PROJECT CHINA STONE

Water Management System Modelling Report

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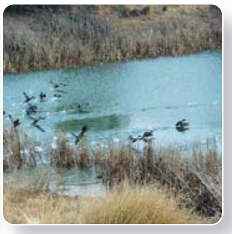

PROJECT CHINA STONE

WATER MANAGEMENT SYSTEM MODELLING REPORT

for

MacMines Austasia Pty Ltd

March 2015

Hansen Bailey
ENVIRONMENTAL CONSULTANTS

PROJECT CHINA STONE

WATER MANAGEMENT SYSTEM MODELLING REPORT

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17 March 2015

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1 INTRODUCTION

Hansen Bailey was commissioned by MacMines Austasia Pty Ltd (the proponent) to complete an assessment of water management system performance as part of the Environmental Impact Statement (EIS) for Project China Stone (the project).

1.1 PROJECT DESCRIPTION

The project involves the construction and operation of a large-scale coal mine on a greenfield site in Central Queensland. The project site (the area that will ultimately form the mining leases for the project) is remote, being located approximately 270 km south of Townsville and 300 km west of Mackay at the northern end of the Galilee Basin (Figure 1). The closest townships are Charters Towers, approximately 285 km by road to the north, and Clermont, approximately 260 km by road to the south-east. The project site comprises approximately 20,000 ha of well vegetated land, with low-lying scrub in the south and east and a densely vegetated ridgeline, known as ‘Darkies Range’, running north to south through the western portion of the site.

The mine will produce up to approximately 55 million tonnes per annum of Run of Mine thermal coal. Coal will be mined using both open cut and underground mining methods. Open cut mining operations will involve multiple draglines and truck and shovel pre-stripping. Underground mining will involve up to three operating longwalls. Coal will be washed and processed on site and product coal will be transported from site by rail. It is anticipated that mine construction will commence in 2016 and the mine life will be in the order of 50 years.

The majority of the mine infrastructure will be located in the eastern portion of the project site (Figure 2). Infrastructure will include coal handling and preparation plants (CHPPs), stockpiles, conveyors, rail loop and train loading facilities, workshops, dams, tailings storage facility (TSF) and a power station. A workforce accommodation village and private airstrip will also be located in the eastern part of the project site.

The scope of this assessment is restricted to assessing activities that are proposed to be undertaken within the project site and no off-lease activities are considered in this assessment.

1.2 SCOPE AND STRUCTURE

Hansen Bailey has developed a conceptual mine water management system in conjunction with the proponent to support the EIS assessment of surface water impacts for the project. This report provides a detailed description of the modelling undertaken to inform the design and assess the operational performance of the mine water management system.

This report is presented as a technical appendix to the EIS and is intended to be read in conjunction with the surface water assessment presented in the EIS Surface Water Section.

Section 2 of this report provides an overview of the proposed mine water management system for the project, and summarises key water supplies and demands. A more detailed description of the operation of the mine water management system is provided in the EIS Surface Water Section.

A discussion of the regulatory requirements relevant to the design and operational performance of the water management system is presented in Section 3.

Section 4 provides a detailed overview of the modelling method and logic adopted for this assessment. Section 5 presents the modelling results, including dam sizing, external raw water supply requirements and frequency and volumes of controlled release of mine-affected water.

Section 6 provides an overview of water management system monitoring and management.

Section 7 presents the methodology and results for the modelling of the accumulation of water in the remnant final voids.

2 MINE WATER MANAGEMENT SYSTEM

2.1 OVERVIEW

A schematic of the project water management system, showing water supplies and water demands, is shown in Figure 3. The location of key dam storages and other relevant mine infrastructure are shown on Figure 4.

The project will generate mine-affected waters comprising rainfall runoff from mine infrastructure area catchments, pit water from underground and open cut mining areas and return water from mine waste storage facilities. The project will require additional water to be supplied from external sources. The project water demands and supplies are discussed in Sections 2.2 and 2.3, respectively.

The proposed management strategies for mine-affected waters generated by the project are based on the quality of the water and are designed to prevent any adverse impacts on the receiving environment. The requirements to maximise the reuse of mine-affected water for water supply, minimise the demand for external water supply and minimise the risk of uncontrolled discharge of any mine-affected water from the project site were key considerations in the selection of appropriate water management strategies. Detailed strategies for the management of mine-affected waters generated by the project are described in the EIS Surface Water Section.

2.2 WATER DEMANDS

The water demands of the project are listed in Table 1.

Table 1
Summary of Project Water Demands

Project Water Demand	Preferred Modelled Source	Secondary Modelled Source	Peak Demand (MLpa)
CHPP Water Supply	Mine-affected	External	7,288
Power Station	External	n/a	2,975
Dust Suppression	Mine-affected	External	1,811
Northern Underground	External	n/a	1,251
Southern Underground	External	n/a	626
Water Treatment Plant	External	n/a	266
Vehicle Washdown	External	n/a	110

Graphs illustrating the dynamic profile of water demands over the mine life are shown in Appendix A.

Project water demands have been derived from a combination of design specifications and equipment reliability data provided by the proponent and mine site operational experience. All water demands reflect the mine plans and production schedule, and equipment numbers and workforce profile over the life of the project.

The total project water demand peaks at approximately 14,300 MLpa in Project Year 10 (Figure A8). The project water demand will build up progressively over the first eight years of the project at which time both the Northern and Southern Underground Mines will be operating and open cut mining will be close to full production. Water demand will plateau at approximately 14,000 MLpa until Project Year 16, mirroring mine production rates. Water demand will then decrease gradually until Project Year 31 as mining at the Southern Underground, D Seam longwall and open cut all reach completion and associated demands cease. Water demand will remain at approximately 4,800 MLpa over the remainder of the project life, and is largely attributable to dust suppression, power station and CHPP demands.

2.3 WATER SUPPLIES

The water supplies of the project are discussed in the following sections and summarised in Table 2. Graphs illustrating the dynamic profile of key supplies over the life of the project are shown in Appendix B.

Table 2
Sources of Water Supply

Project Water Supply	Water Volume
External Water Supply	As required.
TSF Return Water	Variable recovered supernatant from the deposited tailings of up to approximately 1,500 MLpa; and Variable direct rainfall runoff from the TSF area.
PSWSF Runoff	Variable direct rainfall runoff from the PSWSF area.
Infrastructure Area Runoff	Variable mine-affected runoff from contained infrastructure area catchments including the underground and open cut MIAs, coal and reject stockpile areas, vehicle wash down, servicing and refueling facilities, the power station and train loadout.
Underground Pit Dewatering	Variable groundwater inflows up to approximately 850 MLpa in the Northern Underground and 920 MLpa in the Southern Underground; and Variable excess underground water supply recycled from underground mining operations at up to 500 MLpa from the Northern Underground and 250 MLpa from the Southern Underground.
Open Cut Pit Dewatering	Variable groundwater inflows up to approximately 2,440 MLpa; and Variable rainfall runoff to the open cut pit catchment.

2.3.1 External Water Supply

External water supply will be required to supply demands which require consistently high water quality as indicated in Figure 3. Additional external water supply will also be required during dry periods when mine water stored on site is insufficient to meet mine water demands. The proponent is currently considering options for sourcing external water supplies. Water supply arrangements are discussed in the EIS Surface Water Section.

2.3.2 TSF Return Water

The project will involve the construction of a conventional wet TSF. The footprint of the completed TSF will cover an area of approximately 603 ha and will be developed progressively over the 50 year project life. The catchment of the active TSF area will be isolated by the TSF embankment and temporary diversion drains in the period prior to completion of construction of the embankment around the TSF perimeter.

Tailings will be pumped to the TSF from the CHPP as a slurry. Tailings solids will settle out of suspension within the TSF and supernatant will collect in a decant pond maintained at the low point within the TSF. Rainfall runoff from within the TSF will also collect within the TSF decant pond.

Geochemical characterisation of the tailings was completed as part of the EIS Geochemistry Report. The quality of this water is discussed in Section 4.6.

The management of TSF return water will involve containment within the TSF and the Return Water Dam. The TSF will be constructed and operated such that sufficient freeboard is maintained above the deposited tailings and decant pond to contain rainfall and prevent any potential overflows. A pontoon mounted pump will be moored in the TSF decant pond. This pump will maintain a low level in the TSF decant pond by transferring water to the Return Water Dam. The Return Water Dam storage will be a priority water supply for the CHPP.

2.3.3 Power Station Waste Storage Facility Runoff

The project will involve the construction of a power station waste storage facility (PSWSF) that will store dry waste from the power station for the first 10 years of operations. The completed PSWSF will cover an area of approximately 73 ha and will be developed progressively over the first 10 years of the project. The catchment of the active PSWSF will be isolated by perimeter diversion drains.

The PSWSF will be developed by placing dry power station waste using trucks, similar to an out-of-pit overburden emplacement. The PSWF will be developed such that surface runoff from active emplacement areas drains to internal collection sumps. Rainfall runoff that collects in these sumps will be pumped to the adjacent TSF and will report to the TSF decant pond.

Geochemical characterisation of the power station waste material was completed as part of the EIS Geochemistry Report. The quality of this water is discussed in Section 4.6.

2.3.4 Infrastructure Area Runoff

Runoff from some mine infrastructure areas may contain elevated levels of suspended sediment and possibly hydrocarbons or other chemicals.

These infrastructure area catchments will be isolated with diversion drains and/or bunding, where necessary. Runoff from these areas will be collected in collection drains, directed through sediment traps (and oil separators where hydrocarbons are potentially present), and collected in a dedicated catch dam. Catch dams will be maintained with full storage capacity available for the collection of rainfall runoff. Any collected rainfall runoff will be transferred to a central Industrial Area Dam for use as mine water supply. Each of the catch dams has been sized to ensure they have a low probability of overflow.

2.3.5 Underground Pit Dewatering

Underground mine pit water comprises groundwater inflow to the underground workings and excess underground water supply recycled from longwall mining operations.

Groundwater modelling presented in the EIS Groundwater Report predicts that the rate of groundwater inflow to mine workings will generally increase as the mine excavation increases in area and depth. Groundwater inflows to the Northern Underground are predicted to peak at a rate of 1,410 MLpa at Project Year 16. Inflows to the Southern Underground are predicted to peak at 920 MLpa at Project Year 13. A factor of 0.6 has been applied to these modelled inflow rates to convert them to dewatering volumes. This accounts for losses due to evaporation and infiltration to the walls and floor of the underground workings.

Approximately 250 MLpa of excess underground water supply is estimated to be recycled from each of the longwall mines when in operation. This water will collect in underground sumps with groundwater inflow.

Underground mine pit water quality will be variable and dependent on the relative contributions of raw water and groundwater inflow.

The EIS Groundwater Report states that salinity is the primary consideration with respect to groundwater inflow quality. The report presents water quality data that shows coal seam groundwater to be fresh to moderately saline, with an average electrical conductivity (EC) of

2,000 µS/cm in the Southern Underground Mining Area and 1,700 µS/cm in the Northern Underground Mining Area. Given groundwater will make up only a portion of the total pit water, the salinity of the pit water will be lower than the groundwater. Pit water pumped from the underground mines may also contain elevated levels of suspended sediment. Water quality is discussed further in Section 4.6.

The management of underground mine pit water will involve pumping it to the surface, containment in dedicated on-site storage dams and use as mine water supply. Both the northern and southern undergrounds will have pit water dams at their respective mine industrial areas (MIAs) (Figure 4). Pit water from the undergrounds will be pumped to the MIA pit water dams. Water stored in the MIA pit water dams will be pumped to a central dedicated Mine Water Dam for reuse as mine water supply. The pit water dams will each have nil catchment and will be operated with maximum operating storage levels and minimum freeboard to ensure nil overflow.

2.3.6 Open Cut Pit Dewatering

Open cut mine pit water will include groundwater inflow to the open cut mine and runoff from the open cut pit catchment.

Groundwater modelling presented in the EIS Groundwater Report predicts that groundwater inflows to the open cut mine will generally increase with the size of the excavation. Groundwater dewatering volumes account for losses due to surface wetting, evaporation and infiltration to the walls and floor of the pit. The peak groundwater dewatering volume is 2,440 MLpa.

