HANCOCK GALILEE PTY LTD

Kevin's Corner Project Environmental Impact Statement

M | Surface Water

M1 Geomorphology Technical Report

M2 Hydrology Technical Report

M3 Site Water Management System and Water Balance Technical Report

M4 Surface Water Quality Technical Report

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Kevin's Corner Project Environmental Impact Statement

M3 Site Water Management System and Water Balance Technical Report

Report

Kevin's Corner Project Concept Water Management System and Water Balance Technical Report

15 APRIL 2011

Prepared for

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Abbreviations

Abbreviation	Description
AWBM	Australian Water Balance Model
BOM	Bureau of Metrology
CHPP	Coal Handling and Preparation Plant
CRC	Cooperative Research Centre
DERM	Department of Environment and Resource Management (Qld)
DFIA	Dam Failure Impact Assessment
DME	Department of Mines and Energy (Qld, now DERM)
DSA	Design Storage Allowance
EC	Electrical Conductivity
EIS	Environmental Impact Statement
EV	Environmental Values
HGPL	Hancock Galilee Pty Ltd
LOM	Life of Mine
MIA	Mine Infrastructure Area
MLA	Mine Lease Area
Mtpa	Million tonnes per annum
NSE	Nash-Sutcliffe Coefficient of Efficiency
PET	Potential Evapotranspiration
ROM	Run of Mine
TLO	Train Load Out
TOR	Terms of Reference
TSF	Tailings Storage Facility
WBM	Water Balance Model
WMS	Water Management Strategy
WTP	Water Treatment Plant

Executive Summary

The Kevin's Corner Project proposed concept mine water management system has been designed in accordance with current best practice mine water management strategies. Water will be segregated on the basis of its assumed quality to ensure that the generation and storage of contaminated water is minimised as far as is practicable. Runoff originating from all potentially contaminating sources (open cuts pits, MIA, TLO, product stockpile and all active spoil and overburden areas) and all groundwater inflows from the underground mines will be captured and contained within the mine water management system such that the probability of overflow is less than one occurrence in 100 years. Clean water from upstream natural catchments as well as from all undisturbed areas within the Project area will be passively diverted around the mine WMS reducing inflows to the mine water management system. Stored potentially contaminated mine water will then be preferentially reused to satisfy mine consumptive water demands and optimising system capacity to contain additional inflows.

A water balance validation of the proposed mine WMS under historical climatic conditions has shown that sufficient system capacity exists to reduce the probability of an uncontrolled release to less than 1:100 AEP and that no controlled releases will need to be made. The Project will operate in a water deficit and will require inputs of pipeline raw water to ensure that site water demands are met when the supply of mine water becomes exhausted during periods of prolonged low rainfall. High quality pipeline raw water will also be required to satisfy Project water demands for high quality water.

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1 Introduction

1.1 Background

URS Australia Pty Ltd (URS) has been appointed by Hancock Galilee Pty Ltd (HGPL) to conduct an Environmental Impact Statement (EIS) for its Kevin's Corner Project (the Project), a 30 Mtpa capacity thermal coal mine in the Galilee Basin, Queensland. As part of the EIS process HGPL has commissioned URS to develop a mine water management system (WMS) based on a water balance for the Project to assess that the key WMS objectives set out in the Terms of Reference for an Environmental Impact Statement – Kevin's Corner Project (the TOR) are met.

1.2 Project Description

The Kevin's Corner Project is a new 30Mtpa capacity thermal coal mine located in the Galilee Basin, Central Queensland approximately 65km north of the township of Alpha; 110 km south-west of the township of Clermont and approximately 360 km south-west of Mackay. Operations will consist of both open-cut and underground mines with coal produced primarily to service international energy export markets.

The Project consists of two open cut pits (Central and Northern Open Cut Pit), extending over a total strike length of 6.5 km and in time reducing to a steady strike length of 4 km and three underground longwall operations (Southern, Central and Northern Underground) proposed in three independent mines. Mining of the open cut pits will commence at the seam sub-crop, and progress down dip. The overburden will be removed by truck and shovel, excavators and dragline operations. The overburden will be initially stockpiled in out-of-pit spoil emplacements and then used to backfill the open cut pits.

