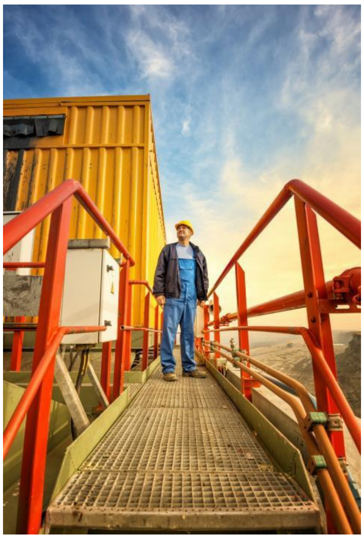


Taroborah Coal Project

Environmental Impact Statement

Section 3 – Description of the Project

Prepared for:

Shenhuo International Group Pty Ltd

Chapter 3

Table of Contents

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

%	per cent
µS	microSiemens
ad	air dried
ar	as received
ABA	Acid Base Accounting
ABBC	acid buffering characteristic curve
AHD	Australian Height Datum
AMD	Acid Mine Drainage
ANC	acid neutralising capacity
AST	Above Ground Storage Tank
bcm / t -	bank cubic metres per tonne
BIBO	Bus In, Bus out
CHPP	Coal Handling and Preparation Plant
cm	centimetres
CEA	*Clean Energy Act 2011* (Cth)
CH_4	Methane
CO_2	Carbon dioxide
CO_2-e	carbon dioxide equivalents
CPP	Coal Preparation Plant
Cth	Commonwealth
DMC	Dense Medium Cyclone
DTMR	Department of Transport and Main Roads
EC	electrical conductivity
ECEC	Effective Cation Exchange Capacity
EEO Act	*Energy Efficiency Opportunities Act 2006*

EGi	Environmental Geochemistry International
EHP	Environment and Heritage Protection
EIS	Environmental Impact Statement
EPC	Exploration Permit for Coal
EPM	Exploration Permit for Minerals
EPP	Exploration Permit for Petroleum
ESD	Ecologically Sustainable Development
ESP	Exchangeable Sodium Percentage
GAI	Geochemical Abundance Index
GCL	Geosynthetic Clay Liner
GHG	Greenhouse Gas
g/s	grams per second
GWP	Global Warming Potential
ha	hectare
HFC	Hydrofluorocarbons
JORC	Joint Ore Reserves Committee
kg	kilograms
kL	kilolitres
km	kilometres
kt	kilotonnes
kV	kilovolt
L	litres
LC	low confidence
Lcm -	loose cubic metres
m	metres
m^3	cubic metres
mg	milligrams

MDL	Mineral Development License
MIA	Mine Infrastructure Area
ML	megalitres
MLA	Mining Lease Application
MPA	maximum potential acidity
Mt	million tonnes
Mtpa	million tonnes per annum
MW	megawatt
NAF	non acid forming
NAG	net acid generation
NAPP	net acid producing potential
N_2O	Nitrous oxide
NGER	*National Greenhouse and Energy Reporting Act 2007 (Cth)*
NPR	net potential ratio
NTU	Nephelometric Turbidity Unit
OSD	Out of Seam Dilution
PAF	potentially acid forming
PFC	Perfluorocarbons
pH	hydrogen ion concentration
PM_{10}	Particulate Matter with an equivalent aerodynamic diameter of 10 µm
$PM_{2.5}$	Particulate Matter with an equivalent aerodynamic diameter of 2.5 µm
PoO	Plan of Operations
QR	Queensland Rail
ROM	run-of-mine
RPD	Real Property Description
S	sulphur
SCR	State Controlled Road

STP	Sewage Treatment Plant
SF_6	Sulphur hexafluoride
SMU	Soil Management Unit
SWMP	Site Water Management Plan
t	tonnes
t / m^3	tonnes per cubic metre
TAL	Tonnes per axle load
TLO	Train load out facility
tph	tonnes per hour
TSP	Total Suspended Particulate matter
UC	Uncertain
UV	Ultraviolet
V:H	vertical to height ratio
VVVF	Variable Voltage Variable Frequency
WICET	Wiggins Island Coal Export Terminal
WMP	Waste Management Plan

3.0 DESCRIPTION OF THE PROJECT

The Project is based upon the development of an estimated 202 Mt thermal coal resource located in the Bowen Basin, in Central Queensland.

Up to 5.75 Mtpa of ROM thermal coal will be mined, resulting in 5.73 Mtpa of product coal for export. The target commencement date for mine construction is late 2017 with coal production proposed for mid-2018. The exact timing will depend on availability of the services and infrastructure that are required for product coal transportation and shipping.

The construction process will begin with a period of earthworks in order to clear vegetation and create a landscape that is suitable for infrastructure development. Following this preliminary site-clearing stage, earthmoving equipment will then be employed to excavate areas for the opencut pit, internal transport corridors, spoil dumps and MIA. Topsoil that is stripped prior to mining will be segregated and stockpiled for later use in rehabilitation works. Subsequent phases of the mine construction programme will involve the development of remaining infrastructure including a rail balloon loop, TLO facility, water management systems, the Coal Handling and Preparation Plant (CHPP), internal haul roads, fuel storage area, workshops, offices, spoil dumps and other associated infrastructure.

The Project will initially focus on opencut mining using truck and excavator methods, followed by underground longwall mining operations. The overburden and interburden that is encountered during opencut pit development will initially be disposed of in out-of-pit spoil dumps until such time the opencut pit progresses and adequate space becomes available for in-pit spoil disposal.

Opencut ROM coal will be hauled via trucks on a dedicated haul road from the pit to the dump hopper / opencut ROM pad (up to 30,000t capacity) prior to being processed in the CHPP. Up to 2.28 Mtpa of opencut ROM coal will be delivered to the dump hopper for primary sizing. This material will then be transferred to a secondary sizing station which will reduce the top size down to – 50 millimetres (mm). The coal will then be directed to either the "wash" or the "bypass" streams, depending upon the type and quality of coal present.

In contrast, underground ROM coal will be transported via conveyor to a dedicated underground ROM stockpile (50,000t capacity). This material will then be reclaimed, conveyed to the secondary sizing station and directed to either the “wash” or the “bypass” streams, depending on the quality of the coal.

The wash coal stream will be crushed, screened and washed in the Coal Preparation Plant (CPP) in order to separate product coal from waste materials. Coarse rejects from the CPP will be dried and directed to a refuse bin for disposal within the opencut spoil dumps. Fine rejects produced by the CPP will be partially dewatered, with the thickener underflow being directed to a belt press filter before being conveyed to the refuse bin to join the coarse rejects and disposal in the spoil dumps. The thickener overflow water will be returned to the CPP.

Construction of the Project site access road may result in disruption to, or temporary closure of, the Capricorn Highway, which will be resolved through the Queensland Department of Transport and Main Roads (DTMR). A rail loop will also be constructed in order to facilitate the transport of product coal off-site. This coal will be transported via the QR Central West rail system which runs through the centre of the Project site and then joins the Aurizon Blackwater rail system at Nogoa Junction. Coal will then be exported via the WICET located in Gladstone. Line upgrades will be required between Taroborah and Burngrove in order to accommodate additional rail traffic.

Based upon a current assessment of the available coal resource, the expected production life of the Project is estimated to be 20 years. Additional periods of mine construction (9 months) and mine closure, decommissioning and rehabilitation (15 months) will result in a whole-of-project life of approximately 22 years. During mine decommissioning, the Project area will have to be rehabilitated in accordance with the standards set out in the Project's EA.

3.1 LOCATION

3.1.1 Regional Context

The Project is located in the Bowen Basin coalfields approximately 22 km west of Emerald, in Central Queensland. The Project lies approximately 265 km west of Rockhampton, 290 km south-west of Mackay and 670 km north-west of Brisbane. Refer to Figure 3.1 for regional Project location details.

The Project is situated entirely within the Central Highlands Regional Council area.

3.1.2 Local Context

The local Project setting is rural / agricultural, encompassed by the townships of Emerald (22 km to the east) and Anakie (20 km to the west. The MDL (467), in which the Project is situated, is approximately 13 km in length (north to south) and 9 km in width (east to west) and encompasses and area of 7,966 ha.

Access to the Project site is via the Capricorn Highway, which dissects the Project site from east to west. The Capricorn Highway is listed as a State Controlled Road by the DTMR and provides a major transport link to inland central Queensland.

The Queensland Rail Central West system also runs directly through the centre of the Project site, running adjacent to the Capricorn Highway, on the southern side of the highway. The proposed Project rail balloon loop will access this line directly and utilise the Central West rail system to transport the coal products.

Located directly adjacent and to the south-east of MDL 467 is Fairbairn State Forest, which is a state forest reserve. Lake Maraboon lies to the south of the Project site, whose water flows are controlled by Fairbairn Dam. Figure 3.2 illustrates the location of MDL 467 in respect to these local features.

Figure 3.1 Regional Context of the Project

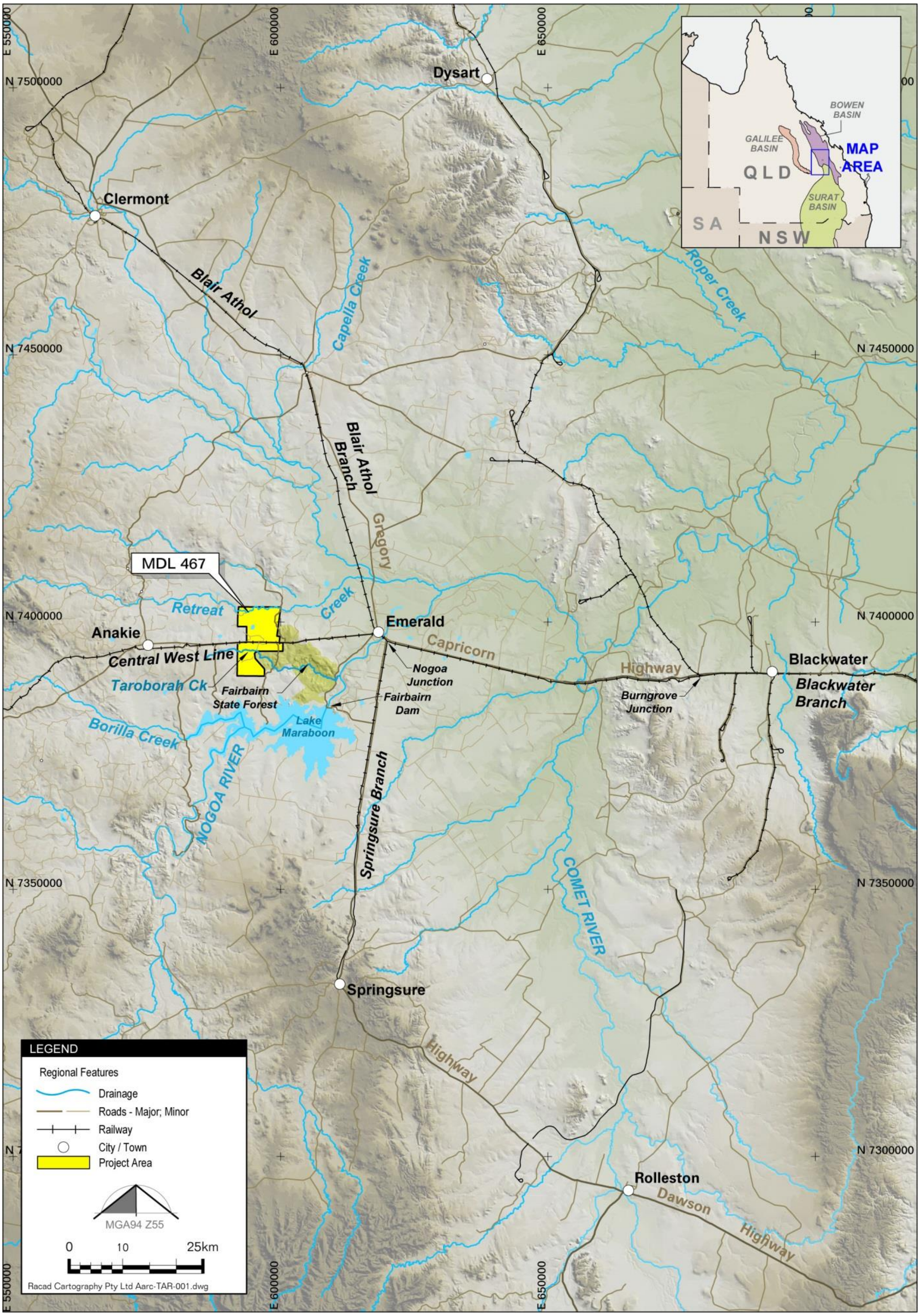


Figure 3.2 Local Context of the Project

3.1.2.1 Land Tenures

The Real Property descriptions of properties underlying MDL 467 are presented in Table 3.1, those adjacent to the underlying properties are depicted in Table 3.2 and the local cadastral map is presented in Figure 3.3. The development of the Taroborah Project and associated infrastructure will affect 19 land parcels underlying MDL 467 (excluding easements); one State highway, one State rail system and the Queensland Stock Route Network (refer to Figure 3.4 for the location of local stock routes).

Properties underlying the Project site are a combination of freehold and leasehold land with some perpetual leases being held in reserve for QR and DTMR in association with the Central West rail system and the Capricorn Highway, respectively.

Table 3.1 Real Property Descriptions for Lots Underlying the Project

Lot Number	Plan Number	Tenure
Lot 124	PT367	Leasehold
Lot 4	PT352	Leasehold
Lot 20	DSN377	Freehold
Lot 203	DSN377	Freehold
Lot 201	DN40176	Freehold
Lot 126	PT372	Freehold
Lot 23	DN40176	Freehold
Lot 24	DN40201	Freehold
Lot 21	DSN29	Freehold
Lot 15	PLA4029	Freehold
Lot 12	RP881318	Freehold
Lot 13	RP881318	Freehold
Lot 14	RP881318	Freehold
Lot 5	PT132	Leasehold – QR land
Lot 12	PT352	Leasehold
Lot 81	SP122079	Leasehold – highway / railway reserve
Lot 82	SP122079	Leasehold– highway / railway reserve
Lot 101	SP122080	Leasehold– highway / railway reserve
Lot 76	PT372	Freehold

Source: Queensland Government Information Service 2013

Table 3.2 Real Property Descriptions for Lots Adjacent to the Project

Lot Number	Plan Number	Tenure
Lot 1	CLM78	Leasehold
Lot 13	DSN703	Leasehold
Lot 223	FTY 1531	State Forest
Lot 3	DSN801	Freehold
Lot 21	DSN572	Freehold
Lot 1	PT387	Freehold
Lot 3	PT373	Freehold
Lot 1	PT117	Freehold
Lot 74	SP159661	Freehold
Lot 96	SP227975	Freehold

Source: Queensland Government Information Service 2013

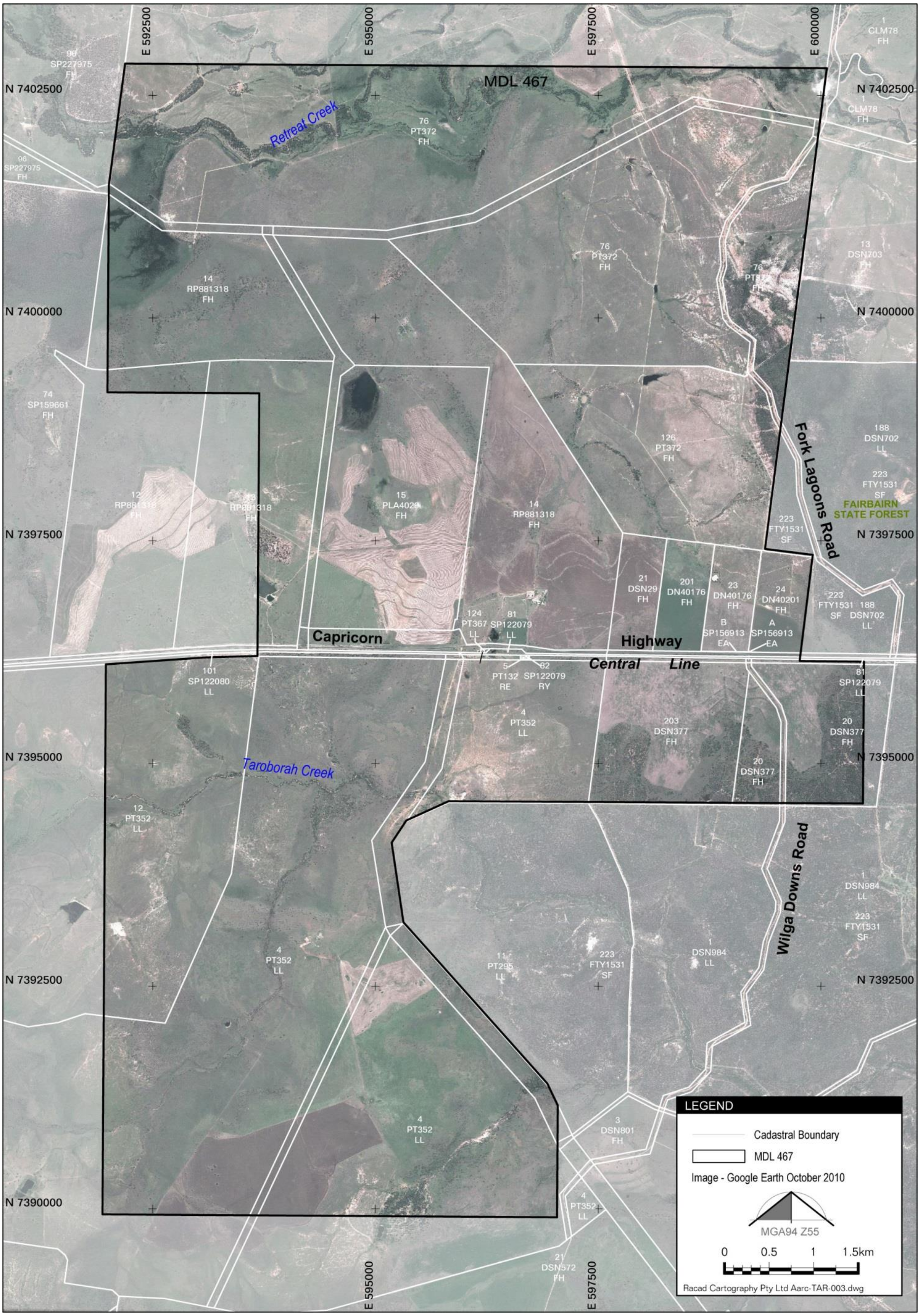


Figure 3.3 **Cadastre Underlying and Adjacent to the Taroborah Project**

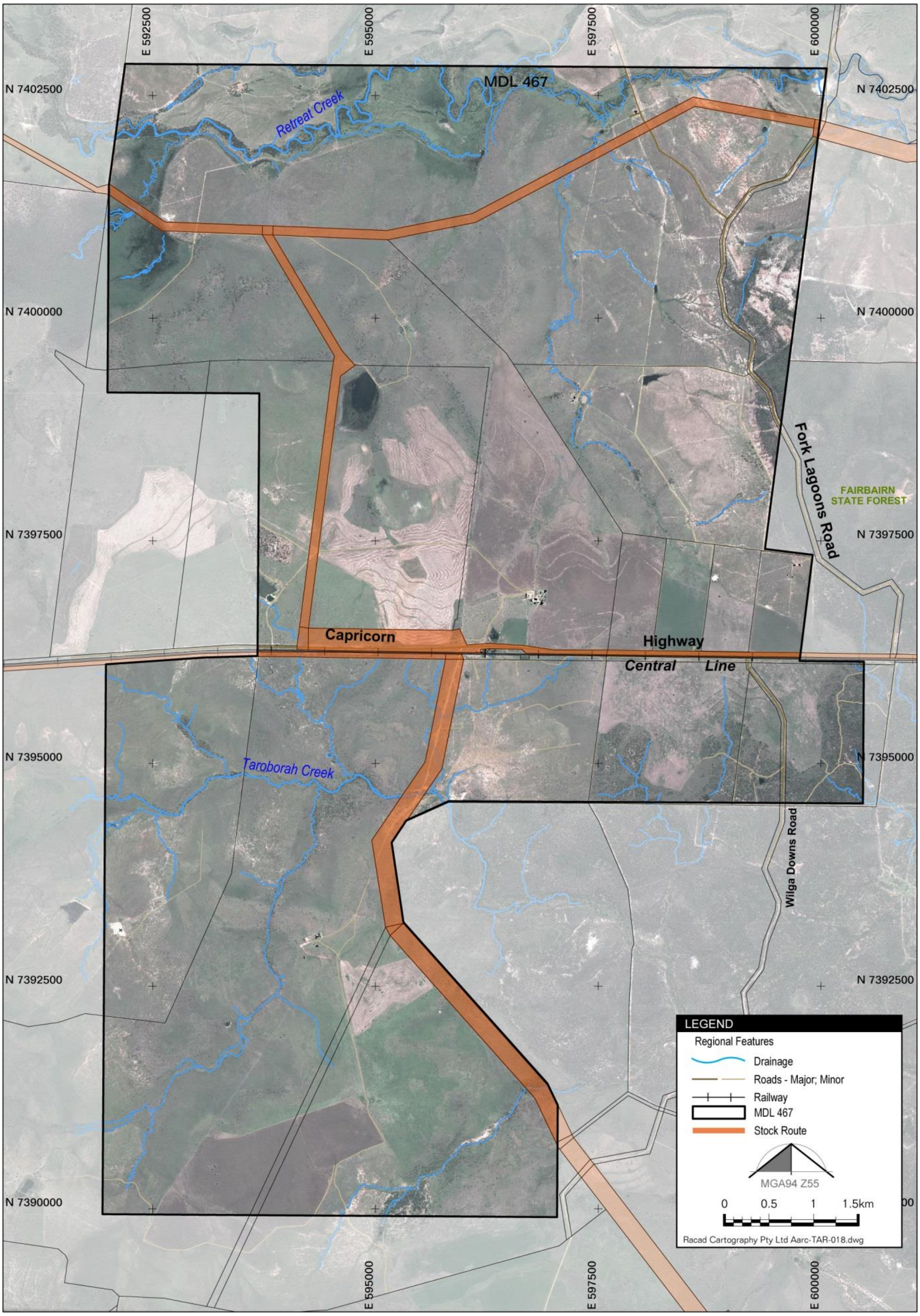


Figure 3.4 Queensland Stock Route Network

3.1.2.2 Proposed Project Infrastructure Footprint

The total area of land disturbed by the Project, within MDL 467, is estimated to be approximately 2,676 ha over the life of the mine. The majority of disturbance associated with mining on the Project site will result from the opencut and underground mine operations as described in Table 3.3.

Table 3.3 Disturbance footprint on the Project Site

Disturbance	Area (ha)
Opencut mining including dumps and haul roads	373
Underground (longwall) mining	2,071
CPP, mine infrastructure and site offices	58
Rail balloon loop, sediment dams, CPP water recycle dam and mine waste water dam	50
Visual amenity bunds	16
Total	**2,568**

In addition to the major disturbance types outlined in Table 3.3, a detailed description of the infrastructure to be developed on the Project site is described below and illustrated in Figure 3.5:

- In-pit and out-of-pit spoil dumps;
- Opencut and underground MIA (includes coal transfer and laydown areas, site offices, stores yard, workshops, change rooms, administration office, mine office, maintenance areas, washdown bays, parking areas, fire water tank, vent fans etc.);
- Primary and secondary sizers;
- CPP and refuse bin;
- Site access and haul roads;
- Main and underground substations;
- Fuel, oil and chemical storage areas and vessels;
- Opencut and underground ROM, CPP feed, product and topsoil stockpiles;
- Clean and dirty water management and drainage systems including sediment dams;
- Mine wastewater dam;
- CPP water recycle dam;
- Water storage system (200 kilolitres (kL));
- Potable water treatment facility for staff use and consumption;

- Visual amenity bunds;
- Sewage treatment plant;
- Overhead feeder power line;
- Electrical substation; and
- Radial stacker, train load-out system and rail balloon loop.

Apart from homesteads, no significant built environments exist within or local to the Project site.

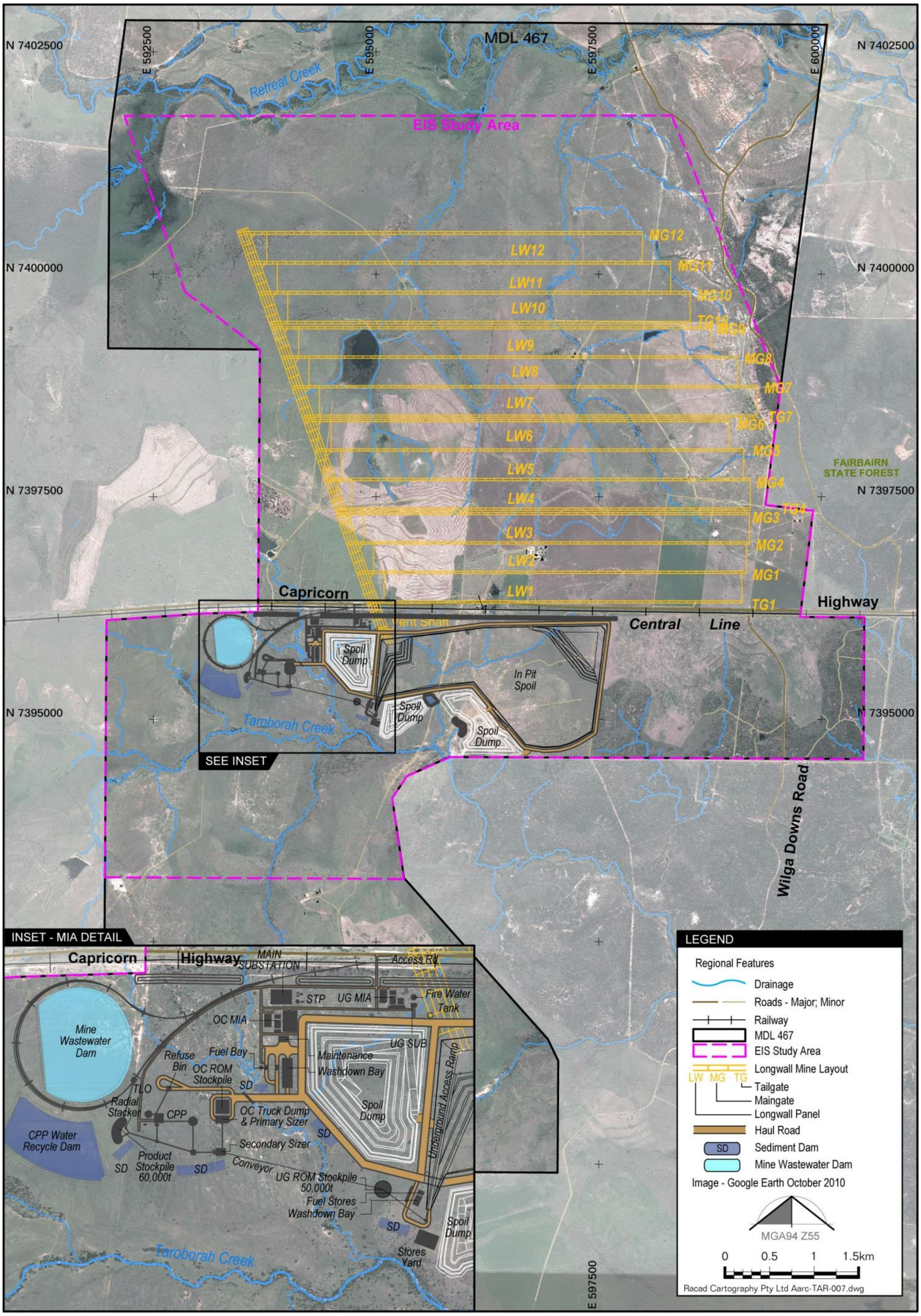


Figure 3.5 The Project Footprint and MIA

3.2 CONSTRUCTION

The Project infrastructure that is required for both opencut and underground mining operations will be constructed over a period of approximately 12 months. Infrastructure components, as detailed in Section 3.1.2.2, will lie south of the Capricorn Highway.

Construction will be staged, following the grant of the ML, with opencut mining operations being conducted concurrently with construction of the underground mine. Initially, the opencut mine and associated operational infrastructure will be established by 2018, with underground mining not expected to commence until 2022.

3.2.1 Vegetation Clearing Schedule

Mining associated with the Project will be predominantly underground; therefore vegetation clearances are mainly associated with mine infrastructure and the opencut pit. Initially vegetation associated with mine infrastructure areas will be cleared within the first three months of the construction period during late 2017. In preparation for opencut mining, vegetation will be cleared during the second three months associated with the construction phase during the first half of 2018. Following the completion of the construction period, the Project will move into its production phase and vegetation clearances will be undertaken progressively as the mine advances. It is anticipated additional opencut strips will be cleared one year in advance of mining.

In total the disturbance footprint owning to the opencut operations and mine infrastructure is approximately 496 ha with 373 ha of disturbance required to accommodate the opencut pit, spoil dumps and haul roads associated with the mining.

3.2.2 Opencut Mine

Hydraulic excavators and large rear-dump trucks will be used to access approximately 12Mt of coal resource in the opencut area of the Project site.

Overburden depths range approximately from 45m – 85m, with interburden depths between the coal seams ranging from 6m – 11m. It is likely that the overburden/interburden will be removed using up to three Hitachi EX5500, 550t capacity excavators, which will load up to 15 Caterpillar 789, 190t capacity rear-dump trucks. The opencut mining operation will utilise a staged strip-mining approach, progressively removing strips of overburden which will be dumped initially to out-of-pit spoil dumps for the first two years of operations. However, thereafter as mining proceeds, in-pit dumping of the overburden and interburden will be undertaken to effectively backfill the opencut pit.

Spoil which does not exhibit Acid Mine Drainage (AMD) properties will also be used for other purposes such as construction of the ROM pad, haul roads and vegetated visual-screen bunds, which will be constructed along the highway.

The opencut mining method is discussed further in Section **Error! Reference source not found.**.

3.2.2.1 Overburden Stripping

Overburden stripping will commence following the construction phase in Year 1 (Year 2018) of mining and blasting will be required to improve the efficiency of the excavators and reduce equipment damage.

The extent of blasting will be dependent on the various overburden types and relative thickness in a typical cross-section running from west through to east through the opencut mining area. It is anticipated the superficial surface layer, comprising mostly clayey sand or sand and the Tertiary layer composed of sandy clay will be free dig with only some areas requiring light blasting due to homogeneity and compactness of the material. However, where the Tertiary contains strong basalt, blasting will be required.

Overburden stripping will advance from the south and progress north towards the Capricorn Highway. Year 6 (Year 2023) will see the greatest quantity of overburden stripped with approximately 32,568,000 loose cubic metres (lcm) excavated, however, during this time overburden will be backfilled into the opencut pit.

The total overburden stripped for the opencut operation is anticipated to be approximately 158.4 million lcm. The schedule of overburden stripping is outlined in the mining sequence provided in Figure 3.13.

3.2.3 Underground Mine Access and Integration

The underground mine area lies to the north of the Capricorn Highway. The mine access will be via the final opencut highwall, in the north-west corner of the pit. An access ramp will be formed in the spoil along the western wall of the opencut pit and will be wide enough to accommodate a conveyor and access road. This access ramp will be formed progressively during the first 4 years of opencut operation. From the highwall, three to five entries will be driven northward in the coal seam underneath the Central West railway and Capricorn Highway to reach the underground mining area to the north (refer to Figure 3.6 for locations details of the underground access ramp).

The underground mine will be constructed via longwall mining techniques, from panels that run along the tenement in an east - west direction extending across to the postulated eastern boundary fault.

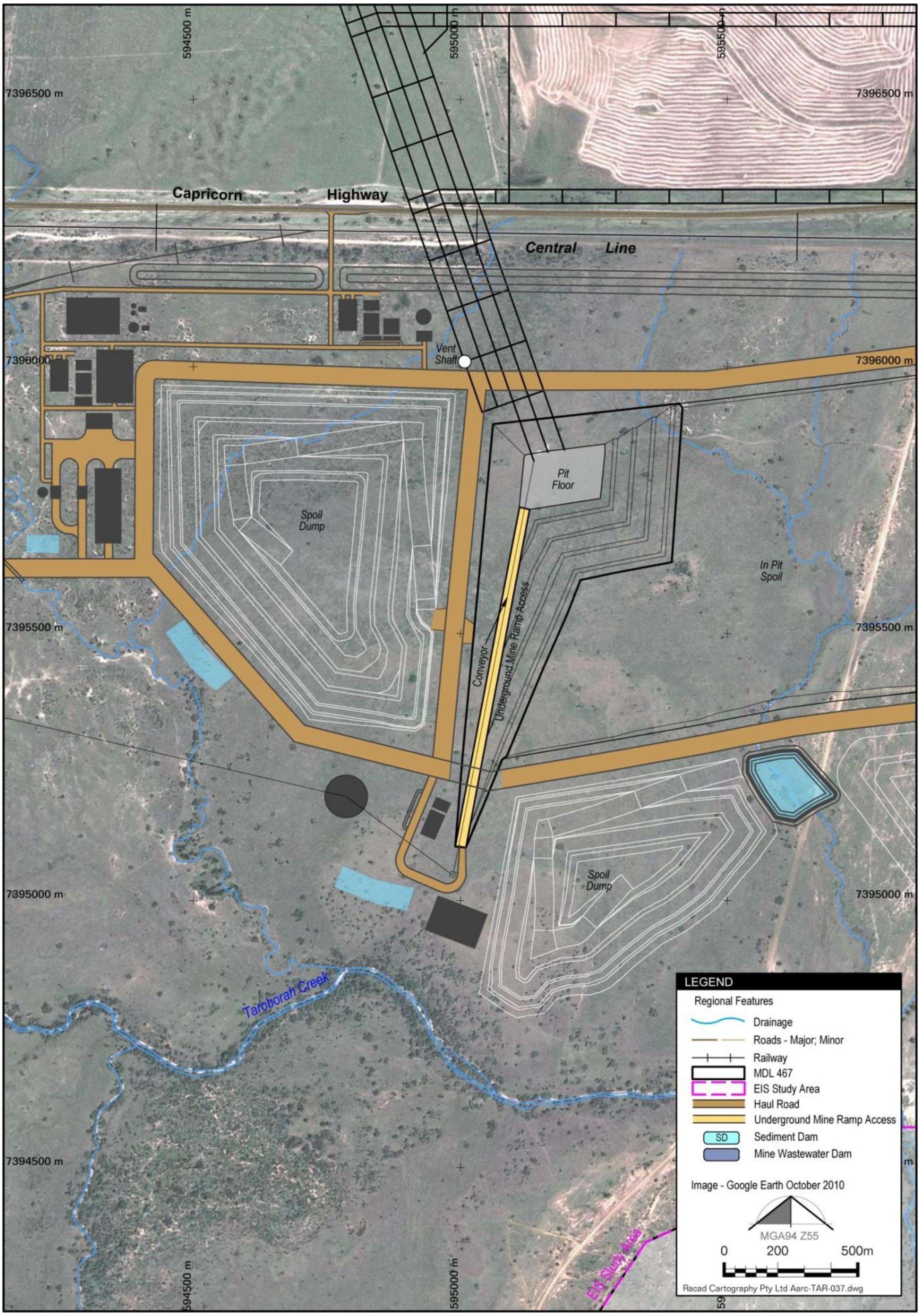


Figure 3.6 Underground Ramp Access

3.2.4 Coal Handling and Preparation Plant

The coal preparation plant and associated coal handling infrastructure will be partially constructed off-site for completion and erection on site. Certain components of the CHPP will be delivered to site by road.

The CHPP will be constructed over the first nine months of 2018 using typical materials and equipment such as specialty fills, concrete and steel components. The CHPP will be erected using various size cranes (ranging from 20t to 180t), D10 dozers, front end loaders, articulated dump trucks, compactors and rollers etc.

Specialist fabricators will be employed to build this plant and associated infrastructure.

3.2.5 Spoil Dumps

The overburden and interburden encountered during development of the opencut pit will initially be stored in out-of-pit dumps. These dumps will be constructed in close proximity to the opencut pit to reduce haul distances, limiting diesel consumption and potential dust nuisance.

An assessment of the spoil characteristics has been undertaken to effectively manage any potential acid, neutral and alkaline drainage issues during the construction of out-of-pit spoil dumps (details of spoil characterisation are provided in Appendix 12).

Initially, construction of the dump will require a 1m deep layer of Non-acid Forming (NAF) material to form the base. Selective handling will be employed to isolate Potentially Acid Forming (PAF) spoil, which will be set back from the face of the dump and compacted during dumping, reducing the transport of oxygen, limiting the potential for AMD. The outer faces of the dump will be constructed with NAF material and rehabilitated once enough room is available in the opencut pit to commence in-pit dumping.

A system of surface water drains will be constructed around the spoil dumps in order to ensure that surface water streams (clean and dirty) are managed separately and contaminated water that may shed from the out-of-pit spoil dumps is managed effectively.

3.2.6 Rail Facility

A train load-out (TLO) facility and rail loop will be constructed on site adjacent to the CPP, in order to transport product coal from the Project site to the Central West rail system (refer to Figure 3.5).

These systems will be constructed by specialist contractors who are managed on site by Shenhuo. The rail facility and rail loop will be constructed over a period of 12 months to accommodate a 26.5 TAL using cut and fill materials onsite as well as standard imported base and ballast. Many items used for the construction of the CPP will also be transferred to assist in the construction of rail infrastructure including various size cranes, concrete and steel components together with articulated dump trucks, front end loaders and compactors etc. It is anticipated the construction of the rail facility and rail loop will be completed by mid-2018 in preparation for thermal coal export.

3.2.7 Regulated Dams

Assessment of the proposed surface water management facilities for the Project, which are described in Section 3.5.3.4, was undertaken against the guidelines contained in the *Manual for Assessing*

Consequence Categories and Hydraulic Performance of Dams (EHP Publication EM635, 2013). Based on this assessment, which can be found in Appendix 13, two regulated dams will be constructed on the Project site in order to collect and supply the Project with adequate water and are described below:

- The Mine Wastewater Dam (MWD) – The purpose of the MWD is to store groundwater inflow and rainfall runoff from in-pit spoil pumped from the opencut pit and underground groundwater inflow; and

- The CPP Water Recycle Dam (CPPWRD) – The purpose of the CPPWRD is to store recovered process water from the CPP, MIA and out-of-pit spoil rainfall water runoff, and excess water from the MWD (as volume allows).

Regulated dams will be designed and constructed in accordance with and conform to the requirements of the EM635 guidelines.

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

Construction of the dams will require the use of various size dozers, front end loaders, excavators and graders supplemented by articulated dump trucks, compactors and rollers etc.

The commissioning of regulated dams will take place prior to the production phase of the Project during approximately mid- 2018.

3.2.8 Overland Flow Protection Bunds

Earthen bunds will be constructed along the perimeter boundary of mine associated infrastructure, diverting clean rainfall run-off water from the natural catchment to tributaries associated with Taroborah Creek. Additionally, earthen bunds will be constructed around the perimeter of the opencut pit to protect against overland flow generated from heavy rainfall potentially flooding the opencut pit. These structures are considered pit protection bunds rather than clean water diversion drains as they do not normally receive water from the upstream catchment.

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

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

The construction of flood protection bunds will take place during the initial construction phase and opencut pit development. Similar to the construction of regulated dams, sufficient material can be

sourced from the rail loop cut material and the initial opencut surface in the form of NAF spoil and clays, and construction will require the use of various size dozers, front end loaders and excavators etc.

3.2.9 Visual Amenity Bund

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

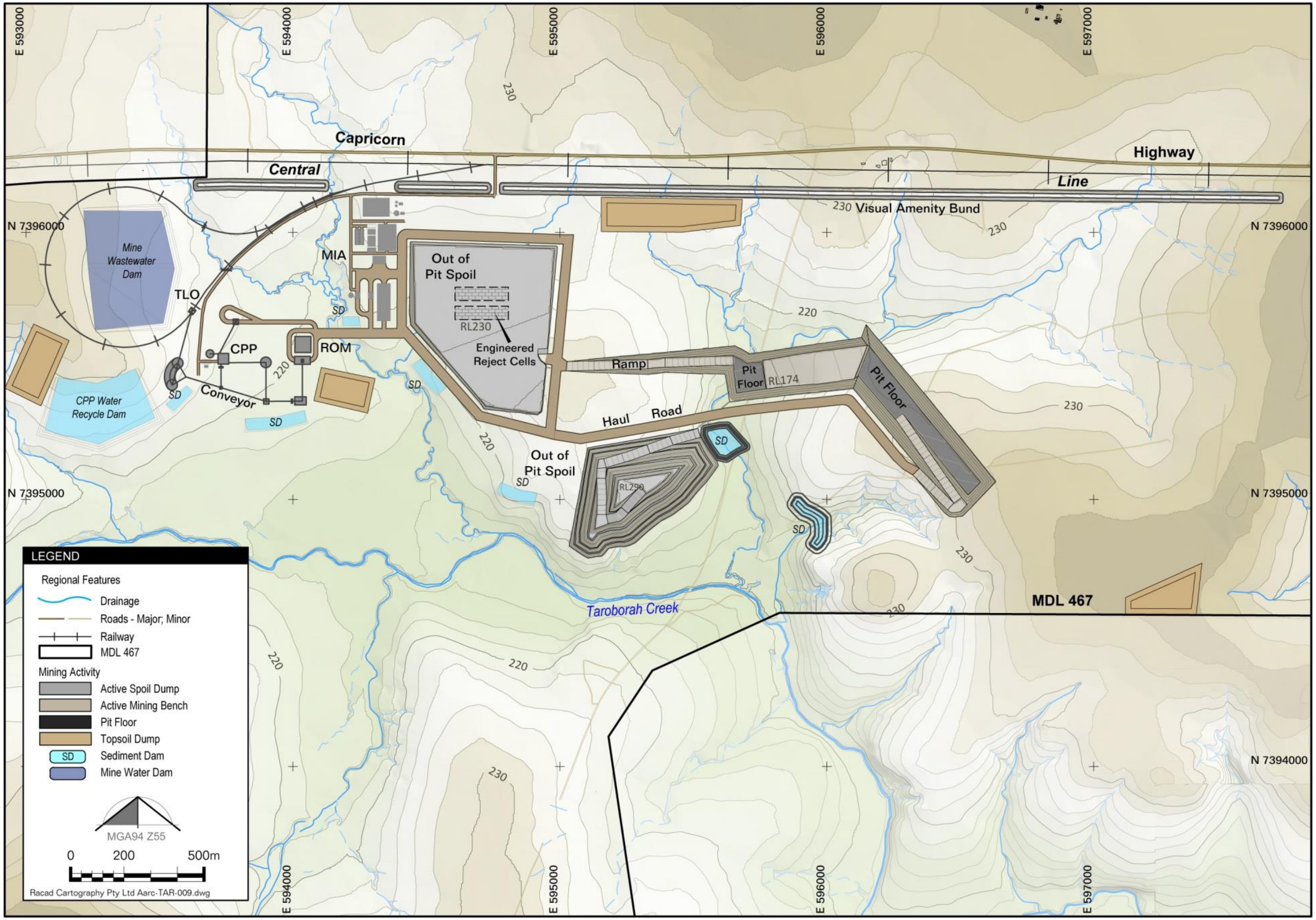


Figure 3.7 Visual Amenity Bund South of the Capricorn Highway

3.2.10 Mine Infrastructure Area

During the initial construction period, the majority of components associated with the MIA will be pre-fabricated in readily transportable units off-site and assembled on-site by specialist contractors to form a significant aspect of the mining operation and, where logistically practical, other components will be fabricated on site.

Certain features of the MIA such as access roads, internal roads, buildings, services, water treatment facilities, rail loop, ROM coal handling pad and the CPP shall be constructed prior to the development of the opencut pit, whereas other aspects such as water storage and drainage structures, visual amenity bund and product coal handling facilities shall be constructed concurrent with the initial pit development.

Components of the MIA will be sourced from various locations within the Central Highlands region, greater Queensland, Australia and overseas**.** Construction of the MIA is anticipated to be largely undertaken by workers sourced in the local area and greater Queensland region and completed by October 2018.

3.2.11 Construction Workforce

The Project will require two separate construction phases, one during initial opencut mining development, anticipated to be completed within 12 months and the other during underground mine development, which will begin in Year 5 of operation and take approximately 6 months.

Project construction will be conducted by specialist contractors that are managed by Shenhuo representatives both via a site-based management team and from Brisbane. During the combined 18 month construction period it is anticipated that construction staff numbers will peak at 150. Figure 3.8 illustrates the anticipated annual construction workforce numbers during both construction phases of the Project.

Where possible, construction staff will be sourced from the local population and a contracted bus-in, bus-out (BIBO) system will be employed to transport locally based construction staff from Emerald to the Project site.

Non-local construction staff will be housed in available temporary accommodation in Emerald and also bussed to and from the site where practical. Further details of the Project's accommodation strategy are discussed in Section 4.10.

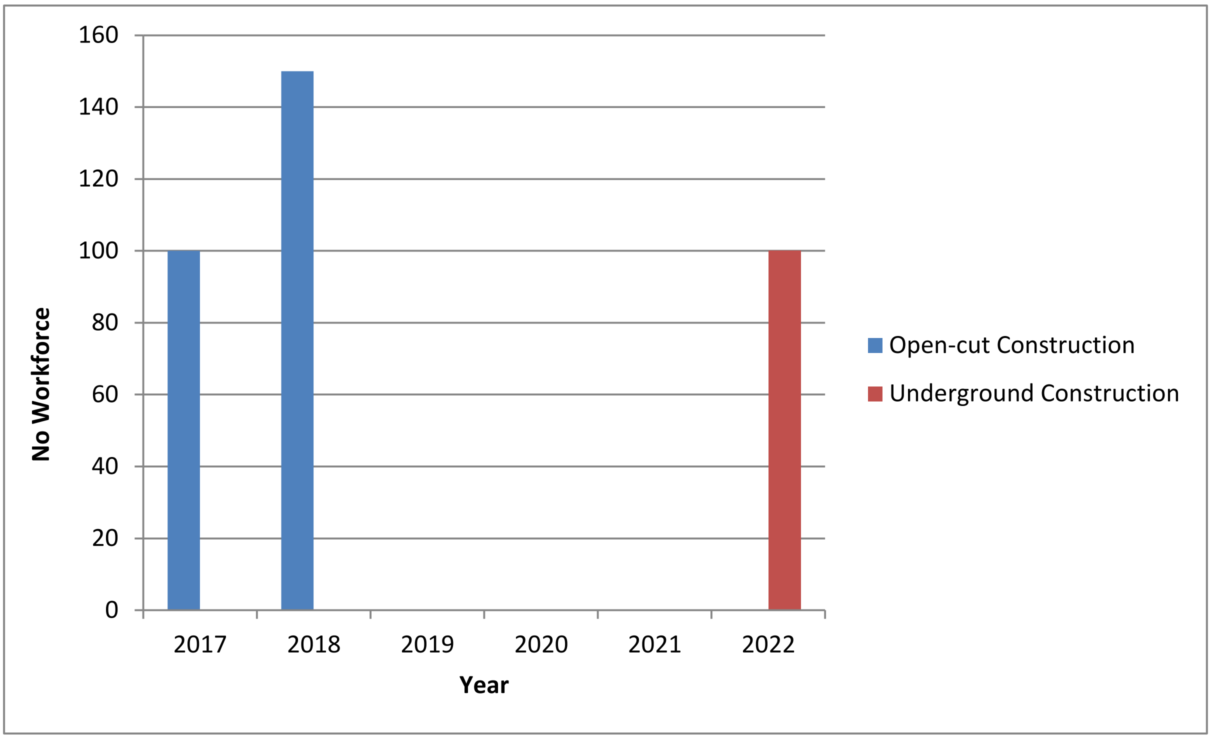


Figure 3.8 Proposed Construction Workforce During Opencut and Underground Construction Phases

3.3 OPERATIONS

3.3.1 Tenements and tenures

The Project will operate within the bounds of MDL 467 (refer to Table 3.4). No other coal, mineral, petroleum, greenhouse gas or geothermal tenements have been identified that overlap MDL 467. However, a number of coal or mineral tenements do lie adjacent to the Project tenement (MDL 467) which are listed in Table 3.5 and illustrated in Figure 3.9.

