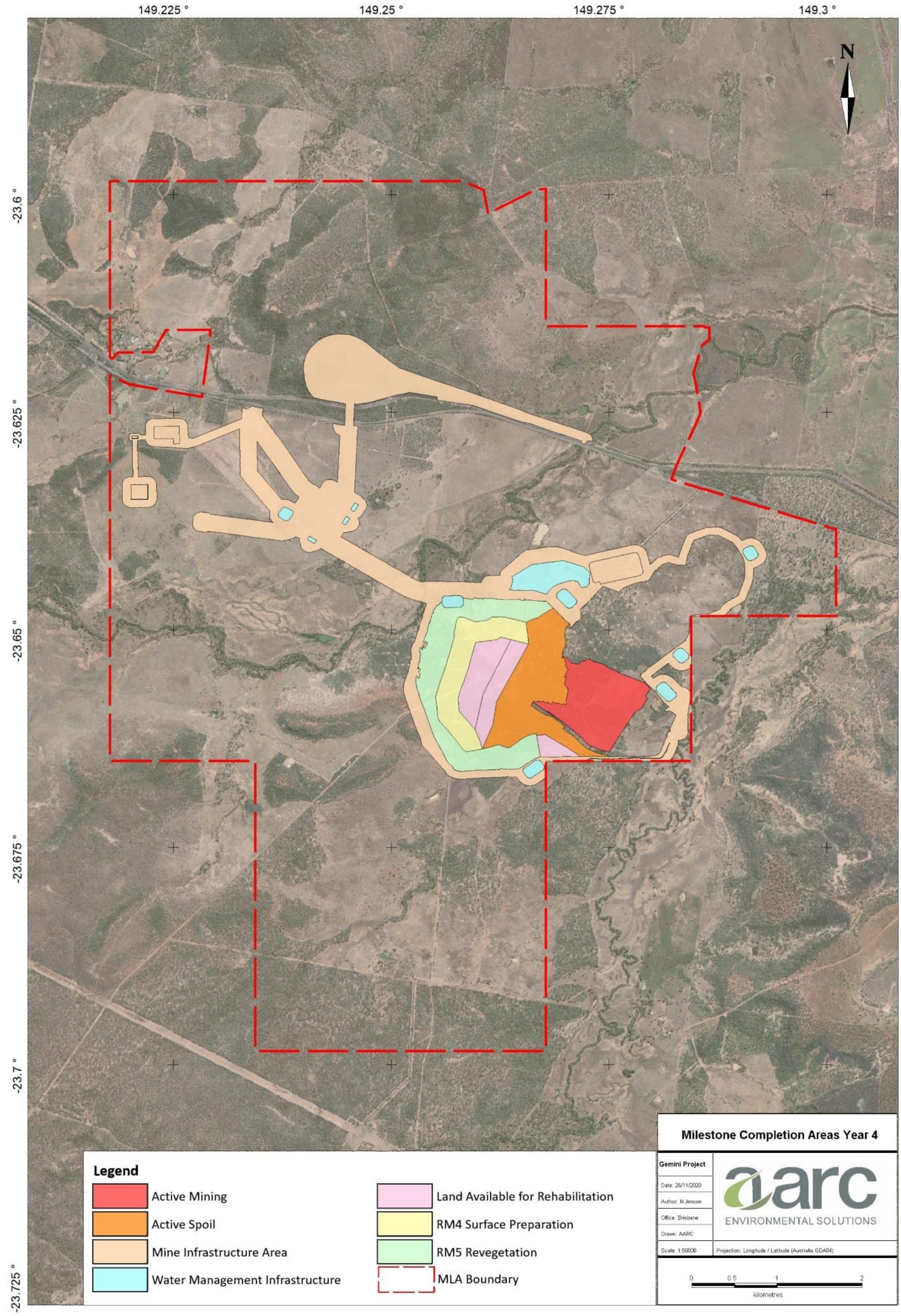


Figure 38 Milestone Completion Areas Year 4

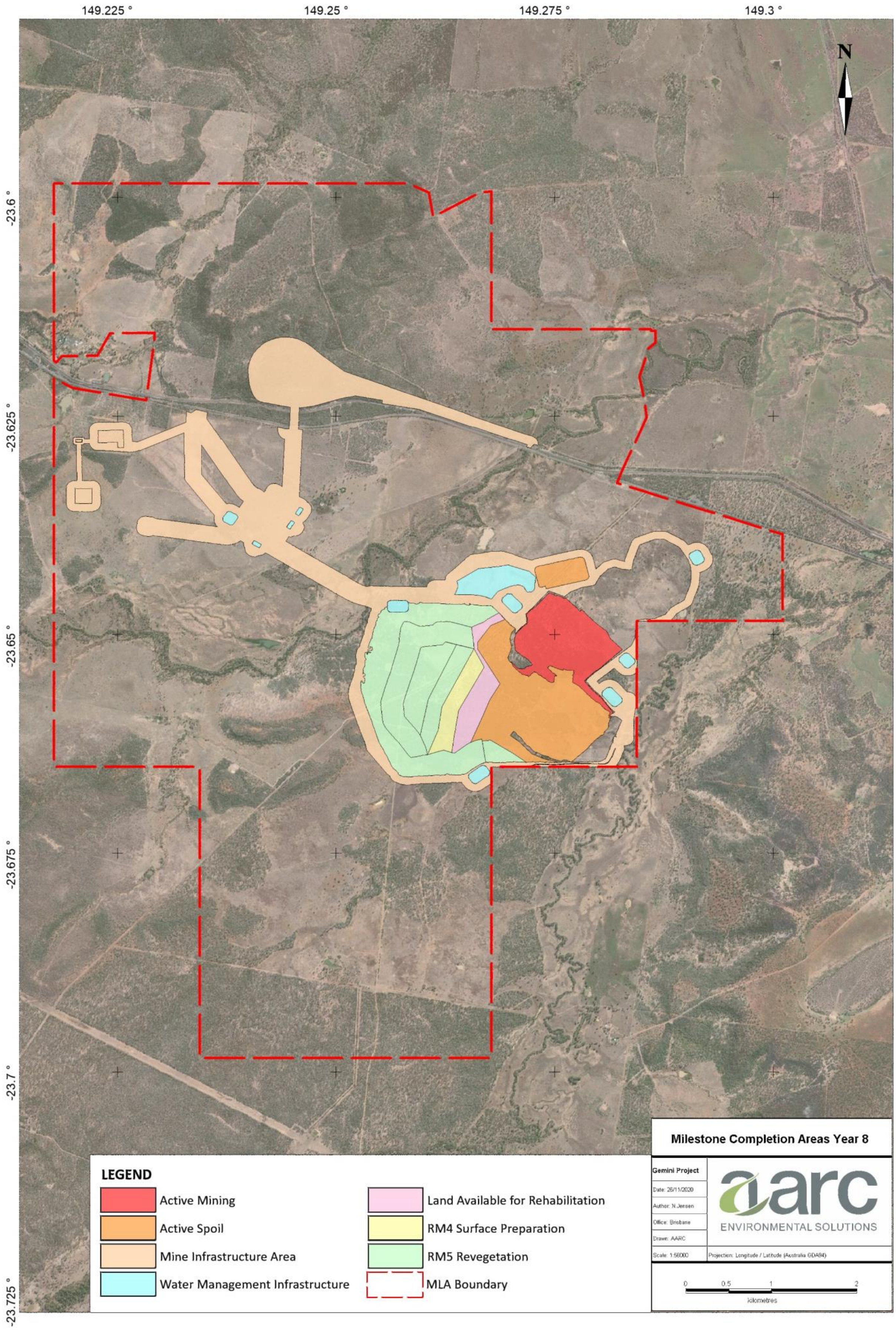


Figure 39 Milestone Completion Areas Year 8

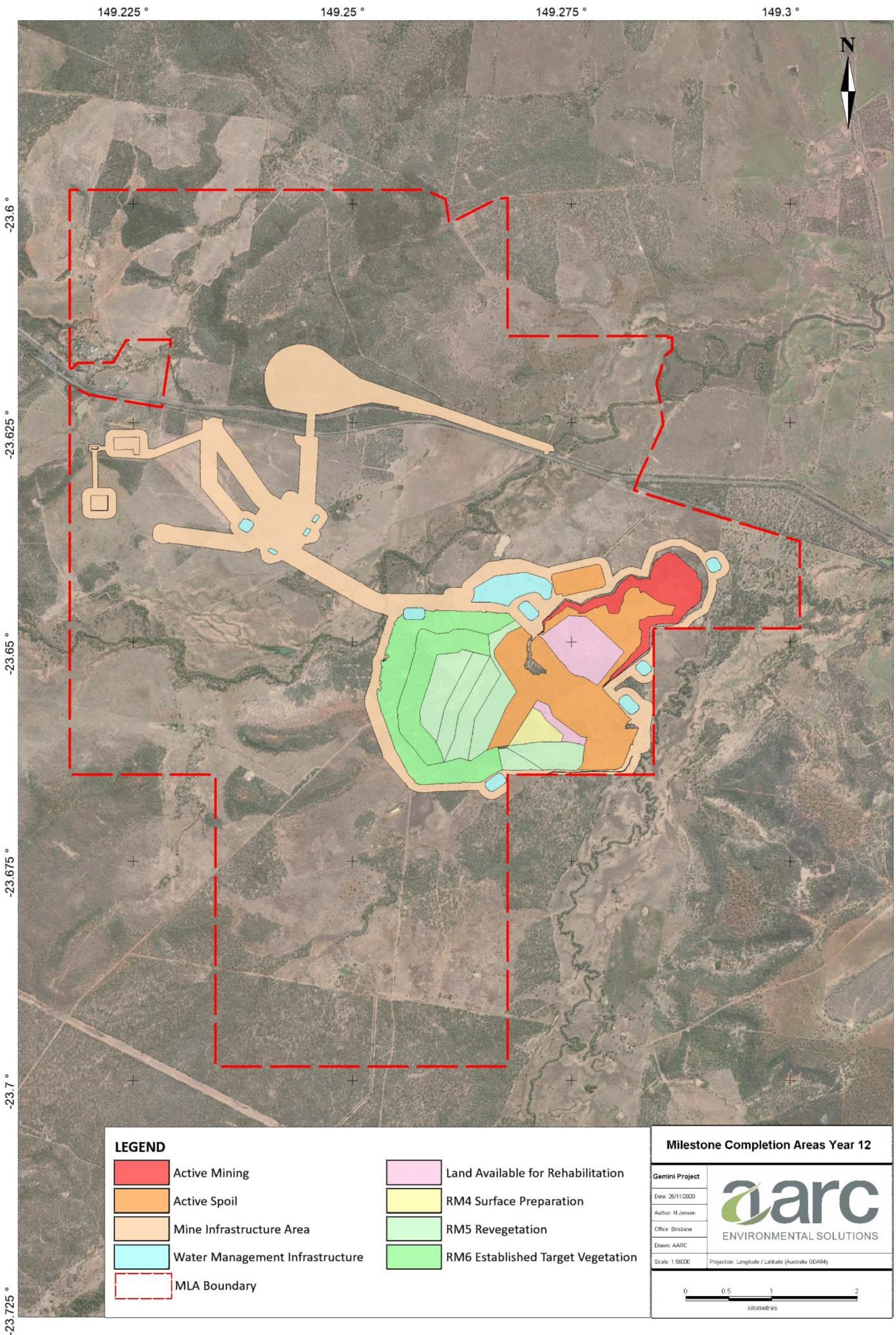


Figure 40 Milestone Completion Areas Year 12

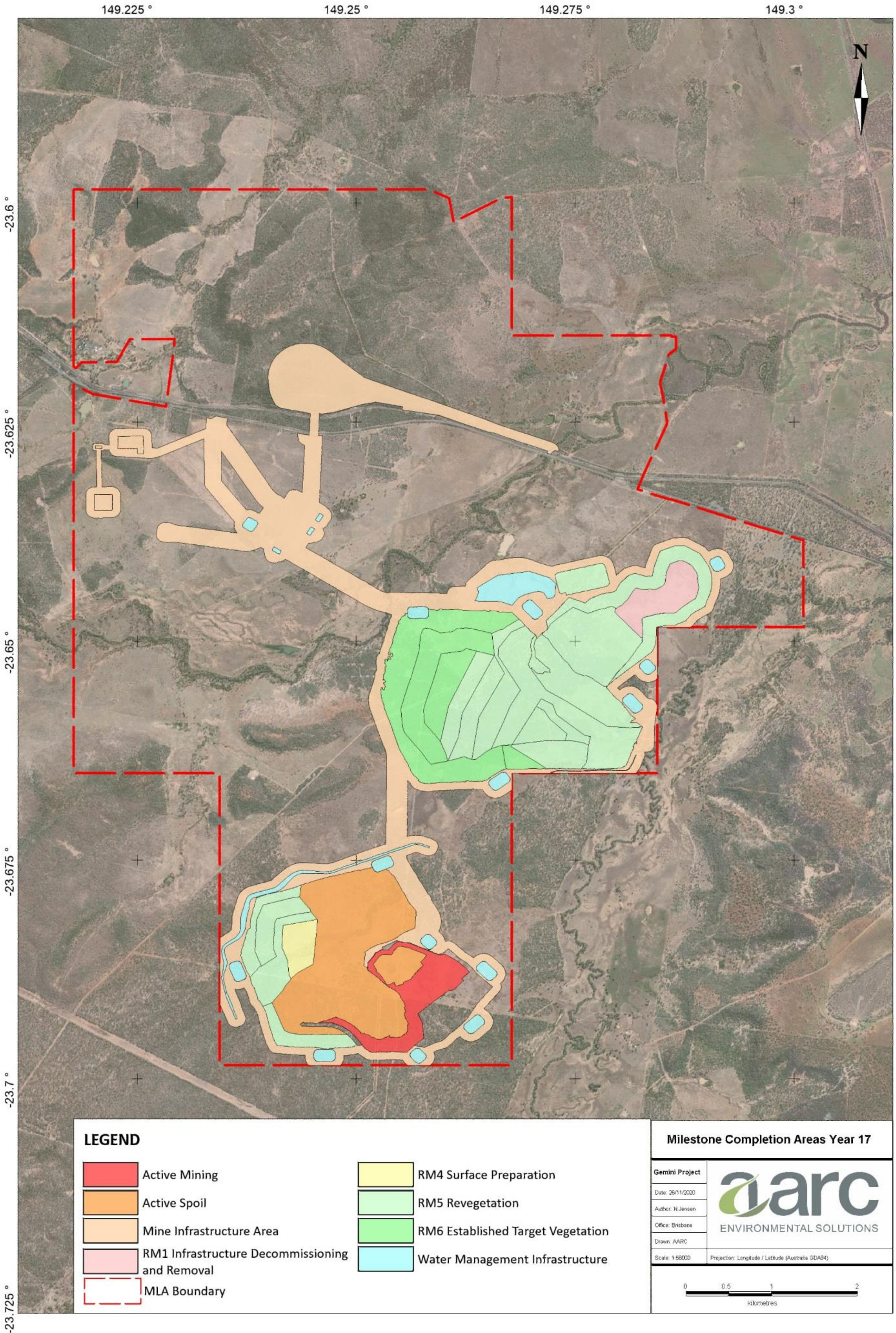


Figure 41 Milestone Completion Areas Year 17

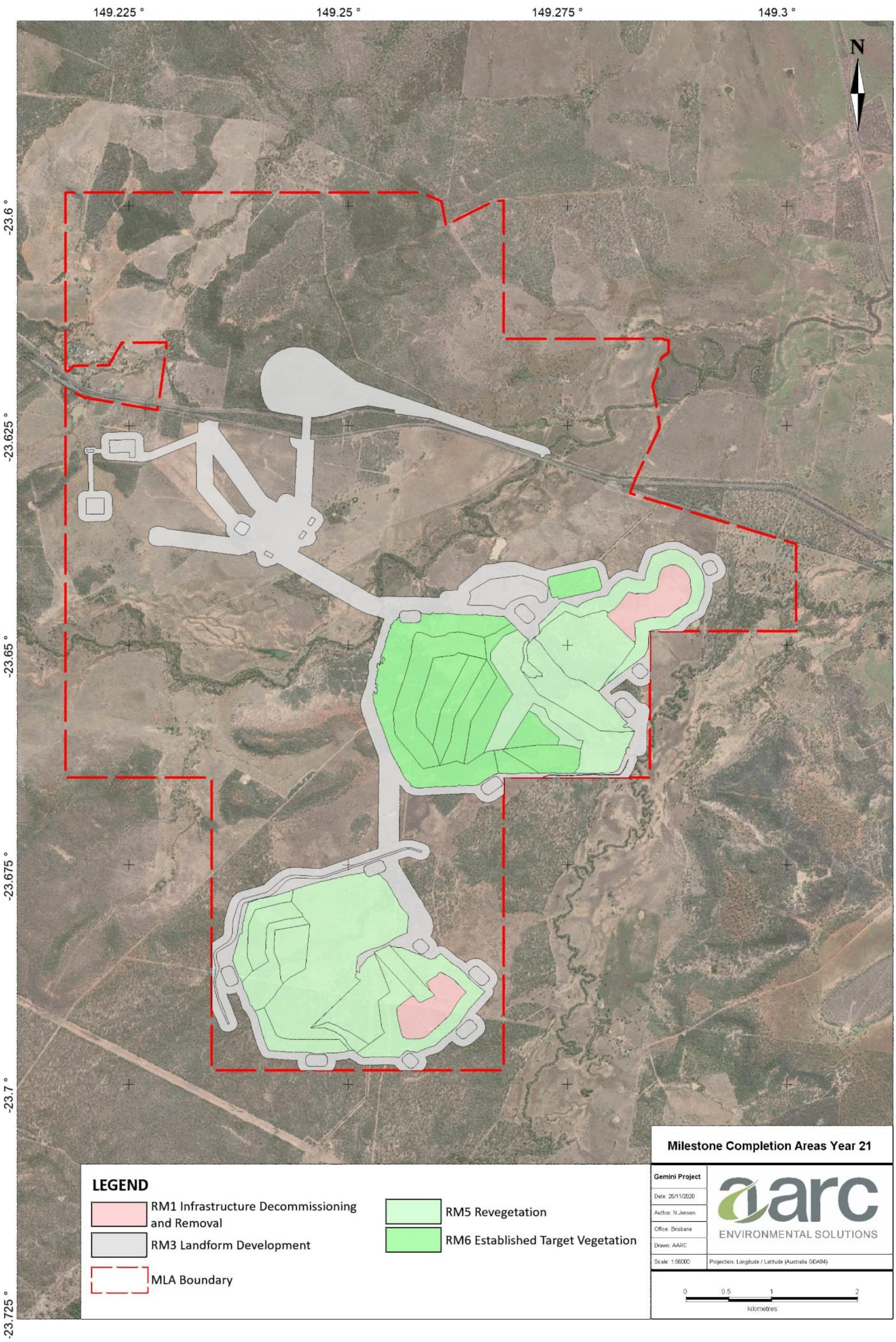


Figure 42 Milestone Completion Areas Year 21

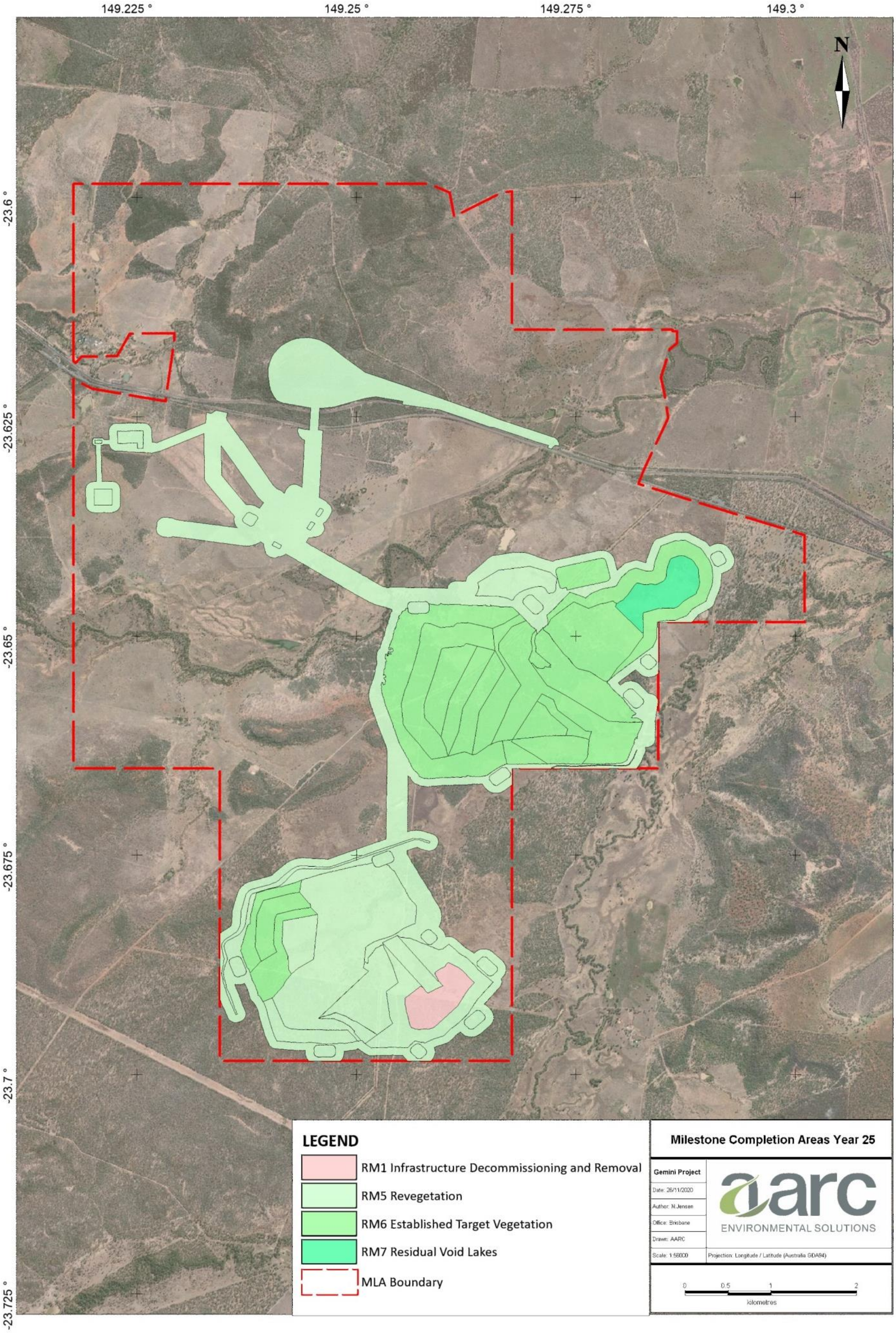


Figure 43 Milestone Completion Areas Year 25

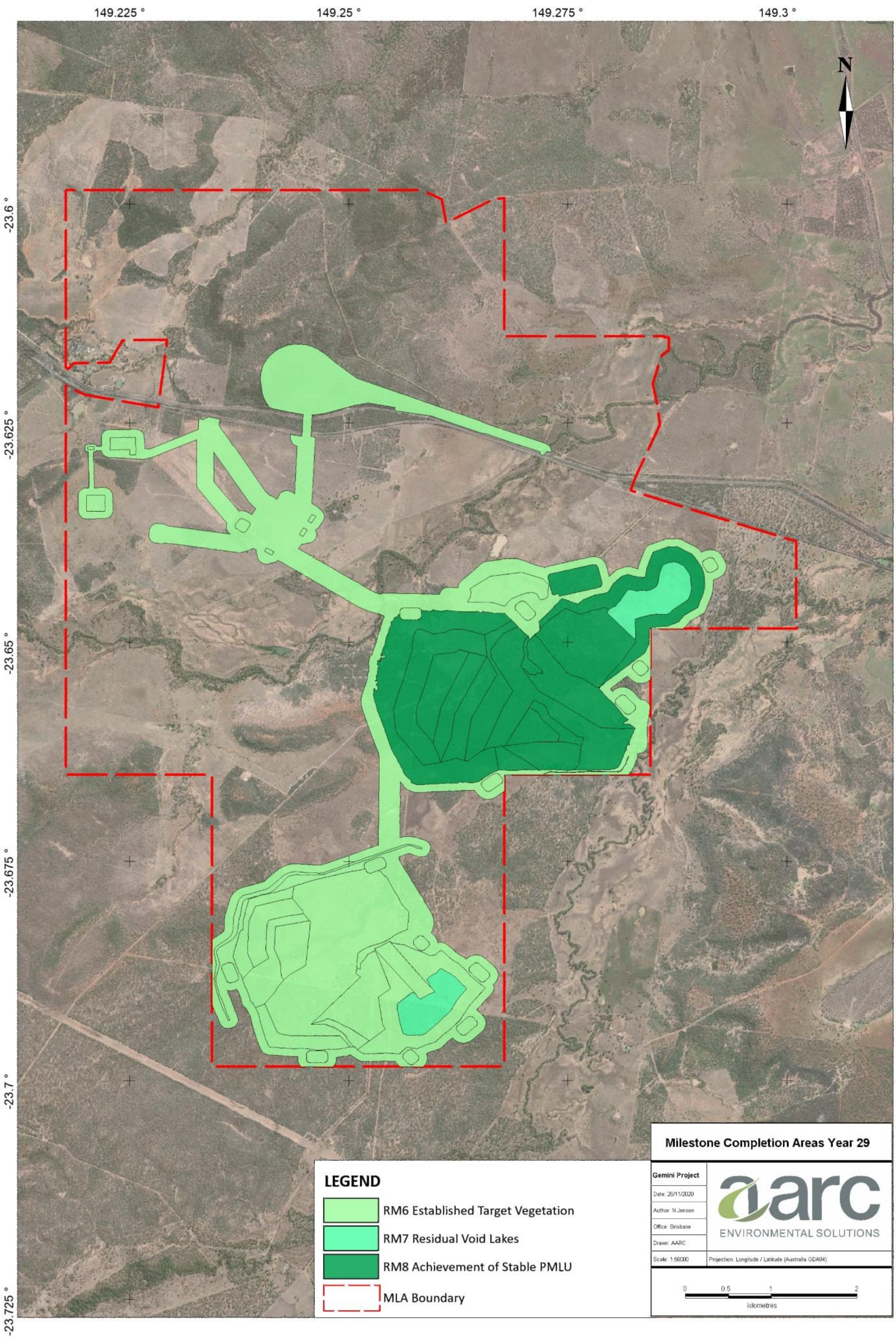


Figure 44 Milestone Completion Areas Year 29

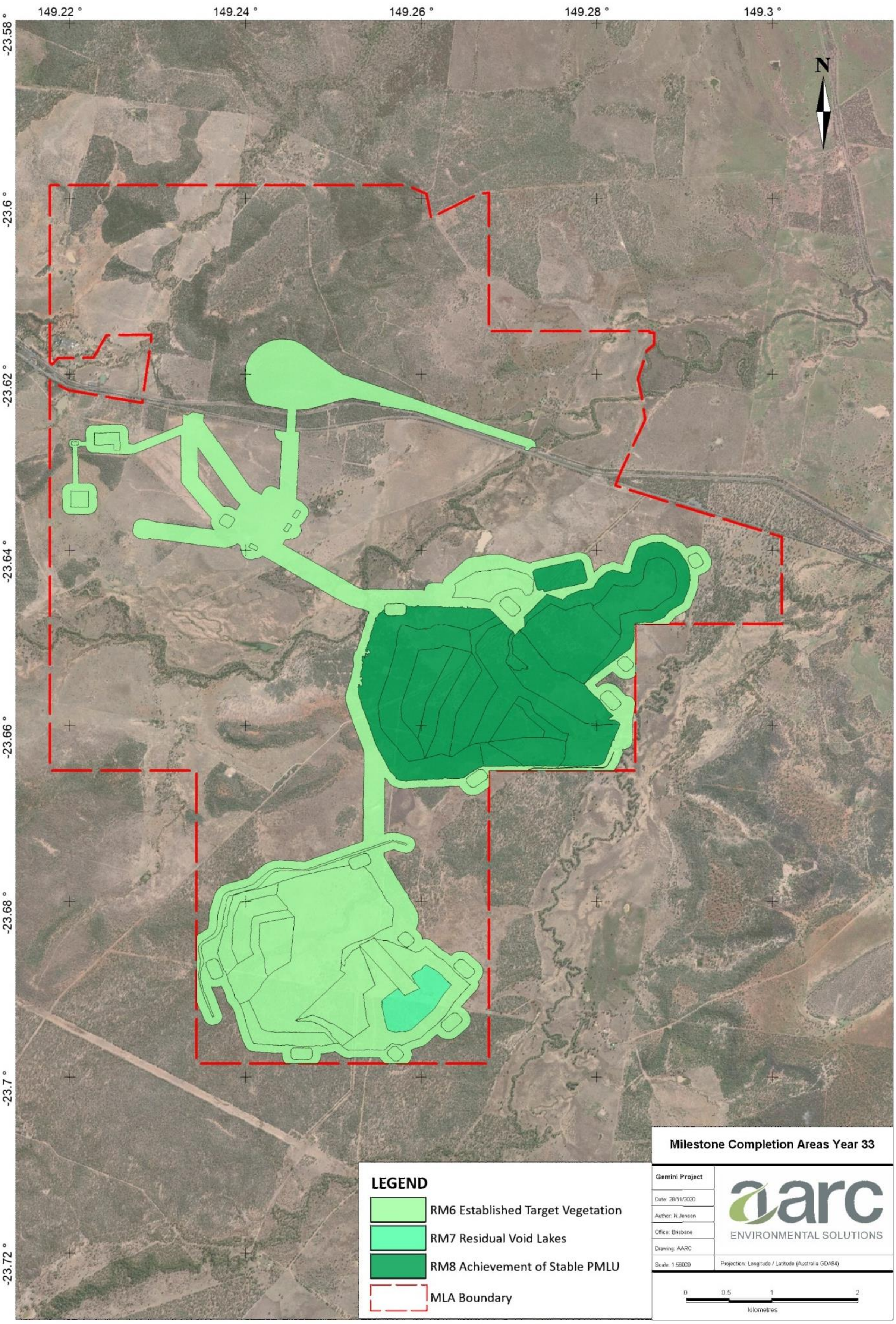


Figure 45 Milestone Completion Areas Year 33

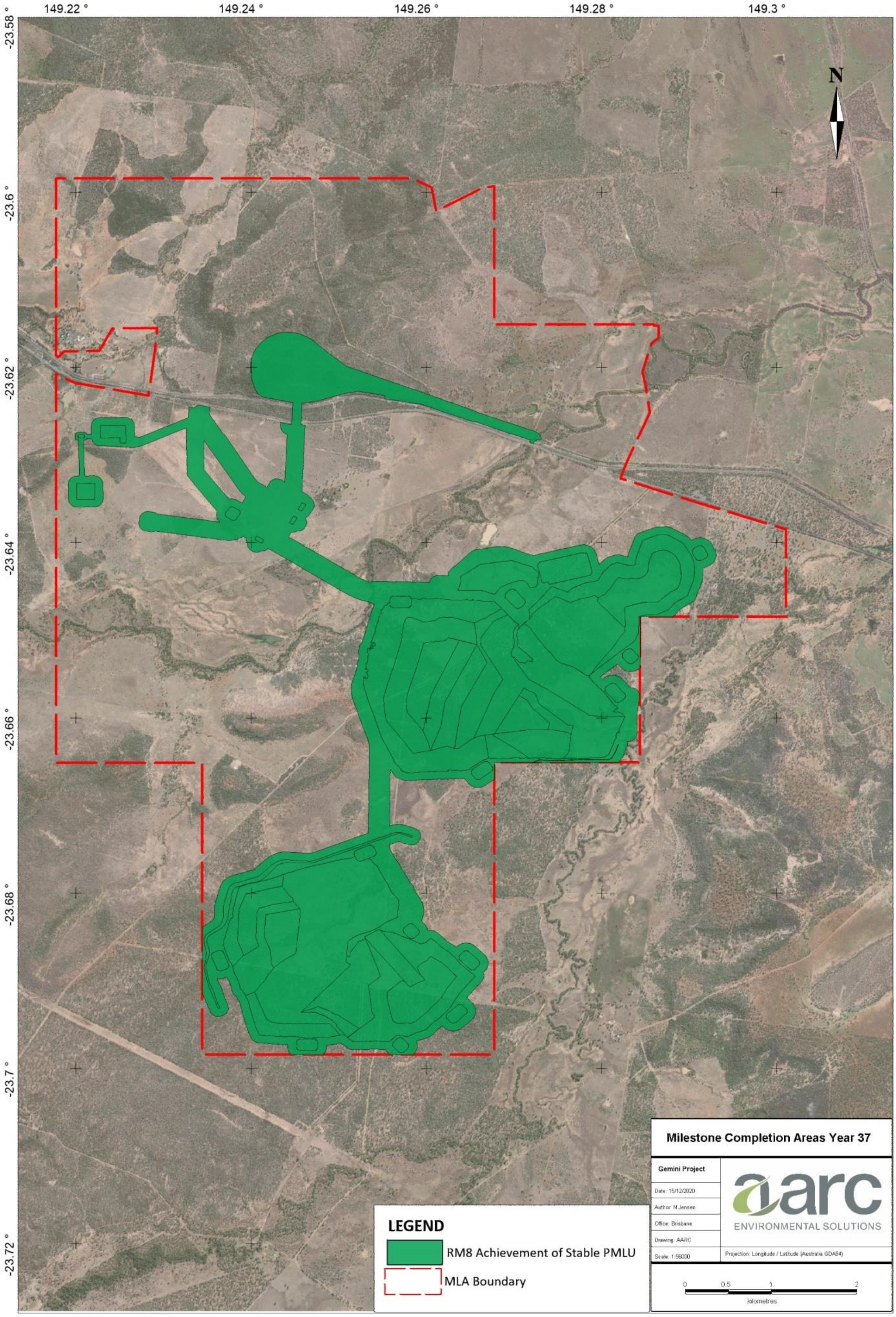


Figure 46 Milestone Completion Areas Year 37

4.7 LAND DISTURBANCE MANAGEMENT AND CONTROLS

4.7.1 Land Disturbance Permit System

A *Land Disturbance Permit System* will be implemented for all land disturbance works within the Project approvals boundary including:

- the disturbance of vegetation (grasses, shrubs, or trees) by machinery or other means (clearing or slashing); and
- the disturbance of soils (topsoils, subsoil, or surface rock layer) by machinery or by soil stripping, the placement of any material or infrastructure on unstripped ground, geotechnical drills, and the development of access roads/tracks.

Prior to any land disturbance, a *Land Disturbance Permit* is to be completed. The *Land Disturbance Permit System* will focus on the minimisation of impacts of land disturbance on the environmental values of the Project and surrounds.

The objective of the *Land Disturbance Permit System* is to ensure all disturbance works are undertaken in accordance with the Project's EA conditions and in an environmentally responsible manner, minimising the impact on the environmental values of the Project site and surrounding region.

The land disturbance procedure will detail the Standard Operating Procedure for the application of land disturbance including procedures for notification periods for relevant personnel, the application process and requirements, roles and responsibilities of personnel, environmental management required for land disturbance, clearing, topsoil removing a stockpiling activities and archaeological finds.

The *Land Disturbance Permit System* will require the following components be completed prior to submission and approval of land disturbance works:

- application details (personal applicant details, a description of the works, size of the disturbance and GPS coordinates);
- map of the disturbance area;
- relevant environmental management controls including a risk assessment, emergency response, erosion and sediment controls, requirements for ecological clearance, heritage clearance;
- legislative approvals, notifications and agreements where required;
- ecological, heritage, community, or land use survey requirements/approvals/notification requirements;
- possible environmental issues identified;
- rehabilitation requirements, where applicable;
- list of contractors and contact details required for any activities associated with land disturbance activities;
- visual inspections of facilities and services; and
- appropriate internal communications established.

4.7.2 Erosion and Sediment Control

A ESCP for the Project has been developed to address the construction, operational and rehabilitation/closure phases of the Project, to the comply with Schedule F31 and F32 of the Project's EA. The ESCP is provided in Appendix P and been designed using a three-tier approach beginning with management, control and treatment; which aims to minimise soil erosion and generation of sediment during disturbance activities and minimise the potential impact of the Project on the water quality of the receiving waters. The ESCP details the following:

- activities with the potential to result in soil erosion or sediment generation, including:
    - land clearing, construction activities and maintenance of haul and access routes;
    - movement of equipment; and
    - surface water run-off from waste rock material, coal, and topsoil stockpiles.
- the description, location and design of erosion and sediment control structures including the sediment dams associated with Pit AB and Pit C (Figures 8 - 12 of Appendix P);
- mitigation measures to reduce soil erosion and sediment migration into receiving waters, these measures include but are not limited to:
    - silt fences, coir logs, hay bales or other flow reduction and sediment entrapment devices;
    - traffic control measures and haul route bunding;
    - pit protection levees;
    - diversion channels;
    - cleaning of vehicles and equipment within designated cleaning areas;
    - sediment traps and dams;
    - cleaning protocols of sediment drains and entrapment devices;
    - waste rock stockpiles designed to slope of 1V:10H (adhering to a slope of 6°) to prevent landform instability and dispersal; and
    - rapid revegetation of disturbed areas and hydromulching of areas subject to short term exposure;
- sediment quality monitoring will be undertaken in accordance with a *Receiving Environment Monitoring Program* (REMP) to ensure the effectiveness of employed control measures, including the enforcement of sediment quality trigger values (further details of the REMP are provided in Section 7.4.4.1, and the REMP Design Document is included as Appendix Q);
- routine inspection and audits of the site, including periodic inspections of site drainage will be undertaken and used to inform the requirement of correction actions;
- any incidents of soil instability and erosion will be reported to the designated environmental representative on-site to facilitate management measures;

- decommissioning processes and requirements; and

- annual review requirements and responsibilities.

Erosion and sediment control structures will be designed and installed in accordance with *Best Practice Erosion and Sediment Control* (IECA Australasia 2008) and *Soil Erosion and Sediment Control: Engineering Guidelines for Queensland Construction Sites* (Witheridge & Walker 1996), as appropriate.

Four sediment dams associated with Pit AB will be installed in mining year 1 and five sediment dams associated with Pit C will be installed in mining year 13. Sediment dam design is discussed in further detail in Section 3.4.3. Temporary erosion and sediment control structures including sediment dams will be retained until re-vegetation within the sediment dam catchment has been established; and surface water run-off meets the water quality trigger values of the receiving water ways as detailed in Schedule F of the Project's EA. The time period of sediment dam retention is likely to be dictated by the germination of seeds which occurs on average within a year from planting. The sediment dam and associated drainage infrastructure would then be decommissioned and contour profiles consistent with the surrounding landscape to allow surface runoff to shed directly into the receiving environment.

The ESCP has been developed as a supporting document for the *Land Disturbance Permit System* (refer Section 4.7.1) and mine water management system (refer Section 3.4.3). Erosion and sediment controls will be routinely inspected and maintained for capacity and structural integrity including inspections following significant rainfall events.

4.7.3 Contaminated Land

The risk of land contamination will be similar to existing mining operations and is likely to be confined to accidental spills such as small diesel spills, and/or spills of chemicals likely to be onsite. Contaminated land management involves preventative management of incidental land contamination by 'Notifiable Activities' listed in Schedule 3 of the EP Act which include:

- item 7: Chemical storage (other than petroleum products or oil under item 29);

- item 15: Explosives production or storage;

- item 29: Petroleum product or oil storage; and

- item 37: Waste storage, treatment or disposal. Risk of contaminated land is associated with inappropriate storage and handling of chemicals, explosives, and waste.

The risk of contamination to land within the Project areas will be minimised through the following measures:

- sediment dams or stormwater dams will be installed and adhere to the design parameters of the '*Manual for assessing consequence categories and hydraulic performance of structures*' (DES 2016) to ensure all catchment areas downstream of the mine infrastructure area will contain any spills or contaminated stormwater run-off;

- explosives storage will be managed in accordance with AS 2187:2006 *'Explosives—Storage, transport and use*' (Standards Australia 2006);

- waste products including oil and other chemicals will be stored and disposed of according to the relevant material data safety sheets to minimise contamination risk;

- all unexpected contamination will be remediated and validated under supervision of a suitably qualified person in accordance with an *Emergency Response Plan* predefined for all hazardous materials stored on-site (the administering authority will be notified within 24 hours of detection being known);

- a contaminated land register and map will be maintained on-site detailing any contamination events, subsequent location and remediation protocols issued;

- chemical and hydrocarbon storage areas will be designed and bunded in accordance with '*AS 1940:2017, The storage and handling of flammable and combustible liquids*' (Standards Australia 2017);

- provision of training to staff on the prevention of spills and the use of spill kits; and

- a register of spill kits will be maintained, and all kits will be inspected for completeness at least quarterly.

With the implementation of the above standard operating procedures, the Project is not predicted to have an impact on the environmental values of land and water resources.

4.7.4 Weed and Pest Management Plan

A *Weed and Pest Management Plan* will be developed in accordance with the Biosecurity Act and the Central Highlands Regional Council *Pest Management Plan 2015-2020.* The objective of the Project's *Weed and Pest Management Plan* is to maintain the environmental values associated with the Project site and surrounding region and to support the local council weed and pest management objectives. The *Weed and Pest Management Plan* will be developed and implement prior to the construction of the Project.

The *Weed and Pest Management Plan* will focus on minimising the occurrence and spread of weeds through the implementation of:

- preventative measures to reduce the risk of weeds and pests on site and the spread of weeds and pests outside the Project boundaries and include;
    - wash down facilities for vehicles identified as a risk of spreading weeds;
    - the inclusion of weed and pest identification and reporting procedures for the Project in induction and training materials distributed to all employees;
    - seeding of fast-growing grass cover to topsoil stockpiles requiring long term storage and rehabilitated areas;
    - inclusion of weed and pest monitoring;
    - weed disposal procedures;
- control measures to minimise the impacts of weeds and pests on environmental values and to prevent the spread of weeds and pests outside the Project boundaries which may include:
    - the manual removal of weeds in instances of isolated weed presence;
    - herbicide application treatments; and

- liaison with local council and surrounding landholders, where required on the control of pests.

The *Weed and Pest Management Plan* will include the following components:

- a description of weed and pest animal species listed under the Biosecurity Act and known to occur on the Project site;
- identification of and commitment to appropriate management strategies to control the occurrence of pest fauna and weed species on the Project site;
- a system for early detection and eradication of new weed and pest fauna species;
- management strategies to prevent the introduction of new pest species onto the Project site;
- delineation of the roles and responsibilities of Project personnel in relation to pest and weed management on the Project site.

The *Weed and Pest Management Plan* will address weeds and pests across the Project as well as in rehabilitation areas. The first few years following planting are the most important for controlling the spread of invasive species. As pioneer species, weeds tend to out-compete native species on disturbed soils before desirable species have had time to set roots and adequately cover a rehabilitated area. During the first three growing seasons, botanical surveys and hand removal of weeds or targeted herbicide applications will be pursued as appropriate. Weed cover should be comparable to analogue sites. Regular monitoring will be undertaken specifically targeted at identified pest and weed species, and management plans implemented as appropriate to the findings of monitoring results.

4.7.5 Grazing and Agriculture Management

A *Grazing and Agriculture Management Plan* will be developed by a suitably qualified person in consultation with the landowner / leaseholder.

Grazing by cattle on rehabilitated areas will only commence once the completion criteria for the area has been met. Fencing around grazing areas / native ecosystems will be undertaken in a manner to enable standard grazing management practices. A suitable stocking rate will be determined subject to the performance of grazing trials and revegetation following the closure of the mine.

In Queensland, the underlying principle to the standard management practices of grazing and agricultural management is to utilise land in a sustainable manner while protecting the environmental value of land. Standard Management practices include the following (DERM 2011):

- managing erosion management through stock fencing (including exclusion zones of riparian corridors and watering points), vegetative cover and stocking rates;
- paddock planning layout management to manage grazing pressure and conserving the biodiversity values of land in accordance with the EPBC Act and *Vegetation Management Act 1999* (VM Act);
- weed and pest management;
- soil management; and
- fire management.

4.8 REHABILITATION MONITORING AND MEASUREMENT

Rehabilitation monitoring for the Project has the goal of assessing compliance with the rehabilitation objectives and agreed completion criteria.

Rehabilitation monitoring will be used to track the progress of revegetated areas and determine requirements for intervention, such as weed control or supplementary planting. Additionally, rehabilitation monitoring will also:

- evaluate coverage and application of topsoil prior to seeding;
- monitor drains and assess water quality to determine whether substantial silting of inverts and/or any localised failure of drain embankments has occurred;
- evaluate topsoiled areas following rainfall events (particularly on slopes) to assess whether significant rill development or loss of topsoil has occurred;
- evaluate the behaviour of placed topsoil over time (erosion or dispersion, compaction, salting or hard setting);
- assess the germination success in revegetated areas (including recording of diversity and abundance);
- monitor revegetation success over time (e.g., survival rate, plant growth, species diversity, weed content, fauna usage);
- evaluate potential threats to rehabilitated areas (e.g., weed invasion, pest species, dispersive soils or potentially acid forming (PAF) low-capacity materials, erosion); and
- record key rehabilitation information (e.g., photographic records, surveys, file notations).

To monitor the success of progressive rehabilitation, permanently marked transects will be established. These transects will generally be monitored for a minimum of five years or longer until criteria area achieved. The results will then be used to continually inform and assess the effectiveness of rehabilitation strategies and methodologies, as well as enabling movement towards progressive certification. Where new monitoring techniques and technologies are identified, these will be adopted as appropriate.

4.8.1 Monitoring Methodology

A transect based approach (consistent with the BioCondition methodology) will be utilised for rehabilitation monitoring. This approach aims to provide a measure of the capacity of a terrestrial ecosystem to maintain biodiversity values at a local or property scale and allows a comparative assessment of pre- and post-mining ecosystems.

BioCondition monitoring assesses a suite of parameters at different landscape positions on each site, namely on flats, slopes and in troughs. Repeated edaphic (soil properties) and biological measurements are taken over time for various parameters that indicate changes in ecosystem function as rehabilitation proceeds. In general, the method involves monitoring two groups of sites:

- **analogue / reference sites:** selected to best reflect the pre-mining land use (i.e., cleared pasture for cattle grazing) to obtain relevant and realistic rehabilitation criteria for the matching

PMLU. Analogue sites will be chosen as close as possible to the rehabilitated area so that the same climatic and environmental conditions existed at both sites to the extent possible; and

- **rehabilitated sites:** monitored for rehabilitation performance, successful or otherwise.

Multiple analogue/reference sites will be established on and around the Project that best represent pre-mining ecosystems. For this Project, reference sites representative of the proposed PMLU of low intensity grazing on native and improved pastures will be established prior to the commencement of the Project.

Structured, periodic monitoring of reference sites will provide an understanding of the pre-mining landscape, assisting in the future planning and refinement of rehabilitation strategies, as well as providing data for determination of completion criteria when assessing rehabilitation success.

Rehabilitation transect sites will also be established within rehabilitated landforms post mining. At each site, the following parameters will be monitored annually:

- aspect and slope;
- tree density (trees/ha);
- shrub density (shrubs/ha);
- herb/grass density (grasses/ha);
- groundcover (%);
- species composition;
- chemical and physical indicators of soil;
- erosion indicators (depth of rills or erosion lines, surface crusting, slopes); and
- photographic records of the site.

In addition to rehabilitation transect monitoring, other related site environmental monitoring will continue throughout and following the life of the mine (e.g., surface water monitoring). These data sets will also work to further inform rehabilitation success.

In accordance with current standards, rehabilitation monitoring will ultimately aim to demonstrate that domain specific completion criteria have been continuously met for a period of three years or greater.

4.8.2 Review of Rehabilitation Monitoring Data

Rehabilitation monitoring data will be used to review rehabilitation success. This will occur through:

- tracking revegetation and/or regeneration progress against performance indicators and completion criteria;
- assessing the performance of landform designs and rehabilitation concept methods;
- evaluating the effectiveness of environmental management measures/controls; and
- identifying the requirement for intervention strategies or ameliorative/contingency measures.

The results of any industry rehabilitation trials and investigations will also continue to be used to inform and refine future rehabilitation concepts, practices and measures.

4.9 CLOSURE AND RELINQUISHMENT

4.9.1 Closure Planning

A *Closure Plan* will be developed for the Project during the first five years of the Project life. The C*losure Plan* will extend the preliminary rehabilitation requirements described in Table 21 and develop detailed planning for the post-mining closure phase of the Project.

The *Closure Plan* will update and refine landform design criteria, particularly residual void slope highwall and low wall slope design and completion criteria on the basis of experience gained during mining operations. Any agreements in relation to retained infrastructure will also be addressed.

The *Closure Plan* will also refine rehabilitation maintenance requirements and provide an update on findings from rehabilitation monitoring undertaken.

4.9.2 Final Rehabilitation Report and EA Surrender

At the point in time that rehabilitation monitoring indicates that completion criteria are being achieved for all or part of the rehabilitation undertaken for the Project, either a final or progressive rehabilitation report will be compiled and submitted to the administering authority for consideration in accordance with Section 264 or Section 318ZF of the EP Act.

The final or progressive rehabilitation report will contain an environmental risk assessment which will identify any residual risks and costs. However, achievement of the completion criteria is anticipated to result in minimal residual risk due to the low risk of acid mine drainage, slope design of the waste rock emplacements is consistent with standard design practices in the Bowen Basin, the exclusion of dispersive/sodic soils from the final landform surfaces and overall landform design consistency with the surrounding environment. Residual risk is predicted to be limited to maintenance of fencing and signage around the residual void and fencing requirements and land management associated with standard cattle grazing management.

Where relinquishment requires the transfer of ownership or management of infrastructure and/or land to other parties, evidence that these parties have been involved in the process and understand the liability and responsibilities associated with the transfer will be provided. Written legal agreement with the subsequent party owners will be sought to identify acceptance of the mining legacy and any outstanding costs of remediation, monitoring and reporting. Legal agreements will be undertaken in accordance with the relevant legislative requirements at the time of relinquishment.

5.0 LAND

This section provides a description of the existing land values within and surrounding the Project. It aims to identify the Project's potential impacts on the existing values and propose mitigation measures and management strategies to prevent or minimise adverse environmental effects.

This section is informed by the *Soil and Land Suitability Assessment* (AARC 2019) presented as Appendix I.

5.1 ENVIRONMENTAL OBJECTIVES AND PERFORMANCE OUTCOMES

The environmental objective relevant to potential impacts to land as described in the EA guideline for *Application requirements for activities with impacts to land [ESR/2015/1839]* (DES 2017b) is:

The activity is operated in a way that protects the environmental values of land including soils, subsoils, landforms and associated flora and fauna.

The Project would achieve all of the following performance outcomes identified in Schedule 8, Part 3, Division 1 of the EP Regulation:

(a) activities that disturb land, soils, subsoils, landforms and associated flora and fauna will be managed in a way that prevents or minimises adverse effects on the environmental values of land;

(b) areas disturbed will be rehabilitated or restored to achieve sites that are:

  (i) safe to humans and wildlife;

  (ii) non-polluting;

  (iii) stable; and

  (iv) able to sustain an appropriate land use after rehabilitation or restoration;

(c) the activity will be managed to prevent or minimise adverse effects on the environmental values of land due to unplanned releases or discharges, including spills and leaks of contaminants; and

(d) the application of water or waste to the land is sustainable and is managed to prevent or minimise adverse effects on the composition or structure of soils and subsoils.

5.2 DESCRIPTION OF ENVIRONMENTAL VALUES

5.2.1 Landform and Visual Amenity

Landform

The topography of the Project area varies from flat to undulating hills, with elevation ranging between 120-150 mAHD. The landscape is strongly influenced by the presence of Charlevue Creek and its associated floodplains, which have relatively lower elevations than the surrounding landscape of undulating hills. An elevated ridgeline is located 2-5 km east of the Project at an elevation of 170 mAHD.

The major water body associated with the Project is Charlevue Creek, which dissects the MLA, flowing in a northeast direction. This creek begins within the boundaries of Blackdown Tablelands National Park, flowing northeast before joining with Springton Creek and the Fitzroy River, eventually reaching the Pacific Ocean approximately 46 km north of Gladstone. Two significantly smaller creeks, Stanley and Springton, cross the Project boundaries in the northwest and southeast respectively. These two creeks eventually converge with the Mackenzie River. Associated tributaries, agricultural dams and unnamed drainage features also appear across the site.

Visual Amenity

Visual amenity refers to the quality and appreciation of a geographical location in the context of valued features, characteristics and attributes. The existing visual environment of the Project and surrounding area is typical of the Bowen Basin; with a predominant rural landscape character comprised primarily of grazing land and areas of bush reserve. To the west, views of the Arthurs Bluff State Forest can be seen from the eastern MLA boundary.

The landscape amenity is dissected by major transport infrastructure including the Capricorn Highway and the Blackwater Railway. A number of small towns and rest stops are located along the Capricorn Highway serving the local residents and mining communities. Along the transport route heading west of the Project, coal mines and associated infrastructure can occasionally be observed from public transport corridors.

The mining infrastructure relevant to potential visual exposure, includes:

- The out-of-pit waste rock emplacement of Pit AB (beginning at the commencement of mining activities) will be located approximately 2 km south of the Capricorn Highway. The topography surrounding the waste rock emplacement is relatively flat with minimal obstruction by natural features. The Pit AB waste rock emplacement will have a maximum height of 175 mAHD and be progressively rehabilitated throughout the life of mine to resemble the surrounding landscape of gently undulating hills. Whilst the Pit AB void is a depression below natural ground surface and not expected to be visible from public or private sensitive locations.

- The out-of-pit waste rock emplacement of Pit C (beginning Year 12) will be located approximately 500 m north of the Cooinda Road diversion. The Pit C waste rock emplacement will have a maximum height of 190 mAHD and also rehabilitated throughout the life of mine.

- All haul roads are internal to the MLA and are located 1 km, or more, away from the closest residential dwelling.

- The TLO will be located approximately 300 m north of the Capricorn Highway connecting to the existing Blackwater Railway. The Blackwater Railway services coal export from the Bowen Basin and is a dominant visual feature along the length of the Capricorn Highway with rail infrastructure and trains frequently visible. The proposed TLO will contain a rail spur, rail loop and train loading bin.

- An overland conveyor will transport export material from the CHPP to the TLO, crossing over the Capricorn Highway (conceptual design provisions are shown in Figure 12 to Figure 14). The proposed overhead conveyor will cross the transport route at a minimum height elevation of 7m and 10m in length, similar to that of the existing conveyor across the Capricorn Highway at Boonal, approximately 28 km west.

A *Visual Amenity Assessment* was undertaken by AARC (Appendix O). A total of five photographic vantage points were selected as representative points to reflect the visual landscape at major sensitive receptor locations and also relatively high traffic areas within the local region (refer to Table 29 for detailed vantage point descriptions). A number of visual simulations were produced at each vantage point to identify the risk of any visual modification to the surrounding landscape, potential impacts on visual amenity are summarised below in Section 5.3.2.

Table 29 Visual Amenity Vantage Points

Vantage Point	Location Description	Coordinates (Lat/Long)	Approximate Distance from MLA
VA1	Southern side of Capricorn Highway facing south west towards Pit AB between the pit and the residence of the Rubina property. This property is owned by the proponent and as the residence will be vacated prior to the commencement of operations, it is not considered to be a sensitive receptor.	-23.641, 149.292	Within MLA
VA2	Southern side of Sanders Road facing west towards Pit C at the entrance to the residence on the Namoi Hills property along the eastern boundary. This property is owned by the proponent and as the residence will be vacated prior to the commencement of operations, it is not considered to be a sensitive receptor.	-23.696, 149.281	1.3 km
VA3	Northern side of Sanders Road facing north towards Pit AB at the entrance to the residence on the Namoi Hills property along the eastern boundary. This property is owned by the proponent and as the residence will be vacated prior to the commencement of operations, it is not considered to be a sensitive receptor.	-23.694, 149.280	1.2 km
VA4	Southern side of Capricorn Highway facing south towards Pit AB. This location is closest to the northern boundary of the Namoi Hills property.	-23.629, 149.272	Within MLA
VA5	Western side of Cooinda Road facing north towards Pit C at the entrance to the residence on the Glenwood property.	-23.720, 149.246	2.4 km

5.2.2 Native Title and Cultural Heritage

Native title determination areas described by the National Native Title Tribunal is extinguished within the boundary of the ML. As such, a native title process is not required to be undertaken as part of the MLA process.

The Proponent will comply with the *Aboriginal Cultural Heritage Act 2003* and the supporting *Duty of Care Guidelines* (DATSIP 2004) when undertaking activities within the area of EPC 881 and the proposed ML.

A *Cultural Heritage Management Plan* has been developed for the Project and signed in accordance with the *Aboriginal Cultural Heritage Act 2003*.

5.2.3 Geology

Regional Geology

The Gemini Project coal deposit is hosted within the Permian Rangal Coal Measures and the Yarrabee Structural Zone. Seven seams or seam groups have been identified at site, which belong to either the Rangal Coal Measures or the underlying Burngrove Formation (BOYD 2019). In descending stratigraphic order, the seams include the Aries, Castor, Pollux, Orion, Pisces, Virgo and Leo seams. The seams contain several individual plies that have identified for mining at the site.

The site surface geology is shown in Figure 47. It predominantly comprises sediments of the Tertiary Duaringa Formation and Quaternary alluvium associated with ephemeral creeks including Charlevue Creek and Springton Creek.

Figure 48 shows the project location in relation to the underlying Bowen Basin solid geology (i.e., the surficial unconsolidated Quaternary and Tertiary units have been removed, revealing the relationship between the underlying Triassic and Permian sediments, as well as the prevalence of regional-scale faults). The two mining areas (Pit AB and Pit C) are in areas where folding has brought the coal seams close to surface at depths that can be economically mined.

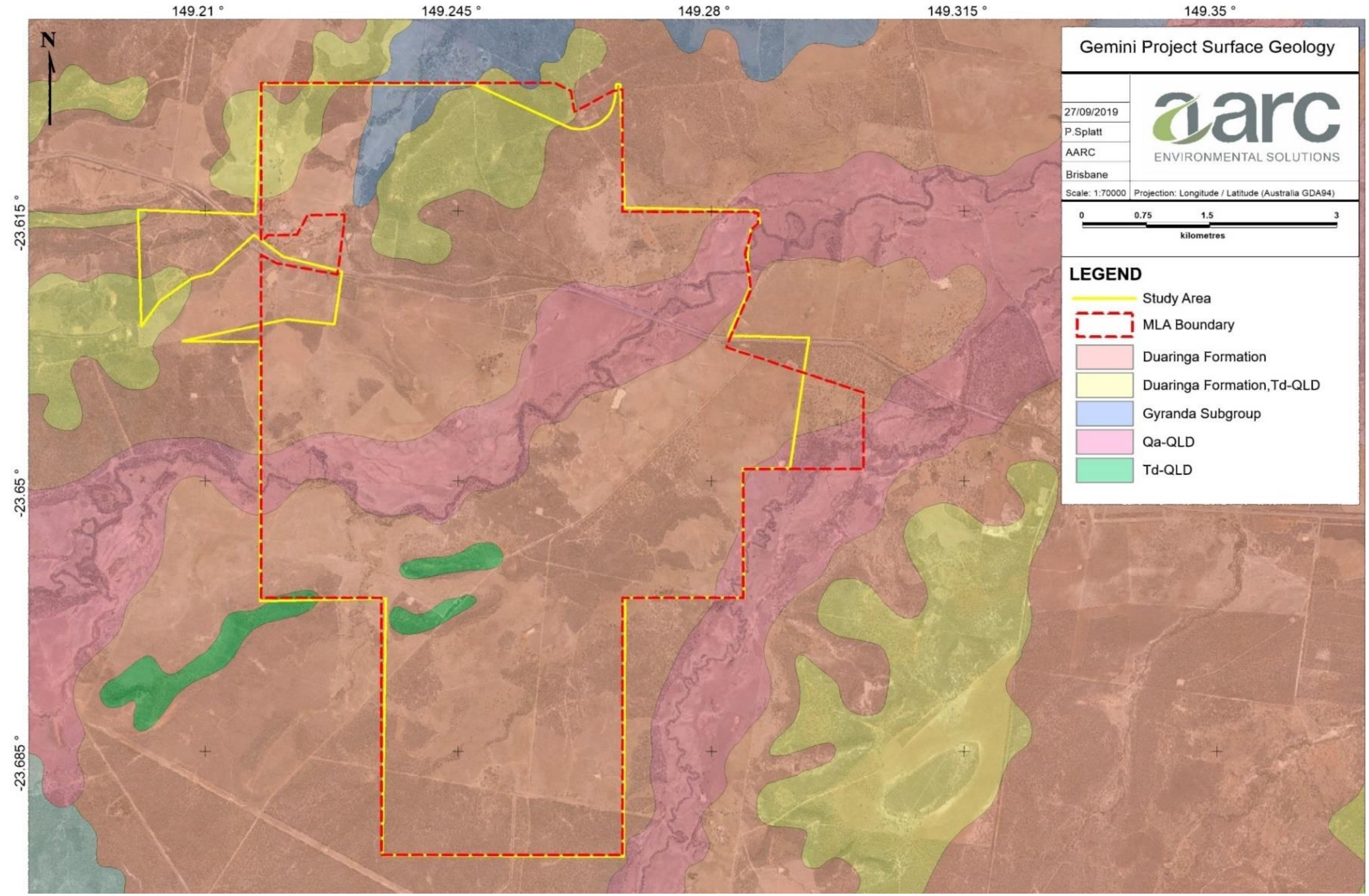


Figure 47 Surface Geology

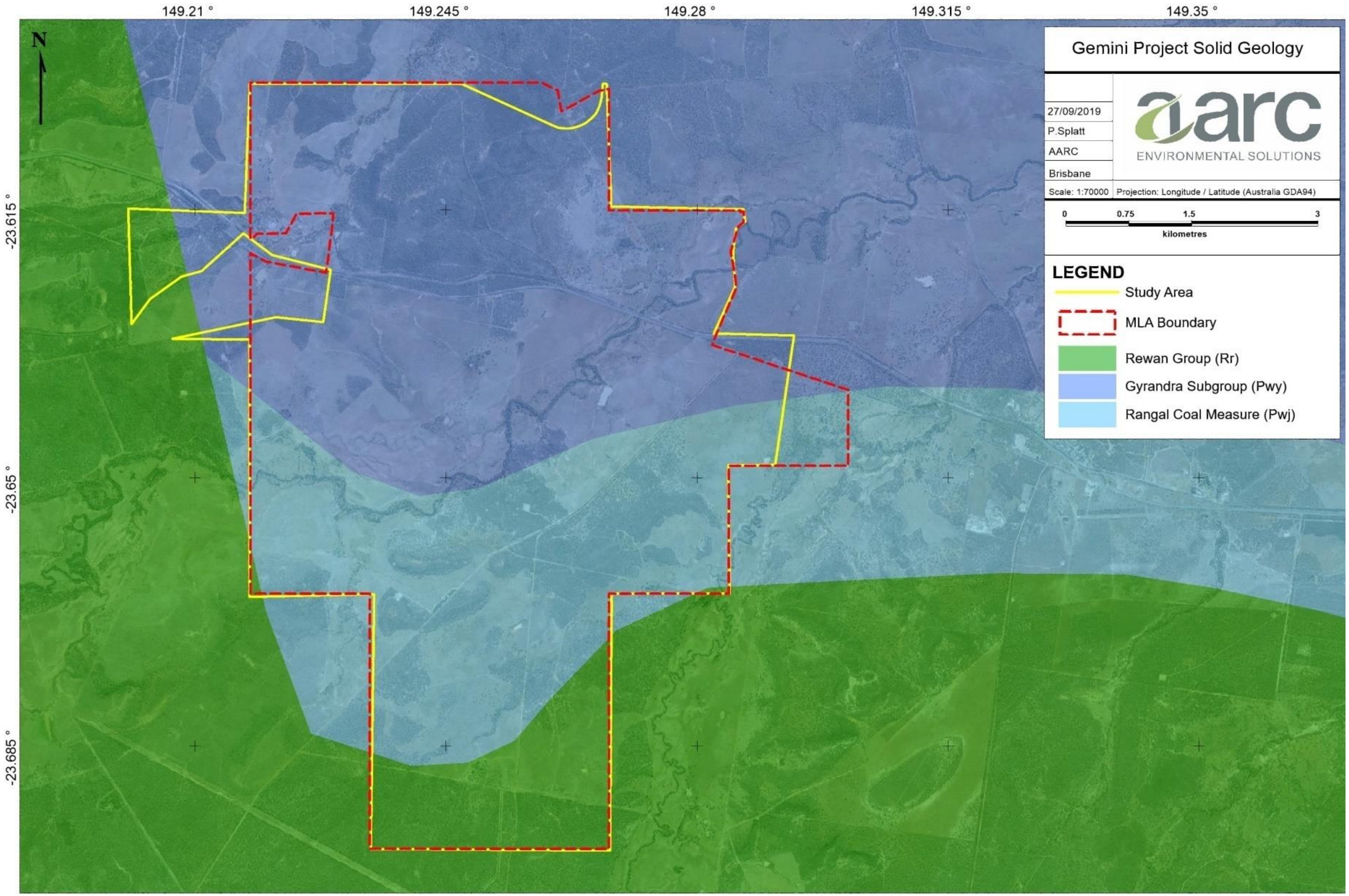


Figure 48 Solid Geology

5.2.4 Land Systems

Two land systems are mapped within the Project area and are described as follows.

Dingo Land System

The Dingo land system is characterised by fluvial plains surrounding significant waterways. It is mostly composed of stable flood plains traversed by a branching pattern of drainage floors. The majority of deposits are weathered alluvium, with slopes of coarser or finer textured alluvium (depending on flow patterns). Channels can be up to 30 m wide and 3 m deep, with fringing riparian vegetation. Main drainage floors can then extend 800 m outwards, with deep texture contrast sandy loams over mottled clays, and open spaces of *Eucalyptus tereticornis* (blue gum) and *Eucalyptus crebra* (narrow-leaved ironbark) with sparse shrubs. Large plains surround drainage features (up to 3 km wide) which can contain either deep texture contrast soils with *Eucalyptus populnea* (poplar box) woodlands, or deep layered soils on alluvium with woodlands of blue gum and narrow-leaved ironbark. Slopes within this land unit are usually the result of strongly Gilgai shrink-swell clays, forming depressions of finer soil textures with *Acacia harpophylla* (brigalow) scrub.

Geology in this unit is comprised of weathered Quaternary alluvium.

Melbadale Land System

The Melbadale land system is characterised by the shallow dissection of weathered tertiary land surfaces, forming undulating plains dominated by complex depositional mid and lower slopes, with minor lateritic upper slopes in some places. This land system features moderately dense branching drainage patterns, with local relief usually less than 15 m. Depending on the steepness of terrain, upper slopes are often dominated by deep loamy red earths (gentle slopes) with narrow-leaved ironbark, or shallow fine sandy loams (steep terrain) with *Acacia shirleyi* (lancewood) forests. Mid to lower slopes are often associated with deep texture contrast soils of loamy sands overlying mottled sandy clays, with grassy woodlands of open-spaced narrow-leaved ironbark and shrubs. Lower slopes are often associated with deep light to medium clays, with tall forests of narrow-leaved ironbark. Tributaries have variable soil textures depending on slope, though stratified loams and texture contrast soils are common.

Geology in this land system is comprised of Quaternary to late Tertiary colluvial/alluvium, laterised tertiary sandstone, conglomerate, and shale.

5.2.5 Soils

A *Soil and Land Suitability Assessment* was undertaken within the MLA by AARC (2019a) and attached as Appendix I.

Methodologies employed throughout this study are detailed in Appendix I and followed procedures in the *Australian Soil and Land Survey Field Handbook* (NCST 2009) and the *Guidelines for Surveying Soil and Land Resources* (McKenzie et al 2008). The soil survey was based on a free-survey technique with soil profile and observation sites located to best represent all soil types present in the Project. At the time of the survey, the Project MLA was subject to frequent changes, therefore, the study area was based of the EPC 881 boundary, land owner access, and a 5 km buffer around the boundary of the Walton State Forest.

Within the Project, a total of 12 SMUs were described. Table 30 provides an overview of each SMU and its extent within the MLA. The spatial distribution of the SMUs has been mapped at a scale of 1:70,000 and is depicted in Figure 49.

No acid sulphate soils have been identified within the Project area.

Table 30 SMUs Within The Study Area

SMU	Surface Area (ha)	Percent of Study Area (%)	General Description
Anderson	37.80	0.61	Hard setting soil unit associated with isolated hills. Soil textures grade from loams at the surface, to light medium clays with depth, sometimes exhibiting red mottling. Vegetation associated with this unit includes *Eucalyptus crebra*, *Corymbia clarksoniana*, and *Acacia rhodoxylon* with *Erythroxylon australe* in the shrub layer. The Anderson SMU has a very strongly acidic pH throughout the profile, ranging from 4.6 in the topsoil, to 4.8 in the lower subsoil. EC and chloride results indicate that at all depths, salinity is very low, with EC ranging from 0.064 deciSiemens per metre (dS/m) in the topsoil, to 0.02 dS/m in the subsoil layer. Chloride concentrations reflected this result, decreasing with depth from 30 mg/kg to 10 mg/kg, both well below toxic limits.
Barry	156.50	2.54	Hard setting soil associated with rivers, drainage lines and levees. Surface soils in this unit are comprised of clay loams to medium clays, grading into light or medium clays at variable depths. Dominant vegetation includes *Eucalyptus tessellaris*, *Eucalyptus populnea* and *Eucalyptus tereticornis*, with *Bauhinia hookeri, Carissa spinarum* and *Cassia brewsteri* in the shrub layer. The Barry SMU has a slightly acidic pH (6.5) which increases gradually with depth, becoming neutral at 0.2 m (6.8), and increasing to pH 7.2 with depth. EC is very low throughout the profile, ranging from 0.063 dS/m in the topsoil, to 0.012 dS/m in the lower subsoil. Chloride concentrations reflect this result, ranging from 20 mg/kg to <10 mg/kg with depth.
Charlevue	232.90	3.77	Hard setting soil associated with plains and rises. Textures within this unit grade from sandy clay loams or light clays in the surface soil, to medium heavy clays in the subsoil horizons. Dominant vegetation includes *Eucalyptus populnea* and *Eucalyptus crebra,* with *Flindersia dissosperma* (sometimes dominant) and *Carissa spinarum* in the shrub layer. The Charlevue SMU has a variable pH, ranging from 5.4 (strongly acid) in the topsoil to 7.9 (moderately alkaline) in the lower subsoil. EC is medium in the surface soil (0.28-0.43 dS/m) and increases to high in the subsoil (0.46 dS/m). Chloride is considered to be high from 0.2 m depth downwards (>600 mg/kg), which can cause toxicity by interfering with plants' osmotic capacity.
Cooinda	34.90	0.57	Hard setting soil associated with plains. Texture development within this unit is gradual, changing from a sandy clay loam in the topsoil, to a sandy light clay at mid-depth, and a medium heavy clay in the deeper subsoil. Dominant vegetation includes *Eucalyptus populnea* and *Flindersia dissosperma* (sometimes dominant), with *Carissa spinarum* in the shrub layer. The pH of the Cooinda SMU ranges from moderately acid (5.6) in the topsoil, to neutral (6.8) in the lower subsoil. EC is very low throughout the profile, with topsoil values of 0.015 dS/m, increasing to 0.043 dS/m in the subsoil. Chloride levels reflect EC, increasing from <10 mg/kg to 40 mg/kg with depth.

SMU	Surface Area (ha)	Percent of Study Area (%)	General Description
Ellesmere	14.60	0.24	Hard setting soil associated with isolated hills of weathered tertiary surfaces (laterite). Textures within this unit grade from fine sandy loams in the surface soil to medium clays in the subsoil horizons. Dominant vegetation is *Acacia shirleyi*, with *Erythroxylon australe* in the shrub layer. The Ellesmere SMU is a highly acidic soil unit, ranging from 4.6 (very strongly acid) in the topsoil to 5.5 (strongly acid) in the lower subsoil layer. EC is very low throughout the profile, changing from 0.02 dS/m in the topsoil, to 0.026 dS/m in the lower subsoil. Chloride concentrations are very low, consistently presenting at <10 mg/kg.
Geoffrey	4,079.00	66.10	This unit consists of texture contrast soils with soft surface conditions, associated with undulating plains and rises. Textures range from loamy sands to sandy light clays, overlying sandy medium clays with conspicuous orange or red mottling. Where these soils were exposed due to insufficient groundcover, extensive washouts and large erosion gullies were observed. In these areas, overland flow had removed coarse sandy material, leaving the easily eroded clays exposed to surface runoff. The Geoffrey SMU was often cleared, though when present dominant vegetation included *Eucalyptus crebra*, *Melaleuca leucadendra*, *Casuarina cunninghamiana* and *Corymbia clarksoniana*, with *Alphitonia excelsa*, *Petalostigma pubescens*, and *Acacia rhodoxylon* in the shrub layer. Due to the stark difference in textures between the topsoil and subsoil layers, pH for the Geoffrey SMU changes quite dramatically down the soil profile. Sandy, massive horizons (0.0-0.6 m) are moderately acidic, with pH gradually increasing with depth from 5.8 to 6.0. The clay B2 horizon has a pH value over two units higher (8.1) and is classified as 'moderately alkaline'. This is likely due to the increased CEC of the clay in the B2 horizon compared with the sand in the upper horizons.
James	145.20	2.35	Hard setting red soils associated with hills and rises. Textures within this unit vary depending on slope, with lesser developed soils found on crests (sandy clay loams to clay loams) and more developed/deeper soils found on mid slopes (clay loams to light medium clays). Dominant vegetation includes *Acacia rhodoxylon, Eucalyptus crebra,* and *Corymbia clarksoniana.* The pH in the James SMU is slightly acidic throughout the profile, with very little variation. It increases gradually with depth from 6.2 in the topsoil, to 6.4 in the lower subsoil. EC is very low at all depths, ranging from 0.013 dS/m in the topsoil to 0.015 dS/m in the subsoil. Chloride levels reflect this result, presenting at <10 mg/kg throughout the profile.

SMU	Surface Area (ha)	Percent of Study Area (%)	General Description
Kosh	927.60	15.03	Hard setting soil associated with alluvial plains, plains and low rises. Textures within this unit are gradational, changing from sandy clay loams and light clays in the topsoil, to medium heavy clays in the lower subsoil. Commonly, this unit was cleared for grazing, with regrowth consisting of scrub species including *Vachellia nilotica*, *Carissa spinarum, Capparis lasiantha, Cassia brewsteri*, and *Eucalyptus spp.* shrubs. When present, vegetation included *Eucalyptus tereticornis, Acacia hemiglauca, Acacia salicina, Bauhinia hookeri, Eucalyptus crebra* and *Eucalyptus populnea*. Due to the stark difference in textures between the topsoil and subsoil layers, pH for the Kosh SMU changes quite dramatically down the soil profile. Sandy, massive horizons (0.0 to 0.6 m) are moderately acid, with pH gradually increasing with depth from 5.8 to 6.0. The low CEC calculated for this unit resulted in extremely low concentrations of exchangeable cations. In the surface soil, calcium and magnesium were relatively equally represented, though concentrations of these cations were extremely limited.
Namoi	177.60	2.89	Hard setting soil associated with hills and rises. Textures within this unit are gradational, changing from a sandy clay loam in the topsoil to a light medium clay in the subsoil. Dominant vegetation includes *Eucalyptus crebra,* with *Heteropogon contortus* and juvenile *Acacia spp.* The pH in the Namoi SMU is slightly acidic throughout the profile, with very little variation. It increases gradually with depth from 6.2 in the topsoil, to 6.4 in the lower subsoil. EC is very low at all depths, ranging from 0.013 dS/m in the topsoil to 0.015 dS/m in the subsoil. Chloride levels reflect this result, presenting at <10 mg/kg throughout the profile. CEC remains fairly consistent with depth, ranging from 4.3 milliequivalent per 100 grams (meq/100g) (very low) in the topsoil to 5.8 meq/100g (very low) in the subsoil.
Nigel	286.40	4.64	Hard setting soil associated with isolated high relief areas of tertiary land surface. Textures within this unit are rudimentary, grading from sands to sandy light clays. Vegetation is variable between sites, but includes *Acacia shirleyi, Acacia rhodoxylon, Eucalyptus crebra, Melaleuca leucadendra, Corymbia clarksoniana,* and *Eucalyptus tessellaris.* The pH within the Nigel SMU is highly variable, changing from 6.3 (slightly acid) in the topsoil to 8.5 (strongly alkaline) in the lower subsoil. EC follows a similar pattern, changing from very low between 0.0-0.3 m depth, to medium in the subsoil. CEC increases with depth from low (6.8 meq/100g) to moderate (17.4 meq/100g), likely due to the increased clay content in the subsoil layers.

SMU	Surface Area (ha)	Percent of Study Area (%)	General Description
Normanby	48.50	0.79	Deep red earth with soft surface condition, associated with plains, and the flat areas of upper slopes. Textures within this unit are relatively consistent throughout the profile, ranging from loamy sands to sandy light medium clays. Vegetation is mostly cleared, but when present includes *Eucalyptus crebra* and *Alectryon oleifolius*. The Normanby soil unit has a neutral to slightly acidic pH throughout the soil profile, decreasing with depth from 6.7 to 6.1. EC is very low throughout the profile, ranging from 0.036 dS/m in the topsoil to 0.003 dS/m in the subsoil. Chloride levels reflect this result, presenting at less than 10 mg/kg at all depths. CEC measurements are considered very low, ranging from 2.4 meq/100g to 1.6 meq/100g with depth. The Normanby soil unit has limited nutrient holding capacity of this soil can be attributed to its low clay content and low organic matter levels.
Wallace	32.00	0.52	Shallow, self-mulching, cracking clay associated with upper slope flats. Textures within this unit grade from medium heavy clays to heavy clays, with the B3/C horizon met at approximately 0.24 m depth. The Wallace SMU is extensively cleared, with the boundary of the unit corresponding to an increase in standing vegetation. The dominant grass species is likely *Aristida latifolia*, with confirmation required during the wet season when an accurate identification can be made. The pH within the Wallace SMU is variable changing from 6.8 (neutral) in the topsoil to 7.4 (slightly alkaline) in the lower subsoil. EC changes from low in the topsoil to very low in the lower subsoils (0.09 - 0.038). CEC increases with depth from high (39 meq/100g) to very high (44 meq/100g), likely due to the increased clay content in the subsoil layers. High clay content, low sodicity, and desirable nutrient concentrations make this unit one of the best growth mediums in the survey area.

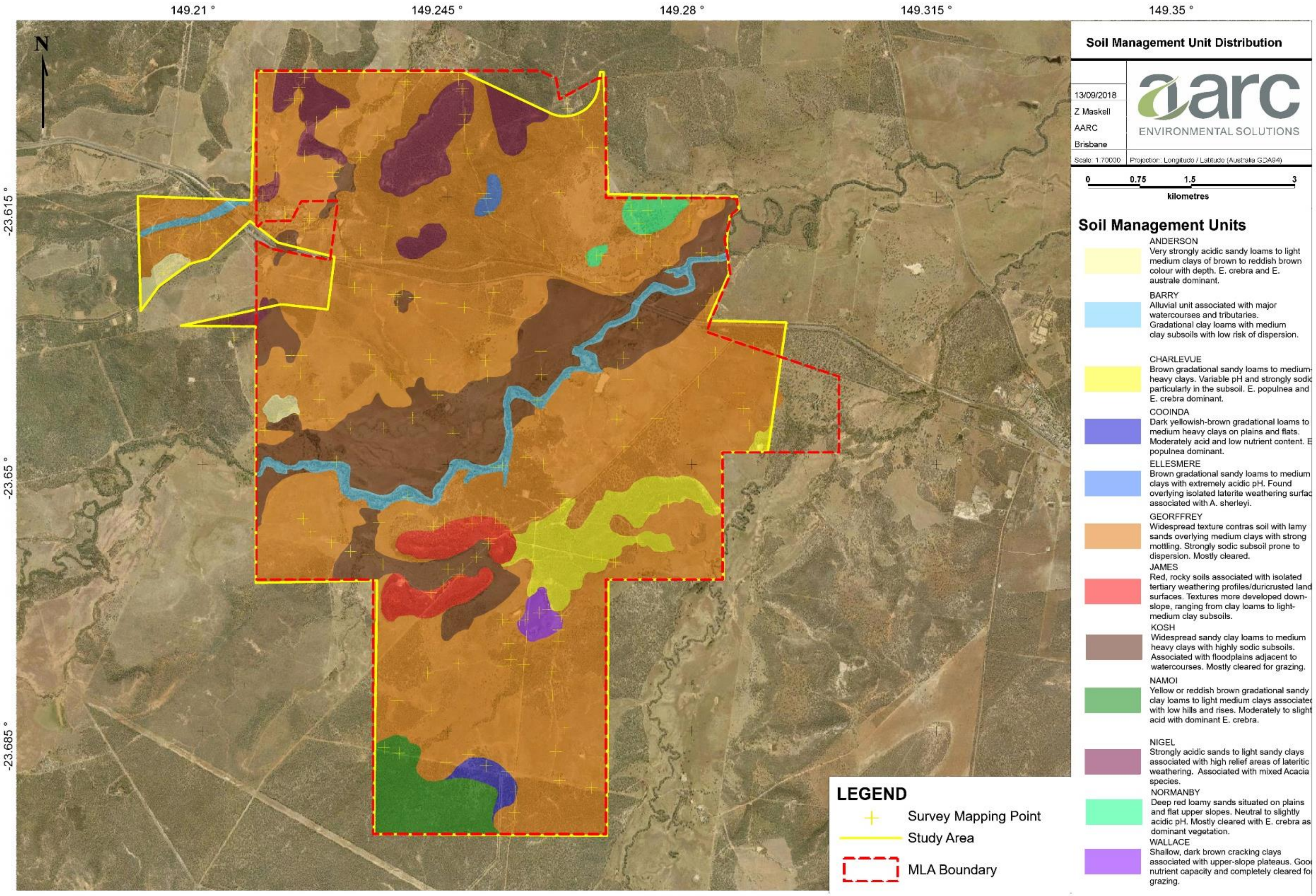


Figure 49 Distribution of SMUs

5.2.6 Land Suitability

The *Soil and Land Suitability Assessment* (AARC 2019) (Appendix I) considers environmental factors including climate, soils, geology, geomorphology, erosion, topography and the effects of pre-mine land use. The classification indicates the potential of the land to be used for a range of agricultural activities.

The assessment for land suitability (cattle grazing and dryland cropping) was carried out in accordance with the methodologies described in:

- *Guidelines for Agricultural Land Evaluation in Queensland* (DSITI & DNRM 2015); and
- Chapter 10 (Suitability framework for the inland Fitzroy and southern Burdekin area) of the *Regional Land Suitability Frameworks for Queensland* (DNRM & DSITI 2013).

An interpretation of the data collected on the physical, chemical and nutritional characteristics of the soil was made to rank the land according to the five-class land suitability system provided in the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* (DME 1995). The five land suitability classes used for assessing the land are defined in Table 31.

Table 31 Agricultural and Conservation Land Classes

Agricultural Land Class	Type	Description
Class 1	Agricultural	Suitable land with negligible limitations. This is highly productive land requiring only simple management practices to maintain economic production.
Class 2	Agricultural	Suitable land with minor limitations which either reduce production or require more than the simple management practices of class 1 land to maintain economic production.
Class 3	Agricultural	Suitable land with moderate limitations which either further lower production or require more than those management practices of class 2 land to maintain economic production.
Class 4	Agricultural	Marginal land, which is presently considered unsuitable due to severe limitations. The long-term significance of these limitations on the proposed land use is unknown or not quantified. The use of this land is dependent upon undertaking additional studies to determine whether the effect of the limitation(s) can be reduced to achieve sustained economic production.
Class 5	Agricultural	Unsuitable land with extreme limitations that preclude its use.

Notes: green shading suitable
orange shading unsuitable

The land use of the Project area is more suitable for cattle grazing than dryland cropping based on the average land suitability class across the identified SMUs of the Project.

A summary of the land suitability classes for both dryland cropping and cattle grazing for each SMU identified within the study area is provided in Table 32.

Table 32 Land Suitability Classes for SMUs

SMU	Land Suitability Class (Grazing)	Land Suitability Class (Cropping)
Anderson	4	4
Barry	2	3
Charlevue	4	5
Cooinda	3	5
Ellesmere	3	5
Geoffrey	3	5
James	4	4
Kosh	2	5
Namoi	3	4
Nigel	4	5
Normanby	4	4
Wallace	3	5

Notes: green shading suitable
orange shading unsuitable

Cattle Grazing Suitability

Within the study area, the suitability of land for cattle grazing is most limited by nutrient deficiency, ESP, and vegetation. Low nutrient levels and high sodicity in the soils may limit livestock production through a reduction in pasture growth and nutritive value of pasture species. Vegetation regrowth species can also impact the suitability of the land if they contain woody or poisonous species. In addition to this, high density regrowth and a woody shrub layer may reduce the carrying capacity of the land, making it unsuitable for grazing.

While no Class 1 land was identified within the study area, examination of the land suitability limitations for cattle grazing (Figure 50) indicate 1,080.5 ha of the study area is suitable for cattle grazing with minor limitations (Class 2), while 4,338 ha is suitable for cattle grazing with moderate limitations (Class 3). The remaining area (750.84 ha) was comprised of Class 4 land, with no Class 5 land identified.

Figure 50 shows the distribution of land suitability classes for cattle grazing across the Project.

Dryland Cropping

Land suitability for dryland cropping on the study area is most limited by soil water availability, soil wetness, erosion, and surface condition. Plants require suitable quantities of water to reach optimum production, and therefore maximum rooting depth, with the ability of the soil to take in water (wetness) playing a large part in crop survival. Topsoil and subsoil erosion also limit the ability of the soil to support crops. Soil preparation for sowing in the form of tillage may increase the risk of soil dispersion through slaking caused by the manipulation of soil aggregates by machinery. Surface condition also limits the soil classes, with hard setting soils found across most SMUs. Surface condition directly impacts seedling emergence and establishment by reducing seed-soil contact.

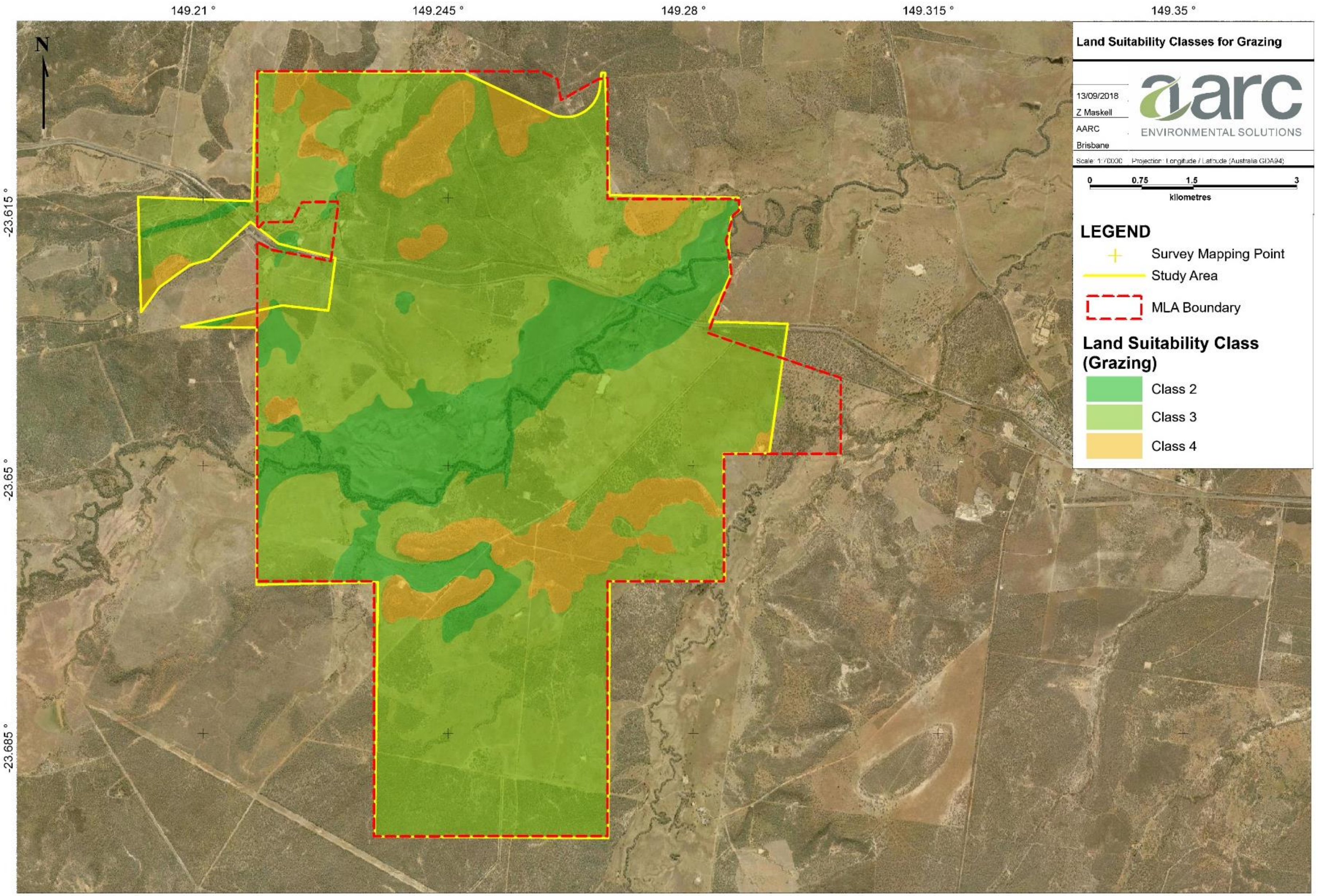


Figure 50 Land Suitability Classes - Cattle Grazing

In central Queensland, Class 1, 2 and 3 lands for dryland cropping are required to have the capacity to store sufficient levels of moisture to sustain a crop cycle from planting to harvesting with minimal rainfall. Class 4 lands are considered marginal for dryland cropping, requiring significant levels of rainfall for crop success. Class 5 lands are unsuitable for dryland cropping due to severe limitations.

Examination of the land suitability limitations for dryland cropping (Figure 51) indicates that 156.5 ha of the study area is suitable for cropping with moderate limitations (Class 3), and 409.1 ha of land is marginally suitable for cropping (Class 4). The remaining 5,607 ha of land is unsuitable (Class 5) due to land and soil limitations. Figure 51 shows the distribution of land suitability classes for broadacre cropping across the Project.

5.2.7 Land Use

The Project is located within the 'Central Queensland Regional Plan' area. Queensland land use mapping classifies the Project area as 'grazing modified pastures'. Other minor land use classifications over the site include 'residential', 'reservoir/dam', 'marsh/wetland', and primarily in association with the Capricorn Highway; 'transport and communication', 'utilities', 'services', and 'other minimal use'.

Dominant land uses within the local region are:

- grazing modified pastures;
- mining;
- other minimal use;
- managed resource protection; and
- production forestry.

The land within the Project boundary is currently used for low intensity cattle grazing and resource exploration activities. Cattle grazing being the major land use within the Project reflects the land suitability assessment which describes the site as mostly Class 2 and 3, suitable for grazing with minor to moderate limitations. The majority of the area has been cleared for cattle grazing; however, some patches of remnant vegetation remain, including riparian vegetation associated to Charlevue Creek.

The land in and around the Project is also used for purposes other than cattle grazing; including road transport, stock routes, protected areas, and coal mining. These land uses are discussed in Section 2.1.

5.2.8 Areas of Regional Interest

The Project activities are not in areas located within mapped areas of regional interest; however, a strategic cropping land trigger area exists northeast of the Project. The Project does not intersect any areas mapped as priority living areas, priority agricultural areas, strategic cropping land or strategic environmental areas.

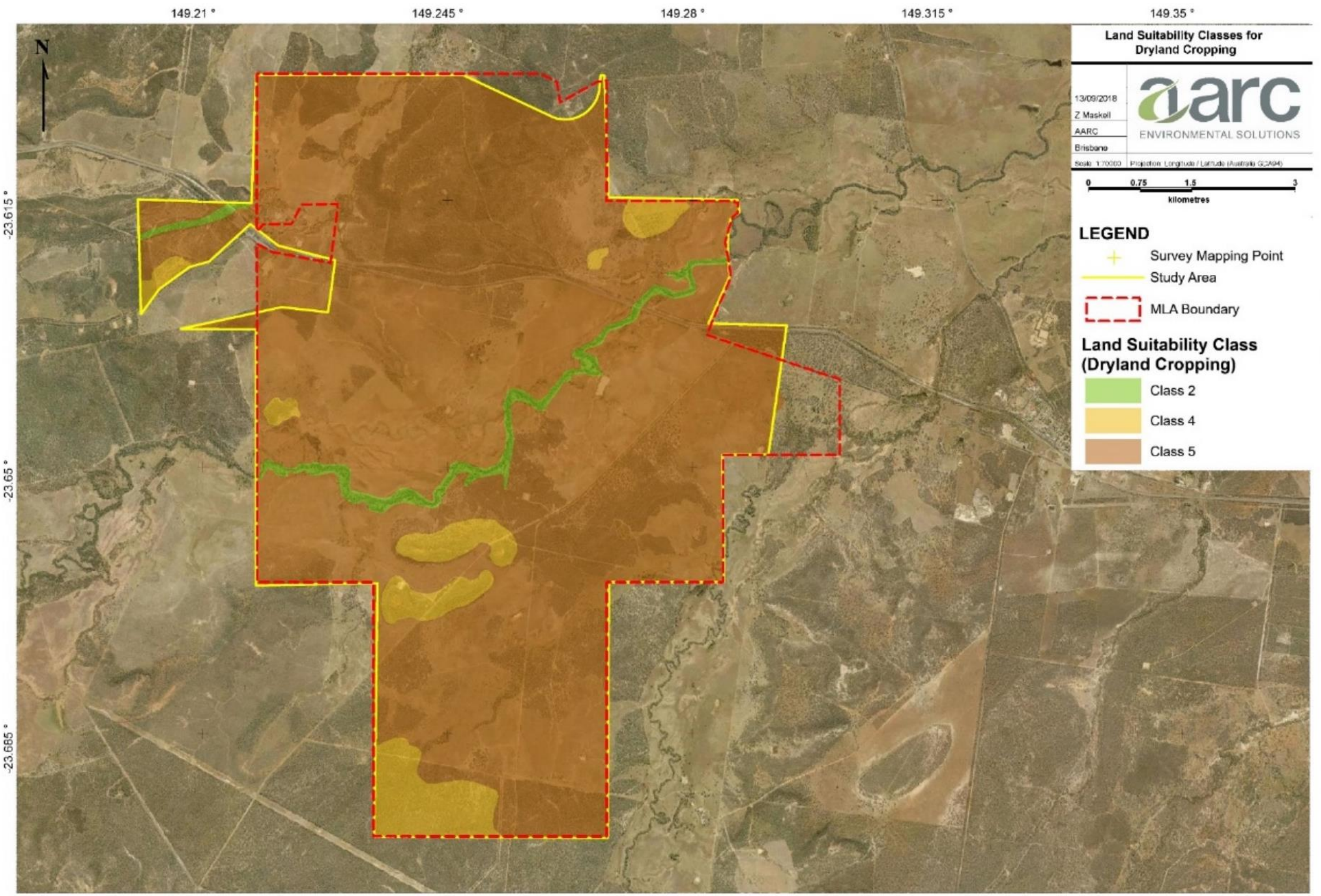


Figure 51 Land Suitability Classes - Dryland Cropping

5.3 POTENTIAL IMPACTS

5.3.1 Landform

Project activities involved in the construction of elevated landforms, open-cut pits and voids may impact land values by modifying the pre-mine topography. Some changes to the local topography will be temporary, such as the development of bunds and drains.

Waste rock emplacements associated with Pit AB and Pit C will be developed during operation. Where possible, spoil will be hauled and placed in-pit, behind the mining void. However, rehabilitated out-of-pit waste rock emplacement areas will remain as permanent features in the post-mining landform facilitating a slope of 1:10 vertical to horizontal ratio (V:H) and a maximum height of 190 m. Rehabilitated final void lakes are also proposed in the final landform, below the pre-mining topography.

Impacts from mining activities on the landform values of the Project may result in alteration to hydrological regimes within drainage features and an increase in Project landform exposure to erosion and instability.

Disturbance of vegetation and the topsoil layer can lead to the mobilisation of soil through the process of erosion, particularly water erosion through heavy rainfall or overland flow. The risk of erosion at the Project will be increased by the following activities:

- clearing of vegetation;
- topsoil stripping and stockpiling;
- construction of infrastructure; and
- exposure of slopes.

Erosion of rehabilitated landforms reduces the likelihood of revegetation success, and in extreme cases can compromise the structural integrity of the landform, making it unstable and unsafe. In addition, if not managed correctly, erosion can result in the release of suspended sediments and potential contaminants into the receiving environment. Soils and spoil within the Project have some dispersive characteristics within their subsoils, and will be potentially subject to erosion, particularly on artificial slopes.

5.3.2 Visual Amenity

Based on the findings of the *Visual Amenity Assessment* (AARC 2020c), the visual impacts arising from the Project are predominantly considered low. In terms of the significance of visual impacts for surrounding sensitive receptors, the following key points were identified:

- Magnetic South have purchased properties all vantage points which include a residence. The dwelling vacancy and lack of visual exposure at these vantage points means the visual sensitivity is significantly reduced and the subsequent visual impacts are minimised in the immediate surrounds of the Project.
- Low impacts for visual amenity were predominantly identified across all assessed vantage points, except for vantage point VA1 observing a moderate impact and visual exposure to the final landform of the waste rock emplacement to Pit AB. The property of vantage point VA1 is owned by the proponent and will be vacated prior to the commencement of mining activities.

- The overhead conveyor is not expected to be visible from any nearby local residences, or sensitive receptors (2.9 km east on the Ellesmere property owned by the proponent and 2.9 km west at the Redrock Park property). Local topography, and the retention of existing vegetation outside of the disturbance footprint, would provide natural screening to obscure any visual modification that the conveyor might impose in either direction.

- Residual short-term and intermittent moderate visual impacts will be unavoidable for road users exposed to the overhead conveyor across the Capricorn Highway when using the main transport route; however, all mining infrastructure areas, including the overhead conveyor will be subject to decommissioning and rehabilitation. Therefore, the identified moderate impacts of the conveyor will be limited to the operational phases of the Project.

In summary, the exposure of mining infrastructure is limited to the spoil crest of Pit AB and the overhead conveyor across the Capricorn Highway connecting the TLO facility. Visual elements of the Project are not anticipated to have a significant impact for those residing in nearby properties and therefore impacts are predominantly limited to intermittent exposure when using nearby roads. In-depth descriptions of each visual simulation at the five vantage points are provided in Appendix O.

5.3.3 Soils

Mining activities, including the stripping, stockpiling, handling, and compaction of soil, have the potential to impact its physical, chemical and biological properties. Potential impacts from mining activities on the existing soils within the Project area may include:

- potential soil and land contamination through:
    - spills from mine-affected water storages or pipelines;
    - spillage of chemicals or fuel; and
    - effluent irrigation from the STP;
- loss of soil physical structure due to excavation and handling;
- loss of the soil seedbank; and
- impacts on soil fertility due to mixing with subsoils or resulting from changes in chemistry when subsoils are exposed to oxygen.

5.3.3.1 Sodic Soils

As shown in Table 30, the Project Area is dominated by the Geoffrey and Kosh SMU. These SMUs are, therefore, reflective of the predominant soil characteristics of the Project area. The subsoils of the Geoffrey and Kosh SMUs are considered strongly sodic (ESP > 14%). This indicates that subsoil may become dispersive if exposed to surface water run-off for prolonged periods of time post topsoil striping.

This dispersion can initiate the processes of sheet of gully erosion which can contribute to a loss of ground cover, surface crusting and subsequent reduction in seedling emergence as well as sedimentation of downstream water bodies. Additionally, dispersion can cause the collapse of soil structure. Collapse of soil structure reduces the porosity of soil, which subsequently increases the risk of waterlogging and reduces soil aeration and thus microbial activity.

While these SMUs have sodic subsoils, topsoil layers are not considered sodic. Stripping depths have accounted for this and have been determined to exclude any sodic subsoil material from the topsoil resource. This topsoil resource used for rehabilitation is therefore not considered sodic and dispersive. Specialised segregation and demarcation of topsoil is therefore not considered necessary for any topsoil stockpiling within the Project area. Rehabilitated landforms are thus at low risk of the beforementioned impacts associated with sodic soils. Mitigation measures that target sodic and dispersive soils is not considered necessary. Although, it is recommended that stockpiles should be monitored monthly for evidence of erosion/structural instability.

5.3.4 Land Suitability and Land Use

Project activities will disturb and alter the current land use of low intensity cattle grazing in the short term. Cattle grazing within the Project area is categorised predominantly as land suitability class 3; suitable for cattle grazing with moderate limitations. A total area of 4, 338 ha of class 3 land exists within the Project's disturbance footprint occupying 70.20% of this extent. The remaining disturbance footprint of the Project is categorised as class 2 (17.49%) and class 4 (12.31%).

The Project aims to achieve a PMLU for all areas of rehabilitation, with no proposed NUMAs. Primarily, the land will be returned to cattle grazing land use across flat and gentle slopes. Secondly, the proposed post-mining beneficial land use will allow for the establishment and support of native ecosystems on areas of steeper slopes (i.e., treated high walls). Establishment of native ecosystems is defined as the establishment of vegetation that allows colonisation by surrounding non-weed species such that vegetation will progress towards native bushland with no designated agricultural or grazing use.

The rehabilitated final voids will remain in the post mining landform in a safe, geotechnically stable and non-polluting condition. As described in Section 4.4.7.1, the void will contain a fresh to brackish pit lake that is expected to provide suitable habitat for fauna species, particularly migratory and marine bird species. The final voids will provide a reduced land suitability of class 5.

5.4 MITIGATION MEASURES, MANAGEMENT AND MONITORING

The Project will be managed to minimise the extent and severity of land disturbance.

5.4.1 Landform

Management practices to minimise impacts to landform values are provided below:

- land clearing will be limited to the minimum area required for safe operation of the Project. An internal *Land Disturbance Permit System* is proposed to prevent unnecessary or unauthorised impacts to land values during construction and operation;

- erosion and sediment control structures will be developed and implemented during operation in accordance with *Best Practice Erosion and Sediment Control* (IECA Australasia 2008);

- waste rock emplacements will be constructed to a slope of 1V:10H (adhering to a maximum slope of 6°) and a maximum height of 190 mAHD;

- construction of contour banks on slopes is proposed at a spacing of 80 m for slopes of 1V:10H to manage runoff and prevent erosion and associated landform instability;

- highwalls within Pit AB and Pit C will be pushed back after mining to form a slope angle of approximately 22° to ensure stability of the final landform. Treated upper slopes will be rehabilitated to achieve a PMLU suitable for native ecosystems; and

- erosion monitoring and maintenance is proposed throughout the mine life and during mine closure, until it can be demonstrated that final landforms are stable.

5.4.2 Visual Amenity

A series of management actions and measures can be employed to reduce unfavourable conditions at the selected vantage points, or sensitive receptors to minimise potential impacts on visual amenity. These measures, include:

- the use of neutral tones for infrastructure cladding to reduce any stark colour contrast between the visual modification and surrounding visual landscape and environment;
- placement of infrastructure where practical at greater distances from sensitive places (residences and transport corridors);
- placement, configuration and direction of lighting to reduce light emissions during the operational phase of the Project, in accordance with AS 4282:1997 '*Control of the obtrusive effects of outdoor lighting*' (Standards Australia 1997);
- establishment of important visual buffer zones (i.e., vegetation screening) between points of high visual impact and vulnerable sensitive receptors;
- as soon as land becomes available, out-of-pit overburden dumps be rehabilitated to reduce contrast between altered landforms and the unaffected surrounding landscape;
- overburden dumps designed to have a final landform that does not contrast significantly with the existing topography; and
- decommissioning of infrastructure in accordance with a *Closure Plan* to ensure the post-mine visual amenity resembles the previous landscape character as much as possible.

These mitigation and management strategies would support the retention of visual amenity during both construction, operation, and decommissioning of the proposed Project.

5.4.3 Land Contamination

5.4.3.1 Emergency Response and Spill Management Plan

An *Emergency Response and Spill Management Plan* will be developed to inform staff and contractors of the procedure for responding to a spill or potentially hazardous release. The objective of the *Emergency Response and Spill Management Plan* is minimising the risk of harm to persons and the environment.

The *Emergency Response and Spill Management Plan* will include the following components:

- identification of potential hazards and spill types;
- a register of hazardous chemicals and dangerous goods including the storage location and quantity;
- requirements for a risk assessment to be undertaken prior to the commencement of mining and ancillary activities;
- resource requirements for responding to spills;

- storage and handling requirements for all chemicals and hydrocarbons stored onsite including appropriate bunding, standard operating procedures and access to spill kits;
- a detailed response procedure including and emergency response plan for spills requiring evacuation; and
- reporting, investigation and review requirements following a spill or potentially hazardous release in accordance with the *Coal Mining Safety and Health Act 1999* (CMSH Act) and Coal Mining Safety and Health Regulation 2017 (CMSH Regulation) which will also be included in induction and training manuals.

Management measures to reduce the risk of spills and the consequent impact on the environmental values of land and water resources will be targeted at avoiding spills, minimising the risk of spills and the impacts on persons and the environment and the management of spill events. These will be used as key principles in the development of the *Emergency Response and Spill Management Plan.*

Avoid

Hazardous chemicals and dangerous goods will be stored in accordance with relevant Australian Standards, in bunded containment and inspections of the areas are regularly undertaken. Hazardous chemicals and dangerous goods will be handled strictly in accordance with the Material Safety Data Sheets

In the response to handling spills, safety is paramount. Spill containment or clean up should only be undertaken by trained personnel and when considered safe to do so.

Minimise

The risk of spills on human health and the environment will be minimised through the following mitigation measures:

- a detailed spills response procedure which will outline the following:
  - identification of the spill type, size and location i.e., sediment dam, topsoil stockpile, coal stockpiles etc;
  - control processes to isolate the sources and elimination of possible sources of ignition;
  - containment measures for the spill area to prevent the spill spreading into the surrounding environment and the exclusion of personnel or machinery from the spill area;
  - clean up procedures to be implemented including methodologies and application for the use of each spill kit item and disposal requirements for waste;
  - notification requirements for surrounding sensitive receivers;
- resource requirements for responding to spills in a timely manner including:
  - trained personnel in spill response procedures and training materials to ensure all staff onsite are aware of the hazards and risks associated with the hazardous chemicals and dangerous goods stored onsite;

- spill kits with stocked with appropriate response requirements for hazardous chemicals and dangerous goods stored on site;
    - spill kits appropriately located onsite for quick response handing;
    - signage in work areas indicating the location of the nearest spill kit;
- the development of Standard Operating Procedures for the spill management for all hazardous chemicals and dangerous goods in accordance with the CMSH Regulation and Australian Dangerous Goods Code*;*
- management of site water system to operate below maximum operating level and the implementation of a spillway to direct mine water dam overflows to the mine pit; and
- requirements for risk assessments for activities involving the storage or handling of hazardous chemicals or dangerous goods to identify and reduce the risks associated with each activity/hazardous chemical or dangerous good.

Manage

The hazards associated with spills onsite will be managed through the following:

- A standardised framework for reporting requirements following a spill or potentially hazardous release including the requirement for the investigation and notification of any contamination to land resulting from a spill or release event to the DES in accordance with the Project's EA.
- An annual review of the *Emergency Response and Spill Management Plan* will be undertaken and may be revised due to the following;
    - updates to relevant legislation or policy or industry best practices;
    - procedures based on post-incident evaluation; and
    - new hazardous materials brought onto site.

5.4.3.2 Fuel and Hazardous Storage Management Plan

A *Fuel and Hazardous Liquids Storage Management Plan* will be developed. The *Fuel and Hazardous Liquids Storage Management Plan* will minimise the risk of harm to the environment and human health and address the regulatory requirements for the storage and handling of hazardous chemicals and dangerous goods as detailed in the:

- CMSH Act and CMSH Regulation;
- Australian Dangerous Goods Code;
- RS 17 Recognises Standards for Hazardous Chemicals (2019); and
- Relevant Australian Standards.

The *Fuel and Hazardous Liquids Storage Management Plan* will consist of the following components:

- a register of hazardous chemicals and dangerous goods;
- a system for the recording of material safety data sheet;
- labelling requirements for all hazardous chemicals and dangerous goods;
- standard operating procedures for the storage, handling, use and disposal of each hazardous chemical and dangerous good;
- placard requirements for the storage of hazardous chemical and dangerous goods;
- a framework for performing risk assessments for the storage, handling, use and disposal of each hazardous chemical and dangerous goods;
- a monitoring program to assess the performance of storage and handling practices and to ensure the integrity of materials prior to use;
- training requirements for relevant personnel; and
- reporting, investigation, and review procedures following incidents regarding hazardous chemicals and dangerous goods.

The management of *Fuel and Hazardous Liquids Storage Management Plan* focuses on mitigation measures that improve employee awareness of the hazards associated with hazardous materials and that minimise the risk of adverse impacts to human health and the environment. A brief summary some of the *Fuel and Hazardous Liquids Storage Management Plan* components are provided below.

Storage

Fuels will be stored within the MIA, with additional self-bunded tanks located as required in the mining area, depending the current location of the main fleet and advancing mine face.

Fuels (including diesel) will be delivered to the Project by contractors. The transport, storage and handling of fuels (including diesel) will be undertaken in accordance with relevant legislation and guidelines.

Storage and handling practices will ensure that the chemical and goods are:

- protected against damage and deterioration;
- secure to prevent loss, misuse and theft; and
- liquids are bunded to contain spillage.

Register

An up-to-date register of hazardous chemicals and dangerous goods will be maintained in accordance with the CMSH Regulation and will record:

- any hazardous chemical or dangerous good used, handled, stored or produced at the mine;
- current safety data sheet for all hazardous chemicals and dangerous goods;
- the storage location; and

- storage incompatibilities.

The register must be readily accessible by each worker required to use, handle, store or produce a hazardous chemical or dangerous good at the mine.

Labelling

The labelling requirements for all incoming hazardous materials are to be inspected upon receiving the hazardous material onsite and is the responsibility of the site senior executive. Labelling must meet the requirements set out in Part 7, Division 2 of the CMSH Regulation including:

- a warning of the presence of chemical or good;
- identification of chemical or good;
- to the extent necessary for managing risk, provides basic information about using, handling, storing, producing, or transporting the chemical or goods;
- if it is not practicable to mark or label a hazardous chemical or dangerous good, the site senior executive must ensure a notice that gives the warning, identification and basic information of the hazardous material is place in a conspicuous place as near as practicable to the chemical or good; and
- labelling must meet the requirements stated in the Globally Harmonised System, a recognised standard, the Australian Dangerous Goods Code or AS 1345.

Standard Operating Procedures

In accordance with the CMHS Regulation*,* Standard Operating Procedures are required for using, handling or storing of a hazardous chemical or dangerous good. In developing a standard operating procedure, the site senior executive must ensure regard is had to the material safety data sheet for the chemical or good.

Risk Assessments

Risks to be managed with regard to the conditions outlined in Part 7, Division 2, section 56F of the CMHS Regulation and consideration given to the hazardous properties of the chemical or goods

Monitoring Program

Regular monitoring to confirm the location and quantity of chemical or goods onsite, deterioration of the chemical or goods or any packaging, ensure the chemical are fit for intended use, detect leaks spills and unintended emissions, detect misuse, theft, disposed is monitoring shows deterioration or unfit.

Training

All equipment and vehicle operators will be trained in the safe operation of the equipment (including operating procedures for the refilling and maintenance of fuel storage tanks and mine vehicles) and the relevant emergency response and spill management procedures in the event of an incident.

5.4.4 Soils

Impacts to soil will be mitigated to reduce the risk of soil degradation and improve the chances of rehabilitation success. Mitigation strategies for soil include:

- Topsoil across the disturbance area will be stripped to a depth that excludes any constraining layer/properties (i.e., above a sodic/highly saline soil horizon) to ensure the topsoil resource is of good quality.

- Progressive rehabilitation of landforms and direct placement of topsoil will be carried out to help preserve the seed bank and reduce erosion.

- If topsoil resources are to be stockpiled for a period in excess of six months, testing of soil properties (including physiochemical analysis) will occur prior to use in rehabilitation. This monitoring information is only required prior to topsoil application to assess changes in topsoil quality (changes to soil chemistry and biological activity as a result of being stockpiled). Key parameters would include pH, ESP%, CEC (major cations), organic matter content and other essential nutrients such as nitrate, phosphorous and sulphate.

- If topsoil degradation has occurred, the subsequent action will be to apply fertilizers, soil ameliorants, and the application of a seed mix (refer to Section 4.4.3) to increase the likelihood of rehabilitation success. The most significant risk to topsoil is deterioration as a result of stockpiling for extended periods of time, however, topsoil is not anticipated to deteriorate to the point of becoming unsuitable for use in rehabilitation works (AARC 2019).

5.4.5 Erosion Protection Measures

Erosion protection measures developed to reduce the risk and impacts of erosion include:

- topsoiled areas will be deep ripped to reduce compaction from heavy machinery, encourage infiltration of water and prevent erosion. Areas will be ripped along the contour to reduce the velocity of runoff water down the slope. Ripping depths will vary depending on the type of spoil material, depth of topsoil and equipment used for rehabilitation operations;

- ensuring that when required, stockpiles are generally less than 2 m high and contoured to encourage water to drain;

- where required, seeding of topsoil as soon as possible after placement onto rehabilitated areas, to ensure root masses assist in preventing erosion;

- topsoil stockpiles will be placed away from drainage areas, roads, machinery, transport corridors, and stock grazing areas;

- topsoil stockpiles will be seeded or covered with a water-shedding lining to prevent unnecessary erosion of soil; and

- seeding of topsoil as soon as possible after placement onto rehabilitated areas, to ensure root masses assist in preventing erosion.

5.4.6 Topsoil Handling Procedures

A *Topsoil Management Plan* will be developed for the Project. The overarching principle of the *Topsoil Management Plan* will be to reduce the risk of topsoil degradation and improve the chances of rehabilitation success. The objectives of the Project's *Topsoil Management Plan* are to:

- maintain a soil balance that will achieve the rehabilitation requirements throughout the life of the mine;

- maintain topsoil viability through the utilisation of best practices in soil stripping, stockpiling and application activities; and
- provide a standard practice for the Project's storage and handling of topsoil resources.

Section 4.4.2 provides further details on topsoil handling for the Project.

5.4.7 Land Suitability and Land Use

Potential impacts on soil can be mitigated through:

- determining PMLUs that align with pre-mining land use and the surrounding properties;
- a final landform design that aims to maximise PMLU areas;
- progressive rehabilitation to return the land to a productive land use as soon as practicable; and
- ongoing monitoring, maintenance and rehabilitation trials to ensure a safe, stable and non-polluting landform.

The majority of areas in the final landform will be restored to a PMLU of cattle grazing. The exceptions being water management features such as ponds and drains, which will be returned to a PMLU of native ecosystems or equivalent. This includes the final pit lake and high walls, that will be restored to achieve a fauna habitat land use. These areas are expected to be unsuitable for grazing and will achieve a reduced land suitability score of 5.

5.4.8 Cultural Heritage Management Plan

A *Cultural Heritage Management Plan* has been developed in accordance with the *Aboriginal Cultural Heritage Act 2003* and the supporting *Duty of Care Guidelines* (DATSIP 2004). The Cultural Heritage Management Plan has been developed in consultation with Traditional Owner groups and any other relevant representatives. The *Cultural Heritage Management Plan* has been developed upon formal assessment of cultural heritage by a suitable qualified person and the outcomes of the assessment will be utilised to inform the Cultural Heritage Management Plan.

The objective of the *Cultural Heritage Management Plan* is to minimise the potential impacts of the Project's activities on the cultural heritage of the site through a knowledge of the site's cultural heritage and an effective monitoring and reporting framework for the management of cultural heritage and responsibilities within the Project in compliance with all Aboriginal cultural heritage management requirements under legislation, guidelines, and existing consents.

The *Cultural Heritage Management Plan* includes the following components to at minimum:

- establish the roles and responsibilities of personal relating to the coordination, implementation, management, and future conduct of matters arising in relation the *Cultural Heritage Management Plan*;
- provide a summary of the potential impacts to the cultural heritage of the Project site;
- provide procedures for the management of known and unexpected finds, where;
    - options to avoid, minimise or mitigate these impacts in a culturally appropriate fashion are developed;

- outline details for an aboriginal find procedure (described further below);
- detail the process to follow for the findings of human skeletal remains (described further below);

- provide procedures for consultation with relevant parties;
- include cultural heritage assessment requirements in the *Land Disturbance Permit* for Project activities involving any ground disturbance, where;
  - information regarding cultural heritage will be identified, collated and documented;
- provide a standard procedure for the reporting of the discovery of any Aboriginal cultural heritage in the Project area, where reporting is undertaken as soon as reasonably practical to the designated personnel and also as required by law; and
- distribute Indigenous cultural heritage awareness information and legal obligations in employee/contractor induction programs.

5.4.8.1 Aboriginal Object Find

At any time throughout the life of the Project, if suspected Aboriginal material has been uncovered due to the Project's activities, work in the surrounding area is to stop immediately and the following procedure followed:

- a temporary fence or barrier with a buffer zone of at least 10 m around the known edge of the site is to be erected around the site and no unauthorised entry or earth disturbance is to be carried out until the area has been assessed;
- an appropriately qualified archaeological consultant is to be engaged to identify the material and prepare an assessment report including recommended mitigation measures; and
- if the object is confirmed to be of cultural heritage significance, the relevant traditional owner groups and government personnel will be notified.

The process for handling of objects of cultural heritage significance is defined and provided in the *Cultural Heritage Management Plan* following consultation with the relevant Traditional Owner groups and government bodies.

5.4.8.2 Human Skeletal Remains Find

If suspected human skeletal remains (that are or may be those of an Aboriginal person) are uncovered due to the Project's activities it is important that all personnel adhere to provisions of the *Aboriginal Cultural Heritage Act 2003*, *Coroner's Act 2003* and the *Criminal Code Act 1899* section 236(2). The following actions should be followed:

- work in the vicinity of the find is to stop immediately, until works are authorised to resume;
- the site should be cordoned off with a buffer zone of at least 10 m around the known edge of the site and the remains left untouched. No unauthorised entry or earth disturbance is to be carried out until the area has been assessed;
- the discovery should be reported to the nearest Police Station as soon as possible; and

- a process for the reporting and handling of remains that are confirmed to be of Aboriginal origin, where the remains have not been removed by the coroner, have been developed during consultation in the development of the *Cultural Heritage and Management Plan* with the relevant Traditional Owner groups and the Department of Aboriginal and Torres Strait Islander Partnerships.

6.0 FLORA AND FAUNA

This section provides a description of the existing flora and fauna values within the Project. It aims to identify the Project's potential impacts on the existing values and propose mitigation measures and management strategies to prevent or minimise adverse environmental effects.

This section also discusses potential impacts to wetland values and groundwater dependent ecosystems (GDEs), however all other water values are discussed in Section 7.0 and Section 8.0.

This section is informed by:

- *Terrestrial Ecology Assessment* (AARC 2020b) (Appendix J);
- *Aquatic Ecology Assessment* (AARC 2020a) (Appendix K);
- *Groundwater Dependent Ecosystem Assessment* (3D Environmental 2020) (Appendix F);
- *Surface Water Assessment* (WRM 2020b) (Appendix B); and
- *Groundwater Impact Assessment* (JBT 2019) (Appendix C).

6.1 ENVIRONMENTAL OBJECTIVES AND PERFORMANCE OUTCOMES

The environmental objective relevant to potential impacts to flora and fauna as described in the EA guideline for *Application requirements for activities with impacts to land [ESR/2015/1839]* (DES 2017b) is:

The activity is operated in a way that protects the environmental values of land including soils, subsoils, landforms and associated flora and fauna.

The Project would achieve all of the following performance outcomes identified in Schedule 8, Part 3, Division 1 of the EP Regulation:

(a) activities that disturb land, soils, subsoils, landforms and associated flora and fauna will be managed in a way that prevents or minimises adverse effects on the environmental values of land;

(b) areas disturbed will be rehabilitated or restored to achieve sites that are:

(i) safe to humans and wildlife;

(ii) non-polluting;

(iii) stable; and

(iv) able to sustain an appropriate land use after rehabilitation or restoration;

(c) the activity will be managed to prevent or minimise adverse effects on the environmental values of land due to unplanned releases or discharges, including spills and leaks of contaminants; and

The environmental objective relevant to potential impacts to wetlands as described in the EA guideline for *Application requirements for activities with impacts to water* (DES 2017c) is:

The activity will be operated in a way that protects the environmental values of wetlands.

The Project would achieve the following performance outcomes identified in Schedule 8, Part 3, Division 1 of the EP Regulation:

a) *there will be no potential or actual adverse effect on a wetland as part of carrying out the activity; and*

b) *the activity will be managed in a way that prevents or minimises adverse effects on wetlands.*

The environmental objective relevant to potential impacts to surface ecological systems (i.e., GDEs) as described in the EA guideline for *Application requirements for activities with impacts to water* (DES 2017c) is:

The activity will be operated in a way that protects the environmental values of groundwater and any associated surface ecological systems.

The Project would achieve the following performance outcomes identified in Schedule 8, Part 3, Division 1 of the EP Regulation:

(a) there will be no direct or indirect release of contaminants to groundwater from the operation of the activity; and

(b) *there will be no actual or potential adverse effect on groundwater from the operation of the activity.*

Or, the activity will be managed to prevent or minimise adverse effects on groundwater or any associated surface ecological systems.

6.2 DESCRIPTION OF ENVIRONMENTAL VALUES

6.2.1 Regional and Local Setting

The Project is located within the Brigalow Belt bioregion. This bioregion occupies over a fifth of Queensland; from Townsville in the north to near the border of New South Wales in the south. The Brigalow Belt bioregion is characterised by brigalow (*Acacia harpophylla*) woodland but presents other vegetation such as semi evergreen vine thickets, dry eucalypt woodlands and native bluegrass (*Dichanthium sp.*) grasslands. Due to the size of Brigalow Belt bioregion, it covers a broad climatic gradient as well as a diversity of soils and topography, the Brigalow Belt hosts a high diversity flora and fauna (DES 2018a).

As a result of agricultural and development activities, most of the relatively undisturbed areas are confined to the rugged parts of the landscape with less development value (DES 2018a), parks and reserve areas. At a local level, the Project is positioned in a relatively flat landscape, dissected by Charlevue Creek, which has a lower elevation than the surrounding land. The Project is also crossed by Stanley Creek and Springton Creek, as well as small tributaries associated with the main waterways.

Several protected areas and state forest surround the study area. State Forests in Queensland have been traditionally used as a source of supplies such as timber; however, the presence of large areas of remnant vegetation now act as ecological corridors that connect isolated habitats. The Project is situated south of Taunton National Park (Scientific), (Taunton Nation Park), a scientific reserve under the *Land Act 1994 (Queensland)*, established to protect a population of Bridled nail-tail wallabies. Taunton National Park connects to the Walton State Forest via Wallaby Late Nature Refuge, which contains suitable remnant and regrowth remnant areas used by the bridle nail-tail wallaby for feeding and shelter.

Walton State Forest connects to the sandstone ridges and plateau located at the west and south of the Project on which is located Arthur's Bluff State Forest, Blackdown Tableland National Park and Dawson Range State Forest. Dawson Range Forest is connected via remnant vegetation, to Duaringa State Forest, which, like Walton State Forest, is not located in the sandstone plateau. State mapped ecological corridors connect all the protected areas mentioned above.

Importantly, none of the described protected areas and state forests are directly connected to the study area, which is comprised of predominately pastureland and fragmented remnant vegetation. This fragmentation is the result of farming activities, including historical vegetation clearing to facilitate grazing and selective logging (e.g., Rosewood (*Acacia rhodoxylon*).

6.2.2 Terrestrial Flora

An assessment of terrestrial flora ecological values was conducted within EPC 881 (herein referred to within Section 6.0 as the study area) (Appendix J). Six field surveys were undertaken between 2017 and 2019 covering a range of seasonal and climatic conditions to ensure temporal and seasonal survey requirements for the Brigalow Belt bioregion were met. The dates of these surveys were:

1) 4th - 12th May 2017;
2) 18th - 30th September 2017;
3) 16th - 23rd February 2018;
4) 22nd - 29th March 2018;
5) 1st - 2nd August 2019; and
6) 19th August 2019.

The surveys were conducted in accordance with the following guidelines:

- *Site examination for threatened and endangered plant species* (Goff, Dawson & Rochow 1982);
- *Management of endangered plants* (Cropper 1993); and
- *Methodology for surveying and mapping regional ecosystems and vegetation communities in Queensland (V5.0)* (Neldner *et al.* 2019).

Threatened Ecological Communities

Desktop assessments identified four threatened ecological communities (TECs) that could potentially occur within 10 km of the study area:

- Brigalow (*Acacia harpophylla* dominant and co-dominant);
- Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions;
- Weeping Myall Woodlands; and
- Poplar Box Grassy Woodland on Alluvial Plains.

Vegetation surveys over the Project determined that communities recorded within the study area do not meet the condition thresholds to constitute a TEC (Appendix J).

Regional Ecosystems

Flora surveys confirmed the presence of six vegetation communities classed as remnant vegetation within the study area. Table 33 outlines the regional ecosystems (REs) characteristic of each vegetation community, where applicable, as well as a short description of the vegetation present. Figure 52 displays the distribution of vegetation communities on the study area.

Table 33 Summary of Vegetation Communities

Vegetation Community	Regional Ecosystem	VM Act Status	Biodiversity Status	Community Description
VC1	11.5.2	LC	NC	Narrow-leaved ironbark (*Eucalyptus crebra*) and Clarkson's bloodwood (*Corymbia clarksoniana*) woodland with a sparse shrub layer on sand plains.
VC2	11.7.2	LC	OC	Lancewood (*Acacia shirleyi*) and/or rosewood (*Acacia rhodoxylon*) woodland on lateritic duricrust.
VC3	11.3.25	LC	OC	Blue gum (*Eucalyptus tereticornis*) or River gum (*Eucalyptus camaldulensis*) with *Bauhinia spp.* and *Casuarina cunninghamiana* fringing woodland on drainage features.
VC4	11.3.2	OC	OC	Poplar box (*Eucalyptus populnea*) woodland on alluvial plains.
VC5	11.5.2 / 11.3.25	LC	NC / OC	Mixed polygon where the dominant vegetation community was VC1 (*Eucalyptus crebra* and *Corymbia clarksoniana* woodland) but along ephemeral creeks and with an important presence of blue gums (*Eucalyptus tereticornis*).
VC6	11.3.25 / 11.3.2 / 11.5.2	LC / OC / LC	OC / OC / NC	Mixed polygon as a result of combination of VC3 with elements of VC4 and some elements of VC1 due to edge effect.

Notes: VM Act *Vegetation Management Act 1992*
LC least concern
OC of concern
NC no concern at present

Flora Species of Conservation Significance

Field surveys included targeted searches for flora species of conservation significance. Surveys covered all potential habitat within the study area based on database searches and field observations. Targeted searches across the study area detected the presence of one flora species of conservation significance; *Cerbera dumicola,* listed as near threatened under the *Nature Conservation Act 1992* (NC Act).

Cerbera dumicola is a shrub or small tree growing to 4 m high (DES 2018d). The species occurs across a range of habitats in central and southern Queensland and is associated with a range of vegetation communities. The species is regionally abundant, having been recorded outside of the study area on multiple occasions (AVH 2019). *Cerbera dumicola* was identified during the vegetation surveys in two very localised rocky areas associated with vegetation community (VC) 2 and VC1 (on an ecotone with VC2) (Figure 53). This species was not identified within similar habitat types elsewhere in the study area during targeted searches.

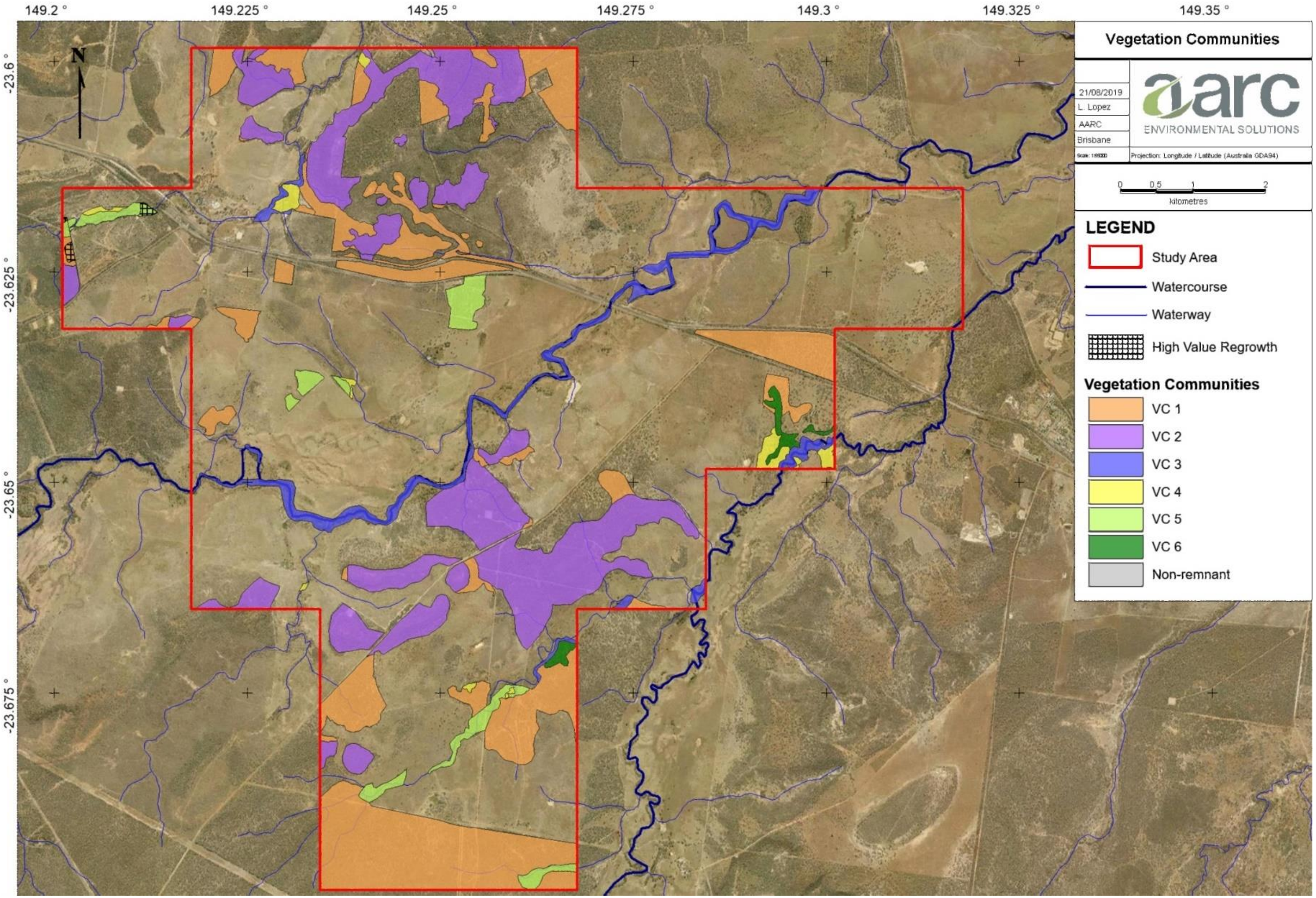


Figure 52 Vegetation Communities

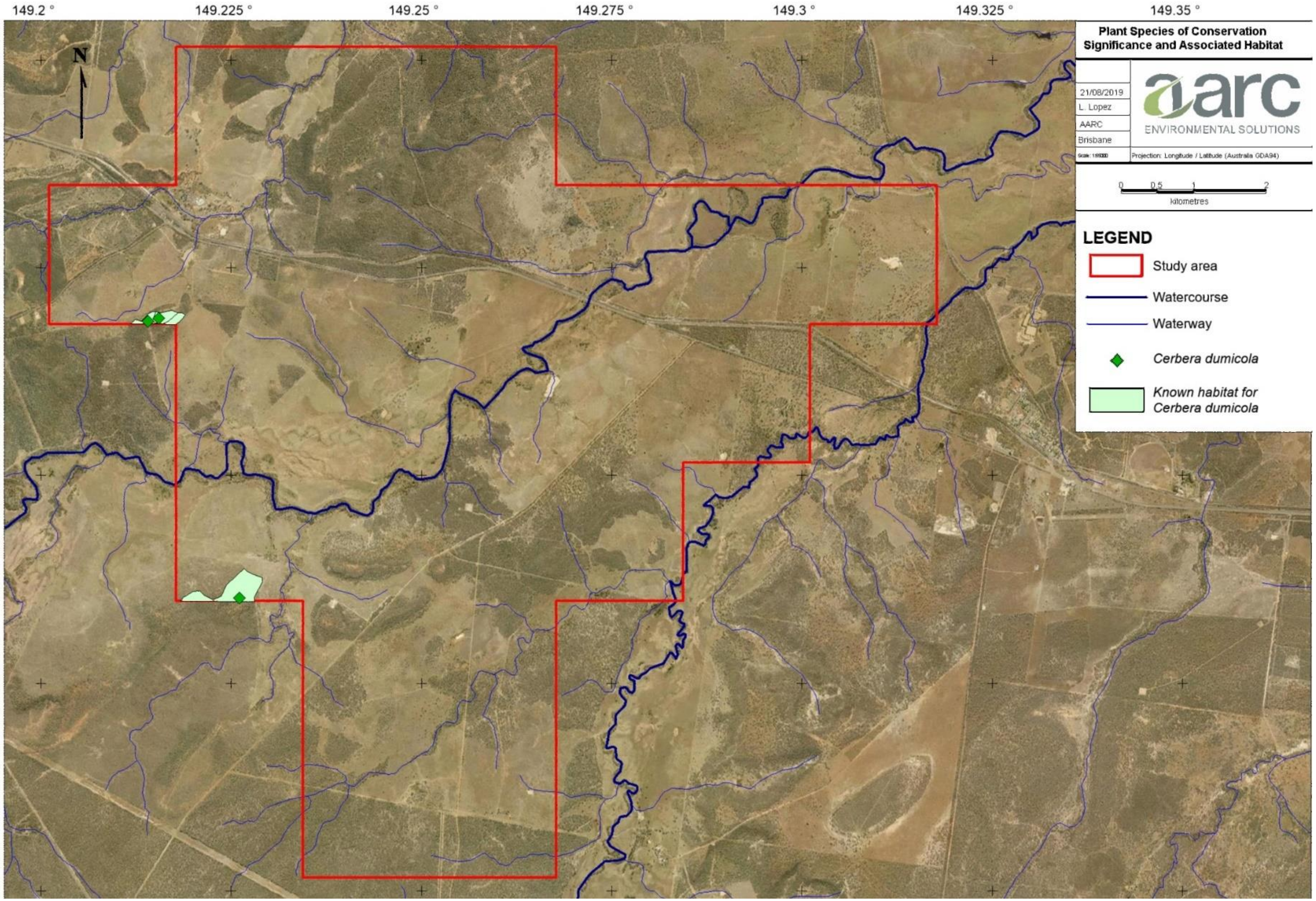


Figure 53 ***Cerbera dumicola*** **Locations and Known Habitat**

Weed Species

A total of 33 introduced flora species were recorded on the study area. Five of which are classed as WoNS and/or as RIS under the Biosecurity Act (DAF 2018a). Introduced plant species are classified as WoNS if they present a serious threat to industry, water supply, human health/safety, plant communities and/or cultural values.

Weeds of management concern (i.e., WoNS or Biosecurity Act RIS) identified within the study area are listed in Table 34. A full list of all introduced species can be found in Appendix J.

Table 34 Weed Species of Management Concern

Scientific Name	Common Name	WoNS	Biosecurity Act RIS (Category 3)
Harrisia martinii	Harrisia cactus	-	x
Cryptostegia grandiflora	Rubber vine	Yes	x
Opuntia tomentosa	Velvety tree pear	Yes	x
Parthenium hysterophorus	Parthenium	Yes	x
Bryophyllum sp.	Mother of millions	-	x
*Vachellia farnesiana**	Mimosa bush	-	-

Notes: * Considered a noxious weed of management concern.
Category 3: A person must not distribute the invasive plant either by sale or gift, release it into the environment.

Wetlands

Field surveys concluded that all the potential lacustrine and palustrine wetlands identified within the study area from desktop searches (Appendix J) were either not present or were identified as artificial (farm) dams. The only natural wetlands within the study area are riverine wetlands associated with riparian and vegetation along Charlevue Creek, Springton Creek and some larger tributaries. These have been mapped as VC3, VC5 and VC6 (Figure 52).

Outside the study area, there is a large palustrine wetland (approximately 82 ha) located approximately 4 km east of the MLA boundary. This wetland, identified as of high ecological significance (HES) under the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP (WWB)), is not connected to the study area through any waterbodies or watercourses. Current government mapping and field inspections of the mapped wetlands identified the vegetation as non-remnant. Field assessment identified the presence of flora species known to inhabit wetland environments. No water was observed during the site inspection (Appendix K).

Groundwater Dependent Ecosystems

The above-mentioned wetlands have the potential to be partially dependent on groundwater (BoM 2019b). Within the study area high potential terrestrial GDEs and moderate potential aquatic GDEs were identified by database searches in association with Charlevue Creek and Springton Creek. Moderate potential terrestrial GDEs were also mapped in association with some of the smaller waterways.

The HES wetland located 4 km to the east of the study area was also identified as potentially groundwater dependant during the database searches.

The *Groundwater Dependent Ecosystem Assessment* (Appendix K) identified two areas within the study area containing terrestrial GDEs, both dependent on alluvial perched groundwater systems that recharge from surface flow. One of these GDEs is located within Charlevue Creek while the other one is situated within a tributary of the Springton Creek. This study also determined that the HES does not constitute a GDE and therefore, is not discussed further.

Based on the location of the aquifer, salinity data and stable isotope comparisons between water sampled from the trees and groundwater, it is concluded that both perched aquifers are hydraulically disconnected from the regional groundwater table. Furthermore, the results indicate that the trees sampled are not utilising groundwater from the regional Tertiary, alluvial or Permial coal seam aquifers to any significant degree.

Assessment of impact to potential GDEs within the Project has been addressed in Section 6.3.1 and Appendix F.

6.2.3 Terrestrial Fauna

An assessment of terrestrial fauna ecological values was conducted within the study area by AARC (2020b) (Appendix J). Four field surveys were undertaken between 2017 and 2018 covering a range of seasonal and climatic conditions to ensure temporal and seasonal survey requirements for the Brigalow Belt bioregion were met. The dates of these surveys were:

1) 4-12 May 2017;
2) 18-30 September 2017;
3) 16-23 February 2018; and
4) 22-29 March 2018.

The surveys were conducted in accordance with the guidelines:

- *Survey guidelines for Australia's threatened bats* (DEWHA 2010a);
- *Survey guidelines for Australia's threatened birds* (DEWHA 2010b);
- *Survey guidelines for Australia's threatened mammals* (DEWHA 2011a);
- *Survey guidelines for Australia's threatened reptiles* (DEWHA 2011b); and
- *Terrestrial Vertebrate Fauna Survey Guidelines for Queensland (V 3.0)* (Eyre *et al.* 2018).

Fauna Species of Conservation Significance

Field surveys across the study area detected the presence of four fauna species of conservation significance, the southern Squatter pigeon (*Geophaps scripta scripta*), the Greater glider (*Petauroides volans*), the Short-beaked echidna (*Tachyglossus aculeatus*) and the Rufous fantail (*Rhipidura rufifrons)*.

The southern squatter pigeon and the greater glider are listed as vulnerable under the EPBC Act and the NC Act. The short-beaked echidna, listed as special least concern under the NC Act, was recorded across several sites over the survey seasons. The Rufous fantail is listed as a migratory species under the EPBC Act, but it is not listed under the NC Act.

The observed locations of these species within the study across the field surveys are displayed in Figure 54.

Pest Species

Four introduced and/or pest fauna species listed as RIS under the Biosecurity Act were identified within the study area (Table 35). A further two species; the cane toad (*Rhinella marina*) and the house mouse (*Mus musculus*), are not invasive species declared under the Biosecurity Act, but are recognised as invasive pests in Queensland.

Table 35 Introduced Fauna Species

Scientific Name	Common Name	Biosecurity Act RIS			
		Category 3	Category 4	Category 5	Category 6
Canis familiaris/ Canis lupus dingo	Wild dog/dingo	x	x	x	x
Oryctolagus cuniculus	Rabbit	x	x	x	x
Felis catus	Feral cat	x	x	-	x
Sus scrofa	Feral pig	x	x	-	x

Notes: Category 3: the invasive animal must not be distributed either by sale or gift or released into the environment.
Category 4: the invasive animal must not be moved.
Category 5: the invasive animal must not be kept.
Category 6: the invasive animal must not be fed.

6.2.4 Aquatic Ecology

To describe the aquatic ecology values of the Project, an assessment of aquatic ecological values was conducted within the study area by AARC (2020a) (Appendix K).

Four field surveys were undertaken between 2018 and 2020 covering a range of seasonal and climatic conditions to ensure temporal and seasonal variation. The dates of these surveys were:

1) 23rd -24th February 2018;
2) 3rd - 9th April 2019;
3) 1st - 2nd August 2019; and
4) 17th - 23rd March 2020.

Field surveys employed standard methodologies derived from:

- *Australian River Assessment System (AusRivAS) Physical Assessment Protocol* (Parsons *et al.* 2002);
- *Queensland AusRivAS Sampling and Processing Manual* (DNRM 2001);
- *Monitoring and Sampling Manual: Environmental Protection (Water) Policy 2009* (DES 2018c).
- *Survey guidelines for Australia's threatened birds* (DEWHA 2010b);
- *Survey guidelines for Australia's threatened reptiles* (DEWHA 2011b); and

- *Terrestrial Vertebrate Fauna Survey Guidelines for Queensland (V 3.0)* (Eyre et al. 2018).

Aquatic ecology values pertaining to flora, fauna, wetlands and GDEs are discussed within this section. Refer to Section 7.0 for discussion of values pertaining to water quality and hydrology.

Aquatic Ecosystems

The waterways of the study area are ephemeral, experiencing periodic flows. The aquatic setting of the Project is described in Section 5.2.1.

Charlevue Creek and Springton Creek are the major determined watercourses under the Water Act, all other waterways crossing the Project are determined drainage features. Extensive clearing for agricultural purposes has been undertaken across much of the study area including the removal of riparian vegetation. The removal of riparian vegetation and direct stock access to the waterways has resulted in bank instability, erosion and occurrence of weeds.

Priority was given to aquatic fauna sampling along the major watercourses; specifically, Charlevue Creek and Springton Creek. Charlevue Creek and Springton Creek were identified to be of higher ecological value than the other surrounding waterways. In this regard, additional fauna survey methods were completed at the chosen sites along Charlevue Creek and Springton Creek in order to identify any riparian fauna species that are reliant on the existing aquatic values within the study area.

Site scoping identified the potential for aquatic trapping to be undertaken along Stanley Creek, however the ephemeral nature of this waterway combined with its low stream order Stanley Creek resulted in not enough water to have aquatic fauna trapping undertaken or to allow for macroinvertebrate sampling to occur.

Water Quality

Surface water quality was found to be generally poor. Results for physico-chemical parameters were outside of the water quality objective (WQO) guideline values for the protection of aquatic ecosystems at many sites. Exceedances included, pH, suspended solids, dissolved oxygen, turbidity, ammonia, nitrogen, phosphorus and sulphate. Petroleum hydrocarbons were also found to exceed WQO guideline values at several sites, considered likely due to the highway and agricultural practices. However, no exceedances of the WQOs for dissolved metals were detected at any site, across all sampling periods during 2020. Water quality is discussed in detail in Section 7.0 (Surface Water).

Stream Sediment Quality

Stream sediment quality was found to contain a high proportion of sand particles with some sites containing a mixture of silt, clay and gravel. No particles were large enough to be classified as cobbles (>6 cm).

Metal concentrations in stream sediment were generally low, except for one exceedance of the Sediment Quality Guideline (SQG) for nickel levels along a tributary of Springton Creek. The 2018 sample was the highest (28.1 mg/kg), with a continued reduction in nickel levels present over the following two surveys to levels barely exceeding the low trigger value (21.9 mg/kg in 2019 and 21.3 mg/kg in 2020). Stream sediment quality is discussed in detail in Section 7.0.

Biological Indicators

Macroinvertebrate diversity, abundance and Plecoptera, Ephemeroptera and Trichoptera (PET) taxa richness were generally low with a high percent tolerant taxa. SIGNAL scores were correspondingly low and consistent with the expected results for ephemeral streams in an agricultural setting. The AusRivAS predictive modelling found the aquatic environments to be significantly impaired through to highly degraded. Ephemeral creeks are commonly known to have impaired habitats as a result of limited water availability and separation of micro-habitats. Based on the extent and severity of this impairment, the assessment indicates poor water quality and low availability of macroinvertebrate habitat was present.

Aquatic Habitat Condition

The habitat bioassessment identified most sampling sites as having moderate biological health with evidence of bank erosion, and sparse vegetative cover; whilst the remainder were either poor or good, with none as excellent. This assessment indicates a primarily low to moderate quality of habitat available and correlates with the general low diversity and abundance of aquatic fauna present.

The condition assessment revealed most sites had a moderate to major impact from localised influences such as clearing practices disturbing or removing the riparian zone, erosion from cattle access and increased run-off (due to clearing practices), and ephemeral waterways being vulnerable to frequent instream and geomorphological changes. All sites had an indiscernible or minor influence from local or regional upstream major industries (i.e., mining, agriculture, water extraction etc) or urbanisation, with the exception of few sites with farmer dams slightly upstream.

Species of Conservation Significance

Database searches identified four fauna species of conservation significance with potential to occur within 50 km of the study area. No aquatic flora of conservation significant were identified by the desktop searches.

The *Aquatic Ecology Assessment* (AARC 2020a) (Appendix K) confirmed the absence of threatened aquatic fauna or flora within the study area. This is consistent with the highly ephemeral nature of watercourses and the disturbed condition occurring as a result of past clearing and agricultural land use.

The *Rheodytes leukops* (Fitzroy River turtle) was previously identified as potentially impacted by the 'Dingo West Project', subject to the particular manner in which the Project is undertaken (EPBC Referral Decision (2010/5775)). This was based on the likely habitat for the turtle occurring approximately 54 km downstream of the Project. The *Aquatic Ecology Assessment* (AARC 2020a) (Appendix K) confirmed that the species did not inhabit watercourses within or immediately downstream of the Project and concluded that suitable habitat for the species was not present. From this survey, the *QEOP: Significant Residual Impact Guideline* (EHP 2014) was used to determine whether or not the impacts of the Project will, or is likely, to have a significant residual impact on the Fitzroy River turtle. The assessment found the Project is considered unlikely to result in a significant residual impact.

Fish Passage

The *Queensland Waterways for Waterway Barrier Works* (DAF 2013) identifies watercourses within the Project as providing value for fish passage mapped as moderate to major risk to proposed infrastructure. Despite watercourses within the study area only containing water for very short periods of the year (post rainfall), during a flow event Charlevue Creek and Springton Creek would be utilised by fish species.

Fish passage was assessment using the *QEOP: Significant Residual Impact Guideline* (EHP 2014) to determine whether or not the impacts of the Project will, or are likely to, have a significant residual impact. The assessment identified that the Project is unlikely to result in a significant residual impact on waterways providing for fish passage. Additionally, there are no known migratory aquatic species likely to rely on the watercourses for regular movement or as access to known breeding locations.

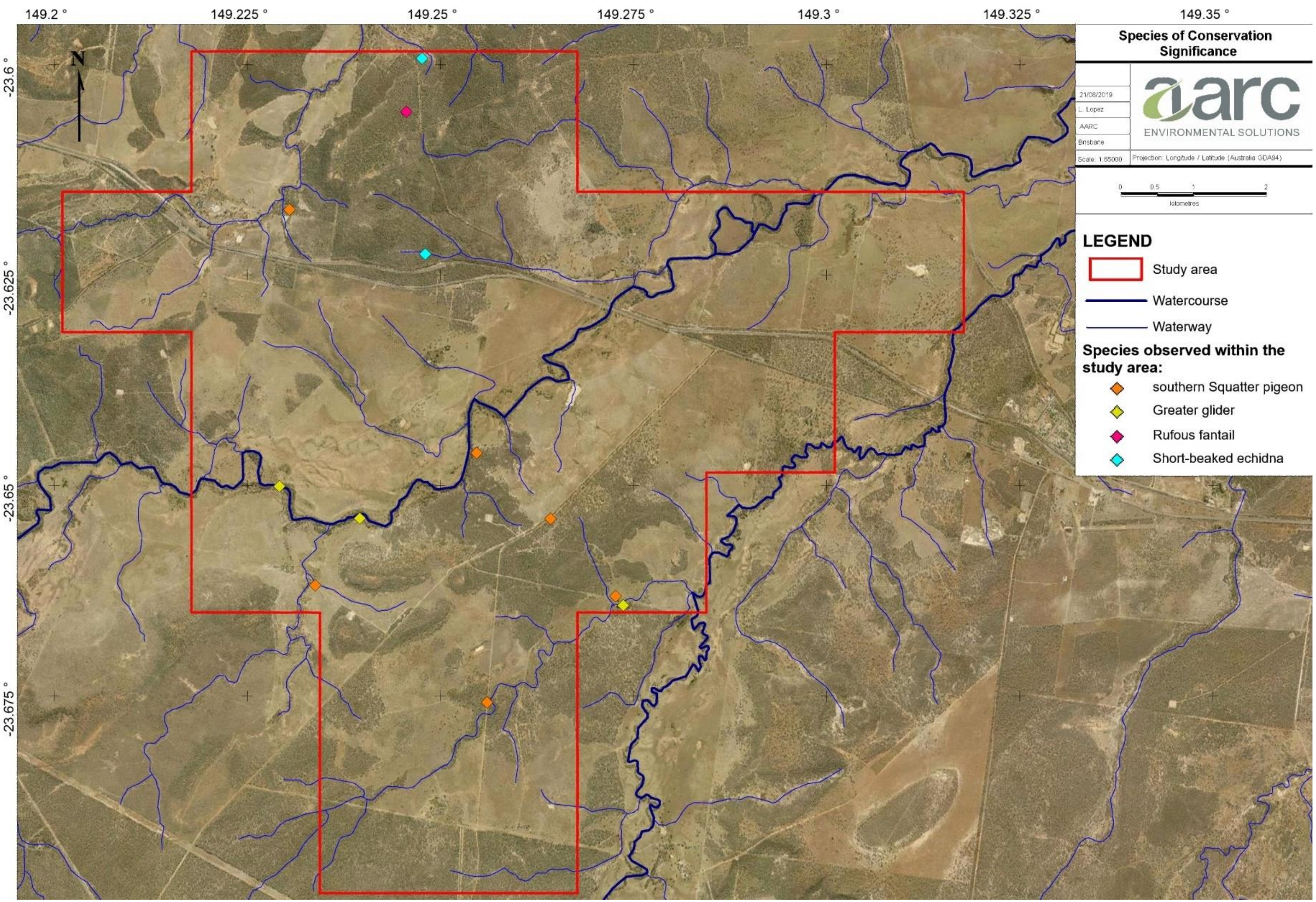


Figure 54 Locations of Fauna Species of Conservation Significance

6.3 POTENTIAL IMPACTS

6.3.1 Terrestrial Flora

Vegetation Communities

The Project will include vegetation clearance and land disturbance during the construction and operation of the mine. The extent of land disturbance would be approximately 1953 ha, of which, approximately 711 ha of remnant vegetation clearing is required over the life of the Project.