The coal from the open cut operations will be mined and transported by truck and shovel operations. Raw coal will be processed at two ROM facilities where it will be reduced in size for further processing at the CHPP. For the underground longwall operations, all ROM coal will be transported directly to the CHPP via an overland conveyor.

1.3 Scope of Work

The scope of work covered by the Kevin's Corner WMS and water balance assessment for the Project EIS includes the following key tasks:

- Development of concept surface water management systems for the year 5, year 10, and year 30 mine landforms;
- Diversion of runoff from undisturbed catchments (clean water) around the Project area;
- Segregation of waters within the project area based on expected quality;
- Reuse of contaminated water around the site with emphasis placed on preferential reuse of contaminated water in operations for coal processing;
- Determination of sufficient water storage capacity within Project site dams for the for the containment of mine-affected water;
- Preparation of a concept water balance assessment to estimate runoff volumes, mine water generation, mine water consumption, potential overflows and potential water deficits or surpluses for each of the year 5, year 10, and year 30 landforms.

Concept Design Objectives and Criteria

2.1 Water Management System Design Objectives

The proposed mine water management system (WMS) comprises runoff containment systems for disturbed (open cut pits, spoil/overburden emplacement areas) and all mine-affected (MIA, ROM, CHPP, TLO, product stockpile) areas, mine water dams with a range of functions (runoff capture, water transfers and storage) and a network of pipes, pumps and drains to transfer water around the system. In accordance with current best practice management strategies the mine WMS will satisfy the following key objectives:

- Minimise the generation and containment of mine-affected water by the passive diversion around the mine WMS of all clean water entering the Project site as well as the onsite segregation of runoff according to its predicted quality;
- Provide sufficient system capacity to capture and contain potentially contaminated runoff from all disturbed and mine-affected sources such that the probability of overflow is less than one occurrence in 100 years;
- Allow for the preferential reuse of mine-affected water in mine operations (CHPP, underground mining operations, dust suppression, industrial uses) which will:
    - Avoid the need for the controlled release of contaminated water (under modelled historical conditions) by continually drawing down on the site water inventory;
    - Maximise the systems available storage capacity for potential large inflows to the system during extreme rainfall events; and
    - Reduce the reliance on external water sources.
- Allow for the dewatering of both the open-cut and underground mines to sustain mining operations including direct pumping of runoff and groundwater from the open-cut pits and groundwater from the underground mines.

The mine WMS described herein provides recommended concept design criteria based on estimated hydrologic risks and relevant legislative guidelines. This report is not meant to describe comprehensive criteria for the development of the WMS but instead describe the mine WMS in general terms, quantify the hydrologic risks associated with the proposed WMS and allow for analysis of the potential environmental impacts associated with the Project

2.2 Relevant Legislation and Guidelines

The Water Act, 2000 (Qld) is the primary statuary document that establishes a system for the planning, allocation and use of non-tidal water. Subordinate to the Water Act is the Environmental Protection (Water) Policy 2009 (EPP Water) which provides a framework for the identification of environmental values (EVs) associated with Queensland waters and provision of water quality guidelines and objectives aimed at enhancing or protecting the EVs.

The concept mine water management system including all Project water storages have been designed to comply with the relevant guidelines:

- *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* (Department of Mines and Energy (DME), 1995 (currently administered by DERM). These are commonly referred to as the DME guidelines and require that the design of a site WMS for any mining and processing operation be based on the concept of risk management for the purpose of protection of the environment.

- *Code of Environmental Compliance for Environmental Authorities for High Hazard Dams Containing Hazardous Waste* (DERM, 2009).
- *Model Water Conditions for Coal Mines in the Fitzroy Basin* (DERM, 2009)

2.2.1 Design Criteria to Limit Uncontrolled Discharges

In order to limit the potential for uncontrolled discharges (overflows) from the mine WMS adequate storage capacity must be provided to contain extreme runoff inflows from prolonged or extreme wet season rainfall. In simple terms the objective is to ensure that the probability of an uncontrolled discharge from each mine water storage to the receiving environment is less than one occurrence in 100 years.