The open cut pit catchment will increase progressively over the mine life as the open cut mine develops. The pit catchment area will include the active pit area as well as any areas of the overburden emplacement and areas above the highwall that cannot be drained around or away from the pit. The open cut mine drainage strategy is designed to limit the catchment area of the open cut pit. This strategy will minimise potential disruption to production due to flooding of the pit and also minimise the generation of large volumes of mine-affected pit water from rainfall runoff.

Open cut pit water quality will vary depending on the relative contributions from groundwater inflow and rainfall runoff. The quality of this water is discussed in Section 4.6.

Pit water will drain to collection sumps in the floor of the open cut pit. The management of open cut mine pit water will involve containment in dedicated on-site storage dams and use as mine water supply. A series of four open cut pit water dams will be located along the length of the open cut mining area (Figure 4). Water from pit sumps along the length of the active pit will be transferred to these dams. Water from these dams will then be pumped to the Mine Water Dam for storage and use as mine water supply. The pit water dams will each have nil catchment and will be operated with maximum operating storage levels and minimum freeboard to ensure nil overflow.

3 REGULATORY REQUIREMENTS

3.1 OVERVIEW

The *Guideline: Structures which are dams or levees constructed as part of environmentally relevant activities* and the accompanying *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (the Manual) detail the regulatory requirements in relation to the design and certification of dams constructed as part of environmentally relevant activities (ERAs) under the *Environmental Protection Act 1994* (EP Act).

The design and performance criteria applicable to the mine water management system are derived from an assessment of the consequence categories of the proposed water dams in accordance with the Manual. Dams determined to be 'significant' or 'high' consequence category structures in terms of potential to overflow are required to meet the following requirements:

- Provide a storage allowance termed the Design Storage Allowance (DSA) at 1 November each year;
- Provide a storm storage allowance termed the Extreme Storm Storage (ESS); and
- Determine the warning level or Mandatory Reporting Level (MRL) for dam(s) where the remaining available volume is equivalent to the ESS.

No DSA or ESS requirements are applicable to 'low' consequence category structures.

Where dams are designed to operate as part of an interconnected mine water storage system, the DSA and ESS requirements may be shared across multiple storages within the system. Storages for the purposes of this assessment include pits and voids.

3.2 ASSESSMENT OF PROJECT DESIGN REQUIREMENTS

A preliminary consequence category assessment of the proposed mine water dams has been undertaken for the EIS and is presented in the EIS Surface Water Section. The preliminary assessment concludes that the proposed dams are considered 'low' consequence category structures and are not considered to be 'regulated structures' under the EP Act. Further consequence category assessment and refinement of the mine water management system will be undertaken at the detailed design stage.

Notwithstanding the preliminary assessment, DSA volumes and ESS volumes/MRL levels have been determined for the integrated mine water system in accordance with the Manual requirements for ‘significant’ hazard category structures. This will ensure that the mine water management system complies with the design and performance requirements in the event that any of the dams are assessed as regulated structures at the subsequent detailed design stage. DSA volumes and ESS volumes/MRL levels are discussed in Section 4.5.1.

4 WATER MANAGEMENT SYSTEM MODEL

4.1 MODEL OVERVIEW

An operational simulation model has been used to assess the project water balance across a range of climatic conditions over the life of the project. The model provides a dynamic simulation of water movement and salinity within the proposed mine water management system over the life of the project.

The water balance model has been used to assess:

- Appropriate sizing of catch dams and storage dams to collect and store mine-affected water with a low probability for uncontrolled discharge;
- Operational compliance of the mine water management system and individual storages with relevant regulatory requirements;
- Optimum utilisation of mine-affected water for mine water supply and minimising the volume of external raw water supply necessary for the project; and
- Frequency and volumes of any necessary controlled releases of mine-affected water to enable dewatering of the open cut pits following extended wet periods and avoid disruption to production.

The modelling was undertaken using GoldSim software. GoldSim is an operational simulation program used for modelling both natural and industrial water resource systems. It is industry recognised and has been used extensively throughout the Australian resource sector and is ideally suited for application to the project water balance.

4.2 MODEL LOGIC AND KEY ASSUMPTIONS

The operation of the mine water management system and the requirement for external water supply, or any controlled discharge of mine-affected water, will be dependent on numerous dynamic factors which will vary over the life of the mine. Consideration of static project stages in isolation over single wet or dry years will therefore not capture the full range of operational water management scenarios which may occur over the proposed mine life.

The operational performance of the mine water management system has therefore been simulated over the entire mine life. The operational mine life has been represented by detailed profiling of the incremental mine development stages and the mine production schedule and has been assessed using 50 year historical climate sequences. This approach has enabled an assessment of a broad range of water supply, water demand and management scenario combinations which could potentially occur over the mine life.

The simulations are based on daily water balance iterations. The performance of the water management system was simulated for a total of 74 consecutive 50-year climate sequences from the 124 years of historical climate records available for the project site. The model simulation consequently involved a total of 3,700 mine operating years. The performance of the water management system has therefore been evaluated for all possible combinations of mine development timing and climate sequences on record. This includes the worst case combinations of mine development timing and high and low rainfall sequences. Climate data is discussed in Section 4.3.

Catchment yield has been modelled using the Australian Water Balance Model (AWBM). The adopted AWBM parameters are provided in Section 4.4.

The logic of the water management system model simulations at each daily time step is as follows:

- Climate conditions are calculated from time-series data;
- Rainfall runoff volumes for contained catchments are calculated using the AWBM catchment runoff model;
- Groundwater inflows to each mining area are calculated from the EIS Groundwater Report model predictions;
- Project water demands are calculated;
- Open cut pits and underground mines are dewatered to the Mine Water Dam via pit water transfer dams;
- Runoff from contained infrastructure area catchments is collected in the respective catch dams and pumped to the Industrial Area Dam;
- PSWSF runoff is transferred to the TSF decant pond;
- The TSF decant pond is dewatered to the Return Water Dam;
- Evaporative losses are deducted from all dams in the mine water management system;
- Project water demands are supplied from the Mine Water Dam, Industrial Area Dam and the Return Water Dam;

- If there is insufficient mine water volume to meet project water demands from the Mine Water Dam, Industrial Area Dam and Return Water Dam, any deficit is met from external water supply held in the Raw Water Dam; and
- If there is insufficient storage capacity in the Mine Water Dam and pit water transfer dams to dewater the open cut pits then the controlled release of excess pit water is undertaken from the Mine Water Dam.

The median predicted inventory for the key mine water supply dams are presented in Figures C1 to C3. Probability distributions for annual external water supply requirements and annual controlled discharge volumes are presented in Figures C4 and C5, respectively.

4.3 CLIMATE DATA

For the purpose of the water balance model, a SILO Data Drill climate dataset was acquired from the Queensland Department of Science, Information Technology, Innovation and the Arts (DSITIA). The dataset comprised 124 years (1889 – 2013 inclusive) of rainfall and evaporation data interpolated from Bureau of Meteorology data. Key climate statistics for the SILO dataset are presented in Table 3.

Table 3
Summary of Key Climate Statistics

Climate Statistic	Rainfall (mm) (Year)	Pan Evaporation (mm) (Year)
Maximum Annual	1,303 (2010)	4,785 (1969)
Minimum Annual	134 (1902)	1,059 (1960)
Annual Average	616	3,216

Average annual rainfall is approximately 616 mm. Rainfall is summer dominant, with the highest levels recorded from December to February and the lowest from July to September.

The daily rainfall ranges between 0 mm and 163 mm. The wettest month on record is January 1974 with 674 mm of rain. Monthly rainfall is frequently 0 mm during the winter months. The 50 year rolling annual average rainfall ranges from 514 to 614 mm.

Annual pan evaporation ranges from 1,059 mm to 4,785 mm. Annual average pan evaporation is 3,216 mm and exceeds annual average rainfall by 2,600 mm.

4.4 RUNOFF MODELLING

The volume of runoff from contained catchments will be dependent on rainfall rates, permeability and storativity of the catchment surface, and catchment areas which will vary over the mine life. Modelled catchment areas are presented in Table 4 and shown on Figure 4.

Table 4
Summary of Model Catchment Areas

Catchment	Area (ha)
Mine Infrastructure Area Catchments	
Northern Underground MIA	21
CHPP	39
Open Cut MIA	60
Product Coal Stockpiles	94
Power Station	24
Raw Coal Stockpiles	72
Southern Underground MIA	15
Rejects Stockpile	14
Train Loadout	23
Open Cut Pit Catchment	3,424 (maximum)
Mine Waste Storage Facilities	
Tailings Storage Facility	603 (maximum)
Power Station Waste Storage Facility	73 (maximum)

Runoff volumes in the model are calculated using the AWBM. Runoff modelling parameters for contributing catchment areas have been selected based on experience and a review of comparable mining operations in central Queensland and the Galilee Basin. The runoff parameters used in the model are shown in Table 5.

Table 5
Summary of Rainfall Runoff Modelling Parameters

Parameter	**Catchment Type**				
	Undisturbed	**Overburden Emplacement Rehabilitated**	**Pit**	**Overburden Emplacement**	**Infrastructure Areas**
C1 Storage (mm)	15	15	1.8	10.8	1.8
C2 Storage (mm)	100	100	19	110.5	19
C3 Storage (mm)	650.6	650.6	54	221	54
A1 Partial Area	0.013	0.013	0.134	0.134	0.134
A2 Partial Area	0.444	0.444	0.433	0.433	0.433
A3 Partial Area	0.543	0.543	0.433	0.433	0.433
Baseflow Recession Constant	0.914	0.914	0	0	0
Baseflow Index	0.21	0.21	0	0	0

4.5 WATER DAMS

A total of 19 water storage dams are proposed as part of the mine water management system. The water storage dams comprise six pit water dams, four mine water supply storage dams and nine infrastructure area catch dams. The water storage dams are shown in Table 6.

Table 6
Project Water Storage Dams

Dam	**Contained Catchment Area (ha)**	**Design Operating Volume (ML)**	**Dam Capacity (ML)**
Pit Water Dams			
Open Cut Pit Water Dam N2	Nil	300	340
Open Cut Pit Water Dam N1	Nil	300	340
Open Cut Pit Water Dam S1	Nil	300	340
Open Cut Pit Water Dam S2	Nil	300	340
Northern Underground Pit Water Dam	Nil	50	55
Southern Underground Pit Water Dam	Nil	50	55
Mine Water Supply Storage Dams			
Mine Water Dam	Nil	1,500	1,600
Return Water Dam	Nil	800	850
Industrial Area Dam	Nil	1,250	1,350
Raw Water Dam	Nil	675	700

Dam	Contained Catchment Area (ha)	Design Operating Volume (ML)	Dam Capacity (ML)
Infrastructure Area Catch Dams			
Northern Underground MIA Dam	21	N/A	50
CHPP Dam	39	N/A	95
Open Cut MIA Dam	60	N/A	145
Product Coal Stockpile Dam	94	N/A	228
Power Station Dam	24	N/A	58
Raw Coal Stockpile Dam	72	N/A	174
Southern Underground MIA Dam	15	N/A	36
Rejects Stockpile Dam	14	N/A	34
Train Loadout Dam	23	N/A	55

Figure 3 provides a schematic representation of the position of key dams within the mine water management system. The location of these dams is shown in Figure 4.

4.5.1 Design Criteria

The method of deciles and the operational simulation method were each used to calculate the DSA volume requirements for the mine water system in accordance with the Manual. The ESS volume was calculated using the method of deciles.

In the method of deciles calculation, the DSA volume was derived from a 5% Annual Exceedance Probability (AEP) 3 month rainfall depth of 690 mm, and the ESS volume was calculated from a 10% AEP 72 hour rainfall depth of 202 mm. The DSA and ESS volumes derived using this method are presented in Table 7.