Table 3.4 Relevant Mining Tenements

Tenement	Holder	Status	Granted/Lodged	Expiry
MDL 467	Shenhuo International Group Pty Ltd	Granted	28 October 2013	31 October 2017

Table 3.5 Surrounding Mining Tenements

Tenement	Holder	Status	Granted/Lodged	Expiry
EPC 1011	Shenhuo International Group Pty Ltd	Granted	1st February 2006	31st January 2015
EPC 1977*	ACN Mining Pty Ltd	Granted	19th April 2011	18th April 2016
EPC 1000*	RMA Energy Limited	Granted - Renewal Lodged	31st May 2006	30th May 2011
EPC 2323*	ACN Mining Pty Ltd	Granted	27th June 2011	26 June 2016
EPC 1826*	ACN Mining Pty Ltd	Granted	31st July 2012	30 July 2017
EPC 2093*	ACN Mining Pty Ltd	Application	1st April 2010	N/A
EPC 2095*	Citation Resources Operations Pty Ltd	Application	1st April 2010	N/A
EPC 2086*	Stanmore Coal Limited	Application	1st April 2010	N/A
EPC 2705*	RDB Coal Pty Ltd	Application	1st August 2011	N/A
EPC 2702*	Great White Nominees Pty Ltd	Application	1st August 2011	N/A
Exploration Permit for Minerals (EPM) 17924*	Shenhuo International Group	Granted	21st May 2010	20th May 2015
Exploration Permit for Petroleum(EPP) 693	BNG (Surat) Pty Ltd	Granted	19thNovember 2001	30thNovember 2017
Mining Lease Application (MLA) 70499	Shadowfax Minerals Pty Ltd	Application	5th April 2013	N/A

* tenement directly adjacent to MDL467, Source: DNRM Interactive resource and tenure maps

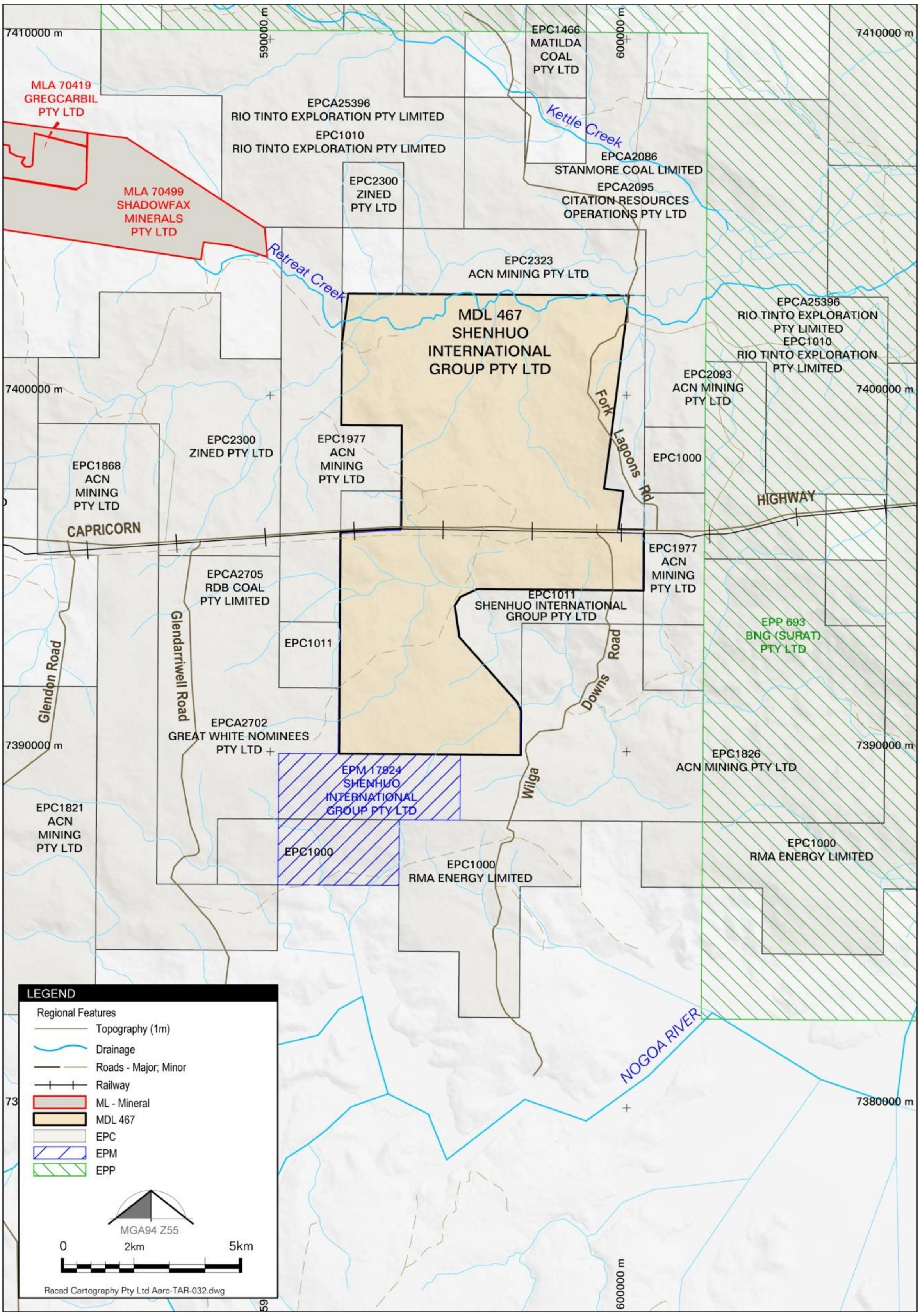


Figure 3.9 Exploration and Mining Tenements within the Vicinity of MDL 467

3.3.2 Resource Base and Mine Life

3.3.2.1 Mine Life

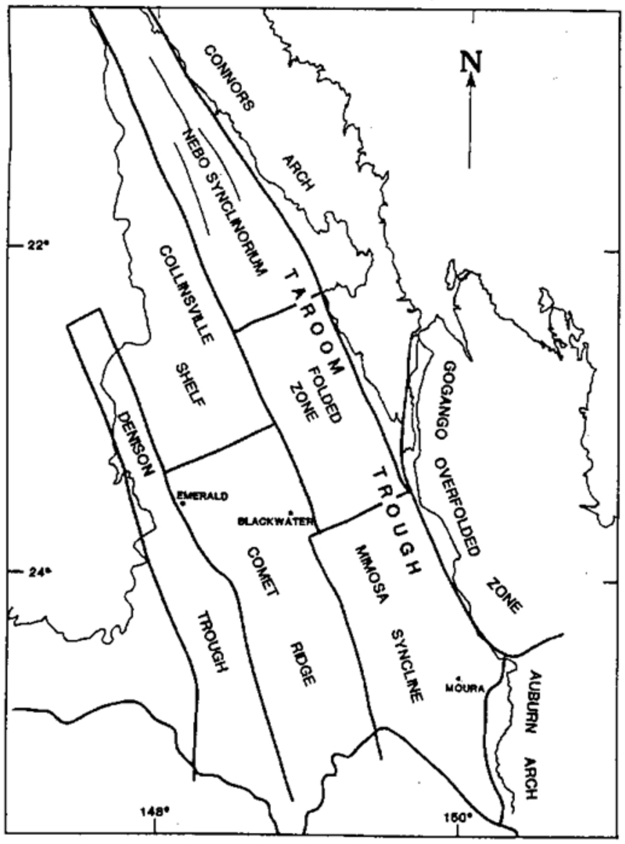
The Project has an estimated mine life of 22 years including construction, operation and decommissioning. The Project is anticipated to mine up to 5.75 Mtpa of ROM coal and 5.73 Mtpa of product coal at peak production between the years 2018 to 2038 of mine life.

Initially, the construction phase of the Project is anticipated to last 12 months, followed by 20 years of thermal coal production, during which time progressive rehabilitation will take place. By Year 5 of the mine life the underground construction phase will begin, concurrent with opencut operations, and be completed within 6 months. The final 15 months of mine life will be associated with decommissioning of infrastructure, ensuring a safe and stable landform and completion and monitoring of rehabilitation.

3.3.2.2 Resource Base

Seam Stratigraphy

The Project is located on the western edge of the Bowen Basin in the Denison Trough, where two successions of marine-bed coal measures lie un-conformably over the Retreat Granite and Devonian-Carboniferous sediments (refer to Figure 3.10 and Table 3.6).



Source: IMC 2009

Figure 3.10 Bowen Basin Main Structural Elements

Table 3.6 Bowen Basin General Stratigraphic Units

Tectonics		Southeast	Southwest	Central		Northern	Coal Group	Facies
Compression with local sag	Foreland Basin Phase	Rowan FM	Rowan FM	Rowan FM		Rowan FM		Terrestrial flood plain & flood basin
sag		Rangal CM	Bandanna FM	Rangal CM		Rangal CM	IV	Coal measures gradually extend from the north to eventually cover all the basin
		Gyranda FM	Black Alley Sb.	Burngrove FM Fairhill FM		Fort Cooper Coal Measures	IIIa	
		Flat Top FM	Peawaddy FM	McMillam FM		Moranbah CM	III	
			Catherine FM / Crocker S/S	German CK FM				
Compression		Barfield	Ingelara FM	Maria FM		Blenheim FM		Widespread transgression with no non marine known
			Freitag FM	West	East			
	Transition	Oxtrack FM	Upper		Back Ck. Group	Gebbie	I	Shallow & marginal marine with local coal measures
		Brae FM	Aldebaran FM	Blair Athol CM		Collinsville CM		
		Pindari FM	Lower			Formation		
sag	Extension Phase	Camboon Volcanics	Cattle Ck. FM	.		Tiverton FM		Marine transgression with some coals
			Upper Reids Dome Beds					
Extension rifts			Reids Dome Beds	Upper Reids Dome Cong	Camilla Beds	Lizzie Ck. Volcanics		Coals in west volcanics (mainly terrestrial) in east

Source: IMC 2009

These successions of marine-bed coal measures are comprised of five coal seams, with the top two seams (referred to as "A" and "B" seams) being the thickest and therefore, most commercially viable in terms of mining. The lower seams are too deep for economic opencut extraction and too thin for economic underground extraction.

The A and B seams are thought to be equivalent to the Cetus and Cygnus seams of the Freitag Formation, which occurs near Tieri to the north-east of Emerald. The Freitag Formation contains thin and often split paralic coals, unrepresentative of consistent and widespread seams.

The B seam is sub-divided into two separate groups, the B tops and B bottoms, based upon a distinguishable change in coal quality that occurs within the B seam. Cover depths of the A seam range from 30-40m at the subcrop with a maximum depth of over 190m in the northern extent of the tenement. Cover depths for the B seam range from 40-50m at the subcrop and reach a maximum of over 200m in the north.

The coal resource was classified in 2010 by IMC into measured, indicated and inferred confidence categories in accordance with the JORC Code (*Australasian Code for the Reporting of Exploration Results Mineral Resources and Ore Reserves* 2004 Edition). It is estimated that the total resource within the MDL is 202.1 Mt of *in-situ* coal, which is comprised of the following categories:

- 150.5 Mt Measured Resource - sufficient data is available (at least three observation points within a 500m proximity to each other) to reliably estimate coal extent, thickness, depth and quality with a high level of confidence;

- 37.3 Mt Indicated Resource - data acquired from at least three observation points within a 1000 m proximity to each other, providing a reasonable level of confidence to estimate coal extent, thickness, depth and quality; and

- 14.3 Mt of Inferred Resource - a low-confidence resource estimate in terms of coal quantity and quality, with at least three observation points within a 2000m radius.

The average yield for opencut coal (washed A seam and B tops) has been estimated to be 68.4%, whilst the average yield for underground coal (which will require minimal washing based upon a <1% sulphur seam section) has been estimated to be 99.3%.

Seam Thickness

Seam thicknesses for both the A and B seams have been modelled based upon exploration drilling data depicted in Figure 3.11. This data indicates the A seam thickness ranges from 0.1m in the north-west of the resource area to a maximum of 1.9m in the southwest and south central sectors of the Project site.

The B seam thickness remains reasonably consistent throughout the resource area; averaging about 3m (refer to Figure 3.12 for exploration drilling sites). Slight reductions in B seam thickness are observable to the east of the opencut resource area, with seam thickness ranging between 2.7 – 3m. Further reductions occur in the north of the underground resource area with seam thickness declining to 2.3 - 2.5m, since approximately 0.5m of the seam's base splits off onto the B seam floor.

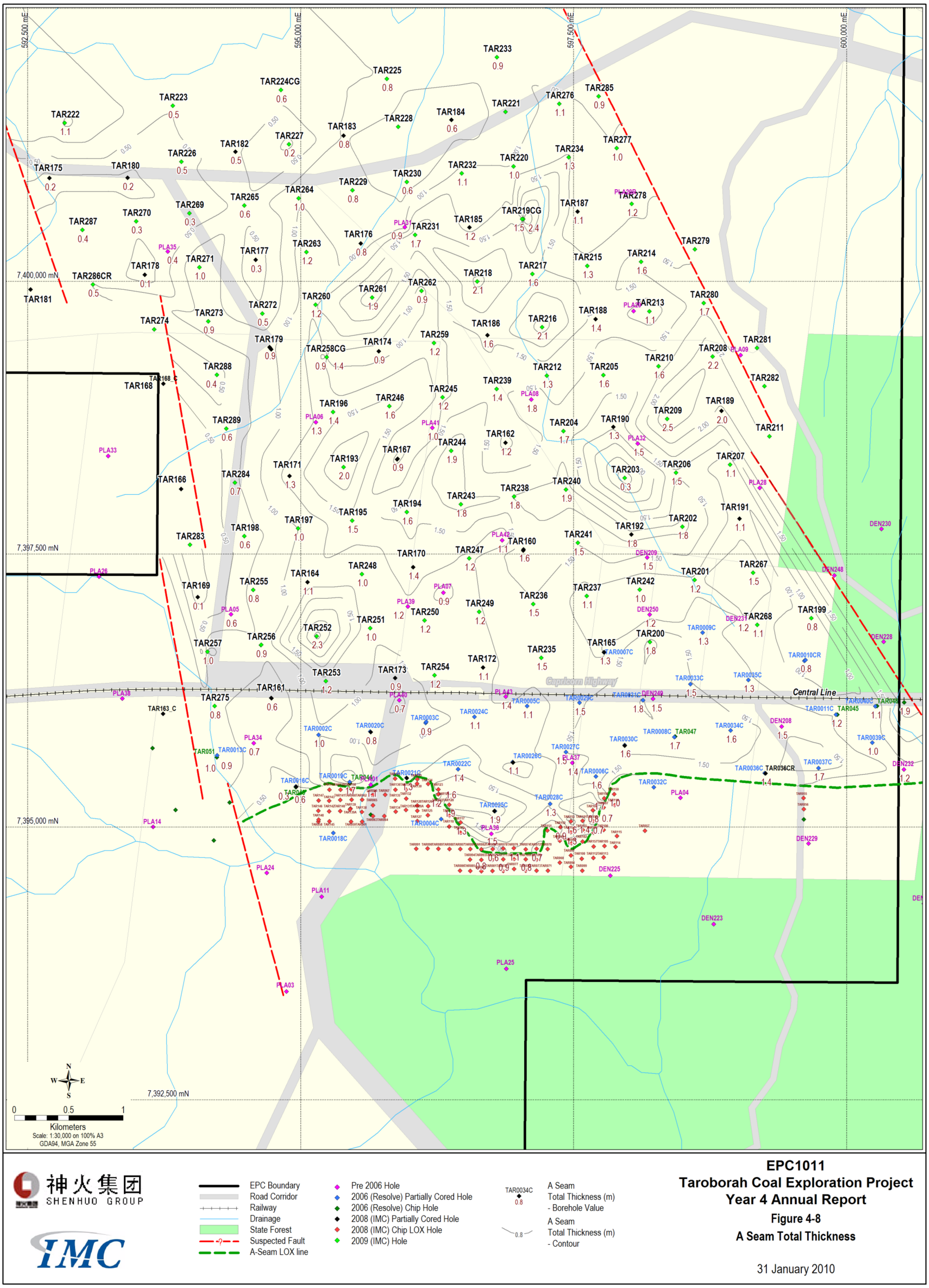


Figure 3.11 Coal Seam "A" total thickness

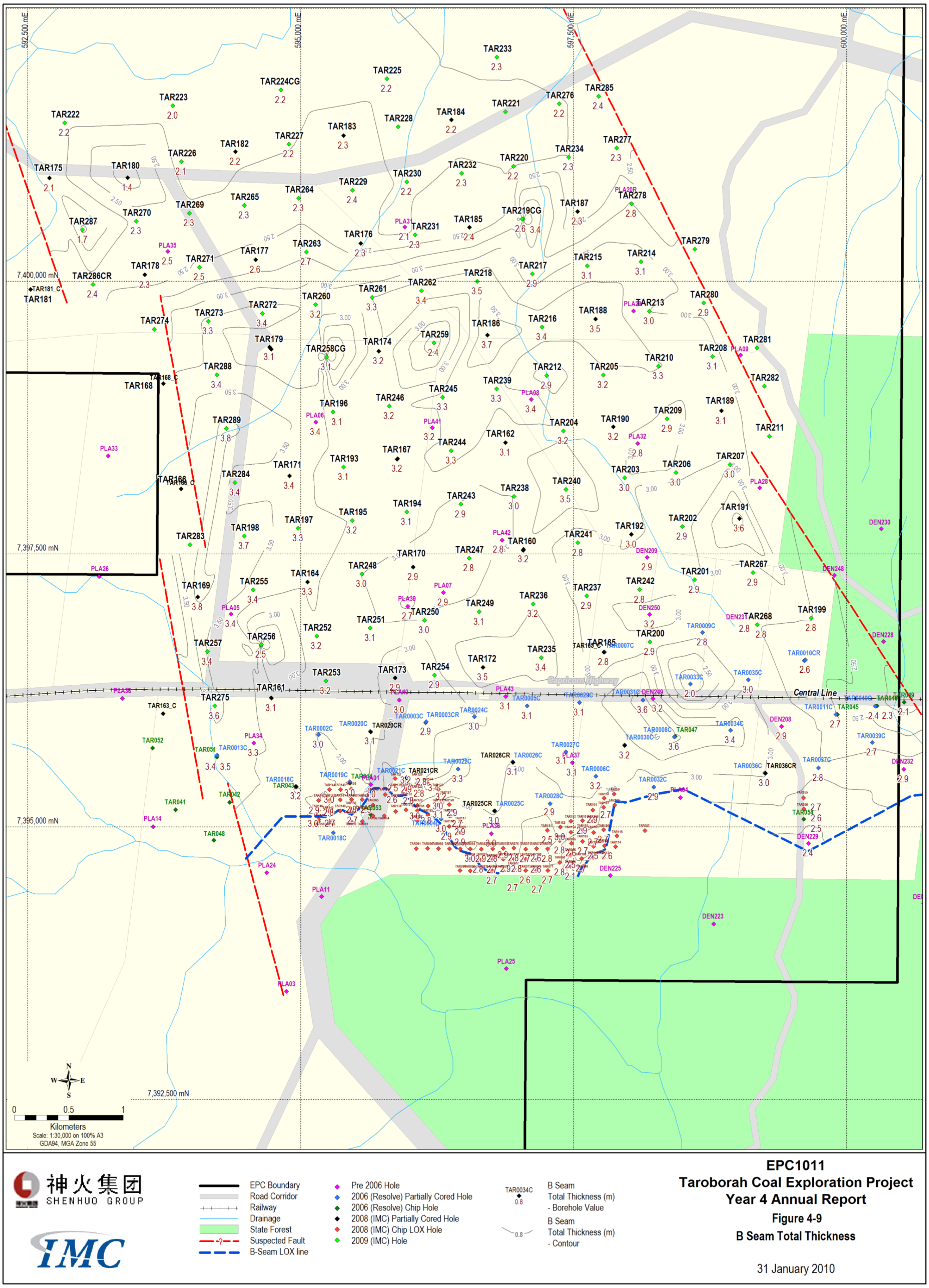


Figure 3.12 Coal Seam "B" total thickness

Coal Quality and Recovery

The B seam has been sub-divided into two separate sections on the basis of sulphur content. Total sulphur concentrations for raw coal from the 0.5m thick B tops seam section range from <1% to 20% (air dried (ad)). Similar sulphur concentrations were recorded for the A seam with an average value of 10% (ad). Coals with such elevated sulphur concentrations are not saleable and therefore require washing. In contrast, coal sampled from the B bottoms seam section recorded an average sulphur concentration of 0.9%; therefore, ROM coal from this seam section can be mined and transferred to the coal product stockpile with minimal washing.

Due to the expressed coal quality, only the A and B coal seams (A, B tops and B bottoms) are economically viable for extraction via opencut mining methods. Underground coal extraction, via the longwall method, will recover only the B seam sections, with depths ranging from 80-100m just north of the Capricorn Highway to a maximum of around 180m in the northern most longwall panel.

Opencut

At the Project's pre-feasibility stage, the key indicator for opencut mining economic limits was the stripping ratio, expressed in bank cubic metres of waste (striped material) per coal tonnage (bcm/t). A projected increase in strip ratio from 8 bcm/t in the south-west sector of the opencut resource area, to over 15 bcm/t in the north and east sectors has been determined from exploration drilling. Estimations of economic stripping ratios range from 8 bcm/t to approximately 14 bcm/t, therefore, a number of potential strip blocks have been excluded from the mine plan.

A total of 11.5 Mt of recoverable coal is estimated to be available within the planned opencut strips, comprising 3.7 Mt from the A seam and 7.8Mt from the B seam. The proposed in-pit strip configuration and extraction schedule is presented in Figure 3.13.

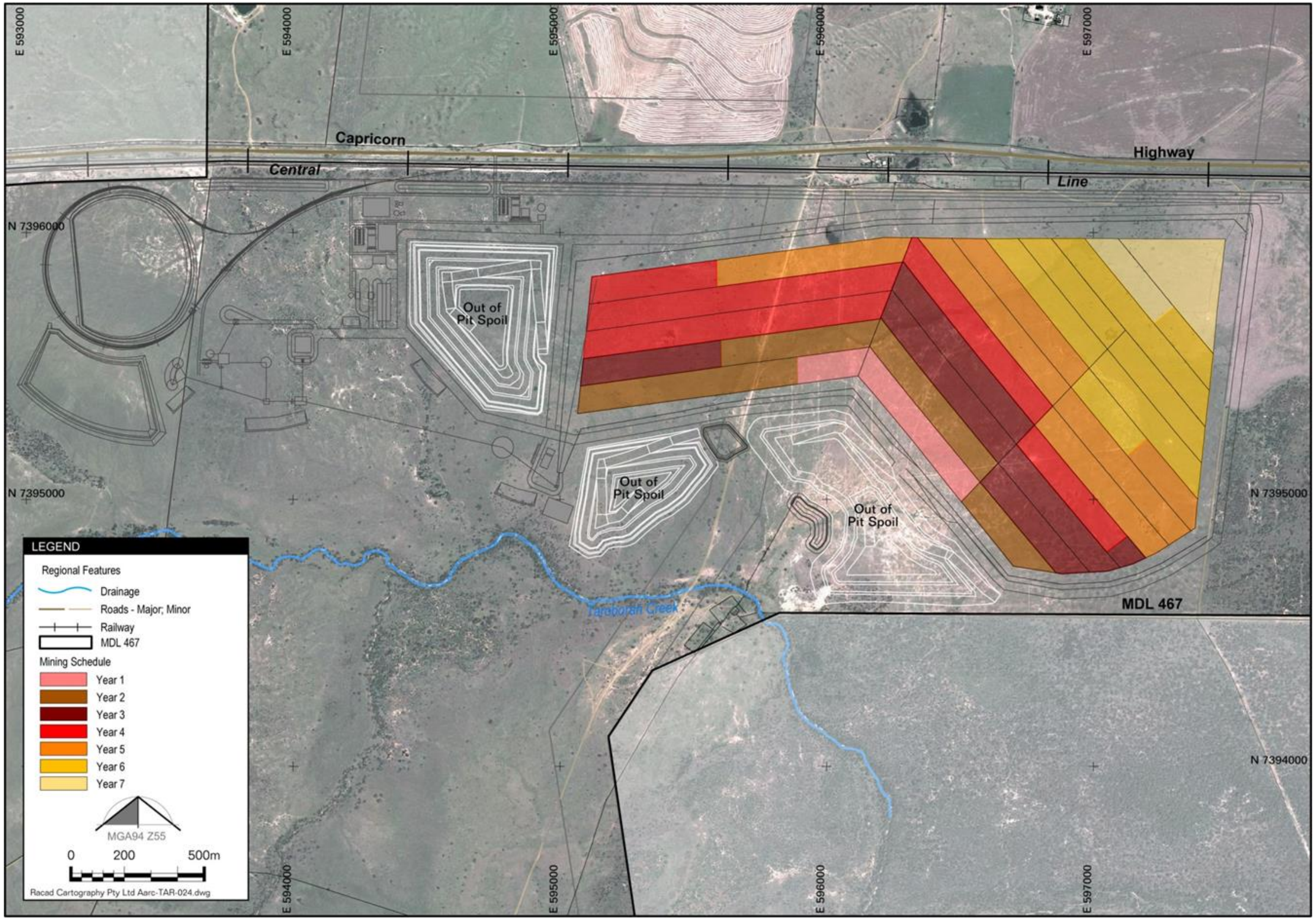


Figure 3.13 Opencut Operation Strip Layout

Underground

The underground mine operation (located north of the Capricorn Highway) will utilise longwall mining techniques within the B bottoms or full B seam, in order to ensure that the sulphur concentrations in underground ROM coal are less than 1% with minimal coal washing.

The layout of the proposed longwall mine is presented in Figure 3.14 with the longwall panels (LW) divided by Maingate (MG) and Tailgate (TG) roads[1]. Each of the mining blocks have been modelled and the mining section selected to ensure that the desired minimum mining thickness and average quality parameters are achieved during underground mining.

In order to estimate the tonnages of ROM coal available from the underground mine, out of seam dilution and coal washability parameters were included in underground production calculations. Where the average ROM sulphur concentration exceeded 1%, the amount of this coal that had to be washed and blended with low-sulphur ROM coal, in order to produce a final coal product with a sulphur concentration less than 1%, was estimated.

Estimates of recoverable underground coal have been developed (based upon the above parameters) and are presented in Section 3.3.4 in Table 3.10. The longwall mine plan includes 4.3 Mt of ROM development coal (produced during the formation of development headings which are used to create new longwall panels) and 64.3 Mt of ROM longwall coal. Since coal with a sulphur concentration of generally <1% will be mined, minimal coal washing will be required for this material and total washing yields are anticipated to average 99.3%, resulting in 68.1 Mt of saleable product coal from the underground mine.

[1] Gate roads are driven to the back of each panel before longwall mining begins. The gate road along one side of the block is called the *maingate*; the road on the other side is called the *tailgate*.

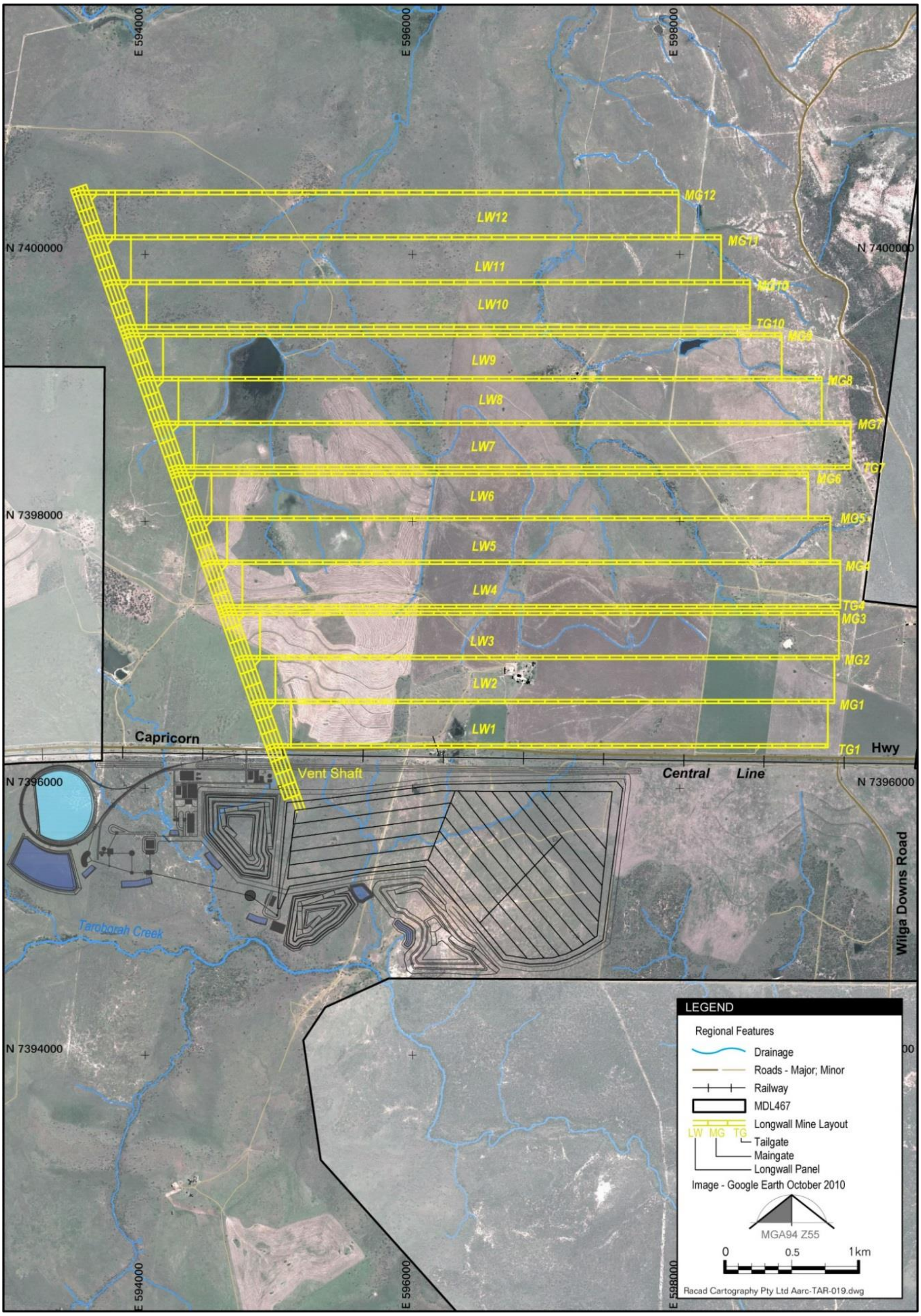


Figure 3.14 Longwall Mine Layout

3.3.2.3 Resource Sterilisation

Viable areas of coal resource have been delineated during pre-feasibility studies via geological interpretations and exploration drilling.

Pre-feasibility mine planning considered all viable resource within economic and practical mining limits, determined as maximum stripping ratio of approximately 14 bcm/t for the opencut and average minimum mining thickness >2.4m for the underground mine (assuming a maximum cutting height of 3.5m and a practical 1m operating range of longwall equipment). Considering these economic and practical mining limits, a number of potential strip blocks in the east were excluded from the opencut mine plan and underground mining was curtailed to the north due to seam thinning.

Subsequent to the pre-feasibility study, new legislation concerning the avoidance of opencut mining of Strategic Cropping Land were introduced, which resulted in the further reduction of the opencut mining area in the eastern portion of shallow resources.

Respecting all viable coal resource within MDL 467 and Strategic Cropping Land restrictions, the MIA has been located south of the Capricorn Highway and west of opencut strip ratio limits to avoid economically viable coal seams and minimise the sterilisation of coal resources.

3.3.2.4 Other Resource Utilisation

In addition to the coal that is being mined, the Project will also require the following additional resources:

- Electricity – up to 91.6 million kWh / annum; and
- Water –between 1340 and 2680 ML / annum.

Further details concerning power and water consumption are provided in Sections 3.5.2 and 3.5.3.

3.3.3 Mining Methods and Equipment

3.3.3.1 Mine Setting

Mining methods and equipment selection have been influenced by the following local features and coal deposit characteristics:

- Relatively thin seams, with only two of the five seams being economically viable;
- Coal seams generally dip gently to the north away from the subcrop, except at the central west anticline, where the dip increases to 5^o;
- The local surface topography is relatively flat;
- The deposit exhibits a relatively high stripping ratio (waste volume / coal tonnage);
- The proposed depths of the opencut pit are relatively shallow, up to 85m;

- Overburden and interburden horizons vary in type and thickness, some units can be free dug (clayey sand, sand or weathered material), others require light blasting (partially weathered material), whilst the strong basalt units and competent sandstone require full blasting; and

- A multiple track, heavy-gauge railway system is not available at Taroborah.

3.3.3.2 Mining Methods

Prior to opencut mining, local vegetation will be cleared and the associated topsoil will be excavated and stockpiled for subsequent use in rehabilitation. Topsoil stockpiles will be managed in order to retain biological activity and soil structural properties.

Overburden, interburden and ROM coal will be extracted from the opencut pit via hydraulic excavators and rear dump trucks.

The overburden and interburden within the opencut pit area are comprised of a variety of geological materials. Unconsolidated clays, clayey sand, sands and highly weathered material are amenable to being free dug, partially weathered but consolidated material (sandy clay) will require light blasting, whilst strong basalt material and fresh, competent sandstone will require a concerted programme of blasting. Free dug and blasted material will be removed by hydraulic excavators and initially transferred via rear dump trucks to out-of-pit spoil dumps, which will be located at the southern edge of the opencut pit. However, once the opencut pit is large enough, in-pit dumping will be utilised.

Mining of the opencut pit will see both A and B coal seams selectively mined, with the A and B tops washed in the CPP to reduce sulphur concentrations in this material. The B bottoms material will not generally be washed as it predominantly exhibits sulphur concentrations less than 1% and will therefore bypass the CPP.

The overall yield of opencut washed A and B seam product coal has been estimated to be 68.4%, whilst the yield of bypassed (unwashed) B bottoms coal is estimated at 100%.

Underground mining of the B seam (<1% sulphur concentration) north of the Capricorn Highway, will be achieved by longwall full extraction mining and will commence five years after the commencement of opencut mining.

Longwall coal mining involves the development of a long, 300 m wide block of coal (or wall) within the coal seam . A number of roads ("headings") are developed to form main entries, with maingate roadways consisting of two headings developed generally perpendicular from the main headings for up to 5 km and then joined to the previous maingate or tailgate roadways to form the starting face of the longwall. This approach allows large rectangular blocks of coal (termed "panels") to be extracted in a single, continuous operation.

As the coal is being mined in 1 m slices from this coal face, the overlying rock of the longwall is allowed to collapse into the void behind. A safe working space is maintained along the mining face for the miners to operate the coal mining machinery via the use of hydraulic roof supports. As the mining face advances, the immediate roof above the coal is allowed to collapse behind the line of roof supports forming the collapsed "goaf" material.

Longwall panels will be developed in a west-east direction along strike and follow the coal seam as it dips towards the north of MDL 467.

Since spontaneous combustion represents a significant risk for underground mining, fire barrier pillars will be left between every fourth longwall panel. In addition, mine fans will be located out of pit on the surface and connected to the main headings by a vertical shaft in order to avoid potential combustion issues which arise as a result of air leakage from around the fan portal.

The longwall mine plan includes 4.3 Mt of ROM development coal (produced during the formation of development headings which are used to create new longwall panels) and 64.3 Mt of ROM longwall coal. Therefore, the recoverable, saleable product coal is approximately 68 Mt at an average yield of 99.3%. Access to the underground mine will be via the highwall in the western sector of the opencut pit.

3.3.3.3 Mining Equipment

Several important aspects were considered during the equipment selection process, for both the opencut and underground mining operations, including coal loss and dilution, machine integrity (including environmental performance) and machine productivity.

Opencut Mining

Opencut spoil extraction will be conducted via 550t hydraulic excavators loading 190t rear dump trucks. Once overburden has been removed, opencut coal mining will be undertaken with the assistance of 160t hydraulic excavators and 90t rear-dump trucks.

The Project's opencut mining fleet has been based upon opencut operational requirements, annual production targets (up to 2.78 Mtpa of ROM coal) and equipment productivities. The indicative mining fleet requirement, for each year of opencut operations, is presented in Table 3.7.

Table 3.7 Opencut Indicative Mining Fleet

Function and Equipment	Capacity	Maximum Operating Hours Per Machine / Year	2018	2019	2020	2021	2022	2023	2024
Waste Mining									
Hitachi EX5500	550t, 28m^3	5,745	1	2	3	3	3	3	2
Coal Mining									
Komatsu PC1600	160t, 10m^3	3,186	1	1	1	1	1	1	1
Caterpillar 988	46t, 7m^3	5,745	1	1	1	1	1	1	1
Waste Haulage									
Caterpillar 789	190t	5,184	6	13	12	14	13	14	12
Caterpillar 777 Water Truck	78 t	4,289	1	1	1	2	2	2	2
Coal Haulage									
Caterpillar 777	90t	4,289	2	2	2	2	3	3	2
Support Plant									
Large Track Dozer	634kw	4,289	2	2	2	2	2	2	2
Rubber Tyred Dozer	235kw	1,814	1	1	1	1	1	1	1
Small Track Dozer	228kw	4,289	1	2	2	2	3	3	3
Large Grader	205kw	4,289	1	2	2	2	2	3	3

Underground Mining

Underground longwall mining operations will require the use of two continuous miners for panel development and one 300m wide longwall system for panel extraction (primary production). The continuous miners will run in conjunction with cable shuttle cars, which haul the mined coal from the working face to the feeder/breaker at the panel conveyor boot-end. A total of 4 cable shuttle cars of 14t capacity each are projected to be required to service the two continuous miner sections.

The longwall system will consist of a shearer for mining the coal, an armoured face conveyor (AFC) for transporting the coal off the face, 150 hydraulic roof supports behind the face, a beamed stage loader for sizing the coal from the AFC and transferring onto the panel belt conveyor, and a pump station to supply high pressure solcenic (water based hydraulic fluid) to the roof supports.

In addition to the production fleet, a number of rubber tyred vehicles will be required to support operations, including worker transports, service vehicles, load haul dumps (LHD) (a vehicle used in underground mining) and a grader.

A summary of the indicative underground mining fleet is presented in Table 3.8.

Table 3.8 Underground Indicative Mining Fleet

Function &Equipment	Capacity	Maximum Operating hours per machine /year	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Coal Mining																			
Continuous Miner	10t / min	1300	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	0
Cable Shuttle Cars	12t	950	4	4	4	4	4	4	4	4	4	4	4	4	2	2	2	2	0
Feeder / Breakers	165t / hr	1300	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	0
Longwall System	3000t / hr	2800	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Support Equipment																			
Small LHD	10t	4,200	2	4	6	6	6	6	6	6	6	6	6	6	5	5	5	5	3
Large LHD	55t	4,200	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Man Transport	12 persons	3,500	3	6	8	8	8	8	8	8	8	8	8	8	6	6	6	6	6
Service Vehicle	4 persons	3,500	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Grader	85kW	2,800	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

3.3.3.4 Chemicals

A number of chemicals will be used on site in order to assist with the coal beneficiation process. Both cationic and anionic flocculants are required to settle out the fine solids in the fine rejects thickener and clarify the wash water. In addition, chemical coagulants will be required to assist with the thickening of fine rejects.

Magnetite will be used in the dense medium circuit, any circuit losses of this chemical which occur, will be topped up via a pump and stored in a dry-storage pit adjacent to the CPP.

Various other chemicals listed as Dangerous Goods under the *Australian Dangerous Goods Code 7th Edition* (National Transport Commission 2011) will be used and warehoused in dry storage conditions on the Project site, as listed in Table 3.9.

The estimated annual consumption of these chemicals is presented in Table 3.9.

Table 3.9 Chemical Inventory and Consumption

Chemical	Total Annual Consumption (kg)
Flocculent	25,000 (OC) – 15,000 (UG)
Coagulant	10,000 (OC) – 5,000 (UG)
Magnetite	315,000 (OC) – 165,000 (UG)
Detonators, primers, boosters, cord	11,250 (OC only)
ANFO: Explosives, Blasting, Type B: Or agent, Blasting Type B	4,050,000 (OC only)
Natural Gas – methane, compressed natural gas	Limited volumes to be stored on site
Acetylene (Acetylene, Dissolved)	Limited volumes to be stored on site
Paint related Materials	Limited volumes to be stored on site
C1 Combustible liquids – Diesel	15,750,000 (OC) – 4,500,000 (UG)
C2 Combustible liquids – Petroleum distillates, Petroleum & N.O.S Products, N.O.S	160,000 (OC) – 50,000 (UG)
Solcenic	27,000 (UG only)
Solvents	Limited volumes to be stored on site
Batteries	Limited volumes to be stored on site
Detergent	Limited volumes to be stored on site
Oxygen (compressed)	Limited volumes to be stored on site

3.3.4 Mine Sequencing

The Project mine plan is based upon initial development of a single opencut pit south of the Capricorn Highway over a period of seven years. The opencut pit will run east-west, parallel to the highway. After four years of opencut mining, an underground access corridor will be developed along the western end wall of the opencut, in order to gain access to the underground coal resource north of the Capricorn Highway. Longwall mining techniques will be employed to extract the underground coal.

During the initial six years of the mine life, opencut operations will contribute significantly to coal production until longwall operations become underway.

Initial opencut production will see approximately 0.51 Mtpa to 2.28 Mtpa of ROM coal and 0.43 Mtpa to 2.02 Mtpa of product coal being produced between Year 1 to Year 7 of production. Following this period, from Year 5 to Year 20 of production, underground operations will produce from 0.09 Mtpa to 5.75 Mtpa of ROM coal and 0.09 Mtpa to 5.73 Mtpa of saleable product coal.

Figure 3.15 and Figure 3.16 indicate the anticipated annual volumes of waste (overburden, interburden, coarse and fine rejects), ROM coal and product coal produced by the Project during opencut and underground operations respectively. Table 3.10 indicates the annual ROM coal, coal washing and product coal production schedule.

