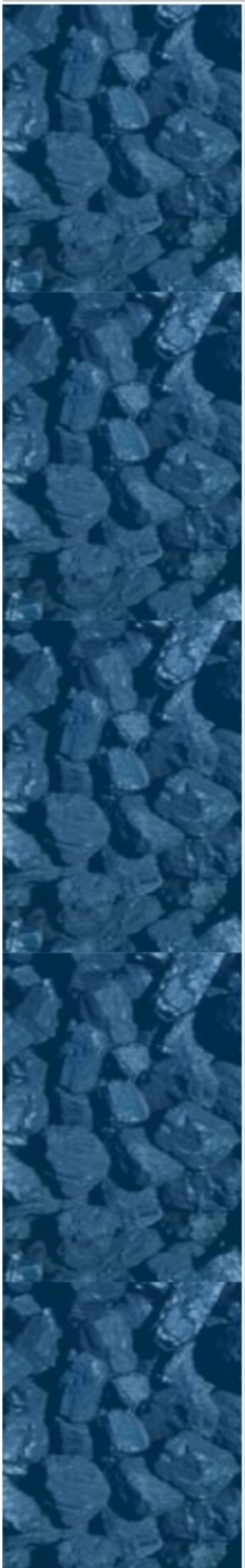
Adani Mining Pty Ltd



Carmichael Coal Mine and Rail Project SEIS

Report for Water Balance

22 October 2013

This Carmichael Coal Mine and Rail Project SEIS: Water Balance ("the Report") has been prepared by GHD Pty Ltd ("GHD") on behalf of and for Adani Mining Pty Ltd ("Adani") in accordance with an agreement between GHD and Adani.

The Report may only be used and relied on by Adani for the purpose of informing environmental assessments and planning approvals for the proposed Carmichael Coal Mine and Rail Project (Purpose) and may not be used by, or relied on by any person other than Adani.

The services undertaken by GHD in connection with preparing the Report were limited to those specifically detailed in Section 1 of the Report.

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- *any error in, or omission in connection with assumptions, or*
- *reliance on the Report by a third party, or use of this Report other than for the Purpose.*

Table of contents

Table index

Figure index

Appendices

1. Introduction

1.1 Project overview

Adani Mining Pty Ltd (Adani, the Proponent), commenced an Environmental Impact Statement (EIS) process for the Carmichael Coal Mine and Rail Project (the Project) in 2010. On 26 November 2010, the Queensland (Qld) Office of the Coordinator General declared the Project a ‘significant project’ and the Project was referred to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (referral No. 2010/5736). The Project was assessed to be a controlled action on the 6 January 2011 under section 75 and section 87 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The controlling provisions for the Project include:

- World Heritage properties (sections 12 & 15A)
- National Heritage places (sections 15B & 15C)
- Wetlands (Ramsar) (sections 16 & 17B)
- Listed threatened species and communities (sections 18 & 18A)
- Listed migratory species (sections 20 & 20A)
- The Great Barrier Reef Marine Park (GBRMP) (sections 24B & 24C)
- Protection of water resources (sections 24D & 24E)

The Qld Government’s EIS process has been accredited for the assessment under Part 8 of the EPBC Act (1999) in accordance with the bilateral agreement between the Commonwealth of Australia and the State of Queensland.

The Proponent prepared an EIS in accordance with the Terms of Reference (ToR) issued by the Qld Coordinator-General in May 2011 (Qld Government, 2011). The EIS process is managed under section 26(1) (a) of the *State Development and Public Works Act 1971* (SDPWO Act), which is administered by the Qld Government’s Department of State Development, Infrastructure and Planning (DSDIP).

The EIS, submitted in December 2012, assessed the environmental, social and economic impacts associated with developing a 60 million tonne (product) per annum (Mtpa) thermal coal mine in the northern Galilee Basin, approximately 160 kilometres (km) north-west of Clermont, Central Queensland, Australia. Coal from the Project will be transported by rail to the existing Goonyella and Newlands rail systems, operated by Aurizon Operations Limited (Aurizon). The coal will be exported via the Port of Hay Point and the Point of Abbot Point over the 60 year (90 years in the EIS) mine life.

Project components are as follows:

- The Project (Mine): a greenfield coal mine over EPC 1690 and the eastern portion of EPC 1080, which includes both open cut and underground mining, on mine infrastructure and associated mine processing facilities (the Mine) and the Mine (offsite) infrastructure including a workers accommodation village and associated facilities, a permanent airport site, an industrial area and water supply infrastructure

- The Project (Rail): a greenfield rail line connecting to mine to the existing Goonyella and Newlands rail systems to provide for the export of coal via the Port of Hay Point (Dudgeon Point expansion) and the Port of Abbot Point, respectively including:
  – Rail (west): a 120 km dual gauge portion running west from the Mine site east to Diamond Creek
  – Rail (east): a 69 km narrow gauge portion running east from Diamond Creek connecting to the Goonyella rail system south of Moranbah
  – Quarries: The use of five local quarries to extract quarry materials for construction and operational purposes.

The project location is shown in Figure 1.

1.2 Report purpose

This report forms part of the Supplementary Environmental Impact Statement (SEIS) for the Carmichael Coal Mine and Rail Project (Project).

Due to changes in the mine design, the mine life has changed from 90 (EIS) to 60 years (SEIS), refer to Appendix A. This water balance allows for a mine life of 60 years. The mine areas are split by the Carmichael River with open cut pits and underground mines both north and south of the Carmichael River. The mine and water management infrastructure is reflecting this topographic feature, for example by having a Mine Affected Water dam on each site of the river.

1.3 Objectives

The water balance has been developed to support the SEIS for the Project with the following specific objectives:

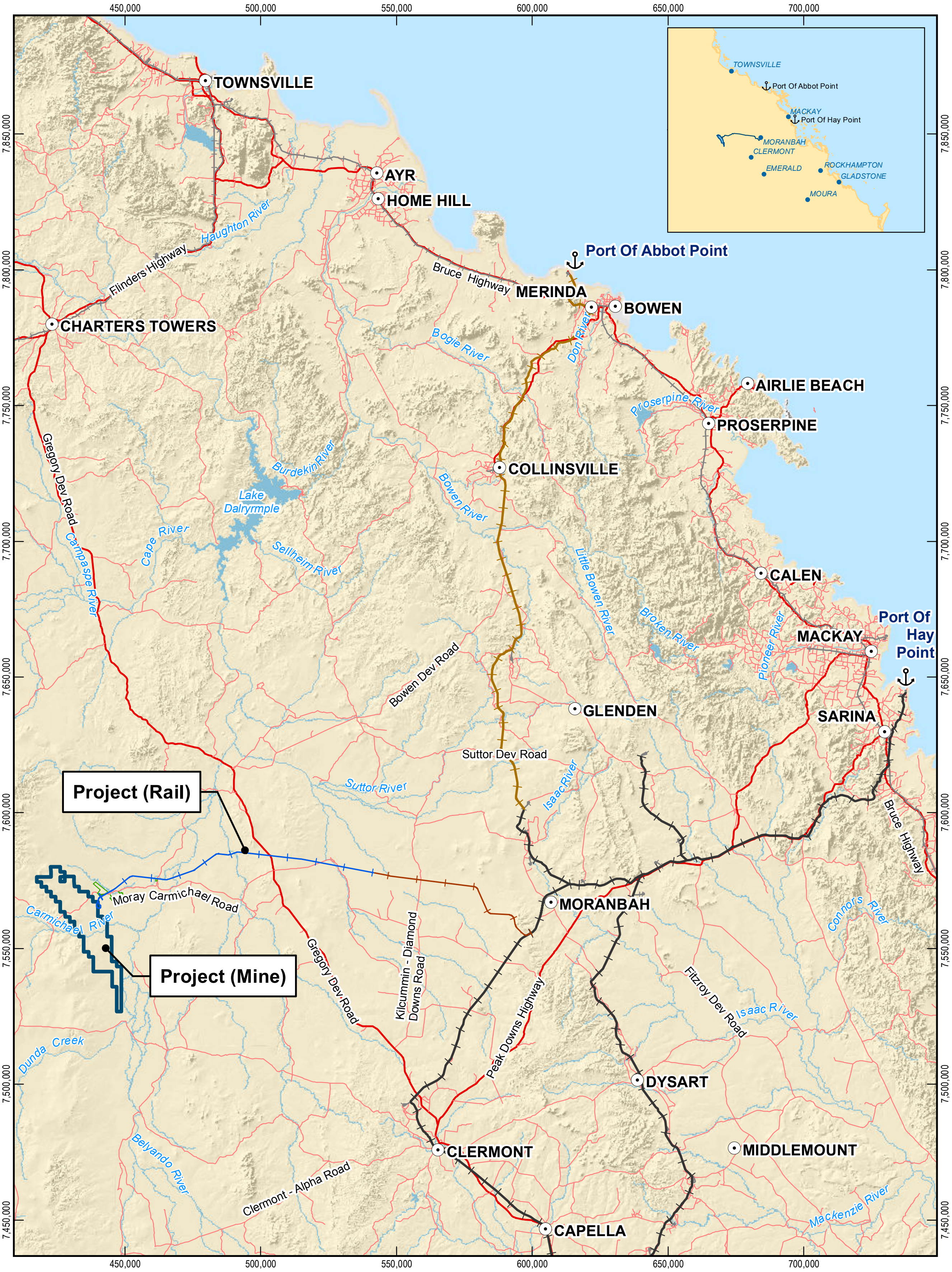
- Determine the external water supply requirements
- Determine required water storage volumes
- Determine the requirements of controlled discharge from the project to the environment
- Determine the salinity of the potential discharge volumes.

1.4 Document status

This water balance has been developed as a part of the SEIS. It basically forms a further refinement of the water balance developed as part of the EIS and it is expected that this water balance will be further developed and refined during future design phases and that the final water balance will ultimately form an integrated part of the Water Management Plan (WMP) for the mine.

1.5 Peer review

This water balance study has been peer reviewed. Results of this review have been considered in the study and the peer review letter is included in Appendix B



LEGEND

- Major Port
- Other Rail Network
- Goonyella System
- Newlands System
- Local Road
- Watercourse
- Project (Rail)
  - Rail (West)
  - Rail (East)
- Mine (Offsite)
- Project (Mine)

Based on or contains data provided by the State of QLD (DERM) [2010]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

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Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Job Number	41-26422
Revision	B
Date	14-10-2013

Project Location

Figure 1

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Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: © Commonwealth of Australia (Geoscience Australia): Town, Railways, Watercourses (2007); DNRM: LGA, (2011), Hillshade (2009); DMR: State Roads (2008); DME: EPC1690 (2010), EPC1080 (2011); Adani: Mine Offsite, Alignment SP1 Opt11 Rev2, SP2 Opt 9 Rev 3 (2013). Created by: MS

2. Key project elements for the water balance

2.1 Introduction

An overview of the Project is provided in the form of a mine layout plan in Figure 2. This mine plan forms the basis from which all key elements for the water balance have been extracted. In this section relevant legislation and guidelines along with all key elements from the mine plan that affect the water balance are defined and how they are represented in the water balance is described.

2.2 Relevant legislation and guidelines

The following sections provide an overview of the key regulatory and non-regulatory instruments, guidelines and policies relevant to the surface water resources of the Burdekin River Basin.

2.2.1 Commonwealth legislation and policies

Commonwealth Environment Protection and Biodiversity Conservation Act 1999

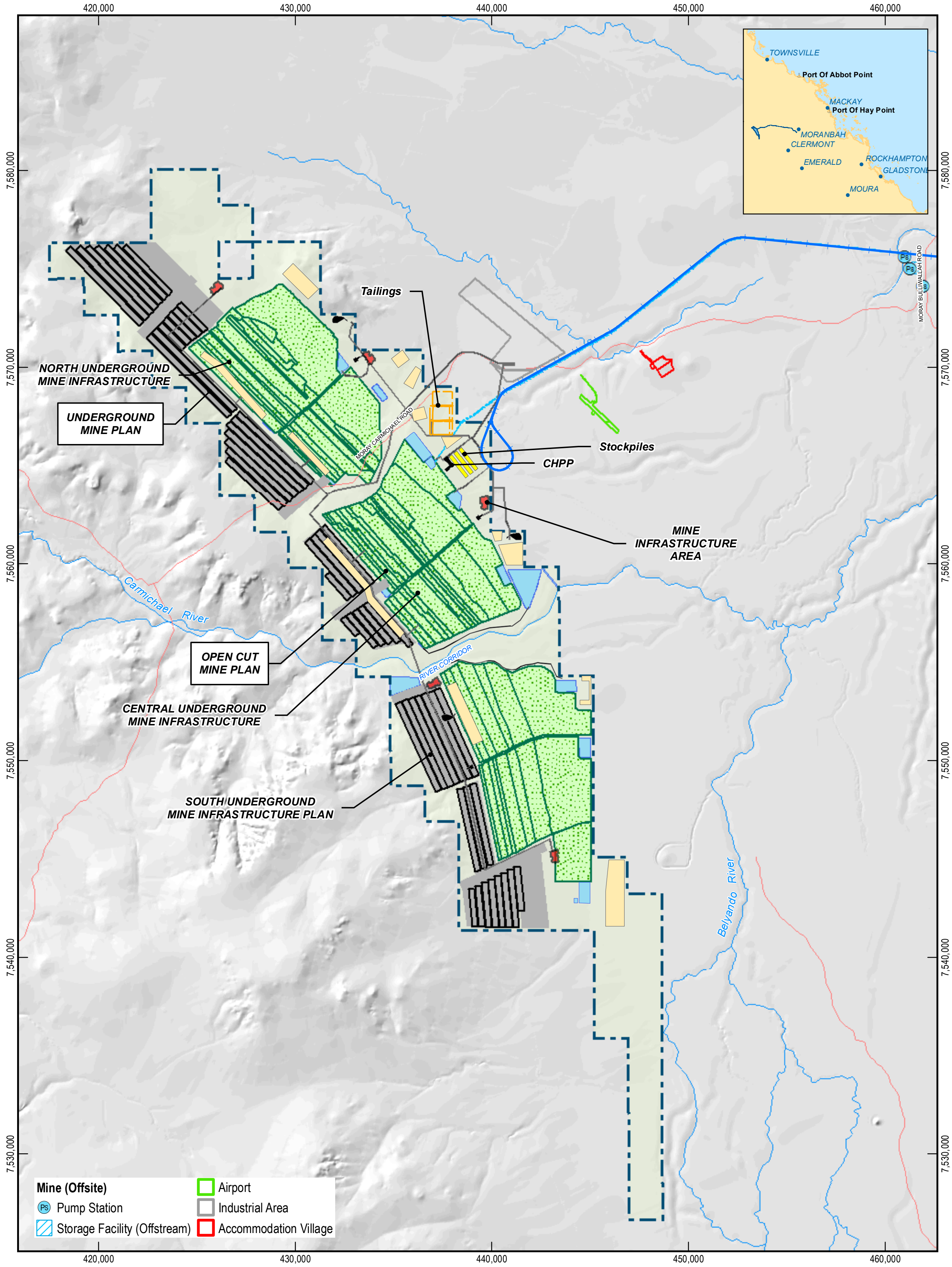
The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Australian Government's central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places, which are defined in the EPBC Act as matters of national environmental significance.

On 21 June 2013, the EPBC Act was amended to include a new matter of national environmental significance in relation to coal seam gas (CGS) and large coal mining development - the 'water trigger'. As a result, any CSG development or large coal mining development that has, will have or is likely to have a significant impact on water resources now requires referral and possibly approval by the Commonwealth Environment Minister under the EPBC Act.

Australian and New Zealand Guidelines for Fresh and Marine Water Quality

The Guidelines (ANZECC 2000) provide recommended parameters for:

- Water and sediment quality that will sustain the ecological health of aquatic ecosystems
- Irrigation and general water use
- Livestock drinking water Aquaculture and human consumers of aquatic food
- Waters for recreational activities, such as swimming and boating
- Preservation of the aesthetic appeal of these waters.



LEGEND

- Local Road
- River / Watercourse
- Overland Conveyors
- Rail (West)
- Mine (Onsite)
- Open Cut Blocks
- Out of Pit Waste Dumps
- Water Management Dams
- Mine Infrastructure Area
- Mine Infrastructure
- Stockpiles
- Tailings Cell
- Top Soil Storage

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0 2 4 6 8 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

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Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Onsite and Offsite
Mine Infrastructure

Job Number	41-26422
Revision	B
Date	18-10-2013

Figure 2

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Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: GA: Road, River / Watercourse (2007); DME:EPC1690 (2010), EPC1080 (2011); Adani: Alignment, Offsite(2013), Mine Layout / Infrastructure (2013); Created by: MS

2.2.2 Queensland legislation and policies

Environmental Protection Act 1994

The aim of the *Environmental Protection Act 1994* (EP Act) is to protect Queensland's environment while allowing for development that improves the quality of life as well as maintaining the ecological processes on which it depends.

The EP Act also imposes a general environmental duty on all persons (including corporations) such that they must not conduct any activity that causes, or is likely to cause, environmental harm, unless they take all reasonable and practicable measures to prevent or minimise the harm.

The *Environmental Protection Regulation 2008* identifies environmental relevant activities (ERAs) prescribed under the EP Act, for which development approval is required.

Environmental Protection (Water) Policy 2009

The *Environmental Protection (Water) Policy 2008* (EPP Water) (part 2, Section 6) provides a framework for:

- Identifying environmental values (EVs) for Queensland waters
- Deciding and stating water quality guidelines and objectives to enhance or protect the EVs
- Making consistent and equitable decisions about Queensland waters that promote the efficient use of resources and best practice environmental management
- Involving the community through consultation and education, and promoting community responsibility.

The EVs considered applicable to the Project (Mine) to be particularly enhanced or protected under the EPP (Water) are the following:

- Biological integrity of an aquatic ecosystem
- Suitability for agricultural use
- The cultural and spiritual values of the water.

Guideline: Preparation of Water Management Plans for Mining Activities

A Water Management Plan (WMP) may be mandated within the conditions of an approval under the EP Act or to comply with the EPP Water. This guideline (2010) is to assist the operators of mining activities to plan and implement water management practices in a manner that protects EVs and meets obligations under the EP Act. The guideline applies to all existing and proposed level 1 mining projects.

Manual for Assessing Hazard Categories and Hydraulic Performance of Dams constructed as part of environmentally relevant activities pursuant to the Environmental Protection Act 1994, Version 2

The Manual (2011) sets out the requirements of the Department of Environment and Heritage Protection (DEHP) (the administering authority), for hazard category assessment and certification of the design of dams and other land-based containment structures, constructed as part of ERAs under the EP Act.

Guideline: Regulated dams in environmentally relevant activities

This guideline (2010) provides information about the procedures of the administering authority, for dealings involving dams and related containment structures, constructed as part of ERAs pursuant to the EP Act. This Guideline should be read in conjunction with the Manual described above.

Sustainable Planning Act 2009

Under the SP Act, development authorised to occur on a mining lease is generally exempt from the requirements for assessment and approval. However, there are some limited exceptions, such as approvals for building, plumbing and drainage work. Adani seeks recommendations from the Coordinator-General that development approval be given for all of the identified aspects of assessable development for the Project, subject to appropriate conditions. As an alternative, if considered more appropriate by Coordinator-General, Adani seeks a recommendation that a preliminary approval be granted, subject to appropriate conditions

Queensland Dam Safety Guidelines

The aim of this guideline prepared by the Department of Natural Resources and Mines (DNRM) in 2002 is to describe practices dealing with the construction and management of referable dams. It assists dam owners to safely manage their dams and protect the community from dam failure.

Guideline: Activities in a watercourse, lake or spring associated with a resource activity or mining operations

This guideline is to allow activities in a watercourse, lake or spring associated with a resource activity or mining operations without the need for a riverine protection permit. Activities include the destruction of native vegetation, excavation and placement of fill in a watercourse, lake or spring. The *Water Regulation 2002* permits these activities provided the activity is in accordance with this guideline.

This guideline outlines the requirements, providing outcomes and acceptable solutions to ensure activities minimise adverse impacts on water quality, water flow, vegetation and the physical integrity of the watercourse, lake or spring.

Water Act 2000

The *Water Act 2000* provides a framework for management and allocation of water resources and licences, based on development of catchment-based Water Resource Plans (WRPs). The WRPs are then activated through related Resource Operations Plans (ROPs) which provide detail on how the water resources will be managed to implement the strategies and objectives as set out in the WRP.

The *Water Act 2000* defines a watercourse as a:

- River, creek or stream in which water flows permanently or intermittently in a natural channel, whether artificially improved or not
- Or in an artificial channel that has changed the course of the watercourse

Approvals are required for activities that interfere with a watercourse.

The *Water Act 2000* also sets out the law with respect to:

- Rights to surface and groundwater
- Control of works with respect to surface and groundwater conservation and protection
- Irrigation, water supply, drainage and flood control.

Under the *Water Act 2000,* an approval/licence will be required for any works which may affect surface and groundwater. The following permits may be required under relevant sections of the *Water Act 2000*:

- Section 206 – taking water from a watercourse, lake, spring or underground water source (Water Licence)
- Section 286 – destroy vegetation, place fill or excavate in a watercourse (Riverine Protection Permit).

Water Regulation 2002

The Water Regulation 2002 is subordinate to the Water Act 2000 and defines the purpose of use (such as stock / domestic use) that do not require authorisation to take water and, by omission, those purposes that do require authorisation.

Water Resource (Burdekin Basin) Plan 2007

The Burdekin Basin WRP serves to provide a framework for sustainably managing water and the taking of water within the Burdekin Basin, within which the Project (Mine) lies. The Project (Mine) lies within sub-catchment E of the WRP area (see Schedule 2 of the ROP discussed below) thus waterway diversions and stormwater collection systems required for the Project will come under Section 147 of the WRP which establishes need for monitoring of various parameters by the operators of infrastructure for interfering with water (including overland flows).

Burdekin Basin Resource Operations Plan 2009

The Burdekin Basin ROP implements the provisions made by the Burdekin Basin WRP, specifically the rules and operational requirements for managing the surface water in that basin. The ROP also informs the granting of a licence for the interference with water under Section 206 of the *Water Act 2000*, which will apply to the Project (Mine).

Water Resource (Great Artesian Basin) Plan 2006

The Project (Mine) lies within the Great Artesian Basin WRP management area. The purpose of the Great Artesian Basin WRP is to:

- Define the availability of water in the plan area
- Provide a framework for sustainably managing water and the taking of water
- Identify priorities and mechanisms for dealing with future water requirements
- Provide a framework for establishing water allocations
- Provide a framework for reversing, where practicable, degradation that has occurred in natural ecosystems.

Great Artesian Basin Resource Operations Plan 2007 Amended November 2012

The Great Artesian Basin Resource Operations Plan (GABROP) specifies rules and operational requirements for managing ground water resources that are defined to be within one of the 25 groundwater catchments listed under the Water Resource Plan (WRP). The Project as a whole triggers various aspects of the WRP depending on the activity and location.

Water Supply (Safety and Reliability) Act 2008

Failure impact assessment determines whether a dam is a referrable dam, that is, a dam that would put population at risk in the event of failure, by reference to the provisions of the *Water Act 2000* and the *Water Supply (Safety and Reliability) Act 2008* (WSSR Act).

All large storage dams for the Project will require failure impact assessment in the detailed design phase, and on an ongoing basis as required under the WSSR Act.

Guidelines for Failure Impact Assessment of Water Dams

These guidelines have been developed by the Department of Energy and Water Supply (2012) to help owners comply with the WSSR Act and dam safety conditions for referable dams (these include both conditions relating to dam safety imposed on development permits and safety conditions imposed under the Act).

The Guidelines provide information about:

- Referable dams
- Failure impact ratings
- Failure impact assessment and how it is done
- Certification of a failure impact assessment
- Lodging a failure impact assessment for an existing dam
- Lodging a failure impact assessment for a new or proposed dam
- Lodging a failure impact assessment for works on an existing dam
- Timing requirements for undertaking failure impact assessments
- Processes for accepting, rejecting or reviewing a dam failure impact assessment Responsibilities, penalties and provisions for appeals.

Queensland Water Quality Guidelines 2009

These guidelines interpret the ANZECC 2000 Guidelines by providing guideline values (numbers) that are tailored to Queensland regions and water types, and providing a process/framework for deriving and applying more locally specific guidelines for waters in Queensland.

Water Accounting Framework for the Minerals Industry Version 1.2 2012

This user guide prepared by the Minerals Council of Australia allows sites to account for, report on and compare site water management practices in a rigorous, consistent and unambiguous manner that can easily be understood by non-experts. It has also been designed to align with frameworks for the global reporting initiative (GRI) and Australian water accounting standard (AWAS).

Best Practice Erosion and Sediment Control

This document prepared by the International Erosion Control Association (IECA) in 2008 contains the necessary strategies and techniques to assist erosion and sediment control practitioners to reduce the degradation of land and water from uncontrolled erosion and sedimentation.

2.3 Water status

Water within the water balance is either considered raw, mine affected water (MAW), sediment affected, clean, process, or treated:

- Raw water is water that is received from an external water supply as an input, is considered clean and has not been used in a task
- MAW (also called worked water) is that which has been through a task and is potentially contaminated by the mining activities
- Sediment affected water contains a higher sediment load but has not been contaminated by direct mine activities
- Clean water is runoff from undisturbed catchments and will be diverted around the Project. As such clean water will not be part of the water balance
- Treated water is water that has been treated on site to achieve a particular water quality objective. Raw water and MAW can be treated to allow further use or release as a controlled discharge from a designated outlet
- Process water is that which is used on site to complete a task.

2.3.1 Mine affected water

MAW is generated in active mining areas. Sources of MAW are:

- Dewatering of 6 pits (4 North of the Carmichael River and 2 South of the Carmichael River)
- Dewatering of 5 underground mines (3 North of the Carmichael River and 2 South of the Carmichael River)
- Dewatering of 3 boxcut areas – underground mines 1, 4 and 5 (from north to south)
- Dewatering of 2 high wall access areas – Pit D and Pit C
- CHPP tailings decant dam
- Runoff from industrial working areas including the Mine Industrial Area (MIA), the Run of Mine (ROM) coal area, Coal Handling and Processing Plant (CHPP) and the Train Load Out (TLO) facility.

2.3.2 Sediment affected water

Sediment affected water (SAW) is generated from disturbed areas; areas where runoff will not be contaminated with coal or other mining associated contaminants, but are likely to be disturbed due to vehicle movements or for example pre-stripping. Runoff from these areas typically has higher sediment loads than runoff from undisturbed areas. Runoff from overburden areas is also considered sediment affected water.

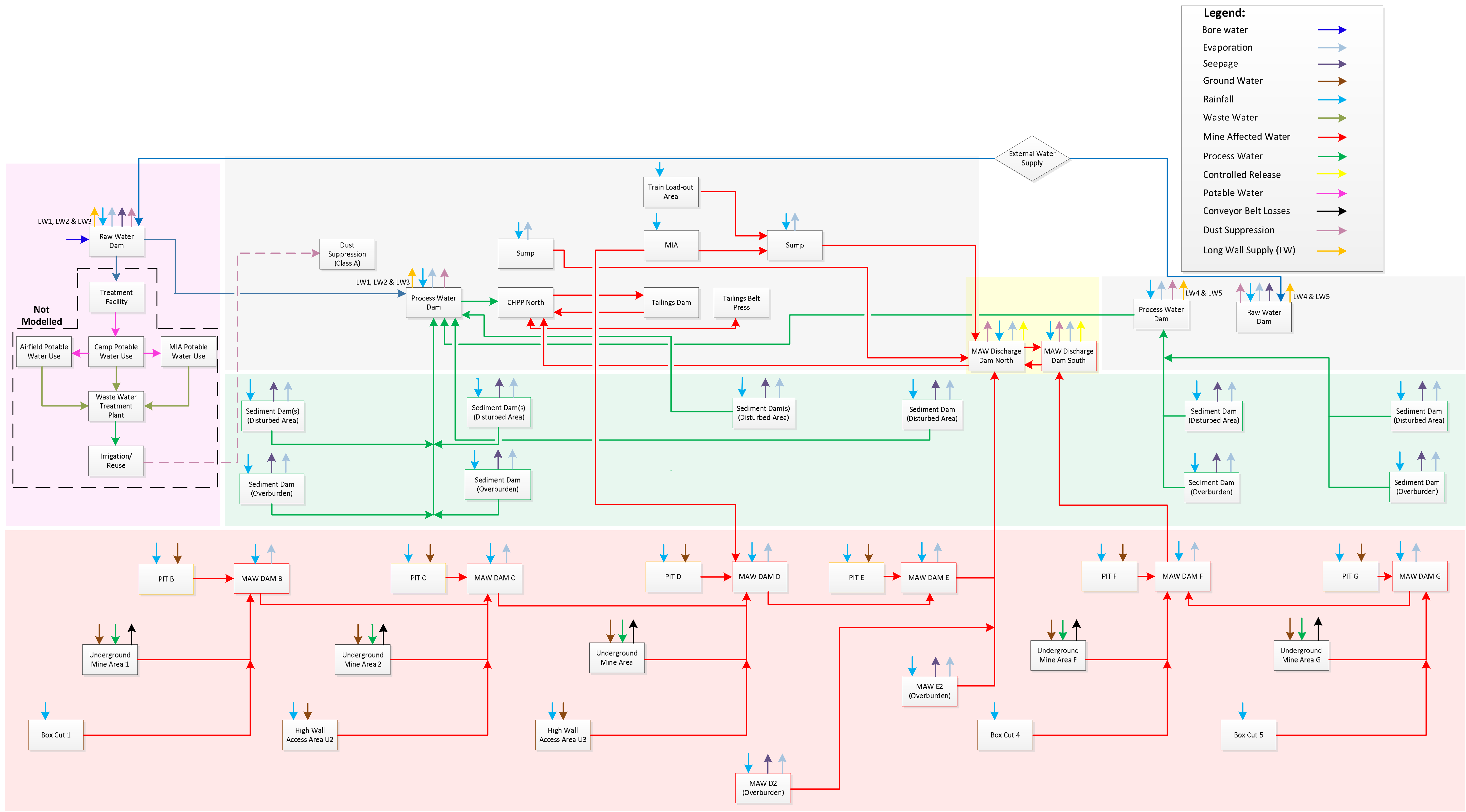
2.4 Principles of water management

A schematic representing the water management principles, both general and site specific is provided in Figure 3. This schematic also forms baseline input into the GoldSim model.