Other potential impacts to vegetation communities include:

- removal of habitat for terrestrial flora and fauna;
- further habitat fragmentation and loss of connectivity. It is noted that existing vegetation clearing due to agricultural land use has already limited habitat connectivity due to the highly fragmented remnant vegetation remaining on site; and
- potential for reduced condition of neighbouring vegetation communities due to the introduction of weeds or the release of contaminants associated with mine operations.

Flora Species of Conservation Significance and Habitat

Cerbera dumicola has been identified during the vegetation surveys in two very localised rocky areas associated with VC2 and VC1 (Figure 53). This species was not identified elsewhere in the study area.

The proposed mining activity proposes no impacts to populations of *Cerbera dumicola*.

Weed Species

Project development has the potential to create or enhance conditions for invasive weed species, which may spread and out-compete native and pasture species. Weed species may be introduced via the spread of seed on persons, vehicles and equipment, and may quickly colonise disturbed areas if left untreated.

The introduction of weed species can reduce native species abundance and diversity through competition. This can lead to the reduced condition of vegetation and native fauna habitat.

Wetlands

The Project has potential to impact on wetlands via:

- direct clearing;
- changes in hydrology;
- erosion and sedimentation; and
- contaminant release.

Groundwater Dependent Ecosystems

Where wetlands exhibit a degree of dependence on groundwater for survival, drawdown from the mine can result in a reduced ecosystem condition, changes to vegetation composition or die back.

Water quality data, groundwater level and groundwater drawdown estimation (JBT 2019) (Appendix C) were to assess GDEs and the associated impact of drawdown (AARC 2020b) (Appendix J).

Data from the *Groundwater Dependent Ecosystem Assessment* (Appendix F) together with the data obtained over several studies by JBT Consulting (Appendix C) were used in the assessment of the GDEs and the associated impact of drawdown.

Potential Impacts on GDEs within the study area

The GDEs identified within the study area are riverine type wetlands, including riparian vegetation on watercourses and floodplains.

The impacts identified to the GDEs within the study have been assessed within the GDE study (Appendix F) and summarised below:

- Direct clearing: the GDE located within the tributary of Springton Creek falls within the footprint of the mine and therefore subject to unavoidable vegetation clearing. Direct impacts on riparian vegetation (vegetation clearing) have been addressed above in this section. Impact mitigation as well as offsets requirements have been addressed in Sections 8.1.1.1 and 9.1.1 respectively of Appendix J.

- Groundwater drawdown: groundwater modelling estimated that the Project has the potential to cause a maximum drawdown of 5 m (steady-state post-mining drawdown) at some locations below the Charlevue and Springton Creeks (Appendix C), on the Tertiary and alluvial sediments (regional groundwater table). This drawdown will not have an impact on the riparian habitat identified as GDE within Charlevue Creek based on the limited hydraulic connectivity between the regional groundwater table and the perched aquifer that supports the GDE (Appendix F). Further, considering that the Project's is situated downstream of the Charlevue Creek's GDE and there will be no loss of catchment area, it is unlikely the Project will reduce the surface flows that replenish the associated perched aquifer (Appendix F).

6.3.2 Terrestrial Fauna

Fauna Species of Conservation Significance and Habitat

Field surveys across the study area detected the presence of four fauna species of conservation significance. Three of these species are listed under the NC Act, the southern Squatter pigeon (*Geophaps scripta scripta*), the Greater glider (*Petauroides volans*) and the Short-beaked echidna (*Tachyglossus aculeatus*) whilst the Rufous fantail (*Rhipidura rufifrons*) is listed as Migratory species under the EPBC Act).

Potential impacts of the Project to threatened fauna species include:

- direct clearing of habitat within the Project defined impact areas;

- further habitat fragmentation and loss of connectivity, particularly along Charlevue Creek which provides partial connectivity to larger downstream riparian communities. It is noted that existing vegetation clearing due to agricultural land use has already limited connectivity within this community;

- potential for fauna mortality through interactions with vehicles on roads and/or heavy machinery used for land clearing;

- potential for habitat degradation through increased risk of release of contaminants or sediments into receiving environments within and downstream of the Project; and

- potential for increased invasive flora and fauna.

Southern squatter pigeon (Geophaps scripta scripta)

Suitable habitat for the southern Squatter pigeon exists in open grassy woodland throughout the study area. Within this suitable habitat, fifteen birds were observed during the ecological surveys; the majority during spring 2017. The species is regionally abundant, having been observed outside of the study area on multiple occasions, with the species observed multiple times on local roads and elsewhere in the local area. No breeding activity was observed within the study area.

It is unlikely that the proposed Project will have a significant impact on the southern squatter pigeon; either the local population or the population in its entirety due to:

- the species being highly mobile;

- the abundance of equivalent and more suitable habitat outside of the study area in adjacent areas;

- the observed high local abundance of the southern squatter pigeon within and surrounding the study area; and

- the likely suitable habitat to be provided by rehabilitated land, post mining.

Greater glider (Petauroides volans)

The preferred habitat of the greater glider consists of tall, montane, moist eucalypt forests with relatively old trees and abundant hollows. It favours forests with a diversity of eucalypt species, due to seasonal variation in its preferred tree species. Critical microhabitat is an abundance of large hollows in large, old trees for daily denning shelters and breeding purposes. The species is absent from cleared areas and has little ability to disperse between fragments across cleared areas, with habitat connectivity critical to species survival (TSSC 2016).

Suitable habitat for the great glider within the study area is confined to the Eucalypt riparian woodlands such as along the Charlevue Creek; that features tall open woodland containing hollows and a sparse shrub layer.

It is unlikely that the proposed Project will have a significant impact on the greater glider; either the local population or the population in its entirety due to:

- no significant impact proposed to habitat within the study area, specifically Charlevue Creek. Proposed disturbance within this habitat is limited to the development of a small culvert crossing;

- the observed abundance of greater gliders within the study area and within the broader central Queensland region; and

- the abundance of equivalent and more suitable habitat outside of the study area in adjacent areas.

Short-beaked echidna (Tachyglossus aculeatus)

The Short-beaked echidna is found in a variety of habitat types including open forests, grasslands and heavily vegetated woodlands. Suitable habitat for the species exists across the study area.

It is unlikely that the proposed Project will have a significant impact on the short-beaked echidna, either the local population or the population in its entirety due to:

- the known abundance and wide-ranging distribution of the species;
- the presence of ample equivalent or better suited habitat surrounding the Project;
- the relatively small extent of impact proposed by the Project; and
- the likely suitable habitat to be provided by rehabilitated land, post mining.

Rufous fantail (Rhipidura rufifrons)

The Rufous fantail is generally found in rainforest, dense wet forests, swamp woodlands and mangroves, preferring deep shade, and is often seen close to the ground. During migration, it may be found in more open habitats, such as those within the study area.

It is unlikely that the proposed Project will have a significant impact on the rufous fantail, either the local population or the population in its entirety due to:

- the rufous fantail is a common and secure species (Blakers, Davies & Rielly 1984);
- the study area does not contain the preferred habitat type for the species;
- the species is highly mobile and likely only passing through the Project on its migratory path;
- no known breeding sites or nesting habitat was identified on the study area; and
- ample equivalent or higher quality habitat exists surrounding the study area.

It should be noted that the Rufous fantail is listed migratory under the EPBC Act and is not listed under the NC Act. For the purpose of this assessment, only listed species under the NC Act are further assessed, and therefore the Rufous fantail has not been discussed further.

Pest Species

Pest species compete with, and prey on native fauna. Construction and operation of the Project increases the risk of pest species on the study area through:

- generation of food and other waste that may attract pests; and
- creation of artificial ponding areas providing habitat for pest species such as cane toads.

6.3.3 Aquatic Ecology

The aquatic ecology values within the study area are limited to riverine ecosystems including Charlevue Creek, Springton Creek, and some tributaries. The creeks are highly ephemeral, experiencing periodic flows only following heavy or repeat rainfall events. Past clearing for agricultural purposes has been undertaken across much of the study area including the removal of riparian vegetation. The removal of riparian vegetation and direct stock access to the waterways has resulted in bank instability, erosion and occurrence of weeds.

The Project has potential to impact on aquatic ecology values through:

- the release of MAW to the receiving waterways and associated impacts to ecosystem health;
- potential for spills and leaks from the mining operation to cause contamination in the receiving waterways;
- direct impacts to riverine ecosystems via land disturbance for vehicle crossings or diversion of drainage features;
- risk of increased erosion from cleared lands or mine infrastructure such as spoil dumps, resulting in increased sediment loads entering the aquatic ecosystems; and
- impediments to fish or other aquatic fauna movements due to the construction of crossings or other infrastructure.

6.4 MITIGATION MEASURES, MANAGEMENT AND MONITORING

6.4.1 Terrestrial Flora

Vegetation Communities

To minimise and mitigate impacts to vegetation communities on the Project the following management strategies will be implemented:

- clearing of land and vegetation will be limited to areas defined in the Project approval and required for safe operation; and managed through:
    - an internal *Land Disturbance Permit System* will be implemented to minimise the chances of unauthorised clearing; and
    - areas to be cleared will be clearly defined and demarked to equipment operators;
- inductions and training materials provided to employees will identify the EVs of the site as well as the company procedures for managing impacts within its authority;
- rehabilitation will be undertaken progressively and will aim to return the land to the pre-mining land use where possible; and
- where impact to Matters of State Environmental Significance (MSES) cannot be avoided and are authorised by the Project approval, environmental offsets will be provided.

Flora Species of Conservation Significance

Suitable habitat for the *Cerbera dumicola* exists to the west of the Project, within the MLA. The proposed mine construction and development will not impact on the populations. To ensure no inadvertent impacts to *Cerbera dumicola* the following management strategies will be implemented:

- an internal *Land Disturbance Permit System* will be implemented to minimise the chances of unauthorised clearing and impacts to the populations within the MLA;

- inductions and training materials provided to employees will identify the EVs of the site as well as the company procedures for managing impacts within its authority; and
- existing populations will be monitored for abundance, distribution and health over the mine life.

It should be noted that the Rufous fantail is listed migratory under the EPBC Act and is not listed under the NC Act. For the purpose of this assessment, only listed species under the NC Act are further assessed, and therefore the Rufous fantail has not been discussed further.

Weed Species

To control the abundance and spread of weed species the following management strategies will be implemented:

- a *Weed and Pest Management Plan* will be prepared and implemented prior to construction (refer to section 4.7.4 for full description);
- as required, weeds within the MLA will be controlled using herbicides and other recommended methods;
- inductions and training materials provided to employees will assist the identification of common weeds and will include procedures for reporting; and
- access to vehicle wash down facilities will be provided for vehicles at risk of spreading weeds.

Wetlands/GDEs

Wetlands/GDEs include riverine vegetation on the MLA, particularly riparian vegetation associated with Charlevue and Springton creeks. In addition, a HES wetland is located to the southeast of the Project. To manage potential impacts on wetlands, the following will be undertaken:

- sediment and erosion control structures will be installed and maintained near all at risk areas to prevent sediment release to wetlands;
- a REMP has been developed for the project (Appendix Q), and will be implemented including monitoring of water, sediments, riparian/riverine vegetation health and biological indicators in aquatic environments;
- the release of MAW will be in accordance with the quality controls provided in the *Model Mining Conditions* (DES 2017e) and the Project's EA conditions;
- the development of a SWMS and associated ESCP; and
- groundwater bores adjacent to Charlevue Creek (DW7076W) and Springton Creek (DW7292W1), have been fitted with dataloggers. This data will allow the assessment of the range of water levels within the alluvium and the response of groundwater levels within the alluvium to rainfall recharge, stream flow events and mining activities.

6.4.2 Terrestrial Fauna

Fauna Species of Conservation Significance

Fauna species of conservation significance identified on the Project include; the southern Squatter pigeon (*Geophaps scripta scripta*), the Greater glider (*Petauroides volans*), the short-beaked echidna

(*Tachyglossus aculeatus*) and the Rufous fantail (*Rhipidura rufifrons*) (migratory). The proposed mine construction and development will not have a significant impact on these Species. To ensure no inadvertent impacts occur the following management strategies will be implemented:

- an internal *Land Disturbance Permit System* will be implemented to minimise the chances of unauthorised clearing and impacts to the threatened fauna within the MLA;
- inductions and training materials provided to employees will identify the EVs of the site as well as the company procedures for managing impacts within its authority;
- vehicles speeds will be limited within the MLA, to minimise the risk of collision;
- vegetation clearing will be done in a staged manner, allowing time for fauna to leave the area; and
- pre-clearing inspections will be undertaken by qualified staff to minimise the risk of fauna mortality.

Pest Species

To prevent the introduction of pest species and to control their spread, the following management strategies will be implemented for the Project:

- a *Weed and Pest Management Plan* will be prepared and implemented prior to construction (refer to section 4.7.4 for full description);
- rubbish and food scraps will be managed so as not to encourage pest species;
- inductions and training materials provided to employees will assist the identification of common pests and will include procedures for reporting; and
- control of feral cats and other animals will be undertaken within the MLA.

6.4.3 Aquatic Ecology

Aquatic ecology values are primarily attributed to Charlevue Creek and Springton Creek within the MLA. The following mitigation measures will be implemented to protect existing values:

- sediment and erosion control structures will be installed and maintained near all at risk areas to prevent sediment release to wetlands;
- fish passage will be managed during all phases, such that:
    - crossing design should provide for the fish passage during low and high flow events:
    - crossing design will be developed upon finalisation of the Mine Design Plans. Crossing designs for fish passage will be designed in accordance with the management measures in the *Accepted Development Requirements for Operational Work that is Constructing or Raising Waterway Barrier Works* (DAF 2018b) (i.e., using box culverts to permit crossing during low flow events, enabling fish passage to be maintained within / through the Project area) and the performance outcomes detailed in State Code 18: Constructing or raising waterway barrier works in fish habitats (DILGP 2020)

- upon finalisation of crossing design plans by a suitably qualified person development approval will be sought in accordance with the *Planning Act 2016*.

- the release of MAW, will be in accordance with the quality controls provided by the *Model Mining Conditions* (DES 2017e);

- fuel and hazardous liquids will be stored in a bunded facility, in accordance with relevant Australian Standards;

- an *Emergency Response and Spill Management Plan* will be implemented during construction and operation to minimise the risk of contaminant release to aquatic ecosystems;

- open-cut pits will be appropriately bunded or located in a manner that prevents surface water from entering the voids during a 1:1000-year flood event and dams will be appropriately bunded or located in a manner that prevents surface water from entering or damaging the dams during a 1:1000-year flood event. *This is consistent with the EPBC Referral Decision: not a controlled action if undertaken in a particular manner;* and

- a REMP will be implemented and will include monitoring of water, sediments, riparian/riverine vegetation health and biological indicators in aquatic environments.

6.5 ENVIRONMENTAL OFFSETS

The offsets framework requires environmental offsets to be delivered where an activity is likely to result in a significant residual impact on a prescribed environmental matter. The *Queensland Environmental Offset Policy Significant Residual Impact Guideline* (EHP 2014) was used to determine whether Project impacts are considered to be significant. This guideline outlines the criteria for identifying when an impact on a prescribed environmental matter (i.e., MSES) may be significant. The significant impact criteria provide a trigger for consideration of offsets (EHP 2014).

As part of the ecological assessments (AARC 2020a; AARC 2020b), significant impact assessments were conducted for all prescribed environmental matters identified in the study area. A summary of results from the assessment is provided in Table 36, and the full assessments can be found in Appendix J and Appendix K.

Of the prescribed matters that will be significantly impacted by the proposed disturbance further details of the impact assessment and offset requirements are summarised in Table 37.

Magnetic South is committed to delivering environmental offset requirements for matters with a significant residual impact as a result of the Project. Offsets will be delivered as either a financial settlement or proponent-driven offset (i.e., a land-based offset or *Direct Benefit Management Plan*), or a combination of both.

Table 36 Summary of Project MSES and Likelihood of Significant Residual Impact

Protected Matter		NC Act Status	VM Act Status	Likelihood of Occurrence Within Study Area	Likelihood of Significant Impact
Of concern RE 11.3.2		n/a	OC	Present	Yes
REs located within the defined distance from the defining banks of a VM Act watercourse		n/a	n/a	Present	Yes
Connectivity area		n/a	n/a	Present	Yes
Wildlife Habitat and Essential Habitat	Southern squatter pigeon	V	n/a	Present	No
	Greater glider	V	n/a	Present	No
	Short-beaked echidna	SLC	n/a	Present	No
Waterways providing for Fish Passage		n/a	n/a	Present	No
HES Wetlands		n/a	n/a	Not present	No

Notes:
n/a not applicable
OC of concern
NT near threatened
V vulnerable
SLC special least concern

Table 37 Summary of MSES Impact Assessment and Gemini Project Offset Requirements

MSES	Total Impact Area (ha)	Impact Assessment	Offset Requirement	Habitat Description
Of concern RE11.3.2	2.57	Clearing is non-linear and exceeds the clearing threshold.	Offset Required	This vegetation community was characterised by *Eucalyptus populnea* (poplar box) woodland on alluvial plains. It was represented in several small to moderate patches within the study area and is subject to pressures from grazing, exotic species invasion.
REs located within the defined distance from the defining banks of a VM Act watercourse	58.32	Clearing of watercourse vegetation is required. The clearing widths and areas exceed significant impact guidelines. REs supporting watercourse vegetation includes RE 11.3.25, RE 11.5.2, RE 11.3.2 and RE 11.7.2.	Offset Required	A number of VM Act watercourses traverse the MLA. Impacts will occur to watercourse vegetation that is associated with RE 11.3.25, RE 11.5.2, RE 11.3.2 and RE 11.7.2.
Connectivity area*	710.72	The *Landscape Fragmentation and Connectivity Tool** was applied to the proposed extent of disturbance area. The results found that significant impact would occur to connectivity at both local scale and to core remnant areas.	Offset Required	The *Landscape Fragmentation and Connectivity Tool* determined that there is significant impact to the connectivity of the remnant vegetation within the Project.

Notes: * *Landscape Fragmentation and Connectivity Tool* is based on current government mapping.

7.0 SURFACE WATER

This section provides a description of the existing surface water values within and surrounding the Project. It aims to identify the Project's potential impacts on the existing values and propose mitigation measures and management strategies to prevent or minimise adverse environmental effects.

This section is informed by the *Surface Water Assessment* (WRM 2020b) presented in Appendix B. A *Flood Impact Assessment* (WRM 2020a) was also conducted to inform the *Surface Water Assessment* (WRM 2020b).

Surface water values pertaining to flora, fauna and wetlands are addressed in Section 6.0.

7.1 ENVIRONMENTAL OBJECTIVES AND PERFORMANCE OUTCOMES

The environmental objective relevant to potential impacts to surface water as described in the EA guideline for *Application requirements for activities with impacts to water [ESR/2015/1837]* (DES 2017c) is:

The activity will be operated in a way that protects the environmental values of waters.

The Project would achieve all of the following performance outcomes identified in Schedule 8, Part 3, Division 1 of the EP Regulation:

a) *the storage and handling of contaminants will include effective means of secondary containment to prevent or minimise releases to the environment from spillage or leaks;*

b) *contingency measures will prevent or minimise adverse effects on the environment due to unplanned releases or discharges of contaminants to water;*

c) *the activity will be managed so that stormwater contaminated by the activity that may cause an adverse effect on an environmental value will not leave the site without prior treatment;*

d) *the disturbance of any acid sulphate soil, or potential acid sulphate soil, will be managed to prevent or minimise adverse effects on environmental values;*

e) *acid producing rock will be managed to ensure that the production and release of acidic waste is prevented or minimised, including impacts during operation and after the environmental authority has been surrendered;*

f) *any discharge to water or a watercourse or wetland will be managed so that there will be no adverse effects due to the altering of existing flow regimes for water or a watercourse or wetland; and*

g) *the activity will be managed so that adverse effects on environmental values are prevented or minimised.*

Of the performance outcomes described above, (d) assessment of acid sulphate soils is addressed in Section 5.0, (e) assessment of acid producing rock is addressed in Section 13.0 and (f) assessment of impacts to wetlands are addressed in Section 6.0.

7.2 DESCRIPTION OF ENVIRONMENTAL VALUES

The following documents were consulted to assist in identification of the surface water EVs for the Project:

- *Environmental Protection (Water and Wetland Biodiversity) Policy 2019*;
- *Environmental Protection (Water) Policy 2009 Mackenzie River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Mackenzie River Sub-basin* (EHP 2011a); and
- *Water Resource (Fitzroy Basin) Plan 2011*.

The EPP (WWB) is the primary instrument for surface water management under the EP Act; it governs discharge to land, surface water and groundwater, aims to protect EVs and sets water quality guidelines and objectives.

Schedule 1 of the EPP (WWB) outlines the *Environmental Protection (Water) Policy 2009 Mackenzie River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Mackenzie River Sub-basin* (EHP 2011a) as the relevant document for defining EVs and WQOs for the Project region, as described in Section 7.2.3.

The *Water Resource (Fitzroy Basin) Plan 2011* sets out the allocation and sustainable management of water resources in the Fitzroy Basin. The plan also identifies outcomes for sustainable management of water, the water plan area, general and specific surface water and groundwater outcomes, as well as general and specific ecological outcomes.

7.2.1 Drainage Network

The Project area lies within the Fitzroy River Basin, which encompasses an area of 142,545 km^2 and contains the Comet, Connors, Dawson, Don, Nogoa and Mackenzie Rivers, which make up its six sub-catchment areas (BoM 2018; DES 2018b). The study area lies within the Mackenzie River catchment, which covers a total area of 12,985 km^2, and is situated in the centre of the Fitzroy River Basin (Figure 55).

The Project area also lies within the local site catchments of Springton Creek and Charlevue Creek (Figure 56). Charlevue Creek flows through the Project area in a northeast direction. This watercourse begins within the boundaries of Blackdown Tablelands National Park, flowing northeast before joining with Springton Creek and the Fitzroy River, and eventually flows into the Pacific Ocean approximately 46 km north of Gladstone. Springton Creek flows though the Project area in a north-northeast direction. These two creeks eventually converge with the Mackenzie River. First and second order streams associated with Charlevue Creek and Springton Creek also occur in the study area.

Stanley Creek traverses the northwest corner of the Project area and flows in a northeast direction to join with Duckworth Creek (offsite), which then joins with Springton Creek further downstream of the Charlevue - Springton Creek confluence (Figure 57).

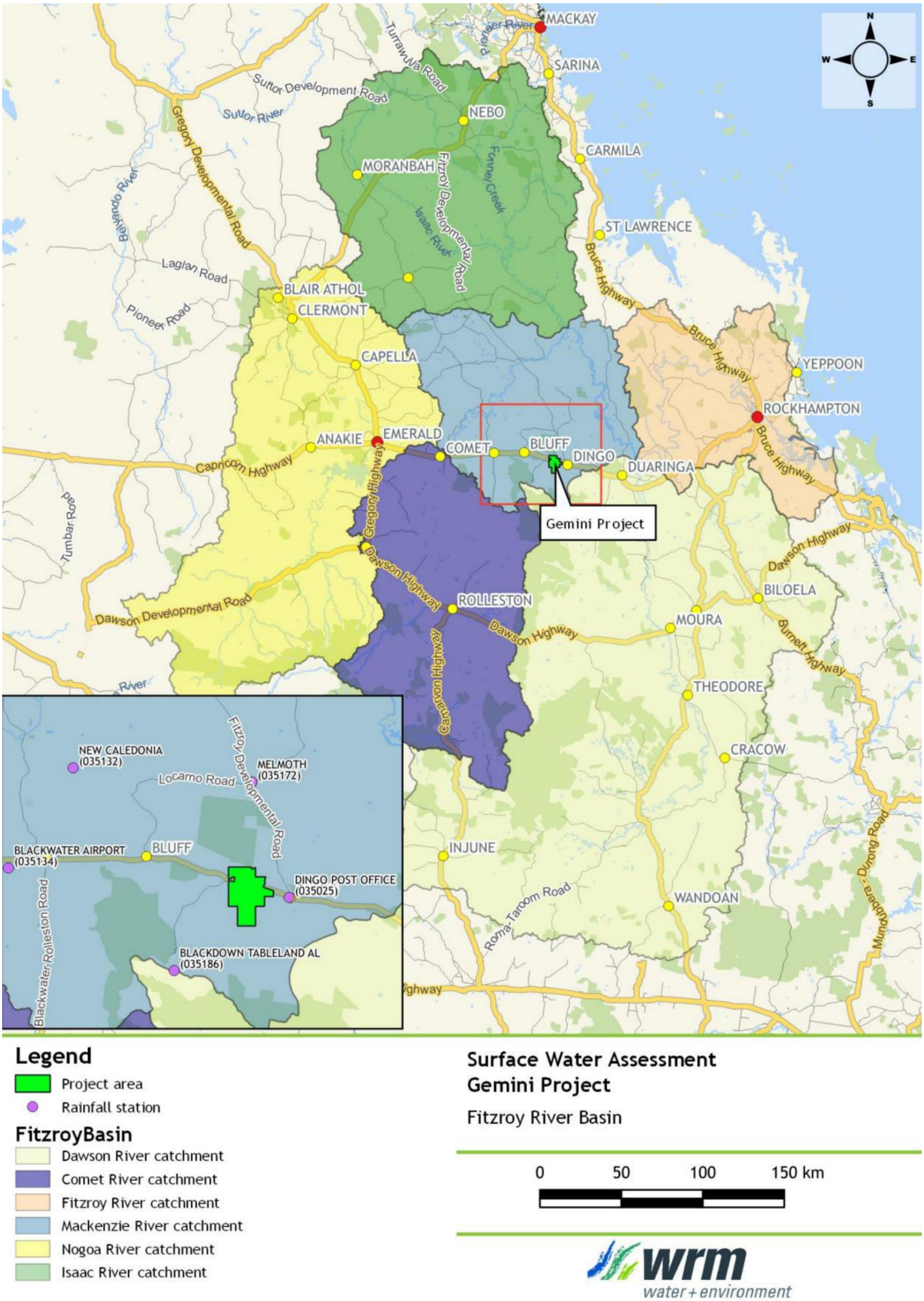


Figure 55 Fitzroy River Basin

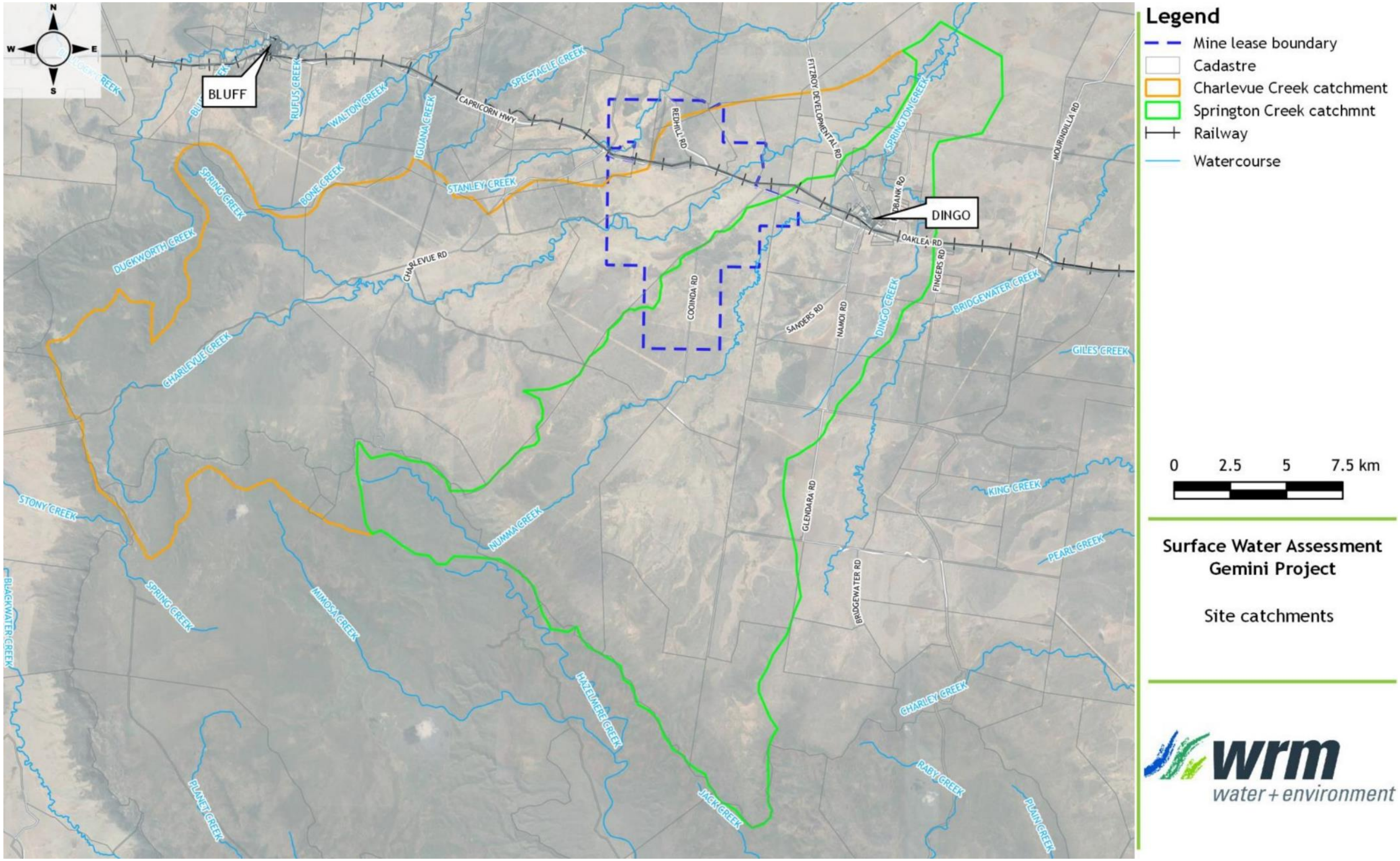


Figure 56 Local Catchments

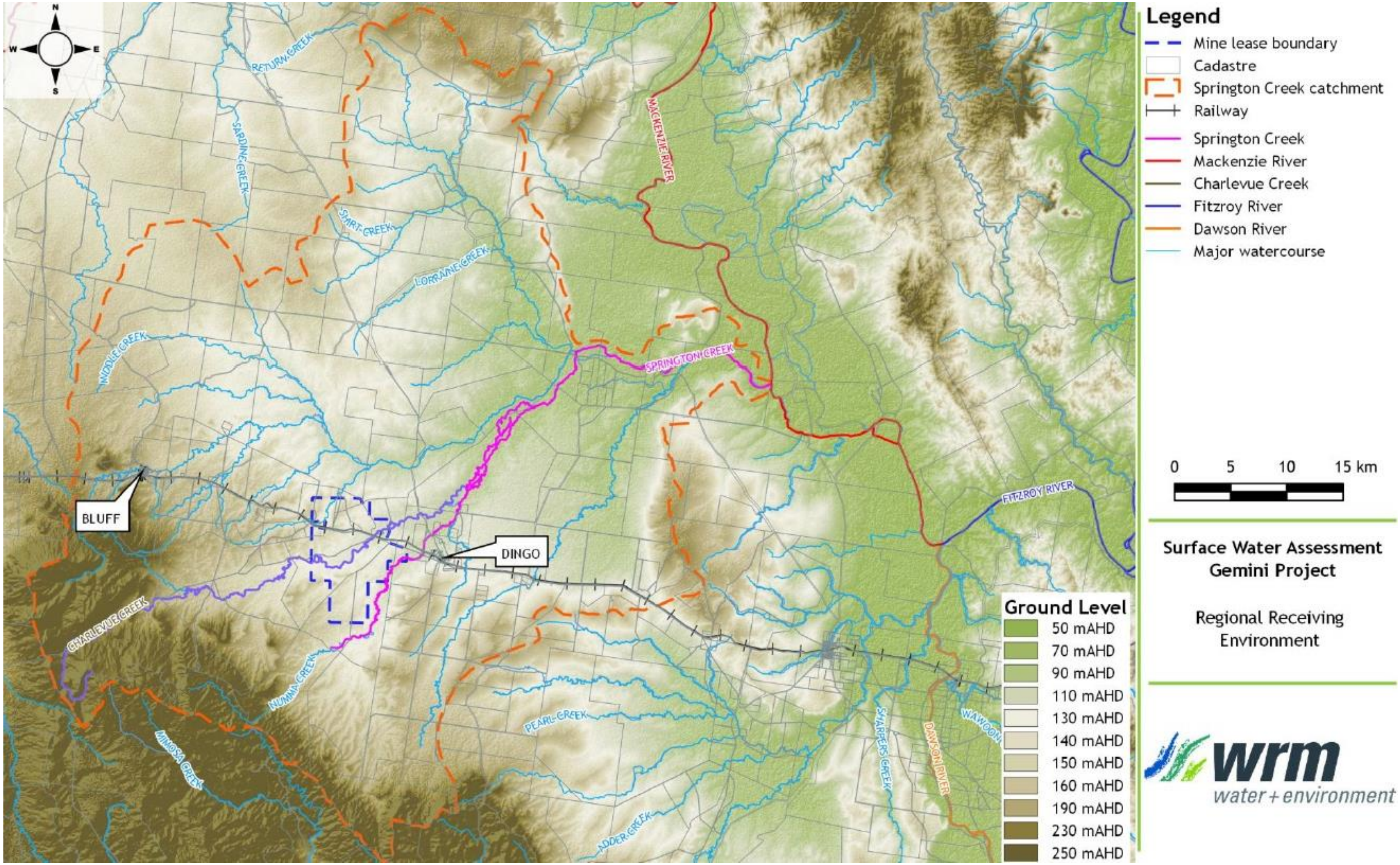


Figure 57 Regional Receiving Environment

Local Stream Morphology

All local waterways are ephemeral, with streamflow mostly occurring shortly after rainfall between September and April. Stream flows are highly variable, with most channels remaining dry during winter to early spring when rainfall and runoff is low, although some pools hold water for extended periods. Typical depth of channels reaches up to 0.8 m and a channel widths range between 1.2 and 3.5 m.

Within the Project, Springton Creek and Charlevue Creek cross alluvial floodplains. The reaches of Springton Creek and Charlevue Creek in the proposed mining area have well-defined channels, typically characterised of predominant sandy beds with a mixture of silt and clay at varying proportions, and well-established riparian vegetation.

The riparian vegetation constituted a mixture of low to moderate disturbance and were located within remnant and non-remnant environs. Disturbance of clearing for agricultural purposes and direct stock access to waterways have contributed to bank instability, erosion and occurrence of weeds. Further details are addressed in Section 6.0.

Topography of the surrounding land varies from flat to undulating, with elevation within the Project ranging from 120-150 mAHD. The landscape is influenced by Charlevue Creek, which has a lower elevation than the surrounding landscape.

7.2.2 Wetlands

The assessment of wetlands within and outside of the Project area is provided in Section 6.0, along with the description of potential impacts and mitigation measures proposed. To avoid duplication, no further discussion of wetlands is included in this section.

7.2.3 Surface Water Quality

Regional Water Quality Objectives

The document *Environmental Protection (Water) Policy 2009 for the Mackenzie River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Mackenzie River Sub-basin* (EHP 2011a) provides WQOs to support and protect the different EVs identified for waters within the Mackenzie River southern tributaries of the Mackenzie River sub-basin. Ten EVs are nominated broadly to the mapped areas of this zone, of which the following are relevant to the Project and its receiving waters:

- aquatic ecosystems (slightly to moderately disturbed (SMD)); and
- water suitable for stock watering.

The guideline WQOs for the protection of aquatic ecosystems and for stock watering are provided in Table 38. Collected water samples in February 2018 and April 2019 have been compared to these WQO values to characterise the existing water quality of the site-specific waterways and drainage features.

Table 38 WQO Guideline Values

Mackenzie River Sub-basin EVs and WQO Basin No. 130 (part)		
Management Intent (Level of Protection)	**WQOs to Protect EV**	
	Parameter	**Water Quality Objective**
Aquatic ecosystem *(moderately disturbed)*	**Water**	
	Ammonia N	<20 µg/L
	Oxidised N	<60 µg/L
	Organic N	<420 µg/L
	Total nitrogen	<7 µg/L
	Filterable reactive phosphorus	<20 µg/L
	Total phosphorus	<160 µg/L
	Chlorophyll a	<5.0 µg/L
	DO	85-110% saturation
	Turbidity	<50 NTU
	Suspended solids	<110 mg/L
	pH	6.5-8.5
	Conductivity (EC) baseflow	<310 µS/cm
	Conductivity (EC) high flow	<210 µS/cm
	Sulphate	<10 mg/L
	Macroinvertebrates	
	Taxa richness (composite)	12-21
	Taxa richness (edge habitat)	23-33
	PET taxa richness (composite)	2-5
	PET taxa richness (edge habitat)	2-5
	SIGNAL index (composite)	3.33-3.85
	SIGNAL index (edge habitat)	3.31-4.20
	% tolerant taxa (composite)	25-50%
	% tolerant taxa (edge habitat)	44-56%
Stock watering	**Water**	
	Total dissolved solids	3000 mg/L
	Aluminium	5 mg/L
	Arsenic	0.5 (up to 5) mg/L
	Beryllium	*not determined**
	Boron	5 mg/L
	Cadmium	0.01 mg/L
	Chromium	1 mg/L
	Cobalt	1 mg/L
Stock watering (cont.)	Copper	0.4 mg/L (sheep) 1 mg/L (cattle) 5 mg/L (pigs) 5 mg/L (poultry)
	Fluoride	2 mg/L

Mackenzie River Sub-basin EVs and WQO Basin No. 130 (part)		
Management Intent (Level of Protection)	WQOs to Protect EV	
	Iron	*not sufficiently toxic*
	Lead	0.1 mg/L
	Manganese	*not sufficiently toxic*
	Mercury	0.002 mg/L
	Molybdenum	0.15 mg/L
	Nickel	1 mg/L
	Selenium	0.02 mg/L
	Uranium	0.2 mg/L
	Vanadium	*not determined**
	Zinc	20 mg/L

Notes: N nitrogen
NTU Nephelometric Turbidity Units
* insufficient background data to calculate

Local Surface Water Quality Assessment

As part of an ongoing surface water monitoring program implemented at the site in 2018, water quality sampling across Charlevue Creek, Springton Creek and Stanley Creek included field readings of pH, EC and temperature and has occurred following two flow events to date. Surface water samples were also collected at each waterway that contained standing or flowing water. Location of the survey sites are displayed in Figure 59.

Flow data is unavailable for the period preceding the sampling events, however, results of the site water balance model have been used to estimate the relative magnitude of the flow events occurring in the days prior to the samples being taken.

As runoff was observed to have essentially ceased at the time of sampling, the modelled runoff for the ‘undisturbed’ catchment type over the 7 days prior to the sampling events on 23 February 2018 and 8 April 2019 was compared to the range of modelled weekly totals estimated over the period of climate record from 1889. The results are plotted in Figure 58 below, which shows that during both periods the modelled runoff would have been exceeded in the wettest 3% to 4% of weeks in the climate record (noting that runoff greater than 1 mm/week would only occur about 6% of the time).

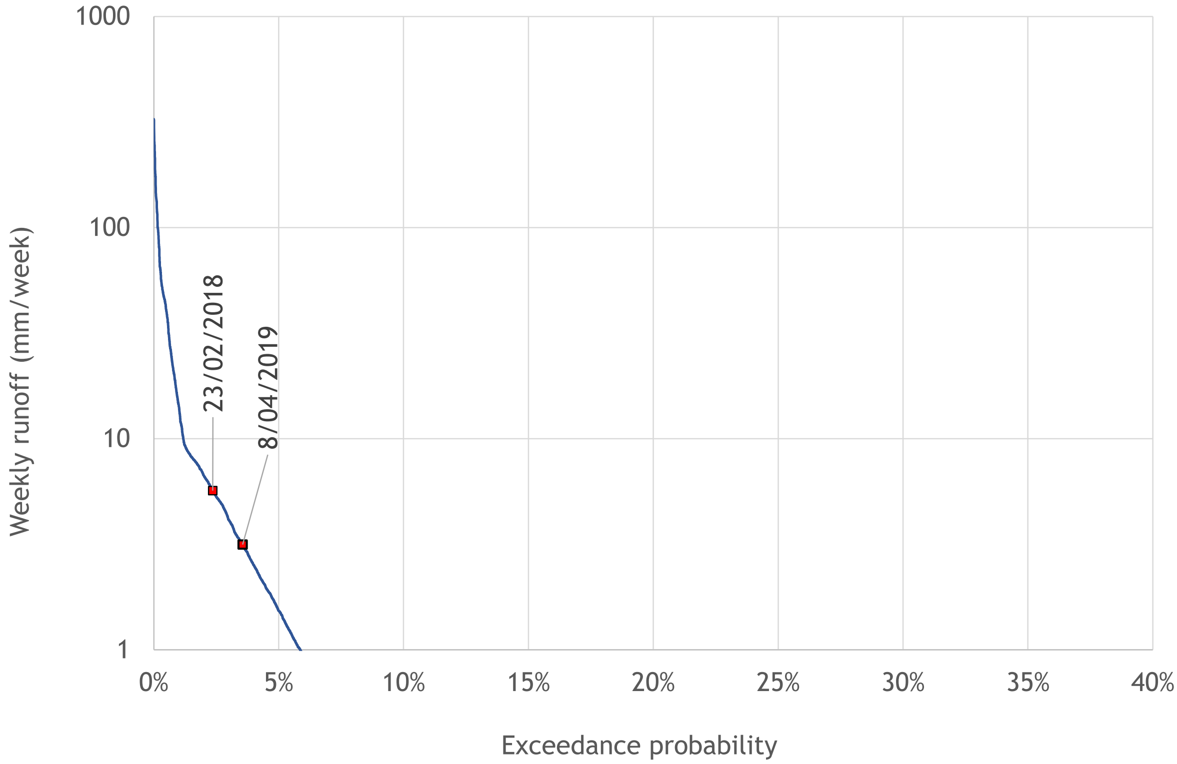


Figure 58 Water Quality Monitoring Dates on Flow Frequency Curve

Samples were analysed at a National Association of Testing Authorities (NATA) accredited laboratory for various physico-chemical parameters, metals, nutrients, hydrocarbons and pesticides and assessed against WQOs. Exceedances of WQOs are highlighted orange in Table 39 and Table 40.

Exceedances of WQOs for turbidity across all sites and years were observed, which can be attributable to soil erosion, runoff, pollution and algal blooms; however, some waterways can have naturally high levels of suspended solids and turbidity (Fondriest Environmental Inc. 2014).

Low levels of dissolved oxygen were observed across most sampling sites in 2018 and 2019. The low levels of dissolved oxygen were recorded in stagnant pools along ephemeral waterways, which naturally experiences dissolved oxygen values below 50% saturation (EHP 2011a). Therefore, these exceedances are not a reliable indicator of the long-term health of the system.

Petroleum hydrocarbons across sampling sites at the three waterways exceeded WQO values during the 2018 survey. Site DWR5, which is located upstream of Charlevue Creek, recorded the highest exceedance of petroleum hydrocarbons, which is mostly likely attributable to the agricultural and pastoral land uses close to or at this site. Although there were no recorded exceedances during the 2019 survey, it will continue to be closely monitored due to the existing and consistent local source of petroleum hydrocarbons.

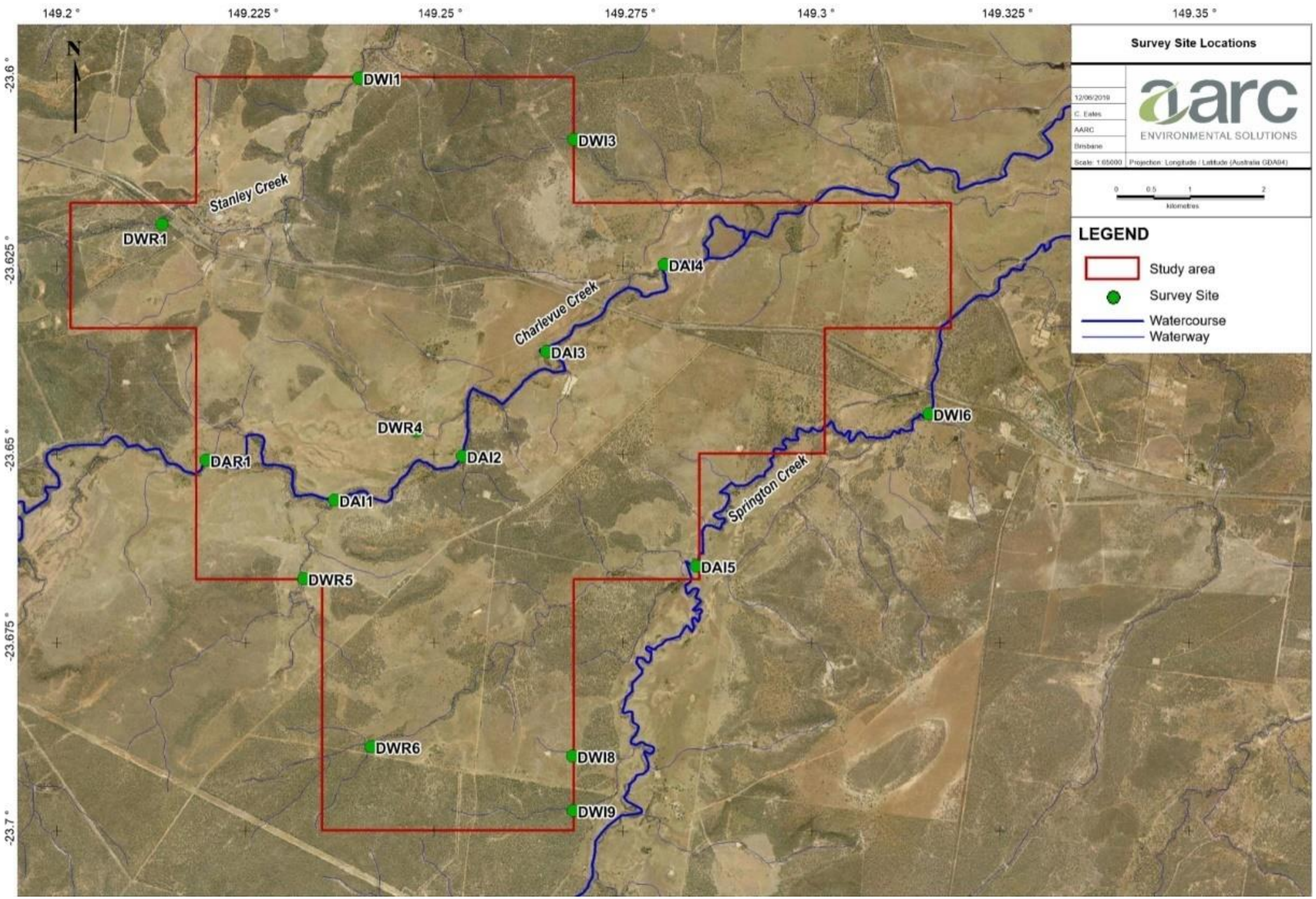


Figure 59 Surface Water Sampling Locations

Table 39 Physico-chemical Parameters (Charlevue Creek)

Parameter	Units	WQO	Charlevue Creek																			
			DAR1			DWR5			DAI1			DAI2			DWR4	DAI3			DAI4			DAI7
			2018	2019	2020	2018	2019	2020	2018	2019	2020	2018	2019	2020	2020	2018	2019	2020	2018	2019	2020	2020
Temperature	°C	n/a	27.1	20.5	23.5	29.5	21.2	23.9	30.8	20.7	24.8	26	21	21.6	28.5	26.8	20.1	22.5	26.3	21.2	22.8	23.7
pH	pH unit	6.5 - 8.5[a]	7.27	7.12	7.36	7.28	6.27	7.26	6.63	6.24	7.57	6.91	6.37	7.12	7.04	6.92	6.78	7.55	6.87	6.58	7.38	7.20
EC (baseflow)	µS/cm	<310[a]	73.1	120.6	205.7	209.5	211.2	195.2	74.1	113.9	203.4	67	128.1	197.8	98.5	83.6	124.4	181.3	70.3	105.4	181.8	164.1
DO	%	85-110[a]	87	28	85.7	88	61	25.8	67	58	65.0	80	15	19.2	80.7	80	46	40.0	81	56	33.4	15.7
ORP	mV	n/a	140.5	179.8	124.5	205.4	203.8	151.3	228.7	197.8	134.5	269.3	160.6	101.4	43.5	198.3	184	119.6	137.4	210.8	106.8	130.7
SS	mg/L	<110[a]	58	172	36.0	8660	43	28	2080	131	18.0	880	228	22.0	166	6170	103	31.0	168	152	50.0	31.0
TDS	mg/L	3000[b]	45.6	85.8	122.0	125.3	147.9	114	43.5	80.6	120.0	42.8	90.1	125.0	55	51.9	89.3	111.0	44.6	73.8	110.0	98.0
Turbidity	NTU	<50[a]	387	12154.4	112	1231.6	23199	657	2050.3	13046.2	450	831.2	13896.6	128	330	2582.6	16031.5	184	506.3	13455.6	130	247
Ammonia	mg/L	<0.02[a]	0.02	0.1	0.04	0.28	0.43	1.35	0.04	0.23	0.02	0.09	0.07	<0.01	0.02	0.08	0.14	0.03	0.14	0.13	0.02	0.07
N (total)	mg/L	<0.007[a]	1.3	1.5	1.1	9.5	4.5	3.2	5.8	1.8	1.2	2.3	2.1	1.6	2.3	8.2	2	1.4	2.3	1.8	1.5	2
P (total)	mg/L	0.16[a]	0.31	0.6	0.18	3.94	0.72	0.16	1.91	0.66	0.17	0.87	0.84	0.3	0.79	2.92	0.84	0.27	0.4	0.75	0.22	0.25
P (reactive)	mg/L	<0.02[a]	0.07	0.03	<0.01	<0.01	0.03	<0.01	0.11	0.07	<0.01	0.06	0.04	0.02	0.03	0.01	0.04	0.01	0.05	0.06	<0.01	<0.01
Fluoride	mg/L	2[a]	0.1	0.2	0.2	0.1	0.1	0.2	0.1	0.3	0.2	0.1	0.3	0.2	<0.1	0.2	0.2	0.2	0.1	0.2	0.2	0.2
SO^{4-}	mg/L	<10[a]	2	<1	<1	5	15	3	2	<1	<1	<1	<1	<1	<1	2	<1	<1	<1	1	<1	<1

Notes: a aquatic ecosystem WQO
b livestock drinking WQO
Orange cells denote an exceedance of the WQO

Table 40 Physico-chemical Parameters (Stanley Creek and Springton Creek)

Parameter	Units	WQO	Stanley & Duckworth Creek			Springton Creek							
			DWR1 (S)	DWR1 (N)	DAI8	DAR2	DWI9	DAI5			DWI6		
			2018	2018	2020	2020	2019	2018	2019	2020	2018	2019	2020
Temperature	°C	n/a	28.1	31.4	23.9	25.6	22.9	27.8	21	26.2	24.6	23.2	23.5
pH	pH unit	6.5 - 8.5[a]	6.61	7.61	7.30	7.00	6.11	6.84	6.28	7.07	7.34	5.95	7.35
EC (baseflow)	µS/cm	<310[a]	113.8	0.4	212.3	246.6	140.7	121.2	137.2	259.1	0.3	65	201.9
DO	%	85-110[a]	4	98	38.9	17.9	17.1	53	46	29	95.0	50	21.3
ORP	mV	n/a	98.2	147.1	138.9	146.8	116.5	242.5	220.9	97.4	158.6	222.8	80.2
SS	mg/L	<110[a]	106	145	65.0	22	238	852	68	40	215.0	86	41
TDS	mg/L	3000[b]	69.9	0.25	127.0	139	95.4	74.8	96.6	144	0.2	43.8	122
Turbidity	NTU	<50[a]	155.3	4.1	537	146	44098.4	3734.08	30580.5	311	21	10730.4	392
Ammonia	mg/L	<0.02[a]	0.12	0.13	0.008	0.04	0.9	<0.01	0.2	0.14	0.02	0.12	0.06
N (total)	mg/L	<0.007	1.4	2.2	1.3	1.1	4.9	3.5	4.1	1.8	1.4	1.6	1.6
P (total)	mg/L	0.16	0.32	0.43	0.28	0.14	1.11	1.5	2.15	0.25	0.27	0.47	0.24
P (reactive)	mg/L	<0.02	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01
Fluoride	mg/L	2[a]	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2
SO^{4-}	mg/L	<10[a]	10	2	3	<1	4	7	4	<1	<1	2	<1

Notes: a aquatic ecosystem WQO
b livestock drinking WQO
Orange cells denote an exceedance of the WQO

Given the higher carbon chain fractions being reported, possible sources include; crude oil, heavy fuel oils, lubricating oils, asphalts and pitch and even waxes and other related products. Sites DWR1 (Stanley Creek) and DWI6 (Springton Creek) occur along the Capricorn Highway, which is a possible point source for the petroleum hydrocarbons observed at these locations.

Macroinvertebrate diversity, abundance and PET richness were generally low, which is reflective of the system's low waterway health at time of sampling.

All laboratory analysis results for dissolved metals, total metals, and petroleum hydrocarbons are presented in Appendix K.

7.2.4 Stream Sediment Quality

Stream Sediment Quality Objectives

Baseline levels of metals in stream sediments provide an additional indication of waterway health. Stream sediment quality sampling was carried out at all sites in 2018 and 2019. Samples were tested for various contaminants and results were compared to the SQG values listed in *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018) (Table 41).

Table 41 SQG Objective Values

Contaminant	Sediment Quality Guideline Value (mg/kg)	
	Low Value	High Value
Arsenic	20	70
Cadmium	1.5	10
Chromium	80	370
Copper	65	270
Lead	50	220
Nickel	21	52
Mercury	0.15	1
Zinc	200	410

7.2.4.1 Stream Sediment Characteristics

Stream sediment quality was well below the relevant SQG low and high trigger values for all parameters except nickel, which exceeded the SQG low trigger value at DWR6 during both years. This site is located along an unnamed waterway which feeds into Springton Creek at DAI5.

Particle size analysis and particle size classification demonstrated that Stanley Creek (DWR1) the stream sediment is predominantly sand with small amounts of clay and silt. However, further downstream along Stanley Creek (DWI1), sediment is characterised as sand (92-96%) with negligible presence of gravel, silt or clay.

Charlevue Creek stream sediment is characterised by high percentages of sand (56-94%) at the majority of sites with variable levels of clay (1-24%) and silt (1-17%). Though minor, the presence of gravel was recorded across the sites along Charlevue Creek. Sites DWR4, DAI2, and DAI5 presented lower levels of sand (9-45%), and higher percentages of clay (25-41%) and silt (17-66%). Of these sites only DWR4 had higher levels of fine particles during both the 2018 and 2019 sampling periods. This site was located along a natural depression which flows into Charlevue Creek.

Along Springton Creek stream sediment levels vary between sites but remain consistent across sample years. Springton Creek itself is characterised by predominantly sand, with consistent levels of clay and silt.

Particle size analysis is presented graphically in Figure 60 and all stream sediment laboratory analyses are provided in Appendix K.

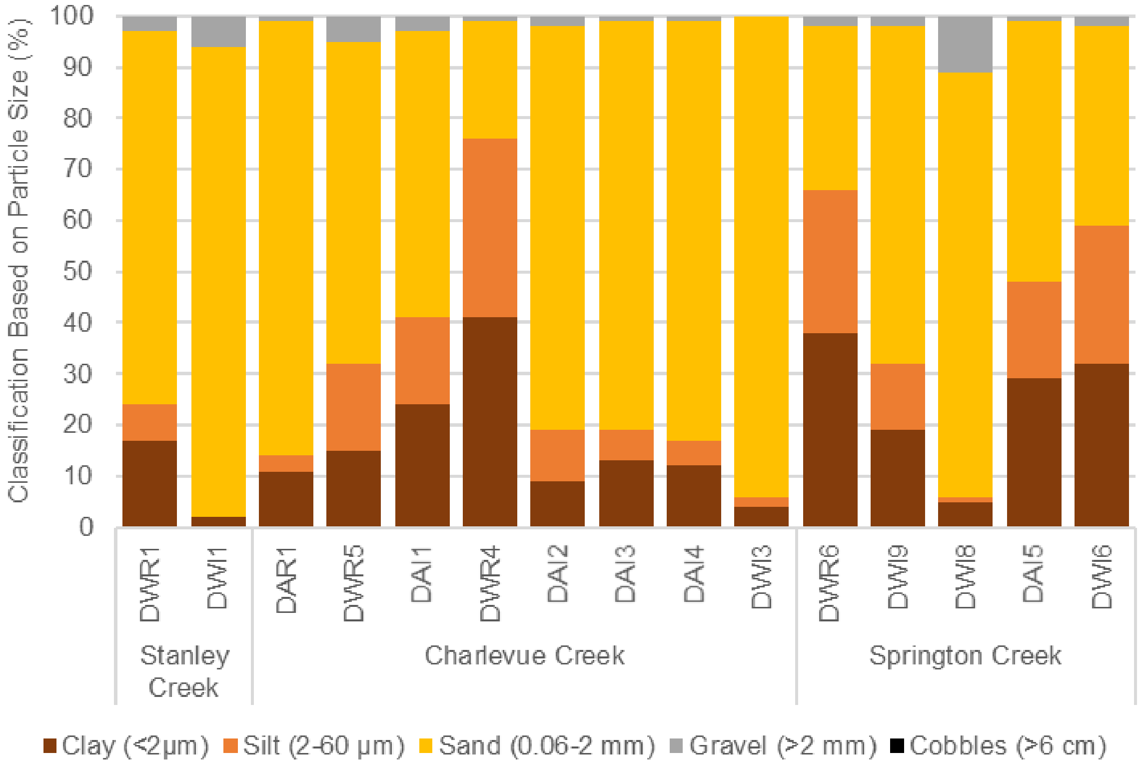


Figure 60 Stream Sediment Particle Size Analysis

7.2.5 Existing Flood Conditions

The *Flood Impact Assessment* (WRM 2020a) attached to Appendix B; defines existing flood conditions across the Project area for a range of design events, in terms of peak water level, peak velocity and water depth.

The XP-RAFTS flood model was used to estimate design discharges for the 50%, 10%, 2%, 1% and 0.1% AEP as well as the probable maximum flood (PMF) design discharge using an ensemble of design temporal patterns. In absence of gauged streamflow data, the resulting peak discharges were validated against the rational method and regional flood frequency estimation estimates (refer to Appendix B).

The XP-RAFTS modelling was then adopted as inflows to the TUFLOW hydraulic model to estimate flood extents and depths along the channel and floodplain of Charlevue Creek and Springton Creek for the nominated design events.

Under existing conditions, all flow generally remains contained within the Charlevue Creek and Springton Creek floodplain channels during a 50% AEP flood event with water depth of <1.5 m. The extent of flooding is more widespread during a 10% AEP event along the drainage features, with small areas of localised inundation with depth of up to 2.5 m along Charlevue Creek floodplains. This flood extent is generally consistent for the 2%, 1% and 0.1% AEP and PMF events, however, flood depth can increase up to 4 m in some areas along the floodplains and reaches up to more than 5 m in the main channels. This predicted flooding regime is mainly attributable to the flat and undulating topography of the area.

Flood extent along the unnamed tributary of Springton Creek throughout all modelled AEP events are not widespread and are contained within close proximity to the main channel with shallow depths of up to 1.5 m. Peak flood depth reaches up to 2.5 m during the PMF event.

The general flooding patterns along the two drainage features indicate that flood velocity increases (up to 3.0 m/s) respective to decreasing AEP. Flood modelling also indicate lower flood velocity (less than 1.0 m/s) with further distance from the main creek channels.

Flood velocity during PMF event can reach a maximum of 4.0 m/s across most of the predicted flooding areas.

Figure 61 and Figure 62 illustrate the flooding extents, depths and velocity for 1% AEP event.

Graphical representation of all modelled existing flood conditions, showing extent, depth and velocity are provided in Appendix B.

7.3 POTENTIAL IMPACTS

The potential impacts of the Project on the surface water EVs include:

- impacts on regional water availability due to the potential need to obtain water from external sources to meet operational water requirements of mining operations;
- short-term and/or long-term loss of catchment area draining to local drainage paths due to capture of runoff within the SWMS and the open-cut pits;
- adverse impacts on the quality of surface runoff draining from the disturbed areas to the various receiving waters surrounding the Project;
- adverse impacts associated with the release of contaminants in MAW;
- impacts on flood levels at the Capricorn Highway and the Blackwater Railway upstream of the proposed rail loop and TLO facility; and
- potential impacts of the Project on flood levels and flood velocities of Charlevue Creek and Springton Creek.

7.3.1 Project Water Availability

Raw water for the Project will be sourced from the Bedford Weir, which is part of the Nogoa-Mackenzie River pipeline network, via a spur pipeline from the Blackwater Pipeline (see Section 3.5.2). The site water balance model indicates that due to the relatively low water requirements of the CHPP, the mine site water requirements of the Project can largely be sourced from water collected within the SWMS under average rainfall conditions. During low rainfall periods, the reliance of water supply from the external pipeline is expected to increase.

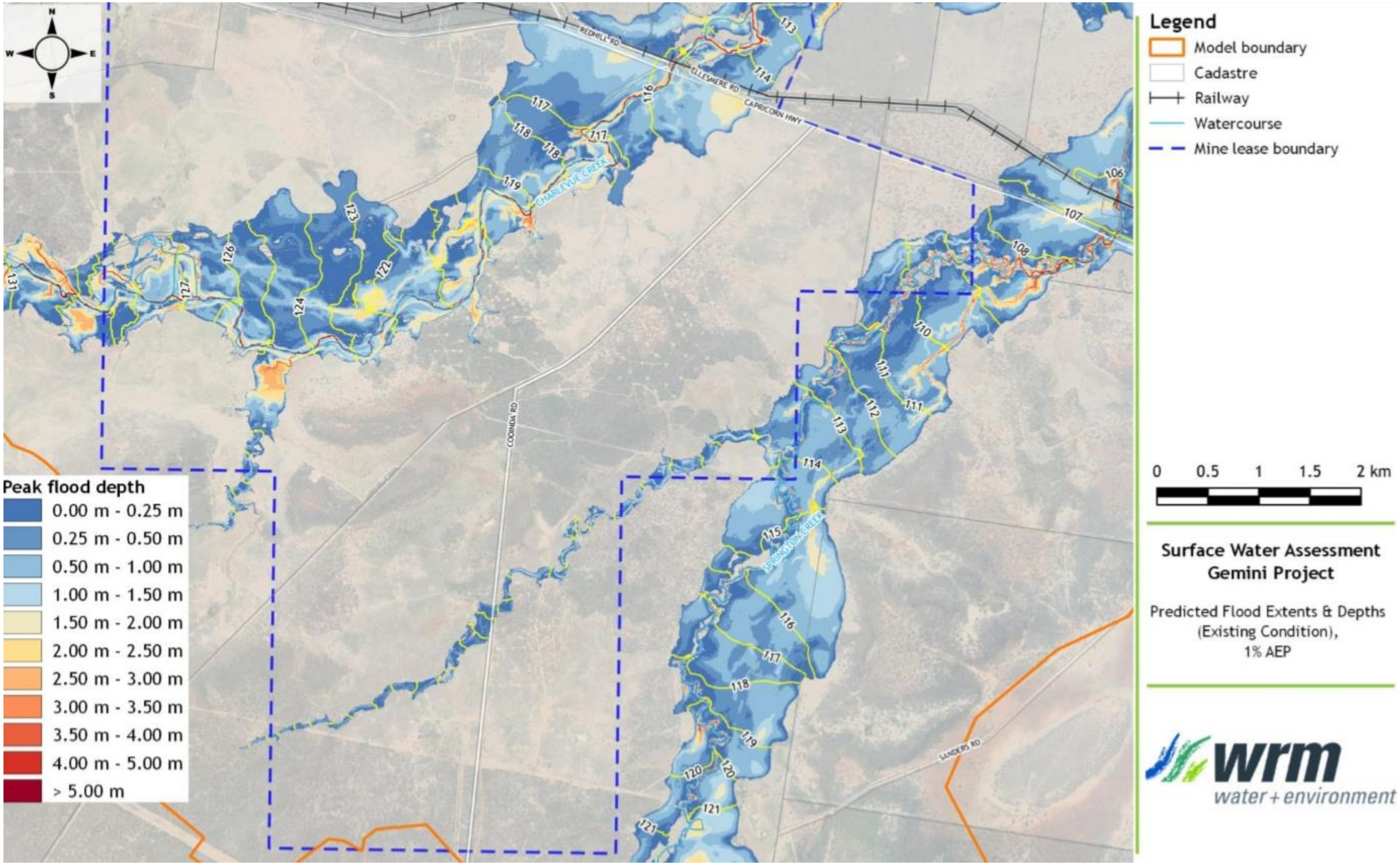


Figure 61 Predicted Flood Extent and Depth For Existing Conditions (1% AEP)

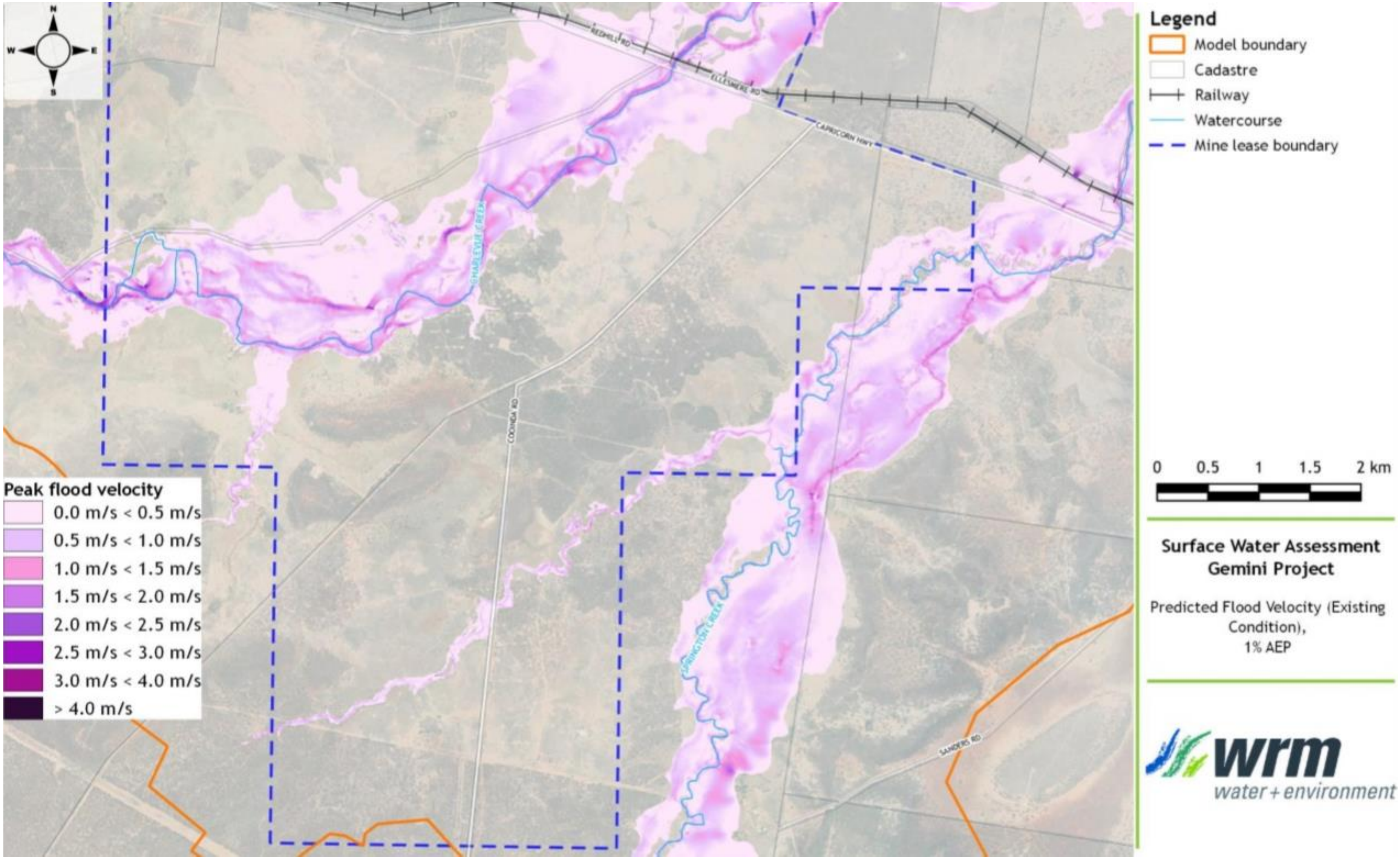


Figure 62 Predicted Flood Velocity for Existing Conditions (1% AEP)

Figure 63 demonstrates the raw water requirements from the pipeline based on the median model performance. Water requirements from the external pipeline are highest in the early Project stages. Under very dry conditions, the demand could reach 500 Ml/a, however, median demand for Year 1 is less than 100 Ml/a. During later years, accumulated stored pit and sediment dam water is sufficient to supply demands in all but the driest years.

The raw water supply contract will be sufficient to ensure continued operation even in the driest of years.

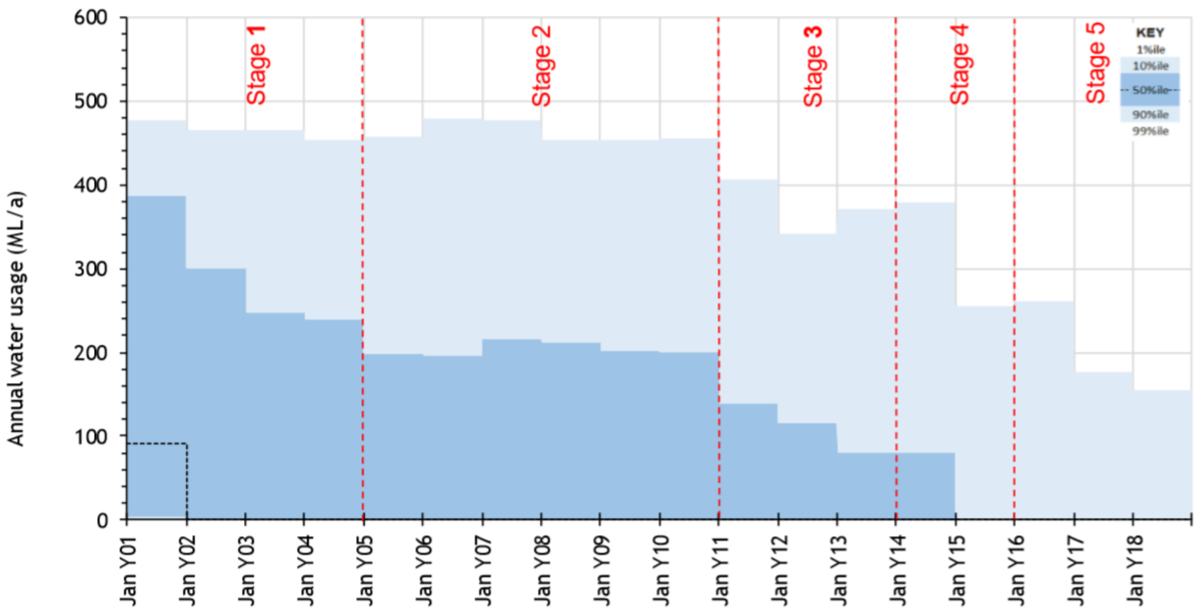


Figure 63 Raw Water Pipeline Usage

7.3.2 Loss of Catchment Area

During operations, the Project will intercept runoff from disturbed areas of the mine site. The SWMS will capture runoff from areas that previously would have flowed to receiving waters of Springton Creek and Charlevue Creek, and therefore, the catchment areas will change with the development of the Project (Table 42). The maximum captured catchment areas at Year 18 represent:

- 1.0% of Charlevue Creek catchment upstream of the confluence with Springton Creek;
- 3.6% of Springton Creek catchment upstream of the Charlevue Creek confluence; and
- 2.3% of the total combined Springton Creek catchment area, downstream of the confluence with Charlevue Creek.

Table 42 Catchment Intercepted by SWMS at Year 18

	Charlevue Creek Catchment	Springton Creek Catchment	Total Combined Catchment
	Upstream of Confluence		*Downstream of Confluence*
Total Area Intercepted by SWMS	336.9 ha	1,174.9 ha	1,511.8 ha
Total Catchment Area	32,243 ha	32,497 ha	64,740 ha
Proportion of Catchment Area Intercepted by SWMS	1%	3.6%	2.3%

After mine closure, the SWMS will be decommissioned with some residual impact on streamflow due to surface water runoff to the final voids from some areas (Table 43). The maximum captured catchment area at mine closure consists of approximately:

- 0.03% of Charlevue Creek catchment upstream of the confluence with Springton Creek;
- 1.1% of Springton Creek catchment upstream of the confluence Charlevue Creek; and
- 0.6% of the total combined Springton Creek catchment area, downstream of the confluence with Charlevue Creek.

Table 43 Catchment Intercepted by Final Void at Mine Closure

	Charlevue Creek Catchment	Springton Creek Catchment	Total Combined Catchment
	Upstream of Confluence		*Downstream of Confluence*
Total Area Intercepted by Final Void	10.0 ha	345.0 ha	355.0 ha
Total Catchment Area	32,243 ha	32,497 ha	64,740 ha
Proportion of Catchment Area Intercepted by Final Void	0.03%	1.1%	0.6%

The impact on environmental values as a result of this catchment loss is expected to be negligible, based on an estimate of the impact of catchment loss on the frequency of low flows, as illustrated in Figure 10.1 of Appendix B.

7.3.3 Impacts on Surface Water Quality

Land disturbance associated with mining has the potential to adversely affect the quality of surface runoff by increasing sediment loads and transporting contaminants from spoil and coal seams. However, with implementation of the SWMS, environmental risks resulting from disturbed area runoff are expected to be low.

MAW includes runoff from processing and coal stockpile areas, groundwater, and wastewater from the CHPP. This water will be contained in designated mine water dams onsite and will only be released in accordance with EA conditions.

Other runoff from disturbed areas, such spoil dumps, will be intercepted by sediment dams designed in accordance with the SWMS. Discharge from sediment dams directly into the receiving environment (after settlement of suspended sediments) would only occur during rainfall events. The discharge is expected to have insignificant impacts on water quality, as overburden runoff quality is expected to be relatively benign.

7.3.4 Mine Affected Water Releases

The results of the water balance modelling show no uncontrolled spills from the MAW system to receiving waters; as any unplanned overflows from mine water dams would overtop back into the pit. Additionally, the model results also show that the maximum modelled water level for both voids is well below the surface overflow level.

The release of MAW from the Project will occur in accordance with the *Model Mining Conditions* (DES 2017e) only; as set out in the EA. Relatively small volumes of water are expected to be released to Charlevue Creek, primarily due to the relatively low and infrequent flows in this waterway. Such release events would likely only occur post significant rainfall and flow within local catchments. Such conditions present opportunity for release without environmental harm, while reducing the risk of accumulating legacy water in the void. The proposed EA conditions for water release are provided in Section 15.0.

7.3.5 Post-mining Final Void Lakes

Pit AB and Pit C is proposed to be backfilled progressively during mining, with two final voids at the end of mining which will meet the rehabilitation objectives addressed in Section 4.3. Key water inputs in the voids include rainfall on pit lake water surfaces, runoff from pit faces and rehabilitated upstream catchment areas and groundwater interception. Further information regarding the final void configuration has been addressed in Section 4.4.7.1 and Table 21.

The voids are intended to be partially backfilled to a level that prevents the interchange of water between the coal seams and the lakes, resulting in lower water levels and salinities than would otherwise be the case. Backfilling with waste rock material will elevate the void floor above the level of groundwater flows to prevent pit water transiting into any aquifers.

The final pit floor of Pit AB will be at an elevation of approximately 40 mAHD, which is 72 m below the natural surface elevation. Pit C final pit floor will be at an elevation of approximately 60 mAHD or approximately 60 m below the natural surface elevation. Final void modelling suggests that during the first 200 years after closure, lake salinities will be less than 10,000 mg/L. After 500 years salinity is conservatively modelled to increase to 30,000 mg/L, however, modelling is based on an assumption that salt levels in spoil leachate do not decline over time.

Final voids were modelled to remain as a groundwater sink and do not present a risk of overtopping. The maximum modelled water level for Pit AB is 57.6 mAHD, which is approximately 54 m below the void overflow level/natural surface elevation (112 mAHD). Similarly, the maximum modelled water level for Pit C is around 73.5 mAHD, which is 54.4 m below the void surface overflow level/natural surface elevation of approximately 128 mAHD. Modelled water levels in the voids are presented in Table 44.

Table 44 Final Void Surface Water Model

Water Level	Pit AB (mAHD)	Pit C (mAHD)
Long term equilibrium water levels	52.9	70.3
Maximum long-term water levels	57.6	73.5
Minimum long-term water levels	47.4	66.0
Overflow level at natural surface	112.0	128.0

7.3.6 Impacts on Flooding

As part of the *Flood Impact Assessment* (WRM 2020a), modelling was undertaken to determine the change in flood behaviour in Charlevue Creek, Springton Creek and its unnamed tributary during developed conditions. The results are as follows:

- the Project will temporarily increase Charlevue Creek flood levels immediately upstream of the proposed haul road crossing. In a 1% AEP flood event, these impacts are contained within the MLA (Figure 64);

- the works at Pit AB will increase flood levels in Springton Creek by up to 0.22 m in a 1% AEP flood (Figure 65). These impacts would extend off-lease onto land owned by Magnetic South, and reduce with distance downstream of the boundary;

- there will be localised off-lease impacts on flood levels in the unnamed tributary of Springton Creek immediately upstream of Pit AB and Pit C;

- the proposed rail loop will not have an impact on Charlevue Creek or Springton Creek flooding;

- there will be no impact on flood levels at these waterways at Capricorn Highway, Blackwater Railway, or downstream of the Project;

- there are four locations where (based on the flood model results) floodwaters could potentially come into contact with the overburden dumps:

    - north-eastern end of Pit C – due to flow backing up to the west of the haul road crossing of the engineered drainage feature. Modelled flow velocities in this area are less than 0.4 m/s in the 0.1% AEP design flood, and would therefore not cause the migration of sediment from the final landform;

    - western side of Pit AB – due to water backing up a minor tributary of Charlevue Creek. Flow velocities in this area are expected to be less than 0.2 m/s, and therefore the likelihood of migration of sediment from these dumps is minimal;

    - eastern side of Pit AB – due to flow on the left (western) floodplain of Springton Creek. Flow velocities against the final landform are modelled to be less than 1.2 m/s in the 0.1% AEP flood, and therefore the likelihood of erosion of the dump toe is minimal; and

    - southern side of Pit AB – due to water overflowing from the unnamed tributary of Springton Creek upstream of the inlet to the engineered drainage feature. During operations, this section of the dump would be protected by a temporary levee, which would be incorporated into the final landform profile on closure. In events up to the 0.1% AEP design flood, modelled flow velocities are less than 1 m/s along most of the length of the proposed levee. Such flows would be non-erosive – and especially given the relatively short flow durations in this small catchment, the risk of migration of sediment in floodwaters would be minimal. During detailed design of the engineered drainage feature, provision will be made to ensure that flows will be non-erosive along the final landform post-closure.

Graphical representation of all modelled developed flood conditions, showing extent, depth and velocity are provided in Appendix B.

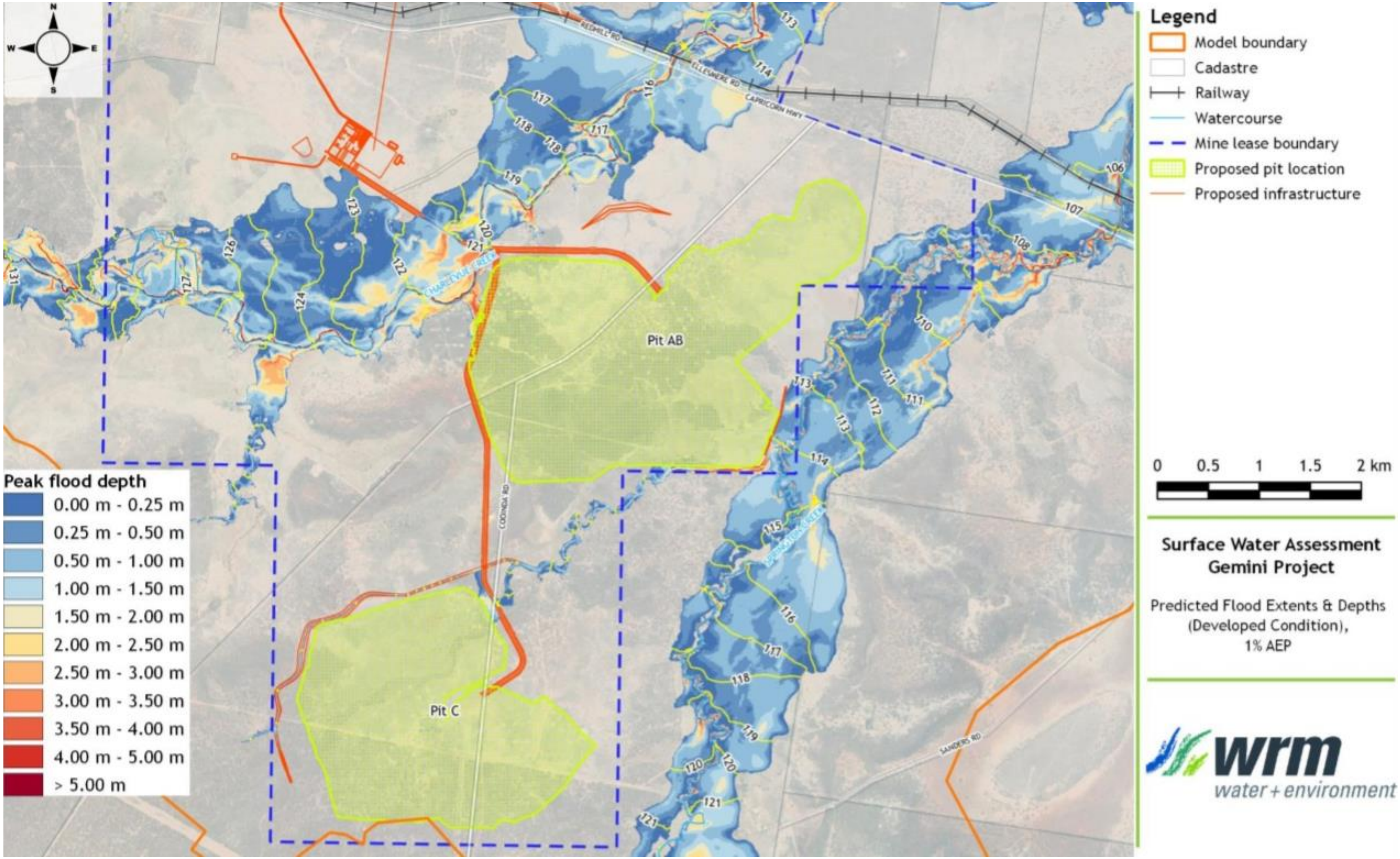


Figure 64 Predicted Flood Extent and Depth for Developed Conditions (1% AEP)

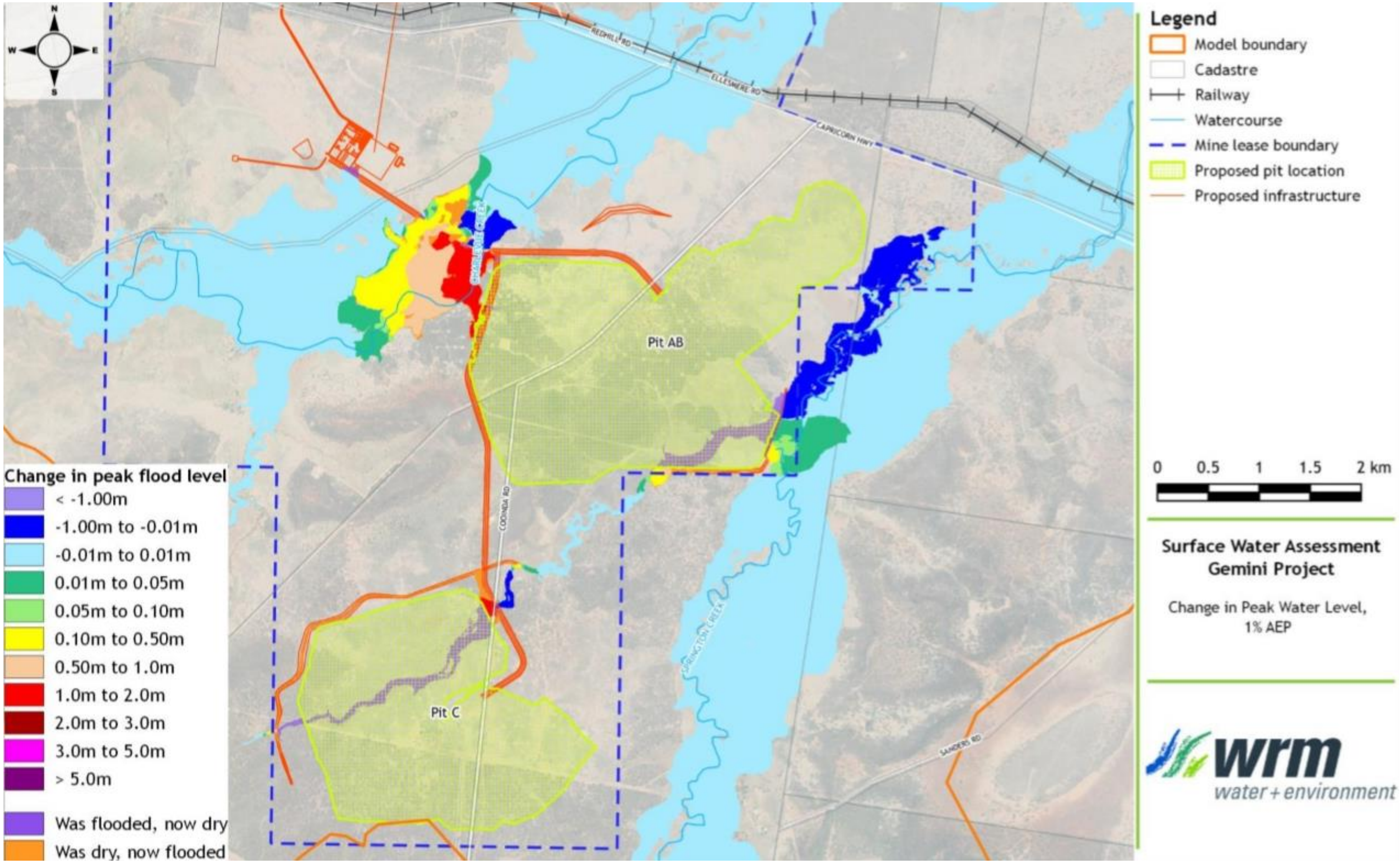


Figure 65 Change in Peak Flood Level from the Project (1% AEP)

7.3.7 Cumulative Impacts

Bluff PCI Project, located approximately 12 km west of the Project, is the nearest operation to the Gemini Project, and also contributes to the Springton Creek catchment, downstream of both Projects (Figure 57). The Walton Coal Project is proposed within the same catchment. The Bluff PCI Project and Walton Coal Project are of relatively small scale and short mine life.

Water supply for the Bluff PCI Project and Walton Coal Project are to be partially sourced from the Jellinbah Mine. Therefore, the potential cumulative impacts of these projects on flows in Springton Creek will be minimal.

Waterways that traverse the Gemini Project eventually flow into the Mackenzie River, which is a major tributary within the Fitzroy River basin. The Fitzroy River basin is the largest catchment in Queensland; draining into the Pacific Ocean and also the largest catchment draining into the Great Barrier Reef. However, it does not contribute significant freshwater flows to the coastal environment when compared to river systems further north.

Potential impacts (increased sediment load and salinity) on the water quality of the Fitzroy River basin and the connecting tributaries in the catchment will be mitigated through the use of the SWMS, including sediment basins, progressive rehabilitation, spill controls, release controls and water quality monitoring.

Provided that uncontrolled and controlled releases from the three Projects are managed in accordance with respective EA conditions, the proposed management approach for mine water from the Gemini Project is expected to have negligible cumulative impact on surface water quality and associated EVs.

Given the scale and nature of the three projects, cumulative impacts on flooding are not expected to lead to any adverse impacts on human populations, property or other environmental or social values.

7.4 MITIGATION MEASURES, MANAGEMENT AND MONITORING

7.4.1 Site Water Management Plan

The *Site Water Management Plan* will be developed in accordance with the Project's proposed EA conditions and will be informed by the *Surface Water Assessment* (Appendix B). The overarching objectives for the *Site Water Management Plan* is to minimise the impact of the Project's activities on the environmental values of the Project site and surrounding environment. The *Site Water Management Plan* will:

- minimise the use of clean water on site;
- minimise the requirement to source water from external supplies;
- minimise impacts on the receiving environment;
- minimise the impacts of flooding on mining operations; and
- minimise cumulative impacts with other mines in the region.

The Project's *Site Water Management Plan* will include the following components:

- an overview of the water management strategy and a description of the site water balance;
- design details of water management infrastructure;

- a description of baseline environmental values and water quality trigger values;
- reference to *a REMP* and *Groundwater Monitoring Program*;
- a description of the monitoring locations, methods, and reporting procedures for a *Site Water Management Monitoring Program*;
- a risk assessment to determine the risk of contaminates on the receiving environment;
- a response procedure for the reporting of unexpected exceedances of water quality trigger values;
- the reporting requirements and annual review process applicable to the Project's *Site Water Management Plan;* and

The *Site Water Management Plan* will focus on minimising impacts to surface water and groundwater quality and resources in accordance with the management hierarchy. The management hierarchy for surface water and groundwater as set out in the EPP (WWB) requires that, to the extent that it is reasonable to do so, surface water and groundwater impacts must be dealt with in the following order of preference:

- reduce the production of wastewater or contaminants by reducing the use of water:
- prevent waste and implement appropriate waste prevention measures;
- evaluate treatment and recycling options and implement appropriate treatment and recycling;
- evaluate the options for wastewater or contaminants in the following order of preference:
    - appropriate treatment and release to a waste facility or sewer;
    - appropriate treatment and release to land; and
    - appropriate treatment and release to surface waters or groundwaters.

Reduce the production of wastewater or contaminants by reducing the use of water

The production of wastewater or contaminants by reducing the use of water will managed through the following;

- defined operating rules for water related activities (refer Table 6.7, *Surface Water Impact Assessment,* Appendix B); and
- through the use of water efficient infrastructure including the use of belt press filters in the CHPP.

Prevent wastewater and implement appropriate waste prevention measures

The mine affected water system is a closed system designed to prevent the releases of mine affected water to the environment. Overflows of the Mine Water Dam have been designed to be directed via a diversion drain to the mine pit. The mine affected water system will manage runoff and seepage form the mine pits, CHPP, coal stockpiles and MIA. There is some potential for seepage of water from the Mine Water Dam to Charlevue Creek. This dam will be designed with a floor and sides of material that will limit seepage to avoid environmental harm.

The sediment water system is designed to capture sediments transported from runoff from overburden dumps. Overburden runoff quality is expected to be relatively benign and will potentially discharge to the receiving environment. The sediment water system will be managed under an *Erosion and Sediment Control Plan.*

Clean water from undisturbed areas is generally diverted around the areas of disturbance.

The *Site Water Management Plan* will manage water storages and transfers within the site in order to maximise onsite storage to meet reasonably anticipated periods of wet and dry weather.

Evaluate treatment and recycling options and implement appropriate treatment and recycling

The *Site Water Management Strategy* has been designed to promote the use/recycle lesser quality water in preference to higher quality water and to use potentially contaminated water in preference to imported raw water or uncontaminated water through the transfer of water onsite where:

- The Mine Water Dam receives pumped groundwater and surface runoff dewatered from Pit AB and Pit C. Water will be transferred from the Mine Water Dam for reuse at the CHPP, to meet the TLO water demands and for other uses as required.

- The TLO Dam comprises a series of sediment traps and small drainage dams that will be used to capture washdown and overflow from trains and sumps before it is directed to the TLO Dam. Water collected in this small dam will pumped to the Mine Water Dam.

Evaluate the options for wastewater or contaminants

To avoid significant downstream impacts, the system has been designed to achieve a high level of containment without the need for controlled releases. However, should water quality allow, the release water from site only in accordance with the conditions of the EA, such that the released water will not significantly impact on the values of the receiving waters or downstream properties;

Any unplanned overflows from the Mine Water Dam, would overflow to the mine pit. The only potential mine water release points are the MIA Dam spillways. However, these dams will be operated in such a way that the risk of release is small. Runoff from overburden dumps will be managed under an erosion and sediment control plan to reduce sediment loads to background levels before release. Water would be discharged either via sediment dam spillways or perforated riser pipes.

The potential impacts on receiving water quality and downstream flow are to be managed by the SWMS, which are discussed in Section 3.4. This includes:

- clean water drains to divert two sections of the unnamed tributary of Springton Creek around disturbed areas;

- sediment water drains to divert water from waste rock emplacement areas, and areas yet to be rehabilitated;

- sediment water dams to store water from waste rock emplacement areas and allow settlement of sediment loads before discharging treated water or recycling back to the CHPP;

- mine water drains to divert water from MIA, CHPP and coal stockpile areas into the MAW system; and

- mine water dams to store water pumped out of the pit, and capture water from the MIA, CHPP and coal stockpile areas.

7.4.2 Mine Affected Water Release

If any controlled releases are to occur, it would be in accordance with the EA conditions; consistent with the *Model water conditions for coal mines in the Fitzroy basin [ESR/2015/1561]* (DES 2013). The model conditions provided in this document are used as a basis for proposing specific water related protection commitments of EVs in the application documentation. The conditions include minimum flow and quality criteria and include commitments for monitoring during release events.

Section 6.9 of the *Surface Water Assessment* (WRM 2020b) outlines the potential for accumulation of water in the mine water dam and the mine pits. The mine water dam would overflow to Pit AB. The results show that the risk of discharge from the Pits is negligible, and that mining operations could be sustained in the long-term by transferring excess water to Pit AB once mining there was complete. The likelihood of discharging mine affected water from the pit MAW system is minimal. As mentioned previously, at the MIA and CHPP, the MAW system has been sized to ensure the likelihood of discharge is small.

Water would only be discharged from the system when there are significant flows in the receiving waters in accordance with the EA conditions.

7.4.3 Flood Mitigation

The proposed mine operations and associated infrastructure are largely located outside of Charlevue Creek and Springton Creek flood inundation areas, as illustrated in Figure 64.

Flood management controls for the Project include construction of a temporary flood protection levee for Pit AB. The flood levee design will ensure that the mine void is outside the 0.1% AEP flood event as well as the PMF event during operations and at final landform. Design of the flood level is provided in Section 3.4.3.1.

Clean water drains are also designed to divert clean water from the unnamed tributary of Springton Creek around disturbed areas; largely Pit AB and Pit C. It is therefore proposed that the design of the drains will take into account key design principles and requirements for the functionality of permanent diversions, including for operations, maintenance, monitoring and revegetation.

7.4.4 Receiving Water Monitoring

The *Aquatic Ecology Assessment* (AARC 2020a) (Appendix K) identified exceedances of regional WQOs, including high turbidity and suspended solids in the existing receiving waters. In this instance, the regional WQOs have not been considered a reliable indicator of the local system's long-term health. Site-specific reference/baseline values will be developed after a period of monitoring to assess future local water quality data. As a result, water quality in surrounding the Project will be monitored in accordance with a REMP that has been detailed below.

7.4.4.1 Receiving Environment Monitoring Program

A REMP Design Document has been developed for the Project in accordance with the *Model Mining Conditions* (DES 2017e) to demonstrate compliance with the EA release conditions. The REMP Design Document has detailed:

- release characteristics (quality and quantity);
- environmental values of the receiving environment that may be affected by a release and need to be enhanced and protected under the EPP (WWB);

- spatial extent of suitable test sites (including the location of monitoring sites and a controlled background reference);
- temporal context (including timing and frequency of sampling);
- monitoring indicators (including physical, chemical and biological);
- water quality objectives to measure chosen indicators;
- methodologies; and
- all implemented quality control and assurance procedures.

The REMP Design Document speculates that monitoring measures will be undertaken in line with Queensland's *Monitoring and Sampling Manual 2009* (DES 2018c) during periods of stream flow, ideally towards the end of the wet season, when safe access is available, and will include the following measures:

- monitoring of water quality parameters, including but not limited to; pH, EC, major anions (sulphate, chloride and alkalinity), major cations (sodium, calcium, magnesium and potassium), TDS, and a broad suite of soluble metals/metalloids;
- sediment and macroinvertebrate sampling;
- visual records of vegetation;
- stream morphology; and
- stream flow (level and velocity).

Data collection during the REMP will be undertaken annually at the two downstream sites and two upstream sites of the Project (Table 45) to compare background data and ensure any impacts to the local receiving environment are accurately reflected in the results of the REMP report.

Table 45 Receiving Water Monitoring Locations

Description	Location in Relation to the Project	Latitude	Longitude
Springton Creek US	Upstream	-23.6976	149.2738
Springton Creek DS	Downstream	-23.6434	149.3145
Charlevue Creek US	Upstream	-23.6305	149.2715
Charlevue Creek DS	Downstream	-23.6469	149.2104

Notes: Coordinates relevant to GDA94.

Monitoring will also occur at these locations during any controlled release of mine affected water. The receiving water thresholds that govern release opportunities are, pH (6.5 - 8.5), EC 310 µS/cm and sulphate 10 mg/L with streamflow parameters yet to be determined until a streamflow gauge is installed along Charlevue Creek. Under these provisions, the release of mine affected water into Charlevue Creek will only occur during periods of natural stream flow; and when receiving conditions are able meet the thresholds required to maintain relevant site-specific baseline water quality values.

Further details on the management of the receiving environment are provided in the REMP Design Document (Appendix Q).

7.4.5 Site Water Management System Monitoring

Onsite SWMS monitoring will be implemented to validate the SWMS performance against the design assumptions regarding water quality and water quantity. Monitoring will be specifically undertaken at the mine water dams and sediment dams. If required, adaptive management decisions will be undertaken where necessary to ensure protection of the surface water environment.

Mine Water Dam Monitoring

Any surface runoff and seepage water collected in mine water dams and the process water dam will be monitored for ‘standard’ water quality parameters including, but not limited to; pH, EC, major anions (sulphate, chloride and alkalinity), major cations (sodium, calcium, magnesium and potassium), TDS and a broad suite of soluble metals/metalloids.

Sediment Dam Monitoring

Monitoring of sediment dams will be used to validate the anticipated runoff quality reporting to sediment dams and haul road runoff dams. Initial monitoring will occur on a regular (e.g., monthly) basis to demonstrate the water quality of stored waters is consistent with the relevant operating parameters to allow releases from sediment dams to occur when required. Subject to demonstrating water quality is in accordance with the WQOs, the frequency of monitoring and suite of parameters for the sediment dam monitoring will be reviewed and updated accordingly when a release occurs.

8.0 GROUNDWATER

This section provides a description of the existing groundwater values within and surrounding the Project. It aims to identify the Project's potential impacts on the existing values and propose mitigation measures and management strategies to prevent or minimise adverse environmental effects.

This section is informed by the *Groundwater Impact Assessment* (JBT 2019) presented as Appendix C.

Surface water values have been discussed in Section 7.0, and GDEs within Section 6.0, and groundwater inflows are discussed in Section 3.4.5 and Section 4.0.

8.1 ENVIRONMENTAL OBJECTIVES AND PERFORMANCE OUTCOMES

The environmental objective relevant to potential impacts to groundwater as described in the EA guideline for *Application requirements for activities with impacts to water [ESR/2015/1837]* (DES 2017c) is:

The activity will be operated in a way that protects the environmental values of groundwater and any associated surface ecological systems.

The Project would achieve one of the following performance outcomes identified in Schedule 8, Part 3, Division 1 of the EP Regulation whereby:

1. *both of the following apply:*

   (a) *there will be no direct or indirect release of contaminants to groundwater from the operation of the activity; and*

   (b) *there will be no actual or potential adverse effect on groundwater from the operation of the activity; or*

2. *the activity will be managed to prevent or minimise adverse effects on groundwater or any associated surface ecological systems.*

8.2 DESCRIPTION OF ENVIRONMENTAL VALUES

The EPP (WWB) describes EVs to be protected or enhanced in Queensland. The Project is located within the 'Mackenzie Groundwaters' region within the broader Fitzroy Basin. The EVs identified on the *WQ1310 – Fitzroy Basin Groundwater Zones map* (EHP 2011b) for this region and their relevance to the Project are:

- **aquatic ecosystems:** values that are potentially associated with groundwater include those that support GDEs and are discussed in Section 6.0;
- **cultural & spiritual:** the groundwater that may be impacted by the Project is not known to have any cultural and spiritual value;
- **industrial use:** the groundwater that may be impacted by the Project may be suitable for industrial purposes, however, other than coal mining, there is no known industrial users of groundwater;
- **agricultural purposes:** groundwater use for agricultural purposes is limited to livestock and is discussed in Section 8.2.2; and

- **drinking water:** the groundwater that may be impacted by the Project is not known to be used as a drinking water supply due to its poor quality, as discussed in Section 8.2.2.

The values relevant to the MLA and surrounding area include:

- agricultural uses, where groundwater is extracted from surrounding agricultural bores; and
- aquatic ecosystems, where shallow groundwater may support GDEs in some capacity.

The *Groundwater Impact Assessment* (JBT 2019) (Appendix C) describes site-specific EVs in detail. The following sections provide a summary.

8.2.1 Geology and Hydrogeology

The surface geology of the Project predominantly comprises sediments of the Tertiary Duaringa Formation and Quaternary alluvium associated with ephemeral creeks. The underlying Bowen Basin solid geology is illustrated in Figure 66, showing the Project location in relation to the underlying Triassic and Permian sediments, as well as the prevalence of regional-scale faults. The target mining areas are located where folding has brought the coal seams closer to the surface at economically mineable depths.

There are 48 registered bores (listed as 'existing' or 'abandoned but useable') within 10 km of the MLA, with the majority of bores screened within Tertiary units (26 bores) or the Permian coal measures (15 bores). Aquifer data and groundwater EC data from the Department of Natural Resources, Mines and Energy (DNRME) groundwater database is displayed in Figure 67, and detailed in Table 4-5 of Appendix C.

The Project comprises a groundwater monitoring bore network of 38 bores at 17 sites (Figure 68), with locations detailed in Table 4-1 of Appendix C.

Analysis of available monitoring data from these regional and local bore networks concludes that groundwater occurs within three main groundwater units at site, including:

- Quaternary alluvium associated with Charlevue Creek and Springton Creek;
- Tertiary sediments of the Duaringa Formation; and
- Permian Rangal Coal Measures, where groundwater occurs preferentially within the coal seams.

A minor occurrence of Tertiary basalt has been identified from geological drilling to the north of Pit C. The area of basalt is approximately 600 m long, 200 m wide and 20 m thick and has been interpreted as a localised basalt paleochannel (JBT 2019). One groundwater monitoring bore has been located within the basalt (bore DW7105W1); the bore is 23 m deep and the basalt is dry at the bore location. The basalt flow is interpreted to be dry (as it is above the regional groundwater level) and of limited extent and is therefore not an important groundwater feature within the project area. Extensive geological drilling across the project area has shown no other evidence of basaltic flows or intrusions (JBT 2019).

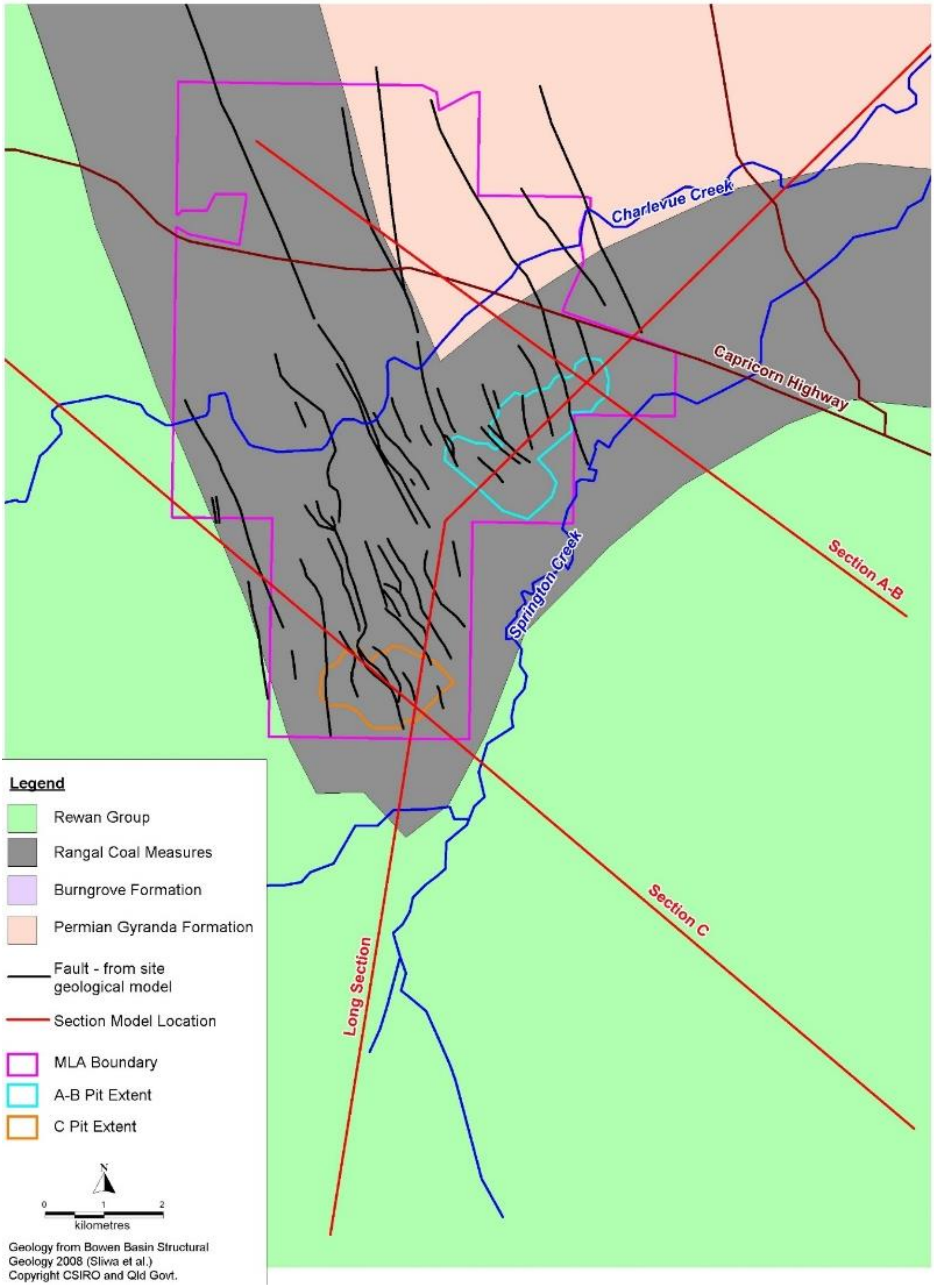


Figure 66 Project Location and Bowen Basin Solid Geology

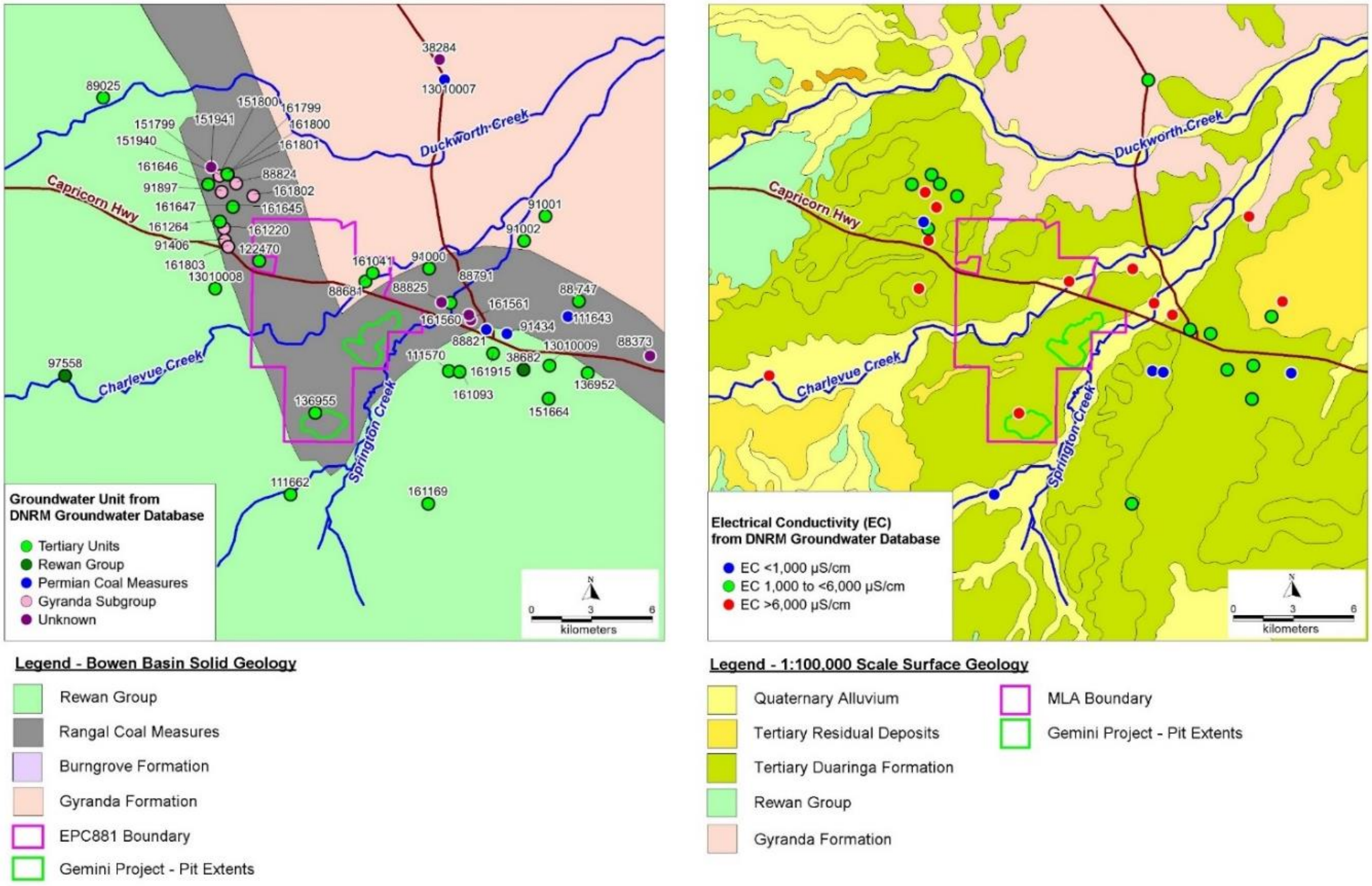


Figure 67 DNRME Groundwater Database - Aquifer and EC data

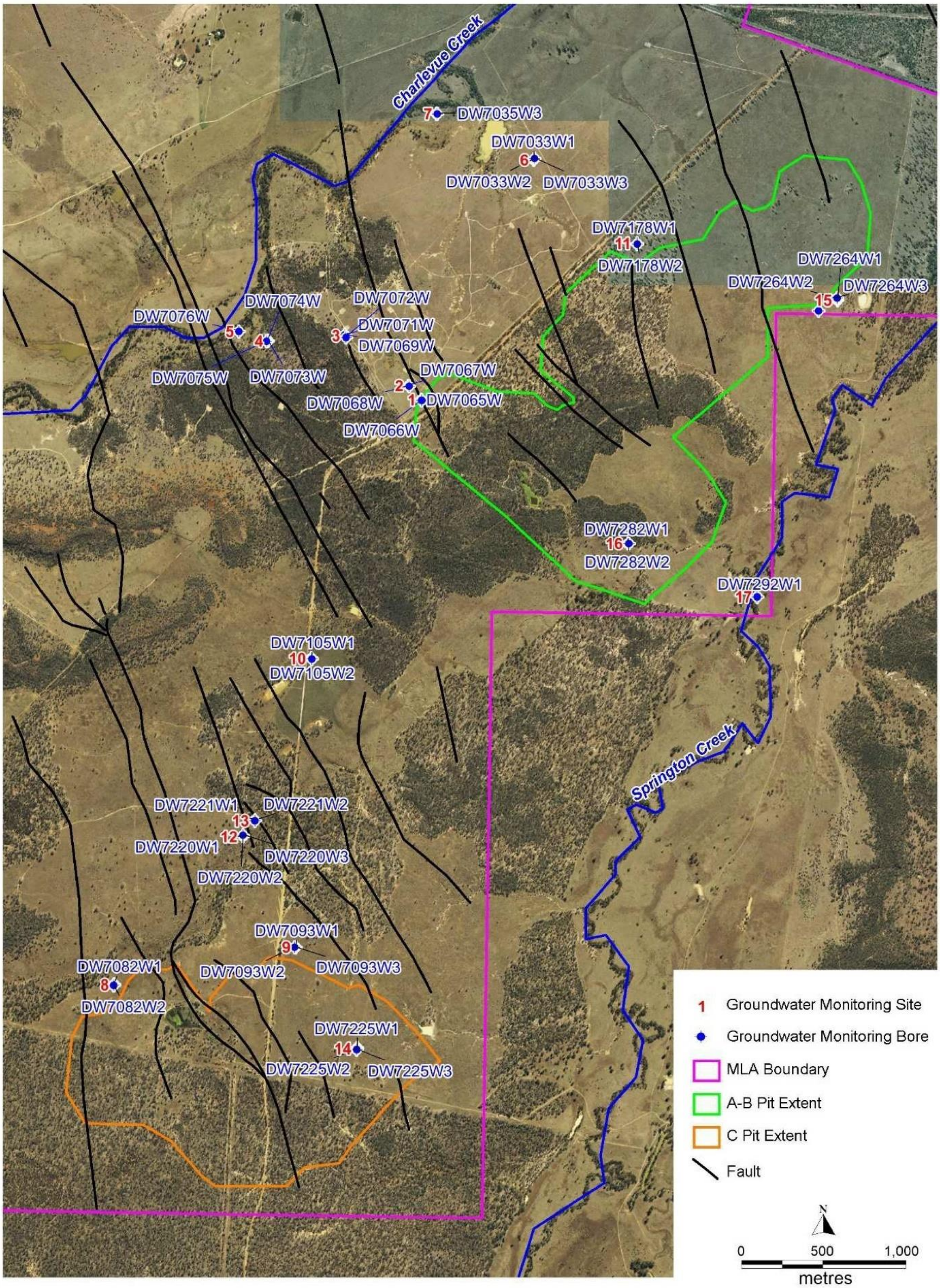


Figure 68 Groundwater Monitoring Bore Network

Detailed discussion of the installation and monitoring of the Project groundwater monitoring network can be found within Section 4.0 of Appendix C. Utilising data from the local and regional bore networks, an overview of the site-specific groundwater aquifers as described as follows. Characteristics of the aquifers are discussed in further detail in Section 8.2.2 Section 8.2.3 and Section 8.2.4.

Quaternary Alluvium

The Project has two monitoring bores within the Quaternary alluvium which is present within ephemeral waterways to the east and west of the mining areas (Springton Creek and Charlevue Creek, respectively). Recharge to alluvium is via direct rainfall recharge and occurs at a low rate. This is consistent with the observation of elevated salinity in the shallow sediments, likely due to the low rate of recharge, as well as high residence times for groundwater.

Tertiary Sediments

There are 26 registered bores in the region screened within Tertiary units and ten Project monitoring bores (one within Tertiary basalt); five of which are dry (including the Tertiary basalt bore). The presence of dry bores within the Tertiary, as well as a variation in water level between the topographically elevated base of Tertiary and topographically lower base of Tertiary, suggest that a continuous water surface does not exist in the Tertiary sediments and that the elevation of the base of Tertiary will be a control on the presence of groundwater within the sediments. From review of available data, it is assessed that it is probable that the Tertiary sediments are dry above 120 mAHD and likely dry above 110 mAHD. The Tertiary sediments exhibit similar recharge and salinity characteristics to the Quaternary alluvium.

Permian Rangal Coal Measures

There are 15 registered bores in the region screened within Permian coal seams and 26 Project monitoring bores (including three within the overburden/interburden sediments); only one of which is dry (Aries seam). Within the Permian coal measures the coal seams are the primary conduits for groundwater flow with no significant trend for upward or downward movement of groundwater between the coal seams. However, a trend occurs for groundwater movement through the coal seams from the southwest to the northeast, and also from the northwest to the southeast, towards a depression that is centred on the area where Pit AB is proposed to be developed. The coal seams are recharged in subcrop areas where the coal seams directly underlay Tertiary and/or Quaternary sediments. The extremely high salinity of groundwater within the coal measures supports an interpretation of a low rate of recharge to these units.

8.2.2 Groundwater Quality

Regional Groundwater Quality

ANZG (2018) outline a livestock drinking limit for salinity for beef cattle of 4,000 mg/L (equates to an approximate EC of 6,000 µS/cm). Bores that recorded a salinity in excess of this were assessed to be of limited or no use for stock watering.

The majority of bores within or close to the MLA recorded EC in excess of 6,000 µS/cm (refer to Table 4-5 in Appendix C). JBT (2019) noted that the EC of groundwater within the Tertiary sediments was often in excess of 10,000 µS/cm and at some sites in excess of 20,000 µS/cm (highly saline); which was consistent with groundwater quality data from the Project bore network. The majority of Tertiary bores outside the tenement area recorded an EC of <6,000 µS/cm, with four bores in Tertiary sediments to the east or south of the project area recording an EC <1000 µS/cm (mostly fresh). There is potential these bores may be used for stock-watering purposes.

Local Groundwater Quality

Groundwater quality data is available from samples taken between December 2018 and October 2020. Results are presented in Appendix D and have been summarised in Table 46.

Table 46 Summary of Groundwater Quality Results from Monitored Bores

Groundwater Unit		Field pH	EC (µS/cm)	Sulphate (mg/L)	Boron (mg/L)	Copper (mg/L)	Zinc (mg/L)
Quaternary Alluvium	Range	5.53-7.49	1,560-16,600	10-249	0.16-4.71	0.002-0.452	0.009-0.570
	Mean	6.77	10,221	140	2.83	0.129	0.142
	Median	7.21	14,300	184	3.89	0.096	0.053
Tertiary Sediments	Range	5.77-7.47	1,400-22,600	25-635	0.12-1.6	0.001-0.160	0.008-0.426
	Mean	6.5	12,413	170	0.85	0.014	0.079
	Median	6.75	9,880	146	0.78	0.007	0.058
Coal Seams	Range	5.56-8.5	959-32,800	2-841	0.1-2.1	0.001-1.470	0.007-0.420
	Mean	6.66	18,173	384	0.872	0.022	0.069
	Median	6.55	19,900	348	0.88	0.007	0.055

All groundwater units (Quaternary alluvium, Tertiary sediments and Permian coal measures) recorded very high EC above the ANZG (2018) livestock drinking limit for beef cattle of approximately 6,000 µS/cm. Salinity increases with aquifer depth, and it is unlikely that groundwater units within the Project are used for stock watering. Due to the high salinity of the groundwater, samples were also relatively high in sulphate, especially for the coal seams.

Groundwater quality was typically above the ANZG (2018) freshwater ecosystem protection trigger value (95% species protection) for boron (all samples), copper and zinc (majority of samples) as well as aluminium, arsenic, lead and nickel (a number of samples for each analyte).

The pH (field testing) of groundwater within the Project area was mostly neutral, with the Quaternary alluvium ranging from 5.53 to 7.49; the Tertiary sediments ranging from 5.77 to 7.47; and the Permian coal seams ranging from 5.56 to 8.5.

8.2.3 Hydraulic Conductivity

Falling head tests were undertaken on 25 bores from the Project bore network to obtain site-specific hydraulic conductivity data from all Project groundwater units. Hydraulic conductivity and air-lift yield data for each monitoring bore is in Table 4-2 of Appendix C (JBT 2019) and summarised for each groundwater unit in Table 47.

A total of 17 slug tests were performed on bores that are screened within the coal seams. The hydraulic conductivity decreased with depth with the difference evident when comparing coal seam bores screened at a depth of less than 80 mbgl to bores screened at a depth greater than 80 mbgl.

Table 47 Hydraulic Conductivity and Air-Lift Yield Data Per Groundwater Unit

Groundwater Unit	No. of Tests	Hydraulic Conductivity (metres per day)			Average Air-lift Yield (L/s)
		Min	Max	Geometric Mean	
Quaternary Alluvium	1	0.097	-	-	-
Tertiary	5	0.027	3.805	0.27	0.548
Permian Coal Seams	17	0.002	5.387	0.13	1.185
Coal Seams <80 mbgl	11	0.012	5.387	0.37	1.578
Coal Seams >80 mbgl	6	0.002	0.245	0.02	0.320
Permian Interburden	2	0.001	0.002	-	-

The relationship between hydraulic conductivity and depth is shown graphically in Figure 69. Of particular interest is the data for the coal seam bores, where the trend for lower hydraulic conductivity with increasing depth is illustrated via the trend line and the 95% confidence interval that has been applied to the data.

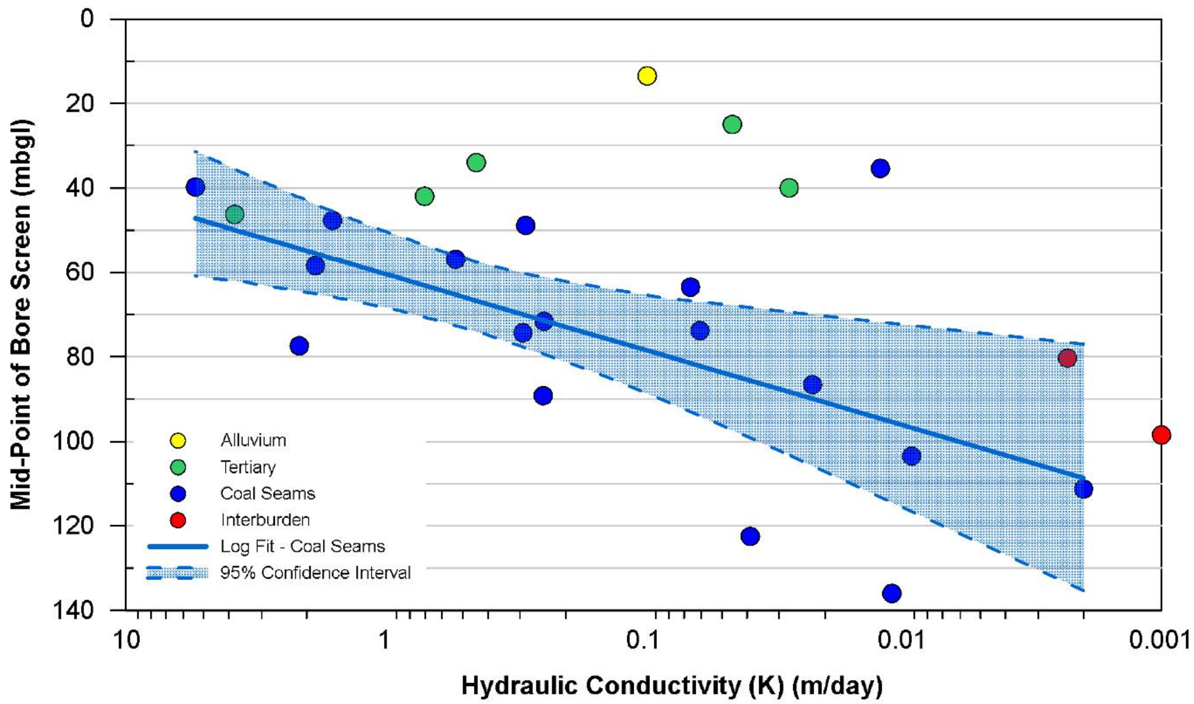


Figure 69 Relationship Between Hydraulic Conductivity and Depth

8.2.4 Groundwater Level

The most recent groundwater level data for the Project monitoring network bores is detailed in Appendix D. Figure 70 and Figure 71 illustrate water level data for Tertiary and coal seam groundwater units, respectively.

Six of the monitoring bores were dry; five within Tertiary sediments (depth: 14 m to 23 m) and one within the Aries seam (depth: 31.6 m).

Of the five dry sites; two were drilled to base of Tertiary, indicating that the Tertiary is dry at these locations, whilst the other three were not constructed to the full depth of Tertiary sediments. There was a significant reduction in depth to base of Tertiary to the west and northwest of Pit AB, where the base of Tertiary lowers from approximately 100 mAHD to 70-80 mAHD. The bores within the lower elevation area of base of Tertiary tended to record water levels in the order of 90 to 95 mAHD, whereas the bores in the higher elevation area tended to range between 105 to 113 mAHD.

The data for bores within the coal seams suggest that the coal measures are continuously saturated and that there is no significant trend for upward or downward movement of groundwater between the coal seams. Figure 71 shows the pre-mining groundwater level contours for the coal measures; indicating a trend for groundwater movement within the coal seams from the southwest to the northeast, and also from the northwest to the southeast, towards a depression that is centred on the area where Pit AB is proposed to be developed.

Bore DW7076W is located adjacent to Charlevue Creek (refer Figure 68) and screened in the Quaternary alluvium. The bore has been fitted with a data logger that records water level at 3-hourly intervals which will allow the relationship between creek flow and water level to be established over time. To date, the water level has been relatively stable, displaying a slight downward water level trend between 9-10 mbgl. A downward spike in water level following sampling is evident in the bore hydrograph (Figure 72), indicating that sampling events may have some influence on water level. An increase in water level after February 2020 suggests some correlation between rainfall events and associated streamflow, and water level. Further data will continue to be collected to establish the long-term water level trend.

Bore DW7292W1 is screened in the Quaternary alluvium adjacent to Springton Creek. The bore was initially fitted with a data logger in April 2020. However, the logger was found to be faulty and was replaced in July 2020, and records water level at 6-hourly intervals which will allow the relationship between creek flow and water level to be established over time. To date, the water level has been relatively stable, displaying a slight downward water level trend between 10-11 mbgl. A downward spike in water level following sampling is evident in the bore hydrograph (Figure 73), indicating that sampling events may have some influence on water level.

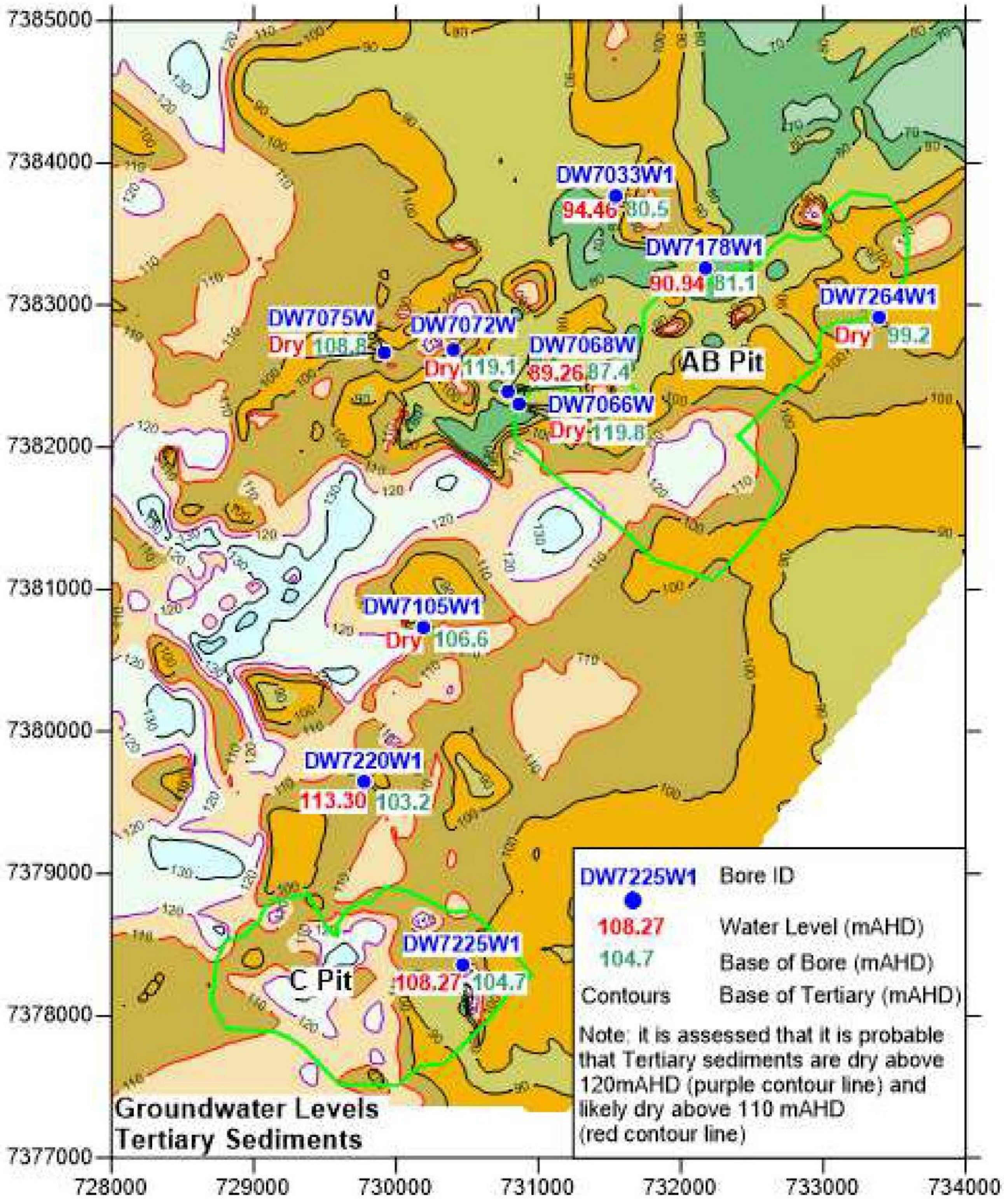


Figure 70 Water Level Data (Tertiary Groundwater Units)

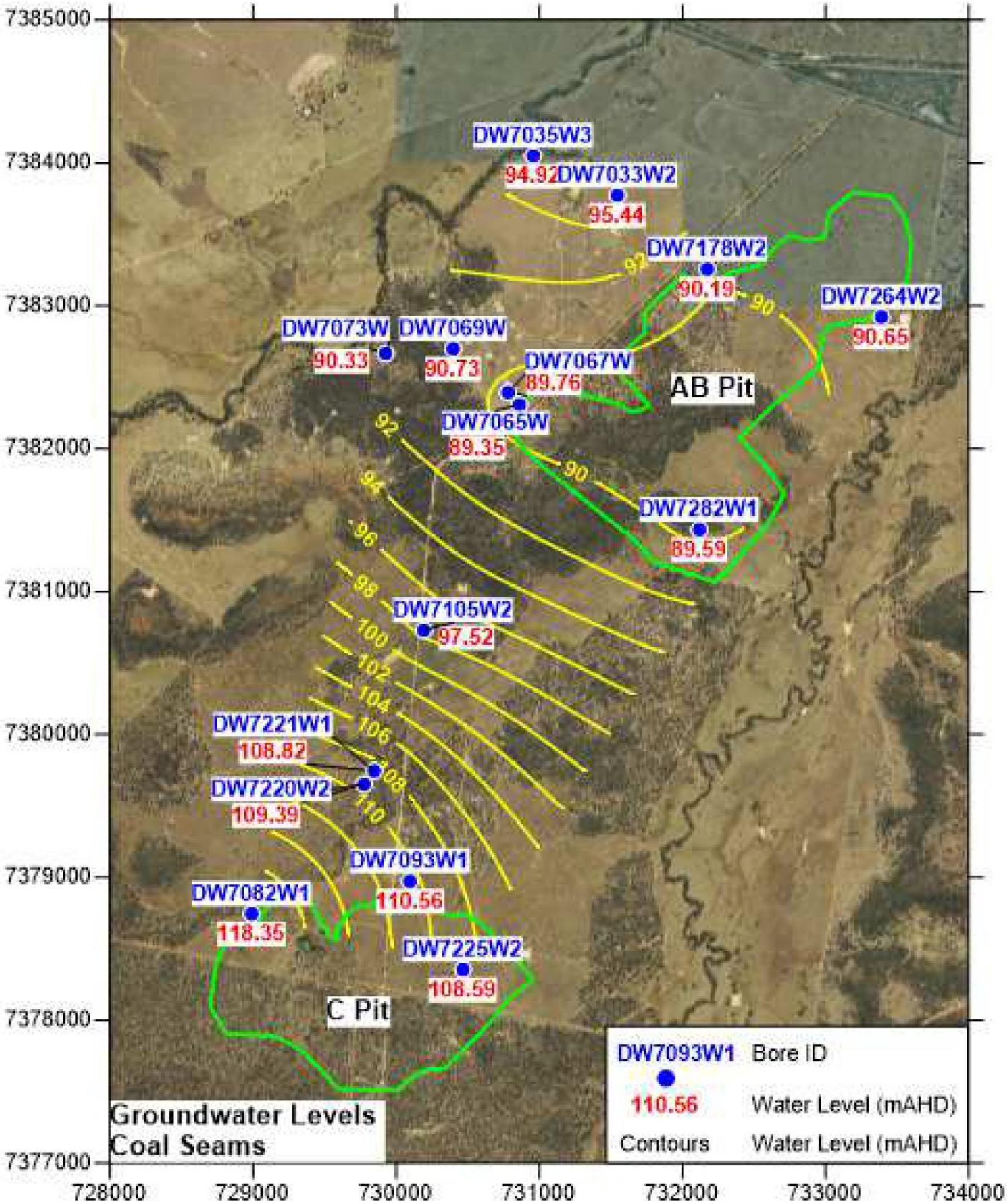


Figure 71 Water Level Data (Permian Coal Seam Groundwater Units)

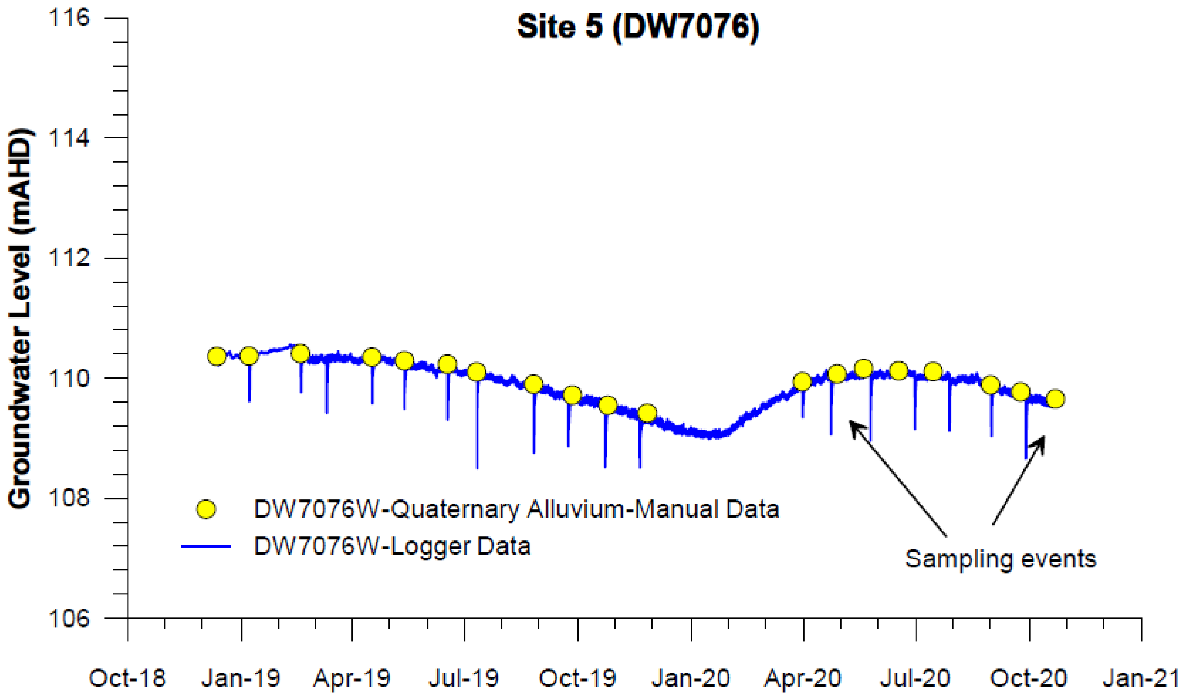


Figure 72 Water Level Data (Quaternary Alluvium - Bore DW7076W)

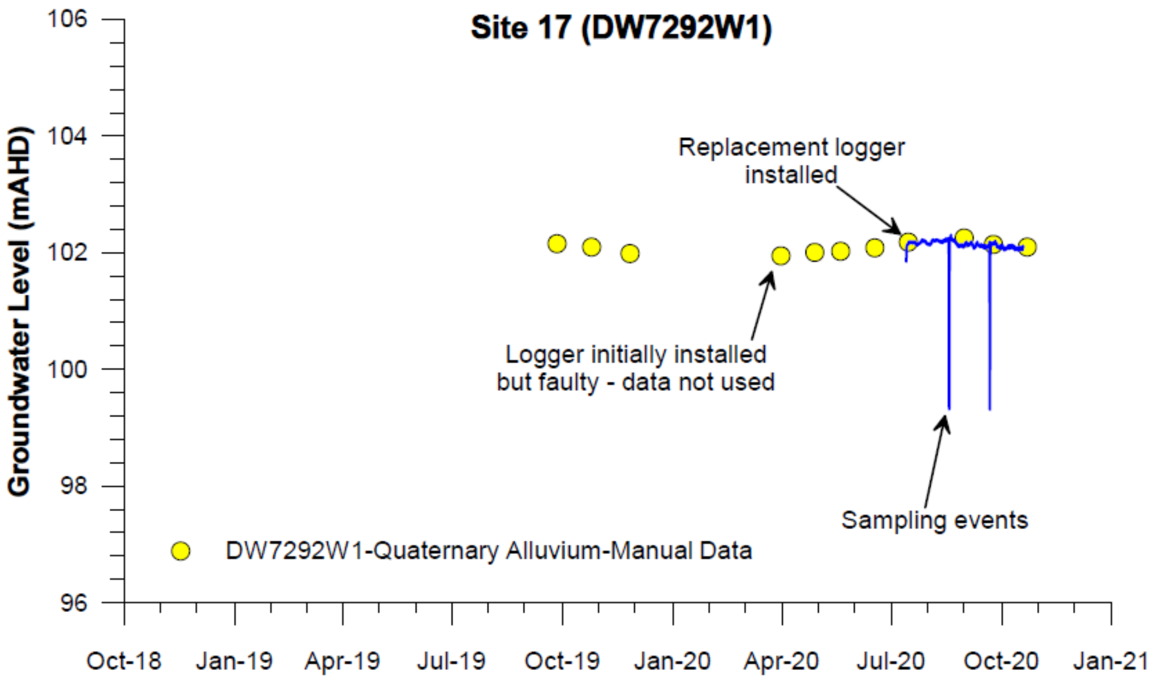


Figure 73 Water Level Data (Quaternary Alluvium - Bore DW7292W1)

8.3 POTENTIAL IMPACTS

The proposed mining activity has potential to impact groundwater values of the Project via:

- A drop in surrounding groundwater level occurring as a result of drawdown from the mining activity. The change in water level has potential to reduce the availability of water in existing groundwater bores. In addition, the drop in groundwater level may also reduce available supply for potential GDEs, where they exist within the zone of influence.

- An increased risk of groundwater contamination either via spills or leaks that might occur during the operation and have potential to seep to shallow aquifers, or in the post mining landform, subject to the final void equilibrium level and the associated risk of water in the void seeping in surrounding aquifers.

It is noted that the risk of groundwater drawdown from the project is limited to the take of Associated Water only. Groundwater is not proposed to be extracted as a source of water for any other related activity. The total predicted take of associated water is detailed in Table 48 (JBT 2019; JBT 2019, pers. comm., 8 October). For the purpose of future associated water reporting, JBT (2019) concluded that it would be more reasonable to assume the rate of inflow prior to development of the spoil aquifer, (approximately ~500 m^3/day) as the water that is developed from the spoil is derived mainly from rainfall recharge to the spoil and does not represent water from the natural formation. It is estimated that annual take of associated water will range from 150 Ml/a to 345 Ml/a.

Table 48 Estimated Take of Associated Water

Year	Pit AB		Pit C		Total
	m^3/day	Ml/a	m^3/day	Ml/a	Ml/a
1	626	228	0	0	228
2	626	228	0	0	228
3	433	158	0	0	158
4	433	158	0	0	158
5	508	185	0	0	185
6	508	185	0	0	185
7	946	345	0	0	345
8	946	345	0	0	345
9	493	180	0	0	180
10	493	180	0	0	180
11	493	180	0	0	180
12	493	180	121	44	224
13	493	180	121	44	224
14	493	180	241	88	268
15	453	165	241	88	253
16	453	165	239	87	253
17	248	91	239	87	178
18	248	91	163	59	150

The *Groundwater Impact Assessment* (JBT 2019) (Appendix C) was undertaken to assess the impacts of the Project. The following sections provide a summary of impacts relating to groundwater drawdown and the risk of contamination.

The potential for impacts of the Project on GDEs is described within Section 6.0. The potential impacts associated with final void water levels are described in more detail within Section 4.0.

Additional impacts from groundwater leaching have been identified in the *Land-Based Effluent Disposal Assessment* (Appendix N). According to the Model for Effluent Disposal through Land Irrigation (MEDLI) model scenario, elevated levels of nitrogen can be leached into the groundwater table when more nitrogen is added than removed to the soil (i.e., heavy rain periods). A construction and operational average of nitrate is predicted to leach 0.17 kg/ha/year via deep drainage during extremely impermeable conditions and during extremely permeable conditions, an average of 1.29 kg/ha/year. These conditions are still well within the accepted limit of 5 kg/ha/year. The irrigation scheme will still need to be managed via use of an appropriate irrigation rate and set back distances to minimise any impact on groundwater and any potential GDEs. The management measures of sewage effluent are discussed in Section 12.7.1.1.

8.3.1 Groundwater Model

To estimate the extent of water level impact from the proposed project, the *Groundwater Impact Assessment* (JBT 2019) (Appendix C) utilised 2-dimensional seepage modelling using the program Seep/W.

Section 5.0 of Appendix C details the essential elements of the conceptual model used to inform the Seep/W numerical model. The choice of the numerical model code was based on an assessment of the model platform and appropriate to the study requirements (assessment details in Section 6.1 of Appendix C). Sections 6.2 through to 6.5 (of Appendix C) present technical details of model inputs, whilst Section 6.7 details the uncertainty analysis.

8.3.2 Assessment Criteria

Criteria against which groundwater drawdown was assessed is based on the ‘bore trigger thresholds’ for the Water Act. A ‘bore trigger threshold’ as defined under section 362 of the Act; is a decline in the water level in the aquifer that is:

(a) the prescribed threshold for the area (if a regulation prescribes the bore trigger threshold for an area in which the aquifer is situated); or

(b) otherwise:

- *(i) for a consolidated aquifer – 5 m; or*
- *(ii) for an unconsolidated aquifer – 2 m.*

The potential for impact on existing groundwater users is discussed in Section 8.3.4, whilst the potential for water level impact on GDEs is discussed in Section 6.0.

8.3.3 Modelling Results

Water Quality

Modelling predicted that a permanent cone of depression will develop, directing groundwater flow towards the final voids. Therefore, the risk of the Project impacting on water quality (via outflow to the groundwater system) was assessed to be low.

It was, however, assessed that the Project could impact groundwater quality if the water within the final void were able to exit the void via unconsolidated sediments (i.e., the base of Tertiary) and flow via the groundwater system towards sensitive environmental receptors such as Springton Creek. For this reason, an assessment of the potential for water within the final voids to exit the void via the base of Tertiary sediments was undertaken. This assessment concluded that there is no outlet via the base of Tertiary for water within the final void of either Pit AB or Pit C, for either the maximum 'base case' water level or the maximum 'high inflow case' water level. It is concluded that there is a low risk of the Project impacting on groundwater quality.

Groundwater Level

The modelled drawdown extent at the end of mining is shown in Figure 74, and at post-mining equilibrium (i.e., steady-state post-mining drawdown) in Figure 75. The contours are shown as drawdown extent based on extrapolation of data points from each of the cross-section models (as depicted on Figure 74 and Figure 75).

At the end of mining, the 5 m drawdown extent is approximately 2 km from Pit AB and 1.8 km from Pit C, on the western side of the mining areas. On the eastern side, the 5 m extent is approximately 2 km from both Pit AB and Pit C. The 5 m extent of drawdown is approximately 1 km from Pit C at the southern end of the mining area, and approximately 2 km from Pit AB at the northern end. The 2 m drawdown contour extends approximately a further 1 km, than the 5 m drawdown extent.