Table 7
DSA and ESS Volumes (from the Method of Deciles)

Storage	Contained Catchment Area (ha)	DSA Volume (ML)	ESS Volume (ML)
Pit Water Dams	Nil		
Mine Water Supply Storage Dams	Nil		
Infrastructure Area Catch Dams			
Northern Underground MIA Dam	21	145	42
CHPP Dam	39	269	79
Open Cut MIA Dam	60	414	121
Product Stockpile Dam	94	649	190
Power Station Dam	24	166	48
Raw Stockpile Dam	72	497	145
Southern Underground MIA Dam	15	104	30
Reject Stockpile Dam	14	97	28
Train Loadout Dam	23	159	46
Dams Total	362	2,498	731
Open Cut Pit (Maximum)	3,424	23,624	6,916
Mine Water Management System Total	3,786	26,122	7,647

The DSA is intended to manage the potential for uncontrolled discharge to arise from accumulation of rainfall runoff over single or sequential wet seasons. Distribution of the DSA volume requirement over the timeframes of these wet season accumulations (i.e. at least 3 months) is feasible. The DSA volume for the proposed mine water management system is shared across available storages, including the water dams and open cut pit void.

The DSA volume required to be made available at 1 November each year is 26,122 ML in Project Year 30 when the open cut pit has its largest contributing catchment area, based upon the method of deciles. The maximum storage capacity of the open cut pit is in the order of 1,037,000 ML. This storage capacity represents 40 times the total mine water management system DSA volume, and 415 times the combined DSA volume of the infrastructure area catch dams. Based upon the significant available storage capacity of the open cut pit, the potential for wet season accumulation of contained rainfall runoff is not predicted to result in uncontrolled release of mine-affected water.

All pit water dams and mine water supply storage dams will be constructed with nil catchment. The pit water dams and mine water supply storage dams were sized to contain the maximum simulated storage volume over all modelled rainfall scenarios. Each dam has been assigned a maximum operating level. Pumped inflows to each dam will cease when the maximum operating level is reached. Above the maximum operating level, each dam receives only direct rainfall to the internal catchment of the dam (i.e. no external inflows). The pit water dam and mine water supply storage dam sizes and operating rules are detailed in Section 4.5.2.

The infrastructure area catch dams will be installed to collect and contain runoff from isolated infrastructure area catchments. Each of the infrastructure area catch dams have been conservatively sized to the ESS volume, assuming 100% runoff from the isolated infrastructure area catchments is captured during the design rainfall event. Each infrastructure area catch dam has also been sized with a 1 m freeboard above the ESS volume level.

This highly conservative design approach is considered to satisfy the DSA and ESS requirements for the mine water management system and ensure a low potential for overtopping.

4.5.2 Water Dam Operations

The mine water supply storage dams will operate as follows:

- Return Water Dam – this dam will be used to store water from the TSF decant pond including PSWSF runoff. This dam is a priority source of CHPP water supply.
- Mine Water Dam – this dam will be used to store pit water from the underground mine workings and the open cut pit. This dam is a primary source of dust suppression water and a secondary source of CHPP water supply.
- Industrial Area Dam – this dam will be used to store water collected in numerous catch dams on isolated contained catchments in the mine infrastructure area. This dam is a primary source of dust suppression water and a secondary source of CHPP water supply.
- Raw Water Dam – this dam will be used as buffer storage for raw water delivered from external water supplies. This dam is the primary source of raw water supply demands and a secondary source of dust suppression and CHPP water supply.

The modelled transfer of water between supplies, water storages and demands is summarised in Table 8.

Table 8
Water Transfer Details

Water Storage	Maximum Pump Rate (L/s)	Transfer Destination
Open Cut Pit		
Active Open Cut Pit	2,800	Open Cut Pit Water Dams
Open Cut Pit Water Dam N2	300	Mine Water Dam
Open Cut Pit Water Dam N1	300	Mine Water Dam
Open Cut Pit Water Dam S1	300	Mine Water Dam
Open Cut Pit Water Dam S2	300	Mine Water Dam
Underground Mines		
Northern Underground Pit	100	Northern Underground Pit Water Dam
Southern Underground Pit	100	Southern Underground Pit Water Dam
Northern Underground Pit Water Dam	200	Mine Water Dam
Southern Underground Pit Water Dam	200	Mine Water Dam
Mine Water Supply Storage Dams		
Mine Water Dam	As required*	Demands
Return Water Dam	As required*	Demands
Industrial Area Dam	As required*	Demands
Raw Water Dam	As required*	Demands
Infrastructure Area Catch Dams		
Northern Underground MIA Dam	100	Industrial Area Dam
CHPP Dam	100	Industrial Area Dam
Open Cut Pit MIA	100	Industrial Area Dam
Product Stockpile Dam	100	Industrial Area Dam
Power Station Dam	100	Industrial Area Dam
Raw Stockpile Dam	100	Industrial Area Dam
Southern Underground MIA Dam	100	Industrial Area Dam
Reject Stockpile Dam	100	Industrial Area Dam
Train Loadout	100	Industrial Area Dam

*Pumps on these dams will be sized to satisfy maximum demand

4.6 WATER QUALITY

The Department of Environment and Heritage Protection (EHP) model Environmental Authority (EA) conditions for the discharge of mine-affected water include discharge water volume and quality limits that are designed to protect downstream water quality and environmental values. These conditions were developed by EHP following a comprehensive study of the cumulative impacts of mining activities on water quality undertaken in 2009 by its predecessor, the Department of Environment and Resource Management (DERM). The DERM cumulative study identified increased salinity levels resulting from mine water discharges as the greatest risk to water quality from coal mines.

A salt balance has been undertaken to determine the salinity of stored water in the dams within the mine water management system. For the purposes of this report, salinity is expressed in terms of electrical conductivity values.

Project water supplies and their component water quality are described in Table 9. The assumed overburden, coal (including rejects and tailings) and power station waste runoff quality is based upon geochemical testing and analysis presented in the EIS Geochemistry Report. However, it should be recognised that direct application of leach test data to the salt balance can be misleading. Using sample pulps (ground to passing 75 μm) provides a very high surface area to solution ratio, which encourages mineral reaction and dissolution of the solid phase. As such, the results of geochemical tests on water extract solutions represent an assumed 'worst case' scenario for undiluted leachate from tested materials. The quality of actual runoff and/or seepage water from these materials would be better than these results due to the less optimum conditions for leaching and the significant dilution from fresh rainfall runoff. Nevertheless, the leach test data has been used as the basis of runoff salinity assumptions in the mine water management system modelling and hence the predicted salinity of stored and released mine-affected water is conservative.

Groundwater inflow quality is based upon measured groundwater quality data presented in the EIS Groundwater Report. Groundwater within the target coal seams is fresh to moderately saline, with an average EC of 2,000 μS/cm. Inflows to the underground and open cut mines are predicted to be dominated by groundwater from the target coal seams. The contribution of overlying and underlying strata to inflows is proportionally small and is not predicted to significantly change the overall quality of the groundwater inflows to these mining areas.

External raw water and rainfall have been considered fresh, and assigned negligible salinity in the model.

Table 9
Summary of Water Quality

Water Supply	Salinity (EC)*
TSF Return Water	Recovered supernatant and tailings runoff – 279 µS/cm
PSWSF Runoff	PSWSF runoff – 907 µS/cm
Infrastructure Area Runoff	Contained infrastructure area catchment runoff – 279 µS/cm
Underground Pit Dewatering	Groundwater inflows – 2,000 µS/cm (average) Excess underground water supply – negligible salinity
Open Cut Pit Dewatering	Overburden emplacement runoff – 346 µS/cm Groundwater inflows – 2,000 µS/cm (average)

* EC reported as median values unless otherwise shown

4.7 DISCHARGE MODELLING

The capacity of proposed dams has been purposefully designed to ensure that uncontrolled discharges of mine-affected water are not required. Dams have been sized so that had the mine operated at any time in the last 124 years, it would not have needed to discharge mine-affected water in an uncontrolled manner. The probability of an uncontrolled discharge is therefore less than a 1 in 124 year average recurrence interval. Uncontrolled discharges are therefore not likely to be necessary.

The mine water management system has been designed to allow for controlled discharge of any potential excess mine-affected water in accordance with the EHP model EA conditions. The volumes, probability and quality of controlled discharges have been assessed as part of the operational simulation modelling of the mine water management system.

The model logic governing controlled discharges ensures that discharges are only undertaken from the Mine Water Dam during extended rainfall periods when significant volumes of rainfall runoff accumulate within the open cut pits. Controlled discharges are proposed when the accumulated water in the open cut pits exceeds the site pit water storage capacity. In this scenario open cut mining would need to cease unless pit water storage capacity can be created by the controlled discharge of stored pit water. This scenario triggers the release of water from the Mine Water Dam at a nominal rate of 500 ML/d. This is equivalent to one-third of the Mine Water Dam design operational capacity of 1,500 ML. The controlled release volume during each release event would be equivalent to the pit water volume in excess of site pit water stage capacity.

4.8 EXTERNAL WATER SUPPLY

External raw water supply will be used to meet high quality water supply requirements. These water demands are shown in Table 1.

External water supply will also be used to make up any shortfall in the site water balance. The model has calculated the external water supply requirement over the life of the project.

The proponent is currently considering options for sourcing external water supplies. External water supply options are discussed in the EIS Surface Water Section.

4.9 MODEL VALIDATION

The model has been validated by undertaking a mass balance on the performance of key dams. The mass balance has been completed by quantifying any difference between modelled dam inflows and outflows. This assessment is based upon three randomly selected model realisations. The significance of the residual mass balance error has then been assessed. The mass balance results are presented in Section 5.4.

5 WATER BALANCE MODELLING RESULTS

This section presents the results of water balance modelling over the mine life. The water balance of the final open cut void lake is assessed in Section 6.

The representative long-term water balance for the project is best represented by the overall median (i.e. 50th percentile) of model results for the mine water management system. Additional statistics are provided here to provide context to the discussion of system performance under extreme climate and operating conditions.

5.1 SIMULATED INVENTORIES

Figures C1 to C3 present charts showing the median predicted inventories of the Mine Water Dam, Industrial Area Dam and the Return Water Dam over the 50 year scenarios modelled. Table 10 provides a full summary of the peak mine water inventory for each dam.

Table 10
Dam Inventories

Dam	Operating Volume (ML)	Dam Capacity (ML)	Peak Median Simulated Volume (ML)	Maximum Simulated Volume (ML)
Open Cut Pit Water Dams				
Open Cut Pit Water Dam N1	300	340	272	337
Open Cut Pit Water Dam N2	300	340	272	337
Open Cut Pit Water Dam S2	300	340	272	337
Open Cut Pit Water Dam S1	300	340	272	337
Underground Pit Water Dams				
Northern Underground Pit Water Dam	50	55	49	54
Southern Underground Pit Water Dam	50	55	37	53
Mine Water Supply Storage Dams				
Mine Water Dam	1,500	1,600	1,493	1,594
Return Water Dam	800	850	271	816
Industrial Area Dam	1,250	1,350	113	1,318
Raw Water Dam	675	700	673	689

Dam	Operating Volume (ML)	Dam Capacity (ML)	Peak Median Simulated Volume (ML)	Maximum Simulated Volume (ML)
Infrastructure Area Catch Dams				
Northern Underground MIA Dam	N/A	50	0	15
CHPP Dam	N/A	95	0	50
Open Cut MIA Dam	N/A	145	0	114
Product Coal Stockpile Dam	N/A	228	0	214
Power Station Dam	N/A	58	0	18
Raw Coal Stockpile Dam	N/A	174	0	160
Southern Underground MIA Dam	N/A	36	0	9
Reject Stockpile Dam	N/A	34	0	8
Train Loadout Dam	N/A	55	0	16

The maximum predicted inventory of the mine water management system over the life of the project is 6,476 ML. This is approximately 95% of the 6,845 ML total dam storage capacity. This demonstrates that there would be sufficient storage capacity for mine-affected water during the range of historical climate conditions over the life of the mine. A minimum of 369 ML spare storage capacity is available in the proposed dams even during the most extreme climate conditions experienced in 124 years of climate data.

The maximum predicted inventory of each individual dam is less than its assigned design capacity. This means that each dam could operate at the design operating volume during any climate extremes within the range experienced over the previous 124 years without the need for uncontrolled discharges of mine water or to actively pump water to other dams to avoid uncontrolled discharge. Nonetheless, spare storage capacity of up to in excess of 1,000,000 ML is also available in the open cut pit.