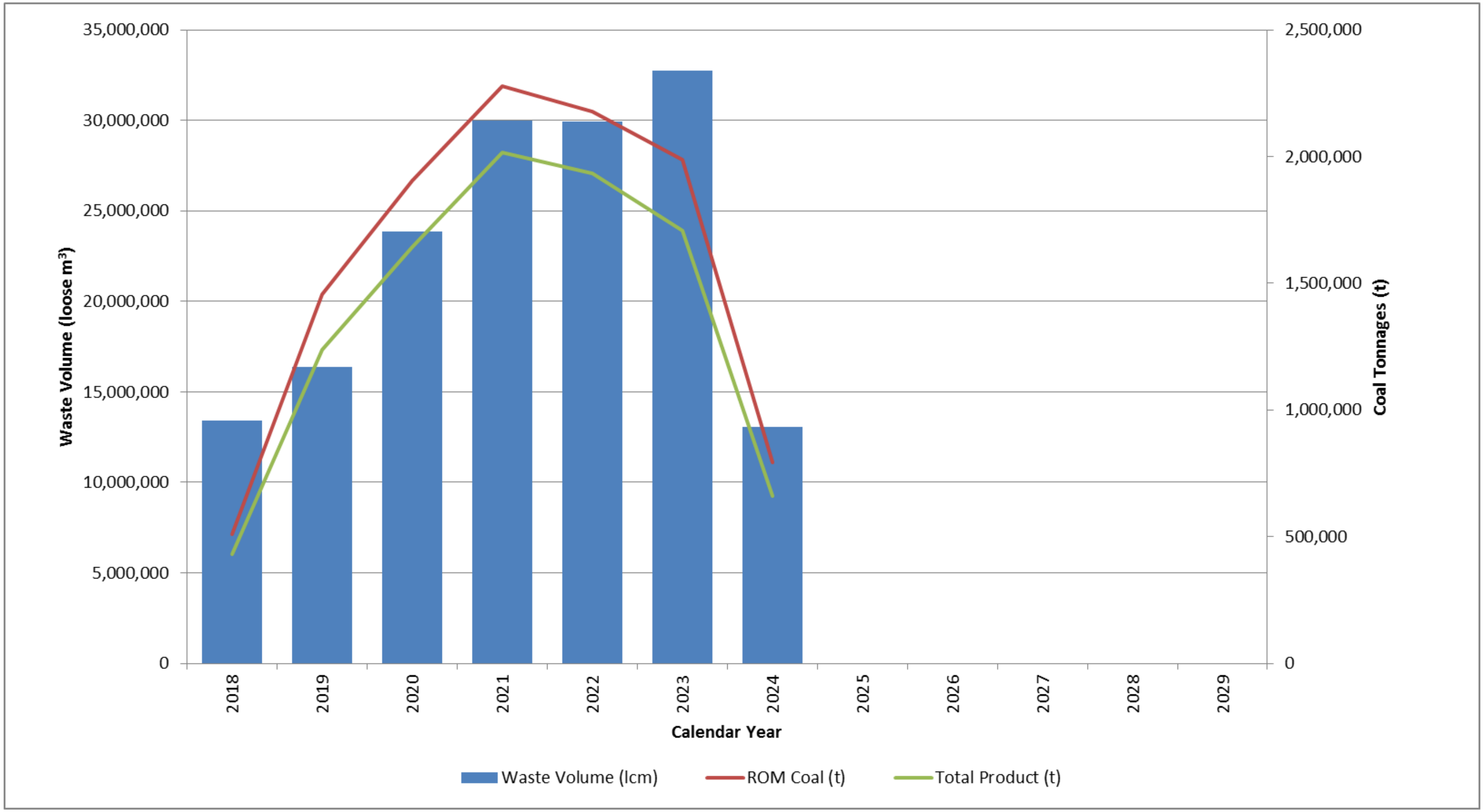


Figure 3.15 Opencut Annual ROM, Total Product and Waste Production (including rejects)

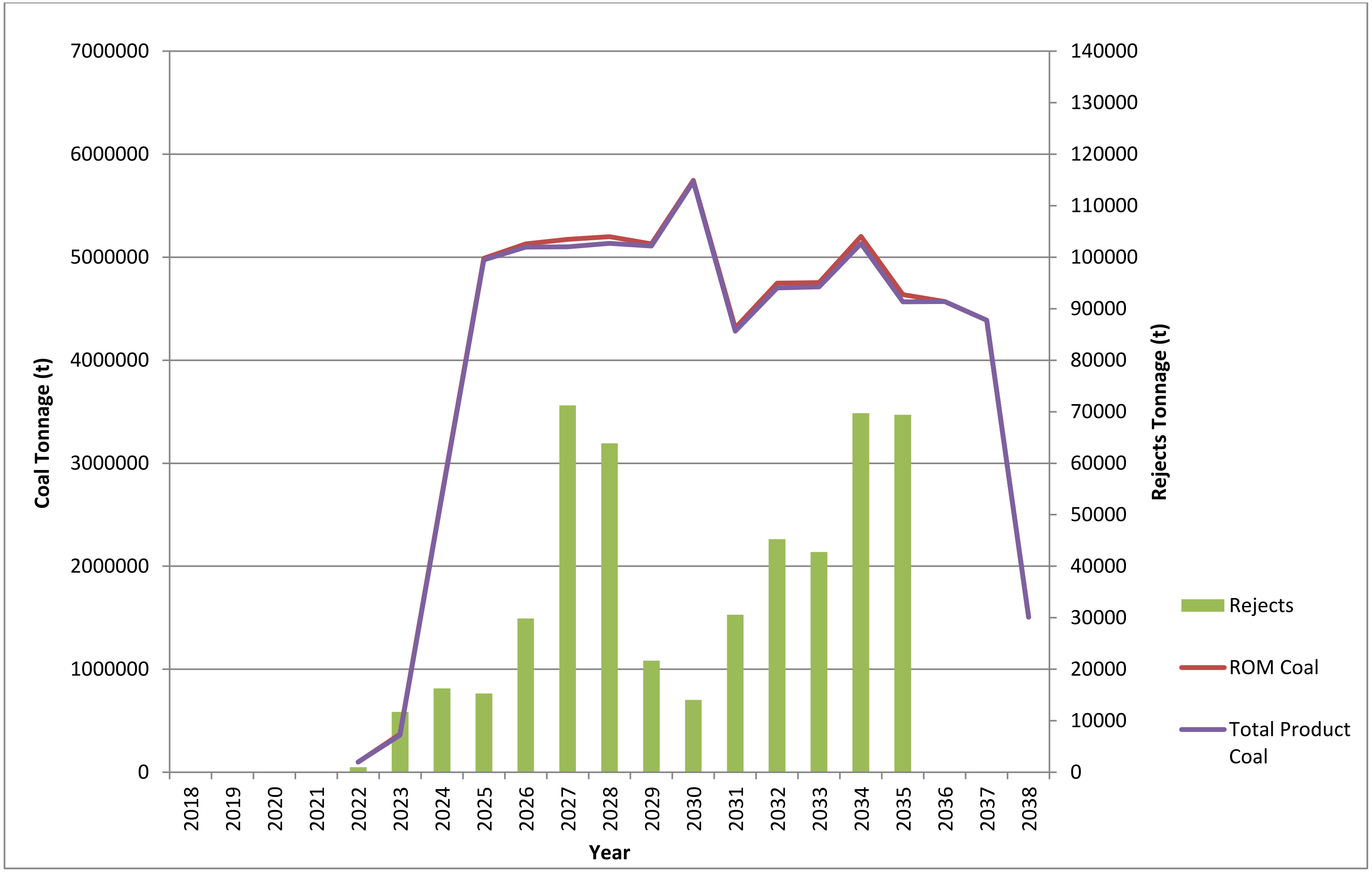


Figure 3.16 Underground Annual ROM, Total Product and Rejects Production

Table 3.10 Annual ROM, Coal Washing and Product Coal Production Schedule

Opencut Production Year	Underground Production Year	Expected Year	Mining Method		ROM Coal (t)			Coal Washing (t)			Total Product (t)		
					Opencut	Underground	Total	Bypassed	Washed	Rejects	Opencut	Underground	Total
1		2018			511,179		511,179	295,864	215,314	78,905	432,273		432,273
2		2019			1,456,517		1,456,517	868,011	588,506	218,082	1,238,435		1,238,435
3		2020			1,905,988		1,905,988	1,093,846	812,142	262,587	1,643,401		1,643,401
4		2021	Opencut		2,278,491		2,278,491	1,382,030	896,461	263,395	2,015,096		2,015,096
5	1	2022			2,177,615	98,460	2,276,076	1,446,268	829,808	245,728	1,932,892	97,456	2,030,348
6	2	2023			1,988,289	370,905	2,359,194	1,527,734	831,460	291,150	1,708,827	359,217	2,068,044
7	3	2024			793,847	2,693,072	3,486,919	3,046,411	440,508	151,066	659,036	2,676,817	3,335,854
8	4	2025				4,989,940	4,989,940	4,937,562	52,378	15,309		4,974,631	4,974,631
9	5	2026				5,129,130	5,129,130	4,878,384	250,745	29,851		5,099,278	5,099,278
10	6	2027				5,172,949	5,172,949	4,558,299	614,651	71,214		5,101,735	5,101,735
11	7	2028				5,198,559	5,198,559	4,637,504	561,056	63,864		5,134,695	5,134,695
12	8	2029				5,130,576	5,130,576	4,949,538	181,038	21,639		5,108,937	5,108,937
13	9	2030		Underground		5,746,405	5,746,405	5,654,731	91,675	14,018		5,732,387	5,732,387
14	10	2031				4,312,098	4,312,098	3,940,252	371,846	30,559		4,281,539	4,281,539
15	11	2032				4,747,456	4,747,456	4,395,385	352,071	45,273		4,702,183	4,702,183
16	12	2033				4,754,496	4,754,496	4,231,182	523,314	42,773		4,711,722	4,711,722
17	13	2034				5,201,350	5,201,350	4,404,811	796,539	69,719		5,131,631	5,131,631
18	14	2035				4,636,380	4,636,380	3,857,692	778,688	69,414		4,566,967	4,566,967
19	15	2036				4,569,902	4,569,902	4,569,902	0	0		4,569,902	4,569,902
20	16	2037				4,388,030	4,388,030	4,388,030	0	0		4,388,030	4,388,030
21	17	2038				1,506,275	1,506,275	1,506,275	0	0		1,506,275	1,506,275

3.3.4.1 Opencut

Opencut production will commence with mining of the lowest strip-ratio blocks (south-west sector of the pit), followed by progressive mining of the higher strip-ratio blocks (north and east sectors of the pit). Within three years, ROM coal will be mined at a rate of 2 Mtpa, with peak production of up to 2.28 Mtpa expected to be maintained for the next three years.

Initial opencut production (Year 1) will utilise one hydraulic excavator and associated rear dump trucks for overburden removal, and a combination of a hydraulic excavator and front end loaders plus two rear dump trucks for coal extraction. Two hydraulic excavators will be employed in overburden removal in Year 2, whilst three hydraulic excavators will be employed for overburden removal in Year 3 and beyond.

For the opencut pit, the A seam and B tops seam section will be washed to reduce sulphur concentrations. In contrast, the B bottoms seam section (representing about 58% of the in-situ coal) will generally not require washing in order to achieve its thermal coal specification for export.

Over the seven years of opencut operations, a total mass of approximately 11 Mt of ROM coal will be mined. Over the life of the opencut operations, on average, approximately 2 Mtpa of ROM coal will be produced comprising 1.3 Mtpa of bypass ROM coal and 0.7 Mtpa of ROM coal requiring washing.

An opencut production schedule for the Project is presented in Table 3.11, which includes the volumes of topsoil stripped, interburden / overburden excavated (stored via in-pit and out-of-pit spoil dumps), tonnages of ROM / product coal produced and pit disturbance areas.

Conceptual mine stage plans for Years 1, 3, 5, 7 and end of mine life, which depict progress of the mine at specific stages of development, including the development sequence of in-pit and out-of-pit spoil dumps, engineered reject cells and underground operations, are presented in Figure 3.17 to Figure 3.21.

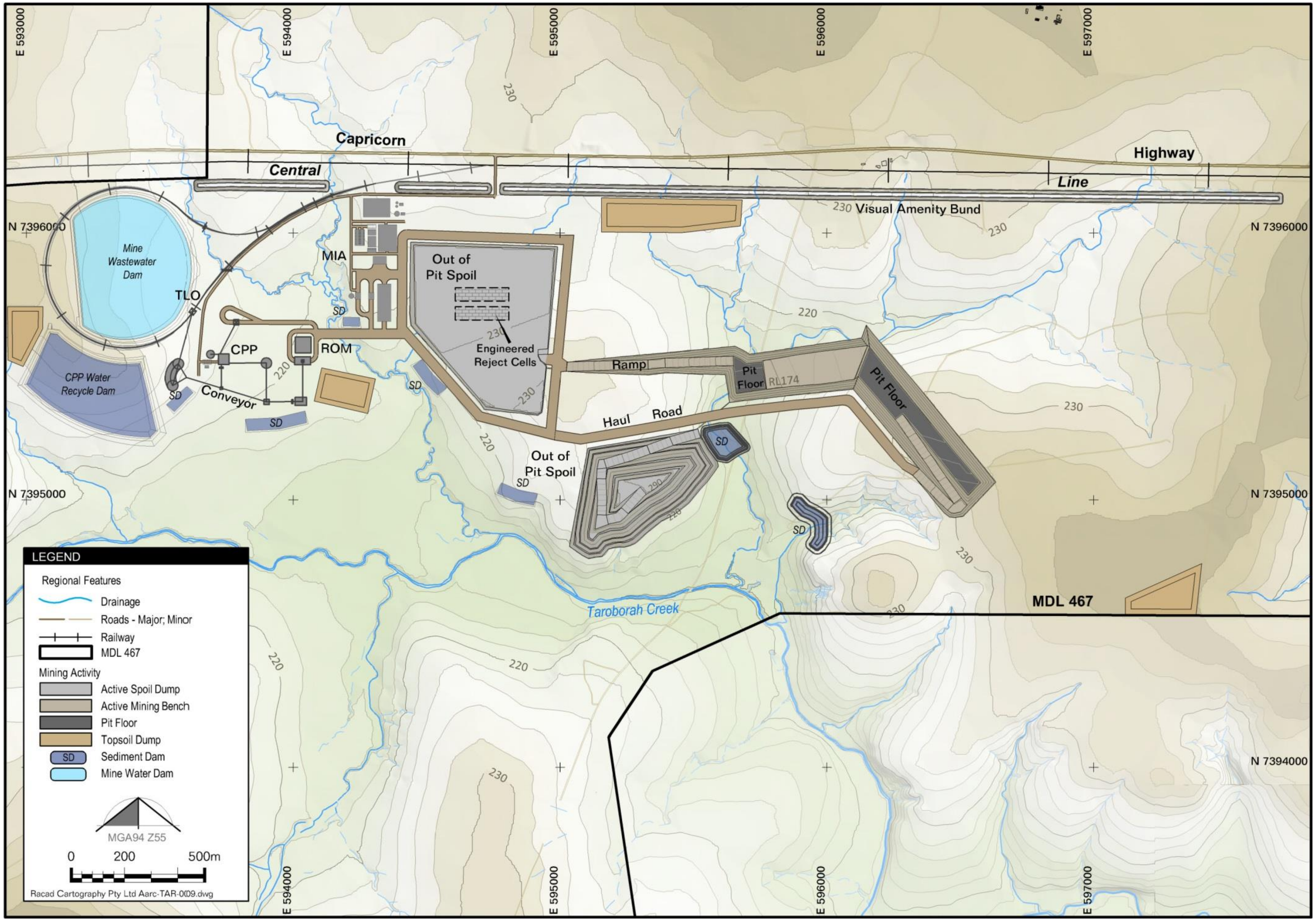


Figure 3.17 Mine Stage Plan – Year 1

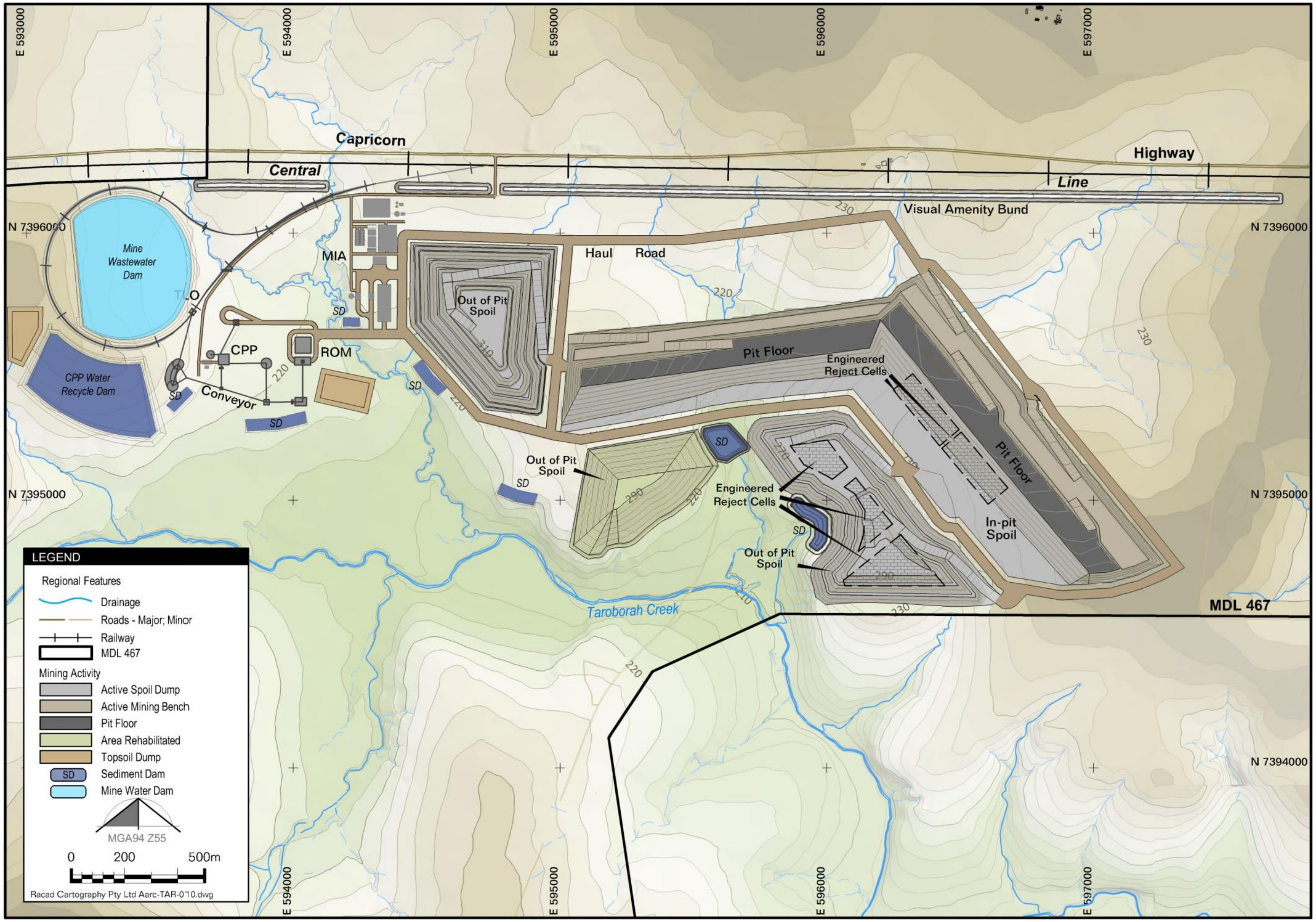


Figure 3.18 Mine Stage Plan – Year 3

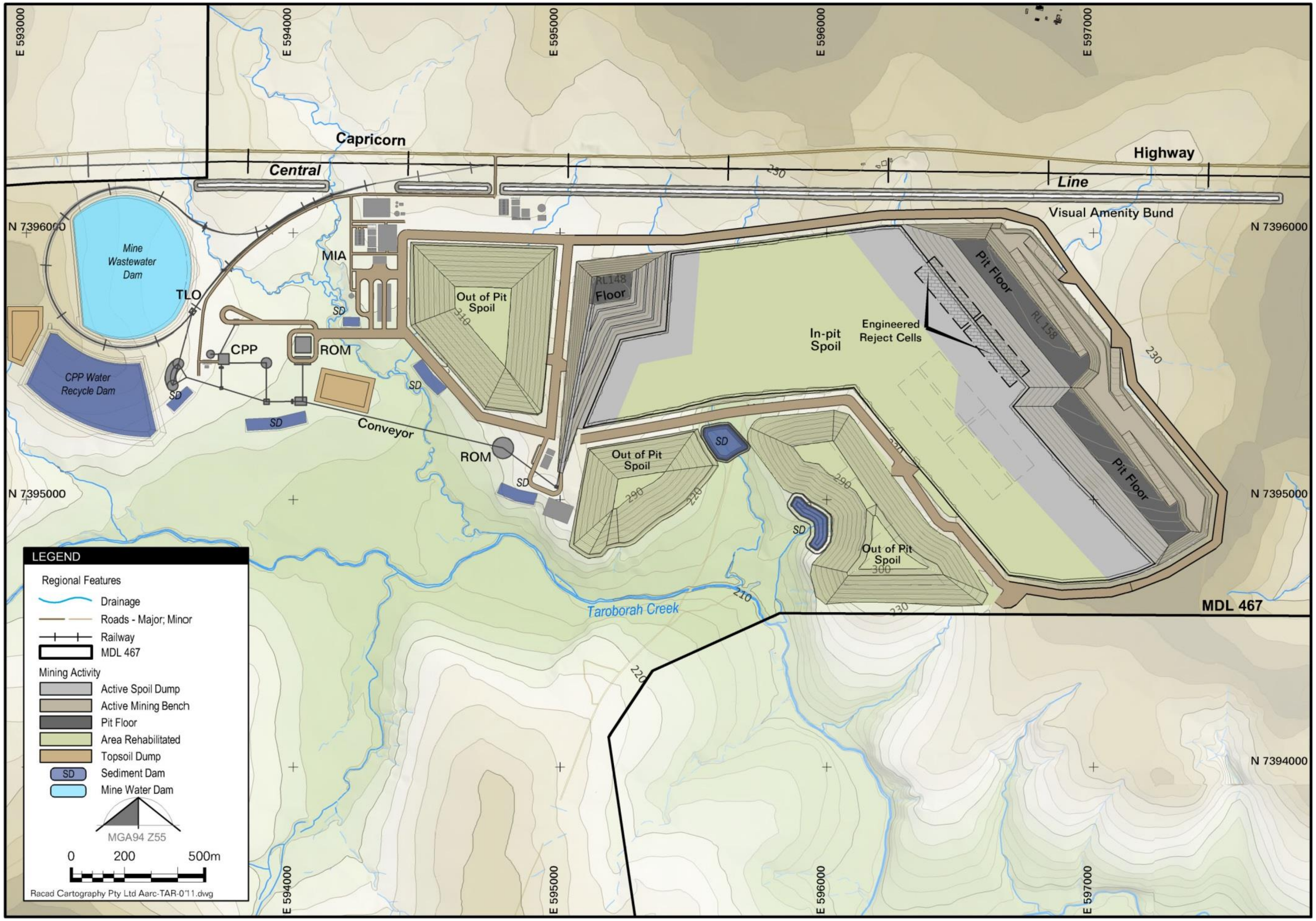


Figure 3.19 Mine Stage Plan – Year 5

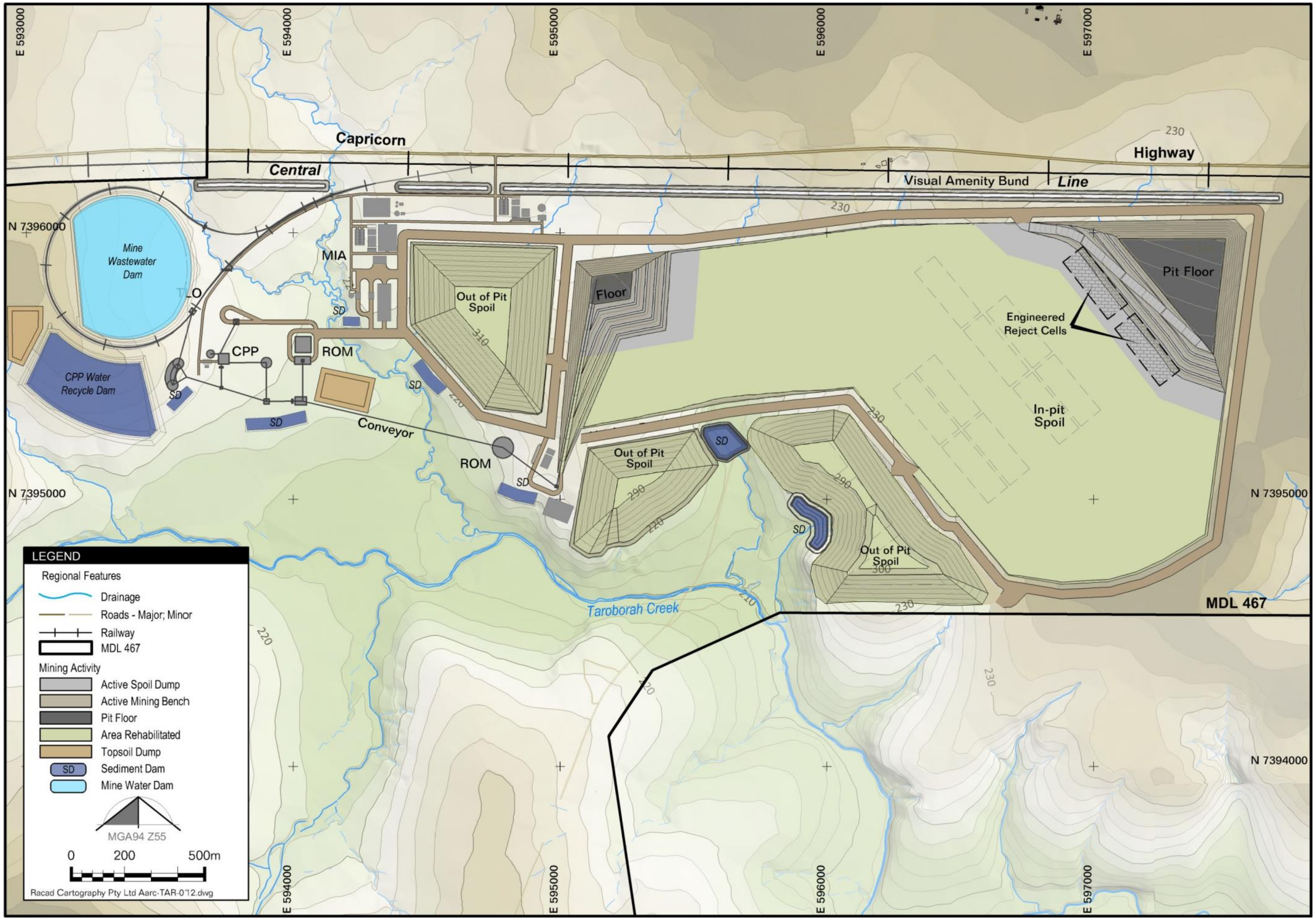


Figure 3.20 Mine Stage Plan – Year 7

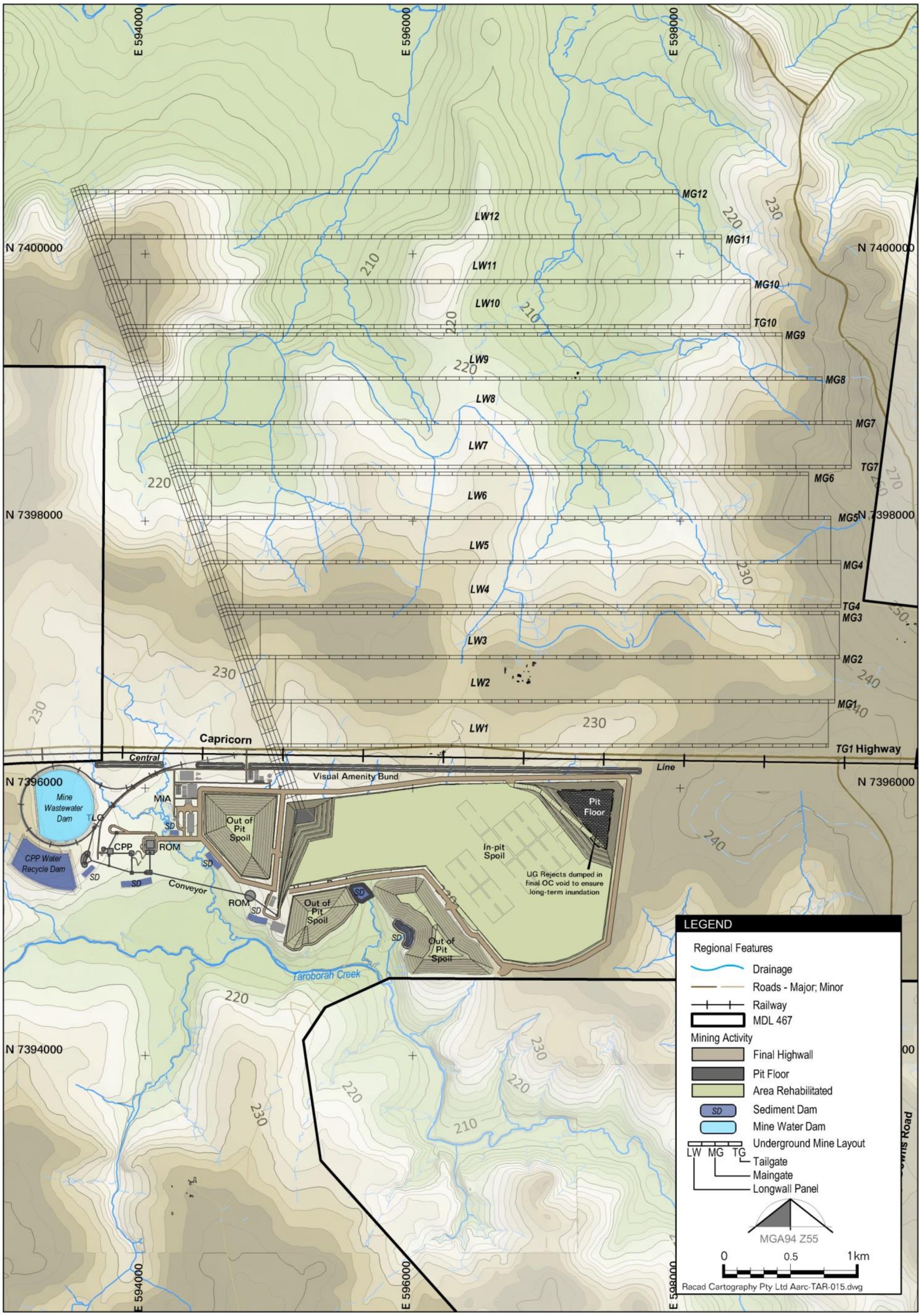


Figure 3.21 **Mine Stage Plan – End of Mine: Year 21**

Table 3.11 Opencut Mine Production and Waste Schedule

Item	Units	Total (Life of mine)	1	2	3	4	5	6	7
			2018	2019	2020	2021	2022	2023	2024
Waste Volumes									
Topsoil volume excavated (assuming an excavation depth of 0.5m)*	million lcm**	3.223	2.040	0.178	0.285	0.285	0.285	0.115	
Overburden / interburden waste volume – external dumping	million lcm	29.62	13.42	14.05	2.15				
Overburden / interburden waste volume– in-pit dumping	million lcm	129.78	0	2.33	21.70	29.98	29.96	32.74	13.06
Production Tonnages									
ROM coal	Mt	11.11	0.511	1.46	1.91	2.28	2.18	1.99	0.79
Product coal	Mt	9.63	0.43	1.24	1.64	2.02	1.93	1.71	0.66
Cummulative Disturbance Areas									
Active pit disturbance area	ha		27.1	35.2	53.8	47	40.2	31.2	22.2
Active in-pit waste disturbance area	ha		0	28	45.4	56.2	67	45.5	24

Active out-of-pit waste disturbance area ***	ha		63.7	79.75	71.9	39.5	0	0	0
Total disturbance area	**ha**		**90.8**	**142.9**	**171.1**	**142.7**	**107.2**	**76.7**	**46.2**
CummulativeRehabilitation Areas									
Rehabilitated Waste Dumps out-of-pit	ha		0	7.85	15.7	48.1	87.6	87.6	87.6
Rehabilitated Waste Dumps in-pit	ha		0	0	0	38.6	77.2	130.1	183
Total Rehabilitated area	**ha**		**0**	**7.85**	**15.7**	**86.7**	**164.8**	**217.7**	**270.6**

* Includes MIA, CPP and rail loop area topsoil

** lcm values assume a bulking factor of 1.25

*** Excludes rehabilitated areas

3.3.4.2 Underground

Following completion of the western sector of the opencut pit, an underground mine portal will be developed via the highwall in 2021, in order to gain access to the underground resource. It is anticipated that the first development coal will be extracted 6 months later.

Upon commencement of underground development mining in 2022, the initial continuous miner will progress the first maingate, whilst the second unit (installed six months after the first unit) will advance the first tailgate. Operating two shifts per day, 7 days per week, development of the first longwall is scheduled to be completed within 18 months by approximately 2023, with an additional two months required to install the longwall before longwall production begins.

Continuing production with two development units and one longwall, annual production capacity is projected at around 4.5 – 5.2 Mt, with the scheduled recoverable coal estimated to be exhausted by 2038.

The areal extraction by year for the underground mine is presented in Figure 3.22.

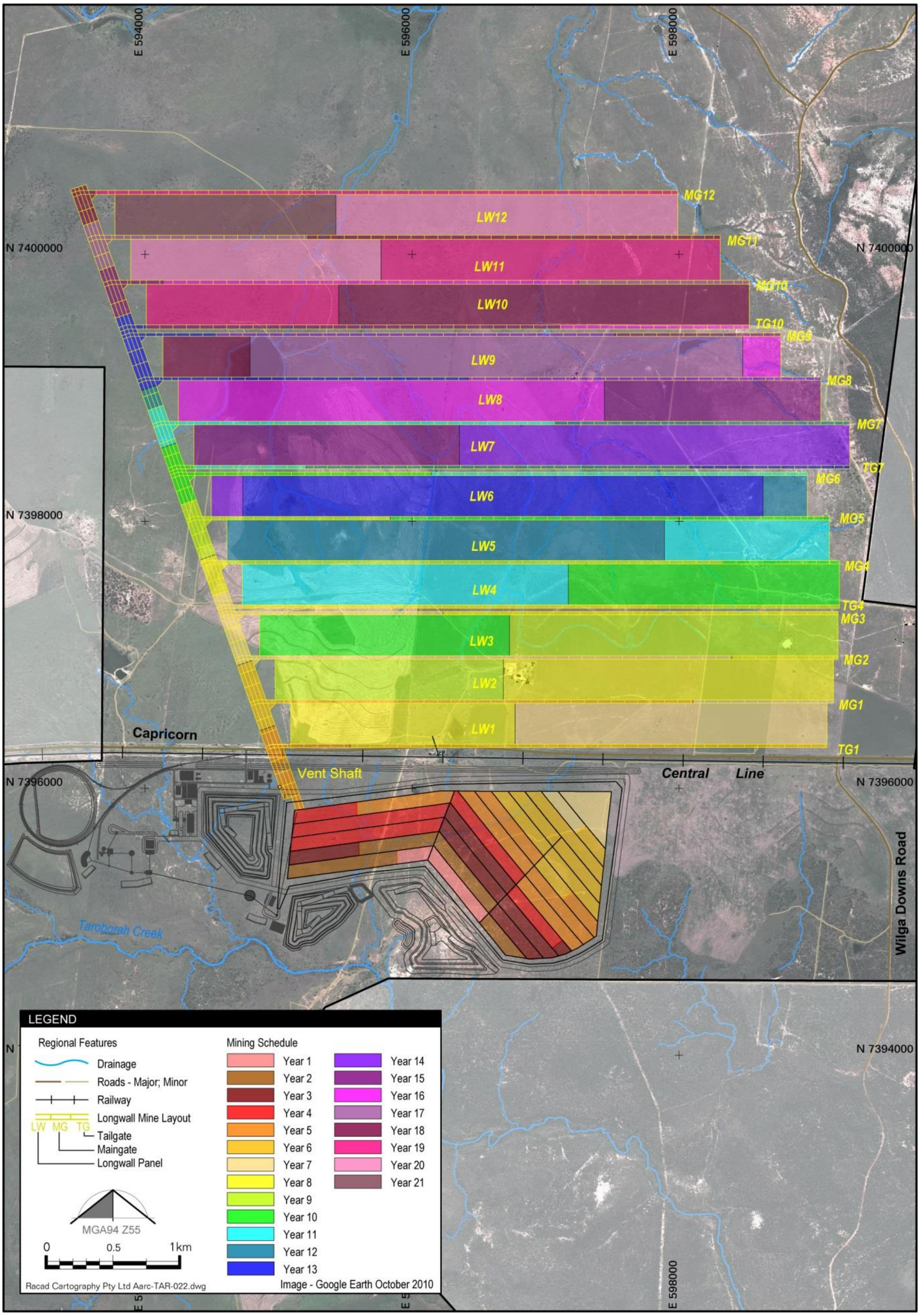


Figure 3.22 Opencut and Underground Indicative Mining Sequence

3.3.5 Workforce

3.3.5.1 Workforce Numbers

During the initial opencut construction phase, the construction workforce is projected at 100 personnel for the first 3 months, increasing to 150 personnel for the remaining 9 months. Following five years of opencut mining, the second phase of construction will begin, with up to 100 personnel contracted to construct the underground mine infrastructure, which will be completed within 6 months.

Section 3.2.11 provides a breakdown of construction force figures for the combined 18 month construction period (also refer to Figure 3.8).

As the Project is commissioned and enters its operational phase, it is estimated that approximately 375 full-time staff will be employed over the life of the mine during both opencut and underground operations. As Table 3.12 describes, the opencut mine will be in operation for seven years during which time between 62 and 141 staff will be employed. Manning requirements for the opencut operation are also illustrated in Figure 3.23.

The Project will operate on a 24 hours a day, seven days a week roster system, based upon 2 x 12 hour shifts for the opencut, and 2 x 10 hour production shifts with an overlapping maintenance shift for the underground.

The workforce categories required for the Project have been summarised as follows:

- Management, supervision and administration staff;
- Operational staff – opencut mining, underground operations and support staff;
- Maintenance staff – general and mining maintenance crews; and
- Contractors that will be required for CPP operations and periodic roles such as maintenance shut downs and specialist mine operational works.

Table 3.12 Proposed Workforce for the Opencut Operation

Year	2018	2019	2020	2021	2022	2023	2024
Operators	37	68	63	90	90	90	60
Maintenance	12	22	21	30	30	30	20
Contractors	4	8	8	8	8	8	4
Supervision & Administration	9	13	13	13	13	13	13
Total	**62**	**111**	**105**	**141**	**141**	**141**	**97**

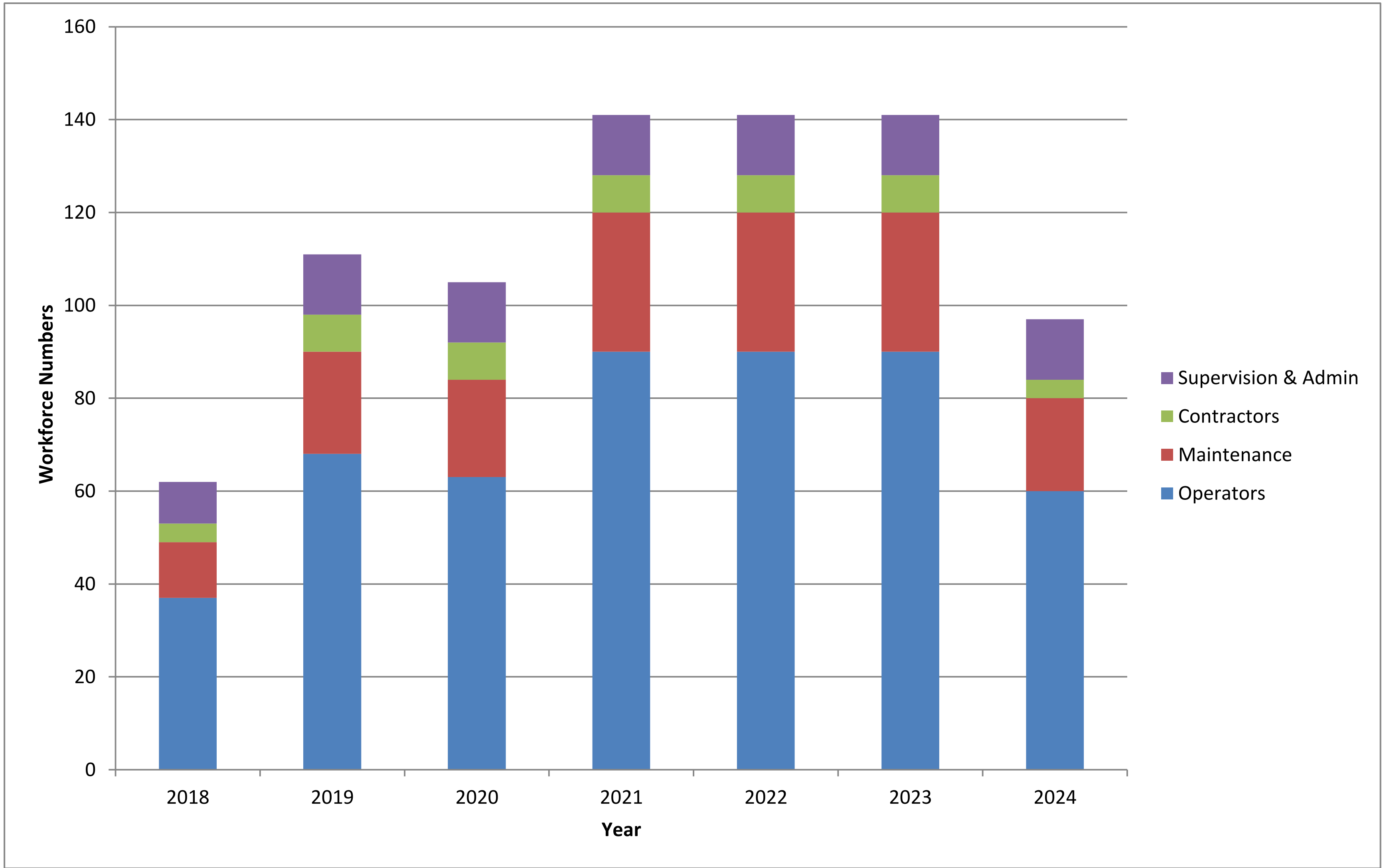


Figure 3.23 Indicative Opencut Workforce Numbers

Following construction of the underground mine, production will steadily increase and similarly the operational workforce will grow, peaking at approximately 352 staff and contractors for the combined opencut and underground operations in 2023, and reducing to a peak of 258 staff and contractors for the underground operation alone.

Anticipated workforce requirements for the underground operation are provided in Table 3.13 and depicted in Figure 3.24. Figure 3.25 depicts the workforce totals over the life of the mine including construction, commissioning / operations and decommissioning phases.

The final 15 months of mine life will be associated with decommissioning, disassembling infrastructure and rehabilitating final landforms. Workforce from the operational phase will be retained where appropriate and specialist contractors will be brought in to dismantle infrastructure during decommissioning. Approximately 50 to 70 staff will be employed during the decommissioning phase of the Project.

Table 3.13 Proposed Workforce for the Underground Longwall Operation

Year	Operators	Maintenance	Contractors	Supervisors / Admin	Annual Total
2022	48	23	8	16	**95**
2023	103	45	16	31	**195**
2024	149	58	16	32	**255**
2025	149	58	16	35	**258**
2026	149	58	16	35	**258**
2027	149	58	16	35	**258**
2028	130	58	16	35	**239**
2029	130	54	16	35	**235**
2030	130	54	16	35	**235**
2031	130	54	16	35	**235**
2032	130	54	16	35	**235**
2033	130	54	12	35	**231**
2034	96	36	9	28	**169**
2035	96	36	9	28	**169**
2036	96	36	9	28	**169**
2037	55	20	9	23	**107**
2038	48	18	9	22	**97**

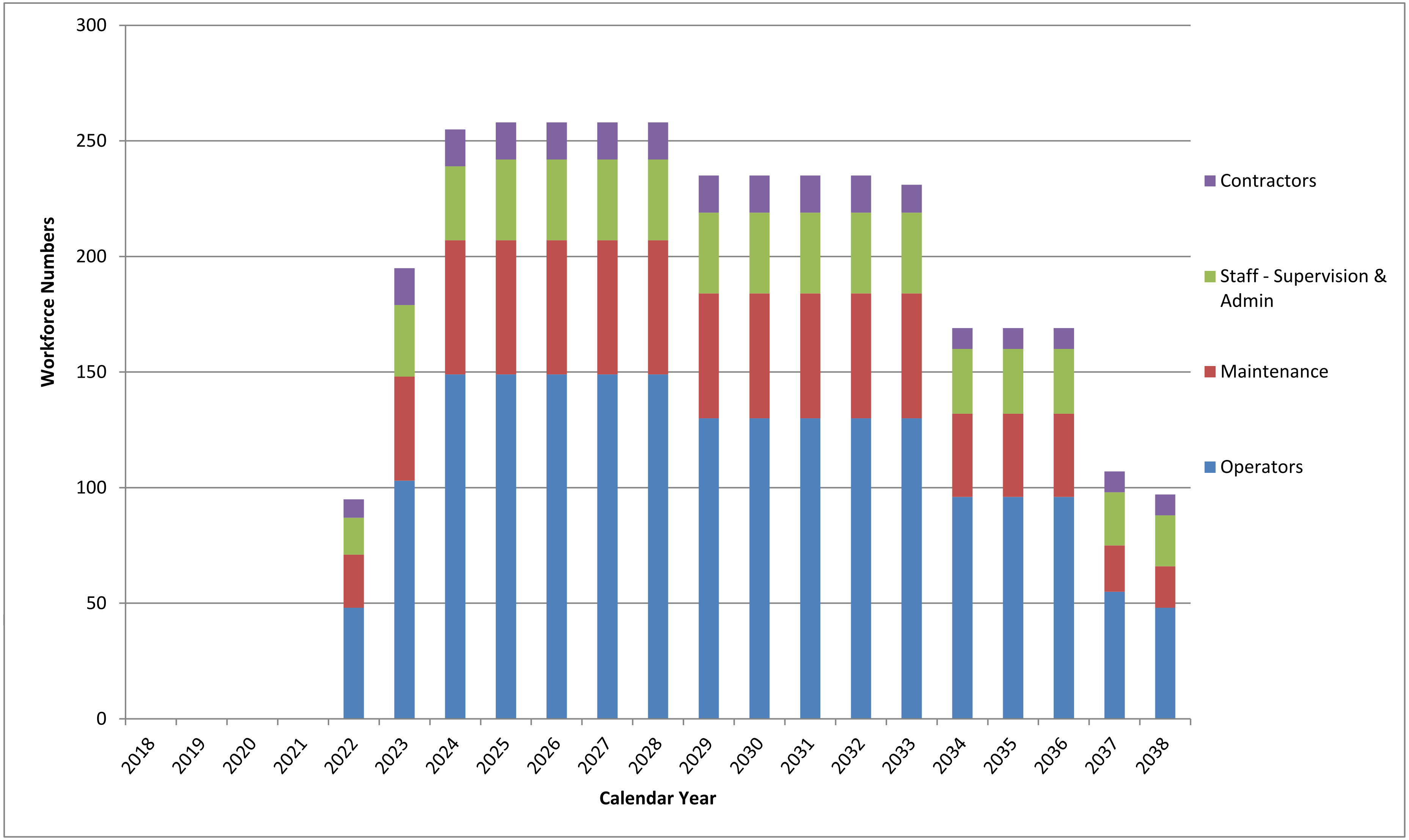


Figure 3.24 Indicative Underground Workforce Numbers

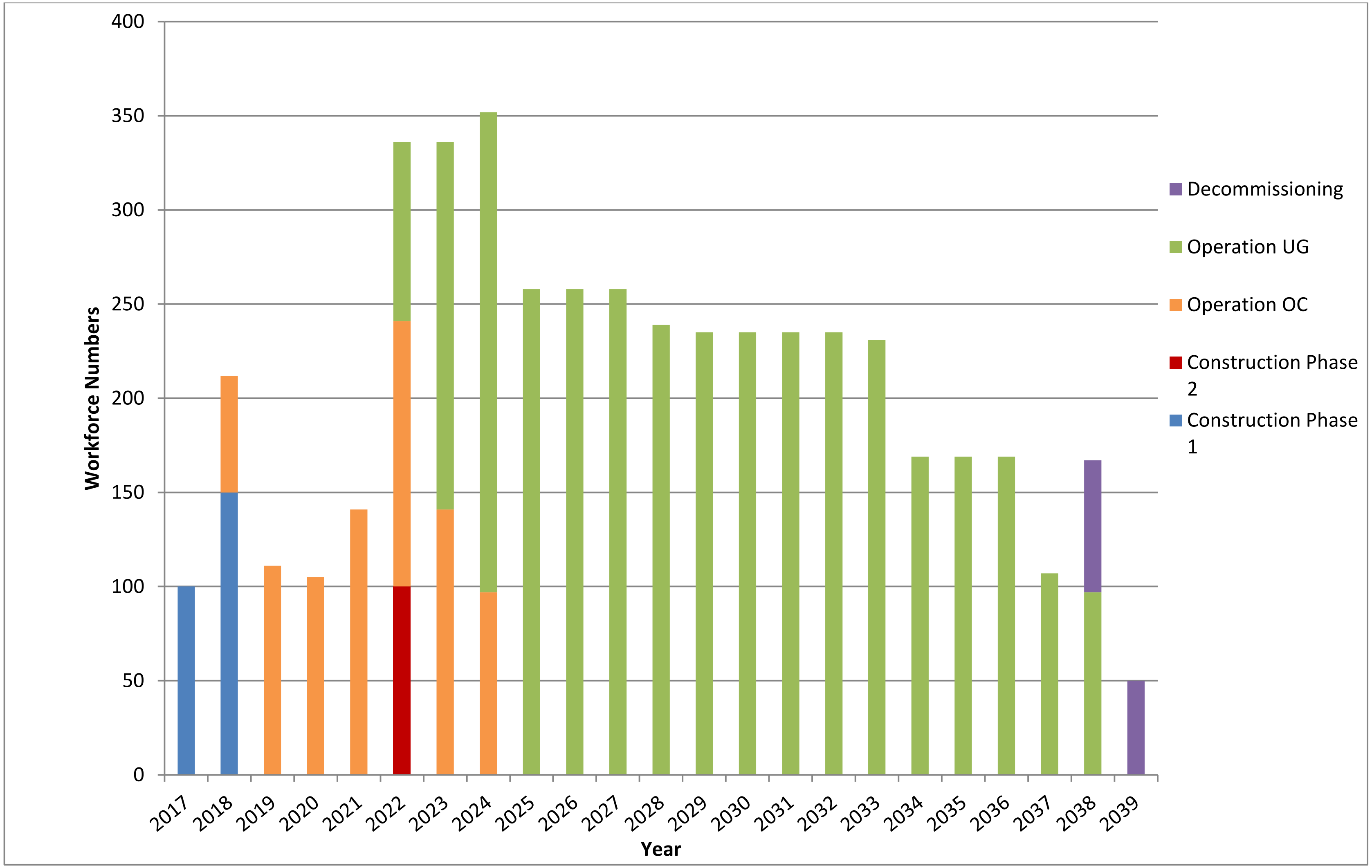


Figure 3.25 Workforce Requirements over the Life of the Project

3.3.5.2 Employment Strategy

The Project's primary employment strategy is to source employees for both the construction and operational phases of the Project from the Emerald area. While the Project has made this commitment to maximising the benefits of the Project to the local community, it is recognised that local labour may not be able to supply all of the Project's skills and experience requirements. This would mean construction and operational staff would need to be sourced both regionally and from across the State, if they cannot be found locally.