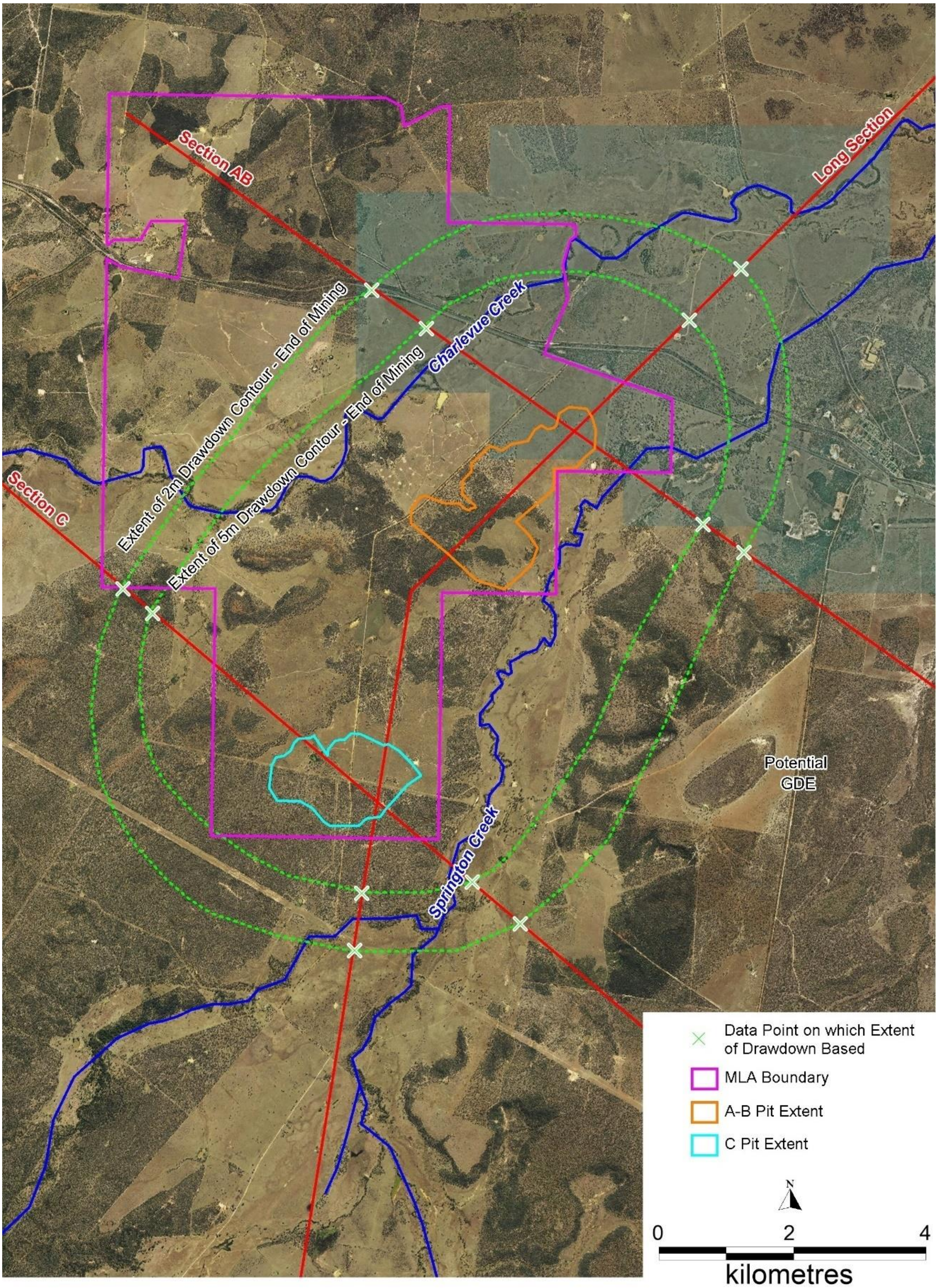


Figure 74 Water Level Drawdown Contours (2m and 5m) - End Of Mining

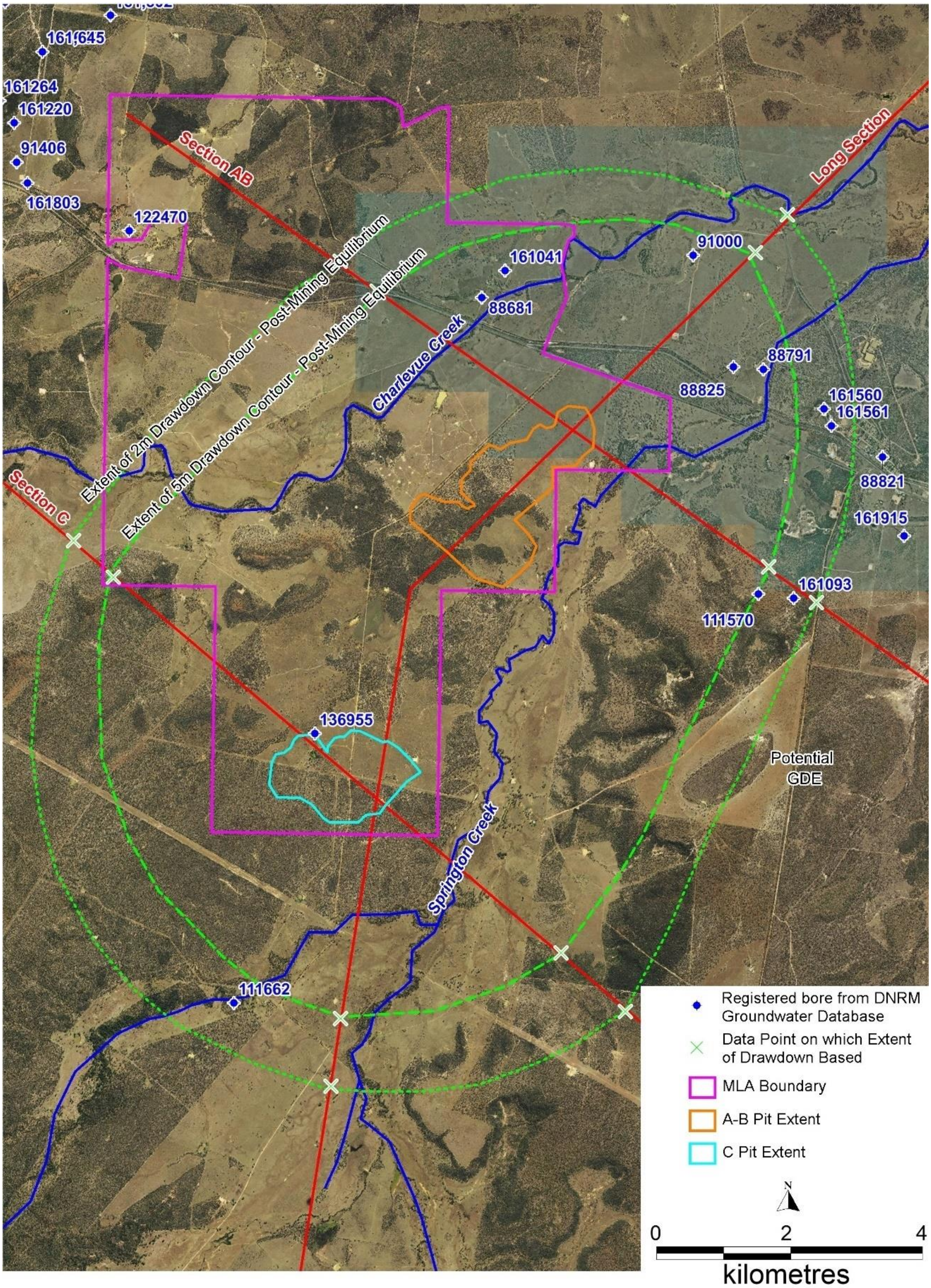


Figure 75 Water Level Drawdown Contours (2m and 5m) - Post-Mining Equilibrium

At post-mining equilibrium, the 5 m drawdown extent is approximately 2 km further from Pit C at the southern side and 2 km further from Pit AB at the northern end of the mining area, than at end of mining. The drawdown contours also extend further to the east and west another approximately 2.5 km. There are no mining operations within the zone of predicted drawdown from mining at the Gemini Project; therefore, there are no cumulative impacts to assess.

8.3.4 Impacts on Existing Groundwater Users

Groundwater Level

Figure 74 (end of mining) and Figure 75 (post-mining equilibrium) show 11 registered groundwater bores (from the DNRME groundwater database) within the 2 m drawdown zone. Summary data for the bores within this zone are shown in Table 49 and summarised as follows:

- seven bores (111662, 136955, 111570, 161093, 88973, 161041 and 88681) are located on land that is owned by Magnetic South;
- two bores (161560 and 161561) appear to be monitoring bores for the Dingo Landfill;
- three bores record groundwater that is highly saline and assessed to be of no beneficial use (in excess of the upper limit of salinity tolerance for beef cattle, sheep, horses and pigs with no loss of production, with a decline in animal health at progressively higher salinity values (ANZG 2018). These bores recorded EC values of 10,000 µS/cm (88681), 19,200 µS/cm (88791) and 14,660 µS/cm (91000);
- two bores (88825 and 161041) are sites with relatively little available data, but which are located within the zone of potential impact to the northeast and west-northwest of Pit AB respectively; and
- two bores (111570 and 161093) recorded relatively fresh groundwater (<1,000 µS/cm) at shallow depth. While these bores are located within the extent of 2 m drawdown, they were assessed to be isolated from the regional groundwater system as discussed in detail with relation to GDEs in Section 7.2.1 of Appendix C. At these sites it is noted that they are not located within the zone of potential impact at end of mining but are within the zone of potential impact at post-mining equilibrium.

Based on the assessment of bores within the zone of influence, it is unlikely that the Project will significantly impact on the availability of groundwater for agricultural land use.

Where there is remaining uncertainty over the presence, or the productive use of bores within the zone of influence, further assessment in the form of a bore plan and assessment will be undertaken prior to development. It is further noted that make-good agreements will be put in place where it is determined that drawdown affects the utility of the bore.

Water Quality

Considering the mining activity is predicted to result in a permanent cone of depression, and the lack of an outlet via the base of Tertiary for water within the final void of either Pit AB or Pit C, it was concluded that the risk of significant groundwater contamination was very low.

The risk of spills or leaks causing contamination is assessed to be manageable and unlikely to result in environmental harm.

Table 49 Bores from DNRME Groundwater Database Within 2 M Drawdown Zone

RN	Aquifer	EC (µS/cm)	SWL (mbgl)	Original Bore Name	Comment
88681	Duaringa Formation	10,000	-	-	Extremely saline - no beneficial use based on water quality.
88791	Duaringa Formation	19,200	-20	New Bore	Extremely saline - no beneficial use based on water quality.
88825	Unknown	-	-	Windmill	-
91000	Duaringa Formation	14,660	-20	Mackenzie OLO	Extremely saline - no beneficial use based on water quality.
111570	Tertiary-Undefined	240	-16	Ward	Refer to Appendix C (Section 7.2.1) for discussion.
111662	Tertiary-Undefined	750	-17	Smith	Located on land owned by Magnetic South.
136955	Tertiary-Undefined	10,300	-21	-	Located within MLA on land owned by Magnetic South.
161041	Duaringa Formation	-	-29	-	-
161093	Tertiary Mafic Volcanics	710	-19.5	-	Refer to Appendix C (Section 7.2.1) for discussion.
161560	Unknown	28,102	-	Dingo Landfill MW2	Assumed to be a monitoring bore at Dingo Landfill.
161561	Unknown	-	-	Dingo Landfill MW1	Assumed to be a monitoring bore at Dingo Landfill.

Notes: RN registration number
SWL surface water level

8.4 MITIGATION MEASURES, MANAGEMENT AND MONITORING

Overall, the *Groundwater Impact Assessment* (JBT 2019) (Appendix C) concluded that there is a low risk the Project would impact on groundwater quality, groundwater level or potential GDEs. The management and monitoring strategies will ensure groundwater resources are managed and risk remains low. Magnetic South is committed to implementing procedures for monitoring and complaints resolution to control magnitude of risk.

Impacts and mitigation measures for protection of potential GDEs is discussed in detail within Section 6.0.

Associated Water Take

Monitoring and annual reporting of associated water take will be in accordance with the requirements of the MR Act.

Landholder Bores

Magnetic South will prepare an *Underground Water Impact Report* for submission and approval in accordance with the Water Act. The report will identify aquifers that are predicted to be impacted by the exercise of underground water rights; establish obligations to monitor impacts on aquifers and springs;

impose a strategy to mitigate impacts on any spring of interest; assist with management of impacts of the exercise of water rights by resource tenure holders; and establish underground water obligations (make good obligations of the resource tenure holder for private water bores.

Where it has been determined that an impact on landholder bores exists, a *Baseline Assessment Plan* will be prepared (as required by the Water Act) identifying water bores located on a holder's tenure and setting out a timetable for undertaking baseline assessments of those bores.

If required, bore assessments and 'make good agreements' will be established (in accordance with the Water Act) with any relevant stakeholders.

Groundwater Monitoring and Evaluation Program

The Project groundwater monitoring bore network established for the baseline studies will continue to be monitored throughout operation and decommissioning. A copy of the *Groundwater Monitoring and Management Plan* for the Project is included as Appendix E, with the main elements summarised below.

The monitoring program will record groundwater levels and water quality from existing monitoring bores to provide long term groundwater level data from the Project area, and to detect and quantify potential drawdown occurring during and post mining.

The groundwater monitoring bore network was designed based on the following considerations:

- bores are located within all groundwater units present at site (Quaternary alluvium of Charlevue Creek and Springton Creek, Tertiary sediments, Permian coal seams and interburden units);
- the majority of bores were located in the area of the AB pit, as this pit is planned to be developed first;
- the bores are broadly aligned in two transects to provide drawdown data within the mined area, immediately adjacent to the mined area, and at distance towards Charlevue Creek and Springton Creek;
- bores are located within all groundwater units that exist between the AB Pit and the C Pit, to provide information on the extent of drawdown between the pits and as a way of providing drawdown data to validate the groundwater model;
- additional bores are located within and immediately adjacent to the C Pit, within all groundwater units encountered in that area (to base of mining) to provide both water level and water quality data in that area;
- the spatial and vertical layout of the bore monitoring network (which includes 38 bores at 17 sites) will allow:
    - assessment of the variability of water quality across the site and within vertically separated groundwater units at the same location (e.g., coal measures and overlying Tertiary sediments);
    - assessment of the potential for upward vs downward groundwater movement at a single location;
    - assessment of groundwater flow direction within the distinct groundwater units; and

- o assessment of recharge potential of the various groundwater units, particularly the Quaternary alluvium where water level loggers have been fitted to bores DW7076W and DW7292W.

Compliance and reference bores have been selected as follows:

- The compliance bores provide a spatial coverage within all groundwater units identified at site and where possible are located close to mining areas (within the zone of predicted impact) but not within the disturbance footprint of mining (i.e., within the proposed pit area).

- Reference bores have been selected to be located within the same groundwater units but at locations that are distant from the area where mining is first proposed to commence (the AB Pit Area). As mining progresses towards the C Pit area, the existing reference bores are likely to become the compliance bores for that area.

Because a large number of Tertiary monitoring bores are dry, the proposed compliance bore network for Tertiary bores is limited to the bores that contain water. One bore (DW7225W1) is located within the mining footprint of the C Pit, though mining of the AB Pit will occur in advance of mining in this area. The bore is included to provide spatial coverage of the Tertiary sediments but will require replacement once mining in the C Pit area commences.

Bores within the alluvium are targeted for monitoring via water level dataloggers to allow assessment of the range of seasonal water level variation at these sites, with data loggers fitted to bores DW7292W1 (Springton Creek alluvium) and DW7076W (Charlevue Creek alluvium).

A summary of the Project groundwater monitoring bore network is provided in Table 50.

Table 50 Groundwater Monitoring Bores

Site	Bore ID	Unit Monitored	Easting (GDA94)	Northing (GDA94)	Collar RL (mAHD)	Monitoring Frequency
Control Bores						
2	DW7068W	Tertiary	730785	7382391	134	2-Monthly
3	DW7069W	Permian	730397	7382699	132.57	2-Monthly
	DW7071W	Permian	730394	7382703	132.4	2-Monthly
4	DW7073W	Permian	729926	7382666	122.09	2-Monthly
	DW7074W	Permian	729922	7382666	122.04	2-Monthly
	DW7075W	Tertiary	729918	7382666	121.83	2-Monthly
5	DW7076W	Quaternary Alluvium	729750	7382723	119.81	2-Monthly
6	DW7033W1	Tertiary	731543	7383768	124.4	2-Monthly
	DW7033W2	Permian	731546	7383773	124.45	2-Monthly
	DW7033W3	Permian	731548	7383777	124.43	2-Monthly
7	DW7035W3	Permian	730957	7384050	116.67	2-Monthly
11	DW7178W1	Tertiary	732174	7383260	128.65	2-Monthly
15	DW7264W2	Permian	733391	7382921	112.24	2-Monthly
	DW7264W3	Permian	733391	7382925	112.24	2-Monthly
17	DW7292W1	Quaternary Alluvium	732905	7381108	113.58	2-Monthly
Reference Bores						

Site	Bore ID	Unit Monitored	Easting (GDA94)	Northing (GDA94)	Collar RL (mAHD)	Monitoring Frequency
8	DW7082W1	Permian	728989	7378746	135.26	2-Monthly
	DW7082W2	Permian	728986	7378742	135.33	2-Monthly
9	DW7093W1	Permian	730096	7378974	139	2-Monthly
	DW7093W2	Permian	730092	7378973	139.05	2-Monthly
	DW7093W3	Permian	730088	7378974	139.12	2-Monthly
10	DW7105W2	Permian	730193	7380729	128.7	2-Monthly
12	DW7220W1	Tertiary	729775	7379648	128.68	2-Monthly
	DW7220W2	Permian	729775	7379651	128.64	2-Monthly
	DW7220W3	Permian	729774	7379655	128.68	2-Monthly
13	DW7221W1	Permian	729846	7379745	129.32	2-Monthly
	DW7221W2	Permian	729845	7379742	129.25	2-Monthly
14	DW7225W1	Tertiary	730467	7378359	140.64	2-Monthly
	DW7225W2	Aries 3 Seam	730466	7378355	140.69	2-Monthly
	DW7225W3	Castor Seam	730465	7378351	140.7	2-Monthly

Groundwater Trigger Values

Based on the baseline monitoring data collected to date, trigger levels have been proposed for the compliance monitoring bores within the groundwater monitoring network. The trigger levels are proposed as interim trigger levels and it is proposed that the levels are further reviewed after collection of an additional 2 years of data. Trigger levels are provided in Table 51, and have been proposed based on the following rationale:

- for EC and sulphate the trigger level is based on the 95th percentile of the data for each groundwater unit;
- for pH, the proposed trigger level range is based on the range of site data;
- for metals/metalloids where the data is generally below the ANZG (2018) aquatic ecosystem protection limit for moderately disturbed system (95% protection), the proposed trigger level is based on the ANZG (2018) limits;
- for mercury, the proposed trigger is based on the limit of reporting (LOR) of the analytical method FIMS; and
- for metals/metalloids where the site background data is generally above the ANZG (2018) freshwater protection limit, the proposed trigger level is based on the 95th percentile of the data for each groundwater unit.

Data for each of the proposed compliance bores compared to the proposed trigger levels are shown graphically in Appendix D.

Table 51 Proposed Groundwater Quality Trigger Levels

Parameter	Groundwater Unit			Figure No (6)
	Quaternary Alluvium	Tertiary	Permian	
pH (pH units)	5.5 – 8.5 (1)	5.5 – 8.5 (1)	5.5 – 8.5 (1)	25
Electrical conductivity (µS/cm)	16209 (2)	22362 (2)	28692 (2)	23
Metals/metalloids (dissolved – mg/L) (5)				
Aluminium	0.09 (2)	0.13 (3)	0.13 (3)	26
Arsenic	0.013 (3)	0.013 (3)	0.019 (2)	27
Boron	4.66 (3)	1.46 (3)	1.42 (3)	28
Cadmium	0.0002 (2)	0.0002 (2)	0.0002 (2)	29
Cobalt	0.004 (3)	0.004 (3)	0.019 (2)	30
Chromium	0.001 (3)	0.001 (3)	0.001 (3)	31
Copper	0.069 (2)	0.065 (2)	0.083 (2)	32
Mercury	0.0001 (4)	0.0001 (4)	0.0001 (4)	33
Manganese	0.227 (2)	0.19 (2)	0.468 (2)	34
Molybdenum	0.004 (2)	0.017 (2)	0.081 (2)	35
Nickel	0.056 (2)	0.02 (2)	0.002 (2)	36
Lead	0.034 (3)	0.034 (3)	0.034 (3)	37
Selenium	0.005 (3)	0.005 (3)	0.005 (3)	38
Uranium	0.058 (2)	0.01 (2)	0.018 (2)	39
Vanadium	0.026 (2)	0.006 (3)	0.006 (3)	40
Zinc	0.46 (2)	0.17 (2)	0.015 (2)	41
Major Ions (mg/L)				
Sulphate	226 (2)	346 (2)	766 (2)	24
Calcium, chloride, potassium, magnesium, sodium, alkalinity	For interpretation purposes only			

(1) Range of site data
(2) 95th Percentile of data for each groundwater unit
(3) ANZG (2018) Aquatic ecosystem protection for moderately disturbed system (95% protection)
(4) LOR of FIMS analytical method
(5) All metals and metalloids to be measured as total (unfiltered) and dissolved (filtered).
(6) Figures provided in Appendix D

Proposed groundwater level triggers are based on the bore trigger thresholds in the *Water Act 2000* as shown in the excerpt below:

> ***bore trigger threshold**, for an aquifer, means a decline in the water level in the aquifer that is—*
>
> *(a) if a regulation prescribes the bore trigger threshold for an area in which the aquifer is situated — the prescribed threshold for the area; or*
>
> *(b) otherwise—*
>
> > *(i) for a consolidated aquifer—5m; or*

(ii) for an unconsolidated aquifer—2m.

Proposed water level triggers are therefore:

- consolidated aquifers (Permian Sediments/ Rewan Group) – 5 m/year; and
- unconsolidated aquifers (Quaternary Alluvium, Tertiary sediments) – 2 m/year

The assessment of water quality data will be undertaken as follows:

- two consecutive exceedances of a trigger value as defined in Table 4-1 will constitute a trigger level exceedance; and
- four consecutive exceedances of a trigger value as defined in Table 4-1 will constitute a limit exceedance.

9.0 AIR QUALITY

This section provides a description of existing air quality within and surrounding the Gemini Project. It aims to predict any changes in air quality as a result of the Project and propose mitigation measures and management strategies.

The *Air Quality and Greenhouse Gas Assessment* (Katestone 2020) provided in Appendix L has been conducted to determine the likely impacts of the Project on airborne concentrations and dust deposition rates. Particulates considered in this assessment are:

- total suspended particulate matter (TSP);
- particulate matter with equivalent aerodynamic diameters of 10 µm or less (PM_{10}); and
- particulate matter with equivalent aerodynamic diameters of 2.5 µm or less ($PM_{2.5}$).

9.1 ENVIRONMENTAL OBJECTIVES AND PERFORMANCE OUTCOMES

The environmental objective relevant to potential impacts to air, as described in the EA guideline for *Application requirements for activities with impacts to air [ESR/2015/1840]* (DES 2017a) is:

The activity will be operated in a way that protects the environmental values of air.

The Project would achieve all of the following performance outcomes identified in Schedule 8, Part 3, Division 1 of the EP Regulation:

(a) fugitive emissions of contaminants from storage, handling and processing of materials and transporting materials within the site are prevented or minimised;

(b) contingency measures will prevent or minimise adverse effects on the environment from unplanned emissions and shut down and start up emissions of contaminants to air; and

(c) releases of contaminants to the atmosphere for dispersion will be managed to prevent or minimise adverse effects on environmental values.

9.2 DESCRIPTION OF ENVIRONMENTAL VALUES

In accordance with the *Environmental Protection (Air) Policy 2019* (EPP (Air)) the EVs pursuant to air quality to be enhanced or protected include the qualities of the air environment that are conducive to protecting:

- the health and biodiversity of ecosystems;
- human health and wellbeing;
- the aesthetics of the environment, including the appearance of buildings, structures and other property; and
- agricultural use of the environment.

9.2.1 Land Use

The Project and surrounding area is currently used predominately for cattle grazing with most of the area cleared of remnant vegetation for agricultural purposes.

To the east of the Project lies Dingo, a small town of approximately 450 people, and includes residences, sporting facilities (sports oval, tennis courts), a primary school, and local businesses (post office, hotel, shops, etc).

The study area covers approximately 400 km^2 and extends beyond the borders of the MLA in order to assess the potential impact of the Project on the air quality of the wider community. The context of the land considered in the air quality assessment of the Project is shown below in Figure 76 through topographical contours expressed in mAHD.

9.2.2 Climate and Wind Characteristics

Meteorological modelling was used to generate wind speed and direction inputs for the impact assessment as described in Appendix A of the *Air Quality and Greenhouse Gas Assessment* (Katestone 2020) (refer Appendix L). The local meteorological conditions relating to the Project have been described in Section 2.2 of this document.

9.2.3 Existing Air Quality

9.2.3.1 Existing Sources of Emissions

Ambient dust levels across the area will be influenced by natural sources of dust such as wind erosion and fires, as well as dust emissions from existing anthropogenic sources in the area, possibly including local agriculture or horticulture, and existing mines.

The National Pollution Inventory (NPI) is a public database of annual emissions of 93 substances reported by industries across Australia. The closest facility currently reporting to the NPI program is more than 10km away from the Project and unlikely to contribute to existing levels of dust within the study domain. There are seven NPI reporting facilities within a 50 km radius of the Project including six mines and one quarry. Potential contributions from the surrounding facilities, including the Bluff Coal Mine, on sensitive receptors are expected to be adequately accounted for in the Blackwater monitoring data used to determine background particulate concentrations utilised in the cumulative assessment of the Gemini Project. Further, the closest reporting facility the Bluff Mine is currently in care and maintenance with no certainty of return to operations.

These existing seven facilities are listed in Appendix L and are considered far enough away from the Gemini Project to have a minimal impact on the local dust levels near the Project or will be adequately accounted for in the ambient background monitoring data.

9.2.3.2 Ambient Air Quality

The *Air Quality and Greenhouse Gas Assessment* (Katestone 2020) (Appendix L) has estimated the expected background concentrations of relevant air contaminants (Table 52). A total of 12-months of data (April 2019 to April 2020) from the DES monitoring station at Blackwater, approximately 35 km west of the Project, was relied upon to characterise the existing environment. It is noted that DES does not conduct monitoring for TSP and dust deposition, therefore either alternative data sources have been utilised or calculated using the existing DES monitoring data (each parameter data source has been listed in Table 52). For the purposes of the cumulative impact assessment, the ambient background concentrations of PM_{10} and $PM_{2.5}$ were taken as the 70^{th} percentile 24-hour average from the Blackwater monitoring site. Use of the 70th percentile value was based on the methodology published by EPA Victoria (EPA Victoria 2007) and is accepted in Queensland.

On the occasions where the 24-hour background concentrations of PM_{10} and $PM_{2.5}$ exceeded the EPP (Air) objectives at the Blackwater monitoring site; a discussion on temporal and meteorological variation has been included in Table 4 of Appendix L to explain existing exceedances.

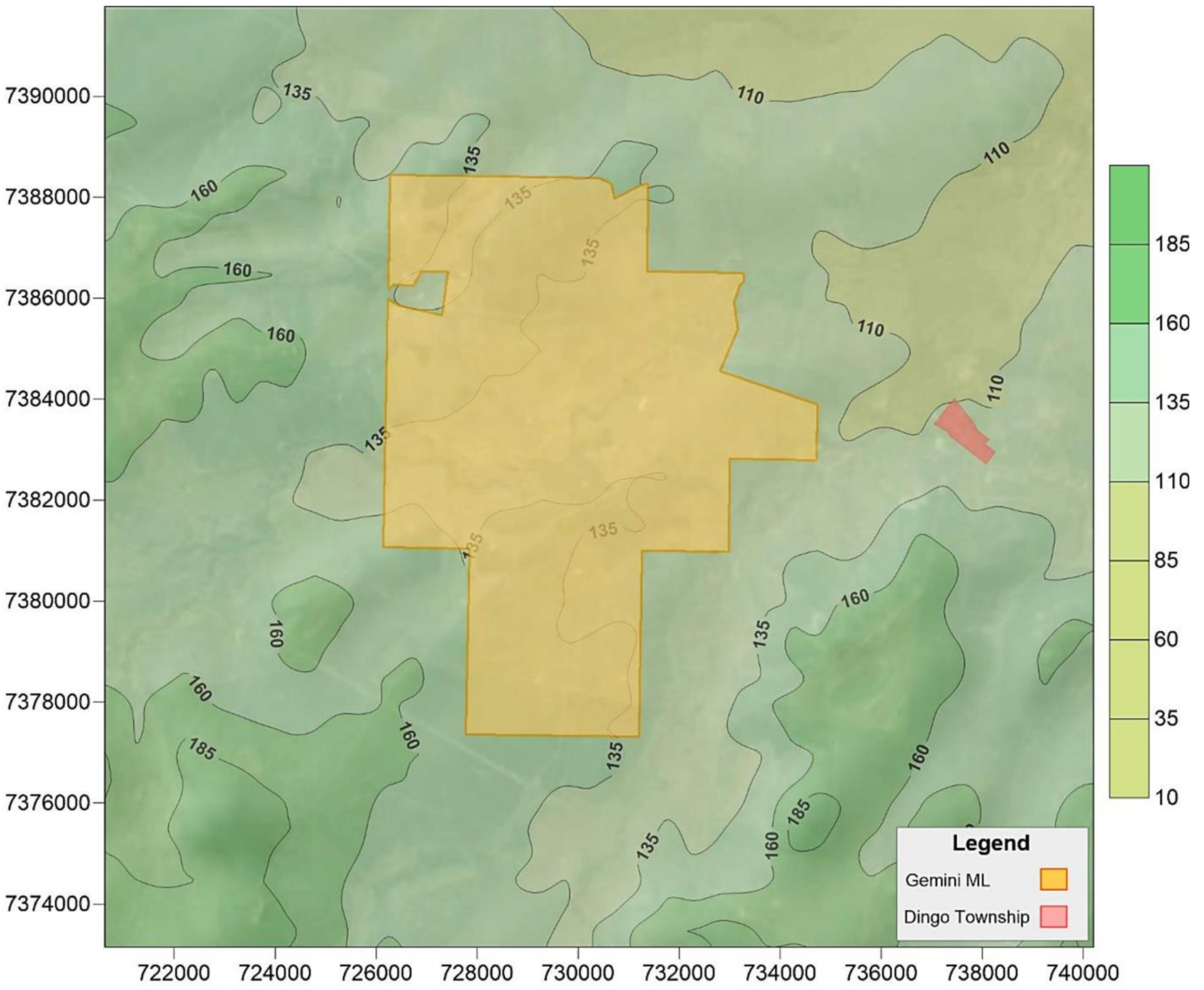


Figure 76 Local Terrain

Table 52 Ambient Background Concentrations Used To Assess Cumulative Impacts

Pollutant	Averaging Period	Concentration	Source
TSP	Annual	45.8 µg/m^3	Calculated from the average PM_{10} data measured at Blackwater using PM_{10}/TSP ratio of 0.5.
PM_{10}	24-hour	23.8 µg/m^3	70th percentile of monitoring data at Blackwater.
	Annual	22.9 µg/m^3	Average of monitoring data at Blackwater.
$PM_{2.5}$	24-hour	7.4 µg/m^3	70th percentile of monitoring data at Blackwater.
	Annual	6.8 µg/m^3	Average of monitoring data at Blackwater.
Dust Deposition	Monthly	50 mg/m²/day	Typical value for rural areas.

9.2.4 Sensitive Receptors

A desktop assessment identified a total of 25 sensitive receptors within 5 km of the Project based on the definition from the EPP (Air). Sensitive receptors considered in the assessment are presented in Figure 77 and Table 53, encompassing residences, businesses, and recreational areas.

At the time of reporting the following sensitive receptors are owned or pending purchase by Magnetic South and have not been considered further in this assessment: SR09, SR14, SR15, SR18, SR19, SR20, SR21, SR23 and SR24.

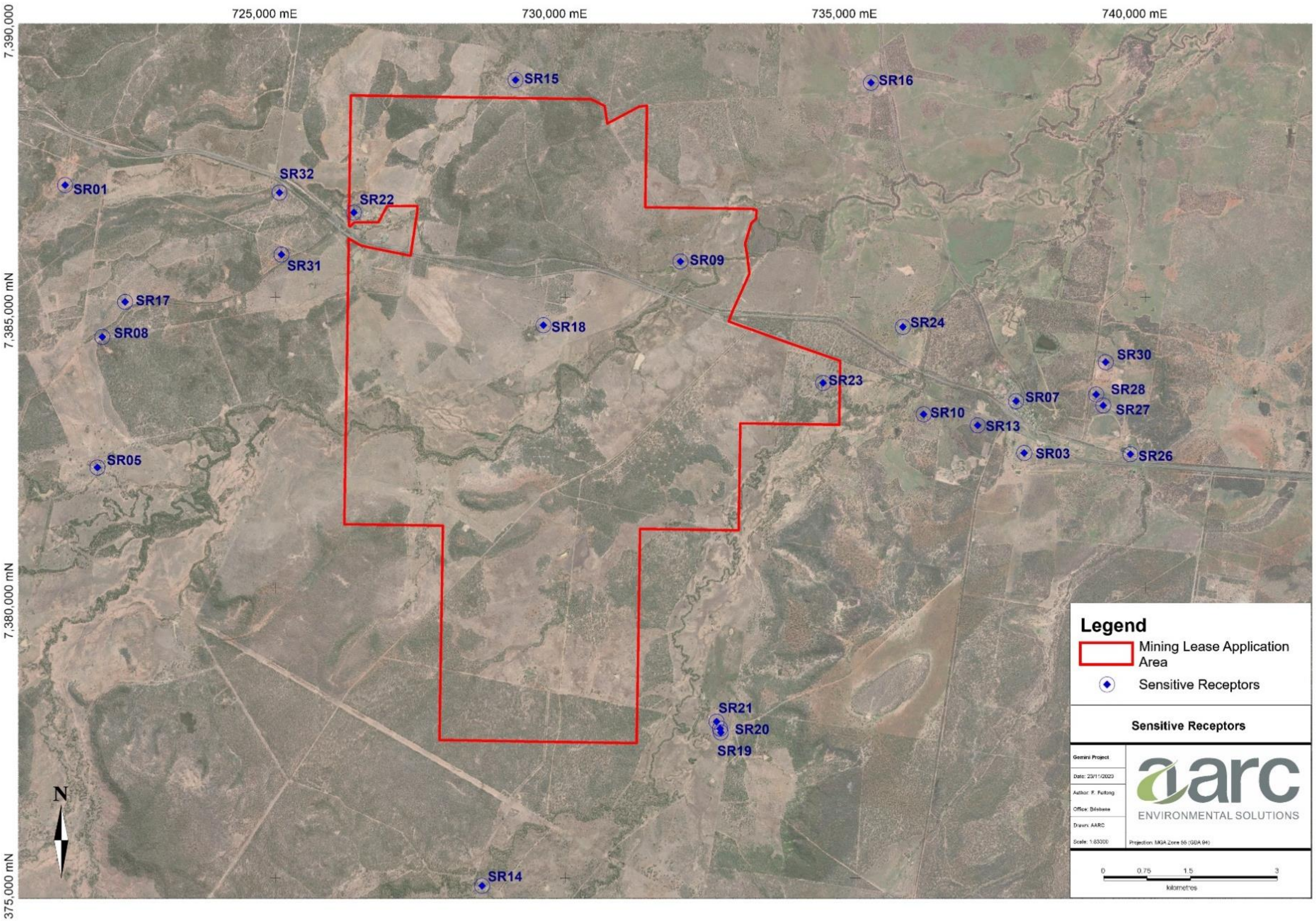


Figure 77 Sensitive Receptors Within 5 km of the Project

Table 53 Sensitive Receptors Within 10 km of the Project

Receptor ID	Receptor Type	Property Name	Easting	Northing	Location
SR01	Residential	3SP165527	721380	7386940	4.8 km W
SR03	Residential	6SP152759	737915	7382328	3.2 km E
SR05	Residential	Charlevue	721937	7382077	4.2 km W
SR07	Dingo Township (*residential, businesses & facilities*)	Dingo Township	737777 (town centre)	7383220 (town centre)	2.3 km E
SR08	Residential	Dunkerinn	722022	7384327	4.2 km W
SR09	Residential	2RP904099	2RP904099	731988	Within MLA
SR10	Residential	Fairview Park	736181	7382995	1.4 km E
SR13	Residential	Fairview Park	737113	7382802	2.3 km E
SR14	Residential	Glenwood	728569	7374873	2.5 km S
SR15	Residential	4HT165	729144	7388750	0.3 km N
SR16	Residential	Lanlea	735273	7388705	3 km NE
SR17	Residential	Myimbarr	722415	7384928	3.9 km W
SR18	Residential	1HT424	729626	7384531	Within MLA
SR19	Residential	2HT138	732684	7377515	1.4 km SE
SR20	Residential	2HT138	732671	7377581	1.4 km SE
SR21	Residential	2HT138	732614	7377700	1.4 km SE
SR22	Residential and Accommodation	Redrock Park	726358	7386469	Within MLA
SR23	Residential	47H406	734446	7383534	Within MLA
SR24	Residential	20H4017	735824	7384500	1.2 km NE
SR26	Residential	The Lazy H and Hopevale	739747	7382306	5 km E
SR27	Residential	The Lazy H and Hopevale	739278	7383145	4.5 km E
SR28	Residential	The Lazy H and Hopevale	739157	7383337	4.4 km E
SR30	Residential	The Lazy H and Hopevale	739319	7383894	4.6 km E
SR31	Residential	Unknown	725109	7385743	1.1 km NW
SR32	Residential	Unknown	725075	7386813	1.2 km NW

Notes: Datum: Map Grid of Australia (MGA) Zone 55.
Green owned or pending purchase by Magnetic South.

9.3 POTENTIAL IMPACTS

Katestone (2020) used standard industry dispersion models suitable for use in Australia and regulatory approved assessment techniques to predict ground-level concentrations of air pollutants in the areas surrounding the Project. Technical details of the methodology and models are provided in Appendix A of the *Air Quality and Greenhouse Gas Assessment* (Katestone 2020) (Appendix L).

9.3.1 Air Quality Objectives and Criteria

The EP Act provides for the management of the air environment in Queensland. The EPP (Air) was made under the EP Act with the objective "*to identify the environmental values of the air environment to be enhanced or protected and to achieve the objective of the EP Act (i.e., ecologically sustainable development)*". The EPP (Air) air quality objectives relevant to key air pollutants that may be generated from the Project are presented in Table 54.

Table 54 EPP (Air) Relevant Air Quality Objectives

Pollutant	Environmental Value	Averaging Period	Air Quality Objective	Number Exceedances Allowed Per Year
TSP	Health and Wellbeing	1 year	90 μg/m^3	None
PM_{10}		24 hours	50 μg/m^3	None
		1 year	25 μg/m^3	None
$PM_{2.5}$		24 hours	25 μg/m^3	None
		1 year	8 μg/m^3	None
Dust Deposition	Amenity	1 month	120 mg/m^2/day	None

Notes: Dust deposition value is a DES recommended design objective rather than EPP (Air) objective and applies to total insoluble solids.

9.3.2 Emissions

Dust emissions will be generated over the life of the Project as a result of material extraction, handling, haulage and wind erosion of exposed mine areas. Emissions of oxides of nitrogen, sulphur dioxide and carbon dioxide (CO_2) would also occur due to blasting activities and combustion of fuels onsite. However, these emissions are transient (contained within the haul road corridor and open-cut pits) and low in magnitude compared with dust emissions. For these reasons, dust is the sole pollutant of interest for this assessment. Key dust-generating activities associated with the Project include:

- drilling and blasting;
- material extraction and handling (overburden and ROM coal);
- bulldozer activity;
- material haulage (overburden and ROM coal);
- road grading; and
- wind erosion of exposed mine areas.

Three operational modelling scenarios were used within the assessment as being the worst-case potential for dust emissions over the life of the Project based upon volumes of material extracted, proposed mining schedule and proximity of sensitive receptors. These assessed years include:

- year 2;
- year 8; and
- year 15.

The emissions estimation techniques applied in this assessment were based on standard methods that are applied throughout Australia and in the United States. These methods are consistent with those adopted for other air quality assessments conducted for other coal mines in Australia. Emissions of TSP, PM_{10} and $PM_{2.5}$ from mining activities were estimated using an approximation of emission rates from NPI emissions estimation technique handbook (DSEWPAC 2012a) and the United States Environmental Protection Agency AP42 emission handbooks (EPA 1998; EPA 2006).

Dust emissions from individual mining activities for the modelling scenarios were accounted for and have been explicitly modelled using Project specific activity information. The size distribution of dust particles was derived from the emission rates estimated for TSP, PM_{10} and $PM_{2.5}$.

Emissions have been presented inclusive of standard mitigation control factors to minimise dust emissions from mining activities. Deviation away from the NPI emissions estimation technique handbook has occurred under confidence that standard efficiency factors can be achieved. Standard efficiency factors for these control measures are presented in Table 55. Schematics and a breakdown of dust emission rates estimated for the three assessment scenarios is presented in Table 6, and Figures 7 to 9 of Appendix L.

9.3.3 Modelling Results

The dispersion modelling assessment has erred on the side of caution and selected conservative inputs; therefore, the predicted concentrations of dust are conservative estimates. Results have been presented as ground-level concentrations or deposition rates at the sensitive receptors as well as contours across the modelling domain. Results provided are subject to the standard mitigation measures outlined in Table 55.

Background dust levels have been added to the incremental model predictions in order to estimate the potential cumulative impacts of the Project with existing sources of dust in the region. Results have been assessed by comparing the cumulative concentrations and dust deposition rates with the air quality objectives described in Table 54.

Table 55 Dust Control Measures and Relative Reduction in Emissions

Activity	Control Measure	Reduction Factor
ROM coal haulage	Watering and/or suppressants/vehicle speed reduction	85%
Overburden haulage	Watering and/or suppressants/vehicle speed reduction	85%
Drilling	Drill dust suppression sprays	70%
ROM unloading at CHPP	Water sprays	70%
Crushing	Enclosure	70%
Product stockpile	Wet from CHPP	50%
Train loading	Telescopic chute with water spray	85%
Conveyor	Enclosure	70%
Conveyor	Uncovered	0%

Note: Reduction factors for coal haulage are calculated using '*NSW Coal Mining Benchmarking Study*' (Katestone, 2011) and ACARP report '*Mobile Sampling of Dust Emissions from Unsealed Roads*' (ACARP 2015). A review of both indicates that an 85% control of haul road dust emissions is achievable through a combination of watering level 2 (75% control), use of chemical suppressants (84% control) and reduction of vehicle speeds to 30 km/hr (85% control).

When interpreting the results, it is important to note that the predictions are not contemporaneous. The values presented are the maximum concentration predicted independently at each sensitive receptor or grid point for the entire modelling period and thus constitute a worst-case or near worst-case result. These values do not necessarily occur at the same time or under the same meteorological conditions.

9.3.3.1 Suspended Particulate Matter (TSP)

Annual average TSP modelling results, inclusive of the estimated annual average background level, show concentrations of TSP comply with the relevant air quality objective at all sensitive receptors in isolation and cumulatively using the standard mitigation measures for all assessed years.

The maximum cumulative annual average TSP concentration predicted at any sensitive receptor over the three scenarios modelled is 58.3 $\mu g/m^3$, at SR22 in Year 2. This equates to 64.77% of the relevant objective value of 90 $\mu g/m^3$.

Modelled scenarios for TSP concentrations, with standard mitigation measures, have been provided as contour plots for all modelled runs alongside detailed results (Appendix L).

9.3.3.2 Suspended Particulate Matter (PM_{10})

Modelling results for PM_{10} predicted concentrations when using standard mitigation measures exceeded the 24-hour average and annual objective value of 50 $\mu g/m^3$ and 25 $\mu g/m^3$ respectively for each of the assessed mining years, these exceedances are summarised below:

- year 2:
  - 24-hour average (SR03, SR13, SR22, SR27, SR28, SR31 and SR32); and
  - annual average (SR22, SR31, and SR32).
- year 8:
  - 24-hour average (SR03, SR07, SR10, SR13, SR16, SR22, SR26, SR27, SR28, SR31 and SR32); and
  - annual average (SR22, SR31, and SR32).
- year 15:
  - 24-hour average (SR17, SR22, SR31 and SR32); and
  - annual average (SR17, SR22, SR31, and SR32).
- Further analysis of 24-hour average PM_{10} concentrations identified a time length for exceedances of at most one to three days (year 2), one to five days (year 8) and fifty days (year 15).

Modelling has shown that using standard and, when necessary, additional mitigation measures, predicted 24-hour average concentrations of PM_{10} comply with the relevant air quality objective at all sensitive receptors. Additional mitigation measures used to achieve this compliance may include but are not limited to the modification of activity rate or ceasing of certain operations. Detailed mitigation measures that will be employed are discussed in Section 9.4.

Modelled scenarios for 24-hour average and annual average PM_{10} concentrations with standard mitigation measures and additional measures, when necessary, have been provided as contour plots for all modelled runs alongside detailed results (Appendix L).

9.3.3.3 Suspended Particulate Matter ($PM_{2.5}$)

Modelling results for 24-hour average $PM_{2.5}$ concentrations, inclusive of the estimated background levels, show levels of $PM_{2.5}$ comply with the relevant air quality objective at all sensitive receptors using the standard mitigation measures for years 2, 8 and 15.

Modelling results for annual averages of $PM_{2.5}$ concentrations, inclusive of the estimated background levels, show levels of $PM_{2.5}$ comply with the relevant air quality objective at all sensitive receptors using the standard mitigation measures for years 2 and 8. However, the annual average $PM_{2.5}$ objective of 8 µg/m^3 was exceeded at SR22, SR31 and SR32 during year 15.

Modelled scenarios for $PM_{2.5}$ concentrations, with standard mitigation measures and additional measures, when necessary, have been provided as contour plots for all modelled runs alongside detailed results (Appendix L).

9.3.3.4 Dust Deposition

Monthly dust deposition modelling results, inclusive of the estimated background level, show dust deposition rates comply with the relevant air quality objective at all sensitive receptors using the standard mitigation measures for all years.

The maximum cumulative monthly dust deposition rates predicted at any sensitive receptor over the three scenarios modelled is 62.5 mg/m^2/day, at SR22 in Year 15. This equates to 52.08% of the relevant objective value of 120 mg/m^2/day.

Modelled scenarios for dust deposition concentrations, with standard mitigation measures have been provided as contour plots for all modelled runs alongside detailed results (Appendix L).

9.3.4 Impacts and Risks

Modelling shows that with the inclusion of standard and additional mitigation measures, where necessary, the Project can be operated in accordance with the EPP (Air) objectives at all sensitive places. Under these provisions, the Project is unlikely to result in impacts to air quality that could adversely affect:

- human health and wellbeing;
- health and biodiversity of ecosystems including Taunton National Park;
- aesthetics of the environment including odour, dust, visibility reducing particles or light; or
- agriculture activities including crop production.

Additional mitigation measures will be employed on an as required basis during operations to avoid any anticipated exceedances. There is a low risk that the Project would exceed the modelled scenarios with addition measures in place as the modelling has assessed potential worst-case conditions with conservative assumptions.

The management strategies discussed in Section 9.4 demonstrate the feasibility to ensure risk remains low throughout the life of the Project and provides for implementing procedures for monitoring and complaints resolution to control magnitude of risk. Appendix B (*Surface Water Assessment*) demonstrates through the water balance model that adequate amounts of water will be available to meet the water demand for the proposed dust suppression. A water supply pipeline is also proposed to provide make up water during dry periods, if required.

9.4 MITIGATION MEASURES, MANAGEMENT AND MONITORING

The management hierarchy for air emissions as set out in the EPP (Air) requires that, to the extent that it is reasonable to do so, air emissions must be dealt with in the following order of preference:

1. avoid (e.g., using technology that avoids air emissions);
2. recycle (e.g., re-using air emissions in another industrial process);
3. minimise (e.g., treating air emissions before release); and
4. manage.

Dust management and mitigation measures will be implemented for the Project. Magnetic South is committed to implementing the following measures:

- Develop and implement a dust and particulate matter monitoring program for three sites representative of surrounding sensitive receptors for early detection of elevated PM_{10} concentrations, refer to Appendix L for approximate monitoring locations. At minimum, monitoring of air quality at these locations will include:
    - continuous monitoring of PM_{10} at one primary location;
    - continuous monitoring of $PM_{2.5}$ at one primary location;
    - dust deposition monitoring at one primary location; and
    - meteorological monitoring (including temperature, wind speed and direction) at a single location representative of the Project.
- Monitoring equipment will be installed in accordance with relevant standards (i.e., dust deposition - *AS/NZS 3580.10.1:2003*, wind speed and direction - *AS/NZS 3580.14:2014*, PM_{10} - *AS3580.9.6* and $PM_{2.5}$ - *AS3580.9.10*) or otherwise approved by the administering authority.
- Ensure mitigation measures are put in place where the dust monitoring indicates a potential exceedance. This may include, increased watering of haul roads and other dust sources, and if required, timing blasts or other high-risk activities to occur outside of high-risk weather conditions.
- Develop an *Air Quality Management Plan* that will include a range of available measures to be implemented as necessary, including the implementation of a *Trigger Action Response Plan* to ensure compliance with approval conditions (refer to section 9.4.1).
- Enter into discussions and, as appropriate, commercial arrangements with affected surrounding landholders which could include:
    a. measures (e.g., purchase or relocation) which result in homesteads no longer being considered a sensitive receptor; or
    b. installation of receptor-side mitigation (e.g., air conditioners / purifiers in affected residences).

9.4.1 Air Quality Management Plan

An example *Air Quality Management Plan* has been developed to assist in the implementation of the monitoring and reporting requirements of the proposed EA and has been provided in Appendix L. The objective of the *Air Quality Management Plan* is to ensure the integrity of the environmental values of the Project site and surrounds to minimise potential impacts to air quality.

The *Air Quality Management Plan* will include the following components:

- a summary of the baseline environment and the potential impacts of the Project on air quality;
- identification of sensitive receivers surrounding the Project;
- use of real-time measurement of dust levels and meteorological conditions;
- details of mitigation measures implemented for mining and ancillary activities;
- implementation of a *Trigger Action Response Plan* as a dust management procedure that aims to investigate and respond to unexpected dust exceedances by:
  - trigger: nomination of air quality trigger values based on complaints and/or real-time dust and meteorological measurement and a range of additional measures which will be implemented, as necessary;
  - alert: an alert occurs as a result of the conditions of a trigger being met. Each alert requires one or more responses;
  - response: a response is a dust management action that may be implemented as a result of an alert being issued; and
  - action: an action is a specific activity that is condition as part of a response.
- an air quality monitoring program detailing the monitoring network, equipment requirements and monitoring, reporting and review procedures;
- a complaints and handling response procedure; and
- details of the roles and responsibilities of personnel.

The *Air Quality Management Plan* will focus on minimising air emissions in accordance with the management hierarchy set out in the EPP (Air) in the order of avoid, recycle, minimise and manage air emissions.

Due to the nature of air emissions associated with the Project, the *Air Quality Management Plan* will implement adaptive management that includes avoidance, minimisation, and management of air quality emissions.

Avoid

Air emission avoidance is defined as the prevention of air emissions. Air emissions will be avoided by:

- the adjustments to activity rates of ceasing of certain operations under adverse meteorological conditions in accordance with a meteorological forecast system and a dust risk forecast system;

- the unauthorised clearing of land and early identification of mitigation requirements through the *Land Disturbance Permit*;
- the seeding of long-term storage topsoil stockpiles; and
- progressive rehabilitation where vegetative cover will be established as soon as possible.

Minimise

A series of mitigation measures will be implemented to minimise air emissions to the receiving environment. Air emissions generated by the Project will be minimised by:

- ensuring mitigation measures are put in place where the dust monitoring or modelling indicates a potential exceedance. This may include increased watering of haul roads and other dust sources;
- the implementation of additional remedial actions for air emissions control in the event of complaints being received, exceedances of criteria being recorded, or other trigger levels in accordance with the *Trigger Action Response Plan* being breached; for example:
    - applying additional at-source and/or at-receptor dust controls under median and high-risk trigger scenarios;
    - increasing the intensity of dust controls under median and high-risk trigger scenarios; and/or
    - modifying certain operations under high-risk trigger scenarios;
- the implementation of a dust and particulate matter monitoring program at sites representative of surrounding sensitive receptors for early detection of elevated PM_{10} concentrations.

Manage

Air emissions produced by the Project will be managed through the following measures;

- entering into discussions and, as appropriate, commercial arrangements with affected surrounding landholders which could include:
    - measures (e.g., purchase or relocation) which result in homesteads no longer being considered a sensitive receptor; and
    - installation of receptor-side mitigation (e.g., air conditioners / purifiers in affected residences).
- a response plan for complaints handling; and
- an annual review program where the performance of air quality mitigation measures is assessed and where necessary, refined.

10.0 GREENHOUSE GAS

Climate change refers to long-term fluctuations in temperature, precipitation, wind, and other elements of the Earth's climate system. The Earth naturally absorbs and reflects incoming solar radiation and emits longer wavelength terrestrial (thermal) radiation back into space. A portion of this terrestrial radiation is absorbed by gases, known as greenhouse gasses (GHGs) in the atmosphere. Changes in the atmospheric concentrations of these GHGs can alter the balance of energy transfers between the atmosphere, space, land, and the oceans. The major GHGs which make the largest contribution to global warming are CO_2, methane (CH_4) and nitrous oxide (N_2O).

The main GHG associated with the Project is CO_2, with smaller contributions from CH_4 and N_2O. These gases vary in effect and longevity in the atmosphere, however identifying the global warming potential of each gas allows them to be described in terms of CO_2 (the most prevalent GHG); called carbon dioxide equivalent (CO_2-e). A unit of one tonne of CO_2-e is the basic unit used in carbon accounting.

The *Air Quality and Greenhouse Gas Assessment* (Katestone 2020) (Appendix L) identifies the potential sources of GHG emissions associated with the Project and quantifies the emissions from each source over the life of the Project. The estimated emissions have then been compared to State and National GHG emission inventory totals to provide an assessment of the potential significance of the Project in relation to Australia's GHG emission inventory.

10.1 REGULATORY FRAMEWORK FOR GREENHOUSE GAS EMISSIONS

The *National Greenhouse and Energy Reporting Act 2007* (NGER Act) establishes a mandatory scheme, the *National Greenhouse and Energy Reporting Scheme* (NGER Scheme) for the reporting of company GHG emissions and energy production and consumption.

The supporting *National Greenhouse and Energy Reporting Technical Guidelines* (NGER Guidelines) (DoEE 2017) are applicable across all industry sectors and cover important concepts under the NGER Act and supporting regulations, including scheme participation, and the determination of corporate, facility and operational control, and registration and reporting obligations. The *National Greenhouse and Energy Reporting (Measurement) Determination 2008* (NGER Determination) provides methods and criteria for calculating GHG emissions and energy data under the NGER Act.

The range of emission sources covered in the NGER Determination includes:

- the combustion of fuels for energy;
- fugitive emissions from the extraction of coal;
- oil and gas;
- industrial processes (such as producing cement and steel); and
- waste management.

Registration and reporting is mandatory for corporations that have an energy consumption or GHG emissions, including Scope 1 and Scope 2, that exceed the thresholds summarised in Table 56.

Scope 1 emissions in relation to a facility refers to the release of GHG into the atmosphere as a direct result of an activity or series of activities (including ancillary activities) that constitute the facility. Scope 2 emissions refers to the release of GHG into the atmosphere as a direct result of one or more activities that generate electricity, heating, cooling or steam that is consumed by the facility but that do not form part of the facility.

A third classification of emissions, Scope 3, is defined as indirect greenhouse gas emissions other than Scope 2 emissions that are generated in the wider economy. They occur as a consequence of the activities of a company, but from sources not owned or controlled by that company. To limit the potential of double counting of GHG emissions on a national scale, Scope 3 are not included in NGER reporting however for information purposes will be included below (Section 10.3.2).

In addition, GHG emissions associated with land clearing are not covered by the NGER scheme but for information purposes are also detailed below (Section 10.2.1 and Section 10.3.1).

Table 56 Reporting Thresholds for Greenhouse Gas Emissions and Energy Use

Threshold Level	Threshold Type	
	GHG Emissions (kt CO_2-e per year)	Energy Consumption (TJ per year)
Facility	25	100
Corporate	50	200

10.2 EMISSIONS SOURCES

For the purposes of this assessment, Scope 1, 2 and 3 GHG emissions, including land clearing estimates, were calculated on an annual basis for the Project. This includes emissions from:

Scope 1: diesel combustion from heavy machinery and equipment and haulage vehicles, fugitive emissions of CH_4 from mining of coal deposits (i.e., waste mine gas), land clearing and use of explosives;

Scope 2: electricity usage for conveyors, CHPP and other amenities; and

Scope 3: transport of coal, rail transport to coal terminal and use of coal (coking applications).

A complete summary of emission sources associated with Project is documented in Table 15 of Appendix L.

10.2.1 Land Clearing

The GHG emissions associated with land clearing have been estimated and included below (Table 57). Land clearing is considered Scope 1 and emissions were estimated based on the Full Carbon Accounting Model developed by the Australian Government to support the estimation of carbon stock change on forest systems.

Land clearing required for the Project is made up of:

- Eucalyptus woodland – 407.17 ha;
- Acacia woodland – 313.57 ha; and
- Grazing land (previously cleared) – 1,240 ha.

To account for the prolonged nature of emissions from land clearing, total GHG emissions associated with land clearing for the life of the Project have been averaged across each year of the Project. Carbon sequestration associated with land rehabilitation was not included in the assessment due to its delayed impact in the years following the conclusion of the Project.

10.3 EMISSIONS ESTIMATION

10.3.1 Scope 1 and Scope 2

Predicted GHG emissions, exclusive of land clearing, is summarised as reportable emissions (Section 10.3.3). Estimated GHG emissions (Scope 1 and Scope 2) associated with the Project are detailed in Table 57. A complete breakdown of emissions is provided in Appendix L.

The following emissions (Scope 1 and Scope 2), inclusive of land clearing, are predicted:

- total predicted emissions are expected to average 145 kt CO_2-e per year; and
- total predicted emissions range between 12 - 217 kt CO_2-e (peaking at Year 16).

For total Project GHG emissions, the percentage of relative GHG emissions sources is shown below in Figure 78. The most significant source of GHG emissions is attributed to diesel consumption for heavy machinery, mining equipment, haulage and other onsite vehicles. Similarly, fugitive methane emission and electricity usage were also identified as significant sources of GHG emissions. These emission-source trends were frequently observed for most individual years.

Table 57 Summary of Scope 1 and Scope 2 GHG Emissions

Year	GHG Emissions (kt CO_2-e/yr)		Total Scope 1 and 2	
	Scope 1	Scope 2	Incl Land Clearing	Excl Land Clearing
Year 1	22.83	1.62	24.45	18.47
Year 2	184.71	18.25	202.96	196.98
Year 3	153.58	18.25	171.83	165.85
Year 4	163.17	18.25	181.42	175.44
Year 5	175.49	18.25	193.74	187.76
Year 6	155.29	18.25	173.54	167.56
Year 7	184.55	18.25	202.80	196.82
Year 8	191.15	18.25	209.40	203.42
Year 9	157.30	18.25	175.54	169.56
Year 10	155.12	18.25	173.37	167.39
Year 11	152.13	18.25	170.37	164.39
Year 12	161.03	18.25	179.28	173.30
Year 13	168.29	18.25	186.54	180.56
Year 14	175.41	18.25	193.66	187.68
Year 15	172.91	18.25	191.15	185.17
Year 16	198.66	18.25	216.91	210.93
Year 17	171.35	18.25	189.59	183.61
Year 18	198.53	18.25	216.78	210.80
Year 19	114.33	18.25	132.58	126.59
Year 20	28.65	3.98	32.62	32.62
Year 21	29.06	2.65	31.71	31.71

Year	GHG Emissions (kt CO_2-e/yr)		Total Scope 1 and 2	
	Scope 1	Scope 2	Incl Land Clearing	Excl Land Clearing
Year 22	11.26	2.65	13.91	13.91
Year 23	11.06	2.65	13.71	13.71
Year 24	11.06	1.33	12.38	12.38
Total (kt CO_2-e)	**3146.90**	**343.34**	**3490.23**	**3376.59**

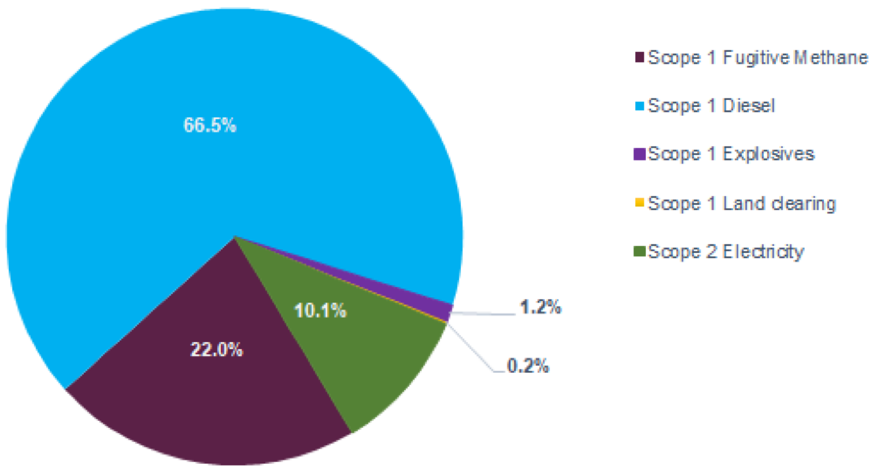


Figure 78 Total Greenhouse Gas Emissions by Scope

For comparative purposes; the latest GHG inventory estimates (excluding emissions from land use, land use change and forestry) is 538 Mt CO_2-e per year for Australia and 162 Mt CO_2-e per year for Queensland (DoEE 2019a; DoEE 2019b). Accounting for the estimated maximum year of annual GHG emissions of 217 kt CO_2-e (Year 16), the Project could contribute up to 0.04% of Australia's emissions and 0.13% of Queensland's emissions.

10.3.2 Scope 3

Total estimated annual scope 3 emissions ranged between 1905 - 3943 kt CO_2-e per year (refer to Appendix L for detailed annual summary).

10.3.3 Reportable Emissions

In accordance with the NGER scheme, the approximate reportable annual GHG emissions of the Project (excluding land clearing), range from:

Scope 1: 11 - 193 kt CO_2-e per year

Scope 2: 2 -18 kt CO_2-e per year

Total: 12 - 211 kt CO_2-e per year

Based on the NGER Act reporting thresholds detailed in Table 56, the Gemini Project will have ongoing reporting obligations including an annual assessment of GHG emissions as set out by the NGER Act and the NGER Determination.

10.4 MITIGATION MEASURES, MANAGEMENT AND MONITORING

The following management measures are proposed to minimise GHG emissions and energy use from the Project during operation:

- where practicable, energy efficiency design aspects will be investigated as part of the detailed design process in order to reduce energy and fuel consumption;
- fuel efficiency of the construction plant/equipment will inform equipment selection, and where possible, equipment with the highest fuel efficiency and lower GHG intensive fuel (e.g., biodiesel) requirements will be used;
- minimise vegetation clearing at the Project to the authorised areas required for Project development;
- consideration of renewable energy options for initial design or future improvements, such as solar powered lighting for the MIA, CHPP and accommodation facilities;
- logistical planning to improve efficiency and minimise energy use, including route and load optimisation of mining equipment and production scheduling to reduce idle time;
- maintenance of mining equipment in accordance with manufacturer and supplier guidelines to maximise fuel efficiency;
- on-site power factor correction optimised to minimise the usage of grid electricity;
- where practical, adjust peak electricity demand through production scheduling to allow for optimal and well utilised diesel power generation capacity;
- spontaneous combustion of coal will be managed to avoid unexpected emission through the burial of reactive materials, spoil dump design, temperature monitoring and spoil dump ventilation;
- using appropriately sized equipment; and
- ongoing monitoring and reporting of GHG emissions including an annual review of energy use to identify potential energy efficiency opportunities on a regular and ongoing basis.

11.0 NOISE AND VIBRATION

This section describes the assessment of potential noise, vibration and blasting impacts from the construction, operation, and closure of the Gemini Project.

This section is informed by the *Noise Impact Assessment* (ASK 2020) provided as Appendix M.

11.1 ENVIRONMENTAL OBJECTIVES AND PERFORMANCE OUTCOMES

The environmental objectives relevant to potential noise impacts have been developed in accordance with the *Application requirements for activities with noise impacts [ESR/2015/1838]* (DES 2017d) to ensure:

The activity will be operated in a way that protects the environmental values of the acoustic environment.

The Project would achieve either one of the following performance outcomes identified in Schedule 8, Part 3, Division 1 of the EP Regulation:

1. *sound from the activity is not audible at a sensitive receptor; and*
2. *the release of sound to the environment from the activity is managed so that adverse effects on environmental values including health and wellbeing and sensitive ecosystems are prevented or minimised.*

11.2 DESCRIPTION OF ENVIRONMENTAL VALUES

11.2.1 Land Use

The Project site and surrounding area is currently used predominately for cattle grazing with most of the area cleared for agricultural purposes. To the east of the Project lies Dingo, a small town of approximately 450 people, and includes residences, sporting facilities (sports oval, tennis courts), a primary school, and local businesses (Post Office, hotel, shops, etc.).

11.2.2 Sensitive Receptors

A total of 25 sensitive receptors were identified within 5 km of the Project in parallel with the *Air Quality and Greenhouse Gas Assessment* (Katestone 2020) (Appendix L) based on the definition from the *Environmental Protection (Noise) Policy 2019* (EPP (Noise)). A number of the identified sensitive receptors are located within 1 km of the Capricorn Highway and Blackwater Railway that extends through the northern section of the MLA. Eight sensitive receptors (SR09, SR14, SR15, SR19, SR20, SR21, SR23 and SR24) are located on land owned or under purchase by Magnetic South. Any dwellings situated on these properties will be vacant prior to the commencement of mining activities and therefore have been excluded from the noise assessment.

The same suite of receptors encompassing multiple dwellings and residences, facilities, businesses, and recreational areas, including the Dingo township, was used for both the air quality and noise assessments (refer to Figure 77 and Table 53).

The nearest mining operation to the Gemini Project is Bluff PCI Project, located approximately 12 km west of the Gemini Project's proposed ROM pad. At the time of submission, this mine is in care and maintenance, with no certainty of returning to operations during the life of the Gemini Project.

11.2.3 Climate and Wind Characteristics

The propagation of noise in the outdoor environment can be influenced by the local meteorological conditions. Air temperature, humidity, wind speed, wind direction and stability of the atmosphere can all influence noise either in isolation or as combined weather conditions.

Computer modelling was used to input specific meteorological conditions to predict noise levels under unfavourable 'adverse' day and night meteorological conditions using wind conditions from the southeast and west directions. The meteorological scenarios used in these modelled calculations are provided in further detail below (Table 58).

Table 58 Meteorological Scenarios

Parameter	Day Meteorological Scenarios			Night Meteorological Scenarios		
	Scenario D1	Scenario D2	Scenario D3	Scenario N1	Scenario N2	Scenario N3
Pasquill Stability Class	D	D	D	F	F	F
Temperature (°C)	25	25	25	10	10	10
Wind Speed (m/s)	2	2	2	2	2	2
Wind direction	Towards receivers	SE	W	Towards receivers	SE	W
Relative humidity (%)	40	40	40	70	70	70

11.2.4 Background Noise Levels

The Project is located in a rural area with influences from transport and the agricultural industry. Specifically, the existing acoustic environment is affected by:

- traffic on the Capricorn Highway and other local roads;
- coal trains;
- native birdlife;
- insect noise;
- agricultural equipment; and
- cattle.

A baseline noise monitoring study was conducted to determine baseline background noise prior to the commencement of the Project (Appendix M). Monitoring was undertaken in general accordance with *Australian Standard AS1055: Acoustics – Description and measurement of environmental noise* and the *Noise Measurement Manual* (EHP 2013b).

Noise levels were continuously monitored with noise loggers for up to 13 consecutive days in June 2019, and attended logging was undertaken for two nights for separate 15-minute periods. Noise logging was undertaken at three locations to produce representative modelling outcomes:

Location A: Accommodation facility (the same location as SR22). Located in an open-field, approximately 360 m northeast of the railway line and 440 m northeast of the Capricorn Highway.

Location B: Dingo Roadhouse (approximately the same location as SR03). Located in an open-field location, approximately 220 m southwest of the Capricorn Highway.

Location C: Rural residence (approximately the same location as SR19, SR20 and SR21). Located in an open-field position, approximately 200 m northeast of the homestead.

The existing background noise levels were influenced by a variety of natural sources (insects, birdsong, windblown vegetation, cattle) at all locations. In particular, locations A and B were influenced by transport related sources of background noise including the Capricorn Highway and Blackwater Railway, and locations A and C were influenced by levels of high insect noise. As insect noise is a seasonal influence, the noise level data was filtered to remove the insect noise from Locations A and C. The background noise level results were calculated using the lowest 10th percentile method and have been provided in Table 59.

Table 59 Background Noise Level

Period	Background Noise Level (L_{90} dBA)		
	Location A	Location B	Location C
Day (7am to 6pm)	33	35	25
Evening (6pm to 10pm)	23	37	29
Night (10pm to 7am)	20	27	22

Notes: dBA 'A' weighted decibel.
L_{90} 'A' weighted sound pressure level equalled or exceeded 90% of the time.

11.3 POTENTIAL IMPACTS

To assess impacts and risks of the Project to the existing noise environment, ASK (2020) undertook a noise and vibration assessment. A summary of the impact assessment and modelled results are detailed below.

11.3.1 Noise Quality Objectives and Criteria

ASK (2020) consulted several sources of information in order to propose relevant noise and vibration objectives for the Project:

- EP Act;
- EPP Noise
- *Guideline (Noise): Planning for noise control* (EHP 2004);
- *Guideline (Noise): Noise and vibration from blasting [EM2402]* (EHP 2016); and
- *Guideline (Mining): Model mining conditions [ESR/2016/1936]* (DES 2017e).

In accordance with *Model Mining Conditions* (DES 2017e), the EPP (Noise) and the *Planning For Noise Control* guideline (EHP 2004), the following noise criteria provided in Table 60 has been adopted.

Table 60 Proposed Noise Limits

Period	Noise Limit ($L_{Aeq,adj,1hr}$ dBA)
Day (7am to 6pm)	40
Evening (6pm to 10pm)	40
Night (10pm to 7am)	35

Notes: $L_{Aeq,adj,1hr}$ means an ‘A’ weighted sound pressure level of a continuous steady sound, adjusted for tonal character, that within a 1-hour period has the same mean square sound pressure of a sound that varies with time.

It is noted by the *Planning For Noise Control* (EHP 2004) that the noise reduction provided by a typical residential building façade is 7 dBA with windows open. Based on a façade reduction of 7 dBA (i.e., 7 dBA reduction in noise levels from outside a house to inside a house when windows are fully open), the EPP (Noise) indoor noise objectives could be converted to the proposed noise limits (with windows open) presented in Table 60.

The *Noise and vibration from blasting* and the *Model Mining Conditions* (DES 2017e) contain the same criteria for blasting. ASK (2020) propose that these criteria are adopted for the Project, as outlined in Table 61.

Table 61 Proposed Blasting Vibration and Air-blast Criteria

Issue	Criteria
Airblast overpressure	115 dB (linear) peak for nine out of ten consecutive blasts initiated and not greater than 120 dB (linear) peak at any time.
Ground vibration peak particle velocity	5 mm/s PPV for nine out of ten consecutive blasts and not greater than 10 mm/s PPV at any time.

PPV peak particle velocity

11.3.2 Noise Prediction Model

Mining noise emissions from the Project have been predicted for the three mine year scenarios; Year 2, Year 8, and Year 15. These years were selected to give a representation of mine noise levels near the beginning, middle and end of the project. Modelling of the scenarios has incorporated mine ground elevations, and type, number and location of equipment for each mine year. Mining noise levels at residential receptors can vary significantly depending upon the meteorology and the mine activities. Meteorology has significant effects on noise levels, predominantly due to wind speed and direction, and vertical temperature gradients, including temperature inversions. Detailed information regarding model inputs including noise source emissions, noise source locations, mobile equipment numbers and total scenario power levels is provided in Appendix M.

A SoundPLAN (Version 8.2) computer noise model was used to predict noise levels at sensitive receptors. The computer model calculated the noise levels at sensitive receptors, accounting for noise propagation variables such as distance attenuation, ground absorption, air absorption and shielding attenuation from topography, buildings or barriers.

The CONCAWE industrial noise prediction methodology was utilised within SoundPLAN, which is specially designed for large facilities and incorporates the influence of wind effects and stability of the atmosphere.

11.3.3 Noise Modelling Results

The predicted noise levels at nearby sensitive receptors for the three mining year scenarios are presented for 'adverse' night and day scenarios below (Table 62, Table 63 and Table 64). The results are compared against the proposed noise limits of 35 dBA $L_{Aeq,adj,1hr}$ (night) and 40 dBA $L_{Aeq,adj,1hr}$ (day/evening). From this, potential noise impacts associated with the Project include the following:

- no exceedances are recorded during day/evening operations; and
- night exceedances are limited to:
  - Year 2 (SR10: 2 dBA and SR22: 1 dBA); and
  - Year 8 (SR10: 3 dBA).

Therefore, the maximum exceedance is limited to 3dBA at sensitive receptor SR10 located 1.4 km to the east of the Project.

Model Mining Conditions and the EPP (Noise) for sleep disturbance recommend the assessment of L_{Amax}, L_{A01} and L_{A10}, however these parameters have not been included in this assessment. Most mine noise source data is available in the L_{Aeq} parameter and where noise limits of L_{Amax}, L_{A01} and L_{A10} are specified for the Project, they would be 15, 10 and 5 dBA higher than the L_{Aeq} noise limits, respectively. It is noted that L_{A01} and L_{A10} noise limits cannot be accurately used for compliance during warmer months as noise levels are commonly dominated by insect noise (i.e., removal of insect noise is not strictly possible from these noise parameters). The L_{Amax} parameter can also be challenging for compliance monitoring as extraneous L_{Amax} events (e.g., birds, animals, farm activities) need to be removed from the noise monitoring data.

In this instance, L_{Aeq} is the preferred parameter. If L_{Aeq} noise levels comply with relative limits, no further assessment is proposed for the L_{Amax}, L_{A01} and L_{A10} parameters as they would subsequently comply (refer to Appendix M).

The predicted noise levels are displayed graphically as noise contours below (Figure 79 through to Figure 84).

Table 62 Predicted Noise Levels - Year 2

Receptor	Predicted Noise Emission Levels (L_{eq} dBA)																	
	Day Meteorological Scenarios									Night Meteorological Scenarios								
	Mine Only			Mine & Rail Loadout			Night Criterion Exceedance (35 dBA)			Mine Only			Mine & Rail Loadout			Night Criterion Exceedance (35 dBA)		
Scenario	**D1**	**D2**	**D3**	**D1**	**D2**	**D3**	**D1**	**D2**	**D3**	**N1**	**N2**	**N3**	**N1**	**N2**	**N3**	**N1**	**N2**	**N3**
SR01	23	24	15	24	24	15	(-16)	(-16)	(-25)	24	24	18	24	24	19	(-11)	(-11)	(-16)
SR03	31	23	31	31	23	31	(-9)	(-17)	(-9)	32	30	32	32	30	32	(-3)	(-5)	(-3)
SR05	26	25	17	26	25	17	(-14)	(-15)	(-23)	26	27	20	26	28	20	(-9)	(-7)	(-15)
SR07	31	24	31	31	24	31	(-9)	(-16)	(-9)	32	32	32	32	32	32	(-3)	(-3)	(-3)
SR08	24	25	15	24	25	15	(-16)	(-15)	(-25)	25	25	19	25	26	19	(-10)	(-9)	(-16)
SR10	36	29	36	26	29	36	(-4)	(-11)	(-4)	37	37	37	37	37	37	2	2	2
SR13	33	25	33	33	25	33	(-7)	(-15)	(-7)	34	33	34	34	33	34	(-1)	(-2)	(-1)
SR16	29	30	29	29	30	29	(-11)	(-10)	(-11)	30	30	30	30	30	30	(-5)	(-5)	(-5)
SR17	26	27	17	26	27	17	(-14)	(-13)	(-23)	27	27	21	27	27	21	(-8)	(-8)	(-14)
SR22	33	34	24	35	35	25	(-5)	(-5)	(-15)	35	35	29	36	36	30	1	1	(-5)
SR26	26	18	26	26	18	26	(-14)	(-22)	(-14)	27	25	27	27	25	27	(-8)	(-10)	(-8)
SR27	27	20	27	27	20	27	(-13)	(20)	(-13)	28	28	28	28	28	28	(-7)	(-7)	(-7)
SR28	27	20	27	27	20	27	(-13)	(-20)	(-13)	28	28	28	28	28	28	(-7)	(-7)	(-7)
SR30	27	20	27	27	20	27	(-13)	(-20)	(-13)	28	29	28	28	29	28	(-7)	(-6)	(-7)
SR31	31	31	21	31	22	(-9)	(-9_	(-8)	(-18)	32	32	26	33	33	26	(-2)	(-2)	(-9)
SR32	29	29	20	30	30	20	(-10)	(-10)	(-20)	30	30	24	31	31	25	(-4)	(-4)	(-10)

Noise levels that exceed the EPP (Noise) and the *Planning For Noise Control guideline* (EHP 2004) are highlighted in pink.
Noise levels below exceedance criterion are included in brackets.

Table 63 Predicted Noise Levels – Year 8

Receptor	Predicted Noise Emission Levels (L_{eq}, dBA)																	
	Day Meteorological Scenarios									Night Meteorological Scenarios								
	Mine Only			Mine & Rail Loadout			Night Criterion Exceedance (35 dBA)			Mine Only			Mine & Rail Loadout			Night Criterion Exceedance (35 dBA)		
Scenario	**D1**	**D2**	**D3**	**D1**	**D2**	**D3**	**D1**	**D2**	**D3**	**N1**	**N2**	**N3**	**N1**	**N2**	**N3**	**N1**	**N2**	**N3**
SR01	21	22	12	21	22	12	(-19)	(-18)	(-28)	22	22	16	22	22	16	(-13)	(-13)	(-19)
SR03	32	24	32	32	24	32	(-8)	(-16)	(-8)	33	31	33	33	31	33	(-2)	(-4)	(-2)
SR05	24	23	15	24	23	15	(-16)	(-17)	(-25)	25	26	18	25	26	18	(-10)	(-9)	(-17)
SR07	32	24	32	32	24	32	(-8)	(-16)	(-8)	33	33	33	33	33	33	(-2)	(-2)	(-2)
SR08	22	23	13	23	23	13	(-17)	(-17)	(-27)	23	24	17	24	24	17	(-11)	(-11)	(-18)
SR10	37	30	37	37	30	37	(-3)	(-10)	(-3)	38	38	38	38	38	38	3	3	3
SR13	34	26	34	34	26	34	(-6)	(-14)	(-6)	35	35	35	35	35	35	(0)	(0)	(0)
SR16	28	29	28	28	29	28	(-12)	(-11)	(-12)	29	29	30	29	29	30	(-6)	(-6)	(-5)
SR17	24	25	15	24	25	15	(-16)	(-15)	(-25)	25	25	19	25	25	19	(-10)	(-10)	(-16)
SR22	32	32	22	34	34	23	(-6)	(-6)	(-17)	33	33	27	35	32	29	(0)	(0)	(-6)
SR26	27	18	27	27	18	27	(-13)	(-22)	(-13)	28	26	28	28	26	28	(-7)	(-9)	(-7)
SR27	28	20	28	28	20	28	(-12)	(-20)	(-12)	29	29	29	29	29	29	(-6)	(-6)	(-6)
SR28	28	20	28	28	20	28	(-12)	(-20)	(-12)	29	29	29	29	29	29	(-6)	(-6)	(-6)
SR30	27	20	27	27	20	27	(-13)	(-20)	(-13)	28	30	28	28	30	28	(-7)	(-5)	(-7)
SR31	28	30	19	30	30	20	(-10)	(-10)	(-20)	30	30	24	31	31	24	(-4)	(-4)	(-11)
SR32	27	28	17	28	29	18	(-12)	(-11)	(-22)	29	29	22	30	30	23	(-5)	(-5)	(-12)

Noise levels that exceed the EPP (Noise) and the Planning For Noise Control guideline (EHP 2004) are highlighted in pink.
Noise levels below exceedance criterion are included in brackets.

Table 64 Predicted Noise Levels – Year 15

Receptor	Predicted Noise Emission Levels (L_{eq}, dBA)																	
	Day Meteorological Scenarios									Night Meteorological Scenarios								
	Mine Only			Mine & Rail Loadout			Night Criterion Exceedance (35 dBA)			Mine Only			Mine & Rail Loadout			Night Criterion Exceedance (35 dBA)		
Scenario	**D1**	**D2**	**D3**	**D1**	**D2**	**D3**	**D1**	**D2**	**D3**	**N1**	**N2**	**N3**	**N1**	**N2**	**N3**	**N1**	**N2**	**N3**
SR01	22	23	13	23	23	13	(-17)	(-17)	(-27)	23	23	18	23	23	18	(-12)	(-12)	(-17)
SR03	24	18	24	24	18	25	(-16)	(-22)	(-15)	25	28	25	25	28	25	(-10)	(-7)	(-10)
SR05	28	28	18	28	28	18	(-12)	(-12)	(-22)	28	29	22	28	29	22	(-7)	(-6)	(-13)
SR07	24	19	24	24	19	24	(-16)	(-21)	(-16)	24	27	24	25	27	25	(-10)	(-8)	(-10)
SR08	24	24	14	24	24	14	(-16)	(-16)	(-26)	25	25	19	25	25	19	(-10)	(-10)	(-16)
SR10	27	23	27	27	23	27	(-13)	(-17)	(-13)	28	29	28	28	29	28	(-7)	(-6)	(-7)
SR13	25	21	26	25	21	26	(-15)	(-19)	(-14)	26	28	26	26	28	26	(-9)	(-7)	(-9)
SR16	20	21	21	21	21	22	(-19)	(-19)	(-18)	21	21	21	21	22	21	(-14)	(-13)	(-14)
SR17	26	26	16	26	26	16	(-14)	(-14)	(-24)	27	27	21	27	27	21	(-8)	(-8)	(-14)
SR22	32	32	23	33	33	24	(-7)	(-7)	(-16)	33	33	29	35	35	30	(0)	(0)	(-5)
SR26	21	15	21	21	15	21	(-19)	(-25)	(-19)	21	24	21	22	24	22	(-13)	(-11)	(-13)
SR27	22	16	22	22	16	22	(-18)	(-24)	(-18)	22	25	22	22	25	22	(-13)	(-10)	(-13)
SR28	22	16	22	22	16	22	(-18)	(-24)	(-18)	22	25	22	22	25	22	(-13)	(-10)	(-13)
SR30	22	17	22	22	17	22	(-18)	(-23)	(-18)	22	25	22	22	25	22	(-13)	(-10)	(-13)
SR31	30	30	20	30	30	21	(-10)	(-10)	(-19)	31	31	26	32	32	26	(-3)	(-3)	(-9)
SR32	28	28	19	28	29	19	(-12)	(-11)	(-21)	29	29	24	30	30	25	(-5)	(-5)	(-10)

Noise levels that exceed the EPP (Noise) and the Planning For Noise Control guideline (EHP 2004) are highlighted in pink.
Noise levels below exceedance criterion are included in brackets.

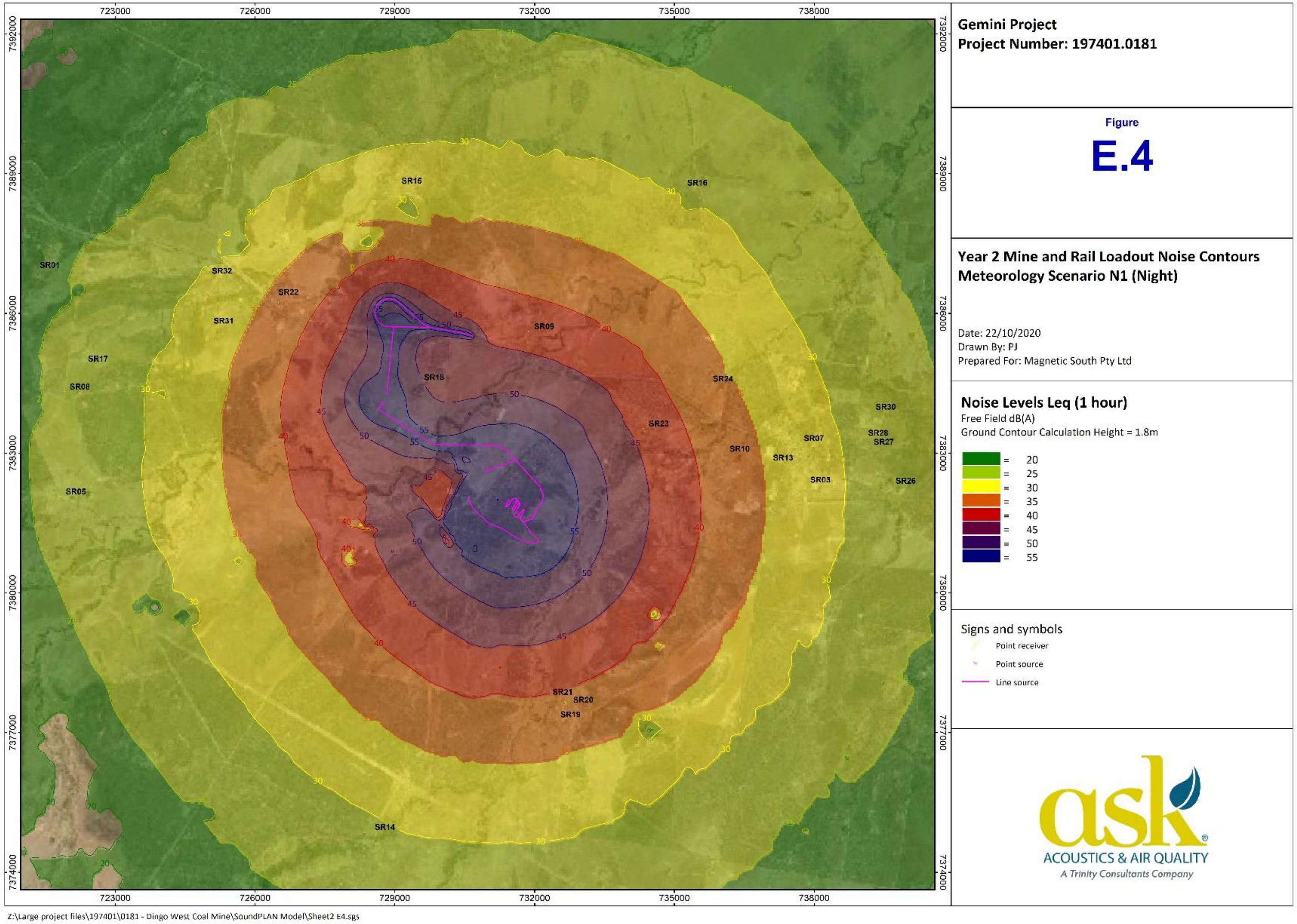


Figure 79 Year 2 - Night 'Adverse' Scenario (Mine and Rail Loadout)

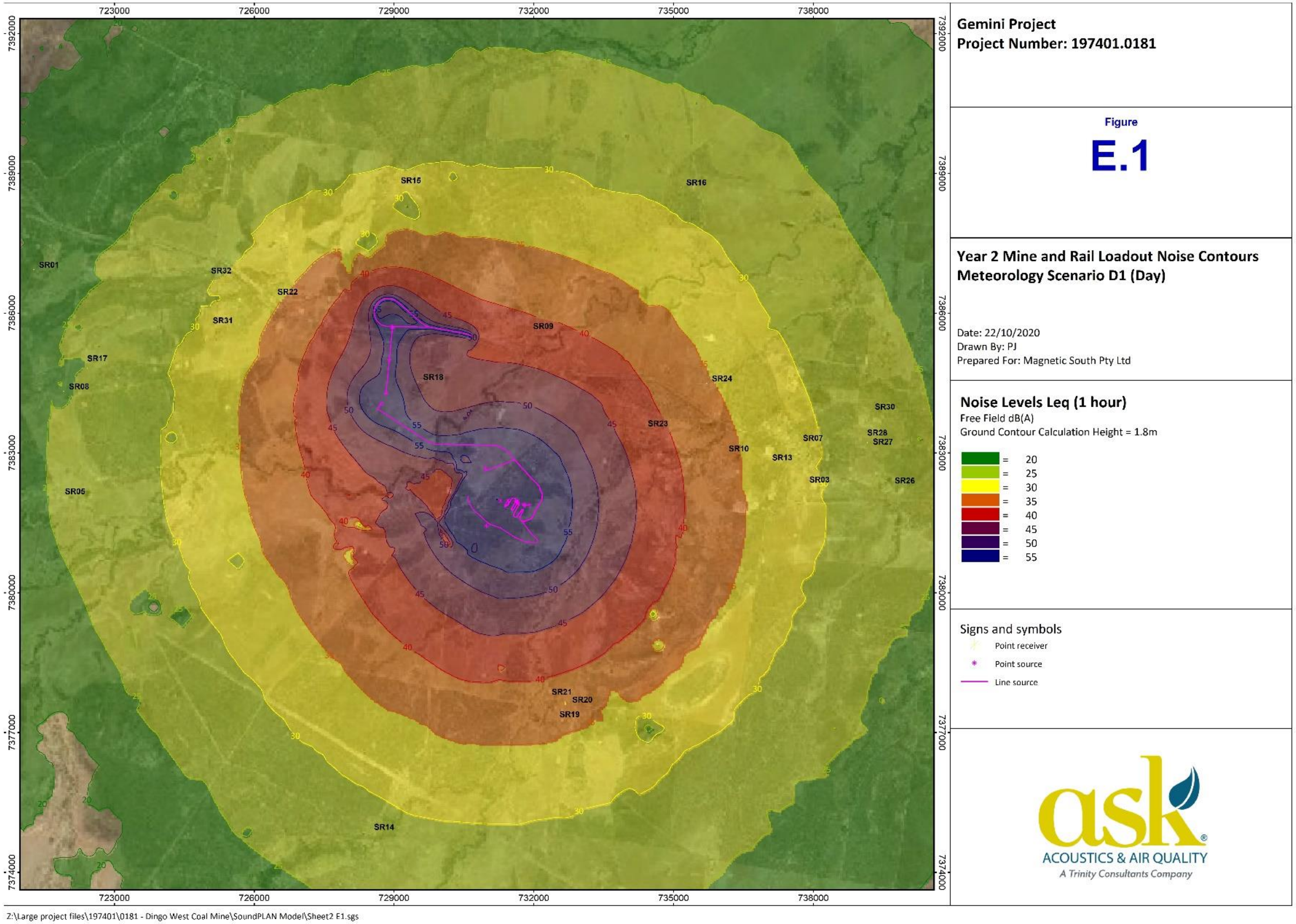


Figure 80 Year 2 - Day 'Adverse' Scenario (Mine and Rail Loadout)

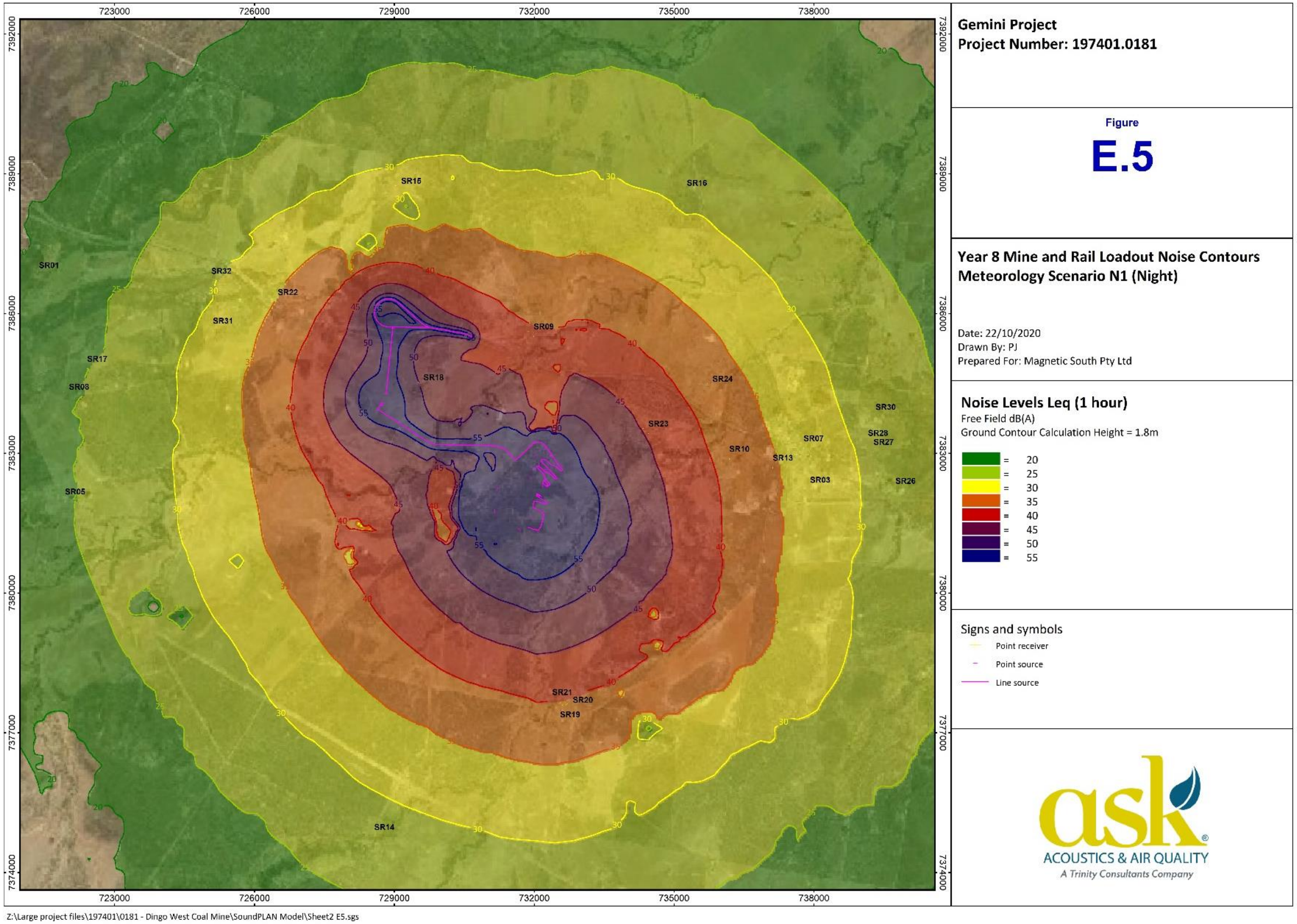


Figure 81 Year 8 - Night 'Adverse' Scenario (Mine and Rail Loadout)

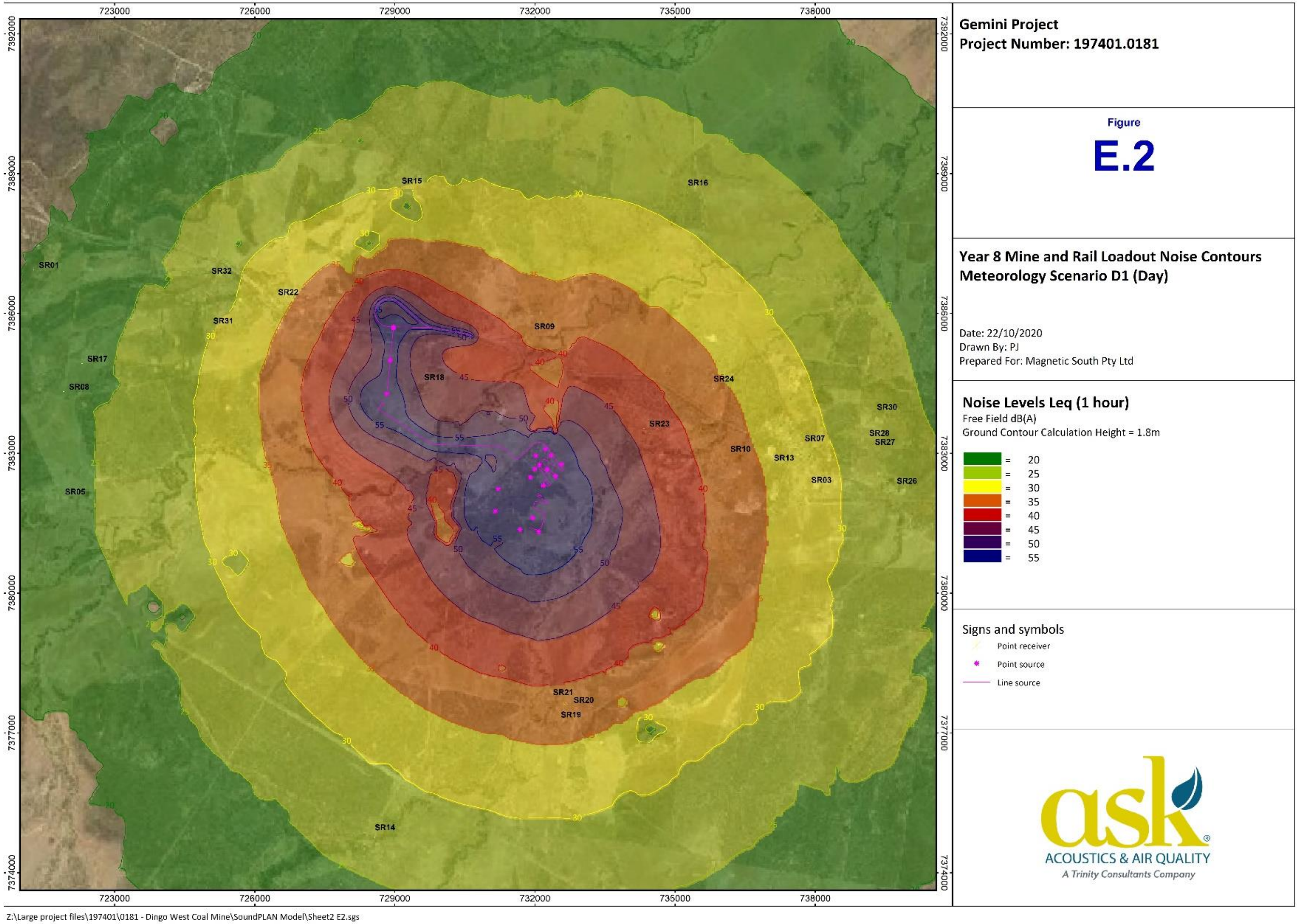


Figure 82 Year 8 - Day 'Adverse' Scenario (Mine and Rail Loadout)

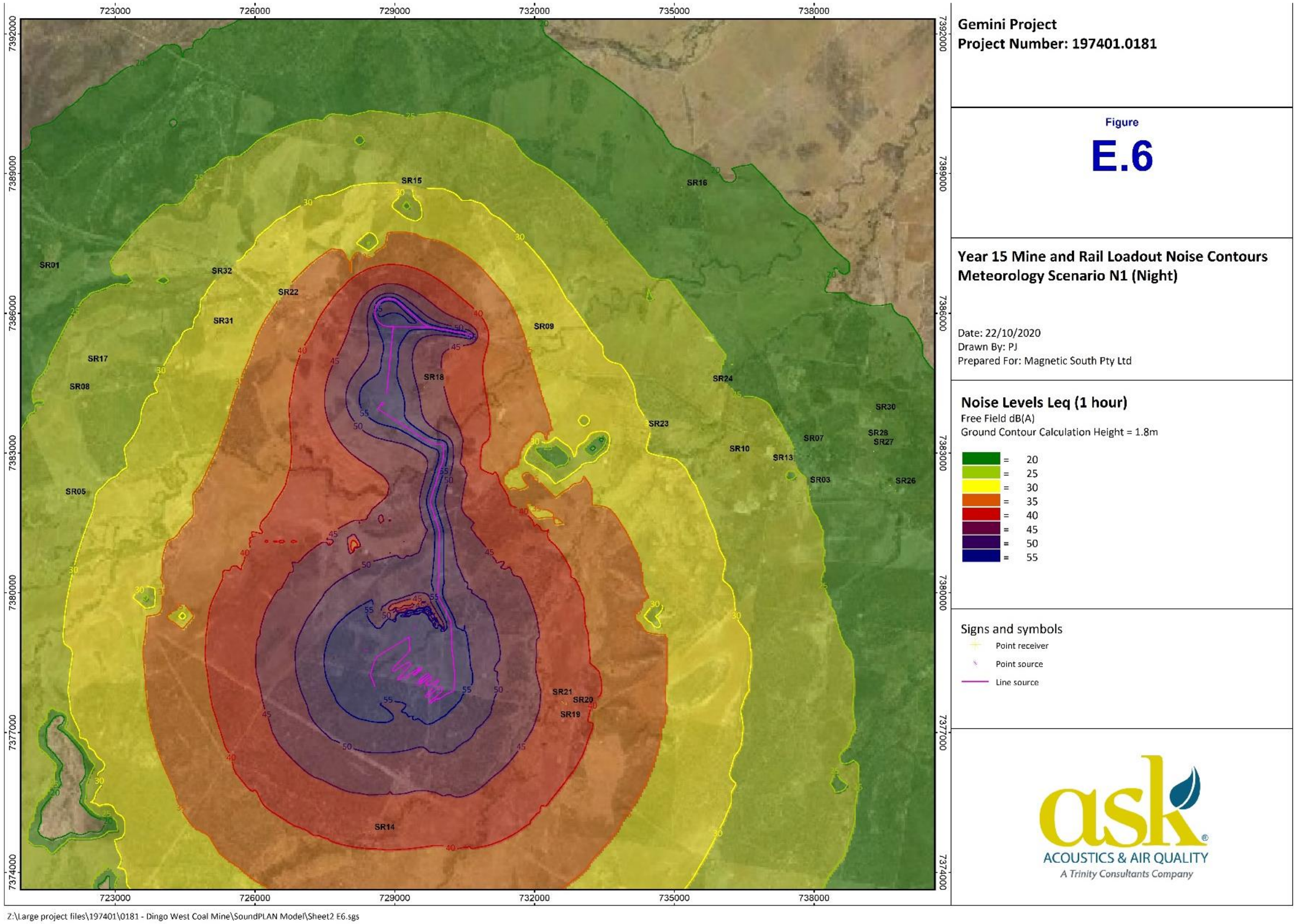


Figure 83 Year 15 - Night 'Adverse' Scenario (Mine and Rail Loadout)

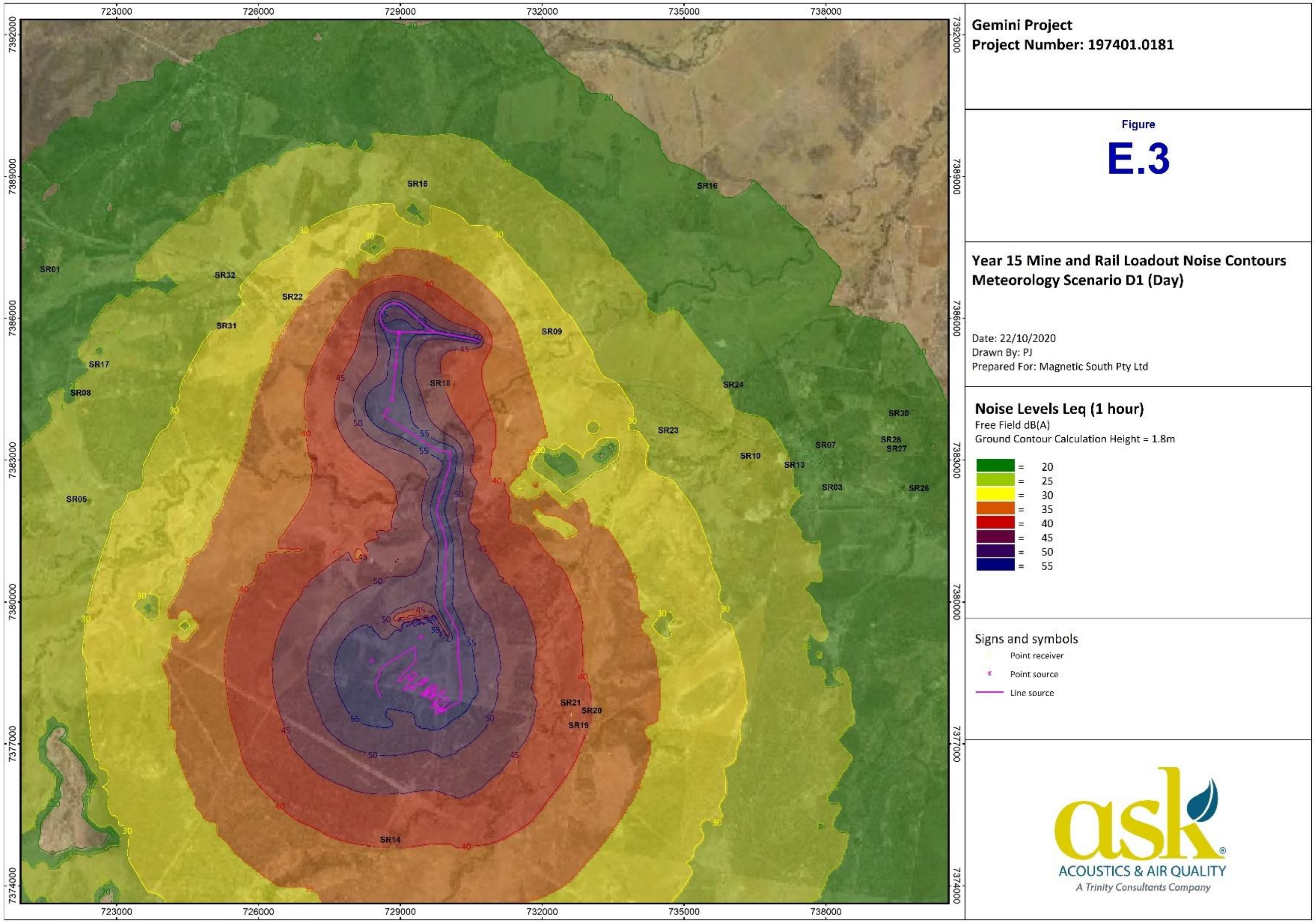


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Figure 84 Year 15 - Day 'Adverse' Scenario (Mine and Rail Loadout)

11.3.4 Background Creep

The EPP (Noise) no longer contains criteria for background creep, but states that background creep should be prevented or minimised, to the extent that it is reasonable to do so. In consideration of the *Noise Measurement Manual (ESR/2016/2195 - formerly EM1107*), background creep is defined as 'a gradual increase in the total amount of background noise in an area or place.' Therefore, consideration of cumulative impacts, including other developments, is required to ensure background creep is minimised in accordance with the EPP (Noise) recommendations.

The nearest existing mine is Bluff Mine to the west of the Project. The sensitive receptors that have the most potential to be impacted by the Project to the west are SR22, SR31 and SR32, with noise levels of up to 36 dBA, 33 dBA and 31 dBA L_{Aeq} respectively. The Bluff Mine is over 12 km from these receptors (SR22, SR31 and SR32) and only 1 km from the township of Bluff. Given the requirement to comply with noise criteria in the township, it would be expected that Bluff mine noise levels at the receptors would be well below the 35 dBA noise limit and would not significantly contribute to exceedances at these locations. In addition to this, cumulative impacts from adverse wind conditions cannot occur for both mines simultaneously at these receptors since they are in opposite directions. Similarly, due to the broadscale consistency of adopted noise limits for the Project with other mining operations such as the Bluff Mine and Jellinbah Mine in the surrounding region (limits detailed above in Section 11.3.1), a 'no wind scenario' is considered to produce the same outcome. Additionally, it is noted that, at the time of submission, Bluff mine is under care and maintenance, with no certainty of returning to operations during the life of the Gemini Project. Therefore, it is unlikely that cumulative noise impacts from surrounding mines would contribute to background creep.

11.3.5 Vibration Assessment

It is anticipated that the existing vibration levels around the Project and at the location of sensitive receptors will generally be negligible, except at locations which are close to roads, rail lines or near major items of fixed plant. The only vibration source of significance from the mining of the Project would be blasting. Blasting activities within the pits have been assessed for both ground vibration and airblast.

Ground vibration and airblast levels caused by blasting activities were predicted based on the formulas and methodology of *Australian Standard AS2187.2: Explosives - Storage Transport and Use - Use of Explosives*, which predicts the PPV in mm/s and the airblast over pressure (peak pressure) in dB. Technical details of assessment methodology and inputs for ground vibration and airblast can be found in Section 7 of the *Noise Impact Assessment* (ASK 2020) (Appendix M).

Based on the ASK (2020) blasting calculations, the ground vibration and airblast levels from the Project are predicted to be acceptable at the nearest sensitive receptors based on the nominated criteria (Table 61).

Table 65 shows that the 10 mm/s PPV criterion would not be exceeded at distances greater than 1.0 km from the blast, whilst the 5 mm/s PPV criterion would not be exceeded at distances greater than 1.5 km from the blast. The nearest sensitive receptor is approximately 1.9 km away from the nearest pit shell area where blasting would occur. Therefore, ground vibration due to blasting is predicted to be compliant with the nominated criteria at all sensitive receptors.

Table 65 Ground Vibration Levels at Various Distances from The Blast

Distance from Blast (km)	Vibration Level (mm/s)	
	K = 800	K = 1600
1.0	2.9	5.9
1.5	1.5	3.1
2.0	1.0	1.9
2.5	0.7	1.4
3.0	0.5	1.0
3.5	0.4	0.8
4.0	0.3	0.6
4.5	0.3	0.5
5.0	0.2	0.4
5.5	0.2	0.4
6.0	0.2	0.3
6.5	0.1	0.3
7.0	0.1	0.3
7.5	0.1	0.2
8.0	0.1	0.2
8.5	0.1	0.2
9.0	0.1	0.2
9.5	0.1	0.2
10.0	0.1	0.1

Notes: K site and rock constant. Assumed to be in the range of 800 to 1600 for the Gemini Project (ASK 2020).

Table 66 contains the separation distances and the reduction of airblast noise levels due to distance. The distance to the airblast criterion contour line of 120 dB (linear) was calculated to be 880 m. The distance to the 115 dB (linear) contour line is calculated to be 1,290 m. Based on these calculations and blast parameters, the airblast criteria would not be exceeded at any sensitive receptors.

Table 66 Airblast Noise Levels at Various Distances from The Blast

Distance from Blast (km)	Airblast Level (dB (linear))
1.0	118.3
1.5	113.0
2.0	109.3
2.5	106.4
3.0	104.0
3.5	102.0
4.0	100.3
4.5	98.8
5.0	97.4
5.5	96.2
6.0	95.0
6.5	94.0
7.0	93.0
7.5	92.2
8.0	91.3
8.5	90.5
9.0	89.8
9.5	89.1
10.0	88.4

11.3.6 Impact Summary

The Project has potential to impact on EVs as a result of Project related noise impacts. Noise criteria was proposed (Table 60) in line with current policy.

From the predicted noise levels in Section 11.3.3, of the properties that are not owned by Magnetic South at the time of submission, exceedances of the 35 dBA night objective is predicted at two receptors:

- SR10 (Year 2 and Year 8);
- SR22 (Year 2).

Compliance is predicted at all other sensitive receptors during both day and night 'averse' conditions.

Of these potentially impact receptors, SR22 is located within the MLA, whilst SR10 is located 1.4 km east of the MLA. Given there is a potential for exceedances, a range of mitigation measures will be implemented, as necessary, to achieve compliance for residual sensitive receptors in the area. These measures are detailed in the subsection below.

11.4 MITIGATION MEASURES, MANAGEMENT AND MONITORING

The management hierarchy for noise as set out in the EPP (Noise) requires that for an activity involving noise that affects, or may affect, an EV, to the extent that it is reasonable to do so, noise must be dealt with in the following order of preference:

1. avoid the noise (e.g., locating an activity in an area that is not near a sensitive receptor);

2. minimise the noise by preferably:

    a. orientating an activity to minimise the noise (e.g., facing a part of an activity that makes noise away from a sensitive receptor); or alternatively

    b. using the best available technology to minimise the noise; or

3. manage the noise (e.g., using heavy machinery only during business hours).

The potential requirements for noise mitigation at this time are based solely on noise modelling for the Project. Magnetic South will monitor and verify noise levels before considering the implementation of mitigation measures.

11.4.1 Noise Monitoring

Prior to mining operations, noise level compliance will be undertaken by real time noise monitoring at the most noise affected receptor/s (i.e., SR10 and SR22). A noise monitoring survey will be then conducted at the commencement of operations to verify the noise emissions within the Project and the level of noise impact at sensitive receptors. The verified noise levels will direct the noise limits that will be administered under the EA and subsequent auditing compliance.

The following noise monitoring measures will be undertaken to inform the ongoing design of operations and any noise mitigation requirements:

- Develop and implement a noise monitoring program at sites representative of surrounding sensitive receptors for verification of modelling results. All noise monitoring will be conducted in accordance with *Australian Standard AS1055: Acoustics – Description and measurement of environmental noise* and the *Noise Measurement Manual* (EHP 2013b).

- Operate a real time noise monitoring system that will report one-third octave band noise levels (including L_{eq} ,L_1, L_{10} and L_{90}.) over 15-minute periods and provide audio recording/snapshots and 1 second time period noise levels. The system will have the capability to email, text message, or otherwise transmit alerts to mine operators to enable the mine to react to potential exceedances and may also provide a web portal interface where mine operators can track the noise during night periods.

- A blast monitoring program will be developed to monitor the airblast overpressure and blast vibration levels during all blast events. The blast design details will be the responsibility of the blast contractor and observations before and after blasting will also be recorded.

Where the monitoring programs indicate a potential exceedance, the following mitigation measures below would be implemented, as necessary.

11.4.2 Noise Mitigation Management and Scenarios

Noise and vibration management and mitigation measures will be undertaken for the Project to ensure all noise objectives and limits have been achieved. Magnetic South is committed to implementing the following measures:

- Develop a *Noise and Blast Management Plan* that will detail noise monitoring frequency and a range of available measures to be implemented as necessary to ensure compliance with approval conditions.

  Measures that will be considered for inclusion in the *Noise and Blast Management Plan* as opportunities for noise reduction and additional remedial actions for noise control in the event of complaints being received, exceedances of criteria being recorded, or other trigger levels being breached include:

  - management of mining equipment locations (i.e., moving mine equipment further from the most-affected receptors);
  - where appropriate, ceasing operations at times of the day that are predicted to result in exceedances (i.e., night-time) is considered to minimise effects;
  - where appropriate, ceasing operations under meteorological conditions that are predicted to result in exceedances at highly affected receptors (real time noise monitors can inform reactive operation to meteorological conditions if limits are exceeded);
  - reducing the number of equipment in operation during the night (e.g., halving of equipment numbers would be expected to provide a reduction of 3 dBA, assuming the shutdown equipment was spread around the mine operations);
  - attenuation of equipment, particularly the mobile fleet, could result in noise reductions of the order of 3 to 8 dBA, at $250,000 to $750,000 per item of equipment;
  - construction of bund walls where possible nearest to the noise source (i.e., adjacent a haul road, or sensitive receptors);
  - the requirement that Magnetic South will investigate, if monitoring indicates unexpected exceedances of noise or blast objectives; and/or
  - roles and responsibilities for implementation, monitoring and review of the *Noise and Blast Management Plan*.

- Enter into discussions and, as appropriate, commercial arrangements with any affected surrounding landholders which could include:

  - measures (e.g., purchase or relocation) which results in homesteads no longer being considered a sensitive receptor; or
  - installation of receptor-side mitigation (e.g., air conditioners and glazed windows in affected residences to allow for closed windows).

Based on the modelled noise results in Section 11.3.3, a number of noise mitigation scenarios are outlined below (Table 67). These optional scenarios focus on removing or relocating equipment and should be considered as examples only as other acoustically equivalent scenarios could be developed. The mine could operate compliantly by selecting and operating to one of the optional scenarios below.

Table 67 Example Mitigation Scenarios

Year	Scenario	Example Scenarios and Resulting Noise Levels Under Adverse Conditions for Each Time Period	
		Day and Evening (7am to 10pm)	**Night (10pm to 7am)**
Year 2	Original	36 dBA at SR10 and 35 dBA at SR22, as per Table 62.	37 dBA at SR10 and 36 dBA at SR22, as per Table 62.
	Option 2A	No change to day/evening operations. Results as per Original scenario already achieve compliance.	35 dBA at SR10 and 35 dBA at SR22, i.e., compliance achieved when 5 of 12 x OB haul trucks removed.
Year 8	Original	37 dBA at SR10, as per Table 63	38 dBA at SR10, as per Table 63.
	Option 8A	No change to day/evening operations. Results as per original scenario already achieve compliance.	35 dBA at SR10, i.e., compliance achieved when 1 of 6 x D11 dozers are removed from dump and 6 of 15 x OB haul trucks are removed.

12.0 WASTE GENERATION

This section provides a description of the waste streams that are likely to be produced over the life of the Project and describes the proposed measures for minimising and managing waste generated. This section refers to general and regulated waste streams to be managed at the Project. Other waste products not addressed here include water, air, GHG and waste rock. These are addressed in the relevant technical sections:

- surface water runoff and wastewater is addressed in Section 7.0;
- groundwater inflows into the open pits is addressed in Section 8.0;
- airborne wastes excluding GHGs is addressed in Section 9.0;
- GHGs and fugitive emissions is addressed in Section 10.0; and
- excavated waste rock and coal rejects is addressed in Section 13.0.

12.1 ENVIRONMENTAL OBJECTIVES AND PERFORMANCE OUTCOMES

The environmental objective relevant to waste, as described in the EA guideline for *Application requirements for activities with waste impacts [ESR/2015/1836]* (DES 2019), is:

Any waste generated, transported, or received as part of carrying out the activity is managed in a way that protects all environmental values.

The Project would achieve the following performance outcomes identified in Schedule 8, Part 3, Division 1 of the EP Regulation:

a) *waste generated, transported, or received, is managed in accordance with the waste and resource management hierarchy in the Waste Reduction and Recycling Act 2011; and*

b) *if waste is disposed of, it is disposed of in a way that prevents or minimises adverse effects on environmental values.*

12.2 DEFINITION OF WASTE

The EP Act defines 'waste' as anything that is:

a) *left over, or an unwanted by-product, from an industrial, commercial, domestic or other activity; or*

b) *surplus to the industrial, commercial, domestic or other activity generating the waste.*

Section 42 of the EP Regulation defines 'regulated waste' as waste that is:

a) *commercial waste or industrial waste; and*

b) *a type, or contains a constituent of a type, mentioned in schedule 9, part 1, column 1.*

Classified under 'regulated waste' –

Schedule 2 of the EP Regulation defines 'limited regulated' waste to include –

a) *animal effluent and residues, asbestos, biosecurity waste that has been rendered non-infectious, food processing waste, tyres, and sewage sludge or residue produced in carrying out an activity.*

Schedule 19 of the EP Regulation defines ‘commercial waste’ as:

a) *waste produced as a result of the ordinary use or occupation of commercial or premises; and*

b) *waste other than green waste, recyclable waste, interceptor waste or waste discharged to a sewer.*

Schedule 19 of the EP Regulation defines ‘industrial waste’ as:

a) *interceptor waste; or*

b) *waste other than the following—*

    i. *domestic waste, domestic clean-up waste, green waste, recyclable waste, recyclable interceptor waste, waste discharged to a sewer.*

Schedule 19 of the EP Regulation defines ‘biosecurity waste’ as:

a) *waste that is goods subject to biosecurity control under the Biosecurity Act 2015 (Cwlth); or*

b) *goods under the Biosecurity Act 2015 (Cwlth) that are or were in contact with waste mentioned in paragraph (a).*

Schedule 19 of the EP Regulation defines ‘general waste’ as:

a) *waste other than regulated waste;*

b) *chapter 6, part 2, any of the following –*

    i. *commercial waste, other than regulated waste;*

    ii. *domestic waste;*

    iii. *recyclable waste.*

c) *general waste composition includes –*

i. *putrescibles, paper, cardboard, glass, office waste, industrial waste and construction waste.*

Schedule 19 of the EP Regulation defines ‘green waste’ as:

a) *organic waste from vegetation (e.g., trees, shrubs, and grass).*

Schedule 19 of the EP Regulation defines ‘clinical waste’ as:

a) *waste that has the potential to cause disease*

b) *clinical waste composition includes –*

    i. *animal waste, discarded sharps, human tissue waste and laboratory waste.*

12.3 IDENTIFIED WASTE TYPES

The primary source of waste from mining operations is excavated waste (overburden and interburden), coarse rejects and fine rejects (tailings) from the CHPP. Other wastes (regulated and non-regulated) expected to be produced from activities pertaining to the Project include:

- general waste;
- recyclable waste;
- refurbishable items;
- green waste;
- scrap metal;
- personal protective equipment (ppe);
- air filters;
- timber and reusable pallets;
- waste oils;
- engine oil/fuel filters;
- waste greases;
- sewage effluent;
- empty waste oil containers;
- paints;
- hydrocarbon contaminated material;
- miscellaneous chemicals;
- batteries;
- E-waste;
- ozone depleting substances; and
- tyres.

Table 68 describes the expected quantity of each generated waste type, stream and disposal locations during the construction and operational phases of the Project based on different waste definitions listed in the EP Regulation.

Table 68 Anticipated Waste Generation From The Construction and Operation of the Project

Waste Type/ Waste Category	Form	Source	Approximate Quantity (per annum)		Management Strategies	Waste Management Hierarchy	Proposed Disposal Location
			Construction	Operation			
General Waste							
General waste *(i.e., food scraps, non-Class 1, 2 and 5 plastics)*	Solid	Kitchenettes, crib rooms, administration areas, workshop, etc.	<130 t	<170 t	General waste will be stored onsite in bins for regular transport offsite by a licensed waste transport contractor to a licensed landfill.	Waste disposal	General waste will be transported offsite by a licenced waste contractor to an approved landfill.
Recyclable waste *(i.e., aluminium, steel cans, Class 1, 2 and 5 plastics, paper towels, paper and cardboard)*	Solid	Kitchenettes, crib rooms, administration areas, workshop, etc.	<40 t	<70 t	Recyclable waste will be stored onsite in bins for regular transport offsite by a licensed waste transport contractor for recycling.	Waste recycling	Recyclable waste will be transported offsite by a licenced recycling contractor to an approved recycling facility.
Timber/reusable pallets	Solid	Workshop and administration areas	<20 t	<20 t	Reusable pallets will be returned to the supplier.	Waste reuse	Return to supplier for reuse.
					Where pallets are unable to be reused, they will be sent to general waste.	Waste disposal	Pallets that are not reusable will be transported offsite by a licenced waste contractor to an approved landfill.
Refurbishable items *(i.e., pipe work and associated components and fittings, wing nuts, conveyor rollers and belt)*	Solid	CHPP and workshops	<10 t	<10 t	Refurbishable items will be stockpiled within a designated area. If condition is acceptable, items will be reused directly.	Waste reuse	Reuse onsite.
					Where items are unable to be reused, they will be collected and disposed by a licensed waste contractor. Where items are contaminated with hydrocarbons, they will be managed as regulated waste.	Waste disposal	Refurbishable items will be disposed of offsite by a licenced waste contractor to an approved waste facility.

Waste Type/ Waste Category	Form	Source	Approximate Quantity (per annum)		Management Strategies	Waste Management Hierarchy	Proposed Disposal Location
			Construction	Operation			
PPE and other small items *(i.e., gloves, hard hats, safety glasses and face masks)*	Solid	Bathhouse and contractor facilities	<100 kg	<200 kg	Equipment that is not damaged will be reused onsite.	Waste reuse	Reuse onsite.
					Equipment that is sufficiently used and/or damaged will be disposed.	Waste disposal	PPE will be transported offsite by a licenced waste contractor to an approved landfill.
Scrap metal *(i.e., stainless steel, aluminium and any item considered to be metal [ferrous or non-ferrous] including machine and vehicle parts)*	Solid	Construction activities, infrastructure maintenance and workshops	<50 t	<100 t	Small scrap metals will be placed in scrap metal skips. All grease and oils will be removed prior to placement in skips. Specific arrangements will be made for the collection of larger scrap metals. A licensed contractor will remove all scrap metals for segregation at a licensed recycling facility.	Waste recycling	Scrap metal will be transported offsite by a licensed contractor to an approved recycling facility.
Air filters *(i.e., engine air filters)*	Solid	Vehicle and machinery maintenance at workshops	<1 t	<7 t	Air filters will be temporarily stored in the appropriate air filter skip and will be disposed of offsite by a licensed waste contractor.	Waste recycling	Air filters will be transported offsite by a licenced waste contractor to be recycled.
Green & Biosecurity							
Green waste *(i.e., grass, cleared timber and weeds)*	Solid	Clearing of vegetation	As per schedule	As per schedule	Green waste will be mulched and/or placed in timber stacks for reuse onsite during rehabilitation.	Waste reuse	Reuse onsite.
Regulated							
Excavated waste *(i.e., overburden, interburden)*	Solid	Mining activities	n/a	Up to 473.4 Mbcm	Excavated waste rock will be placed in an out-of-pit waste rock emplacement and in-pit waste rock emplacements of Pit AB and Pit C when space becomes available behind the advancing mining operations.	Waste disposal	Excavated waste rock will be disposed of within Pit AB and Pit C and out-of-pit waste rock emplacements.

Waste Type/ Waste Category	Form	Source	Approximate Quantity (per annum)		Management Strategies	Waste Management Hierarchy	Proposed Disposal Location
			Construction	Operation			
Coal rejects *(i.e., coarse and fine rejects)*	Solid	Mining activities	n/a	Up to 0.5 Mt	Coal rejects will be disposed of in out-of-pit waste rock emplacements and in-pit waste rock emplacements of Pit AB and Pit C when space becomes available behind the advancing mining operations.	Waste disposal	Coal rejects will be disposed of within Pit AB and Pit C and out-of-pit waste rock emplacements.
Waste oils	Liquid	Machinery and vehicle maintenance and workshop	30 kL	199 kL	Waste oils will be transported offsite by a licensed regulated waste contractor and will be reused or recycled by a licensed regulated waste receiver.	Waste reuse or recycling	Waste oils will be recycled by a licenced regulated waste contractor.
Engine oil/fuel filters	Solid/ Liquid	Vehicle and machinery maintenance at workshop	50 each	780 each	Engine oil filters will be collected and stored in sealed oil filter disposal pod. They will be transported by a licensed regulated waste contractor to a licensed regulated waste receiver for treatment to recover oil for reuse.	Waste reuse	Re-use onsite.
					If filters are unable to be recovered, they will be recycled by a licensed regulated waste contractor.	Waste recycling	Engine oil/fuel filters will be recycled by a licenced regulated waste receiver at an approved recycling facility.
Waste grease *(i.e., from machinery)*	Liquid	Workshop, large machinery maintenance	<0 kL	<0.5 kL	Waste grease will be stored in sealed containers or tanks in a designated bunded area, which will then be transported offsite by a licensed regulated waste contractor. Waste grease will be recycled at a licensed waste facility.	Waste recycling	Waste grease will be recycled at an approved offsite facility by a licenced regulated waste contractor.

Waste Type/ Waste Category	Form	Source	Approximate Quantity (per annum)		Management Strategies	Waste Management Hierarchy	Proposed Disposal Location
			Construction	Operation			
Empty waste oil containers	Solid	Workshop	<1 t	<1 t	All drums will be segregated and sealed prior to collection by a licensed regulated waste contractor and transported to a licensed waste receiver for recycling.	Waste recycling	Empty waste oil containers will be recycled offsite by a licenced regulated waste receiver.
Paints *(i.e., general paint, air dried insulating varnish)*	Liquid /Gas	Industrial area infrastructure and workshop	<1 t	<1 t	Paints will be transported to a designated sealed and bunded area to be collected by a licensed regulated waste contractor and transported to a licensed regulated waste receiver for treatment before disposal.	Treat waste before disposal	Empty waste oil containers will be recycled by a licenced regulated waste contractor.
Hydrocarbon contaminated material *(i.e., oily rags)*	Solid/ Liquid	Workshop servicing trucks and light/heavy vehicles	<1 t	<5 t	Hydrocarbon contaminated material will be stored in temporary storage facilities in the MIA, which will then be collected for offsite disposal.	Waste disposal	Hydrocarbon contaminated material will be disposed of by licenced waste transport operators at an appropriately licensed waste disposal facility.
Miscellaneous chemicals *(i.e., engine coolant, solvents, sealants, etc.)*	Liquid / Gas	Workshop and administration	<1 kL	40 kL	Miscellaneous chemicals will be transported to a designated sealed and bunded area for collection by a licensed regulated waste contractor and transported to a licensed regulated waste receiver for treatment and disposal.	Treat waste before disposal	Miscellaneous chemicals will be disposed offsite by a licenced regulated waste contractor at an approved licenced facility.
Batteries *(i.e., dry cell, gel cell, lead acid)*	Solid	Operation of portable electrical equipment (radios, phones, etc.) within the	<1 t	<2 t	Batteries will be segregated and stored within dedicated containers in the battery storage area, which will then be collected and transported by a licensed regulated waste contractor to a licensed regulated waste facility for recycling.	Waste recycling	Batteries will be recycled by a licensed regulated waste contractor at a licensed regulated waste facility.

Waste Type/ Waste Category	Form	Source	Approximate Quantity (per annum)		Management Strategies	Waste Management Hierarchy	Proposed Disposal Location
			Construction	Operation			
		workshop and other areas			Remaining batteries that are not recyclable will be disposed of by a licensed regulated waste contractor.	Waste disposal	Batteries will be disposed offsite by a licenced regulated waste contractor at a licensed regulated waste facility.
Ozone depleting substance *(i.e., refrigerants and air conditioning substances)*	Liquid / Gas	Air conditioning units, fridges and cars throughout site	<1 kg	<1 kg	Ozone depleting substances will be stored at the source in cylinders and returned to the supplier for reuse and recycling.	Waste reuse and recycling	Ozone depleting substances will be recycled by a licenced regulated waste contractor.
Limited Regulated							
Tyres *(i.e., light and heavy vehicle tyres)*	Solid	Tyres from light and heavy vehicles	20	50	Tyres will be segregated and re-purposed onsite in a designated area where there will be no flammable materials within a 10 m radius. Tyres will then be transported offsite to a supplier for re-treading.	Waste reuse	Reuse onsite for alternate purposes.
					The remainder of tyres that will not be re-purposed will be disposed onsite in a designated tyre disposal area of the backfilled Pit AB and/or Pit C.	Waste disposal	Tyres will be disposed onsite within a designated tyre disposal area of the backfilled Pit AB and/or Pit C.
Sewage	Liquid	Offices, workshops and accommodation facility	<7,665 kL	<7,665 kL	Sewage generated onsite will be pumped to the STP located west of the accommodation facility. Treated effluent will be irrigated with sprinklers to a designated area located at a distance of at least 500 m away from site offices and residences.	Treat waste before disposal	Treated effluent will be irrigated with sprinklers to a designated area.

Waste Type/ Waste Category	Form	Source	Approximate Quantity (per annum)		Management Strategies	Waste Management Hierarchy	Proposed Disposal Location
			Construction	Operation			
			Low	Low	Sewage sludge will be directed to the septic systems and will be removed as required by a certified regulated waste contractor for offsite disposal.	Disposal	Waste sludge will be disposed of by a regulated waste contractor

12.4 REGIONAL WASTE MANAGEMENT FACILITIES

The CHRC provides a network of 18 waste management facilities available for communities and businesses to dispose waste materials (CHRC 2016). The waste management facilities comprise eight small facilities (<2,000 t/a), three with a landfill capacity of 2,000-5,000 t/a, one large facility with a capacity of 10,000-20,000 t/a located in Emerald, and six bulk bin/transfer stations.

CHRC is currently progressing through an infrastructure rationalisation program in order to ensure environmental and licence compliance with DES requirements, while increasing opportunities for recycling, and ultimately, reducing the amount of waste sent to landfill (CHRC 2016).

Regional and local industry in general and the regional coal industry in particular, has created sufficient demand for waste management services such that the region is well serviced by all major waste service providers. Access to these services has resulted in a relatively mature approach by businesses in the area to waste sorting and recycling.

Current bulk bin, landfill and transfer station facilities are indicated in Figure 85.

12.5 WASTE MANAGEMENT

Waste from the Project will be managed in accordance with the waste and resource management hierarchy from the *Waste Reduction and Recycling Act 2011*, which lists waste and resource management strategies in the order of most to least preferred option:

(a) ***avoid*** *unnecessary resource consumption;*

(b) ***reduce*** *waste generation and disposal;*

(c) ***re-use*** *waste resources without further manufacturing;*

(d) ***recycle*** *waste resources to make the same or different products;*

(e) ***recover*** *waste resources, including the recovery of energy;*

(f) ***treat*** *waste before disposal, including reducing the hazardous nature of waste; and*

(g) ***dispose*** *of waste only if there is no viable alternative.*

Appropriate waste management strategy for each waste stream in accordance with the hierarchy is addressed in Table 68.

Wastes that are not able to undergo processes of onsite reuse, recycling or treatment would be able to do so at offsite waste facilities. Where practicable, consumable suppliers will collect and recycle the waste product, and consider off-site recycling services that may be available. Before disposing waste to landfill, Magnetic South will consider the reuse and recycling of the waste within practicable measures.

Avoid or Reduce

Avoiding the production of waste is predominantly achieved through procurement practices, where the expected life and disposal requirements of materials or products are considered during the purchasing process.

Raw materials would be delivered in bulk where feasible. Otherwise, material that is not purchased in bulk will be determined based on minimal packaging and use of biodegradable and compostable materials. Magnetic South will also consider the use of alternative products, implementation of appropriate technology and procurement processes to ensure that unnecessary waste is not produced.

Magnetic South will aim to reduce the amount of waste produced by limiting the amount of materials being transported to and stored onsite. Waste reduction efforts will also be towards reducing unnecessary consumption of electricity and water resources, along with the use of materials and products such as paper.

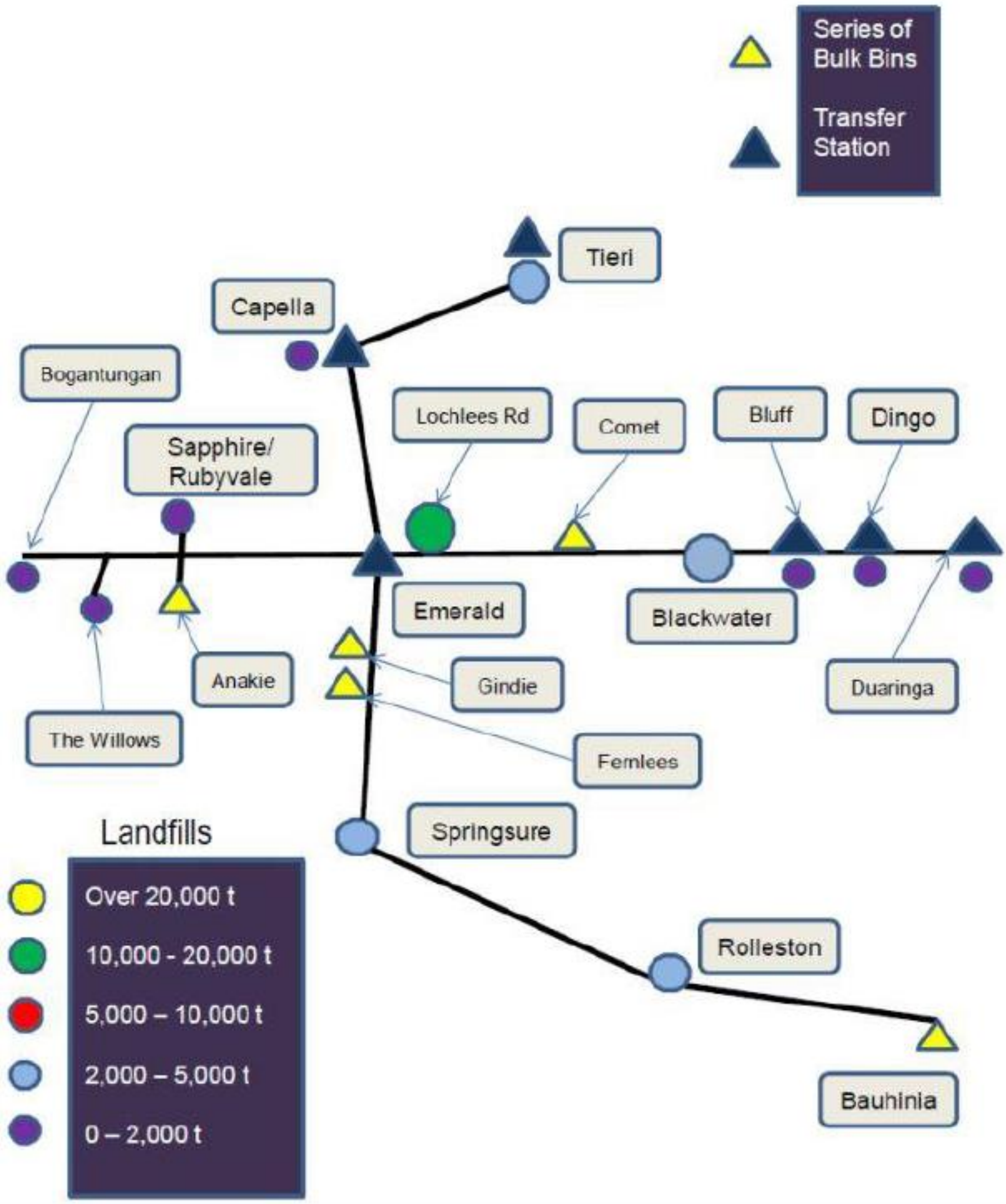


Figure 85 Current CHRC Waste Infrastructure Plan

Reuse

Waste streams will be reused wherever ongoing health, safety and reliability can be ensured. Where possible, waste will be reused onsite or will be returned to the suppliers to enable reuse.

Air filters will be collected and cleaned by local facility, Filter Resources Qld, and reused until considered unsuitable where they will be collected and recycled by Filter Resources Qld.

Recycle

The Project will generate a number of waste materials that can be recycled to generate products for a beneficial reuse.

Wastes that are recyclable, including includes aluminium, steel cans, Class 1, 2 and 5 plastics, paper towels, paper and cardboard will be collected and stored in designated bins, sealed containers or bunded areas, which will then be taken offsite by a licensed waste contractor and recycled at a licensed recycling facility.

Recover

Waste recovery is not proposed to be undertaken at the Project.

Treatment

Treatment of waste before disposal can minimise the environmental impact of waste disposal.

Paints and miscellaneous chemicals will be transported offsite by a licensed regulated waste contractor and treated at a licensed waste facility before disposal.

Hydrocarbon contaminated material will be treated and disposed off-site by licenced waste transport operators at an appropriately licensed waste disposal facility. Cleanaway provides contaminated soil remediation services delivering safe, compliant, and environmentally responsible solutions.

Onsite treatment of waste will be limited to the treatment of sewage effluent within a STP at the on-site accommodation facility towards the northwest boundaries of the MLA. Treatment will comprise standard primary, secondary removal of solids alongside nutrient removal and disinfection. Treated effluent will be released for irrigation in accordance with the EA conditions. Sludge will be treated offsite by Cleanaway, where it may be reused to generate energy or alternatively turned into compost and biosolids for non-agriculture purposes (Cleanaway 2019c).

Dispose

Disposal of waste is to be considered when no other economically feasible option for reuse or treatment exists. The disposal method will seek to minimise environmental effects and the potential for land contamination. In most instances, where waste is proposed to be transported to a licenced landfill facility. Magnetic South will arrange for the waste to be transported offsite. This commitment will form part of the contractual arrangements which will be developed with licenced contractors.

Waste that will be disposed of offsite includes general waste, tyres, and wastes that are no longer in reusable or recyclable conditions such as wooden pallets, refurbishable items and PPE. These waste streams are fundamental to daily operations and other waste management avenues (e.g., avoid, reduce, reuse, and treat) were considered unsuitable.

For instance, it is of preference that tyres will be transported offsite to a supplier for re-treading for reuse. Subject to demonstrating to the administering authority that no other use higher in the waste management hierarchy can be practically implemented, waste tyres will be disposed onsite in a designated tyre disposal area of the backfilled Pit AB and/or Pit C. These disposal areas will be managed to avoid any impedance on saturated aquifers, cause contamination or compromise the stability of the final landform. Tyre recycling was considered unsuitable and not economically feasible as the nearest facility for an accredited member of the Australia Tyre-Recycling Association is approximately 700km south-east.

Burial of waste tyres can lead to environmental impacts associated with contamination, fire risk and health risks. There is also a risk that compounds may leach from the tyres and contaminate soil, groundwater and surface water, and a possibility that tyre piles may become breeding grounds for insects, particularly mosquitoes, rodents and other animals. Tyres have also been known to cause fires that release pyrolytic oils and other compounds into the soil and groundwater and through smoke, coupled with contaminated runoff of water used to extinguish the fire. To mitigate these impacts, the storage and disposal of tyres generated by mining activities will be in accordance with *Operational Policy for Disposal and storage of scrap tyres at mine sites* (ESR/2016/2380). Further details of the disposal of scrap tyres will be addressed in a *Non-Mineral Waste Management Plan,* described in Section 12.8.1.

Excavated waste (over-burden and inter-burden) will be disposed of onsite as its unlikely to pose a significant risk to the quality of surface and groundwater when management measures are implemented.

12.6 CLEANER PRODUCTION

Cleaner production refers to the continuous application of an integrated preventative environmental strategy to processes, products and services to increase energy efficiency and reduce risks to people and the environment.

Cleaner production techniques could be implemented during construction, operational or decommissioning phases of the Project through:

- input substitution – Use of process auxiliaries less polluting and/or raw materials;
- product selection – Use non-hazardous products over hazardous materials;
- improved operation and maintenance – Select and use the most appropriate and practicable fixed and mobile equipment for use in coal extraction, transportation and processing, and high levels of maintenance to ensure items are operating efficiently;
- reuse of resources – Reuse resources onsite that would otherwise be classified as wastes;
- technology modifications – Improve process automation, process optimisation, equipment redesign and process substitution through use of available modern technology; and
- closed-loop cycling – Recycle and reuse the product in the same form.

Magnetic South will progressively seek cleaner production to maximise operational efficiency whilst minimising energy consumption and waste generation and disposal. Potential cleaner production techniques include, but not limited to, the following:

- improving operation and maintenance practices to reduce the resource consumption and minimise waste generation (e.g., reuse of water within the mine water management system and CHPP system);

- selecting best available technology for the CHPP, with consideration of the environmental and economic factors to maximise water use and energy efficiency, minimise dust emissions and waste generation;
- site extraction design to minimise the volume of waste rock respective to the excavated coal;
- reusing resources on-site that would be otherwise classified as wastes; and
- closed-loop recycling where a product is recycled and used again in the same form (e.g., wooden pallets, tyres).

Magnetic South seeks to prioritise cleaner production and waste management strategies for all generated waste types, unless it is not feasible.

12.7 REGULATED WASTE MANAGEMENT

The EP Regulation requires that the administering authority be provided with appropriate information to manage the associated environmental risks of 'trackable wastes' listed in Schedule 11 of the EP Regulation.

Trackable waste will only be transported offsite by a licensed transporter (Section 96 of the EP Regulation). Magnetic South will also be required to provide information to the waste transporter in accordance with Schedule 12 of the EP Regulation.

A register will be developed and maintained for all regulated wastes generated on-site, which will include the following details:

- source, type and quantity of waste;
- storage location;
- dates of collection and recycling/disposal; and
- name and details (including licencing details) of transporter and waste disposal facility.

A full list of regulated waste has been identified for the Project based on the definitions listed in the EP Regulation which is detailed in Table 68.

12.7.1 Regulated Waste Treatment and Disposal

Treating and disposing of waste will predominantly occur offsite and will be carried out in a way that causes least harm to the environment and can be achieved through the following methods:

- employing a bio-treatment to degrade material into a compound or mixture;
- employing a physico-chemical treatment (for example, evaporation, drying, calcination, catalytic processing, neutralisation, precipitation, or encapsulation) to obtain a compound or mixture;
- blending or mixing waste to obtain a compound or mixture storing or repackaging waste;
- employing thermal processes, with or without catalysts, to convert waste into a non-hazardous material;
- disposal to a landfill; or

- thermal destruction without recovering heat or another secondary product.

Regulated waste types that will undergo treatment before disposal include sewage, paints, and miscellaneous chemicals.

Magnetic South will use waste management services within the region such as Cleanaway Emerald Liquid Waste Services (Cleanaway). Cleanaway seeks to prioritise the recycling of waste paint and its by-products and processing to be turned from waste to valuable resources before considering disposal. Cleanaway facilities offer services for metal and plastic paint containers to be recycled and turned into new packaging materials. Water-based paint can be processed, with the by-products used in a variety of industrial applications, such as cement mixer, industrial water or in composting (Cleanaway 2019b). Solvent based paint can be recycled and used as an alternative fuel source for local cement and manufacturers (Cleanaway 2019b).

Cleanaway will be responsible for all waste oil and coolant removal and treatment as their facilities operate onsite treatment plants for liquid and hazardous waste (Cleanaway 2019a). Liquid and hazardous waste can undergo a chemical reaction process called Base Catalysed Dechlorination to treat high concentration persistent organic pollutants oils and reduce polychlorinated biphenyls concentrations. The process will be monitored to ensure the reaction continues to completion (Cleanaway 2019a).

12.7.1.1 Sewage Waste Treatment

A *Land-Based Effluent Disposal Assessment* (Cardno 2020) was undertaken in accordance with the current industry standards for wastewater management set out in *AS/NZ 1547:2012 On-site Domestic Wastewater Management* and provided in Appendix N. As described in Section 12.3 (Table 68), sewage generated onsite will be treated at a STP through a standard primary, secondary removal of solids alongside nutrient removal and disinfection.

A MEDLI was used to assess the suitability of dispersal in the surrounding area. Treated effluent will be released within a designated irrigation area on-site and is expected to achieve the water quality parameters set out in the *Eligibility Criteria and Standard Conditions for Sewage Treatment Works (ERA 63) – Version 2)*. These limits also align with the quality which would be expected from a basic sewage treatment plant as per *Table A3.2 of the Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1)*. These are detailed below (Table 69).

Table 69 Wastewater Quality Limits

Quality Characteristic	Release Limit	Limit Type
Total Nitrogen	30 mg/L	Maximum
Total Phosphorus	10 mg/L	Maximum
Electric Conductivity	1600 µs/cm	Maximum
pH	5.0 – 8.5	Range
Total residue chlorine (if used for disinfection)	1 mg/L	Maximum
E.Coli	<1000 cfu/100mL	Maximum
Total suspended solids	20 mg/L	Maximum
Biochemical Oxygen Demand	30 mg/L	Maximum

To ensure sewage effluent does not pose any risks to surrounding environmental values (water logging, surface runoff or excessive deep drainage), the soil profile of the site (category 6 soil) governs the following application parameters and schedules day in accordance with *AS 1547:2012*:

- construction – expected secondary treated effluent generation ($56m^3$), irrigation area (3.8 ha), rate (2mm/day); and
- operations – expected secondary treated effluent generation ($28m^3$), irrigation area (1.9 ha), rate (2mm/day);

The designed irrigation rate, area and chosen pasture were sufficient to prevent waterlogging, surface runoff or excessive deep drainage in two extreme soil types (i.e., extremely permeable sand and extremely impermeable clay) without requiring trigger limits. Conservative modelling identified no overflows predicted to occur throughout both construction and operational phases. However, it has been noted that during substantial rain events, irrigation should not occur when the ground is showing signs of saturation (such as surface water pooling).

In order to account for such events, 3 days of wet weather storage (168 m^3 tank capacity) was accounted for in the MEDLI model as recommended by the *QLD Government Technical Guideline for Disposal of Effluent via Irrigation.* Once detailed design information is available, a site-specific contingency plan will be developed to manage the wet weather storage tanks, STP shutdowns and maintenance periods when >3 days storage may be required. As closed tanks will be used instead of ponds, a negligible risk is expected for algae blooms or leaching into the groundwater. All released effluent will be monitored for pH and faecal coliforms to comply with the appropriate limits prescribed by the EA for the Project.

Rhodes grass was assumed to be the pasture which will be irrigated on-site. Modelling using Rhodes Grass (moderately salt-tolerant) indicates the resulting salinity would be too low to impact upon the health of the grass. The proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction) was 0% for both construction and operations. The MEDLI model indicates that mowing (with removal of clippings) would only be required approximately 3 times per year to maintain sufficient growth and subsequent nutrient uptake. Modelling of design irrigation rate, area and chosen pasture resulted in negligible concentrations of nutrient leaching to groundwater in either extreme soil type.

The MEDLI model confirms the suitability of the proposed wet weather storage and effluent irrigation areas to cater for the expected volume of wastewater generated, inclusive of climatic conditions, vegetation being irrigated and effluent quality (total nitrogen, total phosphorous, total dissolved solids, EC and soil properties). It concludes that no runoff from the effluent irrigation management area and wet weather storage will occur under the proposed irrigation regime with minimal irrigation-induced deep drainage (Appendix N). When combined with the setback distances discussed above (section 3.5.3.1), the risk of aerosol drift and odour is considered negligible.

12.7.1.2 Sludge Treatment

Sludge will be dewatered on site and the resulting dried sludge will be removed via a licensed regulated waste contractor. No waste residues are anticipated, and tank system sludge accumulation is expected to be 0.0 kg dwt/year.

12.7.2 Regulated Waste Transport

All regulated waste generated onsite will be arranged by the Magnetic South to be transported offsite for recycling, treatment, or disposal at a licensed facility. Regulated waste must only be removed and transported from the site by a person who holds a current licence to transport such waste under the EP Act.

Contractors within the region such as JJ Richards & Sons will be responsible for collection of regulated waste bins as well as collection of recyclable wastes (e.g., cardboard). Waste handlers are required to submit waste tracking information to DES as part of the system for tracking waste listed in Schedule 9 Part 1 of the EP Regulation (i.e., regulated wastes). Waste handlers are defined as generators, transporters and receivers of wastes. Waste Transport Certificates are to be completed by waste handlers (i.e., generators, transporters, and receivers of waste) and submitted to DES as part of the process for tracking wastes in Queensland.

The transport of regulated wastes from the Project will be conducted in compliance the system requirements outlined by DES in *Waste tracking guideline – Overview of managing waste tracking in Queensland (ESR/2016/2425) Version 2.01* (DES 2018e).

Skip bulk or lift trucks will be used for heavier and/or bulkier waste materials such as empty waste oil containers, scrap metals and timber pallets. Mine affected water may be piped, trucked via liquid tankers or transferred in compliance with EA conditions.

Further information regarding the machinery and proposed method of regulated waste transportation will be detailed in a *Non-Mineral Waste Management Plan*, which will be developed at a later stage (refer to Section 12.8.1 for further details). The commitment will form part of the contractual arrangements and will be developed with licenced contractors.

12.8 WASTE AUDITING, MONITORING AND REPORTING

The waste streams and quantities produced would be recorded by Magnetic South over the life of the Project. Audits of the waste management activities will include:

- assessing actual generated wastes against the predicted waste quantities;
- monitoring the actual and potential impacts from wastes;
- reviewing the waste transportation records to ensure compliance; and
- identifying potential improvements in waste management practices, including establishment of waste reduction targets, where practicable.

Magnetic South will also monitor the implementation and effectiveness of the *Non-Mineral Waste Management Plan* and its compliance with relevant Commonwealth and Queensland legislation detailed below.

12.8.1 Non-Mineral Waste Management Plan

A *Non-Mineral Waste Management Plan* will be developed for all non-mining wastes prior to the construction of the Project. The plan will be developed in consideration of the waste hierarchy outlined in Section 12.5 to identify all waste streams and volumes, baseline data, compliance protocols, set measurable waste reduction targets, describe management controls and related environmental impacts. The following principles will be incorporated into the proposed plan:

- waste will be segregated into general waste, various recyclable wastes and regulated waste;
- the collection of general waste will be in clearly designated bins;
- recyclable waste will be separated and stored for collection into streams, including paper and cardboard, metals and recyclable plastics;

- all used tyres will be managed in accordance with the operational policy '*Disposal and storage of scrap tyres at mine sites*' (DES, 2014b). This may result in used heavy machinery tyres being disposed of within spoil dumps if other higher order options are not feasible. In this case, the locations of spoil dumps containing used tyres will be recorded on the Environmental Management Register;

- different forms of waste (e.g., metals, paper, oils, batteries, general waste, etc) will be stored on-site according to their corresponding waste stream. The design of the waste storage facility will consider public health, hygiene and safety standards. For example, flammable material or combustible liquid wastes will be stored in facilities designed to meet '*AS 1940:2017, The storage and handling of flammable and combustible liquids*' (Standards Australia 2017);

- waste oils, chemicals, batteries and other hazardous and/or regulated substances will be stored in bunded areas or on bunded pallets within the waste collection area;

- bins located within offices and workshops will be appropriately labelled to avoid cross-contamination and provide for separation of different waste streams. Bins will be emptied regularly to minimise vermin and pests; and

- regulated and/or hazardous waste will be stored in a separate storage area to ensure that the potential for environmental harm is minimised.