5.2 CONTROLLED DISCHARGE

As discussed in the previous section, modelling of the proposed mine water management system indicates that there will be no uncontrolled discharges of mine-affected water for the 124 years of climate data assessed. This means that the probability that an uncontrolled discharge will occur is less than once in 124 years (i.e. the average recurrence interval of a discharge event is greater than 124 years).

However, during extended wet periods, significant volumes of runoff will accumulate in the open cut pit. To ensure that the open cut mine can continue to operate following these extended wet periods, the ability to discharge mine-affected water under controlled conditions is required. The water management system has therefore been designed to allow for the controlled release of stored water from the Mine Water Dam to the Belyando River catchment. Figure C4 shows the probability distribution for annual discharge requirements over the 50 year mine life. Table 11 provides a summary of the statistics for these discharge requirements.

Table 11
Controlled Discharge of Mine-Affected Water

Statistic	Average Annual Discharge (MLpa)	Peak Annual Discharge (MLpa)	Nil Controlled Discharge (Years)
90^{th} Percentile (Wet conditions)	3,723	9,443	20
Median	405	2,438	35
10^{th} Percentile (Dry conditions)	0	0	50

The modelling results indicate that under median conditions the average annual discharge requirement is approximately 400 MLpa, with a peak annual discharge requirement of 2,438 MLpa. The project is predicted to operate with nil discharge during 70% of project years.

During dry conditions no requirement to discharge mine-affected water is predicted. During wet conditions, controlled discharge of mine-affected water is predicted to be required each year during open cut mining (i.e. Project Years 1 to 30).

The storage capacity of the proposed Mine Water Dam is 1,600 ML. Based on median conditions on average approximately 25% of the Mine Water Dam capacity would need to be discharged under controlled conditions per year. In the year in which the maximum discharge requirement of 9,443 MLpa occurs, the equivalent of less than six discharges of the total Mine Water Dam storage capacity would be required.

Any controlled discharges from the Mine Water Dam would be conducted in accordance with the EHP Model EA Discharge Conditions. These conditions are designed to prevent any adverse impacts on downstream environmental values.

The salinity of water in the Mine Water Dam was modelled over the life of the mine. Salinity in stored water in the Mine Water Dam is predominantly contributed by groundwater inflows to the underground workings and open cut pit. The salinity of pit water stored in the Mine Water Dam increases during dry weather conditions when there is limited or nil surface runoff contributing to open cut pit water to dilute the groundwater salinity.

However, controlled discharges will only be required during and following extreme wet periods when the proportion of fresh rainfall runoff in open cut pit water and the Mine Water Dam storage is higher and groundwater salinity is diluted. During controlled releases, the maximum modelled salinity of water in the Mine Water Dam is 1,500 µS/cm.

5.3 EXTERNAL WATER SUPPLY

External water will be required to supply water demands which require high quality water including supply to underground mines, the water treatment plant, vehicle washdown and the power station. Modelling also shows that additional external water supply is required in dry periods when the volume of mine-affected water stored on site is insufficient to meet project demands.

Table 12 provides a summary of the modelling results for external water supply requirements.

Table 12
External Water Supply Requirements

Statistic	Annual Requirement (MLpa)
Maximum (Driest conditions)	1,978 – 12,300
95th Percentile (Extreme dry conditions)	1,875 – 11,703
Median	1,179 – 8,623
5th Percentile (Extreme wet conditions)	927 – 5,975
Minimum (Wettest conditions)	903 – 5,713

Figure C5 shows the modelled annual external water supply requirement. The mine water management system is predicted to have a water deficit throughout the proposed operations. The annual external water requirement over the life of the mine is predicted to range from approximately 903 MLpa under extreme wet conditions to 12,300 MLpa under extreme dry conditions. Demand for external water supply peaks between Project Years 8 and 16, when mine production is at its peak.

An annual external water supply of up to 12,300 ML will be required to ensure that the mine continues to operate throughout the driest climate conditions with negligible risk that operations would cease due to lack of water supply.

Details of the proposed external water supply are discussed in the EIS Surface Water Section.

5.4 MODEL VERIFICATION

The mass balance results for three realisations are presented in Table 13.

Table 13
Mass Balance Results

Dam	Error in Dam Balance (%)		
	Realisation A	Realisation B	Realisation C
Mine Water Dam	<0.1	<0.1	<0.1
Industrial Area Dam	<0.1	<0.1	<0.1
Return Water Dam	<0.1	<0.1	<0.1

These results indicate a negligible mass balance error of less than 0.1% of the annual inputs to the key water dams. The results confirm that the model performs as intended, with no significant discrepancies or unaccounted losses.

6 MONITORING AND MANAGEMENT

The site water balance including water transfers, consumption and dam storage volumes will be monitored monthly. The water management system will be monitored and managed in accordance with a Site Water Management Plan. The Site Water Management Plan is discussed in detail in the EIS Environmental Management Section. The site water balance will be reviewed annually and will trigger modifications to the water management system, where necessary, to ensure the proper functioning of the system.

Water quality in mine water storage dams will be monitored quarterly. Parameters to be monitored include pH and EC. The monitoring program will also include annual monitoring of a comprehensive suite of water quality parameters, including metals and metalloids.

Any controlled releases of mine-affected water will be monitored in accordance with EHP's model EA conditions relating to the release of mine-affected water. These conditions require monitoring of the water released from the site, as well as the receiving waters.

Sediment control structures will be managed in accordance with an Erosion and Sediment Control Plan. The Erosion and Sediment Control Plan will include an inspection plan for sediment control structures to ensure they are maintained and remain effective.

7 FINAL VOID MODELLING

7.1 MODELLING APPROACH

Modelling of the open cut final void water balance was completed to assess the likely final void water levels following mine closure.

The final void modelling is based on daily water balance iterations. The logic of the final void model simulations at each daily time step is as follows:

- Climate conditions are calculated from time-series data;
- Rainfall runoff volumes are calculated for the final void catchment using the AWBM catchment runoff model;
- Groundwater inflows to the final void generated from the EIS post mining groundwater model are calculated, with inflow rates responding dynamically to the water elevation in the final void; and
- Evaporative losses from the surface of the final void lake are deducted from the final void water storage.

The model was simulated using 123 years of historical rainfall data that was duplicated to assess long-term post closure void behaviour over a 200 year period.

7.2 FINAL VOID CONTAINMENT

The model results are shown in Figure C6. The results indicate that water levels in the final void are likely to reach an equilibrium level in the long-term, less than 200 years after mine closure.

The long-term void water level fluctuates in the range from 249 to 260 m AHD with an average elevation of 255 m AHD. The average final void water level is 50 m below the final void spill point elevation of 305 m AHD. Discharge from the final void is therefore extremely unlikely based upon the range of climate conditions experienced in the last 124 years.