The design criteria to limit the probability of an uncontrolled discharge are applied through conditions in the Environmental Authority (EA) for Regulated Dams (otherwise known as Hazardous Dams). The design criteria are specified according the hazard category of each dam. The hazard category of mine water dams (and tailings dams) are determined using the “Technical Guidelines for environmental management of mining and exploration activities (DME, 1995)”, and in the future will be in accordance with the DERM “Manual for Assessing Hazard Categories and Hydraulic Performance of Dams” which is currently being prepared and will apply when endorsed by the State Government.

Hazard categories for the proposed dams will be determined as part of detailed design when the geometry of the dams, their failure hazards, and overflow locations can be defined to the level required to assess the specific hazard for each dam. At this concept stage, it is assumed that most of the Project mine water dams will be defined as a significant hazard category.

The criterion for storage capacity to limit the probability of overflow can be applied as either a Design Storage Allowance (DSA) to ensure adequate available storage capacity at the start of each wet season to contain runoff from the design probability wet season rainfall, or to limit the probability of an overflow demonstrated through water balance modelling taking into account operating procedures for the mine WMS. The storage design criteria for significant hazard dams are expected to be:

- Sufficient capacity to contain 1:20 AEP wet season rainfall (conservatively assuming 100%) runoff when using the DSA deciles method (as defined in 1995 DME guidelines, and future DERM Manual for Dams); or

- Probability of overflow to be less than 1:100 AEP when assessed using the detailed water balance modelling method (future DERM ‘Manual for Dams’ when this guideline is endorsed).

The proposed EA conditions for Regulated Dams will also include a requirement to annually update the hazard assessment, and annually review the mine WMS available capacity to provide sufficient storage capacity to limit the potential for uncontrolled discharges. The proposed EA conditions will also require a Mandatory Reporting Level (MRL) to be defined for each dam which controls the operation of the available storage volume below the spillway crest, equivalent to the lower level of the 1:100 AEP 72- hour storm or the wave allowance generated by a 1:100 AEP wind speed. The proposed EA conditions will require that DERM shall be notified when the MRL level is exceeded.

2.2.2 Referrable Dams

Only the Raw Water Dam which will contain bulk raw water from a third party supplier will potentially be classified as Referrable under the Queensland Water Act (2000). The referrable category of the proposed Raw Water Dam will be determined through a dam failure impact assessment (DFIA) as required under the Water Supply (Safety and Reliability) Act 2008 during detailed design. The proposed dam will also need to comply with all relevant approvals conditions as required under the Sustainable Planning Act 2009 as part of obtaining a development permit for a referrable dam. At the current concept stage of the Project design the Raw Water Dam is predicted to be 1010 ML which would classify it as a referrable dam.

2.3 Adopted WMS Design Criteria

The proposed concept mine WMS has been designed, on the basis of water balance modelling using 110 years of climate data to ensure that the probability of an uncontrolled discharge satisfies legislative requirements. Each dam that has the ability to overflow to the receiving environment has been sized such that the probability of an overflow is 1:100 AEP or less. All other WMS dams, which will overflow to the open cut pits, have been sized to limit the probability of an overflow to approximately 1:10 AEP with the exceptions of the Process Water and Adit Pit Dams which have no external catchments (i.e. 'turkeys' nest configuration). Additionally, no controlled releases will be made from the system.

Existing Environment

3.1 Climate Data

Climate data was sourced from the Bureau of Meteorology (BOM) SILO Data Drill and consists of 121 years of records (1889 to 2010). The Data Drill is produced by accessing grids of data derived from interpolating the BOM records from individual weather recording stations. The interpolations are calculated using splining and kriging techniques and the resulting Data Drill consists of fully synthetic data. Figure 3-1 shows annual water year (1st July through June 30th) totals for the site and Figure 3-2 shows mean monthly rainfall and evaporation. Summary statistics for both rainfall and evaporation are shown in Table 3-1.

From Figure 3-1 it can be seen that annual rainfall at the Project site is highly variable and subject to prolonged periods of above and below average rainfall. A difference of over 500 mm separates the 10th percentile (1:10 AEP dry year) annual rainfall total of 281 mm and the 90th percentile (1:10 AEP wet year) annual total of 783 mm.

The mean monthly rainfall shows a distinct seasonal distribution (refer Figure 3-2) with monthly rainfall totals greatest in the wet season extending from December through February and peaking in February at 95 mm. Evaporation, which is always in excess of rainfall, shows a similar seasonal distribution peaking in December at 280 mm.