The *Non-Mineral Waste Management Plan* will include procedures and programs that detail monitoring frequency, collection methodologies, performance indicators and reporting requirements to ensure compliance with regulatory frameworks.

13.0 WASTE ROCK AND COAL REJECT GEOCHEMISTRY

This section discusses the characterisation of waste rock and coal rejects for the Gemini Project. The *Geochemical Assessment of Mining Waste Materials* (RGS 2019) (Appendix G) and *Geochemical Assessment of Coal Reject Material* (RGS 2020) (Appendix H) were undertaken with the aim of understanding any potential geochemical risks. The assessments provide a geochemical characterisation of samples representative of the mining wastes (overburden and interburden materials) and coal reject materials.

Both static and kinetic testing methods were utilised to indicate the presence and degree of risk from the oxidation of reactive sulfides, and the potential for acid generation and leaching of soluble metals/metalloids and salts. The assessments also included characterisation of chemical parameters related to sodicity and material stability. The assessments were completed in accordance with relevant industry guidelines:

- *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* (DME 1995);
- *Application requirements for activities with impacts to water [ESR/2015/1837]* (DES 2017c);
- *Leading Practice Sustainable Development Program for the Mining Industry: Mine Closure* (DFAT 2016a);
- *Leading Practice Sustainable Development Program for the Mining Industry: Mine Rehabilitation* (DFAT 2016b);
- *Leading Practice Sustainable Development Program for the Mining Industry: Preventing Acid and Metalliferous Drainage* (DFAT 2016c); and
- *Global Acid Rock Drainage Guide (GARD Guide)* (INAP 2009).

13.1 ENVIRONMENTAL OBJECTIVES AND PERFORMANCE OUTCOMES

Surface waters and groundwaters could potentially be impacted from any adverse geochemical by-product associated with waste rock and coal rejects. The EVs have been determined given that waste rock is being disturbed, placed and rehabilitated, and that coal rejects are a waste stream from coal processing that need to be managed. The relevant environmental objectives were therefore determined to be associated with potential impacts to water.

The environmental objective relevant to water, as described in the EA guideline for *Application requirements for activities with impacts to water [ESR/2015/1837]* (DES 2017c); are:

- *the activity will be operated in a way that protects environmental values of waters; and*
- *the activity will be operated in a way that protects the environmental values of groundwater and any associated surface ecological systems.*

The Project would generally achieve these performance outcomes through implementation of the following measures as outlined in Part 3, Schedule 8, Division 1 of the EP Regulation:

a) *the storage and handling of contaminants will include effective means of secondary containment to prevent or minimise releases to the environment from spillage or leaks.*

b) *contingency measures will prevent or minimise adverse effects on the environment due to unplanned releases or discharges of contaminants to water.*

c) *the activity will be managed so that stormwater contaminated by the activity that may cause an adverse effect on an environmental value will not leave the site without prior treatment.*

d) *the disturbance of any acid sulphate soil, or potential acid sulphate soil, will be managed to prevent or minimise adverse effects on environmental values.*

e) *acid producing rock will be managed to ensure that the production and release of acidic waste is prevented or minimised, including impacts during operation and after the environmental authority has been surrendered.*

f) *any discharge to water or a watercourse or wetland will be managed so that there will be no adverse effects due to the altering of existing flow regimes for water or a watercourse or wetland.*

g) *the activity will be managed so that adverse effects on environmental values are prevented or minimised.*

With respect to the groundwater-related objective, the following measures apply (DES 2017c):

a) *there will be no direct or indirect release of contaminants to groundwater from the operation of the activity; and*

b) *there will be no actual or potential adverse effect on groundwater from the operation of the activity.*

In addition, the activity will be managed to prevent or minimise adverse effects on groundwater or any associated surface ecological systems.

13.2 DESCRIPTION OF ENVIRONMENTAL VALUES

From a geochemical perspective, the EPP (WWB) is the primary instrument for protecting Queensland waters to achieve the object of the EP Act in relation to water. The EPP (WWB) establishes EVs and management goals for waters and wetlands.

A key relevant document for the Project is the *Mackenzie River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Mackenzie River Sub-basin* (EHP 2011a). The document is made pursuant to the provisions of the EPP (WWB). It contains EVs and WQOs for waters in the Mackenzie River sub-basin. The WQOs and EVs are detailed Section 7.0 and Section 8.0.

13.2.1 Surface Water and Groundwater Resources

A description of surface water resources is provided in Section 7.2.1, including several illustrative figures.

All waterways of the Project area are ephemeral and experience flow only after sustained or intense rainfall in the catchment. Stream flows are highly variable, with most channels drying out during winter to early spring when rainfall and runoff is historically low, although some pools hold water for extended periods. Therefore, physical attributes, water quality, and the composition of aquatic flora and fauna communities are expected to be highly variable over time.

The land within the Project boundary is currently used for low intensity cattle grazing and resource exploration activities. The reaches of Springton Creek and Charlevue Creek in the proposed mining area have well-defined channels, typically with alluvial clay beds and well established in-channel vegetation.

Further details regarding the surface water management of the Project have been included in Section 3.4 and Section 7.4.

Groundwater resources are described in detail in Section 8.2.1and Section 8.2.2, including several illustrative figures.

13.3 POTENTIAL IMPACTS

Detailed geochemical assessments were undertaken of waste rock material (RGS 2019) (Appendix G) and coal reject material (RGS 2020) (Appendix H) associated with the Project. Geochemical test work undertaken was based on industry recognised procedures for the geochemical characterisation and assessment of mine materials. Refer to the relevant appendix report for technical details of the methodology and results of each assessment.

13.3.1 Coal Reject Geochemistry

A total of 80 coal reject samples from coal quality washability tests were provided from 14 different drill holes, comprising 52 coarse reject and 28 fine reject samples.

The $pH_{(1:5)}$ of the 22 composite coal reject samples from the Project ranged from 5.1 to 8.3 with a median value of 7.4 indicating that coal reject materials are typically in the pH neutral range. There does not appear to be any significant correlation between pH and reject type or coal seam.

$EC_{(1:5)}$ ranges from 398 to 1,062 µS/cm (median 774 µS/cm), with no apparent correlation between EC and reject type or coal seam. Based on the median pH and EC values, the coal reject samples tested are generally regarded as having ‘high’ soil pH and ‘medium’ salinity values with respect to the criteria for mining waste materials as defined by the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* (DME 1995).

The total sulphur content (measure as total sulphur concentration - %S) of the samples ranges from 0.23-4.20 %S with a median value of 1.03 %S. This compares to a median crustal abundance value of 0.07 %S in unmineralised soils (Bowen 1979; INAP 2009). Materials with a total sulphur content less than or equal to 0.1 %S have negligible capacity to generate acidity. The reject samples used in the kinetic leach column (KLC) tests retained at least about 95.6% of their inherent total sulphur content after three months of exposure to idealised oxidising conditions. This reflects a relatively slow rate of sulfide oxidation (and potential acid generation) for these materials.

The results of the multi-element analysis were assessed against the geochemical abundance index (GAI) in accordance with relevant guidelines and practices (Bowen 1979; INAP 2009). The geochemical abundance index results indicate that of the metals/metalloids measured, none are significantly enriched compared to median crustal abundance. The main findings of the coal reject geochemical assessment (RGS 2020) (Appendix H) are:

- the coal reject samples represent materials with a variety of geochemical characteristics ranging from non-acid forming (NAF) to PAF. As a bulk material, coal reject is expected to be NAF with excess acid neutralising capacity (ANC). Overall, most coal reject materials have a relatively low risk of acid generation and an increased factor of safety with respect to potential for AMD;

- initial and ongoing surface runoff and seepage from coal reject materials is expected to be pH neutral and have a moderate level of salinity. The salinity of leachate from higher sulphur coal reject materials could increase over time if exposed to atmospheric conditions, due to the release of sulphate through sulphide oxidation;

- comparison with guideline values and median crustal abundance in unmineralised soils indicates that the coal reject materials are not significantly enriched with metals/metalloids; and

- most metals/metalloids are sparingly soluble at the current pH of the leachate from coal reject materials. Dissolved metal/metalloid concentrations in surface runoff and leachate from bulk coal reject materials are expected to be relatively low and unlikely to pose a significant risk to the quality of surface and groundwater resources at relevant storage facilities.

13.3.2 Waste Rock Geochemistry

A total of 70 waste samples were collected from three drill holes within the Project area; representative of the main overburden, interburden and potential coal reject materials likely to be encountered during development of the Project. Samples were collected from the surface down through the stratigraphic profile (including economic and uneconomic coal seams) to the base of the open pit. The number of samples was selected to provide a good statistical representation of the amount and types of mining waste materials expected to be generated at the Project.

The $pH_{(1:5)}$ of samples across all sample types, ranged from 5.0 to 9.7 with a median value of 9.2. The samples with the lowest pH values (pH 5.0 to 5.5) represent clay and soil materials.

$EC_{(1:5)}$ ranges from 270 to 1,440 μS/cm with a median of 646 μS/cm, considered to be moderate. The weathered material tends to have a higher EC value than the fresh material.

Total sulphur content ranges from less than 0.01-0.60 %S (median 0.06 %S). Compared to the median crustal abundance of sulphur (0.07%) (INAP 2009), the median value of the mining waste materials is relatively low. The sulphur content of carbonaceous siltstone and coal are both higher than natural background values and both lithologies show greater variation in sulphur content than the weathered material, sandstone and siltstone.

The results of the multi-element analysis were assessed against the geochemical abundance index in accordance with relevant guidelines and practices (Bowen 1979; INAP 2009). The geochemical abundance index results indicate that, compared to median crustal abundance, only one of the 10 selected samples was enriched and then only with respect to cobalt. It should be noted that the nature of a coal deposit means some metals/metalloids are expected to be slightly elevated in various minerals.

Sample analysis indicated that the CEC of the materials varies between 4.2-18 meq/100g with a mean value of 10 meq/100g. The resulting effective CEC rating for the materials is from very low to moderate.

The ESP of the 10 selected samples ranged from low (4.5%) to very high (31.5%) with a median of 19.3%, indicating that some of the sample materials are likely to be sodic.

The findings of the geochemical assessment of waste rock samples (RGS 2019) (Appendix G) can be summarised as follows:

- all of the mining waste samples tested are NAF, have excess ANC and typically have low sulphur content. The sulphur content of coal and carbonaceous siltstone can be elevated compared to typical background concentrations, but is mainly present in a non-sulfidic form, which does not contribute to acid generation. Overall, these materials have a low risk of acid generation and a high factor of safety with respect to potential for AMD;

- initial and ongoing surface runoff and seepage from mining waste materials is expected to be moderately alkaline and have a moderate level of salinity;
- KLC test results indicate that mining waste materials are unlikely to generate acid conditions and more likely to generate pH neutral to alkaline conditions;
- metal/metalloid enrichment in mining wastes, compared to median crustal abundance in unmineralised soils, is limited to cobalt in a single carbonaceous siltstone sample;
- most metals/metalloids are sparingly soluble at the neutral to alkaline pH of leachate expected from bulk mining waste materials. Dissolved metal/metalloid concentrations in surface runoff and leachate from bulk mining waste materials are therefore expected to be low and unlikely to pose a significant risk to the quality of surface and groundwater resources at relevant storage facilities;
- mining waste materials should be amenable to revegetation as part of rehabilitation activities, although, gypsum and fertiliser will be used as necessary for sodic materials to limit dispersion and erosion and to provide a reasonable growth medium for revegetation and rehabilitation; and
- as most mining materials appear to be susceptible to dispersion and erosion, additional testing including field trials, may be needed when the mine is operational and bulk materials are being generated. Such tests would help to determine the most appropriate management option for progressive rehabilitation of these materials during operations at mine closure.

13.3.3 Potential Impacts on Surface and Groundwater Resources

The potential impacts which may arise as a result of adverse mineral waste characteristics are primarily related to acid and saline leachate production and landform stability. With respect to acid and saline leachate potential, the majority of both the coal reject and waste rock material to be produced is classified as NAF, with excess ANC, and essentially devoid of sulphur. These materials have a very low risk of acid generation and a high factor of safety with respect to potential acid generation in leachate from waste dumps and storage facilities.

The static and kinetic geochemical test results indicate that surface runoff and seepage from both coal reject and waste rock materials is likely to be pH neutral and have a moderate salinity value. The pH of surface runoff and seepage from these materials is likely to fall within the range for 95% species protection in freshwater aquatic ecosystems as set out in ANZG (2018).

The major ion concentrations in surface runoff and seepage from both coal reject and the leachate from NAF mining materials are relatively low. The major ions from coal reject are dominated by calcium, magnesium, sodium, sulphate, chloride (and bicarbonate), and the leachate from NAF mining waste materials are dominated by bicarbonate, sodium, chloride and to a lesser extent sulphate. The sulphate concentration in leachate from all mining waste samples tested is well below the applied ANZG (2018) livestock water quality guideline criterion (1,000 mg/L).

The concentration of most trace metals/metalloids tested for water in contact with both coal reject and mining waste materials is low, typically below the LOR for the laboratory analysis, and below the applied water quality guideline criteria. KLC tests exhibit a LOR of below applied water quality guideline criteria. As a result, for these course reject dissolved metal concentrations of Se, Zn, Cr, Cu and Cd exceeded the trigger values for freshwater aquatic ecosystems (95 % species protection). Additionally, Se exceeded trigger values for livestock drinking water guideline values. Similar results were observed for fine reject dissolved concentrations.

Whilst there are no specific regulatory criteria for metal/metalloid concentrations in leachate from mining waste material on mine sites in Queensland. The Australian guideline values for livestock drinking water and aquatic freshwater eco-systems are provided for context are not intended to be interpreted as "maximum permissible levels" for site water storage or discharge" (ANZG 2018).

These trace metals/metalloids are sparingly soluble at the expected pH of coal reject materials. All of the metals/metalloid concentrations are less than the applied livestock drinking water guideline trigger values.

For water in contact with mining waste materials, the static water extract results for a few samples. suggest that the concentrations of arsenic and selenium can be above applied aquatic freshwater ecosystem water quality guideline concentrations for 95 % species protection (ANZG 2018). However, the concentration of these metals/metalloids in surface runoff and seepage from bulk mining waste materials is likely to be much lower and within the applied guideline concentrations described. Whilst one carbonaceous siltstone water extract sample had a selenium concentration marginally above the applied livestock drinking water guideline value, all other water extract samples displayed trace metal/metalloid concentrations at or below the applied livestock drinking water guideline values.

Overall, the static geochemical test results indicate that dissolved metal/metalloid concentrations in initial surface runoff and seepage from coal reject materials are unlikely to significantly impact upon the quality of surface and groundwater resources. However, some coal reject materials, if left exposed to oxidising conditions, may have the potential to generate brackish leachate containing elevated concentrations of sulphate and some metals/metalloids, in comparison to applied water quality guideline values. Therefore, coal reject materials should be encapsulated within spoil storage areas, well away from the outside surface of the final rehabilitated landforms. If coal reject materials are left exposed to oxidising conditions for an extended period of time prior to encapsulation, dosing with agricultural limestone (e.g., fine limestone) could be considered as a contingency measure.

In addition, the results of the CEC and ESP tests on the selected mining waste samples indicate that most of the materials represented by these samples are likely to have elevated sodicity levels and may be susceptible to dispersion and erosion, although these characteristics may be improved to some extent by the addition of gypsum. In addition, fertiliser addition will need to be considered for some mining waste materials to provide a reasonable growth medium for revegetation and rehabilitation.

The management strategies discussed in Section 13.4, will ensure the risk of impact to waters remains low throughout the life of the Project, and will provide for water monitoring activities appropriate to assess any potential adverse effects.

13.3.4 Spontaneous Coal Combustion Potential

The geochemical properties of the Gemini coal deposit are considered high rank for the Project and therefore of lower propensity for spontaneous combustion. Intrinsic factors such the presence of pyrite, moisture, mineral matter, and particle size are known to influence the risk of combustion (Kaymakci, E and Didari 2002). The presence of pyrite within the coal reject materials can generally increase the risks, however the identified qualities within both geochemical assessments (Appendix G; Appendix H) are noted to be relatively low risk of acid generation and below 0.1% (nonsulfide sulfur (ie., non-acid generating). Further to this, the moderate content of ash known to occur in the Rangal measures negatively correlates with the propensity for coal to self-heat and lowers risk based on coal quality (Beamish and Blazak 2005).

The potential for spontaneous combustion of stockpiles is driven by the oxidation of coal and other carbonaceous materials. The reactivity of material contained within spoil dumps is known to vary considerably and therefore assessing combustion risk is often based on external factors (temperature, oxygen concentration, barometric pressure, ventilation, and surrounding strata). Most strategies for control and prevention of spontaneous combustion focus on removing oxygen, or rather, preventing its access to the reactive material.

If not managed, spontaneous combustion in open-cut coal mines poses a number of potentially serious impacts on the receiving environment, of which include:

- toxic emissions such as particulates and trace elements, carbon monoxide, sulfur dioxide, hydrogen sulfide, polynuclear aromatic hydrocarbons and volatile organic compounds;
- greenhouse gas emissions of CO_2 and CH_4;
- destabilisation of spoil piles and long-term problems with rehabilitation; and
- damage of the nearby ecosystems, vegetation loss, windblown dust, and pollution of surface and ground water.

13.4 MITIGATION MEASURES, MANAGEMENT AND MONITORING

13.4.1 Coal Reject Materials

As a result of the geochemical assessment work completed on coal reject materials (RGS 2020) (Appendix H) at the Project, the following management strategies are proposed for all coal reject material to minimise the risk of any significant environmental harm to the immediate and downstream environment:

- operational sampling and geochemical testing of representative samples of all coal reject material (coarse rejects and tailings) will be strategically undertaken at the CHPP to verify and extend the findings of the assessment for management;
- coal reject materials will be transferred from the CHPP and encapsulated within a much larger volume of NAF overburden material in spoil emplacements with excess neutralising capacity well away from the outside surface of the final rehabilitated landforms.
- coal reject material will be placed where there is a lower risk of connectivity to surface water or groundwater resources;
- if coal reject materials are left exposed to oxidising conditions for an extended period of time prior to encapsulation, dosing with agricultural limestone would be considered as a contingency measure; and
- surface water and seepage from the coal reject storage areas will be monitored to ensure that key water quality parameters remain within appropriate criteria.

13.4.2 Mining Waste Materials

As a result of the geochemical assessment work completed on mining waste materials (RGS 2019) (Appendix G) at the Project, a number of management strategies are proposed for these materials to minimise the risk of any significant environmental harm to the immediate and downstream environment.

- placement of any carbonaceous mining waste material encountered during mining at the surface and outer batters of waste rock emplacement areas will be avoided;

- additional overburden/interburden testing and rehabilitation field trials will be completed during operations when bulk materials become available on an as needed basis to confirm the most appropriate management option for progressive rehabilitation of these materials during operations and at mine closure; and

- surface water and seepage from the proposed mining and mining waste storage areas will be monitored to ensure that key water quality parameters remain within appropriate criteria. Water quality monitoring parameters will include pH, EC and total suspended solids on a quarterly basis and the suite of water quality analyses described in Appendix G (refer to Table B4 – Multi-element test results for water extracts from mining waste from the Project).

13.4.3 Spontaneous Combustion

The following prevention and control measures will be adopted to maintain a low risk of spontaneous combustion:

- dispersal and burying of reactive materials within the spoil;

- controlling ventilation through compaction and capping;

- design of spoil dumps to minimize erosion & cracking of capping material avoiding the risk of air ingress;

- firefighting equipment readily available at appropriate locations;

- regular inspections and maintenance of firefighting equipment; and

- operator training.

Magnetic South will develop a *Spontaneous Combustion Management Plan* to ensure long-term management is maintained to:

- identify the source, quantity and timing of potentially reactive carbonaceous material that will be stockpiled;

- identify the main inert materials within the spoil;

- identify availability of local capping material (clays); and

- on-going gas and temperature monitoring around spoil piles.

13.4.4 Waste Rock Emplacement Rehabilitation

Progressive rehabilitation of all waste rock emplacements will be carried out when final placement has been attained and areas are no longer required for mining operations. The geochemical assessment (Appendix G) and soil and land suitability assessment (Appendix I) identified no significant risks for rehabilitation and waste rock materials were considered suitable.

As areas progressively become available, they will be classified as 'available for rehabilitation' (illustrated in Figure 23). The sequence of rehabilitation activities as described in section 4.0 will then commence, staring behind Pit AB and progress systematically north-east (Figure 23 – Figure 32). Three waste rock emplacements (one temporary) will be progressively constructed throughout the course of the operations and be designed to have externally draining slopes of a maximum of 6°, elevation 175-19 0mAHD and slope length 530 m – 540 m. The design of waste rock emplacements is detailed Table 18.

Overburden placement will be undertaken using rear dump trucks in accordance with mine planning schedules. Standard mine survey controls will be utilised to ensure that disturbance footprints are not exceeded and that design slopes will be attained. Regrading to final landform will be undertaken using bulldozers to push to grade utilising standard survey controls. Final trimming of reshaped areas will be undertaken as required to remove excess rock and ensure correct graded bank slopes.

Where highly sodic and/or dispersive spoil are identified, this material would not be placed in final landform surfaces and would not be used in construction activities. As described in section 5, subsoils of the Geoffrey and Kosh SMUs are considered strongly sodic (ESP > 14%). Furthermore, physical assessment of soils within the Project area reveal the medium to medium-heavy clay texture (>45% clay) of subsoils of the Geoffrey and Kosh SMU. Clay rich soils may be more susceptible to erosion due to the small size (<0.002 mm) of clay-sized particles, particularly if soils are dispersive. However, the topsoil layers are not considered sodic. Stripping depths have accounted for this and have been determined to exclude any sodic subsoil material from the topsoil resource.

Coal reject materials and any potentially acid forming waste rock materials identified will be selectively handled and encapsulated within waste rock emplacements and well away from the outside surface of rehabilitated landforms, where there is a low risk of connectivity to surface water or groundwater resources.

Surface drainage will be managed using graded banks and rock-protected spine drains to allow drainage from long rehabilitated slopes to be conveyed to natural ground level. Ongoing monitoring of climate, geotechnical properties of materials, revegetation progress and surface water runoff quality throughout all rehabilitation phases will provide systematic feedback for assessment of the rehabilitation measures to be used.

Topsoil resources have been characterised as suitable for rehabilitation and sufficient material will be available to ensure the recommended respreading depth of 0.3m. A growth medium 0.3m will provide sufficient depth to hold water and support revegetation. Topsoil will be deep ripped into the underlying spoil surface, to encourage surface water infiltration and minimise soil loss due to erosion. Seeding will typically be scheduled to occur prior to wet season to maximise the benefits of subsequent rainfall.

On-going rehabilitation maintenance and monitoring including earthworks repairs, re-seeding supplementary tube-stock planting, fertiliser application and drainage repairs will occur, as necessary.

Low intensity grazing has been determined the preferred PMLU for waste rock emplacements. This PMLU has been determined on the basis of pre-mining land suitability, landholder/stakeholder preferences, the existing land use and EVs of the surrounding landscape. Other rehabilitation management options such as dryland cropping, improved pastures and native pastures were considered, however on the basis of economic value, deemed unsuitable due to limited soil nutrient deficiencies, soil water availability, soil wetness, erosion and surface condition. A conceptual layout for the PMLU is illustrated in Figure 36.

A progressive rehabilitation schedule, including the rehabilitation of waste rock emplacements is provided within schedule calculations (Section 4.6).

13.4.5 Erosion and Sediment Run-Off

Erosion and sediment from waste rock dumps will be managed in accordance with an ESCP that has been designed for the Project by a suitably qualified person. The plan has been designed to address the construction, operational and rehabilitation/closure phases of the Project to prevent adverse impacts from waste rock dumps to nearby local environmental values (i.e., Charlevue Creek and Springton Creek). Management measures to address the risks associated with waste rock dumps will include the following:

- limit land clearing to the minimum required for safe operations of the Project;
- retention of riparian vegetation where possible along Charlevue Creek and Springton Creek;
- diversion of clean overland flow/runoff from the upper reaches of Springton Creek and Charlevue Creek around the out-of-pit waste rock emplacement associated with Pit C and Pit AB;
- rapid revegetation of disturbed areas and hydromulching of areas subject to short term exposure;
- waste rock emplacements have been designed to a slope of 1V:10H (adhering to a maximum slope of 6°) and a maximum height of 190 mAHD;
- installation of sediment entrapment devices and infrastructure between receiving waters and disturbed areas, including:
  - silt fences, coir logs, hay bales or other flow reduction devices;
  - pit protection levees & diversion channels;
  - sediment traps and dams;
  - cleaning protocols of sediment drains and entrapment devices; and
  - traffic control measures and haul route bunding.
- flood protection levee and clean water drains to minimise flood water interaction with waste rock emplacements.

Erosion and sediment control structures will be designed and installed in accordance with *Best Practice Erosion and Sediment Control* (IECA Australasia 2008) and *Soil Erosion and Sediment Control: Engineering Guidelines for Queensland Construction Sites* (Witheridge & Walker 1996), as appropriate.

As described in Section 13.4.2, surface water and seepage from mining waste storage areas will be monitored to ensure that key water quality parameters remain within the appropriate criteria. Sediment and water quality monitoring will be undertaken in accordance with a REMP to ensure the effectiveness of employed control measures, including the enforcement of sediment quality trigger values (refer to Section 7.4.4.1).

13.4.6 Monitoring Program

Environmental monitoring to identify and assess any impacts arising from seepage or contamination associated with the geochemistry of waste rock and coal rejects will comprise the following components:

- Ongoing groundwater monitoring to verify baseline groundwater information. It should be noted that groundwater data collected to date has indicated high EC groundwater associated with all groundwater units (refer to Section 8.0).

- Ongoing surface water monitoring will be undertaken principally to validate water management system performance against the design assumptions, both in terms of water quality and water quantity, so that adaptive management decisions can be undertaken where necessary to protect the surface water environment. Surface runoff and seepage water collection in the mine water dams and process water dam will be monitored for standard water quality parameters including, but not limited to pH, EC, major anions (sulphate, chloride and alkalinity), major cations (sodium, calcium, magnesium and potassium), TDS and a broad suite of soluble metals/metalloids.

- Validation test work will be undertaken on potential spoil materials as the Project develops to enable appropriate spoil management measures to be planned and implemented as required. Where highly sodic and/or dispersive spoil is identified, this material would not be placed in final landform surfaces and would not be used in construction activities. Regardless of the spoil type, especially where engineering or geotechnical stability is required, testing would be undertaken during construction to determine the propensity of such materials to erode. Surface runoff and seepage from spoil piles, including any rehabilitated areas, would be monitored for ‘standard’ water quality parameters including, but not limited to, pH, EC, major anions (sulphate, chloride and alkalinity), major cations (sodium, calcium, magnesium and potassium), TDS and a broad suite of soluble metals/metalloids.

- A REMP will also be developed and implemented in accordance with the *Model Mining Conditions* (DES 2017e). The REMP would be implemented to monitor, identify and describe any adverse impacts to surface water EVs, quality and flows due to the authorised mining activity. Water quality monitoring will be undertaken upstream and downstream of the Project to detect downstream water quality impacts and to demonstrate compliance with the EA release conditions. Further details of the REMP are provided in Section 7.4.4.1, including the location of proposed receiving water monitoring points (Table 45).

14.0 RISK ASESSMENT

14.1 RISK ASSESSMENT REQUIREMENTS

A preliminary risk assessment has been undertaken for the Project, to address the potential or actual impacts on environmental values during the construction, operation, decommissioning and rehabilitation stages.

The risk assessment has been carried out in accordance with the following objectives to identify and address associated Project risks, these include:

- the likelihood of an impact occurring;
- the management/mitigation measures proposed;
- the consequence of the managed impact;
- potential levels of residual impacts on environmental and community values; and
- the cumulative impacts on environmental values.

The risk assessment was carried out in accordance with *AS ISO 31000:2018 Risk management – guidelines.* The corresponding management of environmental risk was informed by both expert opinion and the Project specific technical studies detailed within this EA application.

14.2 RISK IDENTIFICATION

For this assessment, a risk assessment was undertaken by a panel of environmental consultants. In accordance with *Section 6.4.2 of AS ISO 31000:2018,* hazards and risks were considered from three different perspectives (environmental impact, impacted receptors and introduced/exacerbated hazards).

The cohort of risks, segregated by each perspective, can be summarised as:

- environmental impact -
  - land impacts (e.g., loss of land resources and constraints on future land use);
  - noise and air blast related impacts;
  - visual impacts (e.g., landscape and lighting);
  - surface water (e.g., hydrology and water quality);
  - groundwater (e.g., geohydrology and groundwater quality);
  - air quality (e.g., dust and other contaminants);
  - occupational health and safety impacts (e.g., impacts on personnel);
  - impacts arising from pests and diseases (either exacerbated or introduced by the Project);
  - socio-economic impacts; and

- exacerbation of impacts from natural events (e.g., fire, flood, cyclone/ extreme weather, landslide, climate change);

- impacted receptor -
  - impacts on important environmental receptors (e.g., identified MSES, nature refuges, national parks); and
  - impacts on local, regional and state residents;
- introduced or exacerbated hazard -
  - workplace occupational and health risks and hazards;
  - mining-related hazards including:
    - heavy earthmoving equipment;
    - light vehicles;
    - hazardous materials and dangerous goods; and
    - geochemical and geotechnical hazards (e.g., waste rock materials, carbonaceous materials, waste rock dumps and final void).

The identified set of risks and hazards were transferred to a risk assessment template designed for the specific purpose of assessing environmental risks, identifying associated causes, potential impacts and the expected base level of controls.

14.3 RISK ASSESSMENT PROCESS

Any risk assessment needs to be undertaken in consideration of the scope, context and criteria relevant to the assessment. For this risk assessment, the following scope and purpose was discussed and agreed to:

- The purpose of this risk assessment is to identify and analyse any risks arising because of the Project that may impact on environmental aspects, including socioeconomic aspects; at the local, regional and state levels and across the construction, operational and closure stages of the Project.

Several important assumptions and/or criteria have also been identified, including:

- Occupational Health and Safety hazards are assumed to be assessed and managed at an operational level in accordance with legislated requirements and contemporary mining industry practice.
- The risk assessment is a preliminary and high-level assessment set at the overall project level. Therefore, while some risk scenarios may be viewed as being generic, the assessment process interrogates the risk scenarios sufficiently to focus on project and site-specific aspects in assessing hazards and risks.
- Risks are assessed on the basis that expected, contemporary operational controls will be in place on the assumption that the proponent's view of legal and constructive obligations,

statutory controls and management systems are in line with current industry standards and expectations.

The risk assessment was undertaken to analyse and evaluate the risks and hazards identified with the following process steps established:

- The basis and purpose of the risk identification was agreed on, as well as the process used to develop the risk scenarios, causes and impacts proposed in the risk assessment template.
- The risk assessment scheme, including the consequence descriptors for each consequence type, the likelihood classifications and the control effectiveness rankings were evaluated and agreed on.
- Each of the identified risk scenarios or descriptions was then considered in turn. In most cases, one or more of the 'risk/hazard title', 'causes' and 'impacts' proposed were refined as a result.
- The likelihood of each risk/hazard, subject to the expected control level, was then considered and a ranking was provided in accordance with the consensus view.
- The consequence category for the relevant impact or impacts was similarly assessed and ranked.
- The risk class was then determined based on the risk matrix (Table 72).
- For risks and hazards determined as being of Class III and IV, additional control measures were discussed and assessed and, where effective and appropriate, proposed.

A summary of the complete risk assessment outcomes is provided at Table 74.

14.3.1 Risk Assessment Scheme

The risk assessment scheme used is representative of risk schemes used widely within the mining industry. For this risk assessment, the scheme comprised the following components:

- a likelihood classification table (Table 70);
- a severity and consequence classification table (Table 71); and

Table 70 Likelihood of Exposure

Likelihood	Description	Frequency	Probability
Almost certain	The event will occur often.	More than once a year	> 95%
Likely	The event could easily happen.	At least once in 1 year	60%–95%
Possible	The event could happen and has happened elsewhere.	At least once in 3 years	30%–60%
Unlikely	The event has not happened but could.	At least once in 10 years	5%–30%
Rare	Conceivable but only in extreme circumstances.	Less than once in 30 years	< 5%

Table 71 Severity and Consequence Classification

Severity level	Consequence		
	Human Health and Safety	**Natural Environment**	**Community/ Cultural Heritage**
Catastrophic	Multiple fatalities, significant irreversible impairment to multiple persons	Very serious, long-term environmental impairment of ecosystem functions	N/A
Major	Single fatality, significant irreversible impairment to a person	Very serious, long-term environmental impairment of ecosystem functions	Ongoing serious social issues. Significant damage to structures/items of cultural significance
Moderate	Significant reversible impairment to one or more persons (lost time injury, disabling injury)	Serious medium-term environmental effects	Ongoing serious social issues. Significant damage to structures/items of cultural significance
Minor	Reversible impairment requiring medical treatment (medical treatment injury)	Moderate, short-term effects but not affecting ecosystem functions	Ongoing social issues. Permanent damage to items of cultural significance
Insignificant	No treatment or first aid treatment	Negligible/minor effects on biological or physical environment	Minor medium-term social impacts on local population. Mostly repairable

Following the hazard identification, and assessment of likelihood and consequence criteria, the risk level was determined using Table 72, which then defines the assessed risk level. Table 73 describes the appropriate level of action required for each assessed risk level.

Table 72 Risk Level Matrix

Likelihood	Consequence				
	Insignificant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost Certain	II	III	III	IV	IV
Likely	II	II	III	III	IV
Possible	I	II	III	III	III
Unlikely	I	I	II	II	III
Rare	I	I	II	II	III

Table 73 Risk Level Actions

Risk Level Actions	
Very High Risk	Board and/or board level committee attention required; action plans and management responsibility specified.
High Risk	Senior executive management attention required; action plans and management responsibility specified.
Medium Risk	Manage by specific monitoring or response procedures, with management responsibility specified.
Low Risk	Manage by routine procedures, unlikely to need specific application of resources.

14.4 RISK ASSESSMENT OUTCOMES

In total, 47 risks and/or hazards were identified and assessed. There are a number of risks identified where the risk or hazard impacts on more than one environmental aspect or category, resulting in 68 discrete risk assessments in total. Unnecessary duplication was avoided by only including a duplicate scenario where it was felt that there was a legitimate reason to assess both risk scenarios by virtue of either a significantly different environmental impact outcome or, for a high ranked risk, where significantly different mitigation measures might be required. The risk profile for the Project and the risk profile by consequence area are illustrated at Figure 86 and Figure 87 respectively, and the summary of identified risks and mitigation measures is presented in Table 74.

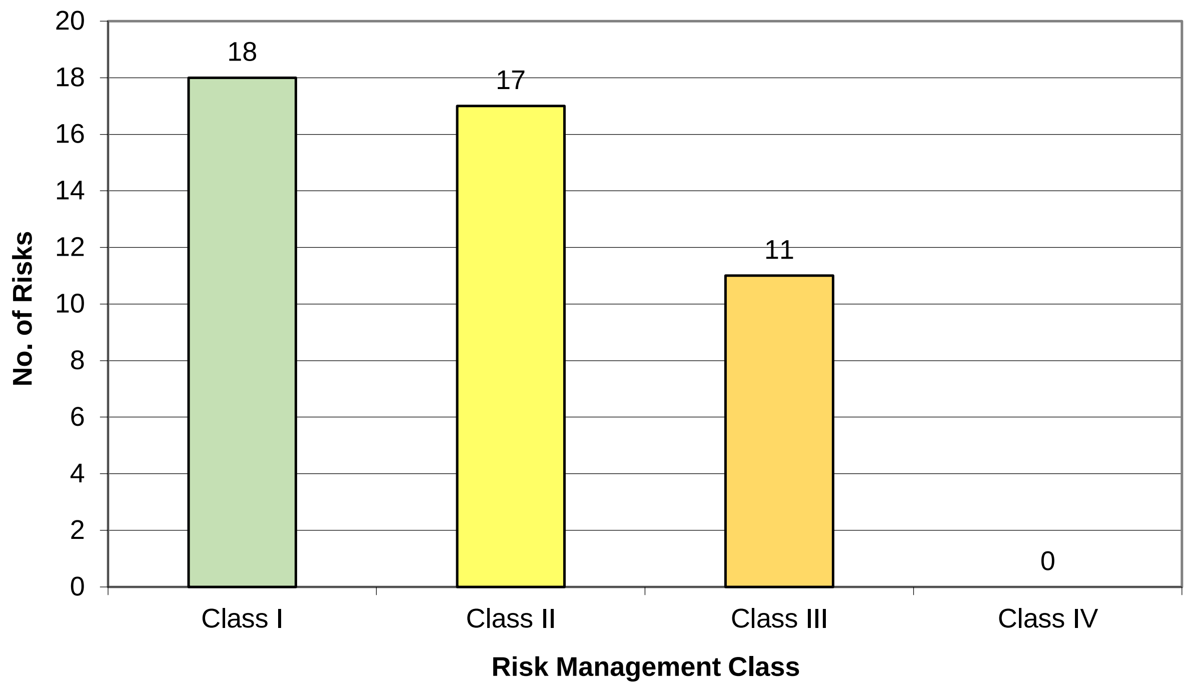


Figure 86 Risk Profile

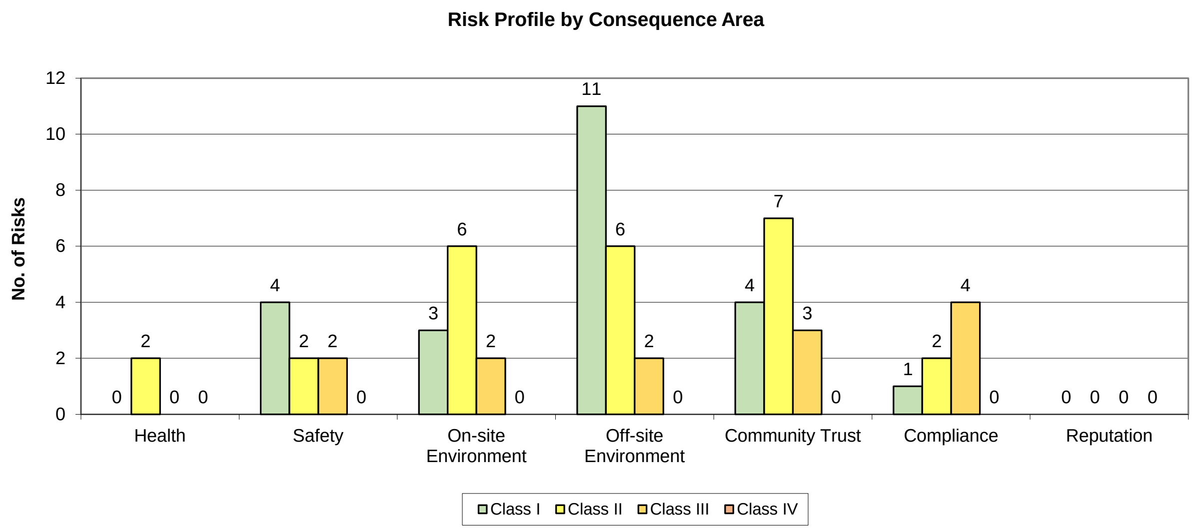


Figure 87 Risk Profile by Consequence Area

14.5 RISK MITIGATION

The following processes and measures will be implemented in addition to expected and standard controls to reduce the risk of impacts on health, safety and the environment associated with the Project:

- Fatigue management/fitness for work, alcohol and drug testing and road safety awareness training to manage the increased risk of motor vehicle incidents.
- Occupational health and safety performance to be closely monitored and assessed and, where required, individual issue specific risk assessments to be undertaken to identify fit-for-purpose safety initiatives.
- Long term monitoring of noise and dust impacts at sensitive receptors.
- Active management of equipment locations and operating hours if required to reduce the likelihood of noise and air quality impacts on sensitive receptors.
- Geochemical characterisation of topsoils and waste rock materials and amelioration measures as appropriate to manage impacts to the environment (downstream watercourses) from erosion of rehabilitated areas.
- Cultural heritage surveys to be undertaken prior to site clearing, and implementation of procedures for the management of any identified cultural heritage values or artefacts.

Table 74 Summary of Identified Risks and Mitigation Measures

Risk Description				Risk Evaluation										Risk Ranking										Risk Management
Risk /Hazard Title	Causes (Triggers / Indicators)	Impacts (Consequences)	Expected/Standard Controls	Likelihood / Probability	Greenhouse	Health	Safety	Environment On-site	Environment Off-site	Community Trust	Compliance	Stakeholders	Cultural Heritage	Greenhouse	Health	Safety	On-site Environment	Off-site Environment	Community Trust	Compliance	Stakeholders	Cultural Heritage	Risk Management Class	Additional Risk Mitigation
Amenity																								
Amenity of local residents																								
Increased risk of motor vehicle incidents	Increase light and heavy vehicle movements associated with the Project	Ranges from inconvenience to fatality	Road access design (subject to regulatory controls) and public road controls	R			H									III							III	Fatigue management/fitness for work, alcohol and drug testing, road safety awareness training
Impacts to local farmers	Construction phase specific Impeding access to properties	Inconvenience	Road access design (subject to regulatory controls)	p						L									II				II	
Increased rail movements	Increase in production	Annoyance, amenity	Restricted TLO operating hours to reduce noise impacts	p						L	M								II	III			III	
Increased heavy vehicle movements	Operational phase only	Impacts limited largely to north of site at intersection with Capricorn Hwy	Road access design (subject to regulatory controls) and public road controls. Road approved for required capacity.	L						L									III				III	
Increased activism associated with coal mining impacts on environmental values	Existence of operation	Inconvenience, worker safety	Media monitoring, community/ stakeholder engagement program	P		L				L					II				II					
Bushfire																								
Impacts to surrounding properties and existing mine rehabilitation	Project-related activities Surrounding land management activities Natural causes	Destruction to surrounding properties, operational cost and rehabilitation failure	Distance from source, firebreaks, ERT with fire-fighting capacity	R			M			M						II			II				II	
Flood																								
Detrimental flooding impacts within Project area	Altered flood regimes due to project	Flooding of project operations and infrasructure	Site Water Management System design to minimise flooding to operations Levee and clean water dams to contain and redirect flows	R				L				VL					I				I		I	REMP, groundwater and surface water monitoring, water management plan, progressive rehabilitation to limit disturbance, flood protection levee surveillance, communications/ consultation with stakeholders
Detrimental flooding impacts to neighbouring residents	Altered flood regimes due to project	Flood depth afflux, velocity, inundation 1% to 10% AEP range	Flood study indicates negligible increase to the extent of inundation up to 0.1% AEP, and duration increases up to 48 hours	R					L			L						I			I		I	REMP, groundwater and surface water monitoring, water management plan, progressive rehabilitation to limit disturbance, flood protection levee surveillance, communications/ consultation with stakeholders
Detrimental flooding impacts to neighbouring residents	Project location and extents (floodplain extents defined by levee location)	Stream power and shear stress	Modelling indicates minimal increase in flow velocities	R					L		L							I		I			I	
Flooding impacts to Dingo township	Project location and extents (floodplain extents defined by levee location)	Increase in flood inundation duration and extent	Modelling shows no significant change at Dingo township	R			VL		VL			VL				I		I			I		I	
Flooding impacts to mine / final void	Project location and extents (floodplain extents defined by levee location)	Pit/ final void flooding, loss of access, property damage	Levee and final landforms designed to provide flood protection to 0.1% AEP and PMF event	R				H									III						III	Effective rehabilitation and final landform design. Ongoing maintenance of water management infrastructure. Business Continuity Plan

Risk Description				Risk Evaluation										Risk Ranking											Risk Management
Risk /Hazard Title	Causes (Triggers / Indicators)	Impacts (Consequences)	Expected/Standard Controls	Likelihood / Probability	Greenhouse	Health	Safety	Environment On-site	Environment Off-site	Community Trust	Compliance	Stakeholders	Cultural Heritage	Greenhouse	Health	Safety	On-site Environment	Off-site Environment	Community Trust	Compliance	Stakeholders	Cultural Heritage	Risk Management Class	Additional Risk Mitigation
Hazards **OHS**																								
OHS consequences	Construction, mining and industrial activities	Health, safety, operational cost	Staff awareness and training, safety management system	R		M	VH								II	III							III	OHS performance to be closely monitored and assessed and, where required individual, issue-specific risk assessments to be undertaken to identify fit-for purpose safety initiatives
Hazardous chemicals																								
Impacts on emergency services	Significant incident involving major hazardous facility	Health, safety, operational cost	Emergency Response Plan, staff awareness and training	U			L			VL						I			I				I	
Physical Environment **Noise**																								
Noise impacts to sensitive receptors (residents)	Noise emissions from plant, equipment and processes, road haulage	Annoyance, amenity, harm to wildlife	Distance from source, positioning of equipment for evening shift, attenuation packages for equipment, construction of noise bunds	L						L	L								III	III			III	Implementation of Noise Management Plan Noie Monitoring Management of equipment locations and operating hours
Air quality																								
Dust impacts to sensitive receptors	Equipment, processes and vehicle movements on unsealed roads, and increased bare areas (waste rock dumps, TSF)	Annoyance, amenity (sensitive receptors), harm to wildlife, crop impact, contamination of water tanks	Distance from source, routine haul road watering, progressive rehabilitation, speed limits	L						L	L								III	III			III	Implementation of Air Quality Management Plan Dust Monitoring Management of equipment locations and operating hours
Impacts to air quality (bushfire) - see 'Bushfire'	Project-related activities	Health, safety, amenity, harm to wildlife, annoyance	Onsite containment and control measures, staff training	R						M										II			II	
Visual amenity																								
Visual impact to sensitive receptors	Changed landforms and prominent plant and equipment	Annoyance, amenity	Progressive revegetation of waste rock dumps, visual impact assessment	U						VL									I				I	

Risk Description				Risk Evaluation										Risk Ranking										Risk Management
Risk /Hazard Title	Causes (Triggers / Indicators)	Impacts (Consequences)	Expected/Standard Controls	Likelihood / Probability	Greenhouse	Health	Safety	Environment On-site	Environment Off-site	Community Trust	Compliance	Stakeholders	Cultural Heritage	Greenhouse	Health	Safety	On-site Environment	Off-site Environment	Community Trust	Compliance	Stakeholders	Cultural Heritage	Risk Management Class	Additional Risk Mitigation
Land																								
Impacts to the environment arising from geotechnical instability	Blasting, wet weather, or a combination of both	Health, safety, rehabilitation landform failure and rehabilitation scheduling delays	Geotechnical advice on levee, landforms, low-walls and high-walls	R				M									II						II	Engineering and blasting design to consider geotechnical stability
Impacts to the environment (downstream watercourses) from erosion of rehabilitated areas	Dispersive soil characteristics, rehabilitated landform (slope, surface preparation, revegetation success, climate)	Downstream water quality, operational cost, compliance	Rehabilitation practices, ESC practices	P					M		L							III		II			III	Geochemical characterion of topsoils and amelioration if necessary
Impacts to the environment (surface water and groundwater)	Waste rock inherent geochemical issues	Downstream water quality, flora, fauna, aquatic fauna, operational cost, compliance	Waste rock characterisations, short residence time on stockpiles, mining schedule	U					M									II					II	Waste rock characterisation program scaled to match findings and identified geochemical risk
Impacts to the environment (land contamination)	Presence of contaminants or potential for acid mine drainage from overburden	Localised land contamination and potential delay in rehabilitation remediation works	Decontamination works, appropriate storage of hazardous chemicals and fuels, training, emergency spill procedures and registers.	R				L									I						I	
Impacts to the environment (revegetation and rehabilitation success)	Unfavourable soil characteristics, climate, inappropriate or unavailable seed mix, weeds and premature grazing	Insufficient tree canopy, poor seedling survival, unfavourable plant community species composition, erosion due to lack of vegetation cover, poor pasture productivity and diversity leading to failure in achieving PMLU	Soil ameliorants and/or fertilisers, seed requirements determined early and purchased to be maintained on site, unavailable seeds planted as tubestocks in the following wet season, weed management, fencing and vegetation monitoring	U				M									II						II	
Impacts to the environment and workforce health	Presence of carbonaceous materials (spontaneous combustion)	Air quality, safety	Appropriate storage and handling of carbonaceous materials, staff training	R			L		L							I		I					I	
Surface water																								
Impacts to local/regional surface water quality	Overtopping of mine pit/ final void	Adverse changes water quality in receiving waterways	Site Water Management System designed to contain mine affected water on site, with releases only under favourable conditions	R					M									II					II	Water management plan, REMP and water quality monitoring, flood protection levee/ landform, progressive rehabilitation to limit disturbance
Impacts to local/regional surface water quality	Catchment disturbance, release of sediment laden waters	Adverse changes to TSS, turbidity, water quality in receiving waterways, HES wetland	Provision of engineered sedimentation structures and ESC measures	U					L									I					I	ESC Plan, SWMS, REMP and water quality monitoring, progressive rehabilitation to limit disturbance
Impacts to local/regional surface water quality	Releases of mine affected water	Adverse changes to salinity, water quality in receiving waterways	Water balance, engineered water management system, licensed release conditions	U					L									I					I	Water management plan, REMP and water quality monitoring, water management system, progressive rehabilitation to limit disturbance
Impacts on surface water resources	Loss of catchment reporting to receiving waterways and wetlands	Impacts to local and regional surface water quality, aquatic ecology and other uses	Water efficiency programs, water management plan	L						VL									II				II	Water management plan, REMP and water quality monitoring, flood protection levee/ landform, progressive rehabilitation to limit disturbance

Risk Description				Risk Evaluation										Risk Ranking										Risk Management
Risk /Hazard Title	Causes (Triggers / Indicators)	Impacts (Consequences)	Expected/Standard Controls	Likelihood / Probability	Greenhouse	Health	Safety	Environment On-site	Environment Off-site	Community Trust	Compliance	Stakeholders	Cultural Heritage	Greenhouse	Health	Safety	On-site Environment	Off-site Environment	Community Trust	Compliance	Stakeholders	Cultural Heritage	Risk Management Class	Additional Risk Mitigation
Groundwater																								
Impacts to groundwater quality	Seepage from MAW water storages	Contamination of groundwater	Engineered MAW water storages	U				M	M								II	II					II	Groundwater and surface water monitoring, REMP, groundwater model validation, make good agreements where required, regular site inspections and housekeeping checklists
Impacts to groundwater resources	Leakage to mine/ final void	Aquifer drawdown	Modelling indicates limited extent of impact	U					M									II					II	Groundwater and surface water monitoring, REMP, groundwater model validation, make good agreements where required
Impacts to groundwater resources	Aquifer disturbance, leakage to mine/ final void	Diminished resource for other users	Modelling indicates limited extent of impact	U					L									I					I	Groundwater and surface water monitoring, REMP, groundwater model validation, make good agreements where required
Impacts to groundwater dependent ecosystems	Aquifer disturbance, leakage to mine/ final void	Impacts to stygofauna habitat	Modelling indicates limited extent of impact	U					L									I					I	Groundwater and surface water monitoring, REMP, groundwater model validation, make good agreements where required
Impacts to groundwater/ surface water	Aquifer disturbance, leakage to mine/ final void	Diminished watercourse baseflow	Modelling indicates limited extent of impact	U					L									I					I	Groundwater and surface water monitoring, REMP, groundwater model validation
Safety																								
Increased safety risk	Steeper landforms, rougher surfaces	Safety, community trust	Relinquishment, exclusion areas and barriers	P			VL	M		L						I	III		II				III	Modify landform design and surface preparation regime to reduce risk
Increased incidence of pests	Introduction of, or creation of conditions to promote, potentially dangerous pest species	Safety	Pest management program, monitoring, raising awareness	R			M									II							II	
Socio-economic																								
Negative impacts to the local and regional economy	Equity of economic contribution	Community trust	DIDO with limited FIFO, local employment opportunities	P						VL									I				I	
Negative impacts to the local and regional economy	Changes associated with closure	Community trust	Wind-down of operations into closure	P						L									II				II	
Cultural Heritage																								
Impacts to cultural heritage values	Planned and/or unplanned disturbance	Degradation of cultural heritage values, compliance	CHMP (presence of CH has not currently been surveyed).	P									L									II	II	Cultural Heritage surveys prior to site clearance Implementation of procedures if cultural heritage values or artefacts are identified
Incident																								
Impacts to the environment (Surface water, groundwater, land contamination, flora, fauna, air quality)	Significant operational/process incident occurring on site (spill, fire, explosion)	Physical environment (soil, landforms, water source), harm to wildlife, compliance	Emergency Response Planning and Training, staff training, awareness, spill control, bunding, containment practices	U				M	H		H						II	III		III			III	Systematic implementation of identified controls
Flora																								
Impacts to flora	Land disturbance, increase in pest species	Loss of native flora outside of approved disturbance area	Land Disturbance Permit System Weed management plan (staff training, equipment/vehicle wash-downs)	P				L	L								II	II					II	
Impacts to flora from bushfire	Project-related activities	Loss of native flora	Containment and control measures, Distance from source, firebreaks, ERT with fire-fighting capacity	R					L									I					I	

Risk Description				Risk Evaluation										Risk Ranking										Risk Management
Risk /Hazard Title	**Causes (Triggers / Indicators)**	**Impacts (Consequences)**	**Expected/Standard Controls**	**Likelihood / Probability**	**Greenhouse**	**Health**	**Safety**	**Environment On-site**	**Environment Off-site**	**Community Trust**	**Compliance**	**Stakeholders**	**Cultural Heritage**	**Greenhouse**	**Health**	**Safety**	**On-site Environment**	**Off-site Environment**	**Community Trust**	**Compliance**	**Stakeholders**	**Cultural Heritage**	**Risk Management Class**	**Additional Risk Mitigation**
Fauna																								
Impacts to fauna	Land disturbance, presence of introduced pests and/or disease	Fauna	Pest management program, habitat offset strategy	P					L									II					II	
Impacts to fauna from bushfire	Project-related activities	Fauna, fauna habitat	Containment and control measures, staff training	R					L									I					I	
Climate change																								
Impacts to climate change	Direct and indirect greenhouse gas emissions from the Project	Localised and regional air quality, extreme weather events (droughts, cyclones and heat waves) with subsquent rehabilitation or mine scheduling delays	Annual review program, efficient and minimal energy use, fuel efficient equipment, equipment maintenance	AC	VL									II									II	
Essential services																								
Impacts on essential services (power, telecoms, potable water)	Additional pressure from the Project	Wearing out of service infrastructure, economic (repair and maintenance)	Annual review, efficient and minimal energy use, audit and monitoring	P						VL									I				I	
Future land use																								
Loss of land resource value	Construction and operation of the Project	Loss of lands having agricultural value	Rehab and closure plan to ensure post mining land use returned to equivalent value and use as pre-mining	L								L									III		III	
Scheduled infrastructure decomissioning and removal delayed or inadequately communicated	Mine planning or changes in the market	Rehab milestones not achieved and failure to remove infrastucture for rehabilitation	Mine scheduling meetings and additonal workforce employed if anticipated that the completion of works in accordance with mine schedule is unlikely	P				L				L					II				II		II	• Infrastructure decommission schedule to be incorporated into annual mine planning. • A register of infrastructure to track which structures exist in each rehabilitation area and which have been removed.
Restrictions on possible future land uses in and around the project area	Post-closure of the Project	Land suitability	Rehabilitation practices, land use assessments, alternative post mining land uses	U				VL									I						I	

15.0 DRAFT EA CONDITIONS

The presentation of the following EA conditions is intended to assist with the process of developing appropriate EA conditions for the Project in consultation with DES. This section does not intend to replace or replicate the Notice of Decision stage of the EA application process under Chapter 5, Division 3, subdivision 2 of the EP Act.

The *Guideline (Mining): Model mining conditions [ESR/2016/1936]* (DES 2017e) provide a basis for proposing environmental protection commitments in EA application documents. The guideline allows for modification of the *Model Mining Conditions* to address the site-specific conditions and circumstances of the Project.

The conditions proposed within this section have been developed to address the anticipated impacts of the Project as described within the EA application, and to be measurable and auditable. Where alternative conditioning has been proposed, an explanatory box is provided beneath the condition. For ease of application and review, the proposed EA conditions have been structured as per the guidelines.

15.1 ENVIRONMENTALLY RELEVANT ACTIVITIES

ERAs include resource activities or specific agricultural activities, or other activities prescribed by the EP Act. Current prescribed ERAs and resource activities are defined in Schedules 2 and 3 respectively of the EP Regulation. The Project will include the resource activity of 'Mining Black Coal' as well as the ancillary activities outlined in Table 75.

Table 75 Environmentally Relevant Activities

Environmentally Relevant Activity	Description
Schedule 2 (Prescribed ERAs)	
8 (1) (c) Chemical storage	Chemical storage (the relevant activity) consists of storing more than 500 m^3 of class C1 or C2 combustible liquids under AS1940 or dangerous goods class 3. Threshold 3) Storing more than 500 m^3 of chemicals of class C1 or C2 combustible liquids under AS1940 or dangerous goods class 3 under subsection (1)(c). *Aggregate Environmental Score: 85*
31 (1) Mineral processing	Mineral processing (the relevant activity) consists of processing, in a year, a total of 1,000t or more of coke or mineral products. Threshold 2) Processing, in a year, the following quantities of mineral products, other than coke (b) more than 100,000 t. *Aggregate Environmental Score: 280*
33 (1) Crushing, milling, grinding or screening	Crushing, milling, grinding or screening (the relevant activity) consists of crushing, grinding, milling or screening more than 5,000 t of material in a year. Threshold Crushing, grinding, milling or screening more than 5,000 t of material in a year. *Aggregate Environmental Score: no score*
60 (1)(ii)(A) Waste disposal	Waste disposal (the relevant activity) consists of operating a facility for disposing of general waste and a quantity of limited regulated waste that is no more than 10% of the total amount of waste received at the facility in a year. Threshold 2) Operating a facility for disposing of, in a year, (h) more than 200,000 t. *Aggregate Environmental Score: 107*
63 (1)(b) (i) Sewage treatment	Sewage treatment (the relevant activity) consists of operating 1 or more sewage treatment works at a site that have a total daily peak design capacity of at least 21EP. Threshold 1) Operating sewage treatment works, other than no-release works, with a total daily peak design capacity of (b) more than 100 but not more than 1500 EP (i) if treated effluent is discharged from the works to an infiltration trench or through an irrigation scheme. *Aggregate Environmental Score: 27*
Schedule 3 (Resource Activity)	
13 Mining black coal	*Aggregate Environmental Score: 128*

15.2 PROPOSED CONDITIONS

Schedule A – General Conditions

General

A1 This environmental authority authorises environmental harm referred to in the conditions. Where there is no condition or this environmental authority is silent on a matter, the lack of a condition or silence does not authorise environmental harm.

A2 In carrying out the mining activity, the holder of this EA must not exceed the allowed disturbance area as detailed in **Schedule 1 – Figure A2 (Approved Plan)**.

A3 This environmental authority authorises the mining of 1.9 million tonnes per annum (Mtpa) ROM (run-of-mine) coal.

A4 The holder of this environmental authority must:

a) install all measures, plant and equipment necessary to ensure compliance with the conditions of this environmental authority;

b) maintain such measures, plant and equipment in a proper and efficient condition;

c) operate such measures, plant and equipment in a proper and efficient manner; and

d) ensure all instruments and devices used for the measurement or monitoring of any parameter under any condition of this environmental authority are properly calibrated.

Monitoring and Records

A5 Except where specified otherwise in another condition of this environmental authority, all monitoring records or reports required by this environmental authority must be kept for a period of no less than five years.

A6 Where monitoring is a requirement of this environmental authority, ensure that a competent person conducts all monitoring in accordance with:

a) the most recent *Monitoring and Sampling Manual* released by the administering authority, or

b) an appropriate method described in Australian Standards (AS), or;

c) any other document approved by the administering authority.

A7 All analyses and tests required to be conducted under this environmental authority must be carried out by a laboratory that has National Association of Testing Authorities (NATA) certification for such analyses and tests, expect as otherwise authorised by the administering authority.

A8 All instruments, equipment and measuring devices used for measuring or monitoring in accordance with any condition of this authority must be:

a) appropriately and competently calibrated, operated and maintained; and

b) calibration reports must be supplied upon request to the administering authority, in accordance with Condition A19.

Estimated Rehabilitation Calculation

A9 The activity must not be carried out until the environmental authority holder has given surety or paid a contribution to the scheme fund, as required by section 297 of the Act.

Risk Management

A10 The holder of this environmental authority must develop and implement a risk management system for mining activities which mirrors the content requirement of the *Standard for Risk Management (ISO31000:2009),* or the latest edition of an Australian standard for risk management, to the extent relevant to environmental management, by 3 months from date of issue.

Notification of Emergencies, Incidents and Exceptions

A11 The holder of this environmental authority must notify the administering authority by written notification within 24 hours, after becoming aware of any emergency or incident which results in the release of contaminants not in accordance, or reasonably expected to be not in accordance with, the conditions of this environmental authority.

A12 Within 10 business days following the initial notification of an emergency or incident, or receipt of monitoring results, whichever is the latter, further written advice must be provided to the administering authority, including the following:

a) results and interpretation of any samples taken and analysed;

b) outcomes of actions taken at the time to prevent or minimise unlawful environmental harm; and

c) proposed actions to prevent a recurrence of the emergency or incident.

Complaints

A13 The holder of this environmental authority must record all environmental complaints received about the mining activities including:

a) name, address and contact number for of the complainant;

b) time and date of complaint;

c) reasons for the complaint;

d) investigations undertaken;

e) conclusions formed;

f) actions taken to resolve the complaint;

g) any abatement measures implemented; and

h) person responsible for resolving the complaint.

A14 The holder of this environmental authority must, when requested by the administering authority, undertake relevant specified monitoring within a reasonable timeframe nominated or agreed to by the administering authority to investigate any complaint of environmental harm. The results of the investigation (including an analysis and interpretation of the monitoring results) and abatement measures, where implemented, must be provided to the administering authority within 10 business days of completion of the investigation, or no later than 10 business days after the end of the timeframe nominated by the administering authority to undertake the investigation.

Third-Party Reporting

A15 The holder of this environmental authority must:

a) within one year of the commencement of this environmental authority, obtain from an appropriately qualified person a report on compliance with the conditions of this environmental authority;

b) obtain further such reports at regular intervals, not exceeding three-yearly intervals, from the completion of the report referred to above; and

c) provide each report to the administering authority within 90 days of its completion.

A16 Where a condition of this environmental authority requires compliance with a standard, policy or guideline published externally to this environmental authority and the standard is amended or changed subsequent to the issue of this environmental authority, the holder of this environmental authority must:

a) comply with the amended or changed standard, policy or guideline within two years of the amendment or change being made, unless a different period is specified in the amended standard or relevant legislation, or where the amendment or change relates specifically to regulated structures referred to in a condition, the time specified in that condition; and

b) until compliance with the amended or changed standard, policy or guideline is achieved, continue to remain in compliance with the corresponding provision that was current immediately prior to the relevant amendment or change.

Schedule B – Air

Dust and Particulate Matter Monitoring

B1 The environmental authority holder shall ensure that all reasonable and feasible avoidance and mitigation measures are employed so that the dust and particulate matter emissions generated by the mining activities do not cause exceedances of the following levels when measured at any sensitive or commercial place:

a) dust deposition of 120 milligrams per square metre per day (mg/m²/day), averaged over one month, when monitored in accordance with the most recent version of *AS3580.10.1: Methods for sampling and analysis of ambient air - Method 10.1: Determination of particulate matter - Deposited matter - Gravimetric method*;

b) a concentration of particulate matter with an aerodynamic diameter of less than 10 micrometres (PM_{10}) suspended in the atmosphere of 50 micrograms per cubic metre over a 24-hour averaging time, when monitored in accordance with the most recent version of either:

i) *AS3580.9.6 Methods for sampling and analysis of ambient air Part 9.6: Determination of suspended particulate matter - PM_{10} high volume sampler with size-selective inlet - Gravimetric method;* or

ii) *AS3580.9.9 Methods for sampling and analysis of ambient air Part 9.9: Determination of suspended particulate matter - PM_{10} low volume sampler - Gravimetric method.*

c) a concentration of particulate matter with an aerodynamic diameter of less than 2.5 micrometres ($PM_{2.5}$) suspended in the atmosphere of 25 micrograms per cubic metre over a 24-hour averaging time, when monitored in accordance with the most recent version of *AS3580.9.10 Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - $PM_{2.5}$ low volume sampler—Gravimetric method*; and

d) a concentration of particulate matter suspended in the atmosphere of 90 micrograms per cubic metre over a 1-year averaging time, when monitored in accordance with the most recent version of *AS3580.9.3 Methods for sampling and analysis of ambient air – Method 9.3: Determination of suspended particulate matter - Total suspended particulate matter (TSP) - High volume sampler gravimetric method*.

B2 The holder of this environmental authority must undertake monitoring of air quality at the locations specified in **Table B1** – **Air Quality Monitoring** in accordance with the standards listed above in Condition B1, which must include:

a) continuous real-time monitoring of PM_{10} at one location;

b) continuous real-time monitoring of dust deposition at one location;

c) meteorological monitoring (including temperature, wind speed and direction) at one location;

d) each location listed in **Table B1** – **Air Quality Monitoring** is monitored for a continuous month each year; and

e) regular reporting of the measured PM_{10} and dust deposition concentrations, including investigations into any possible exceedances, must occur.

B3 When requested by the administering authority or as a result of a complaint, dust and particulate monitoring (including dust deposition, TSP, PM_{10} and $PM_{2.5}$) must be undertaken, and the results thereof notified to the administering authority within 14 days following completion of monitoring.

B4 If the monitoring, which is carried out in accordance with Condition B3, indicates an exceedance of the relevant limits in Condition B1, then the environmental authority holder must investigate whether the exceedance is due to emissions from the activity. If the mining activity is found to be the cause of the exceedance, then the environmental authority holder must:

a) notify the administering authority within seven days of an exceedance of the relevant limits in Condition B3.

b) address the complaint including the use of appropriate dispute resolution if required; and

c) implement dust abatement measures so that emissions of dust from the activity do not result in further environmental nuisance.

Table B1 – Air Quality Monitoring Locations

Monitoring Site ID	Monitoring Location		Air Quality Indicator	Frequency
	Monitoring Point (Eastings)	Monitoring Point (Northings)		
Northwest Primary Site	TBC	TBC	PM_{10}	Continuous
			Dust Deposition	Continuous monthly period as per AS
			Meteorological Conditions	Hourly
Dingo Township	TBC	TBC	PM_{10}	Continuous
			Dust Deposition	Continuous monthly period as per AS
			Meteorological Conditions	Hourly
South Secondary Site	TBC	TBC	PM_{10}	Continuous
			Dust Deposition	Continuous monthly period as per AS
			Meteorological Conditions	Hourly

Schedule C – Waste Management

C1 All general and regulated waste (except tyres) must be removed from site to a facility that is lawfully able to accept the waste under the *Environmental Protection Act 1994*.

C2 An effective firebreak must be installed and maintained around all waste laydown and tyre storage areas.

C3 Subject to demonstrating to the administering authority that no other use higher in the waste management hierarchy can be practicably implemented, waste tyres generated from mining activities may be disposed of onsite in waste rock emplacements.

C4 Scrap tyres resulting from mining activities disposed within the operational land must not impede saturated aquifers, cause contamination or compromise the stability of the consolidated landform.

C5 Unless otherwise permitted by the conditions of this environmental authority or with prior approval from the administering authority and in accordance with a relevant standard operating procedure, waste must not be burnt.

C6 Coarse and fine rejects from the CHPP must be managed in accordance with management plan that provides for:

a) containment of tailings;

b) the management of seepage and leachates both during operation and the foreseeable future;

c) the control of fugitive emissions to air;

d) a program of progressive sampling and characterisation to verify the effective containment of rejects within spoil; and

e) maintaining records of the relative locations of rejects disposed of in spoil.

Schedule D – Noise

D1 The holder of this environmental authority must ensure that noise generated by the mining activities does not cause the criteria in **Table D1 – Noise Limits** to be exceeded at a sensitive place or commercial place.

Table D1 – Noise Limits

Noise Level dBA Measured As:	Sensitive or Commercial Place		
	7:00 am to 6:00 pm	6:00 pm to 10:00 pm	10:00 pm to 7:00 am
$L_{Aeq,adj,1hr}$	40	40	35

In accordance with Note 6 of the Model Mining Conditions, criteria were developed in accordance with the EPP (Noise) and the Planning For Noise Control guideline (EHP 2004).

Airblast Overpressure Nuisance

D2 The holder of this environmental authority must ensure that blasting does not cause the limits for peak particle velocity and air blast overpressure in **Table D2 – Blasting Limits** to be exceeded at a sensitive place or commercial place.

Table D2 – Blasting Limits

Blasting Parameter	Sensitive or Commercial Place Limits	
	7:00 am to 6:00 pm	6:00 pm to 7:00 am
Airblast overpressure	115 dBZ peak for 4 out of 5 consecutive blasts initiated; or Not greater than 120 dBZ peak at any time.	No blasting is allowed during these times.
Ground vibration peak particle velocity	For vibrations of more than 35 Hz – more than 25 mm per second ground vibration, peak particle velocity, or For vibrations of no more than 35 Hz – more than 10 mm of second peak particle velocity.	No blasting is allowed during these times.

D3 Every explosive blast for the mining activity shall be designed by a competent person and be in accordance with a blast monitoring and management program, to achieve the criteria specified in **Table D2 – Blasting Limits**.

Monitoring and Reporting

D4 Noise monitoring and recording must include the following descriptor characteristics and matters:

a) the level and frequency of occurrence of impulsive or tonal noise and any adjustment and penalties to statistical levels;

b) atmospheric conditions including temperature, relative humidity and wind speed and directions;

c) effects due to any extraneous factors such as traffic noise; and

d) location, date and time of monitoring.

D5 The holder of this environmental authority must develop and implement a blast monitoring and management program to monitor compliance with **Table D2 – Blasting Limits** for:

a) at least 50% of all blasts undertaken on this site in each month at the nearest sensitive place or commercial place; and

b) all blasts conducted during any time period specified by the administering authority at the nearest and most affected sensitive place(s) or commercial place(s) or another such place to investigate an allegation of environmental nuisance caused by blasting.

Schedule E – Groundwater

E1 The holder of this environmental authority must not release contaminants to groundwater.

E2 All determinations of groundwater quality must be performed by an appropriately qualified person.

E3 Groundwater quality and levels must be monitored at the locations and frequencies defined in **Table E1 – Groundwater Monitoring Locations and Frequency** for quality characteristics identified in **Table E2 - Groundwater quality**

Bore Construction and Maintenance and Decommissioning

E4 The construction, maintenance and management of groundwater bores (including groundwater monitoring bores) must be undertaken in a manner that prevents or minimises impacts to the environment and ensures the integrity of the bores to obtain accurate monitoring.

Table E1 – Groundwater Monitoring Locations and Frequency

Site	Bore ID	Easting	Northing	Type	Bore Depth (m)	Unit Monitored	Monitoring Frequency
1	DW7065W	730860	7382307	SP	77.27	Permian Coal Seams (Aries 3)	Quarterly
	DW7066W	730863	7382304	SP	17.35	Tertiary sediments	Quarterly
3	DW7069W	730397	7382699	SP	71.38	Permian Coal Seams (Pollux Upper Seam)	Quarterly
	DW7071W	730394	7382703	SP	31.59	Permian Coal Seams (Aries 3)	Quarterly
	DW7072W	730403	7382687	SP	14.01	Tertiary sediments	Quarterly
4	DW7073W	729926	7382666	SP	82.1	Permian Coal Seams (Castor/Pollux Seams)	Quarterly
	DW7074W	729922	7382666	SP	55.78	Permian Coal Seams (Castor Upper Seams)	Quarterly
	DW7075W	729918	7382666	SP	14.03	Tertiary sediments	Quarterly
5	DW7076W	729750	7382723	SP	12	Quaternary alluvium	Quarterly
6	DW7033W1	731543	7383768	SP	45.23	Tertiary sediments	Quarterly
	DW7033W2	731546	7383773	SP	74.77	Permian Coal Seams (Orion 5)	Quarterly
	DW7033W3	731548	7383777	SP	81	Permian Coal Seams (Interburden)	Quarterly
10	DW7105W1	730192	7380733	SP	23.04	Tertiary sediments (Basalt)	Quarterly
	DW7105W2	730193	7380729	SP	69.25	Permian Coal Seams (Pollux Lower Upper Seam)	Quarterly
14	DW7225W1	730467	7378359	SP	37	Tertiary sediments	Quarterly
	DW7225W2	730466	7378355	SP	78.9	Permian Coal Seams (Aries 3)	Quarterly
	DW7225W3	730465	7378351	SP	112.8	Permian Coal Seams (Castor Seam)	Quarterly
17	DW7292W1	732905	7381108	SP	15	Quaternary alluvium	Quarterly

Notes: SP Stand pipe

Table E2 – Groundwater Quality Triggers and Limits

Parameter	Groundwater Unit		
	Quaternary Alluvium	Tertiary	Permian
pH (pH units)	5.5 – 8.5	5.5 – 8.5	5.5 – 8.5
Electrical conductivity (µS/cm)	16209	22362	28692
Metals/metalloids (dissolved – mg/L) (5)			
Aluminium	0.09	0.13	0.13
Arsenic	0.013	0.013	0.019
Boron	4.66 (3)	1.46	1.42
Cadmium	0.0002 (2)	0.0002	0.0002
Cobalt	0.004 (3)	0.004	0.019
Chromium	0.001 (3)	0.001	0.001

Parameter	Groundwater Unit		
	Quaternary Alluvium	Tertiary	Permian
Copper	0.069 (2)	0.065	0.083
Mercury	0.0001 (4)	0.0001	0.0001
Manganese	0.227 (2)	0.19	0.468
Molybdenum	0.004 (2)	0.017	0.081
Nickel	0.056 (2)	0.02	0.002
Lead	0.034 (3)	0.034	0.034
Selenium	0.005 (3)	0.005	0.005
Uranium	0.058 (2)	0.01	0.018
Vanadium	0.026 (2)	0.006	0.006
Zinc	0.46 (2)	0.17	0.015
Major Ions (mg/L)			
Sulphate	226 (2)	346	766
Calcium, chloride, potassium, magnesium, sodium, alkalinity	For interpretation purposes only		

Schedule F – Water (Fitzroy Model Conditions)

F1 A *Water Management Plan* must be developed by an appropriately qualified person and implemented for all stages of mining activities on the site.

F2 The *Water Management Plan* must:

a) Provide for the effective management of actual and potential environmental impacts result from water management associated with the mining activities carried out under this environmental authority.

b) Be developed by an appropriately qualified person and in accordance with administering authority's current guideline for preparation of a water management plan for mining activities, and include:

i) a study of the source of contaminants;

ii) a water balance model for the site;

iii) a water management system for the site;

iv) measures to manage and prevent and/or minimise saline drainage;

v) measures to manage and prevent and/or minimise acid mine drainage; and

vi) contingency procedures for emergencies.

F3 The *Water Management Plan* must be reviewed each calendar year and a report prepared by an appropriately qualified person. The report must:

a) assess the plan against the requirements under Condition F2;

b) include recommended actions to ensure actual and potential environmental impacts are effectively managed for the coming year; and

c) identify any amendments made to the water management plan following the review.

F4 The holder of this environmental authority must attach to the review a report required by Condition F3, a written response to the report and recommended actions, detailing the actions take or to be taken by the environmental authority holder on stated dates:

a) to ensure compliance with this environmental authority; and

b) to prevent a recurrence of any non-compliance issues identified.

F5 A copy of the *Water Management Plan* must be provided to the administering authority on request.

Contamination Release

F6 Contaminants that will, or have the potential to, cause environmental harm must not be released directly or indirectly to any waters as a result of the authorised mining activities, except as permitted under the conditions of this environmental authority.

F7 Unless otherwise permitted under the conditions of this environmental authority, the release of mine affected water to waters must only occur from the release points specified in **Table F1 – Mine Affected Water Release Points and Sources** and depicted in **Schedule 2 – Figure H1 (Post-mining Land Use Areas)** attached to this environmental authority.

Table F1 – Mine Affected Water Release Points and Sources

Release Point	Easting (MGA94 Zone 55)	Northing (MGA94 Zone 55)	Mine Affected Water Source and Location
Mine Water Dam	731,377	7,383,379	Mine affected water system

F8 The release of mine affected water to internal water management infrastructure installed and operated in accordance with a water management plan that complies with Condition F1 - F4 is permitted.

F9 The release of mine affected water to waters in accordance with Condition F7 must not exceed the release limits stated in **Table F2 – Mine Affected Water Release Limits** when measured at the monitoring points specified in **Table F1 – Mine Affected Water Release Points and Sources** for each quality characteristic.

Table F2 – Mine Affected Water Release Limits

Quality Characteristic	Release Limits	Monitoring Frequency
Electrical conductivity (EC) (µS/cm)	Release limits specified in **Table F4 – Mine Affected Water Release During Flow Events**.	Daily during release (the first sample must be taken within two hours of commencement of release).

pH (pH Unit)	6.5 (minimum) 9.0 (maximum)	Daily during release (the first sample must be taken within two hours of commencement of release).
Turbidity (NTU)	TBA	Daily during release (first sample within two hours of commencement of release).

F10 The release of mine affected water to waters from the release points must be monitored at the locations specified in **Table F1 – Mine Affected Water Release Points and Sources** for each quality characteristic and at the frequency specified in **Table F2 – Mine Affected Water Release Limits** and **Table F3 - Release Contaminant Trigger Investigation Levels, Potential Contaminants**.

Table F3 - Release Contaminant Trigger Investigation Levels, Potential Contaminants

Quality Characteristic	Trigger Levels (µg/L)	Comment on Trigger Level	Monitoring Frequency
Aluminium	55	For aquatic ecosystem protection, based on SMD guideline.	Commencement of release and thereafter weekly during release.
Arsenic	13	For aquatic ecosystem protection, based on SMD guideline.	
Cadmium	0.2	For aquatic ecosystem protection, based on SMD guideline.	
Chromium	1	For aquatic ecosystem protection, based on SMD guideline.	
Copper	2	For aquatic ecosystem protection, based on LOR for ICPMS.	
Iron	300	For aquatic ecosystem protection, based on low reliability guideline.	
Lead	4	For aquatic ecosystem protection, based on SMD guideline.	
Mercury	0.2	For aquatic ecosystem protection, based on LOR for ICPMS.	
Nickel	11	For aquatic ecosystem protection, based on SMD guideline.	
Zinc	8	For aquatic ecosystem protection, based on SMD guideline.	
Boron	370	For aquatic ecosystem protection, based on SMD guideline.	
Cobalt	90	For aquatic ecosystem protection, based on low reliability guideline.	
Manganese	1,900	For aquatic ecosystem protection, based on SMD guideline.	
Molybdenum	34	For aquatic ecosystem protection, based on low reliability guideline.	
Selenium	10	For aquatic ecosystem protection, based on LOR for ICPMS.	
Silver	1	For aquatic ecosystem protection, based on LOR for ICPMS.	
Uranium	1	For aquatic ecosystem protection, based on LOR for ICPMS.	

Quality Characteristic	Trigger Levels (μg/L)	Comment on Trigger Level	Monitoring Frequency
Vanadium	10	For aquatic ecosystem protection, based on LOR for ICPMS.	
Ammonia	900	For aquatic ecosystem protection, based on SMD guideline.	
Nitrate	1,100	For aquatic ecosystem protection, based on ambient Qld WQ Guidelines (2006) for TN.	
Petroleum Hydrocarbon (C6 – C9)	20		
Petroleum Hydrocarbon (C10 – C36)	100		
Fluoride (total)	2,000	Protection of livestock and short-term irrigation guideline.	

*The quality characteristics required to be monitored as per **Table F3 - Release Contaminant Trigger Investigation Levels, Potential Contaminants** can be reviewed once the results of two years monitoring data is available, or if sufficient data is available adequately demonstrate negligible risk, and it may be determined that a reduced monitoring frequency is appropriate or that certain quality characteristics can be removed from **Table F3 - Release Contaminant Trigger Investigation Levels, Potential Contaminants** by amendment*.

F11 If quality characteristics of the release exceed any of the trigger levels specified in **Table F3 - Release Contaminant Trigger Investigation Levels, Potential Contaminants** during a release event, the environmental authority holder must compare the downstream results in the receiving waters to the trigger values specified in Table F3 - Release Contaminant Trigger Investigation Levels, Potential Contaminants and:

a) Where the trigger values are not exceeded then no action is to be taken; or

b) Where the downstream results exceed the trigger, values specified **Table F3 - Release Contaminant Trigger Investigation Levels, Potential Contaminants** for any quality characteristic, compare the results of the downstream site to the data from background monitoring sites and:

i) if the result is less than the background monitoring site data, then no action is to be taken; or

ii) if the result is greater than the background monitoring site data, complete an investigation into the potential for environmental harm and provide a written report to the administering authority in the next annual return, outlining:

1. details of the investigations carried out; and
2. actions taken to prevent environmental harm.

Note: *Where an exceedance of a trigger level has occurred and is being investigated, in accordance with Condition F11 (b)(i) of this condition, no further reporting is required for subsequent trigger events for that quality characteristic.*

F12 If an exceedance in accordance with Condition F11 (b)(ii) is identified, the holder of the environmental authority must notify the administering authority in writing within 24 hours of receiving the result.

Mine Affected Water Release Events

F13 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 F4 – Mine Affected Water Release During Flow Events**.

Table F4 – Mine Affected Water Release During Flow Events

Receiving Water	Release Points	Gauging Station	Easting	Northing	Minimum flow
Charlevue Creek	Mine Water Dam	Downstream Charlevue Creek	TBA	TBA	TBA

*No mine affected waters will be released from site until a stream flow gauging, station as required under **Table F4 – Mine Affected Water Release During Flow Events**.*

F14 Notwithstanding any other condition of this environmental authority, the release of mine affected water to waters in accordance with Condition F7 must only take place during periods of natural flow in accordance with the receiving water flow criteria for discharge specified in **Table F4 – Mine Affected Water Release During Flow Events** for the release point(s) specified in **Table F1 – Mine Affected Water Release Points and Sources**.

F15 The 80th percentile of electrical conductivity (EC) values recorded at the downstream monitoring points listed in **Table F4 – Mine Affected Water Release During Flow Events** must not exceed 310 µS/cm over the duration of the release influence period and have a maximum value of no greater than 20 per cent of 310 µS/cm. The 80th percentile must be calculated using all EC values recorded by the monitoring station during the release influence period.

F16 The daily quantity of mine affected water released from each release point must be measured and recorded.

F17 Releases to waters must be undertaken so as not to cause erosion of the bed and banks of the receiving waters or cause a material build-up of sediment in such waters.

Notification of Release Event

F18 The environmental authority holder must notify the administering authority as soon as practicable and no later than 24 hours after commencing to release mine affected water to the receiving environment. Notification must include the submission of written advice to the administering authority of the following information:

a) release commencement date / time;

b) details regarding the compliance of the release with the conditions of department interest: water of this environmental authority (that is, contaminant limits, natural flow, discharge volume);

c) release point/s;

d) release rate;

e) release salinity; and

f) receiving water/s including the natural flow rate.

***Note**: Notification to the administering authority must be addressed to the Manager and Project Manager of the local Administering Authority via email or facsimile.*

F19 The environmental authority holder must notify the administering authority as soon as practicable and nominally no later than 24 hours after cessation of a release event of the cessation of a release notified under Condition F13 and within 28 days provide the following information in writing:

a) release cessation date/time;

b) natural flow rate in receiving water;

c) volume of water released;

d) details regarding the compliance of the release with the conditions of department interest; water of this environmental authority (i.e., contaminant limits, natural flow, discharge volume);

e) all in-situ water quality monitoring results; and

f) any other matters pertinent to the water release event.

***Note**: Successive or intermittent releases occurring within 24 hours of the cessation of any individual release can be considered part of a single release event and do not require individual notification for the purpose of compliance with Conditions F14 and F15, provided the relevant details of the release are included within the notification provided in accordance with Conditions F14 and F15.*

Notification of Release Event Exceedance

F20 If the release limits defined in **Table F2 – Mine Affected Water Release Limits** are exceeded, the holder of the environmental authority must notify the administering authority within 24 hours of receiving the results.

F21 The environmental authority holder must, within 28 days of a release that is not compliant with the conditions of this environmental authority, provide a report to the administering authority detailing:

a) the reason for the release;

b) the location of the release;

c) the total volume of the release and which (if any) part of this volume was non-compliant;

d) the total duration of the release and which (if any) part of this period was non-compliant;

e) all water quality monitoring results (including all laboratory analyses);

f) identification of any environmental harm as a result of the non-compliance;

g) all calculations; and

h) any other matters pertinent to the water release event.

Receiving Environment Monitoring and Contaminant Trigger Levels

F22 The quality of the receiving waters must be monitored at the locations specified in **Table F6 – Receiving Water Upstream Background Sites and Downstream Monitoring Sites** for each quality characteristic and at the monitoring frequency stated in **Table F5 – Receiving Waters Contaminant Trigger Levels**.

Table F5 – Receiving Waters Contaminant Trigger Levels

Quality Characteristic	Trigger Level	Monitoring Frequency
pH (pH Units)	6.5-8.5	Daily during the release
Electrical conductivity (EC) (µS/cm)	310	
Sulphate (SO_4^{2-}) (mg/L)	10	

Table F6 – Receiving Water Upstream Background Sites and Downstream Monitoring Sites

Description	Latitude (decimal degree, GDA94)	Longitude (decimal degree, GDA94)
Upstream Background Monitoring Points		
Springton Ck Upstream (SC1)	-23.6976	149.2738
Charlevue Ck Upstream (CC1)	-23.6305	149.2715
Downstream Monitoring Points		
Springton Ck Downstream (SC2)	-23.6434	149.3145
Charlevue Ck Downstream (CC2)	-23.6469	149.2104

F23 If quality characteristics of the receiving water at the downstream monitoring points exceed any of the trigger levels specified in **Table F5 – Receiving Waters Contaminant Trigger Levels** during a release event the environmental authority holder must compare the downstream results to the upstream results in the receiving waters and:

a) Where the downstream result is the same or a lower value than the upstream value for the quality characteristic, then no action is to be taken; or

b) Where the downstream results exceed the upstream results, complete an investigation into the potential for environmental harm and provide a written report to the administering authority in the next annual return, outlining:

i) details of the investigations carried out; and

ii) actions taken to prevent environmental harm.

Note: *Where an exceedance of a trigger level has occurred and is being investigated, in accordance with Condition F18 (b) of this condition, no further reporting is required for subsequent trigger events for that quality characteristic.*

F24 All determinations of water quality monitoring must be performed by suitably experienced and qualified person.

Receiving Environment Monitoring Program (REMP)

F25 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 the waters of Creek and connected or surrounding waterways within 15 km downstream of the release. 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.

F26 The REMP must:

a) assess the condition or state of receiving waters, including upstream conditions, spatially within the REMP area, considering background water quality characteristics based on accurate and reliable monitoring data that takes into consideration temporal variation (e.g., seasonality);

b) be designed to facilitate assessment against water quality objectives for the relevant environmental values that need to be protected;

c) include monitoring from background reference sites (e.g., upstream or background) and downstream sites from the release (as a minimum, the locations specified in **Table F6 – Receiving Water Upstream Background Sites and Downstream Monitoring Sites**);

d) specify the frequency and timing of sampling required in order to reliably assess ambient conditions and to provide sufficient data to derive site-specific background reference values in accordance with the *Queensland Water Quality Guidelines 2009*. This should include monitoring during periods of natural flow irrespective of mine or other discharges;

e) include monitoring and assessment of dissolved oxygen saturation, temperature and all water quality parameters listed in **Table F5 – Receiving Waters Contaminant Trigger Levels** and **Table F3 - Release Contaminant Trigger Investigation Levels, Potential Contaminants**;

f) include, where appropriate, monitoring of metals/metalloids in sediments (in accordance with ANZG (2018), BATLEY and/or the most recent version of *AS5667.1 Water quality - Sampling - Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples*);

g) include, where appropriate, monitoring of macroinvertebrates in accordance with the AusRivAS methodology;

h) apply procedures and/or guidelines from ANZG (2018) and other relevant guideline documents;

i) describe sampling and analysis methods and quality assurance and control; and

j) incorporate stream flow and hydrological information in the interpretations of water quality and biological data.

F27 A REMP Design Document that addresses the requirements of the REMP must be prepared and made available to the administrating authority upon request.

F28 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.

Water Reuse

F29 Mine affected water may be piped or trucked or transferred by some other means that does not contravene the conditions of this environmental authority and deposited into artificial water storage structures, such as farm dams or tanks, or used directly at properties owned by the environmental authority holder or a third party (with the consent of the third party).

Annual Water Monitoring Report

F30 The following information must be recorded in relation to all water monitoring required under the conditions of this environmental authority and submitted to the administering authority in the specified format:

a) the date on which the sample was taken;

b) the time at which the sample was taken;

c) the monitoring point at which the sample was taken;

d) the measured or estimated daily quantity of mine affected water released from all release points;

e) the release flow rate at the time of sampling for each release point;

f) the results of all monitoring and details of any exceedances of the conditions of this environmental authority; and

g) water quality monitoring data must be provided to the administering authority in the specified electronic format upon request.

Stormwater and Water Sediment Controls

F31 An *Erosion and Sediment Control Plan* must be developed by an appropriately qualified person and implemented for all stages of the mining activities on the site to minimise erosion and the release of sediment to receiving waters and contamination of stormwater.

F32 Stormwater, other than mine affected water, is permitted to be released to waters from:

a) Erosion and sediment control structures that are installed and operated in accordance with the *Erosion and Sediment Control Plan* required by Condition F31; and

b) Water management infrastructure that is installed and operated, in accordance with a *Water Management Plan* that complies with Conditions F2-F4 for the purpose of ensuring water does not become mine affected water.

Schedule G – Sewage Treatment

G1 The only contaminant permitted to be released to land is treated sewage effluent in compliance with the release limits stated in **Table G1 – Contaminant Release Limits To Land**.

Table G1 – Contaminant Release Limits To Land

Contaminant	Unit	Release Limit	Limit Type	Frequency
5-day biochemical oxygen demand	mg/L	20	Maximum	Monthly
total suspended solids	mg/L	30	Maximum	Monthly
Nitrogen	mg/L	30	Maximum	Monthly
Phosphorus	mg/L	15	Maximum	Monthly
E-coli	Organisms/100ml	1,000	Maximum	Monthly
pH	pH units	6.0 – 9.0	Range	Monthly

G2 Treated sewage effluent may only be released to land in accordance with the conditions of this approval.

G3 The application of treated effluent to land must be carried out in a manner such that:

a) vegetation is not damaged;

b) there is no surface ponding of effluent; and

c) there is no run-off of effluent.

G4 If areas irrigated with effluent are accessible to employees or the general public, prominent signage must be provided advising that effluent is present, and care should be taken to avoid consuming or otherwise coming into unprotected contact with the effluent.

G5 All sewage effluent released to land must be monitored at the frequency and for the parameters specified in **Table G1 – Contaminant Release Limits To Land**.

G6 The daily volume of effluent release to land must be measured and records kept of the volumes of effluent released.

G7 When circumstances prevent the irrigation or beneficial reuse of treated sewage effluent such as during or following rain events, waters must be directed to a wet weather storage or alternative measures must be taken to store/lawfully dispose of effluent.

G8 Treated sewage effluent must only be supplied to another person or organisation that has a written plan detailing how the user of the treated sewage effluent will comply with their general environmental duty under section 319 of the *Environmental Protection Act 1994* whilst using the treated sewage effluent.

Schedule H – Land and Rehabilitation

H1 Land disturbed by mining must be rehabilitated in accordance with **Table H1 – Rehabilitation Areas and Post-Mining Land Use** and **Schedule 2 – Figure H1 (Post-mining Land Use Areas)**.

Table H1 – Rehabilitation Areas and Post-Mining Land Use

Rehabilitation Area	Post-mining Land Use	Approximate Footprint Area (ha)	Approximate Proportion of Total Disturbance
In-pit and out-of-pit waste emplacements, including dry rejects disposal areas	Grazing	722.4	37%
Temporary waste emplacements	Grazing	17.54	1%
Residual void lakes	Fauna habitat	76.5	4%
Residual void high walls	Native vegetation supporting fauna habitat	133.1	7%
Residual void low walls	Grazing	187.2	9%
Water management infrastructure	Grazing/native vegetation	85	4%
Mine infrastructure areas	Grazing	731.8	38%

Impacts to Prescribed Environmental Matters

H2 The significant residual impacts to prescribed environmental matters are not authorised under this environmental authority or the *Environmental Offsets Act 2014* unless the impact(s) is specified in **Table H2 – Significant Residual Impacts To Prescribed Environmental Matters**.

H3 Records demonstrating that each impact to a prescribed environmental matter not listed in **Table H2 – Significant Residual Impacts To Prescribed Environmental Matters** did not, or is not likely to, result in a significant residual impact to that matter must be:

a) Completed by an appropriately qualified person; and

b) Kept for the life of the environmental authority.

Table H2 – Significant Residual Impacts To Prescribed Environmental Matters

Prescribed Environmental Matter	Description		Maximum Extent of Impact (ha)
Regulated Vegetation	Of concern regional ecosystem	RE 11.3.2	2.57
	Regional ecosystems within a defined distance of a vegetation management watercourse (RE 11.3.25, 11.5.2, 11.3.2 and 11.7.2)		58.32
Connectivity Areas			710.72

H4 An environmental offset made in accordance with the *Environmental Offsets Act 2014* and the *Queensland Environmental Offsets Policy*, as amended from time to time, must be undertaken for the maximum extent of impact to each prescribed environmental matter authorised in **Table H2 – Significant Residual Impacts To Prescribed Environmental Matters**, unless a lesser extent of the impact has been approved in accordance with Condition H8.

H5 The significant residual impacts to a prescribed environmental matter authorised in Condition H2 for which an environmental offset is required by Condition H2 may be carried out in stages. An environmental offset can be delivered for each stage of the impacts to prescribed environmental matters.

Staged Impacts

H6 The significant residual impacts to a prescribed environmental matter authorised in Condition H2 for which an environmental offset is required by Condition H11 may be carried out in stages. An environmental offset can be delivered for each stage of the impacts to prescribed environmental matters.

H7 Prior to the commencement of each stage, a report completed by an appropriately qualified person, that includes an analysis of the following must be provided to the administering authority:

a) For the forthcoming stage—the estimated significant residual impacts to each prescribed environmental matter; and

b) For the previous stage, if applicable—the actual significant residual impacts to each prescribed environmental matter, to date.

H8 The report required by Condition H7 must be approved by the administering authority before a notice of election for the forthcoming stage, if applicable, is given to the administering authority.

H9 A notice of election for the staged environmental offset referred to in Condition H8, if applicable, must be provided to the administering authority no less than three months before the proposed commencement of that stage, unless a lesser timeframe has been agreed to by the administering authority.

H10 Within six months from the completion of the final stage of the project, a report completed by an appropriately qualified person, that includes the following matters must be provided to the administering authority:

a) An analysis of the actual impacts on prescribed environmental matters resulting from the final stage; and

b) If applicable, a notice of election to address any outstanding offset debits for the authorised impacts.

Chemical and Flammable or Combustible Liquids

H11 All flammable and combustible liquids must be contained within an onsite containment system and controlled in a manner that prevents environmental harm and maintained in accordance with the current edition of *AS1940 The storage and handling of flammable and combustible liquids*.

H12 All explosive, corrosive substances, toxic substances, gases and dangerous goods must be stored and handled in accordance with the relevant Australian Standards.

H13 All chemicals and flammable or combustible liquids stored onsite that have the potential to cause environmental harm must be stored in, or serviced by, an effective containment system that is impervious to the materials stored and managed to prevent the release of liquids to water or land. Where no relevant Australian Standard is available, the following must be applied:

a) Storage tanks must be bunded so that the capacity and construction of the bund is sufficient 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; and

b) Drum storage must be bunded so that the capacity and construction of the bund is sufficient to contain at least 25% of the maximum design storage volume within the bund.

Spills

H14 Any spills or release of flammable and combustible liquids; or chemicals, must be controlled in a manner that prevents environmental harm.

H15 An appropriate spill kit, personal protective equipment and relevant operator instructions/emergency procedure guides for the management of wastes, chemicals and flammable and combustible liquids associated with the activity must be kept at the site.

H16 Anyone operating with wastes, chemicals or flammable and combustible liquids under this approval must be trained in the use of the spill kit.

Infrastructure

H17 All infrastructure constructed by, or for, the environmental authority holder during the licensed activities include water storages, must be removed from the site prior to surrender, except where agreed in writing by the post mining landowner.

Note: *This is not applicable where the landowner/holder is also the environmental authority holder.*

Schedule I - Regulated Structures

Assessment of consequence category

I1 The consequence category of any structure must be assessed by a suitably qualified and experienced person in accordance with the *Manual for assessing consequence categories and hydraulic performance of structures [ESR/2016/1933]* (DES 2016) at the following times:

a) prior to the design and construction of the structure, if it is not an existing structure; or

b) prior to any change in its purpose or the nature of its stored contents.

I2 A consequence assessment report and certification must be prepared for each structure assessed and the report may include a consequence assessment for more than one structure.

I3 Certification must be provided by the suitably qualified and experienced person who undertook the assessment, in the form set out in the *Manual for assessing consequence categories and hydraulic performance of structures [ESR/2016/1933]* (DES 2016).

I4 Conditions I5 to I9 inclusive do not apply to existing structures.

I5 All regulated structures must be designed by, and constructed under the supervision of, a suitably qualified and experienced person in accordance with the requirements of the *Manual for assessing consequence categories and hydraulic performance of structures [ESR/2016/1933]* (DES 2016).

I6 Construction of a regulated structure is prohibited unless:

a) the holder has submitted a consequence category assessment report and certification to the administering authority; and

b) certification for the design, design plan and the associated operating procedures has been certified by a suitably qualified and experienced person in compliance with the relevant condition of this authority.

I7 Certification must be provided by the suitably qualified and experienced person who oversees the preparation of the design plan in the form set out in the *Manual for assessing consequence categories and hydraulic performance of structures [ESR/2016/1933]* (DES 2016) and must be recorded in the Register of Regulated Structures.

I8 Regulated structures must:

a) be designed and constructed in compliance with the *Manual for assessing consequence categories and hydraulic performance of structures [ESR/2016/1933]* (DES 2016).

b) be designed and constructed with due consideration given to ensuring that the design integrity would not be compromised on account of:

i) floodwaters from entering the regulated dam from any watercourse or drainage line; and

ii) wall failure due to erosion by floodwaters arising from any watercourse or drainage line.

I9 Certification by the suitably qualified and experienced person who supervises the construction must be submitted to the administering authority on the completion of construction of the regulated structure, and state that:

a) the 'as constructed' drawings and specifications meet the original intent of the design plan for that regulated structure; and

b) construction of the regulated structure is in accordance with the design plan.

Notification of affected persons

I10 All affected persons must be provided with a copy of the emergency action plan in place for each regulated structure:

a) for existing structures that are regulated structures, within 10 business days of this condition taking effect;

b) prior to the operation of the new regulated structure; and

c) if the emergency action plan is amended, within 5 business days of it being amended.

Operation of a regulated structure

I11 Operation of a regulated structure, except for an existing structure, is prohibited unless the holder has submitted to the administering authority in respect of regulated structure, all of the following:

a) one paper copy and one electronic copy of the design plan and certification of the 'design plan' in accordance with Condition I6;

b) a set of 'as constructed' drawings and specifications;

c) certification of the 'as constructed drawings and specifications' in accordance with Condition I9;

d) where the regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the design storage allowance (DSA) volume across the system, a copy of the certified system design plan;

e) the requirements of this authority relating to the construction of the regulated structure have been met;

f) the holder has entered the details required under this authority, into a Register of Regulated Structures; and

g) there is a current operational plan for the regulated structure.

Mandatory reporting level

I12 Conditions I13 to I16 inclusive only apply to Regulated Structures which have not been certified as low consequence category for 'failure to contain – overtopping'.

I13 The mandatory reporting level (the MRL) must be marked on a regulated dam in such a way that during routine inspections of that dam, it is clearly observable.

I14 The holder must, as soon as practicable but within forty-eight (48) hours of becoming aware, notify the administering authority when the level of the contents of a regulated dam reaches the MRL.

I15 The holder must, immediately on becoming aware that the MRL has been reached, act to prevent the occurrence of any unauthorised discharge from the regulated dam.

I16 The holder must record any changes to the MRL in the Register of Regulated Structures.

Design storage allowance

I17 The holder must assess the performance of each regulated dam or linked containment system over the preceding November to May period based on actual observations of the available storage in each regulated dam or linked containment system taken prior to 1 July of each year.

I18 By 1 November of each year, storage capacity must be available in each regulated dam (or network of linked containment systems with a shared DSA volume), to meet the DSA volume for the dam (or network of linked containment systems).

I19 The holder must, as soon as practicable but within forty-eight (48) hours of becoming aware that the regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on 1 November of any year, notify the administering authority.

I20 The holder must, immediately on becoming aware that a regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on 1

November of any year, act to prevent the occurrence of any unauthorised discharge from the regulated dam or linked containment systems.

Annual inspection report

I21 Each regulated structure must be inspected each calendar year by a suitably qualified and experienced person.

I22 At each annual inspection, the condition and adequacy of all components of the regulated structure must be assessed and a suitably qualified and experienced person must prepare an annual inspection report containing details of the assessment and include a recommendations section, with any recommended actions to ensure the integrity of the regulated structure or a positive statement that no recommendations are required**.**

I23 The suitably qualified and experienced person who prepared the annual inspection report must certify the report in accordance with the *Manual for assessing consequence categories and hydraulic performance of structures [ESR/2016/1933]* (DES 2016).

I24 The holder must within 20 business days of receipt of the annual inspection report, provide to the administering authority:

a) the recommendations section of the annual inspection report;

b) if applicable, any actions being taken in response to those recommendations; and

c) if, following receipt of the recommendations and (if applicable) recommended actions, the administering authority requests a copy of the annual inspection report from the holder, provide this to the administering authority within 10 business days11 of receipt of the request.

Transfer arrangements

I25 The holder must provide a copy of any reports, documentation and certifications prepared under this authority, including but not limited to any Register of Regulated Structures, consequence assessment, design plan and other supporting documentation, to a new holder on transfer of this authority.

Decommissioning and rehabilitation

I26 Regulated structures must not be abandoned but be either:

a) decommissioned and rehabilitated to achieve compliance with Condition I27; or

b) be left in-situ for a use by the landholder provided that:

i) it no longer contains contaminants that will migrate into the environment; and

ii) it contains water of a quality that is demonstrated to be suitable for its intended use(s); and

c) the holder of the environmental authority and the landholder agree in writing that the;

i) dam will be used by the landholder following the cessation of the environmentally relevant activity(ies); and

ii) landholder is responsible for the dam, on and from an agreed date.

I27 Before surrendering this environmental authority the site must be rehabilitated to achieve a safe, stable, non-polluting landform and grazing.

Register of Regulated Structures

I28 A Register of Regulated Structures must be established and maintained by the holder for each regulated structure:

I29 The holder must provisionally enter the required information in the Register of Regulated Structures when a design plan for a regulated dam is submitted to the administering authority.

I30 The holder must make a final entry of the required information in the Register of Regulated Structures once compliance with Condition I11 and I12 has been achieved.

I31 The holder must ensure that the information contained in the Register of Regulated Structures is current and complete on any given day.

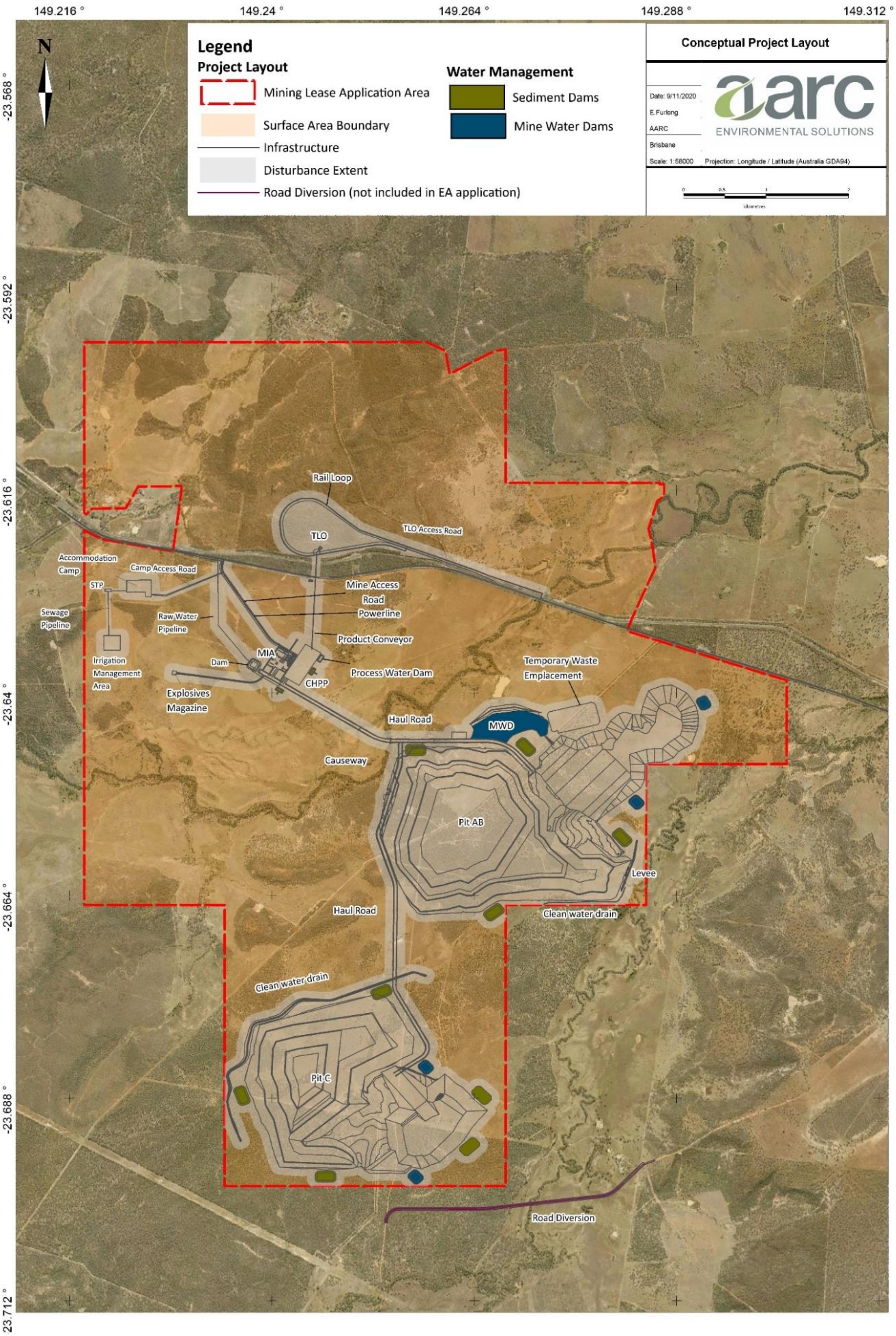
I32 All entries in the Register of Regulated Structures must be approved by the chief executive officer for the holder of this authority, or their delegate, as being accurate and correct.

I33 The holder must, at the same time as providing the annual return, supply to the administering authority a copy of the records contained in the Register of Regulated Structures, in the electronic format required by the administering authority.

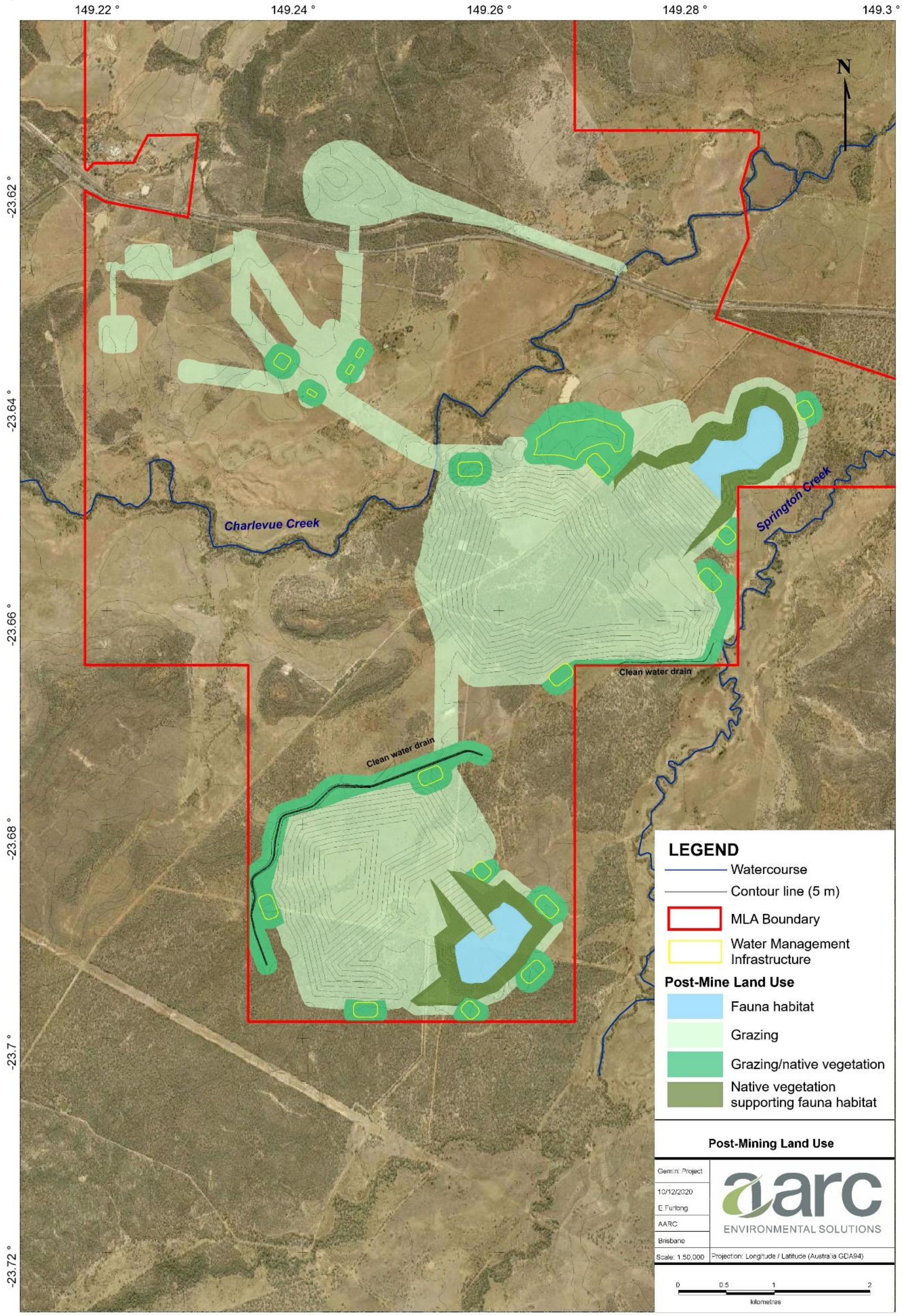
Definitions

The words and phrases used throughout this proposed EA are as per the *Model Mining Conditions* (DES 2017e). Where a definition for a term used in this environmental authority is not provided by the *Model Mining Conditions* but is provided in the EP Act 1994 or subordinate legislation, the definition in the EP Act or subordinate legislation must be used.

Schedule 1 – Figure A2 (Approved Plan)



Schedule 2 – Figure H1 (Post-mining Land Use Areas)



16.0 REFERENCES

AARC Environmental Solutions Pty Ltd (AARC) 2020a, *Aquatic Ecology Assessment*, prepared for Magnetic South Pty Ltd.

AARC Environmental Solutions Pty Ltd (AARC) 2020b, *Terrestrial Ecology Assessment*, prepared for Magnetic South Pty Ltd.

AARC Environmental Solutions Pty Ltd (AARC) 2020c, *Visual Amenity Assessment,* prepared for Magnetic South Pty Ltd.

AARC Environmental Solutions Pty Ltd (AARC) 2019, *Soil and Land Suitability Assessment*, prepared for Magnetic South Pty Ltd.

Atlas of Living Australia (ALAS) 2020, *Chalinolobus gouldii (J.E. Gray, 1841)*, Atlas of Living Australia, viewed August 2020 https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:f2ecb3e3-a6e2-45cc-a986-716a69eec650

Australian Coal Association Research Program (ACARP) 2015, *Mobile Sampling Of Dust Emissions From Unsealed Roads C20023,* Judith Cox, Pacific Environmental Limited, ACARP.

Australian Museum 2020, *Eastern Horseshoe Bat,* Australian Museum, viewed August 2020 https://australian.museum/learn/animals/bats/eastern-horseshoe-bat/.

ASK Consulting Engineers (ASK) 2020, *Noise Impact Assessment,* prepared for Magnetic South Pty Ltd.

Australia and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG) 2018, *Water Quality Guidelines*, Australia and New Zealand Guidelines for Fresh and Marine Water Quality, Commonwealth of Australia, viewed October 2020 https://www.waterquality.gov.au/anz-guidelines.

Australian and New Zealand Minerals and Energy Council (ANZMEC) and the Minerals Council of Australia (MCA) 2000, *Strategic Framework for Mine Closure*, ISBN 0642721386, Australian and New Zealand Minerals and Energy Council and the Minerals Council of Australia, Canberra, Australian Capital Territory.

Austroads Ltd 2017, *Guide to Road Design Part 4A: Unsignalised and Signalised Intersections (3rd ed.)*, ISBN 9781925451733, Austroads Ltd, Sydney, New South Wales.

Beamish, B.B. and Blazak, D.G 2005, Relationship between ash content and R70 self-heating rate of Callide coal, *International Journal of Coal Geology*, 64(1-2), pp.126-132.

Blakers, M, Davies, SJJF & Reilly, PN, 1984, *The Atlas of Australian Birds*, ISBN 0522842852, Melbourne University Press, Melbourne, Victoria.

Boland, DJ, Brooker, MIH, Chippendale, GM, Hall, N, Hyland, BPM, Johnson, RD, Kleinig, DA, McDonald, MW & Turner, JD 2006, *Forest Trees of Australia*, ISBN 9780643069695, CSIRO Publishing, Collingwood, Victoria.

Bowen, HJM 1979, *Environmental Chemistry of the Elements*, pp. 36-37, ISBN 9780121204501, Academic Press, London, New York.

Bureau of Meteorology (BoM) 2018, *Queensland River Basins*, Commonwealth of Australia, Canberra, viewed 20 May 2019, <http://www.bom.gov.au/qld/flood/brochures/qld/map.pdf>.

Bureau of Meteorology (BoM) 2019a, *Design Rainfall Data System (2016)*, Commonwealth of Australia, Canberra, viewed 7 October 2019, <http://www.bom.gov.au/water/designRainfalls/revised-ifd/>.

Bureau of Meteorology (BoM) 2019b, *Groundwater Dependent Ecosystems Atlas*, Commonwealth of Australia, Canberra, viewed 1 May 2019, <http://www.bom.gov.au/water/groundwater/gde/map.shtml>.

Cardno (Qld) Pty Ltd (Cardno) 2019, *Gemini Project Traffic Impact Assessment,* prepared for Magnetic South Pty Ltd.

Cardno (Qld) Pty Ltd (Cardno) 2020, *Land-Based Effluent Disposal Assessment Report,* prepared for Magnetic South Pty Ltd.

Cayley, JWD & Bird PR, 1996, *Techniques for measuring pastures*. Pastoral and Veterinary Institute, Hamilton, ISBN 0 7306 64295.

Central Highlands Regional Council (CHRC) 2016, *Waste Reduction and Recycling Plan 2016-2026*, prepared by pitt&sherry and JustWaste Consulting, Emerald, Queensland.

Churchill, S 2009, *Australian Bats (second edition),* Allen and Unwin, Sydney.

Cleanaway 2019a, Hazardous Chemical Waste Disposal, accessed 6th March 2020, https://www.cleanaway.com.au/waste/chemicals/

Cleanaway 2019b, Paint waste disposal, accessed 6th March 2020, https://www.cleanaway.com.au/waste/paint/

Cleanaway 2019c Contaminated Sludges, viewed December 2019 https://www.cleanaway.com.au/waste/contaminated-sludge/

Cooper RM, McAllan IAW and Curtis BR 2014, *The Atlas of the Birds of NSW and the ACT*, Mini- Publishing, Gordon, New South Wales.

Cropper, SC 1993, *Management of endangered plants*, ISBN 0643055339, CSIRO Publications, Melbourne, Victoria.

Department of Aboriginal and Torres Strait Islander Partnerships (DATSIP) 2004, *Aboriginal Cultural Heritage Act 2003 Duty of Care Guidelines*, State of Queensland, Brisbane.

Department of Agriculture (DA) 2002, *Salinity tolerance of plants for agriculture and revegetation*, Government of Western Australia, Perth, viewed 20 August 2019, <http://www.plantstress.com/articles/salinity_m/salinity_m_files/salt%20tol%20australia.htm>.

Department of Agriculture and Fisheries (DAF) 2013, *Guide for the determination of waterways using the spatial data layer Queensland waterways for waterway barrier works*, State of Queensland, Brisbane.

Department of Agriculture and Fisheries (DAF) 2018a, *Restricted invasive plants of Queensland*, State of Queensland, Brisbane.

Department of Agriculture and Fisheries (DAF) 2018b, *Accepted development requirements for operational work that is constructing or raising waterway barrier works*, prepared by the Department of Agriculture and Fisheries, State of Queensland, Brisbane.

Department of Environment and Heritage Protection (EHP) 2004, *Guideline (Noise): Planning for noise control,* State of Queensland, Brisbane.

Department of Environment and Heritage Protection (EHP) 2011a, *Environmental Protection (Water) Policy 2009 – Mackenzie River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Mackenzie River Sub-basin*, State of Queensland, Brisbane.

Department of Environment and Heritage Protection (EHP) 2011b, *WQO1310 Fitzroy Basin Groundwater Zones Basin 130*, Environmental Protection (Water) Policy 2019 Central Queensland Map Series, State of Queensland, Brisbane.

Department of Environment and Heritage Protection (EHP) 2013a, *Guideline (Resource activity – mining): Model water conditions for coal mines in the Fitzroy Basin [ESR/2015/1561]*, State of Queensland, Brisbane.

Department of Environment and Heritage Protection (EHP) 2013b, *Noise Measurement Manual [EM1107] (Version 4),* State of Queensland, Brisbane.

Department of Environment and Heritage Protection (EHP) 2014, *Queensland Environmental Offsets Policy, Significant Residual Impact Guideline*, State of Queensland, Brisbane.

Department of Environment and Heritage Protection (EHP) 2016, *Guideline (Noise): Noise and vibration from blasting [EM2402],* State of Queensland, Brisbane.

Department of Environment and Resource Management (DERM) 2011, *Managing Grazing Lands in Queensland,* prepared by Science Strategy and Integration, State of Queensland, Brisbane.

Department of Environment and Science (DES), 2011, *Troughton's sheathtail bat,* Department of Environment and Science, Queensland, Brisbane, viewed August 2020 https://environment.des.qld.gov.au/wildlife/animals/living-with/bats/micro-bats/troughtons-sheathtail.

Department of Environment and Science (DES) 2013, *Model water conditions for coal mines in the Fitzroy basin [ESR/2015/1561]*, State of Queensland, Brisbane.

Department of Environment and Science (DES) 2014a, *Guideline (Resource Activities): Rehabilitation requirements for mining resource activities [ESR/2016/1875]*, State of Queensland, Brisbane.

Department of Environment and Science (DES) 2014b, *Operational Policy (Mining): Disposal and storage of scrap tyres at mine sites [ESR/2016/2380]*, State of Queensland, Brisbane.

Department of Environment and Science (DES) 2016, *Manual for assessing consequence categories and hydraulic performance of structures [ESR/2016/1933]*, State of Queensland, Brisbane.

Department of Environment and Science (DES) 2017a, *Application requirements for activities with impacts to air [ESR/2015/1840],* State of Queensland, Brisbane.

Department of Environment and Science (DES) 2017b, *Application requirements for activities with impacts to land [ESR/2015/1839]*, State of Queensland, Brisbane.

Department of Environment and Science (DES) 2017c, *Application requirements for activities with impacts to water {ERS/2015/1837]*, State of Queensland, Brisbane.

Department of Environment and Science (DES) 2017d, *Application requirements for activities with noise impacts [ESR/2015/1838],* State of Queensland, Brisbane.

Department of Environment and Science (DES) 2017e, *Guideline (Mining): Model mining conditions [ESR/2016/1936],* State of Queensland, Brisbane.

Department of Environment and Heritage Protection (DES) 2017f, *Guideline: Stormwater and environmentally relevant activities,* Department of Environment and Science, Brisbane, viewed October 2020 https://environment.des.qld.gov.au/__data/assets/pdf_file/0028/89119/pr-gl-stormwater-guideline-era.pdf.

Department of Environment and Science (DES) 2018a, *A Biodiversity Planning Assessment for the Brigalow Belt Bioregion (Version 2.1): Summary Report,* State of Queensland, Brisbane.

Department of Environment and Science (DES) 2018b, *Fitzroy Drainage Basin – Facts and Maps,* State of Queensland, Brisbane, viewed 20 May 2019, <https://wetlandinfo.des.qld.gov.au/wetlands/facts-maps/basin-fitzroy/>.

Department of Environment and Science (DES) 2018c, *Monitoring and Sampling Manual: Environmental Protection (Water) Policy 2009*, State of Queensland, Brisbane.

Department of Environment and Science (DES) 2018d, *Plants, animals, soils, water and more,* WetlandInfo, State of Queensland, Brisbane, viewed 9 May 2019, <https://wetlandinfo.des.qld.gov.au/wetlands/ecology/components/>.

Department of Environment and Science (DES) 2018e, *Waste tracking guideline – Overview of managing waste tracking in Queensland (ESR/2016/2425) Version 2.01*, Department of Environment and Science, Brisbane.

Department of Environment and Science (DES) 2019, *Application requirements for activities with waste impacts [ESR/2015/1836]*, State of Queensland, Brisbane.

Department of Environment and Science (DES) 2020, *Noise Measurement Manual [ESR/2016/2195 - formerly EM1107 Version 4.01*, State of Queensland, Brisbane.

Department of Foreign Affairs and Trade (DFAT) 2016a, *Leading Practice Sustainable Development Program for the Mining Industry: Mine Closure*, Commonwealth of Australia, Canberra.

Department of Foreign Affairs and Trade (DFAT) 2016b, *Leading Practice Sustainable Development Program for the Mining Industry: Mine Rehabilitation*, Commonwealth of Australia, Canberra.

Department of Foreign Affairs and Trade (DFAT) 2016c, *Leading Practice Sustainable Development Program for the Mining Industry: Preventing Acid and Metalliferous Drainage*, Commonwealth of Australia, Canberra.

Department of Infrastructure, Local Government and Planning (DILGP), 2020, *State Code 18: Constructing or raising waterway barrier works in fish habitats,* State development assessment provisions, version 2.1, State of Queensland, Brisbane.

Department of Minerals and Energy (DME),1995, *Technical Guidelines for Environmental Management of Exploration and Mining in Queensland*, ISBN 0724252606, State of Queensland, Brisbane.

Department of Natural Resources and Mines (DNRM) & Department of Science, Information Technology and Innovation (DSITI) 2013, *Regional Land Suitability Frameworks for Queensland*, Ch 10: Suitability Framework for the Inland Fitzroy and Southern Burdekin area, State of Queensland, Brisbane.

Department of Natural Resources and Mines (DNRM) 2001, *AusRivAS Sampling and Processing Manual*, State of Queensland, Brisbane.

Department of Natural Resources, Mines and Energy, RS 17 Recognised Standard for Hazardous Chemicals Coal *Mining Safety and Health Act 1999 (2019),* State of Queensland, Brisbane.

Department of Science, Information Technology and Innovation (DSITI) & Department of Natural Resources and Mines (DNRM) 2015, *Guidelines for Agricultural Land Evaluation in Queensland* (2nd edition), State of Queensland, Brisbane.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC) 2012a, *National Pollutant Inventory: Emission Estimation Technique Manual for Mining (Version 3.1),* Commonwealth of Australia, Canberra.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC) 2012b, *Aquatic Ecosystems Toolkit. Module 2: Interim Australian National Aquatic Ecosystem Classification Framework*, Version 1.0, prepared by Aquatic Ecosystems Task Group, Commonwealth of Australia, Canberra.

Department of the Environment and Energy (DoEE) 2017, *National Greenhouse and Energy Reporting Scheme Measurement: Technical Guidelines for the estimation of emissions by facilities in Australia,* Commonwealth of Australia, Canberra.

Department of the Environment and Energy (DoEE) 2019a, *Quarterly Update of Australia's National Greenhouse Gas Inventory: March 2019,* Commonwealth of Australia, Canberra.

Department of the Environment and Energy (DoEE) 2019b, *State and Territory Greenhouse Gas Inventories 2017*, Commonwealth of Australia, Canberra.

Department of the Environment, Water, Heritage and the Arts (DEWHA) 2010a, *Survey guidelines for Australia's threatened bats*, Commonwealth of Australia, Canberra.

Department of the Environment, Water, Heritage and the Arts (DEWHA) 2010b, *Survey guidelines for Australia's threatened birds,* Commonwealth of Australia, Canberra.

Department of the Environment, Water, Heritage and the Arts (DEWHA) 2011a, *Survey guidelines for Australia's threatened mammals,* Commonwealth of Australia, Canberra.

Department of the Environment, Water, Heritage and the Arts (DEWHA) 2011b, *Survey guidelines for Australia's threatened reptiles*, Commonwealth of Australia, Canberra.

Diete RL, Adamczyk SM, Meek PD, Dickman CR, and Leung LKP 2015, 'Burrowing behaviour of the delicate mouse (Pseudomys delicatulus) and the management implications for a threatened sympatric rodent (Notomys auilo)', *Australian Mammalogy*, Vol. 37, pp. 260-263.

Environmental Protection Agency (EPA) 1998, *Western Surface Coal Mining, Chapter 11.9* within *Compilation of Air Pollutant Emissions Factors (AP-42) (5th ed.) (Volume 1),* Office of Air Quality Planning and Standards, United States Government, Washington DC.

Environmental Protection Agency (EPA) 2006, *Aggregate Handling and Storage Piles, Chapter 13.2.4* within *Compilation of Air Pollutant Emissions Factors (AP-42) (5th ed.) (Volume 1),* Office of Air Quality Planning and Standards, United States Government, Washington DC.

Environmental Protection Agency Victoria (EPA Victoria) 2007, *Protocol for Environmental Management: State Environment Protection Policy (Air Quality Management) – Mining and Extractive Industries*, Publication 1191, State of Victoria, Melbourne.

Environmental Protection Agency (EPA), 2020, *Salinity,* viewed 20 April 2020, <https://www.epa.sa.gov.au/environmental_info/water_quality/threats/salinity>

Eyre, TJ, Ferguson, DJ, Hourigan, CL, Smith, GC, Mathieson, MT, Kelly, AL, Venz, MF, Hogan, LD & Rowland, J 2018, *Terrestrial Vertebrate Fauna Survey Guidelines for Queensland (Version 3.0),* Department of Environment and Science, State of Queensland, Brisbane.

Fondriest Environmental Inc. 2014, *Fundamentals of Environmental Measurements: Turbidity, Total Suspended Solids & Water Clarity*, viewed 20 May 2019, <http://www.fondriest.com/environmental-measurements/parameters/water-quality/turbidity-total-suspended-solids-water-clarity/>.

Goff, FG, Dawson, GA & Rochow, JJ 1982, *Site examination for threatened and endangered plant species*, Environmental Management, vol. 6, pp. 307-316.

Goodsell JT 1990, 'Distribution of Waterbird Broods Relative to Wetland Salinity and pH in South-western Australia', *Australian Wildlife Research,* Vol. 17, pp. 219-29.

Greig-Smith, P 1964, *Quantitative Plant Ecology*, Butterworths, London.

Griffiths SR, Donato DB, Lumsden LF and Coulson G 2014a, 'Hypersalinity reduces the risk of cyanide toxicosis to insectivorous bats interacting with wastewater impoundments at gold mines'*, Ecotoxicology and Environmental Safety,* Vol. 99, pp. 28-34.

Griffiths SR, Donato DB, Coulson G and Lumsden LF 2014b, 'High levels of activity of bats at golf mining water bodies: implications for compliance with International Cyanide Management Code', *Environmental Science and Pollution Research*, Vol. 21, pp. 7263-7275.

Hart BT, Bailey P, Edwards R, Hortle K, James K, McMahon A, Meredith C and Swadling K 1991, *'A review of the salt sensitivity of the Australian freshwater biota', Hydrobiologia*, Vol. 210, pp. 105-144.

International Erosion Control Association (IECA) Australasia 2008, *Best Practice Sediment and Erosion Control Guideline*, Picton, New South Wales.

International Network on Acid Prevention (INAP) 2009, *Global Acid Rock Drainage Guide*, prepared by Golder Associates on behalf of INAP.

JBT Consulting Pty Ltd (JBT) 2019, *Groundwater Impact Assessment,* prepared for Magnetic South Pty Ltd.

John T. Boyd Company (BOYD) 2019, *Assessment of Final Landform Options*, prepared for Magnetic South Pty Ltd.

Katestone Environmental Pty Ltd (Katestone) 2011, *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining,* Prepared for Office of Environment and Heritage KE1006953 June 2011.

Katestone Environmental Pty Ltd (Katestone) 2020, *Gemini Project: Air Quality and Greenhouse Gas Assessment,* prepared for Magnetic South Pty Ltd.

Kaymakci, E and Didari, V 2002, Relations between coal properties and spontaneous combustion parameters, *Journal of Engineering & Environmental Sciences*, vol.26, 1, pp.59-64.

Keipert, N.L 2005, *Effect of different stockpiling procedures in open cut coal mine rehabilitation in the Hunter Valley*, NSW, Australia (Doctoral dissertation, PhD thesis, University of New England).

Lavery HJ 1972, 'The Grey Teal at saline drought refuges in north Queensland*', Wildfowl,* Vol. 23, No. 23, pp. 56-63.

Loch RJ, 2000, 'Effects of vegetation cover on runoff and erosion under simulated rain and overland flow on a rehabilitated site on the Meandu mine Tarong, Queensland', *Australian Journal of Soil Research*, 38, pp. 299-312.

Luek A and Rasmussen JB 2017, 'Chemical, Physical and Biological Factors Shape Littoral Invertebrate Community Structure in Coal-Mining End-Pit Lakes', *Environmental Management,* Vol. 59, pp. 652-664.

Lund MA and Blanchette ML 2014, *C21038 Enhancing Ecological Values of Coal Pit Lakes with Simple Nutrient Additions and Bankside Vegetation*, Mine Water and Environment Research/Centre for Ecosystem Management report No. 2014-3, unpublished report to the Australian Coal Association Research Program, Perth.

Marszelewski W, Dembowska EA, Napiorkowski P and Solarczyk A 2017, 'Understanding abiotic and biotic conditions in post-mining pit lakes for efficient management: A case study (Poland)', *Mine Water and Environment*, Vol. 36, pp.418-428.

McFarland, D, Haseler, M, Venz, M, Reis, T, Ford, G & Hines, B 1999, *Terrestrial Vertebrate Fauna of the Brigalow Belt South Bioregion: Assessment and Analysis for Conservation Planning*, Queensland Environmental Protection Agency, State of Queensland, Brisbane.

McKenzie, NJ, Grundy, MJ, Webster, R & Ringrose-Voase, AJ 2008, *Guidelines for Surveying Soil and Land Resources,* Australian Soil and Land Survey Handbook Series, CSIRO Publishing, Melbourne, Victoria.

Miguel-Chinchilla L, Boix D, Gascon S and Comin FA 2014, '*Taxonomic and Functional Successional Patterns in Macroinvertebrates Related to Plying Dispersal Abilities: A Case Study from Isolated Manmade Ponds at Reclaimed Opencast Coal Mines'*, Hydrobiologia, Vol. 732, pp. 111-2.

National Committee on Soil and Terrain (NCST) 2009, *Australian Soil and Land Survey Field Handbook* (3rd edition), Australian Soil and Land Survey Handbook Series, CSIRO Publishing, Melbourne, Victoria.

Neldner, VJ, Wilson, BA, Dillewaard, HA, Ryan, TS & Butler, DW 2019, *Methodology for survey and mapping of regional ecosystems and vegetation communities in Queensland (Version 5.0),* Queensland Herbarium, Science and Technology Division, Department of Environment and Science, State of Queensland, Brisbane.

O'Donnell WB and Debus SJS 2012, 'Nest-sites and foraging of the White-bellied Sea-Eagle *Haliaeetus leucogaster* on the subtropical eastern coast of Australia', *Australian Field Ornithology*, Vol. 29, pp. 149-59.

Parsons, M, Ransom, G, Thoms, M & Norris, R 2002, *Australian River Assessment System: AusRivAS Physical and Chemical Assessment Module,* Monitoring River Heath Initiative Technical Report Number. 23, ISBN 0642548897, Environment Australia, Canberra.

Potts RT and Donato DB 2008, ‘Peregrine Falcon *Falco pereginus* breeding success in a disused mining pit while taking prey from cyanide-bearing tailings dams’, *Australian Field Ornithology*, Vol. 25, pp. 132-5.

Proctor H and Grigg A 2006, ‘Aquatic invertebrate in final void water bodies at an open-cute coal mine in central Queensland’, *Australian Journal of Entomology*, Vol. 45, pp. 107-121

RGS Environmental Pty Ltd (RGS) 2020, *Geochemical assessment of coal reject material*, prepared for Magnetic South Pty Ltd.

RGS Environmental Pty Ltd (RGS) 2019, *Geochemical Assessment of Mining Waste Materials*, prepared for Magnetic South Pty Ltd.

Standards Australia 1997, *Control of the obtrusive effects of outdoor lighting (AS 4282 – 1997),* Standards Australia (Standards Association of Australia)

Standards Australia 2006, *Explosives—Storage, transport and use (*AS 2187:2006), Standards Australia (Standards Association of Australia).

Standards Australia 2017, *The storage and handling of flammable and combustible liquids (AS1940:2017)*, Standards Australia (Standards Association of Australia).

State of Queensland 2018, *Mined Land Rehabilitation Policy*, prepared by Department of Environment and Heritage Protection, the Department of Natural Resources and Mines, and the Queensland Treasury, State of Queensland, Brisbane.

The Australasian Virtual Herbarium (AVH) 2019, *The Australasian Virtual Herbarium*, Council of Heads of Australasian Herbaria, viewed 2 August 2019, <http://avh.chah.org.au>.

Threatened Species Scientific Committee (TSSC) 2016, *Commonwealth Conservation Advice Petauroides volans greater glider*, Department of the Environment and Energy, Commonwealth of Australia, Canberra.

Trinity Consultants Australia Pty Ltd trading as ASK Consulting Engineers (ASK) 2019, *Noise Impact Assessment,* prepared for Magnetic South Pty Ltd.

van Etten EJB 2011, The role and value of riparian vegetation for mine pit lakes, in *Mine Pit Lakes: Closure and Management,* McCullough CD (ed.), Australian Centre for Geomechanics, Perth, pp. 91-106.

Van Dyck S, Gynther I and Baker A (eds.) 2013, *Field Companion to The Mammals of Australia*, New Holland, Sydney.

Witheridge, G & Walker, R 1996, *Soil erosion and sediment control: engineering guidelines for Queensland construction sites*, Institute of Engineers; Queensland Division, Brisbane.

WRM Water & Environment Pty Ltd (WRM) 2020a*, Flood Impact Assessment*, prepared for Magnetic South Pty Ltd.

WRM Water & Environment Pty Ltd (WRM) 2020b*, Surface Water Impact Assessment*, prepared for Magnetic South Pty Ltd.

Young, PAR, Wilson, BA, McCosker, JC, Fensham, RJ, Morgan, G, & Taylor, PM 1999, ‘Chapter 11: Brigalow Belt’ in *The Conservation Status of Queensland’s Bioregional Ecosystems* (eds. Sattler, PS &

Williams, RD), Ch. 11, pp. 1-81, Queensland Environmental Protection Agency, State of Queensland, Brisbane.

3D Environmental 2020, *Groundwater Dependent Ecosystems Assessment*, prepared for Magnetic South.

Appendix A Traffic Impact Assessment

Gemini Project
Traffic Impact Assessment

Gemini Project

QTT19061

Prepared for
Magnetic South Pty Ltd

1 October 2019

Cardno®

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Abbreviations

Abbreviations	
Mtpa	Million Tonnes Per Annum
ROM	Run of Mine
CHPP	Coal Handling Preparation Plant
MIA	Mining Infrastructure Area
TLO	Train Load-Out
TMR	Department of Transport and Main Roads
GTIA	Guide to Traffic Impact Assessments
SISD	Safe Intersection Sight Distance
DOS	Degree of Saturation
LOS	Link Level of Service
AADT	Annual Average Daily Traffic
SCR	State Controlled Road
QTRIP	Queensland Transport and Roads Investment Program
T	Tonnes
Tcu/hr	Through Car Units/Hour
BG	Background
AV	Articulated Vehicle
PCI	Pulverised Coal Injection
BAL	Basic Left Turn
BAR	Basic Right Turn
CHR	Channelised Right Turn
AUL(s)	Channelised Left Turn (short)

1 Introduction

1.1 Project Background

Cardno (QLD) Pty Ltd (Cardno) has been commissioned by Magnetic South Pty Ltd (Magnetic South) to prepare a Traffic Impact Assessment (TIA) for the Gemini Project.

The Gemini Project is located on Exploration Permit for Coal (EPC) 881 tenement in the Bowen Basin, Central Queensland and within the proposed Mining Lease Application (MLA) area. Located approximately 15km east of Bluff and 3km west of Dingo, the tenement straddles the Capricorn Highway and the Blackwater-Gladstone rail network.

The Gemini Project involves hauling coal from the Pit AB and Pit C to a Coal Handling Preparation Plant (CHPP) as represented in Figure 1-1. The CHPP will utilise a conveyor to a Train-Load Out (TLO) facility on the north side of the Capricorn Highway. Coal haulage will only be internal as illustrated in Figure 1-2. The only impacts on the surrounding road network will be project traffic due to the construction of the mine and the operations of the mine.

The following TIA has been prepared to understand the traffic impacts associated with the Gemini Project.

1.2 Project Description

Magnetic South is developing the Gemini Project as a greenfields open cut mine providing pulverised coal injection (PCI) coal and coking coal to the export market.

The proposed open cut mine will target the Rangal coal measures. The mine will utilise diesel powered excavators and rear dump trucks to remove overburden and mine coal at a rate of 1.9 Mtpa run of mine (ROM). The mine is scheduled to operate 363 days a year, 24 hours a day. Due to the steeply dipping coal seams a terrace mining operation will be used. Up to seven seams/plies are targeted, ranging in thickness from 0.5 m to 3.0 m. The seams are impacted by faulting and seam splitting and are typically overlain by overburden ranging in depth from 45 m to 60 m (interburden thicknesses vary).

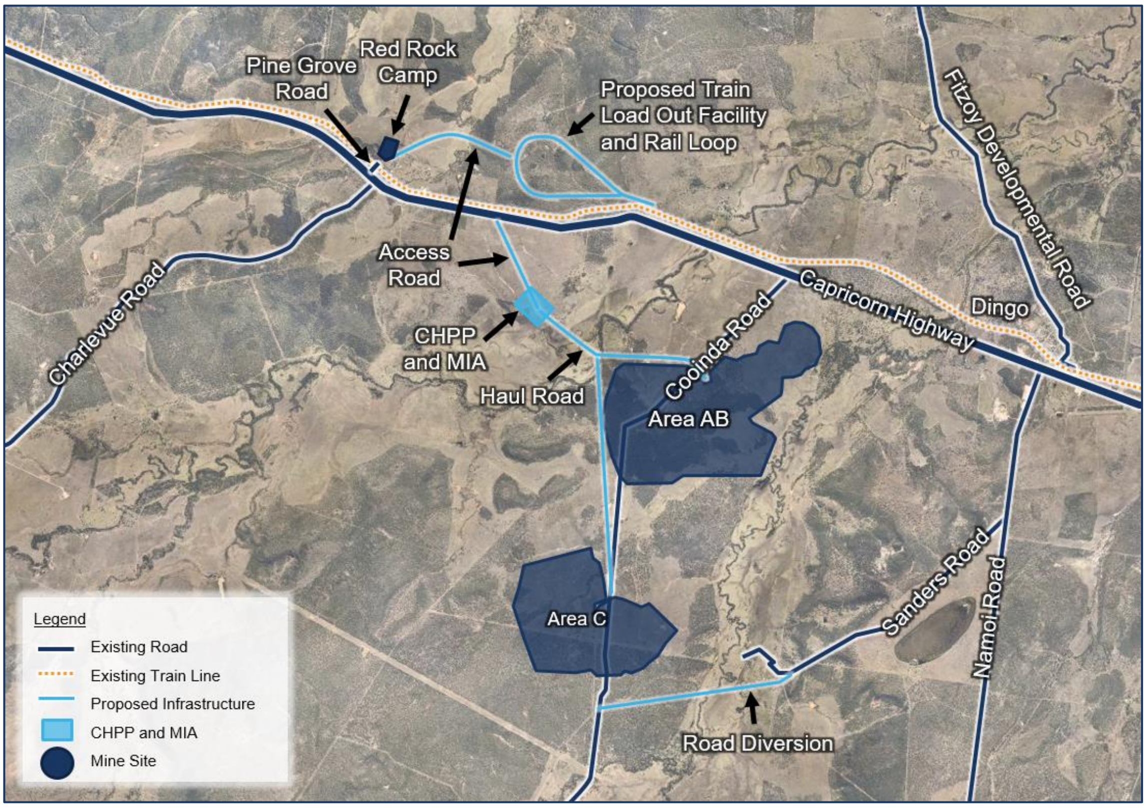
The mined coal will be beneficiated in the CHPP. Low volatile PCI coal or coking coal will be railed to export coal terminals at Gladstone for shipping to international customers.

1.3 References

The following documents have been used in the preparation of this report:

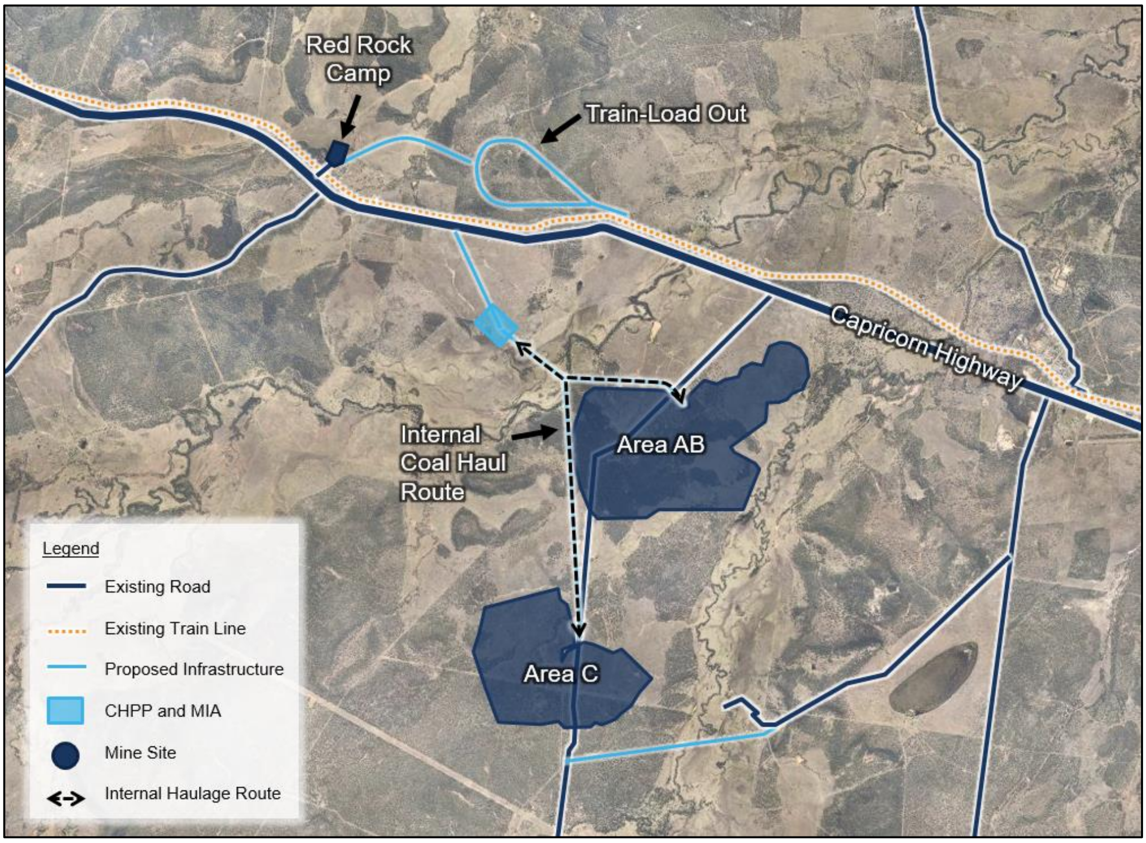
- Traffic Count Data undertaken by Austraffic on Tuesday 23rd July 2019
- Transport Main Roads Guide to Traffic Impact Assessment (GTIA), December 2018
- Austroads Guide to Road Design Part 4A
- Road Planning and Design Manual Edition 2: Volume 3 (Supplement to Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections)
- Austroads Guide to Traffic Engineering Practice – Part 2 Roadway Capacity. (This document is superseded by Austroads Guide to Traffic Management)

Figure 1-1 Gemini Project Proposed Location and Surrounding Infrastructure



Source: Nearmaps

Figure 1-2 Internal Coal Haul Route



Source: Nearmaps

2 Project Assessment Methodology

The Gemini Project assesses the traffic impacts generated by the proposed Gemini Mine (two deposits referred to as Pit AB and Pit C). Magnetic South have provided the locations of the proposed open pits and associated infrastructure (e.g. CHPP and MIA) shown in Figure 1-2. Magnetic South are proposing a new access road and associated intersection onto the Capricorn Highway and an access road from the Redrock accommodation camp connecting to the proposed TLO location in Figure 1-1.

Coal produced will be hauled from the two deposits (Pit AB and Pit C) to the CHPP and Mining Infrastructure Area (MIA) location. Figure 1-2 illustrates the internal haul routes.

The time periods assessed will be the peak construction phase (worst case construction scenario) and end of operations phase (worst case operations scenario). These scenarios will be assessed in isolation and in combination with growth background traffic in order to best reflect actual conditions.

The assessment measures the construction and operations traffic associated with the project during each respective phase. The assessment will utilise all traffic generation information provided by Magnetic South (in Section 5) in order to accurately model the impacted routes of each phase. The coal haulage operations are not considered as these are only operating on internal roads.

The road link capacity and queuing of the roads that are impacted by the Dingo West Project traffic have been assessed according to the GTIA. This will determine any mitigation works required and potentially any impacts that cannot be accommodated by infrastructure upgrades alone.

The Capricorn Highway / Pine Grove Road Intersection and the proposed Mine Access Intersection have been assessed for operation and capacity against the GTIA. The warrants for Turn Treatments and Safe Intersection Sight Distance (SISD) have been assessed in accordance with Austroads Guide to Road Design Part 4A, to ensure adequate protection is proposed for turning vehicles.

2.1 Assessment Scope

The scope of this assessment is limited to the roads used by the proposed Gemini Project traffic. The judgement of whether a road carries a significant amount of traffic is based on Transport Main Roads (TMR) *Guidelines to Traffic Impact Assessments.* These guidelines state that a road carries a significant proportion of project traffic when traffic volumes reach 5% over the existing traffic volumes. Therefore, the following roads and intersections have been assessed:

2.1.1 State Controlled Roads (SCR):

- Capricorn Highway.

2.1.2 Local Council Roads:

- Namoi Road
- Cooinda Road
- Charlevue Road.

2.1.3 State Intersections:

- Capricorn Highway / Namoi Road
- Capricorn Highway / Cooinda Road
- Capricorn Highway / Charlevue Road
- Capricorn Highway / Pine Grove Road.

In addition, the proposed Capricorn Highway / Mine Access intersection, the proposed diversion of an access track connecting Sanders Road to Cooinda Road, and an access road on the north side of the rail network connecting to the TLO is within the scope of this impact assessment.

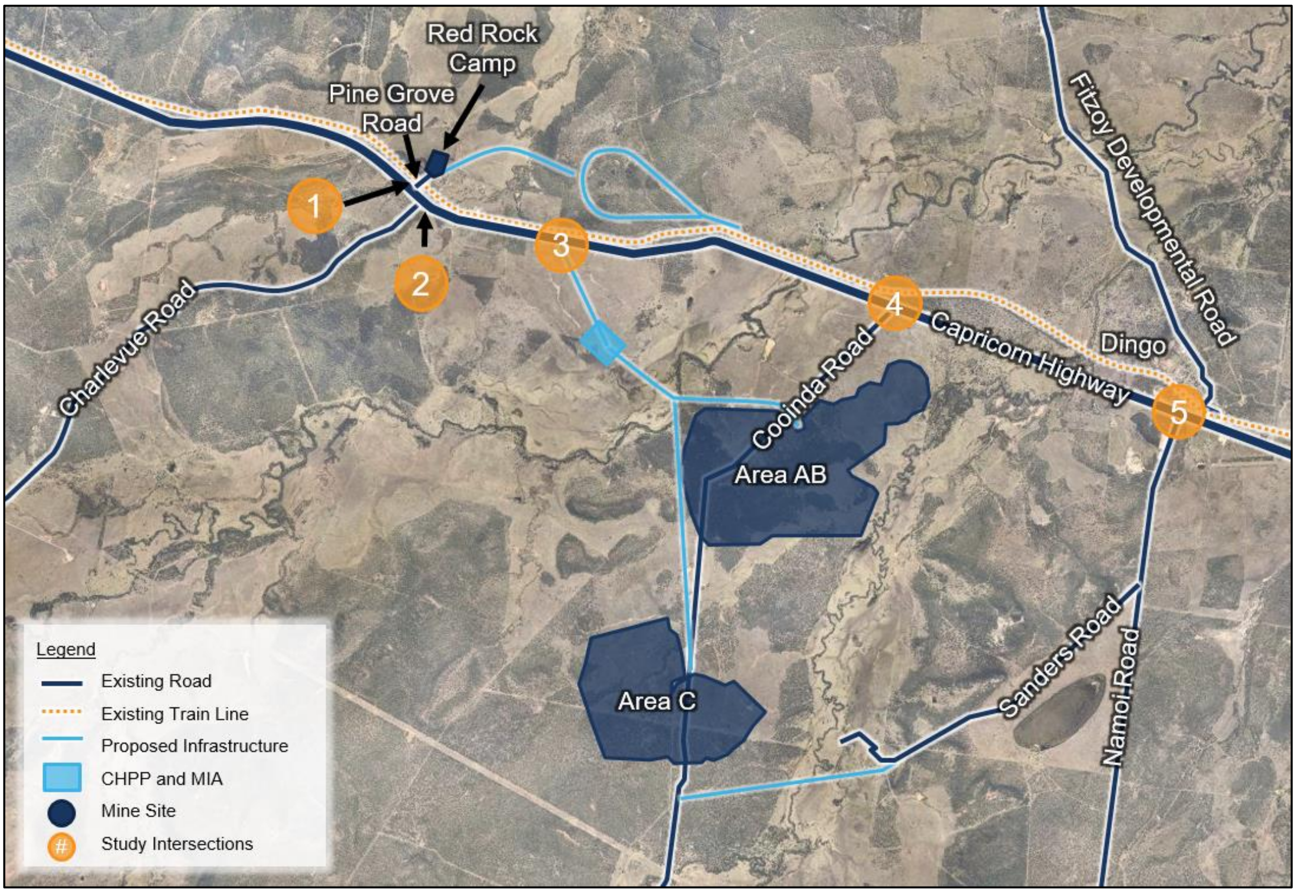
The existing study intersections are outlined in Figure 2-1 and are listed in Table 2-1.