* * *

for
HANSEN BAILEY

Ross Edwards
Senior Environmental Scientist

Peter Hansen
Director

FIGURES

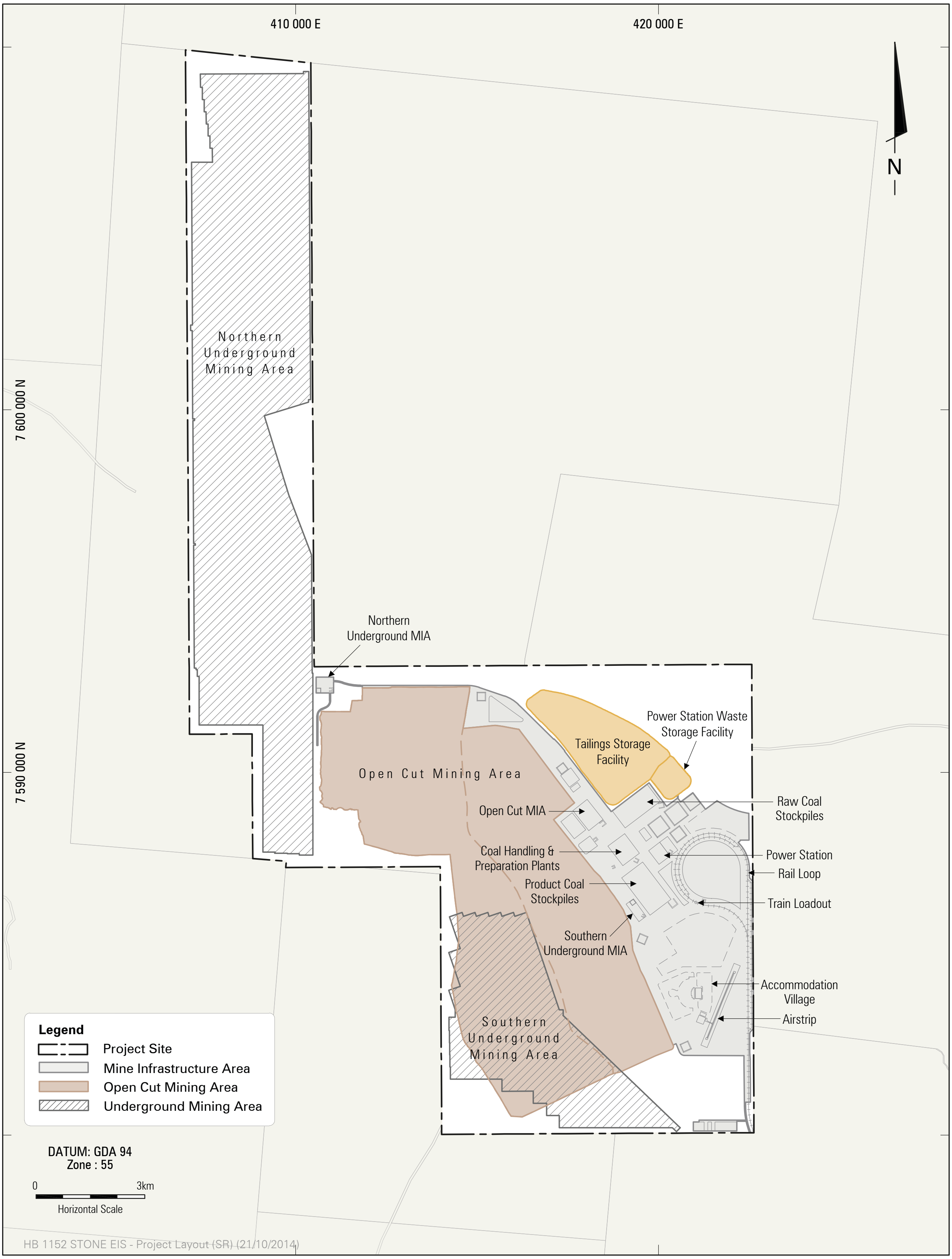
PROJECT CHINA STONE

MACMINES AUSTASIA

Hansen Bailey
ENVIRONMENTAL CONSULTANTS

Project Location

FIGURE 1



PROJECT CHINA STONE

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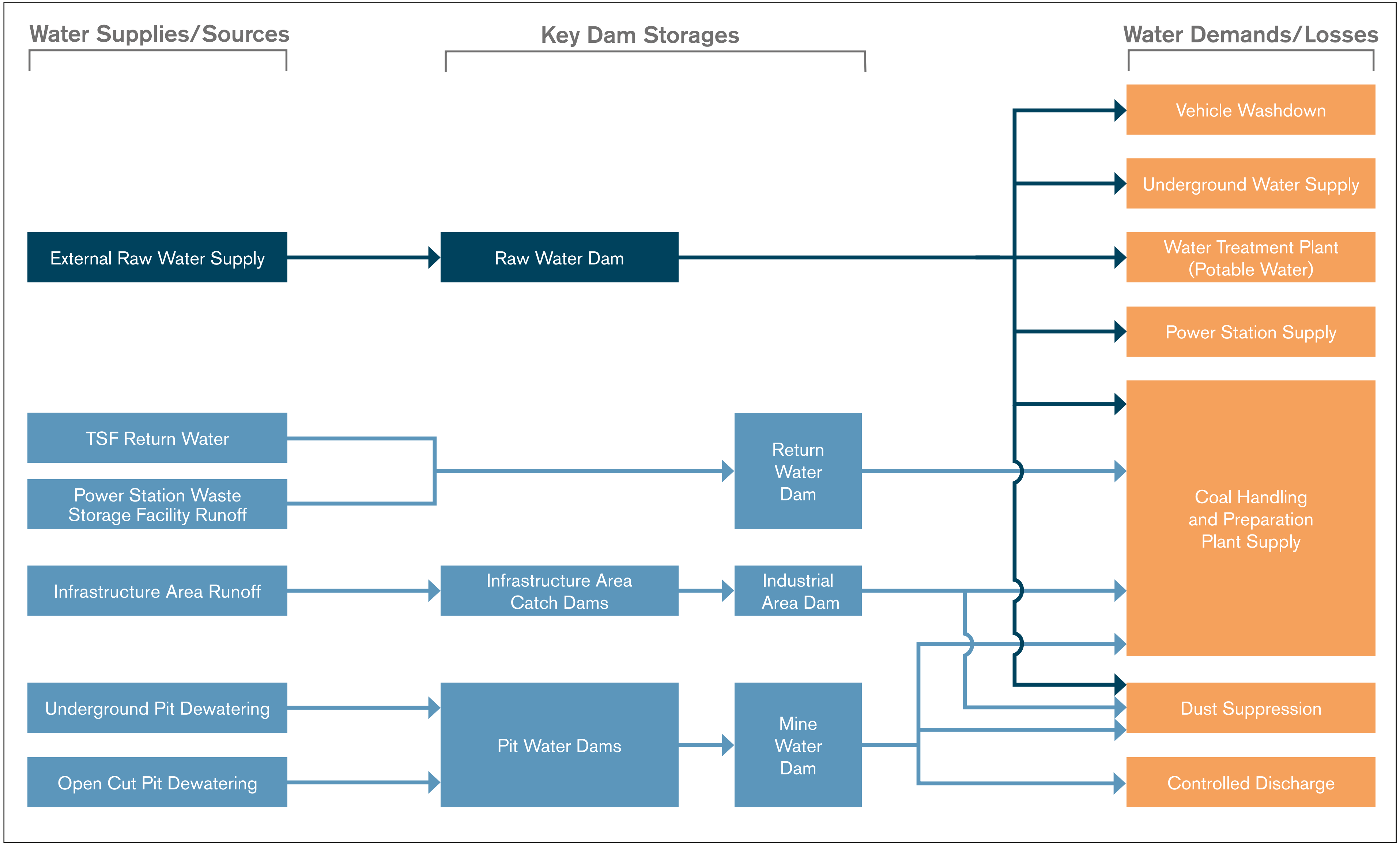
Project Layout

FIGURE 2



PROJECT CHINA STONE

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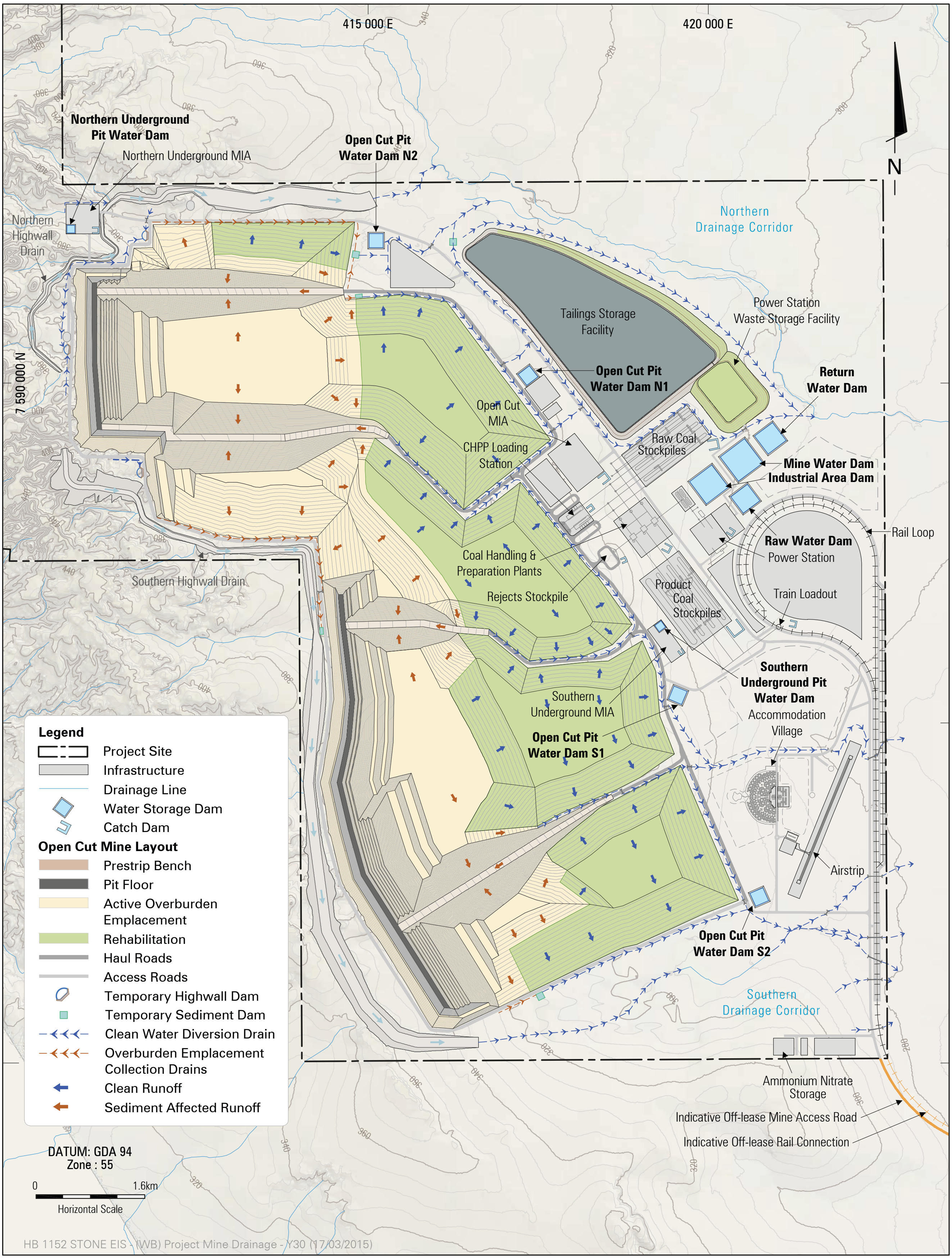
Conceptual Mine Water Management System

FIGURE 3



PROJECT CHINA STONE

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Site Drainage and Water Storages - Project Year 30