A detailed profile of the anticipated workforce is provided in Section 4.10.

3.3.6 Workforce Accommodation

During construction and production, no camps will be used on site. All contractor and operational staff will live in Emerald or the surrounding region, either permanently or in temporary accommodation while on roster. Transport to the mine from Emerald will be on a BIBO basis via a local bus service, purposely contracted to service the Project's workforce needs. Housing staff in the region will help the workforce to integrate into the local community, contribute to the local economy and enhance the level of participation in local activities connected with community objectives.

Staff will be encouraged to use the Emerald BIBO service to and from the Project site, rather than make their own way to site, to minimise potential road safety issues, particularly driver fatigue.

An Emerald housing study was conducted by Think Business Solutions Pty Ltd in 2013 to investigate the availability of suitable housing to meet the requirements of the Project. It was found that an adequate volume of both rental and privately purchased housing for both construction and operational staff currently exists or is approved for construction in the local area. The outcomes of the Emerald housing study are presented in the *Social Impact Assessment* report provided in Appendix 23 and Section 4.10 of this EIS.

3.3.7 Processing and Products

This section describes the coal handling and processing techniques planned to be employed on the Project site, in addition to anticipated annual quantities and the associated chemical properties of the products produced by the Project.

3.3.7.1 ROM Stockpile and Sizing

ROM coal from the opencut pit will be transported via internal haul roads to the opencut stockpile area (located west of the north-west spoil dump). Material will be either directly dumped by the haul trucks, or stockpiled for later transfer, into a 200t live-capacity ROM hopper for primary sizing. The ROM bin has been designed to accept rear dumping from CAT 789 trucks. The top size of this material will then reduce down to 50 mm via a secondary sizing station. Sized material will be scanned and directed to either "wash" or "bypass" streams, based upon coal type and quality (e.g. sulphur concentration).

The wash stream coal will be delivered to the CPP feed stockpile. The CPP feed stockpile will provide 5 kt of surge capacity in order to accommodate opencut mine sequencing. In contrast, bypass coal will be conveyed directly to the product stockpile.

Underground ROM coal will be transported to the surface and stored in a 50 kt conical stockpile. This material will then be transferred to the secondary sizing station, combined with bypass-stream

opencut ROM coal as applicable, and conveyed directly to the product stockpile (refer to Figure 3.26 for a coal processing flow chart) if sulphur levels meet product specifications, or to the CPP stockpile if washing is necessary.

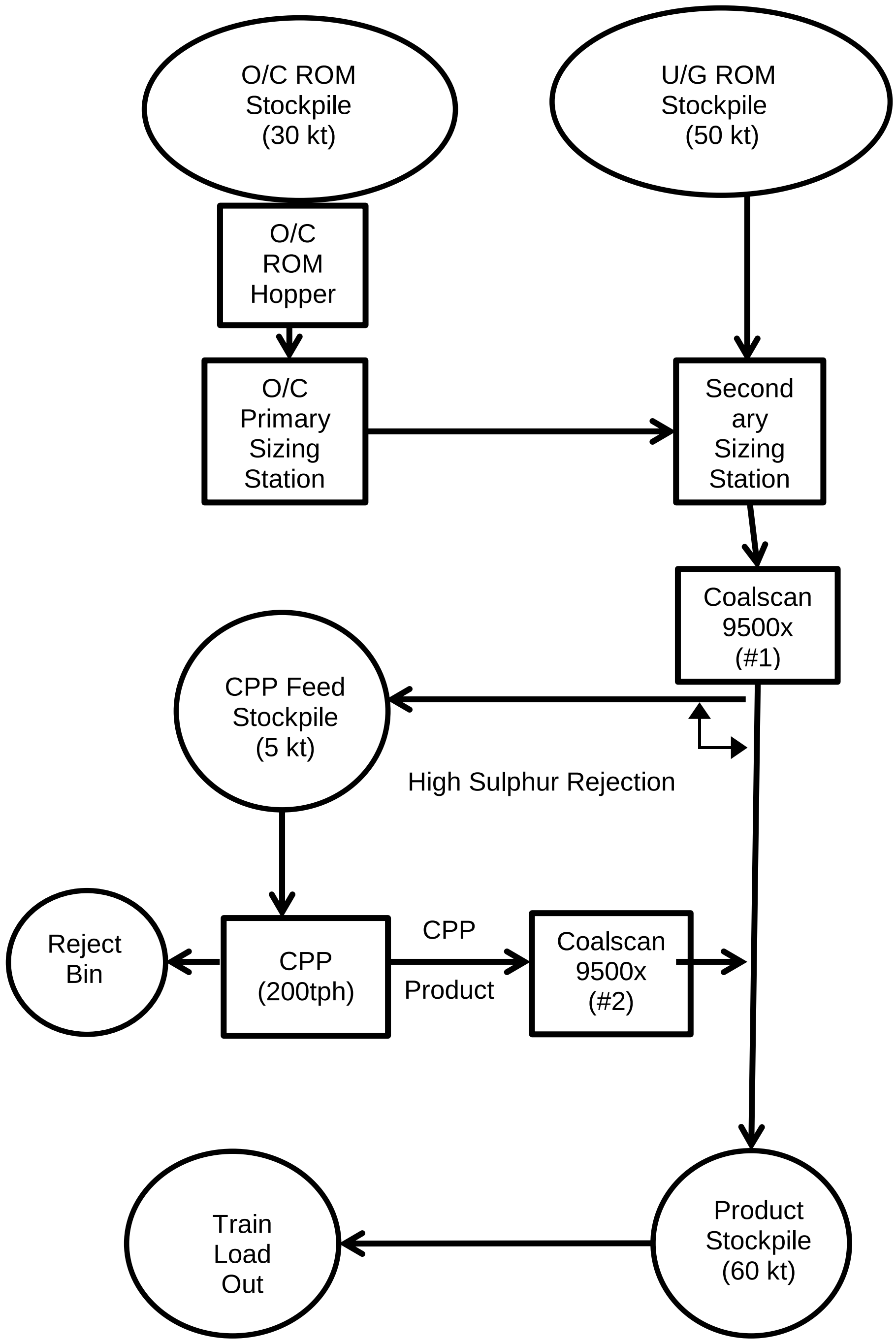


Figure 3.26 CHPP Process Flowsheet

3.3.7.2 Processing

The CHPP will be used to handle and process the opencut and underground ROM coal, with a design process rate of up to 6.3 Mtpa as received[2] (ar) and an annual operating time of 7,500 hours. The proposed CPP will have a nameplate capacity of up to 250 tonnes per hour (tph), while the bypass stream will have a nameplate capacity of up to 850 tph (ar), to achieve the peak production rate of 6.3 Mtpa. Processing specifications for the CHPP over the life of the mine are presented in Table 3.14.

High ash material from the A seam and B tops seam section (approximately 33% of opencut production) will be directed to the 5 kt CPP feed stockpile for processing. Both the opencut B bottoms seam section and the underground ROM material will be sampled and analysed by a Coalscan 9500X machine for moisture, ash, total sulphur and calorific value. Coal that has been analysed and found to possess low sulphur concentrations (<1%) will bypass the CPP and be directed to product stockpiles. The coal that does not meet the total sulphur specifications, will be diverted to the CPP feed stockpile for processing. The CPP layout is illustrated in Figure 3.27.

Table 3.14 CHPP Processing Specifications

Description		Value/Statement
Nameplate annual CHPP feed rate – opencut and underground		6.3 Mtpa as received (ar), 6.15 Mtpa air dried[3] (ad)
Annual opencut / underground ROM capacity		2.3 Mtpa (ar) / 5.5 Mtpa (ar)
ROM feed rates	CPP	250 tph (ar)
	Bypass	850 tph (ar)
CHPP operation / shift roster		Bypass: 24 hr/day, 7 days per week / CPP: 12 hr/day, 7 days per week
Total available operating hours		7,500 hr Bypass and 3,750 hr CPP
Nameplate annual CHPP production		6.1 Mtpa (ar), 5.9 Mtpa (ad)

[2] Includes Total Moisture
[3] Includes Inherent Moisture only

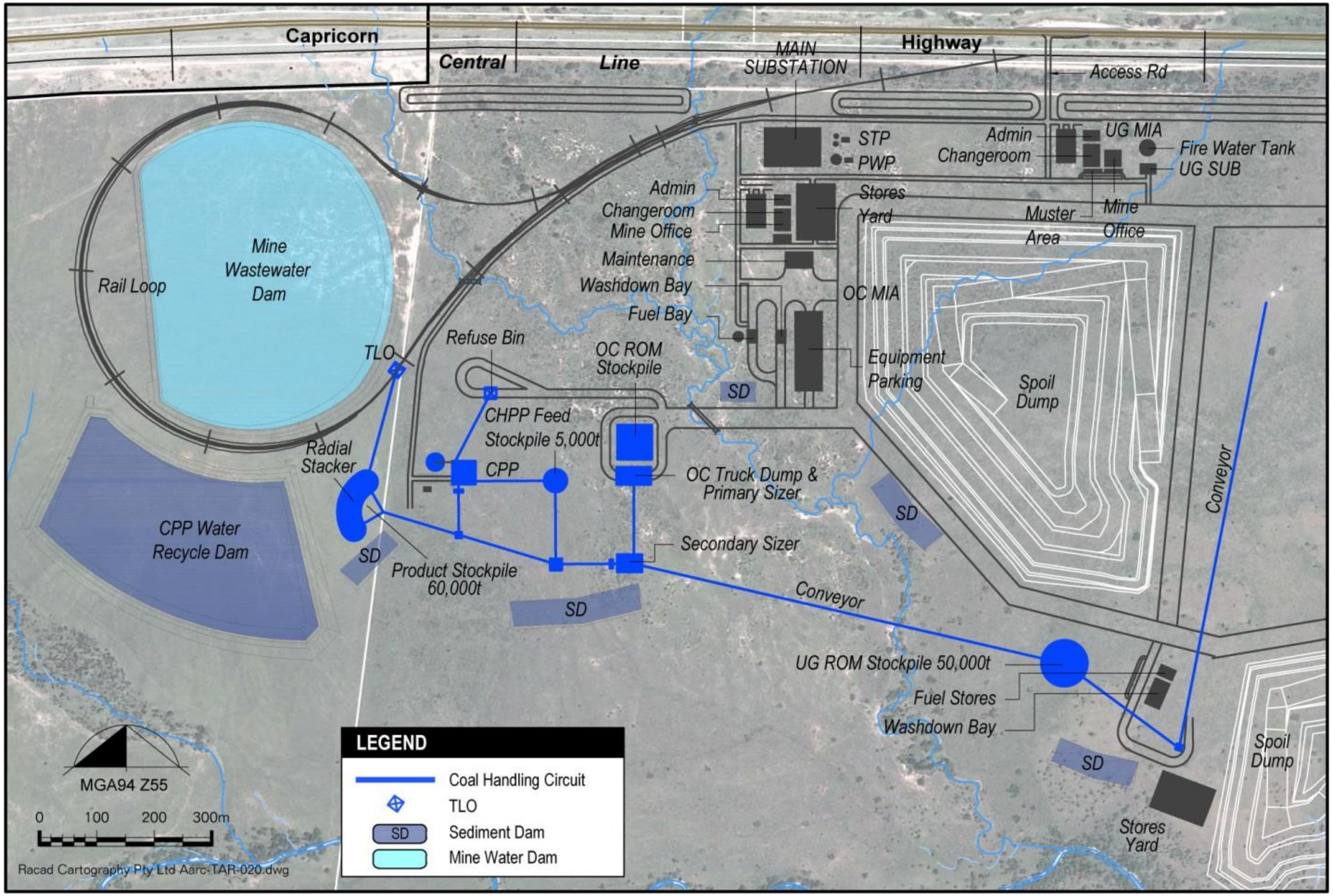


Figure 3.27 Coal Handling Circuit on the Project Site

3.3.7.3 Coal Preparation Plant

The CPP circuit is based upon conventional dense medium cyclones (DMCs) and spirals to process the raw coal and achieve the final coal product specification. The CPP will treat +2.0 mm material in a DMC circuit (nominally 74% of feed) and material between 0.25 mm to 2.0 mm in a mid-size spiral circuit (nominally 16% of feed). The finest particles (<0.25mm and nominally 10% of feed) will be rejected to a tailings thickener prior to dewatering via belt press filters.

Coal will be washed as required to remove ash and sulphur and ensure a consistent product ash and total moisture content that will exceed the target coal calorific-value of 6,000 kcal / kg. The estimated circuit splits and process yields for washed coal only are presented in Table 3.15 and Table 3.16 respectively.

Two products are anticipated to be produced as follows:

- A low ash (<9%), low sulphur (<1%) bypass product from 67% of the opencut tonnage and all underground tonnage; and
- A low ash (<9%), moderate sulphur (2%) washed product from 33% of the opencut tonnage. A nominal washing yield of 75% is anticipated.

Automatic coal samplers will be fitted to the CPP feed, product, bypass and reject belts, together with a TLO sampler, which will enable additional coal samples to be analysed off-site for key product quality parameters.

Table 3.15 Estimated Circuit Splits from Processing Size Envelope

Circuit/Stream	Estimated Circuit Splits (%)		
	Coarse	Nominal	Fine
DMC - ≥2mm	88.8	73.8	31.5
Spirals – 2mm to 0.25mm	8.8	15.9	20.8
Rejects - <0.25mm	2.4	10.3	47.8
Total	100	100	100

Table 3.16 Process Yield Envelope

Circuit/Stream	Estimated Circuit Yield (% ad)		
	Nominal	Minimum	Maximum
Primary DMC - ≥2 mm	83	41	97
Spirals – 2mm to 0.25mm	71	41	84
Estimated Whole of Plant Yield Ranges (% ad)			
Product Yield	75	38	93

3.3.7.4 Rejects Handling

The de-watered coarse and fine rejects produced by the CPP will be combined and sampled, prior to being transferred to the 100t rejects bin. After dumping their ROM coal load, haul trucks will periodically empty the bin (when full) for disposal in the out-of-pit and in-pit engineered spoil dump reject cells upon their return journey to the opencut pit.

3.3.8 Ongoing evaluation and exploration activities

The limits of the targeted coal resource have been largely defined through exploration drilling undertaken during the pre-feasibility stage of the Project. Upon commencement of operations, resource definition drilling will proceed in advance of the opencut pit to provide clarification of the coal structure and support the mining schedule.

No additional exploration drilling is anticipated during the life of the Project.

3.4 PRODUCT HANDLING

3.4.1 Onsite Product Handling

Product coal which is discharged from the CPP, together with bypass coal, will be transferred to the product stockpile via a coal product handling system. This system will comprise an initial product transfer conveyor which moves product coal from the CHPP to a radial stacking conveyor. The radial stacking conveyor will discharge over a 90 degree arc to create separate 20,000 t product coal stockpiles or a single 60,000 t stockpile, with a push out capability of 100,000 t.

Three to four coal valves would be located under the stockpile to transfer product coal from the stockpile to the train load out conveyor. Each coal valve would have a live capacity of approximately 8,000t if coal is fully stacked over it, which is adequate for one train load. The coal valve would consist of a drawdown hopper with stockpile activator, a modulating flow-control gate incorporating hydraulic cylinders, a belt weight-o-meter (measures tonnage rate for control of the flow-control gates), power pack and “No flow” detectors.

The train load out conveyor is approximately 300 m long and delivers product coal to the 250 t TLO bin. Each coal valve and the TLO conveyor are capable of handling 5,000 tph of product coal. A two-stage sampling station will be included on the TLO conveyor to accurately record the quality of product coal loaded on to each rail wagon.

The flood (or volumetric) loading system would consist of a 250 t TLO bin, discharge gate and associated telescopic loading chute. This system represents the simplest form of train loading facility and includes an overload removal facility and local control room, allowing operators to manually flood rail wagons at a flood rate of 4,500 tph. The gate and telescopic chute are operated remotely from the load-out control room. The train loading chute ensures that the coal supplied to each wagon is profiled to the correct shape.

The typical configuration of the TLO is depicted in Photo Plate 3.1 below.

Photo Plate 3.1 Image of a Typical Train Load Out Facility

During product handling, dust-suppression sprays will be used to reduce concentrations of air-borne particulate matter. The dirty water produced by the spray system, direct rainfall, drainage from product stockpiles and TLO washdown water will be collected by sumps and catchment drains and recycled for use in the CPP.

The TLO will also include a veneering system to provide a sealing layer over the loaded wagon and control dust during transit to port.

3.4.2 Offsite Product Handling

Up to approximately 6 Mtpa of product coal will be transported from the Project site via the QR Central West and Aurizon Blackwater rail systems to the WICET at Gladstone. The transport infrastructure utilised for this process is discussed in Section 3.5.1.

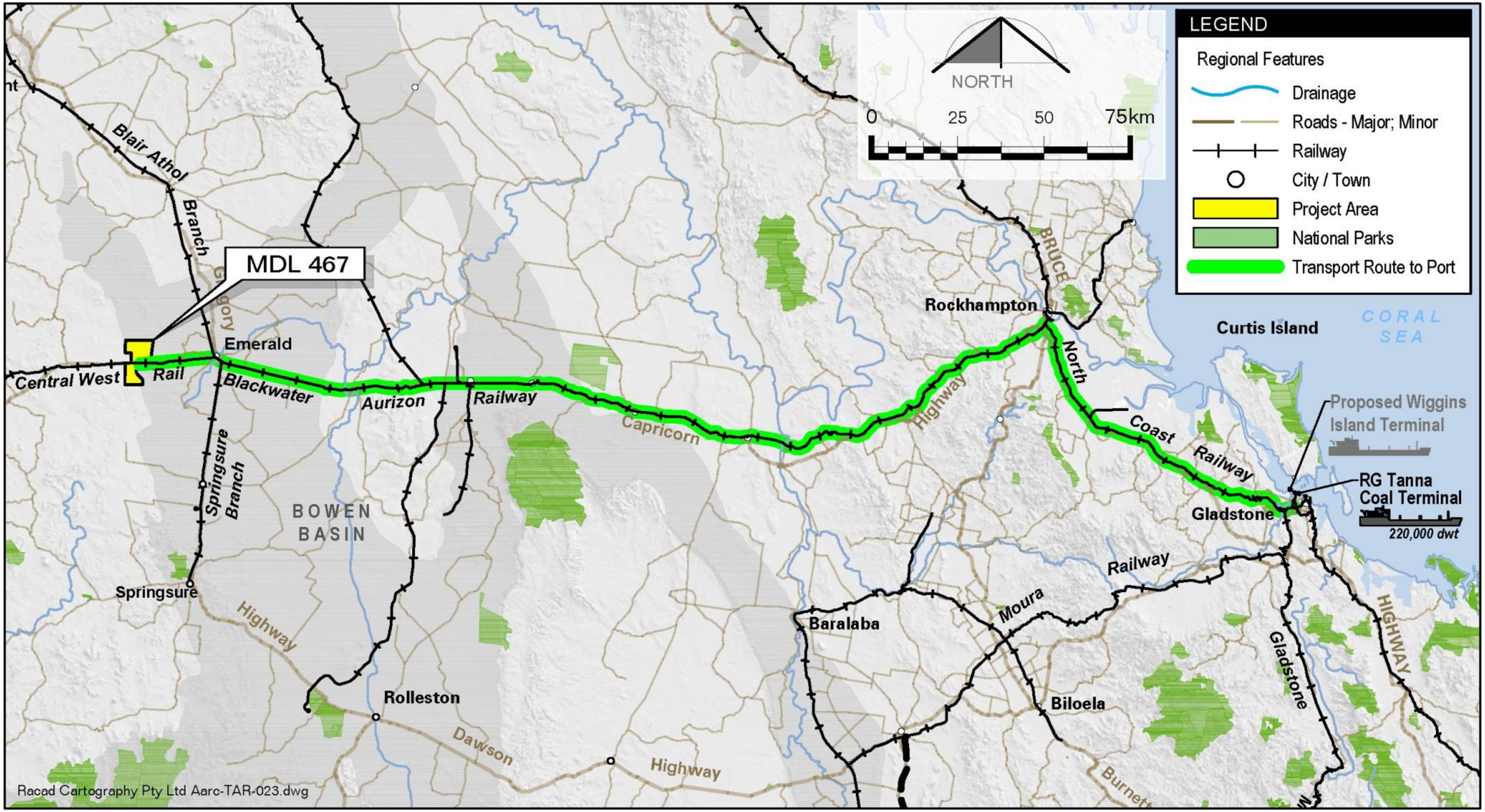


Figure 3.28 Rail Route From Project Site to Port

3.5 INFRASTRUCTURE REQUIREMENTS

3.5.1 Transport

The following provides a synopsis of the transport arrangements anticipated for the Project. A full description of the transport system and analysis of impacts is provided in Section 4.3 and Appendix 11 of this EIS.

3.5.1.1 Road Network

The Project is located approximately 22 km west of Emerald in central Queensland and extends north and south of the Capricorn Highway and Central West Rail System. The Capricorn Highway (A4) links the city of Rockhampton with Emerald and western QLD towns of Alpha and Jericho.

Existing road transport infrastructure within the local Project area is limited to local roads and the State Controlled Road (SCR) network (as shown in Figure 3.29).

The Capricorn Highway is the primary road directly associated with the Project and serves the primary access to the Project site.

Construction Transport

During the construction of the Project, it is anticipated that the majority of mine site personnel will be housed in Emerald. A central bus-collection point in Emerald would allow employees to drive to this collection point and be transported to the Project site to minimise the impact of traffic volume on the Capricorn highway

Construction of the Project is anticipated to take place during the first 12 months of Project life. During this time, construction phase consumables such as road base, concrete, tyres, process chemicals, workshop and office supplies will be delivered to site via the Capricorn Highway, from either Rockhampton or Emerald, and will change in response to Project needs. Project related wastes produced during construction will be transported along the Capricorn Highway by an Emerald based licensed waste disposal contractor.

It is anticipated that 50,000L tankers will transport fuel three times per week from Emerald, while escorted wide-loads will not exceed one consignment per week for the delivery of major structural elements, mechanical equipment, machinery and plant during construction.

Transport of equipment and materials by rail during the construction phase has been considered and discounted due to the relatively low volumes and lack of regular freight services west of Emerald.

Total construction traffic for the Project is projected to increase road volumes in the region by less than 0.5%, on average.

Figure 3.29 Regional Transport Network

Operational Transport

Additional traffic will be generated on the Capricorn Highway during the operational phase of the Project due to site deliveries such as fuel and explosives, in addition to the travel undertaken by mine site employees.

As the Project moves into operation, fuel requirements will increase, with up to one tanker required to deliver fuel daily at peak production. However, significantly less wide-load deliveries are anticipated during the operational phase of the Project.

Similar to construction, consumables such as concrete, tyres, process chemicals, workshop and office supplies will be delivered to site via the Capricorn Highway, from either Rockhampton, Mackay or Emerald, and will change in response to Project needs during various stages of development. Project related wastes produced during operation will be transported along the Capricorn Highway by an Emerald based licensed waste disposal contractor.

Explosives will be delivered to site one to two times per week during opencut operations, depending upon mine staging. Explosives will likely be sourced from the Orica Production Facility in Gladstone, from where approximately 60t consignments will be transported along the highway and delivered to site.

In general, there should not be a need to close the Capricorn Highway during periodic rock blasting exercises, due to the separation distance between the blast area and the highway and typical blasting exclusion zones (200 - 300m). Even along the northern edge in the “east “pit, the minimum separation distance will be approximately 250m. In addition, the visual amenity bund will act to limit flyrock distances since the blasts will be some 40m below ground level.

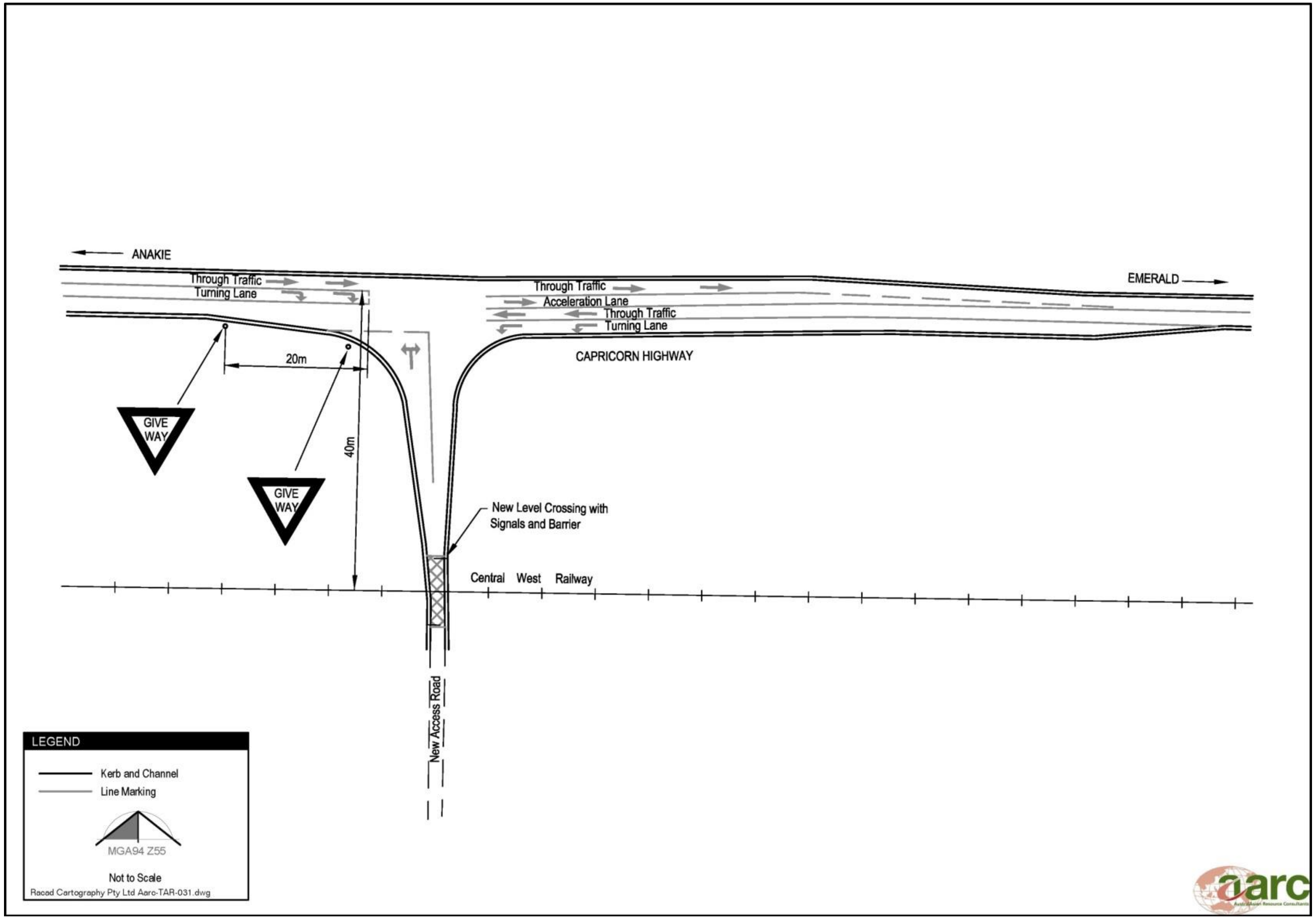
However, where necessary in order to mitigate exposure to fly rock in accordance with Australian Standard AS 2187.2 (*Explosives – Storage and use. Part 2: Use of explosives*), the Capricorn Highway may be closed less than 20 times per year with traffic delays of 20-30 minutes experienced when blasting is conducted along the northern perimeter of the opencut pit (during the last 2 - 3 years of the opencut operation).

Transport of equipment and materials by rail during the operational phase of the Project has been considered and discounted at this stage due to the relatively low volumes and lack of regular freight services west of Emerald.

Total operational traffic for the Project is projected to increase road volumes in the region by less than 1%, on average.

Upgrades

To accommodate Project deliveries and workforce vehicles, the Capricorn highway will be upgraded by constructing a new T–junction for site access. The preliminary design of this upgrade includes the construction of turning lanes from both directions, allowing traffic from the highway to safely enter the Project site without impeding the flow of traffic on the highway. In addition, it is envisaged that acceleration lanes would be constructed, allowing traffic to exit the Project site and safely merge with the flow of traffic on the highway. Final design and road modifications will be facilitated by the DTMR and will be built to State road standards. Figure 3.30 illustrates the preliminary proposed upgrades to the highway.



Source: IMC 2013

Figure 3.30 Preliminary Proposed Capricorn Highway Upgrades Required for Project Site Access

3.5.1.2 Rail Transport

Like the Capricorn Highway, the QR Central West Rail System dissects the Project site and connects to the Aurizon Blackwater rail system at Nogoa Junction (Emerald) (as shown in Figure 3.31), which then runs east to the Gladstone Port zone (refer to Figure 3.29).

A TLO and 4.5 km long rail loop will be constructed on the Project site in order to connect the mine to the QR Central West rail system that runs parallel with the Capricorn Highway (as shown in Figure 3.32).

It is anticipated this rail system will transport up to 6 Mtpa of product coal from the Project site to the WICET via:

- The Central West line – from the Project site (Taroborah) to Nogoa Junction (east of Emerald) – approximately 25 km; and
- The Aurizon Blackwater line – from Nogoa Junction (east of Emerald) to the WICET – approximately 372 km;

Several railway infrastructure upgrades will be required to facilitate the transport of product coal along this proposed route. Infrastructure developments required include:

- An upgrade of the current low-grade track to 20 TAL between Taroborah and Nogoa Junction;
- Strengthening of six minor timber bridges along the Taroborah / Nogoa Junction route;
- Track strengthening between Nogoa Junction and Burngrove; and
- A major upgrade of the Nogoa River bridge, in order to achieve 20 TAL and accept wider coal wagons.

Rail infrastructure upgrades along these systems will likely be facilitated by QR with a strong interest maintained by Shenhuo to ensure the construction of the Project is undertaken in parallel to the required infrastructure developments.

Railway infrastructure upgrades will be initiated following Project approval and will occur simultaneously with the construction phase of the Project between the years 2017 and 2018.

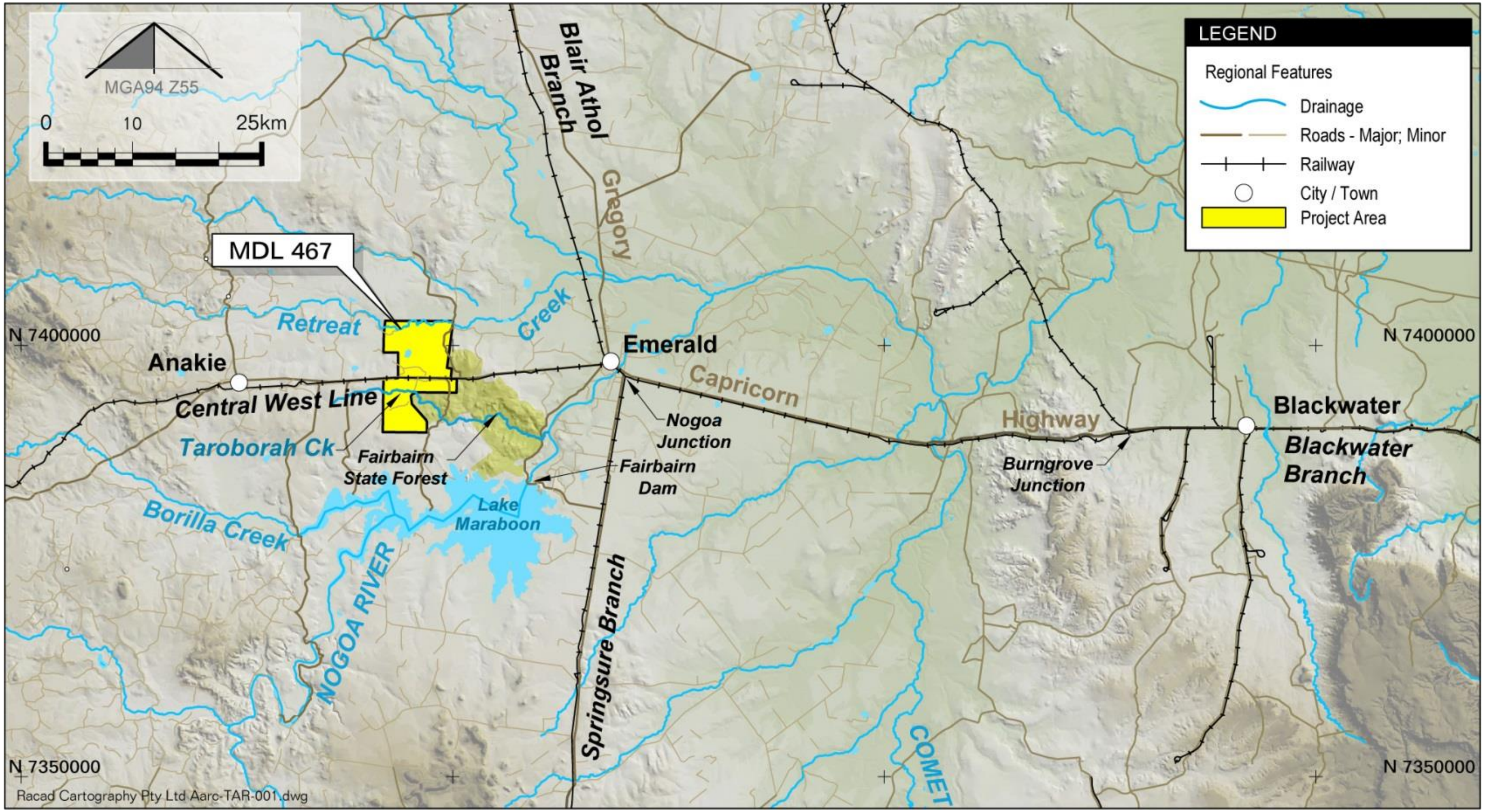


Figure 3.31 Local Road / Rail Network and Project Access

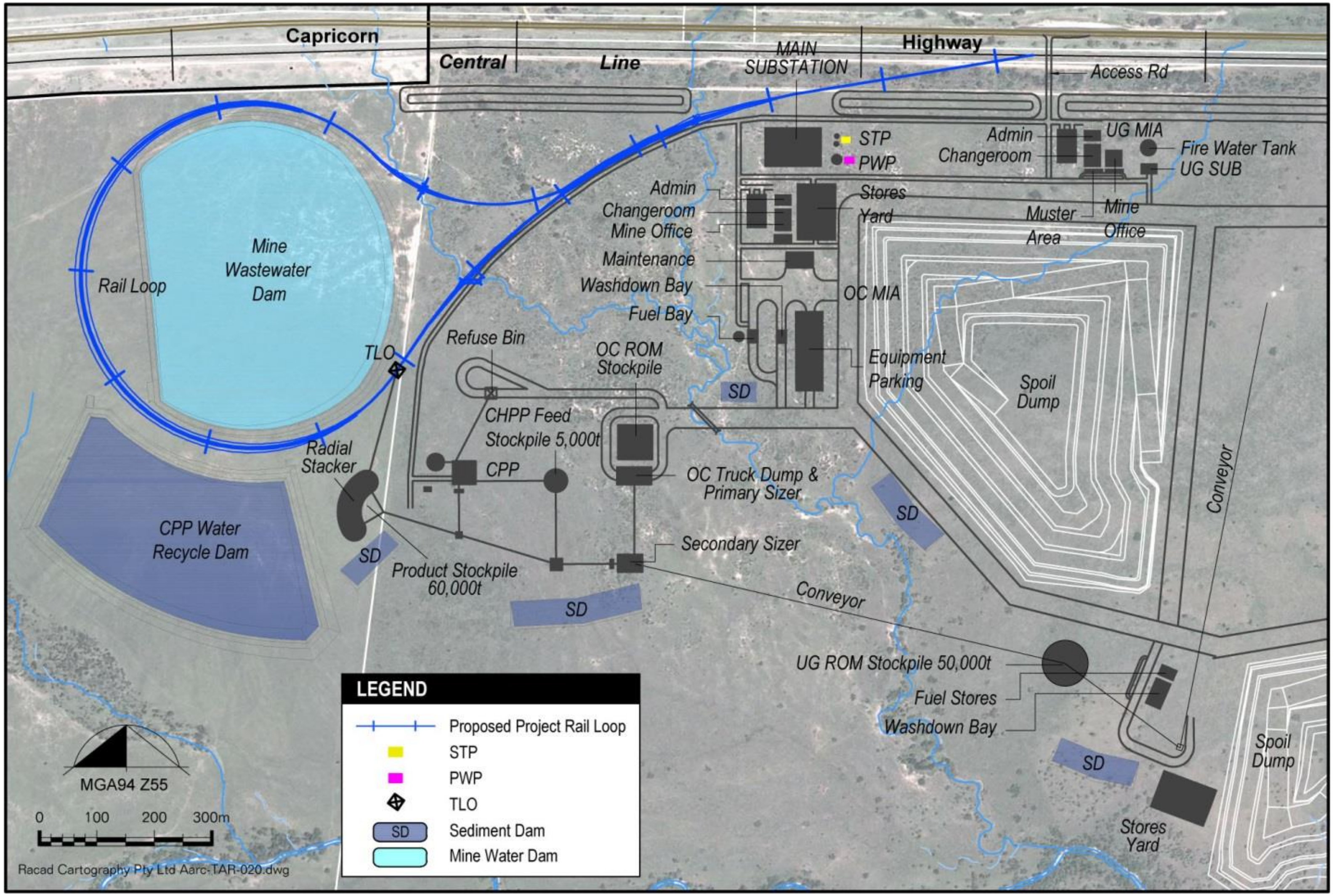


Figure 3.32 **Proposed Project Rail Loop**

3.5.1.3 Port

Wiggins Island Coal Export Terminal

The WICET is a port development project located at Golding Point, west of the existing RG Tanna Coal Terminal, in Gladstone Harbour. It is a privately funded and industry-owned project and does not require State or Federal Government funding. This provides the owners of the WICET with control over the coal export process and increased long-term export coal capacity.

Terminal handling charges at the WICET will be levied on a cost-recovery basis in order to assist the Queensland coal export industry's competitiveness.

Stage one of the WICET project has a target coal processing capacity of 27 Mtpa. The first shipments of coal from the WICET are anticipated to occur in 2014. It is anticipated that Stage two of the WICET project will be delivered in two parts during 2016 and 2018, resulting in a total export capacity of approximately 70 Mtpa. The completion date for the final stage (Stage three) of construction is yet to be determined.

Shenhuo has entered into discussions with the WICET consortium in order to negotiate space at this port for coal stockpiling, handling and export. It is anticipated that the first batch of Project coal will arrive at WICET in 2018 for export.

3.5.2 Energy

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

The anticipated energy requirements during the construction period are approximately 1 million kWh per annum, which will be provided by diesel-fuelled generators.

During operations, the projected installed electrical power demand for the Project has been estimated at 25 MW total for the opencut and underground operations combined. Energy shall be supplied from the Emerald sub-station which will have sufficient capacity to accommodate these energy requirements after the planned upgrade of the supply line from Blackwater.

Necessary site infrastructure for the Project's energy supply include a 66kV/11kV, 25MVa substation to service the CHPP, site buildings and the opencut and underground mines. Power will be distributed around the Project site at 11 kV and will then be stepped down via a transformer to 415 V for plant operations or 220V for buildings.

The maximum electrical energy consumption by the Project has been estimated to be 91.6 GW hours per annum and a maximum instantaneous power demand of 25 MW when in full production.

An emergency generator will be installed on site and used as a temporary supply of Project power, in the event that the supply from the local Emerald substation fails to meet the basic energy required for safe mine operations.

3.5.2.1 Energy Conservation and Greenhouse Gas Management

A compulsory corporate reporting system for greenhouse gas (GHG) emissions, energy consumption and production has been developed as part of the Australian Government's inclusive Climate Change Strategy. This reporting system is addressed by the *National Greenhouse and Energy Reporting Act 2007* (Cth) (NGER Act) 2007 and requires corporations to register for and report GHG emissions and energy consumption / production. Corporations whose GHG emissions, energy consumption and / or production is at or above the following specified thresholds must report these emissions to the Commonwealth Government:

- Facilities controlled by a corporation that emit 25 kt or more of greenhouse gas, or produce / consume 100 TJ or more of energy; or

- A corporate group that emits 50 kt or more of greenhouse gas, or produces / consumes 200 TJ or more of energy.

Since the Project represents an individual facility that will exceed these thresholds, Shenhuo will need to report GHG emissions under the NGER Act to the Clean Energy Regulator and the scheme will be the basis for the Commonwealth *Clean Energy Act* 2011 (CEA Act) and associated carbon pricing mechanism. Shenhuo Group will need to register for reporting under the NGER Act and the Project, as a facility, will contribute to its corporate group emissions.

Since Shenhuo will have operational control of a covered facility whose GHG emissions exceed 25 kt / year, they will become a liable entity under Section 20 of the *Clean Energy Act 2011*. This Act has established an Australian carbon emissions trading scheme which includes fixed price, collar and full emissions trading periods from 1 July 2015. Therefore, Shenhuo will be required to participate in emissions trading and incur a liability to surrender carbon units' equivalent to its annual covered GHG emissions to the Clean Energy Regulator.

The identification and evaluation of energy-efficiency opportunities for large energy-using businesses is driven by the *Energy Efficiency Opportunities Act 2006* (EEO Act), whose aim is to improve and encourage implementation of cost-effective energy-efficient opportunities. Under this Act, large energy-using businesses must undertake an assessment of their energy efficiency opportunities and provide public reports on the outcomes of such an assessment. Since the Project's total annual energy consumption will be in excess of the EEO Act reporting threshold of 0.5 petajoules (triggered in the second year of operation), the Project will need to register under the EEO Act.

A GHG Management Plan for the Project will be developed with specific management objectives as follows:

- Best practice technologies (where practicable and feasible) during the design and construction of the Project will be utilised, in order to reduce energy consumption and subsequent greenhouse gas emissions;

- Where practicable and feasible, best practice technologies will be implemented in order to reduce operational energy consumption and subsequent greenhouse gas emissions;

- The efficiency of greenhouse gas emission reduction strategies will be regularly measured, monitored, audited and reviewed; and

- Registering and reporting activities will be conducted as required under the NGER and EEO Acts.

3.5.3 Water Supply and Storage

This section of the EIS provides details of the Projects water sources, storage systems and water requirements as detailed within the *Site Water Management Plan*, developed by ATC Williams Pty Ltd (ATC) and provided in Appendix 13.

3.5.3.1 Water Demand

The site water requirements associated with the operation of the Project will involve dust suppression, process water used in the CPP and potable water to meet workforce requirements as detailed in Table 3.17.

Table 3.17 Annual Water Requirements of the Project

Operation	Year	Dust Suppression (ML)	Equip Washdown (ML)	CHPP (ML)	UG Mine (ML)	Total Water Usage (ML)
Construction	2017	0.33	0.03			0.33
Construction/ OC Ops	2018	1.66	0.03	0.15		1.81
OC Ops	2019	1.33	0.03	0.40		1.74
OC Ops	2020	1.18	0.03	0.56		1.74
OC Ops	2021	1.24	0.03	0.61		1.86
OC Ops + UG	2022	1.30	0.03	0.57	0.38	2.24
OC Ops + UG	2023	1.36	0.035	0.57	0.75	2.68
OC Ops + UG	2024	1.24	0.045	0.30	1.00	2.54
UG Only	2025	0.34	0.015	0.04	1.20	1.57
UG Only	2026	0.34	0.015	0.17	1.20	1.71
UG Only	2027	0.34	0.015	0.42	1.20	1.96
UG Only	2028	0.34	0.015	0.38	1.20	1.92
UG Only	2029	0.34	0.015	0.12	1.20	1.66
UG Only	2030	0.34	0.015	0.06	1.20	1.60
UG Only	2031	0.34	0.015	0.25	1.20	1.79
UG Only	2032	0.34	0.015	0.24	1.20	1.78
UG Only	2033	0.34	0.015	0.36	1.10	1.80
UG Only	2034	0.34	0.015	0.55	1.00	1.89
UG Only	2035	0.34	0.015	0.53	1.00	1.87
UG Only	2036	0.34	0.015	-	1.00	1.34
UG Only	2037	0.34	0.01	-	1.00	1.34
UG Only	2038	0.34	0.01	-	1.00	1.34

The site water requirements will vary over the life of the Project and a water balance model has been developed to estimate the extent to which water arising from necessary de-watering of the mining operations plus rainfall run-off from the mine site can meet construction and operational water demands for the Project and is further described in Section 3.6.6.5 and provided in Appendix 13.