Section 6 illustrates the Capricorn Highway / Pine Grove Road intersection and the proposed mine access intersection are assessed for capacity and operation. It is not considered necessary to assess intersections for their capacity and operation where no turning movements occur from development traffic.

Table 2-1 List of study intersections

Intersection #	Intersection Name
1	Capricorn Highway / Pine Grove Road / Redrock Camp Access Road Intersection
2	Capricorn Highway / Charlevue Road Intersection
3	Capricorn Highway / Proposed Main Access Road Intersection
4	Capricorn Highway / Cooinda Road Intersection
5	Capricorn Highway / Namoi Road Intersection

Figure 2-1 Study Intersection Locations



Source: Nearmaps

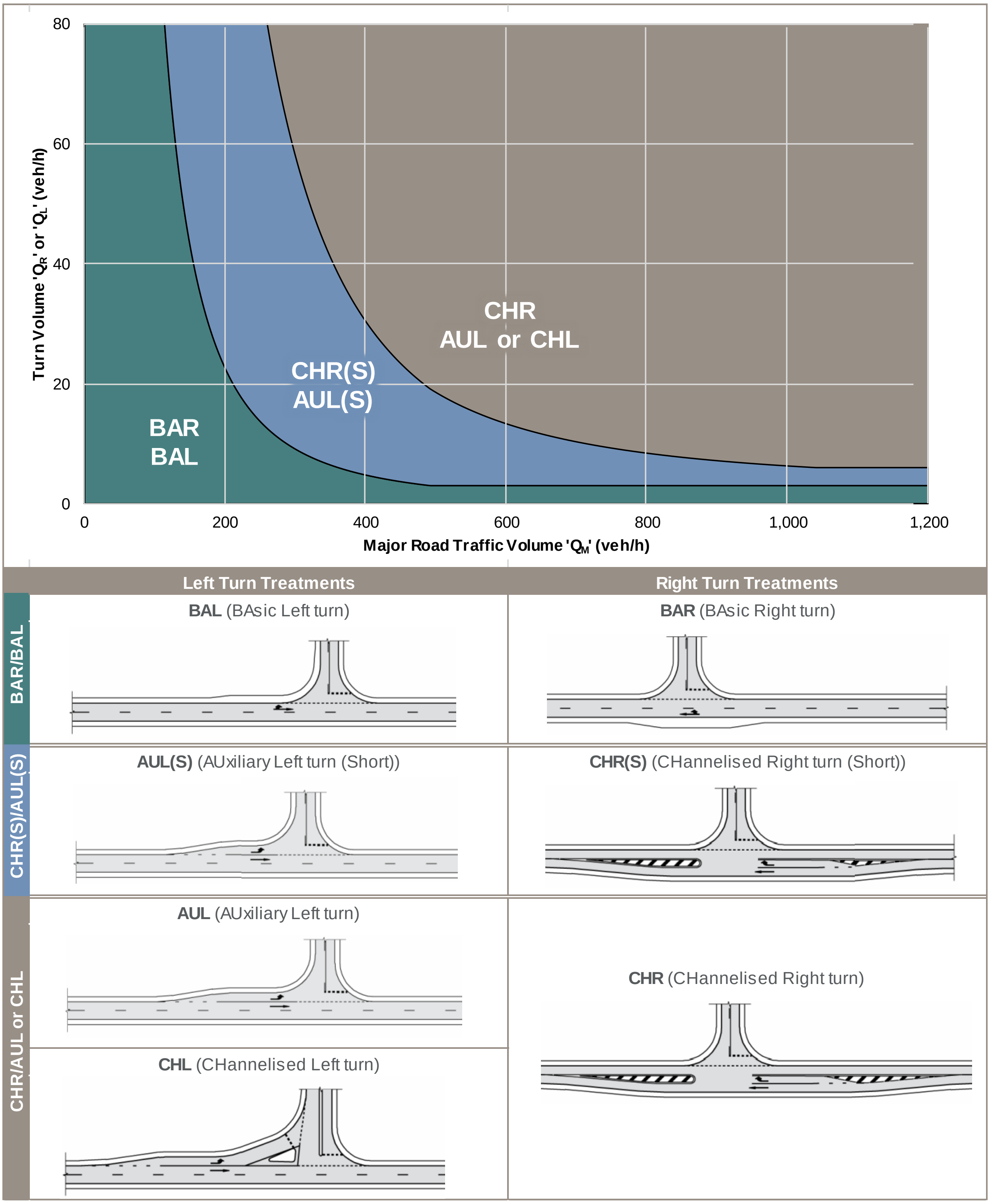
2.2 Intersection Safety Criteria

2.2.1 Warrants for turn treatment

While the Degree of Saturation (DOS) and critical delay statistic provide an indication of the operational performance of an intersection, the Austroads warrants for turn treatments provide an indication of which turn treatments will likely provide an appropriate level of safety.

The warrants for turn treatment provide guidance where deceleration lanes and turning lanes should be used based on traffic volumes. The warrants were developed by Arndt, Troutbeck, Handley & Slattery (2006) and were produced by identifying the location at which the benefits of providing a higher-level treatment (the reduction in estimated crash costs) are equal to additional construction costs associated with the treatment. The benefits and costs of a higher-level treatment were compared to the base case (minimum turn treatments) to develop the curves demonstrated on Figure 2-2. Figure 2-2 reproduces the warrants for turn treatments for rural roads with speeds greater than or equal to 100 kilometres per hour (km/h). For design speeds between 70km/h and 100km/h the turn warrant boundary slopes illustrated in Figure 2-2 are amended to suit.

Figure 2-2 Warrants for Turn Treatments for Design Speed Greater Than or Equal to 100km/h



Source: Austroads 2010

2.3 Link Capacity Criteria

Link Level of Service (LOS) relates to the operating conditions encountered by traffic. It is a qualitative measure of factors as speed, trip time, interruptions, interference, freedom to overtake, ability to manoeuvre, safety, comfort, convenience and vehicle operating costs. TMR's definitions of LOS for uninterrupted flow are defined in terms of traffic flow as detailed in Table 2-2, in addition to indicative photographs.

The performance of the assessed links were analysed including and excluding project traffic using the link LOS methodology detailed in Austroads *Guide to Traffic Engineering Practice Part 2 Roadway Capacity.* Table 2-3 identifies the level of service thresholds specified for varying K factors which represents the ratio of the design hour volume to the annual average daily traffic (AADT). It is noted that the *Guide to Traffic Engineering Practice* has been superseded, by the Austroads *Guide to Traffic Management*. However, as the *Guide to Traffic Engineering Practice* contains the source research for contemporary standards, it has been listed here as the source.

Table 2-2 Level of Service Definitions

LOS	Level of Service Description		LOS	Level of Service Description	
A	Free flow conditions where drivers are unaffected by the presence of others in the traffic stream		D	Close to the limit of stable flow and is approaching unstable flow. Drivers are severely restricted to select their speed and manoeuvre.	
B	Stable flow where drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream.		E	Traffic volumes are at or close to capacity and there is virtually no freedom to select desired speeds or to manoeuvre.	
C	Stable flow, but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre.		F	Forced flow. Traffic approaching the point under consideration exceeds that which can pass it. Flow breakdown occurs.	

Source: TMR's Road Planning and Design Manual

Table 2-3 Maximum AADT Thresholds for Level Terrain on Two-Lane Two-Way Rural Roads

K factor	Level of Service				
	A	B	C	D	E
0.10	2,400	4,800	7,900	13,500	22,900
0.11	2,200	4,400	7,200	12,200	20,800
0.12	2,000	4,000	6,600	11,200	19,000
0.13	1,900	3,700	6,100	10,400	17,600
0.14	1,700	3,400	5,700	9,600	16,300
0.15	1,600	3,200	5,300	9,000	15,200

Source: Traffic Engineering Practice Part 2 Roadway Capacity (1988)

3 Existing Road Network

3.1 Road Conditions

3.1.1 Capricorn Highway

The Capricorn Highway is the only identified SCR within the study area. Recent AADT Segment Analysis Reports for the Capricorn Highway were provided by TMR. The 2018 AADT Segment Analysis Report indicated the Capricorn Highway covering the study area had an AADT of 2,836 with 25% classed as heavy vehicles (HV). In comparison, the 2017 AADT for this segment was 2,475 with 24.5% classed as HV.

Table 3-1 summarises the existing road conditions for SCR within the study area. Further information from site investigations and Queensland Government sources assisted in the generation of Table 3-1.

Table 3-1 State Controlled Roads Summary

Road	Hierarchy	Form	Posted Speed Limit	AADT	HV%	Stock Route
Capricorn Highway	Highway	2 lane 2 way undivided	80km/h - 100km/h	2,836	25%	Primary

Figure 3-1 illustrates a typical section of the Capricorn Highway as of July 2019 conditions. The Highway did not contain signs of rutting or shoving and appeared to be in relatively good condition. The Highway had clear zones on both sides of the road for large sections within the study area.

A few private properties have access onto the Capricorn Highway within the study area.

Figure 3-1 Typical section of Capricorn Highway (facing west)

Source: Site Investigation conducted by Cardno on 16th July 2019

3.1.2 Capricorn Highway / Namoi Road Intersection

Namoi Road connects onto the Capricorn Highway forming the Capricorn Highway / Namoi Road intersection, approximately 420m west from the Capricorn Highway / Fitzroy Developmental Road intersection. Figure 3-2 gives a visual representation of the intersection looking east toward the Dingo township. The posted speed limit is 80km/h when passing this intersection and consists of BAL and BAR (refer to Figure 2-2) turning treatments. Namoi Road currently only services a small number of private properties.

Namoi Road is approximately 4.6km east from Cooinda Road Intersection in Figure 2-1.

Figure 3-2 Capricorn Highway / Namoi Road Intersection (facing east)

Source: Site Investigation conducted by Cardno on 16th July 2019

3.1.3 Capricorn Highway / Cooinda Road Intersection

Cooinda Road connects onto the Capricorn Highway forming Capricorn Highway / Cooinda Road intersection approximately 7.9km east of the Capricorn Highway / Charlevue Road intersection. Figure 3-3 gives a visual representation of the intersection looking west. The posted speed limit is 100km/h when passing this intersection and consists of BAL and BAR turning treatments (refer to Figure 2-2). This intersection only provides access to a few private properties.

Figure 3-3 Capricorn Highway / Cooinda Road Intersection

Source: Site Investigation conducted by Cardno on 16th July 2019

3.1.4 Capricorn Highway / Charlevue Road Intersection

Charlevue Road connects onto the Capricorn Highway forming Capricorn Highway / Charlevue Road intersection. Figure 3-4 gives a visual representation of the intersection looking east. The posted speed limit is 100km/h passing this intersection and consists of AUL(S) and CHR turning treatments (refer to Figure 2-2).

This intersection is staggered with the Capricorn Highway / Pine Grove Road intersection. Capricorn Highway / Charlevue Road intersection is approximately 140m east of the Capricorn Highway / Pine Grove Road Intersection.

Figure 3-4 Capricorn Highway / Charlevue Road Intersection (facing east)

Source: Site Investigation conducted by Cardno on 16th July 2019

3.1.5 Capricorn Highway / Pine Grove Road Intersection

Pine Grove road connects onto the Capricorn Highway forming Capricorn Highway / Pine Grove Road intersection. Figure 3-5 gives a visual representation of the Capricorn Highway / Pine Grove Road intersection looking east toward Capricorn Highway / Charlevue Road intersection. The posted speed limit is 100km/h passing this intersection and consists of BAL and CHR turning treatments (refer to Figure 2-2). This intersection provides access to the existing Red Rock Camp and the proposed Train Load Out Facility.

Figure 3-5 Capricorn Highway / Pine Grove Road Intersection

Source: Site Investigation conducted by Cardno on 16th July 2019

3.2 Background Traffic Volumes

In order to understand the existing traffic conditions within the study area, a traffic survey was undertaken by Austraffic for 3-hour AM and PM periods on Tuesday 23rd July 2019. The survey included the Capricorn Highway / Cooinda Road Intersection, Capricorn Highway / Charlevue Road Intersection, and Capricorn Highway / Namoi Road Intersection (traffic counts and traffic volumes are supplied in Appendix A and B respectively).

A review of the surveys indicated that the AM and PM network peak hour across the three intersections was:

> 8:00 AM – 9:00 AM
> 3:30 PM – 4:30 PM

Figure 3-6 illustrates the AM peak period (08:00 – 09:00) background traffic volumes. It is evident that the traffic turning off the Capricorn Highway at the minor roads is insignificant in comparison to the through movements at each intersection. The highest identified traffic volume during the AM peak hour was 104 vehicles heading eastbound on the Capricorn Highway after the Capricorn Highway / Charlevue Road Intersection.

Along sections of the Capricorn Highway a few private properties exist and this is reflected in the traffic counts where slight differences in volumes can be seen in-between intersections.

Figure 3-6 AM Peak Background Traffic

Source: Nearmap and Austraffic

Figure 3-7 illustrates the PM peak period (15:30 – 16:30) background traffic volumes. The peak movement is 150 vehicles per hour heading westbound on the Capricorn Highway past Capricorn Highway / Charlevue Road Intersection. The majority of vehicle movements are heading westbound in the PM peak and eastbound in the AM peak. Charlevue Road and Namoi Road road carry an insignificant percentage of the traffic compared to the through movements on the Capricorn Highway.

Figure 3-7 PM Peak Background Traffic

Source: Nearmap and Austraffic

3.3 Capricorn Highway / Pine Grove Road Background Traffic Volumes

At the time of the traffic counts (23rd July 2019) the proposed route for project traffic (TLO access and accommodation) was not confirmed by Magnetic South. This means turning movements into Pine Grove Road were not assessed by Austraffic and therefore in order to best model the Capricorn Highway / Pine Grove Road intersection engineering assumptions must be made. Traffic Volumes are supplied in Appendix B.

Figures 3-6 and 3-7 currently illustrate the background traffic volumes for the three intersections assessed. These figures clearly illustrate the low portions of traffic utilising Charlevue Road, Cooinda Road, and Namoi Road. Each road generally services only a few private properties which confirms the low activity on these side roads. Similarly, Pine Grove Road services only a few private properties as well as the Red Rock Camp.

3.3.1 Pine Grove Road Traffic Volume Assumptions

The Redrock Camp contains up to 280 rooms as mentioned in Section 5.4.4 however, movements will be a mixture of bus and LV. Conservative assumptions for both AM and PM peaks are as follows:

- 5 vehicles in both directions travel along Pine Grove Road due to the private properties. 50% will travel to/from Blackwater and the other 50% to/from Dingo.
- Background trips for the Red Rock Camp will be the equal to the trips generated by the Dingo West Project as a worst case scenario (see below). This is a conservative assumption which assumes the Red Rock Camp is full at the time of surveys.

Magnetic South have indicated the following traffic generations to/from Redrock Camp (adapted from Table 5-2):

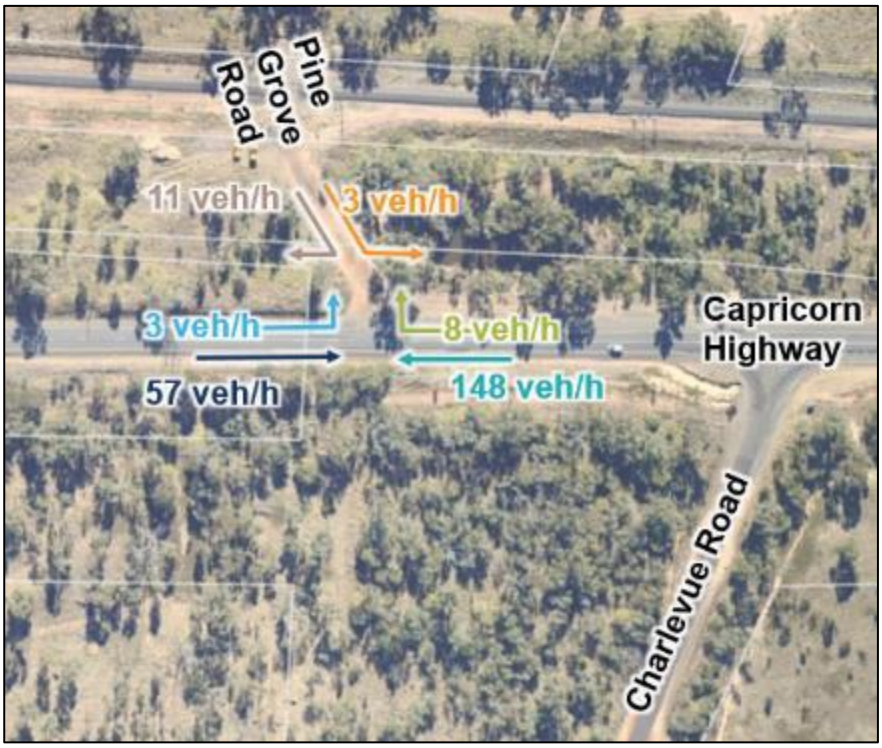
- Workforce Shift Change will produce 10 buses per day from Redrock Camp to the mine (worst case). According to Table 5-4 50% of buses will travel during the peak hours
- Workforce Roster Change (DIDO) will produce 25 LV trips per day from Central Queensland Region to Redrock Camp (worst case). According to Table 5-4, 30% will travel during the peak hours.

Figures 3-8 and 3-9 outline the movements on the Capricorn Highway / Pine Grove Road intersection which includes the traffic generated by the Redrock Camp and private properties. These movements are balanced with the current background 2019 survey data such that no additional vehicles are accumulated heading eastbound.

Figure 3-8 AM Peak Pine Grove Road Intersection Movements (2019 Background)

Source: Nearmaps

Figure 3-9 PM Peak Pine Grove Road Intersection Movements (2019 Background)



Source: Nearmaps

3.4 Active Transport

A site visit was undertaken for all the study road networks on the 16th of July 2019. The site visit did not identify any pedestrian or cycling facilities. Due to the rural nature of the study area and associated road networks, there is a very low level of pedestrians and cyclist usage. Active Transport facilities are not considered to be required.

3.5 Public Transport

Greyhound Australia offer multiple bus services that stop at Dingo. One Emerald bus service route originates from Dingo departing at 8:30pm each day. The return bus service from Emerald to Dingo departs at 1:30pm.

Rockhampton to Emerald and Longreach bus service stops at Dingo at 10:00am on a Tuesday and Saturday and at 8:20pm Monday, Wednesday, Thursday, Friday, and Sunday.

The Longreach/Emerald to Rockhampton services pass through Dingo at 7:00am on Monday, Tuesday, Thursday, Friday, and Saturday and 3:00pm on a Sunday and Wednesday.

3.6 Future Network Planning

Future network planning for State Controlled roads is derived from TMR who produce the Queensland Transport and Roads Investment Program (QTRIP) every two years. This document reports the planned spending committed to by the state government for all state funded transport initiatives in Queensland.

QTRIP indicates pavement rehabilitation is planned throughout 2018-2020 for sections of the Capricorn Highway between Duaringa and Emerald (sections 14.65km – 140.39km). The indicative total cost for the works is $618,000.

Overtaking lanes are also planned for construction throughout 2018-2020 for sections from Gracemere to Emerald. The indicative total cost for these works are $19,000,000.

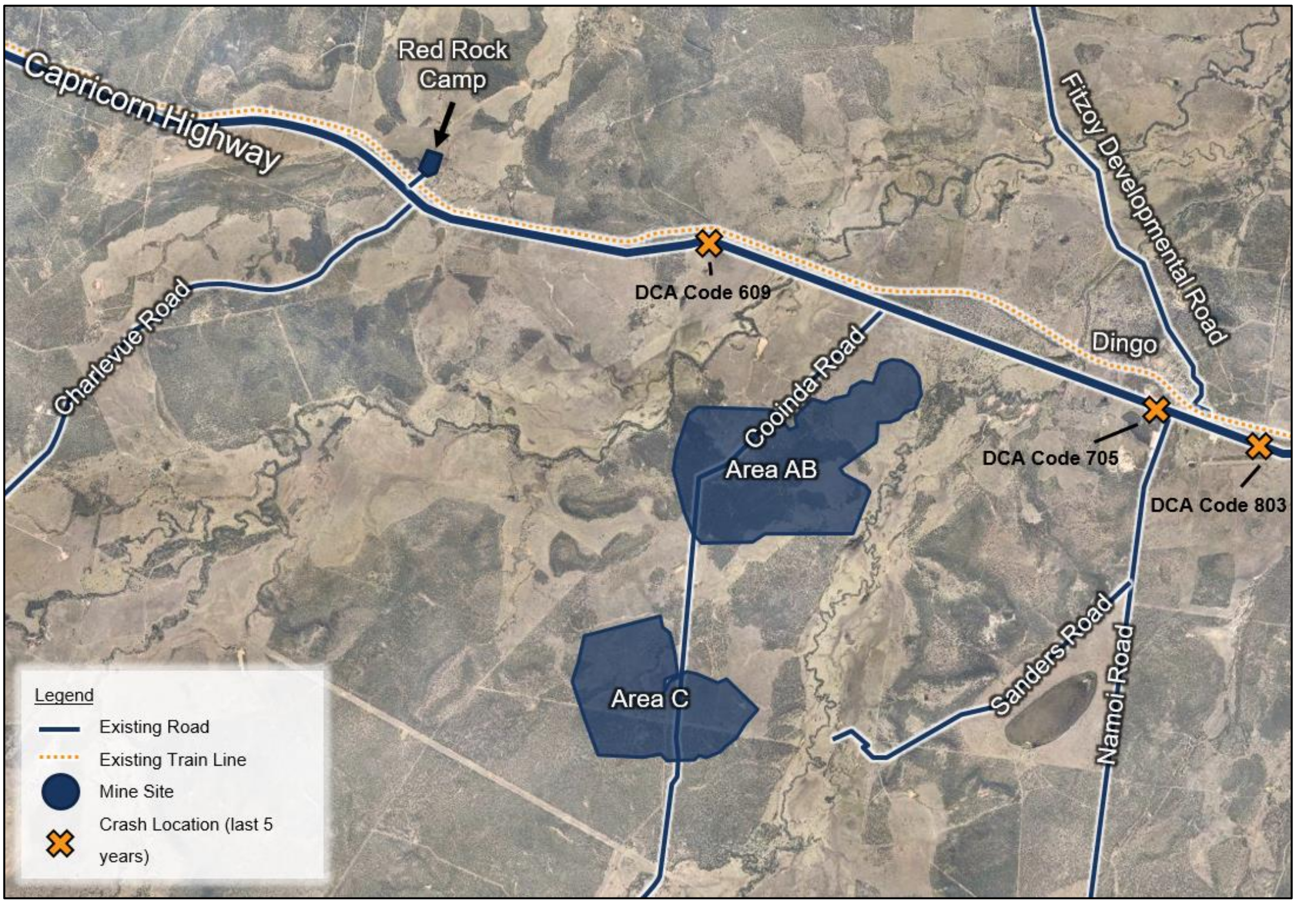
4 Crash History

In order to determine any incident trends in the vicinity of the haulage route, crash data was obtained from TMR. Data was collected from 1st January 2001 to 30th June 2018 and then filtered to the last 5 years of crashes (2014 – 2019). The filtered data shows three reported crashes within close proximity of the project. Table 4-1 lists the crashes identified, these are also displayed graphically on Figure 4-1. A common indicator of these crashes is driver error in darkness.

Table 4-1 Summary of haulage route crash sites

Location	Date	Type and DC Code	Crash Severity
Capricorn Highway	July 2015	Hit Animal - 609	Minor Injury
Capricorn Highway	April 2016	Off Path-Straight: Out of Control - 705	Hospitalisation
Capricorn Highway	March 2014	Off Path-Curve: Hit Object - 803	Hospitalisation

Figure 4-1 Crash locations in the vicinity of the subject area



Source: Nearmaps and TMR crash data 2014-2019

5 Proposed Operation

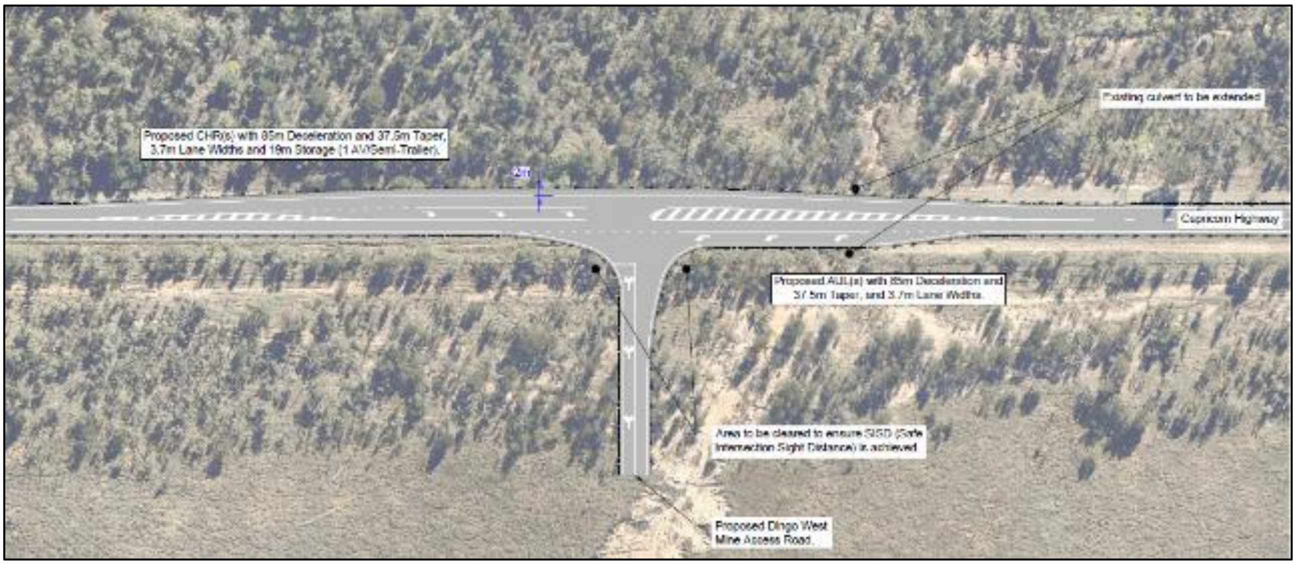
The greenfield open cut mine is expected to produce up to 1.9 Mtpa saleable coal. Subject to granting of the Project ML and EA, construction of the mine and infrastructure will begin in July 2021 and peak construction is anticipated to occur during January 2022. It is anticipated that it will take approximately six months to establish the necessary infrastructure to commence overburden removal and 18 months to commence coal production. Coal production is expected to finish in 2040.

5.1 Proposed Mine Access Intersection

The proposed mine access intersection is located approximately 2.65km east of the Capricorn Highway / Charlevue Road intersection (Intersection 3 on Figure 2-1). This access will be primarily used for all mine access, deliveries, waste removal, and workforce shift changes.

Figure 5-1 illustrates the concept layout of the proposed mine access intersection (refer to Appendix D for all concept drawings). The design includes a AUL (S) and a CHR (S) turning treatment with 85m deceleration lanes and 37.5m tapers, which has been designed in accordance with Austroads Guide to Road Design Part 4A.

Figure 5-1 Proposed Mine Access Intersection Concept Design



5.1.2 Swept Path

Swept paths included in Appendix D show 19m Articulated Vehicles (AV) can adequately achieve 500mm clearances whilst make turning movements into and out of the proposed mine access road.

5.2 Diversion of Non-Gazetted Access Track

To maintain the connection of Cooinda Road to the Capricorn Highway (via Sanders Road and Namoi Road), the access track extending from Sanders Road is proposed to be diverted. The diversion will be approximately 2 km in length and will connect onto Cooinda Road approximately 1 – 1.2 km south of its current connection. The diversion works are located outside of the MLA and will be subject to separate approval from the Central Highlands Regional Council (i.e. approval is not being sought by this EA application). Notwithstanding, the approximate location of the proposed diversion is shown on **Error! Reference source not found.** 1-1.

The 2019 background traffic counts confirm 7 and 2 vehicles in both directions use Namoi Road in the AM and PM peak hours, respectively. These counts confirm the portion of traffic utilising Namoi Road (and therefore Sanders Road) is insignificant and any diversion will have minimal disturbance to users.

5.3 Train Load Out Access

Construction and/or operations traffic will have access to the TLO via an access track connecting from the Pine Grove off the Capricorn Highway. The access road will straddle around adjacent properties as indicated in Figure 1-1. TLO deliveries, concrete deliveries, and construction materials outlined in the traffic generation summary (Table 5-2) will all utilise the access road. Section 5.4 outlines the workforce summary that will also use the access track.

5.4 Workforce

Traffic assumptions have been confirmed with Magnetic South in order for Cardno to accurately model the workforce traffic generation for the Dingo West Project.

The confirmed assumptions are presented below.

5.4.1 Construction and Operations Workforce

Table 5-1 outlines the peak construction and operations workforce split across the mine and TLO. During the construction phase 88% of workers will service the mine and only 12% at the TLO. During operations phase, 100% of the workforce will service the mine.

Peak construction and peak operations workforce are 260 and 330 workers in total, respectively.

Table 5-1 Workforce Summary

	Construction	Operations
Mine	230	330
TLO	30	0
Total	260	330

Source: Magnetic South

5.4.2 Workforce Origin

Staff will originate from a number of sources:

- 80% Drive-in-Drive-Out (DIDO) stay in camp and bused to site
- 20% Local Staff (Local to Dingo/Blackwater region).

Of the DIDO Staff, 80% will travel by car from Rockhampton region to the Redrock camp, with 20% of staff arriving by car from Emerald region to the camp, at the start and end of their roster.

The remaining staff traveling daily from Dingo (50%) and Blackwater (50%) to the mine site will use light vehicle.

5.4.3 Workforce Roster

Mining operations will operate on a 24-hour shift cycle roster, working 7 days on, 7 days off. Technical staff will work 10 hours per day, on a 5 days on, 2 days off roster. Senior management and staff will work on a 5 days on, 2 days off roster.

5.4.4 Accommodation

Accommodation options include the following:

- Use of the Redrock camp containing up to 280 rooms
- Use of Magnetic South owned or leased houses in the Dingo/Blackwater vicinity (any location between Dingo and Blackwater) (20 houses); or
- Self-accommodation and rental accommodation (60 rooms).

Approximately 20% of the workforce would be self-accommodated with the remaining 80% being accommodated by Magnetic South (in Redrock camp or in Magnetic South houses).

Local staff living in Dingo to Blackwater region are expected to travel to the mine site in light vehicles with 50% carpooling.

5.5 Traffic Generation

The following assumptions will be used to calculate staff trips:

> Light vehicles are assumed to carry 1.2 passengers (carpooling);
> Buses have a capacity of 25-40 people (55 seat coach);
> Workforce shift change movements are considered to be from the accommodation camp, to the mine;
> Workforce roster change movements are considered to be from accommodation camp to home-town.

Table 5-2 summarises all assessed traffic generation for the Dingo West Project during the Construction and Operations phases separately.

Table 5-2 Traffic Generation Summary

Item	Origin	Destination	Typical Vehicle	Average Loads per Day	
				Construction/Operation	Operation
Deliveries – parts, explosives, waste	Rockhampton/Gladstone	Mine	Class 9 truck	2	1
Oversized Loads	Rockhampton/Gladstone/ Brisbane	Mine	Low Loader	1	0
Other deliveries – small trucks	Emerald/ Rockhampton	Mine	Class 3 truck	1	1
Fuel	Gladstone	Mine	B-Double	0.5	1
HDPE Pipes and concrete culverts	Rockhampton/ Gladstone	Mine	B-Double	0.5	0
Mine equipment for facilities and operations e.g. CHPP	Gladstone/ Brisbane	Mine	Low Loader/ B-Double	0.5	0
Construction materials for all infrastructure at the mine (not covered in other items)	Emerald/Rockhampton/ Gladstone	Mine	Low Loader/ B-Double	1	0
TLO Deliveries (Ballast, sleepers, rail tracks)	Rockhampton/ Gladstone	TLO	Semi	1	0
Food	Blackwater/Rockhampton	Mine	Class 3 truck	0.5	0.5
Water	Blackwater	Mine	23,000 Litre Tanker Tri-Axle Trailer	0.2	0.2
Concrete	Blackwater	Mine	Five Axle Articulated	1	0

Item	Origin	Destination	Typical Vehicle	Average Loads per Day	
Concrete	Blackwater	TLO	Five Axle Articulated	0.2	0
Quarry Materials for road construction	Site/Blackwater	Mine	Five Axle Dump Truck	1	0
Quarry Materials for road construction	Site/Blackwater	TLO	Five Axle Dump Truck	0.2	0
Solid waste	Mine	Blackwater Sewage Treatment Plant	Quad Axle Truck Dog, Twin Steer with Triple Axle Prime Mover	0.2	0.2
Liquid Waste	Mine	Gladstone Waste Facility	Single Steer Twin Axle	0.2	0.2
General waste	Mine	Blackwater Waste Facility	Single Steer Twin Axle	0.2	0.2
Workforce Shift Change	Dingo/Blackwater	Mine	Light Vehicle	50	20
	Redrock Camp	Mine	Buses	10	8
Workforce Roster Change (DIDO)					
	Central Queensland region	Redrock Camp	Light Vehicle	25	20
Total				**96.2**	**52.3**

Source: Magnetic South

Table 5-3 below summarises the total trips from each origin/destination for the items illustrated in Table 5-2. During the construction phase, 96.2 (97) loads are expected per day. On average this equates to 4 loads every hour (in a single direction). During the operations phase a total of 52.3 (53) loads are expected per day this equates on average 2 loads every hour (in a single direction).

A graphical display of the data presented in Table 5-3 and the associated routes are provided in Figures 5-2 and 5-3 on the following page. The number of vehicles per day shown in Figures 5-2 and 5-3 are rounded up to the nearest number.

Trips using the east route include trips to Rockhampton, Gladstone, Dingo, and Brisbane. Trips using the west route include trips to Blackwater, Emerald, and Central Queensland Region. The other routes included are the Redrock Camp and TLO routes.

Referring to Figures 5-2 and 5-3 the following statements are made:

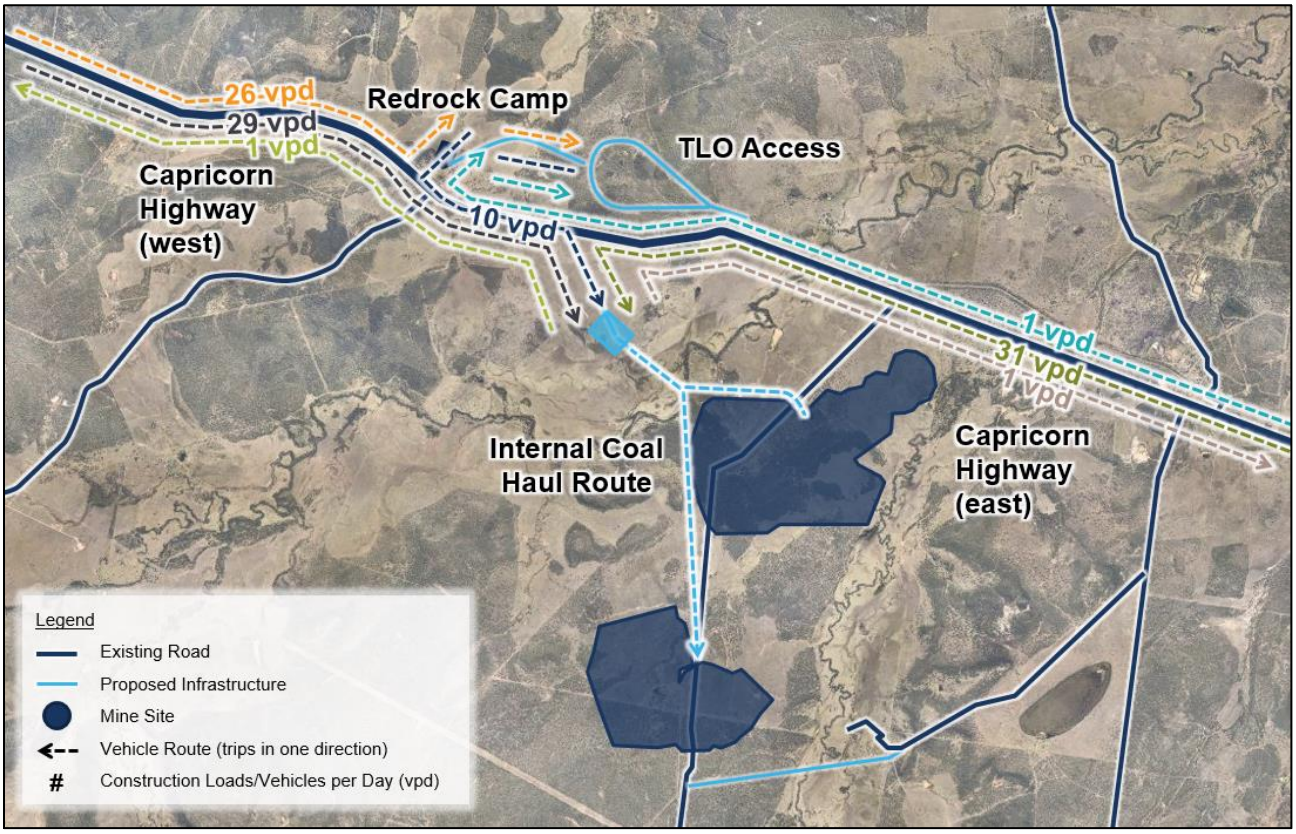
- During the construction and operations phases an additional 33 and 14 vehicles per day respectively will utilise the Capricorn Highway east segment.
- During construction and operations phases an additional 56 and 32 vehicles per day respectively will utilise the Capricorn Highway west segment.
- During construction and operations phases an additional 41 and 20 vehicles per day respectively will utilise sections of the Capricorn Highway between the proposed mine access intersection and Capricorn Highway / Pine Grove Road Intersection.

Table 5-3 Total Development Trips for Each Origin/Destination Route from Table 5-2

Origin/Destination		Total Loads Per Day	
From	To	Construction	Operations
Capricorn Highway (via east route)	Mine	30.75	12.75
Capricorn Highway (via east route)	TLO, or Redrock Camp	1	0
Capricorn Highway (via west route)	Mine	28.45	10.95
Capricorn Highway (via west route)	TLO, or Redrock Camp	25.4	20
Redrock or TLO	Mine	10	8
Mine	Capricorn Highway (via east route)	0.2	0.2
Mine	Capricorn Highway (via west route)	0.4	0.4
Total		**96.2**	**52.3**

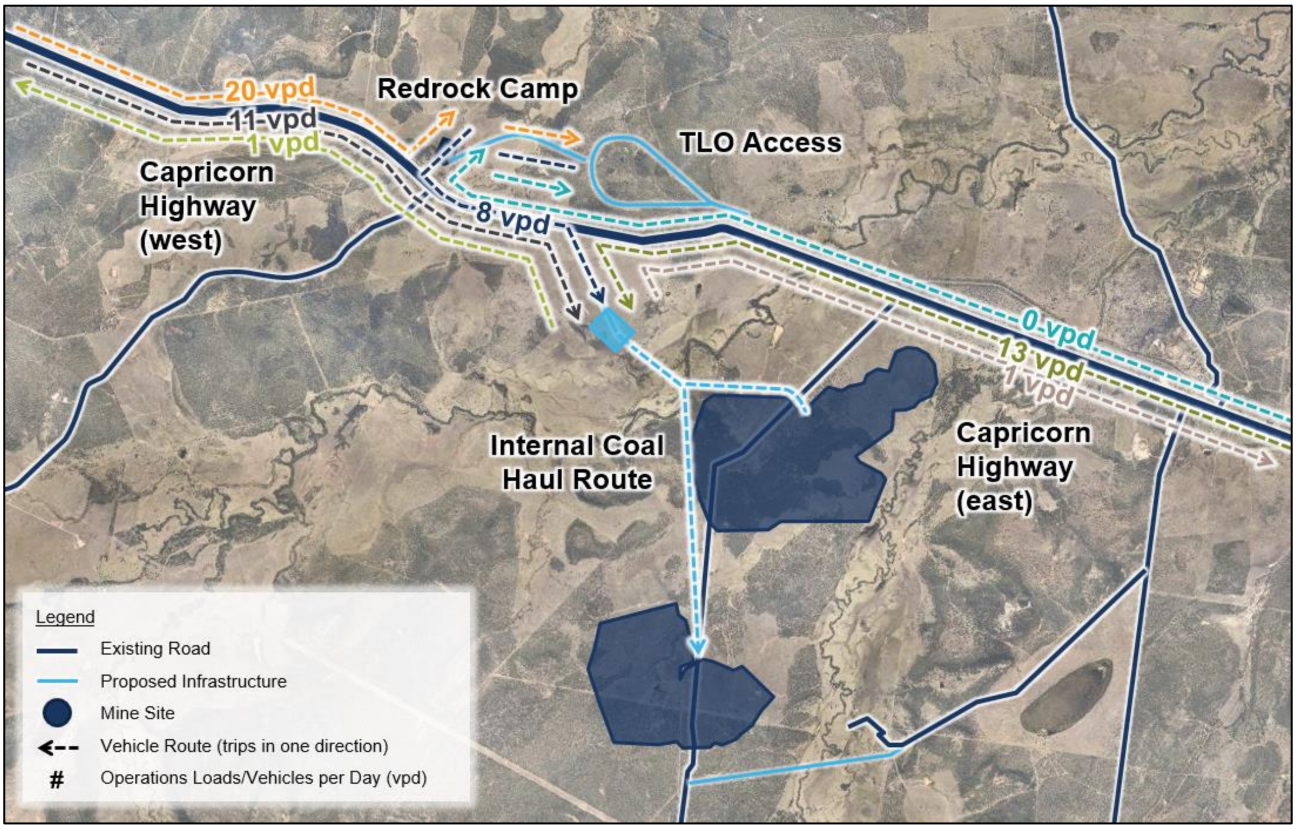
Source: Calculated from Table 5-2

Figure 5-2 Construction Vehicles per Day (Rounded Nearest Number)



Source: Nearmaps and Magnetic South

Figure 5-3 Operations Vehicles per Day (Rounded Nearest Number)



Source: Nearmaps and Magnetic South

The percentage of trips to occur during the peak hours (8:00AM – 9:00AM and 3:30PM – 4:30PM) for different items are illustrated below in Table 5-4. When assessing the peak hour networks, the following percentages will be applied to the loads per day vehicle volumes in order to best model the peak hour scenarios.

Table 5-4 Percentage of Peak Hour Trips

Item/Operation	% Trips During Peak Hour
Deliveries and Waste Removal	10%
Shift Change Bus and Roster Change	50%
Shift Change LV	30%

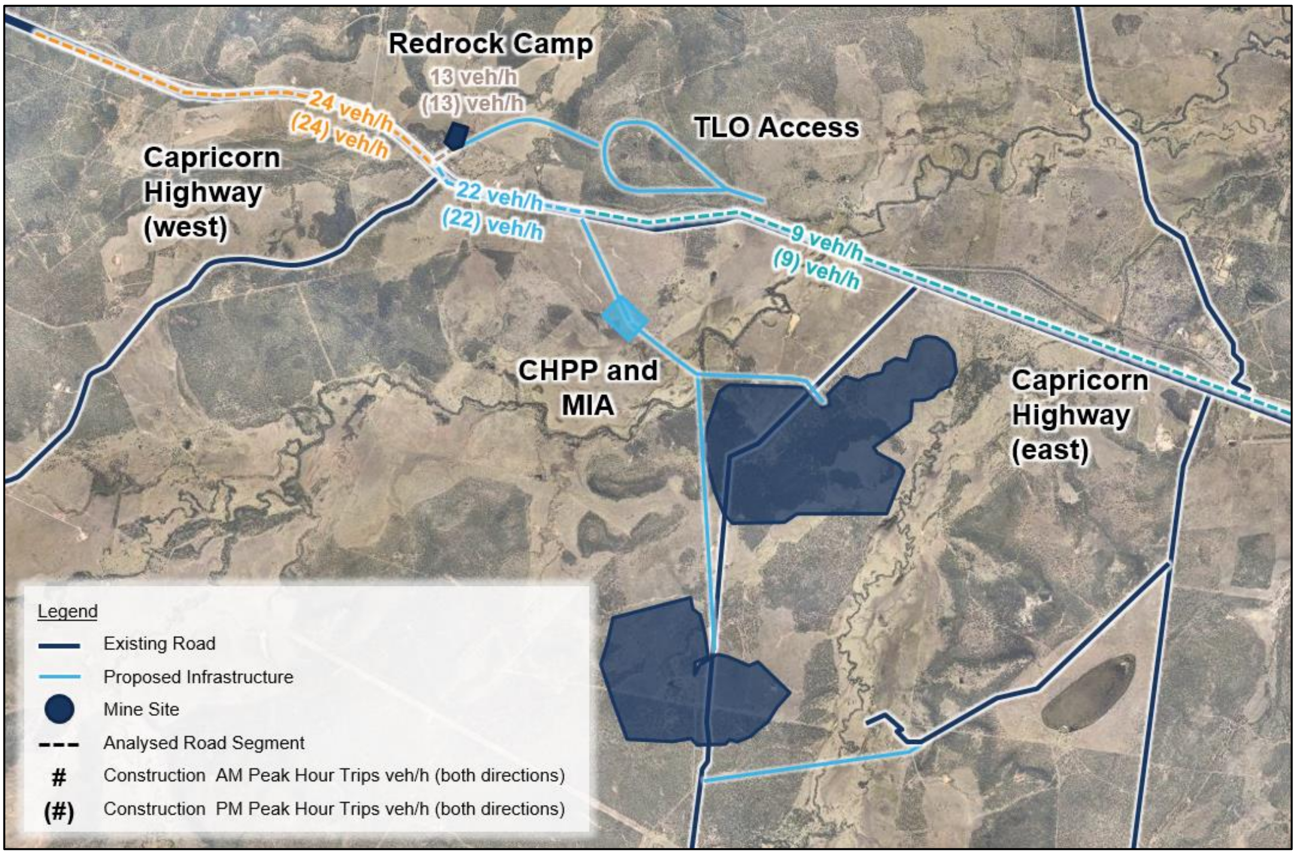
Source: Previous Cardno assessments in nearby regions

Figures 5-4 and 5-5 display the expected trips during both the peak hours (including return trips) with the applied percentages illustrated in Table 5-4.

Figure 5-4 represents the construction phase and Figure 5-5 represents the operations phase. Both figures look at each individual segment of road as per their colour scheme.

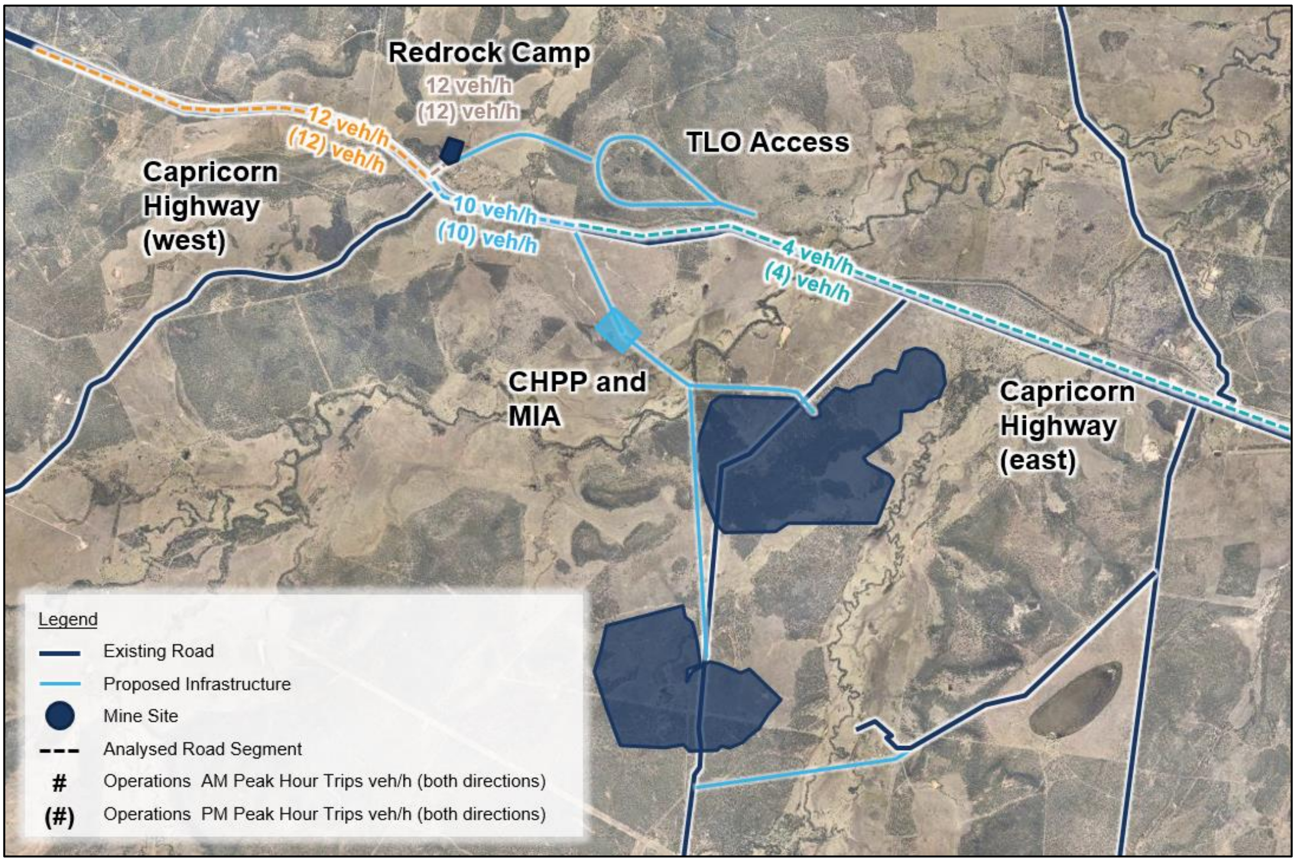
It is assumed all returning trips head back on the same route to their origin. Workforce trips are assumed to travel to the desired destination in the AM peak hour and return in the PM peak hour, all other items are expected to return in the same peak hour.

Figure 5-4 Construction Peak Hour Trips (Including Return Trips) on Various Road Segments



Source: Nearmaps

Figure 5-5 Operations Peak Hour Trips (Including Return Trips) on Various Road Segments



Source: Nearmaps

5.6 Safe Intersection Sight Distance

Site investigation has been undertaken for the Safe Intersection Sight Distance (SISD) at the location of the study intersections illustrated in Figure 2.1. Table 5-5 outlines the Austroads Guide to Road Design Part 4a, minimum sight distance requirements are 285m for 110km/h and 214m for 90km/h design speeds. From onsite SISD checks, all intersections meet the required distances as illustrated in Table 5-5.

It is to be noted that the design speeds are 10km/h higher than the posted speed. Additionally, if reaction times were increased from 2 seconds to 2.5 seconds, a 90km/h and 110km/h SISD requirement would increase to 226m and 300m, respectively.

Table 5-5 Minimum Safe Intersection Sight Distance (Normal Design Domain)

Intersection Approach	Design Speed	Reaction Time	Minimum SISD Required	Recorded SISD	Meet 2 second requirement
Capricorn Highway / Charlevue Road					
East	110km/h	2 seconds	285m	500m+	✓
West	110km/h	2 seconds	285m	300m	✓
Capricorn Highway / Cooinda Road					
East	110km/h	2 seconds	285m	700m+	✓
West	110km/h	2 seconds	285m	580m+	✓
Capricorn Highway / Namoi Road					
East	90km/h	2 seconds	214m	323m	✓
West	90km/h	2 seconds	214m	260m	✓
Proposed Mine Access Intersection					
East	110km/h	2 seconds	285m	350m	✓
West	110km/h	2 seconds	285m	300m	✓
Pine Grove Road / Redrock Park Access Road / Capricorn Highway Intersection					
East	110km/h	2 seconds	285m	385m+	✓
West	110km/h	2 seconds	285m	500m+	✓

Table 5-5 clearly indicates all existing intersections meet the 2 second reaction time SISD requirement. It is to be noted all existing intersections also meet 2.5 second reaction time SISD requirements except the west direction of Capricorn Highway / Namoi Road intersection.

6 Intersection Assessment

In accordance with the DTMR G*uide to Traffic Impact Assessment* (2017), the impact assessment year has been assumed as the whole project life.

The assessment scenarios are selected to accurately compare the worst case development and background scenarios with the non-developed background scenarios for that year. Therefore, the impact assessment year for the site access should be the peak construction (worst case construction) and worst case project traffic. Table 6-1 summarises the impact assessment scenarios.

Table 6-1 Impact Assessment Scenarios

Impact Assessment Scenario	Study Intersections
2019 Background (surveyed year)	Pine Grove Road / Redrock Park Access Road Intersection
2022 Background	Pine Grove Road / Redrock Park Access Road Intersection
2022 Background + Peak Construction	Proposed Mine Access Intersection and Pine Grove Road / Redrock Park Access Road Intersection
2040 Background	Pine Grove Road / Redrock Park Access Road Intersection
2040 Background + Peak Operations (End of Operations)	Proposed Mine Access Intersection and Pine Grove Road / Redrock Park Access Road Intersection

6.2 Assessment Criteria

The performance of the study intersections have been analysed using SIDRA Intersection 8 (SIDRA). SIDRA is an industry recognised analysis tool that estimates the capacity and performance of intersections based on input parameters, including geometry and traffic volumes, and provides estimates of an intersection's Degree of Saturation (DOS), queues, and delays.

6.2.1 Intersection Delay

The TMR GTIA recognises the intersection delay as a greater indicator of intersection performance in comparison to the previous TMR GARID's focus on the degree of saturation (DOS) criteria. The TMR GTIA appreciates that in urban networks, the DOS of an intersection may not be the most accurate representation of the intersection's operation as it is expected that existing intersections are approaching capacity with the growth of our cities.

The desired outcome outlined by the GTIA is to ensure that the sum of all intersection delays on the base traffic within the study area does not significantly worsen (i.e. does not increase average delays by more than 5% in aggregate) as a result of the development.

The TMR GTIA outlines that the proposed development should seek to achieve no net worsening to efficiency across the impact assessment area. While Council intersections should be included in the impact assessment area, the no net worsening calculations should only apply to intersections with at least one state-controlled road approach, unless otherwise stated by Council.

Intersection mitigation measures (avoid, manage or mitigate) must be considered where the sum of all intersection delays on the base traffic is greater than 5% in aggregate.

Furthermore, for priority controlled intersections and roundabouts, where the average peak hour delays for any movement exceeds 42 seconds, as outlined in the GTIA, the intersection should be upgraded for safety reasons. At an individual intersection-level, where this threshold has been exceeded, Cardno has made further comments. For signalised intersections, given the delay is dependent on the cycle length and phasing arrangement, the DOS is still considered.

6.2.2 Intersection Degree of Saturation

While the movement delay is considered to provide a better indication of intersection performance and safety for priority controlled intersections and roundabouts, the DOS should still be considered when assessing the performance of the intersection.

Table 6-2 provides the DOS thresholds adopted for the assessment.

Table 6-2 Adopted Intersection Performance Threshold – Degree of Saturation

Intersection Treatment	DOS Threshold
Priority controlled intersections	Less than or equal to 0.80

Source: TMR Guidelines for Assessment of Road Impacts Development

6.3 Modelling Parameters

A summary of the SIDRA Modelling parameters adopted for this assessment are summarised below:

> Peak Flow Factor – 0.95 (30min/60min)
> Basic Saturation Flow – 1,950tcu/hr.
> Heavy vehicle proportion as surveyed for all movements

6.4 Capricorn Highway / Proposed Mine Access Intersection

The proposed configuration of this intersection is a three-way priority controlled arrangement. The proposed layout and intersection assessment is illustrated on Table 6-3. Appendix C supplies all SIDRA layouts and summaries.

Table 6-3 Existing layout and intersection assessment for Capricorn Highway / Proposed Mine Access Road Intersection

Capricorn Highway / Proposed Mine Access Intersection

Safety Assessment at 2040 with Gemini Project traffic:	
Required Left Turn Standard:	BAL
Required Right Turn Standard:	BAR
Proposed Left Turn Treatment	AUL (S)
Proposed Right Turn Treatment	CHR (S)

Scenario	AM Peak			PM Peak		
	DOS	Critical Delay	95th %ile Queue	DOS	Critical Delay	95th %ile Queue
2022 BACKGROUND + PEAK CONSTRUCTION	0.066	6.0 sec	0.6m	0.080	6.1 sec	0.4m
2040 BACKGROUND + PEAK OPERATIONS	0.073	6.0 sec	0.3m	0.094	6.1 sec	0.2m

This intersection is intended for project traffic only and thus only the peak construction and peak operations scenarios are assessed. The proposed formation consists of a AUL (S) and a CHR. Turn warrant analysis performed for 2040 background plus worst case operations traffic indicate that this formation will satisfactorily cater for the traffic volumes assessed.

The results of the performance analysis indicate that the three-way priority controlled arrangement operates within the typical performance thresholds (DOS ≤ 0.80 for priority controlled) for all assessed scenarios.

6.5 Capricorn Highway / Pine Grove Road Intersection

The current configuration of this intersection is a three-way prioritised controlled arrangement. Table 6-4 outlines the existing conditions and SIDRA results. Appendix C supplies all SIDRA layouts and summaries.

Table 6-4 Existing layout and intersection assessment for Capricorn Highway / Pine Grove Road Intersection

Capricorn Highway / Proposed Mine Access Intersection

Existing Condition:	
Formation:	Sealed
Left Turn Standard:	AUL
Right Turn Standard:	CHR
Speed Limit:	100km/h
Accident History:	0

Safety Assessment at 2040 with Dingo West Operations Project traffic:	
Required Left Turn Standard:	BAL
Required Right Turn Standard:	BAR
Proposed Left Turn Treatment	AUL
Proposed Right Turn Treatment	CHR

Scenario	AM Peak			PM Peak		
	DOS	Critical Delay	95th %ile Queue	DOS	Critical Delay	95th %ile Queue
2019 BACKGROUND	0.052	5.8 sec	0.3m	0.080	6.3 sec	0.4m
2022 BACKGROUND	0.053	5.8 sec	0.3m	0.082	6.3 sec	0.4m
2022 BACKGROUND + PEAK CONSTRUCTION	0.057	5.9 sec	0.4m	0.086	6.6 sec	0.7 m
2040 BACKGROUND	0.063	6.3 sec	0.4m	0.096	6.6 sec	0.5m
2040 BACKGROUND + PEAK OPERATIONS	0.064	5.9 sec	0.4m	0.098	6.8 sec	0.7m

The existing formation consists of an AUL, and CHR. Turn warrant analysis performed for 2040 background plus worst case operations traffic indicate that this formation will satisfactorily cater for the traffic volumes assessed.

No crashes were reported at the intersection within the TMR reporting period observed as illustrated in Section 4.

The results of the performance analysis indicate that the three-way priority controlled arrangement operates within the typical performance thresholds (DOS ≤ 0.80 for priority controlled), for all assessed scenarios. It is noted that with the inclusion of the proposed development traffic, the average delay and 95th percentile queue are not significantly impacted, when compared to the background scenarios.

Although a BAL and BAR is all that is required for this intersection, the existing AUL and CHR provides improved safety at the intersection. This will provide further separation for turning movements at the intersection and reduce the possibility of a rear end crash.

7 Link Capacity Assessment

Link capacity has been assessed under the worst case scenario for the end of operations for the development (2040). The analysis has been performed according to the methodology established in Section 2. The results of this analysis are shown on Table 7-1 and Table 7-2.

A K factor of 0.10 is used as illustrated in Table 2-3 in Section 2. The K factor is the ratio of the design hour volume to the AADT volume.

Table 7-1 is calculated based off background traffic counts which best represent the roads AADT rather than 2018 AADT supplied by TMR.

Table 7-1 Link Performance with Baseline Traffic Volumes

Road	Section	2040	
		AADT	LOS
Capricorn Highway	East of Charlevue Road Intersection	2305	A

Table 7-2 Link Performance with Baseline and Dingo West End of Operations Project Traffic Volumes

Road	Section	2040		
		AADT	LOS	Dingo West Impact
Capricorn Highway	East of Charlevue Road Intersection	2510	B	8.8%

The above analysis suggests that the study network operates at the highest level of service under baseline traffic conditions to the end of operations. The addition of the Dingo West Project traffic lowers the performance of the network to a LOS B according to the Austroads Guide to Traffic Engineering Practice.

The definition of LOS B is as follows:

- “Stable flow where drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream”

Therefore, it is considered that the study network will operate acceptably to the end of operations without the addition of overtaking lanes.

8 Summary and Conclusions

Based on the review the following statements are made:

> The Gemini Project proposes to produce up to 1.9 Mtpa saleable coal Construction is expected to begin in July 2021. It is anticipated that it will take approximately six months to establish the necessary infrastructure to commence overburden removal and 18 months to commence coal production. Coal production is expected to finish in 2040.

> Haulage will be internal and the only impacts will be associated project construction and operations traffic. Coal will be beneficiated in the CHPP and conveyed to a TLO facility north of the Capricorn Highway.

> The current AADT on the Capricorn Highway within the study area is 2,836 (with 25% HV) based off 2018 AADT segment analysis reports provided by TMR.

> The Austraffic Surveys indicated the AM peak and PM peak hours were 8:00AM – 9:00AM and 3:30PM – 4:30PM, respectively. A maximum traffic volume of 150veh/h occurred heading west on the Capricorn Highway during the PM peak. It was identified the majority of vehicles travelled east on the Capricorn Highway in the AM and west in the PM.

> TMR crash data showed three reported crashes in the study area within the last five years. Two crashes required hospitalisation and the other was a minor injury crash. Driver error and darkness are identified as common factors for all the reported crashes.

> A proposed mine access intersection is located approximately 2.65km east of the Capricorn Highway / Charlevue Road intersection. This access will be primarily used for mine access deliveries, waste removal, and workforce shift changes.

> TLO access will be via an access road off Pine Grove Road. The access road will straddle adjacent properties as indicated in Figure 1-1.

> All study intersections including the proposed mine access intersection location successfully meet SISD requirements.

> The Austroads turn warrant assessment requires a BAL and BAR for the proposed Mine Access intersection however, a higher order turn facility AUL (S) and CHR lane are proposed to improve road safety.

> Traffic generation assumptions confirmed with Magnetic South indicated a total of 97 and 53 total loads per day will occur during the construction and operations phases of the mine, respectively. The majority of the trips originated from the west via Capricorn Highway.

> The access track extending from Sanders Road is proposed to be diverted. The diversion will be approximately 2 km in length and will connect onto Cooinda Road approximately 1 – 1.2 km south of its current connection The diversion works are located outside of the MLA and will be subject to separate approval from the Central Highlands Regional Council.

> SIDRA modelling and analysis indicated that both the proposed Mine Access Intersection and Pine Grove Road intersection three-way priority-controlled arrangements operated within the performance thresholds (≤ 0.80 for priority controlled), indicating the intersections can accommodate anticipated design horizon development traffic.

> The link capacity assessment indicated that the study network operates at the second highest level of service under development traffic conditions to the end of project life according to Austroads: Traffic Engineering Practice Part 2 Roadway Capacity.

APPENDIX

A

TRAFFIC COUNTS

AUSTRAFFIC VIDEO INTERSECTION COUNT

Site No.: 1 **Weather:** Fine

Location: Capricorn Highway/Namoi Road, Dingo

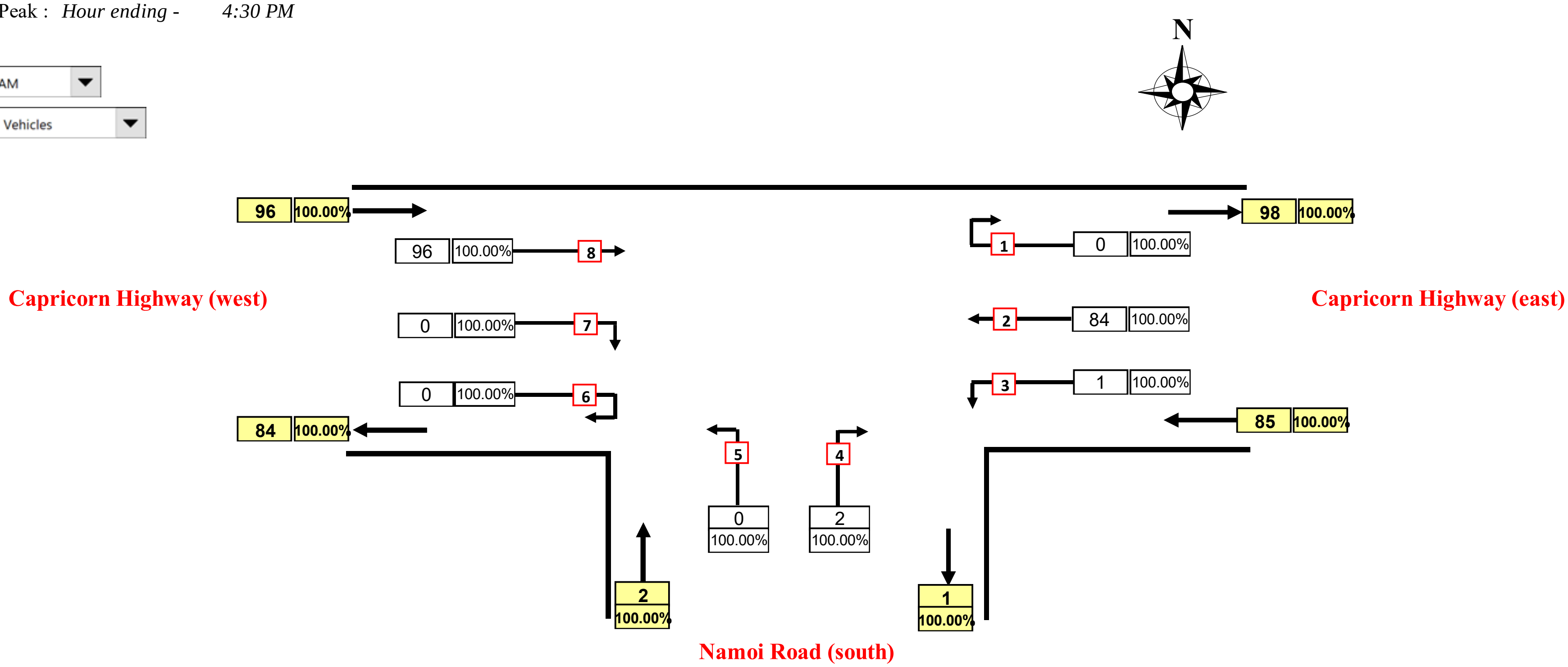
Day/Date: Tuesday, 23 July 2019

Summary: AM Peak : *Hour ending - 9:00 AM*

PM Peak : *Hour ending - 4:30 PM*

Hour Ending: 9:00 AM

Classification: Total Vehicles



AUSTRAFFIC VIDEO INTERSECTION COUNT

Site No.: 1 **Weather:** Fine

Location: Capricorn Highway/Namoi Road, Dingo

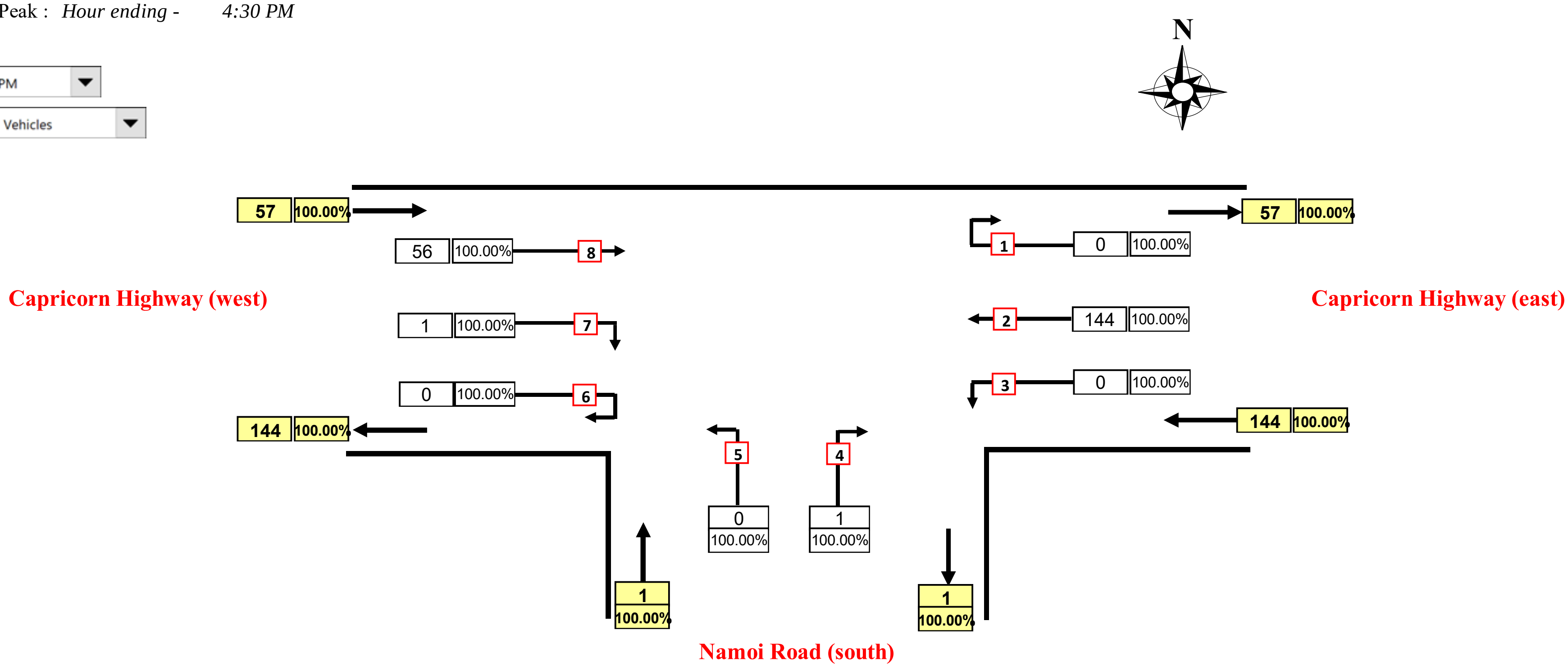
Day/Date: Tuesday, 23 July 2019

Summary: AM Peak : *Hour ending - 9:00 AM*

PM Peak : *Hour ending - 4:30 PM*

Hour Ending: 4:30 PM

Classification: Total Vehicles



AUSTRAFFIC VIDEO INTERSECTION COUNT

Site No.: 2 **Weather:** Fine

Location: Capricorn Highway/Cooinda Road, Dingo

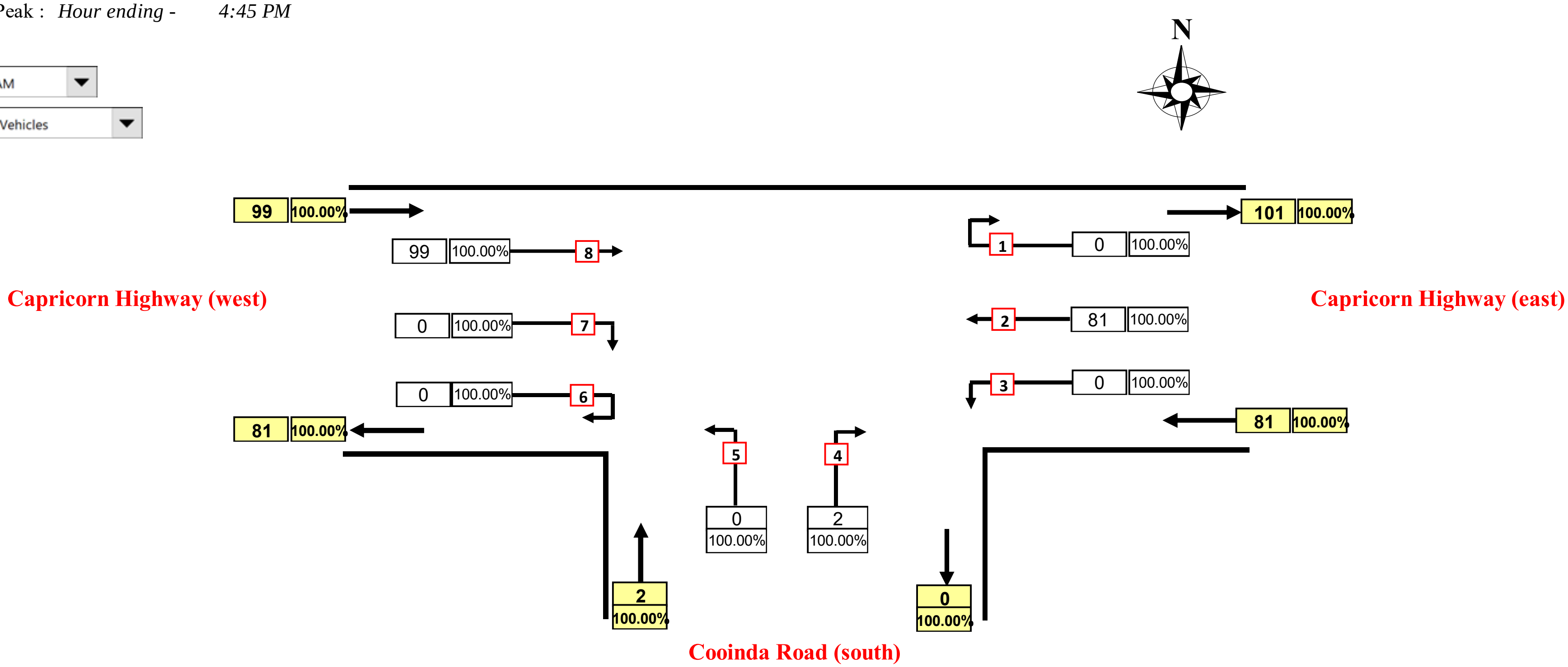
Day/Date: Tuesday, 23 July 2019

Summary: AM Peak : *Hour ending - 9:00 AM*

PM Peak : *Hour ending - 4:45 PM*

Hour Ending: 9:00 AM

Classification: Total Vehicles



AUSTRAFFIC VIDEO INTERSECTION COUNT

Site No.: 2 **Weather:** Fine

Location: Capricorn Highway/Cooinda Road, Dingo

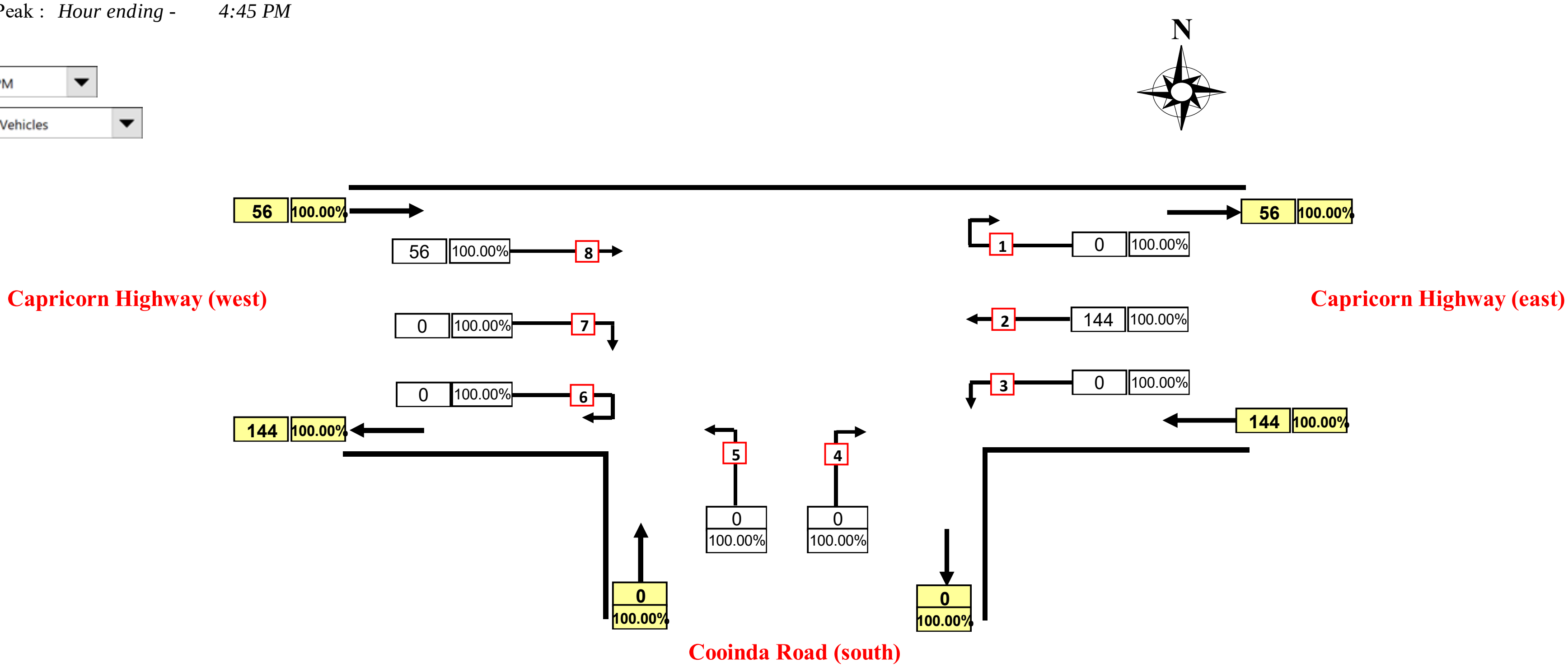
Day/Date: Tuesday, 23 July 2019

Summary: AM Peak : *Hour ending - 9:00 AM*

PM Peak : *Hour ending - 4:45 PM*

Hour Ending: 4:30 PM

Classification: Total Vehicles



AUSTRAFFIC VIDEO INTERSECTION COUNT

Site No.: 3 **Weather:** Fine

Location: Capricorn Highway/Charlevue Road, Dingo

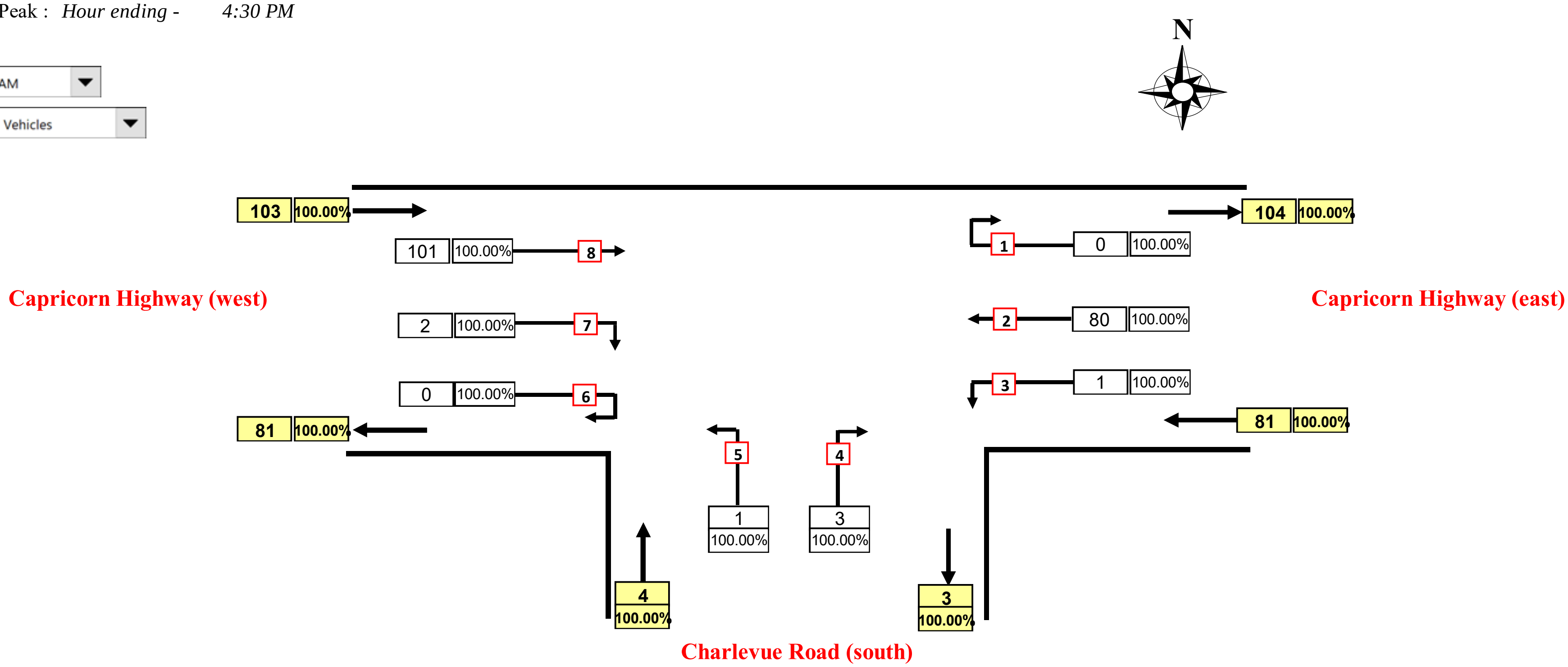
Day/Date: Tuesday, 23 July 2019

Summary: AM Peak : *Hour ending - 9:00 AM*

PM Peak : *Hour ending - 4:30 PM*

Hour Ending: 9:00 AM

Classification: Total Vehicles



AUSTRAFFIC VIDEO INTERSECTION COUNT

Site No.: 3 **Weather:** Fine

Location: Capricorn Highway/Charlevue Road, Dingo

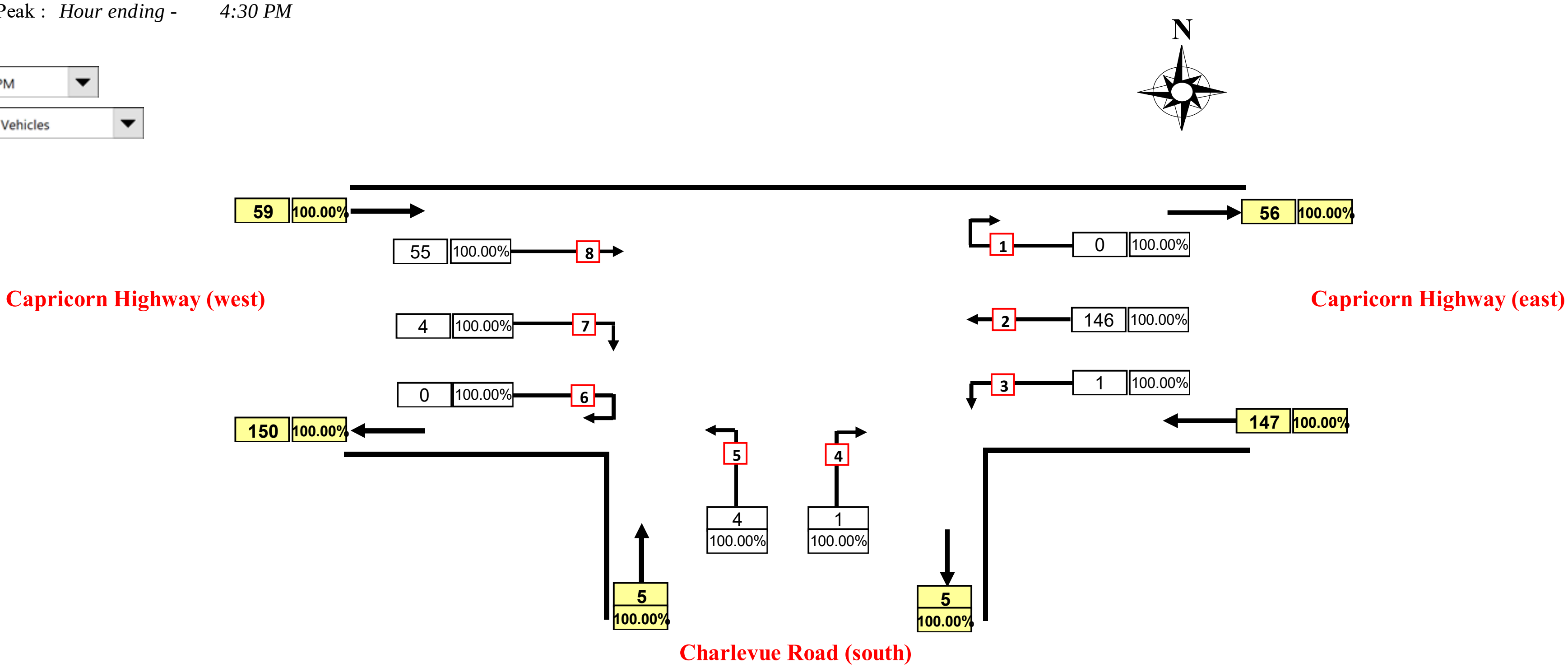
Day/Date: Tuesday, 23 July 2019

Summary: AM Peak : *Hour ending -* *9:00 AM*

PM Peak : *Hour ending -* *4:30 PM*

Hour Ending: 4:30 PM

Classification: Total Vehicles



APPENDIX

B

TRAFFIC VOLUMES

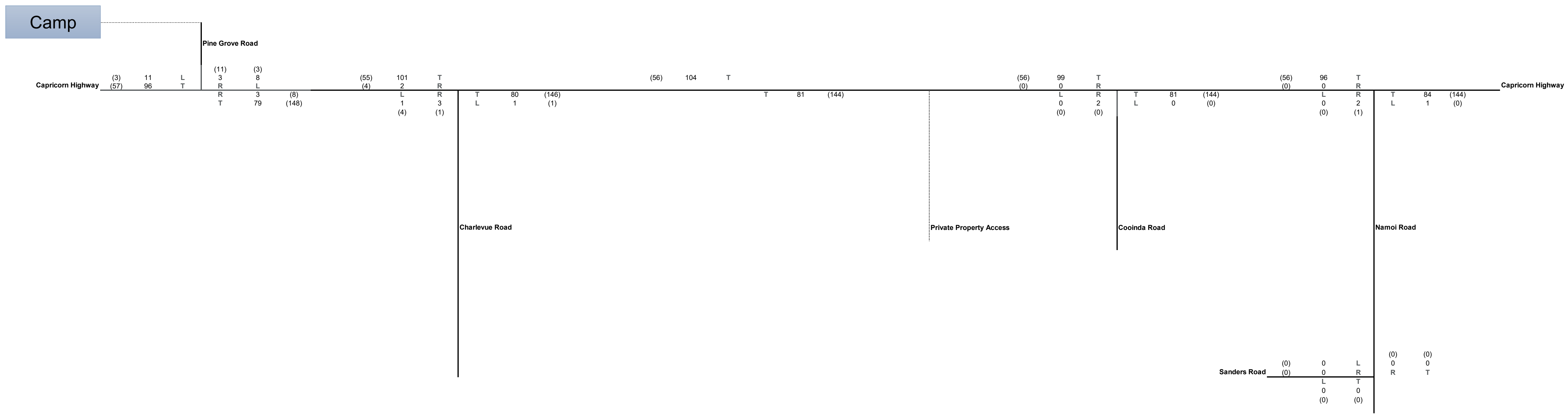


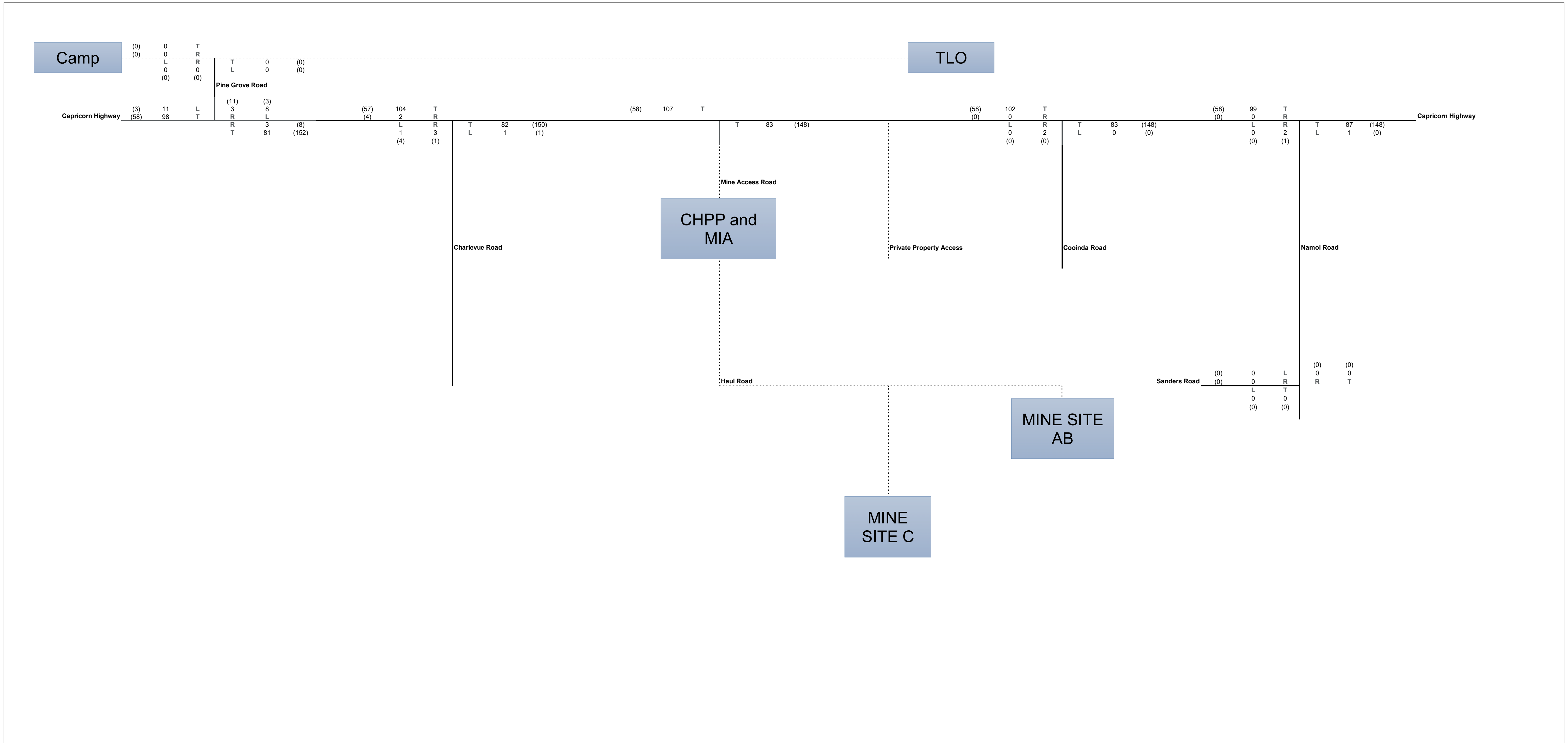
Figure **Background 2019 Traffic Flow Diagram**

Project no. QTT19061
Prepared by Nicholas Stone

Project Gemini Project TIA
Reviewed by John Peace

Legend

L	Left turn	00	AM Peak Volume
T	Through	(00)	PM Peak Volume
R	Right turn		
U	U-turn		



Cardno

Figure **Background 2022 Traffic Flow Diagram (1% p.a. Growth on 2019 Background Volumes)**

Project no. QTT19061
Prepared by Nicholas Stone

Project Gemini Project TIA
Reviewed by John Peace

Legend

L	Left turn	00	AM Peak Volume
T	Through	(00)	PM Peak Volume
R	Right turn		
U	U-turn		

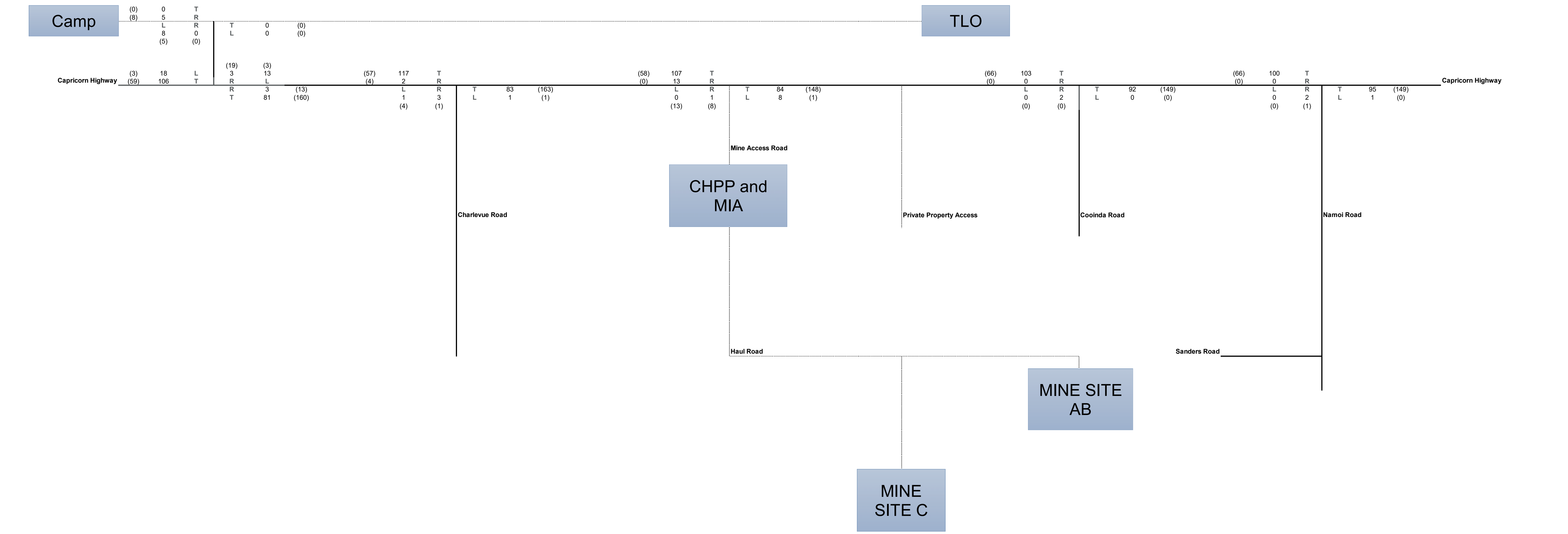


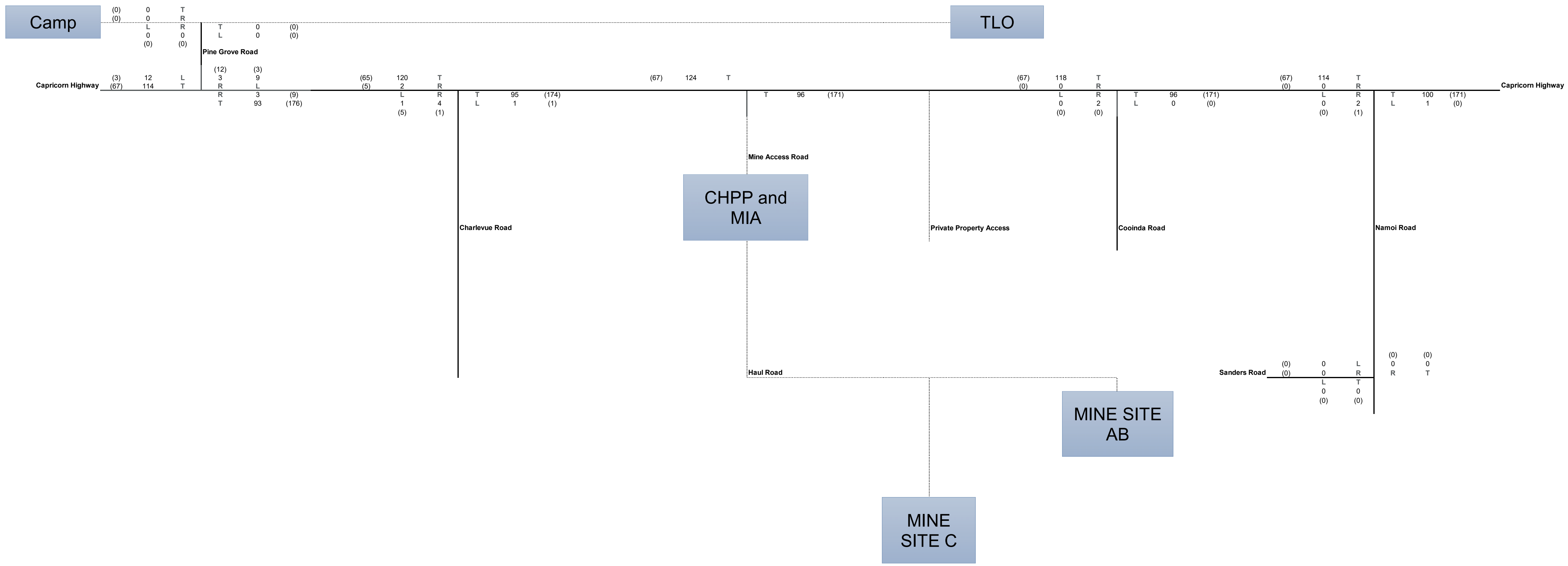
Figure Background 2022 + Peak Construction Traffic Flow Diagram

Project no. QTT19061
Prepared by Nicholas Stone

Project Gemini Project TIA
Reviewed by John Peace

Legend

L	Left turn	00	AM Peak Volume
T	Through	(00)	PM Peak Volume
R	Right turn		
U	U-turn		



Cardno

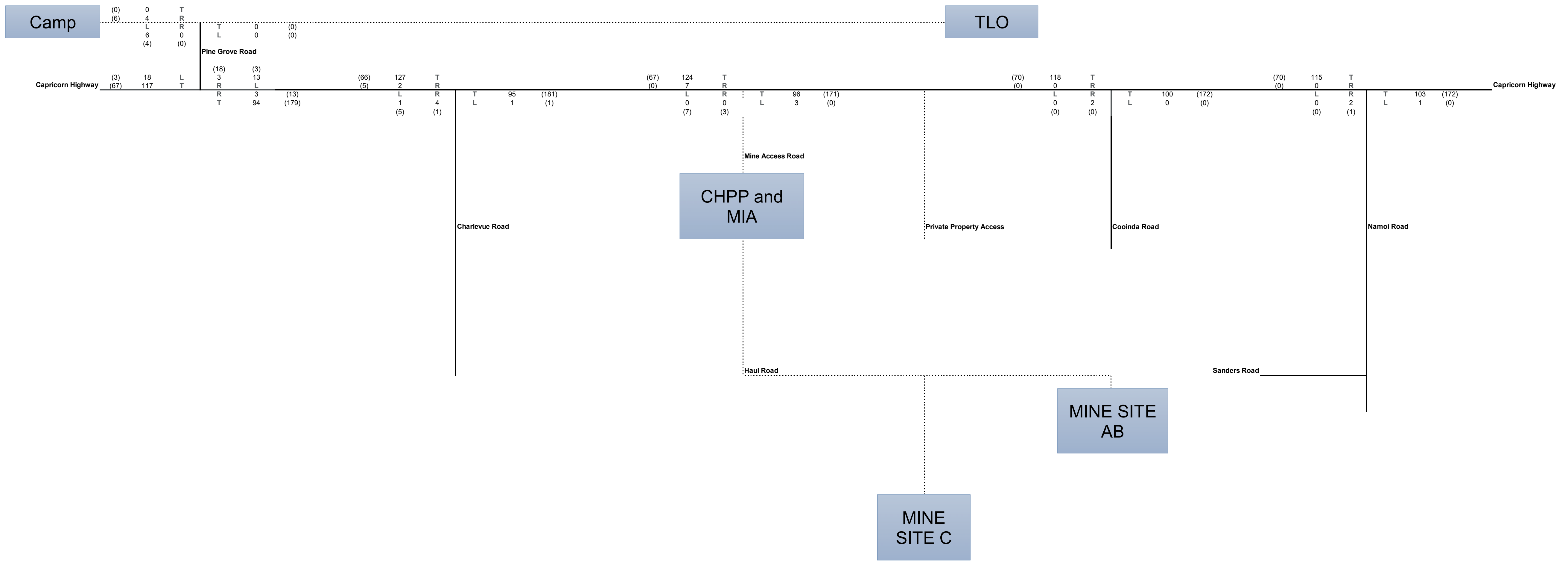
Figure #N/A

Background 2038 Traffic Flow Diagram (1% p.a. Growth on 2019 Background Volumes)

Project no. QTT19061
Prepared by Nicholas Stone
Project Gemini Project TIA
Reviewed by John Peace

Legend

L	Left turn	00	AM Peak Volume
T	Through	(00)	PM Peak Volume
R	Right turn		
U	U-turn		



Cardno

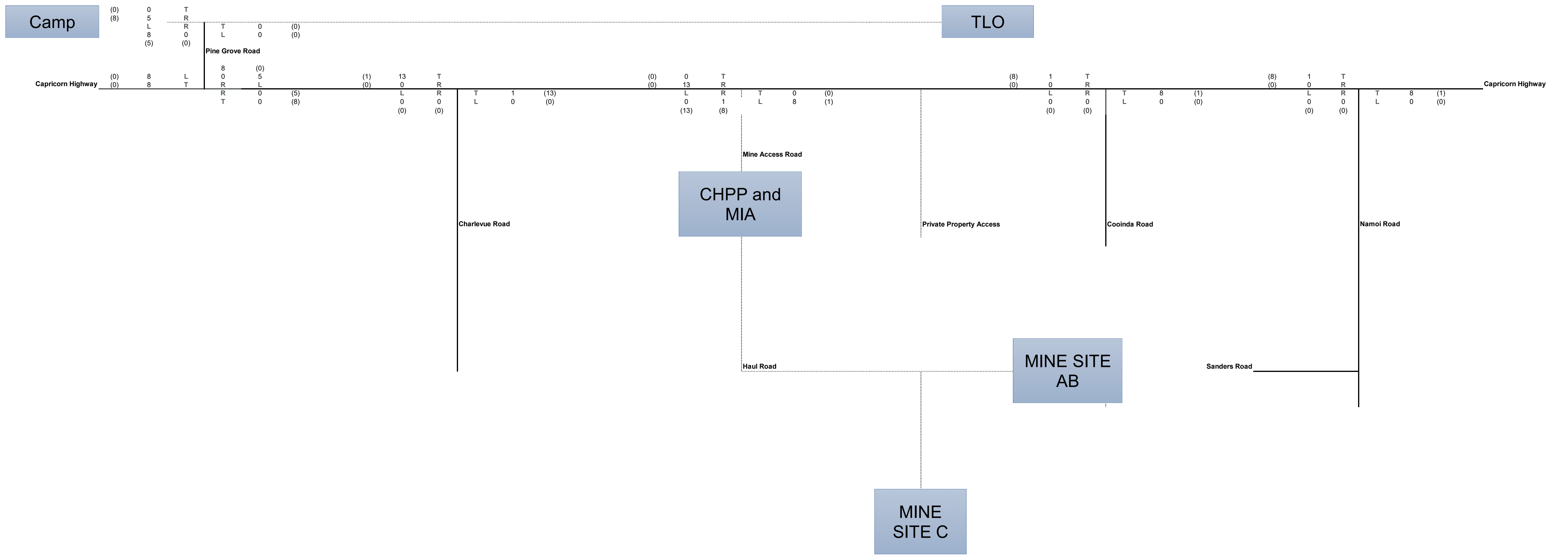
Figure **Background 2038 + End of Operations Traffic Flow Diagram**

Project no. QTT19061
Prepared by Nicholas Stone

Project Gemini Project TIA
Reviewed by John Peace

Legend

L	Left turn	**00**	AM Peak Volume
T	Through	**(00)**	PM Peak Volume
R	Right turn		
U	U-turn		



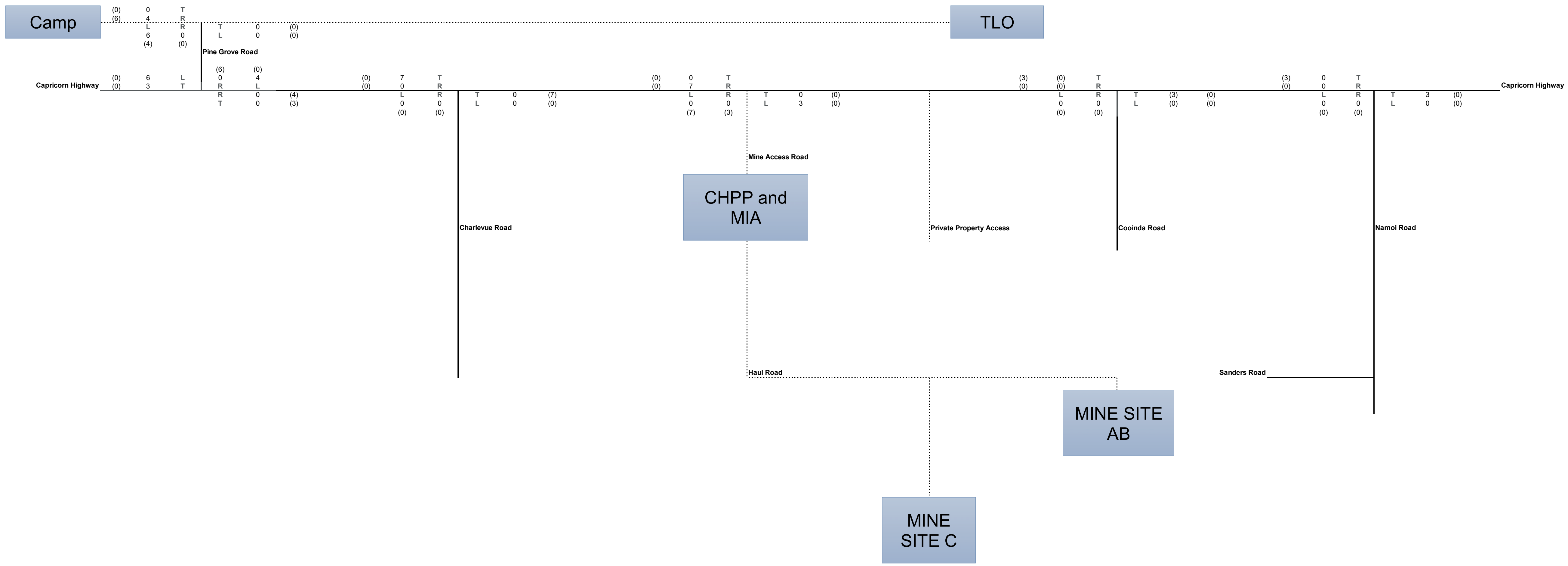
Cardno

Figure Peak Construction Traffic Flow Diagram

Project no. QTT19061
Prepared by Nicholas Stone

Project Gemini Project TIA
Reviewed by John Peace

Legend
L Left turn 00 AM Peak Volume
T Through (00) PM Peak Volume
R Right turn
U U-turn



Cardno

Figure **End of Operations Traffic Flow Diagram**

Project no. QTT19061
Prepared by Nicholas Stone

Project Gemini Project TIA
Reviewed by John Peace

Legend

L	Left turn	00	AM Peak Volume
T	Through	(00)	PM Peak Volume
R	Right turn		
U	U-turn		

APPENDIX

C

SIDRA LAYOUT, RESULTS, AND TURN WARRANT TREATMENTS

LANE SUMMARY

Site: 101 [2022 BG + PEAK CONSTRUCTION AM PEAK]

Capricorn Highway / Proposed Mine Access Road
Site Category: (None)
Giveway / Yield (Two-Way)

Lane Use and Performance

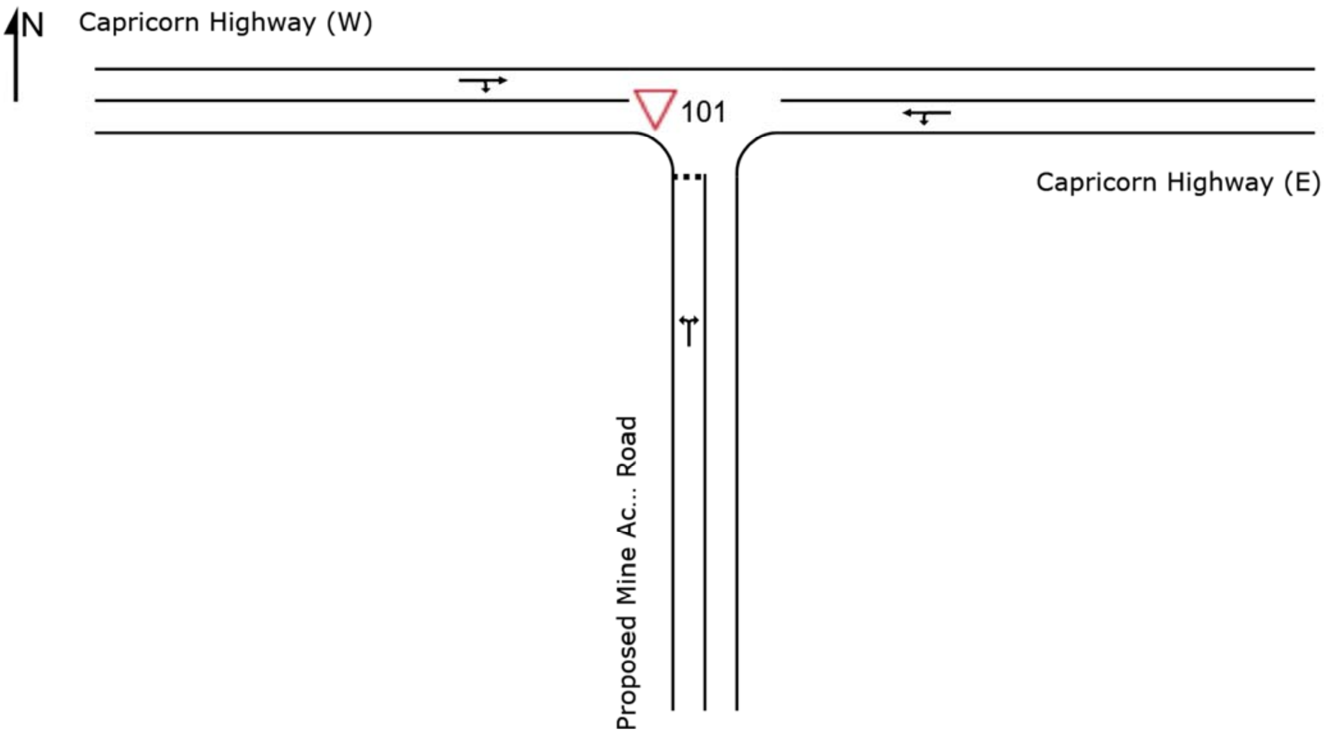
	Demand Flows Total veh/h	Demand Flows HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	95% Back of Queue Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Proposed Mine Access Road													
Lane 1	2	0.0	1253	0.002	100	6.0	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	2	0.0		0.002		6.0	LOS A	0.0	0.0				
East: Capricorn Highway (E)													
Lane 1	97	0.0	1942	0.050	100	0.5	LOS A	0.0	0.0	Full	800	0.0	0.0
Approach	97	0.0		0.050		0.5	NA	0.0	0.0				
West: Capricorn Highway (W)													
Lane 1	126	0.0	1904	0.066	100	0.7	LOS A	0.1	0.6	Full	800	0.0	0.0
Approach	126	0.0		0.066		0.7	NA	0.1	0.6				
Intersection	225	0.0		0.066		0.6	NA	0.1	0.6				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

SITE LAYOUT

▽ Site: 101 [2022 BG + PEAK CONSTRUCTION AM PEAK]

Capricorn Highway / Proposed Mine Access Road
Site Category: (None)
Giveway / Yield (Two-Way)



LANE SUMMARY

Site: 101 [2022 BG + PEAK CONSTRUCTION PM PEAK]

Capricorn Highway / Proposed Mine Access Road
Site Category: (None)
Giveway / Yield (Two-Way)

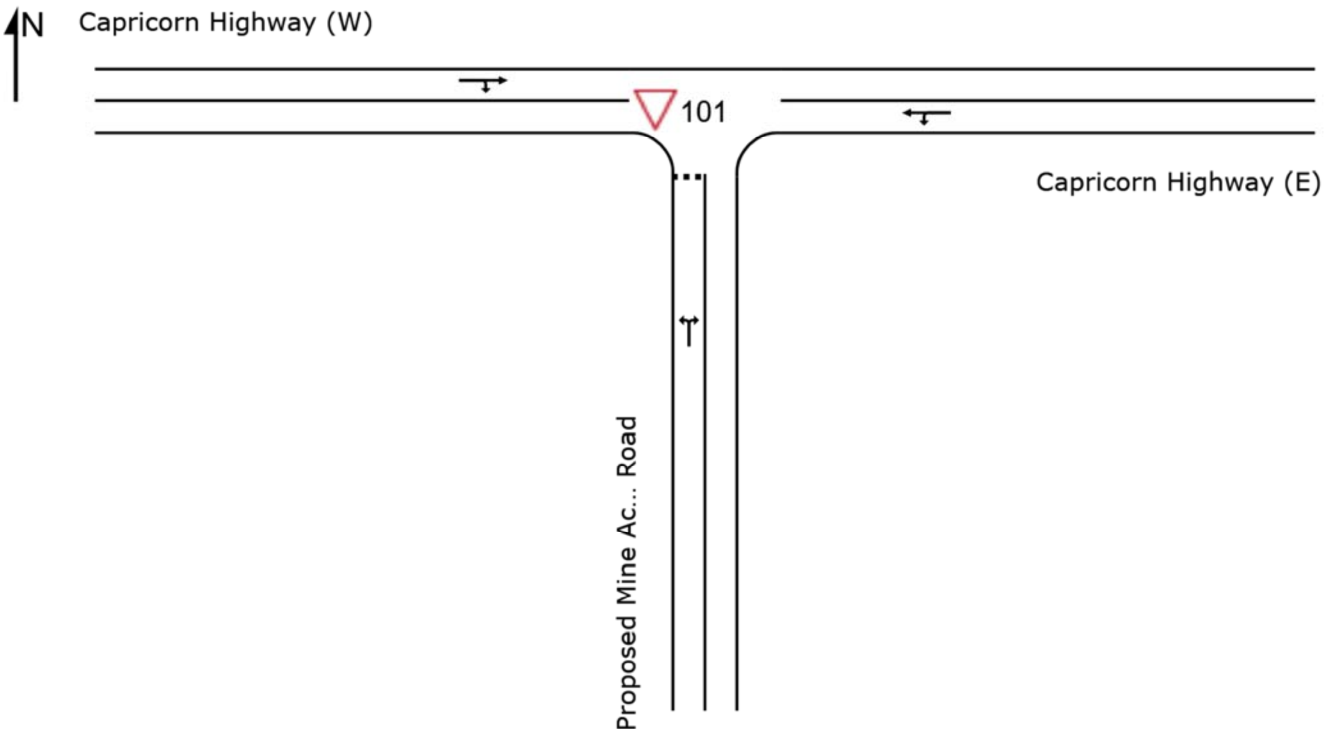
Lane Use and Performance														
	Demand Flows Total veh/h	Demand Flows HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	95% Back of Queue Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Proposed Mine Access Road													
Lane 1	22	0.0	1266	0.017	100	6.1	LOS A	0.1	0.4	Full	500	0.0	0.0
Approach	22	0.0		0.017		6.1	LOS A	0.1	0.4				
East: Capricorn Highway (E)													
Lane 1	157	0.0	1949	0.080	100	0.0	LOS A	0.0	0.0	Full	800	0.0	0.0
Approach	157	0.0		0.080		0.0	NA	0.0	0.0				
West: Capricorn Highway (W)													
Lane 1	62	0.0	1940	0.032	100	0.1	LOS A	0.0	0.1	Full	800	0.0	0.0
Approach	62	0.0		0.032		0.1	NA	0.0	0.1				
Intersection	241	0.0		0.080		0.6	NA	0.1	0.4				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

SITE LAYOUT

▽ Site: 101 [2022 BG + PEAK CONSTRUCTION PM PEAK]

Capricorn Highway / Proposed Mine Access Road
Site Category: (None)
Giveway / Yield (Two-Way)



Organisation: CARDNO (QLD) PTY LTD | Created: Monday, 12 August 2019 3:19:45 PM
Project: G:\QTT19061 - Dingo West Coal Mine TIA\5_PROJECT ANALYSIS\Analysis\SIDRA\Mine Access Intersection.sip8

LANE SUMMARY

Site: 101 [2038 BG + PEAK OPERATION AM PEAK]

Capricorn Highway / Proposed Mine Access Road
Site Category: (None)
Giveway / Yield (Two-Way)

Lane Use and Performance

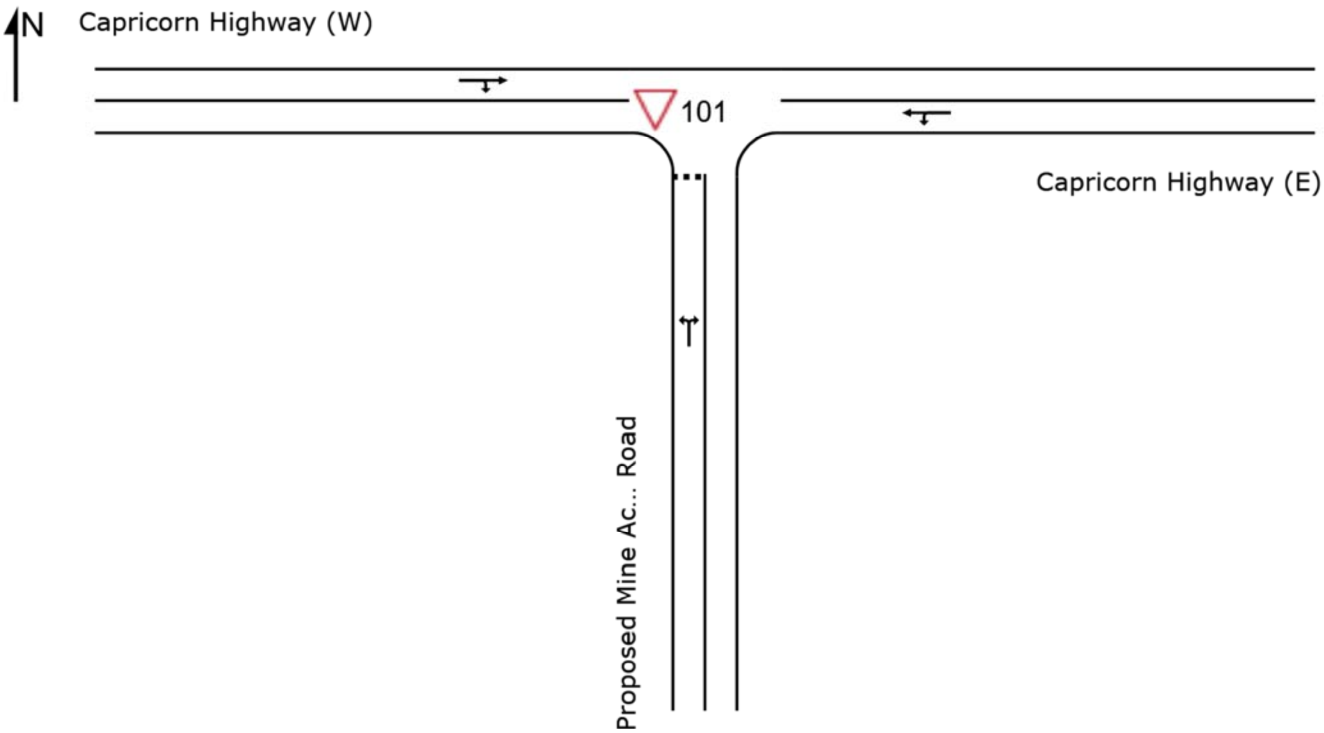
	Demand Flows Total veh/h	Demand Flows HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	95% Back of Queue Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Proposed Mine Access Road													
Lane 1	2	0.0	1233	0.002	100	6.0	LOS A	0.0	0.0	Full	500	0.0	0.0
Approach	2	0.0		0.002		6.0	LOS A	0.0	0.0				
East: Capricorn Highway (E)													
Lane 1	104	0.0	1947	0.054	100	0.2	LOS A	0.0	0.0	Full	800	0.0	0.0
Approach	104	0.0		0.054		0.2	NA	0.0	0.0				
West: Capricorn Highway (W)													
Lane 1	138	0.0	1926	0.072	100	0.3	LOS A	0.0	0.3	Full	800	0.0	0.0
Approach	138	0.0		0.072		0.3	NA	0.0	0.3				
Intersection	244	0.0		0.072		0.3	NA	0.0	0.3				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

SITE LAYOUT

▽ Site: 101 [2038 BG + PEAK OPERATION AM PEAK]

Capricorn Highway / Proposed Mine Access Road
Site Category: (None)
Giveway / Yield (Two-Way)



LANE SUMMARY

▽ Site: 101 [2038 BG + PEAK OPERATION PM PEAK]

Capricorn Highway / Proposed Mine Access Road
Site Category: (None)
Giveway / Yield (Two-Way)

Lane Use and Performance

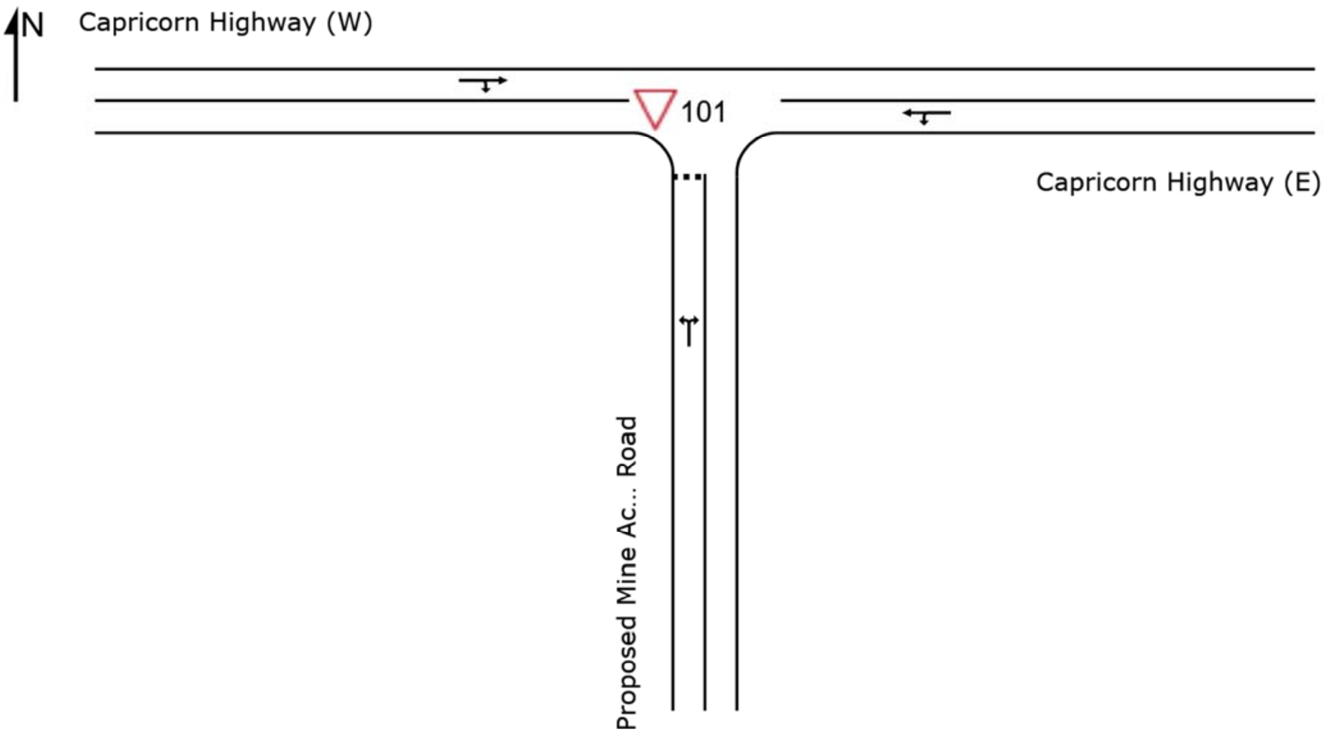
	Demand Flows Total veh/h	Demand Flows HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	95% Back of Queue Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Proposed Mine Access Road													
Lane 1	11	0.0	1265	0.008	100	6.1	LOS A	0.0	0.2	Full	500	0.0	0.0
Approach	11	0.0		0.008		6.1	LOS A	0.0	0.2				
East: Capricorn Highway (E)													
Lane 1	181	0.0	1949	0.093	100	0.0	LOS A	0.0	0.0	Full	800	0.0	0.0
Approach	181	0.0		0.093		0.0	NA	0.0	0.0				
West: Capricorn Highway (W)													
Lane 1	72	0.0	1941	0.037	100	0.1	LOS A	0.0	0.1	Full	800	0.0	0.0
Approach	72	0.0		0.037		0.1	NA	0.0	0.1				
Intersection	263	0.0		0.093		0.3	NA	0.0	0.2				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

SITE LAYOUT

▽ Site: 101 [2038 BG + PEAK OPERATION PM PEAK]

Capricorn Highway / Proposed Mine Access Road
Site Category: (None)
Giveway / Yield (Two-Way)



Organisation: CARDNO (QLD) PTY LTD | Created: Monday, 12 August 2019 3:20:16 PM
Project: G:\QTT19061 - Dingo West Coal Mine TIA\5_PROJECT ANALYSIS\Analysis\SIDRA\Mine Access Intersection.sip8

LANE SUMMARY

▽ Site: 101 [2019 BG AM PEAK]

Capricorn Highway / TLO Access Road
Site Category: (None)
Giveway / Yield (Two-Way)

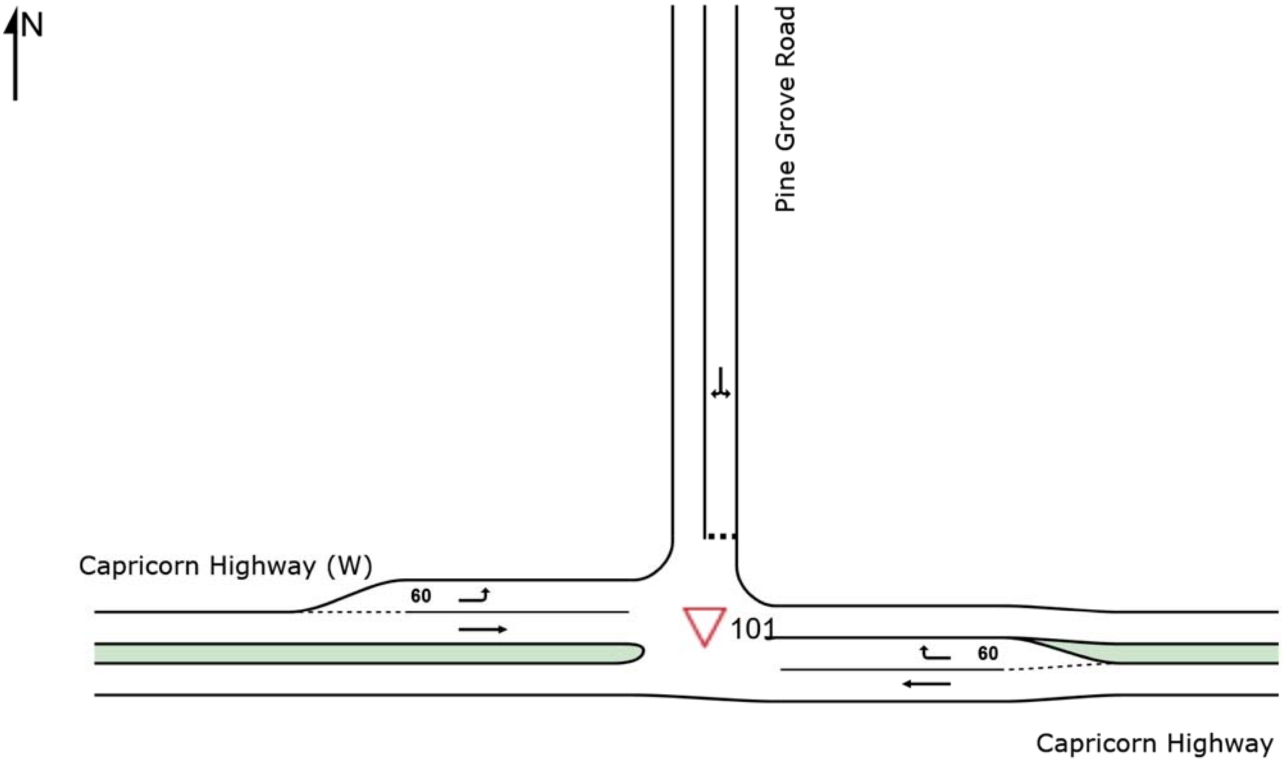
Lane Use and Performance														
	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
East: Capricorn Highway (E)													
Lane 1	83	0.0	1950	0.043	100	0.0	LOS A	0.0	0.0	Full	800	0.0	0.0
Lane 2	3	0.0	1296	0.002	100	5.8	LOS A	0.0	0.1	Short	60	0.0	NA
Approach	86	0.0		0.043		0.2	NA	0.0	0.1				
North: Pine Grove Road													
Lane 1	12	0.0	1094	0.011	100	5.7	LOS A	0.0	0.3	Full	80	0.0	0.0
Approach	12	0.0		0.011		5.7	LOS A	0.0	0.3				
West: Capricorn Highway (W)													
Lane 1	12	0.0	1857	0.006	100	5.5	LOS A	0.0	0.0	Short	60	0.0	NA
Lane 2	101	0.0	1950	0.052	100	0.0	LOS A	0.0	0.0	Full	800	0.0	0.0
Approach	113	0.0		0.052		0.6	NA	0.0	0.0				
Intersection	211	0.0		0.052		0.7	NA	0.0	0.3				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

SITE LAYOUT

Site: 101 [2019 BG AM PEAK]

Capricorn Highway / TLO Access Road
Site Category: (None)
Giveway / Yield (Two-Way)



Organisation: CARDNO (QLD) PTY LTD | Created: Tuesday, 1 October 2019 9:09:12 AM
Project: G:\QTT19061 - Dingo West Coal Mine TIA\5_PROJECT ANALYSIS\Analysis\SIDRA\Pine Grove Road.sip8

LANE SUMMARY

Site: 101 [2019 BG PM PEAK]

Capricorn Highway / TLO Access Road
Site Category: (None)
Giveway / Yield (Two-Way)

Lane Use and Performance

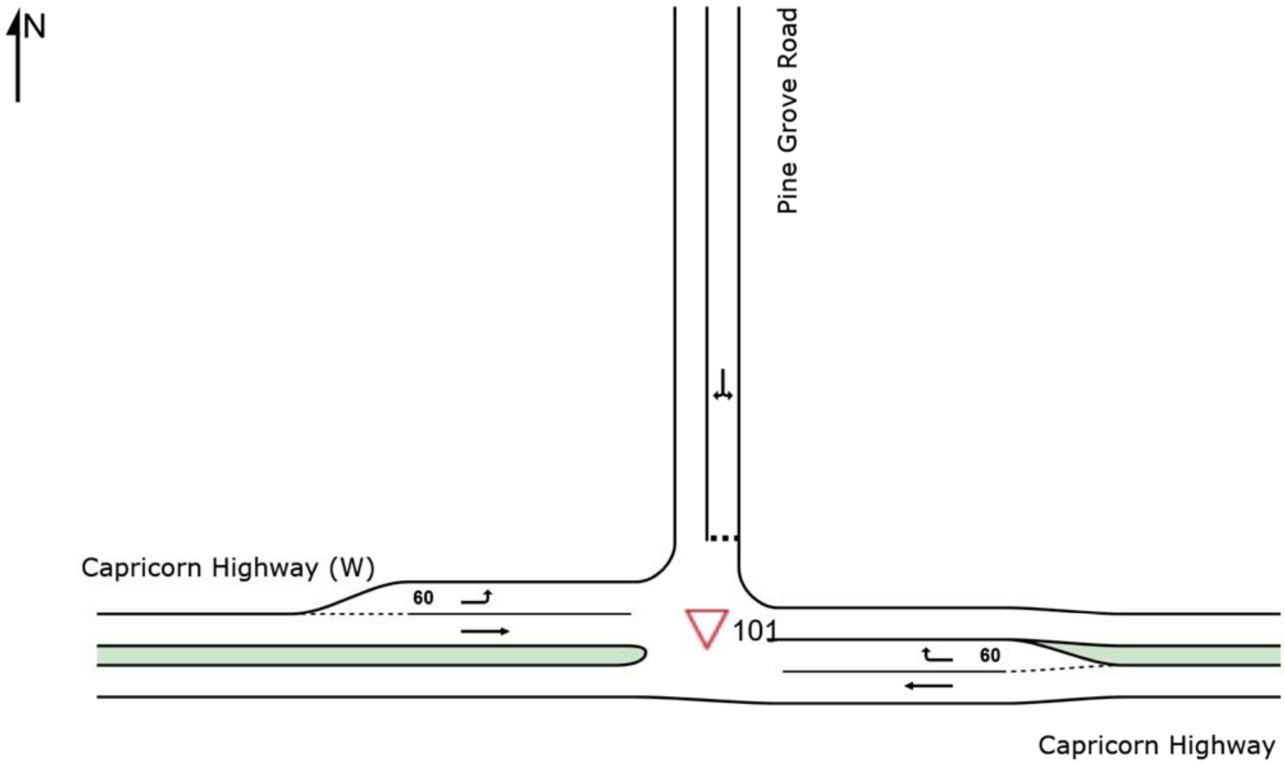
	Demand Flows Total veh/h	Demand Flows HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	95% Back of Queue Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
East: Capricorn Highway (E)													
Lane 1	156	0.0	1950	0.080	100	0.0	LOS A	0.0	0.0	Full	800	0.0	0.0
Lane 2	8	0.0	1358	0.006	100	5.7	LOS A	0.0	0.2	Short	60	0.0	NA
Approach	164	0.0		0.080		0.3	NA	0.0	0.2				
North: Pine Grove Road													
Lane 1	15	0.0	892	0.017	100	6.3	LOS A	0.1	0.4	Full	80	0.0	0.0
Approach	15	0.0		0.017		6.3	LOS A	0.1	0.4				
West: Capricorn Highway (W)													
Lane 1	3	0.0	1857	0.002	100	5.5	LOS A	0.0	0.0	Short	60	0.0	NA
Lane 2	60	0.0	1950	0.031	100	0.0	LOS A	0.0	0.0	Full	800	0.0	0.0
Approach	63	0.0		0.031		0.3	NA	0.0	0.0				
Intersection	242	0.0		0.080		0.7	NA	0.1	0.4				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

SITE LAYOUT

▽ Site: 101 [2019 BG PM PEAK]

Capricorn Highway / TLO Access Road
Site Category: (None)
Giveway / Yield (Two-Way)



Organisation: CARDNO (QLD) PTY LTD | Created: Tuesday, 1 October 2019 9:09:53 AM
Project: G:\QTT19061 - Dingo West Coal Mine TIA\5_PROJECT ANALYSIS\Analysis\SIDRA\Pine Grove Road.sip8

LANE SUMMARY

Site: 101 [2022 BG + PEAK CONSTRUCTION AM PEAK]

Capricorn Highway / TLO Access Road
Site Category: (None)
Giveway / Yield (Two-Way)

Lane Use and Performance

	Demand Flows Total veh/h	Demand Flows HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	95% Back of Queue Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
East: Capricorn Highway (E)													
Lane 1	85	0.0	1950	0.044	100	0.0	LOS A	0.0	0.0	Full	800	0.0	0.0
Lane 2	3	0.0	1273	0.002	100	5.9	LOS A	0.0	0.1	Short	60	0.0	NA
Approach	88	0.0		0.044		0.2	NA	0.0	0.1				
North: Pine Grove Road													
Lane 1	17	0.0	1115	0.015	100	5.7	LOS A	0.1	0.4	Full	80	0.0	0.0
Approach	17	0.0		0.015		5.7	LOS A	0.1	0.4				
West: Capricorn Highway (W)													
Lane 1	19	0.0	1857	0.010	100	5.5	LOS A	0.0	0.0	Short	60	0.0	NA
Lane 2	112	0.0	1950	0.057	100	0.0	LOS A	0.0	0.0	Full	800	0.0	0.0
Approach	131	0.0		0.057		0.8	NA	0.0	0.0				
Intersection	236	0.0		0.057		0.9	NA	0.1	0.4				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

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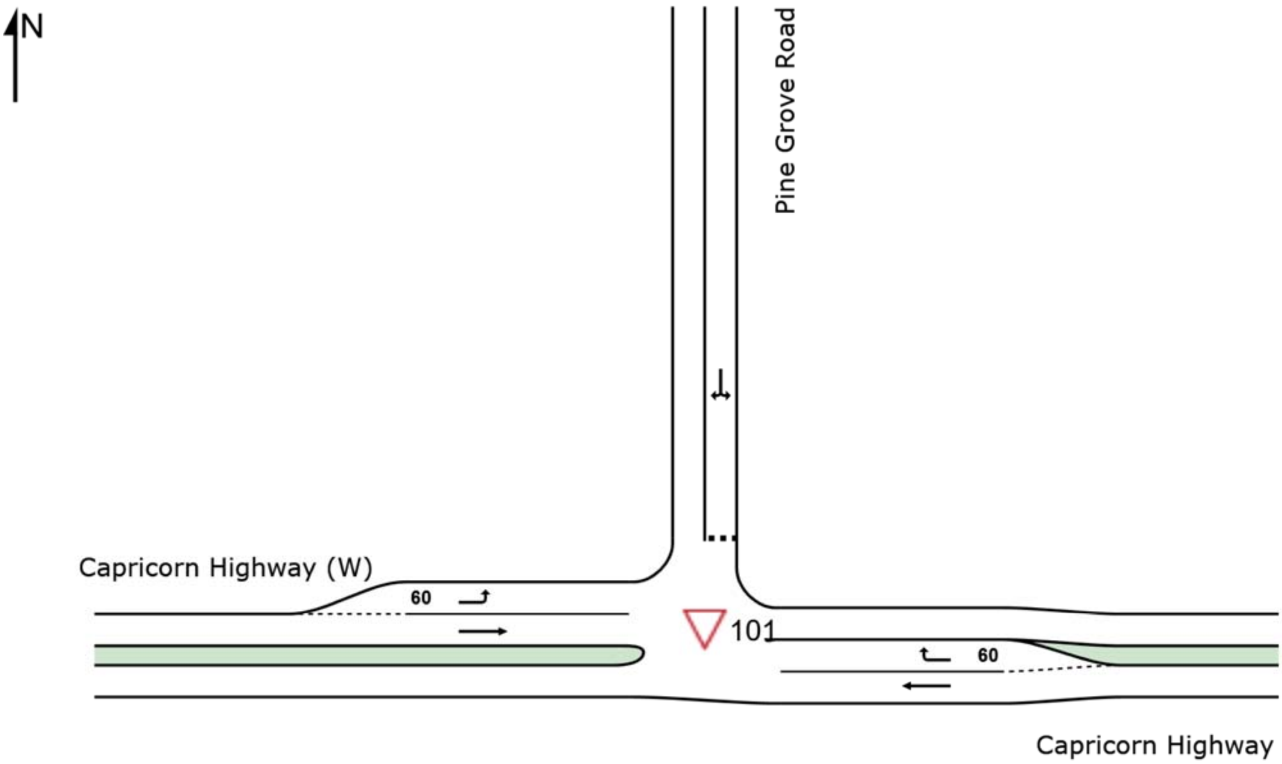
Project: G:\QTT19061 - Dingo West Coal Mine TIA\5_PROJECT ANALYSIS\Analysis\SIDRA\Pine Grove Road.sip8

SITE LAYOUT

▽ Site: 101 [2022 BG + PEAK CONSTRUCTION AM PEAK]

Capricorn Highway / TLO Access Road
Site Category: (None)
Giveway / Yield (Two-Way)



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Project: G:\QTT19061 - Dingo West Coal Mine TIA\5_PROJECT ANALYSIS\Analysis\SIDRA\Pine Grove Road.sip8

LANE SUMMARY

▽ Site: 101 [2022 BG + PEAK CONSTRUCTION PM PEAK]

Capricorn Highway / TLO Access Road
Site Category: (None)
Giveway / Yield (Two-Way)

Lane Use and Performance

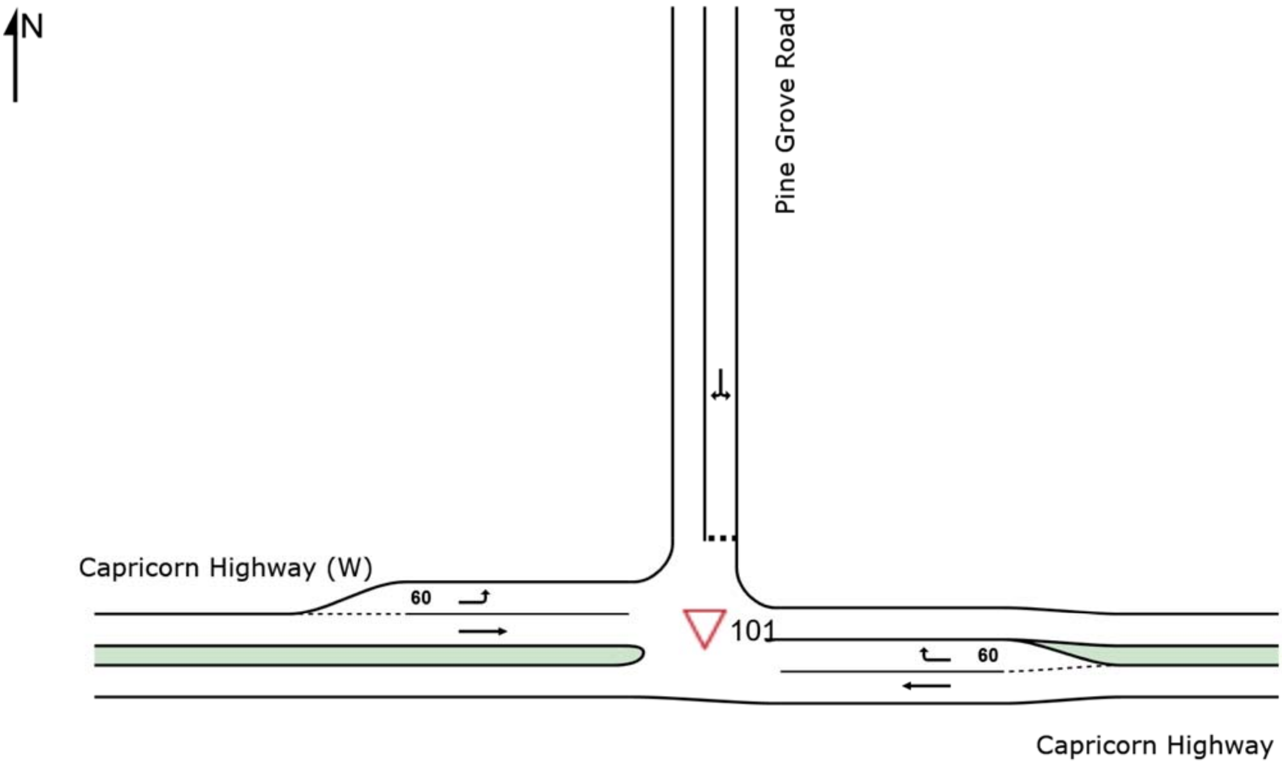
	Demand Flows Total veh/h	Demand Flows HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	95% Back of Queue Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
East: Capricorn Highway (E)													
Lane 1	168	0.0	1950	0.086	100	0.0	LOS A	0.0	0.0	Full	800	0.0	0.0
Lane 2	14	0.0	1356	0.010	100	5.7	LOS A	0.0	0.3	Short	60	0.0	NA
Approach	182	0.0		0.086		0.4	NA	0.0	0.3				
North: Pine Grove Road													
Lane 1	23	0.0	846	0.027	100	6.6	LOS A	0.1	0.7	Full	80	0.0	0.0
Approach	23	0.0		0.027		6.6	LOS A	0.1	0.7				
West: Capricorn Highway (W)													
Lane 1	3	0.0	1857	0.002	100	5.5	LOS A	0.0	0.0	Short	60	0.0	NA
Lane 2	62	0.0	1950	0.032	100	0.0	LOS A	0.0	0.0	Full	800	0.0	0.0
Approach	65	0.0		0.032		0.3	NA	0.0	0.0				
Intersection	271	0.0		0.086		0.9	NA	0.1	0.7				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

SITE LAYOUT

▽ Site: 101 [2022 BG + PEAK CONSTRUCTION PM PEAK]

Capricorn Highway / TLO Access Road
Site Category: (None)
Giveway / Yield (Two-Way)



LANE SUMMARY

Site: 101 [2022 BG AM PEAK]

Capricorn Highway / TLO Access Road
Site Category: (None)
Giveway / Yield (Two-Way)

Lane Use and Performance

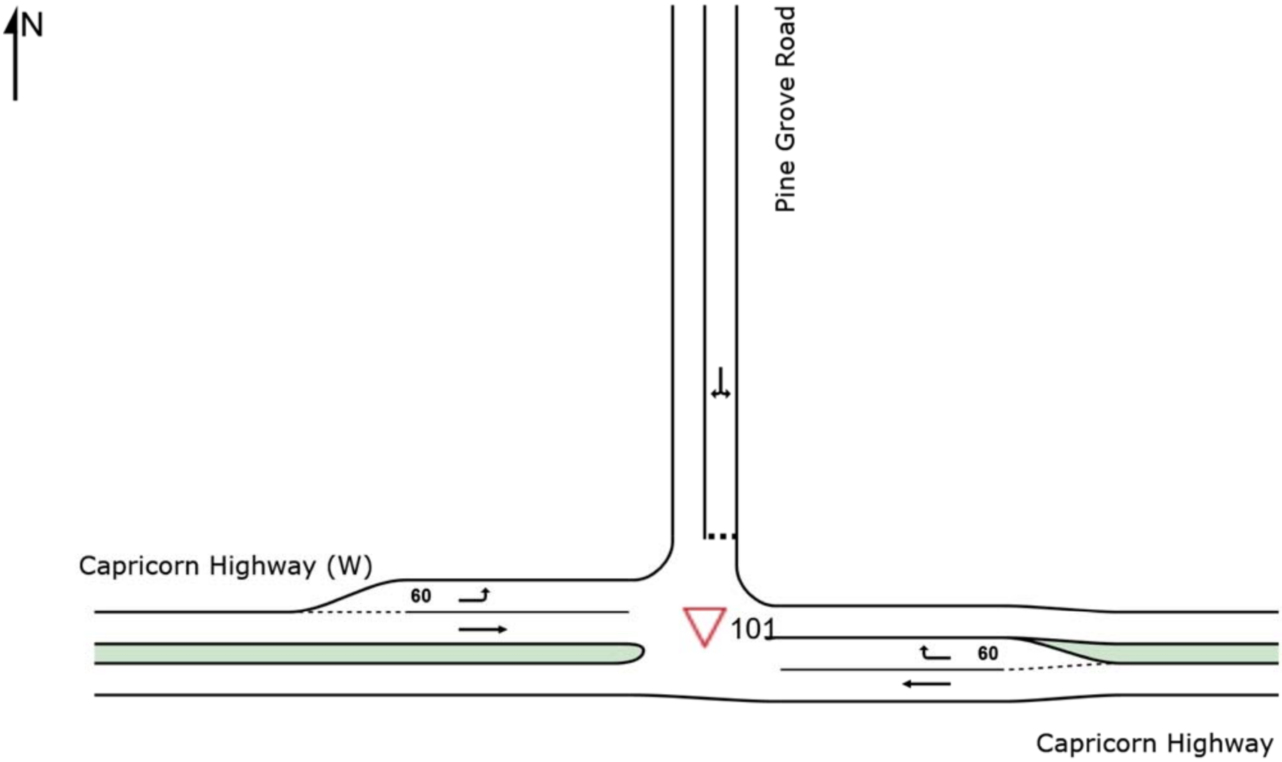
	Demand Flows Total veh/h	Demand Flows HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	95% Back of Queue Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
East: Capricorn Highway (E)													
Lane 1	85	0.0	1950	0.044	100	0.0	LOS A	0.0	0.0	Full	800	0.0	0.0
Lane 2	3	0.0	1293	0.002	100	5.8	LOS A	0.0	0.1	Short	60	0.0	NA
Approach	88	0.0		0.044		0.2	NA	0.0	0.1				
North: Pine Grove Road													
Lane 1	12	0.0	1091	0.011	100	5.7	LOS A	0.0	0.3	Full	80	0.0	0.0
Approach	12	0.0		0.011		5.7	LOS A	0.0	0.3				
West: Capricorn Highway (W)													
Lane 1	12	0.0	1857	0.006	100	5.5	LOS A	0.0	0.0	Short	60	0.0	NA
Lane 2	103	0.0	1950	0.053	100	0.0	LOS A	0.0	0.0	Full	800	0.0	0.0
Approach	115	0.0		0.053		0.6	NA	0.0	0.0				
Intersection	215	0.0		0.053		0.7	NA	0.0	0.3				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