FIGURE 4

APPENDIX A

Project Water Demands

LIST OF FIGURES

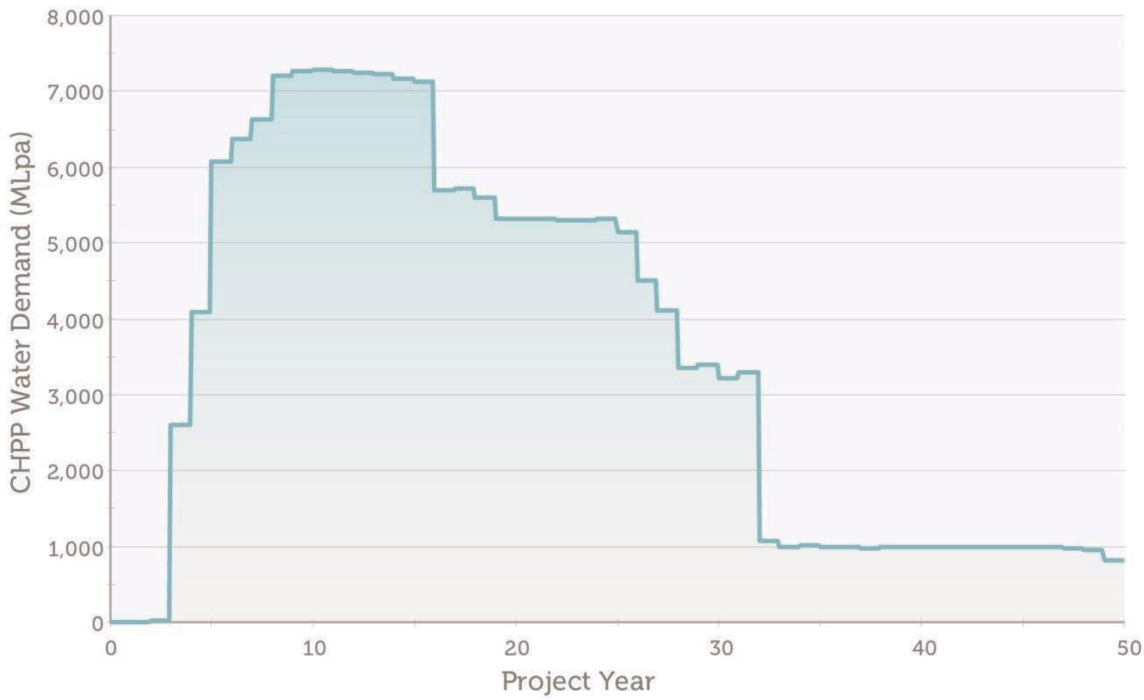

Figure A1 – CHPP Water Demand

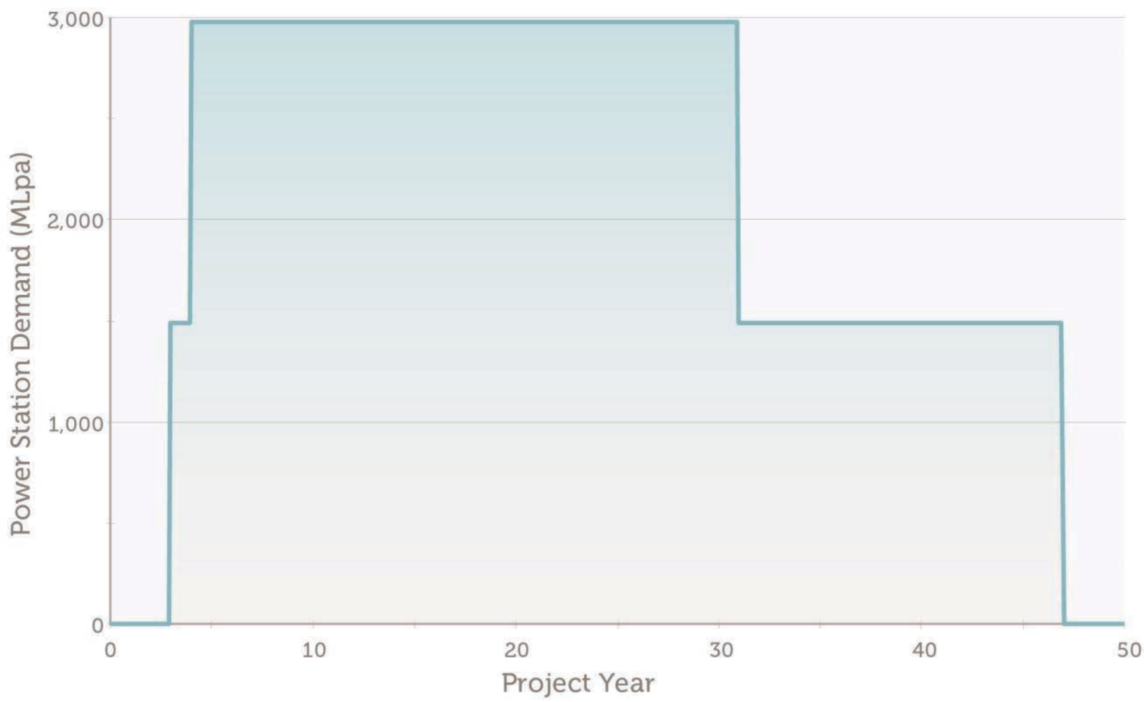

Figure A2 – Power Station Demand

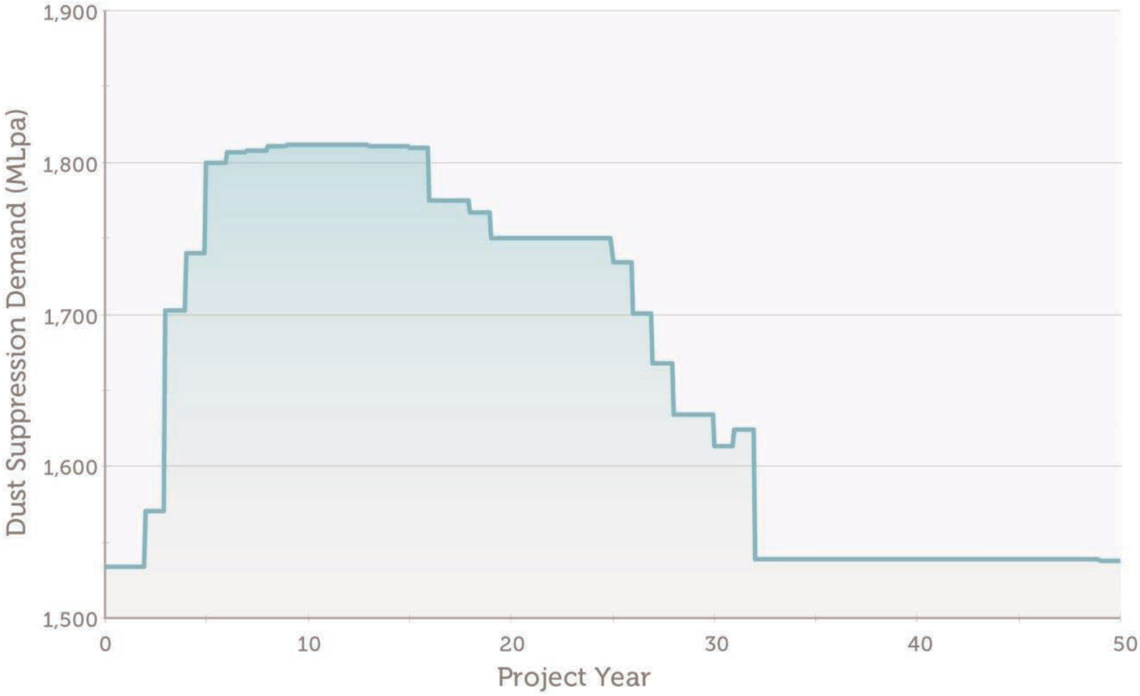

Figure A3 – Dust Suppression Demand

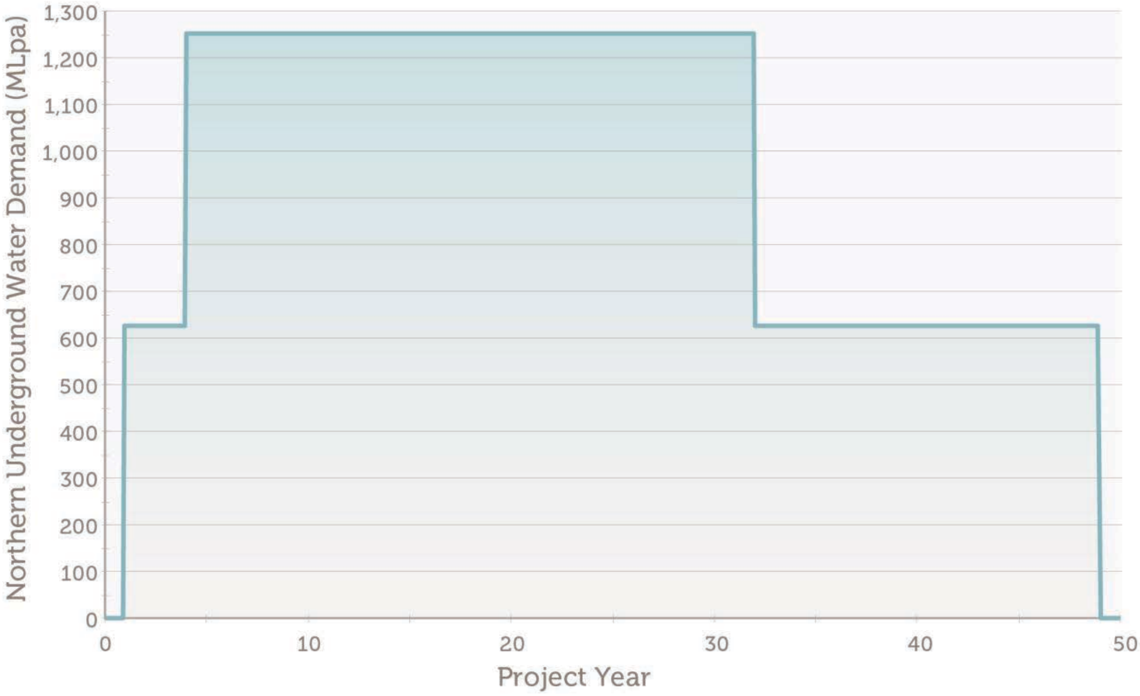

Figure A4 – Northern Underground Demand

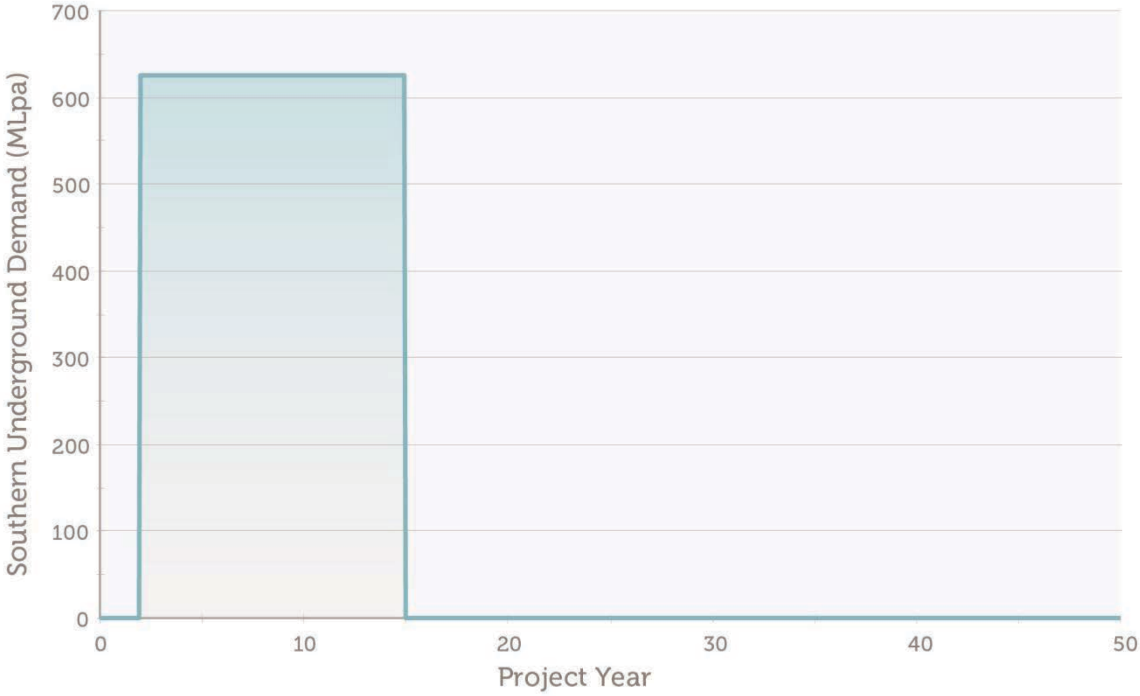

Figure A5 – Southern Underground Demand

Figure A6 – Water Treatment Plant Demand

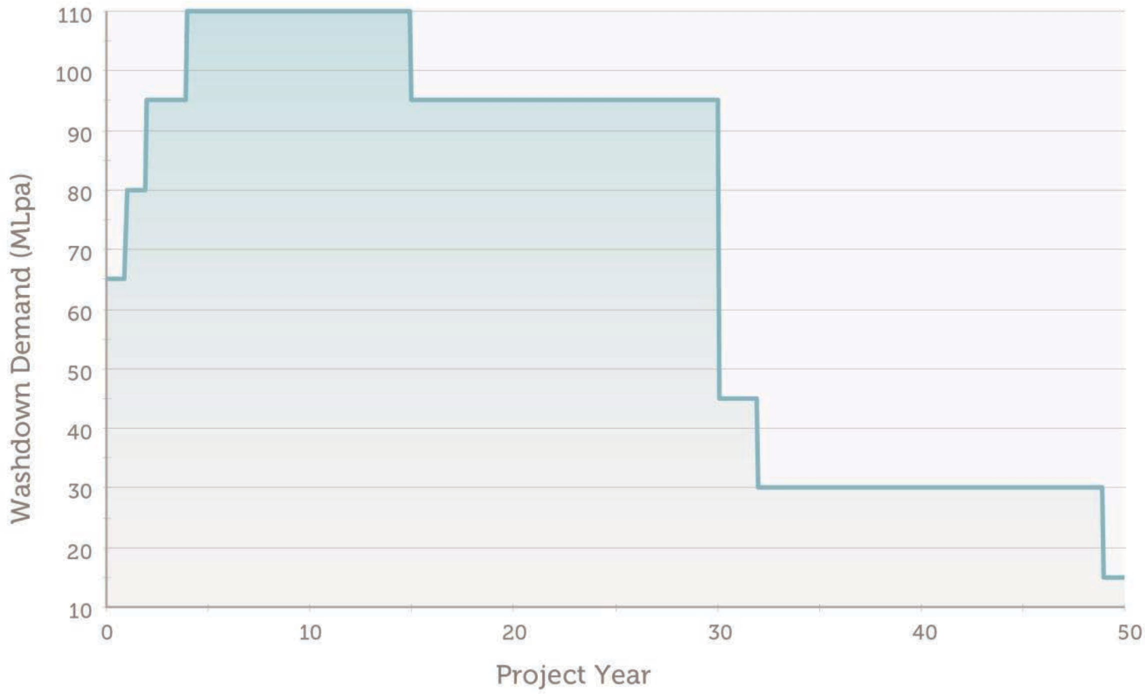

Figure A7 – Vehicle Washdown Demand

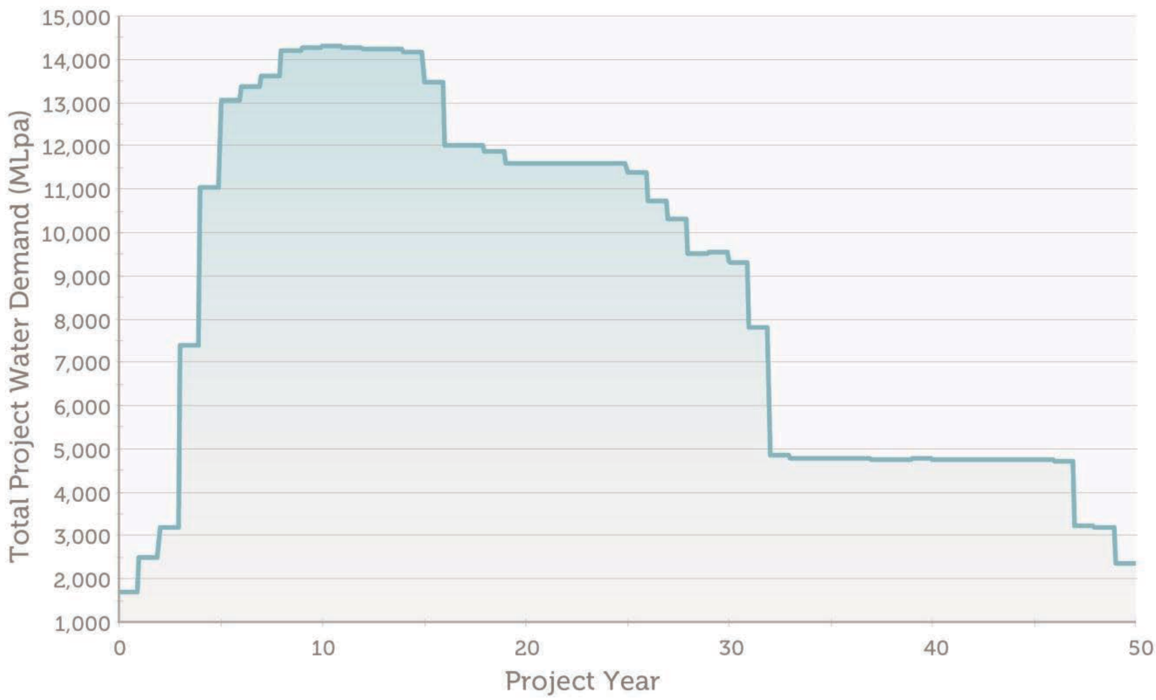