2.4.1 General principles

The following general water management principles are proposed for the Project:

- Raw water will be delivered and temporarily stored in a raw water dam
- MAW is to be retained on site and stored in the MAW storages (dams) that will be designed and managed in accordance with the Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (DERM, 2012)
- MAW will, when necessary, be discharged into receiving waterways from the centrally located MAW collection storages (central MAW dams) one for north and the other for south of the Carmichael River. Discharges will be in accordance with relevant licence conditions under the relevant approval.The aim is not to discharge into the river system except during extreme climatic circumstances in which the AEP of the storm event exceeds the design parameters adopted
- Runoff from disturbed catchments (SAW) has to be treated to achieve minimum reductions in key pollutant levels before being reused or released into the natural environment
- Clean water runoff from undisturbed catchments is diverted around any mine workings or disturbed areas and released downstream into the same waterway where possible
- Mine workings are protected from local stormwater runoff and regional flooding
- Any controlled discharges are in accordance with Environmental Authorities licence conditions
- Acid Mine Drainage (AMD) water needs to be treated through neutralisation processes in the sediment basins or the MAW storages. The nature of treatment will depend upon the water quality.



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DO NOT SCALE

Drawn By Shaun Kelly | Designed
Drafting Check | Design Check
Approved
Date
Scale NTS

This Drawing must not be used for Construction Unless signed as approved

Client: ADANI MINING PTY LTD
Project: CARMICHAEL COAL MINE PROJECT
Title: WATER BALANCE SCHEMATIC

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Figure 3

Rev: A

2.4.2 Site specific

The following site specific water management principles are proposed for the Project:

- Each pit area and associated waste rock spoil (overburden) area and disturbed areas are protected from overland floods by a levee with a design height equivalent to a 1 in 1,000 year ARI flood level. Within those protected areas the pit will be specifically protected by a bund directly upstream of the highwall (refer to Figure A0 in Appendix A for the levee locations)
- Upstream (clean water) runoff is directed around the protected areas and will be diverted around the mine site to minimise the site water inventory and maintain pre-development discharges into Carmichael River
- Clean water catch drains will be developed to divert runoff from minor catchments around the mine site, where practical. Catch drains have been considered when delineating catchments, but have not been designed as part of the water management system. The size of catch drains will be considered further during detailed design. (refer to the Conceptual Fllod Mitigation and Creek Diversion Design report)
- Each overburden area has a dedicated sedimentation basin that treats runoff to clean water. It concerns the overburden areas for pit B, C, F and G
- In the overburden areas of pit D and E dry tailings will be placed. The sediment basins for these overburden areas are sized as a MAW storage due to potential water quality issues
- Potentially disturbed areas upstream of the pits (on the advancing site of the highwall) are confined and protected by a levee in order to minimise any sediment affected water entering the natural waterways. Sediment affected water (runoff) in these areas will be collected in sumps from which water will be transferred to the central process water storages
- On both sides of the Carmichael River water from disturbed areas is collected in a central process water dam from which water will be extracted for dust suppression or coal washing
- Each pit has a dedicated MAW storage at the far end of the highwall. Inflows (both rainwater and groundwater) to the pit areas will be pumped to these dedicated MAW storages from which the MAW will be pumped to two central MAW storages
- MAW water from the underground workings is also pumped to the pit MAW storages, from which this MAW is also directed to the central MAW storages
- On the north and south side of the Carmichael River is a central MAW storage in which all MAW water on site is stored. These two storages also function as the dedicated discharges points for MAW, if required
- Raw water is stored in two storages of 1 GL each, one (1) north and one (1) south of the Carmichael River.

2.5 Limitations

The following limitations are relevant:

- It is expected that a range of small sedimentation basins will be required on site for treatment of small disturbed areas. These basins have not been included in the water balance as the current design level for the mine has not reached that level of detail and these small basins are expected to be immaterial to the findings of this report.
- No design specifics are available at this stage for the underground access areas (boxcuts). Hence they have not been included in the water balance
- The water balance does not take into account the exclusion of fully rehabilitated areas
- Potential impacts of long term climate change have not been considered
- Offsite infrastructure is outside of the scope of this report with exception of potable water usage for the mine workers accommodation village.

3. Water balance

3.1 Introduction

The water balance has been developed using GoldSim. This is a Monte Carlo simulation program for dynamically modelling complex systems. It supports decision and risk analysis by simulating future performance while quantitatively representing the uncertainty and risks inherent in all complex systems.

One of the objectives for the water balance is to determine the requirements of controlled discharge from the Project to the environment, refer to Section 1.3. Within the mine plan two potential discharge locations have been identified: the central MAW storages on both sides of the Carmichael River. Hence input and output information is frequently provided separately for the parts of the mine on both sides of the Carmichael River. In Figure 4 an overview of the mine and the diverse storage (dam) locations is provided. The staged mine plans used for the water balance is provided in Appendix B.

3.2 Modelling approach

Within GoldSim there are two approaches available for modelling a site water balance:

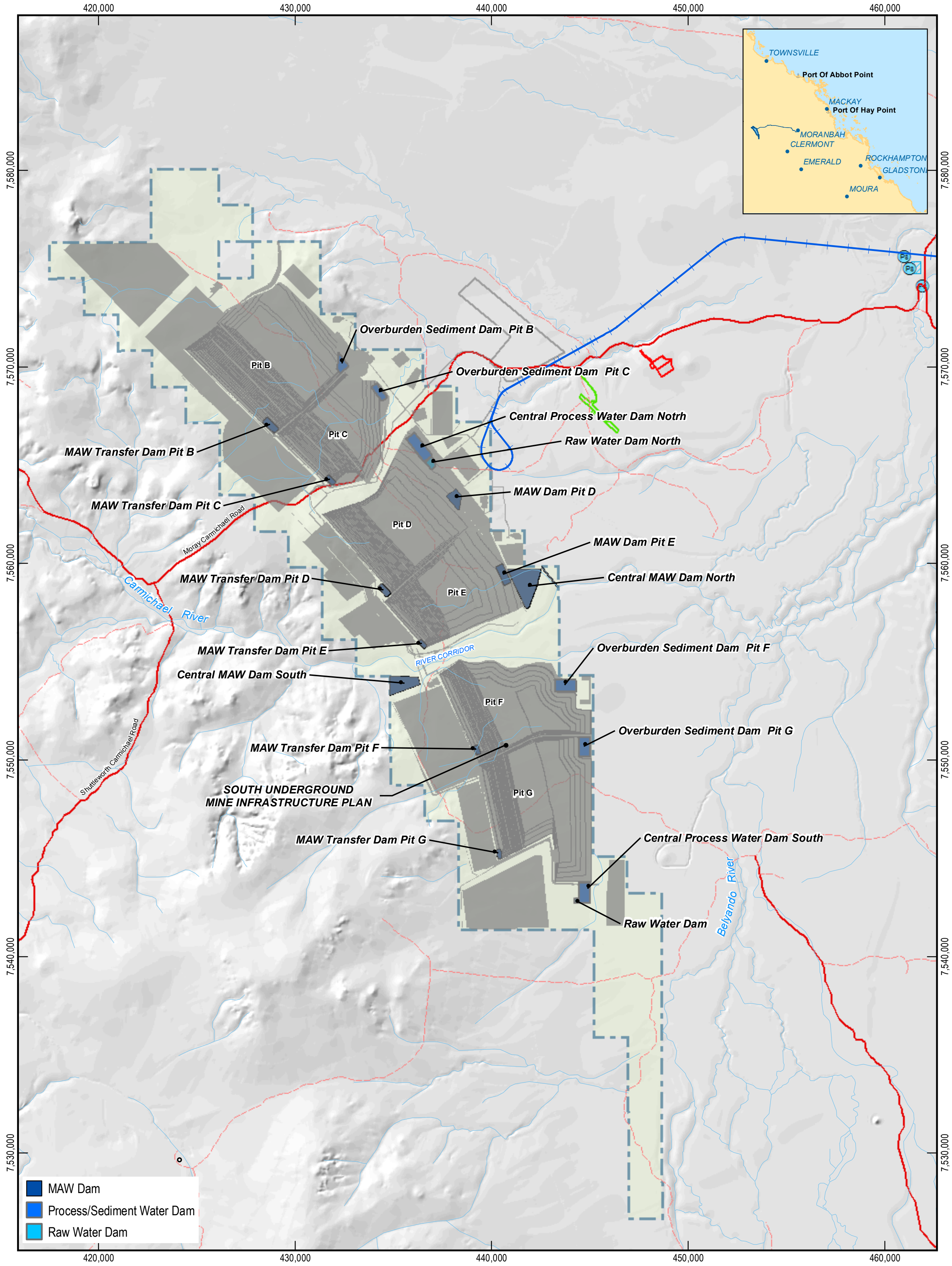
1. A deterministic approach where modelling of crucial mine stage snapshots and running the entire historical climate data for this single mine stage
2. A probabilistic approach where a number of climate sequences are run through the water balance of the mine to produce a statistical distribution of results from which a measure of risk can be extracted.

The probabilistic option has been applied for the following reasons:

- It provides a robust indication of water requirements over the life of the mine
- It represents a more robust estimation of storage volumes and the associated carry over storage between different mine phases.

Using this method the performance of water storage and water supply facilities have been assessed on the basis of the GoldSim models simulations across the 60 year life of the mine. Historical climate data, as discussed in sections 3.3 and 3.4, is used in the model to generate an input into the GoldSim Monte Carlo simulation, which runs the model for multiple realisations of the climate data for the 60 year mine life span.

The bootstrapping method has been used as a way to input the available climate data as a changing variable into the system. This technique involves using the historical climate record and running the GoldSim model numerous times for various sections of this record which are equivalent in length to the mine life. These numerous runs of the model are referred to as realisations, which are used to perform statistical analysis of the model. For the water balance it has been opted to use 100 realisations. Using 100 realisations allows for calculation of 5th and 95th percentile values; which allows for a proper risk based assessment to be undertaken.



LEGEND

Minor Road
Track
Watercourse
Rail (West)
Mine Site
Mine Layout
Mine (Offsite)
Pump Station
Storage Facility (Offstream)
Airport
Industrial Area
Accommodation Village

1:275,000 (at A4)

0 2 4 6 8 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

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Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Job Number 41-26422
Revision C
Date 24-10-2013

Project (Mine) Onsite and Offsite Infrastructure - Year 2071

Figure 4

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Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: GA: Road, River / Watercourse (2007); DME:EPC1690 (2010), EPC1080 (2011); Adani: Mine Layout / Infrastructure (2013), Mine (Offsite) (2013). Created by: MS

Bootstrapping can be implemented in a number of different ways which includes selecting a start year and extracting a 60 year sequence and thereafter advancing the start year of the subsequent 60 year sequences by a prescribed number of years and repeating the process a prescribed number of times. Variations include criteria for non-overlapping sequences and allowing the end of the historical record to 'fold back' on the beginning to provide a continuous 'loop' of data from which to select sequences.

For this study random sampling based on an initial start date *(day and month chosen remain constant)* has been chosen as the preferred method as it provides a more complete input from the entire climate record, as opposed to only getting a certain selection of it.

Random sampling has been set to pick a random number from a statistical distribution which determines the start year and the subsequent 60 years of the climate data to be run through the model. To make the process random a uniform distribution has been used, meaning that no statistical weighting is given to any particular value in the specified range. Once the sequence of sampling has been selected in the initial model run, then every model run after this will use the same random sequence to ensure consistency of results.

3.3 Inflows

3.3.1 External water supplies

The water balance informs the total required external water supply for the Project. Refer to report for update mine hydrology for relevant information on the water supply for the mine.

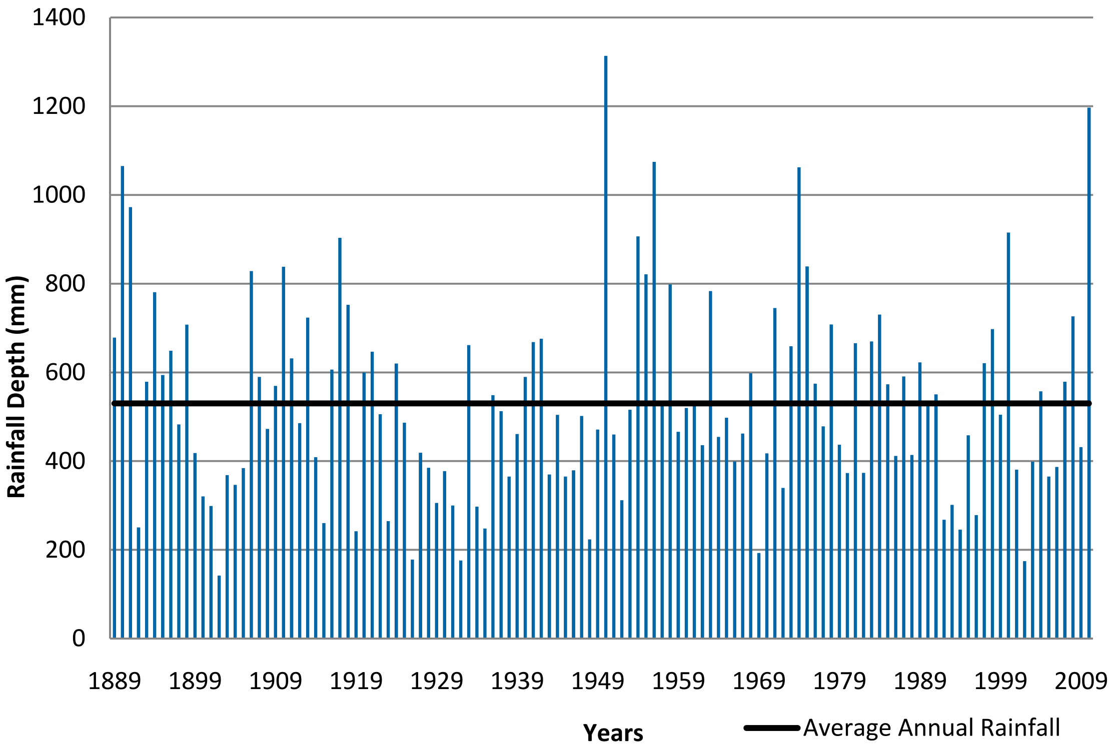
3.3.2 Rainfall

Long term (1890-2010) rainfall data for the mine site was extracted from the Bureau of Meteorology SILO Data Drill (22 09'S 146 24'E with elevation of 297 m[1]) which provides interpolated values. The principal influence on the hydrological regime of the site is the patterns of rainfall. Monthly rainfall averages suggest a distinct wet season between December and March, and dry season between June and October. Annual rainfall (1890 – 2010) is shown in Figure 5.

The annual rainfall ranges from a low of 142 mm/year in 1902 to a high of 1309 mm/year in 1950. Average rainfall represented by 1957 is about 529 mm/year.

[1] Approximately the middle of the mine lease area.

Figure 5 Annual rainfall at the mine site (1890 – 2010)



3.3.3 MAW and dirty water runoff

Runoff volumes have been calculated from the various catchments producing MAW or sediment affected water on site. This has been done using the Australian Water Balance Model (Boughton, 2004) which considers catchment characteristics such as soils ability to hold water and base flow. The AWBM adequately captures the non-linear nature of surface water runoff which some simpler forms of calculation fail to account for.

As limited stream flow data is available for the site the model has been run un-calibrated based on parameters as set out in Table 1 used in past experience in Central Queensland. This is considered acceptable based on the fact that the catchments being considered are not natural catchments and are therefore not as exposed to the effects of the local conditions outside the effect of climate. The parameters used are contained in Table 1.

Table 1 AWBM mine site parameters

	Soil Capacity (mm)			Partial Area (%)				
Area	Soil 1	Soil 2	Soil 3	Soil 1	Soil 2	Soil 3	Baseflow Index (Kb)	Recession Constant
Industrial	5	0.1	0.1	100.0	0.0	0.0	0.00	0.813
Spoil	5	40.0	100.0	13.4	43.3	43.3	0.35	0.960
Disturbed mining (pre-strip)	13	23.0	75.0	13.4	43.3	43.3	0.00	0.960
Pit	5	10.0	75.0	5.0	20.0	75.0	0.00	0.898

Industrial areas

The industrial areas are expected to generate MAW runoff. These areas will be predominantly comprised of the MIA. Other areas such as the train load out will also contribute MAW runoff to the system however these are currently excluded from the GoldSim model as it is not considered they will generate sufficient flows to affect the outcomes of this report. MIA catchments generating runoff are shown in Figure 2.

Spoil areas

The spoil areas are expected to generate sediment affected runoff. The expected areas of spoil for each pit are presented in Table 2. Pit D and E spoil areas have been excluded as tailings rejects will be placed within the catchment and as such these areas have been considered to generate mine affected runoff. The catchment areas for Pit D and E spoil areas are shown in Table 3.

Table 2 Overburden catchments generating SAW (km^2)

Year	Pit B	Pit C	Pit F	Pit G
2015	1.07	0.00	0.00	0.00
2016	1.32	0.69	0.00	0.00
2017	4.23	2.11	0.00	0.00
2018	5.08	3.21	0.00	0.00
2019	7.08	5.54	0.00	0.00
2020	8.23	5.76	0.00	0.00
2021	8.52	5.98	0.00	0.00
2022	8.37	6.20	0.00	0.00
2023	8.21	6.42	0.00	0.00
2024	8.43	6.64	0.00	10.92
2025	9.12	7.26	0.00	10.66
2026	10.00	7.88	0.00	10.51
2027	10.95	8.50	0.00	10.47
2028	11.89	9.12	0.00	10.55
2029	12.70	9.74	6.35	10.74
2030	13.38	9.99	7.45	11.08
2031	14.00	10.25	8.41	11.57
2032	14.57	10.51	9.24	12.16
2033	15.08	10.76	9.95	12.78
2034	15.53	11.02	10.52	13.38
2035	15.88	11.06	10.92	13.98
2036	16.12	11.11	11.15	14.63
2037	16.33	11.16	11.28	15.28
2038	16.60	11.20	11.36	15.90
2039	17.02	11.25	11.46	16.45
2040	17.67	11.50	11.54	16.84
2041	18.51	11.75	11.54	17.09

Year	Pit B	Pit C	Pit F	Pit G
2042	19.38	12.01	11.56	17.34
2043	20.16	12.26	11.65	17.73
2044	20.71	12.51	11.92	18.38
2045	20.72	12.54	12.38	19.30
2046	20.74	12.56	12.84	20.22
2047	20.75	12.58	13.30	21.13
2048	20.76	12.60	13.76	22.05
2049	20.78	12.63	14.22	22.96
2050	20.79	12.65	14.69	23.88
2051	20.81	12.67	15.15	24.80
2052	20.89	12.67	15.29	24.90
2053	20.97	12.67	15.44	25.00
2054	21.06	12.67	15.58	25.10
2055	21.14	12.67	15.73	25.20
2056	21.23	12.66	15.87	25.30
2057	21.31	12.66	16.02	25.40
2058	21.39	12.66	16.17	25.50
2059	21.48	12.66	16.31	25.60
2060	21.56	12.66	16.46	25.70
2061	21.65	12.66	16.60	25.80
2062	21.77	12.66	16.68	25.89
2063	21.90	12.66	16.76	25.98
2064	22.02	12.66	16.84	26.07
2065	22.15	12.66	16.92	26.15
2066	22.28	12.66	17.00	26.24
2067	22.40	12.66	17.08	26.33
2068	22.53	12.66	17.16	26.42
2069	22.66	12.66	17.24	26.51
2070	22.78	12.65	17.32	26.59
2071	22.91	12.65	17.40	26.68

Table 3 Overburden catchments generating MAW (km^2)

Year	Pit D	Pit E
2015	0.95	1.61
2016	1.51	1.44
2017	2.44	3.03
2018	3.04	3.78
2019	3.74	3.91
2020	4.30	4.04
2021	4.87	4.18

Year	Pit D	Pit E
2022	5.43	4.31
2023	5.99	4.43
2024	0.95	1.61
2025	6.80	4.51
2026	7.05	4.42
2027	7.30	4.34
2028	7.55	4.39
2029	7.81	4.67
2030	8.77	5.29
2031	9.74	6.16
2032	10.70	7.15
2033	11.67	8.09
2034	12.63	8.84
2035	12.67	9.37
2036	12.71	9.78
2037	12.74	10.12
2038	12.78	10.41
2039	12.82	10.70
2040	12.90	10.99
2041	12.98	11.26
2042	13.06	11.50
2043	13.13	11.70
2044	13.21	11.86
2045	13.29	11.89
2046	13.36	11.92
2047	13.44	11.95
2048	13.52	11.98
2049	13.59	12.01
2050	13.67	12.04
2051	13.74	12.07
2052	13.79	12.06
2053	13.83	12.06
2054	13.87	12.05
2055	13.91	12.05
2056	13.95	12.04
2057	13.99	12.04
2058	14.04	12.04
2059	14.08	12.03
2060	14.12	12.03
2061	14.16	12.02

Year	Pit D	Pit E
2062	14.16	12.02
2063	14.16	12.02
2064	14.16	12.02
2065	14.16	12.02
2066	14.16	12.02
2067	14.16	12.02
2068	14.16	12.02
2069	14.16	12.02
2070	14.16	12.02
2071	14.16	12.02

Disturbed mining areas

Disturbed mining areas are located on the advancing highwall side of the mine. These areas will be exposed to a range of activities preparing for the mine to advance, including pre-stripping and a levee and drain protecting the pit from runoff entering the pit. As such this water has been considered as sediment affected. Relevant areas are shown in Table 4 per pit and mine stage.

Table 4 Disturbed mining areas generating SAW (km^2)

Year	Pit B	Pit C	Pit D	Pit E	Pit F	Pit G
2015	35.04	0.00	20.08	14.40	0.00	0.00
2016	32.84	17.79	17.88	12.98	0.00	0.00
2017	28.26	15.15	15.97	10.34	0.00	0.00
2018	25.89	13.44	14.10	8.82	0.00	0.00
2019	24.49	10.04	12.75	7.81	0.00	0.00
2020	23.20	9.29	11.80	6.96	0.00	0.00
2021	22.02	8.55	10.86	6.25	0.00	0.00
2022	20.92	7.81	9.91	5.67	0.00	0.00
2023	19.88	7.06	8.96	5.19	0.00	0.00
2024	18.86	6.32	8.02	4.78	0.00	18.28
2025	17.85	5.85	7.56	4.48	0.00	18.10
2026	16.86	5.37	7.10	4.30	0.00	17.76
2027	15.92	4.90	6.63	4.20	0.00	17.26
2028	15.07	4.43	6.17	4.12	0.00	16.58
2029	14.32	3.95	5.71	3.99	13.34	15.73
2030	13.74	3.64	5.40	3.83	12.24	14.59
2031	13.31	3.32	5.10	3.67	11.20	13.14
2032	12.94	3.01	4.79	3.50	10.22	11.60
2033	12.54	2.69	4.49	3.32	9.31	10.15
2034	12.02	2.37	4.18	3.11	8.45	9.00
2035	11.35	2.12	4.01	2.86	7.65	8.22
2036	10.58	1.88	3.83	2.57	6.91	7.69

Year	Pit B	Pit C	Pit D	Pit E	Pit F	Pit G
2037	9.77	1.63	3.65	2.28	6.24	7.28
2038	8.97	1.38	3.47	1.99	5.62	6.88
2039	8.24	1.13	3.30	1.74	5.05	6.37
2040	7.55	0.93	2.85	1.52	4.56	5.72
2041	6.87	0.74	2.40	1.32	4.14	5.00
2042	6.23	0.54	1.95	1.13	3.77	4.27
2043	5.67	0.34	1.51	0.96	3.42	3.57
2044	5.22	0.14	1.06	0.79	3.05	2.96
2045	5.11	0.12	1.05	0.67	2.79	2.67
2046	5.00	0.10	1.05	0.56	2.52	2.37
2047	4.88	0.08	1.05	0.45	2.26	2.08
2048	4.77	0.06	1.04	0.34	1.99	1.78
2049	4.66	0.04	1.04	0.22	1.72	1.49
2050	4.55	0.02	1.03	0.11	1.46	1.19
2051	4.44	0.00	1.03	0.00	1.19	0.89
2052	4.10	0.00	0.93	0.00	1.07	0.81
2053	3.76	0.00	0.82	0.00	0.95	0.72
2054	3.42	0.00	0.72	0.00	0.83	0.63
2055	3.09	0.00	0.62	0.00	0.72	0.54
2056	2.75	0.00	0.51	0.00	0.60	0.45
2057	2.41	0.00	0.41	0.00	0.48	0.36
2058	2.07	0.00	0.31	0.00	0.36	0.27
2059	1.73	0.00	0.21	0.00	0.24	0.18
2060	1.40	0.00	0.10	0.00	0.12	0.09
2061	1.06	0.00	0.00	0.00	0.00	0.00
2062	0.95	0.00	0.00	0.00	0.00	0.00
2063	0.85	0.00	0.00	0.00	0.00	0.00
2064	0.74	0.00	0.00	0.00	0.00	0.00
2065	0.64	0.00	0.00	0.00	0.00	0.00
2066	0.53	0.00	0.00	0.00	0.00	0.00
2067	0.42	0.00	0.00	0.00	0.00	0.00
2068	0.32	0.00	0.00	0.00	0.00	0.00
2069	0.21	0.00	0.00	0.00	0.00	0.00
2070	0.11	0.00	0.00	0.00	0.00	0.00
2071	0.00	0.00	0.00	0.00	0.00	0.00

Pit areas

Rainfall on the pits (including slopes) generating runoff ends up at the lowest point in each pit and will potentially be contaminated with coal or other mining activities related contaminants. This water is therefore considered MAW and will be collected in MAW (transfer) dams from which it is pumped to the central MAW storages on either the north or south side of the Carmichael River. The areas considered for pits generating MAW are shown in Table 5.

Table 5 Pit areas generating MAW runoff (km^2)

Year	Pit B	Pit C	Pit D	Pit E	Pit F	Pit G
2015	1.59	0.00	1.54	2.04	0.00	0.00
2016	3.53	2.13	3.19	3.64	0.00	0.00
2017	5.21	3.35	4.16	4.69	0.00	0.00
2018	6.73	3.96	5.43	5.46	0.00	0.00
2019	6.13	5.04	6.08	6.33	0.00	0.00
2020	6.27	5.56	6.47	7.05	0.00	0.00
2021	7.16	6.08	6.85	7.62	0.00	0.00
2022	8.40	6.61	7.24	8.07	0.00	0.00
2023	9.61	7.13	7.62	8.44	0.00	0.00
2024	10.40	7.65	8.01	8.76	0.00	4.97
2025	10.73	7.51	8.22	9.06	0.00	5.40
2026	10.84	7.36	8.43	9.33	0.00	5.89
2027	10.82	7.21	8.64	9.50	0.00	6.43
2028	10.74	7.07	8.85	9.54	0.00	7.03
2029	10.68	6.92	9.06	9.39	5.28	7.69
2030	10.58	6.98	8.40	8.94	5.28	8.49
2031	10.39	7.04	7.74	8.22	5.36	9.44
2032	10.19	7.10	7.08	7.40	5.50	10.41
2033	10.08	7.16	6.42	6.64	5.72	11.23
2034	10.14	7.22	5.76	6.10	6.00	11.78
2035	10.46	7.42	5.90	5.82	6.40	11.95
2036	10.99	7.62	6.04	5.69	6.90	11.84
2037	11.59	7.83	6.18	5.66	7.46	11.60
2038	12.12	8.03	6.32	5.65	8.00	11.38
2039	12.43	8.23	6.46	5.61	8.46	11.34
2040	12.47	8.18	6.83	5.54	8.87	11.60
2041	12.32	8.12	7.20	5.47	9.28	12.07
2042	12.08	8.07	7.57	5.42	9.64	12.55
2043	11.86	8.01	7.94	5.39	9.89	12.86
2044	11.77	7.95	8.31	5.40	10.00	12.81
2045	11.87	7.95	8.23	5.49	9.81	12.19
2046	11.96	7.95	8.16	5.57	9.61	11.57
2047	12.06	7.95	8.09	5.65	9.41	10.95

Year	Pit B	Pit C	Pit D	Pit E	Pit F	Pit G
2048	12.16	7.95	8.02	5.74	9.22	10.33
2049	12.26	7.94	7.95	5.82	9.02	9.71
2050	12.35	7.94	7.87	5.90	8.83	9.09
2051	12.45	7.94	7.80	5.99	8.63	8.47
2052	12.70	7.94	7.86	5.99	8.61	8.46
2053	12.96	7.94	7.92	6.00	8.58	8.45
2054	13.21	7.94	7.99	6.00	8.55	8.43
2055	13.47	7.94	8.05	6.00	8.53	8.42
2056	13.72	7.95	8.11	6.01	8.50	8.41
2057	13.97	7.95	8.17	6.01	8.47	8.40
2058	14.23	7.95	8.23	6.02	8.45	8.39
2059	14.48	7.95	8.29	6.02	8.42	8.38
2060	14.74	7.95	8.35	6.03	8.39	8.37
2061	14.99	7.95	8.41	6.03	8.37	8.36
2062	14.97	7.95	8.41	6.03	8.29	8.27
2063	14.95	7.95	8.41	6.03	8.21	8.18
2064	14.93	7.95	8.41	6.03	8.13	8.09
2065	14.91	7.95	8.42	6.03	8.05	8.01
2066	14.89	7.95	8.42	6.03	7.97	7.92
2067	14.87	7.95	8.42	6.03	7.89	7.83
2068	14.85	7.95	8.42	6.04	7.81	7.74
2069	14.83	7.95	8.42	6.04	7.73	7.65
2070	14.80	7.96	8.42	6.04	7.65	7.57
2071	14.78	7.96	8.42	6.04	7.57	7.48

3.3.4 Groundwater inflows

Open cut pit

Open cut pit groundwater inflows have been included in the water balance based on results from hydro-geological modelling conducted for the Project (Mine). Inflows used for each open cut pit are presented in Table 6.