Climatic factors will play a significant role in water requirements for dust suppression and will be assessed on a year to year basis. However, it is anticipated up to 2.7 ML/day shall be required for dust suppression, coal preparation and other miscellaneous usages on-site. Up to a further 30 kl/day of potable water is anticipated to be required during operations to meet workforce demands. To assist with the potable water demand on the Project site a 200 kL water storage tank and potable water treatment plant will also be available during operations for the generation of potable water on-site.

Water management structures including the Mine Wastewater Dam (MWD) and the Coal Preparation Plant Water Recycle Dam (CPPWR, further described in Section 3.5.3.4) shall support the process water requirements associated with the CPP and the dust suppression requirements during operations by providing storage for surface and groundwater flows in addition to water captured from the opencut pit.

3.5.3.2 Water Supply

All water required for the operation of the Project can and will be sourced from a combination of necessary de-watering of mining operations as well as rainfall runoff collected from the Project site. No capture of overland flow unaffected by mine operations is expected to be required.

Groundwater

Data from exploration drilling and hydrogeological studies were used to characterise the hydrogeological aspects associated with the Project site. These studies indicated three different hydrogeological systems within the Project area; the Permian Alderbaran Sandstone, Tertiary Basalt and Alluvium which, together with other potential sources, will supply the Project with adequate water resources during operations.

Section 4.5 of this EIS discusses the water resources of the Project site, while details of the groundwater system and expected water make during mining operations are provided in Appendix 14 and the site water balance model is detailed in Appendix 13.

Rainfall

A relatively small amount of rainfall shall be captured directly by water storage structures, with the majority of rainfall water supply being captured run-off from the mine site area to prevent release of potentially affected water to the downstream environment. During the wet season, this capture of rainfall will contribute a large proportion of the overall water supply.

3.5.3.3 Groundwater Quality

Water quality sampling was undertaken in 2009, April 2013 and May 2014 to deliver an extract of the baseline groundwater quality associated with the Project site.

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

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

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

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

The Aldebaran Sandstone dips towards the north, resulting in the Permian stratigraphy occurring at greater depth. The water quality results and geological setting indicates that the Permian groundwater in the northern end of the Project area has a higher residence time and salinity.

The shallower Aldebaran Sandstone bores record lower concentrations of chloride, and higher concentrations of bicarbonate. This likely relates to increased recharge rates and potential interaction with faults.

Weathering also appears to influence water quality, with slightly brackish water quality recorded in the fresh Tertiary basalt, compared to brackish water quality within the more weathered basalt sequence.

Groundwater quality results from two monitoring events are included in Section 4.5, providing an insight into the baseline groundwater quality associated with the Project site. The complete groundwater monitoring analysis including bore reference is provided in Appendix 14. Additional data continues to be collected on a quarterly basis.

3.5.3.4 Surface Water Management

Overland flow which comes in contact with mine components has the potential to become contaminated through interactions with heavy metals, hydrocarbon exposure or salinity and, without an appropriately designed surface water management system, may subsequently contaminate the receiving environment.

The key objective with respect to surface water management on the Project site is to limit the release of potentially contaminated water from the site to the receiving environment and conserve water for reuse on the Project site and within the process water circuit.

Water likely to be encountered on the Project site has been characterised in to the following two categories:

- Clean Water - Stormwater occurring around the Project area, but not contacting active operating or disturbed areas; and
- Site Water - All water generated from disturbed site areas and associated operating surfaces within the Project area. This includes groundwater that reports to the mine pits.

The water management strategy adopted on the Project site with respect to both clean water and site water consists of:

a) Clean Water Management - Diversion drains are proposed around the site infrastructure area to intercept and transport the clean water away from the disturbed areas of the Project site. The clean water catchment will not be harvested and will be diverted away from the Project site, connecting to the natural downstream tributaries; and

b) Site Water Management - The water management objective relating to the proposed infrastructure and mining areas which include the ROM pad, CPP, MIA, out-of-pit spoil dump area and opencut pit, is for the capture and containment of runoff from these surfaces. It is proposed to contain this stormwater in a water storage dam or sediment dam and reuse as part of the mining and processing water circuits to meet water conservation objectives on the Project site.

Figure 3.33 illustrates the basic components of the surface water management system during Year 3 of the Project. This system will advance as the opencut pit develops, until becoming stable in Year 7 and subsequent years. Diagrams illustrating this advancement, as well as details of the design of specific structures are provided in Section 4.5 and Appendix 13. The following provides a summary of the surface water management system.

Clean Water Management

Clean water diversion drains and bunds capture clean water runoff (water which has not interacted with disturbed land) and divert the flow around mining operations to minimise interaction with any mine impacted water.

Clean water drains and bunds will be constructed along the perimeter boundary of mine associated infrastructure, diverting water from the natural catchment to tributaries associated with Taroborah Creek.

Clean water drain CWD1 will be constructed along the northern margin of the opencut site, together with the visual amenity bund, and will be formed by excavation on a bench into basement sequences. An area of 343 ha drains towards the west portion of the bund to the tributary of Taroborah Creek.

Clean water diversion drain CWD2 will be formed along the eastern portion of the Project site to divert clean catchment water into an existing local drain line (tributary of Taroborah Creek).

In addition, several drains will also be constructed to protect the opencut pit from local flood inundation. These drains are considered pit protection bunds rather than clean water diversion drains as they do not normally receive water from the upstream catchment. Pit protection bunds CWDS1A and CWDS1B (north of the pit), and CWDS1C and CWDS1D (east of the pit) will be required during the initial stages of opencut production and will be constructed to a nominal height of 0.5 m.

Although not considered as regulated structures, clean water diversion drains and bunds are designed to accommodate a 1 in 1,000 year peak flow event. This criterion has been adopted as clean water diversion drains are required to protect the opencut pit and associated underground mine works from inundation by overland flow from a severe storm event. The drain configuration is designed to limit flow velocity, where possible, to 1 m/s.

The overland flow diversion drains will carry the clean catchment water into the pump and sump arrangements north (Sump Pump West) and east (Sump Pump East) of the pit. These sump and pump systems will be progressively moved northward and eastward as the opencut pit advances, The capacity of the sump pumps is proposed to be 100 l/s and shall be discharged into the proposed clean water drains and subsequently flow into existing natural watercourses. Using the assumed pump capacity, the sump will be sized to achieve the appropriate required containment.

An earthen bund will also be constructed west of the MIA to prevent the clean water diverted by CWD1 into a drainage line of Taroborah Creek which runs north to west within the Project boundary from over flowing into these facilities in the event of a severe storm.

Dirty Water Management and Storage

Several water storage structures shall be constructed on the Project site for the purpose of collecting or storing mine affected water and supplying the Project with a viable water supply with which to conduct operations and prevent potentially contaminated runoff from entering the receiving environment.

Seven sediment dams, two opencut pit sumps, and two regulated structures - the MWD and CPPWRD - shall be constructed on the Project site and are described in Table 3.18 below.

Table 3.18 Dirty Water Management Structures and Capacities

Structure	Full Storage Volume (ML)	Contributing Catchment (ha)	Purpose
MWD	1077	22	Store groundwater inflow and rain water capture from the opencut pit and groundwater inflow to the underground
CPPWRD	832	12	Store recovered process water from the CPP and contaminated site water runoff, as well as excess water from the MWD (as capacity allows)
Opencut Pit Sumps	20 total for each pit area	Varies based on mine development	Pit-dewatering and pit surface water catchment runoff
Sediment Dam 1	6	4	To collect rainfall runoff from the product stockpile catchment area
Sediment Dam 2	24	17	To collect rainfall runoff from the CHPP catchment area
Sediment Dam 3	27	19	To collect rainfall runoff from the Northwest Spoil Dump and MIA catchment area
Sediment Dam 4	58	40	To collect rainfall runoff from the Southwest Spoil Dump catchment area
Sediment Dam 5	11	8	To collect rainfall runoff from the Underground ROM stockpile, fuel bay and

Structure	Full Storage Volume (ML)	Contributing Catchment (ha)	Purpose
			equipment washdown catchment area
Sediment Dam 6	24	17	To collect rainfall runoff from the Southwest Spoil Dump catchment area
Sediment Dam 7	56	39	To collect rainfall runoff from the Southeast Spoil Dump catchment area

According to the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (EHP 2013), key criteria relevant to regulated structures relates to accommodating a design storage (wet season containment) allowance, being referred to as the DSA.

Both of the planned water storage dams are classified as High hazard regulated structures and have been designed to accept the appropriate 1 in 100 AEP DSA for their level of risk.

Site Water Collection Drains

Site water collection drains / bunds will be formed to intercept site water which has potentially interacted with disturbed surfaces. Site water drains will be located around the perimeter of active mine areas, with effective capture and transport of site water to sediment dams or collection points.

Three site water collection drains shall be constructed to direct potentially contaminated site water to the various sediment dams. These site water collection drains extend around the perimeter of the out-of-pit spoil dumps on each side and are designed to report towards sediment dams, which then is pumped into the CPPWRD. A total catchment of approximately 84.4 ha is estimated for the proposed site water diversion drains.

Site water collection drains and bunds have been designed to accommodate a 100 year Annual Reoccurrence Interval (ARI) event of critical duration. Similar to the design of clean water drains, site water drains displaying flow velocities greater than 1 m/s will require armouring to limit erosion. The site water management system is depicted in Figure 3.33.

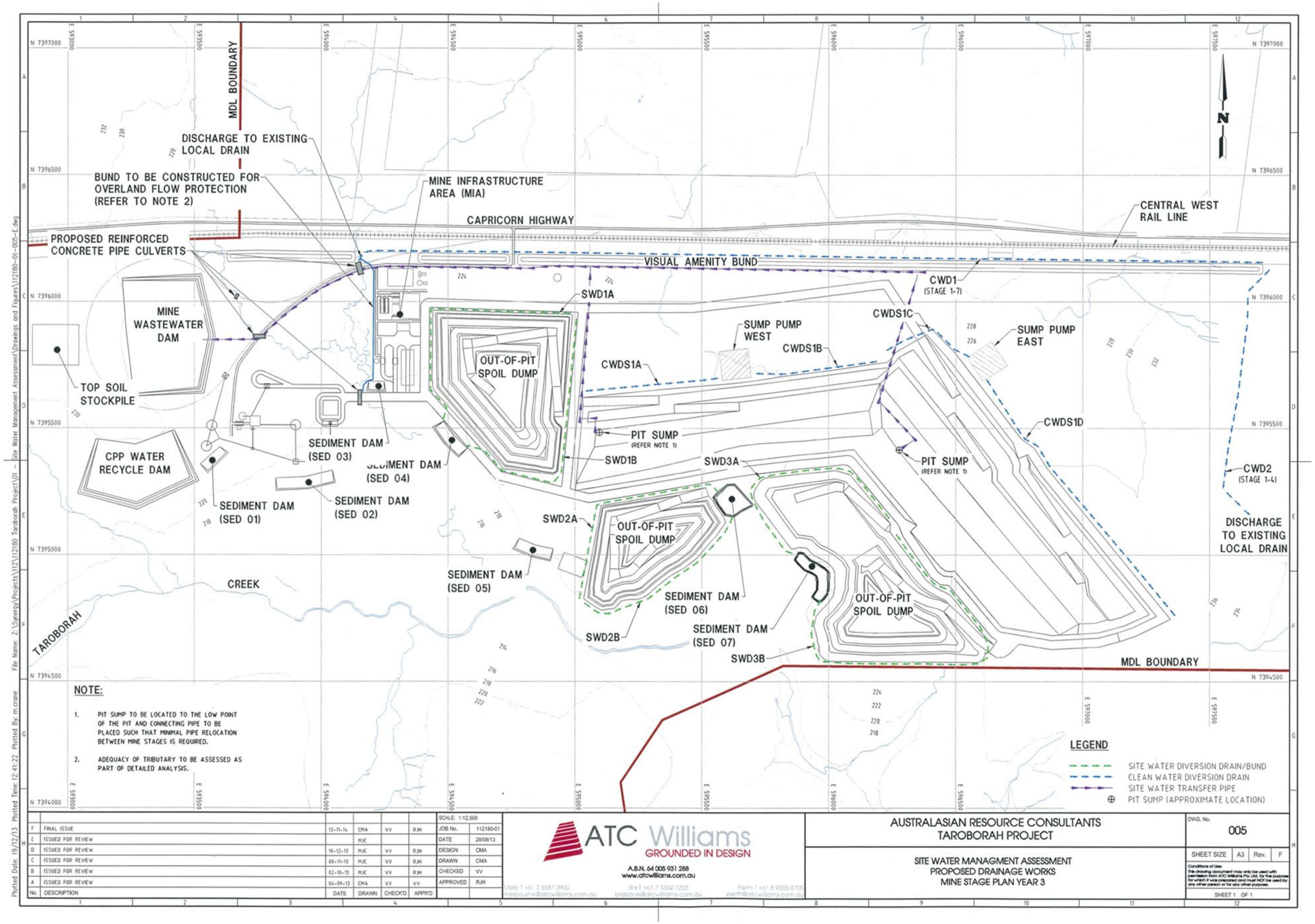


Figure 3.33 Site Water Management System

3.5.4 Stormwater Drainage

The primary drainage lines occurring within the Project site and the surrounding areas are Taroborah Creek, Retreat Creek and Centre Creek which are located south and north of MDL467. Topographically, the Project site catchment is gently undulating and varies from 200 m above Australian Height Datum (AHD) to 280 m AHD.

The alignment of the drainage lines occurring within the Project area together with topographic contours are shown on Figure 3.34.

Opencut Area

The stormwater management system for the opencut area is described above, being the various diversion and storage structures of the site water management system. As detailed in Section 4.5 and Appendix 13, the structures in this system have been designed to handle varying storm events appropriate for their duty and level of off-site contamination risk.

Underground Area

Currently the runoff from the northern, underground area of the Project flows from south (just north of Capricorn Highway) to the north of the Project site into Retreat Creek. The catchment is gently undulating and varies from 235 m above Australian Height Datum (AHD) in the south and falls to 208 m AHD towards Retreat Creek.

Longwall mining will cause subtle changes in topography due to subsidence impacts and potentially reduce surface runoff rates into Retreat Creek during rainfall events. However, these localised changes to the stormwater drainage patterns are not anticipated to detrimentally affect ecosystems, flood levels, land use or the subsequent operation of the Project, as discussed in Section 4.2 of this EIS.

In addition, a subsidence impact assessment on surface hydrology was prepared by ATC Williams (2014) to assess the change in surface hydrology from existing conditions due to the predicted subsidence over the Project site underground mine area, A hydrological simulation model was used to predict the impact of ponding of the surface area due to underground mining to identify potential impacts on the broader catchment hydrology and water resources availability in Retreat Creek and subsequently into Theresa Creek and Nogoa River. The findings of this assessment are presented in Section 4.5 of this EIS.

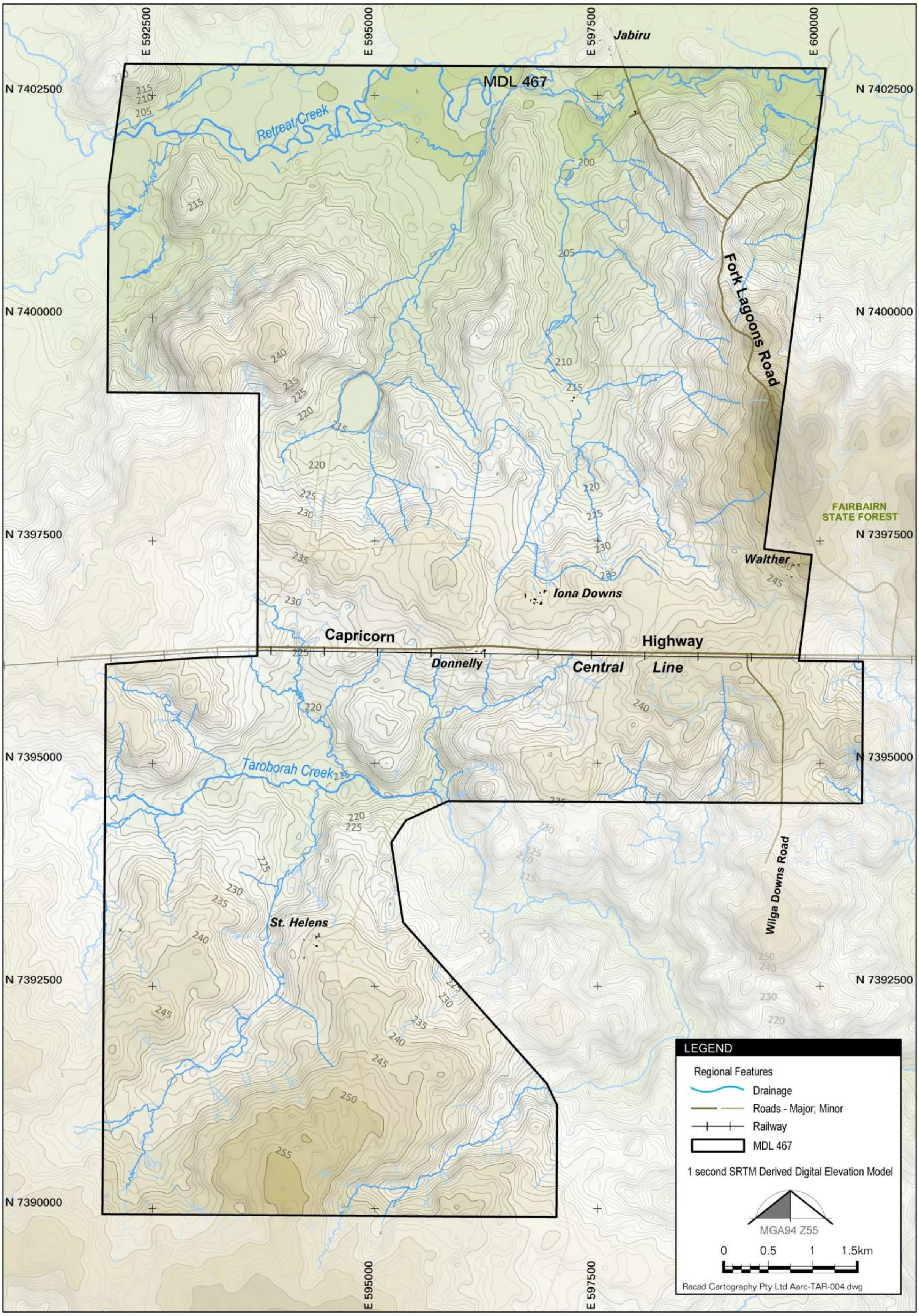


Figure 3.34 Drainage Pathways and Contours Associated with the Project Site

3.5.5 Sewage

During the initial stages of mine construction, portable toilets will be installed on site for contractors use. The waste generated by these toilets will be removed from site and processed by a licensed waste management contractor.

A self-contained sewage treatment plant (STP) will be installed on the Project site that can accommodate up to 200 equivalent persons. Once the STP has been built and commissioned, the portable toilets initially used by construction staff will be decommissioned.

The STP will be located close to the site toilet block in order to minimise drainage runs, and any treated sewage reticulation valves, taps or containers will be identified by appropriate signage and markers. Assuming that each person contributes 145 litres per day to the STP as grey water (sewage and waste water from kitchens, showers etc.), the maximum anticipated flow into the STP would be 29 cubic metres per day (m^3 / day).

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

Human contact with treated effluent aerosols will be avoided. If of suitable quality, the treated effluent will also be used for dust suppression and road watering.

The STP will be designed to achieve Class A effluent quality in accordance with the *Queensland Water Recycling Guidelines* (2005) whose target parameters are presented in Table 3.19. Three levels of STP treatment will be undertaken in order to achieve Class A effluent quality including primary settlement, aeration, clarification, chlorine dosing (if required), filtration and ultraviolet (UV) disinfection. Although total nitrogen and total phosphorus values are not part of the Class A effluent quality parameters, they will be used to further assess the quality of sewage effluent and monitored during operations (refer to Table 3.19).

Table 3.19 STP Effluent Quality Targets

Quality Parameters	Units	Effluent Quality	Limit type	Monitoring Frequency
Biochemical Oxygen Demand	mg/l	<20 median	Upper limit	Monthly
Suspended solids	mg/l	<5 median	Upper limit	Monthly
Turbidity	Nephelometric Turbidity Unit (NTU)	<2	Upper limit (95th percentile)	Monthly
Electrical conductivity	micro Siemens(µS) / centimetre (cm)	1,600	Median	Monthly
pH	pH units	6 – 8.5	Range	Monthly
Coliforms	Colony forming units / 100 ml	<10	Median	Monthly
Total nitrogen	mg/l	<10	Upper limit	Monthly
Total phosphorus	mg/l	<5	Upper limit	Monthly

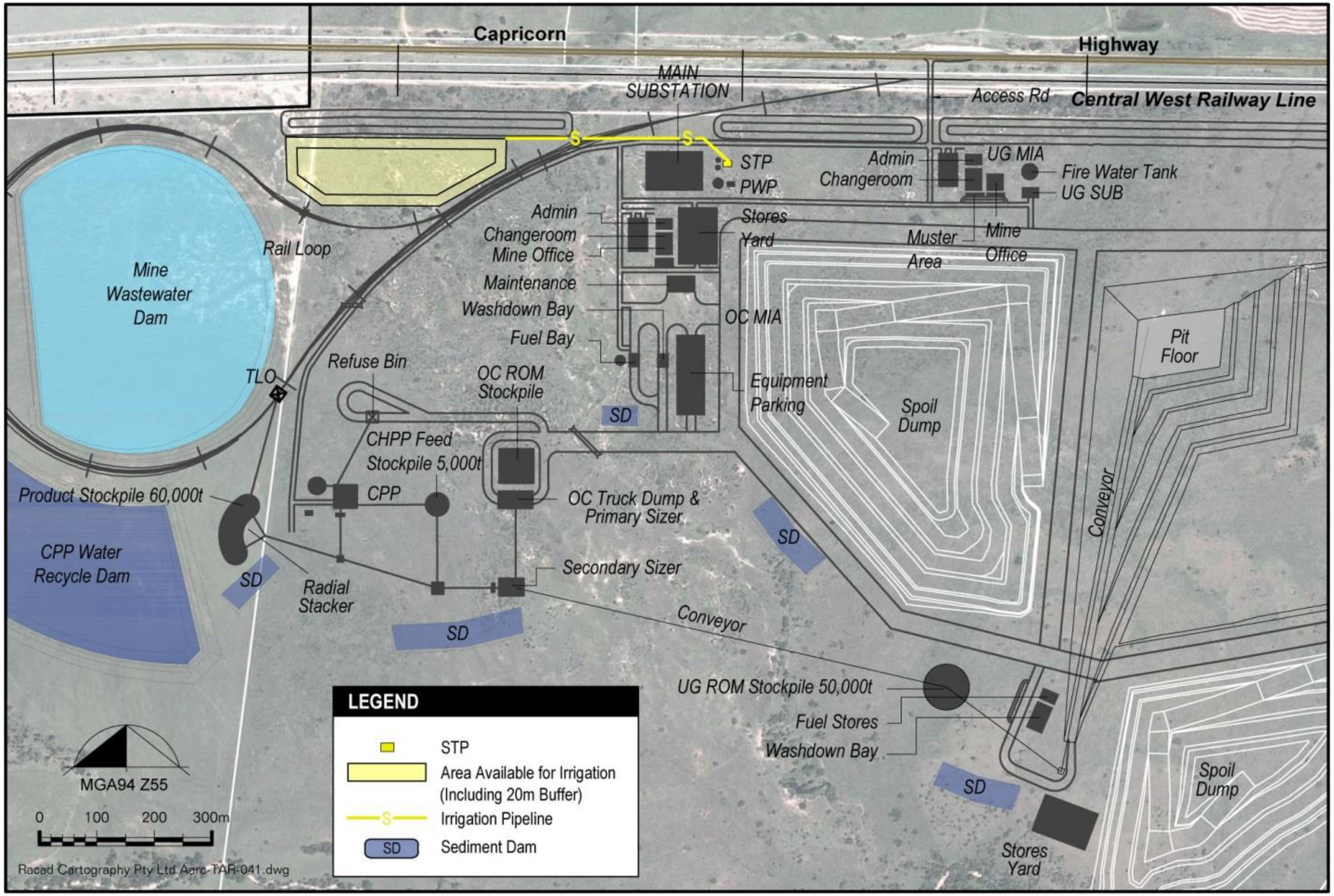
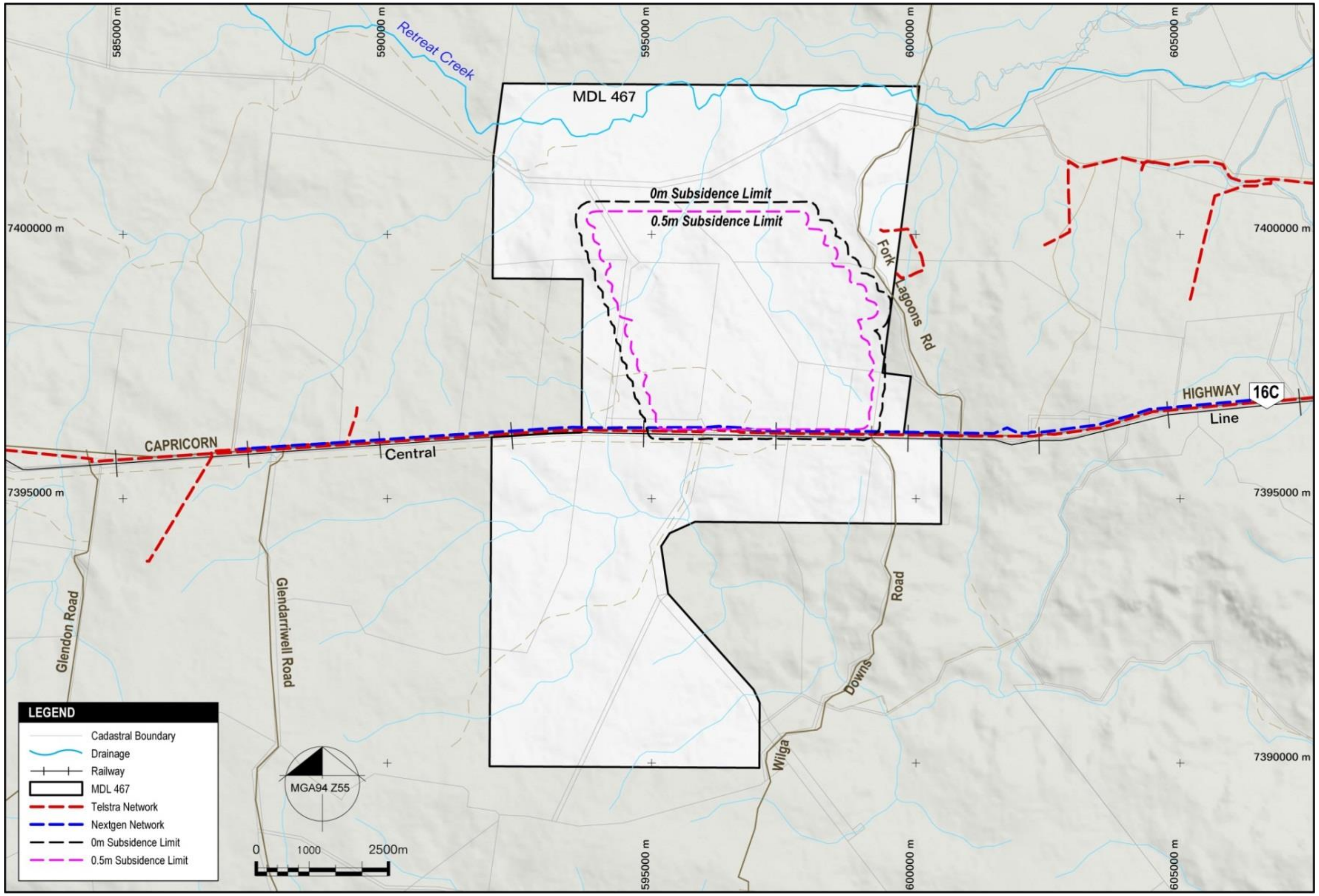


Figure 3.35 STP and Spray Irrigation Area

3.5.6 Telecommunications

The main telecommunications infrastructure associated with the site is a single mode optical fibre cable running parallel with the Capricorn Highway (owned by NextGen Networks) and an underground telecommunications network (owned by Telstra) (refer to Figure 3.36 for local details of this infrastructure). This infrastructure is envisaged to provide an adequate level of service to the Project site during construction and operations.

No telecommunications infrastructure will be affected during opencut mining, however, as initial underground operations progress, areas of fibre optic and telecommunications cabling along the Capricorn Highway will be minimally affected by subsidence. Relocation arrangements of telecommunication assets, if any, will be negotiated with Telstra and NextGen throughout the life of the mine, to ensure no interruptions are experienced within the telecommunication network which services the Project site or community.



Source: NextGen Networks 2012 and Telstra 2012

Figure 3.36 Telecommunications Infrastructure Located within the Project

3.5.7 Other Infrastructure

3.5.7.1 Construction Infrastructure Area

During mine construction, a contractor infrastructure area will be developed which will include a lay down area, workshop, fuel storage area, vehicle washdown bay, water management system, offices and ablutions block. Various elements of this infrastructure shall be retained on site for use by the mine operations team.

3.5.7.2 Workshops and Administration Buildings

The following buildings, as illustrated in Figure 3.37, will be developed on site as part of the operational infrastructure:

- Administration office complex;
- Opencut and Underground Mine Offices
- CPP control room;
- Workshop and store; and
- Change room and toilets.

Several developments may be expanded throughout the mine life to accommodate mine sequencing and workforce numbers.

3.5.7.3 Fuel and Lubricant Storage

Fuel that is required for both the construction and operational phases of the Project will be stored in fully bunded, self-contained above-ground storage tanks. The following storage capacities will be required for each phase of the mine:

- Construction – 25 kL; and
- Operations - 50 kL

It is anticipated that equipment lubricants and hydraulic fluids will be stored in a self-contained and bunded facility near the workshop. Lubricant and hydraulic fluid dispensing will either be conducted at this facility or via a service truck to assist operations.

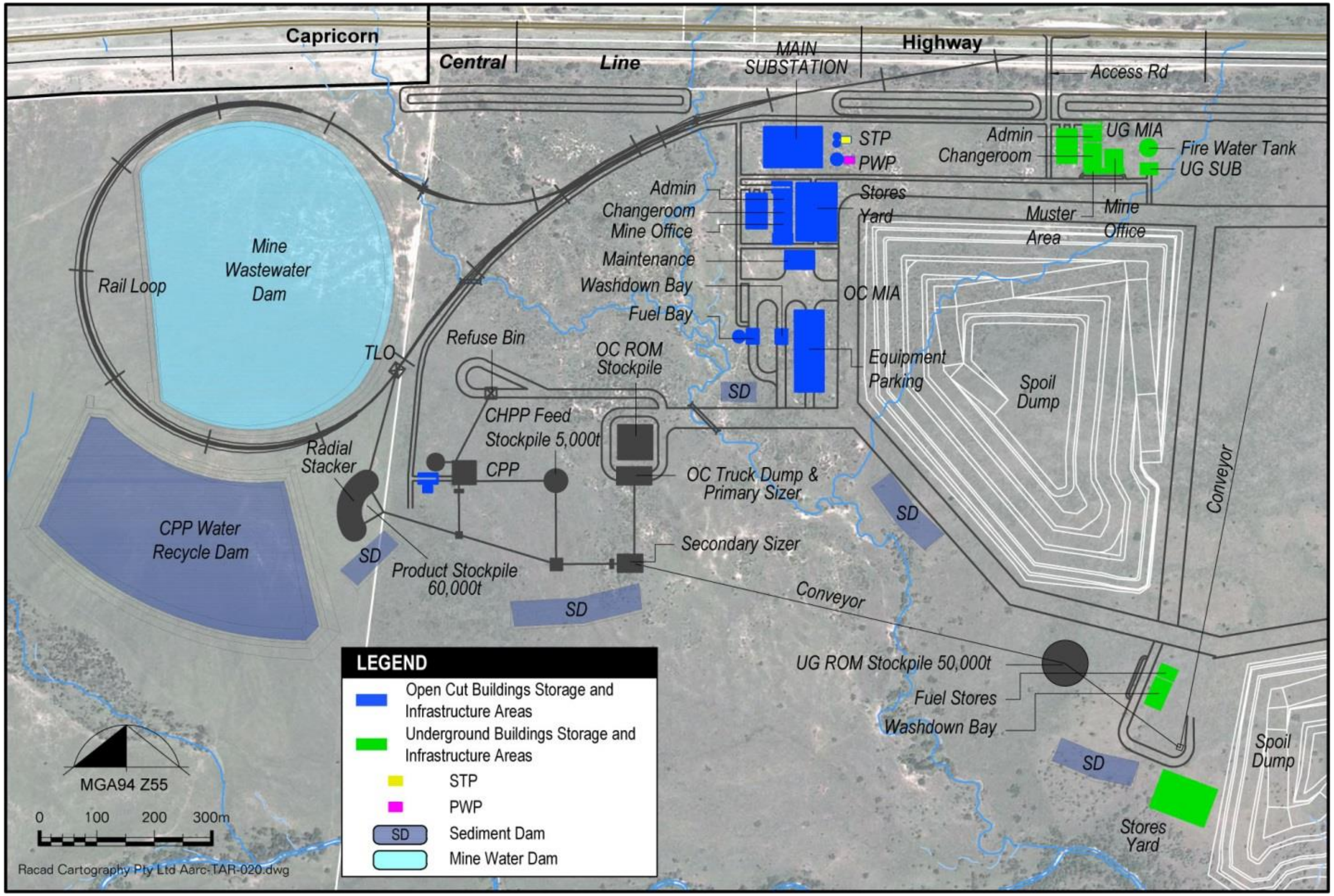


Figure 3.37 Project Buildings, Storage and Infrastructure Areas

3.6 WASTE MANAGEMENT

A Waste Management Plan (WMP) will be developed for the Project in order to manage the potential health and environmental risks associated with the generation, handing, storage and disposal of waste during both mine construction and operations. The WMP will form part of the mine's Plan of Operations (PoO) The effectiveness of this plan during both mine construction and operation will be reviewed on a periodic basis (particularly during PoO amendments) and the plan modified where required. The WMP review process will facilitate improvement of the waste management procedures employed on site and adoption of new procedures where appropriate.

During construction, vehicle loads will be maximised within safe limits, in order to reduce the number of vehicle movements associated with this phase of the Project. Suppliers will be requested to minimise the amount of packaging associated with equipment and supplies that are delivered to site, in order to minimise the volume of waste packaging that is generated on site.

Where possible, wastes will be recycled on or off-site either by the proponent or a licensed waste management contractor respectively.

Queensland's Waste Reduction and Recycling Strategy 2010 – 2020 (DERM 2010) provides a strategic framework for managing waste in Queensland by defining a waste management hierarchy which moves from the most preferred to least preferred management method:

Waste Management Approach:	*Preference:*
• Avoidance	Most Preferred
• Re-use	
• Recycle	
• Treatment and disposal	Least Preferred

3.6.1 Basic Waste Management Methodology

3.6.1.1 Construction and Commissioning Waste

The main wastes that are anticipated to be produced during Project construction and commissioning have been summarised in Table 3.20 as follows:

Table 3.20 Waste Produced in Construction Phase

Waste	Estimated Total Quantity Produced	Method of Re-use/Disposal
Vegetation from clearing activities	1000 cubic metres (m^3)/ 200 tonnes	Vegetation that is removed during site clearance will be chipped/mulched and then stockpiled for landscaping and rehabilitation
Topsoil	877,000 m^3	Stockpiled for future use in rehabilitation programmes
Excavated waste	8,000,000 m^3	Used for constructing mine site infrastructure such as roads, bunds and dams (if material is fit for purpose) or stored in out-of-pit spoil dumps
Scrap Metal	100 tonnes	Removed from site by a licensed waste management contractor and recycled or sold for re-use
Building Materials/ General	200 tonnes	Wastes removed from site by a licensed waste management contractor. Building materials that are surplus to requirements will either be recycled, sold or stored on-site for re-use
Sewage	5,000,000 L	Waste generated by the construction staff portable toilets will be removed from site and managed by a licensed waste management contractor. The treated effluent produced by the on-site STP will be spray irrigated over an area of the site assigned for this purpose or used for dust suppression
Waste Oil and Grease	10 drums	Collected from site by a licensed waste management contractor for disposal or recycling
Decommissioned equipment	NA	Recycled or sold
Waste Tyres	20	Re-used or removed from site by a licensed waste management contractor or buried within the mine spoil. Viable recycling alternatives will be investigated
Vehicle Batteries	20	Collected from site by a licensed waste management contractor for disposal or recycling

3.6.1.2 Operational Waste

The major wastes that will be produced on site during Project operations, estimated quantities of waste and proposed methods of waste reuse or disposal are presented in Table 3.21. The waste management options that are available for operational wastes include:

- **Minimise** – reduce waste production at source;
- **Re-use / recycle** – do not store or dispose of wastes, but re-use and recycle;
- **Treatment / destruction** – waste treatment or destruction to reduce the potential for the waste in question to adversely impact human health or the environment; and
- **Disposal / storage** – on-site storage in engineered storage systems or off-site disposal via a licensed waste disposal contractor.

One or more of these waste management options has been assigned to each of the waste streams identified in Table 3.21.

Table 3.21 Waste Streams Produced During Mining Operations

<table>
<tr><th>Waste Category</th><th>Estimated Quantity</th><th>Waste Management Approach</th><th>Comments</th><th>Cross-reference</th></tr>
<tr><td colspan="5">Solid Wastes</td></tr>
<tr><td>Excavated Waste (Spoil)</td><td>Opencut: Total waste for life of mine (both out-of-pit and in-pit) is estimated to be 159,399,938 (loose m^3)</td><td rowspan="3">Disposal – waste spoil will be deposited in out-of-pit spoil dumps for years one and two. Whilst in-pit dumping of waste spoil is scheduled to commence in Year 3 when the open pit void is large enough, in-pit dumping will then continue for the rest of the mine life</td><td rowspan="3">Wastes which exhibit acid / neutral / alkaline mine drainage will be stored in engineered waste spoil dumps to ensure that this waste does not become oxidised or release acid and / or heavy metals. Where possible, these dumps will also be inundated with groundwater at the end of mine life</td><td rowspan="3">Details of excavated waste are provided in Section 4.4.2.6 and Section 4.4.2.7</td></tr>
<tr><td rowspan="2">Coarse and Fine Rejects</td><td>Opencut: Total plant rejects for life of mine is estimated to be 1,481,966 tonnes</td></tr>
<tr><td>Underground longwall: Total plant rejects for life of mine is estimated to be 502,582 tonnes</td></tr>
<tr><td>Cleared Vegetation</td><td>100 m^3/20t during opencut mining, negligible during underground mining</td><td>Vegetation that is removed will be used for fence posts, chipped/mulched and then stockpiled for landscaping and rehabilitation, or sold to local landscaping contractors</td><td>A Permit is required to harvest State-owned timber resources</td><td>Section 4.8.2.1, Community 11 describes the vegetation that will be cleared during mining operations</td></tr>
</table>

Waste Category	Estimated Quantity	Waste Management Approach	Comments	Cross-reference
General	75 tpa	**Recycle** –for material that can be recycled; collection by licensed waste management contractor **Disposal** - for material that cannot be recycled; collection by licensed waste management contractor	Segregate material into recyclable and non-recyclable waste streams	Section 3.6.5.1 and Section 4.4.2.1 provides further details of domestic waste management
Scrap metal	100 tpa	**Recycle** - collection by licensed waste management contractor	N/A	Refer to Section 3.6.5.3 and Section 4.4.2.2 of the EIS for details of the management of scrap metal
Batteries	40 per annum	**Recycle** - collection by licensed waste management contractor	N/A	Refer to Section 3.6.5.3 and Section 4.4.2.2 of the EIS for details of the management of used batteries
Drums of oil, hydrocarbons and chemicals	10 drums per annum	**Recycle** - collection by licensed waste management contractor	N/A	Refer to Section 3.6.5.4 and Section 4.4.2.3 of the EIS for details of the management chemicals and hydrocarbons
Tyres	20 tyres per annum	**Recycle** - collection by licensed waste management contractor	On-site tyre processing may be a waste management option for the Project in the future	Refer to Section 3.6.5.2 and Section 4.4.2.2 for further details of waste tyre management

Waste Category	Estimated Quantity	Waste Management Approach	Comments	Cross-reference
Liquid Wastes				
Sewage	Up to 10,150,000 L produced per annum	**Disposal**–temporary relocatable toilets used by construction contractors will be serviced by a licensed waste management contractor **Treatment** – Permanent STP will treat raw sewage to Class A quality water for on-site irrigation and dust suppression	N/A	Sections 3.6.6.4 and 4.4.2.5 of the EIS provide details of sewage management
Mine Affected Water	On average 2,400 ML of mine affected water will be produced per annum	**Reuse / recycle** – on site for CPP operations, dust suppression and irrigation. This waste stream is recycled rather than disposed of or stored	N/A	Sections 3.6.6.2 and 4.4.2.4 of the EIS address the management of waste water
Groundwater	Between 220 – 2100ML of groundwater will be captured per annum	**Reuse / recycle –** on site for CPP operations. Groundwater is recycled rather than disposed and excess groundwater is treated and released for Beneficial Use	N/A	Sections 3.5.3.2 and 4.5.2.2 of the EIS address the management of groundwater
Oils, hydrocarbons and solvents	60,000 L per annum	**Reuse / recycle** – collection by licensed waste management contractor	Waste materials will be stored and managed as per appropriate standards	Sections 3.6.6.3 and 4.4.2.3 of the EIS address the management of waste oils, hydrocarbons and solvents in further detail

N/A = not applicable

3.6.1.3 End of Mine Waste

Wastes that persist at the end of mine life will be managed in accordance with best practice management procedures at the time of mine decommissioning. Mine infrastructure will either be removed from site or left in-situ where written agreement is in place with the landowners. Site decommissioning and rehabilitation is described in Section 3.7.

3.6.1.4 Resource Use Efficiency

Resource use efficiency has been considered during the development of the mine water management system, which manages mine area runoff and pit water for reuse within the processing circuit. The recycling of water within the water management system employed on the Project site removes any potential demand on natural waterways for supplementary water, supporting local irrigators and landholders downstream.

During the detailed design phase of the Project, which will comprise the design of workshops, offices, allocation of specific models of equipment and other vital infrastructure, green energy options shall be explored with the objective to promote efficient use of electricity.

This will include the use of energy saving light bulbs and energy rated electrical equipment within workshops and offices where practical. Regular maintenance of electrical equipment will also be undertaken to ensure energy conservation through efficient operation.

3.6.2 Air emissions

The quantity and quality of all air emissions from the Project during construction and operation were assessed by Katestone Environmental Pty Ltd (Katestone) in November 2013. The following air quality parameters were included in this assessment:

- Total suspended particulate matter (TSP);
- Particulate matter with equivalent aerodynamic diameters of 10 µm or less (PM_{10});
- Particulate matter with equivalent aerodynamic diameters of 2.5 µm or less ($PM_{2.5}$); and
- Greenhouse gases.

Although Project coal mining and processing activities are not anticipated to produce any significant odours, the STP and storage of putrescible waste may generate detectable odours. However, both these odour sources will be covered and appropriately managed in order to minimise the release of volatile compounds. Any odours that may be generated on site will only impact mine staff, because no local homesteads are located close to these potential sources of odour.

Since the underground coal mine will be ventilated, there is a risk that odours will emanate from the ventilation system. Although detailed ventilation engineering designs have yet to be developed, the air quality assessment considered the contribution of odour from the Project's ventilation system and this is further described in Section 3.6.2.1.

Details of the air quality assessment methodology and outcomes are provided in Appendix 15, while potential impacts and mitigation measures are discussed in Section 4.6 of this EIS. The following provides a pertinent summary of the air quality assessment conducted and the modelled dust and odour emissions from the Project.

3.6.2.1 Particulate Matter Emissions

The major sources of dust emissions will occur during opencut mining through the use of excavators and haul trucks to transport and remove coal and overburden. The remaining sources of dust from the Project are wind-blown dust from exposed ground and stockpiles, bulldozing activities during operations and wheel generated dust and earthworks during construction. Therefore, two air quality impact assessment scenarios, representative of the years that could result in significant air quality impacts, were modelled for the Project site as follows:

- Year 2; and
- Year 5.

A third model representing maximum emissions in Year 6 was also generated.

Modelling Results

In order to undertake a cumulative air quality impact assessment, a suitable background level of each of the dust metrics was established, representative of the potential levels of dust in the region. This was then added to the projected concentrations of particulate matter due to the Project to allow a conservative assessment of the expected cumulative levels of particulate matter in the local region.

A summary of the modelled dust emission rates for the Project operations are presented in Table 3.22. Further details regarding the outcomes of the air quality impact assessment are provided in Appendix 15 and Section 4.6 of this EIS.

An analysis of the outputs indicated that haul trucks using the haul road to transport coal and overburden are the most significant contributor to elevated PM_{10} concentrations on most days, particularly during Year 5.

In addition, the following mining activities also represent elevated sources of PM_{10}:

- Development of active pits;
- Out of pit spoil dumps in Year 2;
- ROM haul;
- CPP activities; and
- Train load out activities.

During the assessment, the transport of coal by train was not found to significantly add to the fugitive dust emissions since the impacts are often short-lived, meteorologically dependent and localised (measured impacts are often found to be <50m from the rail wagons). In addition, the coal loaded into each rail wagon will be veneered, in order to limit the amount of coal dust that is liberated during rail transport.

The odour assessment indicated that the maximum predicted 99.5^{th} percentile 1-hour average ground-level concentration is 1.7 ou, which is 68% of EHP's odour guideline and occurs approximately 100m to the southwest of the ventilation shaft.