Figure A8 – Total Project Water Demand

APPENDIX B

Project Water Supplies

LIST OF FIGURES

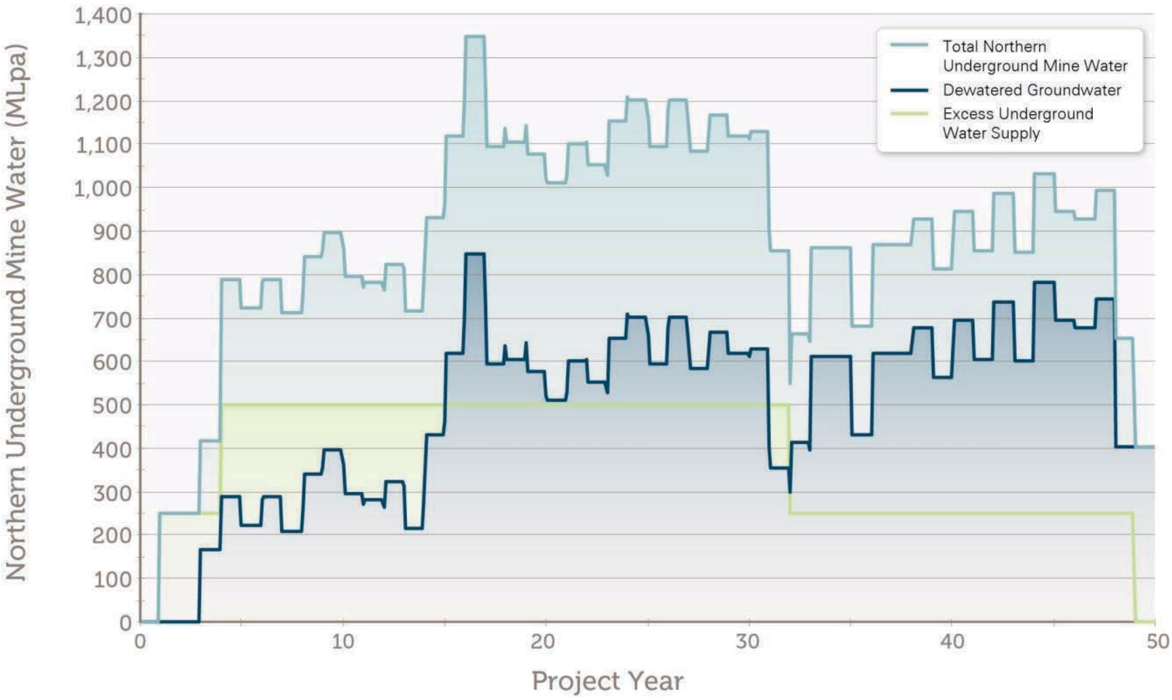

Figure B1 – Northern Underground Mine Water

Figure B2 – Southern Underground Mine Water

Figure B3 – Open Cut Pit Water

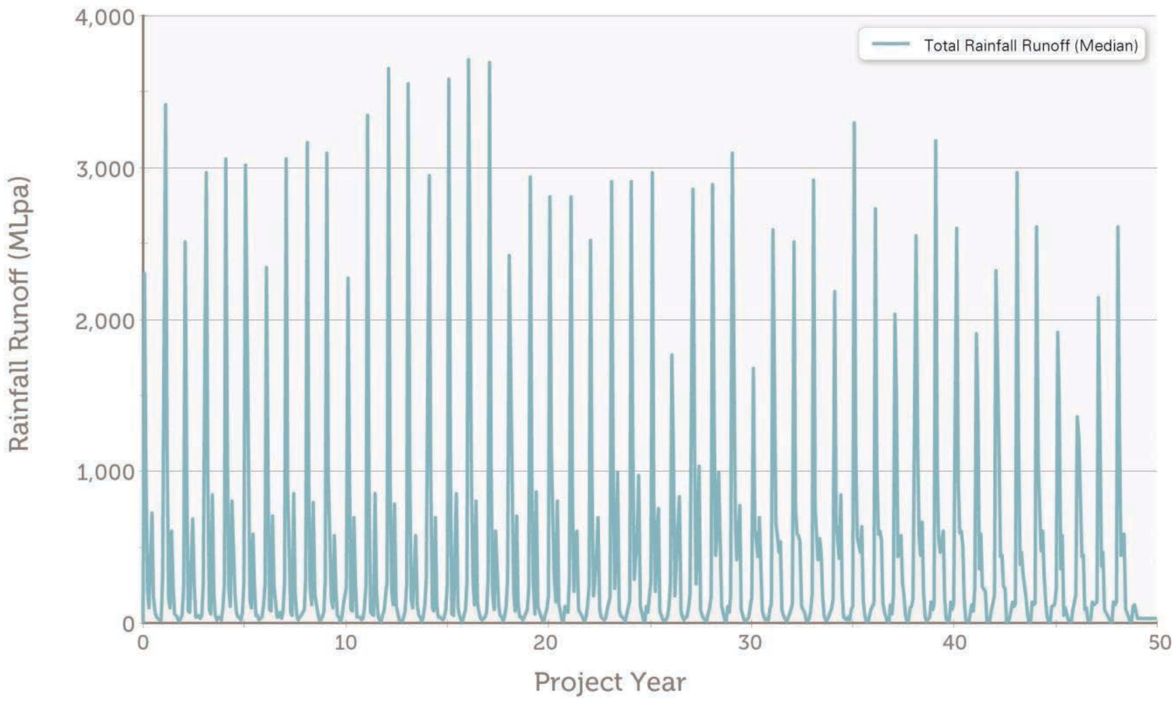

Figure B4 – Rainfall Runoff from Contained Infrastructure Area Catchments

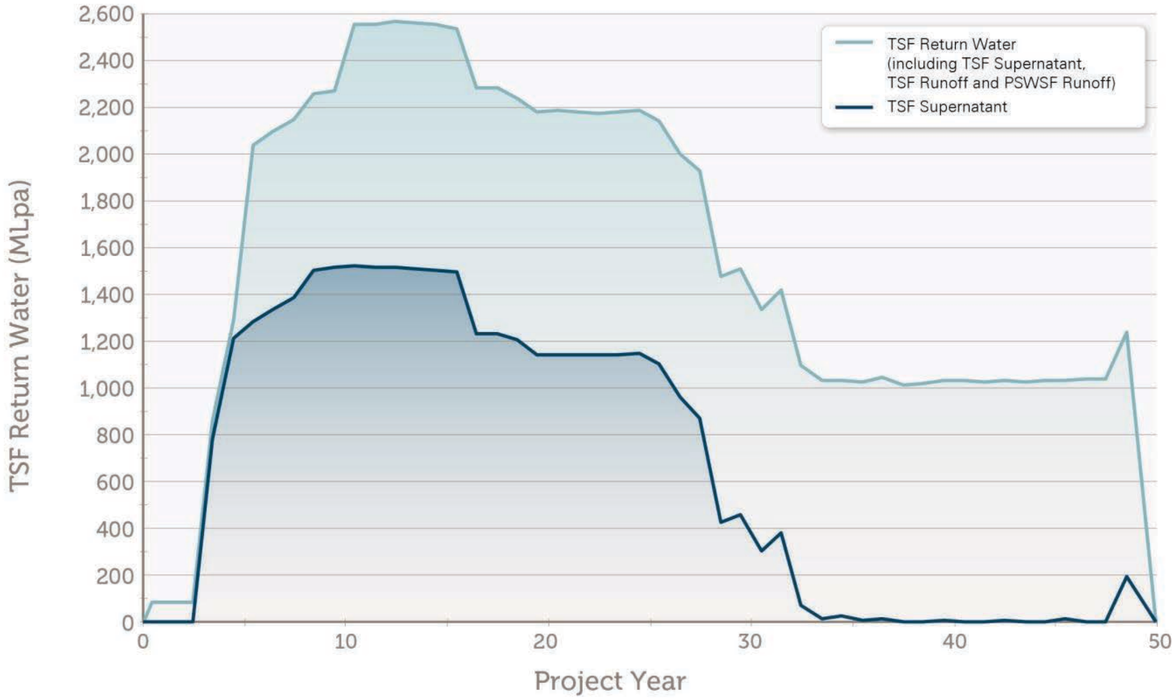

Figure B5 – TSF Return Water

APPENDIX C

Model Results

LIST OF FIGURES

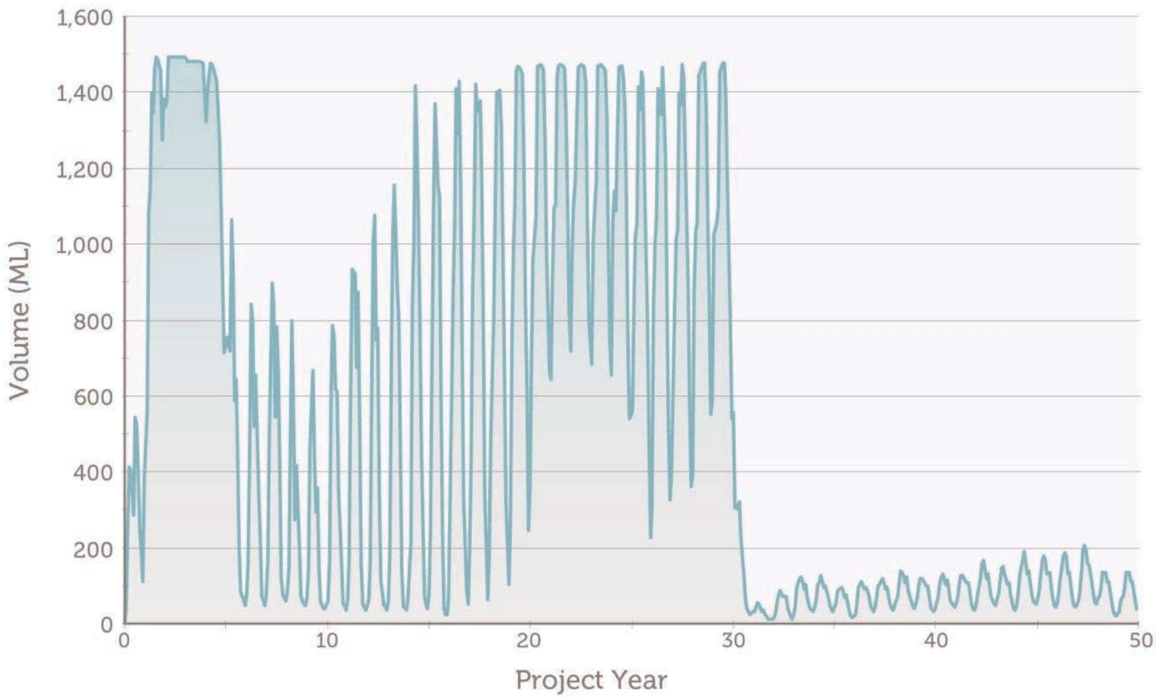

Figure C1 – Mine Water Dam Inventory (Median)