Table 6 Open cut pit ingress (ML/day)

Year	Pit B	Pit C	Pit D	Pit E	Pit F	Pit G
2015	0.2	0.0	2.9	1.8	0.0	0.0
2016	0.1	0.1	3.2	3.6	0.0	0.0
2017	0.9	2.4	3.7	4.6	0.0	0.0
2018	1.4	1.8	3.8	3.7	0.0	0.0
2019	1.6	2.8	3.4	3.9	0.0	0.0
2024	0.7	1.3	2.2	2.2	0.0	4.8
2029	0.6	1.0	2.0	2.0	2.3	2.7

Year	Pit B	Pit C	Pit D	Pit E	Pit F	Pit G
2034	0.4	0.9	1.8	1.6	2.0	1.8
2039	1.2	1.1	1.3	1.8	1.4	1.0
2044	1.0	0.8	1.1	1.3	1.2	2.4
2049	0.8	0.3	0.6	1.3	1.1	2.9
2061	0.8	0.2	0.6	1.2	0.9	2.9
2071	0.5	0.1	0.7	1.3	0.7	2.7

Underground mines

Underground mine groundwater inflows have been included in the water balance based on results from hydro-geological modelling conducted for the Project (Mine). Inflows used for each open cut pit are presented in Table 7.

Table 7 Underground mine inflows (ML/day)

Year	M1 Total	M2 Total	M3 Total	M4 Total	M5 Total
2015	0.0	0.0	0.0	0.0	0.0
2016	0.0	0.0	0.0	0.0	0.0
2017	0.0	0.0	0.0	0.0	0.0
2018	0.1	0.0	0.0	0.0	0.0
2019	1.0	0.0	0.0	0.0	0.0
2024	5.3	0.0	0.0	0.0	0.0
2029	3.2	0.0	0.0	0.6	11.7
2034	0.0	0.0	0.0	1.2	4.6
2039	0.0	0.0	2.8	1.9	2.8
2044	0.0	1.7	2.9	0.0	0.0
2049	0.0	4.1	2.3	0.0	0.0
2061	0.0	0.0	0.0	0.0	0.0
2071	0.0	0.0	0.0	0.0	0.0

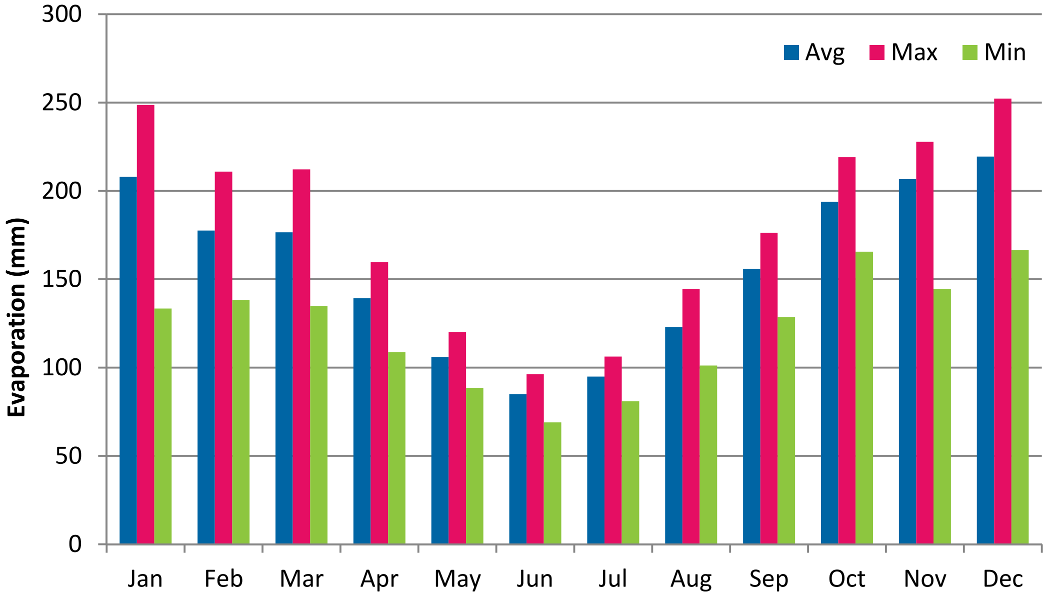
3.4 Outflows

3.4.1 Evaporation

Daily Morton's Lake Evaporation data from 1890-2010 was obtained from the BOM SILO Data Drill. Morton's Lake Evaporation is a method of calculating lake evaporation based on the conceptual and empirical relationship between area and potential evaporation, with the potential to include climatic observations. The Moreton's Lake Evaporation data shows variation from year to year with the highest evaporation being 2,034 mm (1935), and the lowest evaporation being 1,616 mm in 2010. The long term average monthly evaporation ranges from 85 mm in June to 219 mm in December (Figure 6).

Evaporation will take place from all open water bodies on the mine site. Evaporation has been incorporated into the water balance assessment for all storages (MAW, SAW, PWD, TSFs and Raw Water) as well from the sumps located in each of the open cut pits.

Figure 6 Variation in monthly evaporation for the mine site



Due to the climatic circumstances at the mine area net evaporation losses in storages are high. In order to minimise some of these losses it is assumed in the water balance that evaporation reducing chemicals will be used on the four (4) major storages:

1. Central MAW dam north
2. Central MAW dam south
3. Central Process Water dam north
4. Central Process Water dam south

Total evaporation reduction has been assumed at 50 percent (continuously). Refer to section 3.5 and Figure 4 for more information on the storages.

3.4.2 Dust suppression

Dust suppression will be required on areas that would otherwise produce excessive volumes of dust as a result of the mining activities. These areas predominantly include the haul roads and the active mining areas. Progress of the active mining, or open cut pit areas, is currently not available on a daily basis (mine plans reflects years). Therefore it has been assumed that only 0.5 percent of the pit areas will require dust suppression. This assumption is believed to provide realistic (daily) areas requiring dust suppression.

The haul road has been identified on the staged mine plans and areas requiring dust suppression have been calculated assuming an average width of 40 m.

At this stage no information is available for the smaller linear infrastructure on the mine site, mostly other roads not being the primary main haul road. It is expected that dust suppression will also be required on this infrastructure.

Dust suppression is considered a function of daily evaporation with the demand taken as 100 percent of daily evaporation, less any rainfall which occurs on that day. If the rainfall total for the day is greater than the evaporation then no dust suppression is required.

In Table 8 and Table 9 areas requiring dust suppression are presented.

Table 8 Haul road dust suppression areas

	Year online	Area (km^2)
Haul Road North	2015	2.62
Haul Road South	2024	0.81

Table 9 Pit dust suppression areas (Ha)

Year	Pit B	Pit C	Pit D	Pit E	Pit F	Pit G
2015	0.008	0.000	0.008	0.010	0.000	0.000
2016	0.018	0.011	0.016	0.018	0.000	0.000
2017	0.026	0.017	0.021	0.023	0.000	0.000
2018	0.034	0.020	0.027	0.027	0.000	0.000
2019	0.031	0.025	0.030	0.032	0.000	0.000
2020	0.031	0.028	0.032	0.035	0.000	0.000
2021	0.036	0.030	0.034	0.038	0.000	0.000
2022	0.042	0.033	0.036	0.040	0.000	0.000
2023	0.048	0.036	0.038	0.042	0.000	0.000
2024	0.052	0.038	0.040	0.044	0.000	0.025
2025	0.054	0.038	0.041	0.045	0.000	0.027
2026	0.054	0.037	0.042	0.047	0.000	0.029
2027	0.054	0.036	0.043	0.048	0.000	0.032
2028	0.054	0.035	0.044	0.048	0.000	0.035
2029	0.053	0.035	0.045	0.047	0.026	0.038
2030	0.053	0.035	0.042	0.045	0.026	0.042
2031	0.052	0.035	0.039	0.041	0.027	0.047
2032	0.051	0.035	0.035	0.037	0.028	0.052
2033	0.050	0.036	0.032	0.033	0.029	0.056
2034	0.051	0.036	0.029	0.031	0.030	0.059
2035	0.052	0.037	0.029	0.029	0.032	0.060
2036	0.055	0.038	0.030	0.028	0.035	0.059
2037	0.058	0.039	0.031	0.028	0.037	0.058
2038	0.061	0.040	0.032	0.028	0.040	0.057
2039	0.062	0.041	0.032	0.028	0.042	0.057
2040	0.062	0.041	0.034	0.028	0.044	0.058
2041	0.062	0.041	0.036	0.027	0.046	0.060
2042	0.060	0.040	0.038	0.027	0.048	0.063
2043	0.059	0.040	0.040	0.027	0.049	0.064
2044	0.059	0.040	0.042	0.027	0.050	0.064
2045	0.059	0.040	0.041	0.027	0.049	0.061
2046	0.060	0.040	0.041	0.028	0.048	0.058

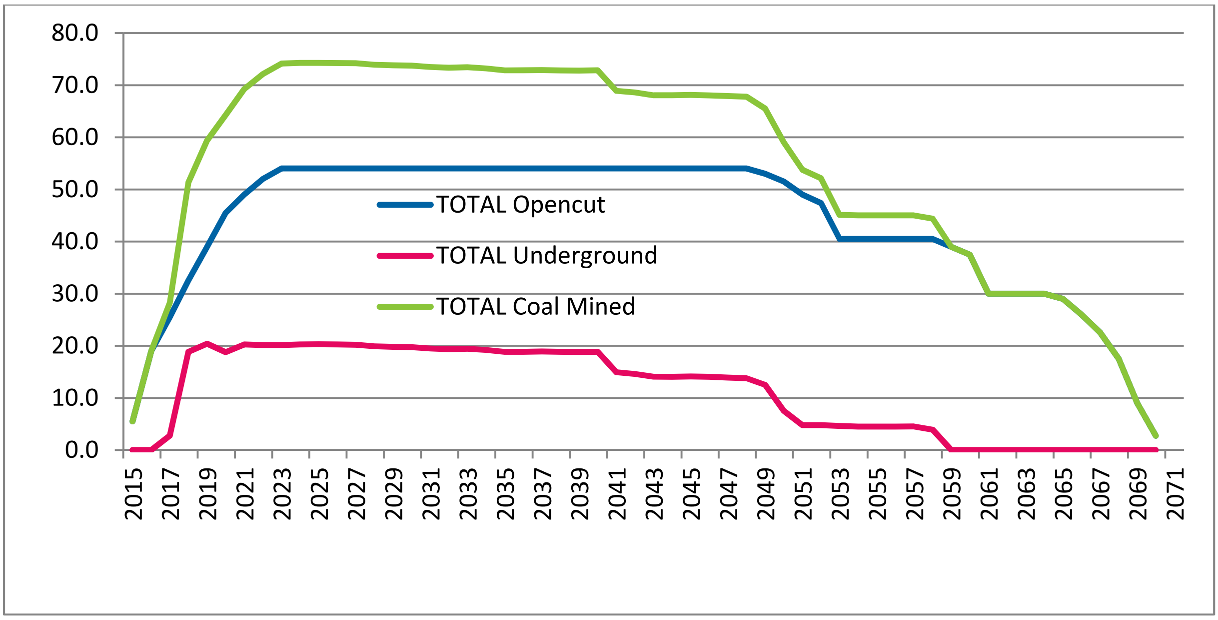
Year	Pit B	Pit C	Pit D	Pit E	Pit F	Pit G
2047	0.060	0.040	0.040	0.028	0.047	0.055
2048	0.061	0.040	0.040	0.029	0.046	0.052
2049	0.061	0.040	0.040	0.029	0.045	0.049
2050	0.062	0.040	0.039	0.030	0.044	0.045
2051	0.062	0.040	0.039	0.030	0.043	0.042
2052	0.064	0.040	0.039	0.030	0.043	0.042
2053	0.065	0.040	0.040	0.030	0.043	0.042
2054	0.066	0.040	0.040	0.030	0.043	0.042
2055	0.067	0.040	0.040	0.030	0.043	0.042
2056	0.069	0.040	0.041	0.030	0.042	0.042
2057	0.070	0.040	0.041	0.030	0.042	0.042
2058	0.071	0.040	0.041	0.030	0.042	0.042
2059	0.072	0.040	0.041	0.030	0.042	0.042
2060	0.074	0.040	0.042	0.030	0.042	0.042
2061	0.075	0.040	0.042	0.030	0.042	0.042
2062	0.075	0.040	0.042	0.030	0.041	0.041
2063	0.075	0.040	0.042	0.030	0.041	0.041
2064	0.075	0.040	0.042	0.030	0.041	0.040
2065	0.075	0.040	0.042	0.030	0.040	0.040
2066	0.074	0.040	0.042	0.030	0.040	0.040
2067	0.074	0.040	0.042	0.030	0.039	0.039
2068	0.074	0.040	0.042	0.030	0.039	0.039
2069	0.074	0.040	0.042	0.030	0.039	0.038
2070	0.074	0.040	0.042	0.030	0.038	0.038
2071	0.074	0.040	0.042	0.030	0.038	0.037

It is expected that during the mine operations water for dust suppression of haul road and hardstand areas will be sourced from pit dewatering dams as a priority (via truck fill stations). However, this level of detail is considered unnecessary for the water balance. This likely operational change is not expected to make much (if any) difference overall on the outcomes of the water balance as volume stays the same. The differences are found in a reduction of pumping volumes and distances the dust suppression trucks need to drive to collect water.

3.4.3 Process water requirements

Process water is required for the CHPP and the longwall mining equipment. Water demands for each will coincide with the planned extraction schedule as shown in Figure 7.

Figure 7 ROM Coal extraction schedule



Coal handling and processing plant

The CHPP is located north of the Carmichael River. Washing and processing of the ROM coal to provide product coal is expected to require 240 L per ROM tonne[2]. Only ROM from open cut mining will be processed at the CHPP as the underground coal mining is specifically targeting deposits that do not require washing. Table 10 shows water demand for the CHPP.

The water provided to the CHPP will be caught within the rejects which are sent to the tailings facilities (refer to Section 3.4.6).

Table 10 CHPP demand (ML/day)

Year	Total CHPP Demand	Year	Total CHPP Demand
2015	0.0	2045	35.5
2016	3.6	2046	35.5
2017	12.5	2047	35.5
2018	16.8	2048	35.5
2019	21.4	2049	35.5
2020	25.6	2050	34.8
2021	29.9	2051	33.9
2022	32.2	2052	32.2
2023	34.2	2053	31.1
2024	35.5	2054	26.6
2025	35.5	2055	26.6
2026	35.5	2056	26.6

[2] Source: data provided by Adani 2013

Year	Total CHPP Demand	Year	Total CHPP Demand
2027	35.5	2057	26.6
2028	35.5	2058	26.6
2029	35.5	2059	26.6
2030	35.5	2060	25.6
2031	35.5	2061	24.6
2032	35.5	2062	19.7
2033	35.5	2063	19.7
2034	35.5	2064	19.7
2035	35.5	2065	19.7
2036	35.5	2066	19.1
2037	35.5	2067	17.1
2038	35.5	2068	14.8
2039	35.5	2069	11.5
2040	35.5	2070	5.9
2041	35.5	2071	1.8
2042	35.5		
2043	35.5		
2044	35.5		

Longwall mining

The longwall mining equipment will require process water for dust suppression in the underground mine. The water required for the longwall mine is equivalent to 2.25 ML/day per longwall being mined[3]. The overall water demand for the longwalls is presented in Table 11.

A loss of 20 percent has been assumed for all process water used for the longwalls with the remaining 80 percent returned to the system as MAW via the MAW transfer dams.

Table 11 Longwall process water demand (ML/day)

Year	Mine 1	Mine 2	Mine 3	Mine 4	Mine 5	Total
2015	0.00	0.00	0.00	0.00	0.00	0.00
2016	0.00	0.00	0.00	0.00	0.00	0.00
2017	0.00	0.00	0.00	0.00	0.00	0.00
2018	2.27	0.00	0.00	0.00	0.00	2.27
2019	6.81	0.00	0.00	0.00	0.00	6.81
2020	6.81	0.00	0.00	0.00	0.00	6.81
2021	6.81	0.00	0.00	0.00	0.00	6.81
2022	6.81	0.00	0.00	0.00	0.00	6.81
2023	6.81	0.00	0.00	0.00	0.00	6.81

[3] Source: data provided by Adani 2013

Year	Mine 1	Mine 2	Mine 3	Mine 4	Mine 5	Total
2024	6.81	0.00	0.00	0.00	0.00	6.81
2025	6.81	0.00	0.00	0.00	0.00	6.81
2026	6.81	0.00	0.00	0.00	2.27	9.07
2027	4.54	0.00	0.00	2.27	2.27	9.07
2028	2.27	0.00	0.00	4.54	2.27	9.07
2029	2.27	0.00	0.00	4.54	2.27	9.07
2030	2.27	0.00	0.00	4.54	2.27	9.07
2031	0.00	0.00	0.00	4.54	4.54	9.07
2032	0.00	0.00	0.00	4.54	4.54	9.07
2033	0.00	0.00	0.00	4.54	4.54	9.07
2034	0.00	0.00	0.00	4.54	4.54	9.07
2035	0.00	0.00	0.00	4.54	4.54	9.07
2036	0.00	0.00	2.27	4.54	2.27	9.07
2037	0.00	0.00	2.27	2.27	2.27	6.81
2038	0.00	0.00	4.54	0.00	2.27	6.81
2039	0.00	0.00	4.54	0.00	2.27	6.81
2040	0.00	2.27	4.54	0.00	2.27	9.07
2041	0.00	2.27	2.27	0.00	2.27	6.81
2042	0.00	2.27	2.27	0.00	2.27	6.81
2043	0.00	2.27	2.27	0.00	2.27	6.81
2044	0.00	2.27	2.27	0.00	2.27	6.81
2045	0.00	2.27	2.27	0.00	2.27	6.81
2046	0.00	2.27	4.54	0.00	0.00	6.81
2047	0.00	2.27	4.54	0.00	0.00	6.81
2048	0.00	4.54	2.27	0.00	0.00	6.81
2049	0.00	4.54	2.27	0.00	0.00	6.81
2050	0.00	4.54	2.27	0.00	0.00	6.81
2051	0.00	2.27	2.27	0.00	0.00	4.54
2052	0.00	2.27	0.00	0.00	0.00	2.27
2053	0.00	2.27	0.00	0.00	0.00	2.27
2054	0.00	2.27	0.00	0.00	0.00	2.27
2055	0.00	2.27	0.00	0.00	0.00	2.27
2056	0.00	2.27	0.00	0.00	0.00	2.27
2057	0.00	2.27	0.00	0.00	0.00	2.27
2058	0.00	2.27	0.00	0.00	0.00	2.27
2059	0.00	2.27	0.00	0.00	0.00	2.27
2060	0.00	0.00	0.00	0.00	0.00	0.00
2061	0.00	0.00	0.00	0.00	0.00	0.00
2062	0.00	0.00	0.00	0.00	0.00	0.00
2063	0.00	0.00	0.00	0.00	0.00	0.00

Year	Mine 1	Mine 2	Mine 3	Mine 4	Mine 5	Total
2064	0.00	0.00	0.00	0.00	0.00	0.00
2065	0.00	0.00	0.00	0.00	0.00	0.00
2066	0.00	0.00	0.00	0.00	0.00	0.00
2067	0.00	0.00	0.00	0.00	0.00	0.00
2068	0.00	0.00	0.00	0.00	0.00	0.00
2069	0.00	0.00	0.00	0.00	0.00	0.00
2070	0.00	0.00	0.00	0.00	0.00	0.00
2071	0.00	0.00	0.00	0.00	0.00	0.00

3.4.4 Seepage

Minimal seepage, 1 percent, has been assumed for all storage facilities due to the available significant volumes of clay on the mine site. For the purposes of the water balance seepage has been taken as 1 percent of the volume of storage per annum. This percentage has changes from the EIS water balance as it is understood that large qualities of clay are available on site which can be used to line the storages.

3.4.5 Potable water

Water for potable use will be required for use at the on-site (mine) facilities and at offsite (mine workers accommodation village and airfield) facilities. A combined demand of 300 L/person/day (for both on-site and offsite facilities) has been used to calculate the potable demand with reference to the expected number of staff to be present on site. The potable water demands over the life of the mine for offsite facilities are presented in Table 12.

Table 12 Site potable water demands

Year	No. People Onsite	Onsite Potable Demand (ML/day)
2014	588	0.176
2015	1,660	0.498
2016	1,905	0.572
2017	1,529	0.459
2018	1,532	0.459
2019	1,595	0.479
2020	1,739	0.522
2021	1,883	0.565
2022	1,925	0.578
2023	1,991	0.597
2024	2,025	0.607
2025	1,993	0.598
2026	1,997	0.599
2027	1,975	0.593
2028	2,013	0.604
2029	1,955	0.586
2030	1,920	0.576

Year	No. People Onsite	Onsite Potable Demand (ML/day)
2031	1,886	0.566
2032	1,888	0.566
2033	1,902	0.571
2034	1,868	0.561
2035	1,872	0.562
2036	1,881	0.564
2037	1,880	0.564
2038	1,888	0.566
2039	1,887	0.566
2040	1,875	0.563
2041	1,841	0.552
2042	1,858	0.557
2043	1,858	0.557
2044	1,867	0.56
2045	1,864	0.559
2046	1,869	0.561
2047	1,849	0.555
2048	1,858	0.558
2049	1,770	0.531
2050	1,758	0.527
2051	1,622	0.487
2052	1,588	0.477
2053	1,540	0.462
2054	1,361	0.408
2055	1,363	0.409
2056	1,360	0.408
2057	1,353	0.406
2058	1,292	0.388
2059	1,279	0.384
2060	1,226	0.368
2061	1,177	0.353
2062	1,020	0.306
2063	1,021	0.306
2064	1,021	0.306
2065	1,019	0.306
2066	1,003	0.301
2067	944	0.283
2068	877	0.263
2069	724	0.217
2070	524	0.157

Year	No. People Onsite	Onsite Potable Demand (ML/day)
2071	407	0.122

Water requirements for construction

Additional water will be required for construction over the period of 2014-2022. This water will be used for purposes such as construction of roads, dam embankments and levees, as well as batching of concrete. The amount of water needed on a yearly basis is shown in Table 13 below. Construction water has been excluded from the water balance as a large part of the construction water requirements is required for dust suppression, which has been accounted for in the water balance.

Table 13 Construction water demands

Year	ML/year	ML/day
2014	1,000	2.74
2015	1,500	4.11
2016	2,000	5.48
2017	2,000	5.48
2018	1,000	2.74
2019	1,000	2.74
2020	500	1.37
2021	500	1.37
2022	500	1.37
Source: Adani		

Water requirements for vehicle washing

Water required for vehicle washing is shown in Table 14. These volumes have been calculated based on the number of vehicles required for mine operations. Based on a combination of previous experience on similar projects and information provided by the Australian Car Washing Association and Adani, the washing frequency and the volumes required for each wash per vehicle has been identified.

Conservatively the volumes provided are assumed net volumes and as such mean the water is leaving the water balance after use. Reuse rates are currently unknown and depend largely on the type of installations that will be used. It is likely that there will be a percentage of reuse and/or the car washing water will be directed to MAW after use.

Table 14 Vehicle wash requirements

Year	Major equipment No	Water req. major equipment (ML/day)	Minor equipment No	Water req. minor equipment (ML/day)	Total water req. (ML/day)
2015	0	0	54	0.01	0.01
2016	0	0	96	0.01	0.01
2017	30	0.01	154	0.02	0.03
2018	36	0.01	200	0.02	0.03
2019	38	0.01	216	0.03	0.04

Year	Major equipment No	Water req. major equipment (ML/day)	Minor equipment No	Water req. minor equipment (ML/day)	Total water req. (ML/day)
2020	54	0.02	212	0.03	0.05
2021	60	0.02	210	0.02	0.04
2022	68	0.02	194	0.02	0.04
2023	66	0.02	192	0.02	0.04
2024	66	0.02	186	0.02	0.04
2025	66	0.02	172	0.02	0.04
2026	66	0.02	172	0.02	0.04
2027	66	0.02	170	0.02	0.04
2028	66	0.02	168	0.02	0.04
2029	64	0.02	168	0.02	0.04
2030	64	0.02	178	0.02	0.04
2031	64	0.02	178	0.02	0.04
2032	64	0.02	178	0.02	0.04
2033	64	0.02	180	0.02	0.04
2034	64	0.02	182	0.02	0.04
2035	64	0.02	190	0.02	0.04
2036	64	0.02	190	0.02	0.04
2037	64	0.02	194	0.02	0.04
2038	64	0.02	206	0.02	0.04
2039	64	0.02	208	0.02	0.04
2040	64	0.02	200	0.02	0.04
2041	64	0.02	200	0.02	0.04
2042	64	0.02	200	0.02	0.04
2043	64	0.02	200	0.02	0.04
2044	66	0.02	180	0.02	0.04
2045	64	0.02	200	0.02	0.04
2046	64	0.02	200	0.02	0.04
2047	64	0.02	200	0.02	0.04
2048	64	0.02	200	0.02	0.04
2049	64	0.02	200	0.02	0.04
2050	64	0.02	200	0.02	0.04
2051	64	0.02	200	0.02	0.04
2052	64	0.02	200	0.02	0.04
2053	64	0.02	200	0.02	0.04
2054	64	0.02	200	0.02	0.04
2055	64	0.02	200	0.02	0.04
2056	64	0.02	200	0.02	0.04

Year	Major equipment No	Water req. major equipment (ML/day)	Minor equipment No	Water req. minor equipment (ML/day)	Total water req. (ML/day)
2057	64	0.02	200	0.02	0.04
2058	64	0.02	200	0.02	0.04
2059	64	0.02	200	0.02	0.04
2060	64	0.02	200	0.02	0.04
2061	64	0.02	200	0.02	0.04
2062	64	0.02	200	0.02	0.04
2063	64	0.02	200	0.02	0.04
2064	64	0.02	200	0.02	0.04
2065	64	0.02	200	0.02	0.04
2066	64	0.02	200	0.02	0.04
2067	64	0.02	200	0.02	0.04
2068	64	0.02	200	0.02	0.04
2069	64	0.02	200	0.02	0.04
2070	64	0.02	200	0.02	0.04
2071	64	0.02	200	0.02	0.04

3.4.6 Tailing facilities

There will be two types of tailings facility on site, a conventional wet tailings facility and a dry belt press tailings facility:

- 40 percent dry tailings (belt press)
- 60 percent wet (or conventional) tailings.

When these facilities are online, they will have an associated decant water dam which will provide water for reuse in the CHPP.

Return water from the tailing facilities is estimated to be as follow:

- Dry tailings: 47 percent
- Wet tailings: 30 percent.

Return water is reused in the CHPP. Water from the wet tailing facility will end up in a decant water dam near the tailings cells. The decant dam has been excluded from the water balance calculations as at this stage no information is available on the design of this facility. Henceforth water available for reuse from the tailings management facilities has been included in the water balance as a function which does not account rainfall and evaporation from decant water dams.

3.5 Storages (dams)

Refer to Figure 4 for an overview of the locations of the dams.

3.5.1 Design criteria for dams

The methodology for the preliminary sizing of the diverse water management storages on site differs per type of storage:

- Central MAW Dams
- Central Process Water Dams
- MAW transfer dams
- Overburden MAW dams have been sized equal to the DSA
- Sediment dams
- Raw water dams.

In the following sub sections information regarding the methodology and sizes applied in the water balance has been provided.

3.5.2 Central MAW storages

Required volumes for both of the MAW dams have been extracted from GoldSim. Conceptual designs have been generated for these volumes to accommodate the calculated volumes, with the dams having 0.5 m freeboard and an 8 m crest width to the embankments. Batters for the dams have been based on 1 in 3 slopes to all sides. The dams have also been fitted within the allocated dam areas provided in the mine plans. For the Central MAW storages a non-rectangular areas is available. Storage curves were developed to provide the relationship between volume of water in the dam and the associated area. This allows for a more accurate prediction of evaporation losses in the dams.

Table 15 provides the maximum volume and baseline dimensions of the Central MAW dams. Within GoldSim a sensitivity analysis has been carried out to verify the proposed maximum volumes against potential discharges. At this stage no detail cognisance has been given to ground water levels or balancing cut to fill.