Table 3.22 Estimated Total Dust Emission Rates for the Project

Activity	Total Dust Emission Rate (g/s)								
	Year 2			Year 5			Year 6		
In-Pit Activities (drilling, blasting and truck loading)	3.0	1.6	0.3	4.7	2.5	0.4	4.7	2.5	0.4
Haul roads	77.3	23.9	2.4	79.2	27.9	2.9	86.5	30.5	3.1
Conveyors	0.4	0.1	0.001	1.6	0.4	0.05	1.5	0.4	0.05
CHPP	6.6	1.2	0.1	10.3	1.8	0.2	10.6	1.9	0.2
Wind erosion of spoil dumps	10.3	5.1	0.8	3.4	1.7	0.3	3.4	1.7	0.3
Train loading	1.8	0.3	0.03	2.9	0.5	0.1	3.0	0.5	0.1
Rail line	0.005	0.002	0.000	0.01	0.004	0.001	0.01	0.004	0.001
Total	**99.3**	**32.2**	**3.7**	**102.1**	**34.8**	**3.9**	**109.6**	**37.4**	**4.1**

Mitigation Measures

Measures to minimise the potential impact of fugitive dust emissions will include proactive and reactive measures which mitigate all potential dust emission sources to reduce adverse impacts that the proposed mining activities may have on the health and amenity of the surrounding community. Mitigation measures are further described in Section 4.6.2.2.

An Air Quality Management Plan (AQMP) will be developed to assist with the implementation of minimisation and management strategies at the Project site and will be developed considering the Air EPP objectives and emissions management hierarchy also outlined in Section 4.6.2.2.

3.6.2.2 Greenhouse Gas Emissions

In addition to the air quality impact assessment, Katestone provided an assessment of the greenhouse gas (GHG) emissions from Project in October 2013, to quantify its relative contribution to the GHG emissions in Australia.

Emissions of GHGs from the Project site were calculated in accordance with National Greenhouse Accounts (NGA) Factors workbook published by the Department of Climate Change and Energy Efficiency (DCCEE) methodology for calculating greenhouse gas emissions (2010 and 2011), based on Australian data.

The GHG assessment concentrated on the following three key GHGs produced by the Project, which are known to contribute to the greenhouse effect:

- Carbon dioxide (CO_2);
- Methane (CH_4); and

- Nitrous oxide (N_2O)

These gases differ in their capacity to trap heat and contribute to the greenhouse effect. The capacity of each gas to contribute to global warming is referred to as its global warming potential (GWP) relative to that of carbon dioxide. Because of the variation in GWP between different gases, the emission factors used to calculate greenhouse gas emissions from the Project are stated in terms of equivalent carbon dioxide emissions (CO_2-e).

GHGs are expected to be generated through the following activities associated with the Project:

- Fugitive emissions from underground coal extraction;
- Fugitive emissions from opencut coal extraction;
- Blasting of material;
- Fuel combustion;
- Electricity consumption;
- Electricity transmission losses; and
- Fuel generation

The total attributable emissions were calculated for the Project and data indicate emissions from electricity consumption are expected to have the greatest contribution to the total GHG emissions from the Project. Gases emitted from diesel combustion are the next largest contributor. Fugitive emissions and blasting emissions make up for the remainder of emissions. Fugitive emissions occur during the mining process due to the fracturing of coal seams, overburden and interburden strata.

The peak annual emission rate of greenhouse gases from the Project is 0.092 Mt CO_2-e in operational Year 6. This represents 0.02% of Australia's estimated 546.3 Mt CO_2-e of greenhouse gas emissions for 2011 (DCCEE, 2011). Therefore peak, annual GHG emissions from the Project are not expected to make a significant contribution to Australia's GHG emissions limits as assigned under the Kyoto Protocol.

Further details of the GHG emissions generated by the Project and abatement measures are provided in Section 4.6.3 of the EIS and Appendix 16.

3.6.3 Excavated Waste

The excavated waste produced by the Project will mainly consist of overburden and interburden material that is extracted during mining operations. The local geology of the Project site and associated waste horizons are described in Section 3.3.2.

3.6.3.1 Volume of Excavated Waste

It is estimated that a total volume of approximately 159 Million lcm of waste (overburden and interburden) will be excavated during the life of the Project. Excavated waste will initially be disposed of in out-of-pit spoil dumps whilst the opencut pit is being developed. Once the opencut pit is large enough, excavated material will be transferred directly to in-pit spoil dumps. Overburden and interburden waste is expected to swell by a factor of 25 % following excavation.

The estimated annual volumes of waste material produced over the life of the Project are presented in Figure 3.38.

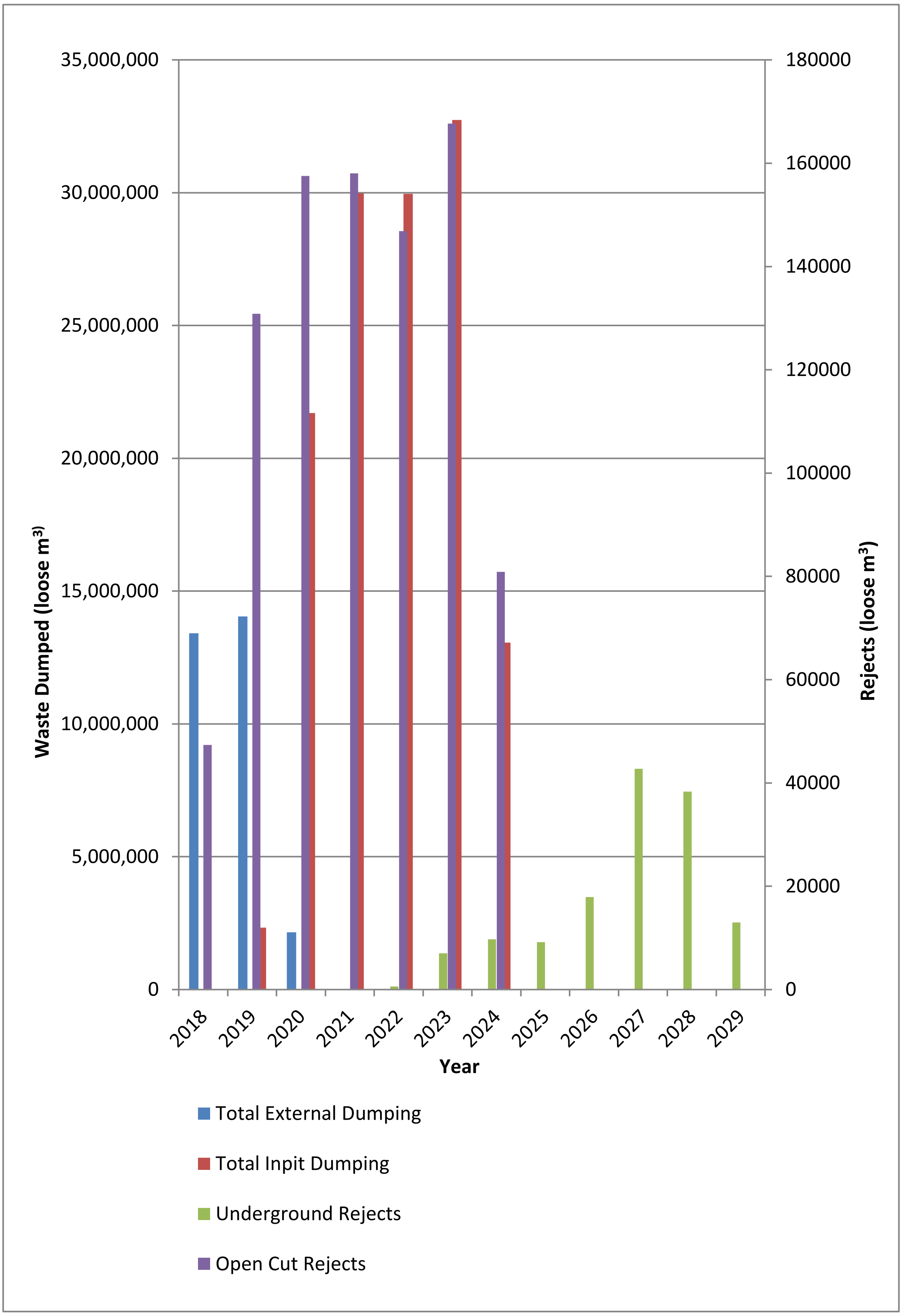


Figure 3.38 Annual Quantities of Mined Waste (Opencut and Underground)

3.6.3.2 Spoil Disposal

Three out-of-pit spoil dumps will be located south of the Capricorn Highway around the western and south-western edge of the opencut pit (refer to Figure 3.39). The staged development of these spoil dumps are illustrated within the mine stage plans presented in Section 3.3.4.1. It is anticipated no out-of-pit spoil dump will exceed 90 m in height above the natural ground level.

Once the opencut pit is large enough, waste material will be transferred directly to in-pit spoil dumps. The design parameters of spoil dumps are summarised in Table 3.23 and a typical cross section of both the spoil dump cover and base are presented in Section 3.6.4.4 in Figure 3.43.

Table 3.23 Typical Spoil Dump Design Parameters

Parameter	Value
Lift height - maximum	20 m
Lift face angle	35 ^{o}
Bench Width	8 m
Ramp width	35 m
Ramp grade	Up to 10%
In-pit overall dump height	Approx. 5 m – 10 m above original landform
Out-of-pit maximum dump height	90 m
Average Waste density (with swell)	2.0 tonnes / m^3
Waste swell factor	25%

3.6.3.3 Spoil Dump Decommissioning

Decommissioning of the spoil dump aims to reduce hydraulic conductivity, stop capillary movement of moisture and encourage the growth of vegetation suitable for the post-mine land use, consistent with the rehabilitation strategy described below (refer to Figure 3.40 for a conceptual cross section of the spoil dump surface cover):

- Clay liner – provides a barrier to water ingress and therefore reduces the volume of water draining through the spoil dump. The hydraulic conductivity of the clay should be less than 106 m/s to ensure that a low permeability barrier is achieved in the waste spoil dumps. Clay liners must also be keyed into other elements of the waste spoil dumps to ensure that drainage pathways are not created;

- Capillary break –a capillary break layer comprised of gravel, will be installed either side of the clay liner in order to stop the capillary movement of moisture into or out of the waste material; and

- Vegetative layer – A growth medium and non-woven geotextile will be placed over the waste spoil dump. The function of this layer is to reduce soil erosion, minimise visual amenity impacts, promote the evaporation of water from surface soils and provide a permanent, robust final capping layer. This layer will be vegetated with hardy, local species which require minimal maintenance.

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

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

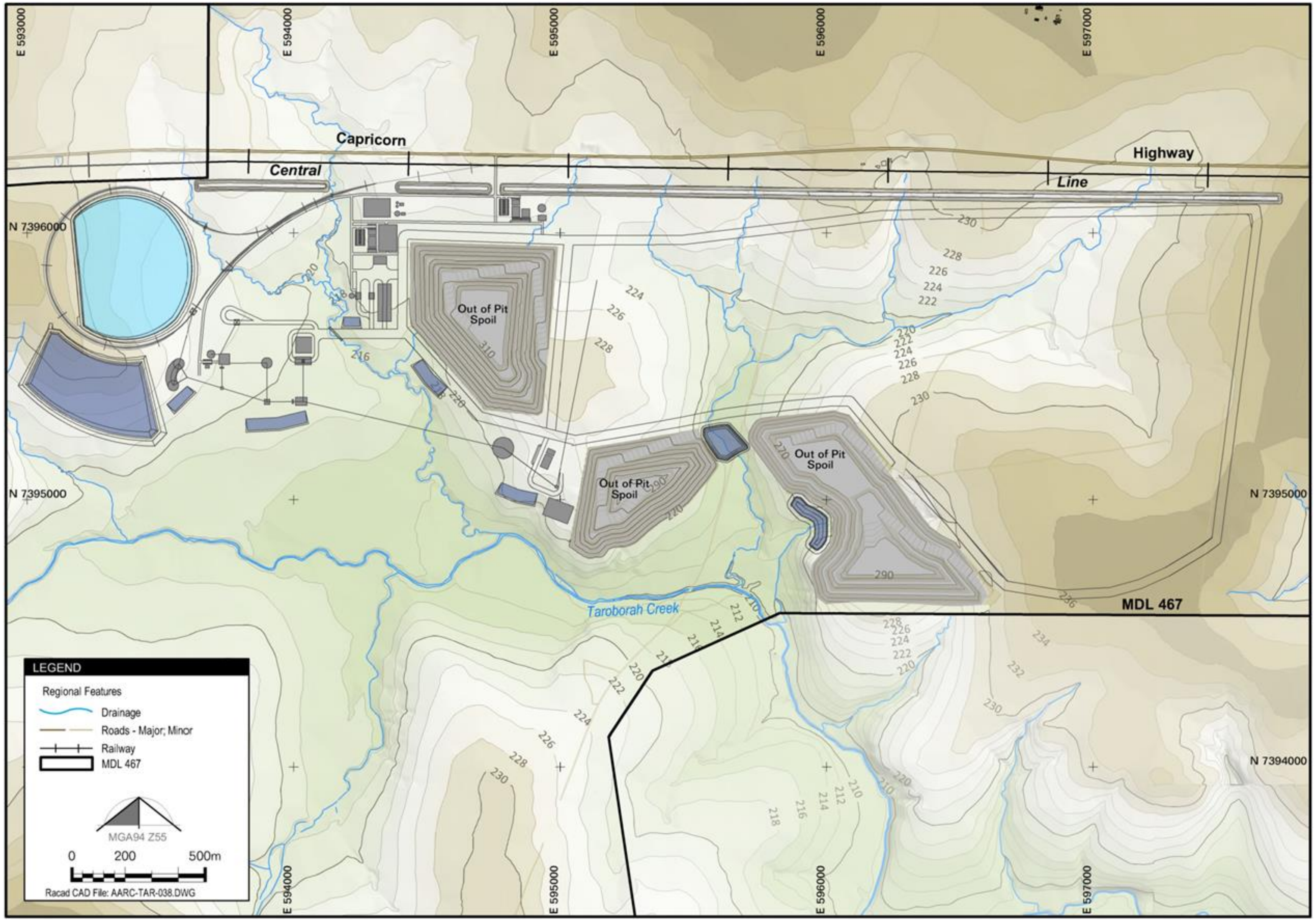
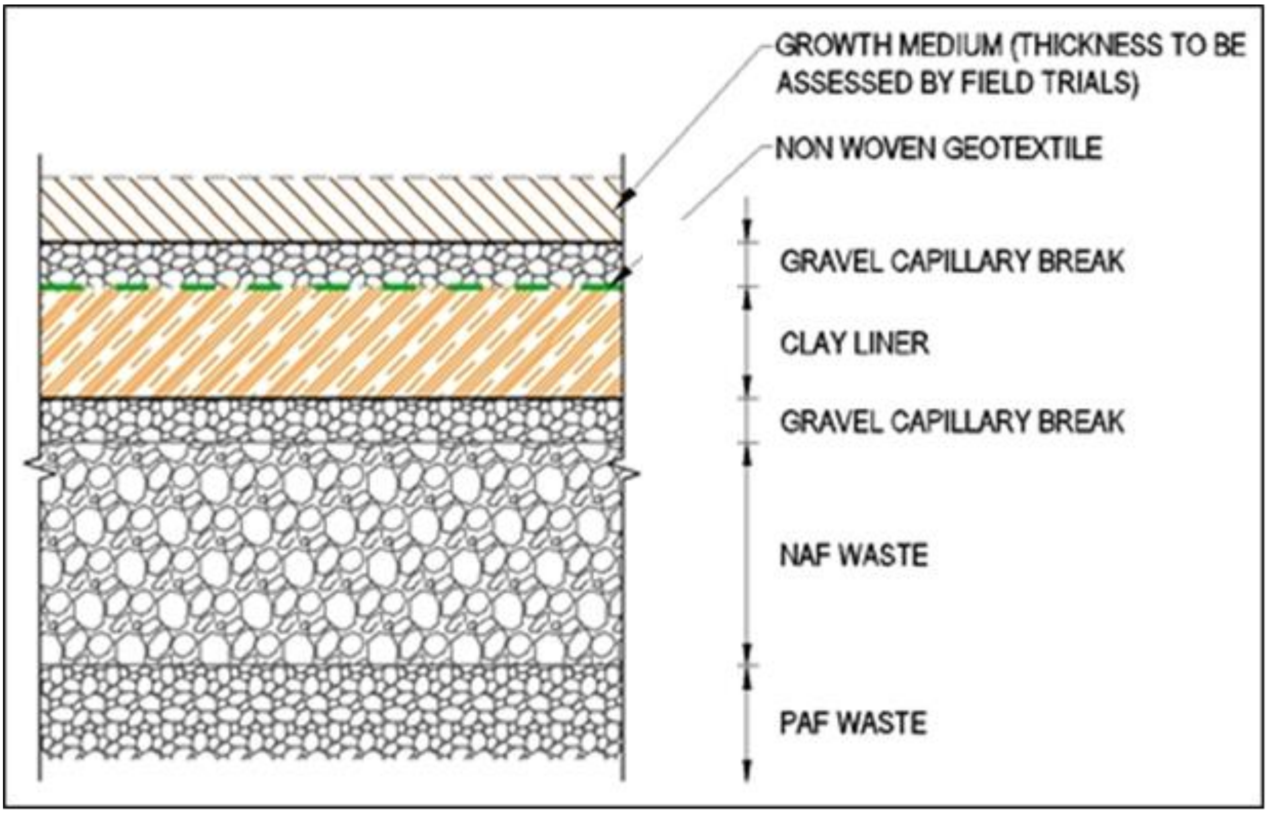
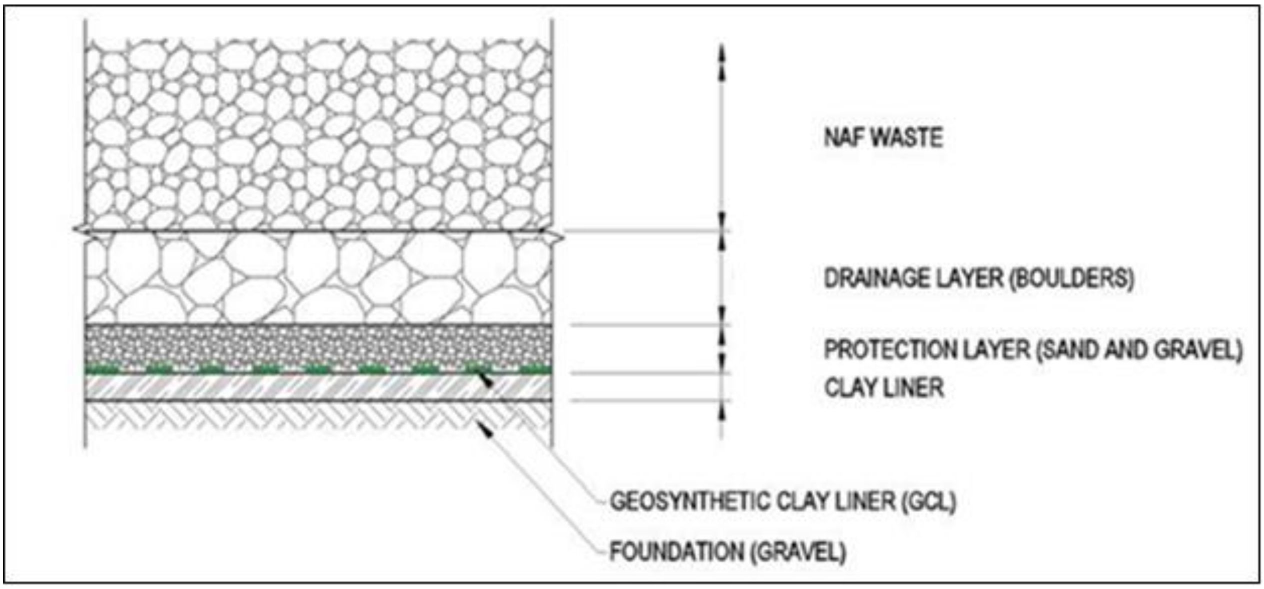


Figure 3.39 Location of Out-of-Pit Spoil Dumps





Note: The GCL is only included where rejects cells are present.

Figure 3.40 Conceptual Design of Spoil Dump Cover (above) and Base (below)

3.6.3.4 Waste Characterisation

Both static and kinetic geochemical testing has been conducted by Environmental Geochemistry International (EGi) on a variety of materials which are indicative of the waste material that will be generated during the mine life (raw coal, overburden / interburden and CPP rejects). Assessment of acid, neutral and alkaline mine drainage was one of the main aims of this testing. Static testing was conducted from July 2012 to September 2012, whilst kinetic testing was conducted from November 2012 to April 2014. The sampling and testing methodology together with results, analysis and interpretation of this data is in the *Static Geochemical Assessment of the Taroborah Coal Project* (2013) report produced by EGi and the *Leach Column Test Results for Overburden and Interburden from the Taroborah Coal Project* report (EGi 2014) provided in Appendix 12.

Static testing of waste rock was also conducted by SGS in 2011 for 172 samples from seven open holes that were drilled across the Project site. The findings from this study and the interpretation developed by SGS have also been included in the EGi reports provided in Appendix 12.

Sampling Approach

The sampling approach was consistent with the concepts prescribed by the Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland series (DME 1995). Samples were collected to represent individual depth intervals and rock units, and the program was designed to take into account the geological variability, complexity and controls in relation to acid rock drainage (ARD) potential.

In the case of sedimentary deposits such as Taroborah, the geological controls allow for more confident prediction of the distribution of ARD than, say, a typical metalliferous deposit, since the geochemical zones occur in sedimentary layers which can be related back to the well-defined coal horizons or weathering boundaries. The total number of samples is less important than capturing the key geochemical horizons over a broad spatial area and confirming the continuity of these horizons by correlating between holes.

Two sampling programmes were carried out. The first in 2011 was arranged by IMC Mining Group Pty Ltd (IMC) and comprised geochemical testing of 172 samples from 6 open holes drilled across the site. Sampling involved scooping of small sub-samples during drilling and compositing in the field, sufficient to provide an overall indication of the relative ARD potential of overburden and floor materials for the deposit. The second programme was organised by EGi with IMC in 2012, and comprised collection of 108 samples from 3 cored drill holes spread across the deposit. The samples comprised entire core collected continuously throughout each core hole to provide more representative samples of overburden, interburden and coal, and obtain a better understanding of geological controls on the distribution of ARD rock types.

Figure 3.41 shows a collar location plan for drill holes sampled for geochemical assessment, showing the combined sampling programmes cover a broad spatial distribution across the proposed opencut pit area. The distribution and abundance of pyrite in coal bearing sedimentary sequences are largely controlled by the original depositional environment, with influences such as seawater incursions and presence of organic matter key to pyrite formation. As a result of these controls, pyrite is usually preferentially distributed in particular lithologies (such as carbonaceous mudstones) and stratigraphic horizons. Coal sequences usually have high lithological variation in the vertical sense but tend to show lateral continuity, and hence sampling for ARD assessment needs to take this into account by obtaining detailed continuous samples in individual holes spaced at wide intervals. The core sampling strategy carried out in 2012 aimed to screen the entire mine stratigraphy for acid potential, identify horizons of concern and look for correlations between holes that indicate continuity, and rely on

geological controls to help predict the distribution of potentially acid forming (PAF) and non-acid forming (NAF) rock types. This approach results in better representation of mine materials in coal deposits, compared with a purely lithological approach to sampling. Results of both programmes were used in the geochemical assessment, and when compared between holes on a stratigraphic basis there were a number of clear correlatable geochemical zones identified. These zones, including estimated volumes and numbers of samples, are shown in Table 3.24.

Table 3.24 Number of Samples Per Volume of Waste Rock Units

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

The stratigraphic controls on pyrite occurrence increase the predictive power of the results, so that fewer samples with intervals linked to geology and correlation of results between holes can be used to defined the distribution and continuity of geochemical horizons.

The horizons defined so far are conservative in that the proportion of PAF materials may be overstated. It is expected that follow up testing during the detailed operational design stage would be able to better delineate PAF horizons and reduce the volume of materials requiring special handling.

AMD Classification Categories

In terms of geochemical classification, each sample was assigned an AMD category based upon the following schemes:

- Net Potential Ratio (NPR) – employs the ratio of Acid Neutralising Capacity (ANC) to Maximum Potential Acidity (MPA) to classify Acid Mine Drainage (AMD) potential, refer to Table 3.25 for details; and

- Acid Base Accounting (ABA - AMIRA scheme) – employs Net Acid Generation (NAG) plus the extended boil NAG test if single addition NAG is less than 4.5 and Net Acid Producing Potential (NAPP) values to classify rock samples, refer to Table 3.26 for details.

Table 3.25 Net Potential Ratio Classification System

Rock Classification	Classification Criteria
Non-Acid Forming (NAF)	NPR >3
Potentially Acid Forming (PAF)	NPR< 1 – sulphate oxidation could produce AMD
PAF-Low Certainty (LC)	PAF associated with low NAG acidities (NAG $_{pH4.5}$< 5 kg H_2SO_4 / t)
Uncertain (UC) (PAF)	NAPP ≤ 0 and NAG pH ≤ 4.5 (NPR >1 and < 3)
UC (NAF)	NAPP ≥ 0 and NAGpH ≥ 4.5

Table 3.26 Acid Base Accounting System

Rock Classification	Classification Criteria
Barren	Total S ≤ 0.1 % and ANC≤ 5 kg H_2SO_4 / tonne – minimal risk of AMD behaviour
NAF	Negative NAPP value and final NAG pH ≥ 4.5
PAF	Positive NAPP value and final NAG pH ≤ 4.5
UC	Positive NAPP value and final NAG pH ≥ 4.5 or negative NAPP value and final NAG pH ≤ 4.5 – it is not possible to be certain of the AMD category of samples which exhibit these properties

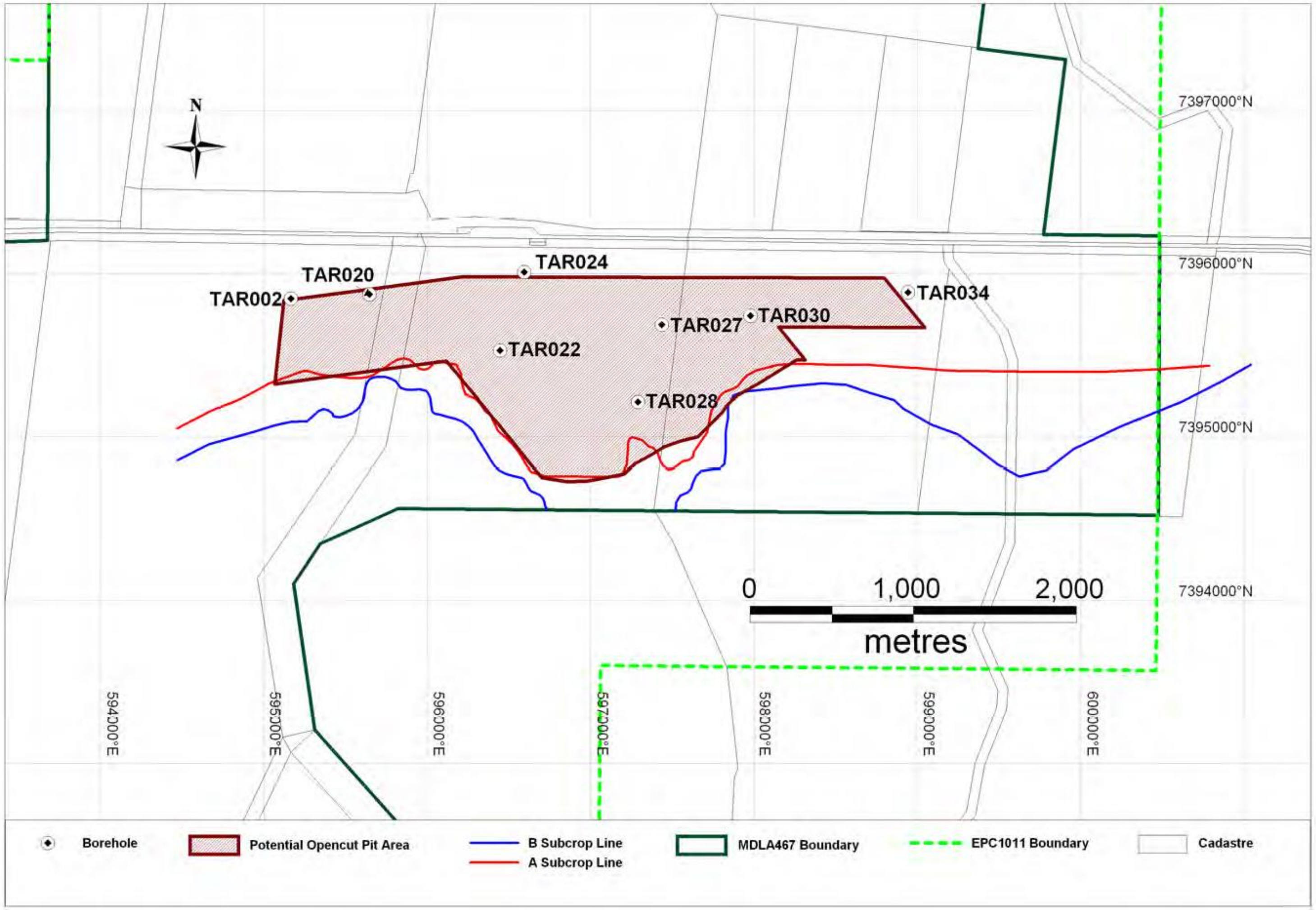


Figure 3.41 Waste Rock Sampling Locations

Waste Characterisation Results

The results of the geochemical characterisation of raw coal, overburden and interburden are summarised in the following sections. A full discussion of the static and kinetic geochemical testing and assessment is provided in Appendix 12.

Acid Generation

Since partial oxidation of the pyritic Sulphur (S) resulting in acid sulphate salts has probably occurred prior to testing, the total concentration of acid-generating S is the sum of the pyritic S and acid sulphate S. The results of the S speciation analysis and potential for acid generation have been summarised as follows:

- A seam ROM coal samples –75 % to 90 % of the S measured is present as acid generating species;

- B seam tops ROM coal – one sample contained a high percentage of acid generating S (67%), whilst the other two samples exhibited lower acid-generating concentrations (27% and 44%);

- B seam bottoms ROM coal – most of the S measured (60% to 75%) was in non-acid sulphate and most likely organic, low-risk forms of S;

- Overburden / interburden –although most of the S present in these materials is likely to be pyritic (ranging from 35% to 84% acid generating S), a significant proportion is NAF (approximately 66 % of the samples that were tested); and

- Coarse and fine rejects –derived from both the A seam and B seam are considered to exhibit a high AMD risk (and subsequent release of metals and other cations and anions), since the acid-generating S species appear to be concentrated during the CPP washing process.

Kinetic NAG Results

Results from the kinetic NAG tests indicate that the PAF overburden / interburden material and ROM coal will generate AMD within weeks of exposure to the atmosphere and subsequent oxidation. The following water soluble components will then be released from the waste material as a result of acid generation:

- Overburden / interburden and ROM coal – Al, Co, Cr, Cu, Fe, Mn, Ni, SO_4 and Zn. At pH 3 or less, slightly elevated concentrations of B, As, U and Th would also be expected;

- Coarse and fine rejects - Al, As, Co, Cr, Cu, Fe, Mn, Ni, SO_4 and Zn; and

- Overburden / interburden, ROM coal and rejects – increased salinity as a function of pyrite oxidation.

Neutral and Alkaline Mine Drainage

Analysis of the water extracts from the NAF overburden / interburden indicated that neutral mine drainage was unlikely to contain significant metal / metalloid contamination.

Acid Neutralisation

Basalt samples were found to exhibit the strongest ANC properties (up to 440 kg H_2SO_4 / t) and samples of clay located close to this basalt material also recorded elevated ANC values. Although three of the sand samples exhibited ANC values greater than 100 kg H_2SO_4 / t, the remainder possessed ANC values less than 12 H_2SO_4/ t. The sandstone, siltstone, carbonaceous shale and coal samples generally exhibited low ANC median values of 5 H_2SO_4 / t.

A strong inverse relationship between ANC and total S concentrations exists, with high ANC material containing low S concentrations. For most of the weathered basalt, soil and sedimentary rock, the majority of the total ANC was readily available as indicated by the strong buffering profiles that emerged from the ABCC test results. Fresh sedimentary sandstone and siltstone were found to possess low to moderate ANC characteristics.

Therefore, material comprised of fresh and weathered basalt should prove suitable ANC material for neutralising acids that are produced by PAF geologies.

Of the samples tested, 35% were found to be NAPP negative (possess sufficient ANC to prevent acid generation) and 65% NAPP positive (acid generating or non-acid neutralising material), therefore only a third of the samples tested exhibited ANC potential.

Classification

Results from the ABA assessment were used to geochemically classify the various geologies that had been sampled, into NAF, PAF and UC categories. The results of this classification process are summarised in Table 3.27.

Table 3.27 Geochemical Classification of Materials to be Mined

Material Source	Number of Samples	AMD Category and % Composition		
		NAF inc UC (NAF)	PAF-LC inc UC (PAF-LC)	PAF inc UC (PAF)
Weathered Basalt	10	100	0	0
Weathered Sedimentary Rock	71	100	0	0
Fresh A Seam Overburden	78	40	40	20
Fresh A Seam	3	0	0	100
Fresh A-B Seam Interburden	70	29	44	27
Fresh B Seam	12	0	0	100
Fresh B Seam Floor	9	14	72	14

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

The coarse and fine rejects samples obtained from the A seam and B seam were considered to possess a high risk of AMD production (PAF material) within a short time period following oxidation, resulting in a low pH eluate with high metal and metalloid concentrations.

ROM coal obtained from the A seam and B seam were also classified as PAF materials with rapid oxidation properties.

Metal Abundance and Solute Leaching

Multi element scans for 20 selected samples were compared with data for median values of metals in soil in order to identify enriched elements via the Geochemical Abundance Index (GAI), where a GAI value of three (10 fold enrichment above median soil abundance) or greater signifies geochemical enrichment.

Only Be was found to be enriched in many of the samples and one sample was enriched for Tl, however their concentrations did not lie outside the normal ranges for sedimentary rock and are therefore unlikely to be of concern in terms of impacting the quality of local water courses or groundwater.

The following metals were found to leach from solid PAF samples (A seam and B tops seam) when acidic conditions developed (pH 2.2 to 4.4) within these samples: Al, Co, Cr, Cu, Fe, Mn, Ni, SO_4 and Zn, and at pH values of three or less, slightly elevated B and elevated As, U and Th.

Some of the clay and soil samples which indicate sodic properties may also be prone to increasing the salinity of the local aqueous environment, however, neutral and alkaline mine drainage does not appear to be an issue for NAF material, since water extracts at the pH values did not contain significant metal and metalloid concentrations.

Dispersivity

The exchangeable cation data indicated that most of the overburden / interburden materials are unlikely to be sodic and therefore not dispersive. However, five clay and soil samples within 12 m of the surface exhibited partly sodic properties (exchangeable sodium percentage (ESP)> 6% and exchangeable cation exchange capacity (ECEC) >25 milli-equivalent %) and therefore may be subject to surface crusting, dispersivity and erosion if employed to cover the surface of waste spoil dumps and thus exposed to precipitation. If these materials are used as capping material they should be treated with gypsum in order to replace monovalent sodium ions with bivalent calcium ions, thereby improving soil structure.

Kinetic Geochemical Results

The following geochemical characterisation results were obtained for the seven column samples analysed based upon total S, MPA, ANC, NAPP, ANC / MPA ratio and single addition NAG tests:

- Weathered, High ANC NAF Basalt Rock = NAF, with 75 % of the ANC readily available;
- Weathered, High ANC NAF Sedimentary Rock = NAF with 100 % of the ANC readily available;

- Weathered, Low ANC NAF Sedimentary Rock = NAF;
- Fresh NAF / PAF-LC A Seam Overburden = NAF;
- Fresh PAF A Seam Roof = PAF (confirmed);
- Fresh PAF / PAF-LC A Seam / B Seam Interburden = PAF; and
- Fresh PAF-LC B Seam Floor = PAF-LC.

Detailed analysis of leach column tests including the associated sulphur content, pH and EC values of each sample are provided in Appendix 12.

Leach Column Conclusions

The following conclusions have been developed for waste rock materials that have been subjected to leach column testing and will be placed in out-of-pit and in-pit spoil dumps:

- Although weathered NAF materials are unlikely to leach significant metals and metalloids, the weathered low ANC NAF sedimentary rock may initially produce some salinity. The weathered low ANC NAF sedimentary material should be investigated further, to determine the extent to which the release of salinity will impact the local environment;
- High ANC basalt and sedimentary rock appear to be suitable for mitigating or delaying the onset of AMD from PAF and PAF-LC materials;
- Operational mixing of the NAF and PAF-LC (from above the A Seam) materials appears to control AMD production. However, note that some salinity and elevated Mn concentrations can be expected to leach from such mixed materials. PAF-LC material should be excluded from the outer slopes of spoil dumps, unless it is blended with high ANC material or limestone. Larger scale trials would be needed to confirm the validity of this approach over a longer timeframe; and
- PAF and PAF-LC materials are likely to produce significant AMD within short time periods and will require selective handling and mitigation measures to prevent AMD production during operations and following mine closure. The production of acid is likely to result in the leaching of Al, As, Co, Cr, Cu, Fe, Mn, Ni and Zn from these materials.

AMD Management Strategies for Excavated Waste

A number of AMD management strategies have been developed for overburden and interburden materials which are placed in out-of-pit and in-pit spoil dumps as follows:

- Out-of-pit spoil dumps will be constructed with NAF material where possible;
- Selective handling will be employed to isolate PAF material;
- PAF materials will be preferentially placed in–pit below the groundwater recovery level, (with oxidation and acid-generation control measures) in order to facilitate inundation of this material at mine closure , thereby preventing long-term exposure to atmospheric oxidation;
- To minimise material oxidation via convection, paddock dumping and traffic compacting will be employed for PAF material in lifts of 5 m or less;

- Prior to inundation, the lifts and faces of placed PAF material will be treated where necessary with crushed limestone for operational control of AMD;

- PAF material which is placed in-pit above the final groundwater recovery level will include a thick outer zone of NAF material (preferably high ANC) and may also require an engineered cover or internal seal which limits oxygen transfer and fluctuating moisture conditions;

- PAF material which is placed in out-of-pit spoil dumps will be set back from the face of the dump and compacted during dumping, in order to prevent conductive / advective transport of oxygen thought the dump, thereby reducing AMD loadings at least by a factor of 4. The immediate base of the dump will be constructed with at least a 1 m deep layer of NAF material in order to limit the exposure of PAF material to water which runs along the interface between the dump and natural ground; and

- Blending ANC materials (limestone, high ANC basalt and high ANC sedimentary materials) with PAF and PAF-LC material will be used to increase lag times before the onset of acid conditions. Use of this AMD management strategy will be confirmed with further trials and kinetic testing.

Further details of these strategies and monitoring of the results are presented in Section 4.4 of this EIS.

Waste management strategies outlined in Section 4.4 have been developed with particular regard to controlling AMD, so as the post mining landholder may resume low-intensity cattle grazing (as per the pre-mining land use) without concern of land maintenance due to previous mining operations.

3.6.4 Rejects Disposal

The coarse and dewatered fine rejects that are produced by the CPP will be combined and disposed of initially in the out-of-pit dumps, then in the in-pit dumps when the opencut pit is large enough.

3.6.4.1 Rejects Production

Following washed coal processing, solid material which is less than 25 mm in diameter will be rejected by the CPP to a thickener, followed by de-watering via belt press filters. The combined de-watered material will be stored in a rejects bin until sufficient material is available to fill a coal haul truck for transport back to the spoil dumps. An automatic sampler will be installed on the rejects belt. The percentages of nominal, coarse and fine rejects that are generated from each stage of the CPP are presented in Table 3.28.

Table 3.28 Nominal CPP Rejects Splits

Circuit / stream	Nominal Rejects %
DMC:+ 2 mm	46.3
Spirals: - 2 mm to + 0.25 mm	16.9
Fines: - 0.25 mm	36.8
Total	**100**

3.6.4.2 Physical and Chemical Characteristics of Rejects

The reject materials produced by the CPP are anticipated to possess physical properties as follows:

- Fine rejects will be less than 0.25 mm in diameter; and
- Coarse rejects will possess diameters of greater than 0.25 mm, but less than 50 mm.

A geochemical characterisation programme was undertaken by EGi as discussed in Section 3.6.3.4 and detailed in Appendix 12. Within this programme, laboratory wash trial samples representing coarse and fine rejects were assessed in addition to raw coal, overburden and interburden samples.

Results from static and kinetic geochemical analysis showed coarse and fine rejects, derived from both the A seam and B seam were considered to possess a high risk of AMD production (PAF material) within a short time period following oxidation, resulting in a low pH eluate with high metal and metalloid concentrations consisting of Al, As, Co, Cr, Cu, Fe, Mn, Ni, SO_4 and Zn.

It was determined due to their high risk of AMD, these materials should be blended with limestone / ANC material and placed in a dedicated, engineered (low permeability) facility to prevent air ingress and seepage into surface water and groundwater. The cells will ideally be located below eventual water table level where possible to provide the added benefit of oxygen deprivation through inundation.

Initial screening of overburden, interburden and rejects material for AMD production via on-site analysis of total S and NAGpH during mining operations will be undertaken so that waste material placement is managed effectively.

Further information on the associated chemical properties of coarse and fine rejects can be found in Appendix 12.

3.6.4.3 Rejects Disposal and Planned Tonnages

The anticipated tonnages of rejects that will be generated each year by the proposed mining operations has been estimated from the coal production schedule and mine sequencing data and is presented in Table 3.29.

Table 3.29 Annual Tonnages of Disposed Rejects

Year	Opencut Rejects (tonnes)	Underground Rejects (tonnes)	Total Rejects (tonnes)
2018	78,905		78,905
2019	218,082		218,082
2020	262,587		262,587
2021	263,395		263,395
2022	244,724	1,004	245,728
2023	279,462	11,688	291,150
2024	134,811	16,254	151,066
2025		15,309	15,309
2026		29,851	29,851
2027		71,214	71,214
2028		63,864	63,864
2029		21,639	21,639
2030		14,018	14,018
2031		30,559	30,559
2032		45,273	45,273
2033		42,773	42,773
2034		69,719	69,719
2035		69,414	69,414
2036		0	0
2037		0	0
2038		0	0
Total	**1,481,966**	502,582	1,984,549

The storage of rejects in spoil dumps has assumed that this material will possess a placement density of 1.67 tonnes per cubic metre (t/m^3) and that over the life of the Project the rejects will occupy a volume of 1,190,729 lcm (1,984,549 t) (refer to Table 3.30).

Rejects will be stored within spoil dumps as illustrated in Figure 3.39. These particular locations have been selected in order to avoid drainage lines and commercially viable coal reserves.

The rejects disposal areas and estimated volume of rejects that will be placed at each location has been summarised in Table 3.30.

Table 3.30 Rejects Storage Capacity

Reject Disposal	Operational Year(s)	Capacity (loose m^3)
South West Spoil Dump – out of pit	1	47,343
South East Spoil Dump– out of pit	2	130,849
In-pit disposal	3 to 21	1,012,537
Total Rejects Design Volume		**1,190,729**

3.6.4.4 Rejects Containment Design

Due to the potential for reject material to produce acid drainage, both coarse and fine rejects will initially be disposed of in purpose-designed cells located within the out-of-pit spoil dumps during the first two years of production (refer to Figure 3.42). In subsequent years, coarse and fine rejects will be disposed of in purpose-designed cells within the in-pit spoil dumps (refer to Figure 3.43). Purpose-designed reject containment cells are synonymous with spoil dump design parameters and consistent with AMD mitigation strategies. A summary of the design of these facilities is provided below in Table 3.31 while details of the design of these facilities and the methods of disposal are provided in Section 4.4.