SITE LAYOUT

▽ Site: 101 [2022 BG AM PEAK]

Capricorn Highway / TLO Access Road
Site Category: (None)
Giveway / Yield (Two-Way)



LANE SUMMARY

Site: 101 [2022 BG PM PEAK]

Capricorn Highway / TLO Access Road
Site Category: (None)
Giveway / Yield (Two-Way)

Lane Use and Performance

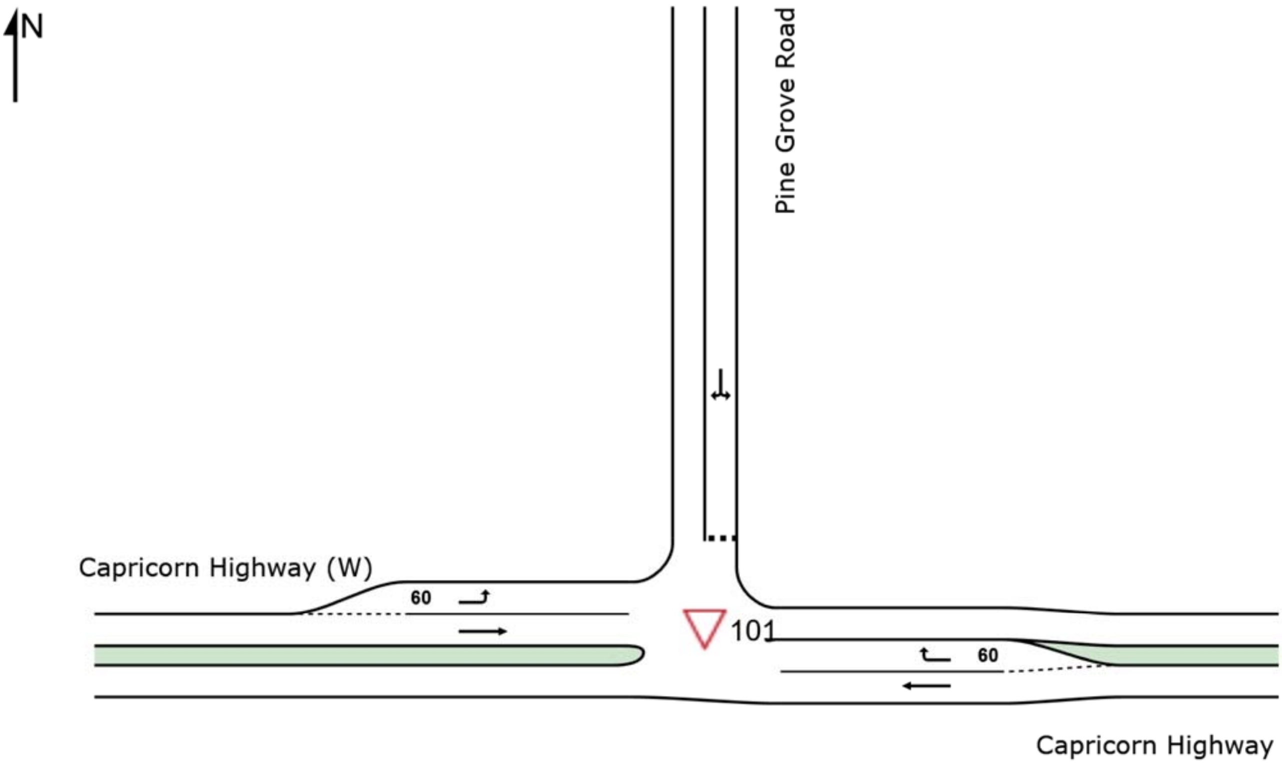
	Demand Flows Total veh/h	Demand Flows HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	95% Back of Queue Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
East: Capricorn Highway (E)													
Lane 1	160	0.0	1950	0.082	100	0.0	LOS A	0.0	0.0	Full	800	0.0	0.0
Lane 2	8	0.0	1357	0.006	100	5.7	LOS A	0.0	0.2	Short	60	0.0	NA
Approach	168	0.0		0.082		0.3	NA	0.0	0.2				
North: Pine Grove Road													
Lane 1	15	0.0	887	0.017	100	6.3	LOS A	0.1	0.4	Full	80	0.0	0.0
Approach	15	0.0		0.017		6.3	LOS A	0.1	0.4				
West: Capricorn Highway (W)													
Lane 1	3	0.0	1857	0.002	100	5.5	LOS A	0.0	0.0	Short	60	0.0	NA
Lane 2	61	0.0	1950	0.031	100	0.0	LOS A	0.0	0.0	Full	800	0.0	0.0
Approach	64	0.0		0.031		0.3	NA	0.0	0.0				
Intersection	247	0.0		0.082		0.6	NA	0.1	0.4				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

SITE LAYOUT

▽ Site: 101 [2022 BG PM PEAK]

Capricorn Highway / TLO Access Road
Site Category: (None)
Giveway / Yield (Two-Way)



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LANE SUMMARY

▽ Site: 101 [2040 BG + PEAK OPERATIONS AM PEAK]

Capricorn Highway / TLO Access Road
Site Category: (None)
Giveway / Yield (Two-Way)

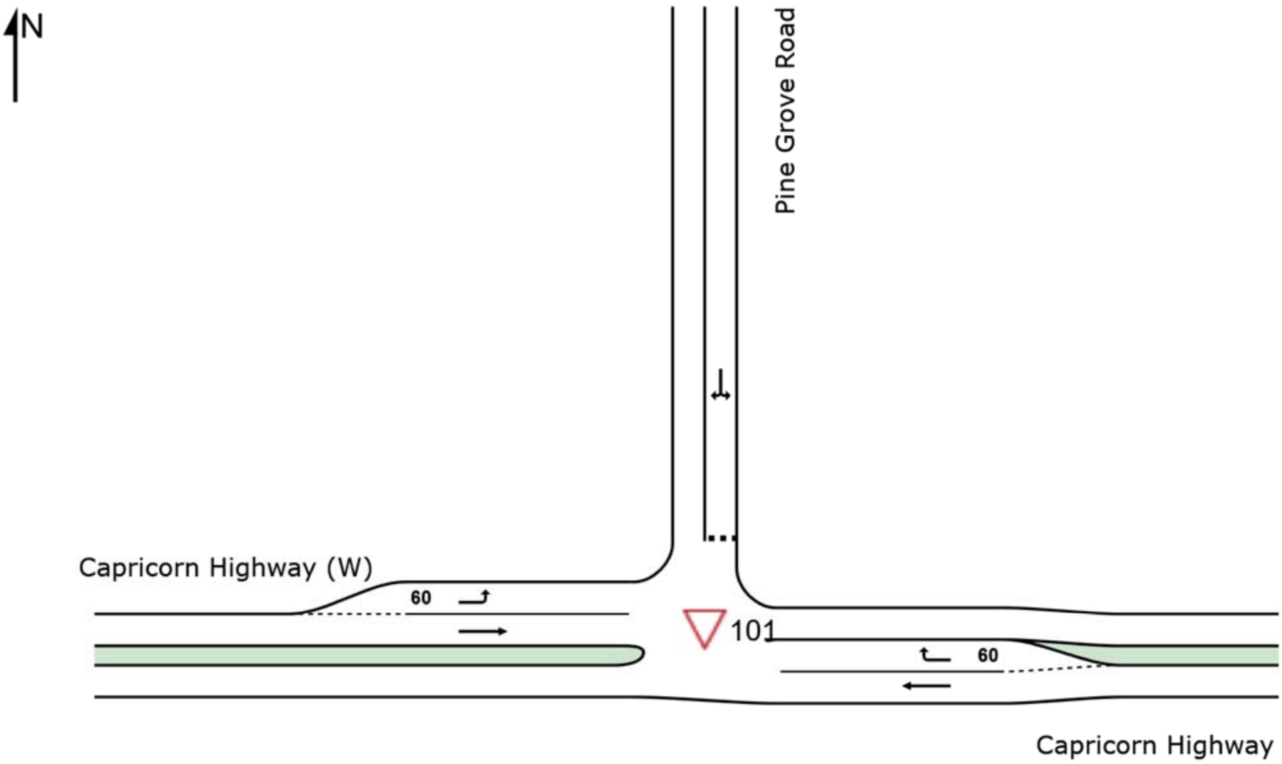
Lane Use and Performance														
	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
East: Capricorn Highway (E)													
Lane 1	100	0.0	1950	0.051	100	0.0	LOS A	0.0	0.0	Full	800	0.0	0.0
Lane 2	3	0.0	1255	0.003	100	5.9	LOS A	0.0	0.1	Short	60	0.0	NA
Approach	103	0.0		0.051		0.2	NA	0.0	0.1				
North: Pine Grove Road													
Lane 1	17	0.0	1094	0.015	100	5.8	LOS A	0.1	0.4	Full	80	0.0	0.0
Approach	17	0.0		0.015		5.8	LOS A	0.1	0.4				
West: Capricorn Highway (W)													
Lane 1	20	0.0	1857	0.011	100	5.5	LOS A	0.0	0.0	Short	60	0.0	NA
Lane 2	125	0.0	1950	0.064	100	0.0	LOS A	0.0	0.0	Full	800	0.0	0.0
Approach	145	0.0		0.064		0.8	NA	0.0	0.0				
Intersection	265	0.0		0.064		0.9	NA	0.1	0.4				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

SITE LAYOUT

▽ Site: 101 [2040 BG + PEAK OPERATIONS AM PEAK]

Capricorn Highway / TLO Access Road
Site Category: (None)
Giveway / Yield (Two-Way)



LANE SUMMARY

Site: 101 [2040 BG + PEAK OPERATIONS PM PEAK]

Capricorn Highway / TLO Access Road
Site Category: (None)
Giveway / Yield (Two-Way)

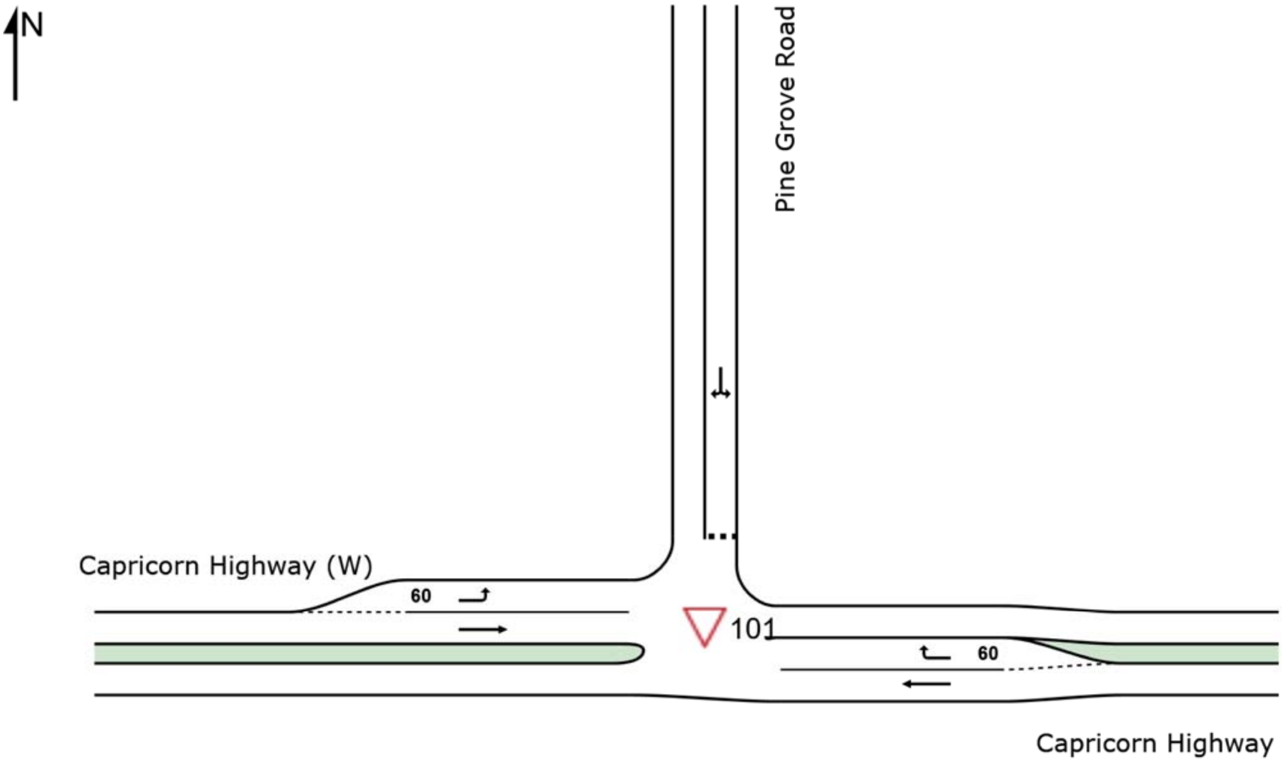
Lane Use and Performance													
	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
East: Capricorn Highway (E)													
Lane 1	192	0.0	1950	0.098	100	0.0	LOS A	0.0	0.0	Full	800	0.0	0.0
Lane 2	14	0.0	1342	0.010	100	5.7	LOS A	0.0	0.3	Short	60	0.0	NA
Approach	205	0.0		0.098		0.4	NA	0.0	0.3				
North: Pine Grove Road													
Lane 1	23	0.0	812	0.029	100	6.8	LOS A	0.1	0.7	Full	80	0.0	0.0
Approach	23	0.0		0.029		6.8	LOS A	0.1	0.7				
West: Capricorn Highway (W)													
Lane 1	3	0.0	1857	0.002	100	5.5	LOS A	0.0	0.0	Short	60	0.0	NA
Lane 2	73	0.0	1950	0.037	100	0.0	LOS A	0.0	0.0	Full	800	0.0	0.0
Approach	76	0.0		0.037		0.2	NA	0.0	0.0				
Intersection	304	0.0		0.098		0.8	NA	0.1	0.7				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

SITE LAYOUT

▽ Site: 101 [2040 BG + PEAK OPERATIONS PM PEAK]

Capricorn Highway / TLO Access Road
Site Category: (None)
Giveway / Yield (Two-Way)



LANE SUMMARY

Site: 101 [2040 BG AM PEAK]

Capricorn Highway / TLO Access Road
Site Category: (None)
Giveway / Yield (Two-Way)

Lane Use and Performance

	Demand Flows Total veh/h	Demand Flows HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	95% Back of Queue Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
East: Capricorn Highway (E)													
Lane 1	100	0.0	1950	0.051	100	0.0	LOS A	0.0	0.0	Full	800	0.0	0.0
Lane 2	3	0.0	1267	0.002	100	5.9	LOS A	0.0	0.1	Short	60	0.0	NA
Approach	103	0.0		0.051		0.2	NA	0.0	0.1				
North: Pine Grove Road													
Lane 1	13	0.0	890	0.014	100	6.3	LOS A	0.1	0.4	Full	80	0.0	0.0
Approach	13	0.0		0.014		6.3	LOS A	0.1	0.4				
West: Capricorn Highway (W)													
Lane 1	14	0.0	1857	0.007	100	5.5	LOS A	0.0	0.0	Short	60	0.0	NA
Lane 2	122	0.0	1950	0.063	100	0.0	LOS A	0.0	0.0	Full	800	0.0	0.0
Approach	136	0.0		0.063		0.6	NA	0.0	0.0				
Intersection	252	0.0		0.063		0.7	NA	0.1	0.4				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

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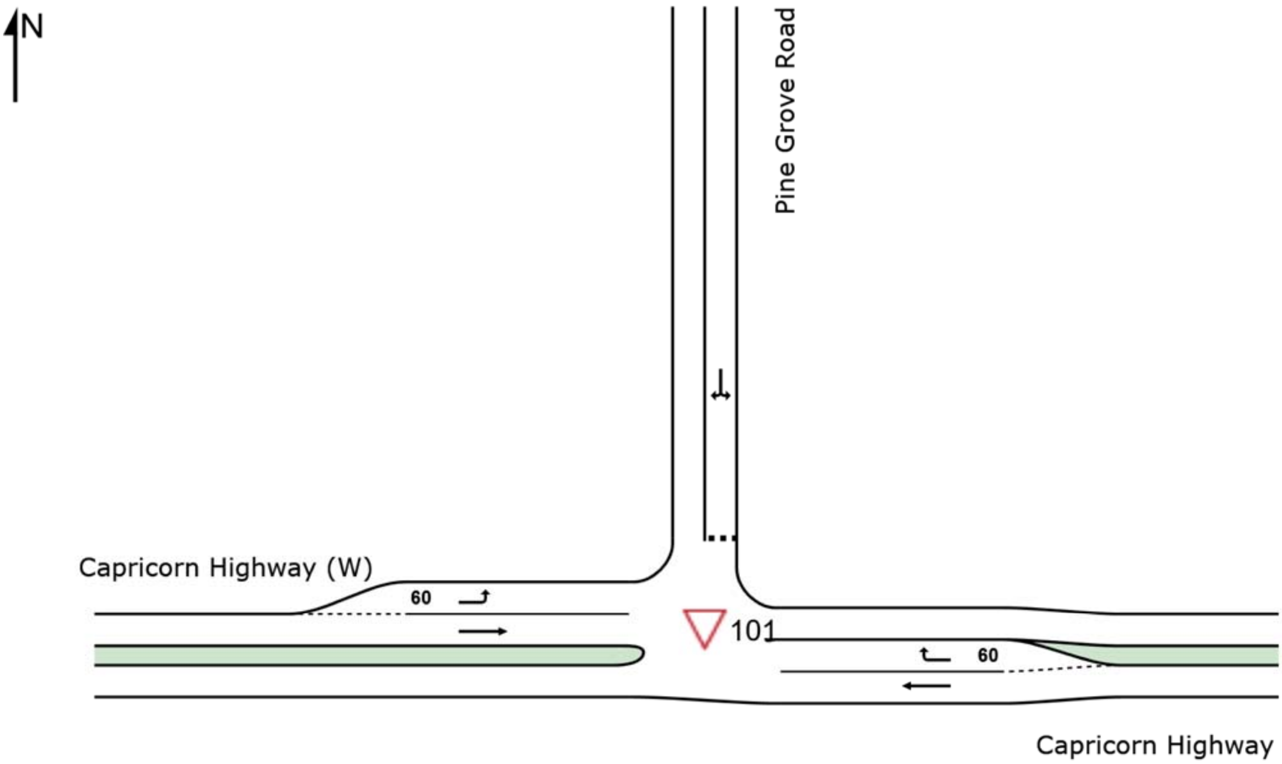
SITE LAYOUT

▽ Site: 101 [2040 BG AM PEAK]

Capricorn Highway / TLO Access Road
Site Category: (None)
Giveway / Yield (Two-Way)



LANE SUMMARY

▽ Site: 101 [2040 BG PM PEAK]

Capricorn Highway / TLO Access Road
Site Category: (None)
Giveway / Yield (Two-Way)

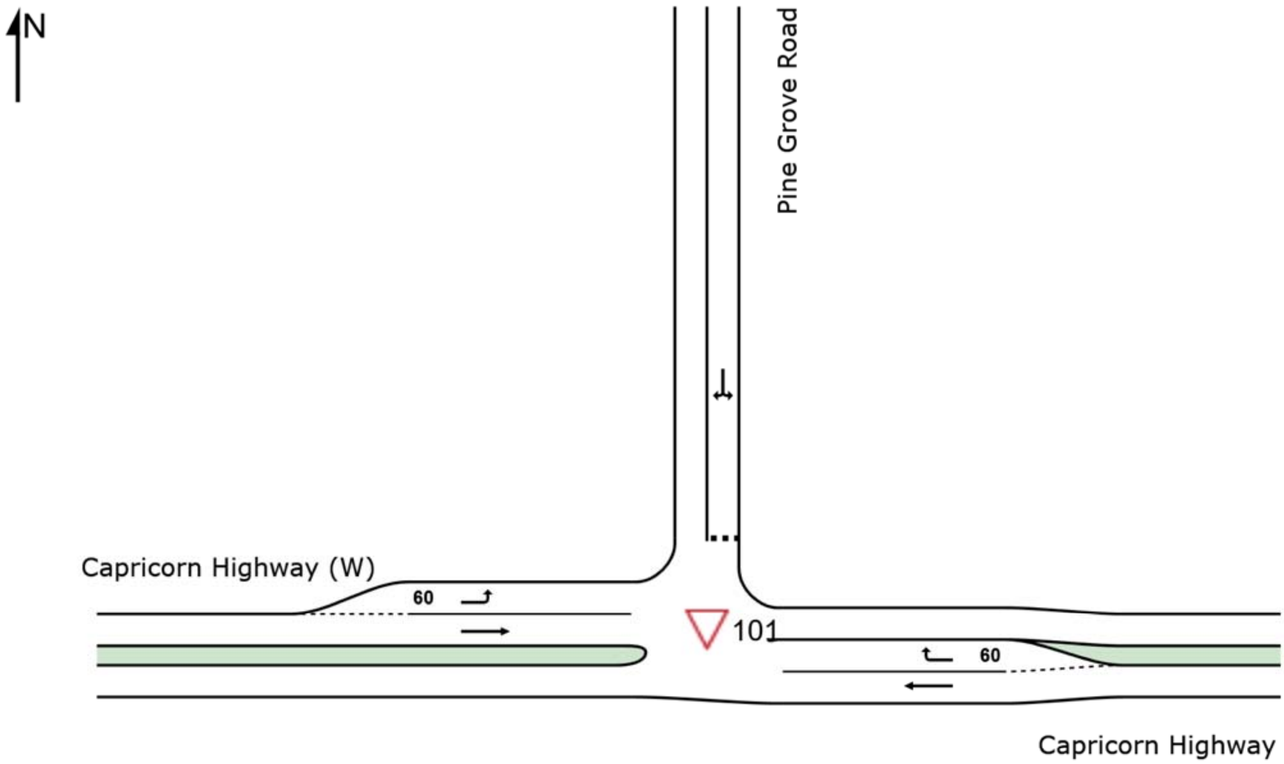
Lane Use and Performance														
	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
East: Capricorn Highway (E)													
Lane 1	187	0.0	1950	0.096	100	0.0	LOS A	0.0	0.0	Full	800	0.0	0.0
Lane 2	9	0.0	1344	0.007	100	5.7	LOS A	0.0	0.2	Short	60	0.0	NA
Approach	197	0.0		0.096		0.3	NA	0.0	0.2				
North: Pine Grove Road													
Lane 1	17	0.0	838	0.020	100	6.6	LOS A	0.1	0.5	Full	80	0.0	0.0
Approach	17	0.0		0.020		6.6	LOS A	0.1	0.5				
West: Capricorn Highway (W)													
Lane 1	3	0.0	1857	0.002	100	5.5	LOS A	0.0	0.0	Short	60	0.0	NA
Lane 2	72	0.0	1950	0.037	100	0.0	LOS A	0.0	0.0	Full	800	0.0	0.0
Approach	75	0.0		0.037		0.2	NA	0.0	0.0				
Intersection	288	0.0		0.096		0.6	NA	0.1	0.5				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

SITE LAYOUT

Site: 101 [2040 BG PM PEAK]

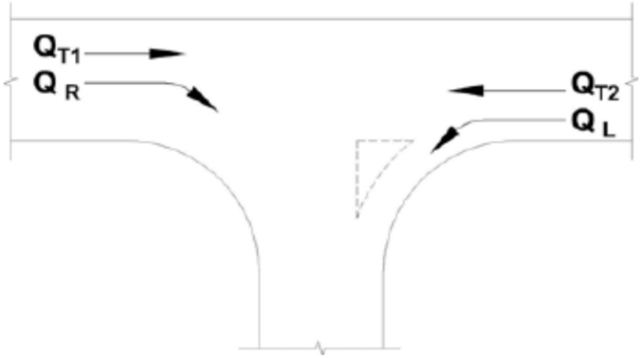
Capricorn Highway / TLO Access Road
Site Category: (None)
Giveway / Yield (Two-Way)



Capricorn Highway / Charlevue Road Intersection

2038 BG + End of Operations

Q_{T1}=	127
Q_R=	2

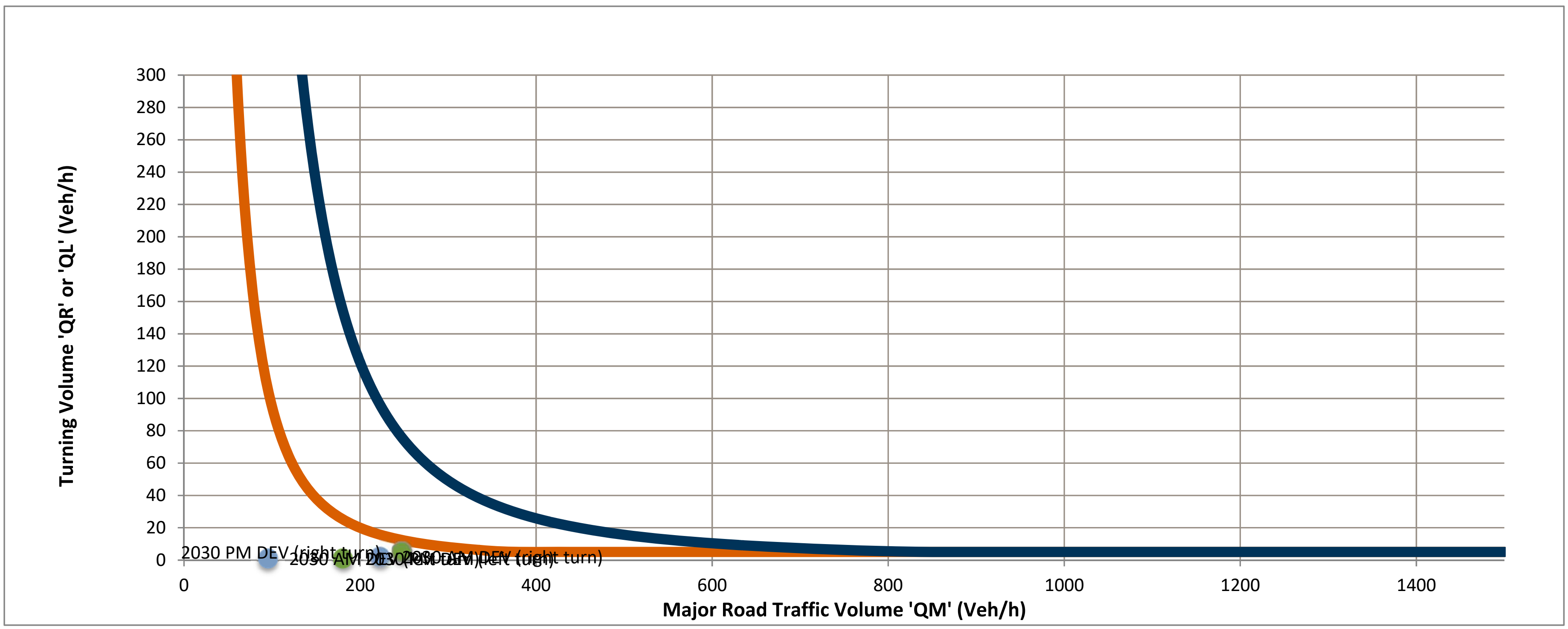


Q_{T2}=	95
Q_L=	1

Through Road	2L2W
Design Year (use 10 as default)	10
Splitter Island?	No
Speed Limit?	>=100km/h

	Q_M	Q_R/Q_L
Right	223	2
Left	95	1

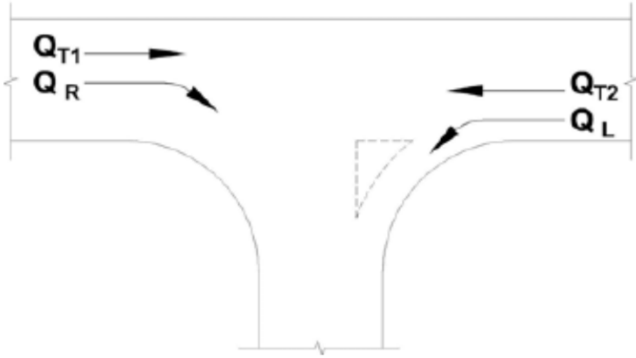
Right Turn Treatment Required	BAR
Left Turn Treatment Required	BAL



Capricorn Highway / Cooinda Road Intersection

2038 Background + End of Operations

Q_{T1}=	118
Q_R=	0

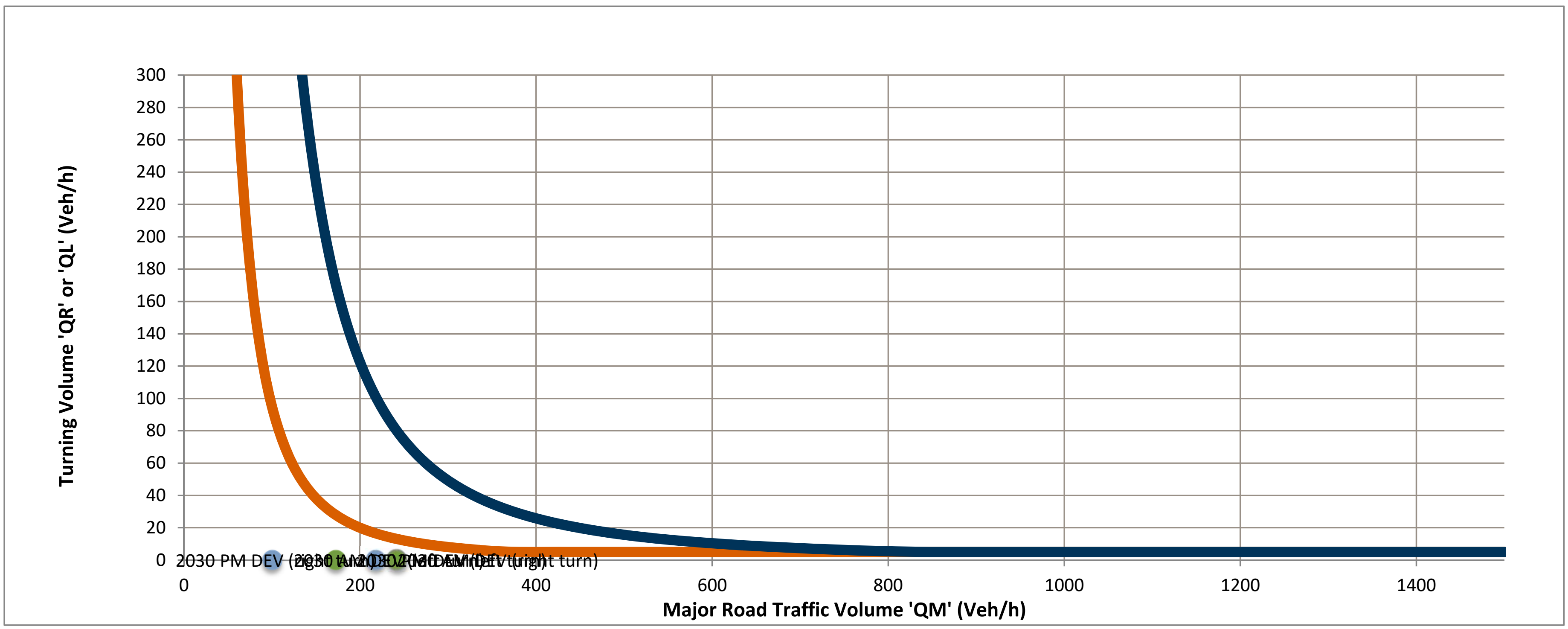


Q_{T2}=	100
Q_L=	0

Through Road	2L2W
Design Year (use 10 as default)	10
Splitter Island?	No
Speed Limit?	>=100km/h

	Q_M	Q_R/Q_L
Right	218	0
Left	100	0

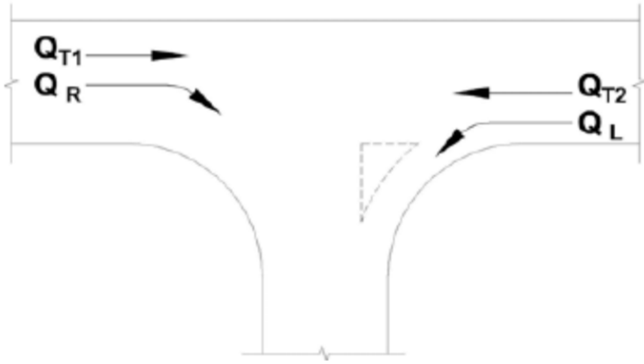
Right Turn Treatment Required	BAR
Left Turn Treatment Required	BAL



Capricorn Highway / Namoi Road Intersection

2030 Background + End of Operations

Q_{T1}=	115
Q_R=	0

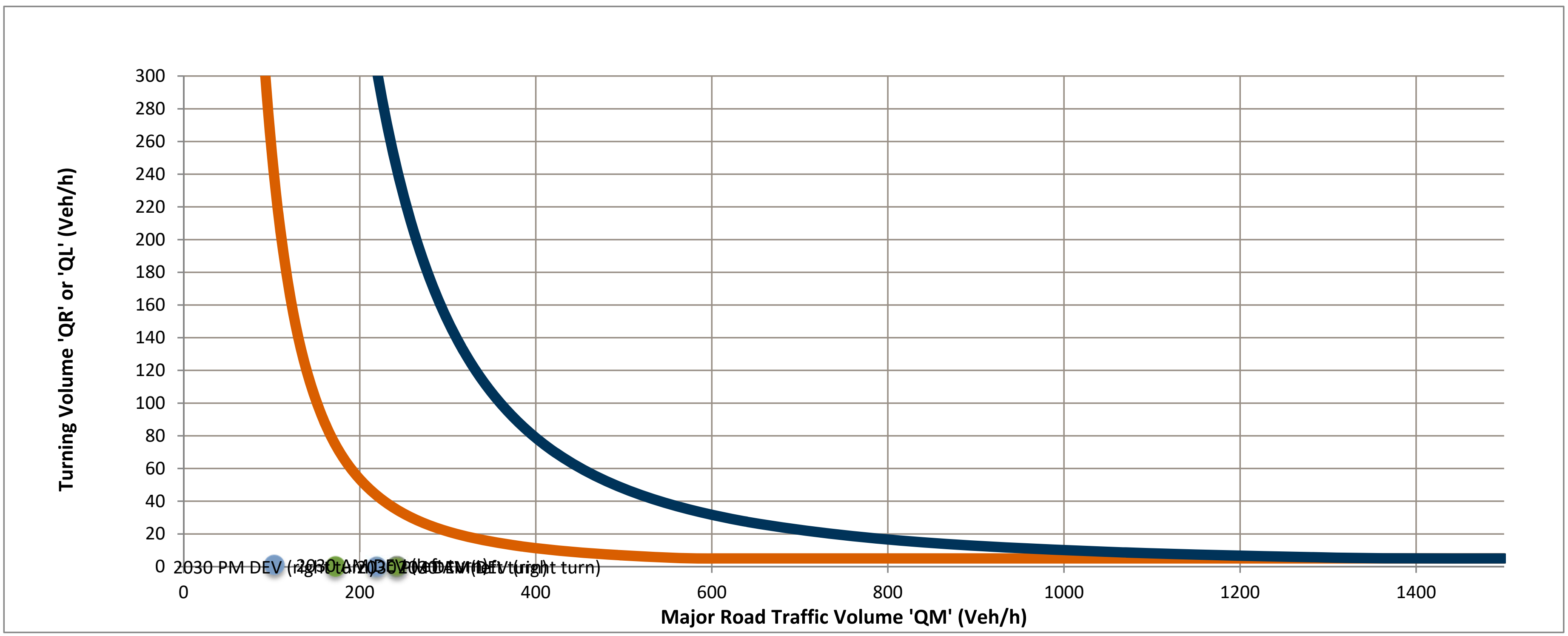


Q_{T2}=	103
Q_L=	1

Through Road	2L2W
Design Year (use 10 as default)	10
Splitter Island?	No
Speed Limit?	70km/h<Design Speed <100km/h

	Q_M	Q_R/Q_L
Right	219	0
Left	103	1

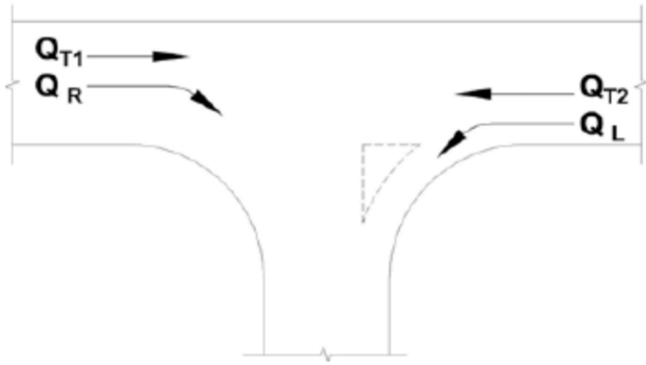
Right Turn Treatment Required	BAR
Left Turn Treatment Required	BAL



Capricorn Highway / Proposed Mine Access Intersection

2038 Background + End of Operations

Q_{T1}=	124
Q_R=	7

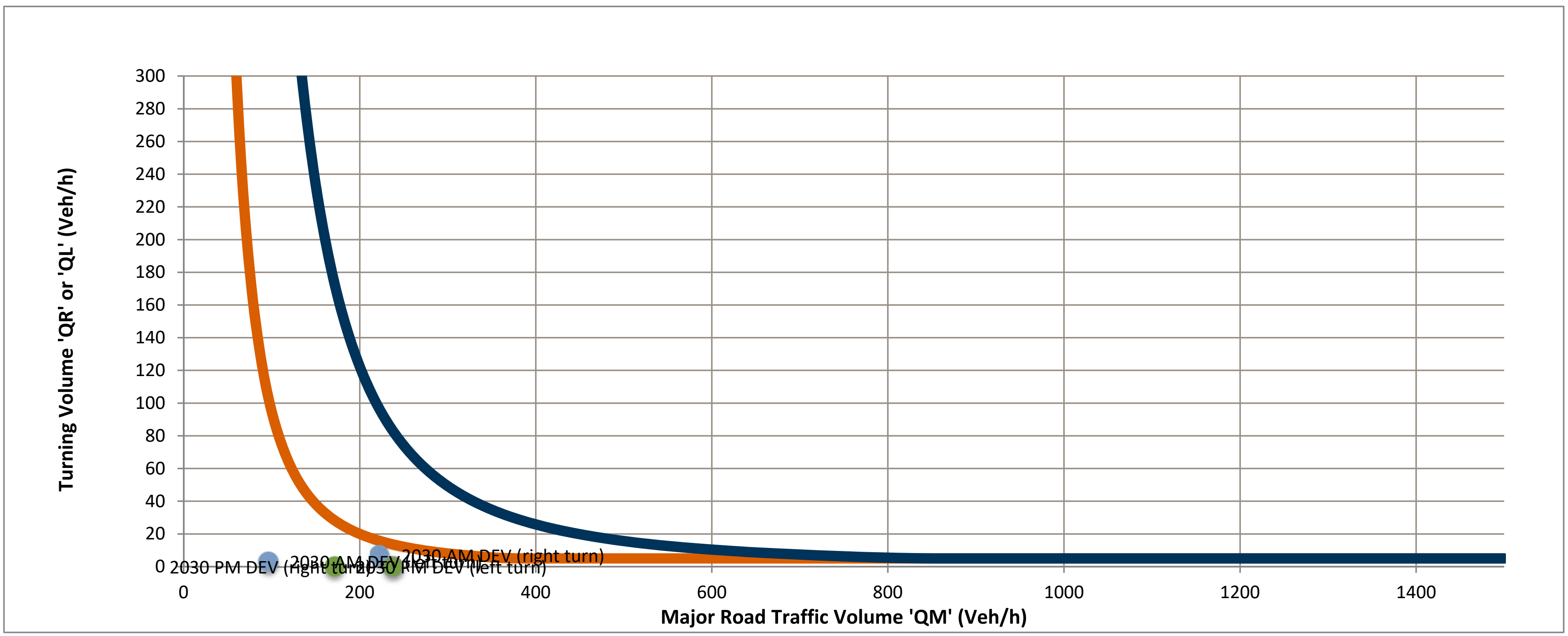


Q_{T2}=	96
Q_L=	3

Through Road	2L2W
Design Year (use 10 as default)	10
Splitter Island?	No
Speed Limit?	>=100km/h

	Q_M	Q_R/Q_L
Right	223	7
Left	96	3

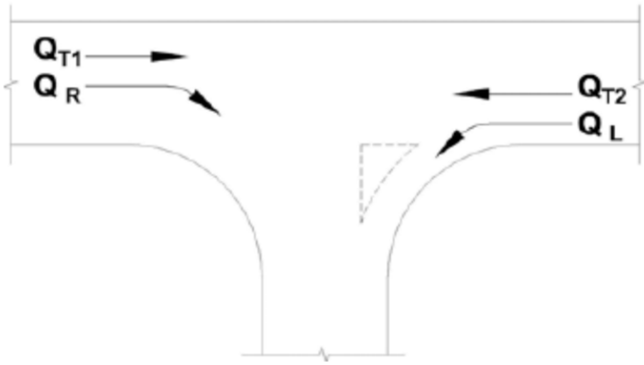
Right Turn Treatment Required	BAR
Left Turn Treatment Required	BAL



Capricorn Highway / TLO Access Intersection

2038 Background + End of Operations (AM and PM peak)

Q_{T1}=	94
Q_R=	3

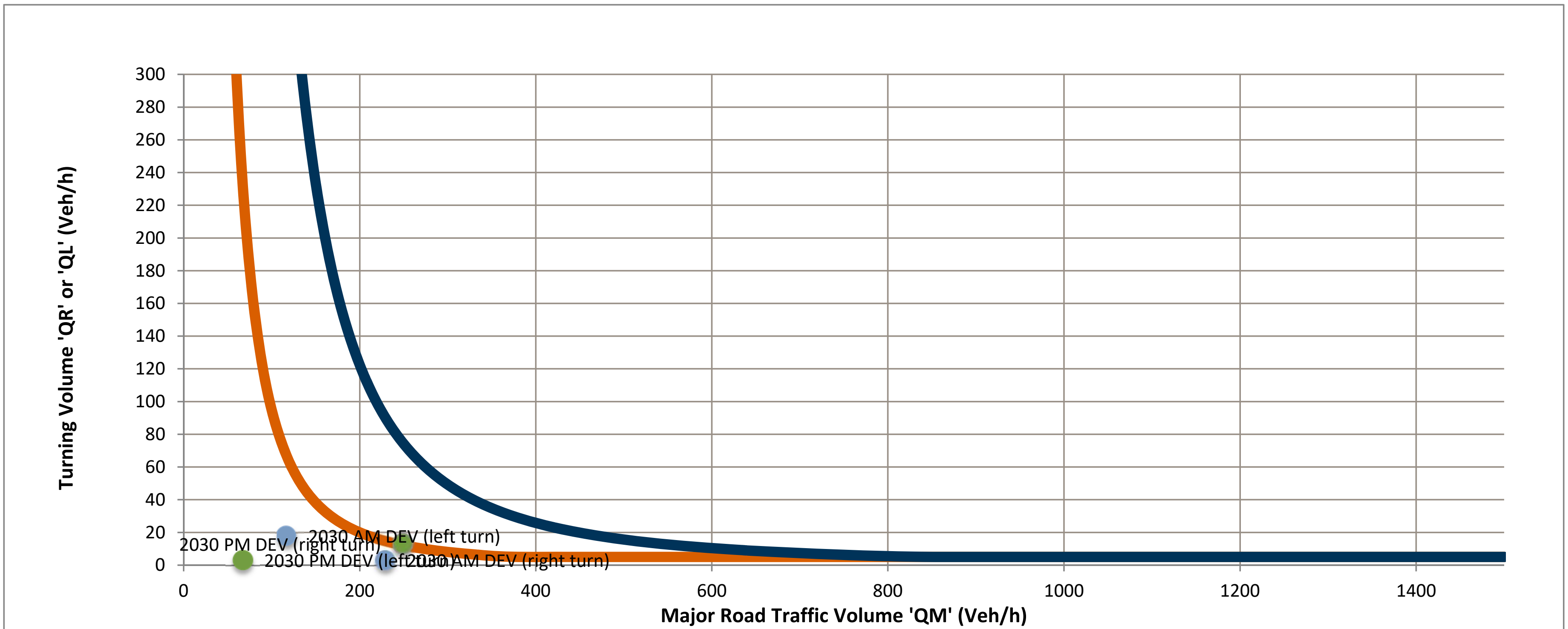


Q_{T2}=	117
Q_L=	18

Through Road	2L2W
Design Year (use 10 as default)	10
Splitter Island?	No
Speed Limit?	>=100km/h

	Q_M	Q_R/Q_L
Right	229	3
Left	117	18

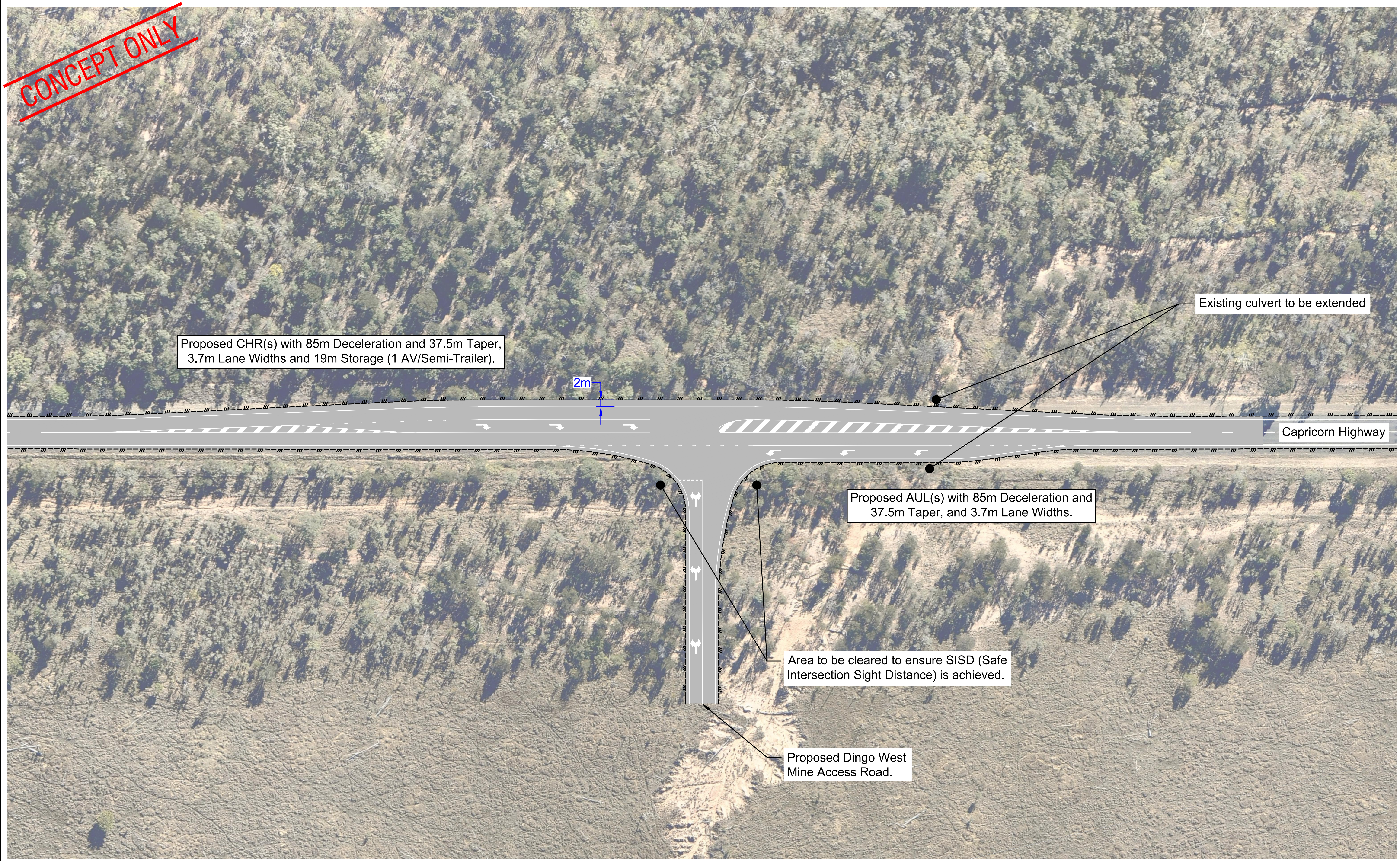
Right Turn Treatment Required	BAR
Left Turn Treatment Required	BAL



APPENDIX

D

PROPOSED MINE ACCESS DRAWINGS



Safe Intersection Sight Distance (SISD)			
Westbound		Eastbound	
Required	Achieved	Required	Achieved
285m	350m+	285m	350m+

NORTH

0 10 20 30 40 50m
SCALE 1:1000 @ A3

Cardno (Qld) Pty Ltd | ABN 57 051 074 992
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Web: www.cardno.com.au

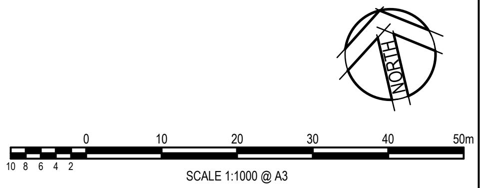
Magnetic South Pty Ltd
Gemini Project Proposed Mine Access

Drawn	Date	Scale	Size
R.Woods	31/07/2019	1:1000	A3

Drawing Number	Revision
QTT19061 - SK01	A

CAD File: G:\QTT19061 - Dingo West Coal Mine TIA\6_ACAD\QTT19061 - SK01_SK03 - A.dwg

Imagery supplied by nearmap, July 2019



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Web: www.cardno.com.au

Magnetic South Pty Ltd
Gemini Project Proposed Mine Access
SISD Review - West

Drawn	Date	Scale	Size
R.Woods	31/07/2019	1:1000	A3

Drawing Number	Revision
QTT19061 - SK02	A

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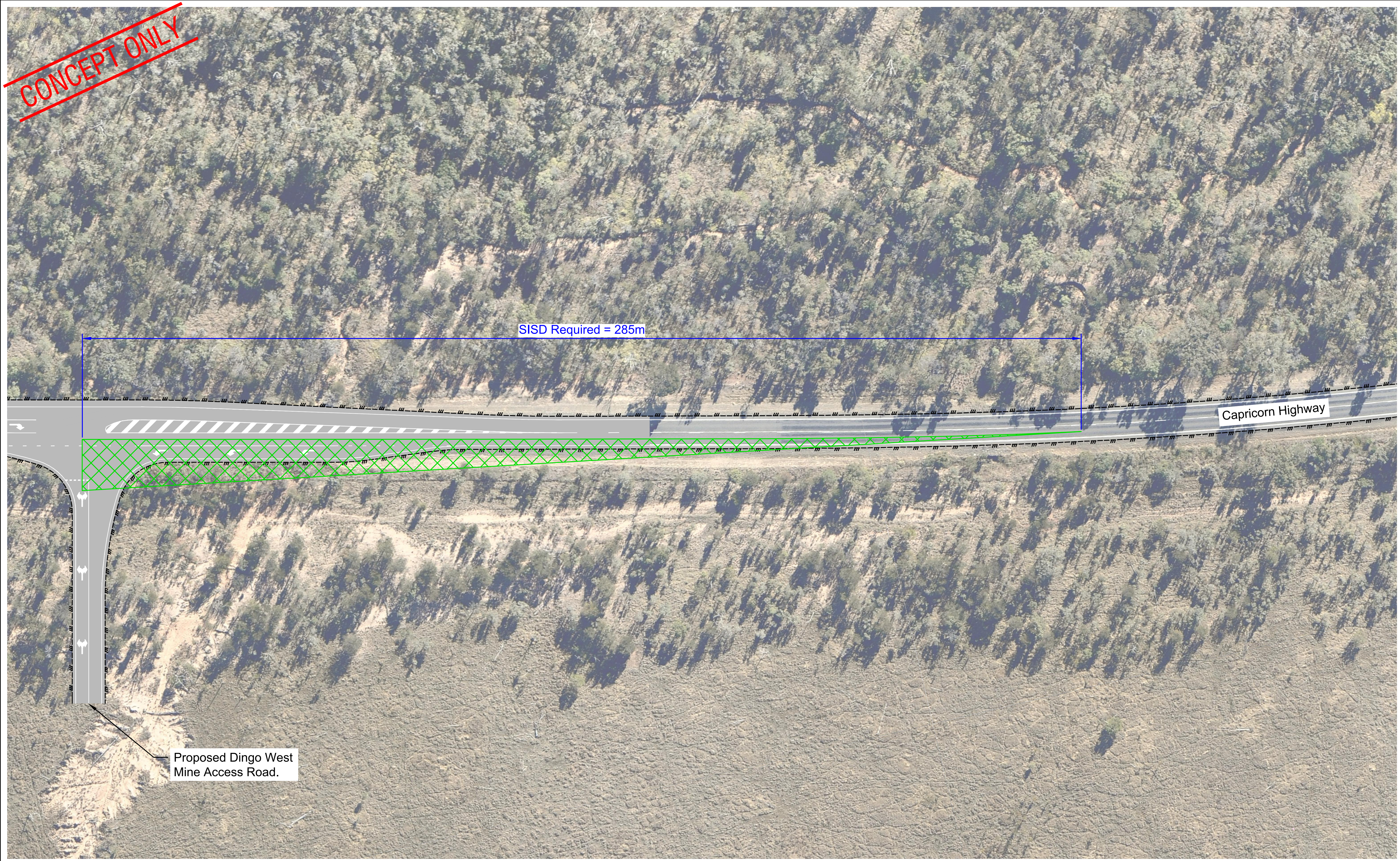
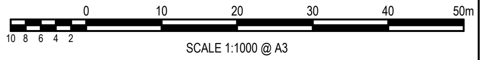
Imagery supplied by nearmap, July 2019





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Tel: 07 3369 9822 Fax: 07 3369 9722
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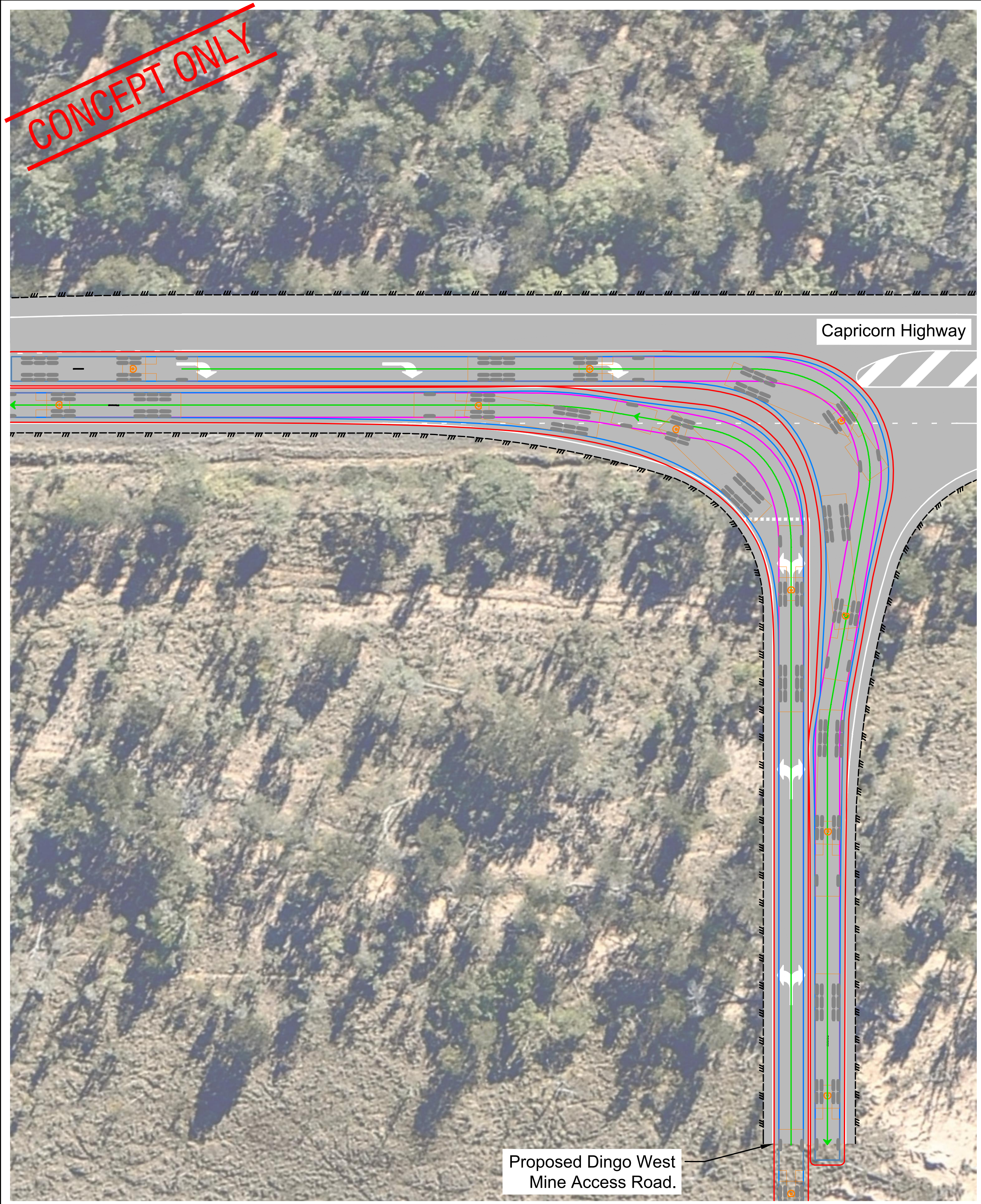
Magnetic South Pty Ltd
Gemini Project Proposed Mine Access
SISD Review - East

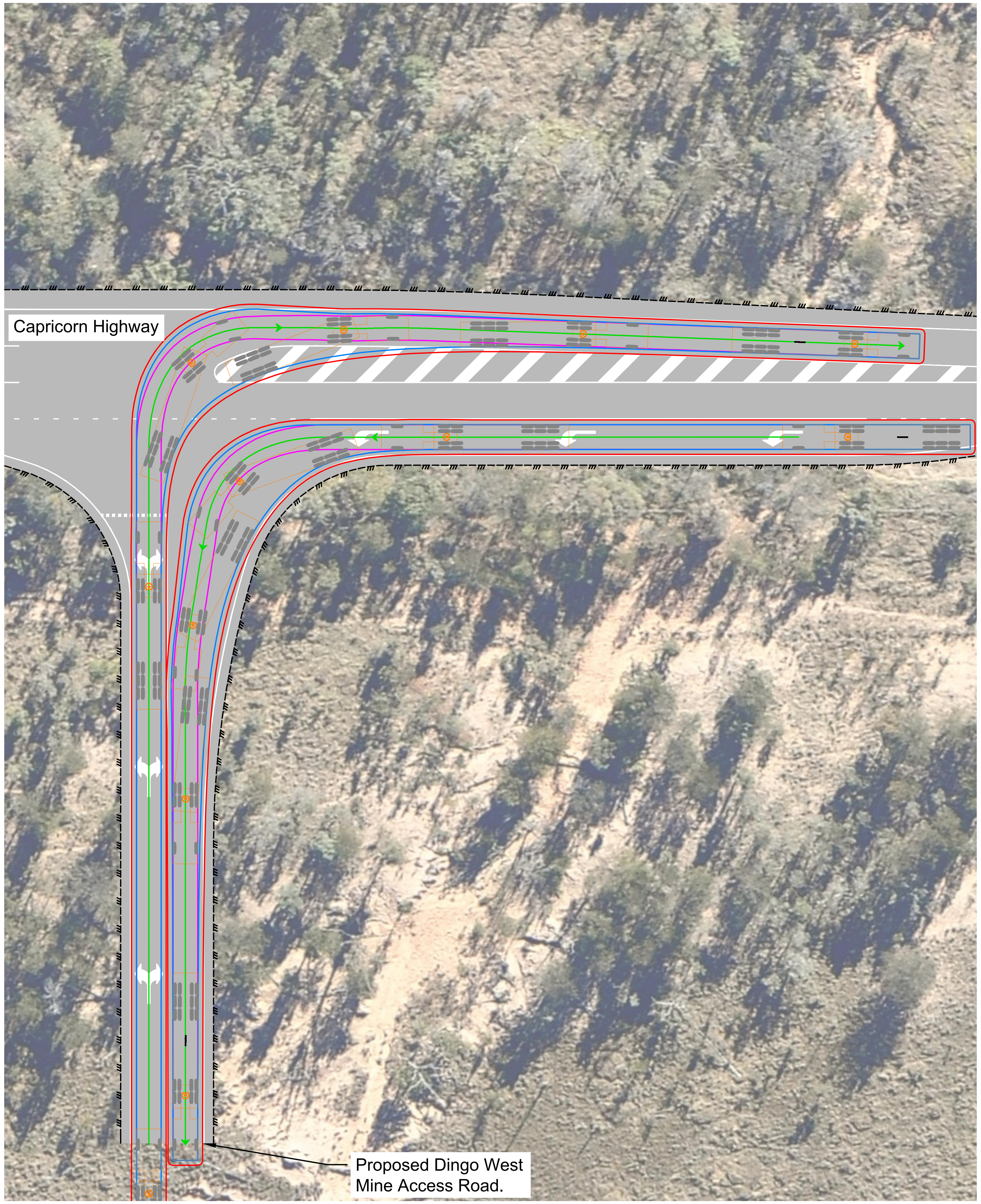
Drawn	Date	Scale	Size
R.Woods	31/07/2019	1:1000	A3

Drawing Number	Revision
QTT19061 - SK03	A

CAD File: G:\QTT19061 - Dingo West Coal Mine TIA\6_ACAD\QTT19061 - SK01_SK03 - A.dwg

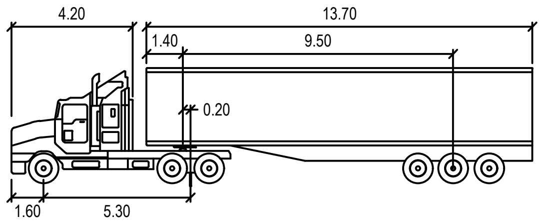
Imagery supplied by nearmap, July 2019





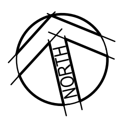
SWEPT PATH LEGEND

- VEHICLE BODY
- FRONT TIRES
- VEHICLE PATH
- VEHICLE CLEARANCE (500mm)
- VEHICLE



19M AV

	Meters
Tractor Width	: 2.50
Trailer Width	: 2.50
Tractor Track	: 2.50
Trailer Track	: 2.50
Lock to Lock Time	: 6.0
Steering Angle	: 27.7
Articulating Angle	: 70.0



5 4 3 2 1 0 5 10 15 20 25m

SCALE 1:500 @ A3

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Magnetic South Pty Ltd
Gemini Project Proposed Mine Access
Swept Path Assessment - 19m AV

Drawn	Date	Scale	Size
R.Woods	31/07/2019	1:500	A3

Drawing Number	Revision
QTT19061 - SK04	A

CAD File: G:\QTT19061 - Dingo West Coal Mine TIA\6_ACAD\QTT19061 - SK01_SK03 - A.dwg

Imagery supplied by nearmap, July 2019

Appendix B Surface Water Assessment

Gemini Project

Surface Water Assessment

Magnetic South Pty Ltd

1238-02-E, 2 December 2020

Report Title	Gemini Project
Client	Magnetic South Pty Ltd
Report Number	1238-02-E

Revision Number	Report Date	Report Author	Reviewer
0	2 December 2020	MJB	DN

For and on behalf of WRM Water & Environment Pty Ltd
Level 9, 135 Wickham Tce, Spring Hill
PO Box 10703 Brisbane Adelaide St Qld 4000
Tel 07 3225 0200

Michael Batchelor
Senior Principal Engineer

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1 Introduction

1.1 BACKGROUND

Magnetic South Pty Ltd proposes to develop the Gemini Project (the Project), a coal mine and associated infrastructure, located within the Fitzroy Basin. The proposed mine development site is located approximately 7.6 km west from the township of Dingo and 19.4 km southeast of Bluff (Figure 1.1).

WRM was commissioned by Magnetic South Pty Ltd to undertake a surface water impact assessment for the Project. This report presents the following:

- An overview of the regulatory framework which applies to the Project;
- A description of the existing surface water environment surrounding the Project, and the associated environmental values;
- A detailed description of the proposed water management strategy in and around the Project and details of the expected performance of the proposed water management system;
- A discussion of the potential impacts of the Project.

1.2 PROJECT DESCRIPTION

The Gemini Project is a greenfield open cut mine to produce Pulverised Coal Injection (PCI) coal and Coking Coal products for export for steel production. The Project term is anticipated to be 25 years from grant of the ML, with this term including initial construction, mine operation and rehabilitation activities. The main activities associated with the Project include:

- Exploration activities continuing in order to support mine planning;
- Development of a Mine Infrastructure Area (MIA) including mine offices, bathhouse, crib rooms, warehouse/stores, workshop, fuel storage, refuelling facilities, explosives magazine and sewage, effluent and liquid waste storage;
- Construction and operation of a Coal Handling Preparation Plant (CHPP) and coal handling facilities adjacent to the MIA (including Run-of-Mine (ROM) coal, product stockpiles and reject stockpiles [coarse and fine rejects]);
- Construction and operation of a surface conveyor from the product stockpiles to a Train Load Out (TLO) facility and rail loop connecting to the Blackwater-Gladstone Branch Rail to transport product coal to coal terminals at Gladstone for export;
- Construction of access roads from the Capricorn Highway to the MIA, and to the TLO facility;
- Installation of a raw water supply pipeline to connect to the Blackwater Pipeline network;
- Construction of a 66 kV transmission line and switching/substation to connect to the existing regional network;
- Other associated minor infrastructure, plant, equipment and activities;
- Development of mine areas (open cut pits) and out-of-pit waste rock emplacements;
- Drilling and blasting of competent waste material.
- Mine operations using conventional surface mining equipment (excavators, front end loaders, rear dump trucks, dozers);

- Mining up to 1.9 Mtpa ROM Coal – average 1.8 Mtpa for an operational mine life of approximately 20 years;
- Progressive placement of waste rock in:
    - Emplacements, adjacent to and near the open cut voids;
    - Mine voids, behind the advancing open cut mining operations.
- Progressive rehabilitation of waste rock emplacement areas and mined voids;
- Progressive establishment of soil stockpiles, laydown area and borrow pits (for road base and civil works). Material will be sourced from local quarries where required;
- Disposal of CHPP rejects (coarse and fine rejects) in out-of-pit spoil dumps, and in-pit behind the mining void;
- Progressive development of internal roads and haul roads including a causeway over Charlevue Creek to enable coal haulage and pit access;
- Development of water storage dams and sediment dams, and the installation of pumps, pipelines, and other water management equipment and structures including temporary levees, diversions and drains.

Figure 1.2 shows the layout of key project features, in particular the two proposed mine pits, associated out-of-pit spoil dumps, haul roads and CHPP, MIA and TLO.

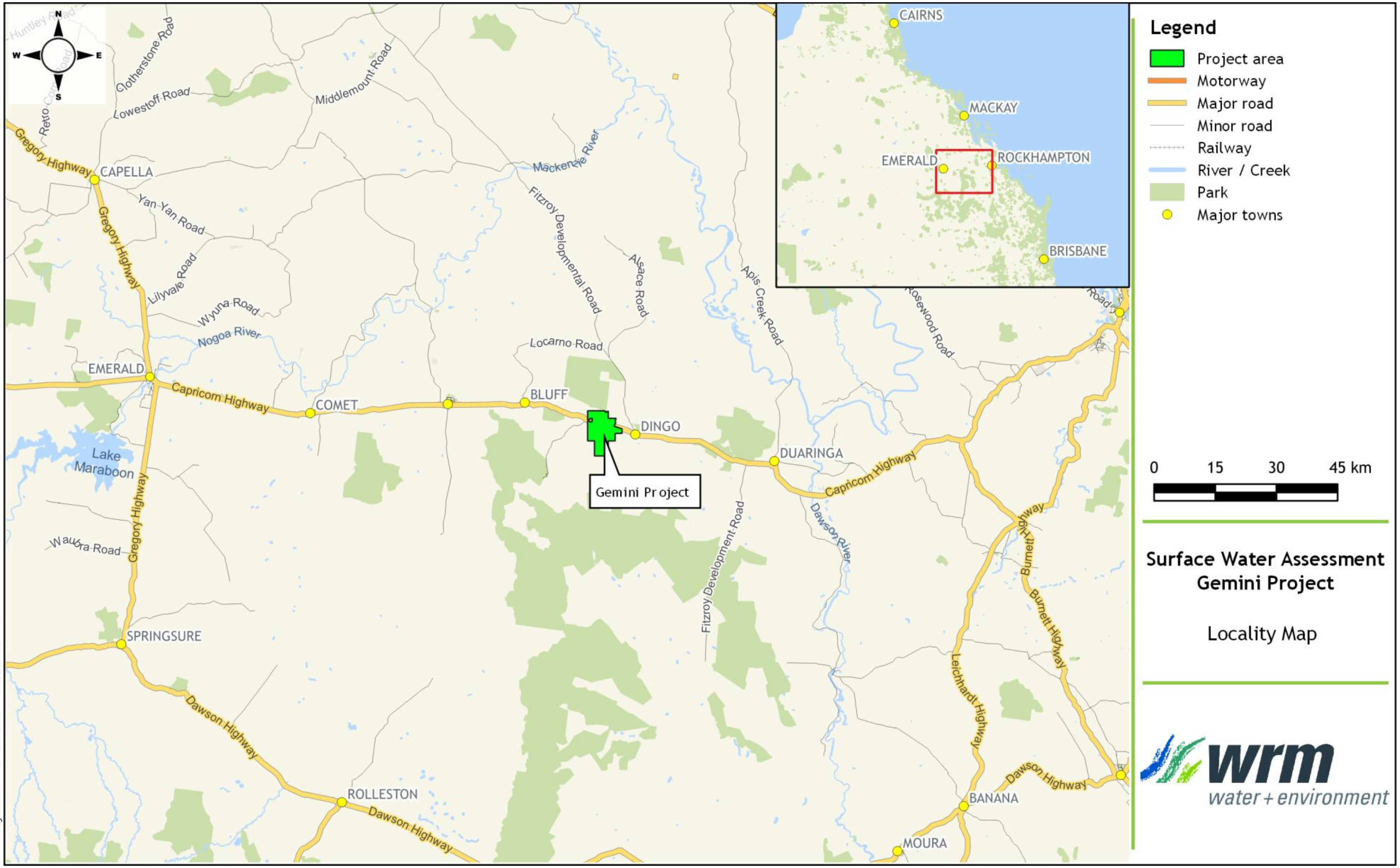


Figure 1.1 – Locality Plan

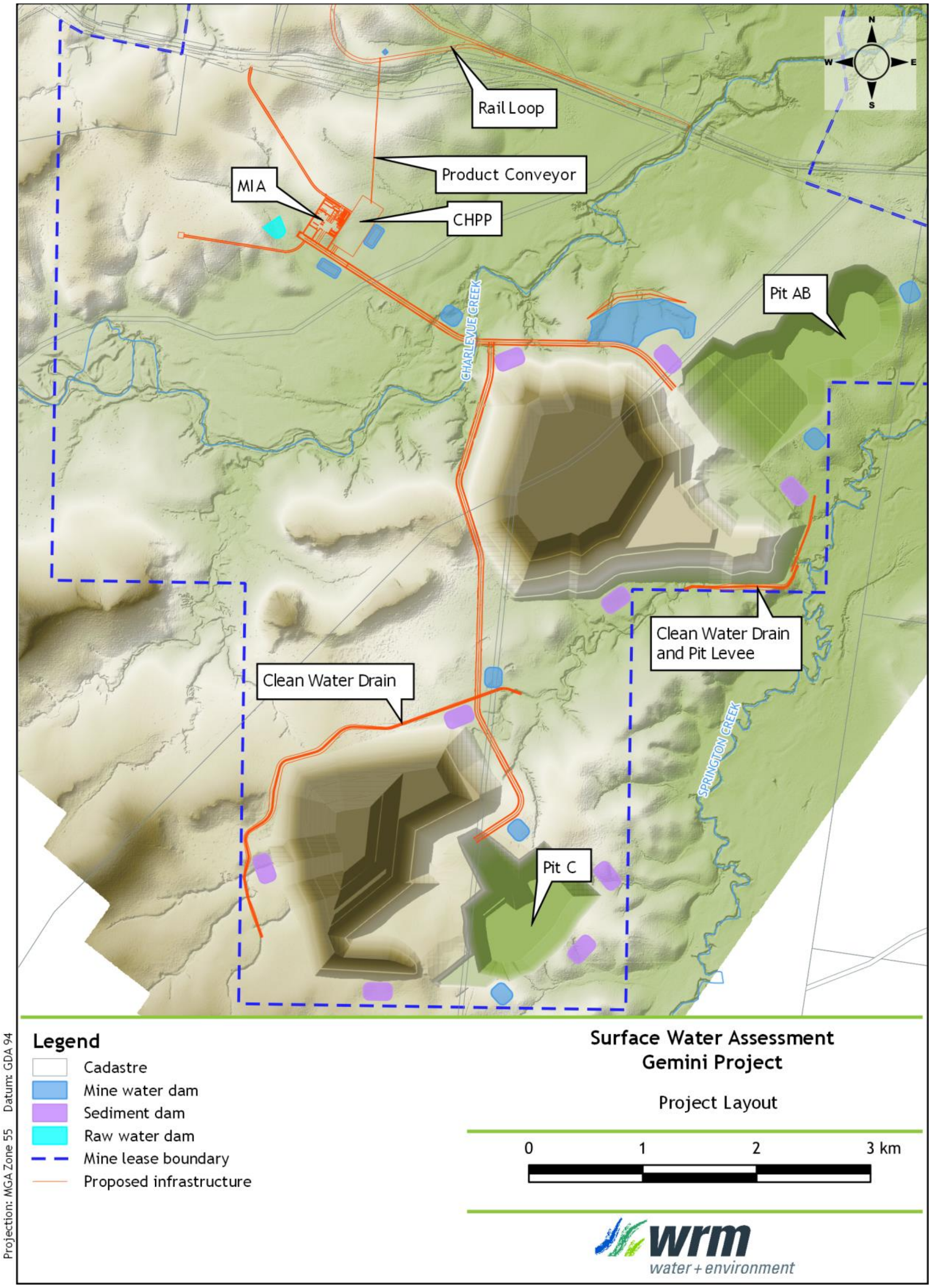


Figure 1.2 – Project layout

2 Regulatory framework

This section describes the regulatory framework (legislation, policies and standards) at Commonwealth and State level that would apply to surface water management for the Project.

2.1 COMMONWEALTH

2.1.1 EPBC Act

Under the Commonwealth Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act), an action requires approval from the Federal Environment Minister if the action has, will have, or is likely to have a significant impact on a Matter of National Environmental Significance (MNES).

An EPBC Referral (2010/5775) for the project lodged in 2010, was declared 'Not a Controlled Action if undertaken in a Particular Manner' in July 2011.

The Particular Manner Decision (EPBC 2010/5775) required the following measures to be taken to avoid significant impacts on the Fitzroy River turtle:

- To prevent downstream impacts to the Fitzroy River Turtle (Rheodytes leukops) the person taking the action must appropriately bund or locate pits in a manner that prevents surface water from entering the pit during a 1:1,000 year flood event.
- To prevent downstream impacts to the Fitzroy River Turtle (Rheodytes leukops) the person taking the action must appropriately bund or locate dams in a manner that prevents surface water from entering or damaging the dams during a during a 1:1,000 year flood event.

The currently proposed Gemini Project is consistent with the original EPBC referral in that:

- It is unlikely to have a significant impact on a MNES; and
- The same measures will be taken for the Gemini Project to avoid significant impacts on the Fitzroy River Turtle.

2.1.2 Independent Expert Scientific Committee

The Independent Expert Scientific Committee (IESC) on Coal Seam Gas and Large Coal Mining Developments provides scientific advice to decision makers on the impact that coal seam gas and large coal mining development may have on Australia's water resources.

The IESC provides independent, expert scientific advice on coal seam gas and large coal mining proposals as requested by the federal and state government regulators. The IESC assesses the proposals against the Information Guidelines for Independent Expert Scientific Committee and provides advice (IESC, 2018) on coal seam gas and large coal mining development proposals where there is a significant impact on water resources. The core purpose of the guideline is to determine whether a coal seam gas (CSG) or large coal mining development has or is likely to have a significant impact on a water resource. The requirements of the guideline have been considered in preparation of this surface water assessment.

2.2 QUEENSLAND

2.2.1 EP Act 1994

Resource activities are defined as environmentally relevant activities (ERAs) under the Queensland Environmental Protection Act 1994 (EP Act) and as such, the development and operation of the Project is regulated by the EP Act. The objective of the EP Act is to:

> *Protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (ecologically sustainable development).*

2.2.1.1 Environmental Authority

An environmental authority (EA) is granted in accordance with the EP Act and details the prescribed conditions that govern the ERA. In the context of surface water management, the EA sets out conditions that will be relevant to the Project, including:

- Management of contained water including release;
- Water management plan requirements;
- Regulation of water structures including dams and levees;
- Saline drainage management;
- Acid rock drainage management; and
- Storm water and sediment laden runoff management.

Model Mining Conditions

New mining project EA applications should apply the model mining conditions as outlined in Model Mining Conditions (DEHP, 2017). The purpose of the model mining conditions is to provide a consistent set of conditions to meet the general environmental protection commitments given for EAs for mining activities administered under the EP Act. The model conditions may be used as a basis for proposing environmental protection commitments in application documents (such as an EIS). Model conditions can be modified to suit the specific circumstances of a mining project, subject to the assessment criteria outlined in the EP Act.

Schedule F – Water (Fitzroy model conditions) form the basis of the requirements for the Project Water Management System design.

2.2.1.2 Environmental Protection (Water) Policy 2009

The Environmental Protection (Water) Policy 2009 (EPP Water) is the primary instrument for surface water management under the EP Act. The EPP Water governs discharge to land, surface water and groundwater, aims to protect environmental values (EVs) and sets water quality guidelines and objectives.

The processes to identify Environmental Values (EVs) and to determine Water Quality Guidelines (WQGs) and Water Quality Objectives (WQOs) in Queensland waters are based on the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ guidelines).

2.2.1.3 Mackenzie River Sub-basin Environmental Values and Water Quality Objectives 2011

The relevant document, pursuant to the EPP Water, for the Project is the Mackenzie River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Mackenzie River Sub-basin (DEHP, 2011). The document is made pursuant to the provisions of the EPP Water. It contains Environmental Values (EVs) and Water Quality Objectives (WQOs) for waters in the Mackenzie River Sub-basin, and they are listed under Schedule 1 of EPP Water. Refer to Section 3 for further details.

2.2.1.4 Manual for Assessing Consequence Categories and Hydraulic Performance of Structures

The Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (the Manual) (DES, 2016) defines the methodology and assessment criteria to determine if a structure associated with an ERA should be regulated under the EP Act. The Manual details the hydraulic design requirements for regulated structures and has been used as a reference in the preliminary design of the water management system and preliminary sizing of dams associated with the Project.

2.2.1.5 Guideline – Application Requirements for Activities with Impacts to Water

This guideline focuses on the types of impacts that environmentally relevant activities (ERAs) can have on water and outlines the information to be provided to the department as part of the ERA application process.

Section 4 of the guideline requires the applicant to provides details on a number of surface water-related issues, including:

- Discharges and releases;
- Unplanned and uncontrolled releases;
- Water infrastructure;
- Wetlands;
- Hydrology of receiving waters; and
- Mixing zones.

The guideline also refers to the department's technical guideline "Wastewater releases to Queensland waters", which is discussed in Section 2.2.1.6.

2.2.1.6 Technical Guideline – Wastewater Release to Queensland Waters

This guideline is provided to support a risk-based assessment approach to licensing releases of wastewater to surface water and applies the philosophy of the ANZECC & ARMCANZ (2000) Water Quality Guidelines and the intent of the Environmental Protection (Water) Policy 2009.

The information requirements identified in this guideline are as follows:

- Describe the proposed activity.
- Describe the receiving environment.
- Predict outcomes or impacts of the proposed wastewater release.
- Set circumstances, limits and monitoring conditions.

The Project's accommodation village will comprise a small sewage treatment plant. Waste sludge is expected to be removed for disposal by a regulated waste contractor. Treated effluent will be irrigated to a designated area in accordance with accepted conditions.

2.2.2 Water Act 2000

In Queensland, the Water Act 2000 (Water Act) is the primary statutory document that establishes a framework for the planning, allocation and use of non-tidal water. The Water Act is primarily administered by the Department of Natural Resources, Mines and Energy (DNRME) and the Department of Energy and Water Supply (DEWS).

The main purpose of the Water Act is to provide a framework for the following:

- The sustainable management of Queensland's water resources and quarry material by establishing a system for:
    - The planning, allocation and use of water; and
    - The allocation of quarry material and riverine protection.
- The sustainable and secure water supply for the south-east Queensland region and other designated regions;
- The management of impacts on underground water caused by the exercise of underground water rights by the resource sector; and
- The effective operation of water authorities.

A watercourse is defined by the Water Act as a river, creek or stream in which water flows permanently or intermittently and includes the bed and banks and any other element of a river, creek or stream confining or containing water.

The diversion of drainage features does not require authorisation under the Water Act.

2.2.2.1 Water Plan (Fitzroy Basin) 2011

The Water Plan (Fitzroy Basin) 2011, which replaces the Water Resource (Fitzroy Basin) Plan 2011, is subordinate legislation to the Water Act. The plan is developed and administered by DNRME. The purpose of the plan is:

- To define the availability of water in the Fitzroy Basin;
- To provide a framework for sustainably managing water and the taking of water;
- To identify priorities and mechanisms for dealing with future water requirements;
- To provide a framework for establishing water allocations;
- To provide a framework for reversing, where practicable, degradation in natural ecosystems;
- To regulate the taking of overland flow water; and
- To regulate the taking of groundwater.

The Project is located in the area managed by the Water Plan (Fitzroy Basin) 2011 that manages overland flow. Works on drainage features that capture overland flow must meet the requirements of the plan and may require authorisation under the Water Act.

2.2.2.2 Water Regulation 2016

Water Regulation 2016 is subordinate legislation to the Water Act and provides details, protocol and instruction for the following:

- Water rights and planning;
- Statutory authorisations to take or interfere with water;
- Matters relating to water licenses;
- Water allocations;
- Water supply and demand management;
- Declarations about watercourses.

2.2.3 Water Supply (Safety & Reliability) Act 2008

The Water Supply (Safety and Reliability) Act 2008 provides for the safety and reliability of water supply in Queensland. The purpose is achieved primarily by:

- Providing a regulatory framework for providing water and sewerage services in the State;
- Providing a regulatory framework for providing recycled water and drinking water quality, primarily for protecting public health;
- The regulation of referable dams; and
- Stating flood mitigation responsibilities.

3 Environmental Values

The Project is located within the Mackenzie Southern Tributaries (refer section 2.2.1.3) of the Mackenzie River sub-basin shown in Figure 3.1. The following EVs have been nominated broadly to the mapped areas for protection of zone:

- Aquatic ecosystems;
- Farm supply/use;
- Stock Water;
- Human consumption;
- Primary recreation;
- Secondary recreation;
- Visual recreation;
- Drinking water;
- Industrial use;
- Cultural and spiritual values.

The following WQOs for the above EVs are provided in Table 3.1. Where different EVs have different WQOs the lowest value has been adopted. WQOs are displayed for physio-chemical parameters only.

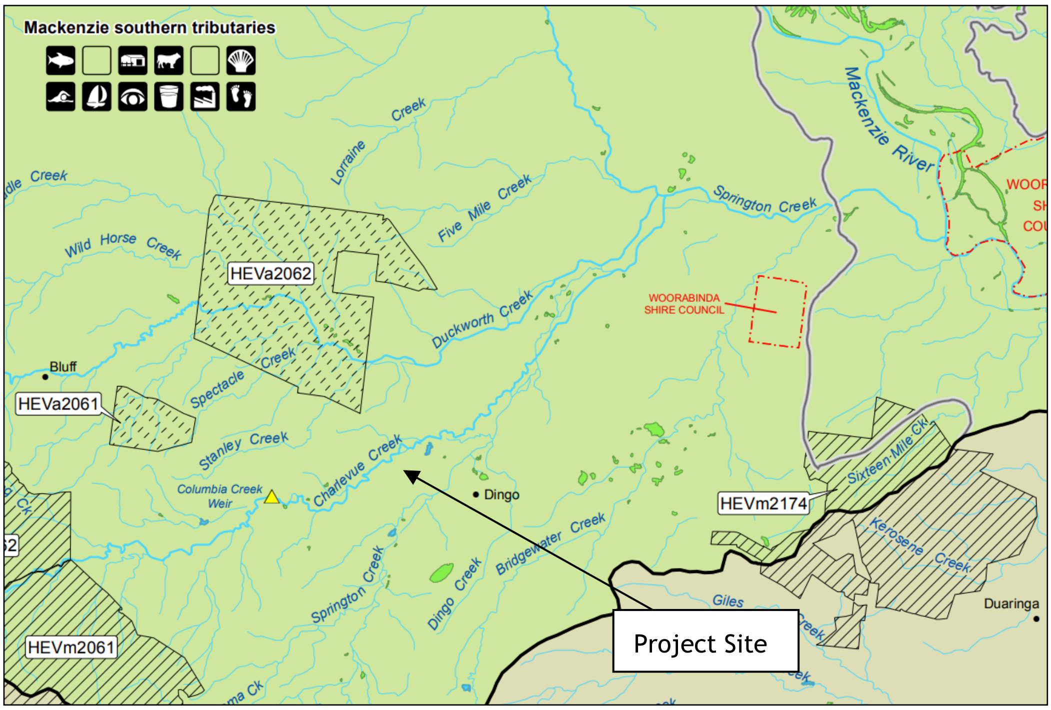


Figure 3.1 – Mackenzie River Sub-basin EVs

Table 3.1 – Water Quality Objectives for the Mackenzie River sub-basin

Parameter	WQO	Relevant EV
Ammonia N	< 20 µg/L	Aquatic ecosystem
Oxidised N	< 60 µg/L	Aquatic ecosystem
Organic N	< 420 µg/L	Aquatic ecosystem
Total nitrogen	< 500 µg/L	Aquatic ecosystem
Filterable Reactive Phosphorus (FRP)	< 20 µg/L	Aquatic ecosystem
Total Phosphorus	< 50 µg/L	Aquatic ecosystem
Chlorophyll a	< 5 µg/L	Aquatic ecosystem
Dissolved oxygen	85-110% saturation > 4 mg/L at surface	Aquatic ecosystem Drinking water
Turbidity	< 50 NTU	Aquatic ecosystem
Suspended solids	< 55 mg/L	Aquatic ecosystem
pH	pH 6.5-8.5	Aquatic ecosystem
Conductivity (EC) baseflow	720 µS/cm	Aquatic ecosystem
Conductivity (EC) high flow	250 µS/cm	Aquatic ecosystem
Sulphate	25 mg/L	Aquatic ecosystem
Total Dissolved Solids	< 2000 mg/L	Stock watering
Colour	50 Hazen Units	Drinking water
Total Hardness	150 mg/L as $CaCO_3$	Drinking water
Sodium	< 30 mg/L	Drinking water
Aluminium	< 5 mg/L < 0.055 mg/L	Stock watering Aquatic ecosystem
Arsenic	2.0 mg/L 0.5 mg/L up to 5 mg/L < 0.024 mg/L	Irrigation, Stock watering Aquatic ecosystem
Beryllium	< 0.5 mg/L	Irrigation
Boron	< 5 mg/L < 0.37 mg/L	Stock watering Aquatic ecosystem
Cadmium	< 0.01 mg/L < 0.0002 mg/L	Stock watering Aquatic ecosystem
Chromium	< 1 mg/L < 0.001 mg/L	Stock watering Aquatic ecosystem
Cobalt	< 0.1 mg/L	Irrigation
Copper	< 1 mg/L < 0.0014 mg/L	Stock watering (cattle) Aquatic ecosystem
Fluoride	< 2 mg/L	Irrigation
Fluoride	< 2 mg/L	Irrigation
Fluoride	< 2 mg/L	Irrigation
Iron	< 10 mg/L	Irrigation
Lead	< 0.1 mg/L < 0.0034 mg/L	Stock watering, Aquatic ecosystem
Lithium	< 2.5 mg/L	Irrigation
Manganese	< 10 mg/L < 1.9 mg/L	Irrigation Aquatic ecosystem
Mercury	< 0.002 mg/L < 0.00006 mg/L	Irrigation Aquatic ecosystem
Molybdenum	< 0.05 mg/L	Irrigation
Nickel	< 1 mg/L < 0.011 µg/L	Stock watering Aquatic ecosystem
Selenium	< 0.02 mg/L < 0.005 mg/L	Stock watering, Aquatic ecosystem
Uranium	< 0.1 mg/L	Irrigation
Vanadium	< 0.5 mg/L	Irrigation
Zinc	< 5 mg/L < 0.008 mg/L	Irrigation Aquatic ecosystem

3.1 AQUATIC ECOSYSTEM ENVIRONMENTAL VALUES

3.1.1 Fitzroy Basin Aquatic Ecosystem Health

The Fitzroy Partnership for River Health is a collaboration between Government, industry, research organisations and community to facilitate improved water quality monitoring, collate and assess data, and publicly report on waterway health and sustainable use.

The Partnership compiles water quality, biological and ecological health data for all waterways in the Fitzroy Basin and assigns them one of the following grades:

a. **Excellent**. All water quality and biological health indicators meet desired levels.
b. **Good**. Most water quality and biological health indicators meet desired levels.
c. **Fair**. There is a mix of good and poor levels of water quality and biological health indicators.
d. **Poor**. Some or few water quality and biological health indicators meet desired levels.
e. **Fail**. Very few or no water quality and biological health indicators meet desired levels.

In 2017-18 the Fitzroy Basin (including the Mackenzie River tributaries covering the Project area) received a C grade for aquatic ecosystem health. The Mackenzie Basin was graded C overall. It was graded B for physical/chemical and nutrients, C for toxicants and D for ecology. It was graded B for stock use and A for cropping use.

3.1.2 Aquatic ecology assessment of the Project area

Baseline aquatic ecology surveys for the Project were undertaken by AARC, and details of the results are provided in a separate report. The following extract from that report summarises the aquatic values of the Project area.

Extensive clearing for agricultural purposes has been undertaken across much of the study area including the removal of riparian vegetation. The removal of riparian vegetation and direct stock access to the waterways has resulted in bank instability, erosion and occurrence of weeds.

Stream sediments were found to contain a high proportion of sand particles with some sites containing a mixture of silt and clay. Metal concentrations in stream sediment were generally low, except for nickel levels at site DWR6.

Macroinvertebrate diversity, abundance and PET richness were generally low. SIGNAL scores were correspondingly low and consistent with the expected results for ephemeral streams in an agricultural setting. The AusRivAS predictive modelling assessed the aquatic environments at the sample sites as significantly impaired to highly degraded. While impaired habitats are common in ephemeral creeks, the extent and severity of the impairment indicates low waterway health.

The diversity and abundance of fish and crustaceans was found to be low.

4 Existing surface water environment

4.1 LOCAL CLIMATE - RAINFALL AND EVAPORATION DATA

Figure 4.3 shows locations of Bureau of Meteorology (BOM) and DNRME rainfall and evaporation recording stations with a significant period of record near the Project. Table 4.1 shows summary details of these stations.

Table 4.2 shows the variability in monthly rainfall at Dingo Post Office, which is the nearest rainfall station.

Table 4.1 - Rainfall stations in the vicinity of the Project

Station No.	Station Name	Data Obtained	Elevation (mAHD)	Distance from Project (km)	Opened	Lat	Long
035025	DINGO POST OFFICE	Rainfall	110	15	1896	-23.65	149.33
035172	MELMOTH	Rainfall	122	17	1914	-23.45	149.26
035186	BLACKDOWN TABLELAND AL	Rainfall	952	20	2010	-23.77	149.12
035132	NEW CALEDONIA	Rainfall	152	33	1968	-23.43	148.93
035134	BLACKWATER AIRPORT	Rainfall/Evap	193	40	2013	-23.60	148.81

Table 4.2 - Monthly Rainfall Statistics for Dingo Post Office (mm/month)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	111.6	110	74.8	37.1	33.4	35.4	26.8	22.5	25.3	46.2	64.5	101	**685.4**
Lowest	0	0	0	0	0	0	0	0	0	0	0	0	**237.6**
5th %ile	10.8	6.7	3.9	0	0	0	0	0	0	0	4.9	6.7	**331.6**
10th %ile	25.6	15	6.9	0	0	0	0	0	0	5.7	7.5	21.1	**395.7**
Median	90.9	84.4	53.3	19.8	16.1	26	11.5	16.4	10.1	30.6	52.8	94	**659.6**
90th %ile	222	245.4	167.1	92.4	76.3	87.3	69.2	54.4	75.6	98.5	140.9	185.2	**993.1**
95th %ile	264.1	281.5	197.9	135.4	118.2	106.8	100.3	76.4	92	130.5	165.9	226.5	**1072.9**
Highest	672.6	513.4	313.8	305.6	259.1	197.9	270	120.7	220.9	207.4	217.5	409.1	**1351.1**

Long term daily rainfall and evaporation data for the area from January 1889 to August 2019 (130 years) was obtained from the SILO (https://www.longpaddock.qld.gov.au/silo/). This data set is corrected for accumulated daily rainfall totals and missing data and is well suited to use in water balance modelling. Annual rainfall is presented in Figure 4.1. Monthly average rainfall and evaporation are shown in Figure 4.2. Average annual rainfall is 692 mm/a and average annual (pan) evaporation is 2,053 mm/a.

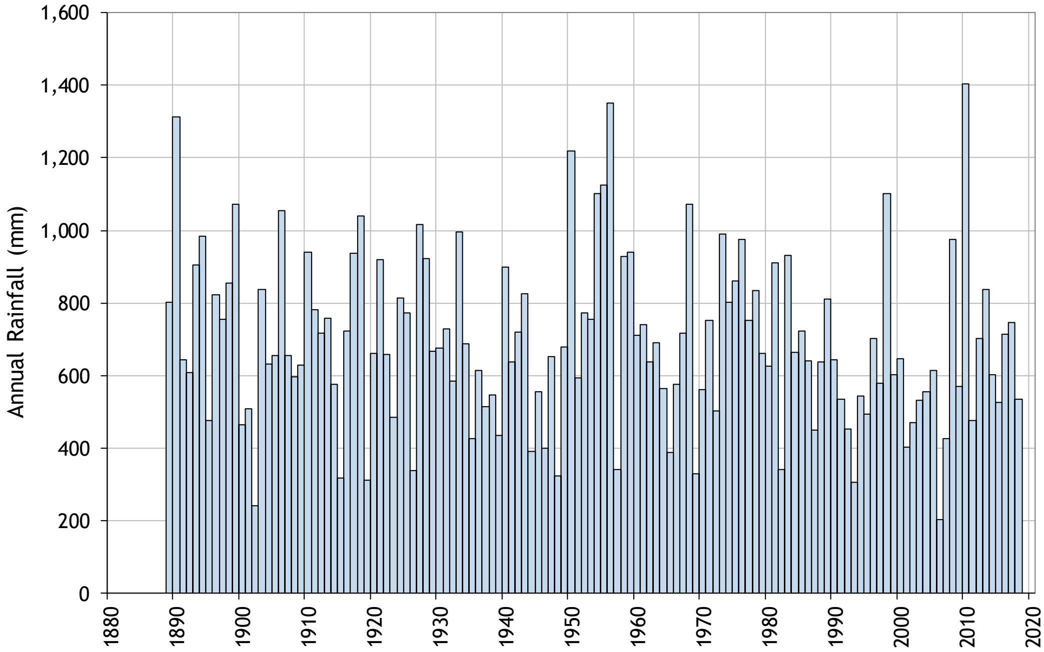


Figure 4.1 - Annual rainfall at Dingo Post Office - 1889 to 2019 (SILO)

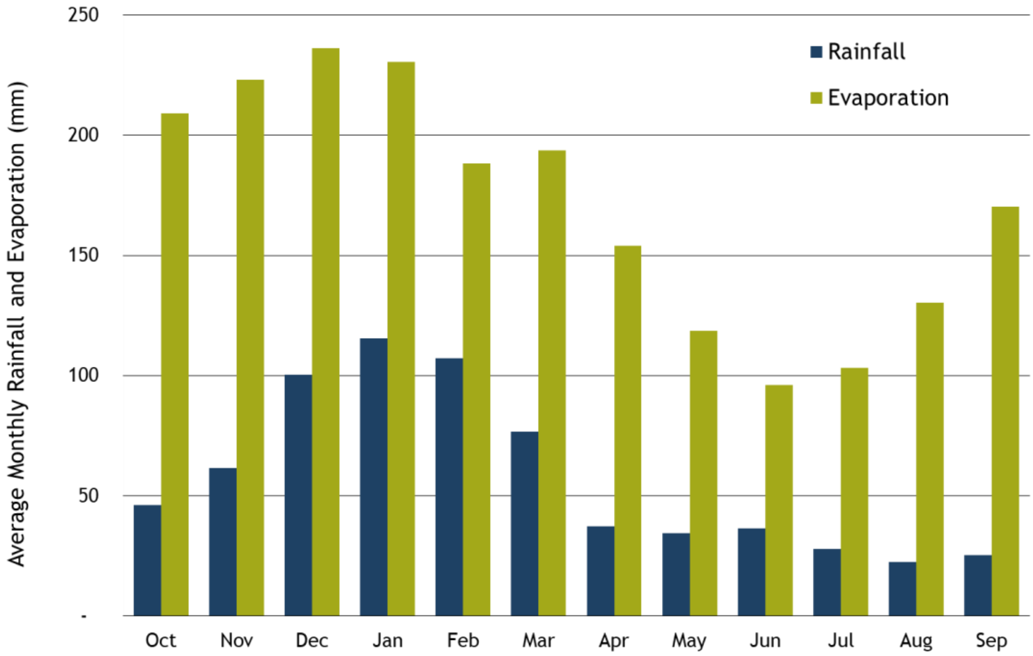


Figure 4.2 - Average monthly rainfall and pan evaporation at Dingo Post Office

4.2 CATCHMENT CONTEXT

As shown in Figure 4.3, the Project area is in the upper Mackenzie River catchment – part of the Fitzroy River Basin.

The Project area is in the catchment of Springton and Charlevue Creeks. Springton Creek joins the Mackenzie River approximately 47 km downstream of the Project. The upstream extent of the Fitzroy River is at the Dawson River/Mackenzie River. The Fitzroy River flows to the ocean east of the City of Rockhampton, approximately 400 km downstream of the Project area, and has a total catchment area of approximately 143,000 km^2. The total catchment area of the Mackenzie River sub-basin (including the catchments of the Nogoa and Comet Rivers) is 12,989 km^2.

As shown in Figure 4.4, the streams crossing the Project area (which include Charlevue Creek and Springton Creek) flow generally northeast, where Charlevue Creek joins Springton Creek approximately 3.6 km downstream of the Project, then later joins the Mackenzie River (Figure 4.4).

The Project mining lease application area is approximately 55.7 km^2. Charlevue Creek has a catchment area of approximately 343 km^2 to its confluence with the Springton Creek crossing the Project area and Springton Creek has a catchment area of 325 km^2 to the confluence with Charlevue Creek.

All waterways of the Project area are ephemeral and experience flow only after sustained or intense rainfall in the catchment. Stream flows are highly variable, with most channels drying out during winter to early spring when rainfall and runoff is historically low, although some pools hold water for extended periods. Therefore, physical attributes, water quality, and the composition of aquatic flora and fauna communities are also expected to be highly variable over time.

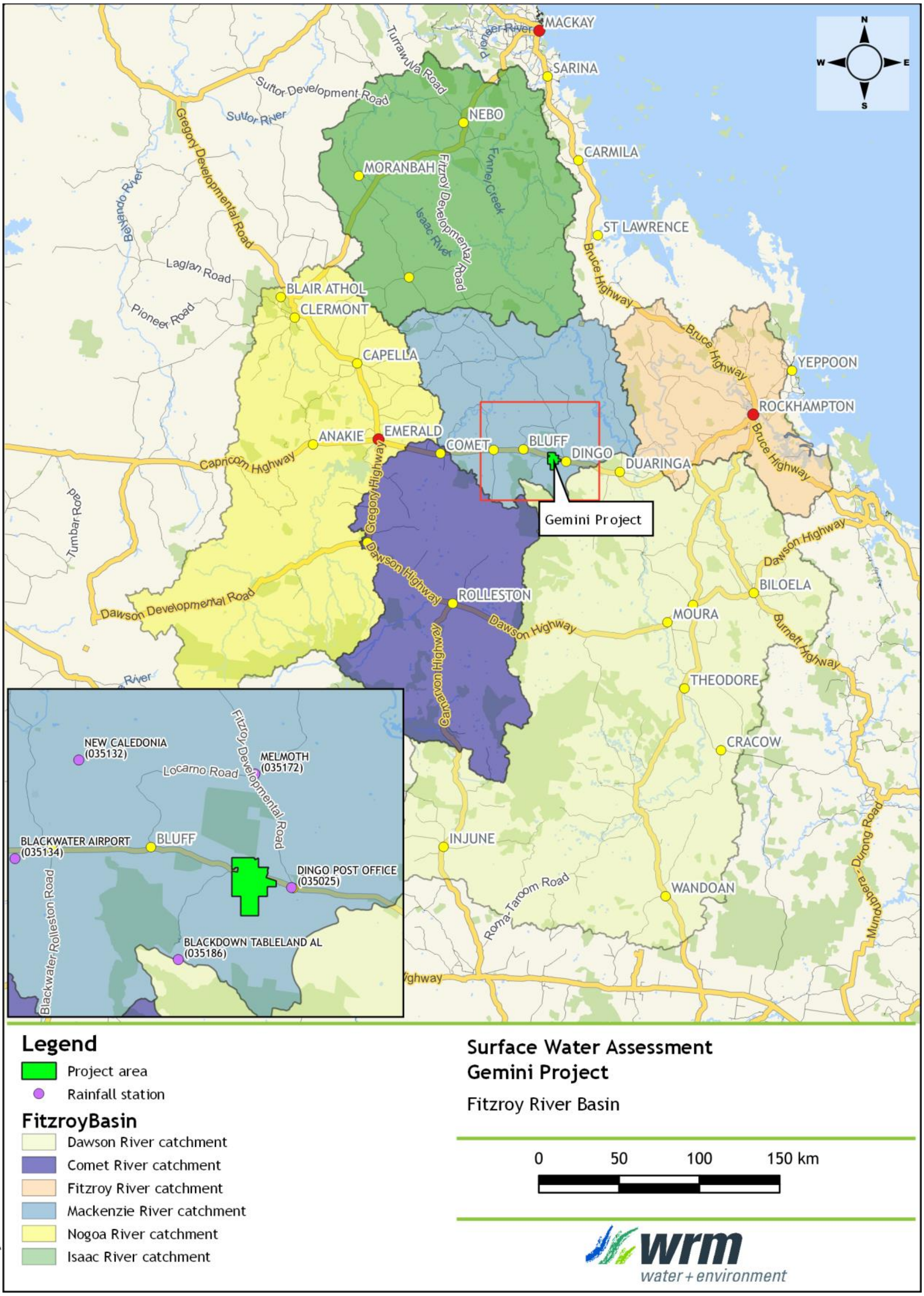


Figure 4.3 – Fitzroy River Basin

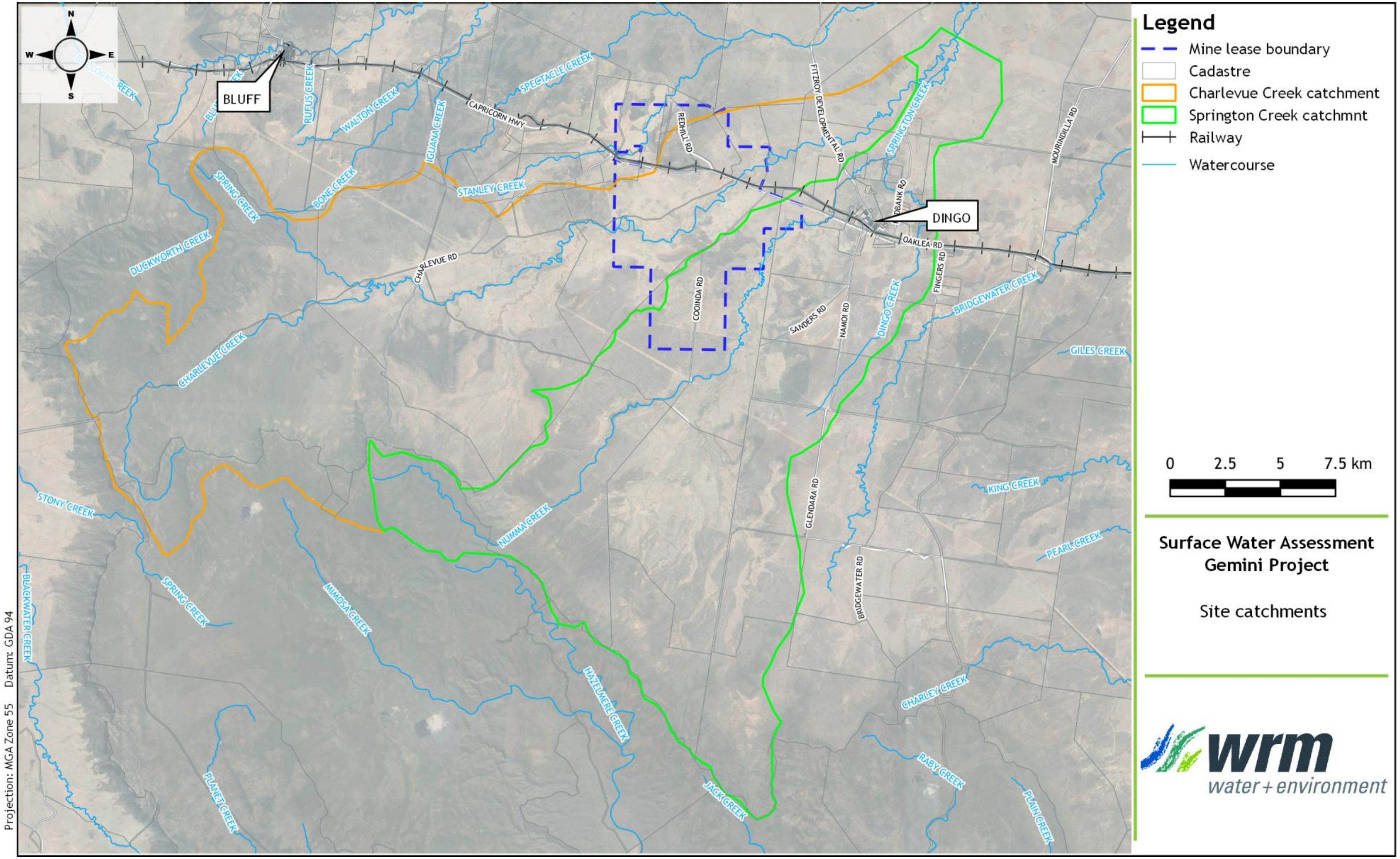


Figure 4.4 - Site catchments

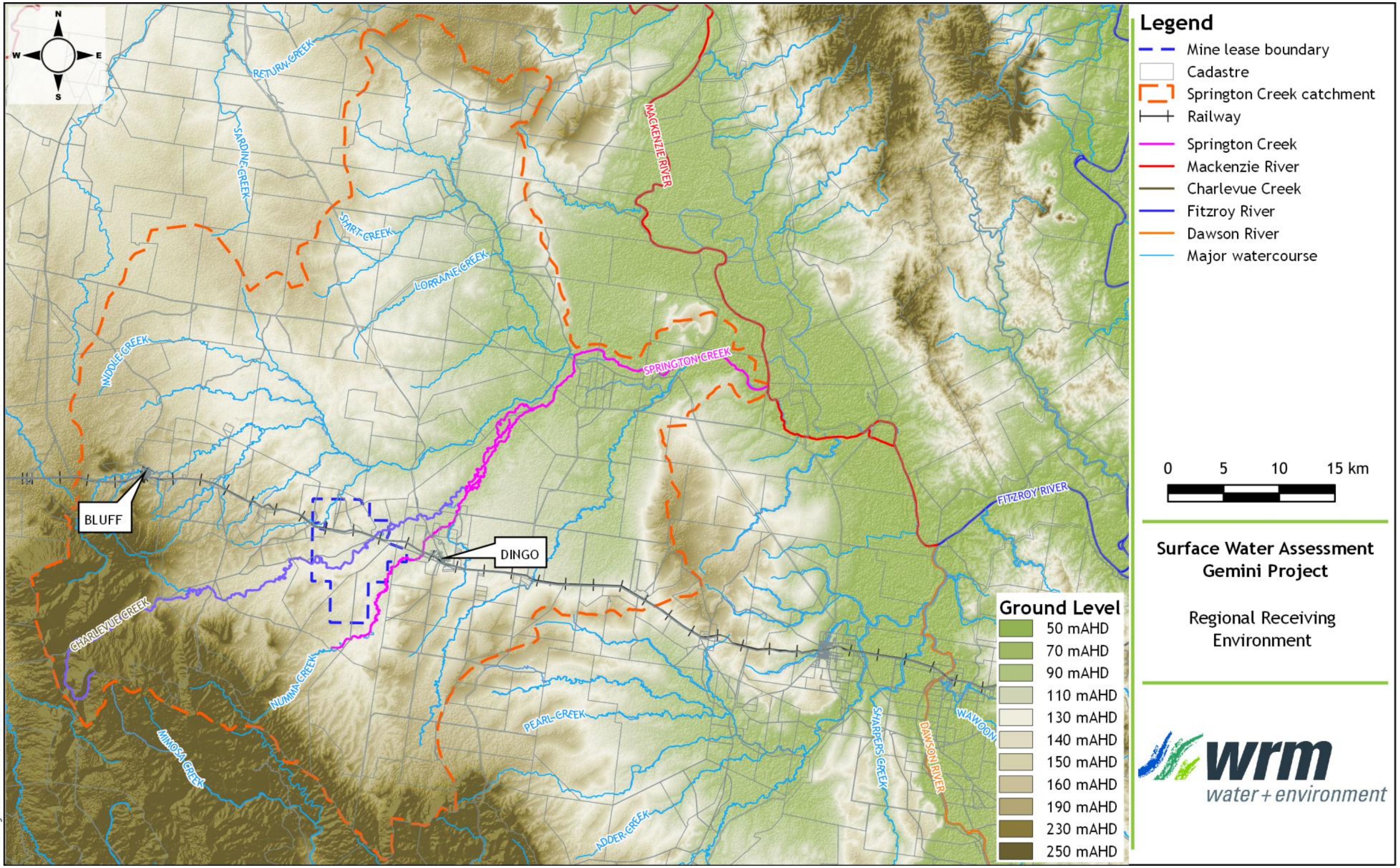


Figure 4.5 – Regional receiving environment

4.3 LOCAL STREAM MORPHOLOGY

The Project area is located within the Central Highlands region of the central Bowen Basin. The Bowen Basin is an early Permian to middle Triassic basin, extending through eastern Queensland from Collinsville in the north to Goondiwindi in the south.

The local stratigraphy typically comprises Permian coal measures overlain by Triassic and Tertiary sediments.

All nearby drainage features are ephemeral. In the Project area, Springton Creek and Charlevue Creek cross alluvial floodplains. The reaches of Springton Creek and Charlevue Creek in the proposed mining area have well-defined channels, typically with alluvial clay beds and well established in-channel vegetation.

Figure 4.6 – Drone photograph looking south across along Charlevue Creek across the Capricorn Highway to the Project area (source: Magnetic South Pty Ltd)

Figure 4.7 – Drone photograph looking southwest along Charlevue Creek at the site of the proposed haul road crossing (source: Magnetic South Pty Ltd)

Figure 4.8 – Photograph of Charlevue Creek channel upstream of the mine area (source: aarc)

Figure 4.9 – Photograph of Charlevue Creek channel upstream of the mine area (source: aarc)

Figure 4.10 – Drone photograph looking south along Springton Creek near the proposed location of AB Pit (source: Magnetic South Pty Ltd)

Figure 4.11 – Photograph of Springton Creek channel near proposed AB Pit location (source: aarc)

Figure 4.12 – Photograph of Springton Creek channel and floodplain near proposed AB Pit location (source: aarc)

Figure 4.13 – Drone photograph looking southeast to Springton Creek at confluence of unnamed tributary crossing proposed AB Pit (source: Magnetic South Pty Ltd)

Figure 4.14 – Drone photograph looking northeast along upper reach of the unnamed tributary of Springton Creek crossing proposed C Pit (source: Magnetic South Pty Ltd)

4.4 STREAMFLOW

There are no streamflow gauges located in the local catchments in the vicinity of the Project. The local streams are ephemeral, and based on the observed behaviour of other streams in the region, streamflow mostly occurs shortly after rainfall between September and April.

4.5 FLOODING

A flood study has been undertaken for this assessment. The extent, depth and velocity of flooding across the MDL in the 1% AEP flood are shown in Figure 4.15 and Figure 4.16. The full details of the flood study are provided in Appendix A.

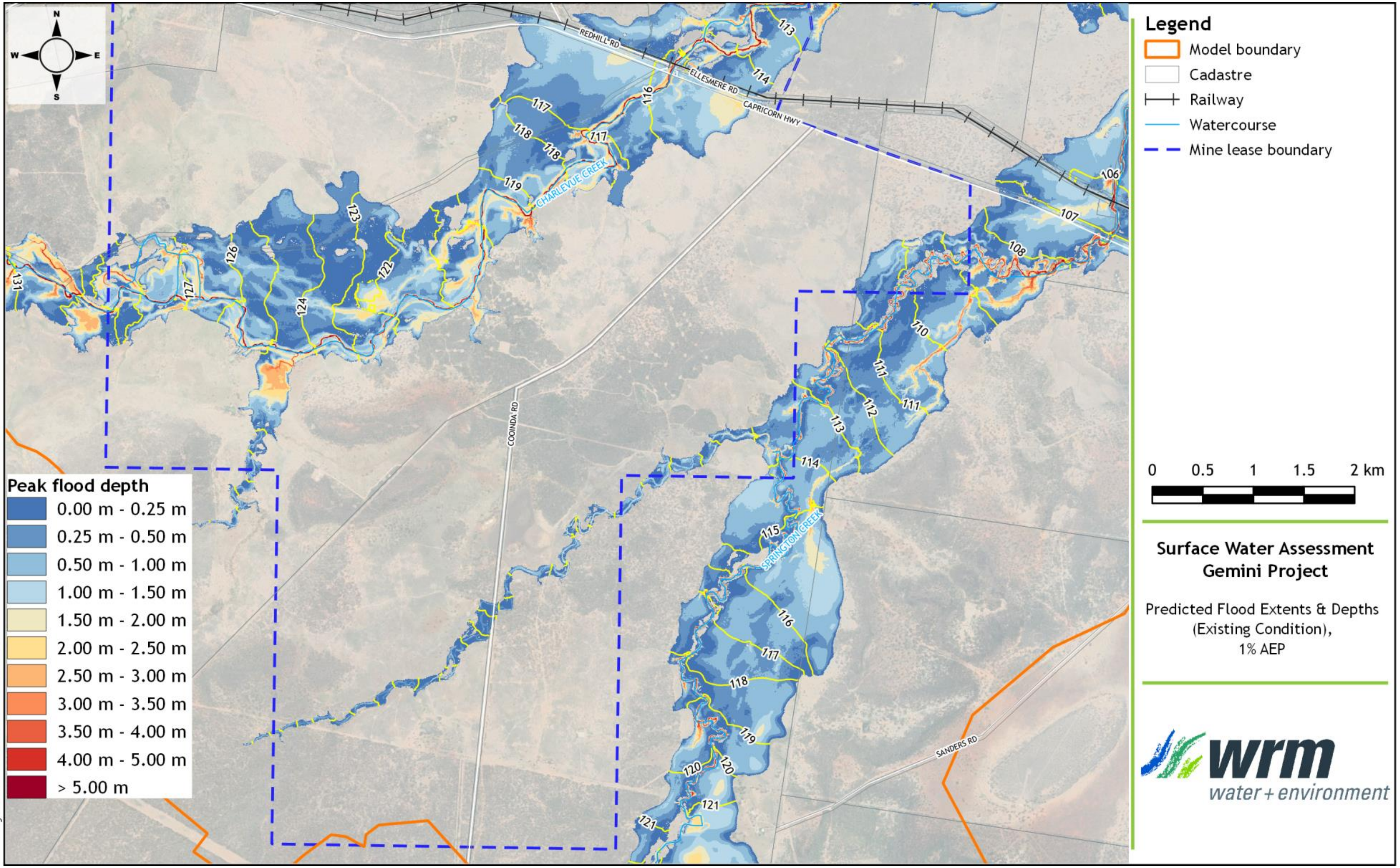


Figure 4.15 – Existing conditions 1% AEP flood depths and water level contours

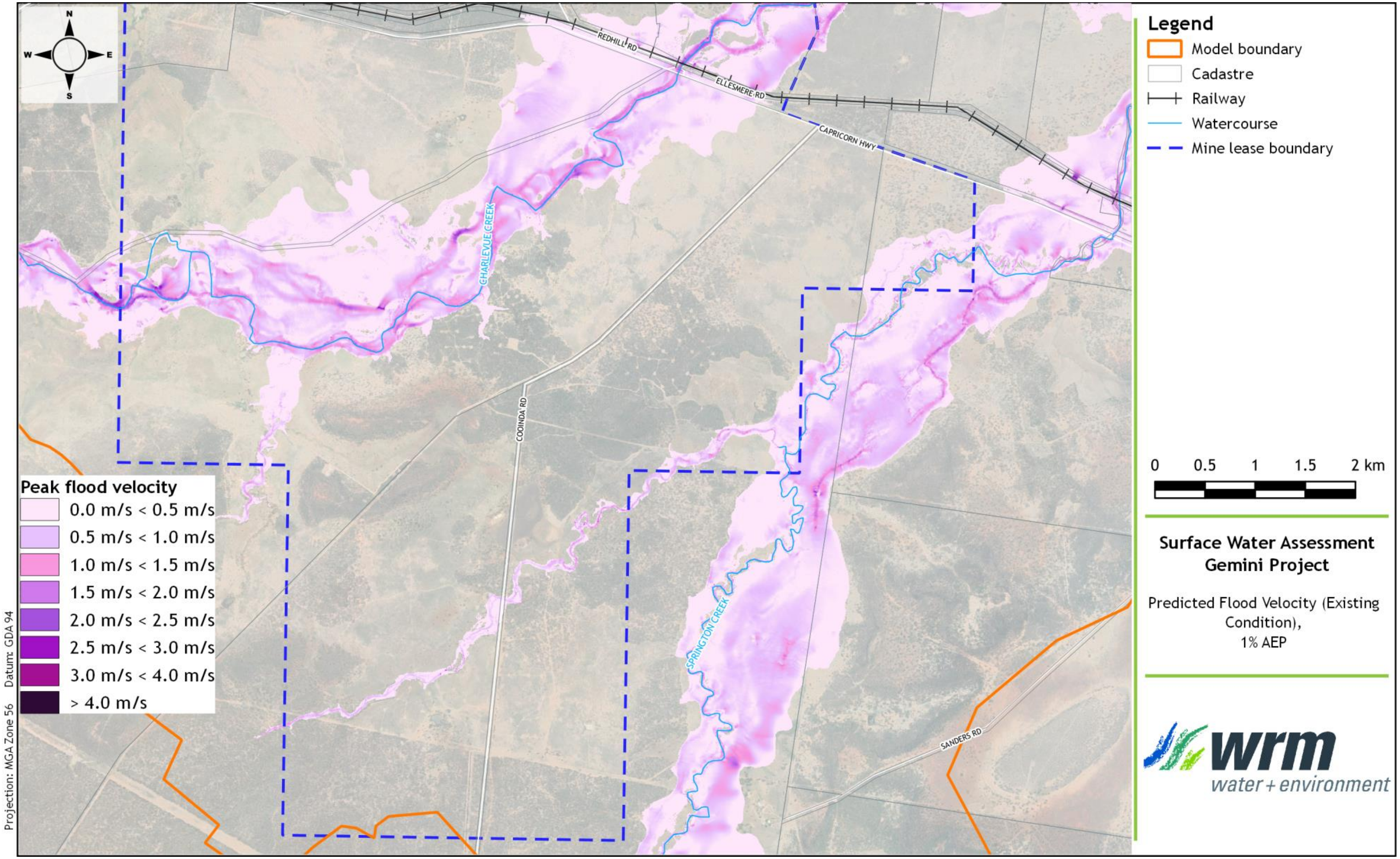


Figure 4.16 - Existing conditions 1% AEP flood velocities

4.6 WATER QUALITY

4.6.1 Baseline quality of receiving waters

Water quality of the region is variable and dependent on antecedent flow conditions and site-specific factors, such as adjacent land use and site disturbances.

A baseline water quality monitoring program has been implemented for the Project, and limited water quality data is available to characterise site water quality.

AARC (2019) provided the results of laboratory testing of field samples taken in Charlevue Creek and Springton Creek in late February 2018 and mid April 2019. The results for some key physico-chemical parameters can be summarised as follows:

- electrical conductivity (EC) within the WQO (i.e. 72 – 138 µS/cm);
- turbidity and suspended solids higher than the WQO (i.e. 422 – 5,630 NTU and 58 - 6,170 mg/L respectively);
- pH generally within but occasionally lower than the WQO (i.e. 6.1 – 7.3).

Surface water quality was found to be generally poor. Exceedances of the turbidity WQO were observed across all sites. Low DO levels were also recorded in stagnant pools along ephemeral the waterways. However, at the time of sampling there was no surface flow, and as such, these exceedances are not reliable indicators of long-term system health.

Petroleum hydrocarbon concentrations in Charlevue Creek and Springton Creek exceeded WQO values at downstream locations. These results may indicate an existing local source of petroleum hydrocarbons. Possible sources include crude oil, heavy fuel oils, lubricating oils, asphalt. The Capricorn Highway is a possible point source for the petroleum hydrocarbons observed at nearby locations.

There were no flow monitoring stations installed at the Project site prior to the surface water quality samples being taken. The results of the site water balance model have been used to estimate the relative magnitude of the flow events occurring in the days prior to the samples being taken.

As runoff was observed to have essentially ceased at the time of sampling, the modelled (using the AWBM) runoff for the ‘undisturbed’ catchment type over the 7 days prior to the sampling events on 23 February 2018 and 8 April 2019 was compared to the range of modelled weekly totals estimated over the period of climate record from 1889. The results are plotted in Figure 4.17 below, which shows that during both periods the modelled runoff would have been exceeded in the wettest 3% to 4% of weeks in the climate record (noting that runoff greater than 1 mm/week would only occur about 6% of the time).

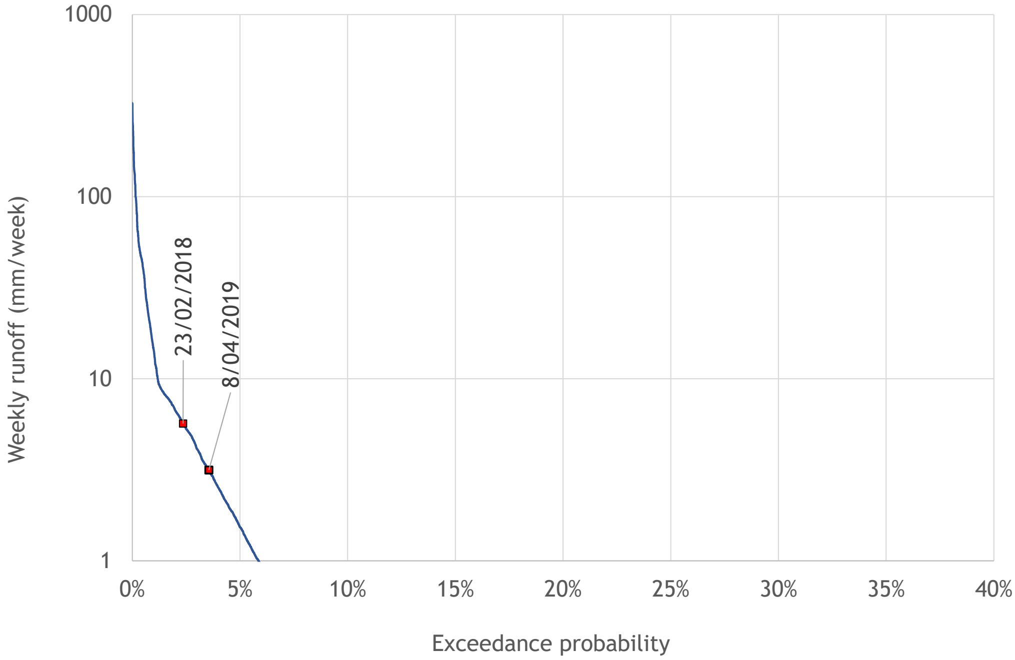


Figure 4.17 – Flow frequency curve based on rainfall runoff modelling of Springton Creek using the AWBM

4.6.2 Geochemical characterisation of overburden

RGS undertook a geochemical assessment (RGS, 2018) of representative samples of mining waste materials for the project. The samples represented the main overburden, interburden and potential coal reject materials likely to be encountered. The main findings of the assessment are as follows:

- Initial and ongoing surface runoff and seepage from mining waste materials is expected to be moderately alkaline and have a moderate level of salinity.
- Kinetic leach column (KLC) test results indicate that mining waste materials are unlikely to generate acid conditions and are more likely to generate pH neutral to alkaline conditions.
- Metal/metalloid enrichment was limited to cobalt in a single carbonaceous siltstone sample. However, the nature of a coal deposit means some metals/metalloids are expected to be slightly elevated in some materials.
- Most metals/metalloids are sparingly soluble at the neutral to alkaline pH of leachate expected from bulk mining waste materials. Dissolved metal/metalloid concentrations in surface runoff and leachate from bulk mining waste materials are therefore expected to be low and unlikely to pose a significant risk to the quality of surface and groundwater resources at relevant storage facilities.
- Most mining materials appear susceptible to dispersion and erosion, and appropriate management processes will need to be developed based on field trials for progressive rehabilitation of these materials during operations and at mine closure.
- Mining waste materials should be amenable to revegetation as part of rehabilitation activities, although, gypsum and fertiliser addition may need to be considered for sodic materials to limit dispersion and erosion and to provide a reasonable growth medium for revegetation and rehabilitation.

5 Proposed water management strategy

5.1 SITE WATER TYPES

Land disturbance associated with mining has the potential to adversely affect the quality of surface runoff in downstream receiving waters through increased sediment loads. In addition, runoff from active mining areas (including coal stockpiles, etc.) may have increased concentrations of salts and other pollutants when compared to natural runoff.

For the purpose of site water management, site water has been classified into the types shown in Table 5.1 on the basis of the likely water quality characteristics.

Table 5.1 - Site water types

Water Type	Definition
Mine affected water	In accordance with the DEHP Guideline Model Mining Conditions, mine affected water means the following types of water: i) pit water, tailings dam water, processing plant water; ii) water contaminated by a mining activity which would have been an environmentally relevant activity under Schedule 2 of the Environmental Protection Regulation 2008 if it had not formed part of the mining activity; iii) rainfall runoff which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated, excluding rainfall runoff discharging through release points associated with erosion and sediment control structures that have been installed in accordance with the standards and requirements of an Erosion and Sediment Control Plan to manage such runoff, provided that this water has not been mixed with pit water, tailings dam water, processing plant water or workshop water; iv) groundwater which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated; v) groundwater from the mine dewatering activities; vi) a mix of mine affected water (under any of paragraphs i to v) and other water.
Sediment water	Surface water runoff from areas that are disturbed by mining operations (including out-of-pit waste rock emplacements). This runoff does not come into contact with coal or other carbonaceous material and may contain high sediment loads but does not contain elevated level of other water quality parameters (e.g. electrical conductivity, pH, metals, metalloids, non-metals). This runoff must be managed to ensure adequate sediment removal prior to release to receiving waters. Note that prior to release through sediment control structures this water is considered mine affected water.
Clean catchment water	Surface runoff from areas unaffected by mining operations. Clean catchment water includes runoff from undisturbed areas and fully rehabilitated areas.
Raw water	Untreated water, generally from an external water supply, that has not been contaminated by mining activities.
Potable water	Treated water suitable for human consumption.

The proposed strategy for the management of surface water at the Project is based on the separation of water from different sources based on anticipated water quality.

On the basis of the expected runoff and groundwater inflow quality, the site water management system separates water into two segregated management systems:

- Mine affected water system - which will manage runoff and seepage from the mine pits, CHPP, coal stockpiles, and MIA. This is a closed system designed to prevent releases of mine affected water to the environment.
- Sediment water system - runoff from overburden dumps will be managed under an erosion and sediment control plan which is to be implemented throughout the Project, such that sediment generated and transported by runoff will be settled in a sediment dam. As overburden runoff quality is expected to be relatively benign, the sediment dams will potentially discharge directly into the environment (after the settlement of suspended sediment), and as such, will not affect the mine water balance. However, the water balance assessment has also assumed sediment dams will be pumped back to the CHPP for reuse.

Clean water from undisturbed areas is generally diverted around the areas of disturbance.

To facilitate the diversion of clean water from undisturbed area, the following drainage works are proposed:

- Minor drainage works and a pit levee are proposed to the south-east of Pit AB to ensure high flows from an unnamed second order tributary of Springton Creek do not access the pit.
- A drain is proposed to divert clean runoff from the upper reaches of an unnamed second order tributary of Springton Creek around the out-of-pit waste rock emplacement associated with Pit C.

These engineered drainage features will be required throughout operations at each mine pit and will become permanent features at mine closure.

A raw water supply pipeline is also proposed to supplement site water supplies, and will be delivered to a dedicated raw water dam, which will also intercept clean water from its local upstream catchment.

5.2 MINE DEVELOPMENT AND STAGING

Over the 18-year operating life of the Project, the operation will be staged as indicated in the following series of figures, which show the catchment areas to each mine water storage and the land use types comprising each catchment. These “snapshots” of mine operations have been adopted for the purpose of the site water balance modelling.

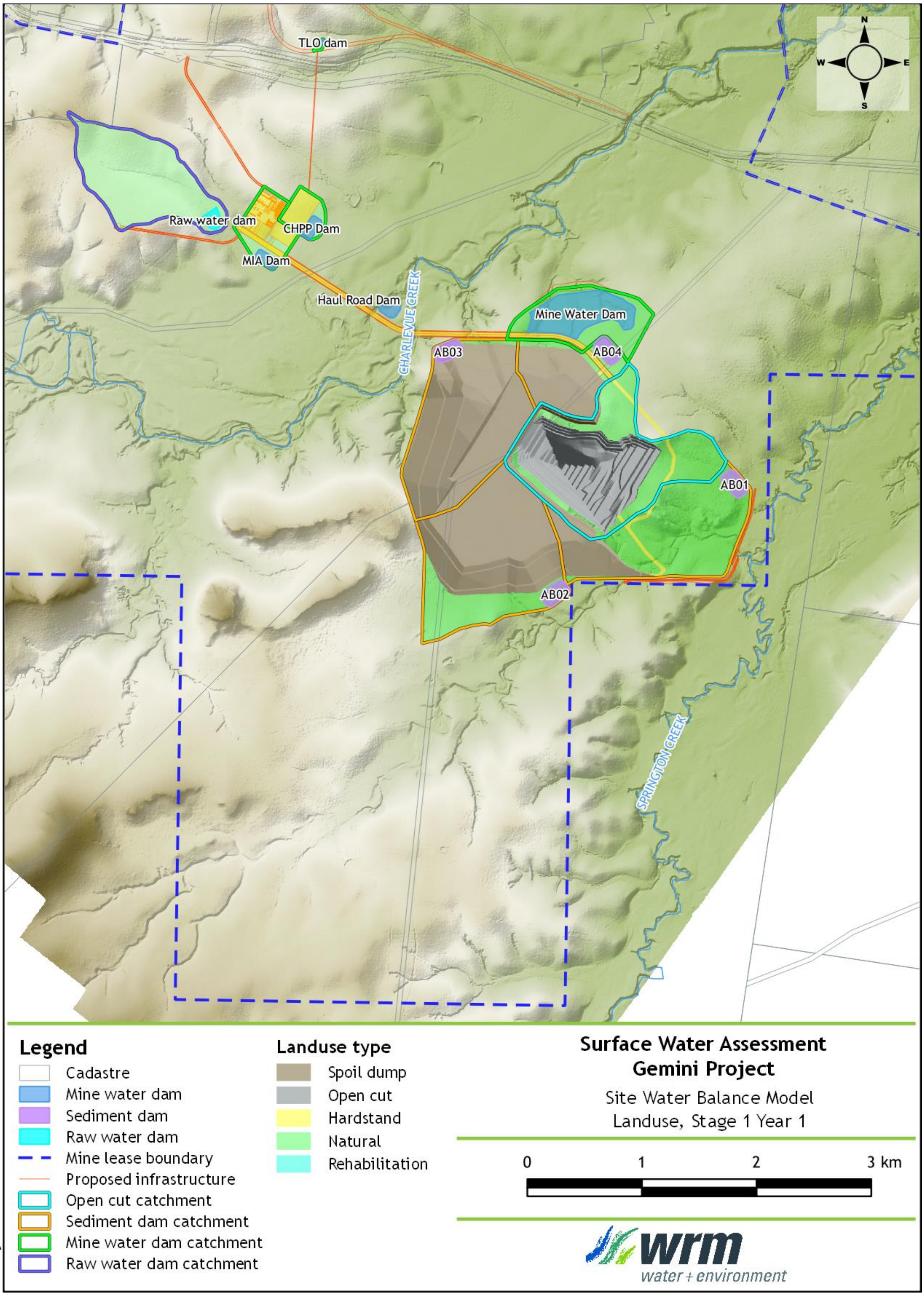


Figure 5.1 – Proposed water management system layout – Stage 1 (Year 1)

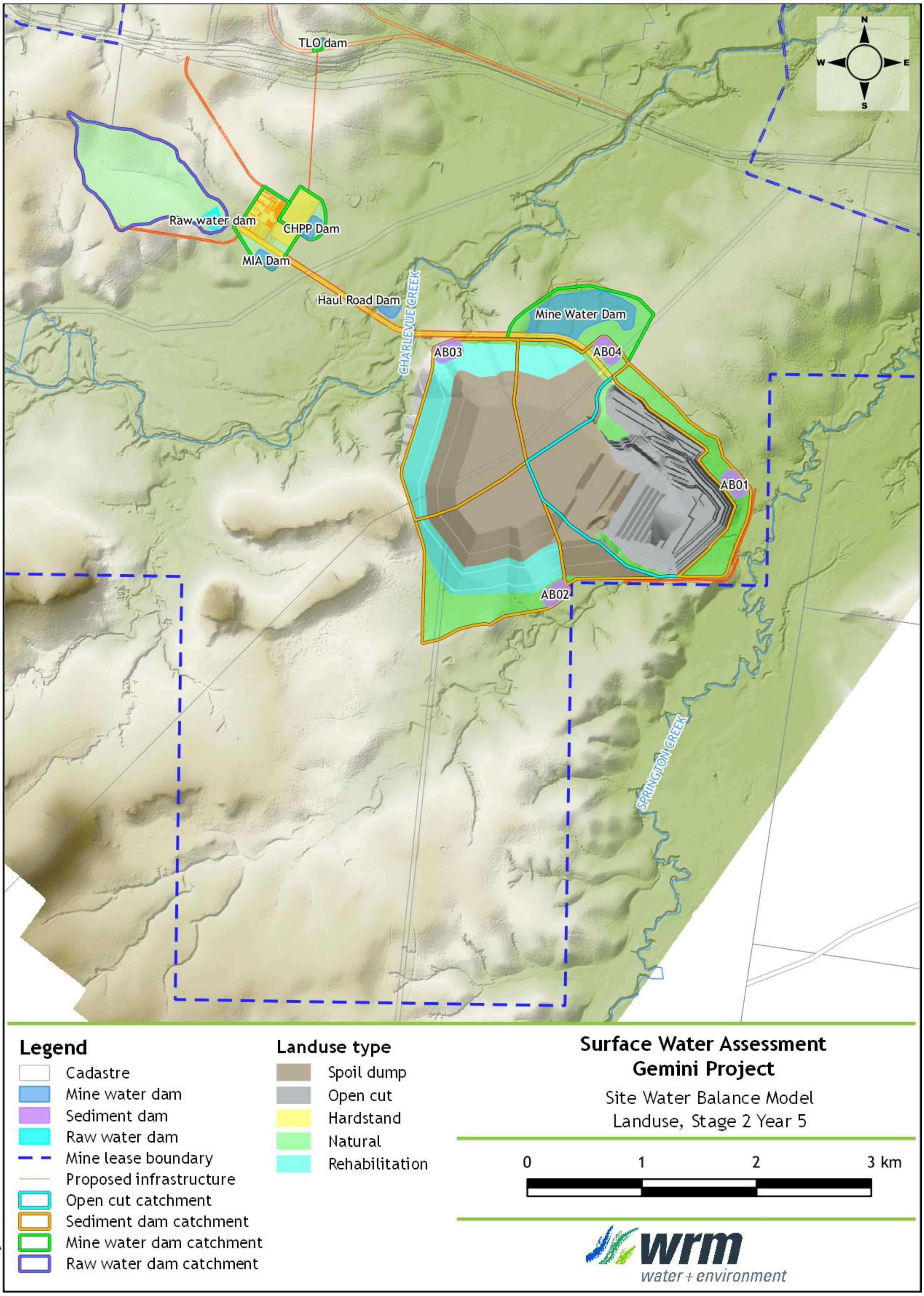


Figure 5.2 – Proposed water management system layout – Stage 2 (Year 5)

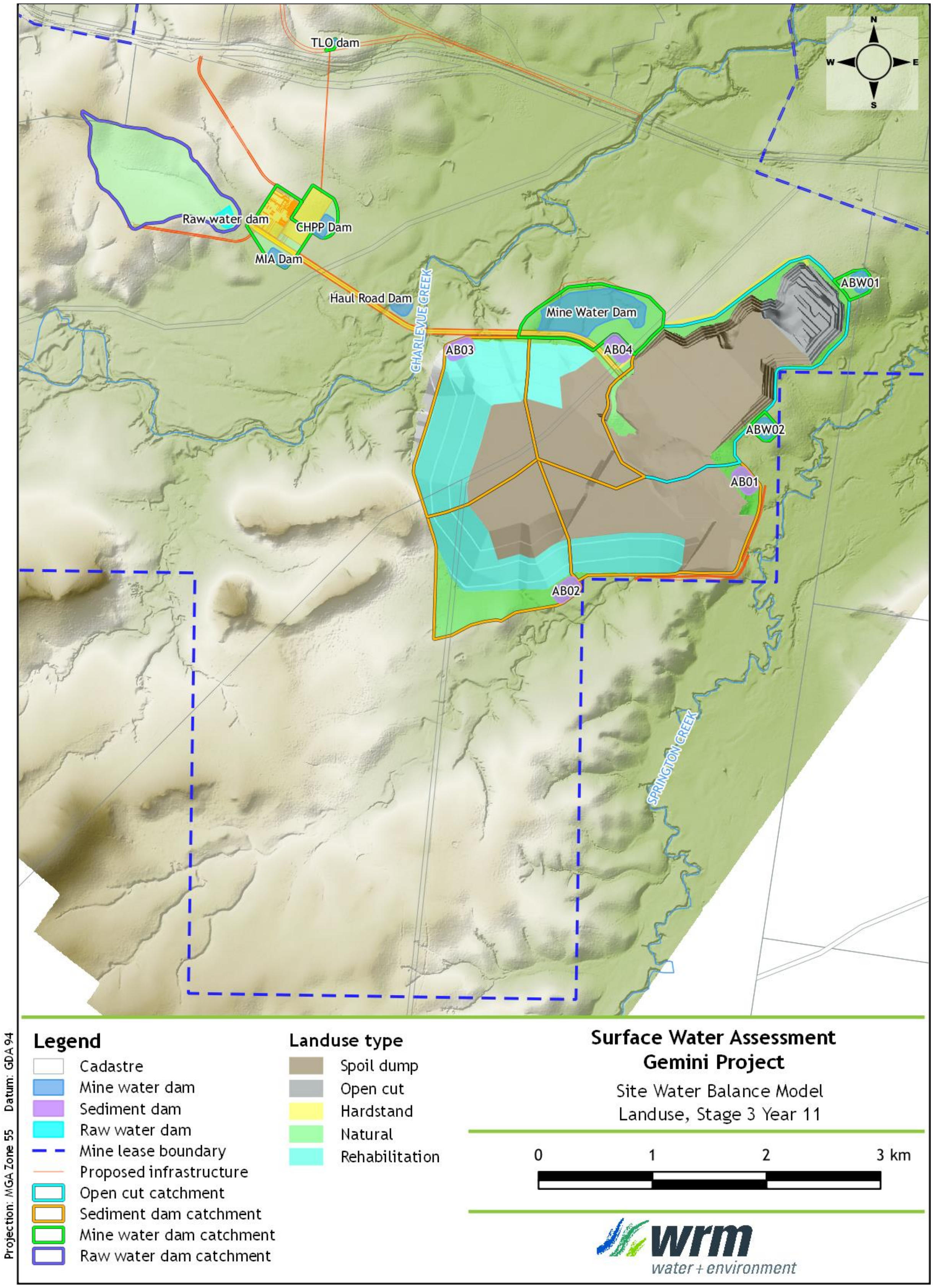


Figure 5.3 – Proposed water management system layout – Stage 3 (Year 11)

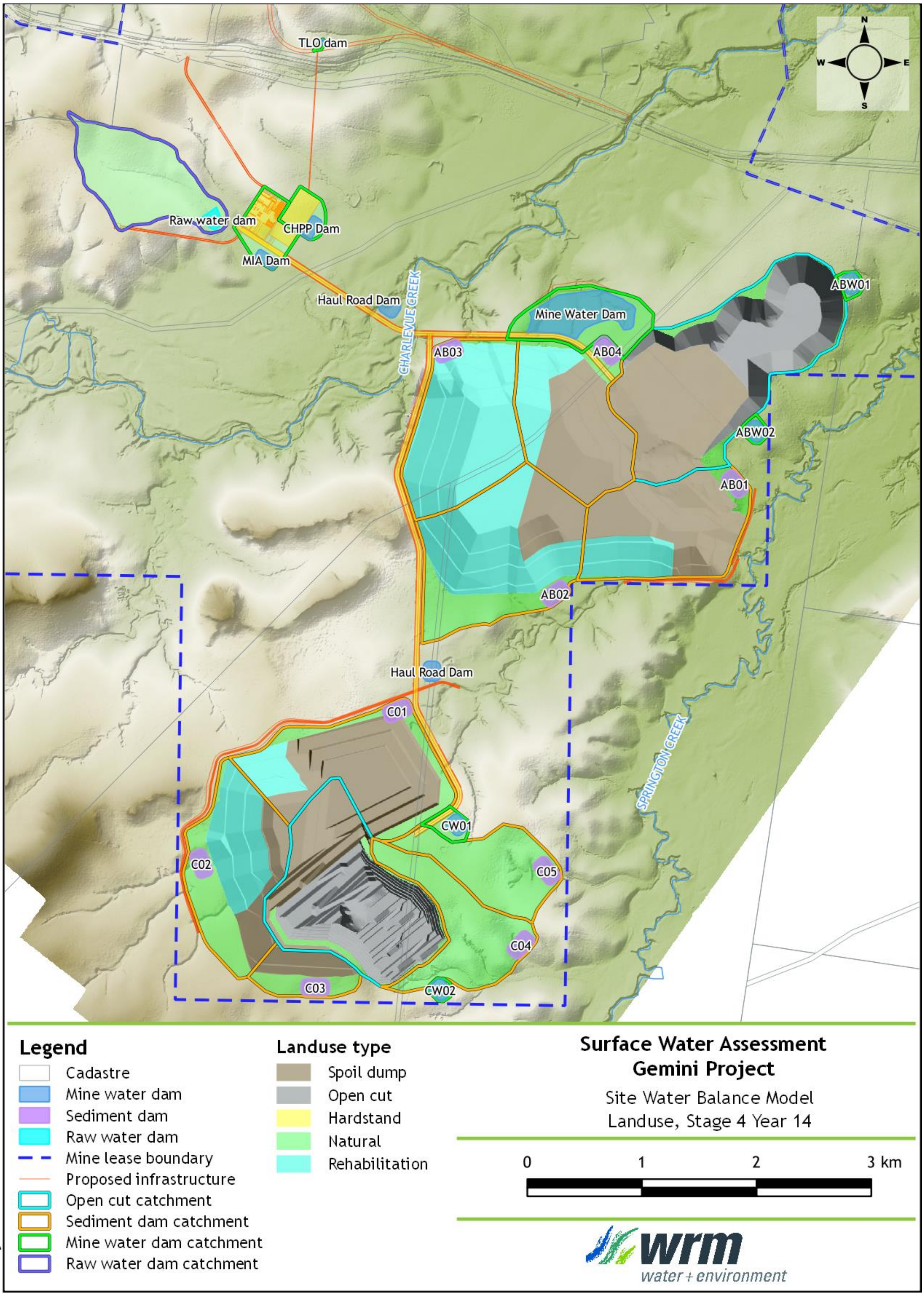


Figure 5.4 – Proposed water management system layout – Stage 4 (Year 14)

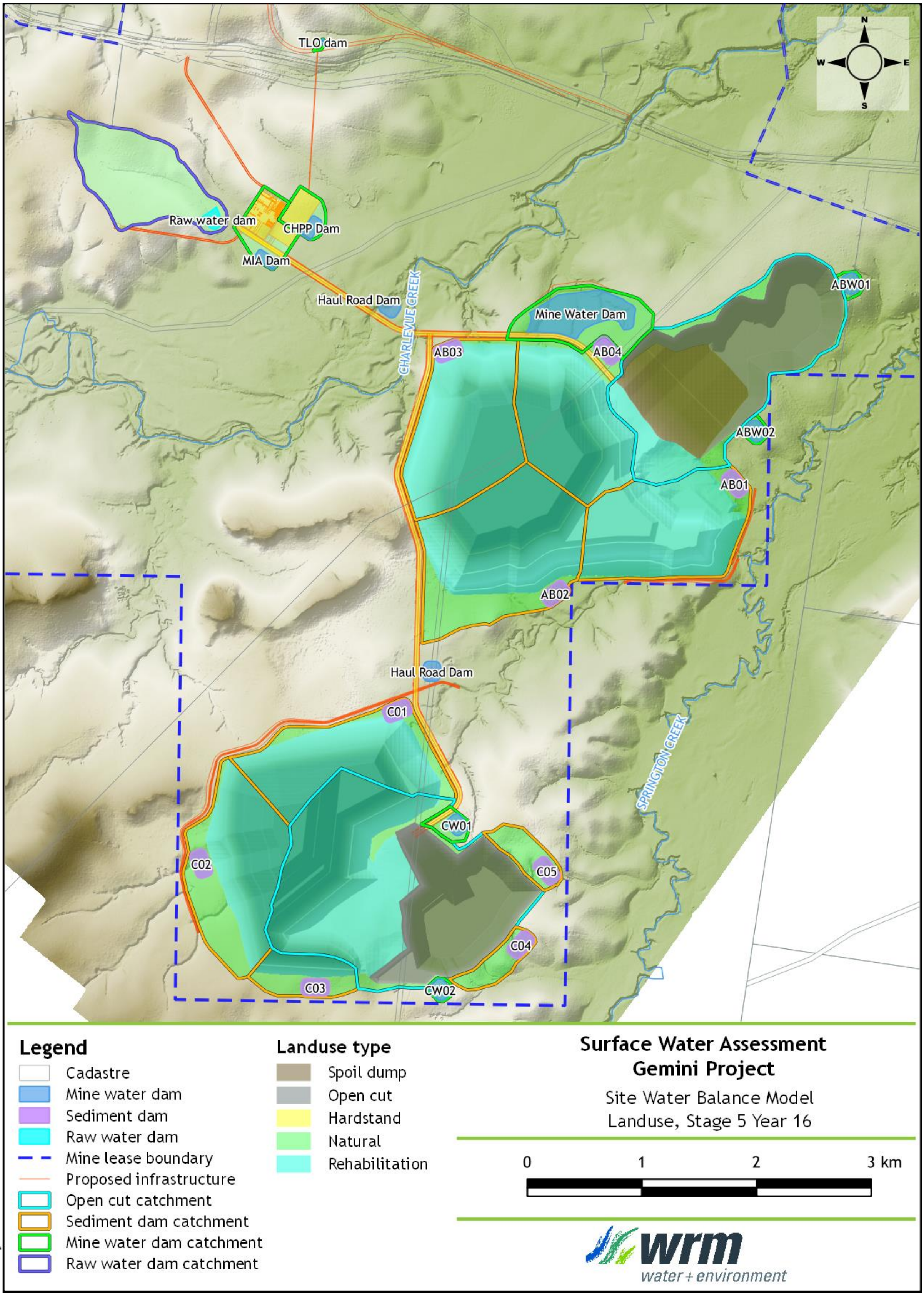


Figure 5.5 – Proposed water management system layout – Stage 5 (Year 16)

5.3 WATER MANAGEMENT SYSTEM COMPONENTS

5.3.1 Mine affected water dams

Several types of dams are proposed to hold mine affected runoff, including:

Mine Water Dam – receives pumped groundwater and surface runoff dewatered from AB Pit and C Pit (and potentially from the MIA and CHPP dams if required). Water will be transferred from the Mine Water Dam for reuse at the CHPP and for other uses as required. Offsite discharge of mine water will be avoided by operating below a maximum operating level and directing emergency overflows from the Mine Water Dam via a spillway to the mine pit. If stored water quality allows, controlled mine water releases may be made to Charlevue Creek in accordance with the Environmental Authority (these releases have been conservatively excluded from the site water balance model to ensure water can be contained on site without release under historical climate conditions).

AB Pit – will be used as a supplementary mine water storage after commencement of mining in C Pit.