Table 15 Central MAW dams

Dam	Required volume (m^3)	Footprint area (m^2)	Storage depth (m)	Water surface area (m^2)
Central MAW - North	8,000,000	695,810	15.9	574,709
Central MAW - South	7,000,000	680,917	13.9	571,861
* Dams have a triangular shape				

3.5.3 Central process water dams

Required volumes for both of the central process water dams have been extracted from GoldSim. Conceptual designs have been generated for these volumes to accommodate the calculated volumes, with the dams having 0.5 m freeboard and an 8 m crest width to the embankments. Batters for the dams have been based on 1 in 3 slopes to all sides. The dams have also been fitted within the allocated dam areas provided in the mine plans. Storage curves were developed to provide the relationship between volume of water in the dam and the associated area.

Table 16 provides the maximum volume and baseline dimensions of the central process water dams.

Table 16 Central process water dams

	Required volume (m3)	Footprint length (m)	Footprint width (m)	Footprint area (m2)	Storage depth (m)	Water surface area (m2)
PWD –North	3,000,000	593	413	244,909	27.5	172,525
PWD –South	2,000,000	861	311	267,771	11.0	217,056

3.5.4 MAW transfer dams

The MAW transfer dams have been sized in accordance with expected pump rates of the two input sources (open cut pits and underground mine dewatering). The size of the dams equals a 7 day pumping volume, disregarding evaporation and seepage losses.

Table 17 provides the maximum volume and baseline dimensions of the central process water dams.

Table 17 MAW transfer dams

	Required volume (m^3)	Footprint length (m)	Footprint width (m)	Footprint area (m^2)	Storage depth (m)	Water surface area (m^2)
MAW-B	200,000	191	191	36,481	13.4	25,728
MAW-C	350,000	240	220	52,800	17.0	36,764
MAW-D	600,000	335	235	78,725	18.4	55,292
MAW-E	900,000	415	255	105,825	20.6	74,029
MAW-F	650,000	356	236	84,016	18.4	59,100
MAW-G	450,000	285	225	64,125	17.3	44,810

3.5.5 Overburden MAW dams

The overburden MAW dams have been sized equal to the DSA. Refer to section 3.5.8 for more details. As these dams will need to collect runoff they will be constructed as inground basins.

Table 18 provides the maximum volume and baseline dimensions of the central process water dams.

Table 18 Overburden MAW basins

	Required volume (m3)	Footprint length (m)	Footprint width (m)	Footprint area (m2)	Storage depth (m)	Water surface area (m2)
MAW Pit - D	13,660,000	1035	600	621,000	20	621,000
MAW Pit - E	11,250,000	1500	400	600,000	20	600,000

3.5.6 Sediment dams

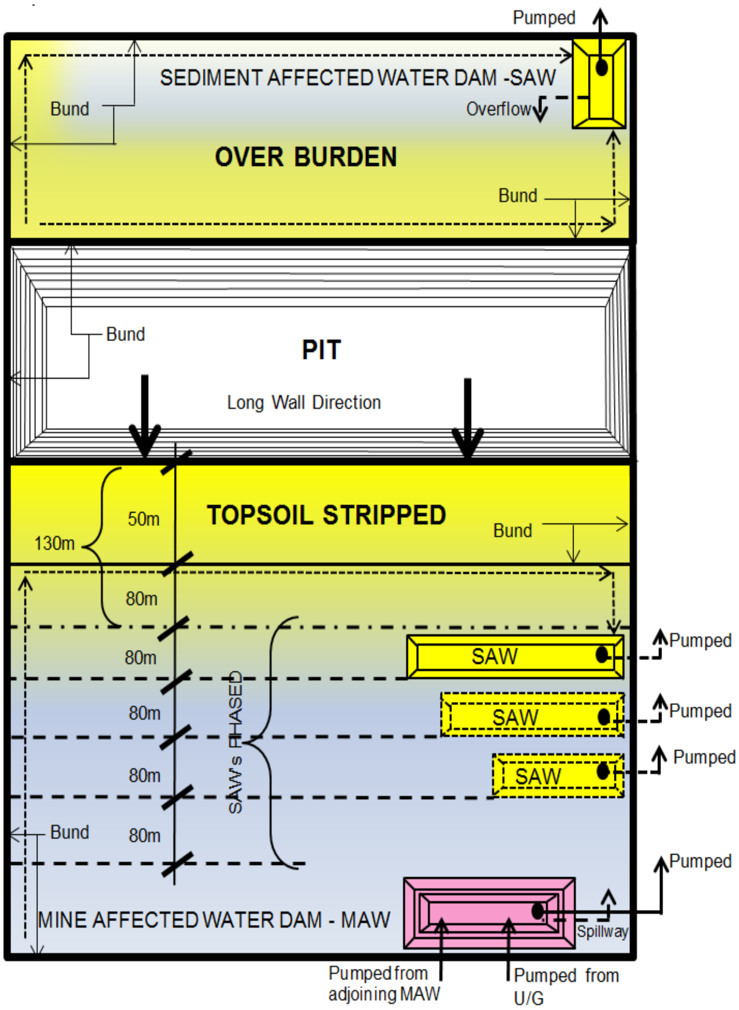
Sediment dams can be found in both the overburden areas and the disturbed areas for each pit. For both situations the sediment dams are sized outside of GoldSim with help of Excel. The size of the catchment areas for the overburden dams and the disturbed area dams change over time with the disturbed areas decreasing over time and the overburden areas increasing over time. This is visualised in Figure 8.

The width of disturbed soil adjacent to each pit at the mine site regresses over the life of the mine at a rate of approximately 50 linear metres per year. As such, the area of disturbed soil adjacent to each pit is systematically reduced over the life of the mine.

The following assumptions were used to calculate a total required storage volume for the sediment basins, in 1 year increments for the disturbed areas and 5 year increments for the overburden areas. This approach is expected to reflect actual mine operations as the sediment dams for the disturbed areas need frequent relocating due to pit progress, while the overburden sediment dams are fixed in location.

- Design rainfall event: 1 in 20 year ARI, 24 event
- Design rainfall depth: 6.77 mm/hr (over 24 hours)
- Runoff coefficient: 0.2 (20 percent of all rainfall reflecting relatively large catchment areas)
- Maximum basin width (disturbed area sediment basins): 80 m.

Figure 8 Concept mine schematic for pits B-C-F and G



The calculated volumes (sizes) of the storages are incorporated within GoldSim. Actual runoff from those areas has been calculated within GoldSim with the AWBM model. Refer to Section 4.3.3. Runoff for the runoff coefficients applied within the AWBM model. Table 19 shows the maximum basin sizes for the disturbed areas.

Table 19 Disturbed area maximum basin sizes

	Area (ha)	Storage Volume (ML)
Pit B	6.3	1,258
Pit C	3.0	602
Pit D	5.0	1,002
Pit E	4.4	883
Pit F	3.4	671
Pit G	3.4	670

Table 20 shows the maximum basin sizes for the overburden sediment basins.

Table 20 Overburden sediment basins

	Required storage volume (m^3)	Footprint length (m)	Footprint width (m)	Footprint area (m^2)	Storage depth (m)	Water surface area (m^2)
SAW Pit-B	744,505	626	200	125,121	10	125,121
SAW Pit-C	411,735	359	200	71,878	10	71,878
SAW Pit-F	565,468	346	400	138,241	5	138,241
SAW Pit-G	867,022	512	400	204,791	5	204,791

3.5.7 Raw water dams

Both raw water dams (north and south) have been sized based on the mine planning requirements at 1 GL each. Table 21 shows the dimensions for the raw water dams.

Table 21 Raw water dams

	Required volume (m^3)	Footprint length (m)	Footprint width (m)	Footprint area (m^2)	Storage depth (m)	Water surface area (m^2)
RWD - North	1,000,000	341	321	109,461	24.0	74,976
RWD- South	1,000,000	404	379	152,959	10.4	122,274

3.5.8 Design storage allowances (DSA)

This design storage allowance is associated with the hazard category of a particular dam. The *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams* (DERM, 2012) informs how to establish the hazard category. A preliminary hazard assessment in accordance with the Manual has been performed for the following dams:

- The central MAW dams where all MAW from the site will be collected
- The dams that capture the runoff in the overburden dams of pits D and E as it is understood that tailings and rejects are likely to be placed within these overburden areas.

The preliminary hazard assessment for the central MAW dams assumes that each dam will maintain a Hazard Category of high and thus need to be designed to withhold a 1 in 100 year AEP event. Section 2.2.2 of the Manual states that two approaches are available for the assessment of DSA. These comprise the 'Method of Deciles' and the 'Method of Operational Simulation for Performance Based Containment' as detailed in Appendix A of the Manual. The 'Method of Operational Simulation …' is a water balance approach based on a series of historical rainfall data (in excess of 100 years) which is assumed to be representative of the extremes in climate that could occur at the site. This approach accommodates the occurrence of a range of individual storm event magnitudes and storm sequences together with operational variations in storage prior to and during storm events. It therefore allows a more detailed representation of the operational performance of the system compared to the alternative approach based on the 'Method of Deciles'. This methodology has been applied for the central MAW dams, i.e. DSA is included in the presented dam dimensions.

The ‘Method of Deciles’ provides a more conservative estimate of the DSA given its reliance on the total volume of a wet season rainfall without losses and a disregard of system operation during the course of the wet season rainfall. This methodology has been applied for the overburden MAW dams as these are not sized within GoldSim.

Both overburden MAW dams have been assumed to have a significant hazard category. This assumption is solely based on the understanding tailings and rejects materials will be placed in the overburden areas for these two pits. While this material is placed it will be exposed to rainfall events meaning that runoff potentially contains contaminants associated with the mining activities. The dam itself will be built as a sump, hence the risk of a dam break failure is considered minimal. The Manual specifies for a significant hazard category a 1:20 AEP event (5 percent AEP)

Model (operational) rules allow for the MAW in the overburden MAW dams to be pumped, when available, directly into the north central MAW dam, henceforth ensuring that the allocated DSA volume is available within in each dam on the 1 November each year. A hazard assessment for all dams on site will be required during future design stages. Note that for dams without an actual catchment, like the MAW transfer dams, allowing for the DSA will be a matter of increasing the storage depth.

3.6 Operational rules

As part of the GoldSim model development appropriate operation rules have been identified to replicate the future site water management as identified by the mine planning. The applied operational rules in the GoldSim model directly impact the outcomes and any alteration of these assumptions and rules could lead to potentially vastly different results. As more mine planning progresses and more data becomes available assumptions should be eliminated as much as possible and replaced with actual mine site information. It is believed that the below described operational rules are realistic and accurately present the future mine operations.

Water priorities

Water will be drawn from storages in the following order of priority:

1. Central MAW storages
2. Process water storages (PWD)
3. Raw water storages.(RWD)

This operational rule does not apply for the longwall mining as MAW is considered unsuitable for use in the underground workings. Water for longwall mining will be drawn from storages with the following priority:

1. PWD
2. RWD.

Pumping rules

- Pumps withdrawing from the MAW transfer dams have been sized to accommodate 7 days' worth of inflow from the pumps contributing to the storages (pits and underground workings)
- Pump out rate of the overburden MAW storages is 100 L/s.

Dead storage allowance

- Dead storage allowance has been set at 100 ML in all of the major storages (central MAW storage, Process Water Dams and Raw Water Dams)
- Dead storage in minor storage infrastructure has been set at 2 ML (MAW transfer dams, overburden and disturbed SAW dams).

Transfer rules

Water will be transferred between storages in different manner depending on the water status.

- MAW captured as either runoff or beneficial reuse will be transferred in series to the central MAW storage either north or south of the Carmichael River. This means that the storages will get incrementally larger as the water progresses toward the central MAW storage. This has been adopted as the water inflows to the underground and the pits will be relatively constant with spikes of inflow occurring with rainfall events
- SAW will be captured in sediment dams and transferred straight to the PWD. This has been adopted because of the scale of the mine site as storages may need to transfer water at different times when isolated rainfall events occur.

Pit dewatering

- Pump dewatering rate for each pit has been set at 250 L/s allowing for runoff to be temporary stored in the pit sumps.

Sediment dams

- Sediment dams are to be maintained in a drawn-down state as much as practical, so that sufficient capacity is available in the 'settling zone' to capture water from subsequent storm events.

DSA volumes

- Only the two storages associated with the overburden area for pit D and E have a DSA. Within the water management rules proposed, MAW in these storages will be transferred directly into the central MAW storage north of the Carmichael River. These storages will be empty at the end of each dry season, meaning that the DSA is available at the start of each wet season (1 November).

Spills

- Spills of MAW have been allowed only from the central MAW storages.

4. Salt balance

4.1 Introduction

Water quality on site, and in particular of potential discharges into the natural environment, is of key importance for determining potential environmental impacts. On the Project (Mine) a variety of contaminants, ranging from metals to hydro-carbons and increased salt concentrations, can be expected in various water storages and runoff. Most of these contaminants can be treated onsite, for example by adding lime to water in storages to treat low pH values, or adding flocculants to settle particulate matter. More importantly most contaminants can be contained on site, for example by installing oil-water separators for parking areas and areas near workshops. In addition water quality can be preserved by making sure that materials potentially producing acid mine drainage are well contained on site. For treatment of sediments a detailed erosion and sedimentation plan for the construction stage and during the mine life is important.

Salinity is difficult to treat; it can be treated by dilution or processing it in a water treatment plant. Inflows of salinity cannot be prevented because all inflows to site have a certain concentration of salt, with groundwater expected to have the highest concentration. Henceforth a salt balance has been included in the water balance study.

4.2 Methodology

The salt balance was developed as an extension of the (GoldSim) water balance model, with expected concentrations of salt applied to water inflows into the system. Transfers of the resulting salt loads were modelled throughout the site and the mass and concentration of salt within particular storages was established such that a mass balance was achieved after allowing for salt discharged via extraction and overflows.

Inflows of water into the system were assigned a specific concentration of salt depending on the source of the water, the value of these concentrations is presented in Table 22. Salt concentrations were based upon recorded water quality data and typical concentration values for similar sites.

Raw water supply was assumed to be obtained from the Belyando River. The assumed concentration for this water was estimated from comparing surface water quality samples collected on site and water quality data from a monitoring station (DNRM gauging station) located at the crossing of the Belyando River and the Gregory Development Road (gauging station 120301B) approximately 70 km downstream of the project. Both data sources indicated an average salinity of approximately 150 uS/cm.

Salinity for groundwater inflows including groundwater make into underground mining and seepage into the open cut pits were determined from a review of groundwater monitoring data collected across the site from 2011 to 2013. Salinity concentrations were shown to vary substantially across the site and over time and the data did not indicate justification for varying the salinity input depending on the location across the site. The approximate average salinity of the groundwater data was input into the modelling at 4,000 uS/cm. Refer to Appendix K1 Updated Mine Hydrogeology Report (GHD, 2013)

The salinity for runoff in potential coal contact areas was determined as a function (50%) of the groundwater inflows determined for the salinity modelling. The assumed proportions for these parameters are presented in Table 22.

A conversion factor of 0.67 was used to convert salinity data in µs/cm to mg/L as used in the model (Department of Natural Resources and Water, 2007). Salt transfers were simulated in within the water balance model with extractions and overflows from each storage assuming instantaneous mixing.

It was assumed that the water leaving the CHPP has the concentration of coal contact water due to the washing process, therefore a salt injection was inserted at the CHPP to simulate salt washing from the coal to the rejects.

Table 22 Adopted salt concentration

Land use	Adopted salt concentration us/cm	Justification
Groundwater inflows to Underground Mining	4,000	Approximately average from available site data
Groundwater inflows to Open Cut Areas	4,000	Approximately average from available site data
Direct Rainfall	30	Department of Natural Resources and Water (2007) Measuring Salinity, Kristie Watling, DNRW, Queensland Government, June 2007
Raw Water Supply (from Belyando River)	150	Approximate average of surface water monitoring locations, consistent with downstream monitoring location for the Belyando River
Coal Contact Runoff	417	Adopted from Geochemical Assessment (SKR, 2013) for average salinity of roof, floor and coal contact material
Overburden Runoff	417	Adopted from Geochemical Assessment (SKR, 2013) for average salinity of roof, floor and coal contact material
Disturbed Area Runoff (no coal contact)	413	Adopted from Geochemical Assessment (SKR, 2013) for average salinity of roof, floor and coal contact material
Undisturbed Areas	150	Approximate average of surface water monitoring sites, consistent with downstream monitoring location for the Belyando River

The elements in the salt balance model were assumed to have the salinity of the land uses as provided in Table 23. This tables shows the salt concentrations applied to the various elements of the water management system.

Table 23 Applied land use for modelled elements

Assumed land use	Elements in water management system
Groundwater inflows to Underground Mining	inflows to all underground mining areas
Groundwater inflows to Open Cut Areas	inflows to all open cut pits
Direct Rainfall	water falling directly onto water storages
Raw Water Supply (from Belyando River)	raw water supply to the raw water dams
Coal Contact areas	runoff from open cut pits runoff to overburden dams D and E runoff collect by sumps
Overburden Runoff	runoff to overburden dams (except dams D and E)
Disturbed Area Runoff (no coal contact)	runoff to disturbed area sediment dams

Salt losses from the CHPP and dust suppression are dictated by the salt concentrations of their sources. On any given day, the transfer of salt is affected by the salt concentrations of the central MAW dam, the process water dam and/or the raw water dam. The contributions of each of these sources are governed by the availability of water for the day as well as the priority of the selection. The order of selection initially calls for the central MAW dam, followed by the process water dam, and ultimately the raw water dam. Since these sources have an inherent salinity, salt is also transferred along with the water. This salt content of the water is to either evaporation (dust suppression) or the processing (conveyor loss, rejects, etc.) once these irrecoverable transfers are completed the carrier (water) is lost, the content (salt) is lost as well.

4.3 General outcomes

Generally, the site collects water of various salinities and recycles this water throughout the site processes. A relatively large proportion of the water inflows into the water management system have higher salinity than the natural undisturbed catchment, resulting from groundwater inflows and the collection of coal contact runoff. However, the main source of salt in the water management system is from groundwater inflows.

The main sources for salinity loss from the system are via conveyor losses in underground mining, dust suppression and salt that is deposited with the fine and course rejects.

5. Modelling results

5.1 Results interpretation

The stochastic nature of the GoldSim model allows for the results to be statistically analysed, meaning that every element of the model performance can be determined based on probability. The result outputs have been given for the 50th (median), mean (average) 75th and 95th percentile values.

A percentile indicates a value below which a certain percentage of the results occur. For example if a value of 100 ML is stated as the 95th percentile storage volume, this means that 95 percent of the values in the model realisations were below 100 ML.

The 50th percentile is another term for the median of a data set. The median is the numerical value separating the higher half of a data sample, a population, or a probability distribution, from the lower half. The median of a finite list of numbers can be found by arranging all the observations from lowest value to highest value and picking the middle one (e.g. the median of {3, 5, 9} is 5). In other words: the median is the value below which 50 percent of the results fall.

The mean or average is the sum of a collection of numbers divided by the number of numbers in the collection. The approach to presenting results is also explained by Figure 9 and Table 24. The mean, or average, includes the largest numbers in a data set, while the median excludes the larger values. This means that results presented for the median are lower than for the mean.

Figure 9 Explanation of results figures

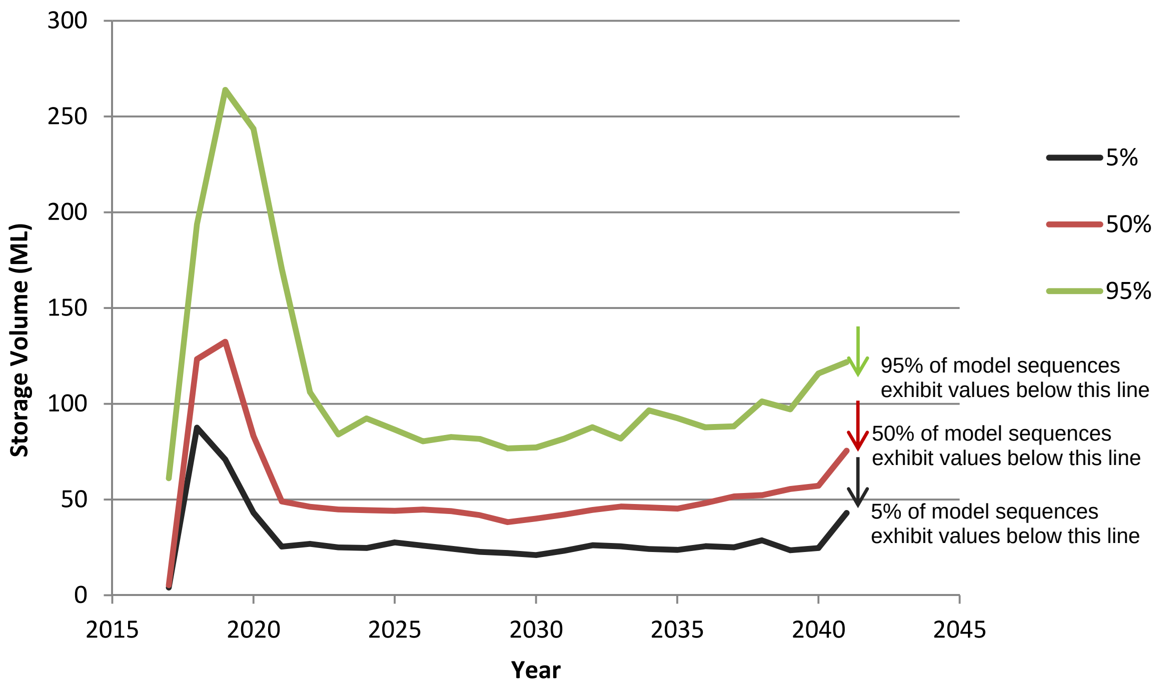


Table 24 Explanation of results tables

Surplus(+) or Shortage (-) (MLpa)			
year	95%	Median (50%)	Mean (average)
2015	95% of model sequences exhibit a surplus or shortage of less than this value	50% of model sequences exhibit a surplus or shortage of less than this value	Average value based on all values

5.2 External Raw water

Raw water demand has been modelled for:

- Mine Section North south of the Carmichael River – Figure 10
- Mine Section South of the Carmichael River – Figure 11
- Total raw water demand – Figure 12.

Raw water demand is presented for the 95th percentile as this is an industry standard for the required reliability of water supply for a mine.

Figure 10 Raw water demand north of the Carmichael River

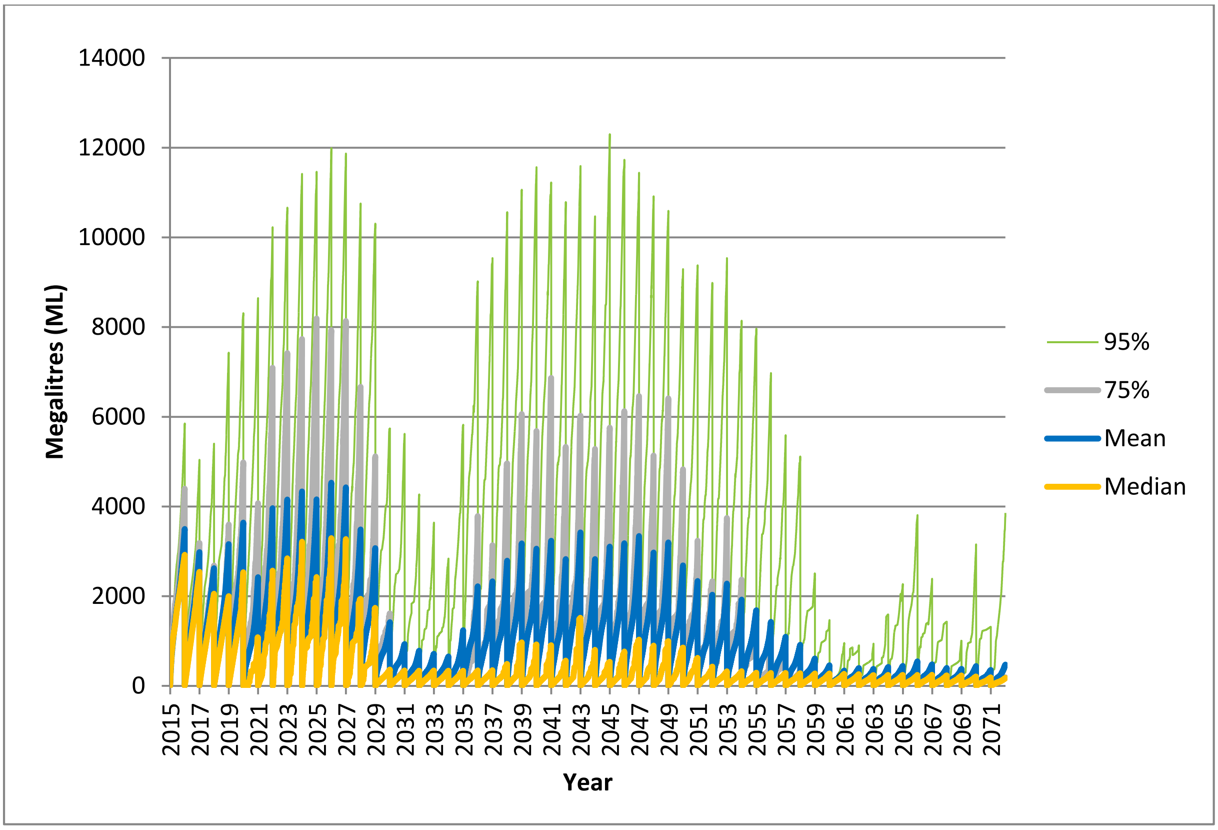


Figure 11 Raw water demand south of the Carmichael River

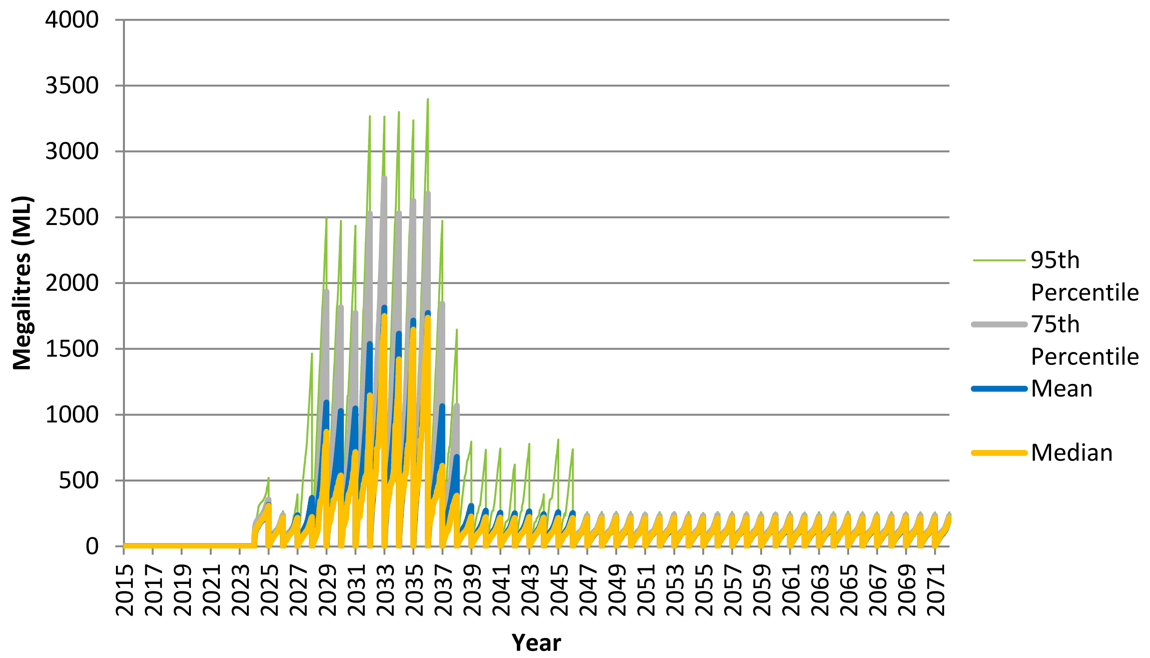
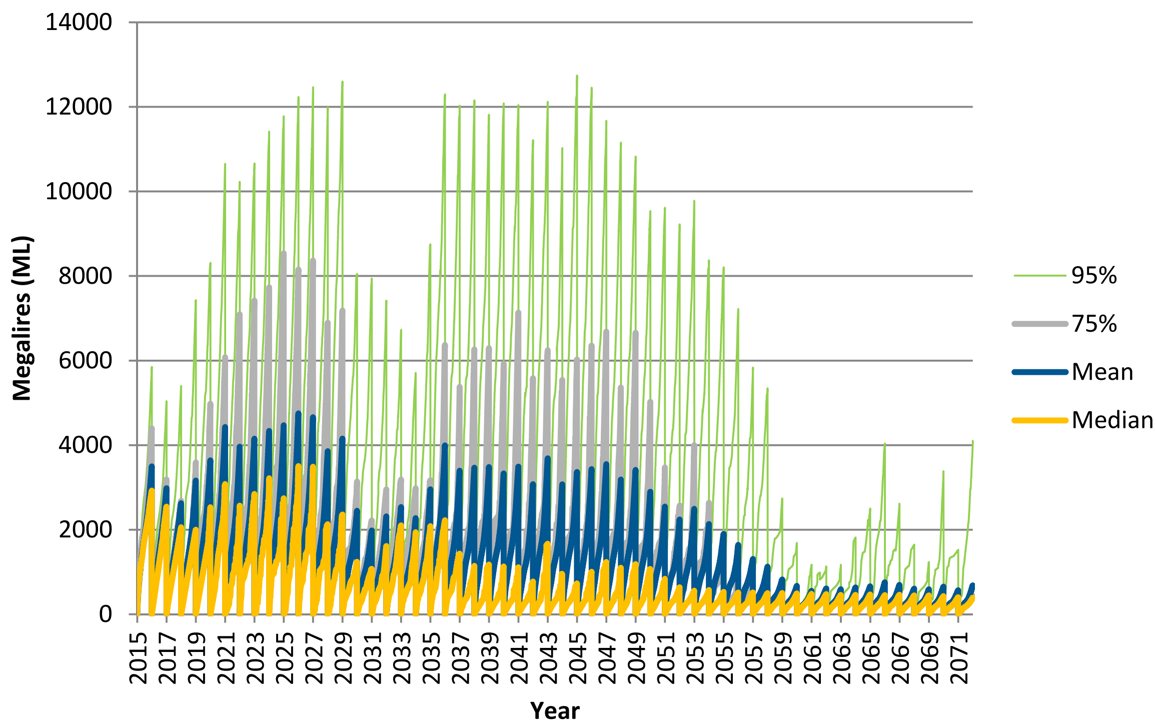


Figure 12 Combined (north and south) total raw water demand



Raw water is pumped from offsite storages, excluded from the water balance refer to section 2.5, into both raw water dams (north and south). Both dams have no actual associated catchment and overflows can only occur due to mismanagement of pumped inflows or exceptional volumes of rainfall directly on the dam. Henceforth overflows from the raw water dams are unlikely. To cater for unlikely events the raw water dams will have an overflow construction allowing for the clean water from these dams to enter the nearest waterway.