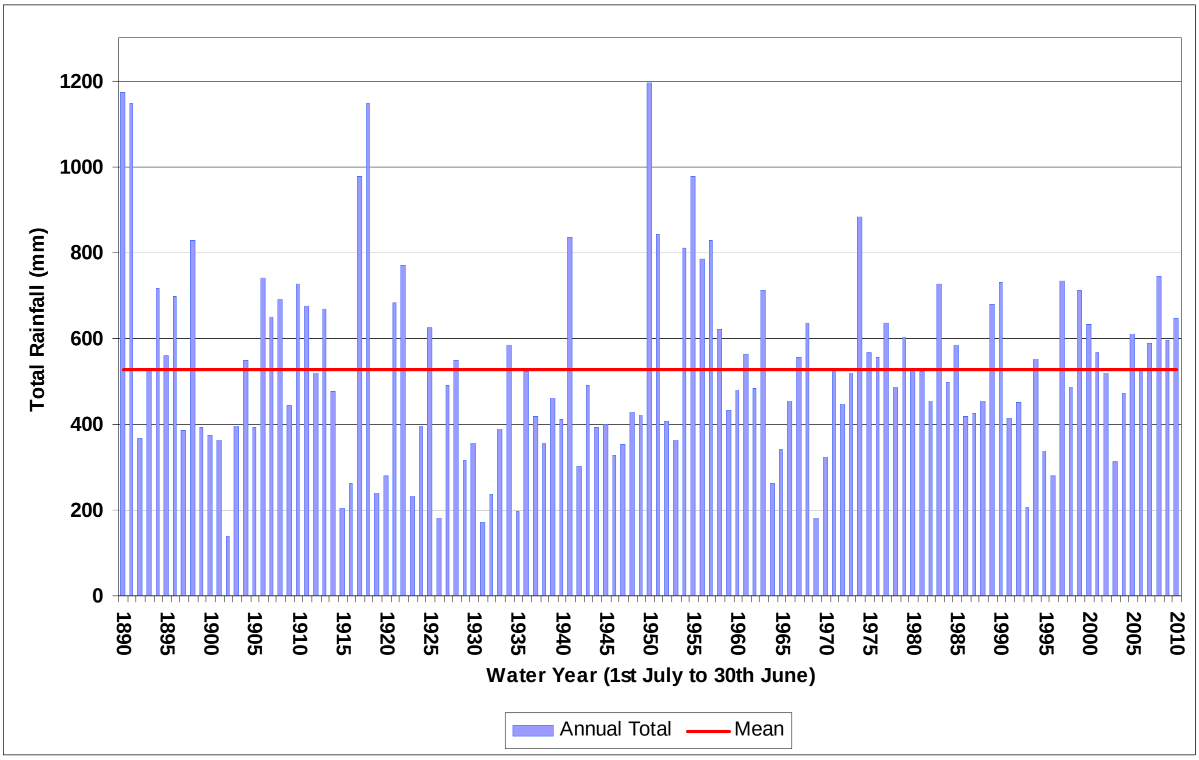

Figure 3-1 Annual Rainfall for Kevin's Corner Project Site (SILO Data Drill)