Table 3.31 Spoil Dump and Reject Containment Cell Design Summary

Structure	Composition	Slope and / or thickness
Outer faces	Growth medium, topsoil, seeds and vegetation	1V:2.5 H to facilitate topsoiling, vegetation and low, long-term maintenance
Capillary break layers	Gravel	0.4m
Clay liner	Clay	1 m will be compacted to 98% standard compaction at 1% to 3% moisture content, these parameters will be tested during construction, to ensure that the liner is being constructed correctly. Engineering supervision will be supplied in order to ensure that clay liners are correctly keyed into other components of the waste spoil dumps
NAF waste	NAF waste	Variable – depends upon mass of waste that needs to be stored
PAF and Rejects waste	PAF and rejects waste	Variable – depends upon mass of waste that needs to be stored
Drainage layer	Boulders	Approximately 1m
Protective layer	Sand and gravel	0.5m, this layer will protect the GCL for erosion by the drainage boulders
Geosynthetic Clay liner	Clay and geotextile membrane	Approximately 0.005m
Clay liner	Clay	0.3m, with similar properties as the clay horizon that is included in the double capillary break layer
Foundation	Gravel	0.5m, compacted to provide a stable base for the waste spoil dump

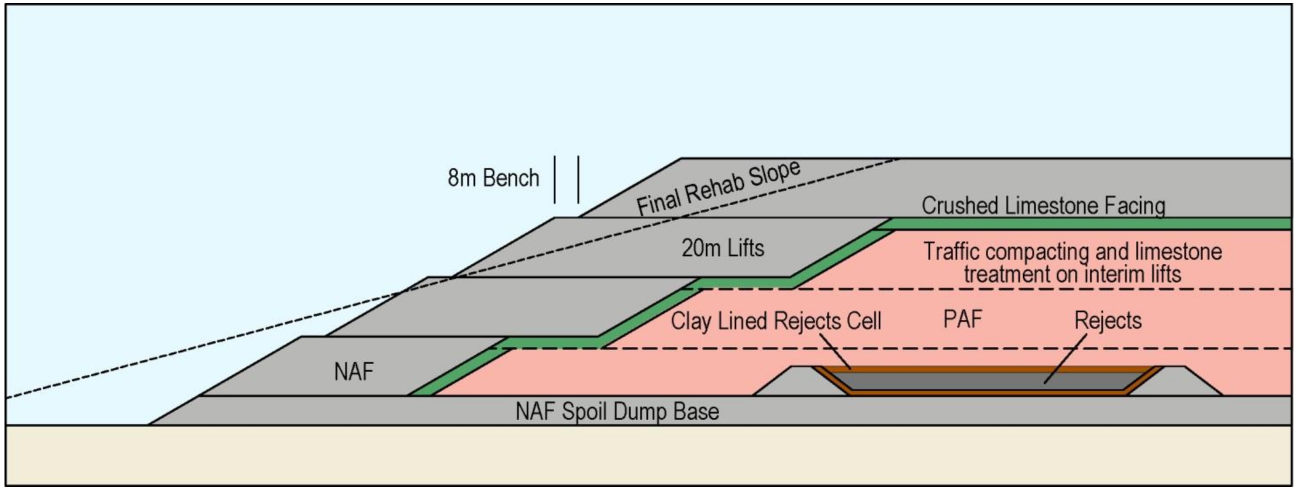


Figure 3.42 **Typical Out-of-Pit Spoil Dump Design Cross Section**

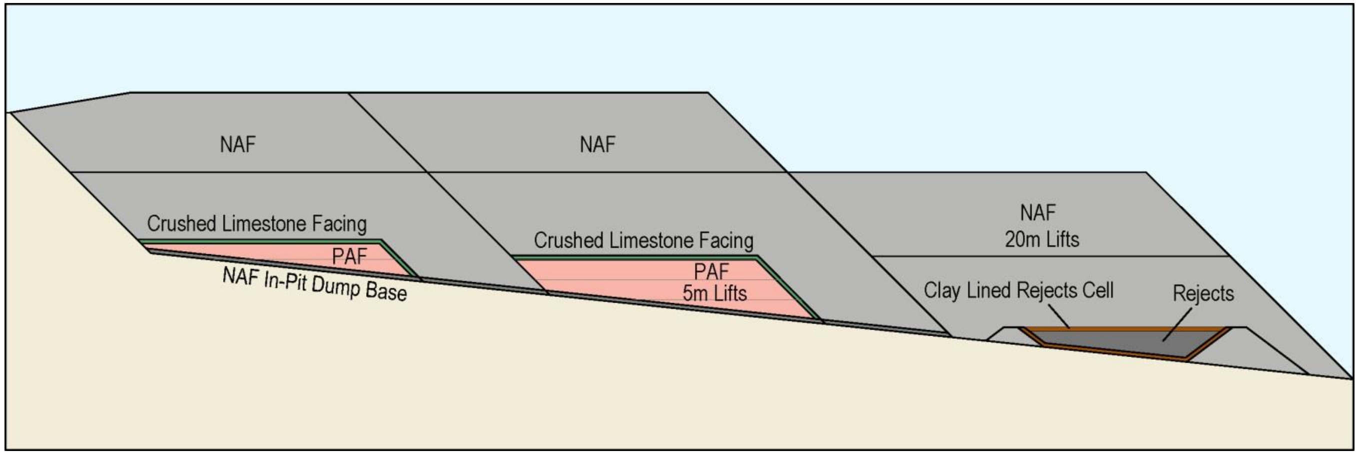


Figure 3.43 **Typical In-Pit Spoil Dump Design Cross Section**

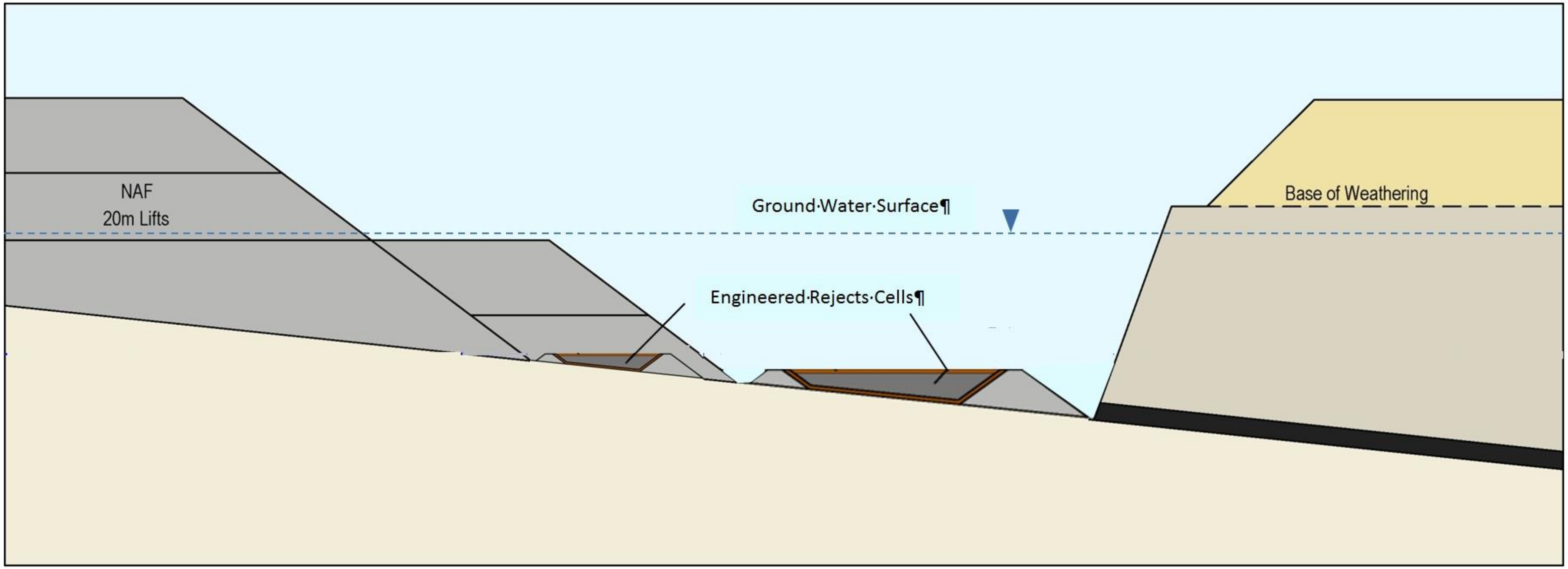


Figure 3.44 Final Void Rejects Placement

3.6.5 Solid Waste Disposal

Solid waste that cannot be re-used or recycled will be removed from site by licensed waste management contractors. The procedures associated with solid waste management are described in the following sections.

3.6.5.1 General Waste

General wastes produced on the Project site will be in the form of putrescible wastes and rubbish generated from the workshop, store and administration offices. General waste will be disposed of within appropriate waste containers and rubbish bins which will be collected on a regular basis by a licensed contractor and delivered to a facility licensed to accept such waste. Should commercial disposal facilities be inadequate or require upgrade, disposal on site may be considered as an alternative if deemed more beneficial to both parties.

Bins shall be fully enclosed to restrict access feral animals and reduce odour nuisance on the Project site.

3.6.5.2 Tyres

A sector of the site will be assigned for the segregation and safe storage of waste tyres, before they are removed from site by a licensed contractor.

Tyre disposal will be conducted in accordance with the *Disposal and Storage of Scrap Tyres at Mine Sites* operational policy developed by the EHP (2012) to assist with the appropriate management of scrap tyres on the mine site.

Although no cost-effective methods for the on-site processing of scrap tyres has currently been developed, the proponent will identify and assess any changes in on-site tyre processing technology which may become commercially feasible during the life of the mine. If the proponent decides that in the future, on-site tyre processing is viable both commercially and operationally, they may elect to adopt this technology in order to address the issue of waste tyre management.

3.6.5.3 Scrap Metal and Batteries

Scrap metal that is generated by the workshop will be stored in suitable bins for off-site removal and recycling (where possible) by a licensed contractor.

Since used batteries constitute a regulated waste, they will be stored in a designated location on site, for off-site removal and recycling (where possible) by a licensed contractor and transported to a facility licensed to accept regulated waste.

3.6.5.4 Hydrocarbons

A specific area of the site will be demarcated for the storage of used oil and hydrocarbon drums. Hydrocarbons are required to be stored in accordance with Australian Standards and used drums will be appropriately identified for removal by a licensed regulated waste contractor. Used oil and hydrocarbon drums will be transported to a facility licensed to accept regulated waste for recycling where possible.

3.6.6 Liquid Waste

The main categories of liquid waste that will be generated on site include:

- Water extracted from the pit;
- Contaminated stormwater runoff;
- Process and rejects water;
- Waste fuel and lubricants; and
- Sewage effluent.

Management strategies for liquid wastes are described in the following sections.

3.6.6.1 Pit water

Pit water from both the opencut pit and underground mine workings will be collected and pumped from purpose built pit sumps to the MWD. This water will be used for dust suppression or transferred to the CPPWRD for recycling through the process water circuit, when required. Projected excess water from this dam will be tested, treated as necessary and released in a controlled manner for beneficial use to local irrigators. Further information on the proposed release volumes and methods are discussed below and included in Appendix 13 and Section 4.5 of this EIS.

3.6.6.2 Stormwater, Process and Rejects Water

Stormwater that has interacted with active mine areas shall be retained on-site via the Project's surface water management system, which separates clean unaffected water entering the site from the catchment from potential contaminated surface water runoff that has been generated through interaction with mine site surfaces.

Stormwater retained on-site shall be combined with the process and rejects water within the CPPWRD for recycling back through the process water circuit in the CPP.

3.6.6.3 Waste oil and lubricants

Waste oil produced by the workshop will be collected in purpose-built tanks. A licensed waste management contractor will be engaged to collect waste oil and lubricants at suitable intervals, remove these liquid wastes from site and recycle them in a licensed oil recycling facility.

3.6.6.4 Sewage

The sewage generated in the portable toilets that are used during the mine's construction stage will be collected and removed from site by a licensed waste management contractor and treated off-site.

The STP that will be installed on site will treat the incoming raw sewage to Class A effluent quality. This treated liquid waste will then be spray irrigated over a designated area of the site. The spray irrigation area will exhibit good drainage characteristics and will not be located close to staff working areas.

3.6.6.5 Water Balance

Water balance modelling has been conducted to estimate the extent to which the capture of rain water run-off from mine site areas and groundwater from necessary mine dewatering together with the recycling of water within the water management system (described in Section 3.5.3) can meet construction and operational water demands for the Project site. The summary of the water balance model is presented below, and a full description of the model structure and associated assumptions are presented in the *Surface Water Management Plan* provided in Appendix 13.

Site Water Requirements

Water requirements on the Project site will vary over the life of the mine. However, it is anticipated up to 2.7 ML/day shall be required for dust suppression, coal preparation and other miscellaneous usages on-site. Up to a further 30 kl/day of potable water is anticipated to be required during operations to meet workforce demands. Climatic factors will also play a significant role in water requirements for dust suppression and will be assessed on a year to year basis. Operational water needs will be preferentially sourced from on-site storage dams, fed by surface and groundwater flows reporting to the mine workings and mine site, which will be collected and pumped to these storage dams. The water contained within the MWD will be used primarily for dust suppression around the Project site or further pumped to the CPPWRD to be used for process make-up water and additional storage volume. A 200 kL water storage tank and Potable Water Treatment Plant for the generation of potable water on site is also proposed.

Model Structure

A dynamic probabilistic simulation modelling approach, utilising the program Goldsim Pro, was adopted for the water balance model based on a daily climatic record for rainfall and evaporation for the site. An integrated catchment yield analysis for the site water catchments was also coupled with the water balance model. Details of the modelling method and assumption used are contained in Appendix 13 and the model inputs and outputs are described in Table 3.32 below.

Table 3.32 Water Balance Model – Inputs and Outputs

Water Source	Data Source	Volume
Input		
Rainfall	SILO Drill Data for Emerald. Daily rainfall for period 1889 to 2013	The mean annual rainfall is 651.9 mm/yr. The mean rainfall runoff volume at site for each year modelled is approximately • Year 1 – 1,580 ML • Year 3 – 2,244 ML • Year 5 – 2,870 ML • Year 7 – 3,150 ML

Water Source	Data Source	Volume
Groundwater Inflow	AGE Groundwater Impact Assessment	The average estimated groundwater inflow at site is 947 ML/yr. Minimum is 219 ML /yr and maximum is 2117 ML /yr.
Output		
Evaporation	SILO Data drill for Emerald. Average monthly Class A Pan evaporation data	Mean annual evaporation rate based on BOM website is 2081 mm/yr. • Year 1 – 5,042 ML • Year 3 – 7,162 ML • Year 5 – 9,158 ML • Year 7 – 10,052 ML
Operational Requirements	Mine Planning Data	470-938 ML/yr
Potable Water	Mine Planning Data	73 ML/yr

Model Results

The water balance model indicates the maximum accumulation within the MWD based on the simulated 123 year rainfall record, has a spill risk of less than 1% using a full storage capacity of 1,077 ML and with the operational conditions in place. Under mean conditions, the excess water accumulation in the MWD from mine dewatering will range between 80ML to 870 ML per annum.

In addition, the model indicated maximum accumulation within the CPPWRD, based on the simulated 123 year rainfall record exceeds the full supply capacity of 832ML only for the final year, being less than 1% of modelled conditions. The storage volume during mean conditions ranges from minimal to 50ML during the dry season to 400ML in the wet season with the higher storage levels occurring in the final 3 years of operation. Modelling indicated the spill risk for the CPPWRD is less than 0.5 % under the operating conditions in place.

The model indicates that water make from necessary removal of groundwater from the mining operations, together with rainfall collected from the mine surface area, will exceed the annual operational water requirements and water lost to evaporation by as much as 2.36 ML/day peak and 0.87 ML/day on average, under the negligible spill risk operating conditions adopted.

As the largely uncontaminated groundwater make from the mine workings is kept separate from the more contaminated rainfall run-off from the waste storage dumps, coal stockpiles and mine infrastructure areas, it is proposed to release this excess water for beneficial use rather than into the local surface drainage system. The quality of the groundwater is suitable for both stock watering and crop irrigation purposes and in general, this groundwater can be collected and pumped to storage

prior to significant interaction with potentially contaminating fuels, oils and solvents used in mining operations or acidic mine waste rock.

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

A second option is to provide the water for supply to industrial users in the area who otherwise might take water from Fairbairn dam, such as the proposed Teresa Mine or the Galilee Basin mines to the west. This second option is currently being investigated with potential water suppliers to the Galilee Basin, who propose to run a pipeline in the near vicinity of Taroborah.

In either case, the water would be released at a controlled rate, lowering the storage dam levels in the dry months and allowing dam levels to rise in the wetter months.

Figure 3.45 Proposed Excess Water Discharge System

3.7 Rehabilitation And Decommissioning

This section of the EIS describes the progressive site decommissioning and rehabilitation works that will be required as part of the process of relinquishing the eventual mining lease.

Rehabilitation of the site during and after mining operations will include the following elements of mine infrastructure:

- Opencut pit – fenced to ensure that livestock or humans do not have access to the pit;
- Waste spoil dumps – out-of-pit dumps will be capped (double capillary break system), re-contoured, ripped and seeded. In-pit dumps will be capped and inundated with groundwater over time;
- Regulated dams - The water contained within regulated dams (MWD and CPPWRD) will either be drained or allowed to evaporate. The remaining void will then be filled in with benign material in order to cover residual sediments in each dam;
- Sediment dams – That are to be rehabilitated will be drained or the water allowed to evaporated, the dam walls will be pushed over to cover the residual sediments and the surface of each dam ripped and seeded;
- ROM and product stockpile areas – assessed for soil contamination, remediated if required, ripped and seeded;
- CPP – dismantled and removed from site. The CPP area will be assessed for soil contamination, remediated if required, ripped and seeded;
- TLO and rail loop – dismantled and removed from site. The rail infrastructure area will be assessed for soil contamination, remediated if required, ripped and seeded;
- Haul roads – either rehabilitated or left on site for future landowner use; and
- Workshops, laboratories and administration buildings – dismantled and removed from site. These infrastructure areas will be assessed for soil contamination, remediated if required, ripped and seeded.

The following documentation and guidance has been employed to develop the site decommissioning and rehabilitation strategy:

- *Guideline (EM1122) Rehabilitation Requirements for Mining Projects (EHP 2011) (herein referred to as Guideline EM1122);*
- *Guideline (EM610) Final and Progressive Rehabilitation Reports and Audit Statements for Level 1 Mining Lease Projects (EHP 2012);*
- *Technical Guidelines for Open Pit Rehabilitation* (DME 1995a);
- *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* (DME 1995b);

- *Leading Practice Sustainable Development Program for the Mining Industry – Mine Closure and Completion* (Australian Government 2006a);

- *Leading Practice Sustainable Development Program for the Mining Industry – Mine Rehabilitation* (Australian Government 2006b); and

- *Leading Practice Sustainable Development Program for the Mining Industry – Tailings Management* (Australian Government 2007).

3.7.1 Rehabilitation Hierarchy

A hierarchical rehabilitation strategy has been developed by the Queensland Government and is presented in *Guideline EM1122* (EHP 2011). This strategy has been adopted for the Project in order to minimise both the environmental impacts and costs associated with site rehabilitation. A summary of this hierarchy, adopted by the Project (with level 1 being the most preferable approach and level 5 the least preferable) is presented below.

1. Avoid site disturbance in general so that rehabilitation actions are not required;

2. Rehabilitate the site to its “natural” pre-mining ecosystem status;

3. Increase the economic value of the site beyond its pre-mining land use;

4. Return the land to its previous use; and

5. Rehabilitate the land to a condition which has a lower final value.

Where possible, the majority of the Project site’s disturbed areas will be returned to their previous use of low-intensity livestock grazing and cropping (suitability class 4). However, the final void will possess a lower final land value (suitability class 5).

The hierarchy adopted for various areas of the Project site may be influenced by the following factors:

- Environmental – the presence of significant environmental values on site may require higher levels of rehabilitation to be selected;

- Economic – level one and two may prove to be prohibitively expensive;

- Social – the Project site may possess significant local community values and therefore, lower levels of rehabilitation may not be acceptable to the local community; and

- Stakeholders – Following negotiations, agreements may be made with landholders for certain items of infrastructure to remain following the cessation of mining.

3.7.2 Rehabilitation Goals

The following rehabilitation goals, which are outlined in both the Ecologically Sustainable Development (ESD) policy framework (*National Strategy for Ecologically Sustainable Development* (1992) as supported by the *EPBC Act 1999*) and *Guideline EM1122* (EHP 2011), have been adopted for the Project:

- Return the site to a condition which is safe for both humans and wildlife;

- Ensure that the post-mining landform is stable;
- Following closure, the site does not pollute the local environment; and
- The agreed post-mining land use (low-intensity livestock grazing and cropping) is sustainable.

Both the rehabilitation hierarchy and goals detailed above will facilitate the long-term maintenance of essential ecological processes following mining operations.

3.7.3 Rehabilitation Objectives, Indicators and Completion Criteria

In order to focus rehabilitation efforts, the Project site has been divided into separate mine domains, each comprising related aspects of the mine, to facilitate explicit rehabilitation goals (refer to Table 3.33).

Table 3.33 Mine Rehabilitation Domains

Mine Domain	Infrastructure Components
Opencut Mining Area (292 ha)	Opencut pit voids (including underground access ramp) and in-pit spoil dumps
Underground Mining Area (2071 ha)	Area above the underground mine workings
Out-of-pit Waste Storage Areas (93 ha)	NW Spoil Dump
	SW Spoil Dump
	SE Spoil Dump
Mine Infrastructure Area (69 ha)	Haul roads
	Opencut and underground MIAs
	Electricity substations – main and underground
	CPP
	Refuse bin
	Conveyors
	Radial stacker
	ROM and Product stockpile bases
	Sizing stations
	TLO and Rail loop
	Fibre-optic network cabling
	High-voltage power line
	Water storage tanks and pipelines
	Visual amenity bund
Water Storage Areas (43 ha)	Sedimentation dams
	Mine Wastewater Dam
	CPP Water Recycle Dam

The Project's rehabilitation objectives, indicators and completion criteria are provided in Table 3.34.

The Project's rehabilitation objectives aim to deliver a post-mining site with a stable landform that can be used for low-intensity cattle grazing and agricultural cropping. The development of rehabilitation objectives for each mine domain has been based upon the environmental, economic and social responsibilities that are central to the ESD principles.These objectives must achieve the highest practical level of rehabilitation, recognise post-mining land uses that are acceptable to local stakeholders and resolve potential environmental impacts.

Rehabilitation indicators which are defensible and measurable have been developed to assist rehabilitation goals for each mine domain. Both domain-specific and more general rehabilitation indicators have been developed.

Measurable, domain-specific rehabilitation completion criteria have been developed for the Project, in accordance with *Guideline EM1122* (EHP 2011). Completion criteria provide a bench mark against which the success of rehabilitation can be compared.

Indicators will be monitored in accordance with the rehabilitation monitoring program (refer to Section 3.7.10) and assessed against completion criteria to determine the success of rehabilitation. Different aspects of the mine will achieve rehabilitation success at different times depending on the objectives of the final landform. Long term rehabilitation monitoring will be required and shall become an important component of the operational responsibilities during the life of the mine and following mine closure.

Table 3.34 Mine Domain Rehabilitation Goals, Objectives, Indicators and Completion Criteria

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Opencut Mining Area	Long term safety	Structurally safe with no hazardous materials	Safety assessment of landform stability	Certification by an appropriately qualified person in the Rehabilitation Report that highwalls and slopes are now safe and exhibit characteristics for long term stability.
				A risk assessment has been completed and risk mitigation measures have been implemented. Where risk mitigation measures include bunds, safety fences and warning signs, these have been erected in accordance with relevant guidelines and Australian Standards.
				Final landform meets the design maximum slope angle requirements of 70^0 for competent rock, 45^0 for incompetent rock and 30^0 for spoil material.
			Exposure to and availability of heavy metals and other toxic materials	Certification by an appropriately qualified person that the Rehabilitation Report includes predictions about future changes and that the specified cover thickness is in place.
				Evidence in the Rehabilitation Report that monitoring results for dust and particulate matter indicates compliance with the limits in the environmental authority.
			Results of site contaminated land investigation report	Evidence in the Rehabilitation Report that protective measures required in the site contaminated land investigation report have been implemented.
		Site is safe for humans and animals now and in the foreseeable future	Safety assessment of landform stability (geotechnical studies)	An appropriately qualified person certifies the long term geotechnical stability of the residual slopes and faces in the voids and evidence of this is documented in the Rehabilitation Report.
			Installation of safety barriers and human/wildlife exclusion fencing of opencut voids	If required, mitigation measures documented in a Safety Plan, e.g. fencing and other suitable barrier around the opencut voids and slopes, are installed to restrict access

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Opencut Mining Area (cont)			Adequacy and predicted long term performance of safety barriers	Evidence in the Rehabilitation Report that a safety risk assessment of the opencut voids and slopes has been completed and proposed mitigation measures are documented in a Safety Plan.
	Non-polluting	Mine affected water contained on site.	Downstream surface water quality	Certification by an appropriately qualified person that surface water quality at monitoring locations is not negatively impacted when trends indicated by results from baseline monitoring and the 5 years previous to mine closure are compared to monitoring results for the rehabilitated landform.
			Groundwater quality	Certification by an appropriately qualified person that groundwater quality at monitoring locations is not negatively impacted when trends indicated by results from baseline monitoring and the 5 years previous to mine closure are compared to monitoring results for the rehabilitated landform.
			Final landform water storages are contained on-site, with no overflows into external surface water systems.	Certification by an appropriately qualified person that surface water quality at monitoring locations is not negatively impacted when trends indicated by results from baseline monitoring and the 5 years previous to mine closure are compared to monitoring results for the rehabilitated landform.
				Receiving water affected by surface water run-off has contaminated limits in accordance with the environmental authority.
			Opencut voids protected from flooding	Certification by a suitably qualified and experienced person in the Rehabilitation Report that the opencut voids have an adequate protection system to prevent inundation from a 1:1000 year annual exceedance probability flood event.
		Hazardous materials adequately managed	Exposure to and availability of heavy metals and other toxic materials	Certification by an appropriately qualified person in the Rehabilitation Report that includes predictions about future changes and that the specified cover thickness for waste cells is in place.

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Opencut Mining Area (cont)	Non-polluting (cont)			Evidence in the Rehabilitation Report that monitoring results for dust and particulate matter indicates compliance with the limits in the environmental authority.
		Removal of potential sources of contamination	Results of site contaminated land investigation report	Evidence in the Rehabilitation Report that measures required in site contaminated land investigation reports have been implemented.
	Stable landform	Very low probability of rock falls with serious environmental consequences	Past record of rock falls	Evidence in the Rehabilitation Report that appropriate control measures are in place to prevent recurrence.
			Geotechnical Studies	Evidence in the Rehabilitation Report that a risk assessment has been undertaken and mitigation measures (if any) have been documented and implemented.
		Landform design achieves appropriate erosion rates	Slope angle and length	Evidence in the Rehabilitation Report that the rehabilitated slopes have been designed to the specifications of maximum 70^0 for competent rock, 45^0 for incompetent rock and 30^0 for spoil material.
			Engineered structures to control water flow	Evidence in the Rehabilitation Report that any required contour banks, channel linings, surface armour, engineered drop structures and other required measures are in place and functioning.
			Rates of soil loss	Certification by an appropriately qualified person that land disturbed by mining activities does not exhibit any signs of continued erosion greater than that exhibited at a comparable local or regional reference site. The comparable reference site must have similar chemical and physical characteristics, including slope, as the rehabilitated landform.
			Dimensions and frequency of occurrence of erosion rills and gullies.	Evidence in the Rehabilitation Report that the dimensions and frequency of occurrence of erosion rills and gullies are no greater than that at comparable local or regional reference sites.

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Opencut Mining Area (cont)	Stable landform (cont)	Vegetation cover sufficient for a self-sustaining community and to minimise erosion	Vegetation type and density	Evidence that the vegetation types and densities are of similar species to comparable reference sites and are suited to the rehabilitated sites' characteristics including soil type, topography, and climate and that soil erosion meets the goals as set in these criteria.
			Foliage cover	Minimum of 70% groundcover is present (50% if rocks, logs or other features are present), with no bare surfaces >20m^2 in area or >10m in length down slope.
		Overland flow diversions and run-off drainage lines mirror natural stream functions	Design and stability of diversions and drainage lines	Documentation in the Rehabilitation Report how overland flow diversions and drainage lines have changed over the life of mine and that, should they remain, are stable at closure and likely to remain that way for the foreseeable future.
	Sustainable land-use	Soil properties support the desired land-use	Chemical properties (e.g. pH, salinity, nutrient content, sodium content) of topsoil support the proposed vegetation and land-use	Certification in the Rehabilitation Report that the topsoil chemical properties do not limit the suitability of the land for the intended land-use and are consistent with the following: - soil salinity content is < 0.6dS/m; - soil pH is between 5.0 and 8.5; - soil exchange sodium percentage (ESP) is <15%; - nutrient accumulation and recycling processes are occurring as evidenced by the presence of a litter layer, mycorrhizae and/or microsymbionts; and - adequate macro and micro nutrients are present.
			Physical properties of topsoil support the proposed vegetation and land-use	Certification in the Rehabilitation Report that the topsoil physical properties (e.g. rockiness, depth of soil, wetness and plant available water capacity) are adequate for plant growth.
				Certification in the Rehabilitation Report of the topsoil's suitability to support the current land-use (cattle grazing) in accordance with the Department of Minerals and Energy (DME) 1995 *Land Suitability Assessment Techniques in Technical Guidelines for Environmental Management of Exploration and Mining.*

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Opencut Mining Area (cont)	Sustainable land-use (cont)		Topsoil thickness	Certification in the Rehabilitation Report that the topsoil has been respread according to the depths specified in the topsoil management plan
			Site soil characteristics	Certification in the Rehabilitation Report that the site's soil characteristics have acceptable levels of surface roughness, infiltration capacity, aggregate stability and surface condition as defined in the *Australian Soil and Land Survey Field Handbook* (National Committee on Soil and Terrain 2009).
		Establish self-sustaining natural vegetation or habitat	Presence of key plant species	Certification by an appropriately qualified person that key plant species identified in the comparable reference site occur on the rehabilitation site. The presence of key plant species may also be guided by future vegetation trials for rehabilitation.
			Density of key plant species	Certification by an appropriately qualified person that key plant species identified in the comparable reference site is similar to the rehabilitation site. The density of key plant species may also be guided by future vegetation trials for rehabilitation.
			Structure of vegetation habitat	Certification by an appropriately qualified person that the structure of vegetation (i.e. groundcover, shrub and canopy structure) on the rehabilitation site is trending towards being similar to a comparable reference site.
		Self-sustaining natural vegetation or habitat	Native fauna species	Certification by an appropriately qualified person that the native fauna species identified in the pre-mining baseline studies and the reference site monitoring prior to the completion of rehabilitation are present or indicators of these species or habitat elements are developing within the rehabilitated areas.
			Plant regeneration	Certification by an appropriately qualified person that plants in rehabilitated areas show evidence of flowering, seed setting and seed germination.

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Opencut Mining Area (cont)	Sustainable land-use (cont)		Abundance of declared plants (weeds) identified through surveys	Certification by an appropriately qualified person that the abundance of declared plants (weeds) identified in rehabilitated areas is no greater than comparable reference sites.
			Actions taken to eradicate plants declared under local or State legislation	Evidence to demonstrate that action has been taken to eradicate declared plants (weeds) under local or State legislation should they occur on the rehabilitated site.
			Abundance of declared animals identified through surveys	Certification by an appropriately qualified person that the abundance of declared animals identified in rehabilitated areas is no greater than comparable reference sites.
			Actions taken to control animals declared under local or State legislation	Evidence to demonstrate that action has been taken to control declared animals under local or State legislation should they occur on the rehabilitated site.
			Weed hygiene procedures	Records indicating that appropriate weed and seed hygiene procedures were implemented during revegetation.
		Agricultural grazing	Livestock stocking rates	An appropriately qualified person has predicted and defined the economics/benefits and these have been agreed with relevant stakeholders.
			Landform stability when grazed	Land maintenance requirements are comparable to comparable reference sites.
			Stock access to water sources	Stock has access as presently available to water that meets accepted livestock drinking water guidelines.
Underground Mining Area	Long term safety	Rehabilitation or conversion of exploration drill holes, groundwater monitoring bores and mine	All non-artesian exploration drill holes undertaken on the mining lease have been rehabilitated or	Certification by an appropriately qualified person that all non-artesian exploration drill holes that have not been converted to either a water bore or a groundwater monitoring bore have been rehabilitated.

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Underground Mining Area (cont)	Long term Safety (cont)	dewatering bores.	converted to water bores.	Certification by an appropriately qualified person that all sub-artesian aquifers have been isolated where exploration drill holes have intersected more than one sub-artesian aquifer, in accordance with the *Minimum Construction Requirements for Water Bores in Australia* (Australian Government February 2012) or latest edition.
				Certification by an appropriately qualified person that all non-artesian exploration drill holes converted to water bores have been converted in accordance with the *Minimum Construction Requirements for Water Bores in Australia* (Australian Government February 2012) or latest edition.
				Certification by an appropriately qualified person that all non-artesian exploration drill holes converted to water bores are compliant with the *Water Act 2000* (QLD).
			All monitoring and mine dewatering bores undertaken on the mining lease have been rehabilitated.	Certification by an appropriately qualified person that all monitoring and dewatering bores have been rehabilitated in accordance with the *Minimum Construction Requirements for Water Bores in Australia* (Australian Government February 2012) or latest edition.
		Structurally safe with no hazardous materials	Safety assessment of portals and shafts	Certification by an appropriately qualified person in the Rehabilitation Report that portal bulkheads and vertical shaft cappings are now safe and exhibit characteristics for long term stability.
				A risk assessment has been completed and risk mitigation measures have been implemented. Where risk mitigation measures include bunds, safety fences and warning signs, these have been erected in accordance with relevant guidelines and Australian Standards.

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Underground Mining Area (cont)	Long term safety (cont)		Stream bank erosion	Evidence in the Rehabilitation Report that drainage line banks in the underground mining domain are currently stable and exhibit characteristics of long term stability.
	Non-polluting	Mine affected water contained on site.	Downstream surface water quality	Certification by an appropriately qualified person that surface water quality at monitoring locations is not negatively impacted when trends indicated by results from baseline monitoring and the 5 years previous to mine closure are compared to monitoring results for the rehabilitated landform.
				Receiving water affected by surface water run-off has contaminated limits in accordance with the environmental authority.
			Groundwater quality	Certification by an appropriately qualified person that groundwater quality at monitoring locations is not negatively impacted when trends indicated by results from baseline monitoring and the 5 years previous to mine closure are compared to monitoring results for the rehabilitated landform.
		Hazardous materials adequately managed	Exposure to and availability of heavy metals and other toxic materials	Certification by an appropriately qualified person in the Rehabilitation Report that includes predictions about future changes and that the specified cover thickness is in place.
				Evidence in the Rehabilitation Report that monitoring results for dust and particulate matter indicates compliance with the limits in the environmental authority.
		Removal of potential sources of contamination	Results of site contaminated land investigation report	Evidence in the Rehabilitation Report that measures required in site contaminated land investigation reports have been implemented.
	Stable landform	Landform design achieves appropriate erosion rates	Engineered structures to control water flow	Evidence in the Rehabilitation Report that any required contour banks, channel linings, surface armour, engineered drop structures and other required measures are in place and functioning.

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Underground Mining Area (cont)	Stable landform (cont)	Landform design achieves appropriate erosion rates (cont)	Rates of soil loss	Certification by an appropriately qualified person that land disturbed by mining activities does not exhibit any signs of continued erosion greater than that exhibited at a comparable local or regional reference site. The comparable reference site must have similar chemical and physical characteristics, including slope, as the rehabilitated landform.
		Vegetation cover sufficient for a self-sustaining community and to minimise erosion	Vegetation type and density	Evidence that the vegetation types and densities are of similar species to comparable reference sites and are suited to the rehabilitated sites' characteristics including soil type, topography, and climate and that soil erosion meets the goals as set in these criteria.
			Foliage cover	Minimum of 70% groundcover is present (50% if rocks, logs or other features are present), with no bare surfaces >20m^2 in area or >10m in length down slope.
		Run-off drainage lines mirror natural stream functions	Design and stability of run-off drainage lines	Documentation in the Rehabilitation Report how run-off drainage lines have changed over the life of mine and that they are stable at closure and likely to remain that way for the foreseeable future.
		Surface water drainage	Stable drainage works	Certification by an appropriately qualified person that local drainage works (e.g. small diversion bunds and engineered rock chute structures) work as intended and are stable.
		Minimal changes to hydrological conditions	Ponding	Evidence in the Rehabilitation Report to demonstrate unimpeded drainage/flows of subsidence basins and run-off drainage lines.
			Cracking	Evidence in the Rehabilitation Report that no surface cracks greater than 50mm in width, and that are attributable to subsidence, remain in the underground mining area.

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Underground Mining Area (cont)	Sustainable land- use	Soil properties continue to support the desired land-use	Chemical properties (e.g. pH, salinity, nutrient content, sodium content) of soil support the proposed vegetation and land-use	Certification in the Rehabilitation Report that the soil chemical properties do not limit the suitability of the land for the intended land-use and are consistent with the following: - soil salinity content is < 0.6dS/m; - soil pH is between 5.0 and 8.5; - soil exchange sodium percentage (ESP) is <15%; - nutrient accumulation and recycling processes are occurring as evidenced by the presence of a litter layer, mycorrhizae and/or microsymbionts; and - adequate macro and micro nutrients are present.
			Physical properties of soil support the proposed vegetation and land-use	Certification in the Rehabilitation Report that the soil physical properties (e.g. rockiness, depth of soil, wetness and plant available water capacity) are adequate for plant growth.
				Certification in the Rehabilitation Report of the soil's suitability to support the current land-use (cattle grazing and broadacre dryland cropping) in accordance with the Department of Minerals and Energy (DME) 1995 *Land Suitability Assessment Techniques in Technical Guidelines for Environmental Management of Exploration and Mining.*
			Topsoil thickness	Certification in the Rehabilitation Report that the topsoil has been respread (where required) according to the depths specified in the topsoil management plan
			Site soil characteristics	Certification in the Rehabilitation Report that the site's soil characteristics have acceptable levels of surface roughness, infiltration capacity, aggregate stability and surface condition as defined in the *Australian Soil and Land Survey Field Handbook* (National Committee on Soil and Terrain 2009).

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Underground Mining Area (cont)	Sustainable land- use (cont)	Establish self-sustaining natural vegetation or habitat	Presence of key plant species	Certification by an appropriately qualified person that key plant species identified in the comparable reference site occur on the rehabilitation site. The presence of key plant species may also be guided by future vegetation trials for rehabilitation.
			Density of key plant species	Certification by an appropriately qualified person that key plant species identified in the comparable reference site is similar to the rehabilitation site. The density of key plant species may also be guided by future vegetation trials for rehabilitation.
			Structure of vegetation habitat	Certification by an appropriately qualified person that the structure of vegetation (i.e. groundcover, shrub and canopy structure) on the rehabilitation site is trending towards being similar to a comparable reference site.
		Self-sustaining natural vegetation or habitat	Native fauna species	Certification by an appropriately qualified person that the native fauna species identified in the pre-mining baseline studies and the reference site monitoring prior to the completion of rehabilitation are present or indicators of these species or habitat elements are developing within the rehabilitated areas.
			Plant regeneration	Certification by an appropriately qualified person that plants in rehabilitated areas show evidence of flowering, seed setting and seed germination.
			Abundance of declared plants (weeds) identified through surveys	Certification by an appropriately qualified person that the abundance of declared plants (weeds) identified in rehabilitated areas is no greater than comparable reference sites.
			Actions taken to eradicate plants declared under local or State legislation	Evidence to demonstrate that action has been taken to eradicate declared plants (weeds) under local or State legislation should they occur on the rehabilitated site.
			Abundance of declared animals identified through surveys	Certification by an appropriately qualified person that the abundance of declared animals identified in rehabilitated areas is no greater than comparable reference sites.

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Underground Mining Area (cont)	Sustainable land- use (cont)		Actions taken to control animals declared under local or State legislation	Evidence to demonstrate that action has been taken to control declared animals under local or State legislation should they occur on the rehabilitated site.
			Weed hygiene procedures	Records indicating that appropriate weed and seed hygiene procedures were implemented during revegetation.
		Agricultural grazing	Landform stability when grazed	Land maintenance requirements are comparable to comparable reference sites.
			Stock access to water sources	Stock has access as presently available to water that meets accepted livestock drinking water guidelines.
		Broadacre Dryland Cropping	Crop Productivity	Evidence in the Rehabilitation Report to indicate that cropping yields of rehabilitated land that is currently cropped achieve >80% of cropping yields for comparable undisturbed land over the same time period.
Mine Infrastructure Area	Long term safety	Rehabilitation or conversion of exploration drill holes and groundwater monitoring bores.	All non-artesian exploration drill holes undertaken on the mining lease have been rehabilitated or converted to water bores.	Certification by an appropriately qualified person that all non-artesian exploration drill holes that have not been converted to either a water bore or a groundwater monitoring bore have been rehabilitated.
				Certification by an appropriately qualified person that all sub-artesian aquifers have been isolated where exploration drill holes have intersected more than one sub-artesian aquifer, in accordance with the *Minimum Construction Requirements for Water Bores in Australia* (Australian Government February 2012) or latest edition.

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Mine Infrastructure Area (cont)	Long term safety (cont)	Rehabilitation or conversion of exploration drill holes and groundwater monitoring bores (cont)		Certification by an appropriately qualified person that all non-artesian exploration drill holes converted to water bores have been converted in accordance with the *Minimum Construction Requirements for Water Bores in Australia* (Australian Government February 2012) or latest edition.
				Certification by an appropriately qualified person that all non-artesian exploration drill holes converted to water bores are compliant with the *Water Act 2000* (QLD).
			All monitoring bores undertaken on the mining lease have been rehabilitated.	Certification by an appropriately qualified person that all monitoring and dewatering bores have been rehabilitated in accordance with the *Minimum Construction Requirements for Water Bores in Australia* (Australian Government February 2012) or latest edition.
		Structurally safe with no hazardous materials	Safety assessment of portals and shafts	A risk assessment has been completed and risk mitigation measures have been implemented. Where risk mitigation measures include bunds, safety fences and warning signs, these have been erected in accordance with relevant guidelines and Australian Standards.
		Site is safe for humans and animals now and in the foreseeable future	Appropriate decommissioning of infrastructure	Certification by an appropriately qualified person in the Rehabilitation Report that the site infrastructure has been decommissioned and rehabilitated. Buildings, water storages(s), roads (except those used by the public), conveyors, stockpile pads and other infrastructure have been removed unless stakeholders have entered into formal agreements for their retention. Access to the area is conducive of the intended purpose of post-mining land use.

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Mine Infrastructure Area (cont)	Non-polluting	Mine affected water contained on site	Downstream surface water quality	Certification by an appropriately qualified person that surface water quality at monitoring locations is not negatively impacted when trends indicated by results from baseline monitoring and the 5 years previous to mine closure are compared to monitoring results for the rehabilitated landform.
				Receiving water affected by surface water run-off has contaminated limits in accordance with the environmental authority.
			Groundwater quality	Certification by an appropriately qualified person that groundwater quality at monitoring locations is not negatively impacted when trends indicated by results from baseline monitoring and the 5 years previous to mine closure are compared to monitoring results for the rehabilitated landform.
		Hazardous materials adequately managed	Exposure to and availability of heavy metals and other toxic materials	Certification by an appropriately qualified person in the Rehabilitation Report that includes predictions about future changes and that the specified cover thickness is in place.
				Evidence in the Rehabilitation Report that monitoring results for dust and particulate matter indicates compliance with the limits in the environmental authority.
		Removal of potential sources of contamination	Results of site contaminated land investigation report	Evidence in the Rehabilitation Report that measures required in site contaminated land investigation reports have been implemented.
	Stable landform	Landform design achieves appropriate erosion rates	Engineered structures to control water flow	Evidence in the Rehabilitation Report that any required contour banks, channel linings, surface armour, engineered drop structures and other required measures are in place and functioning.

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Mine Infrastructure Area (cont)	Stable landform (cont)	Landform design achieves appropriate erosion rates (cont)	Rates of soil loss	Certification by an appropriately qualified person that land disturbed by mining activities does not exhibit any signs of continued erosion greater than that exhibited at a comparable local or regional reference site. The comparable reference site must have similar chemical and physical characteristics, including slope, as the rehabilitated landform.
		Vegetation cover sufficient for a self-sustaining community and to minimise erosion	Vegetation type and density	Evidence that the vegetation types and densities are of similar species to comparable reference sites and are suited to the rehabilitated sites' characteristics including soil type, topography, and climate and that soil erosion meets the goals as set in these criteria.
			Foliage cover	Minimum of 70% groundcover is present (50% if rocks, logs or other features are present), with no bare surfaces >20m^2 in area.
		Run-off drainage lines mirror natural stream functions	Design and stability of run-off drainage lines	Documentation in the Rehabilitation Report how run-off drainage lines have changed over the life of mine and that they are stable at closure and likely to remain that way for the foreseeable future.
	Sustainable land-use	Soil properties support the desired land-use	Chemical properties (e.g. pH, salinity, nutrient content, sodium content) of topsoil support the proposed vegetation and land-use	Certification in the Rehabilitation Report that the topsoil chemical properties do not limit the suitability of the land for the intended land-use and are consistent with the following: - soil salinity content is < 0.6dS/m; - soil pH is between 5.0 and 8.5; - soil exchange sodium percentage (ESP) is <15%; - nutrient accumulation and recycling processes are occurring as evidenced by the presence of a litter layer, mycorrhizae and/or microsymbionts; and - adequate macro and micro nutrients are present.
			Physical properties of topsoil support the proposed vegetation and land-use	Certification in the Rehabilitation Report that the topsoil physical properties (e.g. rockiness, depth of soil, wetness and plant available water capacity) are adequate for plant growth.

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Mine Infrastructure Area (cont)	Sustainable land-use (cont)	Soil properties support the desired land-use (cont)		Certification in the Rehabilitation Report of the topsoil's suitability to support the current land-use (cattle grazing) in accordance with the Department of Minerals and Energy (DME) 1995 *Land Suitability Assessment Techniques in Technical Guidelines for Environmental Management of Exploration and Mining.*
			Topsoil thickness	Certification in the Rehabilitation Report that the topsoil has been respread according to the depths specified in the topsoil management plan
			Site soil characteristics	Certification in the Rehabilitation Report that the site's soil characteristics have acceptable levels of surface roughness, infiltration capacity, aggregate stability and surface condition as defined in the *Australian Soil and Land Survey Field Handbook* (National Committee on Soil and Terrain 2009).
		Establish self-sustaining natural vegetation or habitat	Presence of key plant species	Certification by an appropriately qualified person that key plant species identified in the comparable reference site occur on the rehabilitation site. The presence of key plant species may also be guided by future vegetation trials for rehabilitation.
			Density of key plant species	Certification by an appropriately qualified person that key plant species identified in the comparable reference site is similar to the rehabilitation site. The density of key plant species may also be guided by future vegetation trials for rehabilitation.
			Structure of vegetation habitat	Certification by an appropriately qualified person that the structure of vegetation (i.e. groundcover, shrub and canopy structure) on the rehabilitation site is trending towards being similar to a comparable reference site.
		Self-sustaining natural vegetation or habitat	Native fauna species	Certification by an appropriately qualified person that the native fauna species identified in the pre-mining baseline studies and the reference site monitoring prior to the completion of rehabilitation are present or indicators of these species or habitat elements are developing within the rehabilitated areas.

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Mine Infrastructure Area (cont)	Sustainable land-use (cont)	Self-sustaining natural vegetation or habitat (cont)	Plant regeneration	Certification by an appropriately qualified person that plants in rehabilitated areas show evidence of flowering, seed setting and seed germination.
			Abundance of declared plants (weeds) identified through surveys	Certification by an appropriately qualified person that the abundance of declared plants (weeds) identified in rehabilitated areas is no greater than comparable reference sites.
			Actions taken to eradicate plants declared under local or State legislation	Evidence to demonstrate that action has been taken to eradicate declared plants (weeds) under local or State legislation should they occur on the rehabilitated site.
			Abundance of declared animals identified through surveys	Certification by an appropriately qualified person that the abundance of declared animals identified in rehabilitated areas is no greater than comparable reference sites.
			Actions taken to control animals declared under local or State legislation	Evidence to demonstrate that action has been taken to control declared animals under local or State legislation should they occur on the rehabilitated site.
			Weed hygiene procedures	Records indicating that appropriate weed and seed hygiene procedures were implemented during revegetation.
		Agricultural grazing	Livestock stocking rates	An appropriately qualified person has predicted and defined the economics/benefits and these have been agreed with relevant stakeholders.
			Landform stability when grazed	Land maintenance requirements are comparable to comparable reference sites.
			Stock access to water sources	Stock has access as presently available to water that meets accepted livestock drinking water guidelines.