5.3 Process water storages

The central PWDs receive water that is pumped in from the sediment dams or rains directly on top of the dam area. These dams will be designed and managed to achieve zero overflows. As with the RWDs overflows are expected to be unlikely. To cater for unlikely events the central process water dams will have an overflow construction allowing for the clean water from these dams to enter the nearest waterway.

5.4 Sediment dams for the overburden areas

The overburden sediment dams are allowed to overflow during more extreme events. In Figure 13, Figure 14, Figure 15 and Figure 16 expected overflows from the overburden sediment dams are presented. The figures show that on average each year some overflows can be expected. Total catchment areas for these dams are significant with the maximum catchment sizes being (year 2071):

- Pit B: 22.91 km^2
- Pit C: 12.65 km^2
- Pit F: 17.40 km^2
- Pit G: 26.68 km^2

The overburden sediment dams need further design during future design stages to optimise the sizes and to confirm the (treatment) efficiencies.

Water quality of overflows is expected to be relatively good, with total dissolved solids (turbidity / sediments) being the critical contaminant. When the basins overflow smaller particles suspended in the water column will leave the basin, however larger particles will settle in the basin. Results are presented for the mean situation in order to show potential yearly overflows.

Figure 13 Overburden sediment dam B overflows

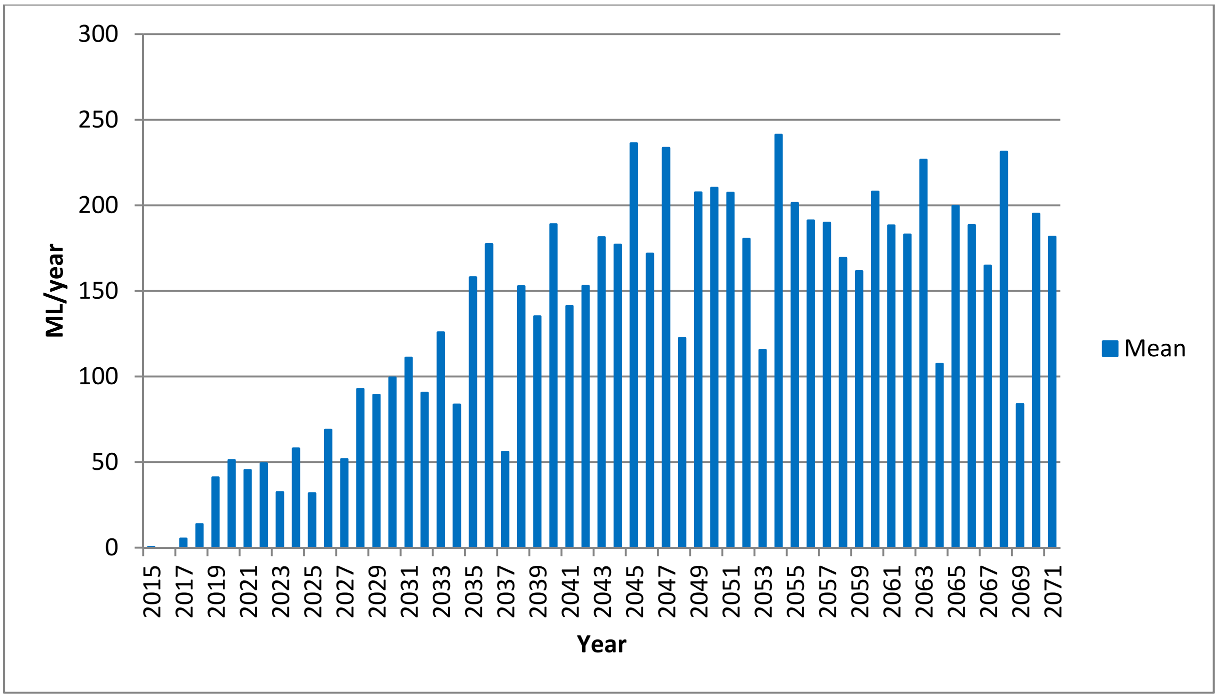


Figure 14 Overburden sediment dam C overflows

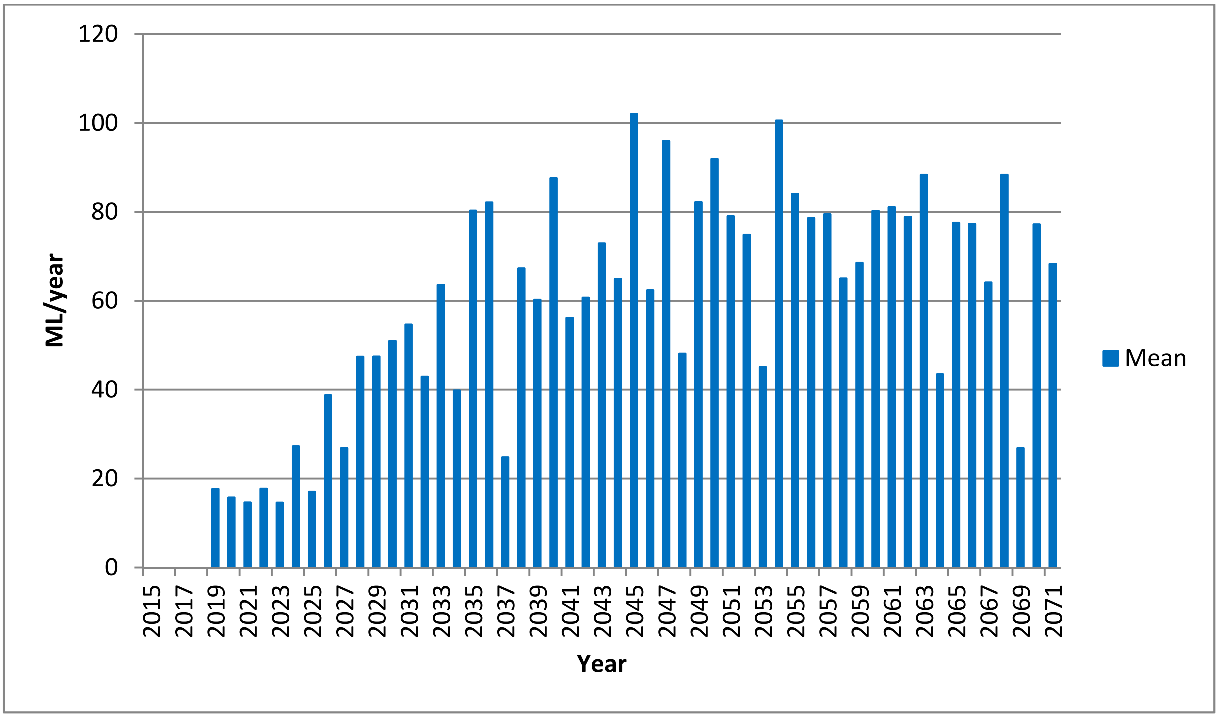


Figure 15 Overburden sediment dam F overflows

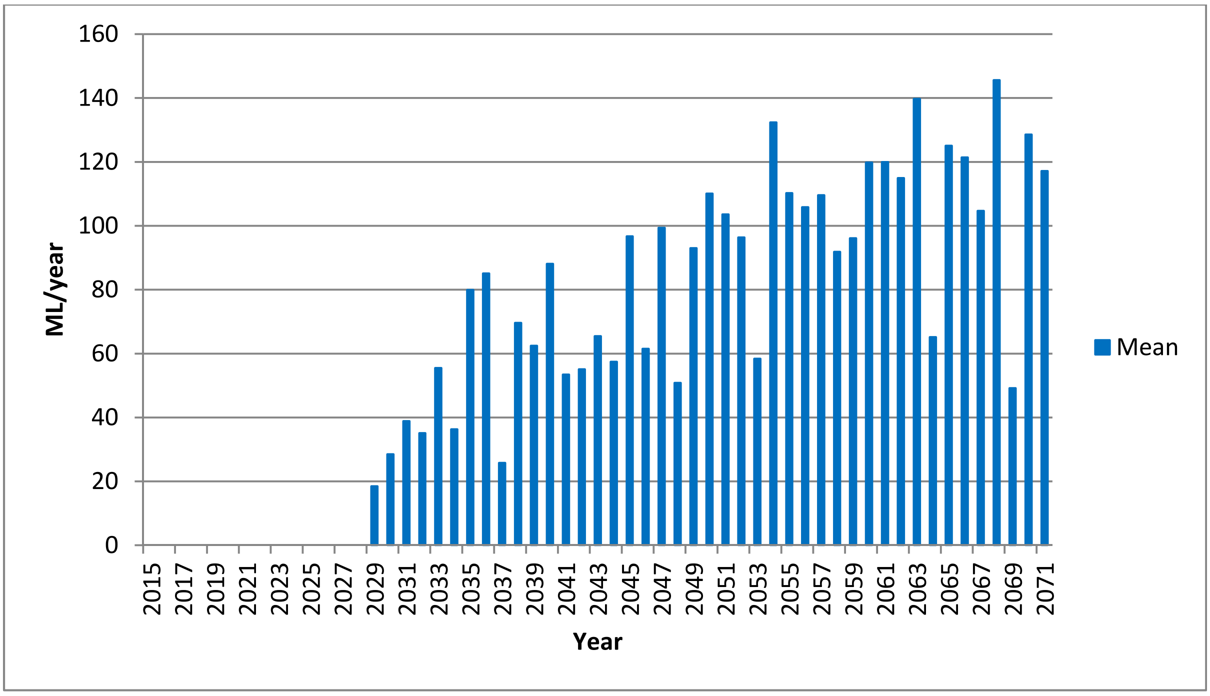
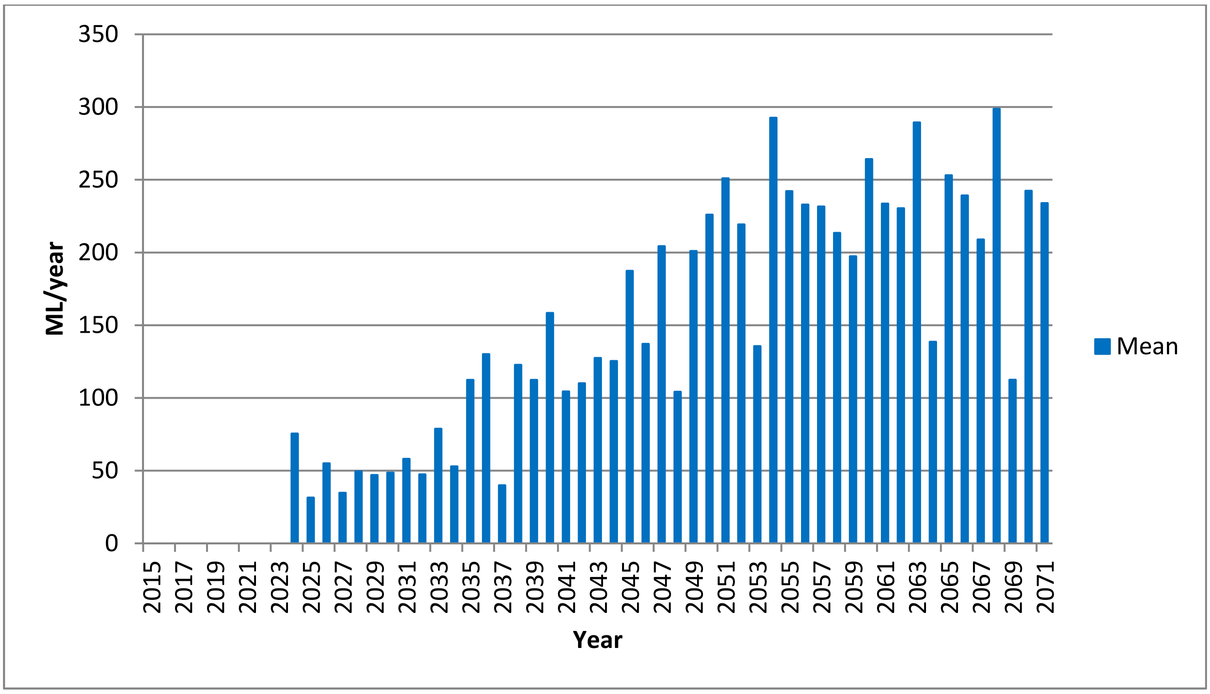


Figure 16 Overburden sediment dam G overflows



5.5 Disturbed area sediment basins

The sediment basins in the disturbed areas are not designed to have any overflows to the local waterways. Overflows are not expected to leave the disturbed area as they are enclosed by a levee with a flood protection level of 1 in 1,000 year ARI. With the highwall protected by a bund overflows will either evaporate or be pumped to the central process water dams.

5.6 Overburden MAW dams

Overflows from these dams are unlikely as these dams are sized as per the DSA event. Any MAW entering these dams is pumped into the central MAW dams meaning that overflows are extremely unlikely considering the pump capacities (100 L/s).

5.7 Central MAW dams / controlled discharge requirements

As stated in previous sections, in particular section 1.1.1, controlled discharges of MAW are only allowed from the two central MAW dams. Within GoldSim the functioning (number and frequency of overflows) of both dams has been determined. As part of the water balance a sensitivity check was performed on the controlled discharge requirements by increasing the sizes of the dams in order to decrease the frequency and volumes of spills.

Model results show that an increase in the dam sizes will have a relatively limited effect on the reduction of discharges but have a more significant effect on total raw water demand requirements as evaporation will increase due to an increase in the dam areas. For example, increasing the size of the north dam with 1 GL and the south dam with 2 GL the yearly total raw water requirements increase with approximately 2 GL (~15 percent increase) for the 95 percentile. Average discharge volumes go down as follows:

- Central MAW north: 236 ML/year
- Central MAW south: 195 ML/year

Typical of the discharges, for the mean scenario, is the actual overflows are also

Potential discharges to the Carmichael River are presented in Figure 17, Figure 18 and Figure 19. Results are presented for the mean situation in order to show potential yearly overflows.

Figure 17 Discharges volumes central MAW north

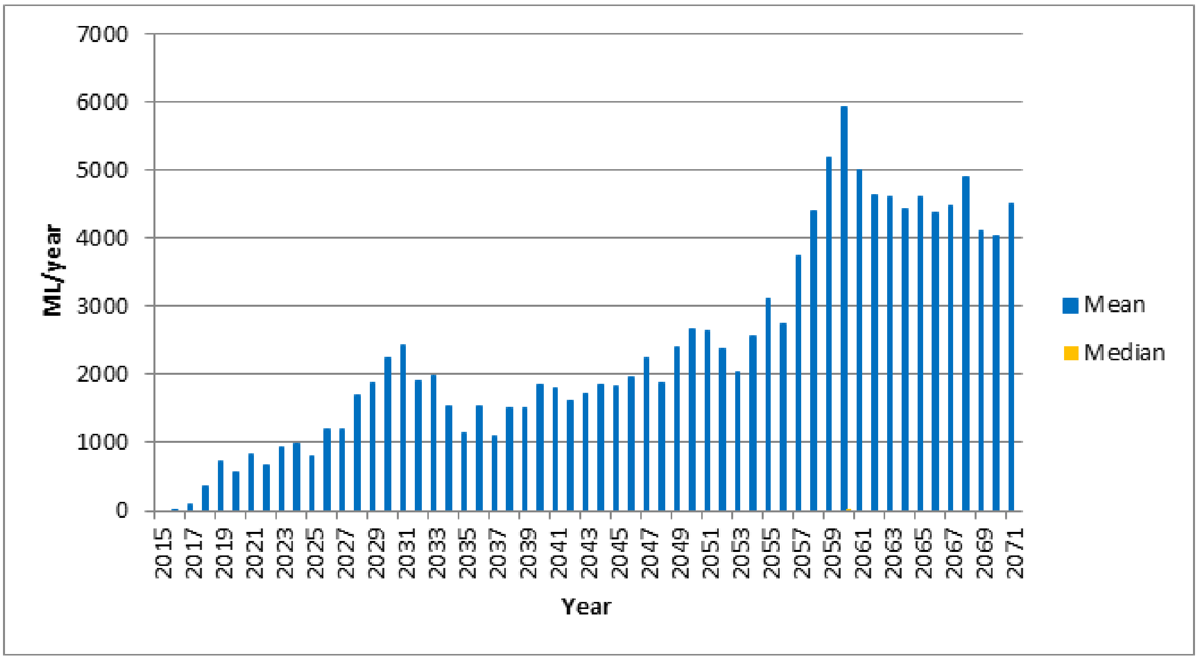


Figure 18 Discharges volumes central MAW south

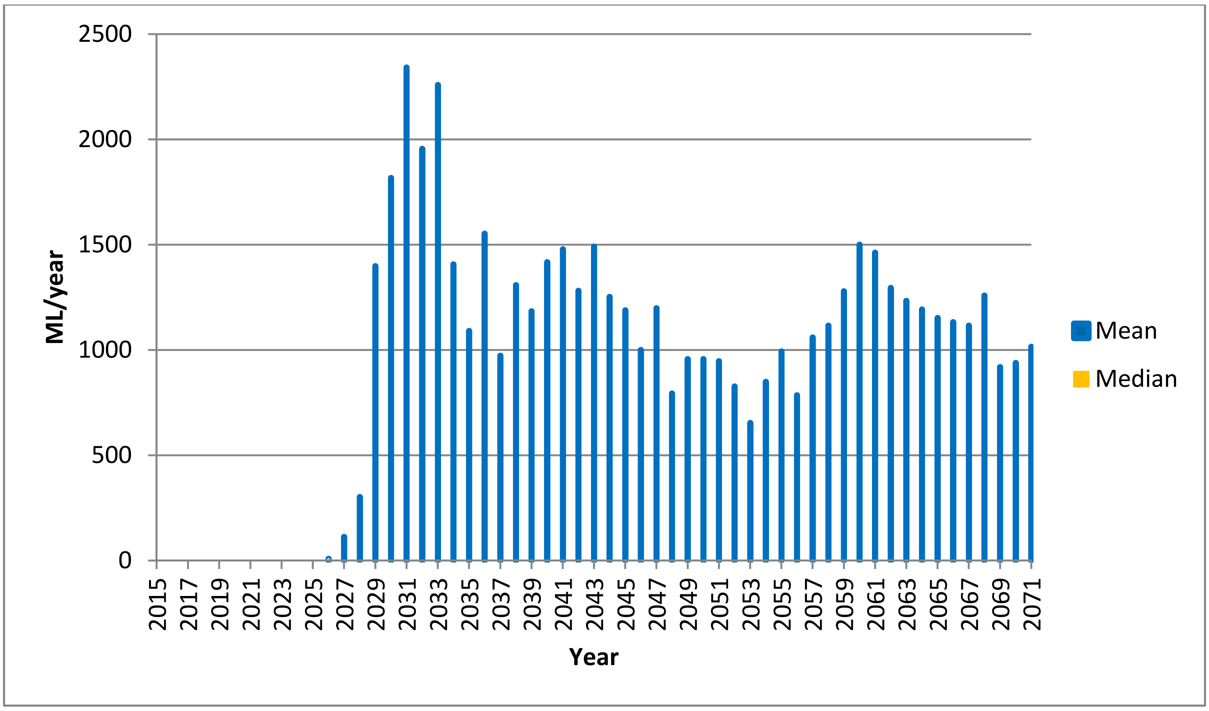
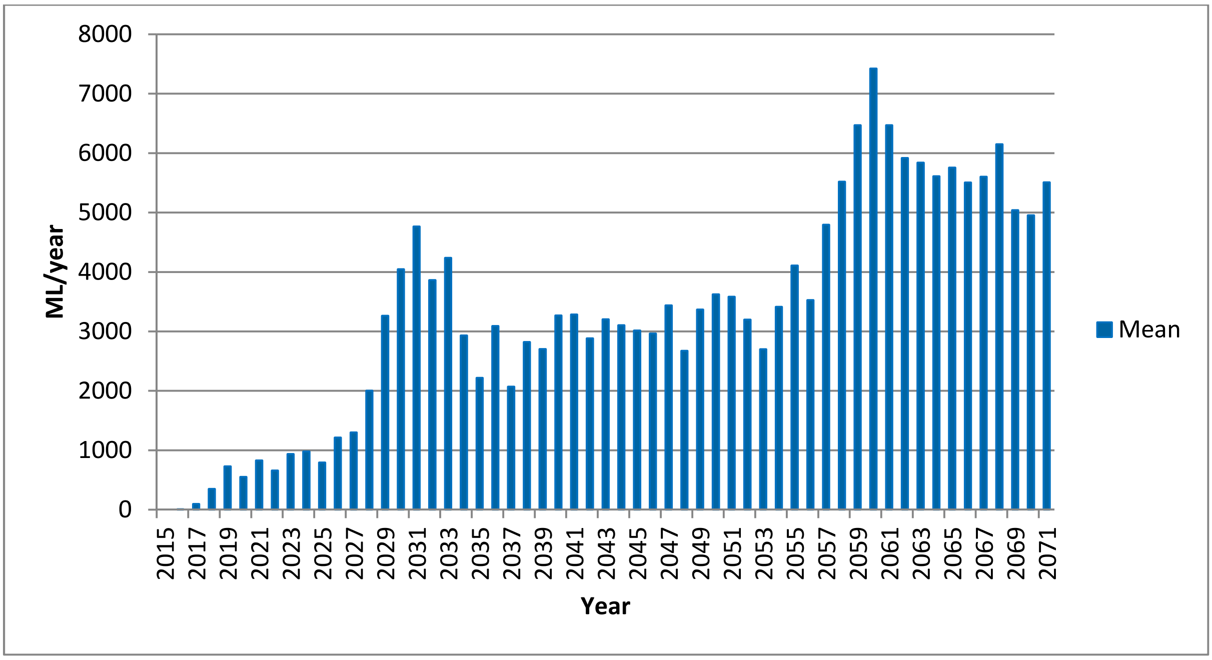


Figure 19 Combined discharges volumes central MAW north & south



The above presented figures show that further optimisation of the water balance, in particular in regard to discharges is required during future design stages. Current results show that the applied chemicals to reduce evaporation on the central MAW dams and the central process water dams will not be required continuously. A trigger level in the storages should be identified in order to bring down the frequency and volume of overflows.

As stated in section 3.4.2 dust suppression requirements for smaller linear infrastructure, among others access roads, is currently not included in the water balance. Henceforth current volumes for dust suppression are likely conservative. An increase in this demand will reduce potential overflows. Potentially another option to reduce overflows is to increase evaporation losses by increasing the dam areas.

The above presented refinements of the water balance will be required during future design stages. Importantly the water balance shows that potential discharges from the Project are, considering the size of the Project, limited in particular in the first years of the mine operations.

For comparison matters the potential maximum discharge volume (average flow conditions) to the Carmichael River are estimated in Appendix B. If the same release conditions are applied for the Project as recently for the Alpha Coal Mine maximum discharge volumes are estimated at approximately 38,000 ML a year. The combined discharge volume of the Project (mine) as determined within the water balance is even for the worst year (2060), less than 30 percent of the estimated potential maximum discharge volumes.

5.8 Salt balance

Expected salt concentrations in the major storages on the mine site are described in the sections below. Graphs showing the salinity over time are only provided for the central MAW dams as water quality is expected to be worst in these dams and because these dams represent the two discharge points of MAW water into the environment.

5.8.1 Raw Water Dams

The salinity of the raw water storages north and south of the Carmichael River are expected to reflect the water quality of the inflows, 100 mg/L (Belyando River) due to the active withdrawals from the dam for underground process water. It is expected that the south raw water storage will be decommissioned upon completion of the underground mining in this area.

5.8.2 Process Water Dams

The salinity of the Process Water Storages is expected to increase from the salinity of raw water or undisturbed runoff and increase over the life of mine to approximately 1,700 mg/L by the end of mine life (2071). As with other storages, the salinity is predicted to fluctuate with variations in rainfall through dry and wet periods.

5.8.3 Sediment dams for the overburden areas

Salinity of the water in the disturbed area sediment dams is expected to closely reflect the salinity of the inflows, i.e. runoff from the overburden areas (417 us/cm or 280 mg/L, refer to Table 22), as any water in these dams is pumped to the central process water dams.

5.8.4 Disturbed area sediment dams

Salinity of the water in the disturbed area sediment dams is expected to closely reflect the salinity of the inflows, i.e. runoff from the disturbed areas (413 us/cm or 277 mg/L, refer to Table 22), as any water in these dams is pumped to the central process water dams. Besides that these dams are almost yearly relocated following the advance of the highwall.

5.8.5 Overburden MAW dams

Salinity of the water in the overburden MAW dams is expected to closely reflect the salinity of the inflows, i.e. runoff from the overburden areas (4,000 us/cm or 2,680 mg/L, refer to Table 22), as any water in these dams is pumped to the central MAW dams.

5.8.6 Central MAW dams

The salinity of the MAW storages was predicted to vary between approximately 1,000 mg/L and 2,000 mg/L. Modelling indicated the salinity of the storages are relatively stable over time and salinity is not expected to follow an increasing or decreasing trend over time. This relatively low and stable salt concentration is due to:

- The relatively large inflows of runoff from the pit areas
- The fact that these dams at times they are empty
- During the mine operations water is always moving around in these dams as MAW water has the highest priority in re-use.

Concentrations over time are presented in Figure 20 and Figure 21 for both the north and south central MAW dam.

Figure 20 Salt concentration central MAW dam north

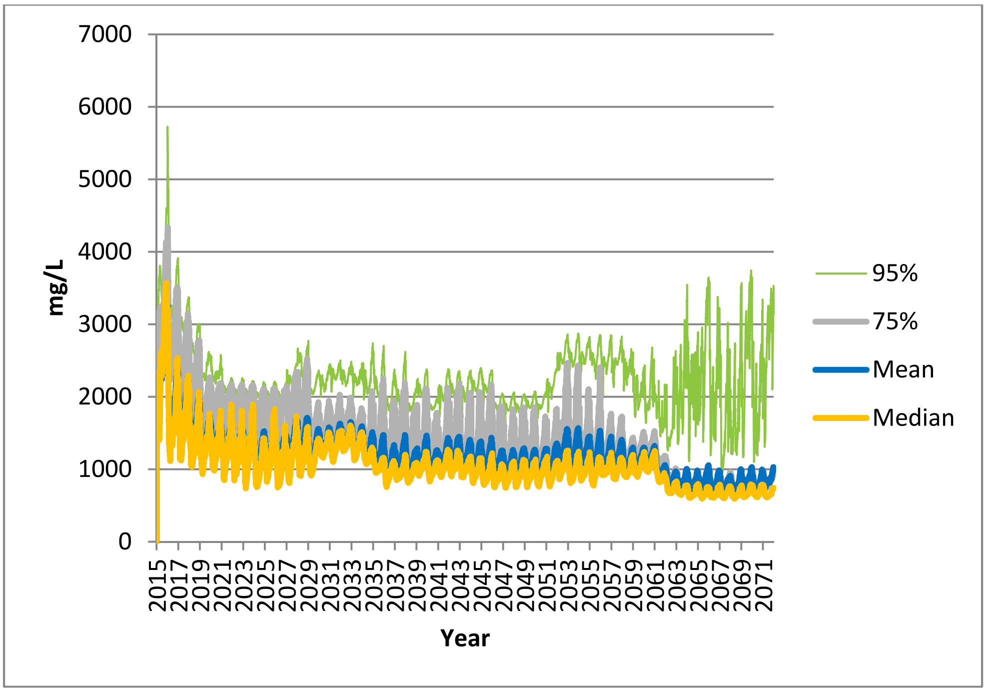
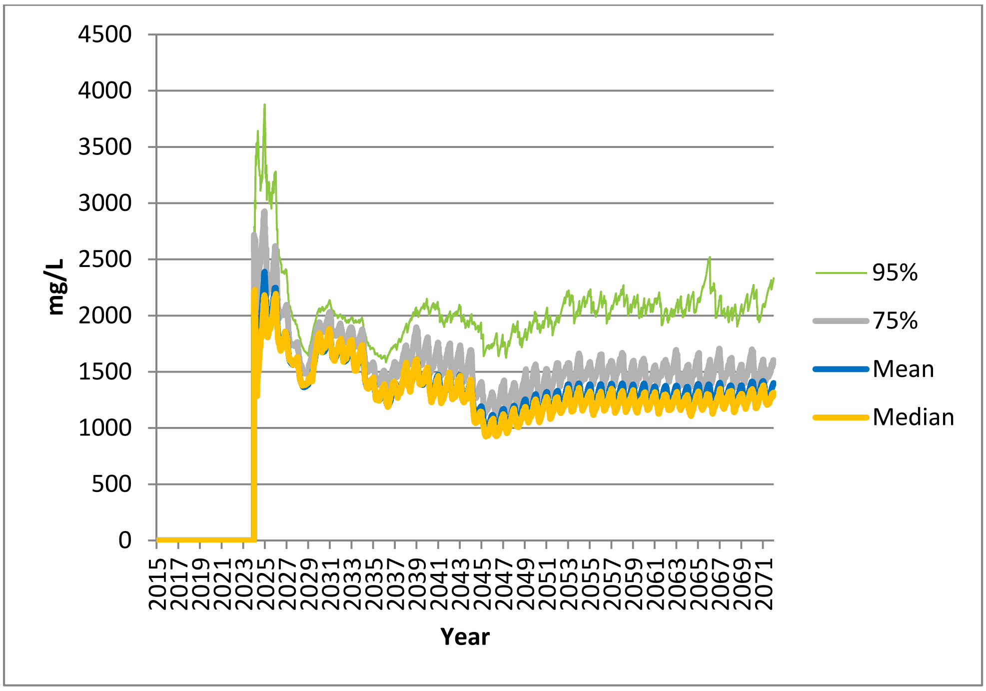


Figure 21 Salt concentration central MAW south



6. Conclusion and recommendations

6.1 Conclusion

External raw water demand for the Project is in the order of 12 GL per year with a 95 percent reliability. It is understood this volume is dependent on raw water supply from offsite raw water infrastructure.