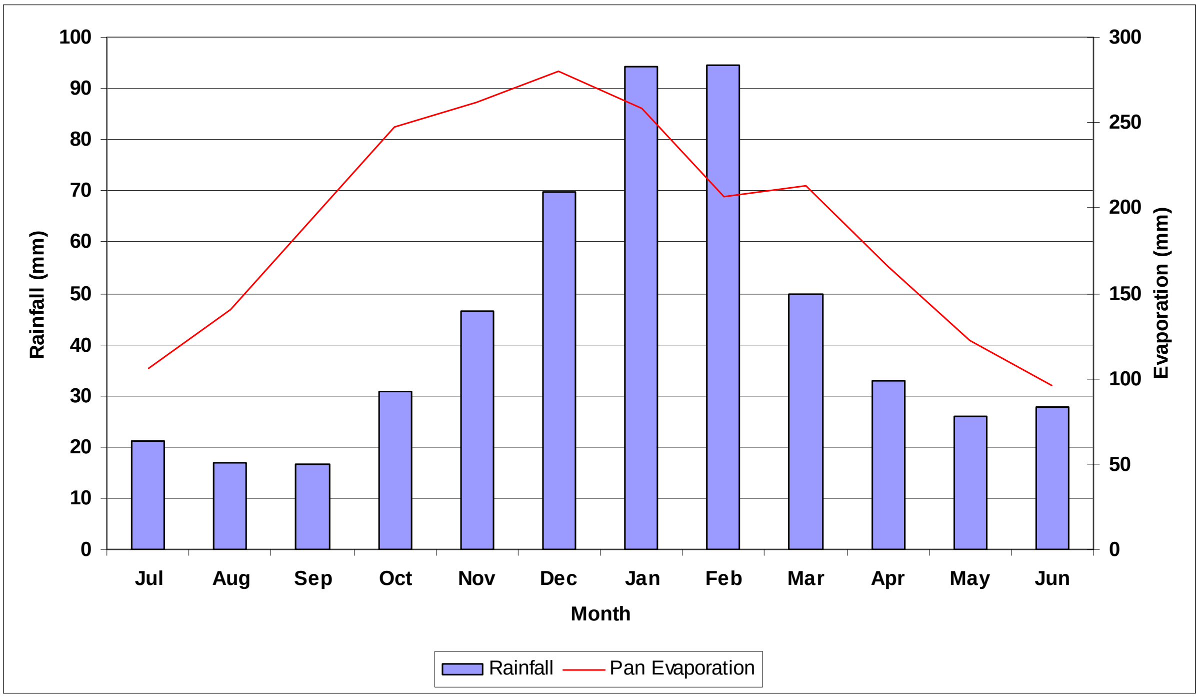

Figure 3-2 Mean Monthly Rainfall and Evaporation (SILO Data Drill 1889 to 2009)

Table 3-1 Summary Climate Statistics (SILO Data Drill 1889 to 2009)

Statistic	Annual[1] Rainfall (mm)	Annual[1] Pan Evaporation (mm)	Annual[1] Potential Evapotranspiration (mm)
10th percentile	281	2219	1664
50th percentile (median)	498	2290	1791
90th percentile	783	2409	1895
99th percentile	1169	2524	1933
Mean	528	2290	1785
Minimum	139	1869	1598
Maximum	1194	2628	1955
Standard deviation	214	101	83

[1] July to June water year

3.2 Catchment Description

The Project site is located within the catchment of Sandy Creek, a tributary of the Belyando River which is located within the upper reaches of the Burdekin Basin. Sandy Creek has a catchment area of approximately 7,700 km^2 to its confluence with the Belyando River although only 2,737 km^2 reports to the Project site. Minor tributaries of Sandy Creek located within the Project area are Well Creek, Middle Creek, Rocky Creek and Little Sandy Creek as shown in Figure 3-3 and their respective catchment areas are shown in Table 3-2. Sandy Creek is generally perennial in nature with the smaller tributaries typically being highly episodic with flow events restricted to periods during and immediately after rain events.

The catchment typically consists of moderately undulating lands which have been extensively cleared, predominately for livestock grazing for beef production or less commonly, cropping.

Table 3-2 Kevin's Corner Project Site – Reporting Catchment Areas

Catchment	Area (km^2)
Sandy Creek	2737.1
Middle Creek	53.1
Well Creek	304.7
Rocky Creek	52.7
Little Sandy Creek	149.4