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Out-of-pit Waste Storage Areas	Long term safety	Structurally safe with no hazardous materials	Safety assessment of landform stability	Certification by an appropriately qualified person in the Rehabilitation Report that highwalls and slopes are now safe and exhibit characteristics for long term stability.
				A risk assessment has been completed and risk mitigation measures have been implemented. Where risk mitigation measures include bunds, safety fences and warning signs, these have been erected in accordance with relevant guidelines and Australian Standards.
				Final landform meets the design maximum slope angle requirements of 30^0 for spoil material.
			Exposure to and availability of heavy metals and other toxic materials	Certification by an appropriately qualified person that the Rehabilitation Report includes predictions about future changes and that the specified cover thickness is in place.
				Evidence in the Rehabilitation Report that monitoring results for dust and particulate matter indicates compliance with the limits in the environmental authority.
			Results of site contaminated land investigation report	Evidence in the Rehabilitation Report that protective measures required in the site contaminated land investigation report have been implemented.
		Site is safe for humans and animals now and in the foreseeable future	Safety assessment of landform stability (geotechnical studies)	An appropriately qualified person certifies the long term geotechnical stability of the residual slopes and evidence of this is documented in the Rehabilitation Report.
			Installation of safety barriers and human/wildlife exclusion fencing of opencut voids	If required, mitigation measures documented in a Safety Plan, e.g. fencing and other suitable barrier around the opencut voids and slopes, are installed to restrict access

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Out-of-pit Waste Storage Areas (cont)			Adequacy and predicted long term performance of safety barriers	Evidence in the Rehabilitation Report that a safety risk assessment of the opencut voids and slopes has been completed and proposed mitigation measures are documented in a Safety Plan.
	Non-polluting	Mine affected water contained on site.	Downstream surface water quality	Certification by an appropriately qualified person that surface water quality at monitoring locations is not negatively impacted when trends indicated by results from baseline monitoring and the 5 years previous to mine closure are compared to monitoring results for the rehabilitated landform.
			Receiving water quality	Receiving water affected by surface water run-off has contaminated limits in accordance with the environmental authority.
			Groundwater quality	Certification by an appropriately qualified person that groundwater quality at monitoring locations is not negatively impacted when trends indicated by results from baseline monitoring and the 5 years previous to mine closure are compared to monitoring results for the rehabilitated landform.
		Acid mine drainage will not cause serious environmental harm	Technical design and construction of spoil dumps and rejects emplacement cells	Certification by an appropriately qualified person in the Rehabilitation Report that spoil dump covers and rejects emplacement cells are constructed in accordance with the design recommendations in the final wasterock geochemical assessment report
		Removal of potential sources of contamination	Results of site contaminated land investigation report	Evidence in the Rehabilitation Report that measures required in site contaminated land investigation reports have been implemented.
	Stable landform	Landform design achieves appropriate erosion rates	Slope angle and length	Evidence in the Rehabilitation Report that the rehabilitated slopes have been contoured to the specifications of maximum 30^0 for spoil material.

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Out-of-pit Waste Storage Areas (cont)	Stable landform (cont)		Engineered structures to control water flow	Evidence in the Rehabilitation Report that any required contour banks, channel linings, surface armour, engineered drop structures and other required measures are in place and functioning.
			Dimensions and frequency of occurrence of erosion rills and gullies.	Evidence in the Rehabilitation Report that the dimensions and frequency of occurrence of erosion rills and gullies are no greater than that at comparable local or regional reference sites.
		Vegetation cover sufficient for a self-sustaining community and to minimise erosion	Vegetation type and density	Evidence that the vegetation types and densities are of similar species to comparable reference sites and are suited to the rehabilitated sites' characteristics including soil type, topography, and climate and that soil erosion meets the goals as set in these criteria.
			Foliage cover	Minimum of 70% groundcover is present (50% if rocks, logs or other features are present), with no bare surfaces >20m^2 in area or >10m in length down slope.
	Sustainable land-use	Soil properties support the desired land-use	Chemical properties (e.g. pH, salinity, nutrient content, sodium content) of topsoil support the proposed vegetation and land-use	Certification in the Rehabilitation Report that the topsoil chemical properties do not limit the suitability of the land for the intended land-use and are consistent with the following: - soil salinity content is < 0.6dS/m; - soil pH is between 5.0 and 8.5; - soil exchange sodium percentage (ESP) is <15%; - nutrient accumulation and recycling processes are occurring as evidenced by the presence of a litter layer, mycorrhizae and/or microsymbionts; and - adequate macro and micro nutrients are present.
			Physical properties of topsoil support the proposed vegetation and	Certification in the Rehabilitation Report that the topsoil physical properties (e.g. rockiness, depth of soil, wetness and plant available water capacity) are adequate for plant growth.

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Out-of-pit Waste Storage Areas (cont)	Sustainable land-use (cont)	Soil properties support the desired land-use (cont)	land-use	Certification in the Rehabilitation Report of the topsoil's suitability to support the current land-use (cattle grazing) in accordance with the Department of Minerals and Energy (DME) 1995 *Land Suitability Assessment Techniques in Technical Guidelines for Environmental Management of Exploration and Mining.*
			Topsoil thickness	Certification in the Rehabilitation Report that the topsoil has been respread according to the depths specified in the topsoil management plan
			Site soil characteristics	Certification in the Rehabilitation Report that the site's soil characteristics have acceptable levels of surface roughness, infiltration capacity, aggregate stability and surface condition as defined in the *Australian Soil and Land Survey Field Handbook* (National Committee on Soil and Terrain 2009).
		Establish self-sustaining natural vegetation or habitat	Presence of key plant species	Certification by an appropriately qualified person that key plant species identified in the comparable reference site occur on the rehabilitation site. The presence of key plant species may also be guided by future vegetation trials for rehabilitation.
			Density of key plant species	Certification by an appropriately qualified person that key plant species identified in the comparable reference site is similar to the rehabilitation site. The density of key plant species may also be guided by future vegetation trials for rehabilitation.
			Structure of vegetation habitat	Certification by an appropriately qualified person that the structure of vegetation (i.e. groundcover, shrub and canopy structure) on the rehabilitation site is trending towards being similar to a comparable reference site.
		Self-sustaining natural vegetation or habitat	Native fauna species	Certification by an appropriately qualified person that the native fauna species identified in the pre-mining baseline studies and the reference site monitoring prior to the completion of rehabilitation are present or indicators of these species or habitat elements are developing within the rehabilitated areas.

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Out-of-pit Waste Storage Areas (cont)	Sustainable land-use (cont)	Self-sustaining natural vegetation or habitat (cont)	Plant regeneration	Certification by an appropriately qualified person that plants in rehabilitated areas show evidence of flowering, seed setting and seed germination.
			Abundance of declared plants (weeds) identified through surveys	Certification by an appropriately qualified person that the abundance of declared plants (weeds) identified in rehabilitated areas is no greater than comparable reference sites.
			Actions taken to eradicate plants declared under local or State legislation	Evidence to demonstrate that action has been taken to eradicate declared plants (weeds) under local or State legislation should they occur on the rehabilitated site.
			Abundance of declared animals identified through surveys	Certification by an appropriately qualified person that the abundance of declared animals identified in rehabilitated areas is no greater than comparable reference sites.
			Actions taken to control animals declared under local or State legislation	Evidence to demonstrate that action has been taken to control declared animals under local or State legislation should they occur on the rehabilitated site.
			Weed hygiene procedures	Records indicating that appropriate weed and seed hygiene procedures were implemented during revegetation.
		Agricultural grazing	Livestock stocking rates	An appropriately qualified person has predicted and defined the economics/benefits and these have been agreed with relevant stakeholders.
			Landform stability when grazed	Land maintenance requirements are comparable to comparable reference sites.
			Stock access to water sources	Stock has access as presently available to water that meets accepted livestock drinking water guidelines.

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Water Storage Areas	Long term safety	Structurally safe with no hazardous materials	Safety assessment of landform stability	Certification by an appropriately qualified person in the Rehabilitation Report that highwalls and slopes are now safe and exhibit characteristics for long term stability.
				A risk assessment has been completed and risk mitigation measures have been implemented. Where risk mitigation measures include bunds, safety fences and warning signs, these have been erected in accordance with relevant guidelines and Australian Standards.
			Exposure to and availability of heavy metals and other toxic materials	Certification by an appropriately qualified person that the Rehabilitation Report includes predictions about future changes and that the specified cover thickness is in place.
				Evidence in the Rehabilitation Report that monitoring results for dust and particulate matter indicates compliance with the limits in the environmental authority.
			Results of site contaminated land investigation report	Evidence in the Rehabilitation Report that protective measures required in the site contaminated land investigation report have been implemented.
		Site is safe for humans and animals now and in the foreseeable future	Appropriate decommissioning of infrastructure	Certification by an appropriately qualified person in the Rehabilitation Report that the site infrastructure has been decommissioned and rehabilitated. Water storages(s) have been drained, filled in and capped unless stakeholders have entered into formal agreements for their retention. Access to the area is conducive of the intended purpose of post-mining land use.
	Non-polluting	Mine affected water contained on site	Downstream surface water quality	Certification by an appropriately qualified person that surface water quality at monitoring locations is not negatively impacted when trends indicated by results from baseline monitoring and the 5 years previous to mine closure are compared to monitoring results for the rehabilitated landform.

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Water Storage Areas (cont)	Non-polluting (cont)	Mine affected water contained on site (cont)	Receiving water quality	Receiving water affected by surface water run-off has contaminated limits in accordance with the environmental authority.
			Groundwater quality	Certification by an appropriately qualified person that groundwater quality at monitoring locations is not negatively impacted when trends indicated by results from baseline monitoring and the 5 years previous to mine closure are compared to monitoring results for the rehabilitated landform.
		Hazardous materials adequately managed	Exposure to and availability of heavy metals and other toxic materials	Certification by an appropriately qualified person in the Rehabilitation Report that includes predictions about future changes and that the specified cover thickness is in place.
		Removal of potential sources of contamination	Results of site contaminated land investigation report	Evidence in the Rehabilitation Report that measures required in site contaminated land investigation reports have been implemented.
	Stable landform	Landform design achieves appropriate erosion rates	Slope angle and length	Evidence in the Rehabilitation Report that the rehabilitated slopes have been contoured to meet the maximum design specifications of $<30^0$.
			Engineered structures to control water flow	Evidence in the Rehabilitation Report that any required contour banks, channel linings, surface armour, engineered drop structures and other required measures are in place and functioning.
			Rates of soil loss	Certification by an appropriately qualified person that land disturbed by mining activities does not exhibit any signs of continued erosion greater than that exhibited at a comparable local or regional reference site. The comparable reference site must have similar chemical and physical characteristics, including slope, as the rehabilitated landform.

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Water Storage Areas (cont)	Stable landform (cont)	Vegetation cover sufficient for a self-sustaining community and to minimise erosion	Vegetation type and density	Evidence that the vegetation types and densities are of similar species to comparable reference sites and are suited to the rehabilitated sites' characteristics including soil type, topography, and climate and that soil erosion meets the goals as set in these criteria.
			Foliage cover	Minimum of 70% groundcover is present (50% if rocks, logs or other features are present), with no bare surfaces >20m^2 in area.
		Run-off drainage lines mirror natural stream functions	Design and stability of run-off drainage lines	Documentation in the Rehabilitation Report how run-off drainage lines have changed over the life of mine and that they are stable at closure and likely to remain that way for the foreseeable future.
		Landform design achieves appropriate erosion rates Landform design achieves appropriate erosion rates (cont)	Engineered structures to control water flow	Evidence in the Rehabilitation Report that any required contour banks, channel linings, surface armour, engineered drop structures and other required measures are in place and functioning.
	Sustainable Land-use	Soil properties support the desired land-use	Chemical properties (e.g. pH, salinity, nutrient content, sodium content) of topsoil support the proposed vegetation and land-use	Certification in the Rehabilitation Report that the topsoil chemical properties do not limit the suitability of the land for the intended land-use and are consistent with the following: - soil salinity content is < 0.6dS/m; - soil pH is between 5.0 and 8.5; - soil exchange sodium percentage (ESP) is <15%; - nutrient accumulation and recycling processes are occurring as evidenced by the presence of a litter layer, mycorrhizae and/or microsymbionts; and - adequate macro and micro nutrients are present.
			Physical properties of topsoil support the proposed vegetation and	Certification in the Rehabilitation Report that the topsoil physical properties (e.g. rockiness, depth of soil, wetness and plant available water capacity) are adequate for plant growth.

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Water Storage Areas (cont)	Sustainable Land-use (cont)	Soil properties support the desired land-use (cont)	land-use	Certification in the Rehabilitation Report of the topsoil's suitability to support the current land-use (cattle grazing) in accordance with the Department of Minerals and Energy (DME) 1995 *Land Suitability Assessment Techniques in Technical Guidelines for Environmental Management of Exploration and Mining.*
			Topsoil thickness	Certification in the Rehabilitation Report that the topsoil has been respread according to the depths specified in the topsoil management plan
			Site soil characteristics	Certification in the Rehabilitation Report that the site's soil characteristics have acceptable levels of surface roughness, infiltration capacity, aggregate stability and surface condition as defined in the *Australian Soil and Land Survey Field Handbook* (National Committee on Soil and Terrain 2009).
		Establish self-sustaining natural vegetation or habitat	Presence of key plant species	Certification by an appropriately qualified person that key plant species identified in the comparable reference site occur on the rehabilitation site. The presence of key plant species may also be guided by future vegetation trials for rehabilitation.
			Density of key plant species	Certification by an appropriately qualified person that key plant species identified in the comparable reference site is similar to the rehabilitation site. The density of key plant species may also be guided by future vegetation trials for rehabilitation.
			Structure of vegetation habitat	Certification by an appropriately qualified person that the structure of vegetation (i.e. groundcover, shrub and canopy structure) on the rehabilitation site is trending towards being similar to a comparable reference site.
		Self-sustaining natural vegetation or habitat	Native fauna species	Certification by an appropriately qualified person that the native fauna species identified in the pre-mining baseline studies and the reference site monitoring prior to the completion of rehabilitation are present or indicators of these species or habitat elements are developing within the rehabilitated areas.

Mine Domain	Rehabilitation Goal	Rehabilitation Objectives	Rehabilitation Indicator	Completion Criteria
Water Storage Areas (cont)	Sustainable Land-use (cont)	Self-sustaining natural vegetation or habitat (cont)	Plant regeneration	Certification by an appropriately qualified person that plants in rehabilitated areas show evidence of flowering, seed setting and seed germination.
			Abundance of declared plants (weeds) identified through surveys	Certification by an appropriately qualified person that the abundance of declared plants (weeds) identified in rehabilitated areas is no greater than comparable reference sites.
			Actions taken to eradicate plants declared under local or State legislation	Evidence to demonstrate that action has been taken to eradicate declared plants (weeds) under local or State legislation should they occur on the rehabilitated site.
			Abundance of declared animals identified through surveys	Certification by an appropriately qualified person that the abundance of declared animals identified in rehabilitated areas is no greater than comparable reference sites.
			Actions taken to control animals declared under local or State legislation	Evidence to demonstrate that action has been taken to control declared animals under local or State legislation should they occur on the rehabilitated site.
			Weed hygiene procedures	Records indicating that appropriate weed and seed hygiene procedures were implemented during revegetation.
		Agricultural grazing	Livestock stocking rates	An appropriately qualified person has predicted and defined the economics/benefits and these have been agreed with relevant stakeholders.
			Landform stability when grazed	Land maintenance requirements are comparable to comparable reference sites.
			Stock access to water sources	Stock has access as presently available to water that meets accepted livestock drinking water guidelines.

3.7.4 Progressive Rehabilitation Strategy

A progressive approach to rehabilitation will be employed for each mine domain, whenever mining activities cease in a particular domain and the area in question becomes available. The benefits of adopting a progressive approach to site rehabilitation are:

- The total area of disturbed land on the Project site will be minimised at any point in time;
- Soil erosion and dust emissions will be minimised;
- Topsoil storage times (in the form of stockpiles) will be minimised;
- Visual amenity impacts will be diminished;
- At any one time, the land available for fauna and flora development will be maximised;
- Rehabilitation costs will be applied over a longer time period;
- Mine resources that are required for the rehabilitation programme will be called upon over a more limited period of time; and
- Rehabilitation methodologies can be modified and refined during mining operations, so that site-specific responses to particular rehabilitation approaches can be modified if required. For example the various plant species used to vegetate disturbed areas may be modified if some species do not become established.

3.7.5 Post Mine Land Use

The proposed post-mining land use is based upon the original pre-mining land activities of low-intensity cattle grazing (opencut and infrastructure area footprint and approximately 65% of the underground footprint) and agricultural cropping (approximately 35% of the underground footprint). Vegetation types similar to those that were present before mining will be used to rehabilitate disturbed areas.

An assessment of the Soil Management Units (SMU) present on the Project site was conducted in 2011 and 2012 and eight separate SMUs were identified. The agricultural suitability of these various soil types have been summarised as follows:

- Orion/Jimbaroo, Adelong/College and College/Lascelles SMUs - considered suitable with moderate limitations for rain-fed broadacre cropping and beef cattle grazing (Class 3);
- Adelong, Rolleston/Glengallan and Glen Idol SMUs - considered marginally suitable with severe limitations for cropping (Class 4) and moderate / severe limitations for beef cattle grazing (Class 3 / Class 4) and
- Glengallan and Jimbaroo SMUs - considered unsuitable for cropping with extreme limitations (Class 5) and severe / extremely limited suitability for beef cattle grazing (Class 4 / Class 5).

The pre-mining agricultural productivity of these SMUs will be used to guide post mining land uses.

Refer to Section 4.2 and Appendix 7 for further details of soil resources on the Project site.

The Environmental Management Register and Contaminated Land Register

The Environmental Management Register (EMR) is a land-use planning and management register. Land that has been or is being used for a notifiable activity, and about which EHP is notified, is recorded on the EMR. The EMR provides information on historic and current land use - including whether the land has been or is currently used for a notifiable activity, or has been contaminated by a hazardous contaminant. Sites recorded on the EMR pose a low risk to human health and the environment under the current land use. Entry on the EMR does not mean the land must be cleaned up or that the current land use must stop (EHP 2013).

The Contaminated Land Register (CLR) is a register of 'risk' sites - proven contaminated land which is causing or may cause serious environmental harm. Land is recorded on the CLR when scientific investigation shows it is contaminated and action needs to be taken to remediate or manage the land (EHP 2013).

Land can be removed from the CLR if, at any time, the landowner or local government provides information to EHP demonstrating that the land is shown not to be contaminated.

A contaminated land assessment, which included a search of environmental management and contaminated land registers, was undertaken on the lots pertaining to MDL 467 and did not identify any known areas of contamination on the Project site.

Following approval and prior to the undertaking of any notifiable activity on the Project site, the relevant lots will be advised to EHP for inclusion on the EMR in accordance with the EP Act. Upon cessation of mining, land owning to the Project site will be assessed by a suitably qualified professional in accordance with the *Guideline for Contaminated Land Professionals* (EHP 2012), who will prepare a site investigation report which will be submitted to EHP for assessment.

Following assessment, land will be remediated where required, reassessed by a suitably qualified professional and removed from the EMR at the discretion of EHP.

3.7.6 Soil Management

A topsoil management strategy has been developed in consideration to the SMUs identified on the Project site that will be impacted. Fertile topsoil is usually confined to the surficial horizons and upper section of the subsurface horizons. It is the aim of the soil management strategy to maintain as far as possible the soil's capacity to promote plant growth.

The following topsoil stripping depths for each SMU will be employed in order to minimise soil erosion and maximise soil fertility by maintaining seed-stock, micro-organisms and nutrients (SMUs have been listed in descending order of topsoil quality). Percentages indicate the relative disturbance area of each SMU associated with the opencut mine and MIA on the Project site:

- Orion / Jimbaroo – 60 cm (9.58%);
- Jimbaroo - 20 cm (60.15%);
- Adelong / College – 30 cm (11.11%);
- Rolleston / Glengallan –10 cm (13.85%);
- College / Lascelles – 30 cm (0.03%); and

- Glengallan –10 cm (5.18%);

In addition, the soil management strategy aims to:

- Minimise soil storage times within stockpiles, in order to retain soil fertility;
- The distance between topsoil stripping and stockpiles areas will be minimised, in order to avoid soil desiccation, degradation of structure and loss of soil during transport;
- Soil stockpiles will be developed in areas which are not close to drainage areas and stock grazing areas; and
- For soil that will be stockpiled for more than six months (one growing season) rip this material and seed with rapid-establishing plants. This strategy will help to reduce erosion and maintain a viable seed-bank within the stockpiled soil.

3.7.7 Rehabilitation Methodology

3.7.7.1 Above Ground

The site rehabilitation programme will employ the following staged methodologies:

- Progressive rehabilitation - Adopt a progressive rehabilitation approach whose progression is presented in detail in the Plan of Operations;
- Surface contouring – employed to minimise erosion, maximise water retention and create a surface topography which (wherever possible) is similar to the pre-mining landscape, except for spoil dumps, which should be rehabilitated in accordance with the spoil dump design presented in Section 3.6.3.3;
- Soil ripping – employed to aerate soil, reduce soil erosion and increase rates of plant establishment. A summary of the ripping depths and tyne spacing's that should be employed for ripping soil slopes of various angles are presented in Table 3.35;
- Soil stockpile management – soil, which for operational reasons, has to be stockpiled for extended periods of time will be managed as detailed in Section 3.7.6;
- Topsoil application – where possible, rehabilitated areas will be covered with topsoil to the original stripping depths and include erosion-control structures where required. Topsoil will be applied to rehabilitated areas as soon as possible, in order to retain the fertility of the applied topsoil; and
- Seeding – rehabilitated areas will be seeded with plant species which occur locally, in order to promote development of native flora and fauna species and achieve the domain specific rehabilitation goals.

Table 3.35 Ripping Depths and Tyne Spacings for Preparation of Disturbed Surfaces

Soil Slope Angle	Ripping Depth	Tyne Spacing
>10%	200 mm	<1.5m
>5% and <10%	200 mm	<2.5m
<5%	200 mm	<5m
Compacted soils	300 mm	As per soil slope angle

Disturbed areas will be revegetated progressively with species native to the local area. Table 3.36 outlines those species suitable for revegetation that shall be utilised on the Project site when considering the potential soil types and constructed or natural landforms and ecosystems.

Table 3.36 Native Species Suitable for Rehabilitation

Scientific Name	Common Name	Target Areas (suitable for)
Groundcover Species		
Dichanthium sericeum	**Queensland Bluegrass**	**Spoil Dump / Other[1, 2]**
Themeda triandra	**Kangaroo Grass**	**Spoil Dump / Other**
Bothriochloa decipiens	Pitted bluegrass	Spoil Dump / Other[2, 3]
Chloris truncata	Windmill Grass	Spoil Dump / Other[1, 2, 4]
Cymbopogon refractus	Barbed Wire Grass	Other
Heteropogon contortus	Black Speargrass	Other
Panicum decompositum	Native Millet	Spoil Dump / Other[1, 2]
Leptochloa digitata	Umbrella Canegrass	Riparian areas
Lomandra longifolia	Long-leaved Mat-rush	Riparian areas
Shrub/Small Tree		
Carissa ovata	Currant Bush	Spoil Dump / Other
Lysiphyllum hookeri	Queensland Ebony	Spoil Dump / Other
Terminalia oblongata subsp. *oblongata*	Yellowwood	Spoil Dump / Other

Scientific Name	Common Name	Target Areas (suitable for)
Diospyros humilis	Small-leaved Ebony	Spoil Dump / Other
Acacia holosericea	Soap Bush	Spoil Dump / Other
Eremophila mitchellii	False Sandalwood	Spoil Dump / Other
Melaleuca bracteata	Black Teatree	Riparian areas
Grevillea striata	Beefwood	Spoil Dump / Other
Tree		
Casuarina cristata	Belah	Spoil Dump / Other (alkaline soils)
Acacia harpophylla	Brigalow	Spoil Dump / Other
Acacia salicina	Native Willow	Riparian areas
Corymbia intermedia	Pink Bloodwood	Spoil Dump / Other
Eucalyptus cambageana	Blackbutt	Spoil Dump / Other
Eucalyptus melanophloia	Silver-leaved Ironbark	Spoil Dump / Other
Eucalyptus populnea	Poplar Box	Spoil Dump / Other
Eucalyptus tereticornis	Forest Red Gum	Riparian areas
Alphitonia excelsa	Red Ash	Spoil Dump / Other

Key:

Species listed in **bold** are locally common and should be used preferentially over other grasses. While Queensland Bluegrass grows on clay soils and is an early coloniser. Kangaroo Grass grows on any soil that is not waterlogged.

[1] Suitable for saline, alkaline dispersible topsoil

[2] Suitable for loam to loamy clays with slightly acid to neutral pH and low salinity

[3] Suitable for highly acidic, sodic loamy sand

[4] Suitable for raw spoil areas, saline, alkaline dispersible topsoil

The regional ecosystem to which rehabilitation species belong is outlined in Table 3.37 below.

Table 3.37 Regional Ecosystem Suitability of Rehabilitation Species

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

3.7.7.2 Underground

Underground longwall mining has the potential to create subsidence induced ponding and tension cracks. The methodology for rehabilitation of impacts created by underground mining includes:

- Subsidence-induced ponding will be mitigated by the completion of minor remedial drainage earthworks to re-establish free drainage; and
- Because surface cracking will only occur over a small portion of the subsided area, the exact locations of tension cracks will be confirmed through monitoring. Surface cracks will then be rehabilitated using remedial earthworks and the use of sealants.

A Subsidence Management Plan will be developed in accordance with the requirements of the EHP guideline *Watercourse Subsidence – Central Queensland Mining Industry (DRAFT Version 7)* to ensure subsidence impacts are mitigated and existing ecological values are maintained. Further information regarding subsidence impacts are provided in Section 4.8.3.6 and Appendix 10.

3.7.8 Domain Specific Rehabilitation Techniques

Specific rehabilitation techniques will be applied to each mine domain, in order to achieve the desired rehabilitation objectives that are presented in Section 3.7.3. The following sections provide a summary of the rehabilitation techniques that will be employed for each mine domain.

3.7.8.1 Final Voids

Final Void Safety

A certain percentage of the opencut pit will be backfilled with spoil, in order to minimise the volume of out of pit spoil dumps. Once in-pit spoil dumping is complete and opencut works finalised, the opencut void will be left in a stable and safe condition by erecting a safety bund around the opencut pit and / or fencing. The main purpose of this bund wall is to stops humans and livestock from gaining access to the final void.

The bund wall will be constructed in accordance with the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* (DME 1995) as follows:

- Minimum height – 2m;
- Base width minimum – 4m; and
- Minimum distance from pit instability edge – 10m.

Final Void Stability

The geotechnical stability of the final void will be assessed by a suitably qualified geotechnical engineer. The following structural parameters will be considered when assessing the stability of the final void highwall:

- Maximum slope angles – competent rock: 60^{o} and incompetent rock 45^{o};

- Rock fractures, faults, bedding planes and other discontinuities –orientation, density and strength of these discontinuities;
- Highwall rock and soil shear strength;
- Slope height and inclination;
- Intermediate bench spacing; and
- Long-term water levels.

Final Void Hydrology

A three-dimensional numerical simulation of groundwater flow for the Project was undertaken to estimate groundwater seepage into the opencut pit. Results indicate groundwater levels will recover to 194 mAHD and 190 mAHD for the western and eastern pit voids respectively, following mine cessation, with both pit lake levels well below the pit crest.

A hydrochemical model developed to predict the water quality during the filling of the final opencut pits is detailed in Appendix14a and has indicated that the pit water will be circum-neutral throughout the 100 year period modelled. It is also predicted that salinity will gradually increase due to the inflow of slightly saline ground water and the concentrating effect of evaporative water loss. The concentration of sulfates, cations and trace elements should not be toxic to livestock. As the pit will act as a groundwater sink, there is little chance of regional contamination of the groundwater system post mining, and any contamination will be confined to the pit itself and the immediate area around the pit walls.

Based on flood modelling detailed in Section 4.5, the final void will not be inundated by a Probable Maximum Flood event and therefore it is considered that no additional flood mitigation measures will be required around the void.

3.7.8.2 Exploration Areas

Land disturbances caused by any additional exploration that may be conducted on the Project site can either be addressed via temporary rehabilitation (for areas which may be disturbed in the future), or permanent rehabilitation (where no disturbance will occur in the future).

Temporary Rehabilitation

Provisional rehabilitation actions will include:

- Removal of all exploration spoil, sample bags and rubbish; and
- Capping of exploration drill holes.

Permanent Rehabilitation

Permanent rehabilitation actions will include:

- Evaporation of water from drilling mud sumps and backfilling of dried sumps;

- Severing hole casing at least 1m below ground level, filling and concrete plugging of exploration drill holes, and construction of a soil drainage mound over each plugged drill hole; and

- Scarification of rehabilitated areas.

The application of native seeds to exploration areas before the wet season may be required, if the rehabilitated areas fail to revegetate naturally.

3.7.8.3 Dams

The following rehabilitation strategies will be applied to dams on the Project site, with the aim of returning the land to its pre-mining land use of low-intensity cattle grazing.

In addition, a contaminated land assessment will be required for all rehabilitated dams to demonstrate that residual soil contamination does not exist following dam rehabilitation.

Regulated Dams

The water contained within regulated dams (MWD and CPPWRD) will either be drained or allowed to evaporate. The remaining void will then be filled in with benign material in order to cover residual sediments in each dam.

These dam areas will then be re-contoured to shed surface water (maximum slope gradient of 1 in 10), compacted to minimise erosion, topsoiled (to a depth of approximately 100 mm) and re-seeded with native flora.

Sedimentation Dams

Following ML relinquishment, sedimentation dams will be rehabilitated via one of the following procedures:

- In accordance with written agreement from landowners, these dams may be left on site for use by local landholders; or

- Water in each dam will be drained / evaporated, the dam walls will be pushed over to cover the residual sediments and the surface of each dam ripped and seeded.

3.7.8.4 Infrastructure

In general, all infrastructure will be removed from the Project site unless written agreements have been obtained from landowners to retain particular items of infrastructure following mine closure. These written agreements will require landowners to maintain and manage any elements of infrastructure which remain on site.

The rehabilitation of infrastructure areas will aim to return the land to its pre-mining land use of low-intensity cattle grazing.

Mine Infrastructure Area

Site buildings (workshop, laboratory and administration units), the CPP, coal conveyance systems, water management reticulation systems, water and sewage treatment facilities, TLO facility and fuel /

chemical storage infrastructure will be demolished and removed from site, together with their respective footings, foundations and pipelines.

Materials generated during infrastructure demolition will be assessed and categorised in accordance with the *Environmental Protection (Waste Management) Regulation 2000* and disposed of accordingly.

Any recyclable materials such as scrap steel will be sold, whilst non-recyclable material will be removed from site by a licensed waste management contractor for disposal in a licensed facility.

Water pipelines and the sewage treatment system will be removed by a licensed waste management contractor, and disposed of at a licensed facility or recycled where appropriate.

Following removal of pipeline infrastructure, any trenches will be re-contoured, ripped and revegetated.

A contaminated land assessment will be conducted in areas where potentially contaminative activities have been conducted and any soil contamination that is encountered will be removed from site by a licensed waste management contractor and disposed of in an appropriate and licensed waste-storage facility. Once infrastructure is removed, these areas will be re-contoured, ripped and revegetated.

Access and Haul Roads

Roads that are not required by the local landowners will be ripped, topsoiled and revegetated.

Rail Loop

It is anticipated that the rail loop will not be required by the landowner and, therefore, will be removed from site by a licensed contractor, recycled and / or sold. The rail loop area will then be re-contoured, ripped and revegetated.

3.7.8.5 Spoil Dumps

In-Pit Spoil Dumps

A progressive approach to spoil dump rehabilitation will be employed over the life of the mine, to minimise the mine's disturbance footprint at any one time. The final landform of rehabilitated in-pit spoil dumps will consist of topsoiled, gently undulating slopes, which have been revegetated with local species that are consistent with the post-mining land use of low-intensity cattle grazing. The in-pit dump will be contoured to replicate the pre-mining drainage pattern to the extent possible. Those dump areas constituting the lowall of the final voids that will exist below the final post-mining groundwater levels will not be revegetated, but re-contoured and engineered with limestone and NAF / ANC material to minimise the release of contaminants into groundwater.

Out-of-Pit Spoil Dumps

Out of pit spoil dumps will be progressively rehabilitated by re-contouring the outer slope with benign waste rock to an angle of 1V (vertical):2.5H (horizontal) followed by topsoiling and revegetating the landform with native plant species (e.g. grasses, herbs and shrubs) that facilitate low-intensity cattle grazing.

3.7.9 Final Rehabilitated Landform

Figure 3.46 illustrates the anticipated configuration of the post-mine landform following the completion of rehabilitation. Flood modelling was conducted to determine where final voids and out-of-pit spoil dumps would lie in relation to flood levels following rehabilitation. Modelling combined 1,000 year ARI design rainfall data with a 90 minute critical duration in order to estimate the probable maximum precipitation for the Project site. In addition, hydraulic modelling was undertaken to assess the hydraulic properties and characteristics of Taroborah Creek, implemented in the flood model.

Figure 3.47 shows the estimated flood extent and depths for the 1,000 year ARI, 90 minutes duration flood. The flood assessment determined that the Taroborah Creek flood extents are largely uncontained to the high flow channel running east to west through the MDL area and that Taroborah Creek overflows to the north-east towards the opencut mine, however, flood extents do not contact any mine components remaining after rehabilitation.

Figure 3.48 shows the Probable Maximum Flood (PMF) (determined to have an AEP of 10^{-7}) event, based on Australian Rainfall and Runoff data derived from BOM (2013). The flood assessment determined the final void will not be inundated subject to the PMF event as modelled and therefore it is considered that no additional flood mitigation measures will be required around the void.

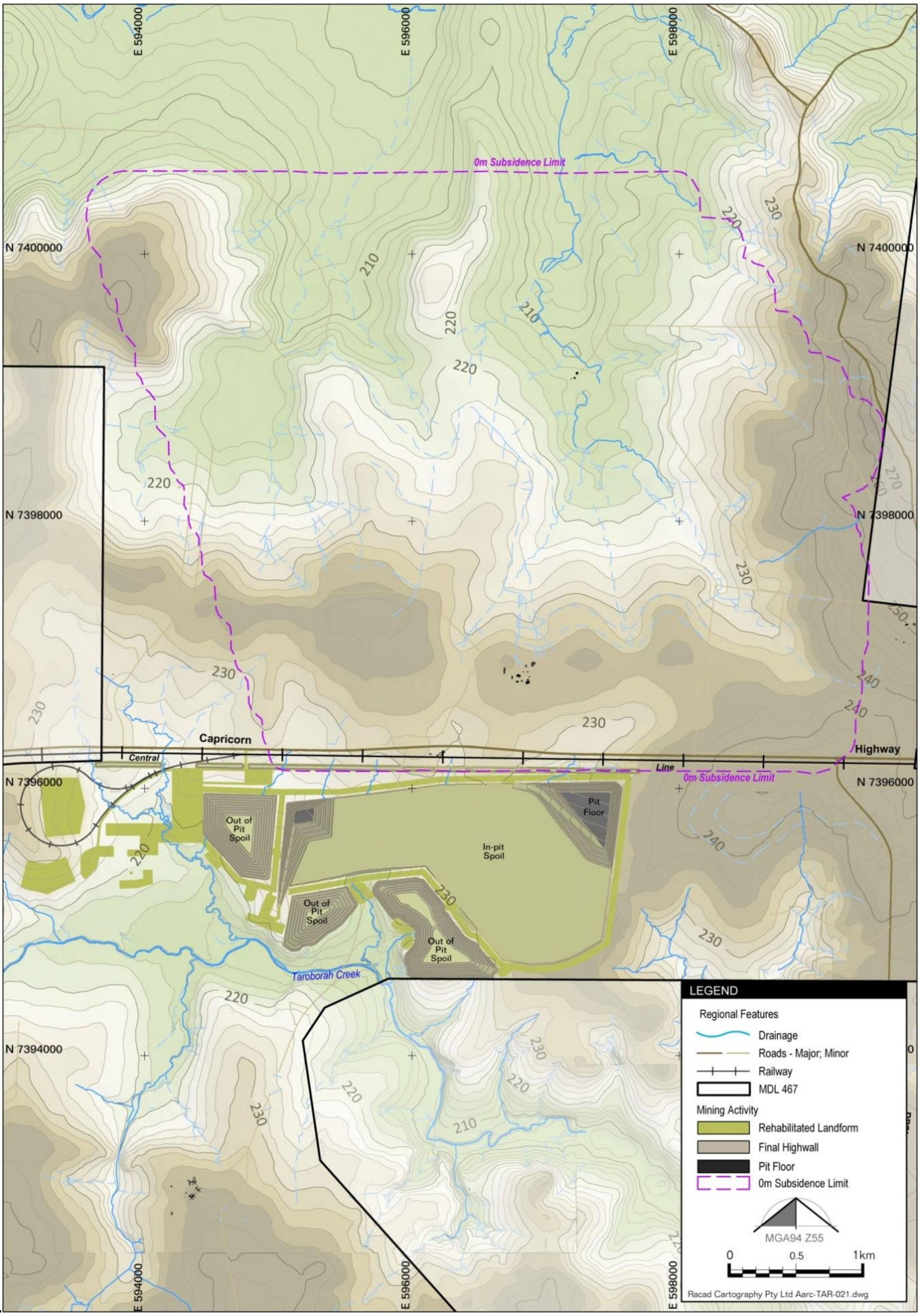


Figure 3.46 Final Rehabilitated Landform

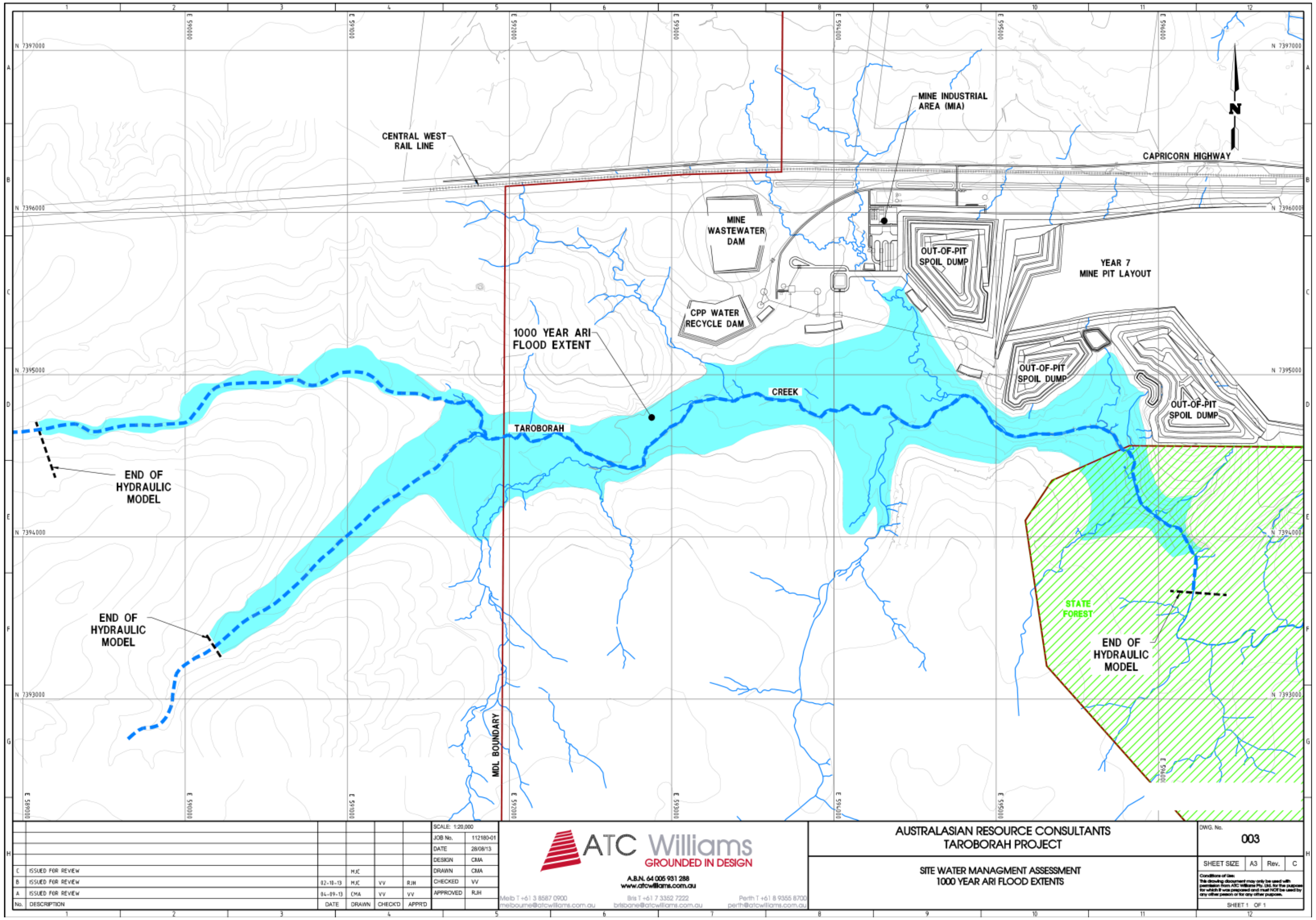


Figure 3.47 Modelled 1,000 Year ARI Flood Extreme

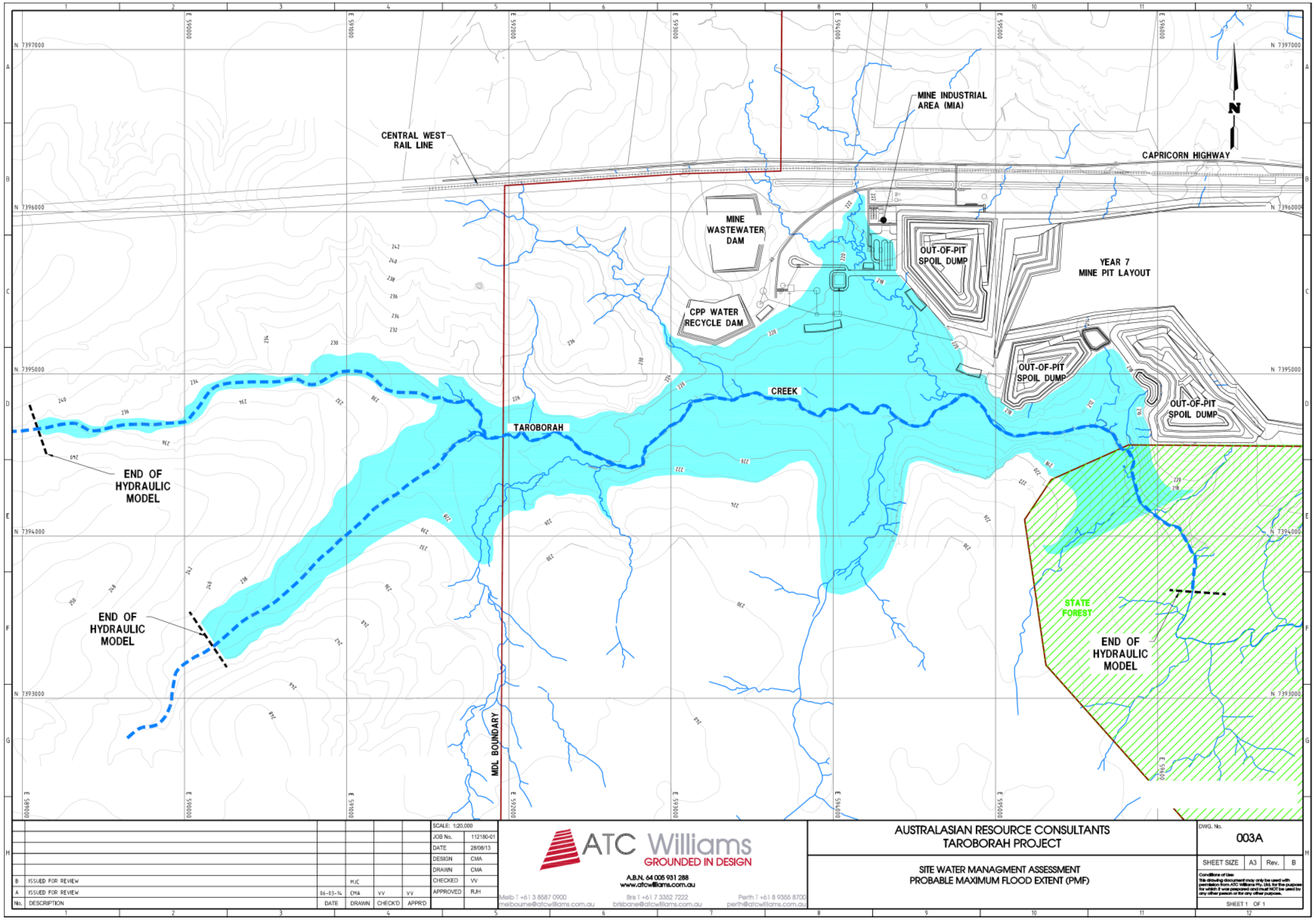


Figure 3.48 Taroborah Creek Probable Maximum Flood Extent

3.7.10 Rehabilitation Monitoring

Following completion of the proposed progressive rehabilitation works, an annual programme of rehabilitation monitoring will be undertaken in order to demonstrate and confirm that the rehabilitation works conducted in each mine domain are heading towards their respective completion criteria. This monitoring process will continue for the life of the mine and in the period following cessation until the EA is surrendered.

The success of the rehabilitation works for each mine domain will be measured by comparing a number of rehabilitation completion criteria for rehabilitated areas with similar, existing, undisturbed ecosystems (analogue sites) over time.

A variety of analogue sites will be selected prior to mine construction, for the purposes of rehabilitation monitoring and to effectively represent pre-mining ecosystems. The local vegetation and landscape character at each analogue site will be similar to the pre-mining ecosystems that will be disturbed. An assessment of these analogue sites will be conducted in order to acquire further knowledge of the pre-mining landscape, assist with the refinement of rehabilitation strategies and completion criteria where appropriate.

The scientific assessment of ecosystems present at both analogue and rehabilitation sites will be conducted via the use of 50m transect lines, with analogue transects sites developed prior to the commencement of mining activities and rehabilitation sites established on post-mining rehabilitated landforms.

The following parameters and evidence will be recorded and assessed annually at each analogue and rehabilitation site:

- Aspect and slope;
- Percentage groundcover;
- Grass and herb density per hectare;
- Shrub density per hectare;
- Tree density per hectare;
- Species composition;
- Soil chemical and physical properties;
- Erosion evidence – depths of rills, erosion lines, surface crusting and slopes; and
- Site photographs.

In addition to rehabilitation monitoring, surface water, creek sediments and groundwater quality will also be monitored during the life of the Project.

3.7.11 Rehabilitation Maintenance

Following mine closure, the following rehabilitation maintenance activities will be employed on site until the site reaches its success criteria and the EA is surrendered, in order to ensure that the progressive rehabilitation programme becomes established and is self-sustaining:

- Progressive maintenance – a programme of planned rehabilitation maintenance will be adopted on site, following the initial rehabilitation works;
- Failure mitigation – employed to address any failures to achieve the rehabilitation objectives; and
- Annual monitoring – For any area that the annual monitoring shows the rehabilitation conducted to date has not met the criteria, the following remedial actions will be employed as applicable to address such failings:
  - Erosion maintenance;
  - Gypsum application;
  - Fertiliser application;
  - Weed control; and
  - Replanting / re-seeing where required.