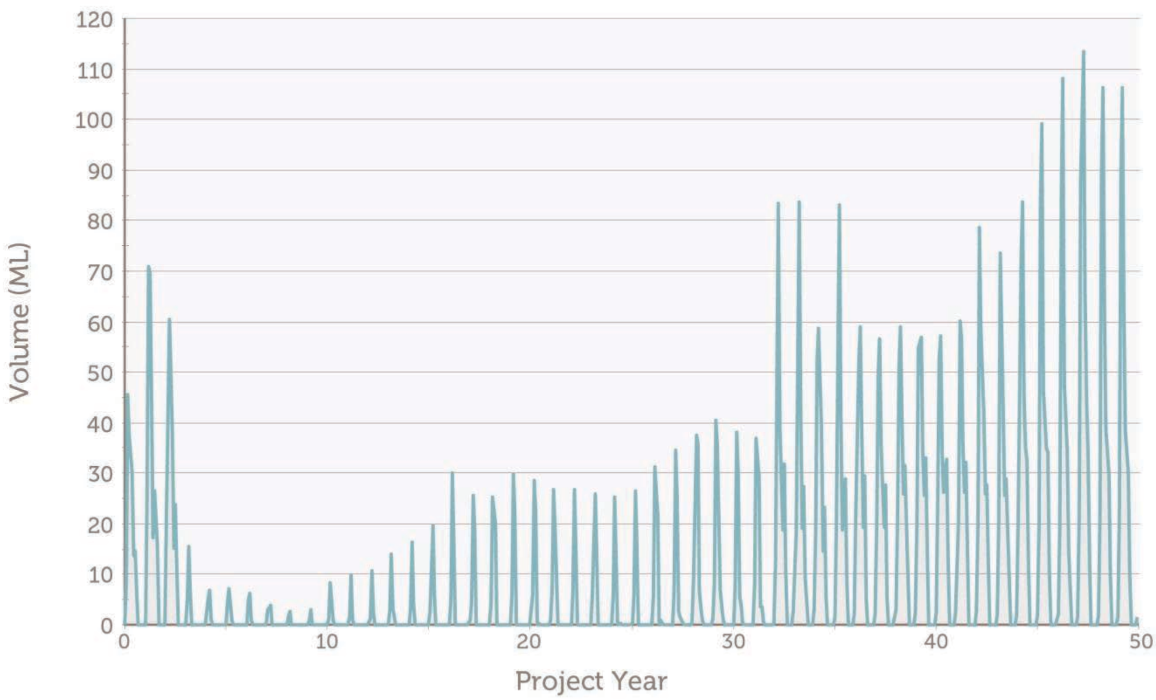

Figure C2 – Industrial Area Dam Inventory (Median)

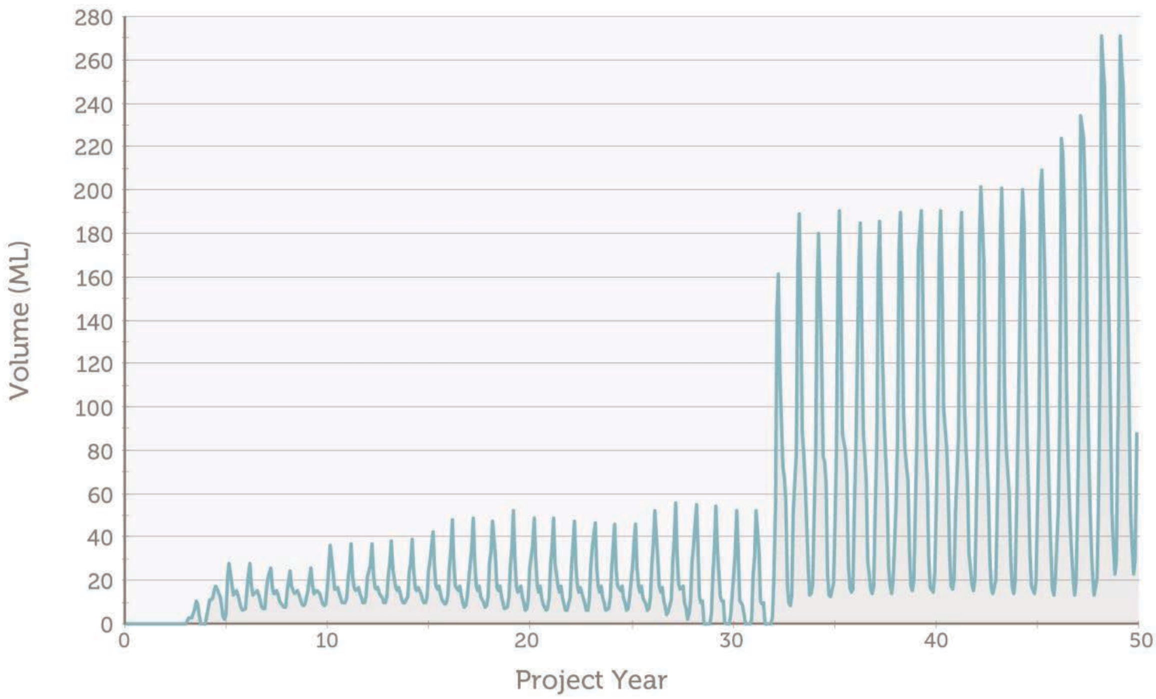

Figure C3 – Return Water Dam Inventory (Median)

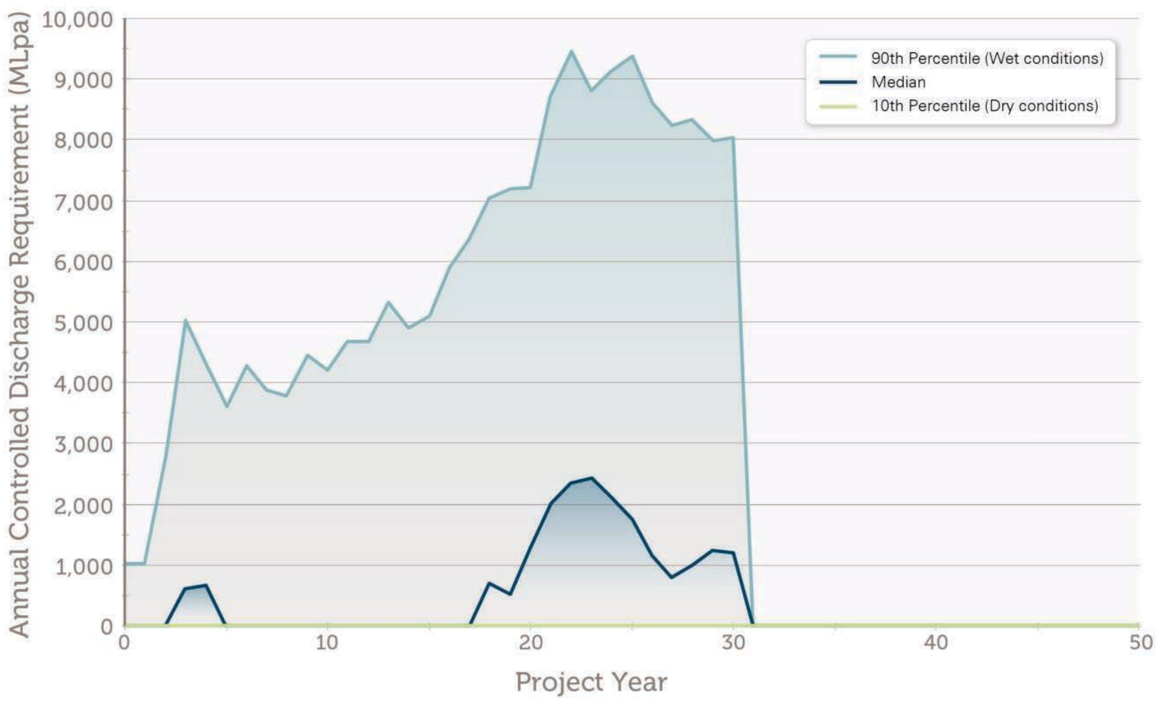

Figure C4 – Annual Controlled Discharge Requirement

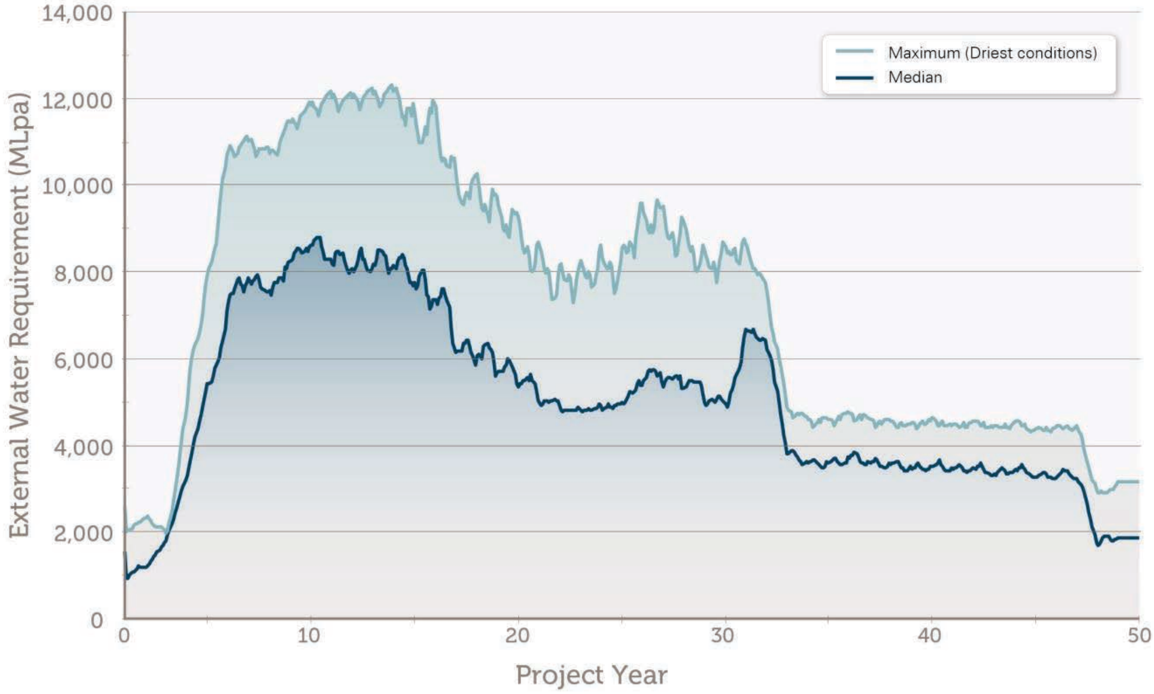

Figure C5 – Annual External Water Supply Requirement

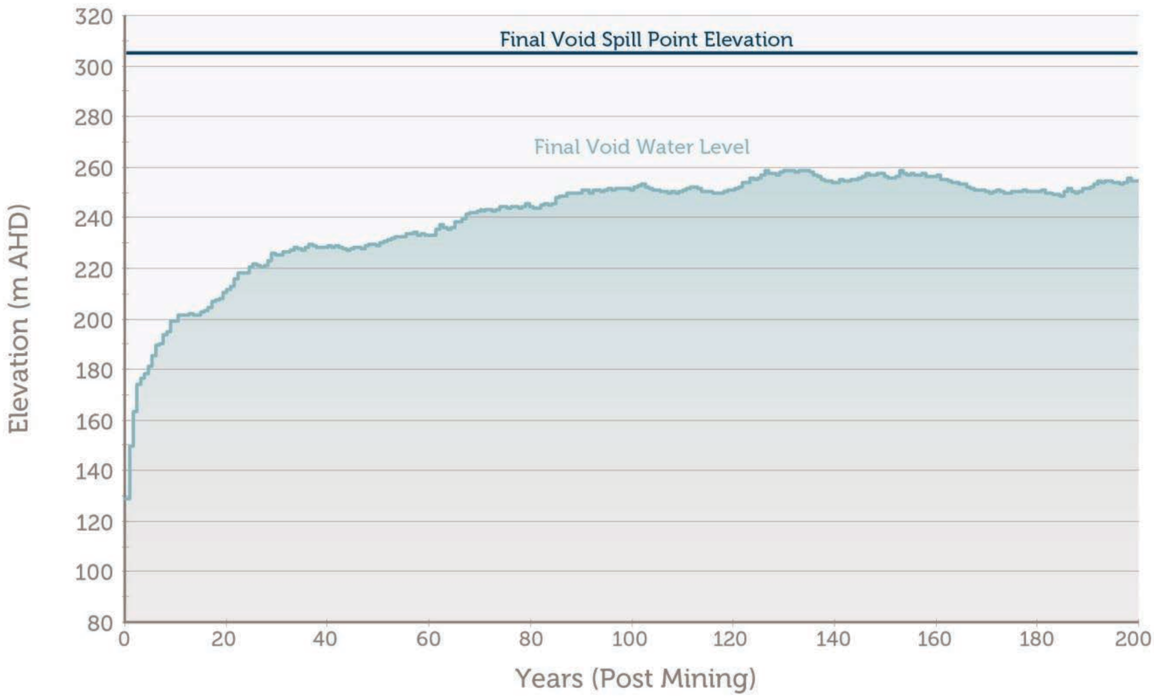

Figure C6 – Final Void Water Level