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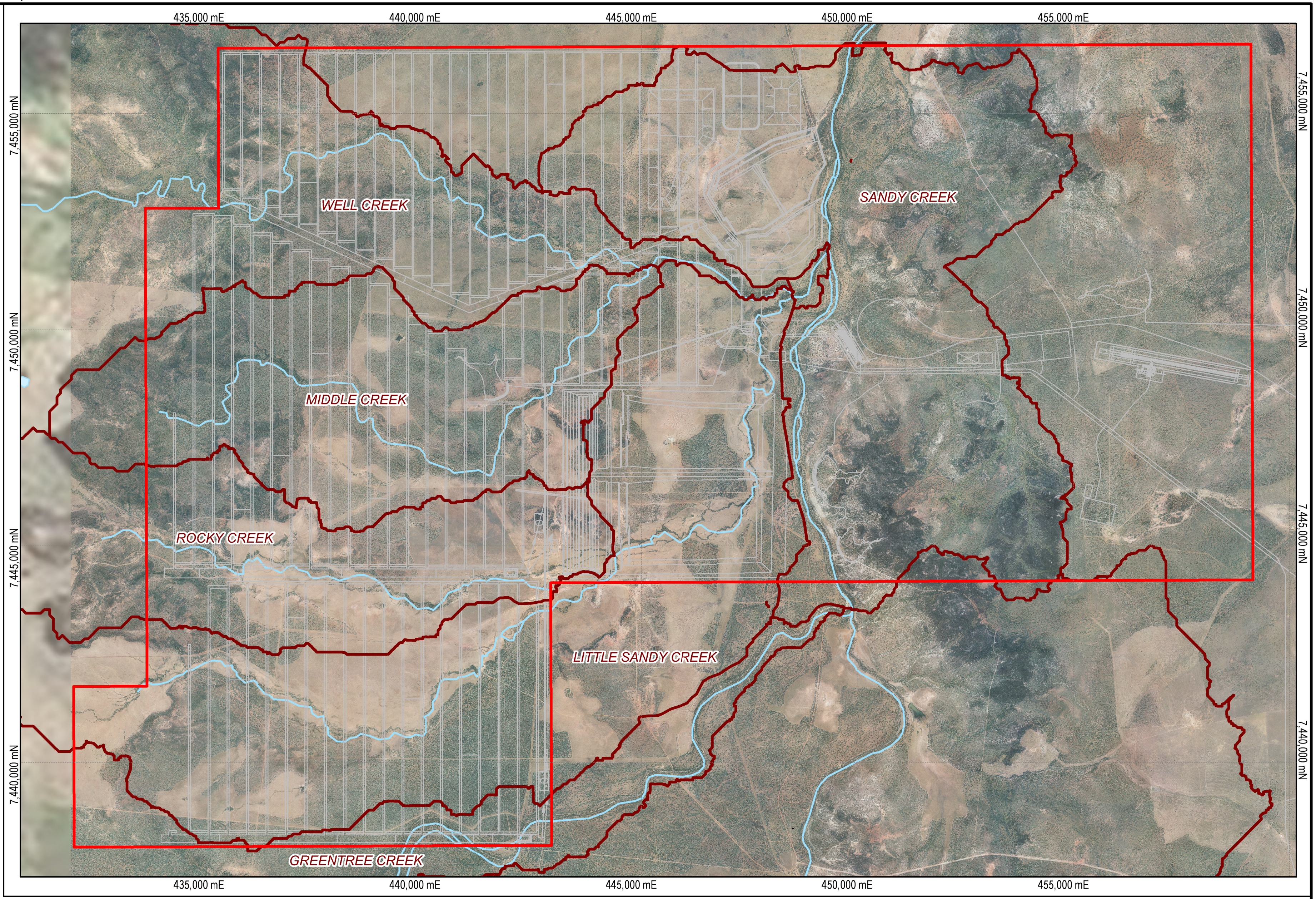
EXISTING CATCHMENTS



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Mining Lease Application (MLA70425) Boundary
Existing Watercourse
Catchment Boundary

3.3 Stream Flow Data

No stream flow gauges are located within the Project site however a detailed evaluation of all of the nearby gauges operated by the Queensland Department of Environment and Resource Management (DERM) as part of the Kevin's Corner Project Flood Hydrology Study (Appendix M2.1) identified four gauges for further analysis as shown in Table 3-3. Based on an assessment of the quality of the gauge data, catchment characteristics and proximity to the Project site the Native Companion Creek gauge at Violet Grove (120305A) was identified as the most suitable source of stream flow data. A detailed description of the evaluation process may be found in Appendix M2.1 - Kevin's Corner Project Flood Hydrology Study. Data from the Violet Grove gauge was used to calibrate the AWBM rainfall-runoff model used in the water balance model (refer section 5.3)

Table 3-3 Stream Flow Gauging Stations

Gauge Number	Location	Period of Record	Catchment Area (km^2)
120306A	Mistake Creek at Charlton	1968 to 1993	2583
120305A[1]	Native Companion Creek at Violet Grove	1967 to present	4065
1303016A	Mimosa Creek at Redcliffe	1957 to present	2473
1303327a	Callide Creek at Goovigen	1971 to present	4457