Out-of-pit mine water dams – a number of small staging dams may be used to collect water pumped from the mine pits before transferring to the Mine Water Dam. These dams are small and have not been included in the site water balance model. Offsite discharge of mine water from these dams will be avoided by directing emergency overflows via spillways to the mine pit.

Haul Road Dams – two small dams will be used to manage runoff from disturbed catchments. One dam (between Pit AB and Pit C) will be used to contain runoff from the Pit C haul road, while the other dam will be used to collect runoff from the haul road on the western side of Charlevue Creek.

MIA Dam – will capture and contain runoff from the MIA and coal stockpiles. Oil/water separators are proposed for vehicle wash and workshop areas to treat hydrocarbon contaminated runoff prior to capture. Compared to runoff captured from other disturbed areas of the site, water captured in the MIA dam will be more likely to contain elevated contaminant concentrations. The dam will be sized and operated such that the risk of off-site release is very low. This would be achieved by providing a water storage capacity approximately equivalent to the runoff from the 1 in 20 AEP 4 month rainfall (4 ML/ha) – which is the hydrological design criteria for the 'failure to contain – overtopping' scenario in the Manual for assessing consequence categories and hydraulic performance of structures.

CHPP Dam - will capture and contain runoff from the CHPP. Compared to runoff captured from other disturbed areas of the site, water captured in the CHPP dam will be more likely to contain elevated contaminant concentrations. The dam will be sized and operated such that the risk of off-site release is very low. This would be achieved by providing a water storage capacity approximately equivalent to the runoff from the 1 in 20 AEP 4 month rainfall (4 ML/ha) – which is the hydrological design criteria for the 'failure to contain – overtopping' scenario in the Manual for assessing consequence categories and hydraulic performance of structures.

TLO Dam – A series of sediment traps and small drainage dams will be used to capture washdown and overflow from trains and sumps before it is directed to the TLO Dam. Water collected in this small dam will pumped to the Mine Water Dam. The dams will be sized and operated such that the risk of off-site release is very low.

Table 5.2 – Gemini Project mine affected water dam details

Storage	Catchment area (ha)	Storage capacity (ML)
Mine Water Dam	50.3	1,000
MIA Dam	22.4	96.5
CHPP Dam	11.9	101.7
Raw Water Dam	78.1	56.6
TLO Dam	0.5	0.5

5.3.2 Raw Water Dam

The raw water dam receives raw water imported via the offsite water supply pipeline described in Section 5.1. This dam will also capture clean surface runoff from its local undisturbed upslope catchment.

5.3.3 Sediment dams

Catchment runoff from overburden dumps at AB Pit and C Pit will be captured in sediment dams. Sediment dams will be designed and operated in accordance with the Department of Environment and Heritage Protection Guideline - *Stormwater and environmentally relevant activities (DEHP, 2017).*

This guideline states that"

"For events up to and including a 24 hour storm event with an ARI of 1 in 10 years, the following must be achieved:

i. a sediment basin must be designed, constructed and operated to retain the runoff at the site(s) approved as part of the ERA application;

ii. the release stormwater from these sediment basins must achieve a total suspended solids (TSS) concentration of no more than 50mg/L for events up to and including those mentioned above. For events larger than those stated above, all reasonable and practical measures must be taken to minimise the release of prescribed contaminants."

The sediment dams have therefore been sized as follows:

- Water storage capacity 1 in 10 AEP 24 hour storm event with and adopted volumetric event runoff coefficient for disturbed catchments of 0.5; and;
- total sediment basin volume = settling zone capacity + sediment storage volume. The sediment storage volume is the portion of the basin storage volume that progressively fills with sediment until the basin is de-silted;
- solids storage volume = 25% of water storage volume.

If required, water captured in sediment dams will be pumped back into the mine water system. Table 5.3 shows the required sediment dam volumes using this method.

Table 5.3 – Gemini Project sediment dam details

Storage	Catchment area (ha)	10year 24 hour water storage capacity (ML)	Solids storage volume (ML)	Total Storage capacity (ML)
AB01	146.1	105.9	26.5	132
AB02	155.5	112.7	28.2	141
AB03	121.8	88.3	22.1	110
AB04	114.9	83.3	20.8	104
C01	132.7	96.2	24.1	120
C02	106.8	77.4	19.4	97
C03	32.4	23.5	5.9	29
C04	76.0	55.1	13.8	69
C05	64.8	47.0	11.7	59

5.3.4 Engineered drainage features

5.3.4.1 Clean water drainage

Engineered drainage features are proposed at two locations to facilitate the diversion of clean water (Figure 1.2):

- Minor drainage works and a pit levee are proposed to the south-east of Pit AB to ensure high flows from an unnamed second order tributary of Springton Creek do not access the pit.
- A drain is proposed to divert clean runoff from the upper reaches of an unnamed second order tributary of Springton Creek around the out-of-pit waste rock emplacement associated with Pit C.

The engineered drainage features will be required throughout operations at each mine pit and will become permanent features at mine closure.

Runoff and seepage from the mine pits will be contained within the mine affected water (MAW) system. The mine pits and MAW dams are located such that it would not be possible for this MAW water to enter the engineered drainage features.

The overburden dumps will be initially placed within the levees, and (in accordance with the erosion and sediment control plan) sediment-laden runoff would be directed to sediment dams via drains designed to prevent overflow into the engineered drainage features.

As the final overburden dump profile is developed, a series of contour drains would direct runoff away from the engineered drainage structures and to sediment dams. Overflows to engineered drainage features would only occur after treatment in a sediment dam.

The preliminary channel designs of the clean water drains are provided in Section 7.

5.3.4.2 Levees

The purpose of the engineered drainage features is to ensure low flows are directed around the active mining area. Where a channel crosses a low-lying area or a gully adjacent to the active pit, a levee would be required to "*reduce the risk of ingress of clean floodwaters into operational areas where they may become contaminated with possible adverse impact on water management operations and containment performance.*"

The levees would therefore be 'regulated structures' and would be designed, constructed and decommissioned in accordance with the 'Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933)' and 'Structures which are dams or levees constructed as part of environmentally relevant activities (ESR/2016/1934)'.

These levee structures would be temporary, required only until the final overburden profile is achieved and the associated permanent drainage systems commissioned. However, they would likely become integral with the final rehabilitated overburden dump landform at decommissioning.

While the engineered drainage channels themselves would not necessarily be regulated structures, they will need to be designed to ensure they do not interfere with the functioning of the levees in the design flood event (for example by inducing scour which could affect the integrity of the levee).

5.4 CATCHMENT AREAS AND LAND USE

A summary of adopted catchment areas and land use types for each stage are provided in Table 5.4 to Table 5.8. The proposed disturbance footprints are shown in Figure 5.1, Figure 5.2, Figure 5.3, Figure 5.4, and Figure 5.5.

Table 5.4 - Catchment areas and land use breakdown summary - Stage 1 - Year 1

Dam	Contributing catchment (ha)					
	Spoil dump	Open Cut	Road/ Hardstand	Natural	Rehabilitation	Total
AB01	21.8	-	3.4	79.1	-	104.3
AB02	98.0	-	-	37.2	-	135.2
AB03	117.6	-	-	2.5	-	120.1
AB04	34.9	-	1.3	10.5	-	46.7
C01	-	-	-	-	-	-
C02	-	-	-	-	-	-
C03	-	-	-	-	-	-
C04	-	-	-	-	-	-
C05	-	-	-	-	-	-
AB PIT	12.1	71.8	2.8	52.8	-	139.5
C PIT	-	-	-	-	-	-
ABW01	-	-	-	-	-	-
ABW02	-	-	-	-	-	-
CW01	-	-	-	-	-	-
CW02	-	-	-	-	-	-
Mine Water Dam	-	-	2.4	47.9	-	50.3
MIA Dam	-	-	13.8	8.6	-	22.4
TLO Dam	-	-	-	0.5	-	0.5
Raw Water Dam	-	-	-	78.1	-	78.1
CHPP Dam	-	-	7.7	4.2	-	11.9

Table 5.5 - Catchment areas and land use breakdown summary - Stage 2 - Year 5

Dam	Contributing catchment (ha)					
	Spoil dump	Open Cut	Road/ Hardstand	Natural	Rehabilitation	Total
AB01	20.8	-	-	1.7	-	22.5
AB02	58.3	-	-	37.2	38.7	134.2
AB03	73.1	-	-	2.5	46.2	121.8
AB04	42.0	-	1.3	10.3	12.6	66.2
C01	-	-	-	-	-	-
C02	-	-	-	-	-	-
C03	-	-	-	-	-	-
C04	-	-	-	-	-	-
C05	-	-	-	-	-	-
AB PIT	58.1	111.9	0.2	9.0	-	179.2
C PIT	-	-	-	-	-	-
ABW01	-	-	-	-	-	-
ABW02	-	-	-	-	-	-
CW01	-	-	-	-	-	-
CW02	-	-	-	-	-	-
Mine Water Dam	-	-	2.4	47.9	-	50.3
MIA Dam	-	-	13.8	8.6	-	22.4
TLO Dam	-	-	-	0.5	-	0.5
Raw Water Dam	-	-	-	78.1	-	78.1
CHPP Dam	-	-	7.7	4.2	-	11.9

Table 5.6 - Catchment areas and land use breakdown summary - Stage 3 - Year 11

Dam	Contributing catchment (ha)					
	Spoil dump	Open Cut	Road/ Hardstand	Natural	Rehabilitation	Total
AB01	102.4	-	-	10.6	33.2	146.2
AB02	44.0	-	-	37.2	51.5	132.7
AB03	32.7	-	-	2.5	86.6	121.8
AB04	59.6	-	1.4	9.7	20.6	91.3
C01	-	-	-	-	-	-
C02	-	-	-	-	-	-
C03	-	-	-	-	-	-
C04	-	-	-	-	-	-
C05	-	-	-	-	-	-
AB PIT	157.3	38.5	0.7	27.6	-	224.1
C PIT	-	-	-	-	-	-
ABW01	-	-	-	5.7	-	5.7
ABW02	-	-	-	3.9	-	3.9
CW01	-	-	-	-	-	-
CW02	-	-	-	-	-	-
Mine Water Dam	-	-	2.4	47.9	-	50.3
MIA Dam	-	-	13.8	8.6	-	22.4
TLO Dam	-	-	-	0.5	-	0.5
Raw Water Dam	-	-	-	78.1	-	78.1
CHPP Dam	-	-	7.7	4.2	-	11.9

Table 5.7 - Catchment areas and land use breakdown summary - Stage 4 - Year 14

Dam	Contributing catchment (ha)					
	Spoil dump	Open Cut	Road/ Hardstand	Natural	Rehabilitation	Total
AB01	79.6	-	-	9.7	27.0	116.3
AB02	29.4	-	-	37.2	88.9	155.5
AB03	-	-	-	2.5	119.3	121.8
AB04	71.9	-	1.2	10.5	31.1	114.7
C01	91.9	-	-	23.0	17.8	132.7
C02	26.3	-	-	37.8	48.6	112.7
C03	16.9	-	-	15.5	-	32.4
C04	-	-	-	76.0	-	76.0
C05	-	-	0.5	64.3	-	64.8
AB PIT	98.0	104.6	-	15.1	-	217.7
C PIT	49.2	98.6	-	11.3	-	159.1
ABW01	-	-	-	3.9	-	3.9
ABW02	-	-	-	3.9	-	3.9
CW01	-	-	0.9	6.4	-	7.3
CW02	-	-	-	3.2	-	3.2
Mine Water Dam	-	-	2.4	47.9	-	50.3
MIA Dam	-	-	13.8	8.6	-	22.4
TLO Dam	-	-	-	0.5	-	0.5
Raw Water Dam	-	-	-	78.1	-	78.1
CHPP Dam	-	-	7.7	4.2	-	11.9

Table 5.8 - Catchment areas and land use breakdown summary - Stage 5 - Year 16

Dam	Contributing catchment (ha)					
	Spoil dump	Open Cut	Road/ Hardstand	Natural	Rehabilitation	Total
AB01	-	-	-	9.7	106.7	116.4
AB02	-	-	-	37.2	118.3	155.4
AB03	-	-	-	2.5	119.3	121.8
AB04	-	-	1.3	10.5	103.2	115.0
C01	-	-	-	15.6	86.9	102.5
C02	-	-	-	37.8	74.9	112.7
C03	-	-	-	15.2	14.7	29.9
C04	-	-	-	15.7	-	15.7
C05	-	-	-	17.6	-	17.6
AB PIT	71.0	104.6	-	15.1	27.0	217.8
C PIT	-	115.7	0.1	15.8	165.2	296.8
ABW01	-	-	-	3.9	-	3.9
ABW02	-	-	-	3.9	-	3.9
CW01	-	-	0.9	6.4	-	7.3
CW02	-	-	-	3.2	-	3.2
Mine Water Dam	-	-	2.4	47.9	-	50.3
MIA Dam	-	-	13.8	8.6	-	22.4
TLO Dam	-	-	-	0.5	-	0.5
Raw Water Dam	-	-	-	78.1	-	78.1
CHPP Dam	-	-	7.7	4.2	-	11.9

5.5 PRELIMINARY CONSEQUENCE CATEGORY ASSESSMENT

5.5.1 Consequence assessment - dams

A consequence assessment has been completed for the dams making up the proposed water management system, in accordance with the Manual for assessing consequence categories and hydraulic performance of structures (DES, 2016) (the Manual).

The Manual sets out the requirements of the administering authority, for consequence category assessment and certification of the design of 'regulated structures', constructed as part of environmentally relevant activities (ERAs) under the Environmental Protection Act 1994 (EP Act).

Each dam is assigned a Consequence Category of High, Significant or Low depending on its potential to cause harm. A structure categorised as a Significant or High consequence, is referred to as a regulated structure. Such structures must comply with hydraulic performance objectives set out in the Manual.

5.5.1.1 Assessment protocols

The manual requires an assessment of the potential for harm under the following failure event scenarios:

(a) ***'Failure to contain – seepage'*** – spills or releases to ground and/or groundwater via seepage from the floor and/or sides of the structure;

(b) **'Failure to contain – overtopping'** – spills or releases from the structure that result from loss of containment due to overtopping of the structure; and

(c) **'Dam break'** – collapse of the structure due to any possible cause.

5.5.1.2 Assessment criteria

For each failure event scenario, a consequence category is assigned depending on the potential to cause:

- Harm to Humans;
- General Economic Loss; or
- General Environmental Harm.

The potential for harm at the Gemini Project is described in general terms in the following section, and the adopted Consequence Categories are summarised in Table 5.9.

Harm to humans

Consumption of contaminated water

The nearest known surface town water supply systems are on the Mackenzie River and Fitzroy River, and would not be materially affected by discharge of the contents of any of the dams at the WCP (due to the total stored volume being less than 1000 ML, and the very large dilution potential).

Due to the ephemeral nature of the nearby streams, surface water is generally not used as a source of potable water in the region. All dams at the WCP are located such that human consumption of any contaminated waters is very unlikely, and would not meet the 'Significant' threshold of potentially affecting the health of 10 or more people.

Dam Break

For the purposes of the Manual, the assessment excludes site personnel engaged by the resource operation and located on the tenements. Due to the sparse population in the region, there are no workplaces or dwellings in the potential failure impact zone of the site water dams. All dams are located such that people are not routinely present in the potential failure path if an embankment was to fail.

General Economic Loss

There are no significant commercial operations in the immediate downstream reaches of Springton Creek or Charlevue Creek likely to be affected by contamination under any of the potential failure impact scenarios.

The potential damage caused by dam-break of the Mine Water Dam embankment is likely limited due to its limited height and storage capacity. However, damage to Aurizon's Blackwater rail line, a critical link for regional coal export, could result in significant economic loss to third parties.

Environmental Harm

Stored water quality in the Mine Water Dam, and MIA/CHPP Dam, are likely to be similar to mine water dams at other Central Queensland mine sites, with moderately elevated salinity, and pH, and some dissolved metals.

As there are no High Environmental Value (HEV) Zones identified in the downstream receiving environment, there is limited potential to cause harm to Significant Environmental Values.

Table 5.9 - Summary of consequence assessment - dams

Failure to contain - seepage	Main Water Dam	CHPP and MIA Dams	Raw Water Dam	Sediment Dams
Harm to humans	L	L	L	L
General environmental harm	S	L	L	L
General economic loss/damages	L	L	L	L
Failure to contain - overtopping				
Harm to humans	L	L	L	L
General environmental harm	S	L	L	L
General economic loss/damages	L	L	L	L
Dam break				
Harm to humans	L	L	L	L
General environmental harm	L	L	L	L
General economic loss/damages	S	L	L	L
OVERALL CCA RATING	S	L	L	L
Requires DSA/MRL	Y*	N	N	L
Requires engineered spillway	Y	Y	Y	Y
Requires lining (unless detailed groundwater investigation indicates risks are low)	Y	Y	N	N

L = Low consequence

S = Significant consequence

*DSA for Mine Water Dam – no DSA required if spills are directed to the Mine Pit via an appropriately robust overflow system (the Mine Pit provides the DSA)

5.5.1.3 Failure to Contain - Seepage

Localised impacts of seepage to the ecology of the on-site reaches of Springton and Charlevue Creek and its tributaries is possible, but any significant impact would be limited in extent. The Mine Water Dam and MIA/CHPP Dams have been therefore been assigned a Significant Consequence category, however, a detailed groundwater assessment should be carried out to further inform the detailed design of seepage management measures or reclassification of structures if appropriate.

5.5.1.4 Failure to Contain - Dam Break and Overtopping

The manual states that a dam is to have a Significant Consequence Category if it meets the following criteria:

> Would *be likely to be caused to Significant Values – and 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) significant 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*

Given the relatively small volume and concentrations of contaminants, it is unlikely that remedial measures would take more than three years. However, it is likely that remediation would take more than one year. Therefore, a Significant Consequence Category is justified for the Environmental Harm trigger for all mine affected water dams. The environmental dam is an excavated storage and therefore dambreak is not a likely failure mechanism for this dam.

5.5.2 Consequence assessment - levees

A consequence assessment has also been completed for the proposed levees protecting the mine pit from flood inundation. The Manual includes specific considerations for the assessment of levees.

5.5.2.1 Assessment protocols

Where a levee is designed to prevent ingress of mine-affected flood water into an operational area, and the pit would be encroached by a flood event with a probability more than or equal to 0.1% AEP, it is designated a regulated structure.

As the levees proposed for the project are required to protect the pit from flooding in the 0.1% AEP flood, they are regulated structures.

There is no requirement for a consequence assessment for the 'failure to contain – seepage' scenario to be conducted for levees.

5.5.2.2 Assessment criteria

For each failure event scenario, a consequence category is assigned depending on the potential to cause:

- Harm to Humans;
- General Economic Loss; or
- General Environmental Harm.

Third parties are unlikely to be impacted in terms of 'Harm to Humans' or 'General Economic Loss', and as a result, 'Low' Consequence Categories are applicable to these classes of 'Harm'.

Under the 'dam break' scenario, the failure of either structure could result in the release of significant quantities of sediment laden water to the downstream receiving environment (due to the subsequent erosion of overburden dumps and other disturbed areas). As a result, a significant consequence category is justified for both levees due to the potential for 'General Environmental harm'.

The potential for harm due to failure of levees at the WCP, and the adopted Consequence Categories are summarised in Table 5.10.

Table 5.10 - Summary of levee consequence assessment ('dam break' scenario)

	Springton Creek levees
Harm to humans	L
General environmental harm	S
General economic loss/damages	L
OVERALL CCA RATING	S

5.5.2.3 Hydraulic performance criteria for levees that are regulated structures

The hydraulic performance objectives for levees in relation to the 'dam break' scenario that relate to the levees at the Gemini Project are to be achieved by designing and maintaining each levee so that:

- it isolates and diverts the peak flow from a design storm of critical duration for the contributing catchment at an AEP of 0.1%; and
- in at least one place in the levee crest, there is a restricted length of low crest, limiting the freeboard at that point, such that a flood exceeding the design protection level of the levee will be directed to a planned area or areas within the zone to be protected.

6 Site water balance

6.1 WATER DEMANDS

6.1.1 Coal handling and preparation plant

The CHPP will comprise a dense medium cyclone / spirals / flotation plant. Flotation tailings, screen bowl effluent and concentrate, fines reject thickening cyclone overflow, fines reject screen undersize and belt press filter filtrate will be fed to a tailings thickener to separate solids. Solids from the tailings thickener will be processed with belt press filters to remove rejects from the flocculants.

The use of the belt press filters reduces the total water demand compared to traditional tailings disposal methods due to the low losses to waste moisture. The project description provides the following CHPP demand estimates throughout the project life, which includes allowance for coal crushing and conveyor dust suppression. Table 6.1 shows the details of forecast CHPP demands.

Table 6.1 - Forecast CHPP and TLO demands

Year	CHPP Demand (ML/a)	TLO Demand (ML/a)
1	162.0	0.72
2	162.0	0.73
3	162.0	0.73
4	162.0	0.73
5	162.0	0.73
6	162.0	0.72
7	162.0	0.72
8	162.0	0.71
9	162.0	0.72
10	162.0	0.72
11	162.0	0.70
12	162.0	0.74
13	162.0	0.74
14	162.0	0.74
15	162.0	0.74
16	162.0	0.72
17	162.0	0.74
18	143.4	0.65

6.1.2 Train loading operation (TLO)

TLO water demands for controlling dust generation for the TLO, rail loading and freight would be managed by:

- Shrouding and sprays on delivery/transfer to the loadout bin;
- During wagon loading;
- Telescopic chutes;
- Use of water sprays and surfactants;
- During freight - application of a veneer prior to departure;
- Removal of any wagon overload situations.

A 40L/wagon water demand is adopted, where a wagon contains 80 tonne of product coal. Table 6.1 shows the details of forecast CHPP demands.

6.1.3 Haul road dust suppression

The proposed mining schedule for the project includes starting mining at AB Pit and progressing to C Pit.

Mine affected water will be used as a priority for haul road dust suppression. Water for haul road dust suppression will be sourced from the Mine Water Dam which will be supplied with water from the operational pits and supplemented with sediment dam or raw water when required.

Haul Road water demand will be increasing throughout the project life where. Haul road dust suppression water demand is expected to commence at around 315 ML/a, and increases to approximately 512 ML/a at Stage 5.

6.1.4 Potable water demands

Potable water will be delivered to site by truck and stored in potable water tanks before distribution around the site using pressure pumps and small-bore poly pipes.

6.2 GROUNDWATER INFLOWS TO MINING PITS

Groundwater inflows were estimated by JBT Consulting Australia Pty Ltd (JBT, 2019). The estimates provided by JBT Consulting are net inflows to the pit after evaporation losses from the pit faces and the entrained moisture losses due to mining. The adopted net inflow rates are provided in Table 6.2.

Groundwater inflows are expected to increase over time and eventually the net inflow would exceed the total site water demand. Water is therefore expected to accumulate in the mine water dam over the long term. The relatively large capacity of the mine water dam has been provided specifically for this purpose.

Table 6.2 – Estimated net annual groundwater inflow to pits after losses

Year	AB Pit Net GW Inflow ML/a	C Pit Net GW Inflow ML/a
1	31.5	-
2	31.5	-
3	31.5	-
4	31.5	-
5	31.5	-
6	31.5	-
7	31.5	-
8	31.5	-
9	31.5	-
10	31.5	-
11	220.8	-
12	220.8	-
13	189.2	-
14	189.2	15.8
15	15.8	15.8
16	15.8	15.8
17	15.8	15.8
18	15.8	31.5

6.3 WATER BALANCE MODEL

A computer-based operational simulation model (OPSIM) was used to assess the dynamics of the mine water balance under conditions of varying rainfall and catchment conditions throughout the development of the Project. The OPSIM model dynamically simulates the operation of the water management system and keeps complete account of all site water volumes and representative water quality on a daily time step.

The model has been configured to simulate the operations of all major components of the water management system. The simulated inflows and outflows included in the model are given in Table 6.3.

Table 6.3 - Simulated inflows and outflows to the water management system

Inflows	Outflows
Direct rainfall on water surface of storages	Evaporation from water surface of storages
Catchment runoff	CHPP demand
Raw water supply	Haul road dust suppression demand
Groundwater inflows	TLO water demands
	Dam overflows

6.4 SIMULATION METHODOLOGY

6.4.1 Modelled staging of mine plans

The water balance model was run on a daily time step for an 18 year period, corresponding with the proposed mine life between Year 1 and Year 18. The model assumes that operations commence in January.

Catchment land use changes were assessed through the discrete stages, described in the previous section. These stages have been selected using the mining progression information, and provide a representative disturbance footprint for each stage.

6.5 CATCHMENT RUNOFF

6.5.1 Catchment runoff salinity

The OPSIM model includes a conservative salt balance with each catchment type assigned a fixed salinity.

Water samples taken from Springton and Charlevue Creeks had a median EC of 114 µS/cm (74 mg/L). For the purpose of the site salt balance, runoff from undisturbed (natural) catchments was assumed to have a salinity (EC) of 150 µS/cm.

Kinetic leach column (KLC) testing of the local overburden material (RGS, 2019) showed that leachate from all KLC samples (apart from the carbonaceous siltstone and coal) had initial EC values less than 800 µS/cm, and at the end of six months less than 203 µs/cm. Based on these results, for the purpose of the site salt balance, runoff from spoil was assumed to have a salinity of 600 µS/cm. Runoff from highwalls was assigned an EC of 8,000 µS/cm to account for potential contact with the coal seams, which would result in increased salinity, and hardstand areas were conservatively assigned an EC of 900 µS/cm.

6.5.2 Catchment runoff rates

The OPSIM model uses the Australian Water Balance Model (AWBM) (Boughton, 2003) to estimate runoff from rainfall. The AWBM is a saturated overland flow model which allows for variable source areas of surface runoff. The AWBM uses a group of connected conceptual storages (three surface water storages and one ground water storage) to represent a catchment. Water in the conceptual storages is replenished by rainfall and is reduced by evaporation (surface stores only). Simulated surface runoff occurs when the conceptual storages fill and overflow.

The model uses daily rainfalls and estimates of catchment evapotranspiration to calculate daily values of runoff using a daily water balance of soil moisture. The model has a baseflow component which simulates the recharge and discharge of a shallow subsurface store. Runoff depth calculated by the AWBM model is converted into runoff volume by multiplying the contributing catchment area.

The model parameters define the storage depths (C1, C2 and C3), the proportion of the catchment draining to each of the storages (A1, A2 and A3), and the rate of flux between them (Kb, Ks and BFI).

Catchments across the site water management system have been characterised into the following land use types:

- Natural/undisturbed, representing areas in their natural state;
- Roads, hardstand and mining pit floor areas;
- Spoil dump, representing uncompacted dumped overburden material;
- Open cut, representing pit area; and
- Rehabilitated, representing established rehabilitated spoil areas.

Adopted rainfall runoff parameters are summarised in Table 6.4. In the absence of site-specific parameters, parameters typical for coal mines in the Bowen Basin were adopted.

Specifically, the adopted parameters were selected so that the values of C_{avg} were less than those established for the corresponding catchments types by validation of the Isaac Plains Mine (IPM) water balance model against recorded site data (including water storage volumes) over the period from January to December 2018. The validation model was configured to reflect the site operations during this period, with appropriate transfer rates, system configuration and water inflows and outflows. Site rainfall and evaporation data was used for the calibration.

During 2018, the primary mine affected water storage at IPM was S3 Pit (a mined-out pit area), therefore the validation of the water balance model was undertaken against the recorded inventory in S3 Pit between January and December 2018.

The simulated S3 Pit storage inventory generally reproduced the observed overall mine observed water inventory fluctuations over the verification period between January and December 2018 with the exception of a few data points

Compacted catchments (mining pit, roads/hardstand and stockpile/industrial areas) are characterised by hard surfaces which inhibit water infiltration, resulting in much higher rates of surface runoff.

To represent compacted catchments, the depth of the model surface stores was substantially reduced and baseflow eliminated. The simulated volumetric runoff coefficient for disturbed catchments was 21%, about 4 times higher than natural catchments. This value is similar to typical values for urban catchments, which have similar characteristics.

The adopted model parameters for “rehabilitated spoil” assume lower opportunities for evapotranspiration than natural catchments and also that a significant component of runoff will seep through the spoil, discharging over several weeks rather than running off within a few hours of rainfall. The modelled runoff coefficient of 8.6% is around 1.5x that for natural catchments.

The model parameters for “spoil” represents the uncompacted dumped overburden material, both in-pit and out-of-pit. It has also been applied to areas available for rehabilitation. The runoff coefficient of 9.8 % is around double that of natural catchments.

Notwithstanding the above, an onsite water monitoring system will be used to validate system performance against the design assumptions (including adopted model parameters) in terms of water quality and water quantity, so that an adaptive management can be implemented to protect the surface water environment. The monitoring system would be used to ensure the performance of the water management system is not affected by any variance between adopted model parameters and actual parameters.

Table 6.4 – Adopted AWBM parameters

Parameter	Spoil Dump	Hardstand	Natural	Established Rehab	Open Cut
A1	0.134	0.134	0.134	0.134	0.134
A2	0.433	0.433	0.433	0.433	0.433
A3	0.433	0.433	0.433	0.433	0.433
C1	10	5	25	11	5
C2	50	20	100	60	20
C3	120	40	180	130	40
C_{avg}	74.9	26.7	124.6	83.7	26.7
BFI	0.35	0	0.2	0.35	0
K_{base}	0.6	0	0.82	0.6	0
K_{surf}	0.1	0.1	0.17	0.1	0.1
Rehab runoff/rainfall	9.8%	20.9%	5.1%	8.6%	20.9%
Runoff salinity (EC) µS/cm	600	900	150	150	8,000

Figure 5.1 to Figure 5.5 show how catchment landuse will change as the project develops.

A schematic of the integrated Gemini Project water management system configuration is shown in Figure 6.1. A summary of the proposed storages within the integrated WMS and their operating strategies are summarised in the following sections.

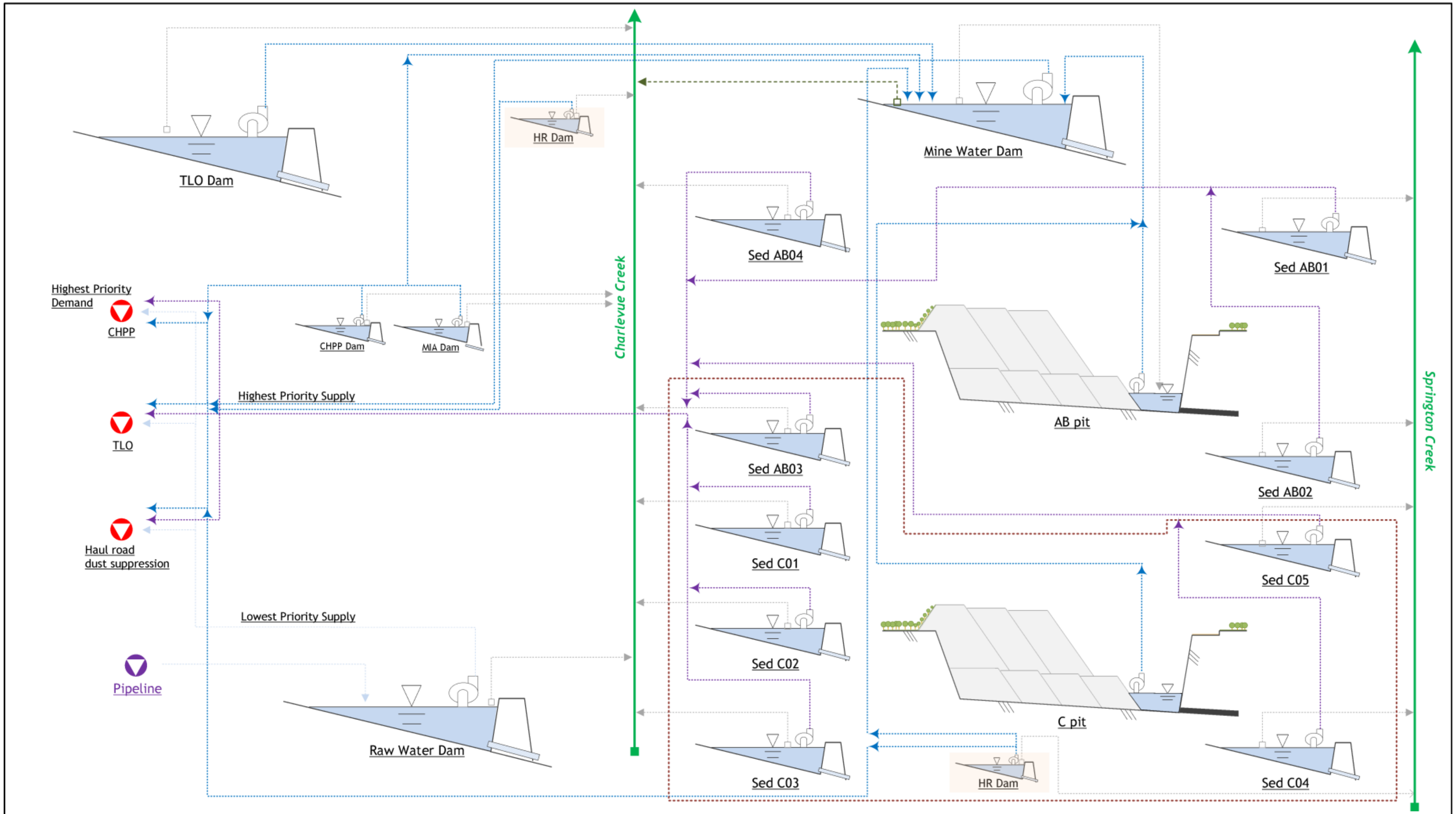
6.6 MODELLING OF WATER DEMAND

6.6.1 Haul road dust suppression

Haul road dust suppression watering rates were applied to haul road areas that vary as mining progresses. The following rules were used to determine the applied dust suppression rate on any given day of the historical rainfall record:

- The assessment used daily evaporation rates sourced from the SILO evaporation dataset;
- For a dry day (zero rainfall), the haul road watering rate is equal to the daily evaporation rate;
- For a rain day when rainfall is less than the daily evaporation rate, the watering rate is reduced and is only required to make up the remaining depth to the daily evaporation rate;
- For a rain day when rainfall exceeds the daily evaporation rate, no haul road watering is required; and
- It was assumed that 29 metres of the haul road width would be watered.

The estimated consumption rates for each phase are summarised in Table 6.5 (but note that the totals will vary with climate in the model).



Gemini Project	
Figure	Proposed integrated water management system schematic
Job	1238-02
Date	2/12/2020

Legend

- Sediment water
- Mine water
- Raw water
- Natural watercourse
- Intermittent flow
- Spillway/overflow
- To be added post Stage 4
- Controlled release
- Excluded from site water balance model

Notes

Spill Flow Directions:
Good engineering practice is to include a stabilised spillway as a contingency for dam safety. This arrow does not indicate that these discharges (spills/overflows) are a part of the water management system or that spills will occur. The arrow is to show the direction of water flow (by gravity) should the dam water level exceed the dam spillway level.

wrm water + environment

Figure 6.1 – Proposed integrated water management system schematic

Table 6.5 - Forecast haul road dust suppression demand

Year	Stage	Haul road length (km)	Average daily application rate (mm/d)	Maximum daily application rate (mm/d)	Average annual demand (ML/a)	Average daily demand (ML/d)
1	1	6.7	4.4	9.7	314.6	0.86
2	1	6.7	4.4	9.7	314.6	0.86
3	1	6.7	4.4	9.7	314.6	0.86
4	1	6.7	4.4	9.7	314.6	0.86
5	2	7.1	4.4	9.7	333.4	0.91
6	2	7.1	4.4	9.7	333.4	0.91
7	2	7.1	4.4	9.7	333.4	0.91
8	2	7.1	4.4	9.7	333.4	0.91
9	2	7.1	4.4	9.7	333.4	0.91
10	2	7.1	4.4	9.7	333.4	0.91
11	3	8.7	4.4	9.7	401.5	1.10
12	3	8.7	4.4	9.7	401.5	1.10
13	3	8.7	4.4	9.7	401.5	1.10
14	4	9.9	4.4	9.7	464.9	1.27
15	4	9.9	4.4	9.7	464.9	1.27
16	5	10.9	4.4	9.7	511.8	1.40
17	5	10.9	4.4	9.7	511.8	1.40
18	5	10.9	4.4	9.7	511.8	1.40

6.7 SUMMARY OF DEMANDS

The estimated annual demands and groundwater inflows to the mine are summarised in Table 6.6 below. Potable water demands have not been modelled.

Table 6.6 - Summary of adopted demands and expected groundwater inflows

Year	Demand (ML/a)				Net GW Inflow (ML/a)
	CHPP	Haul Road	TLO	Total	
1	162.0	314.6	0.72	477.3	31.5
2	162.0	314.6	0.73	477.3	31.5
3	162.0	314.6	0.73	477.3	31.5
4	162.0	314.6	0.73	477.3	31.5
5	162.0	333.4	0.73	496.1	31.5
6	162.0	333.4	0.72	496.1	31.5
7	162.0	333.4	0.72	496.1	31.5
8	162.0	333.4	0.71	496.1	31.5
9	162.0	333.4	0.72	496.1	31.5
10	162.0	333.4	0.72	496.1	31.5
11	162.0	401.5	0.70	564.2	220.8
12	162.0	401.5	0.74	564.2	220.8
13	162.0	401.5	0.74	564.2	189.2
14	162.0	464.9	0.74	627.6	205.0
15	162.0	464.9	0.74	627.6	31.5
16	162.0	511.8	0.72	674.5	31.5
17	162.0	511.8	0.74	674.5	31.5
18	143.4	511.8	0.65	655.9	47.3

6.8 OPERATING RULES

The operating rules to be applied to the links joining the various elements in the water balance model are summarised in Table 6.7 below.

Table 6.7 – Gemini Project water management system operating rules

Item	Node Name	Operating Rules
1.0	***External Water Supply***	
1.1	Pipeline	• Supplies the Raw Water Dam – which in turn supplies the haul road dust suppression, CHPP and TLO; • Yearly allocation assumed unlimited; • Capacity limited to 200L/s.
2.0	***Supply to Demands***	
2.1	CHPP	• Demands in priority, from the Mine Water Dam, Sediment Dams and Raw Water Dam respectively.
2.2	Haul road dust suppression	• Demands from the Mine Water Dam, Sediment Dam and Raw Water Dam; • Demands vary daily according to the loss model detailed in this report.
2.3	TLO	• Demands from the Mine Water Dam, Sediment Dams and Raw Water Dam; • Demands according to the coal production rate and usage rate (L/t ROM).
3.0	***Transfer of pit water***	
3.1	Mine Pit	• Pit dewatering directed to Mine Water Dam, at a nominal rate of 200 L/s. Pumping to cease when the maximum operating level reached.
4.0	***Operation of site dams***	
4.1	Mine Water Dam	• Receives pumped transfers from the Mine Pit up to the maximum operating level; • Receives pumped transfers from the MIA dam, CHPP dam and runoff dams; • Storage overflows to Pit; • Controlled releases in accordance with the EA conditions may be made to Charelevue Creek if required, but this has been conservatively excluded from the model.
4.4	Raw water Dam	• Receives pumped transfers from pipeline to a maximum operating level (to be determined); • Overflows to Charlevue Creek.
4.5	TLO Dam	• Pumping to Mine Water Dam; • Overflows to Charlevue Creek.
4.6	AB01	• Sediment dam, active from Year 1 onwards; • Overflows to Springton Creek.
4.7	AB02	• Sediment dam, active from Year 1 onwards; • Overflows to Springton Creek.
4.8	AB03	• Sediment dam, active from Year 1 onwards; • Overflows to Charlevue Creek.

Item	Node Name	Operating Rules
4.9	AB04	• Sediment dam, active from Year 1 onwards; • Overflows to Charlevue Creek.
4.10	C01	• Sediment dam, active from Year 14 onwards; • Overflows to Charlevue Creek.
4.11	C02	• Sediment dam, active from Year 14 onwards; • Overflows to Charlevue Creek.
4.12	C03	• Sediment dam, active from Year 14 onwards; • Overflows to Charlevue Creek.
4.13	C04	• Sediment dam, active from Year 14 onwards; • Overflows to Springton Creek.
4.14	C05	• Sediment dam, active from Year 14 onwards; • Overflows to Springton Creek.
4.15	MIA Dam	• Receive runoff from MIA area; • Pumping to Mine Water Dam.
4.16	CHPP Dam	• Receive runoff from CHPP area; • Pumping to Mine Water Dam.
4.17	Haul Road Dams*	• Receive runoff from haul road areas; • Pumping to Mine Water Dam.
5.0	***Receiving water***	

5.1	Springton Creek	• Receives uncontrolled overflows from the following sediment dams:
		  ○ AB01;
		  ○ AB02;
		  ○ C04;
		  ○ C05.

5.2	Charlevue Creek	• Receives uncontrolled overflows from the following sediment dams:
		  ○ AB03;
		  ○ AB04;
		  ○ C01;
		  ○ C02;
		  ○ C03.

6.0		• All storages and pits receive local catchment runoff and lose water through evaporation

Note: * Storages have immaterial contribution to overall site water balance and therefore are not included in the site water balance model.

6.9 WATER BALANCE MODEL RESULTS

The results of the site water balance model are summarised in the following sections.

6.9.1 Mine water dam behaviour

The results of the water balance model presented in Figure 6.2 show that as pit catchments and groundwater inflows increase, the likelihood of needing to store large volumes of water in the mine water dam increases. By the end of Year 7, the median stored volume is at the Mine Water Dam's maximum operating volume.

As the mine water dam catchment is so small, fluctuations in water level due to rainfall and runoff are relatively small. The dam can therefore be maintained at an operating level relatively close to the spillway crest level with minimal risk of overflow. Notwithstanding, the mine water dam maximum operating level would include a freeboard to provide additional storage during rainfall events (i.e. the dam's maximum operating level is less than the dam capacity).

The mine water dam's maximum operating level has been chosen to manage the risk of overflows. The spillway directs overflows to AB Pit, so the likelihood of uncontrolled offsite discharge from the Mine Water Dam is negligible. Water would only be discharged from the system when there are significant flows in the receiving waters in accordance with the EA conditions.

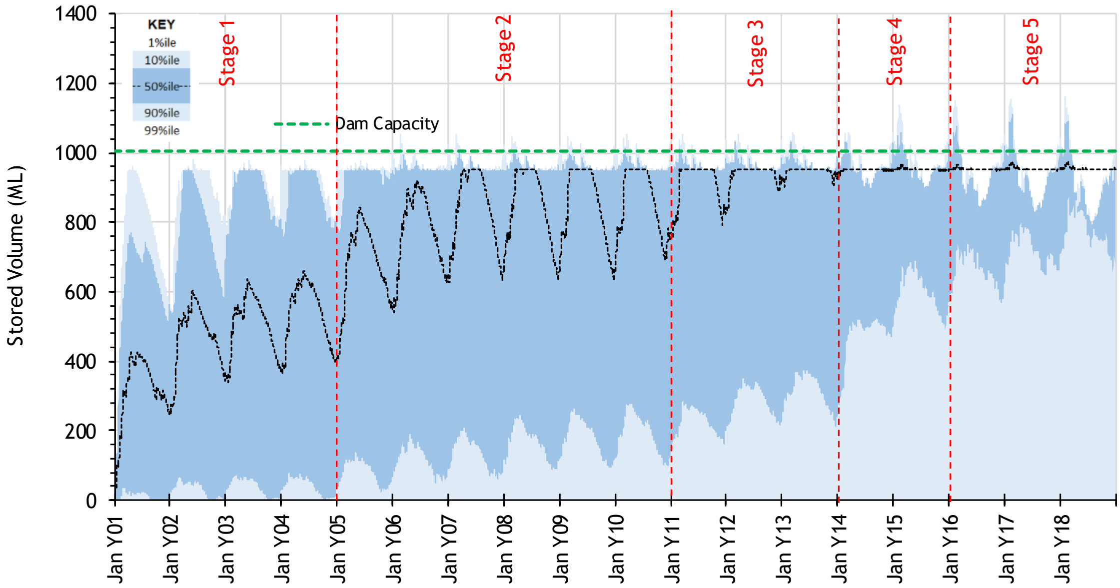


Figure 6.2 – Mine Water Dam – stored water volume behaviour

6.9.2 Likelihood of pit inundation

Figure 6.3 shows a plot of water volumes accumulating in AB pit and C pit over the project life. The plot shows the median stored volume is minimal on all days.

At AB Pit, stored water volumes can be maintained at relatively low volumes which would not interrupt mining operations. The 10th percentile In pit inventory is negligible prior to each wet season, prior to the end of AB Pit mining at the end of Year 13.

After Year 13, AB Pit can be used to stored excess water from C Pit in very wet periods. While the median stored water volume is negligible, up to 3,250ML of water could be stored in AB Pit at the 1% confidence level, which corresponds to a level just below the expected equilibrium final void lake water level.

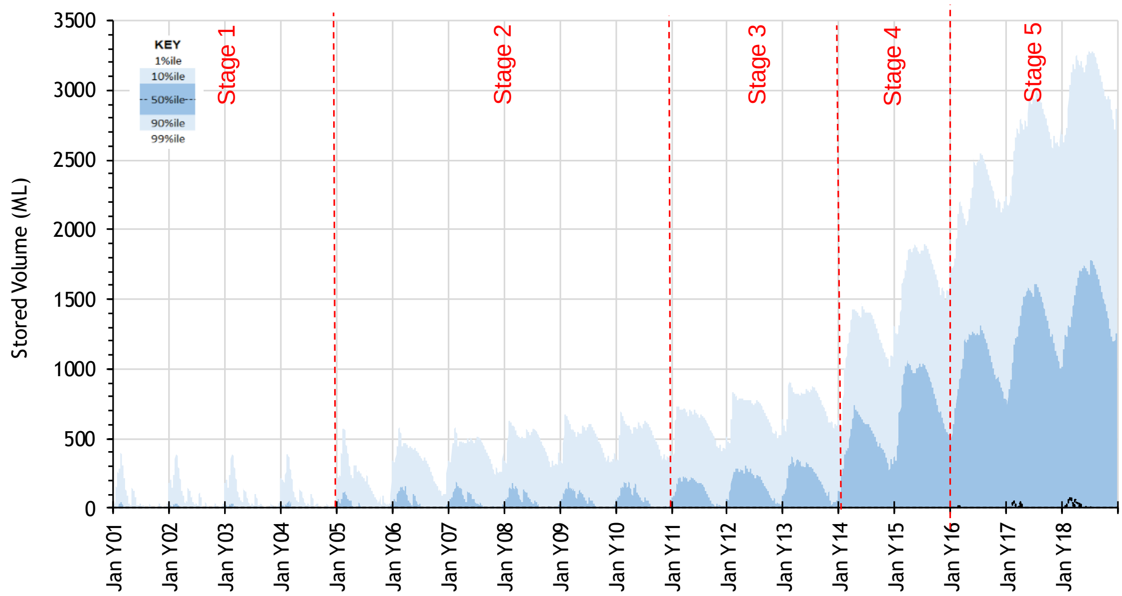


Figure 6.3 - AB pit - stored volume behaviour

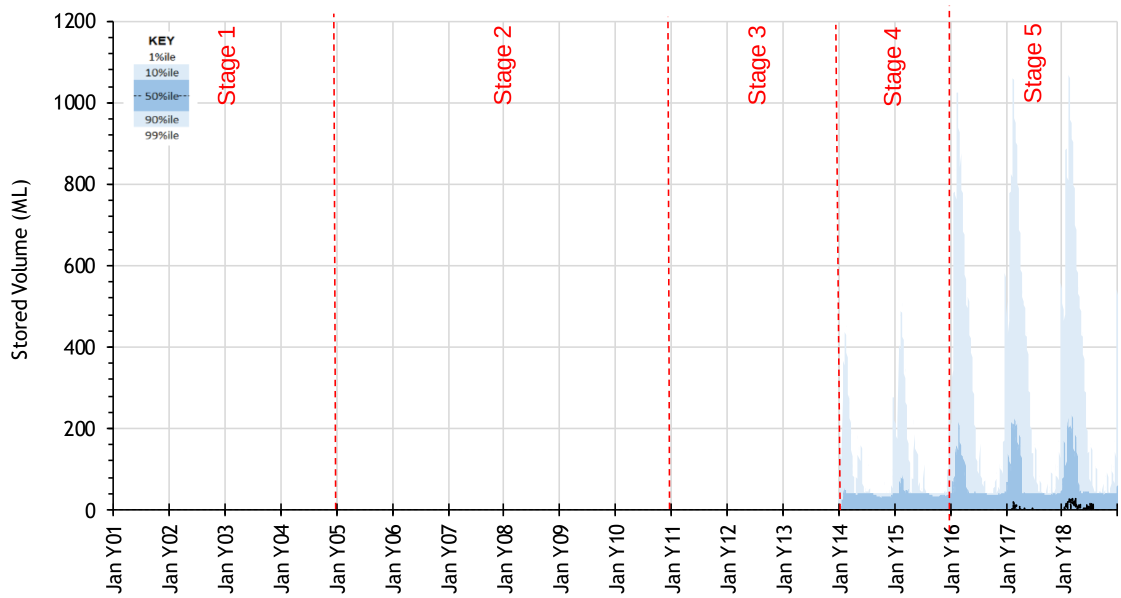


Figure 6.4 - C pit - stored volume behaviour

6.9.3 Water supply reliability

Figure 6.5 shows imported water requirements from the external pipeline are highest in the early project stages. Under very dry conditions, the demand could reach 500 ML/a, but median Year 1 demand is less than 100 ML/a. During later years, accumulated stored pit and sediment dam water is sufficient to supply demands in all but the driest years.

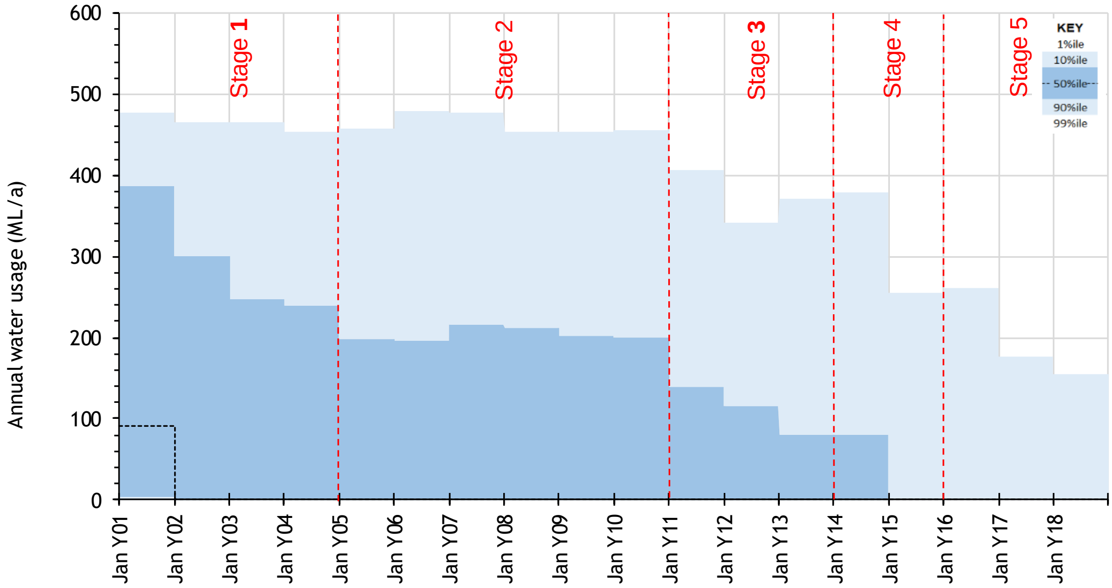


Figure 6.5 – Raw water pipeline usage

6.9.4 Sediment dam releases

Figure 6.6 and Figure 6.7 show that the likelihood of sediment dam discharges to Charlevue and Springton Creeks increases over the mine life. In the early years, the likelihood of discharge is low, as contributing catchments are relatively small, and captured water may be used to supplement site water demands. However, in later years the likelihood of discharges increases. Water captured in sediment dams is expected to have low salinity and coarse sediments will settle out, such that any impacts to downstream water quality are expected to be minor.

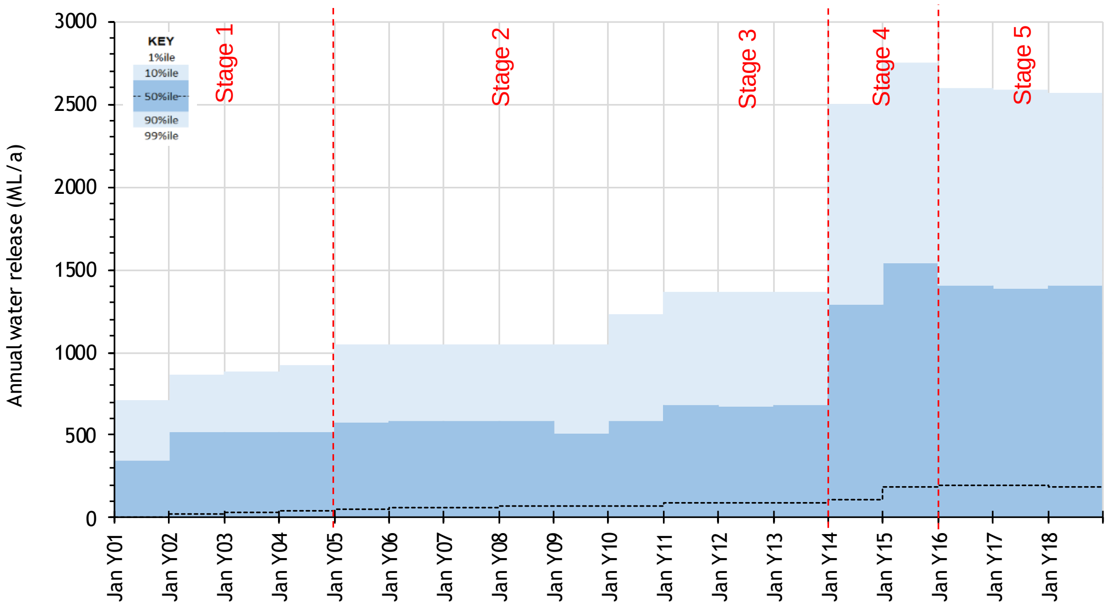


Figure 6.6 - Sediment dam spills to Charlevue Creek

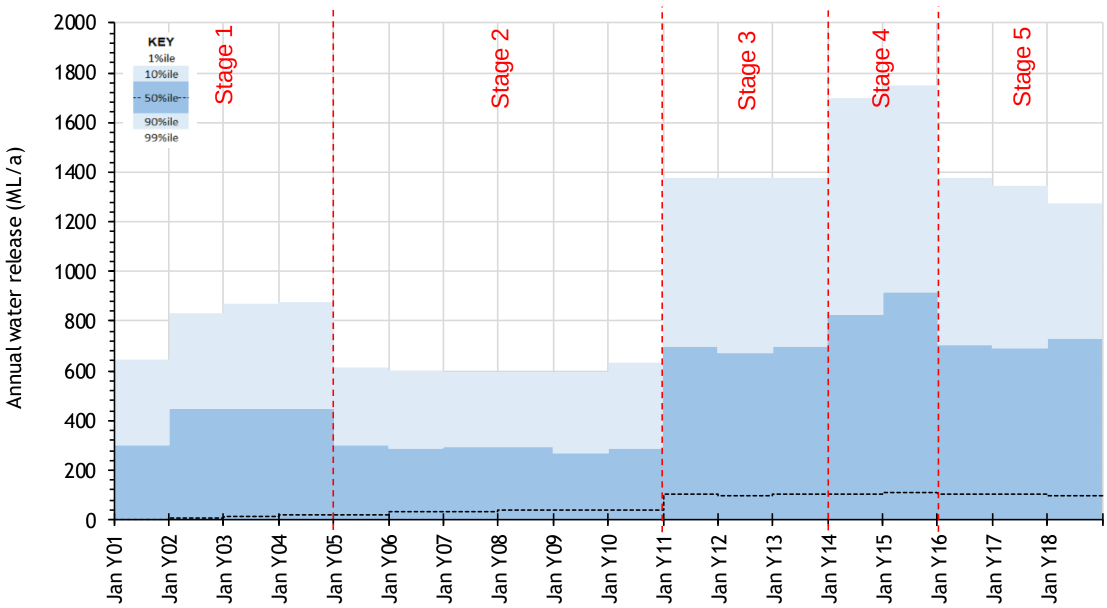


Figure 6.7 - Sediment dam spills to Springton Creek

6.9.5 Overall site water balance

The overall average annual site water balance is summarised in Table 6.8.

Table 6.8 - Average annual site water balance

Component	Process	Volume (ML/a) Stage 1 Y1 - Y4 (4 years)	Stage 2 Y5 - Y10 (6 years)	Stage 3 Y11 - Y13 (3 years)	Stage 4 Y14 - Y15 (2 years)	Stage 5 Y16 - Y18 (3 years)	Total (18 years)
Inflows	Rainfall and runoff	973	1,052	1,215	2,148	2,214	7,602
	Net groundwater inflow	32	32	210	118	37	428
	External supply pipeline	89	51	29	17	11	196
	Total	1,093	1,135	1,454	2,283	2,261	8,226
Outflows	Evaporation	250	317	386	629	762	2,344
	Haul road dust suppression	315	336	405	469	515	2,040
	CHPP Usage	162	162	162	162	162	810
	Spill from Raw Water Dam	37	41	41	43	44	206
	Spill from Sediment Dams	223	245	398	669	652	2,187
	Spill from Mine Affected Water Dams	0	0	0	0	0	0
	Total	988	1,102	1,392	1,972	2,135	7,587
Change in Site Water Inventory		**102**	**29**	**59**	**308**	**122**	**619**

7 Flood mitigation and impacts

The proposed mine operations and associated infrastructure are largely located outside of the Charlevue Creek and Springton Creek flood inundation areas identified in Section 4.5. However, the potential for the following project features to interact with floodwater has been investigated as part of this assessment:

- The rail loop, which is located near the northern margin of the Charlevue Creek floodplain, in close proximity to the existing Capricorn Highway and Aurizon's Blackwater rail corridor.
- The CHPP/MIA fill pad which is located to the north of the Charlevue Creek floodplain.
- The haul road between AB Pit and the CHPP, which crosses Charlevue Creek;
- The AB Pit spoil dump, which encroaches towards the Charlevue Creek floodplain
- The AB Pit levee, which is required to prevent inundation of the AB Pit mine area from flooding at the downstream end of an unnamed second order tributary of Springton Creek, which is to be diverted around the proposed mine area.
- The C Pit overburden dump which will necessitate the construction of a drain to divert clean runoff in the upper reaches of the unnamed second order tributary of Springton Creek around the workings.

The locations of the mine infrastructure horizontal alignments of the drainage channels and associated levees are shown in Figure 7.1. The flood models were used to:

- Assess the impact of the Project on peak flood levels.
- Assess peak water levels and velocities along the levees and channels proposed to protect the proposed mine areas from flooding;

The preliminary channel designs included in the assessment have the following design features:

- Pit AB:
    - compound trapezoidal channel shape:
        - 1 m deep low flow channel with 5 m base width;
        - Base width of high flow channel 15 m;
        - side slopes 1V in 3H;
    - longitudinal slope: 0.4% (the existing channel has a slope of approximately 0.3%);
    - design 1 in 50 AEP depths are up to 3.7 m, and peak velocities range up to 2.5 m/s;
- Pit C:
    - compound trapezoidal channel shape:
        - 1m deep low flow channel with 4 m base width;
        - width of high flow channel 15 m;
        - side slopes 1V in 3H;
    - longitudinal slope varies between 0.25% and 0.4%; and
    - design 1 in 50 AEP depths are up to 1.3 m, and peak velocities range between 1.0 m/s and 2.0 m/s.

Figure 7.1 shows the Project will temporarily increase Charlevue flood levels immediately upstream of the proposed haul road crossing. In the 1% AEP flood, these impacts are contained within the mine lease area.

There will be no impact on flood levels in the Charlevue Creek or Springton Creek at the existing Capricorn Highway, Blackwater Rail corridor, or downstream of the Project area.

While the unnamed tributary of Springton Creek is not a watercourse as defined under the Water Act, the diversion channel will be designed taking into consideration the principles set out in the Guideline: “Works that interfere with water in a watercourse – watercourse diversions” (DNRM, September 2014). This document sets out key design principles and requirements for the functional designs of permanent diversions. It includes guidance on watercourse diversion design and operation including maintenance, monitoring and revegetation. Preliminary designs are shown in Figure 7.3 to Figure 7.8 which also show the post development flood conditions with diversions and levees in place.

The works at AB Pit will locally increase flood levels in Springton Creek by up to 0.22 m in the 1% AEP flood. These impacts would extend off the lease area onto land owned by Magnetic South Pty Ltd, and reduce with distance downstream of the boundary.

The full details of the methodology and results of flood modelling for a range of flood events are presented in Appendix A.

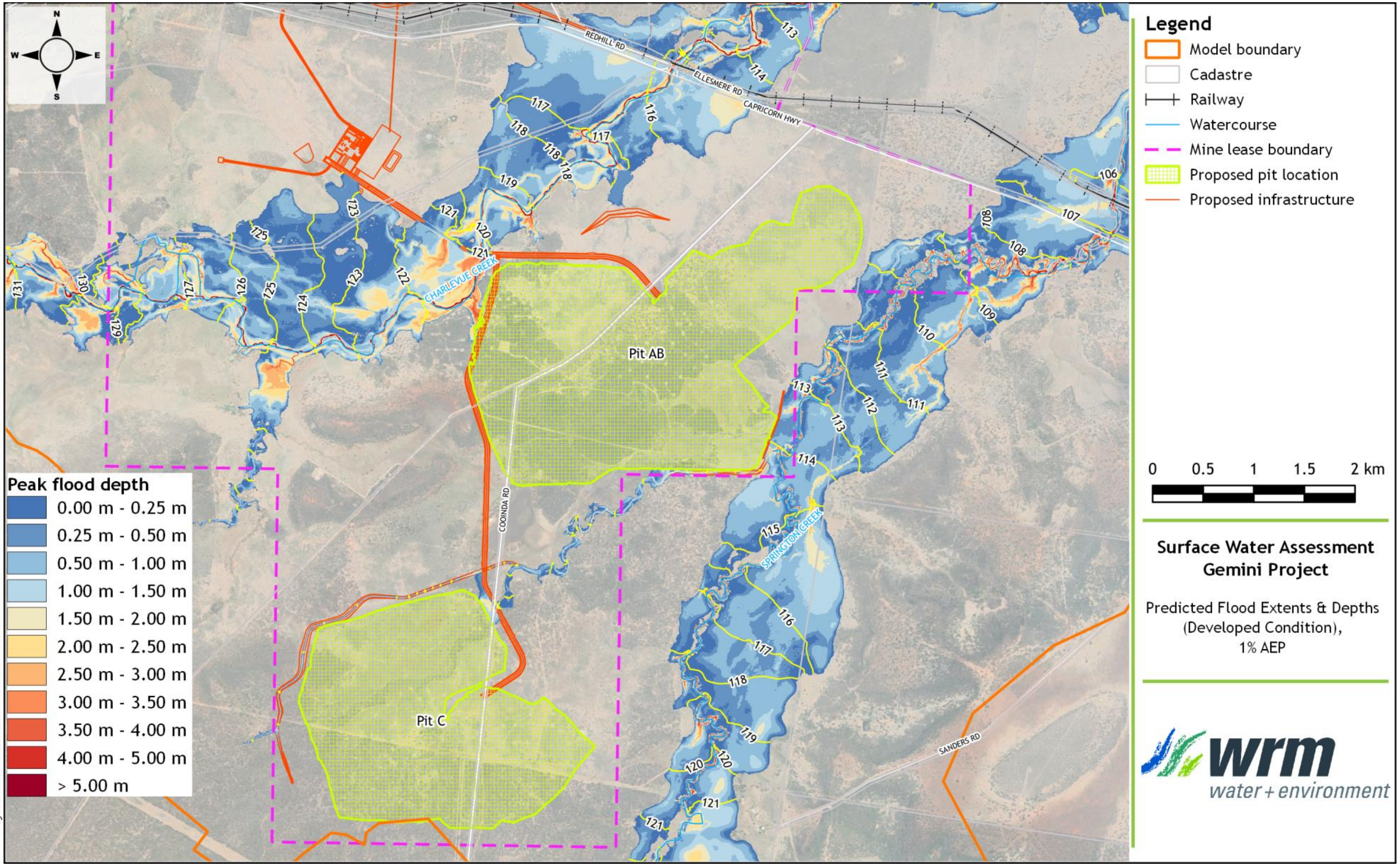


Figure 7.1 – Developed conditions 1% AEP flood depths and water levels

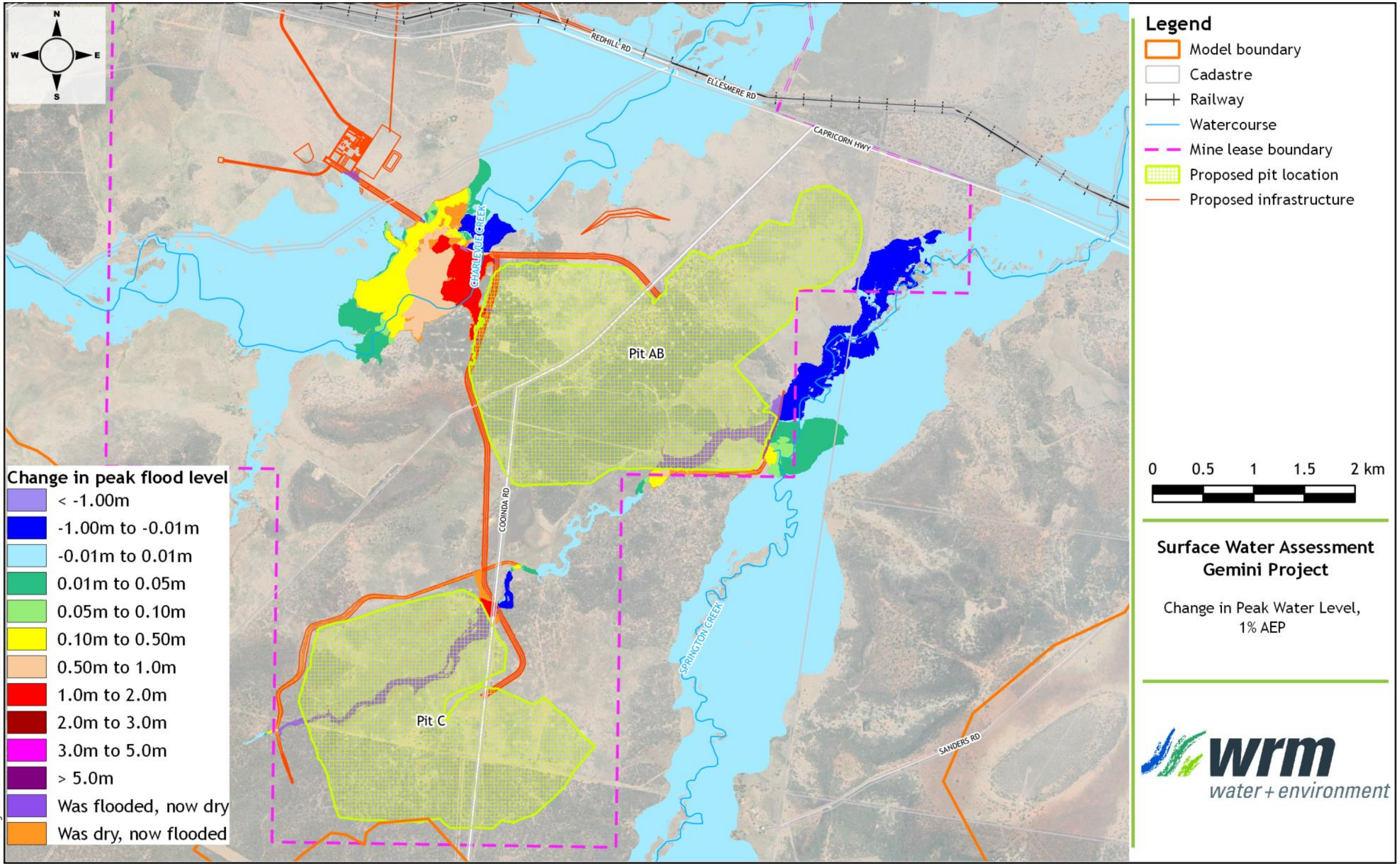


Figure 7.2 – Impacts of the Project on 1% AEP flood levels

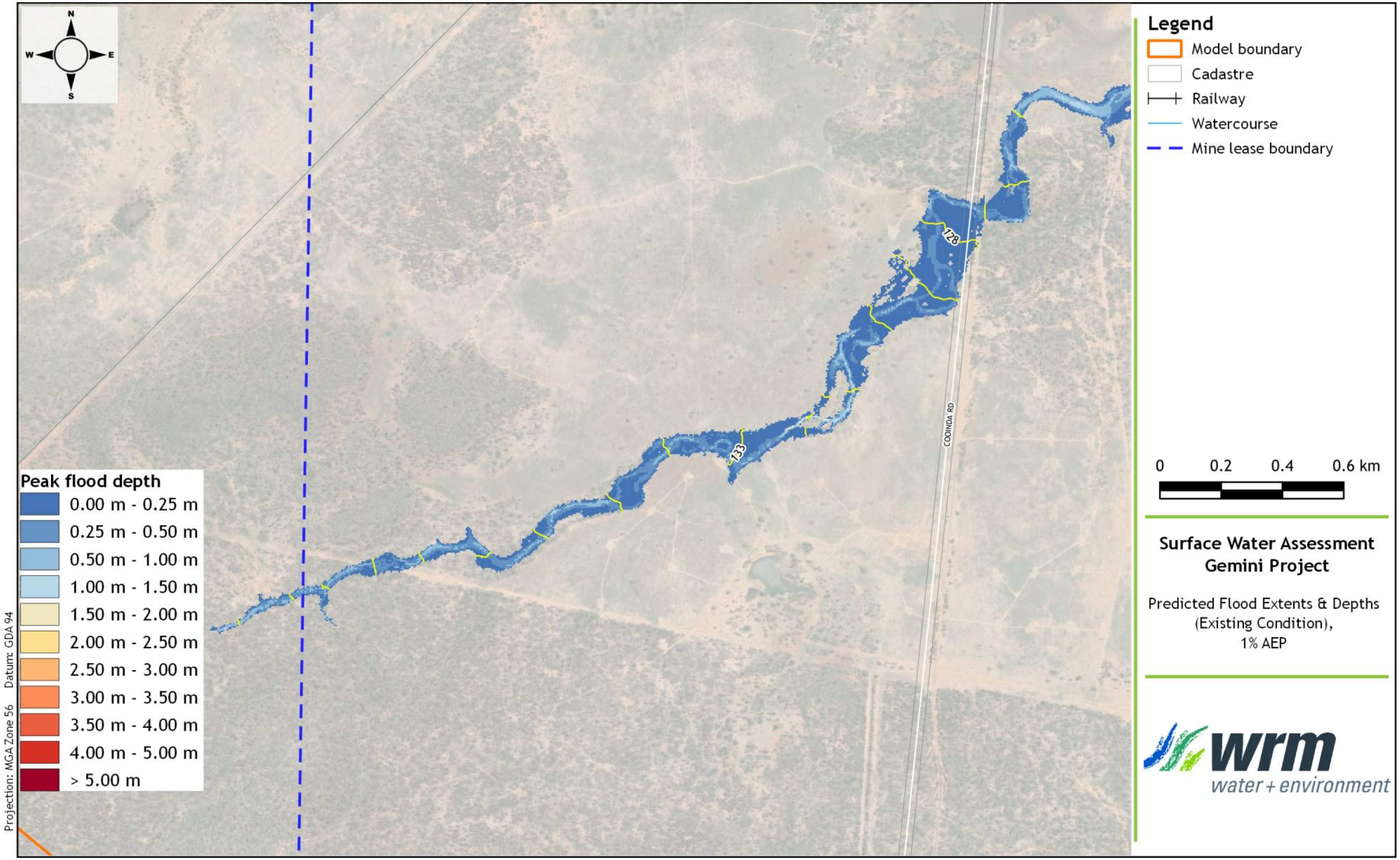


Figure 7.3 – Upper reach of unnamed Springton Creek tributary – existing 1% AEP flood depths

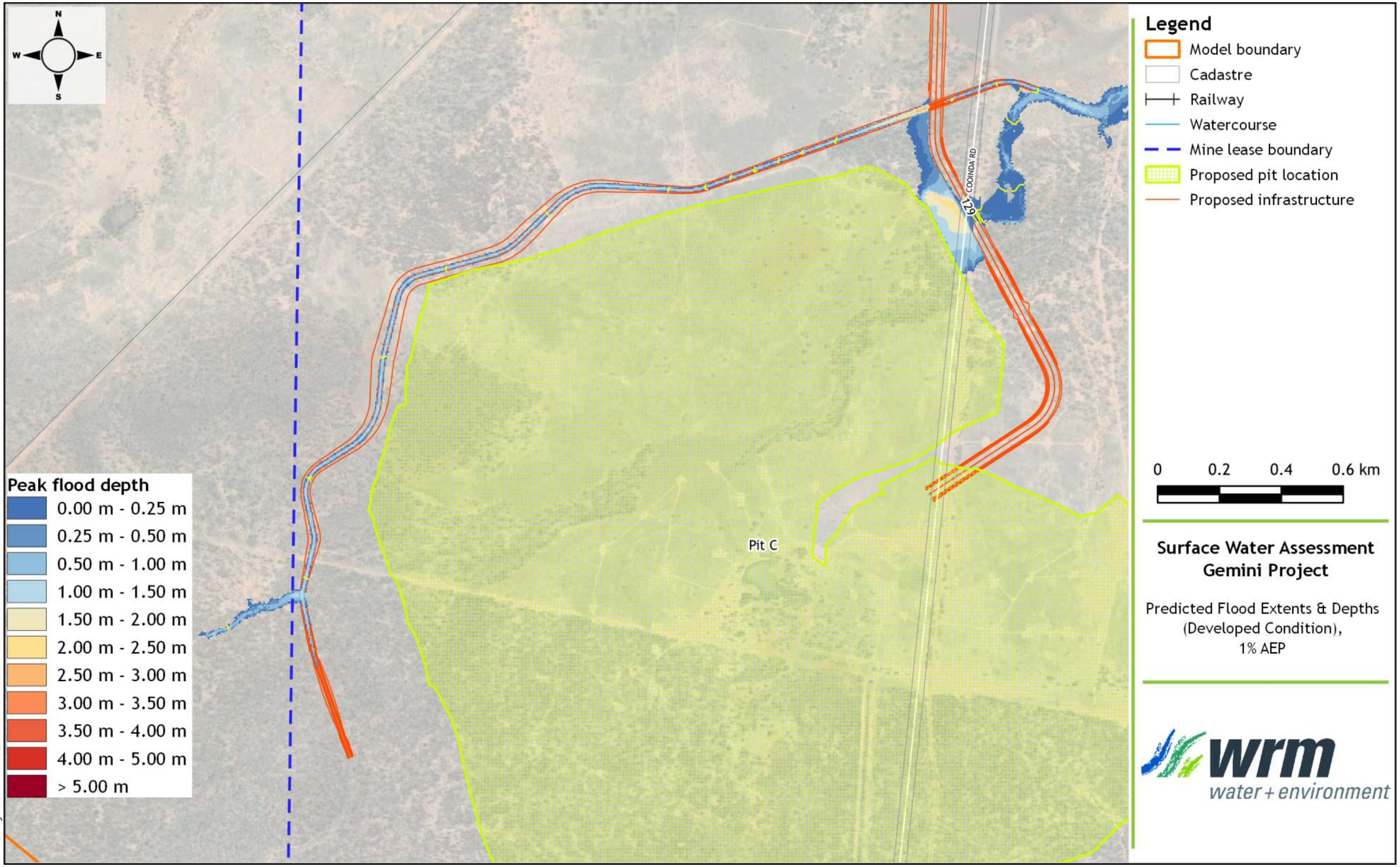


Figure 7.4 – Upper reach of unnamed Springton Creek tributary – proposed 1% AEP flood depths

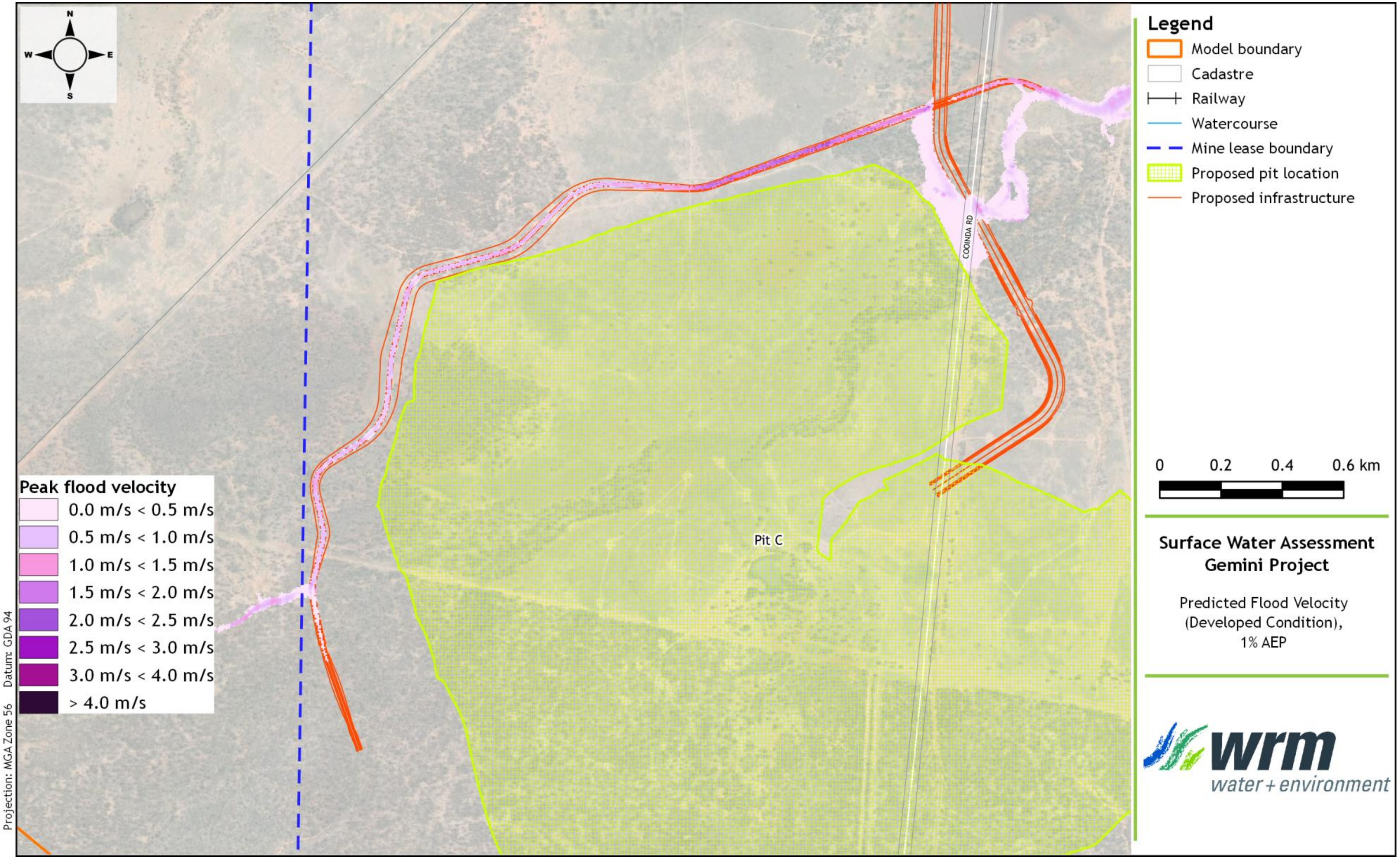


Figure 7.5 - Upper reach of unnamed Springton Creek tributary - proposed 1% AEP flood velocities

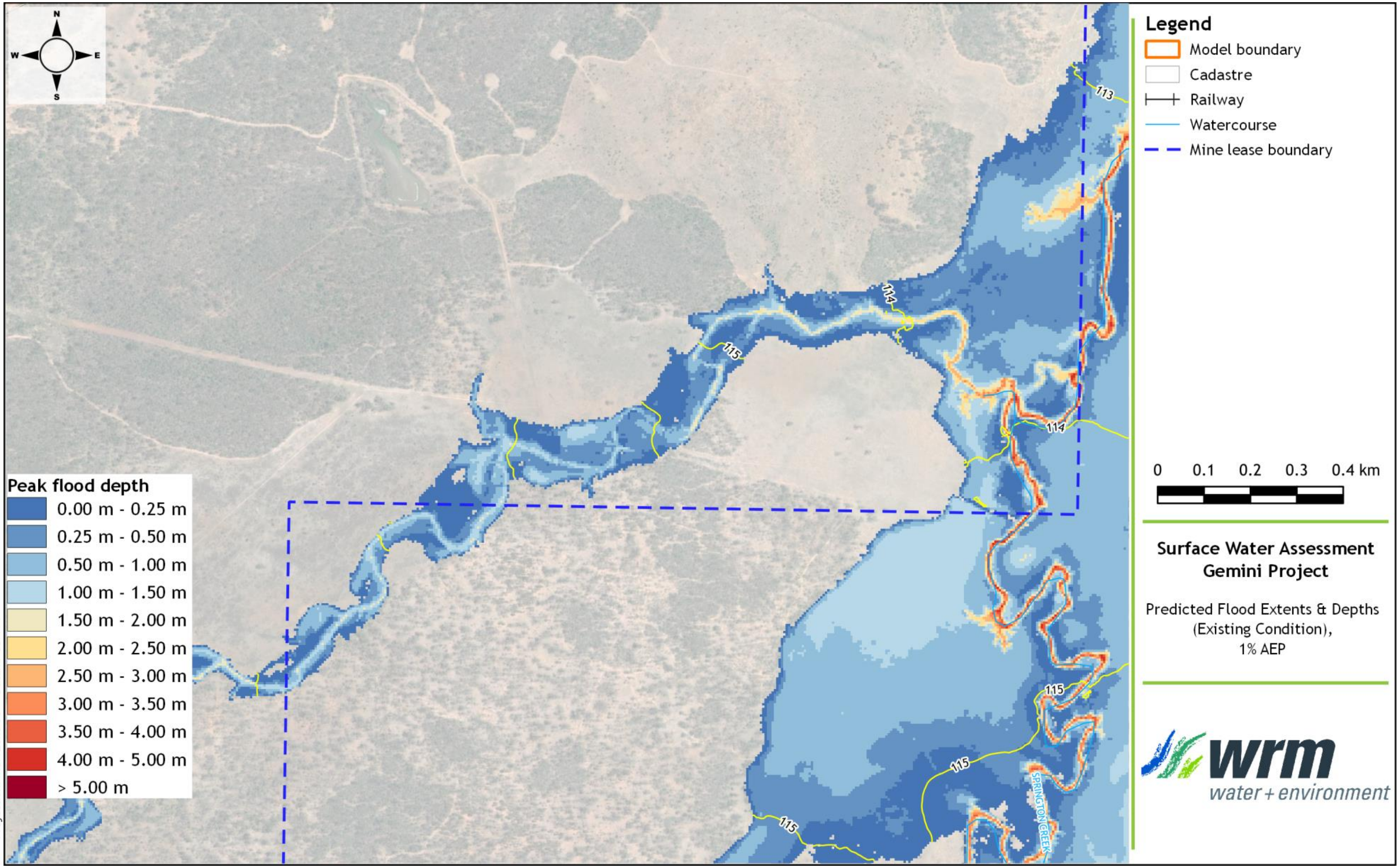


Figure 7.6 – Lower reach of unnamed Springton Creek tributary at AB Pit – existing 1% AEP flood depths

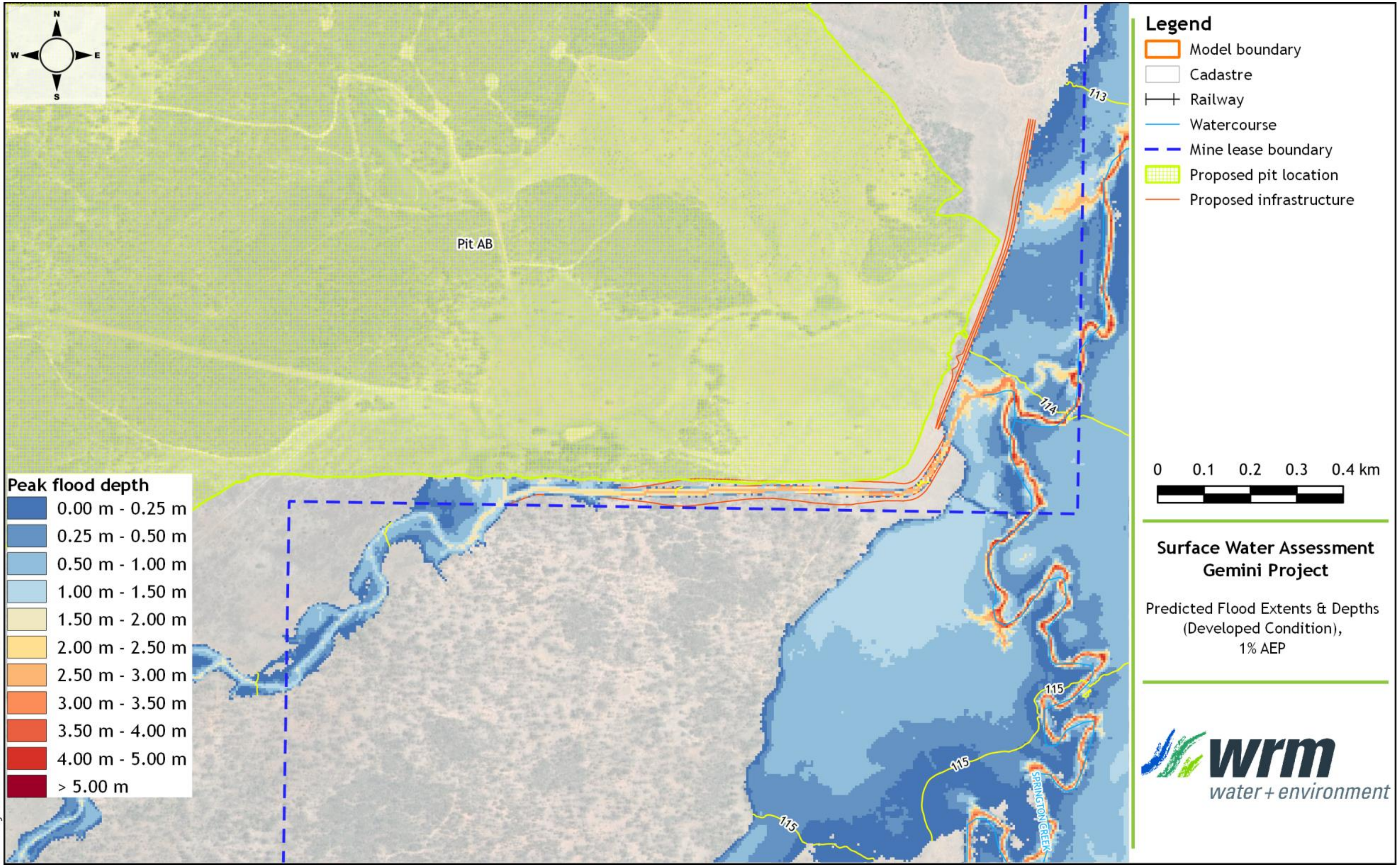


Figure 7.7 – Lower reach of unnamed Springton Creek tributary at AB Pit – proposed 1% AEP flood depths

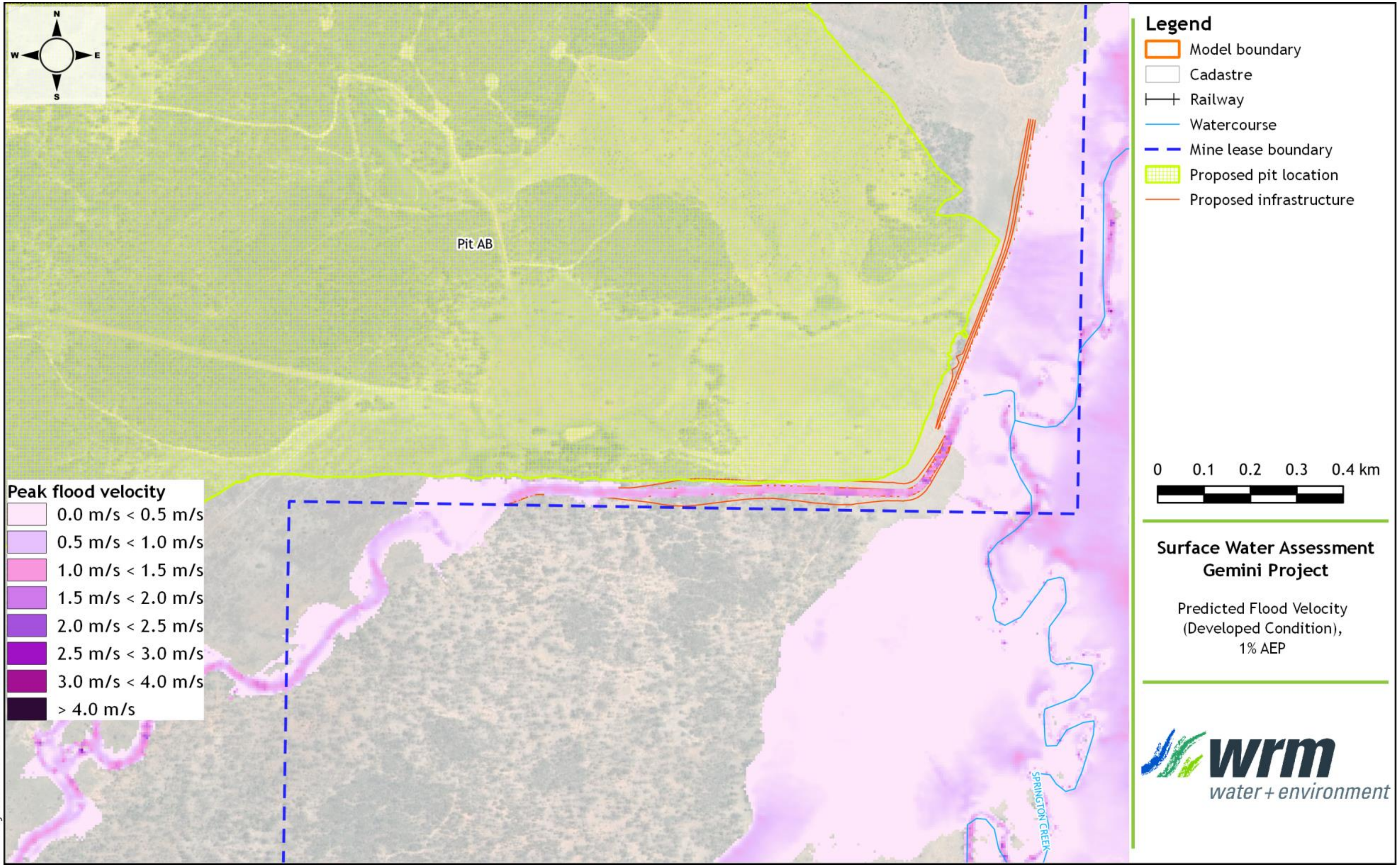


Figure 7.8 - Lower reach of unnamed Springton Creek tributary at AB Pit - proposed 1% AEP flood velocities

8 Final void behaviour

8.1 OVERVIEW

Water levels in the final voids will vary over time, depending on the prevailing climatic conditions, and the balance between evaporation losses and inflows from rainfall, surface runoff, and groundwater.

A GOLDSIM model (separate to the OPSIM model used for the operational modelling) was used to assess the likely long-term behaviour of the final void pit lakes. The historical rainfall and evaporation sequences were repeated 5 times to create a long-term climate record for use in the model.

The potential effects of climate change were assessed using climate-change adjusted SILO climate data developed as part of the Consistent Climate Scenarios (CCS) project by the Queensland Government's Department of Environment and Science (DES).

8.2 FINAL VOID CONFIGURATION

The final void configurations and contributing catchment areas are shown in Figure 8.1. The proposed final void catchments include the pits' plan areas, and immediate upslope catchments. Key details of the final voids are as follows:

- AB Pit final void will be approximately 72 m deep, with a floor level of 40 mAHD and an overflow level of approximately 112 mAHD.
- C Pit final void will be approximately 70 m deep, with a floor level of 58 mAHD and an overflow level of approximately 128 mAHD.

The final void will be located and designed such that it is not inundated by flooding in the probable maximum flood (refer Figure 8.2). Accordingly, no flood levee will be required to prevent inundation of the final void. The levee constructed to protect the operational pit would not be required post-mining, and would therefore be decommissioned or form part of the rehabilitated dump.

The landform would include a surface drain to direct runoff from the southern side of the final landform north-east towards Springton Creek, to prevent runoff from this area entering the final void.

The final landform surface drain channel would be designed in detail as part of design of the final dump landform. It would have a longitudinal slope similar to the slope of the existing minor Springton Creek tributaries in the area, and would be sized to ensure that it is a stable and self-sustaining component of the final landform.

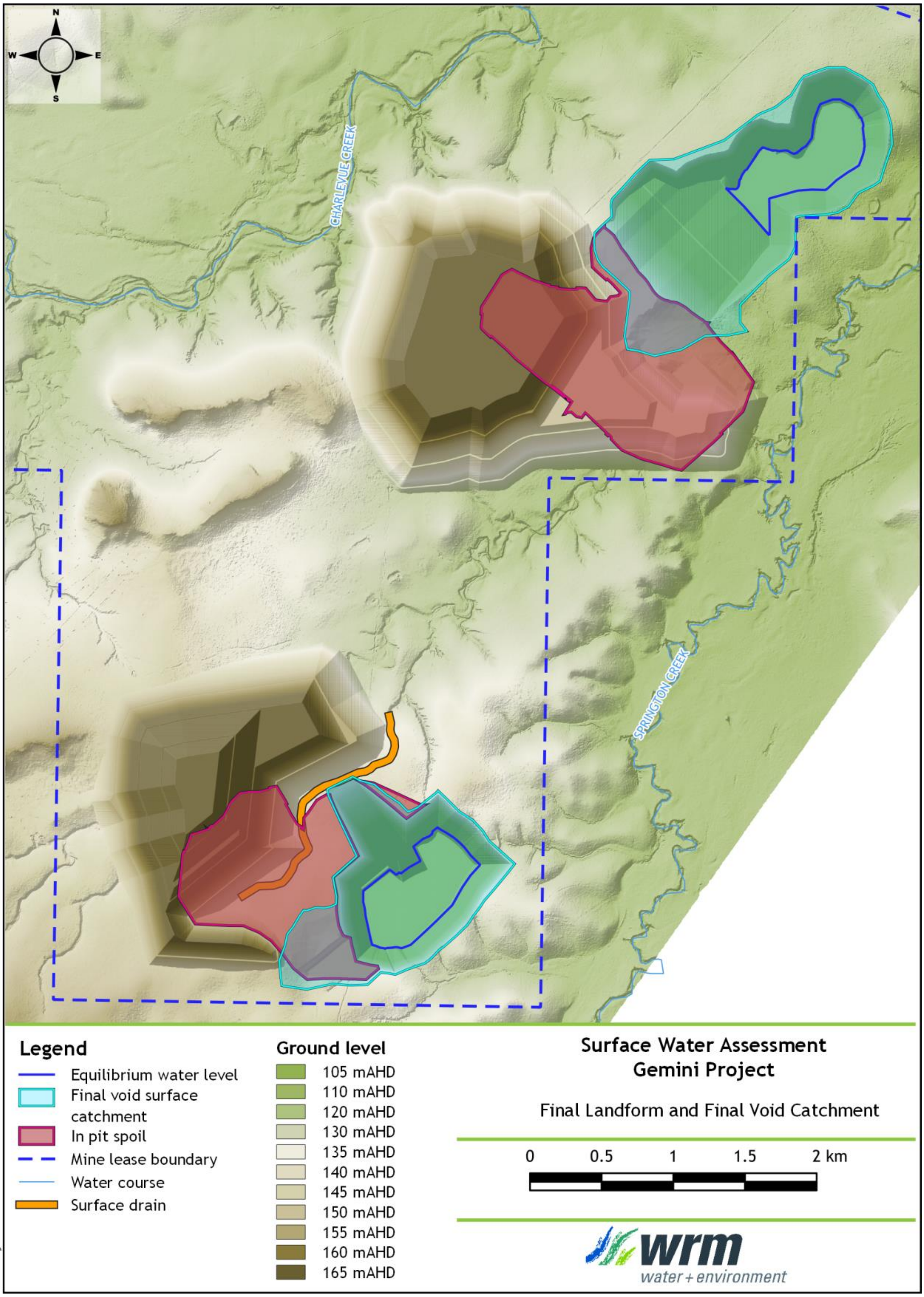


Figure 8.1 – Final landform and final void catchments

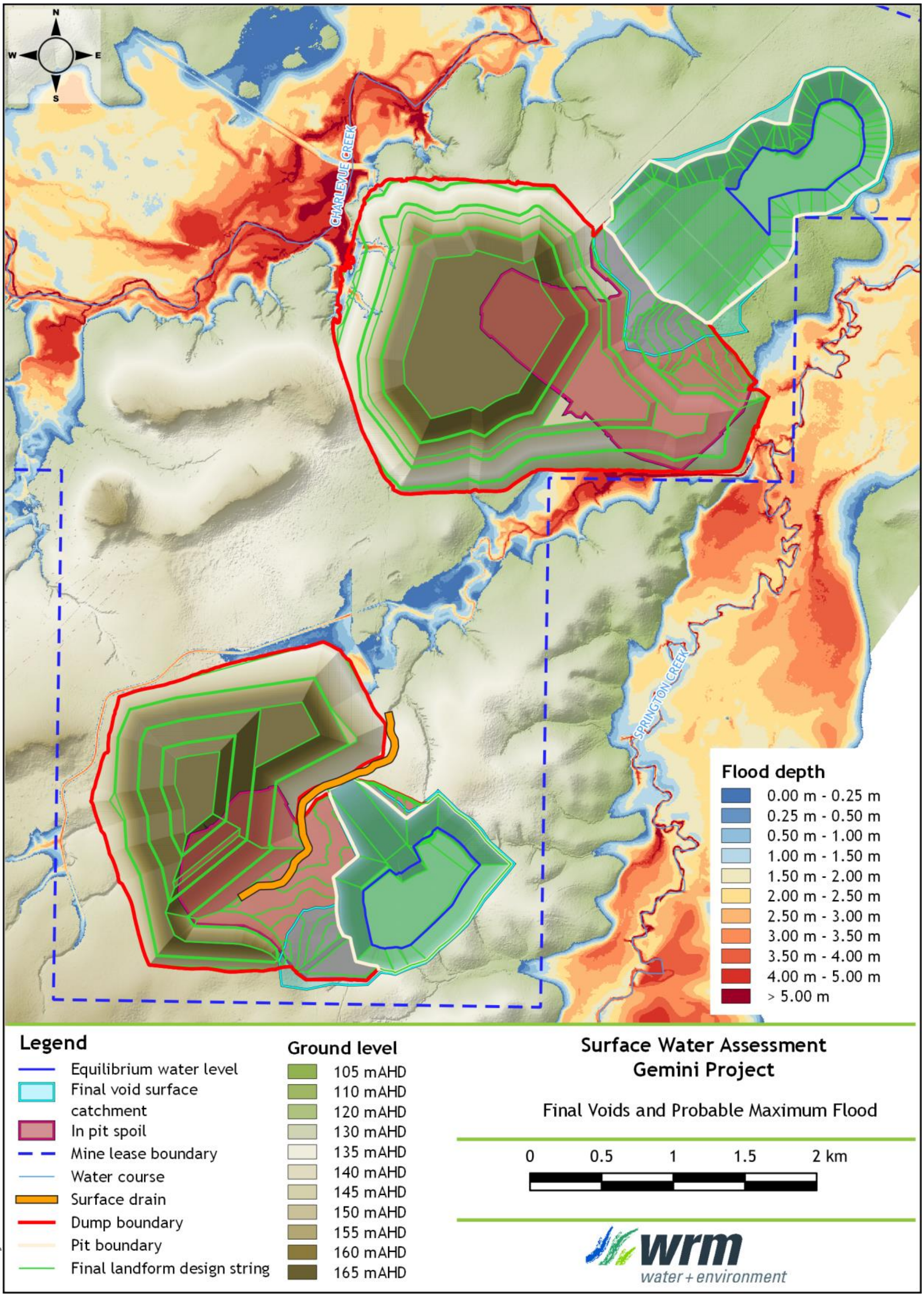


Figure 8.2 – Final landform and flood levels in Probable Maximum Flood

8.3 CONCEPTUAL MODEL

A representative schematisation of a conceptual final void water balance is presented in Figure 8.3.

The figure shows that key water inputs include rainfall on pit lake water surfaces, runoff from pit faces and rehabilitated upstream catchment areas, and groundwater interception. Depending on the configuration of the spoil dump, rainfall may also infiltrate through in-pit spoil.

Outflows are generally limited to evaporation. Under certain circumstances (i.e. if the final void water level exceeds the level of a neighbouring aquifer), outflows may also include seepage losses to surrounding aquifers. Water accumulating in the pit lake may also infiltrate into the adjacent overburden, creating additional water storage in this 'spoil aquifer'.

Sources of salt include salts dissolved in groundwater and catchment runoff. In the absence of any seepage or surface outflows to the environment, there is generally no removal of salt from the system, and thus, salts are expected to accumulate over time.

In principle, for an initially empty void, water is expected to accumulate until evaporative losses from the wetted surface area balance the combined influence of catchment runoff, rainfall and groundwater interception. Where catchment inflows are limited, over a sufficiently long time-scale, water levels are expected to reach a nominal steady state, with some variation about the steady state level during prolonged periods of wet or dry climate bias. This principle works in reverse for any voids that are filled (e.g. by pumping) above their steady state level prior to relinquishment; water levels will reduce due to evaporation until the wetted surface contracts to a point where evaporative losses balance inflows.

The Gemini Project voids are to be partially backfilled to prevent the interchange of water between the coal seams and the lakes - resulting in lower water levels and salinities than would otherwise be the case.

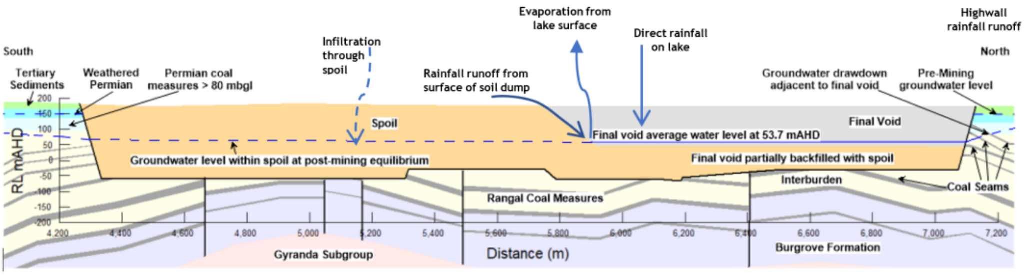


Figure 8.3 – Final landform and pit lake catchment

8.4 NUMERICAL MODELLING APPROACH

The GOLDSIM model simulates the generation, movement and loss of water on a daily time-step within each final void, over a 515-year period. The volume of water in the void is calculated at each time step as the sum of direct rainfall to the void surface, catchment runoff, and groundwater inflows, less evaporation losses.

The model tracks the quantity salt captured and stored within the system. Key components of the model are summarised in the following sub-sections, including descriptions of key model inputs, assumptions and sensitivity parameters.

8.5 STAGE-STORAGE CHARACTERISTICS

The stage-storage and stage-area curves for the voids were estimated from the final landform terrain model. The adopted relationships are shown in Figure 8.6.

8.6 CATCHMENT RUNOFF

Surface runoff catchment areas draining to the final voids were determined based on the adopted final landform. The following land use assumptions were adopted:

- All overburden dumps and cleared areas within the final void catchments will be rehabilitated and revegetated after cessation of mining;
- All rehabilitated catchment will naturally revert toward pre-disturbed conditions over time (as vegetation matures and top soil weathering and consolidation takes place). The long-term runoff properties will be somewhere between rehab and natural catchment.

The AWBM was used to model surface water runoff. The AWBM parameters adopted for rehabilitated areas in the operational water balance were also used for the final void analysis. The modelled surface catchments to each void are summarised in Table 8.1.

Table 8.1 – Final void surface catchments (ha)

Catchment type	AB Pit	C Pit
Natural	15.1	2.0
Pit	104.6	115.7
Rehab	98.0	20.3
Total	**217.7**	**138.0**

8.7 PIT SURFACE EVAPORATION

Evaporation from the void lake water surface was modelled using estimates of Morton's Lake evaporation. The reduced evaporation resulting from shading and wind shielding provided by the pit walls was modelled using an adjustment factor referred to herein as the 'pit factor'. A linearly varying depth-dependent storage evaporation factor has been applied to each void to simulate the change in evaporation as void water levels increase. The storage evaporation factors are as follows:

- Bottom of void – 0.5;
- Top of void – 0.8.

Pit factors are supported by the findings of ACARP Project No. C7007 (2001) which entailed development of a practical methodology for predicting the hydrology and water quality of final spoil-void systems. The study proposed adopting typical pit factors of 0.56 for near-empty pits and 0.78 for near-full pits based on modelling undertaken at several mines in Queensland and NSW.

8.8 GROUNDWATER

Ground water investigations by JBT Consulting indicate that due to partial backfilling of the voids, groundwater inflows to the final voids are expected to be negligible.

8.9 CLIMATE CHANGE IMPACTS

Climate-change adjusted SILO climate data are available from the Queensland Government Department of Environment and Science (DES), and were developed as part of the Consistent Climate Scenarios (CCS) project. The CCS project hosts data from 19 separate global climate models (GCMs), which explore four emissions scenarios, three timing horizons and three climate warming sensitivities. The nineteen separate models can be split into four Representative Future Climate (RFC) partitions, defined below:

- HI: a high level of global warming, where the Eastern Indian Ocean (EIO) warms faster than the Western Pacific Ocean (WPO);
- HP: a high level of global warming, where the WPO warms faster than the EIO;
- WI: a low level of global warming, where the EIO warms faster than the WPO; and
- WP: a low level of global warming, where the WPO warms faster than the EIO.

Figure 8.4 is an excerpt from the CCS project user guide (DSITIA, 2015) showing the four RFC quadrants, component models and indicative rainfall trends. The caption associated with the original version of this figure has been reproduced as a footnote[1].

Data based on the mean result of all models within each RFC quadrant is offered by the CCS for applications where considering the output of all 19 models is not feasible/practical. This approach has been followed for the purposes of assessing climate change sensitivity as part of current investigations. Table 8.2 and Table 8.3 list the percentage change in evaporation and rainfall respectively, based on mean output for the four RFC quadrants. Data is based on the most conservative carbon emission rate (RCP8.5) available in the CCS dataset, and expected climate as at 2070. Data has been listed for the low, medium and high sensitivities. Information is for the Gemini Project location.

The adjustments listed in Table 8.2 and Table 8.3 have been applied to the long-term SILO daily climate time-series, and passed through the AWBM rainfall runoff sub-model to produce daily estimates of runoff (rehabilitated land use AWBM parameter set used). Annual average runoff depths have been plotted against average annual net evaporation depths (evaporation minus rainfall) in Figure 8.5 to illustrate the potential to impact on long-term water levels in the Gemini Project pit lakes. Note the naming convention used in the figure, and henceforth in this document, is XX.Y where XX is the scenario (e.g. HI) and Y is the sensitivity (medium).

Figure 8.5 shows that all scenarios predict increases in net evaporation, and that all scenarios predict reductions in runoff. It is evident that all scenarios will result in lower final void water levels than the base case scenario. The sensitivity of final void water levels to changes in future climate change have been assessed by modelling all the above scenarios.

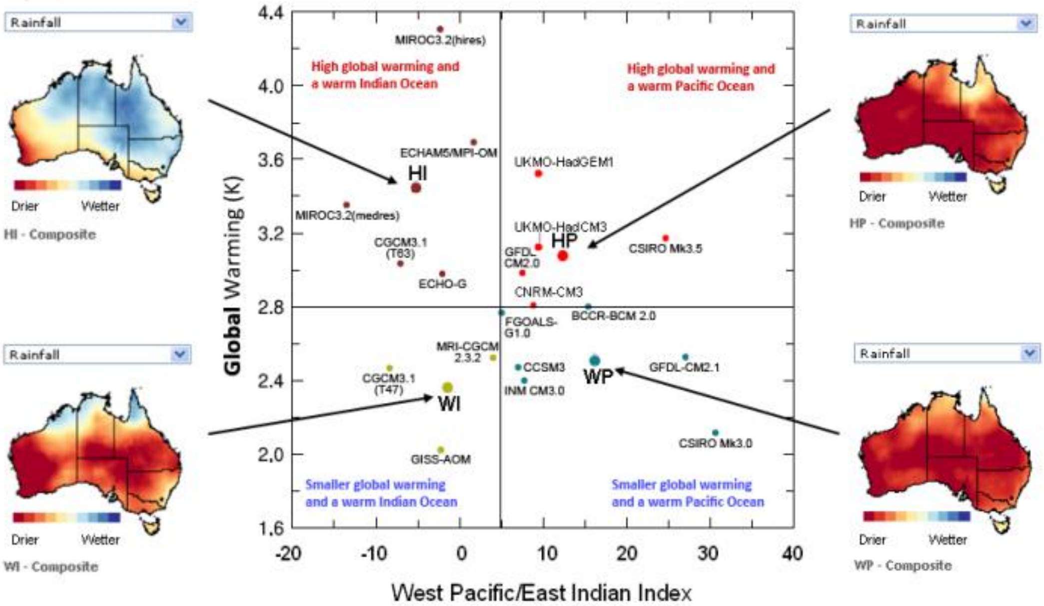


Figure 8.4 – A partition of Global Climate Models for future climate using global warming sensitivity and ocean warming indices (source: DSITIA, 2015)

[1] From DSITIA, 2015 – Figure 8.1 (verbatim): A partition of CMIP3 Global Climate Models (GCMs) for future climate using global warming sensitivity and ocean warming indices (adapted from Watterson, 2011). Values for nineteen individual GCMs (forced by the SRES A1B emissions scenario) are represented by the small dots and labelled by their GCM model code (Table 8.2). The central horizontal and vertical lines separate the four Representative Future Climate (RFC) partitions. The larger dots indicate the CCS composite means for GCMs within each of the four RFC responses: (HI) high global warming and a warmer Indian Ocean; (HP) high global warming and a warmer Pacific Ocean; (WP) lower global warming and a warmer Indian Ocean and (WP) lower global warming and a warmer Pacific Ocean. The maps show projected 21st Century changes in rainfall for the GCMs clustered in each of the four (HI, HP, WI and WP) RFC partitions.

Table 8.2 – Percentage change in evaporation by model and sensitivity

Model*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
HI (high)	16.2	18.6	21.5	15.8	12.8	10.2	8.2	9.2	14.1	14.0	20.1	11.2	13.1
HI (med)	10.0	11.5	13.3	9.8	7.8	6.0	5.0	5.6	8.8	8.8	12.6	7.0	7.5
HI (low)	5.4	6.2	7.2	5.3	4.2	3.1	2.6	2.9	4.8	4.8	6.9	3.8	3.3
HP (high)	16.9	19.2	19.3	16.6	15.8	17.2	13.8	17.1	17.2	18.1	18.4	14.9	15.3
HP (med)	10.7	12.1	12.1	10.4	9.9	10.8	8.6	10.8	10.9	11.5	11.7	9.5	9.0
HP (low)	5.9	6.6	6.6	5.7	5.4	5.9	4.7	5.9	6.0	6.3	6.5	5.3	4.2
WI (high)	15.8	18.1	14.0	10.9	8.6	11.3	12.0	10.5	13.4	9.1	11.6	11.8	10.7
WI (med)	10.0	11.3	8.7	6.7	5.2	6.9	7.4	6.4	8.4	5.6	7.2	7.4	6.0
WI (low)	5.5	6.2	4.7	3.6	2.7	3.7	4.0	3.4	4.6	3.0	4.0	4.1	2.5
WP (high)	27.7	17.9	24.4	24.0	26.2	19.2	15.6	14.1	14.5	16.7	23.4	12.7	17.8
WP (med)	17.5	11.1	15.3	15.2	16.4	11.8	9.6	8.7	9.0	10.5	14.8	7.9	10.5
WP (low)	9.6	6.0	8.4	8.4	9.0	6.3	5.2	4.7	4.9	5.8	8.1	4.3	5.0

Note: * model is RFC partition, text in brackets is the sensitivity

Table 8.3 – Percentage change in rainfall by model and sensitivity

Model*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
HI (high)	-7.3	37.8	-14.3	-55.3	66.7	-48.1	3.3	-10.7	-9.1	-9.0	-46.0	4.1	-3.6
HI (med)	-4.9	25.3	-9.6	-37.0	44.7	-32.3	2.2	-7.2	-6.1	-6.0	-30.8	2.7	-2.4
HI (low)	-2.8	14.7	-5.6	-21.5	26.0	-18.7	1.3	-4.2	-3.5	-3.5	-17.9	1.6	-1.4
HP (high)	-12.2	-6.2	4.8	-20.3	-32.2	-37.4	-14.6	-39.6	-45.5	-60.0	-46.4	-27.8	-23.9
HP (med)	-8.2	-4.1	3.2	-13.6	-21.6	-25.0	-9.8	-26.5	-30.5	-40.2	-31.1	-18.6	-16.0
HP (low)	-4.8	-2.4	1.9	-7.9	-12.5	-14.5	-5.7	-15.4	-17.7	-23.3	-18.0	-10.8	-9.3
WI (high)	-15.7	5.4	9.1	-11.5	2.7	-18.1	-3.6	-14.2	-17.2	-3.3	-21.5	-17.9	-8.4
WI (med)	-10.6	3.6	6.1	-7.7	1.8	-12.2	-2.4	-9.5	-11.6	-2.2	-14.4	-12.0	-5.6
WI (low)	-6.1	2.1	3.5	-4.5	1.0	-7.1	-1.4	-5.5	-6.7	-1.3	-8.4	-7.0	-3.3
WP (high)	-11.1	11.0	7.6	-9.3	-65.5	20.0	-6.6	21.5	-12.5	-29.5	-42.6	12.9	-6.9
WP (med)	-7.5	7.4	5.1	-6.2	-43.9	13.4	-4.4	14.4	-8.4	-19.7	-28.6	8.7	-4.6
WP (low)	-4.3	4.3	2.9	-3.6	-25.5	7.8	-2.6	8.4	-4.9	-11.5	-16.6	5.0	-2.7

Note: * model is RFC partition, text in brackets is the sensitivity

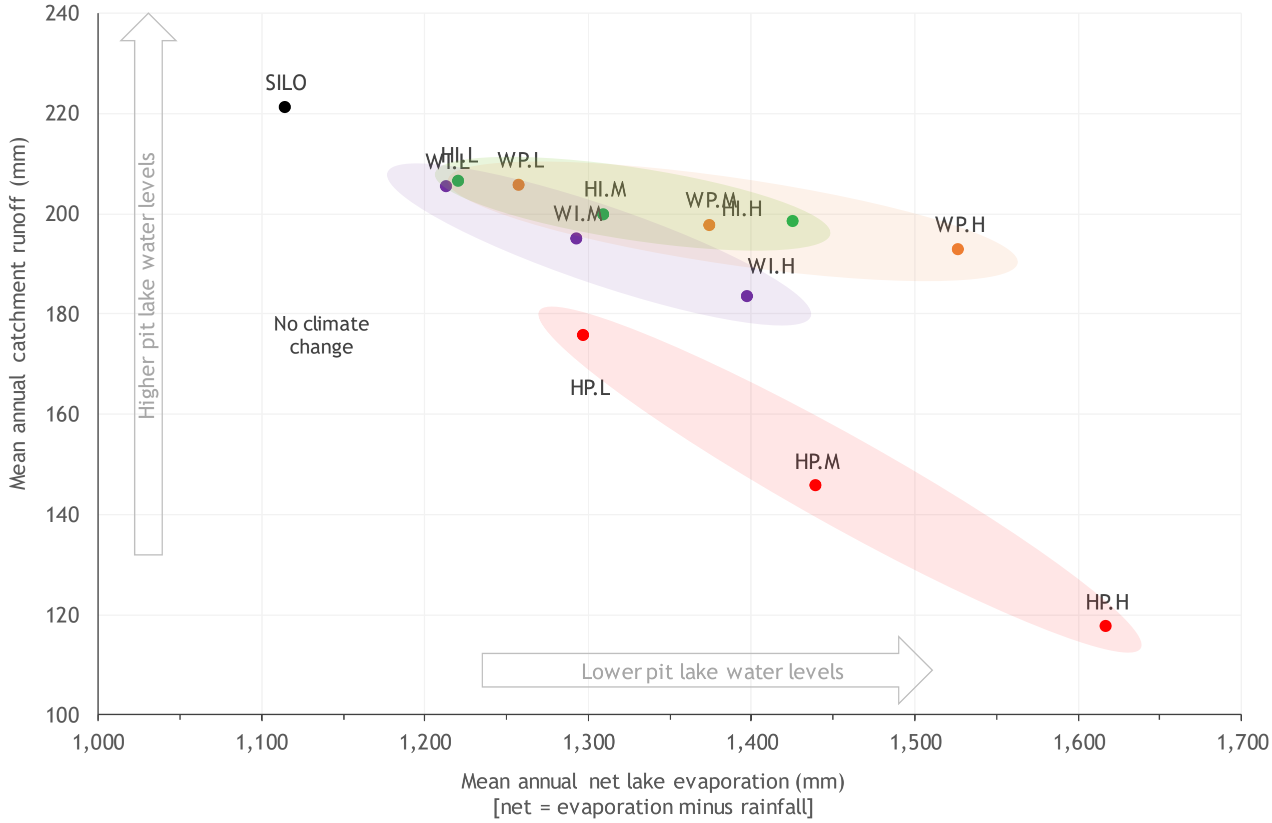


Figure 8.5 - Plot of net evaporation versus AB Pit runoff for HI, HP, WI and WP GCM groupings

8.10 LAKE SALINITY

As the void lake will not spill, and seepage into the local Permian material is expected to be minimal, salinity will rise over time as salts are transported from the local surface catchment and contained in the void. A simple conservative solute model was coupled with the lake water balance to estimate the potential lake salinity.

Water samples taken from Springton and Charlevue Creek had a median EC of 114 µS/cm, while kinetic leach column (KLC) testing of the local overburden material (RGS, 2019) showed that leachate from all KLC samples (apart from the carbonaceous siltstone and coal) had initial EC values less than 800 µS/cm, and at the end of six months less than 203 µs/cm.

While runoff salinity is therefore likely to gradually decline over time as salts are leached from the adjacent ground into runoff and seepage, for this final void assessment, runoff was conservatively assumed to have the following fixed salinities:

- Natural Runoff - 100 mg/L (equivalent to EC of approximately 150 µS/cm);
- Rehabilitation - 200 mg/L (equivalent to EC of approximately 308 µS/cm);
- Pit Runoff - 390 mg/L (equivalent to EC of approximately 600 µS/cm).

These assumptions will tend to result in the model overestimating long-term contribution of runoff to void lake salinity.

8.11 MODEL RESULTS

Figure 8.6 and Figure 8.7 show the simulated long-term water levels in the final voids. The results show the following:

For AB Pit:

- Under the existing (SILO) climate scenario - the modelled water level reaches equilibrium at around 52.9 mAHD within 50 years and generally remains at this level throughout the remainder of the simulation (fluctuating between 47.4 and 57.6 mAHD).
- The maximum modelled water level (57.6 mAHD) is around 54 m below the void overflow level of approximately 112 mAHD, and well below the potential level of groundwater seepage to the tertiary aquifer.
- Figure 8.6 shows that under the climate change scenarios, the equilibrium water level is lower than the existing climate scenario.

For C Pit:

- Under the existing (SILO) climate scenario - the water level reaches equilibrium at around 70.3 mAHD within 50 years and generally remains at this level throughout the remainder of the simulation (fluctuating between 66.0 and 73.5 mAHD).
- The maximum modelled water level is around 54.4 m below the void surface overflow level of approximately 128 mAHD, and well below the potential level of groundwater seepage to the tertiary aquifer.
- Figure 8.7 shows that under all climate change scenarios, the equilibrium water level is lower than the existing climate scenario.

Table 8.4 summarises the simulated long-term water balance for the base case scenario and the WP.M scenario, which is closest to the average of all modelled climate scenarios.

Table 8.5 shows the equilibrium levels for surface water in the final voids for the existing (SILO) climate scenario and the climate change scenario.

Figure 8.8 and Figure 8.9 show the results of the salt balance. Salt accumulates within both voids over time. Under the existing climate conditions scenario, the void lake salinity exceeds a TDS of 30,000 mg/L after approximately 500 years of simulation. During the first 200 years, apart from short periods when inflows are very low, and salt concentrations temporarily increase rapidly due to evaporation, lake salinities are predicted to be less than 10,000 mg/L.

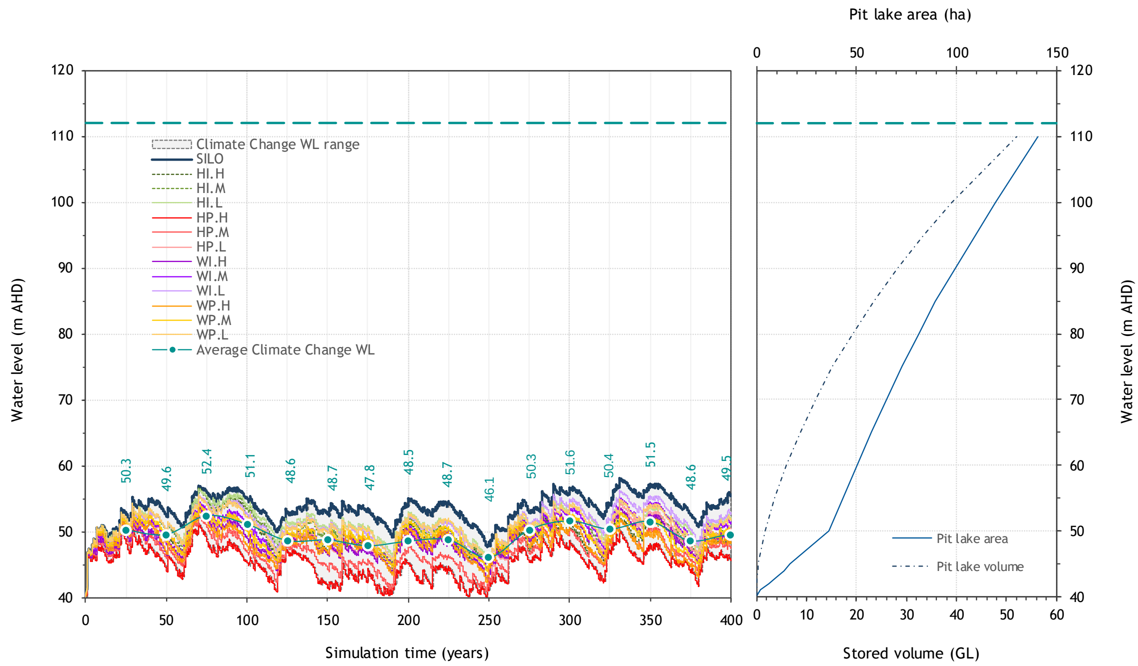


Figure 8.6 – Results of final void modelling AB Pit

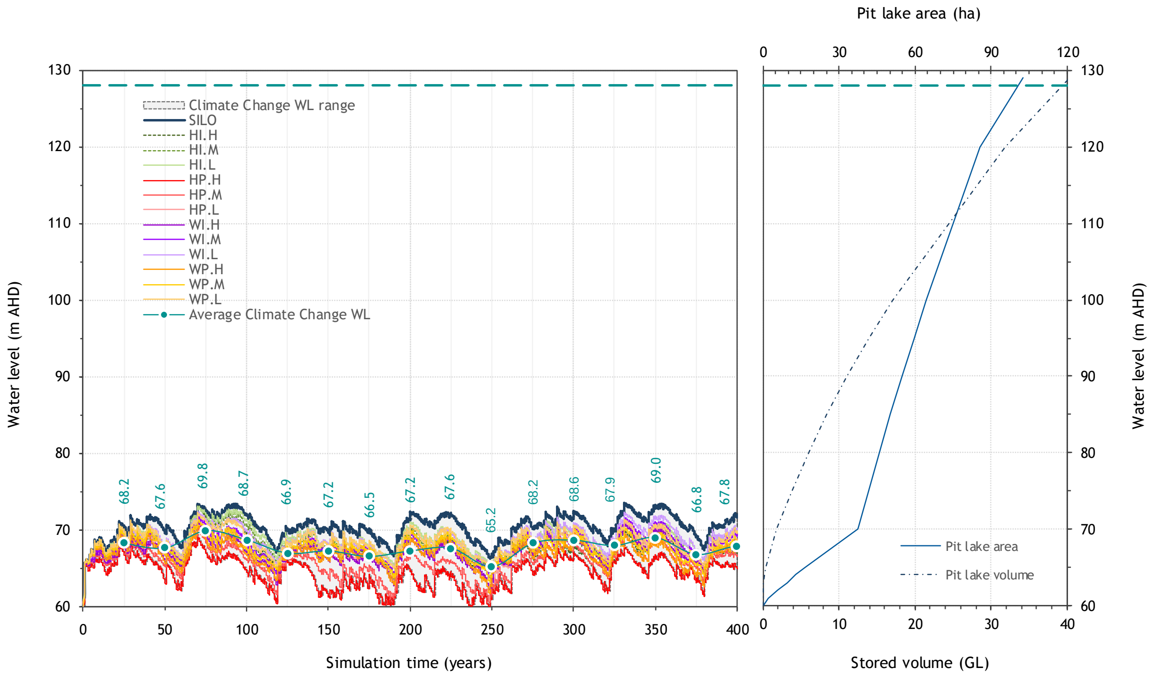


Figure 8.7 – Results of final void modelling C Pit

Table 8.4 - Average annual final void water balance - at equilibrium

		AB Pit		C Pit	
		Climate Scenario		Climate Scenario	
		EXISTING (SILO)	WP.M	EXISTING (SILO)	WP.M
Climate Averages					
Evaporation	mm/a	1,811	2,033	1,811	2,033
Rainfall	mm/a	694	656	694	656
Runoff characteristics					
Rehab runoff	mm/a	*59.9*	*52.6*	*59.9*	*52.6*
Rehab runoff/rainfall		8.6%	8.0%	8.6%	8.0%
Natural runoff	mm/a	*35.6*	*30.7*	*35.6*	*30.7*
Natural runoff/rainfall		5.1%	4.6%	5.1%	4.6%
Pit runoff	mm/a	*145.0*	*129.9*	*145.0*	*129.9*
Pit runoff/rainfall		20.9%	14.3%	20.9%	14.3%
Inflows					
Direct Rainfall	ML/a	283	202	253	176
Runoff	ML/a	156	150	127	125
GW inflow	ML/a	0	0	0	0
Outflows					
Pit evaporation	ML/a	439	352	380	301

Table 8.5 - Final void surface water equilibrium levels

	Pit AB		Pit C	
	Existing climate m AHD	Climate change m AHD	Existing climate m AHD	Climate change m AHD
Long term equilibrium water levels in the two voids (based on modelling).	52.9	52.8	70.3	67.6
Maximum long-term water levels in the two voids (modelled).	57.6	49.1	73.5	66.2
Minimum long-term water levels in the two voids (modelled).	47.4	45.0	66.0	64.3
Overflow level at natural surface for the two voids.	112.0	112.0	128.0	128.0

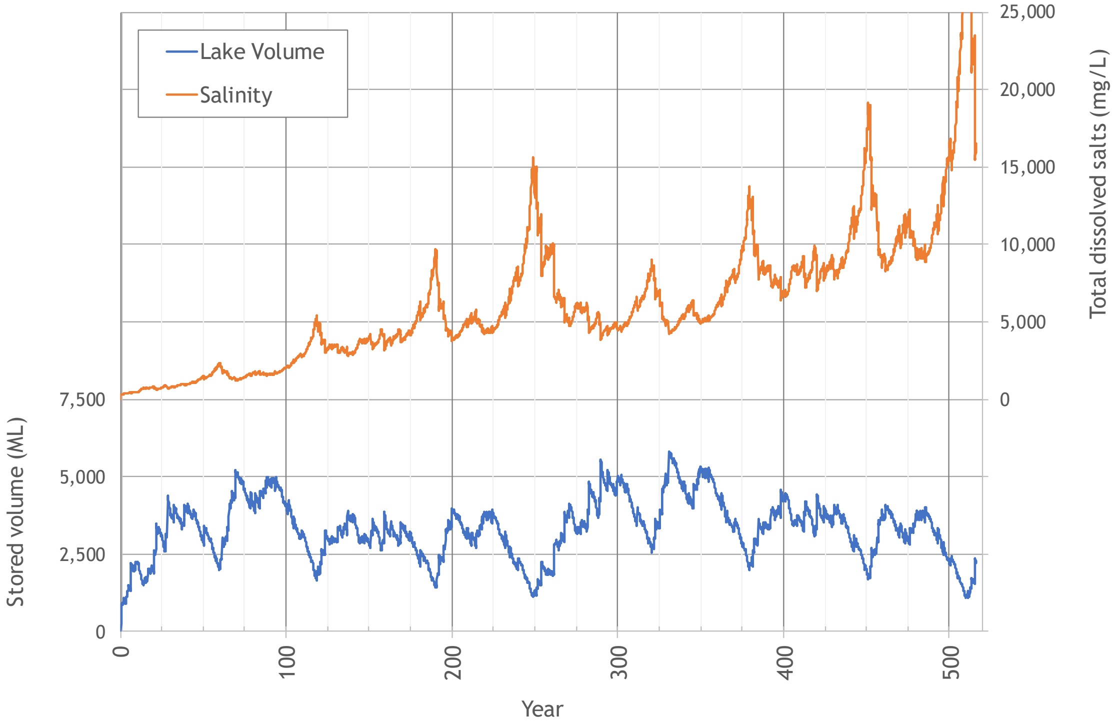


Figure 8.8 - Modelled void lake salinity - AB Pit

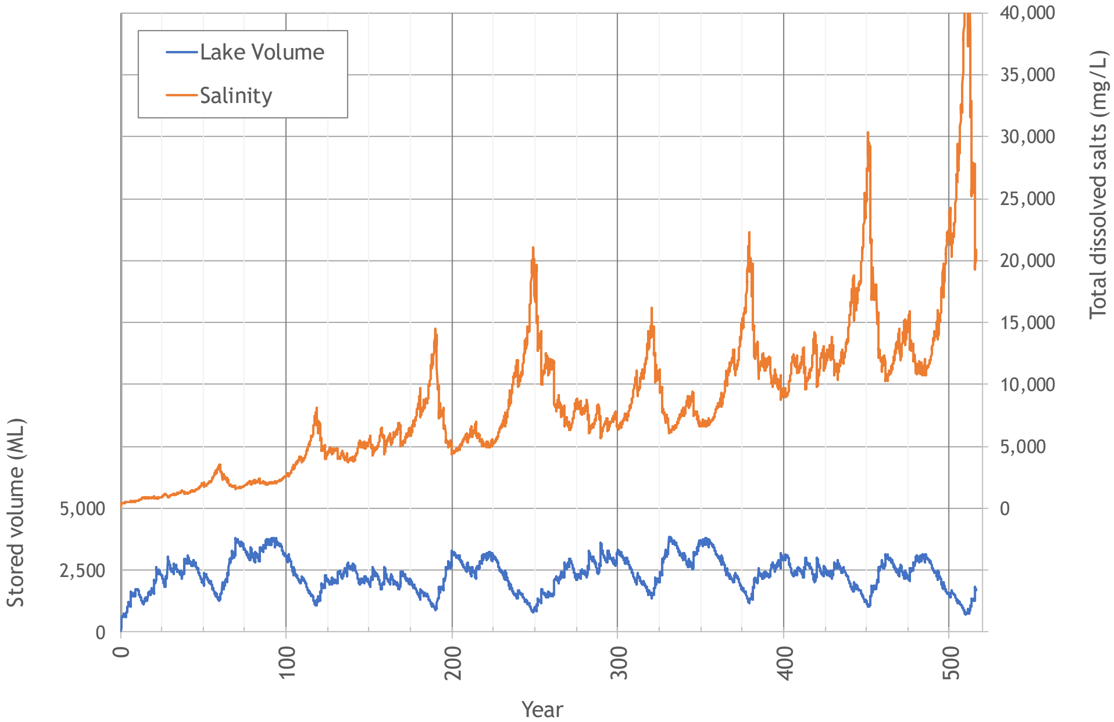


Figure 8.9 - Modelled void lake salinity - C Pit

8.12 SENSITIVITY ANALYSIS

The sensitivity of the equilibrium water level to uncertainty in the key input parameters was tested by reducing the AWBM USC values to half their original values – to increase runoff to the void.

Under these conditions, the equilibrium water level remained below:

- 63.9 mAHD at AB Pit, and
- 80.0 mAHD at C Pit.

Table 8.6 shows that under the high runoff scenario, total average inflows at equilibrium increase by approximately 26% compared to the base case, and the increase in lake water surface area results in a corresponding increase in evaporation.

Table 8.6 - Sensitivity analysis – high runoff - average annual final void water balance – at equilibrium

		C Pit	
		Sensitivity analysis	
		Base Case	High Runoff
Climate Averages			
Evaporation	mm/a	1,811	1,811
Rainfall	mm/a	694	694
Runoff characteristics			
Rehab runoff	mm/a	*59.9*	*111*
Rehab runoff/rainfall		8.6%	16.0%
Natural runoff	mm/a	*35.6*	*35.6*
Natural runoff/rainfall		5.1%	5.1%
Pit runoff	mm/a	*145.0*	*218.8*
Pit runoff/rainfall		20.9%	31.4%
Inflows			
Direct Rainfall	ML/a	253	297
Runoff	ML/a	127	183
GW inflow	ML/a	0	0
Outflows			
Pit evaporation	ML/a	380	480

9 Vulnerability to climate change during operations

The long-term effects of climate change on final void behaviour have been assessed in Section 8.

A number of potential adaptive measures have been considered to assist with resilience to climate change effects, most of which will be implemented in any case to cater for the high climatic variability experienced in the region:

- Contingency measures for directing excess inflows to the mine pit;
- Off-site water supplies of sufficient capacity to deliver the entire site water demand;
- Water efficient plant design;
- Overdesign of drainage and containment systems to cater for increased duration, frequency and intensity of rainfall due to climate change effects.

10 Potential surface water impacts and mitigation measures

10.1 OVERVIEW

The potential impacts of the Project on water resources identified in the preceding sections of the report, and proposed mitigation measures, are summarised in the following sections:

- the diversion of an unnamed tributary of Springton Creek, including changes to the channel and floodplain geometry – and resultant potential changes to stream morphology;
- impacts on the flooding regime in Charlevue Creek and Springton Creek;
- impacts on flood levels at the Capricorn Highway and the Blackwater Rail Corridor upstream of the proposed rail loop and train loadout;
- the creation of a final void lake at the completion of mining;
- short-term loss of catchment area – and subsequent reduction in streamflow in local streams due to the capture of runoff within on-site storages and the open cut pit;
- long-term reduction in streamflow in local streams due to residual loss of catchment to the final void;
- impacts on regional water availability due to the potential need to obtain water from external sources to meet construction and operational water requirements for the Project;
- adverse impacts on the quality of surface runoff draining from the disturbance areas to the various receiving waters surrounding the Project, during both construction and operation of the Project;
- adverse impacts on environmental values in the Mackenzie River catchment associated with releases from the sediment management system.

10.2 FLOODING IMPACTS

The outcomes of the flood impact assessment are as follows:

- The proposed rail loop will not impact Charlevue Creek or Springton Creek flooding.
- The Project will temporarily increase Charlevue Creek flood levels immediately upstream of the proposed haul road crossing. These impacts are contained within the mine lease area.
- There will be no impact on flood levels in the Springton Creek or Charlevue Creek at the existing Capricorn Highway, Blackwater Rail corridor, or downstream of the Project area.
- The works at AB Pit will locally increase flood levels in Springton Creek by up to 0.22 m in the 1% AEP flood. These impacts would extend off the lease area onto land owned by Magnetic South Pty Ltd, and reduce with distance downstream of the boundary.
- There will be localised off-lease impacts on flood levels in the unnamed tributary of Springton Creek immediately upstream of AB Pit and C Pit.
- There are four locations where (based on the flood model results) floodwaters could potentially come into contact with the overburden dumps:

- **Northeastern end of Pit C** – due to flow backing up to the west of the haul road crossing of the engineered drainage feature. Modelled flow velocities in this area are less than 0.4 m/s in the 0.1% AEP design flood, and would therefore not cause the migration of sediment from the final landform;
- **Western side of Pit AB** – due to water backing up a minor tributary of Charlevue Creek. Flow velocities in this area are expected to be less than 0.2 m/s, and therefore the likelihood of migration of sediment from these dumps is minimal;
- **Eastern side of Pit AB** – due to flow on the left (western) floodplain of Springton Creek. Flow velocities against the final landform are modelled to be less than 1.2 m/s in the 0.1% AEP flood, and therefore the likelihood of erosion of the dump toe is minimal; and
- **Southern side of Pit AB** – due to water overflowing from the unnamed tributary of Springton Creek upstream of the inlet to the engineered drainage feature. During operations, this section of the dump would be protected by a temporary levee, which would be incorporated into the final landform profile on closure. In events up to the 0.1% AEP design flood, modelled flow velocities are less than 1 m/s along most of the length of the proposed levee. Such flows would be non-erosive – and especially given the relatively short flow durations in this small catchment, the risk of migration of sediment in floodwaters would be minimal. During detailed design of the engineered drainage feature, provision will be made to ensure that flows will be non-erosive along the final landform post-closure.

10.3 FINAL VOID LAKES

At mine closure, final voids will remain at each mine pit.

The floor of the AB pit will be at an elevation of approximately 40 mAHD or 72 m below the natural surface elevation (112 mAHD). The floor of the C pit will be at an elevation of approximately 60 mAHD or approximately 68 m below the natural surface elevation (128 mAHD).

Over time, the voids will fill with surface water runoff to form a lake. Based on water balance modelling:

For AB Pit:

- Under the existing (SILO) climate scenario - the modelled water level reaches equilibrium at around 52.9 mAHD within 50 years and generally remains at this level throughout the remainder of the simulation (fluctuating between 47.4 and 57.6 mAHD).
- The maximum modelled water level (57.6 mAHD) is around 54 m below the void overflow level of approximately 112 mAHD, and well below the potential level of groundwater seepage to the tertiary aquifer.
- Under the climate change scenarios, the equilibrium water level is lower than the existing climate scenario.

For C Pit:

- Under the existing (SILO) climate scenario - the water level reaches equilibrium at around 70.3 mAHD within 50 years and generally remains at this level throughout the remainder of the simulation (fluctuating between 66.0 and 73.5 mAHD).
- The maximum modelled water level is around 54.4 m below the void surface overflow level of approximately 128 mAHD, and well below the potential level of groundwater seepage to the tertiary aquifer.

- Under all climate change scenarios, the equilibrium water level is lower than the existing climate scenario.

Salt will accumulate within both voids over time. The void lake salinity is expected to exceed a TDS of 30,000 mg/L after approximately 500 years. Final void modelling suggests that during the first 200 years after closure, apart from short periods when inflows are very low, and salt concentrations temporarily increase rapidly due to evaporation, lake salinities will be less than 10,000 mg/L.

10.4 GEOMORPHOLOGICAL IMPACTS

An unnamed tributary of Springton Creek will be diverted to allow mining of the resource at both pits. This stream is not defined as a watercourse under the Water Act. Nonetheless, it is proposed that where practicable, the diversion works will be constructed to comply with the design principles set out in the Guideline: "Works that interfere with water in a watercourse – watercourse diversions".

The proposed diversion channel would be designed to accommodate flood flows at velocities which would be non-erosive in the 1 in 100 AEP flood with appropriate channel lining.

10.5 IMPACTS ON DOWNSTREAM FLOW REGIME

During operations, the Project's water management system will intercept runoff from disturbed areas of the mine site.

The water management system has been designed to achieve a high level of containment of mine affected water, with any overflows from the Main Water Dam directed to the mine pit. As controlled releases are not part of the proposed water management strategy for the mine affected water management system, runoff currently flowing from these parts of the catchment to Charlevue Creek and Springton Creek will be temporarily stopped during project operations.

As overburden runoff quality is expected to be relatively benign, sediment dams will potentially discharge directly into the environment (after the settlement of suspended sediment), and as such, will not reduce downstream flows. However, sediment dams will be pumped back to the mine affected water system if water quality monitoring shows the water is unsuitable for release. As shown in Table 10.1, the maximum captured catchment areas represent:

- 1.0% of Charlevue Creek catchment upstream of the Springton Creek confluence;
- 3.6% of Springton Creek catchment upstream of the Charlevue Creek confluence; and
- 2.3% of Springton Creek catchment downstream of the Charlevue Creek confluence.

Table 10.1 – Catchment excised by site water management system at Year 18

Description	Charlevue Creek	Springton Creek	Total
Total Intercepted in MW System (ha)	336.9	1,174.9	
To confluence (U/S) (ha)	32,243	32,497	
	1.0%	3.6%	
Downstream of confluence (ha)		2.3%	64,740

After mine closure, the water management system will be decommissioned but there will be some residual impact on streamflow due to drainage to the final voids. As shown in Table 10.2, the maximum captured catchment areas represent:

- 0.03% of Charlevue Creek catchment upstream of the Springton Creek confluence;
- 1.1% of Springton Creek catchment upstream of the Charlevue Creek confluence; and
- 0.6% of Springton Creek catchment downstream of the Charlevue Creek confluence.

The resultant impact on environmental values would be expected to be negligible.

Table 10.2 - Catchment excised by site water management system at mine closure

Description	Charlevue Creek	Springton Creek	Total
Total Intercepted in Final Void (ha)	10.0	345.0	
To confluence (U/S) (ha)	32,243	32,497	
	0.03%	1.1%	
Downstream of confluence (ha)		0.6%	64,740

The results of rainfall runoff modelling (using the AWBM) was used to estimate the impact of this loss of catchment on the frequency of low flows (assuming the contiguous rainfall/runoff and baseflow characteristics across the catchment -i.e. by factoring the runoff duration curve by the pre and post-mine catchment areas).

The change in the frequency of flows would be expected to be negligible as illustrated in Figure 10.1.

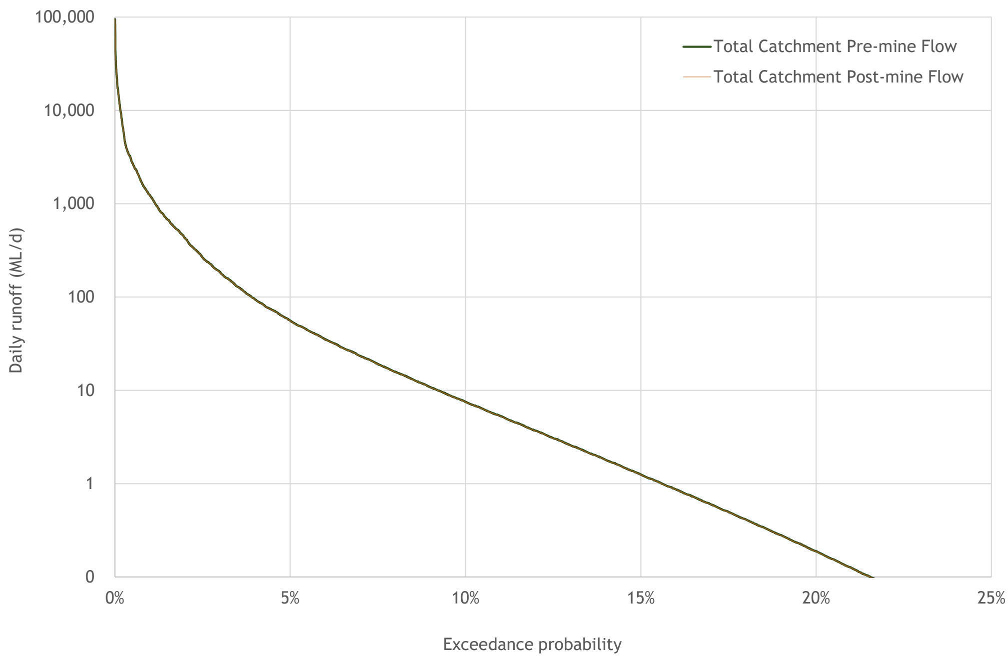


Figure 10.1 - Flow frequency curve based on rainfall runoff modelling of Springton Creek using the AWBM

10.6 IMPACTS ON RECEIVING WATER QUALITY

The potential impacts on receiving water quality will be managed by the site water management system.

To avoid significant downstream impacts, the system has been designed to achieve a high level of containment without the need for controlled releases, as the opportunities to release mine water are likely to be very limited. However, should water quality allow, water may be released to Charlevue Creek in accordance with Environmental Authority conditions consistent with the "*Model water conditions for coal mines in the Fitzroy basin*".

Any unplanned overflows from the Mine Water Dam, would overflow to the mine pit. The only potential mine water release points are the MIA Dam spillways. However, these dams will be operated in such a way that the risk of release is small.

Runoff from overburden dumps will be managed under an erosion and sediment control plan to reduce sediment loads to background levels before release. Water would be discharged either via sediment dam spillways or perforated riser pipes.

10.6.1 Seepage

There is some potential for seepage of water from the Mine Water Dam to Charlevue Creek. The dam will be designed with a floor and sides of material that will limit seepage to avoid environmental harm.

10.7 CUMULATIVE IMPACTS

The only known existing coal mine within the Springton Creek catchment is the recently commenced Bluff Coal Mine. The Walton Coal Project is also proposed within the catchment. These two projects are of relatively small scale and short life. The potential cumulative impacts of the two projects are discussed in the following sections.

10.7.1 Regional water availability

The water balance model shows that (due to the relatively low water requirements of the coal preparation plant) the mine site water requirements of the Gemini Project can largely be sourced from water collected within the site water management system.

Shortfalls in water supply for both the Walton Coal Mine and the Bluff Coal Mine are to be supplied with mine water from the Jellinbah Mine. As a result, the potential cumulative impacts of mine projects on water availability in the catchment of Springton Creek is limited to the effect of cumulative catchment excision by the two projects.

Based on catchment information presented in the Bluff Coal Mine EIS, the cumulative impact of the projects on flows in Springton Creek will be minimal.

10.7.2 Controlled releases

Mine affected water from the Project will be managed through a mine water management system which is designed to achieve full containment of mine water under historical conditions. The water management plans for the other project are similarly designed for the complete containment of mine water. Releases would only occur in accordance with Environmental Authority conditions consistent with the "*Model water conditions for coal mines in the Fitzroy basin*".

Releases from sediment dams are authorised under the EA if an ESCP is appropriately implemented. Water releases from both projects would only be allowed from the sediment water system if water quality meets the sediment dam release criteria to be set in the Environmental Authority.

If operated in accordance with the EA, the impact of releases from the projects on water quality in the regional catchment systems would be minimal.

11 Water monitoring

11.1 RECEVING WATER MONITORING

A Receiving Environment Monitoring Plan (REMP) will be developed for the Project in accordance with the model mining conditions. The REMP would be implemented to monitor, identify and describe any adverse impacts to surface water environmental values, quality and flows due to the authorised mining activity.

Water quality monitoring will be undertaken upstream and downstream of the project to detect downstream water quality impacts and to demonstrate compliance with the Environmental Authority release conditions. The proposed receiving water monitoring points are listed in Table 11.1 and shown in Figure 11.1. Locations have been chosen so that the sites are unaffected by the project operations but are accessible during wet weather.

Water quality will be monitored for the 'standard' suite water quality parameters included in the Model Water Conditions for coal mines in the Fitzroy basin - but not limited to, pH, EC, major anions (sulfate, chloride and alkalinity), major cations (sodium, calcium, magnesium and potassium), TDS and a broad suite of soluble metals/ metalloids.

Water quality monitoring will be compliant with the National Water Quality Management Strategy. Samples will be collected monthly or during each flow event, where possible. Continuous water level, salinity, turbidity and pH monitoring equipment will be installed at the downstream stations.