The site water management system allows for the discharge of MAW from two discharge dams which are located centrally along the north and south sides of the Carmichael River. Combined discharges from the Project)mine) for an average year represent less than 30 percent of the roughly estimated yearly maximum discharge to the Carmichael River (based on the development conditions of the proposed Alpha Coal Mine).

Discharges from the overburden sediment basins are relatively frequent, but considering the size of the catchments and the volumes of the dams the discharges are considered minimal. Water quality of overflows is expected to be relatively good, with total dissolved solids (turbidity / sediments) being the critical contaminant. Overflows are directed into the nearby waterways.

Significant water management infrastructure is required to manage water onsite. The design is targeted to minimise the number of water management storages on site. The defined storages are therefore relatively few, considering the size and complexity of the Project, but are large. The current mine plan allows for sufficient space for all required storages.

The proposed site water management infrastructure is believed to be appropriate for the water balance and forms a good basis for future refining of the water balance.

6.2 Recommendations

The following recommendations are made as part of the water balance study:

- The water balance and proposed site water management infrastructure will undergo refinement during future design stages in order to adequately represent the mine development.
- Now that potential discharges from the central MAW dams and the overburden sediment dams are known it is recommended to develop a release strategy for any future releases taking into account seasonable variability of the receiving environment.
- While the water management system maximises re-use of water on site, the mine is still rather dependent on external water supply. The external water supply is linked to the Belyando River which makes the Project largely dependable on climatic circumstances as the Belyando River is ephemeral. As groundwater resources are more reliable it is recommended to further investigate this resource.

7. References

Boughton, 2004: Australian Water Balance Model (AWBM)

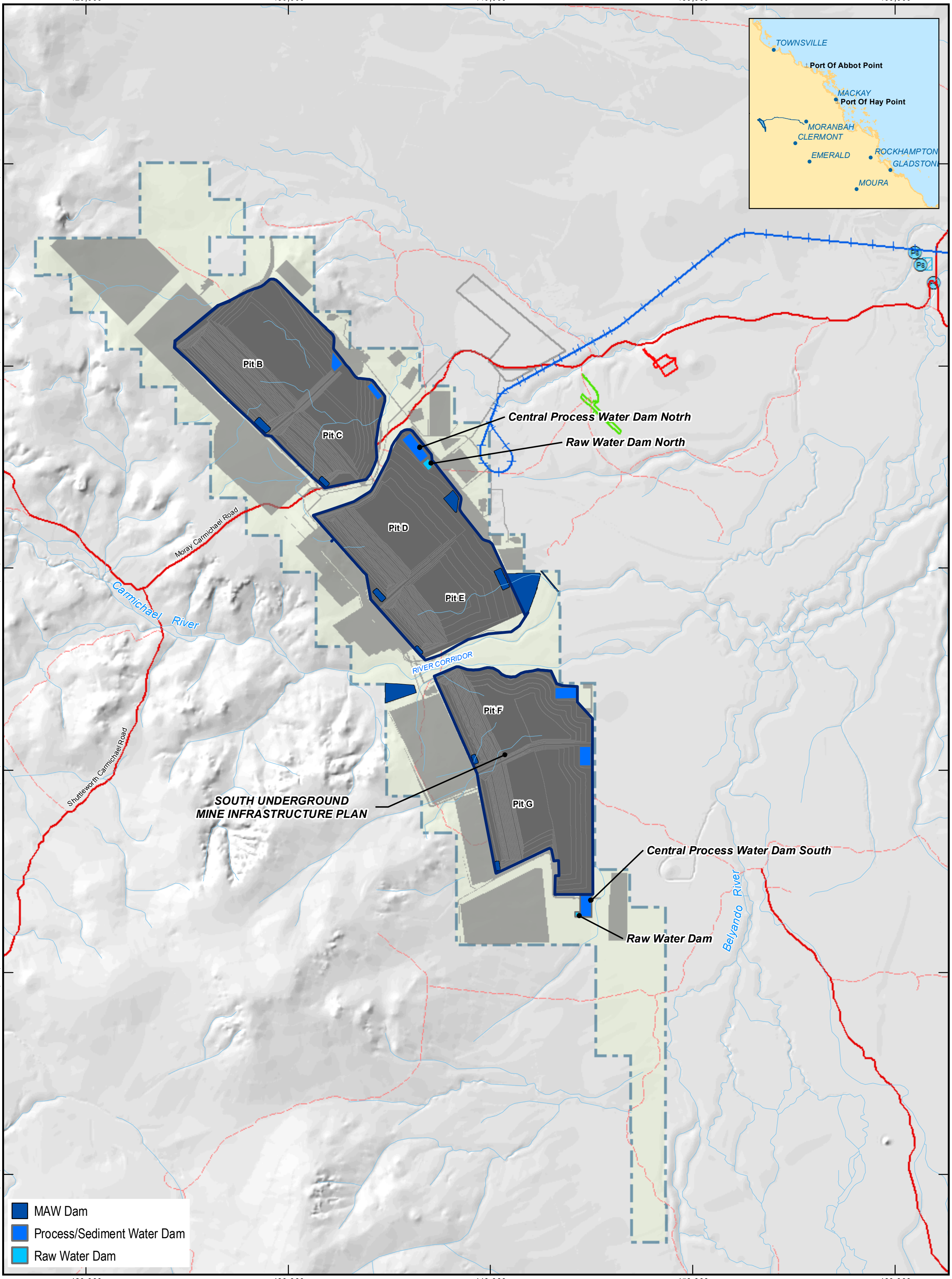
DERM, 2012: Manual for Assessing Hazard Categories and Hydraulic Performance of Dams

GoldSim modelling software, GoldSim Technology Group, 2013

Department of Natural Resources and Water, 2007: *Measuring Salinity*, Kristie Watling, DNRW, Queensland Government, June 2007.

Appendices

Appendix A – Staged mine plans



LEGEND

Minor Road	Flood Protection Bund	Mine Site	Mine (Offsite)	Airport
Track	Rail (West)	Mine Layout	Pump Station	Industrial Area
Watercourse		Pit Area	Storage Facility (Offstream)	Accommodation Village

1:275,000 (at A4)

0 2 4 6 8 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Job Number 41-26585
Revision B
Date 25-10-2013

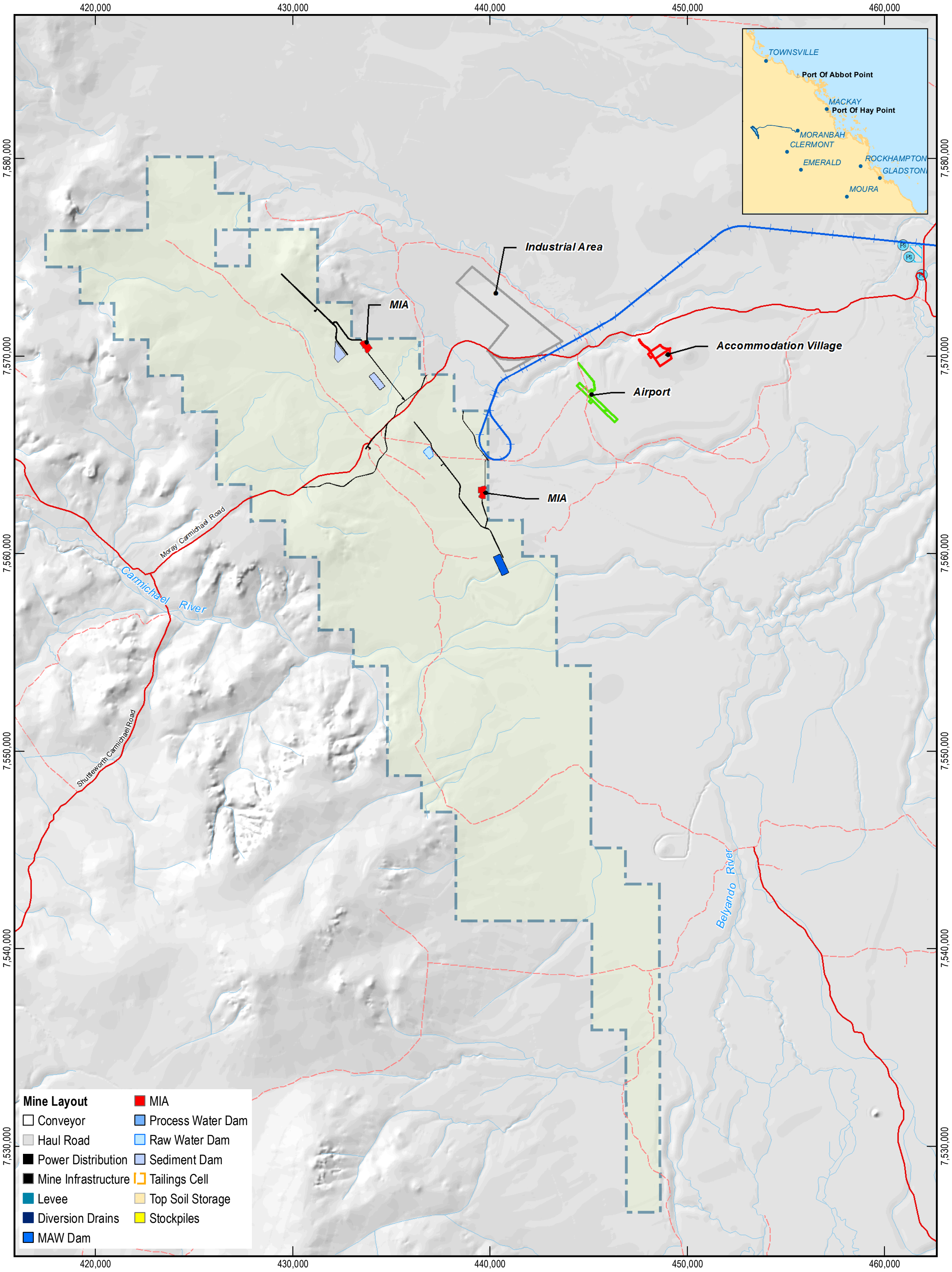
On-site Water Storages and Bunding

Figure A0

G:\41\26585\GIS\Maps\MXD\41_26585_bunds_FigA0_rev_b.mxd

Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: GA: Road, River / Watercourse (2007); DME:EPC1690 (2010), EPC1080 (2011); Adani: Mine Layout / Infrastructure (2013), Mine (Offsite) (2013). Created by: MS



LEGEND

Minor Road | Rail (West) | Mine (Offsite) | Accomodation Village
Track | Mine Site | Pump Station | Airport
Watercourse | Storage Facility | Industrial Area

Based on or contains data provided by the State of QLD (DERM) [2010]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:275,000 (at A4)

0 2 4 6 8 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Job Number | 41-26585
Revision | B
Date | 25-10-2013

Project (Mine) Onsite and Offsite Infrastructure - Year 2014

Figure A1

G:\41\26585\GIS\Maps\MXD\Automaps\41_26585_Template_rev_a_Year2014_rev_b.mxd   Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

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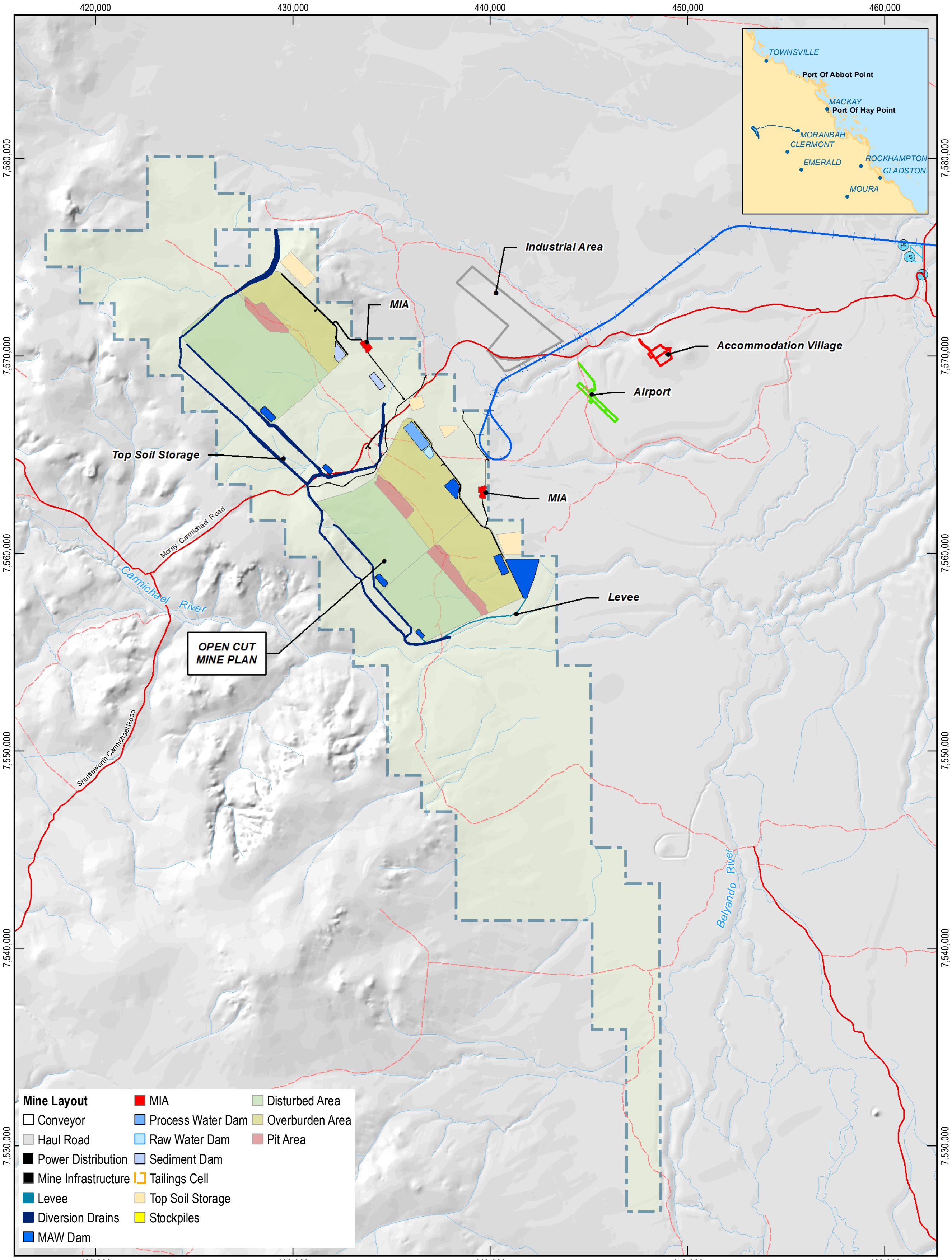

LEGEND

Minor Road	Rail (West) Mine (Offsite)	Accomodation Village
Track	Mine Site	Pump Station	Airport
Watercourse	Storage Facility	Industrial Area

Based on or contains data provided by the State of QLD (DERM) [2010]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:275,000 (at A4)

0 2 4 6 8 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

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GHD adani

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Job Number 41-26585
Revision B
Date 25-10-2013

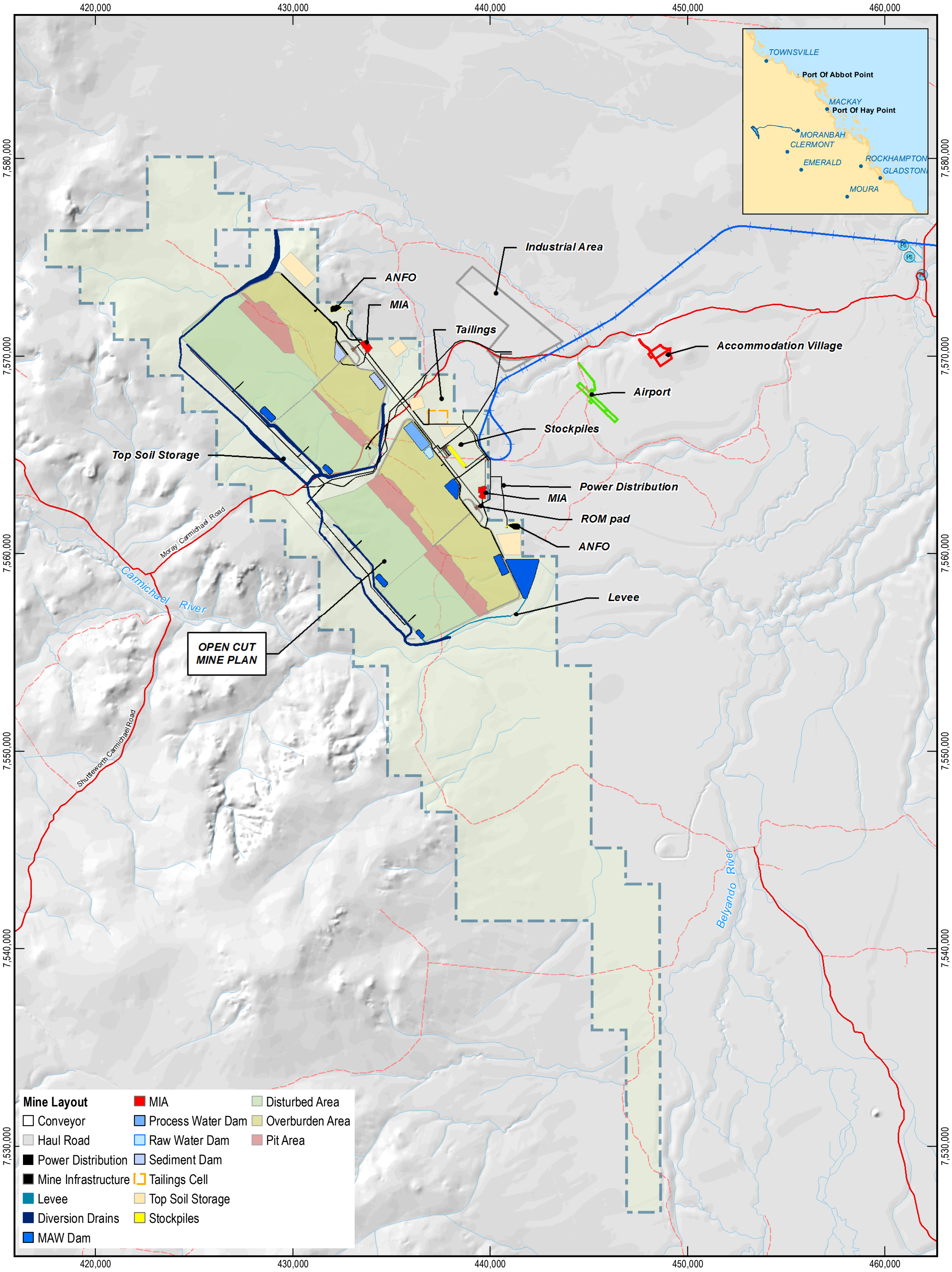
Project (Mine) Onsite and Offsite Infrastructure - Year 2015

Figure A2

G:\41\26585\GIS\Maps\MXD\Automaps\41_26585_Template_rev_a_Year2015_rev_b.mxd

Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: GA: Road, River / Watercourse (2007); DME:EPC1690 (2010), EPC1080 (2011); Adani: Mine Layout / Infrastructure (2013), Mine (Offsite) (2013). Created by: MS & LS



LEGEND

Minor Road	Rail (West) Mine (Offsite)	Accomodation Village
Track	Mine Site	Pump Station
Watercourse	Storage Facility	Industrial Area
		Airport

Based on or contains data provided by the State of QLD (DERM) [2010]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:275,000 (at A4)

0 2 4 6 8 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

GHD adani

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Job Number 41-26585
Revision B
Date 25-10-2013

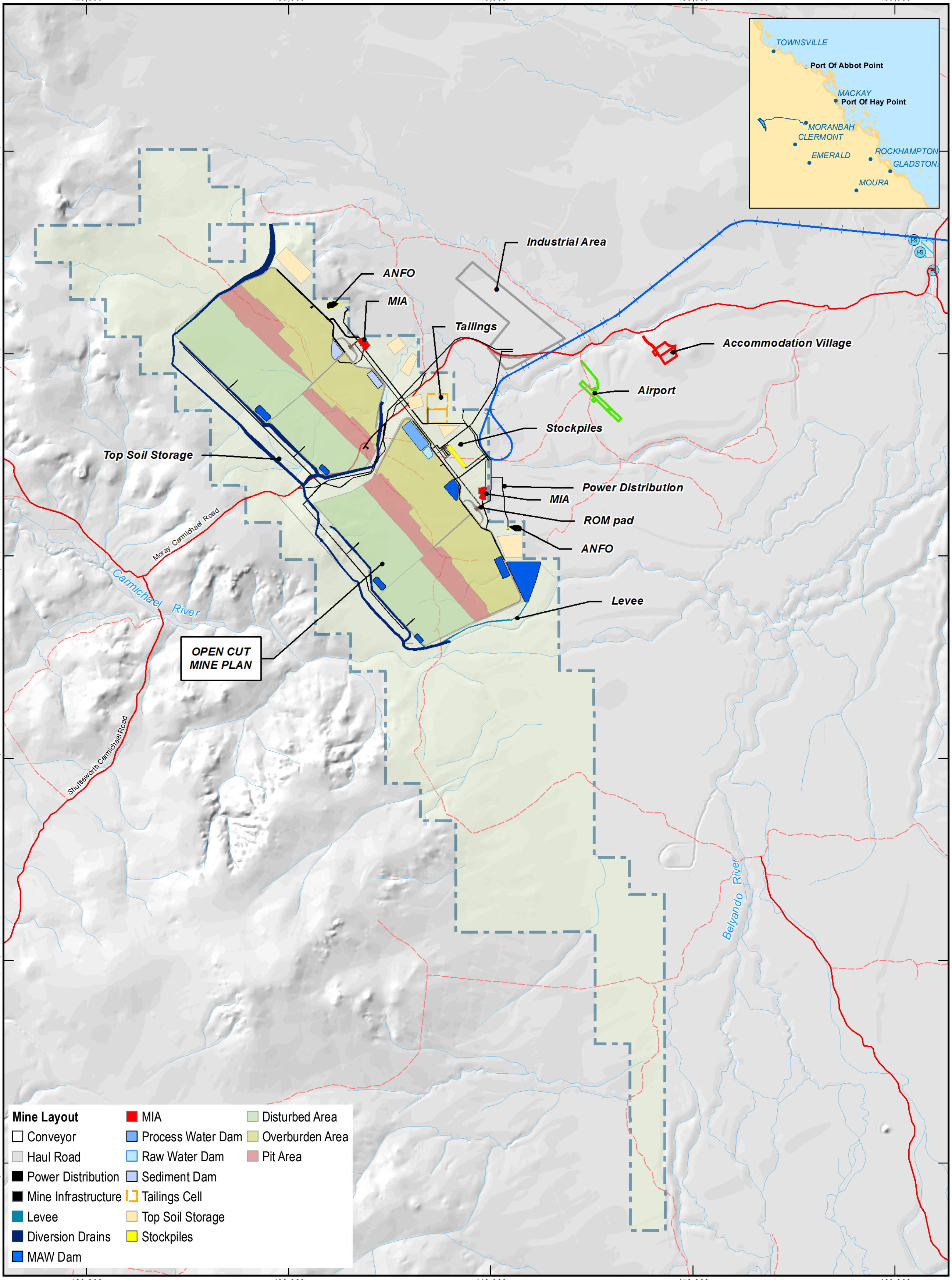
Project (Mine) Onsite and Offsite Infrastructure - Year 2016

Figure A3

G:\41\26585\GIS\Maps\MXD\Automaps\41_26585_Template_rev_a_Year2016_rev_b.mxd

Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: GA: Road, River / Watercourse (2007); DME:EPC1690 (2010), EPC1080 (2011); Adani: Mine Layout / Infrastructure (2013), Mine (Offsite) (2013). Created by: MS & LS



LEGEND

Minor Road
Track
Watercourse
Rail (West) Mine (Offsite)
Mine Site
Pump Station
Storage Facility
Accomodation Village
Airport
Industrial Area

Based on or contains data provided by the State of QLD (DERM) [2010]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:275,000 (at A4)

0 2 4 6 8 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

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Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Project (Mine) Onsite and Offsite Infrastructure - Year 2017

Job Number	41-26585
Revision	B
Date	25-10-2013

Figure A4

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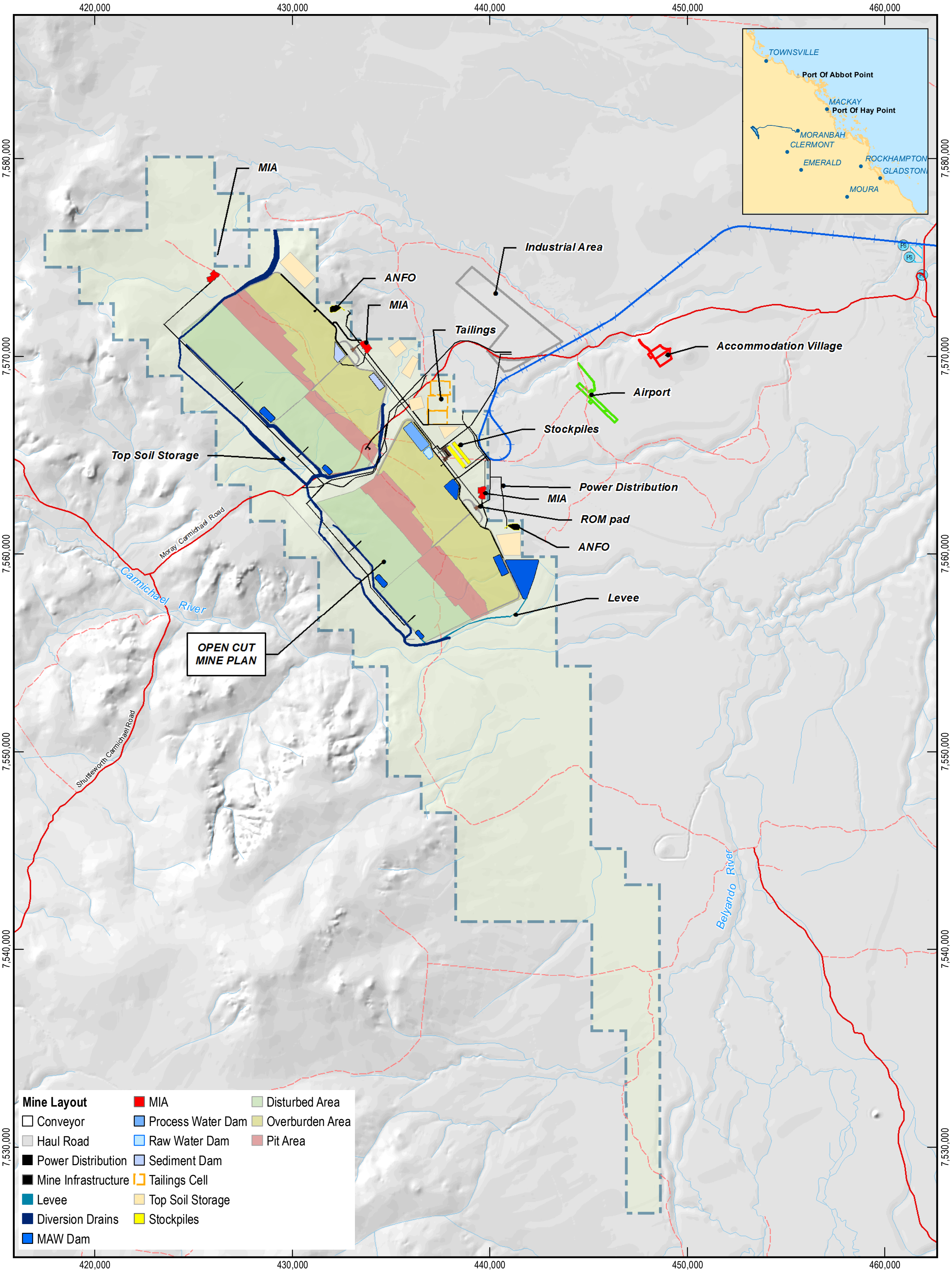