Table 11.1 - Receiving water monitoring points

Description	Latitude (deg)	Longitude (deg)
Springton Creek US	-23.6976	149.2738
Springton Creek DS	-23.6434	149.3145
Charlevue Creek US	-23.6305	149.2715
Charlevue Creek DS	-23.6469	149.2104

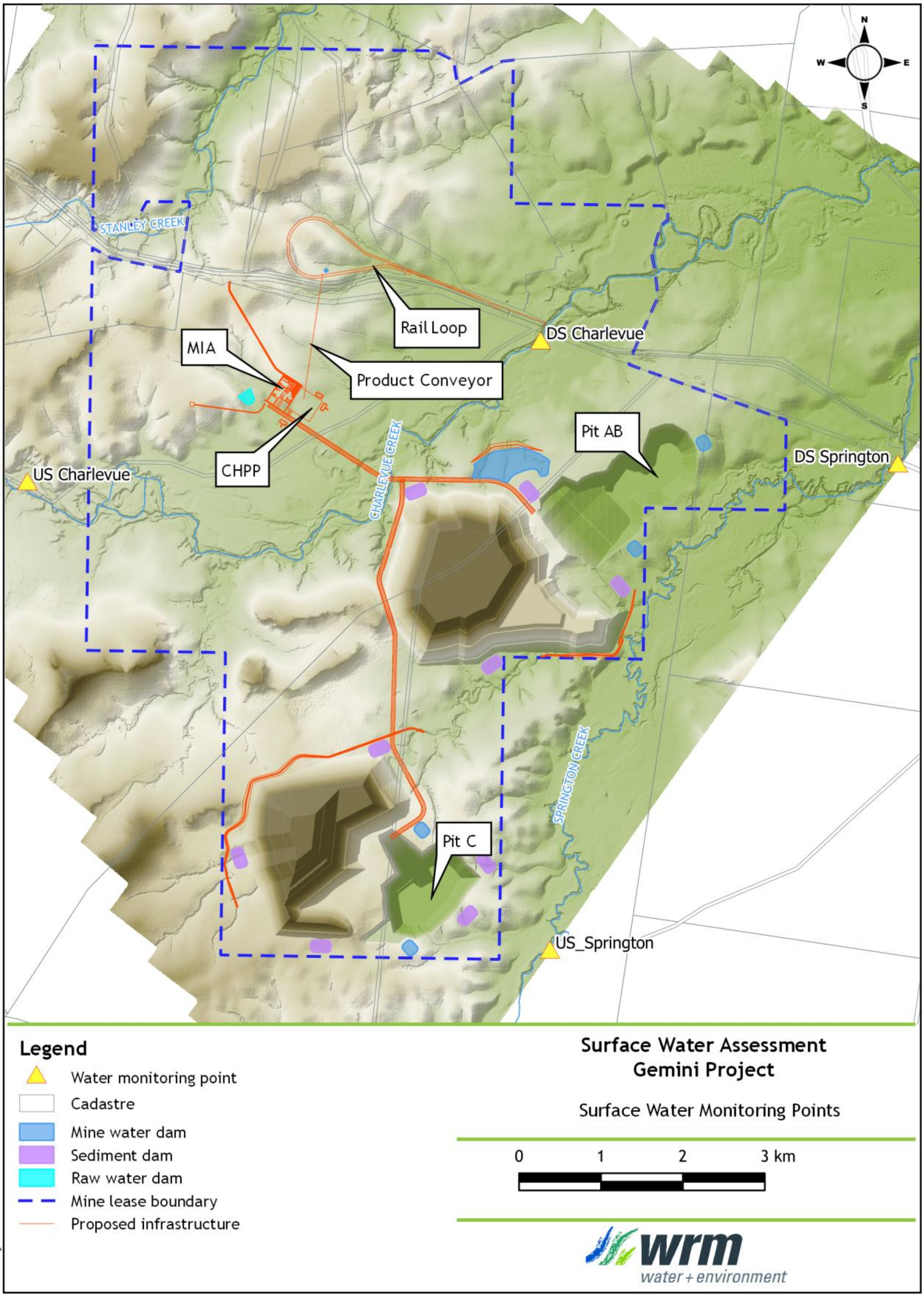


Figure 11.1 – Proposed upstream and downstream receiving water monitoring points

11.2 MINE WATER SYSTEM MONITORING

An onsite water monitoring system will also be used to validate system performance against the design assumptions in terms of water quality and water quantity, so that an adaptive management can be implemented to protect the surface water environment.

11.2.1 Mine affected water dam monitoring

Surface runoff and seepage water collected in the Mine Water Dam and Process Water Dam will be monitored for ‘standard’ water quality parameters including, but not limited to, pH, EC, major anions (sulphate, chloride and alkalinity), major cations (sodium, calcium, magnesium and potassium), TDS and a broad suite of soluble metals/metalloids.

11.2.2 Spoil and sediment dam monitoring

Validation testwork will be undertaken on potential spoil materials as the Project develops to enable appropriate spoil management measures to be planned and implemented as required.

Some spoil materials may be sodic with potential for dispersion and erosion. Where highly sodic and/or dispersive spoil is identified, this material would not be placed in final landform surfaces and would not be used in construction activities. Regardless of the spoil type, especially where engineering or geotechnical stability is required, testing would be undertaken during construction to determine the propensity of such materials to erode.

Surface runoff and seepage from spoil piles, including any rehabilitated areas, would be monitored for ‘standard’ water quality parameters including, but not limited to, pH, EC, major anions (sulfate, chloride and alkalinity), major cations (sodium, calcium, magnesium and potassium), TDS and a broad suite of soluble metals/ metalloids.

The sediment dam monitoring would be used to validate the anticipated quality of water runoff reporting to sediment dams and haul road runoff dams. Initially, the sediment dam monitoring would occur on a regular (e.g. monthly) basis to demonstrate the water quality of stored waters is consistent with the relevant operating parameters to allow releases from sediment dams to occur when required. Subject to demonstrating the water quality objectives can be met, the frequency of monitoring and suite of parameters for the sediment dam monitoring would be reviewed and updated accordingly (e.g. to occur only when releases occur).

12 References

AARC, 2019	*Gemini Project Aquatic Ecology Report* prepared for Magnetic South by aarc environmental solutions, September 2019
DEHP, 2017	*Guideline Stormwater and environmentally relevant activities Department of Environment and Heritage Protection ESR/2015/1653* • Version 1.02 • Effective: 17 FEB 2014 1.02 3-Jul-17 https://environment.des.qld.gov.au/assets/documents/regulation/pr-gl-stormwater-guideline-era.pdf
JBT, 2019	*Gemini Project- Groundwater Assessment* - JBT Consulting Pty Ltd, September 2019
RGS, 2018	*Dingo West Coal Project Geochemical Assessment of Mining Waste Materials* – Report prepared for Magnetic South Pty Ltd, 19 March 2018

Appendix A Flood impact assessment

A1 Introduction

A1.1 PROJECT OVERVIEW

The Gemini Project is a proposed open cut coal mine in the Fitzroy Basin. The proposed mine development site is located approximately 7.6 km west from the town of Dingo and 19.4 km southeast of Bluff. The two main regional centres are Emerald, 110 km west of the site and Rockhampton, 134 km east of the Project area.

The mine development schedules are expected to include two open cut pits, AB Pit and C Pit (Figure A.3). AB Pit will disturb an area of 694 ha within the mining lease application areas and C Pit will have a 465 ha disturbance area. Additional disturbance areas include sediment and mine water dams, a mine industrial area (MIA), a coal handling processing plant (CHPP), a conveyor, a dedicated rail loop, train load out (TLO) and mine roads interconnecting this infrastructure.

The proposed mine lease area is crossed by two main drainage paths flowing in a northeasterly direction. The northern stream is Charlevue Creek and the southern stream is Springton Creek, where Charlevue Creek joins the Springton Creek 5.2 km northeast of Dingo.

A1.2 SCOPE OF THIS STUDY

A1.2.1 Study objectives

This report presents the methodology and results of hydrologic and hydraulic modelling undertaken to assess the impacts of the Gemini Project on flood behaviour in the reaches of Charlevue Creek and Springton Creek crossing the Project area. The modelling results define the existing flood conditions, as well as conditions during operation of the Project. The key outcomes of the study are to:

- Define existing flood conditions across the Project area for a range of design flood events, in terms of peak water levels and peak velocities;
- Assess peak water levels and velocities along the levees proposed to protect the proposed mine areas from flooding;
- Determine the impacts of the proposed Project during project operations;
- Assess the long-term flood conditions in events up to the probable maximum floodi and the residual impacts of the Project following mine closure.

As the flood investigations detailed in this report have been specifically undertaken for the purpose of impact assessment, the results presented herein should not be used for any other purpose without seeking advice from WRM regarding their applicability.

A2 Estimation of design discharges

A2.1 METHODOLOGY

The XP-RAFTS runoff-routing model (XP Software, Version 2018.1.2) was used to estimate design discharges for the Charlevue Creek and Springton Creek catchments. In the absence of suitable stream gauge data, the peak discharges estimated by the XP-RAFTS model were validated against the Rational Method and Regional Flood Frequency Estimation (RFFE) estimates.

The validated XP-RAFTS model was used to estimate design discharges based on design rainfall and temporal pattern data developed using AR&R 2016 methodology (Ball et al, 2016). Design discharge hydrographs were estimated for the 50%, 10%, 2%, 1% and 0.1% annual exceedance probability (AEP) design discharges as well as the probable maximum flood (PMF) design discharge.

A2.2 XP-RAFTS MODEL CONFIGURATION

A2.2.1 Spatial configuration

Figure A.1 shows the XP-RAFTS model configuration adopted in the vicinity of the Project area. The hydrologic model includes both Charlevue Creek catchment and Springton Creek catchment to 4 km downstream of the confluence of Charlevue Creek and Springton Creek. The combined catchment has a total area of 680.5 km^2, consisting of 43 sub-catchments.

A2.2.2 Sub-catchment parameters

The XP-RAFTS model uses a single sub-catchment approach to determine runoff hydrographs, based on the overall sub-catchment parameters (fraction impervious, roughness and slope). Sub-catchment fraction impervious and roughness (Manning's 'n') parameters were weighted based on the various land use types in each sub-catchment based on available topographic data and aerial photographs.

Table A.9 presents the adopted sub-catchment parameters including catchment area, percentage impervious, catchment slope and PERN 'n' catchment roughness coefficients.

Model parameters for each sub-catchment were determined as follows:

- A percentage impervious of zero was adopted for all sub-catchments;
- Catchment slopes were determined based on the available topographic data;
- A sub-catchment storage coefficient multiplication factor 'Bx' of 1.0 was adopted for all events;
- Sub-catchment PERN 'n' values were determined based on the density of vegetation in each sub-catchment. The adopted sub-catchment PERN 'n' value was 0.05 for sub-catchments with largely bushland areas; and
- Initial (IL) and continuing (CL) losses for the validation events were determined based on the recommended AR&R 2016 data hub parameter. The selection of initial and continuing losses for design events is described in Section A2.6.

A2.2.3 Routing parameters

Channel routing in the XP-RAFTS model was configured based on specifying a 'K' and 'X' value for each routing link. An 'X' value of 0.25 was adopted for all routing links. The 'K' values represent estimated flow travel times (in hours) and were calculated based on the flow path lengths and an assumed conservative flow velocity of 1 m/s.

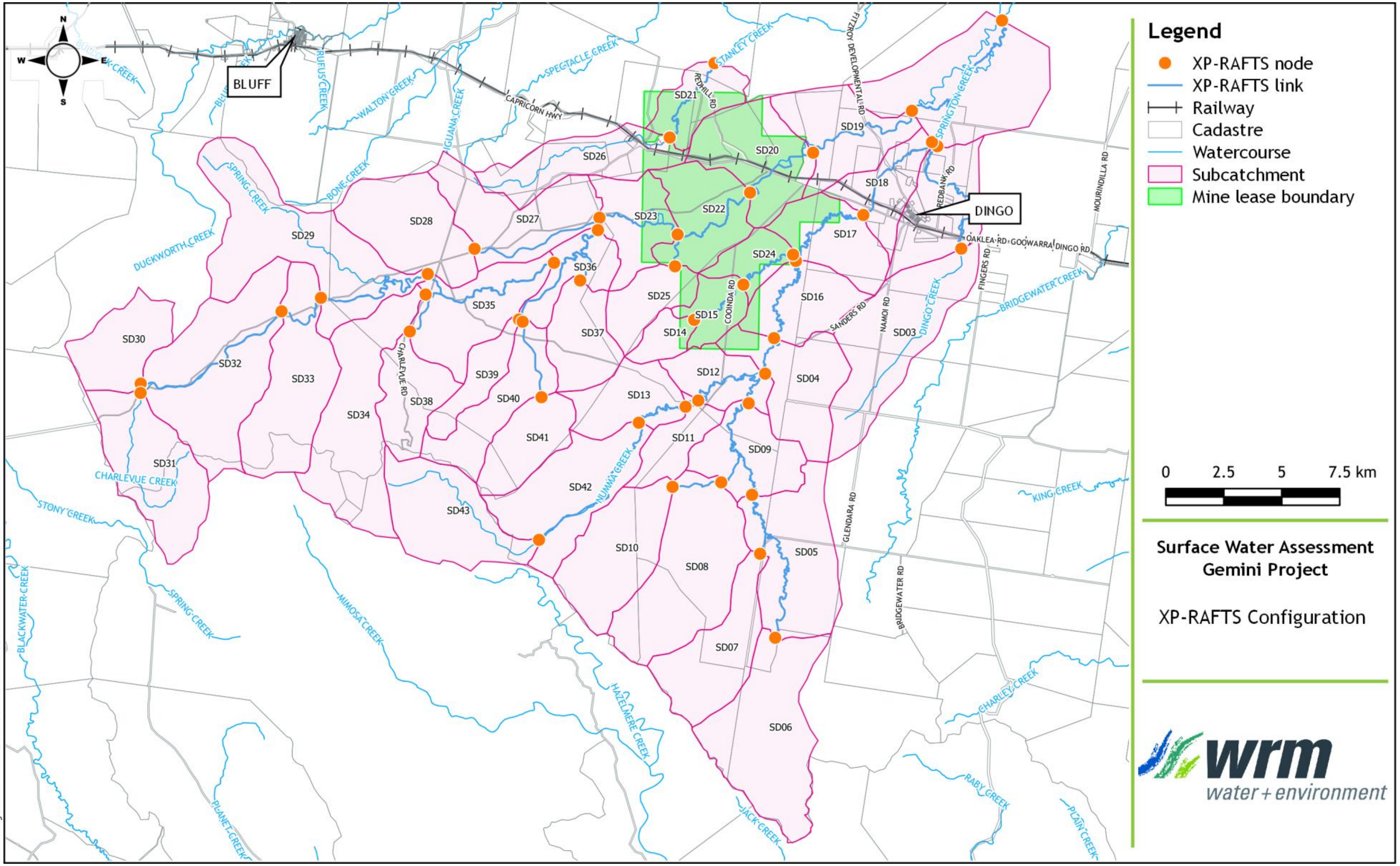


Figure A.1 – XP-RAFTS model configuration

A2.3 DESIGN RAINFALL DEPTH

A2.3.1 50% to 0.1% AEP design events

Design rainfall depths and intensities were derived using intensity-frequency duration (IFD) data obtained from the Bureau of Meteorology's (BoM's) 2016 Rainfall IFD Data System. Design rainfall IFDs were obtained based on the centroid point location at the combined Charlevue Creek and Springton Creek catchment.

A2.3.2 Probable maximum flood design event

PMP rainfall depths for durations up to 6 hours were estimated using the methodology given in *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short Duration Method (GSDM)* (BoM, 2003).

PMF rainfall depths for durations longer than 6 hours were estimated using the standard methodology given in *The Estimation of Probable Maximum Precipitation: Generalised Tropical Storm Method Revised (GTSMR)* (BoM, 2006).

The followings parameters were adopted:

- For GSDM:
    - The terrain was assumed to be 100% rough, S = 0;
    - Elevation Adjustment Factor, EAF = 1;
    - Moisture Adjustment Factor, MAF = 0.85.
- For GTSMR:
    - Located in the coastal zone;
    - Annual Moisture Adjustment Factor, AMAF = 0.75;
    - Winter Moisture Adjustment Factor, WMAF = 0.78;
    - Decay Amplitude Factor, DAF = 1.0;
    - Topographical Adjustment Factor, TAF = 1.13.

Note that aerial reduction factors are already applied to the PMP rainfalls due to the catchment area being incorporated into the PMP rainfall estimation methodology.

A2.4 AREAL REDUCTION FACTORS

The areal reduction factor was obtained from the ARR data hub and has been applied based on the combined catchment size in the model for design events up to 0.1% AEP.

A2.5 TEMPORAL PATTERNS

A2.5.1 50% to 0.1% AEP design events

Temporal patterns were obtained from the AR&R 2016 data hub based on the centroid of the combined Charlevue Creek and Springton Creek catchment. The AR&R 2016 temporal pattern methodology involves the use of an 'ensemble' of 10 temporal patterns, which produces 10 design hydrographs (and peak discharges) for each duration for each AEP. For each location and AEP, the storm duration with the highest median peak design discharge of the ensemble is selected and the temporal pattern that produces the peak design discharge just above the ensemble median is adopted.

A2.5.2 Probable maximum flood design event

The temporal patterns for storm durations up to and including 12 hours were obtained from the GSDM methodology (BoM, 2003). Temporal patterns for durations longer than 12 hours were obtained for Coastal Zone storms from the GTSMR methodology (BoM, 2006).

A2.6 DESIGN RAINFALL LOSSES

For design events up to 0.1% AEP, an initial loss (IL) of 42 mm and continuing losses (CL) of 2.0 mm/hr were adopted for this assessment based on the AR&R 2016 data hub report. An IL of 0 mm and CL of 1 mm/hr were used for PMP design event.

The incorporation of pre-burst depths specified in AR&R 2016 data hub is achieved by applying median depth values (ratio multiplied by initial loss) at an initial timestep for each event duration. Table A.1 shows the adopted median pre-burst and depth ratio values used in calculating design rainfall continuing losses.

Table A.1 – Median pre-burst depths (mm) and ratios

Duration min (hours)	50% AEP	2% AEP	1% AEP
60 (1.0)	0.4 (0.012)	5.5 (0.070)	6.5 (0.074)
90 (1.5)	0.1 (0.003)	4.1 (0.046)	6.1 (0.061)
120 (2.0)	0.0 (0.001)	5.3 (0.054)	7.7 (0.069)
180 (3.0)	0.5 (0.011)	6.8 (0.062)	9.4 (0.076)
360 (6.0)	0.0 (0.000)	14.5 (0.108)	23.4 (0.153)
720 (12.0)	0.0 (0.000)	17.4 (0.104)	27.5 (0.143)
1080 (18.0)	0.0 (0.000)	17.6 (0.092)	27.8 (0.126)
1440 (24.0)	0.0 (0.000)	12.2 (0.058)	20.8 (0.085)
2160 (36.0)	0.0 (0.000)	10.6 (0.043)	18.5 (0.065)
2880 (48.0)	0.0 (0.000)	3.1 (0.011)	5.4 (0.017)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

A2.7 MODEL VALIDATION

The peak design discharges produced by the XP-RAFTS model were validated against the Rational Method and Regional Flood Frequency Estimation (RFFE) estimates.

A2.7.1 Rational method

The Rational Method was applied to a number of sub-catchments with areas less than 25 km^2.

Table A.2 compares the Rational Method results and XP-RAFTS peak discharges estimates at 4 sub-catchment outflow locations. The time of concentration was calculated using the Modified Friend’s equation with no overland flow component.

The outflow locations used in the Rational Method calculation correspond to the XP-RAFTS nodes of SD02, SD15, SD21 and SD24. The Rational Method 1% AEP peak design discharges at these nodes are ranged between 13.8 m^3/s and 34.8 m^3/s. The estimated XP-RAFTS model discharges match the estimated Rational Method discharges well (within 10%) for sub-catchment SD15 and SD24, while the XP-RAFTS model gives a larger discharge compared to the RM estimates at sub-catchments SD02 and SD21.

Table A.2 – Comparison of Rational Method and XP-RAFTS model design discharges

Design event	Sub-catchment	Rational Method	XP-RAFTS	Difference
1% AEP	SD02	23.0	34.8	34%
	SD15	13.7	14.5	6%
	SD21	16.0	20.4	21%
	SD24	12.8	13.8	7 %

A2.7.2 RFFE estimates

The RFFE method was applied to the combined Charlevue Creek & Springton Creek catchment. Figure A.2 and Table A.3 show comparisons between RFFE estimates and XP-RAFTS model results. Design discharges obtained using XP-RAFTS match the RFFE estimates well (within +/-30%) for all design events.

The calibrated XP-RAFTS model was used to derive flood discharge hydrographs for use in the hydraulic model.

Table A.3 - Comparison of RFFE and XP-RAFTS model design discharges

AEP	Adopted XP-RAFTS design discharge (m^3/s)	RFFE discharge (m^3/s)			Difference
		Lower 5% confidence limit	Expected parameter quantile	Upper 95% confidence limit	
50%	180	57	149	391	17.1%
20%	-	137	345	877	
10%	604	199	544	1,480	10.0%
5%	-	262	798	2,420	
2%	1,061	345	1,240	4,410	-16.8%
1%	1,316	411	1,680	6,740	-27.6%

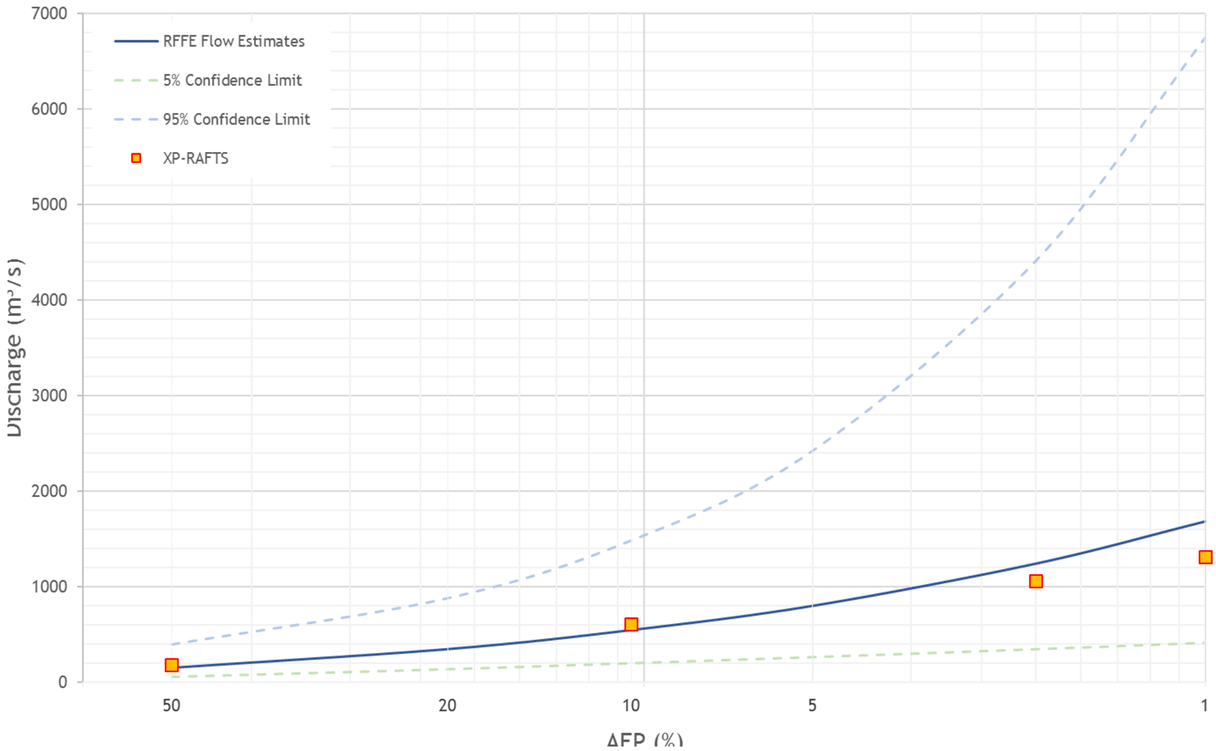


Figure A.2 – Comparison of RFFE and XP-RAFTS design discharges

A2.8 ADOPTED DESIGN DISCHARGES

Design discharges were estimated in accordance with AR&R 2016 guidelines for the 50% (1 in 2), 2% (1 in 50), 1% (1 in 100) and 0.1% (1 in 1,000) AEP events as well as the probable maximum flood (PMF) event.

Table A.4 shows XP-RAFTS predicted design peak discharges and relevant critical storm durations and temporal patterns for all modelled design events at the outlet (SD01) of the combined Charlevue Creek & Springton Creek catchment.

The design discharge hydrographs from the XP-RAFTS model were adopted as inflows to the TUFLOW hydraulic model.

Table A.4 – XP-RAFTS design discharges and critical durations at the outlet (SD01) of the combined Charlevue Creek & Springton Creek catchment

AEP	Combined Charlevue Creek & Springton Creek catchment		
	XP-RAFTS discharge (m^3/s)	Critical duration (hours)	Corresponding Temporal Pattern
50%	180	24	10
10%	604	24	10
2%	1,061	24	6
1%	1,316	24	2
0.1%	2,384	24	9
PMF	12,952	24	-

A3 Hydraulic modelling

A3.1 OVERVIEW

The TUFLOW hydrodynamic model (BMT WBM, 2016) was used to estimate flood extents and depths along the channel and floodplain of Charlevue Creek and Springton Creek and their tributaries for a range of design events. TUFLOW represents hydraulic conditions on a fixed grid by solving the full two-dimensional depth averaged momentum and continuity equations for free surface flow. The model automatically identifies breakout points and flow directions within the study area. All hydraulic modelling was undertaken using the TUFLOW Build 2018-03-AD HPC solver.

Figure A.3 shows the TUFLOW model boundary. The model covers an area of approximately 139.4 km^2 where the Project area is bounded by Charlevue Creek to the north and Springton Creek to the south.

The TUFLOW model was configured using a grid cell size of 5 metres. This provides a reasonable compromise between a coarse grid cell size sufficient for Charlevue Creek and Springton Creek, and a fine enough grid cell size required for the tributaries crossing the Project area.

A3.2 EXISTING CONDITIONS TUFLOW MODEL CONFIGURATION

A3.2.1 Topography

Topographic LiDAR survey data covering the majority of TUFLOW model area (purple region in Figure A.3) was provided by Magnetic South Pty Ltd.

Additional LiDAR data covering the area to the northeast near Dingo (green region in Figure A.3), was obtained from the Foundation Spatial Data Framework – Elevation and Depth portal (http://elevation.fsdf.org.au/) (referred to as ELVIS). The ELVIS LiDAR data is available on a 1 m grid and was acquired in 2012.

Hydrologically-enforced SRTM (Shuttle Radar Topography Mission) lidar data was used to cover an upstream portion of the Springton Creek floodplain (red region in Figure A.3). This data is available on a 30m grid, with a vertical accuracy of +/- 9.8 m. The SRTM was modified to better match the LiDAR at the boundary by lowering it by 1.8 m and applying a z-shape to smooth the transition between (geometry reinforcement in Figure A.4).

The combined data was converted into a digital elevation model (DEM) for use as the base TUFLOW model topography.

A3.2.2 Hydraulic roughness

Hydraulic roughness in the TUFLOW model is represented by Manning's 'n' roughness coefficients. Manning's 'n' values for the various land use types were selected based on typical published values. Land use types within the existing conditions model were identified using aerial photography.

Table A.5 shows the adopted Manning's 'n' values used in the model and Figure A.5 shows the locations of the Manning's 'n regions.

Table A.5 – Adopted hydraulic roughness Manning's 'n' values

Area	Manning's 'n'
Dense riparian vegetation	0.060
Creek / river channel	0.050
Pasture	0.035

A3.2.3 Inflow and outflow boundaries

Figure A.4 shows the locations of inflow and outflow boundaries in the TUFLOW model. The model includes a total of 16 inflow boundaries. The model inflow boundaries were applied within the 2D model domain using surface-area “SA” polygons. Using this approach, flows are initially applied to the lowest point within each SA polygon. Design discharge hydrographs for these inflow boundaries were obtained from the XP-RAFTS hydrologic model.

A3.2.4 Tailwater conditions

The downstream boundary was set to minimise its influence on predicted flood behaviour. Flood slopes between 0.1% and 0.15% were adopted for the Springton Creek outlet in northeast of the Project area. A 0.4% bed slope was applied for the model outlet at Stanley Creek north of the Project area.

A3.2.5 Hydraulic structures

Bridges and culverts within the Project area have been surveyed and modelled in the TUFLOW hydraulic model. Culverts are treated as 1D networks and bridges are modelled as 2D layered flow constrictions, with points snapped onto the lines to represent the road/rail elevation.

Under existing conditions, a total number of 4 culverts were modelled, two located on the east of Charlevue Creek and two located on the west of Charlevue Creek. Two bridges were modelled (Figure A.4). Both bridges are located on the Capricorn Highway, one across Springton Creek and one across Charlevue Creek. An 800 mm thick slab and 500 mm height guard rails were adopted for both bridges.

Table A.6 and Table A.7 provide summary information on the existing culverts and bridges located under Capricorn Highway and Blackwater railway line embankments included in the model.

Table A.6 - Culvert details

Name	Road/ Rail Crossing	Dimension	IL U\S (mAHD)	IL D\S (mAHD)
SM02_a	Capricorn Hwy	3 x 0.75h*1.2w RCBC	114.06	113.53
SM02_b	Blackwater Rly	12 x 1.65m RCPs	113.90	113.63
SM04_a	Capricorn Hwy	9 x 0.75h*1.2w RCBC	113.66	113.31
SM04_b	Blackwater Rly	10 x 1.38m RCPs	113.77	113.68

[a] - RCP = reinforced concrete pipe, RCBC = concrete box culvert

Table A.7 - Bridge details

Name	Road/Rail Crossing	U/S Invert (mAHD)	D/S invert (mAHD)
BRD01	Capricorn Hwy/ Springton Creek	106.85	106.90
BRD03	Capricorn Hwy/ Charlevue Creek	114.90	114.90

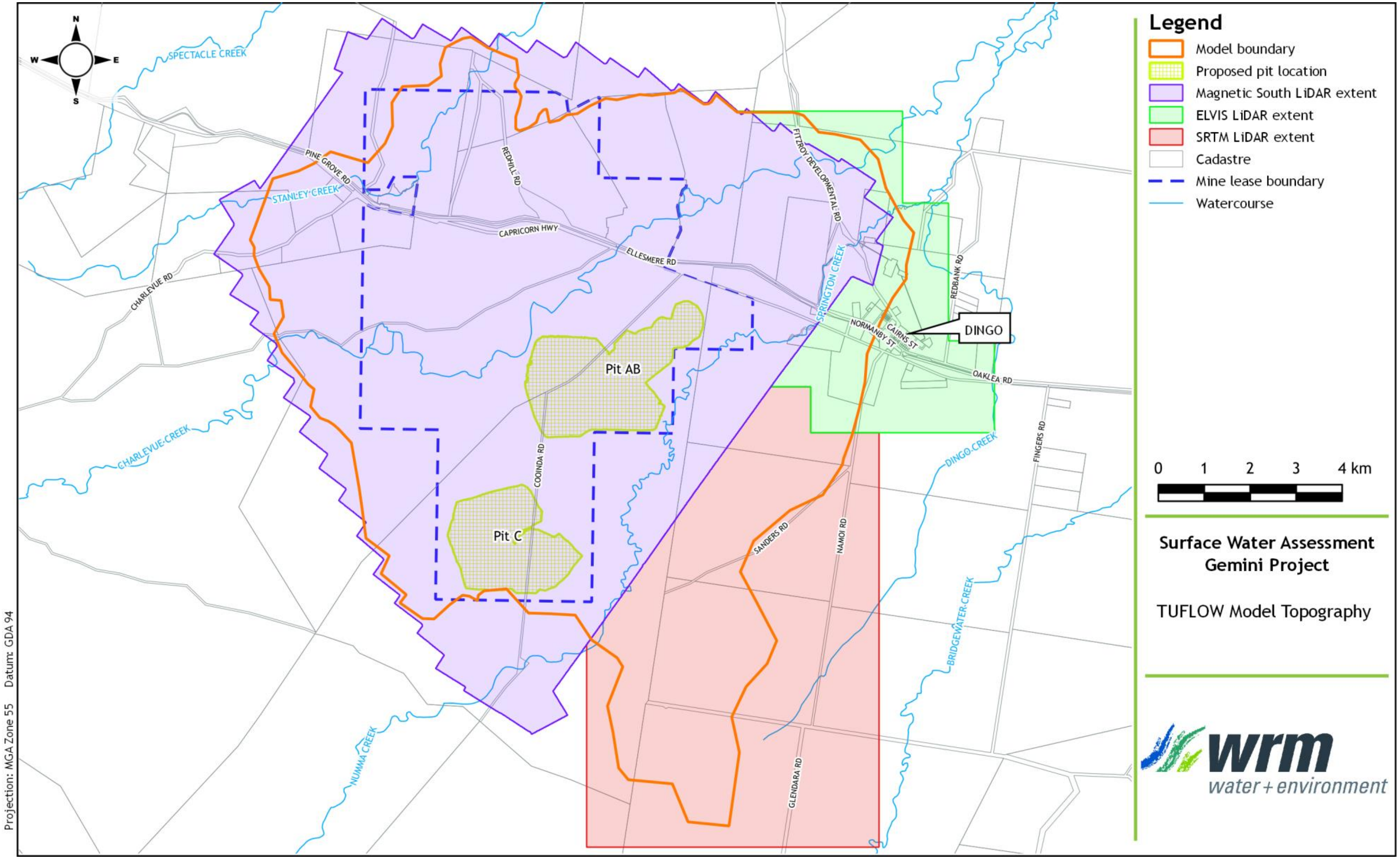


Figure A.3 – TUFLOW model topography

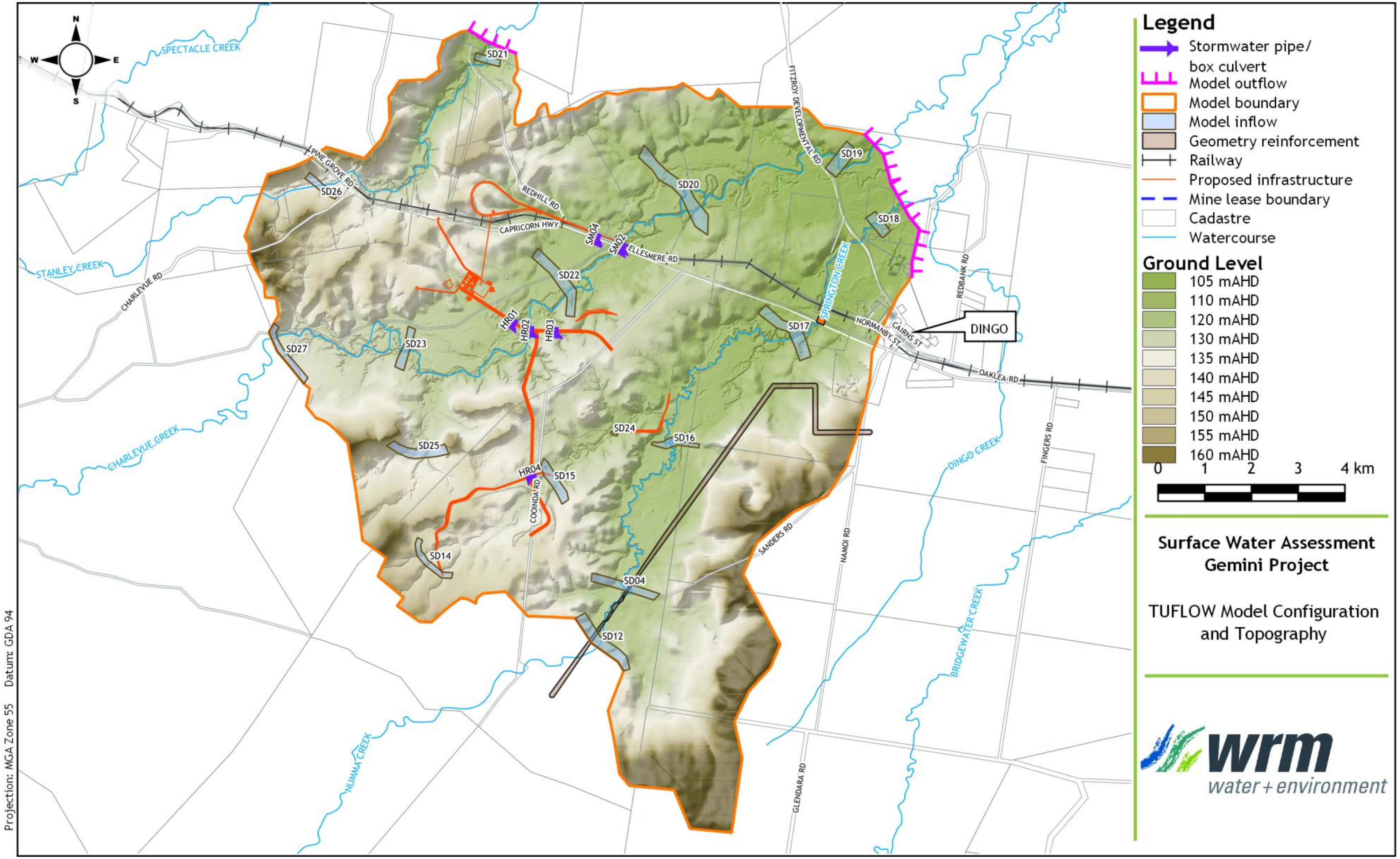


Figure A.4 – TUFLOW model configuration

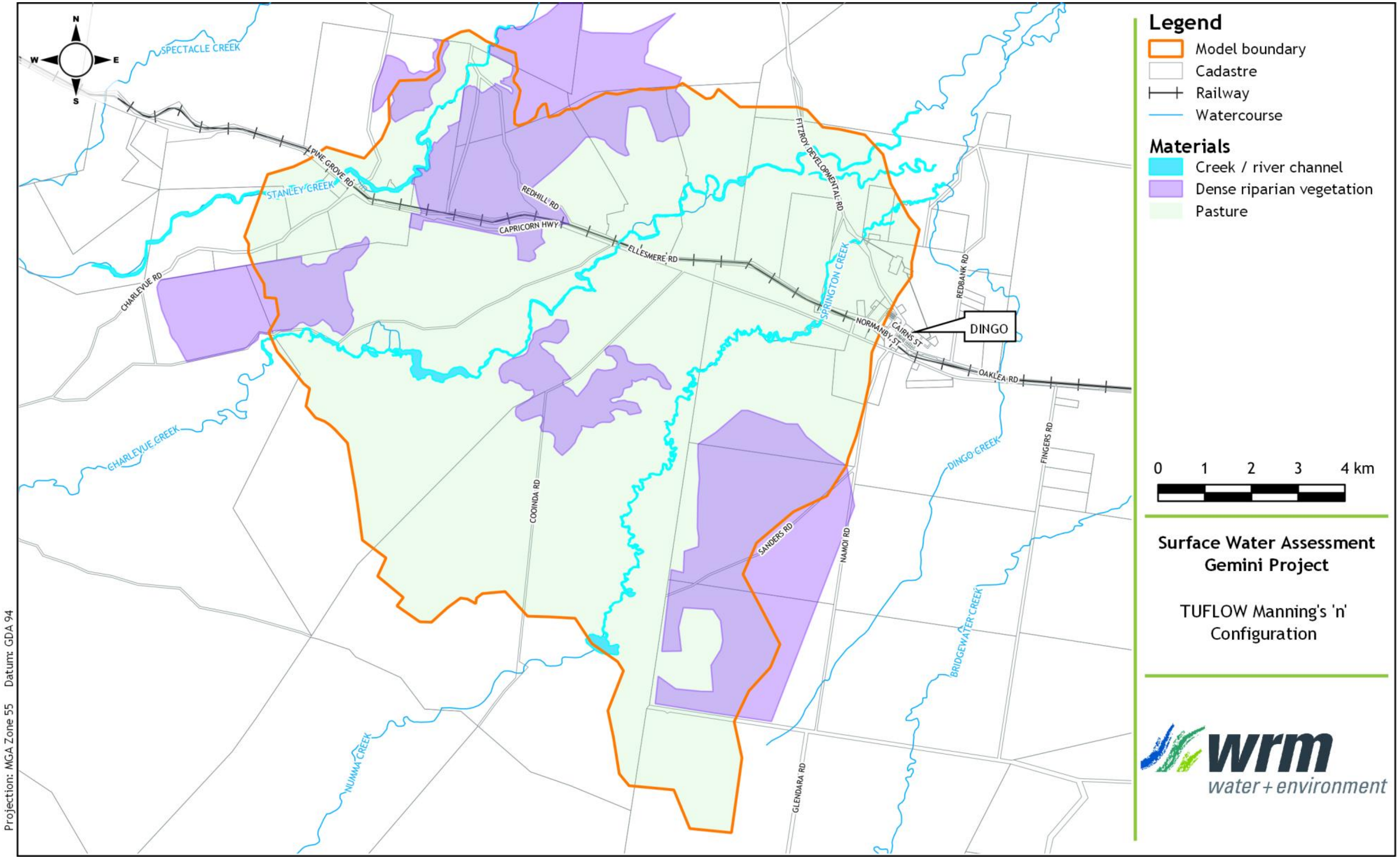


Figure A.5 – Manning's 'n' configuration

A3.3 DEVELOPED CONDITIONS TUFLOW MODEL

A3.3.1 Topography

A number of changes were made to the model DEM to reflect changes associated with:

- proposed overburden dumps and pit protection levees;
- haul roads connecting the two mining pits to the MIA and CHPP;
- diversion channels for the minor tributary of Springton Creek crossing the mine area.

The locations of these proposed structures are shown in Figure A.4.

A3.3.2 Hydraulic roughness

Land use types within the developed conditions model were identical to those defined for the existing conditions model.

A3.3.3 Inflow and outflow conditions

No changes to the existing conditions inflow and outflow locations were made.

A3.3.4 Hydraulic structures

Additional culverts under the proposed haul roads were added in the developed conditions. Details of the proposed Project culvert configurations are provided in Table A.8.

Table A.8 – Proposed new culverts in Project area

Name	Road/ Rail Crossing	Dimension	IL U\S (mAHD)	IL D\S (mAHD)
HR01	Haul Road (North)	3 x 0.9m RCPs	118.34	117.84
HR02	Haul Road (North)	3 x 2.1m RCPs	114.97	114.60
HR03	Haul Road (North)	2 x 0.9m RCPs	122.69	122.20
HR04	Haul Road (South)	3 x 0.9m RCPs	126.70	126.28

A3.3.5 Diversion channels

Earthworks models of the preliminary diversion channel designs were provided by TMM group and included in the model. The transitions between the diversion channels and the adjacent landforms were modified slightly to improve hydraulic performance.

A3.4 TUFLOW MODELLING RESULTS

Flood maps showing design peak flood depths and water level contours for the 1% AEP event under existing conditions and developed conditions are shown in Section A8.

Flood maps showing design peak flood velocities for the 1% AEP under existing and developed conditions are shown in Figure A.13 to Figure A.16 and Figure A.17 to Figure A.19 respectively.

Maps showing the water level difference between developed and existing conditions are shown in Figure A.20 to Figure A.21.

Flood mapping for a range of other design events (50% AEP,2% AEP, 0.1% AEP, and PMF) are provided in Section A8.

A4 Summary of findings

The purpose of this flood study was to:

- Define existing flood conditions across the Project area for a range of design events, in terms of peak water level, peak velocity, and water depth;
- Assess peak water levels and velocities along the levees proposed to protect the proposed works from flooding;
- Determine design flood conditions at the proposed haul road crossing, to assist in the preliminary design of cross-drainage infrastructure;
- Determine design flood conditions at the proposed railway crossing and to determine the potential for impacts on flood conditions;
- Assess the hydraulic conditions in the channels proposed to divert runoff in the unnamed Springton Creek tributary around both mining areas;
- Determine the residual impacts of the proposed Project during project operations.

An XP-RAFTS hydrologic model was developed to estimate design discharge hydrographs for the catchments of Charlevue Creek and Springton Creek which cross the Project area. In the absence of gauged streamflow data, the resulting peak discharges were validated against peak discharges estimated using the Rational Method and RFFE.

The model was used to estimate design discharges for the 50%, 10%, 2%, 1%, and 0.1% AEP events as well as the PMF design event in accordance with the AR&R 2016 approach using an ensemble of design temporal patterns.

- The 0.1% AEP design flood event was used in the design of flood levees;
- The 2% AEP and 1% AEP design events are of interest when assessing the impacts on road, rail and other off-site infrastructure;
- The PMF event was used in the risk analysis for the proposed final void location.

A TUFLOW hydraulic model was also developed to determine existing and developed conditions flood behaviour in Charlevue Creek, Springton Creek, and its unnamed tributary crossing the mine area. The adopted grid cell size was five metres, and the inflow boundaries were represented using design discharge hydrographs estimated using the XP-RAFTS runoff-routing model. The model incorporated the proposed works, including the haul roads, levees and diversion channels.

The outcomes of the study are as follows:

- The Project will temporarily increase Charlevue Creek flood levels in the immediate vicinity of the proposed haul road crossing. These impacts are contained within the mine lease area.
- There will be no impact on flood levels in Charlevue Creek or Springton Creek at the existing Capricorn Highway, Blackwater Rail corridor, or downstream of the Project area.
- While the unnamed tributary of Springton Creek is not a watercourse as defined under the Water Act, the diversion channel will be designed taking into consideration the principles set out in the Guideline: "Works that interfere with water in a watercourse - watercourse diversions" (DNRM, September 2014). This document sets out key design principles and requirements for the functional designs of permanent diversions. It includes guidance on watercourse diversion design and operation including maintenance, monitoring and revegetation. Preliminary designs are shown in Figure 7.3 to Figure 7.8 which also show the post development flood conditions with diversions and levees in place.

- The works at AB Pit will locally increase flood levels in Springton Creek by up to 0.22 m in the 1% AEP flood. These impacts would extend off the lease area onto land owned by Magnetic South Pty Ltd, and reduce with distance downstream of the boundary.
- There will be localised off-lease impacts on flood levels in the unnamed tributary of Springton Creek immediately upstream of AB Pit and C Pit.

A5 References

Ball et al, 2016	Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I (Editors), 2016, *Australian Rainfall and Runoff: A Guide to Flood Estimation*, Commonwealth of Australia
BMT WBM, 2016	*'TUFLOW User Manual'*, GIS Based 2D/1D Hydrodynamic Modelling, Build 2016-10-AA, BMT WBM, 2016.
BOM, 2003	Bureau of Meteorology, *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short Duration Method (GSDM), 2003,* Commonwealth of Australia
BOM, 2006	Bureau of Meteorology, *The Estimation of Probable Maximum Precipitation: Generalised Tropical Storm Method Revised (GTSMR)*, 2006, Commonwealth of Australia
Chow, 1959	*Open-Channel Hydraulics,* McGraw-Hill Inc., Singapore, 1959
XP-Software, 2018	XP-Software, 2018, *XP-RAFTS*, Florida, USA.

A6 Model parameters

A6.1 XP-RAFTS SUB-CATCHMENT PARAMETERS

Table A.9 – Adopted XP-RAFTS sub-catchment parameters

Sub-catchment ID	Area (km^2)	Percentage impervious (%)	Catchment slope (%)	Catchment PERN 'n'
SD01	0.29	0	0.11	0.05
SD02	0.15	0	0.34	0.05
SD03	0.26	0	0.29	0.05
SD04	0.17	0	0.07	0.05
SD05	0.23	0	0.23	0.05
SD06	0.28	0	1.12	0.05
SD07	0.17	0	0.98	0.05
SD08	0.28	0	0.54	0.05
SD09	0.14	0	0.18	0.05
SD10	0.19	0	0.82	0.05
SD11	0.07	0	0.40	0.05
SD12	0.09	0	0.17	0.05
SD13	0.11	0	0.37	0.05
SD14	0.04	0	0.49	0.05
SD15	0.06	0	0.32	0.05
SD16	0.13	0	0.09	0.05
SD17	0.13	0	0.01	0.05
SD18	0.10	0	0.15	0.05
SD19	0.16	0	0.14	0.05
SD20	0.17	0	0.16	0.05
SD21	0.09	0	0.31	0.05
SD22	0.14	0	0.15	0.05
SD23	0.11	0	0.18	0.05
SD24	0.06	0	0.29	0.05
SD25	0.09	0	0.31	0.05
SD26	0.15	0	0.40	0.05
SD27	0.19	0	0.33	0.05
SD28	0.19	0	0.39	0.05
SD29	0.24	0	0.82	0.05
SD30	0.12	0	2.22	0.05
SD31	0.21	0	3.91	0.05
SD32	0.32	0	0.92	0.05
SD33	0.22	0	1.93	0.05
SD34	0.27	0	2.78	0.05
SD35	0.17	0	0.30	0.05
SD36	0.08	0	0.16	0.05
SD37	0.11	0	0.47	0.05
SD38	0.11	0	3.51	0.05
SD39	0.07	0	1.01	0.05
SD40	0.13	0	1.21	0.05
SD41	0.11	0	1.21	0.05
SD42	0.21	0	0.78	0.05
SD42	0.20	0	7.33	0.05

A7 Rational Method calculations

Table A.10 – Springton Creek estimated discharges SD15

Catchment:	**SD15**

Catchment area and coefficient of runoff	
Catchment Area (ha)	612.63
C_{10}	0.40

Channel Characteristics	
Channel length (m)	4009
Channel slope (m/m)	0.003
Manning's 'n'	0.050
Channel bottom width (m)	10.00
Channel side slope (m/m)	0.250

Design Discharges						
ARI (years)	AEP (%)	Frequency Factor F_y	C_y	t_c[a] (mins)	Rainfall Intensity (mm/h)	Peak Discharge (m^3/s)
1	63	0.80	0.32	154.0	16.4	8.93
1.44	50	0.85	0.34	153.3	16.5	9.53
4.48	20	0.95	0.38	151.9	16.6	10.7
10	10	1.00	0.40	151.2	16.6	11.3
20	5	1.05	0.42	150.6	16.7	11.9
50	2	1.15	0.46	149.5	16.8	13.1
100	1	1.20	0.48	149.0	16.8	13.7

a - Time of Concentration (t_c) is calculated using Modified Friend's equation

Table A.11 – Springton Creek estimated discharges SD02

Catchment:	**SD02**

Catchment area and coefficient of runoff	
Catchment Area (ha)	1513.00
C_{10}	0.40

Channel Characteristics	
Channel length (m)	7564
Channel slope (m/m)	0.003
Manning's 'n'	0.050
Channel bottom width (m)	10.00
Channel side slope (m/m)	0.250

Design Discharges

ARI (years)	AEP (%)	Frequency Factor F_y	C_y	t_c[a] (mins)	Rainfall Intensity (mm/h)	Peak Discharge (m^3/s)
1	63	0.80	0.32	255.3	11.1	15.0
1.44	50	0.85	0.34	254.0	11.2	16.0
4.48	20	0.95	0.38	251.8	11.3	18.0
10	10	1.00	0.40	250.8	11.3	19.0
20	5	1.05	0.42	249.9	11.3	20.0
50	2	1.15	0.46	248.2	11.4	22.0
100	1	1.20	0.48	247.3	11.4	23.0

a - Time of Concentration (t_c) is calculated using Modified Friend's equation

Table A.12 – Springton Creek estimated discharges SD21

Catchment:	**SD21**

Catchment area and coefficient of runoff	
Catchment Area (ha)	869.00
C_{10}	0.40

Channel Characteristics	
Channel length (m)	5434
Channel slope (m/m)	0.003
Manning's 'n'	0.050
Channel bottom width (m)	10.00
Channel side slope (m/m)	0.250

Design Discharges

ARI (years)	AEP (%)	Frequency Factor F_y	C_y	t_c [a] (mins)	Rainfall Intensity (mm/h)	Peak Discharge (m^3/s)
1	63	0.80	0.32	199.3	13.5	10.4
1.44	50	0.85	0.34	198.3	13.5	11.1
4.48	20	0.95	0.38	196.5	13.6	12.5
10	10	1.00	0.40	195.7	13.7	13.2
20	5	1.05	0.42	194.9	13.7	13.9
50	2	1.15	0.46	193.5	13.8	15.3
100	1	1.20	0.48	192.9	13.8	16.0

a - Time of Concentration (t_c) is calculated using Modified Friend's equation

Table A.13 – Springton Creek estimated discharges SD24

Catchment:	**SD24**

Catchment area and coefficient of runoff	
Catchment Area (ha)	584.76
C_{10}	0.40

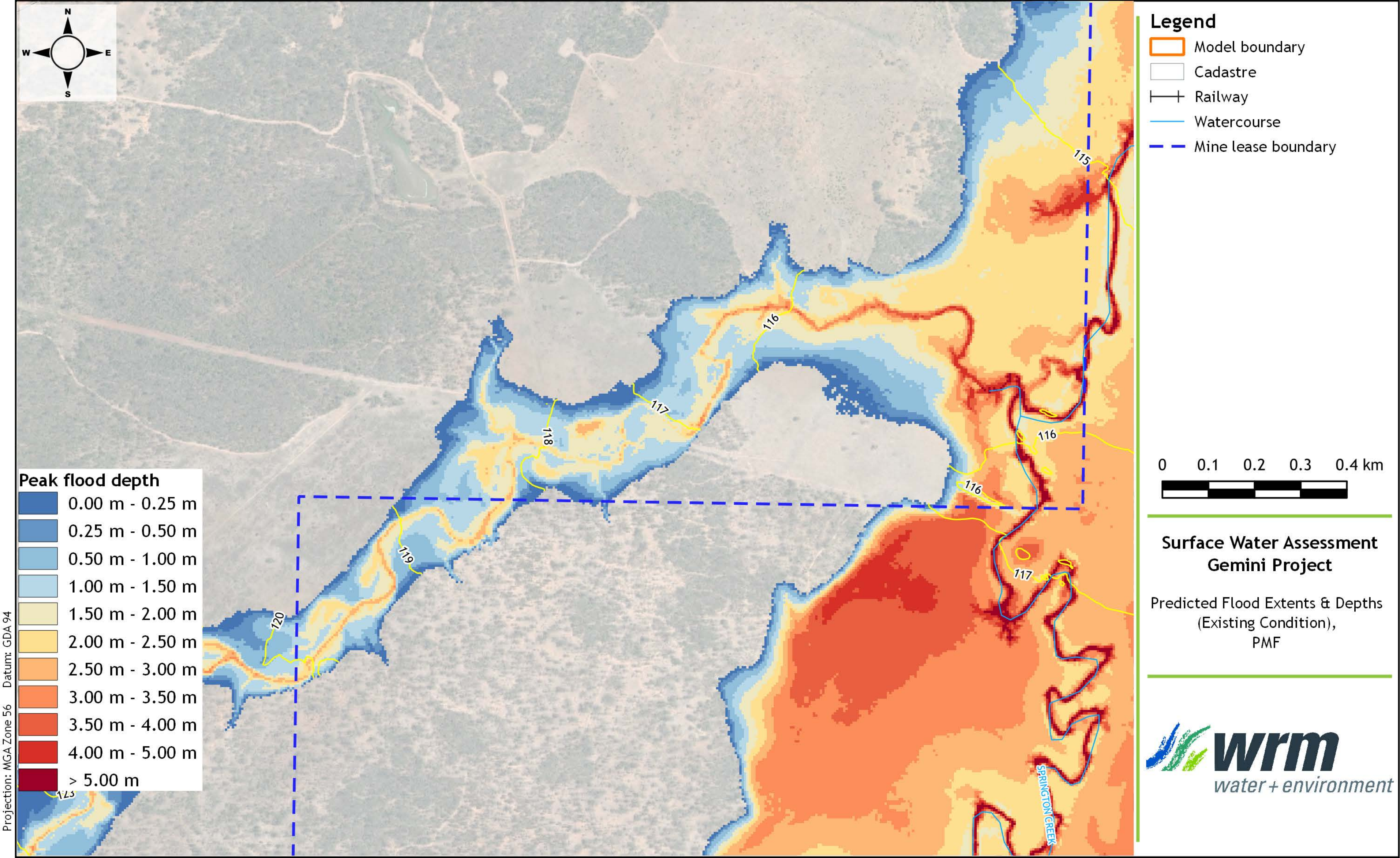
Channel Characteristics	
Channel length (m)	4092
Channel slope (m/m)	0.003
Manning's 'n'	0.050
Channel bottom width (m)	10.00
Channel side slope (m/m)	0.250

Design Discharges

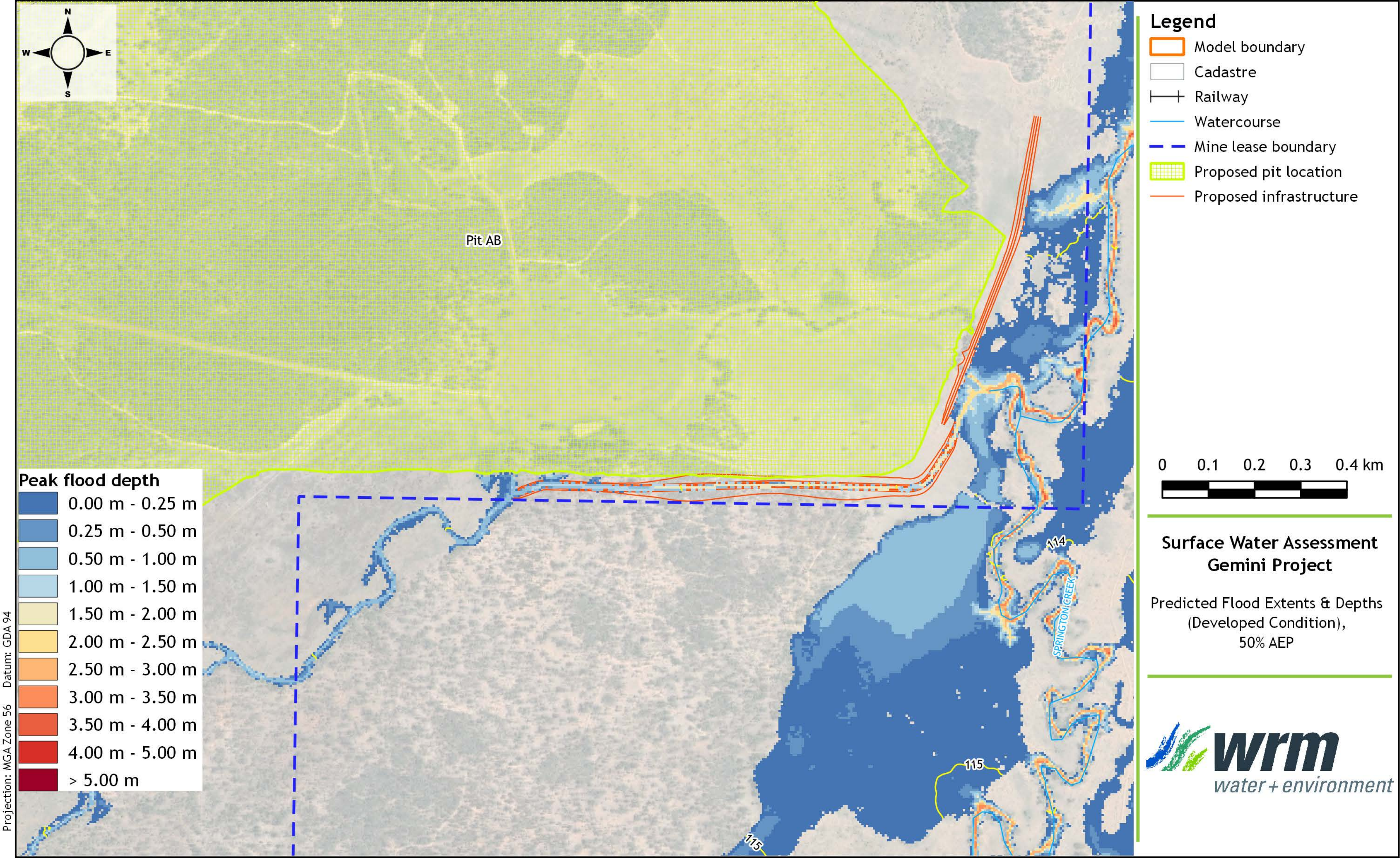
ARI (years)	AEP (%)	Frequency Factor F_y	C_y	t_c [a] (mins)	Rainfall Intensity (mm/h)	Peak Discharge (m^3/s)
1	63	0.80	0.32	158.8	16.0	8.33
1.44	50	0.85	0.34	158.0	16.1	8.89
4.48	20	0.95	0.38	156.6	16.2	10.0
10	10	1.00	0.40	155.9	16.3	10.6
20	5	1.05	0.42	155.3	16.3	11.1
50	2	1.15	0.46	154.2	16.4	12.2
100	1	1.20	0.48	153.7	16.4	12.8

a - Time of Concentration (t_c) is calculated using Modified Friend's equation

A8 Flood maps

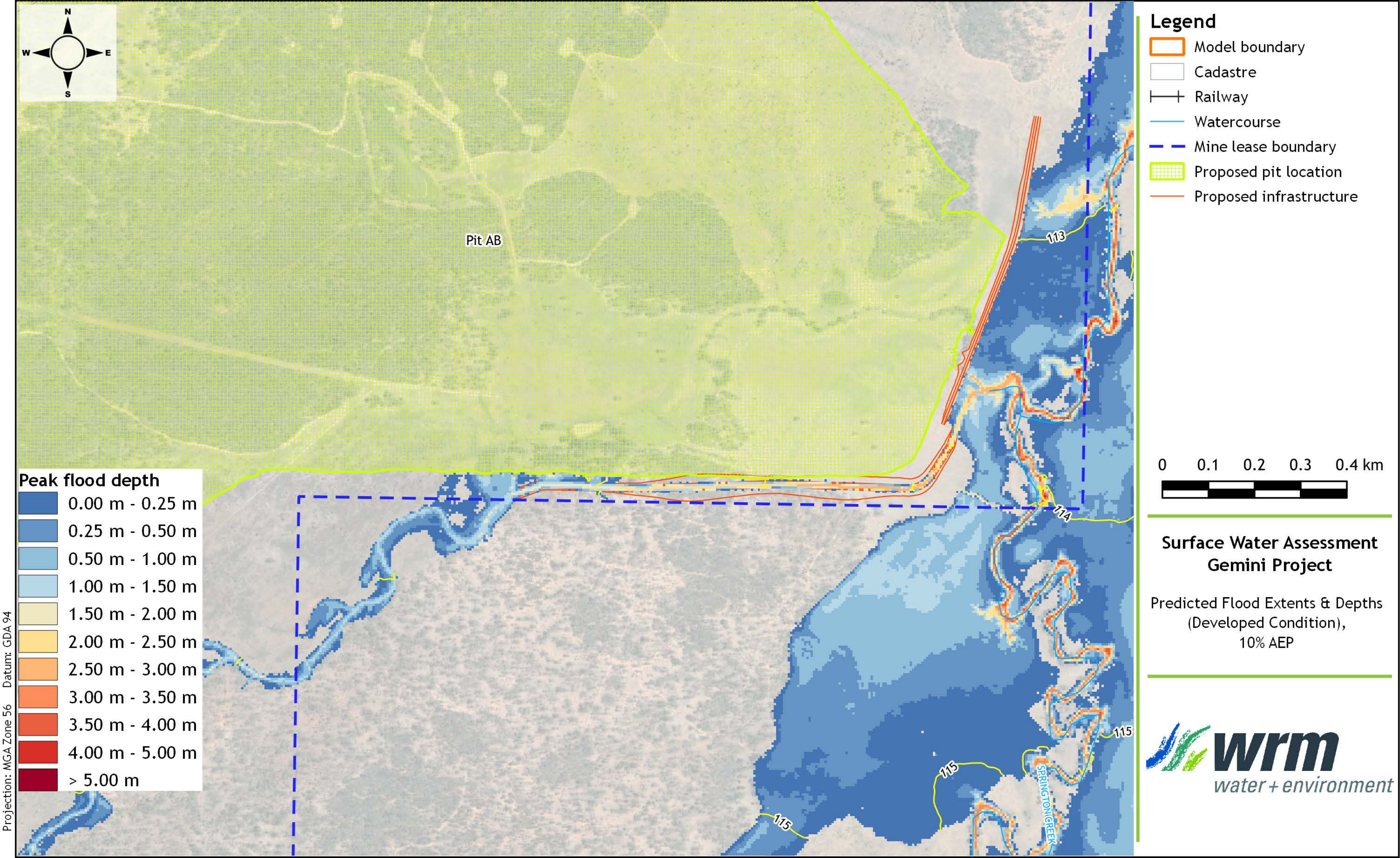


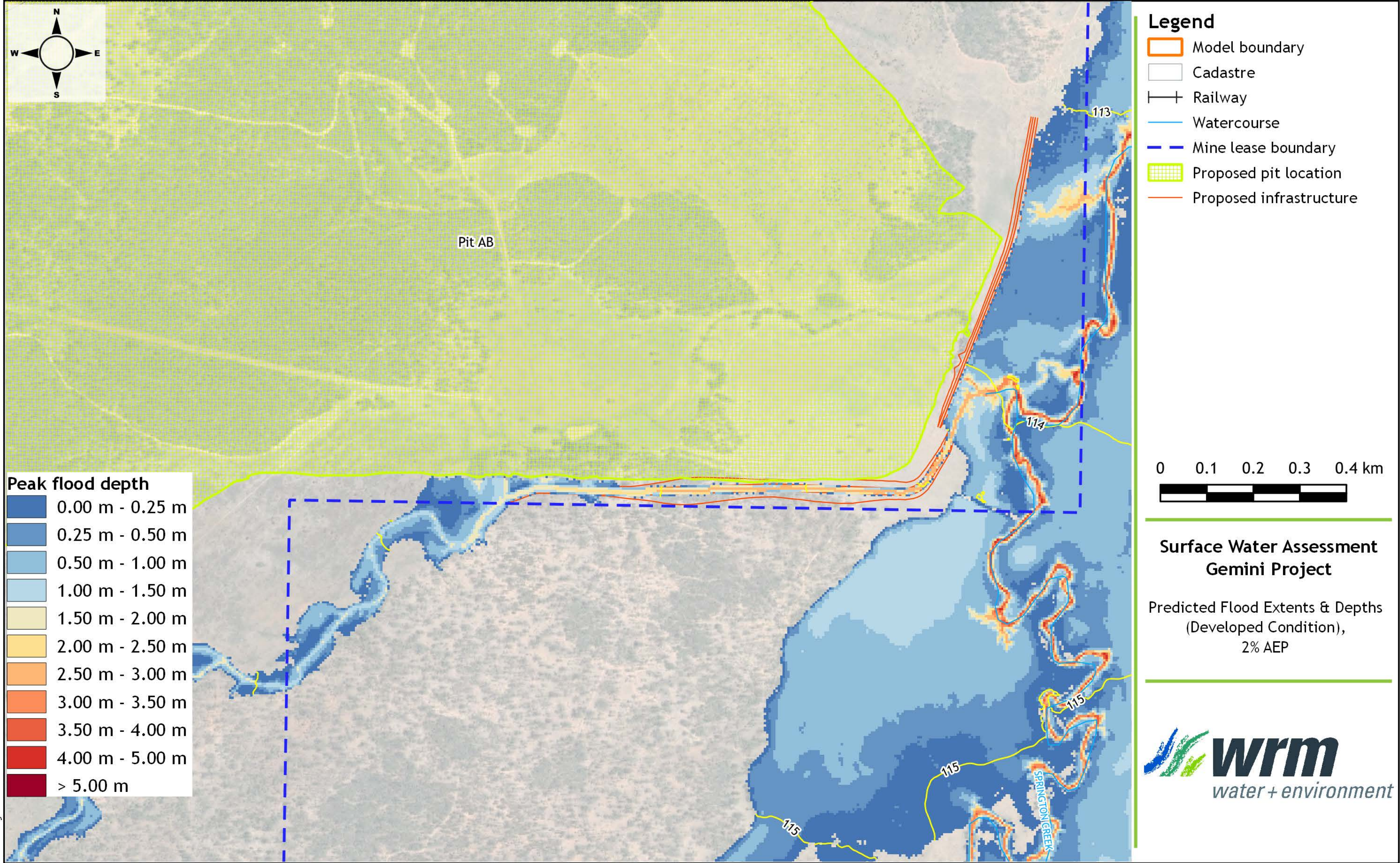
N
W
E
S
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Peak flood depth
0.00 m - 0.25 m
0.25 m - 0.50 m
0.50 m - 1.00 m
1.00 m - 1.50 m
1.50 m - 2.00 m
2.00 m - 2.50 m
2.50 m - 3.00 m
3.00 m - 3.50 m
3.50 m - 4.00 m
4.00 m - 5.00 m
> 5.00 m
115
116
117
118
119
120
123
SPRINGTON CREEK
0 0.1 0.2 0.3 0.4 km
Projection: MGA Zone 56 Datum: GDA 94
Surface Water Assessment
Gemini Project
Predicted Flood Extents & Depths
(Existing Condition),
PMF
wrm
water + environment



Surface Water Assessment Gemini Project

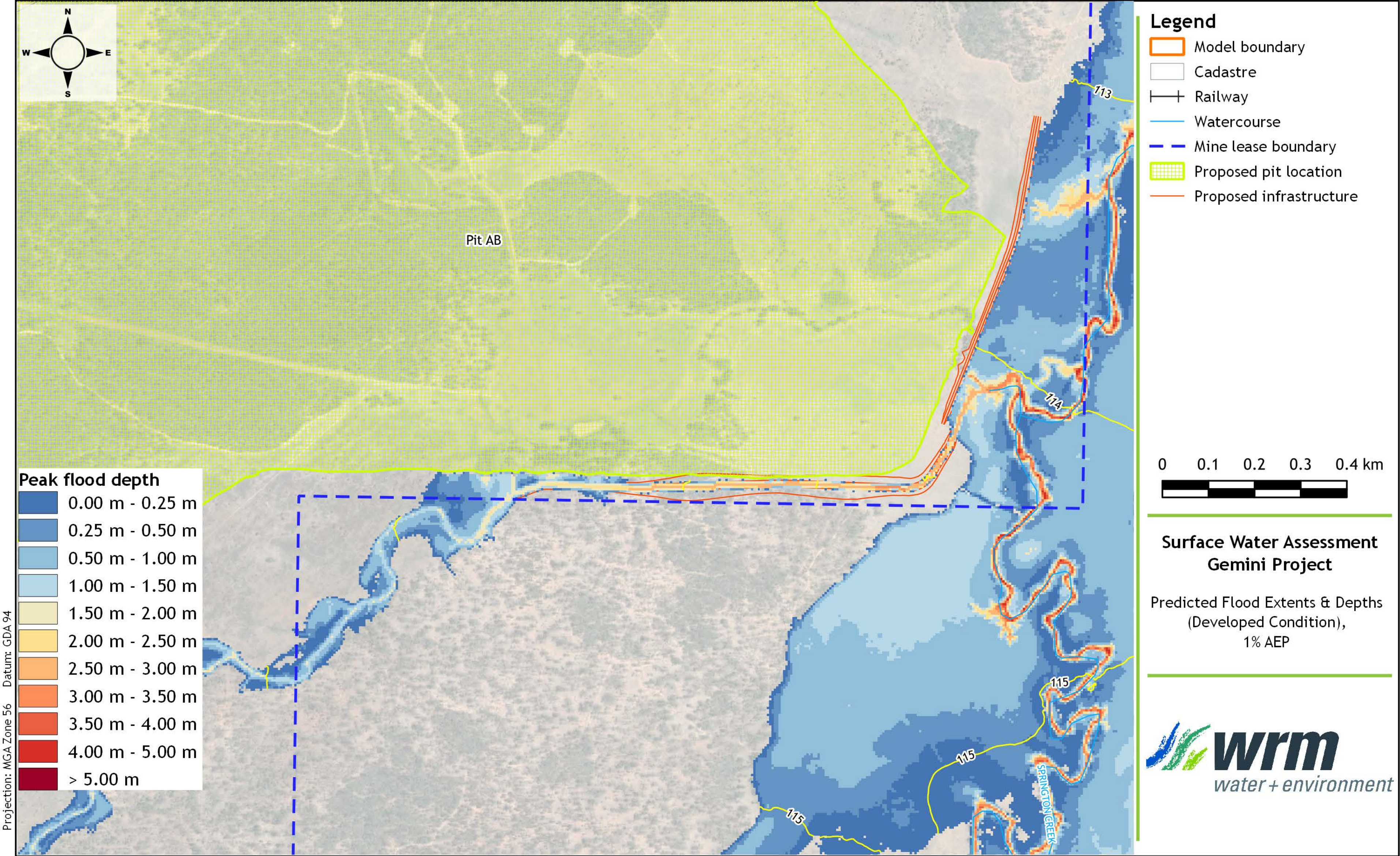
Predicted Flood Extents & Depths (Developed Condition), 50% AEP


N
W
E
S
Pit AB
113
114
115
115
115
SPRINGTON CREEK
Peak flood depth
0.00 m - 0.25 m
0.25 m - 0.50 m
0.50 m - 1.00 m
1.00 m - 1.50 m
1.50 m - 2.00 m
2.00 m - 2.50 m
2.50 m - 3.00 m
3.00 m - 3.50 m
3.50 m - 4.00 m
4.00 m - 5.00 m
> 5.00 m
Projection: MGA Zone 56 Datum: GDA 94
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
0 0.1 0.2 0.3 0.4 km
Surface Water Assessment
Gemini Project
Predicted Flood Extents & Depths
(Developed Condition),
10% AEP
wrm
water + environment



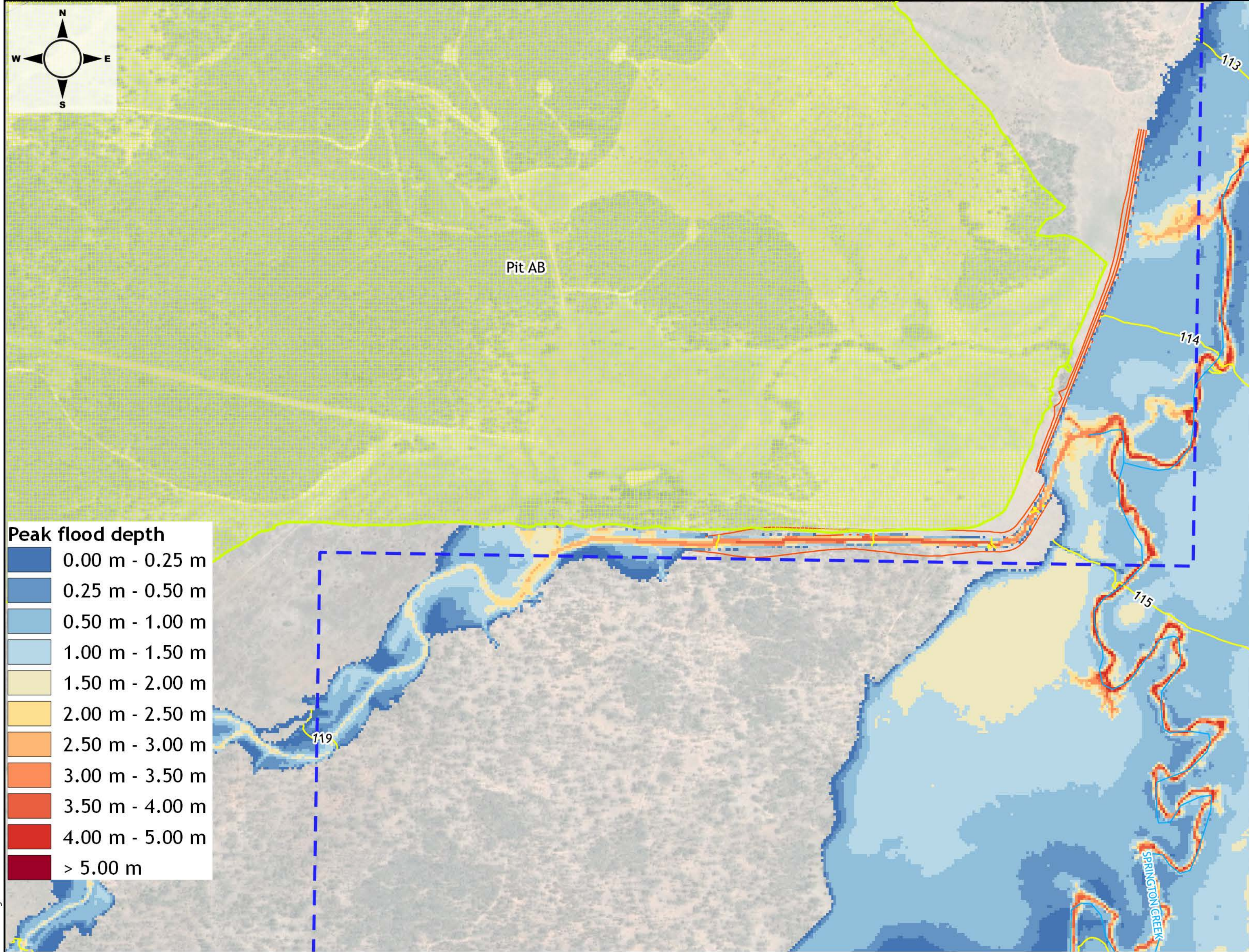
Surface Water Assessment
Gemini Project

Predicted Flood Extents & Depths (Developed Condition), 2% AEP



Surface Water Assessment
Gemini Project

Predicted Flood Extents & Depths (Developed Condition), 1% AEP



Projection: MGA Zone 56 Datum: GDA 94

Legend

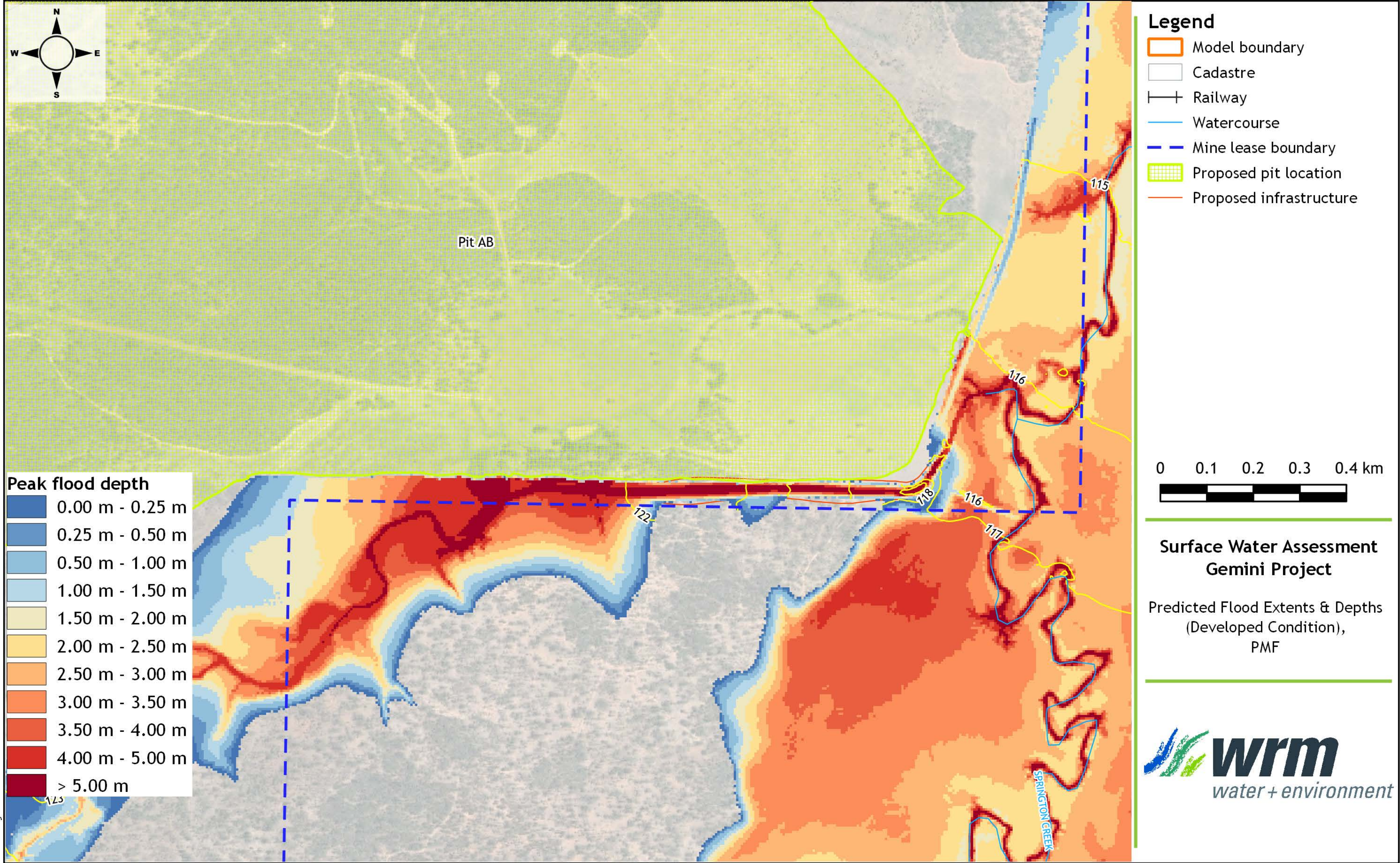
- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary
- Proposed pit location
- Proposed infrastructure

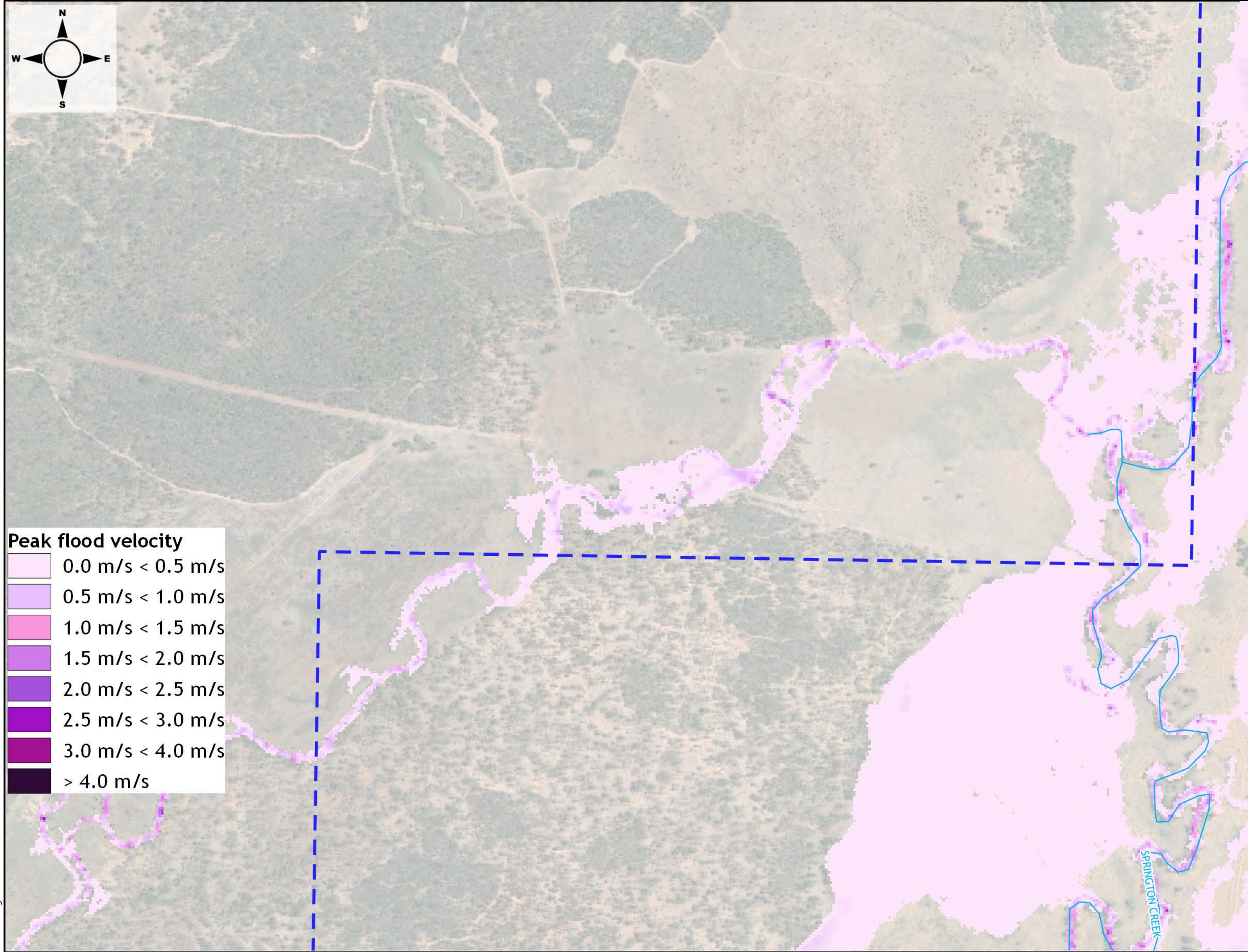
0 0.1 0.2 0.3 0.4 km

Surface Water Assessment
Gemini Project

Predicted Flood Extents & Depths (Developed Condition), 0.1% AEP

wrm water + environment

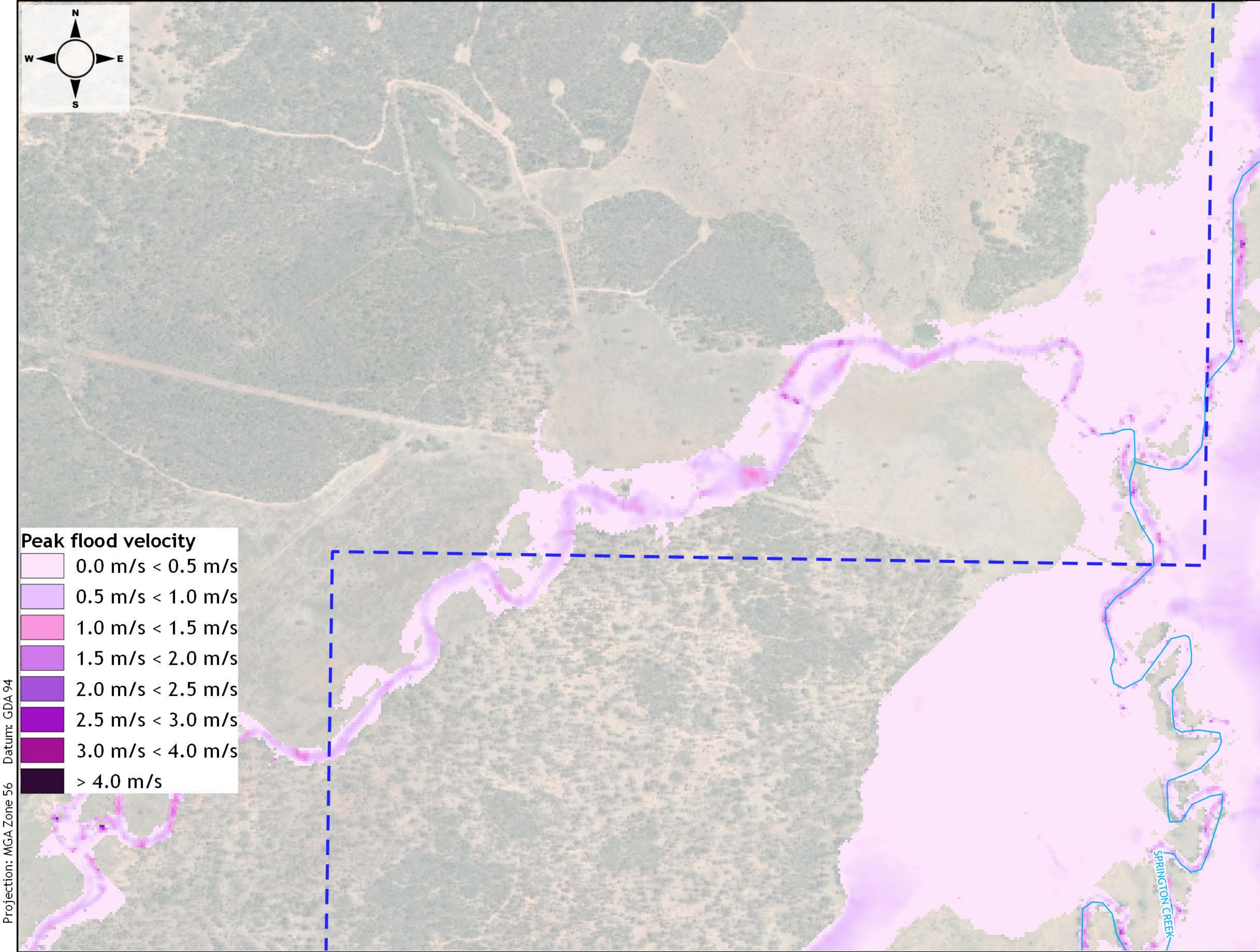

N
S
E
W
Pit AB
115
116
116
117
118
122
123
SPRINGTON CREEK
Peak flood depth
0.00 m - 0.25 m
0.25 m - 0.50 m
0.50 m - 1.00 m
1.00 m - 1.50 m
1.50 m - 2.00 m
2.00 m - 2.50 m
2.50 m - 3.00 m
3.00 m - 3.50 m
3.50 m - 4.00 m
4.00 m - 5.00 m
> 5.00 m
Projection: MGA Zone 56 Datum: GDA 94
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
0 0.1 0.2 0.3 0.4 km
Surface Water Assessment
Gemini Project
Predicted Flood Extents & Depths
(Developed Condition),
PMF
wrm
water + environment



Surface Water Assessment Gemini Project

Predicted Flood Velocity (Existing Condition), 50% AEP

wrm water + environment



Legend

Model boundary

Cadastre

Railway

Watercourse

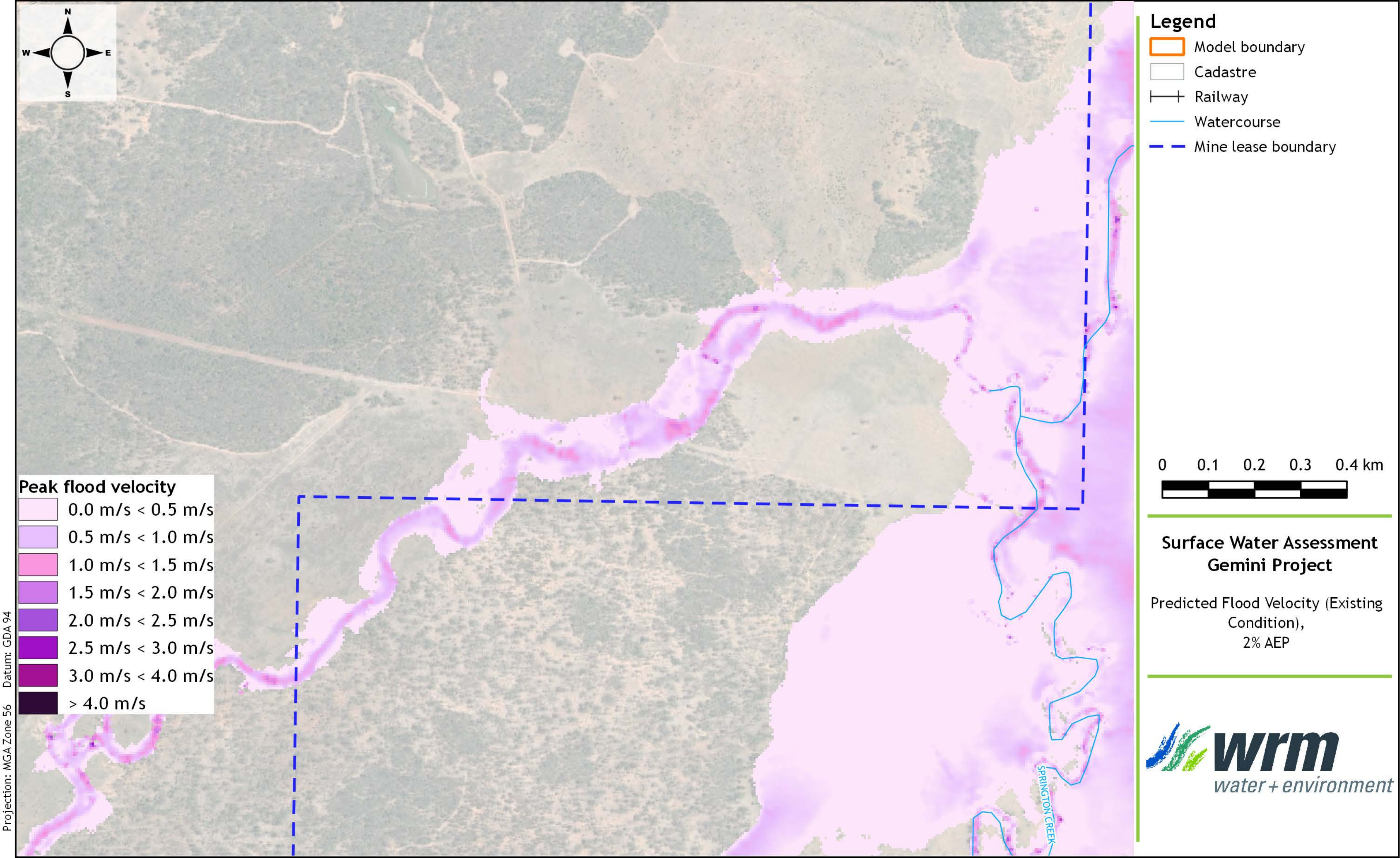
Mine lease boundary

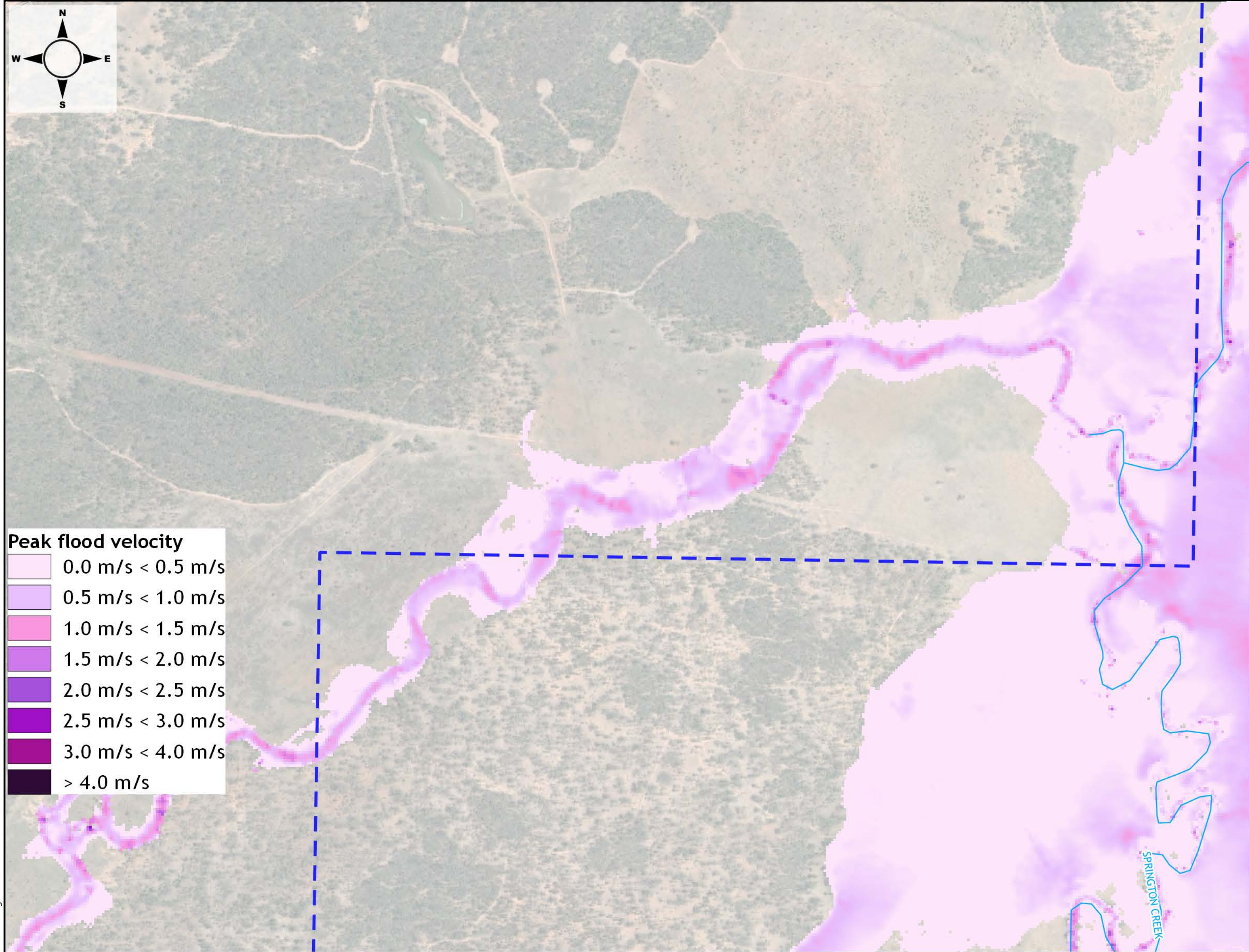
0 0.1 0.2 0.3 0.4 km

Surface Water Assessment
Gemini Project

Predicted Flood Velocity (Existing Condition),
10% AEP

wrm
water + environment


N
S
E
W
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
0 0.1 0.2 0.3 0.4 km
Peak flood velocity
0.0 m/s < 0.5 m/s
0.5 m/s < 1.0 m/s
1.0 m/s < 1.5 m/s
1.5 m/s < 2.0 m/s
2.0 m/s < 2.5 m/s
2.5 m/s < 3.0 m/s
3.0 m/s < 4.0 m/s
> 4.0 m/s
SPRINGTON CREEK
Projection: MGA Zone 56 Datum: GDA 94
Surface Water Assessment
Gemini Project
Predicted Flood Velocity (Existing Condition),
2% AEP
wrm
water + environment



Projection: MGA Zone 56 Datum: GDA 94

Legend

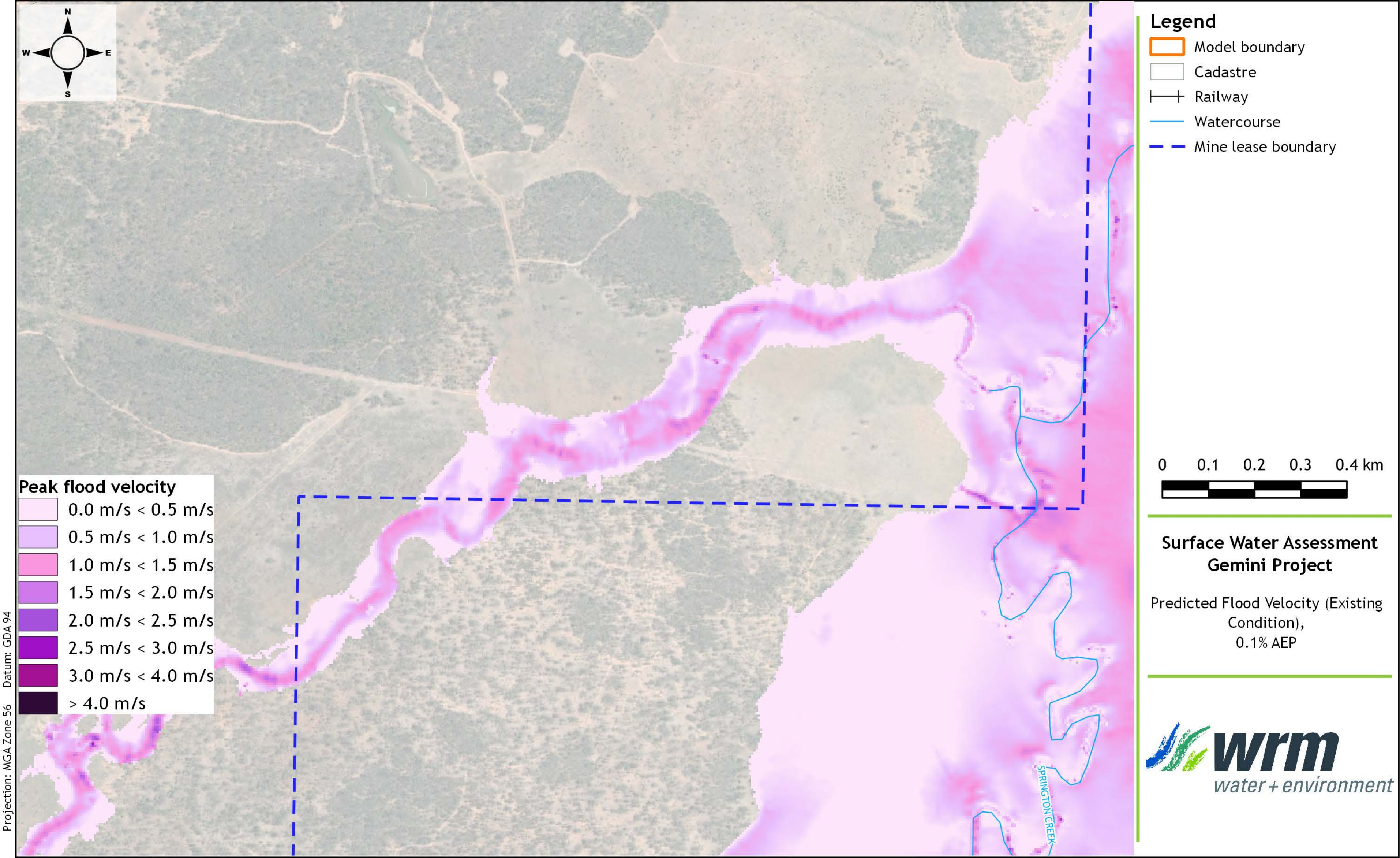
- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary

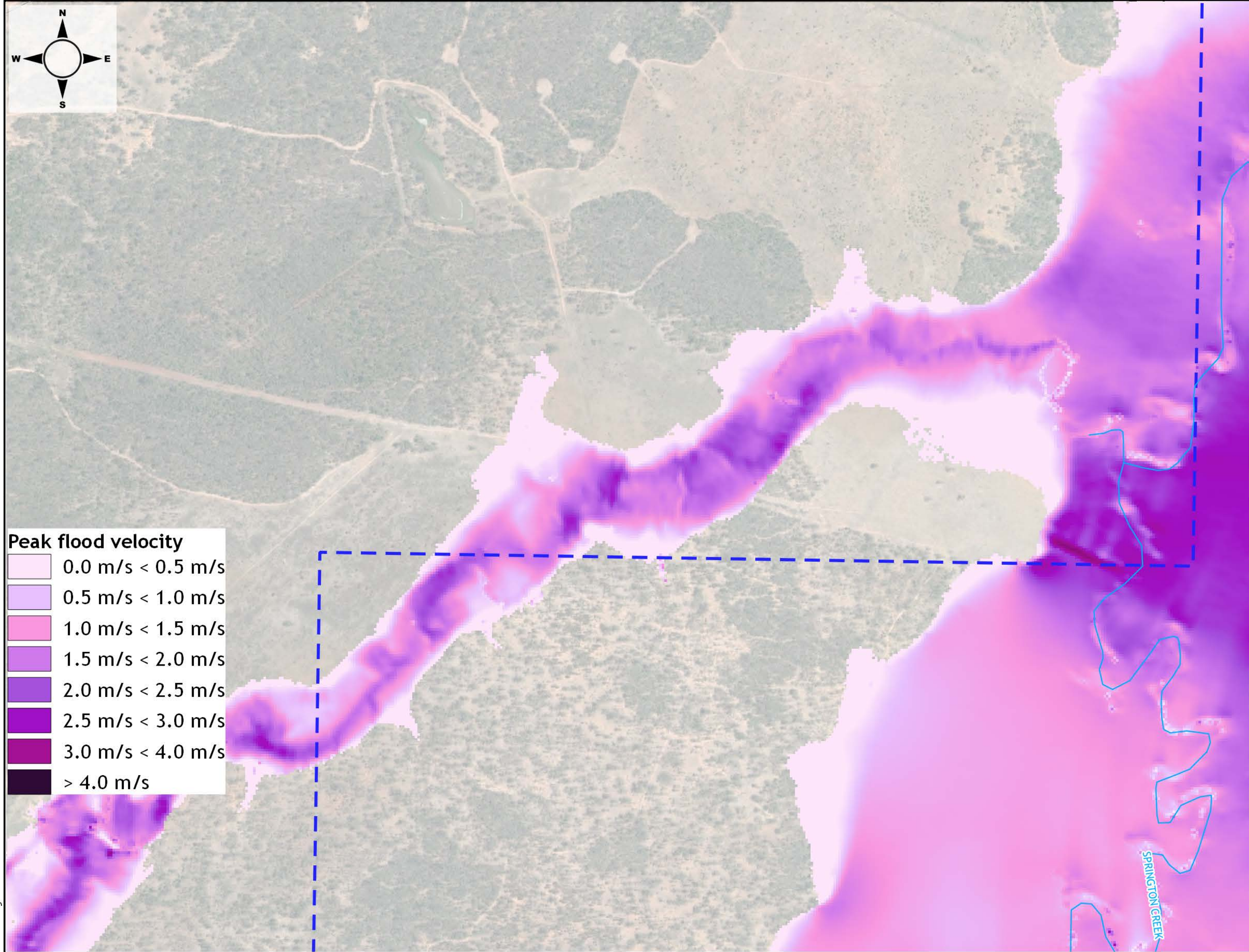
0 0.1 0.2 0.3 0.4 km

Surface Water Assessment
Gemini Project

Predicted Flood Velocity (Existing Condition),
1% AEP

wrm water + environment


N
S
E
W
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Peak flood velocity
0.0 m/s < 0.5 m/s
0.5 m/s < 1.0 m/s
1.0 m/s < 1.5 m/s
1.5 m/s < 2.0 m/s
2.0 m/s < 2.5 m/s
2.5 m/s < 3.0 m/s
3.0 m/s < 4.0 m/s
> 4.0 m/s
0 0.1 0.2 0.3 0.4 km
SPRINGTON CREEK
Projection: MGA Zone 56 Datum: GDA 94
Surface Water Assessment
Gemini Project
Predicted Flood Velocity (Existing Condition),
0.1% AEP
wrm
water + environment



Projection: MGA Zone 56 Datum: GDA 94

Legend

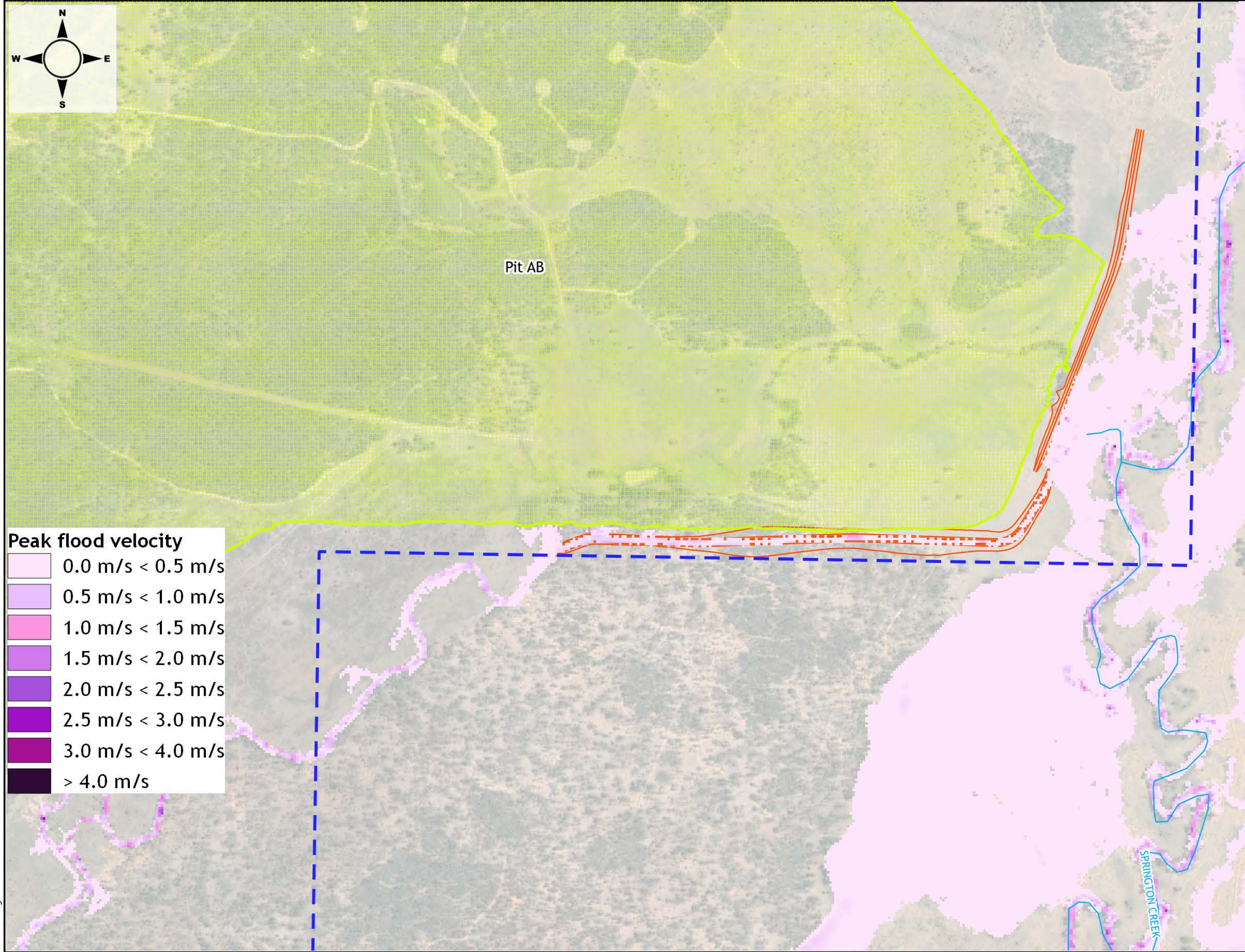
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary

0 0.1 0.2 0.3 0.4 km

Surface Water Assessment
Gemini Project

Predicted Flood Velocity (Existing Condition),
PMF

wrm
water+environment



Legend

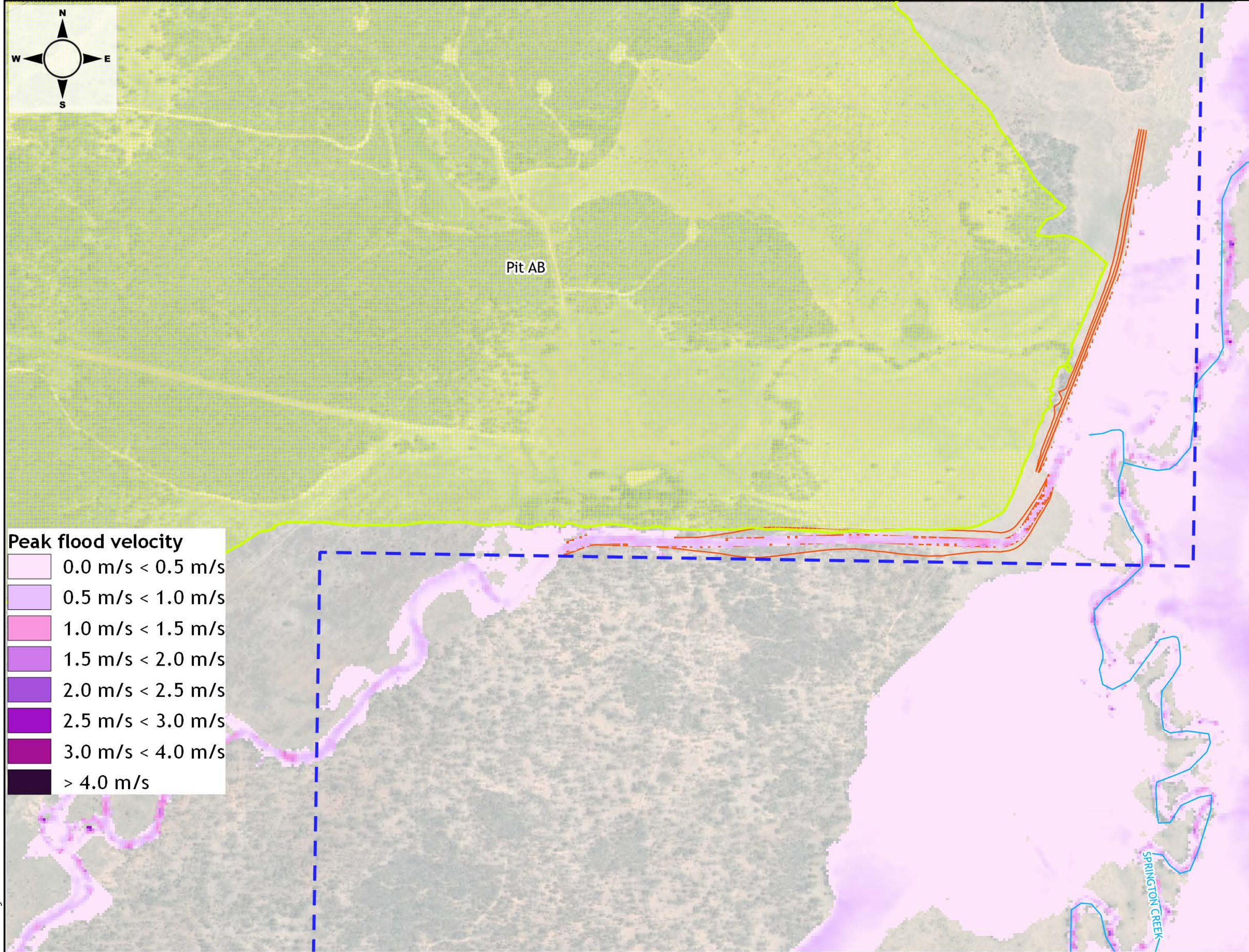
- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary
- Proposed pit location
- Proposed infrastructure

0 0.1 0.2 0.3 0.4 km

Surface Water Assessment
Gemini Project

Predicted Flood Velocity
(Developed Condition),
50% AEP

wrm
water + environment



Legend

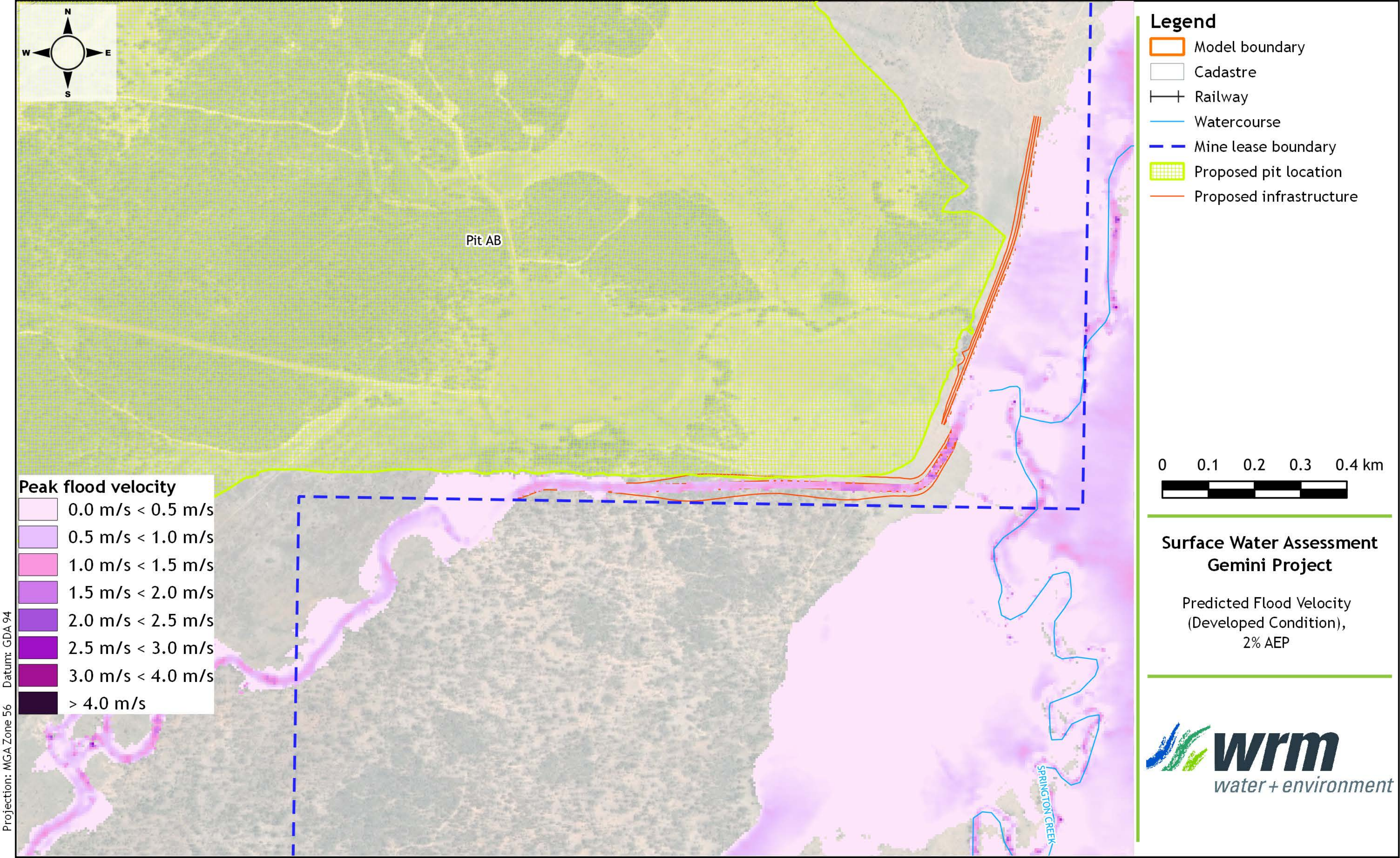
- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary
- Proposed pit location
- Proposed infrastructure

0 0.1 0.2 0.3 0.4 km

Surface Water Assessment
Gemini Project

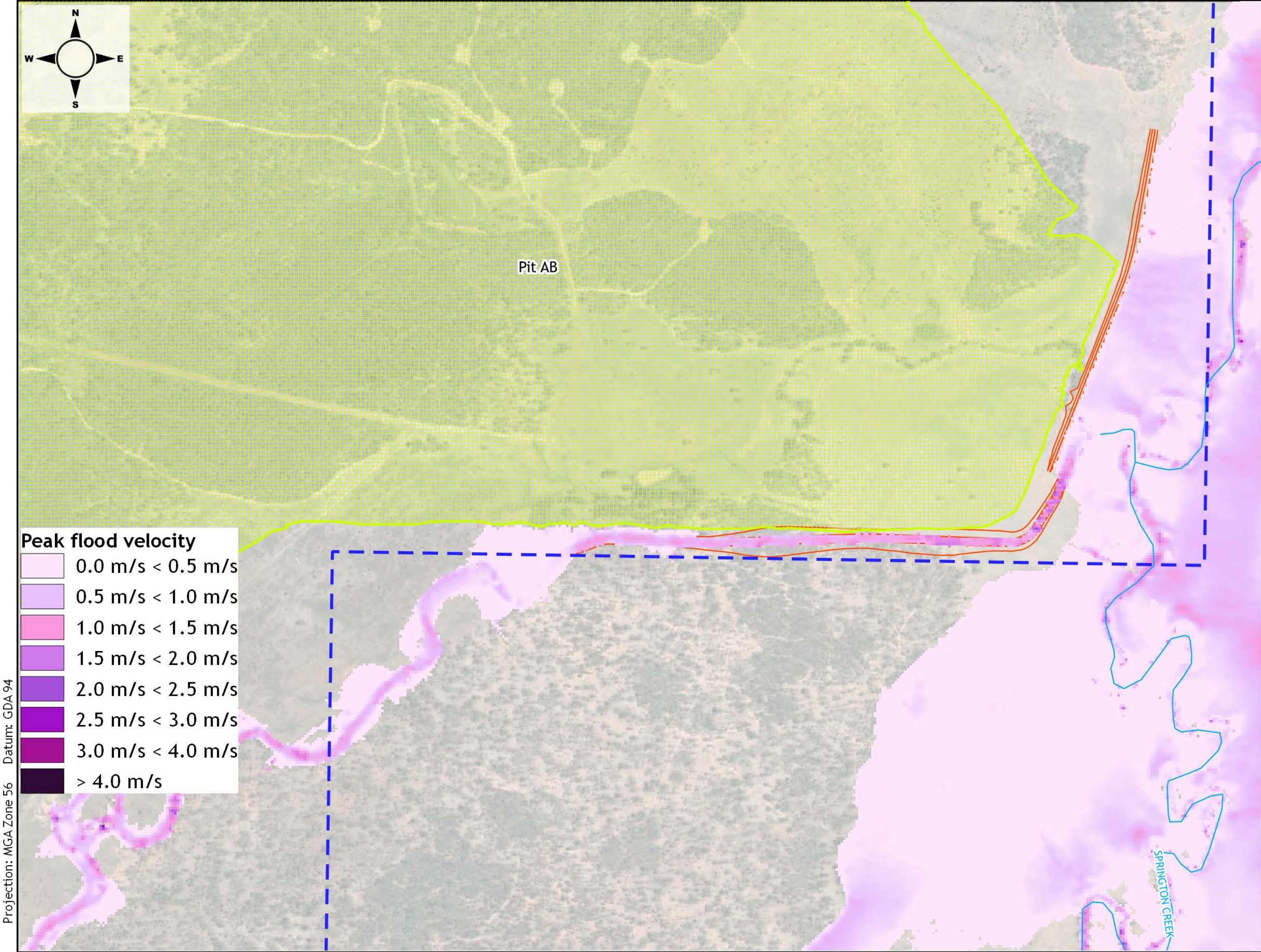
Predicted Flood Velocity
(Developed Condition),
10% AEP

wrm
water + environment



Surface Water Assessment
Gemini Project

Predicted Flood Velocity
(Developed Condition),
2% AEP



Legend

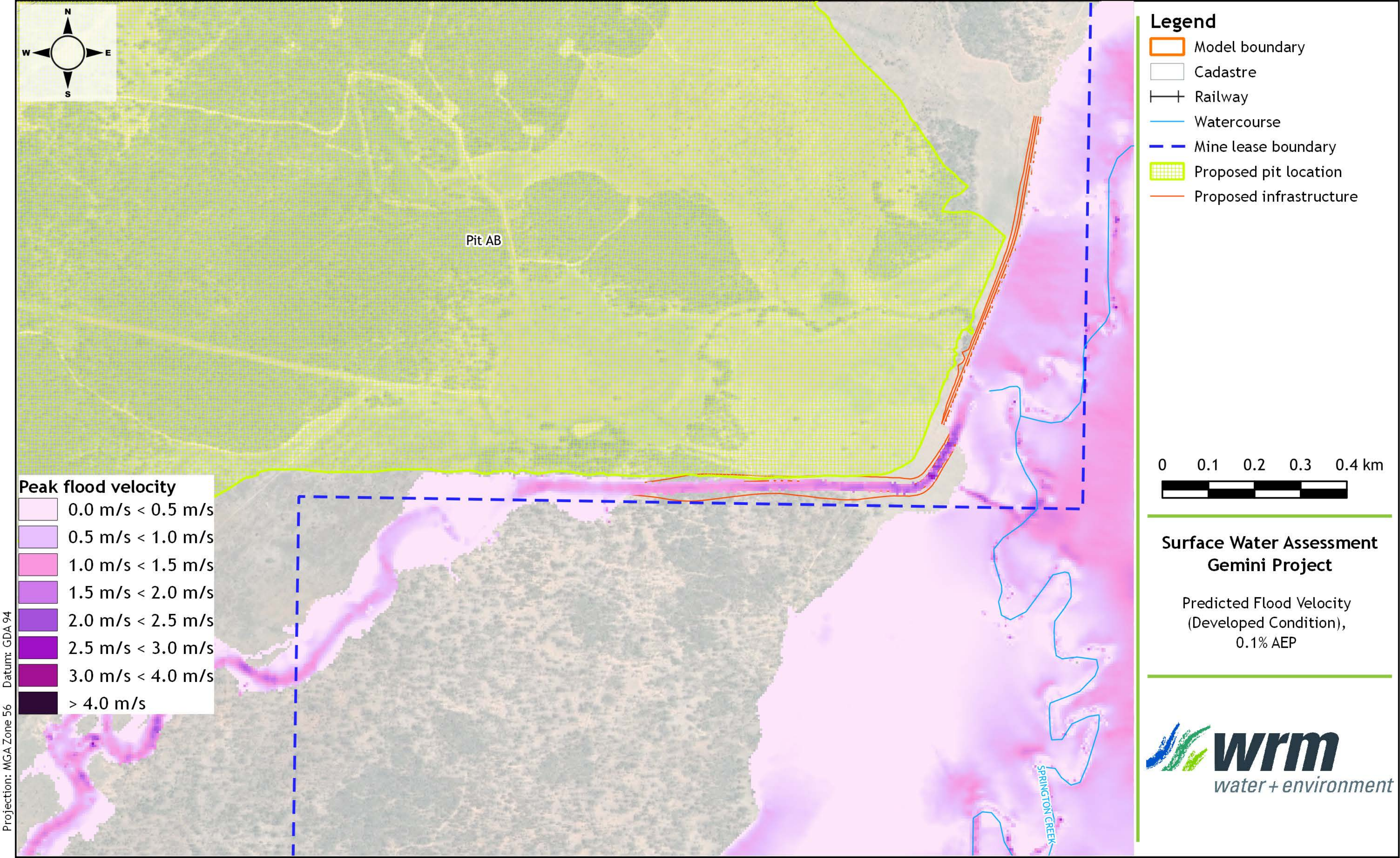
- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary
- Proposed pit location
- Proposed infrastructure

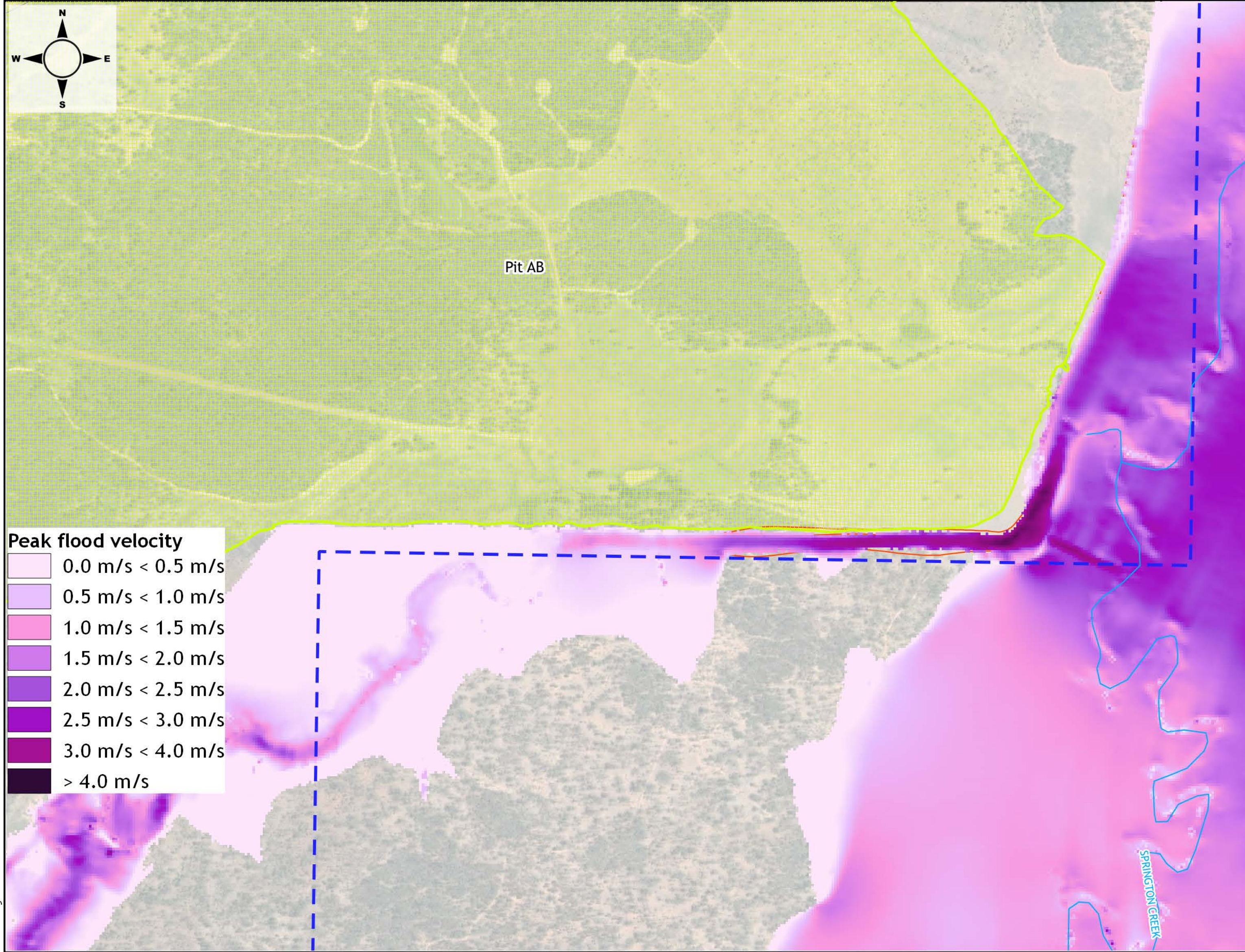
0 0.1 0.2 0.3 0.4 km

Surface Water Assessment
Gemini Project

Predicted Flood Velocity
(Developed Condition),
1% AEP

wrm
water + environment


N
S
E
W
Pit AB
SPRINGTON CREEK
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
0
0.1
0.2
0.3
0.4 km
Peak flood velocity
0.0 m/s < 0.5 m/s
0.5 m/s < 1.0 m/s
1.0 m/s < 1.5 m/s
1.5 m/s < 2.0 m/s
2.0 m/s < 2.5 m/s
2.5 m/s < 3.0 m/s
3.0 m/s < 4.0 m/s
> 4.0 m/s
Projection: MGA Zone 56
Datum: GDA 94
Surface Water Assessment
Gemini Project
Predicted Flood Velocity
(Developed Condition),
0.1% AEP
wrm
water+environment



Projection: MGA Zone 56 Datum: GDA 94

Legend

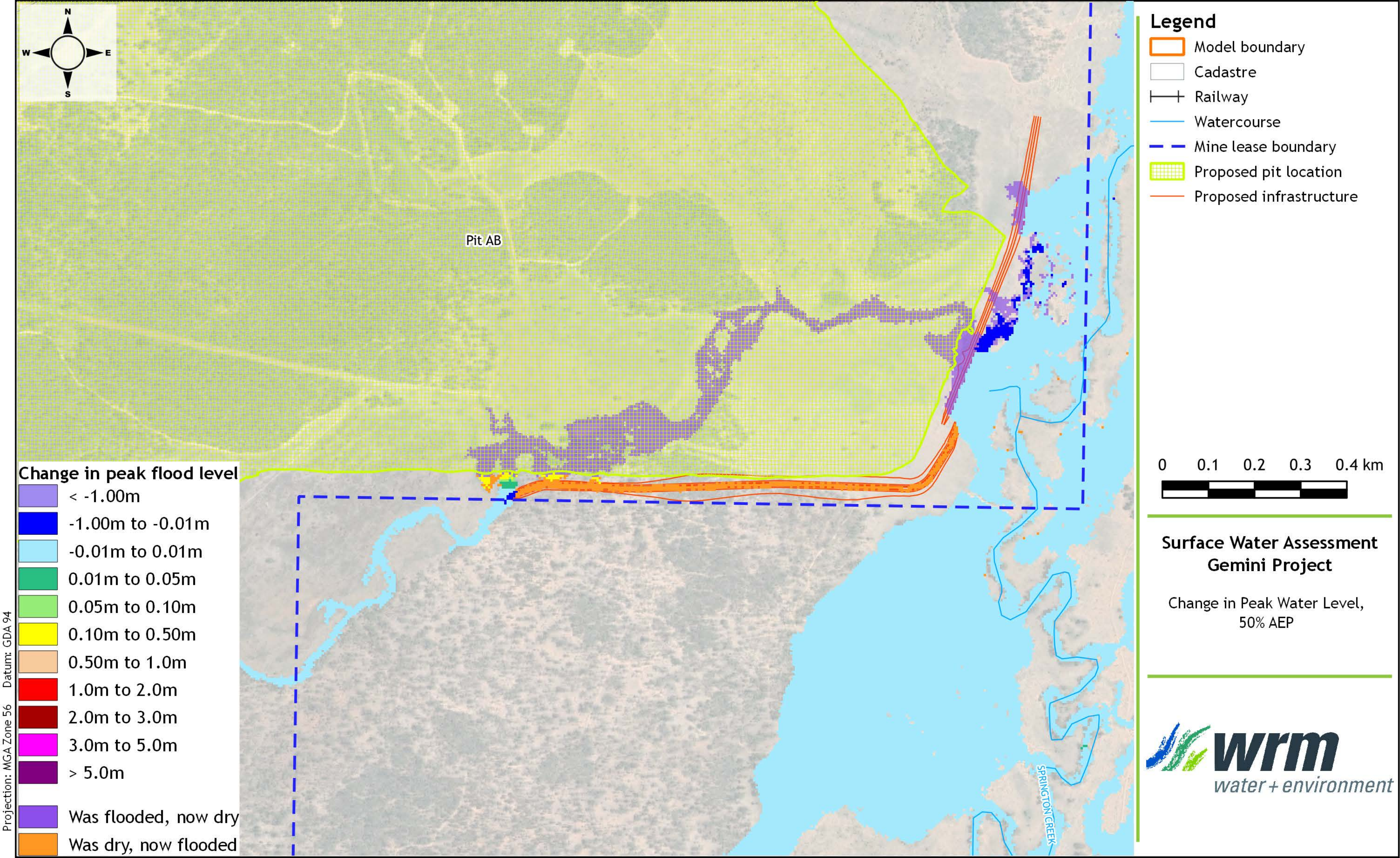
- Model boundary
- Cadastre
- Railway
- Watercourse
- Mine lease boundary
- Proposed pit location
- Proposed infrastructure

0 0.1 0.2 0.3 0.4 km

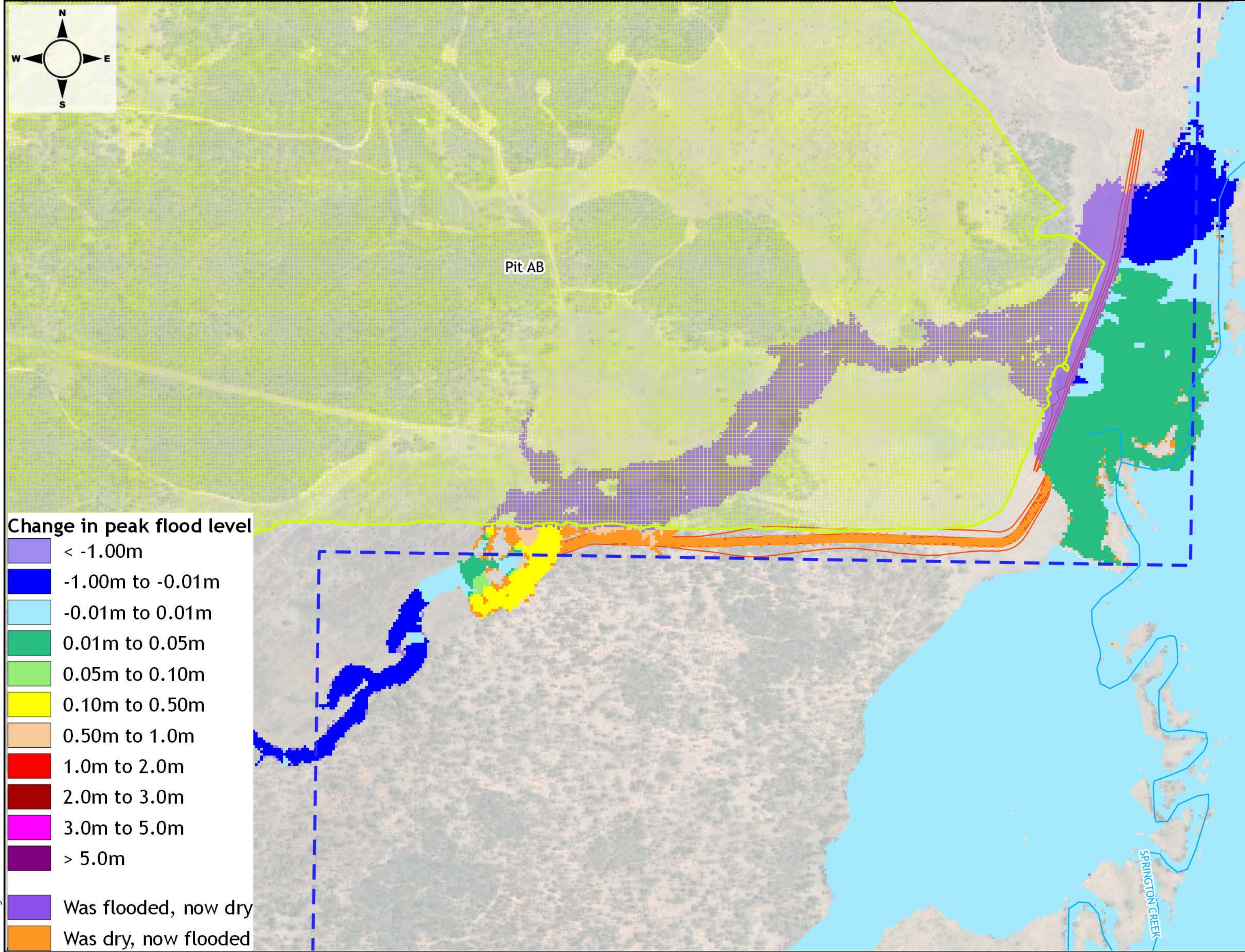
Surface Water Assessment
Gemini Project

Predicted Flood Velocity
(Developed Condition),
PMF

wrm
water + environment

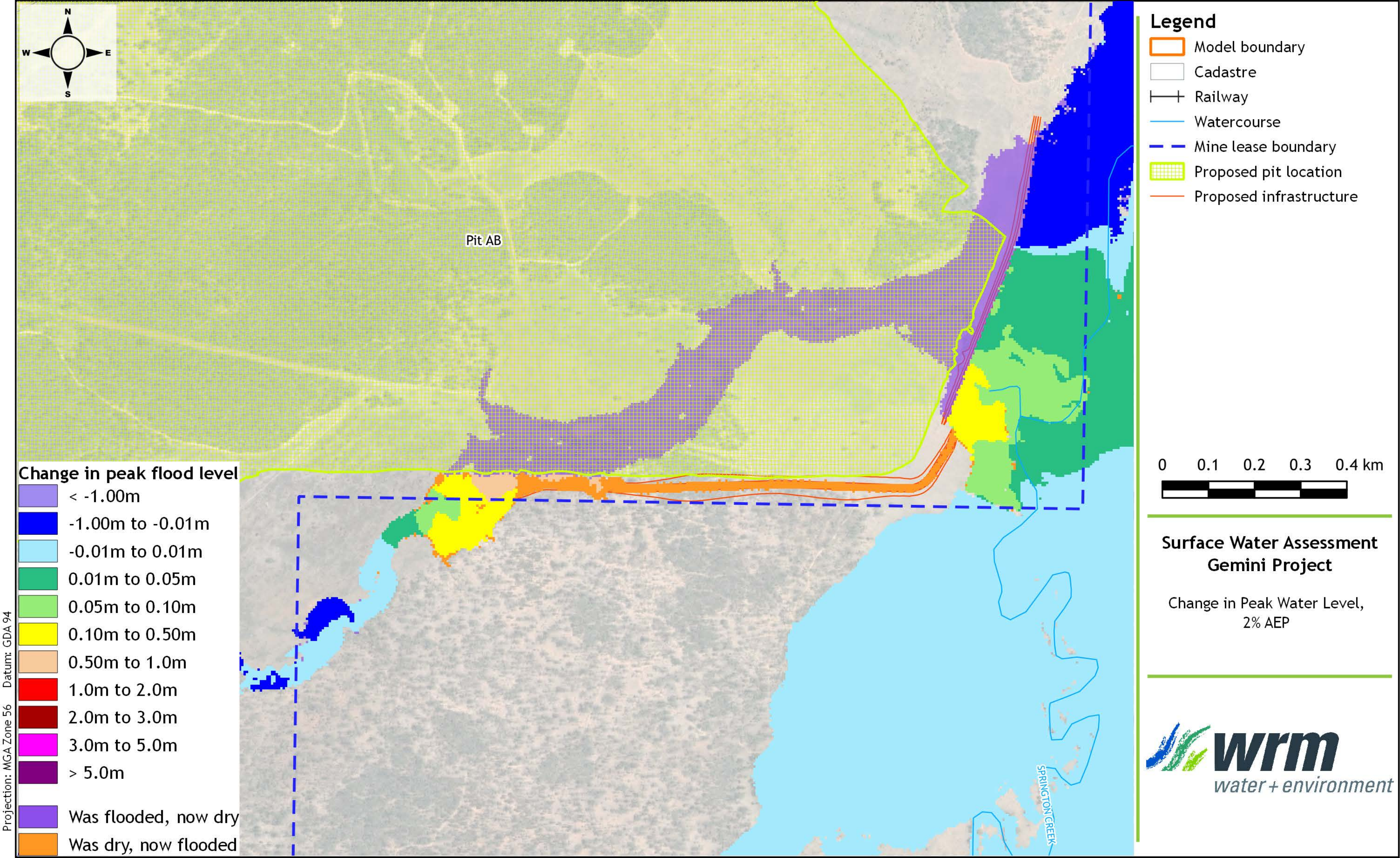


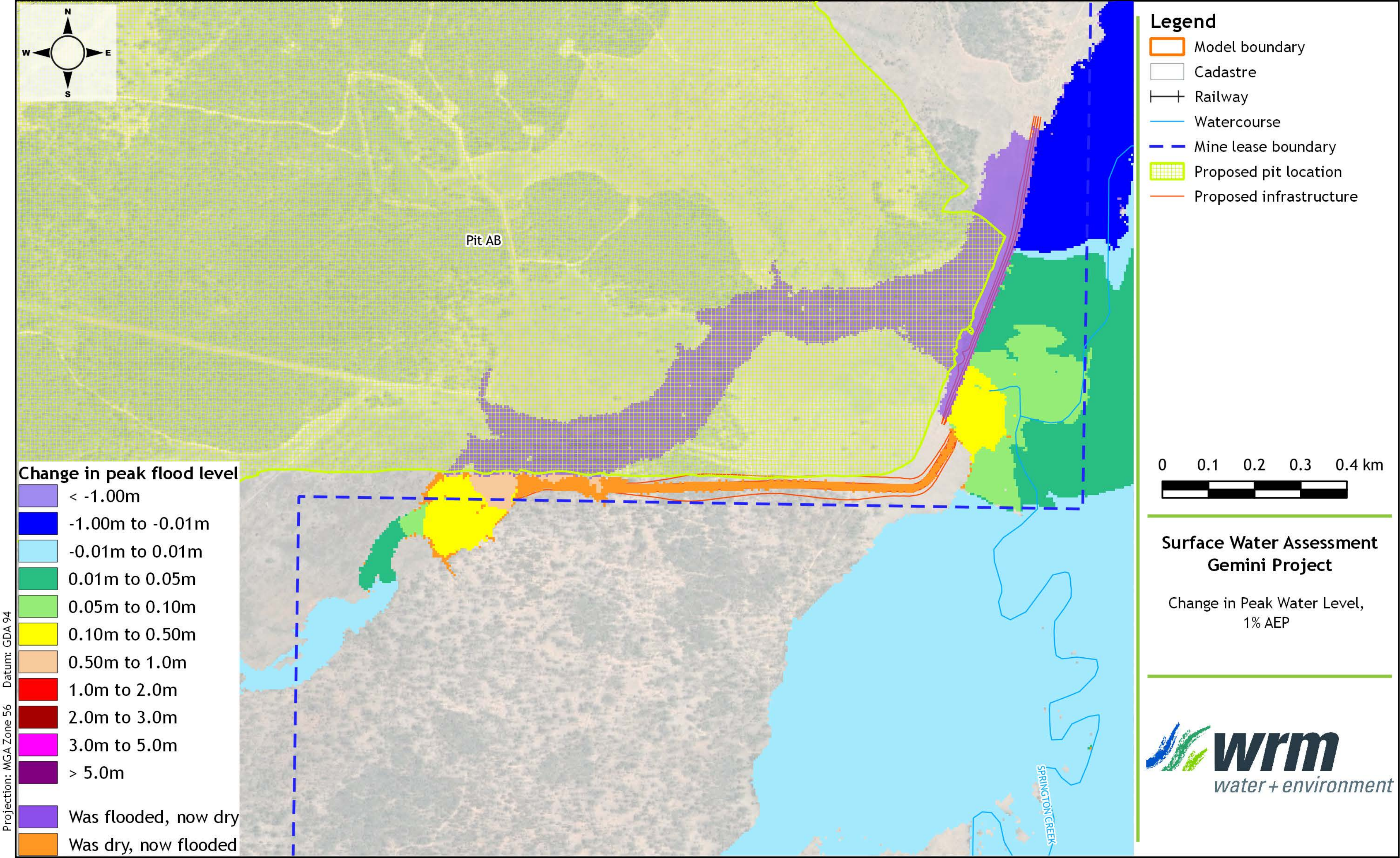
N
E
S
W
Pit AB
SPRINGTON CREEK
Change in peak flood level
< -1.00m
-1.00m to -0.01m
-0.01m to 0.01m
0.01m to 0.05m
0.05m to 0.10m
0.10m to 0.50m
0.50m to 1.0m
1.0m to 2.0m
2.0m to 3.0m
3.0m to 5.0m
> 5.0m
Was flooded, now dry
Was dry, now flooded
Projection: MGA Zone 56
Datum: GDA 94
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
0
0.1
0.2
0.3
0.4 km
Surface Water Assessment
Gemini Project
Change in Peak Water Level,
50% AEP
wrm
water + environment



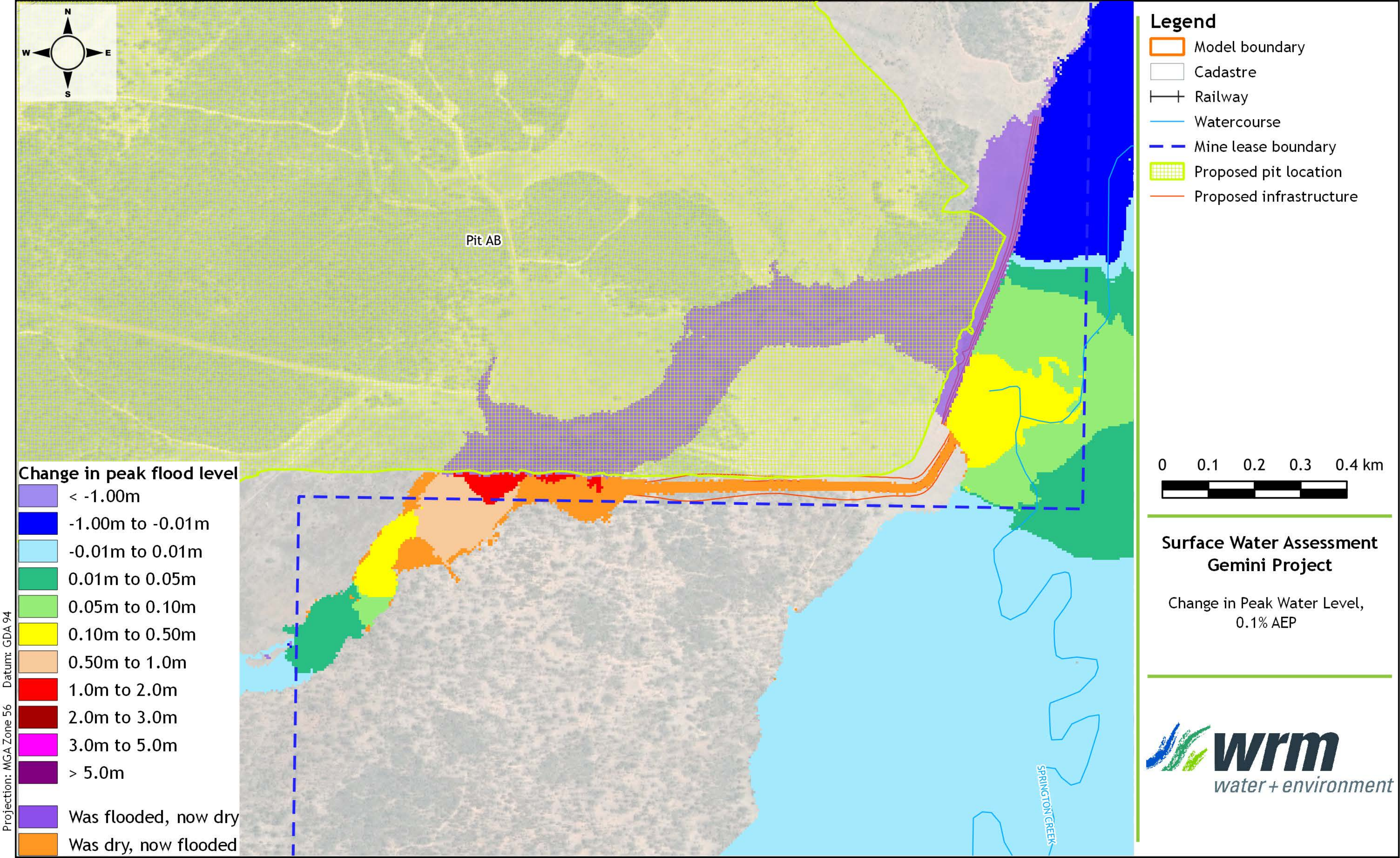
Surface Water Assessment Gemini Project

Change in Peak Water Level, 10% AEP


N
W
E
S
Pit AB
SPRINGTON CREEK
Change in peak flood level
< -1.00m
-1.00m to -0.01m
-0.01m to 0.01m
0.01m to 0.05m
0.05m to 0.10m
0.10m to 0.50m
0.50m to 1.0m
1.0m to 2.0m
2.0m to 3.0m
3.0m to 5.0m
> 5.0m
Was flooded, now dry
Was dry, now flooded
Projection: MGA Zone 56
Datum: GDA 94
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
0
0.1
0.2
0.3
0.4 km
Surface Water Assessment
Gemini Project
Change in Peak Water Level,
2% AEP
wrm
water + environment



N
S
E
W
Pit AB
SPRINGTON CREEK
Change in peak flood level
< -1.00m
-1.00m to -0.01m
-0.01m to 0.01m
0.01m to 0.05m
0.05m to 0.10m
0.10m to 0.50m
0.50m to 1.0m
1.0m to 2.0m
2.0m to 3.0m
3.0m to 5.0m
> 5.0m
Was flooded, now dry
Was dry, now flooded
Projection: MGA Zone 56 Datum: GDA 94
Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
0 0.1 0.2 0.3 0.4 km
Surface Water Assessment
Gemini Project
Change in Peak Water Level,
1% AEP
wrm
water + environment


Legend
Model boundary
Cadastre
Railway
Watercourse
Mine lease boundary
Proposed pit location
Proposed infrastructure
0 0.1 0.2 0.3 0.4 km
Pit AB
SPRINGTON CREEK
Change in peak flood level
< -1.00m
-1.00m to -0.01m
-0.01m to 0.01m
0.01m to 0.05m
0.05m to 0.10m
0.10m to 0.50m
0.50m to 1.0m
1.0m to 2.0m
2.0m to 3.0m
3.0m to 5.0m
> 5.0m
Was flooded, now dry
Was dry, now flooded
Projection: MGA Zone 56 Datum: GDA 94
Surface Water Assessment
Gemini Project
Change in Peak Water Level,
0.1% AEP
wrm
water + environment