LEGEND

Minor Road
Track
Watercourse
Rail (West) Mine (Offsite)
Mine Site
Pump Station
Storage Facility
Accomodation Village
Airport
Industrial Area

Based on or contains data provided by the State of QLD (DERM) [2010]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:275,000 (at A4)

0 2 4 6 8 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

GHD adani

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Job Number 41-26585
Revision B
Date 25-10-2013

Project (Mine) Onsite and Offsite Infrastructure - Year 2018

Figure A5

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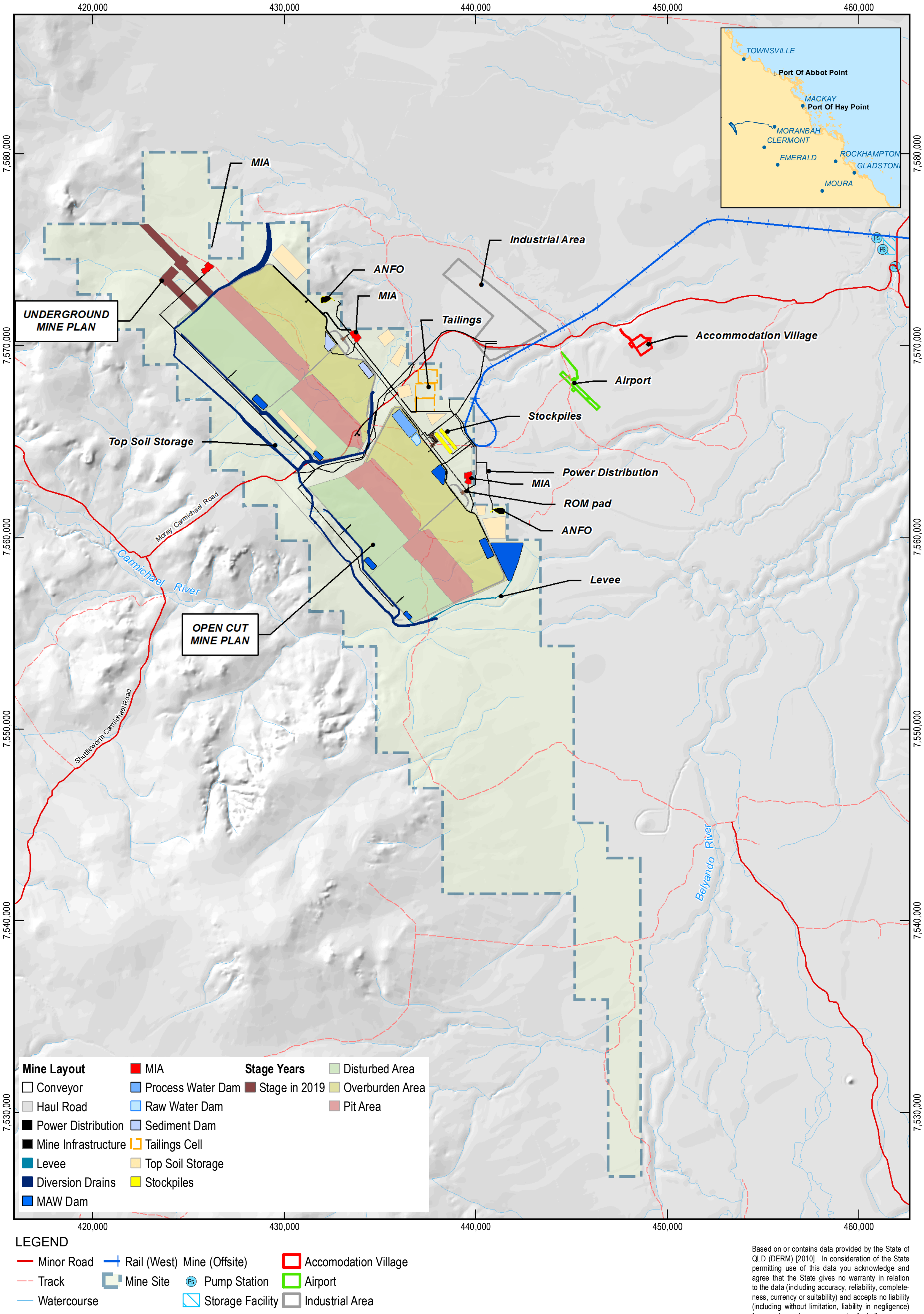
Data Source: GA: Road, River / Watercourse (2007); DME:EPC1690 (2010), EPC1080 (2011); Adani: Mine Layout / Infrastructure (2013), Mine (Offsite) (2013). Created by: MS & LS



Based on or contains data provided by the State of QLD (DERM) [2010]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:275,000 (at A4)

0 2 4 6 8 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

GHD adani

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Job Number 41-26585
Revision B
Date 25-10-2013

Project (Mine) Onsite and Offsite Infrastructure - Year 2019

Figure A6

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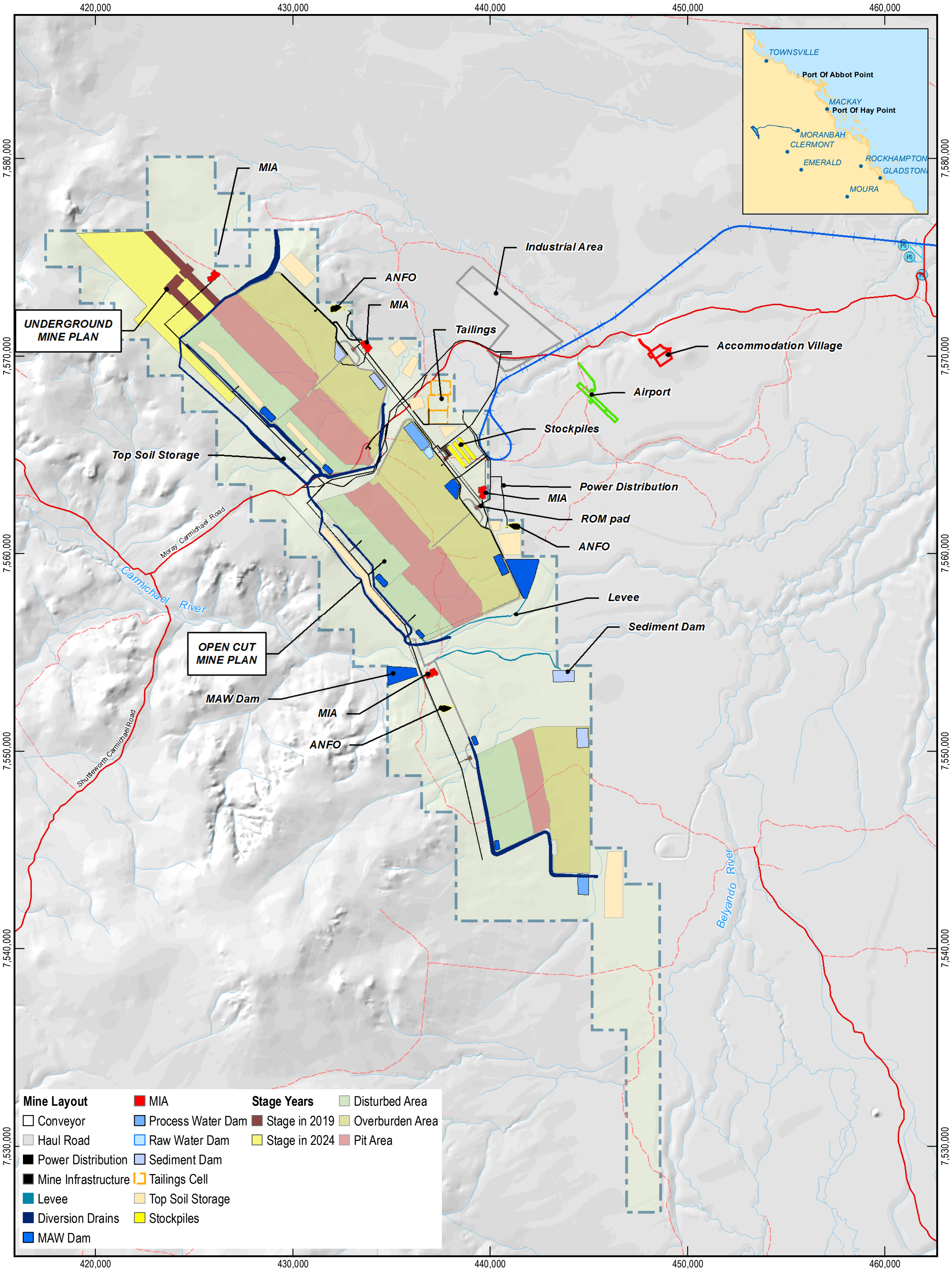

LEGEND

Minor Road | Rail (West) Mine (Offsite) | Accomodation Village
Track | Mine Site | Pump Station | Airport
Watercourse | Storage Facility | Industrial Area

1:275,000 (at A4)

0 2 4 6 8 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

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GHD adani

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Job Number 41-26585
Revision B
Date 25-10-2013

Project (Mine) Onsite and Offsite Infrastructure - Year 2024

Figure A7

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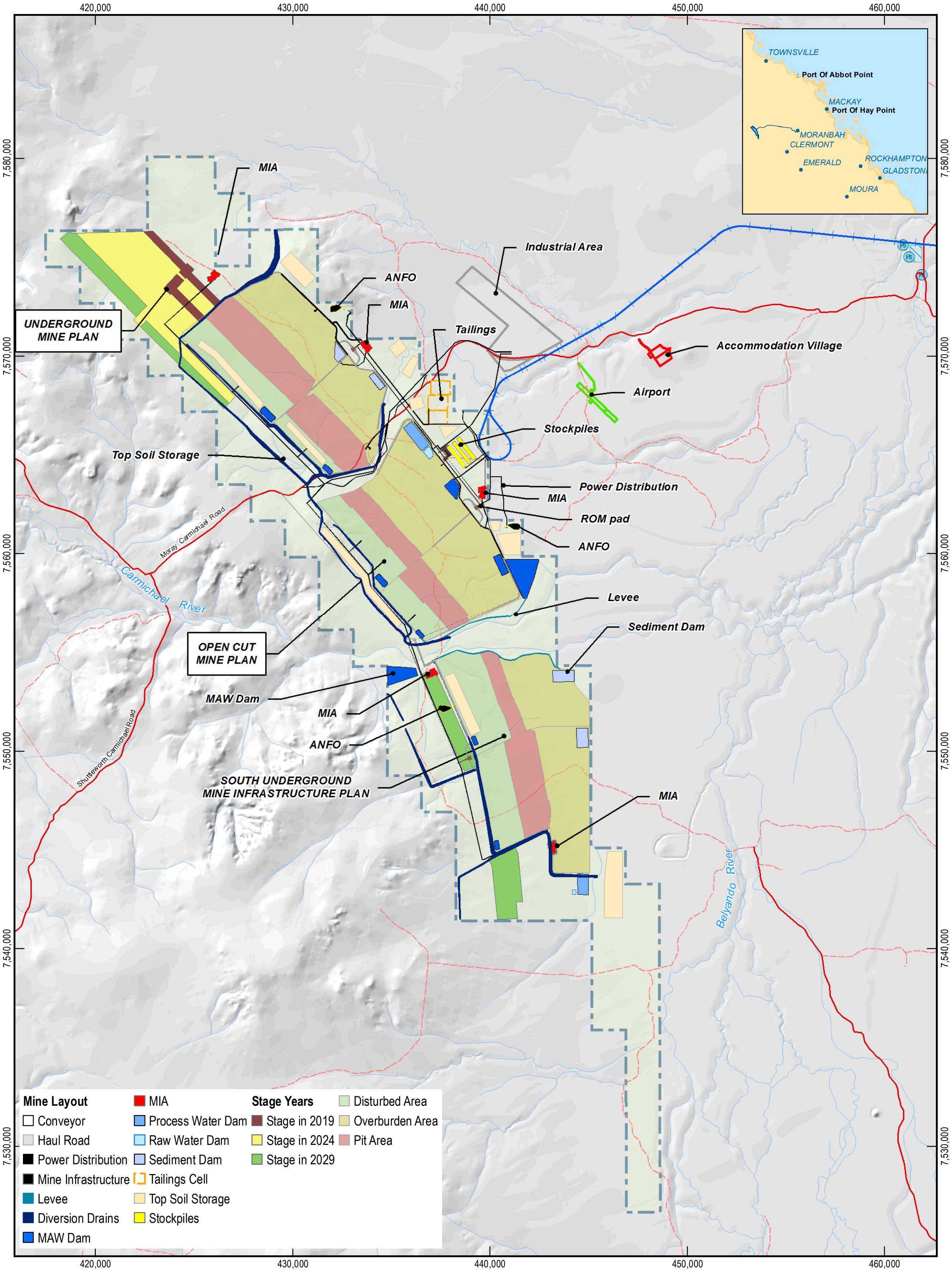

LEGEND

Minor Road — Rail (West) — Mine (Offsite) — Accomodation Village
Track — Mine Site — Pump Station — Airport
Watercourse — Storage Facility — Industrial Area

Based on or contains data provided by the State of QLD (DERM) [2010]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:275,000 (at A4)

0 2 4 6 8 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

GHD adani

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Job Number 41-26585
Revision B
Date 25-10-2013

Project (Mine) Onsite and Offsite Infrastructure - Year 2029

Figure A8

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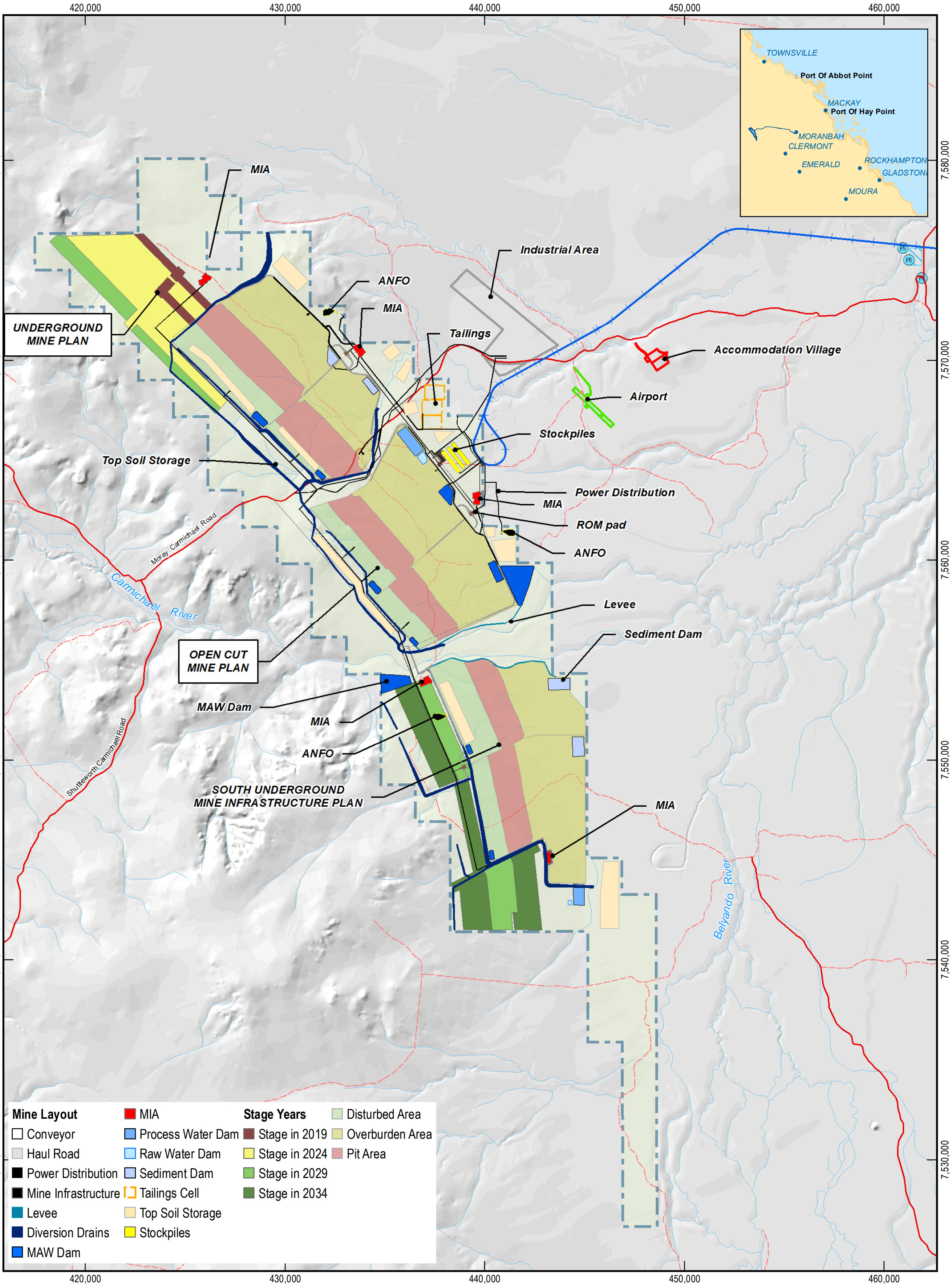

LEGEND

Minor Road | Track | Watercourse | Rail (West) | Mine (Offsite) | Mine Site | Pump Station | Storage Facility | Accomodation Village | Airport | Industrial Area

Based on or contains data provided by the State of QLD (DERM) [2010]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:275,000 (at A4)

0 2 4 6 8 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Job Number 41-26585
Revision B
Date 25-10-2013

Project (Mine) Onsite and Offsite Infrastructure - Year 2034

Figure A9

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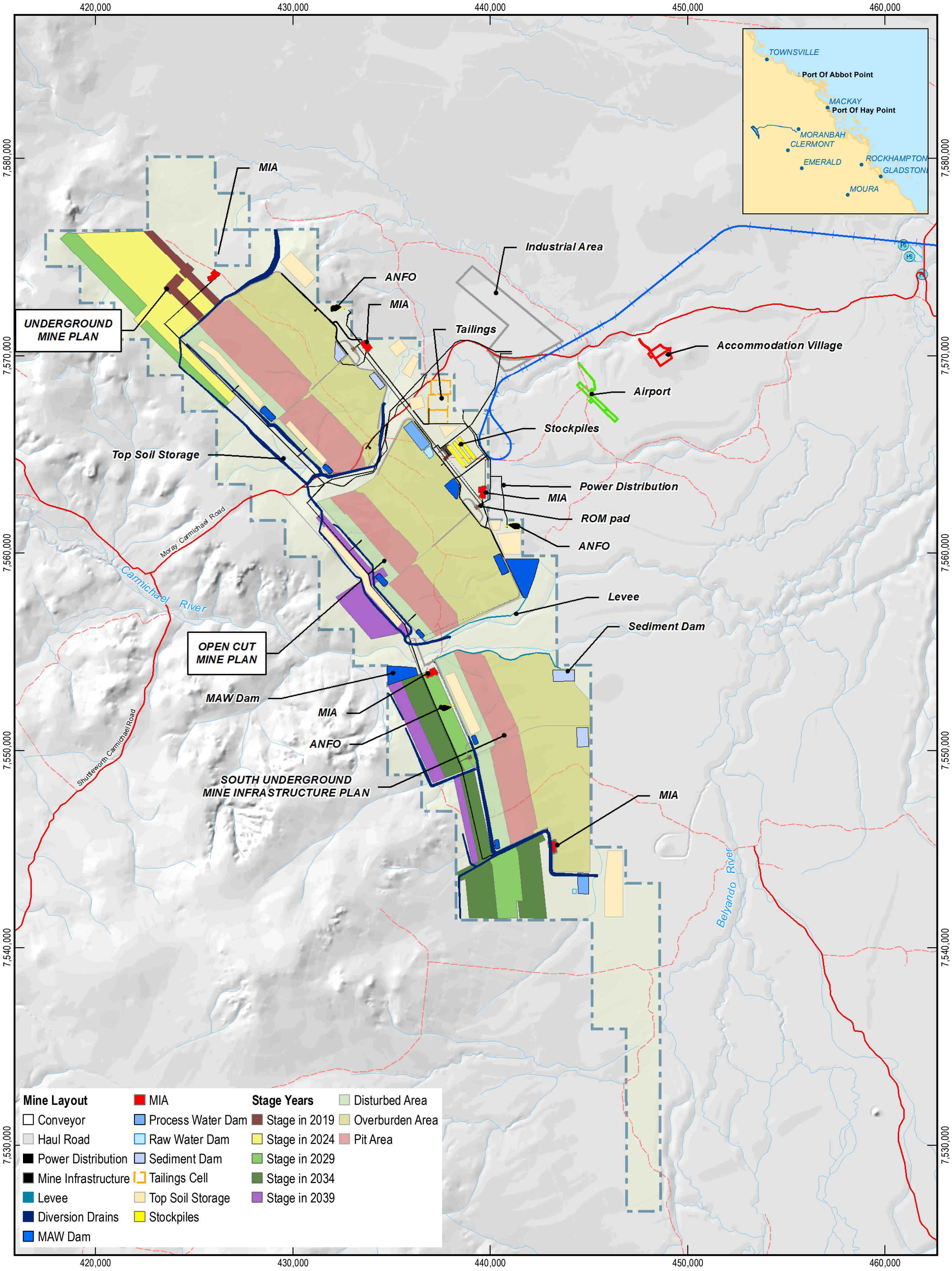

LEGEND

Minor Road
Track
Watercourse
Rail (West) Mine (Offsite)
Mine Site
Pump Station
Storage Facility
Accomodation Village
Airport
Industrial Area

1:275,000 (at A4)

0 2 4 6 8 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

GHD adani

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Job Number 41-26585
Revision B
Date 25-10-2013

Project (Mine) Onsite and Offsite Infrastructure - Year 2039

Figure A10

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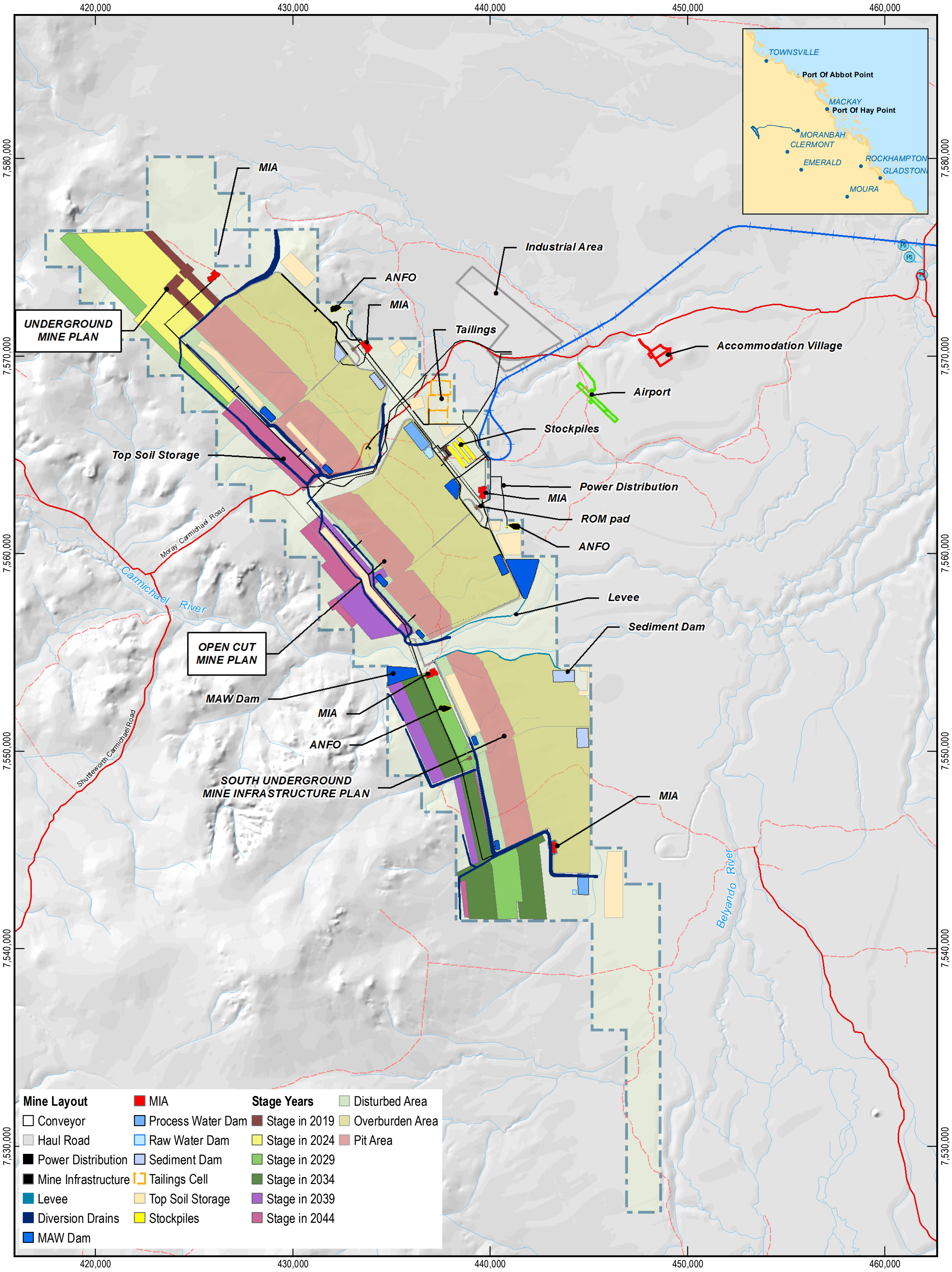
Data Source: GA: Road, River / Watercourse (2007); DME:EPC1690 (2010), EPC1080 (2011); Adani: Mine Layout / Infrastructure (2013), Mine (Offsite) (2013). Created by: MS & LS



LEGEND

- Minor Road
- Track
- Watercourse
- Rail (West)
- Mine (Offsite)
- Mine Site
- Pump Station
- Storage Facility
- Accomodation Village
- Airport
- Industrial Area

1:275,000 (at A4)

0 2 4 6 8 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Job Number	41-26585
Revision	B
Date	25-10-2013

Project (Mine) Onsite and Offsite Infrastructure - Year 2044

Figure A11

G:\41\26585\GIS\Maps\MXD\Automaps\41_26585_Template_rev_a_Year2044_rev_b.mxd

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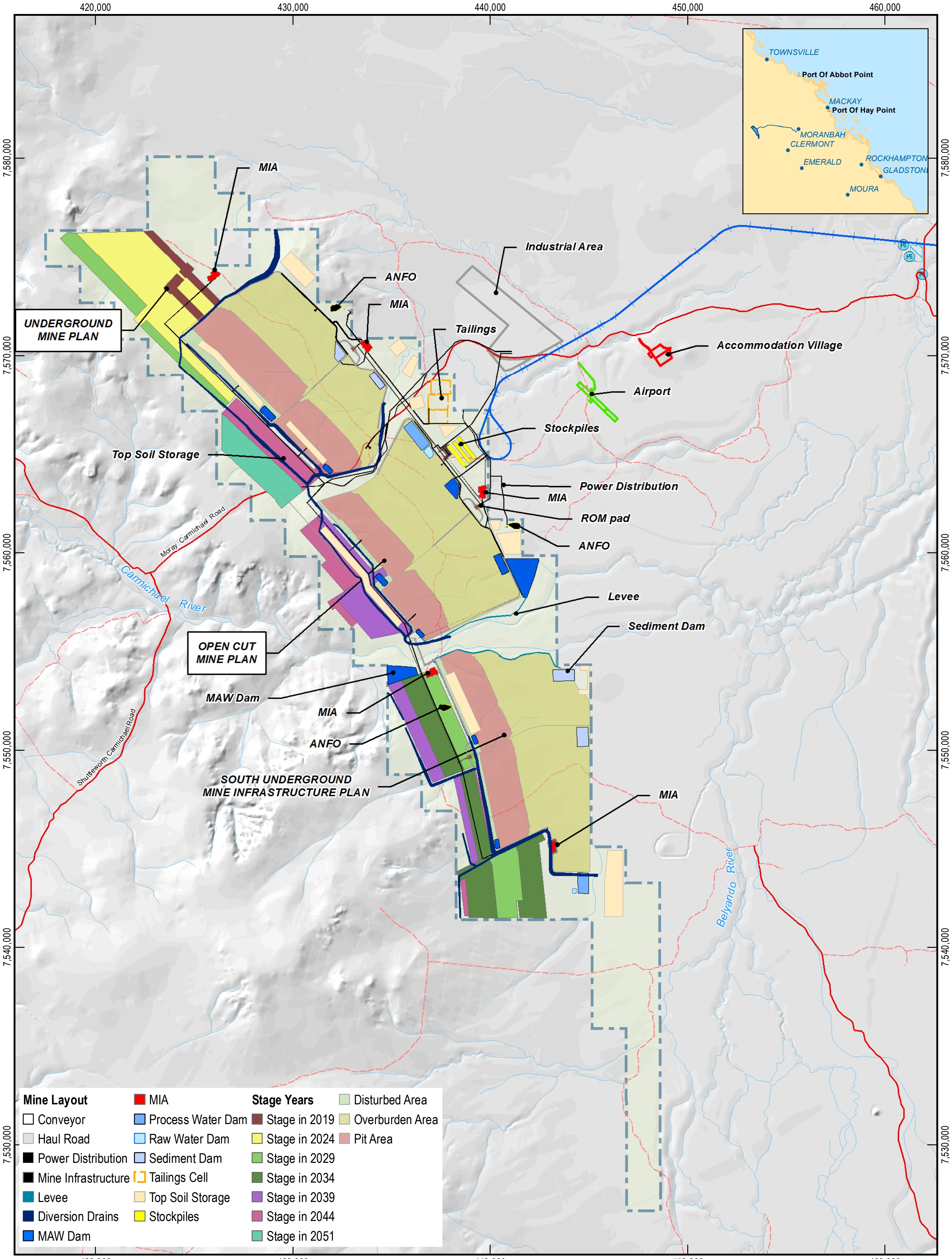

LEGEND

- Minor Road
- Track
- Watercourse
- Rail (West) Mine (Offsite)
- Mine Site
- Pump Station
- Storage Facility
- Accomodation Village
- Airport
- Industrial Area

1:275,000 (at A4)

0 2 4 6 8 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Project (Mine) Onsite and Offsite Infrastructure - Year 2051

Job Number	41-26585
Revision	B
Date	25-10-2013

Figure A12

G:\41\26585\GIS\Maps\MXD\Automaps\41_26585_Template_rev_a_Year2051_rev_b.mxd

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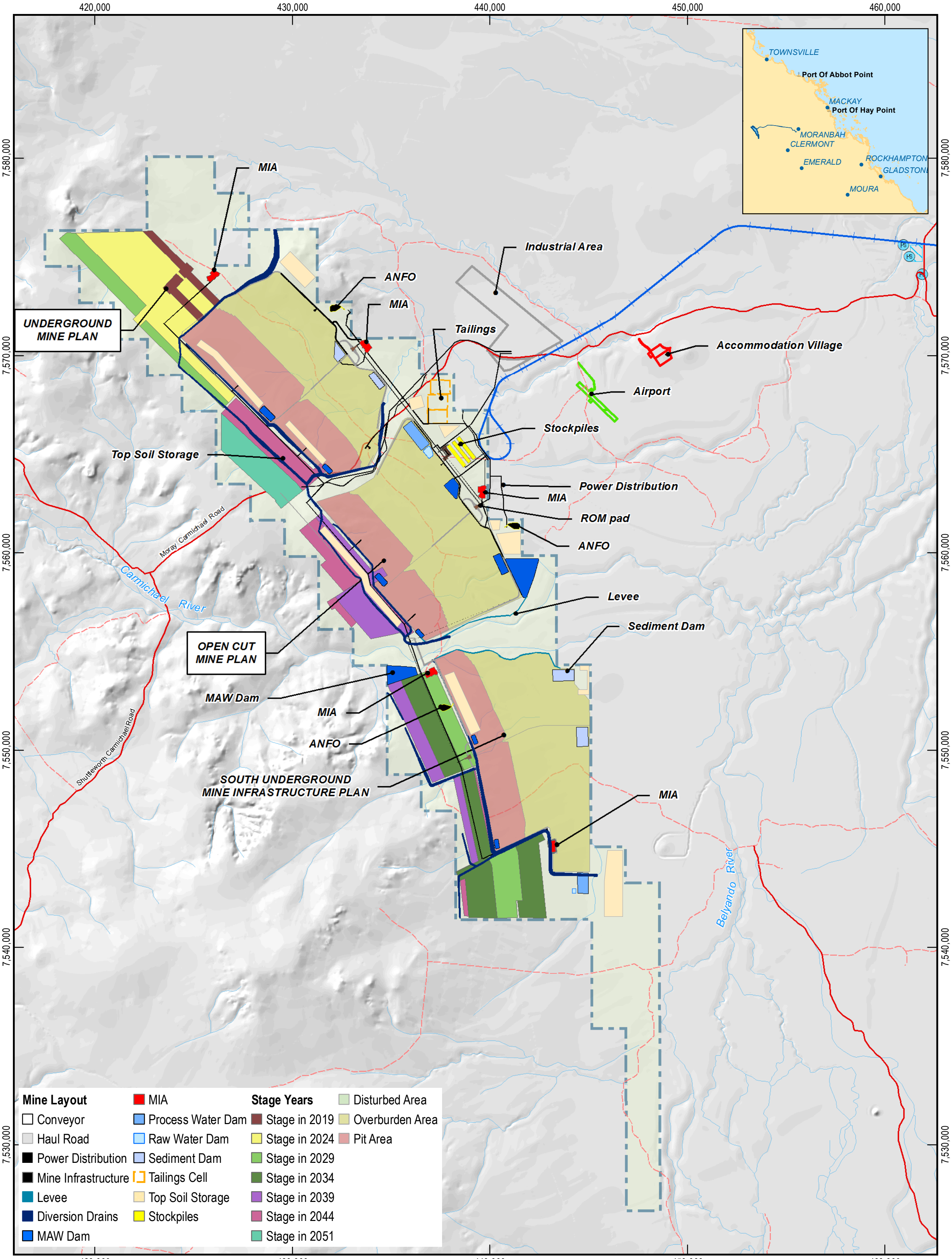


LEGEND

- Minor Road
- Track
- Watercourse
- Rail (West) Mine (Offsite)
- Mine Site
- Pump Station
- Storage Facility
- Accomodation Village
- Airport
- Industrial Area

1:275,000 (at A4)

0 2 4 6 8 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Job Number	41-26585
Revision	B
Date	25-10-2013

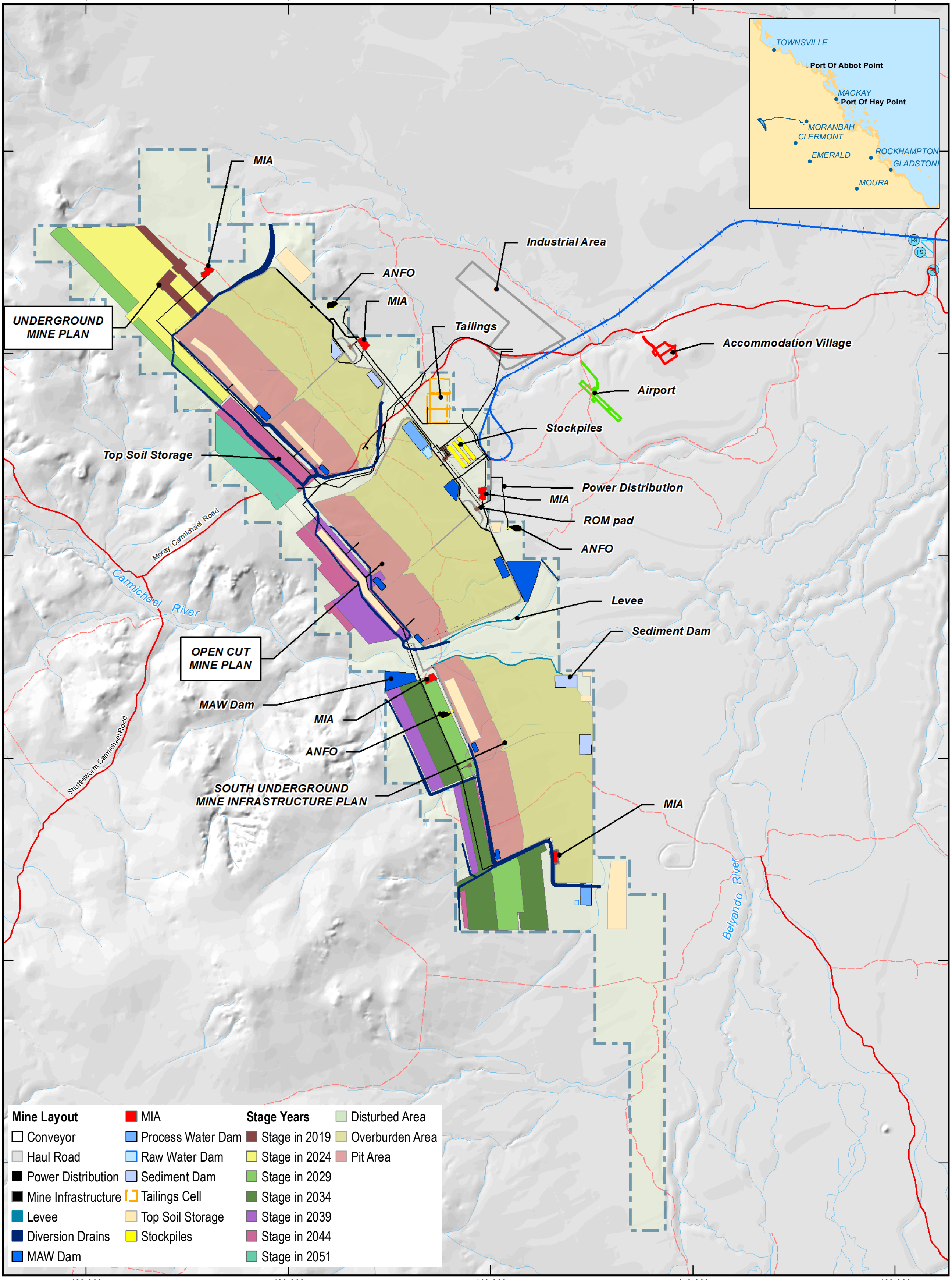
Project (Mine) Onsite and Offsite Infrastructure - Year 2061

Figure A13

G:\41\26585\GIS\Maps\MXD\Automaps\41_26585_Template_rev_a_Year2061_rev_b.mxd

Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: GA: Road, River / Watercourse (2007); DME:EPC1690 (2010), EPC1080 (2011); Adani: Mine Layout / Infrastructure (2013), Mine (Offsite) (2013). Created by: MS & LS



LEGEND

Minor Road
Track
Watercourse
Rail (West) Mine (Offsite)
Mine Site
Pump Station
Storage Facility
Accomodation Village
Airport
Industrial Area

Based on or contains data provided by the State of QLD (DERM) [2010]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:275,000 (at A4)

0 2 4 6 8 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Project (Mine) Onsite and Offsite Infrastructure - Year 2071

Job Number	41-26585
Revision	B
Date	25-10-2013

Figure A14

G:\41\26585\GIS\Maps\MXD\Automaps\41_26585_Template_rev_a_Year2071_rev_b.mxd

Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: GA: Road, River / Watercourse (2007); DME:EPC1690 (2010), EPC1080 (2011); Adani: Mine Layout / Infrastructure (2013), Mine (Offsite) (2013). Created by: MS & LS

Appendix B – Peer Review

Level 11, 344 Queen Street Brisbane QLD 4000
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F: 07 3236 2399
E: admin@engeny.com.au

22 July 2013

Adani Mining Pty Ltd
GPO Box 2569
Brisbane QLD 4001

ATTENTION: Hamish Manzi

Dear Hamish

Peer Review of Water Balance Modelling for Carmichael Coal Project SEIS

Engeny Water Management (Engeny) is pleased to provide the following peer review comments relating to the water balance modelling undertaken by GHD Pty Ltd for the Carmichael Coal Mine and Rail Project Supplementary Environmental Impact Statement (SEIS).

The Carmichael Coal Mine and Rail Project is being developed by Adani Mining Pty Ltd.

1. Scope of Review

Engeny's peer review of the water balance modelling undertaken by GHD Pty Ltd for the Carmichael Coal Mine and Rail Project SEIS has consisted of the following tasks:

- Meeting with personnel from GHD and Adani to develop an understanding of the proposed water management system for the Carmichael Coal Mine.
- Meetings with personnel from GHD and Adani to develop an understanding of the proposed water balance modelling methodology, assumptions and input data.
- Review of GHD Pty Ltd draft Report for Water Balance (Revision A 15 July 2013) prepared for the Carmichael Coal Mine and Rail Project SEIS.

The peer review has focussed on the modelling methodology, assumptions, input data and overall outcomes. The peer review has not included a detailed review of the GoldSim water balance model developed by GHD Pty Ltd.

2. Experience of Peer Reviewer

The peer review has been undertaken by Dr Andrew Vitale who is a civil engineer (Registered Professional Engineer of Queensland) with 19 years of experience in water resources engineering. Andrew has worked on a large range of mine water management projects over the last 12 years including coal, gold, bauxite, nickel and copper mines and coal seam gas facilities.

Andrew has been involved in a significant number of mine water balance modelling projects, and has experience with water balance model development, calibration and operation and also with internal and external peer review of models developed by others.

3. *Objectives of Modelling*

The water balance modelling has been undertaken for the Mine component of the Carmichael Coal Mine and Rail Project.

The stated objectives of the water balance modelling in the Water Balance Report are:

'The water balance has been developed to support the SEIS for the Project with the following specific objectives:

- *Determine the external water supply requirements*
- *Determine required water storage volumes*
- *Determine the requirements of controlled discharge from the project to the environment*
- *Determine the salinity of the potential discharge volumes.'*

4. *Modelling Software*

The water balance model of the Carmichael Coal Mine has been developed using the GoldSim software. The GoldSim software was developed by the GoldSim Technology Group and is a general purpose platform for simulation of dynamic processes. The GoldSim software has good capabilities for stochastic modelling and Montecarlo simulations.

The GoldSim software is widely used in Australia for the development of mine water balance models and the use of this software for the Carmichael Coal Project is consistent with current industry practice.

5. *Proposed Mine Water Management System*

The Carmichael Coal Mine will comprise six open cut mines and five underground longwall mines with a maximum combined production rate of 60 Mtpa (product) and a mine life of 60 years.

The Water Balance Report describes the proposed water management system for the mine which includes:

- An external raw water supply from the Belyando River and/or from groundwater extraction.
- Two raw water dams for storage of raw water.

- Mine affected water (MAW) transfer dams for storage and transfer of water pumped from open cut pits and underground mines.
- MAW storage and transfer dams for two overburden dump areas that will be used to dispose of rejects and filter pressed tailings.
- Central MAW dams for storage, re-use and discharge of mine affected water (transferred from MAW transfer dams).
- Sediment dams for settling and re-use of runoff from overburden dump areas.
- Sediment dams for settling and re-use of runoff from pre-strip areas on the advancing side of the open cut pits.
- Two process water dams for storage and re-use of water transferred from the sediment dams.
- Tailings storage facility for disposal of conventional wet tailings.
- Water distribution systems (pumps and pipework) to transfer water between mine water storages.

Mine water demands will be met where possible through the re-use of water intercepted within the mine water management system (MAW dams and sediment dams), with augmentation provided as required from the external raw water supply.

6. Overall Modelling Approach

The GoldSim water balance model performs daily water and salt balance calculations for the water storages that form part of the mine water management system. The model accounts for the volume of water and the mass and concentration of salt in the mine water storages.

The model has been set-up to run water balance simulations of the 60 year life of the mine, with model inputs (catchment areas, groundwater inflows, water demands, etc.) varying during each year of the simulation in accordance with the proposed mine plan. This continuous modelling approach will account for the carry-over of water between different wet seasons and is considered a good approach.

Rainfall sequences (60 year duration) are selected from the long-term historic rainfall data set (SILO Data Drill), with the starting rainfall year selected randomly and allowing the rainfall data to wrap around between the end and start of the historic rainfall sequence. This approach allows a quasi-stochastic selection of rainfall sequences to be undertaken. The water balance modelling approach utilised a series of 100 stochastically generated rainfall sequences to assess the impact of climate variability on the performance of the water management system.

The combination of continuous modelling over the life of mine and the simulation of a large number of potential rainfall sequences (selected from the long-term historic rainfall data set) is considered a good methodology to assess the performance of the water management system during the life of the mine.

The water balance model includes all key mine water storages (dams and pits) with the exception of the tailings storage facility. The external water source is not specifically modelled, rather the model determines the volume of external water input required to meet all mine water demands (in combination with re-use from the mine water management system).

7. Model Inputs

7.1 Climate Data

Long-term historical daily rainfall and evaporation data used for the water balance model simulations has been obtained from the SILO Data Drill facility. The Data Drill rainfall data is based on an interpolation of observed rainfall data from Bureau of Meteorology weather stations. The use of interpolated rainfall data rather than actual observed rainfall data is considered acceptable given the absence of long-term weather stations in the vicinity of the mine site.

7.2 Catchment Runoff

Catchment runoff is calculated using the AWBM daily rainfall runoff model. This model simulates the non-linear response of runoff to rainfall and is widely used in mine water balance models.

Catchment runoff is calculated separately for the following land use types:

- Industrial (e.g. Mine Industrial Area).
- Spoil (e.g. overburden dumps).
- Disturbed mining (e.g. pre-strip areas).
- Pit.

AWBM model parameters have been assigned for each of these land uses based on the previous experience of the water balance modelling consultant. The consultant has stated that the runoff model parameters are un-calibrated.

It would be useful if the Water Balance Report provided some measure of the amount of runoff generated by the assumed AWBM runoff model parameters for the different land use types (e.g. average annual runoff coefficient). Based on the climate characteristics in the vicinity of the Project, the Peer Reviewer has estimated the following average annual runoff characteristics corresponding to the assumed AWBM model parameters:

- Industrial: 47% average annual runoff coefficient.
- Spoil: 18% average annual runoff coefficient.
- Disturbed mining: 21% average annual runoff coefficient.
- Pit: 18% average annual runoff coefficient.

These runoff characteristics are considered reasonable from an order of magnitude perspective given the lack of site flow gauging data and significant variability in catchment runoff characteristics that can occur.

In the opinion of the Peer Reviewer, the assumed spoil runoff parameters may over-estimate runoff from overburden dumps while the assumed pit runoff characteristics may under-estimate runoff from open cut pits. It would be expected that pits would generate more runoff then overburden dumps (the assumed runoff parameters for these land uses produce similar average runoff generation rates).

It would be useful if the Water Balance Report provided information on runoff generation rates from natural catchment areas (using regional stream gauging data) to provide a benchmark against the assumed runoff characteristics for the mine catchments.

7.3 Catchment Areas

Catchment areas for the different land uses have been determined from the mine plans and vary throughout the life of mine.

7.4 Groundwater Inflows

Groundwater inflows for each year of mining have been input into the water balance model based on groundwater modelling investigations for the Project.

The following groundwater inflows are applied in the model:

- Groundwater inflows to open cut pits (total inflow varies from 1,700 ML/year to 4,300 ML/year).
- Groundwater inflows to underground mines (total inflow varies from 0 ML/year to 5,700 ML/year).
- Advanced pit dewatering: 2,000 ML/year for first five years of mining only.

7.5 Evaporation Losses

Evaporation losses are calculated for the mine water storages based on input lake evaporation rates (from SILO Data Drill). Storage characteristics have been input for the mine water storages which provides for varying evaporation losses depending on the amount of water in the storages.

Chemical evaporation reduction measures are assumed to be applied to the two central MAW dams and the two process water dams to minimise evaporation losses and external water supply requirements. A 50% evaporation reduction rate has been applied for these storages.

The total magnitude of evaporation losses for the mine is not presented in the Water Balance Report.

7.6 Seepage Losses

Seepage losses equivalent to 1% of the volume in the dam per annum have been assumed for the mine water storages.

The total magnitude of seepage losses for the mine is not presented in the Water Balance Report.

7.7 Dust Suppression Water Demand

Dust suppression water demands are calculated for haul road areas and open cut mining operations based on the daily moisture deficit (daily evaporation rate minus daily rainfall rate) and the haul road and open cut mining areas.

Haul road areas have been estimated based on a 40 m average road width while active mining areas in open cut pits are assumed to be 0.5% of the total pit area.

The total magnitude of dust suppression water demand is not presented in the Water Balance Report.

Dust suppression water demands can be met from the central MAW dams, the process water dams or the raw water dams.

7.8 CHPP Water Demand

Water requirements for coal washing are assumed to be 240 L per ROM tonne. Only coal from the open cut mines will require washing. The CHPP gross water requirement varies from 0 to 13,000 ML/year.

The CHPP will produce 60% wet (conventional) tailings and 40% dry (belt press) tailings. It is assumed that 30% of the water in the wet tailings and 47% of the water in the dry tailings will be returned to the CHPP.

It would be useful to identify the net make-up water requirement for the CHPP in the Water Balance Report (i.e. gross water use minus tailings water return) since this will be the amount of water addition required to operate the CHPP.

CHPP make-up water demands can be met from the central MAW dams or the process water dams.

7.9 Longwall Mine Water Demand

Water requirements for longwall mining are estimated at 2.25 ML/day per longwall panel mined. The total longwall mining water demand varies from 0 to 3,285 ML/year (0 to 4 longwall panels being mined).

It is assumed that 80% of the water used in the underground mines will be returned back into the water management system through dewatering of the underground mines into the MAW transfer dams.

Longwall mine water demands can be met from the process water dams or the raw water dams (mine affected water not suitable for longwall mine use).

7.10 Vehicle Washdown Demand

Net water requirements for vehicle washdown (total use minus recycle rate) are estimated at 3.65 to 18.25 ML/year. This washdown demand appears to be low for a large scale coal mine, however it is acknowledged that washdown water demands will be significantly smaller than the other mine water demands and only a small component of the overall site water balance.

7.11 Potable Water Demand

Potable water demands are estimated to vary from 182 to 222 ML/year and will be met from the raw water dams (water treatment required).

7.11 Controlled Releases

The central MAW dams will be used to release excess mine affected water to the Carmichael River during periods of stream flows in accordance with Environmental Authority conditions.

Controlled releases from the central MAW dams have not been included in the water balance model. The volume of overflows from the central MAW dams have been used to indicate the requirement for release of mine affected water from the mine site.

Additional modelling will be required to refine the design of the mine affected water release system for the mine, including prediction of salinity in the central MAW dams, modelling of stream flows and salinity in the Carmichael River, and identification of the required capacity of release infrastructure to make use of release opportunities.

7.12 Dam Storage Capacities

Preliminary dam storage capacities are identified in the Water Balance Report. A total out-of-pit water storage capacity of approximately 58 GL has been identified for the mine consisting of:

- 43 GL of mine affected water dams.
- 5 GL of process water dams.
- 8 GL of sediment dams.
- 2 GL of raw water dams.

The predicted frequency of overflows from the mine water storages has not been made clear in the Water Balance Report, however it appears that the raw water dams, process water dams, MAW transfer dams and MAW overburden dams have been designed not to overflow, while regular overflows will occur from the sediment dams and releases of mine affected water will be required from the central MAW dams.

7.13 Water Quality

At the time of the peer review, no details of the water quality calculations were provided in the Water Balance Report (e.g. total dissolved solids concentrations of catchment runoff, groundwater inflows, etc.). The Peer Reviewer acknowledges that it is difficult to assign water quality parameters in the absence of any site specific water quality data.

8. Model Checks and Balances

The water balance model includes flow and salt balance checks that ensure that all water and salt inflows and outflows have been correctly accounted for in the water balance calculations. This is considered good modelling practice.

9. Presentation of Model Results

The following results are presented in the Water Balance Model Report:

- Statistics of external raw water supply requirements (approx. 12,000 ML/year external raw water supply required to achieve a 95% supply reliability).
- Average overflow volumes for overburden dump sediment dams (average annual overflow of up to 800 ML/year).
- Average overflow volumes from the central MAW dams (average annual overflow of up to 7,000 ML/year). This is used to indicate the requirement for mine affected water releases required to prevent uncontrolled overflows of MAW from the mine.

The Peer Reviewer believes the presentation of the following additional results is required to provide a better understanding of the water balance of the proposed Carmichael Coal Mine:

- Breakdown of average annual inflows and outflows for a limited number of mining horizons. This will provide an understanding of the relative magnitudes of the different inflows and outflows. Inflows should include external raw water supply, rainfall runoff, groundwater inflows to open cut pits, groundwater inflows to underground mines, and advance pit dewatering. Outflows should include evaporation losses, seepage losses, dust suppression water usage, net CHPP make-up water usage, net longwall mine water use, net washdown water use, potable water use, controlled releases (central MAW overflows), and storage overflows.
- Statistics (e.g. 10th, 50th and 90th percentile) of climate dependent inflows and outflows including rainfall runoff volumes, evaporation losses, seepage losses, dust suppression use, controlled releases (central MAW overflows), and storage overflows. The presentation of average results only for sediment dam and central MAW dam overflows does not provide an understanding of the potential magnitude of mine releases and overflows during high rainfall wet seasons.

- Expected water quality of controlled releases from the central MAW dams.

10. Overall Peer Review Opinion

The Peer Reviewer is of the opinion that the water balance modelling has been undertaken in accordance with good industry practice for mine water balance modelling.

The water balance model includes all relevant inflows and outflows and simulates the proposed mine water management system to an acceptable level of accuracy for an Environmental Impact Statement technical study. Climate variability has been adequately considered in the modelling through the use of continuous modelling methods and stochastic selection of rainfall sequences. Model inputs are generally reasonable and consistent with the accuracy and availability of baseline data. Flow and salt balance checks are included in the water balance model to ensure that all water and salt inflows and outflows have been correctly accounted for in the water balance calculations.

The water balance model is an un-validated model and will require further refinement during the future planning and design of the mine.

The main findings of the water balance modelling are as follows:

- A large external water supply will be required to ensure that the estimated mine water demands can be met during dry years.
- Large water storage dams will be required to manage the water intercepted by the mining operations.
- Overflows are likely to occur from the sediment dams in the majority of years.
- Releases of mine affected water are likely to be required in the majority of years.

The Peer Reviewer has not been privy to specific submissions received on the EIS and hence cannot make an assessment of the suitability of the presented water balance modelling results to address the EIS submissions.

Yours faithfully

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Appendix C – Flows in the Carmichael River

Flows in the Carmichael River

As there is currently no adequate historical flow data available for the Carmichael River, a rudimentary methodology has been employed to relate flows in the Belyando River (for which there is a historical record) to potential flows in the Carmichael River.

For the Belyando River, mean daily stream gauge data was obtained for Station 120301B Belyando River at Gregory Development Road (DEHP, 2012). An artificial flow record was created for the Carmichael River by applying a scaling factor (see equation below) to the Belyando flows. The scaling factor is based on the ratio of peak 2-year average recurrence interval (ARI) design flow rates estimated by the Quantile Regression Technique (QRT) (Palmen and Weeks, 2009).

$$Scaling\ Factor = \frac{Q\ (2\ year\ ARI)_{\ Carmichael\ River}}{Q\ (2\ year\ ARI)_{\ Belyando\ River}}$$

$$Where\ Q\ (2\ year\ ARI) = 10^{\left[-0.915+\left(0.757xLog_{10_{Area}}\right)+\left(1.588xLog_{10_{i72h50y}}\right)\right]}$$

In the absence of suitable historical or calibration data for the Carmichael River this is considered a reasonable estimate of the relationship between flows in the two rivers. The QRT is a regional flood estimation method developed in and for Queensland and scales with the logarithmic transform of the catchment area. It is a more realistic method for equating the river flows than simply a linear approach, as a catchment that is ten times the size doesn't produce ten times the peak flows. This approach assumes "hydrological similarity" between the two rivers, and needs to be verified and refined when data becomes available.

The resulting scaling factor of 0.13 was adopted, based on the 35,410 km^2 Belyando catchment area contributing to the Gregory Development Road gauge and the 2,302 km^2 Carmichael River sub-catchment area contributing at the proposed mine site.

The average flow for each day of the year was calculated based on the available record of 37 years. However, 2008 was excluded to obtain more conservative flows since large flooding in this year skewed the 'average year' daily flows to be larger than what would otherwise be expected.

Based on recently published release conditions for other mines, among others for Alpha Mine, it may be expected that the conditions will allow for 'staged release conditions', i.e. maximum discharge volumes are linked to flow conditions. In Table B-1 the release conditions for Alpha Coal Mine are presented.

Release conditions Alpha Coal Mine

Table A19: Mine Affected Water Release during Flow Events

Receiving waters	Release Point (RP)	Gauging Station[1]	Gauging Station Northing (GDA94)[1]	Gauging Station Easting (GDA94)[1]	Receiving Water Flow Recording Frequency	Receiving Water Flow Criteria for discharge (m^3/s)	Maximum release rate for all combined RP flows (m^3/s)	Electrical Conductivity and Sulfate Release Limits
Lagoon Creek	RP1 RP2 RP3 RP4 RP5 RP6 RP7 RP8 RP9 RP10				Continuous	<5 m^3/s	1 m^3/s	Maximum Electrical Conductivity: 250 µS/cm Maximum Sulfate (SO_4^{2-}): 250 mg/L
						>5 m^3/s to 10 m^3/s	1.7 m^3/s	Maximum Electrical Conductivity: 2500 µS/cm Maximum Sulfate (SO_4^{2-}): 985 mg/L
						10 m^3/s to 15 m^3/s	3.5 m^3/s	
						15 m^3/s to 20 m^3/s	5.2 m^3/s	
						20 m^3/s to 25 m^3/s	6.9 m^3/s	
						25 m^3/s to 50 m^3/s	4 m^3/s	Maximum Electrical Conductivity: 3500 µS/cm Maximum Sulfate (SO_4^{2-}): 1800 mg/L
						> 50 m^3/s	8 m^3/s	

Alpha coal mine is much higher in the Belyando catchment than the Carmichael Coal Mine. For this reason the catchment contributing to flows at discharge points is much smaller. Flows receiving the discharges will also be smaller. The discharge conditions for the Carmichael Coal Mine will potentially reflect the larger flows lower in the catchment with the likely difference to be in the low flow discharge condition. Potential discharges for the Project have been calculated with the Alpha Coal Mine conditions and are presented in Table B-2.

Potential Monthly Discharges to the Carmichael River for an ‘Average Flow Year’

Month	Potential discharge volume (ML)
January	3,223
February	6,463
March	4,510
April	2,592
May	3,102
June	2,592
July	2,678
August	2,678
September	2,333
October	2,678
November	2,592
December	2,678
Annual (ML)	38,000

In summary there is potential to release an average of 38,000 ML annually into the Carmichael River when comparable conditions as for the Alpha Coal Mine are enforced for the Project.

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