1 Gauge data used to calibrate AWBM

3.4 Surface Water Licence Holders

The highly ephemeral nature of the existing watercourses within the project area limits the scope of any beneficial use of the water resources around the Project area. A search of the Queensland Water Entitlements System was carried out to identify any regional surface water licence holders. The search indicates that there are no licence holders on Sandy Creek downstream of the Project site and that the nearest downstream licence holder (license number 48434F, domestic supply) is located on the Belyando River near Gregory Development Road approximately 150km downstream of the Project site.

Proposed Mine Water Management System

4.1 Water Segregation

Water within the WMS will be segregated based on its predicted quality to ensure that the generation and storage of contaminated water is minimised as far as is practicable as per current best practice mine water management. Segregation of waters will also optimise the reuse of water in applicable mine processes. The following classifications have been nominated for the site:

- **Clean water management system** – diversion around the mine WMS of uncontaminated runoff entering the Project site from undisturbed up stream catchments as well as the interception and diversion of runoff generated from undisturbed areas within the Project site;
- **Contaminated water system** – management of water originating from all potentially contaminating sources such as open cut and underground mine dewater, various mine process areas and active spoil and overburden areas;
- **Process water management system** – management of all water used in the CHPP, tailings storage facility and the tailings decant and return water system; and
- **Groundwater management system** – this includes all groundwater pumped from the underground mines as well as any water extracted from the borefield.

Groundwater management systems are not discussed any further in this report as they are assessed in detail in the Kevin's Corner Groundwater Technical Report (Appendix N).

4.2 Clean Water Management System

Runoff generated from undisturbed catchments within the Project site as well as clean water entering the project area from undisturbed catchments upstream will be diverted, wherever practical, around the mine WMS. The clean water system will comprise of the following elements:

- Provision of a diversion channel and system of levees to divert flows in Little Sandy Creek and Rocky Creek around the central open cut pit and into Middle Creek and a system of levees along Sandy Creek and Well Creek to prevent inundation of the open cut pits and critical mine infrastructure. The diversion channel and levees will be designed to contain the 1:1000 AEP event. Further design details of the levees and creek diversion are described in Appendix M2.2, Kevin's Corner Hydraulics Technical Report;
- Clean water catch drains will, wherever practicable, direct runoff from undisturbed catchments around the mine WMS. This will include a system of upslope clean water catch drains to minimise the catchments reporting to constructed the proposed raw water and mine water dams;
- Diversion around the WMS of all runoff originating from rehabilitated areas. As rehabilitation of the spoil and overburden emplacement areas progresses appropriate water quality monitoring will determine when runoff will be suitable for release. Runoff from these areas will then be diverted offsite wherever practical;
- Highwall dams and levees upslope of the open cut pits to reduce peak runoff inflows and velocities from undisturbed or rehabilitated catchments. The location and design of highwall dams has not been considered at this concept level but will be further refined during detailed design;

- Raw water dam to store imported raw water; and
- A system of pumps and pipelines to transfer water to various onsite demands including:
  - The CHPP for coal washing;
  - MIA use (workshop, wash down);
  - Haul road dust suppression;
  - Water treatment plant (for potable applications); and
  - ROM stockpile dust suppression.

4.3 Contaminated Water Management System

Water originating from a variety of potentially contaminating sources including dewater from the open cut and underground mines and runoff from various mine operational areas will be carefully managed to minimise the volumes of water requiring capture and storage. The contaminated water system will encompass management of water from the following sources:

- Dewatering of the open cut pits;
- Dewatering of the underground mines (until more detailed analysis of groundwater quality is known it has conservatively been assumed that it would be unsuitable for release);
- Runoff originating from all ROM pads and emplacement areas, MIAs, CHPP, TLO and product stockpile; and
- Runoff originating from all active spoil and overburden emplacement areas.

Water within the contaminated water system will be preferentially sourced for a variety of uses including process water in the CHPP and dust suppression. This will ensure that the contaminated water inventory is optimised and supply of raw water is minimised. The contaminated water system will comprise the following elements:

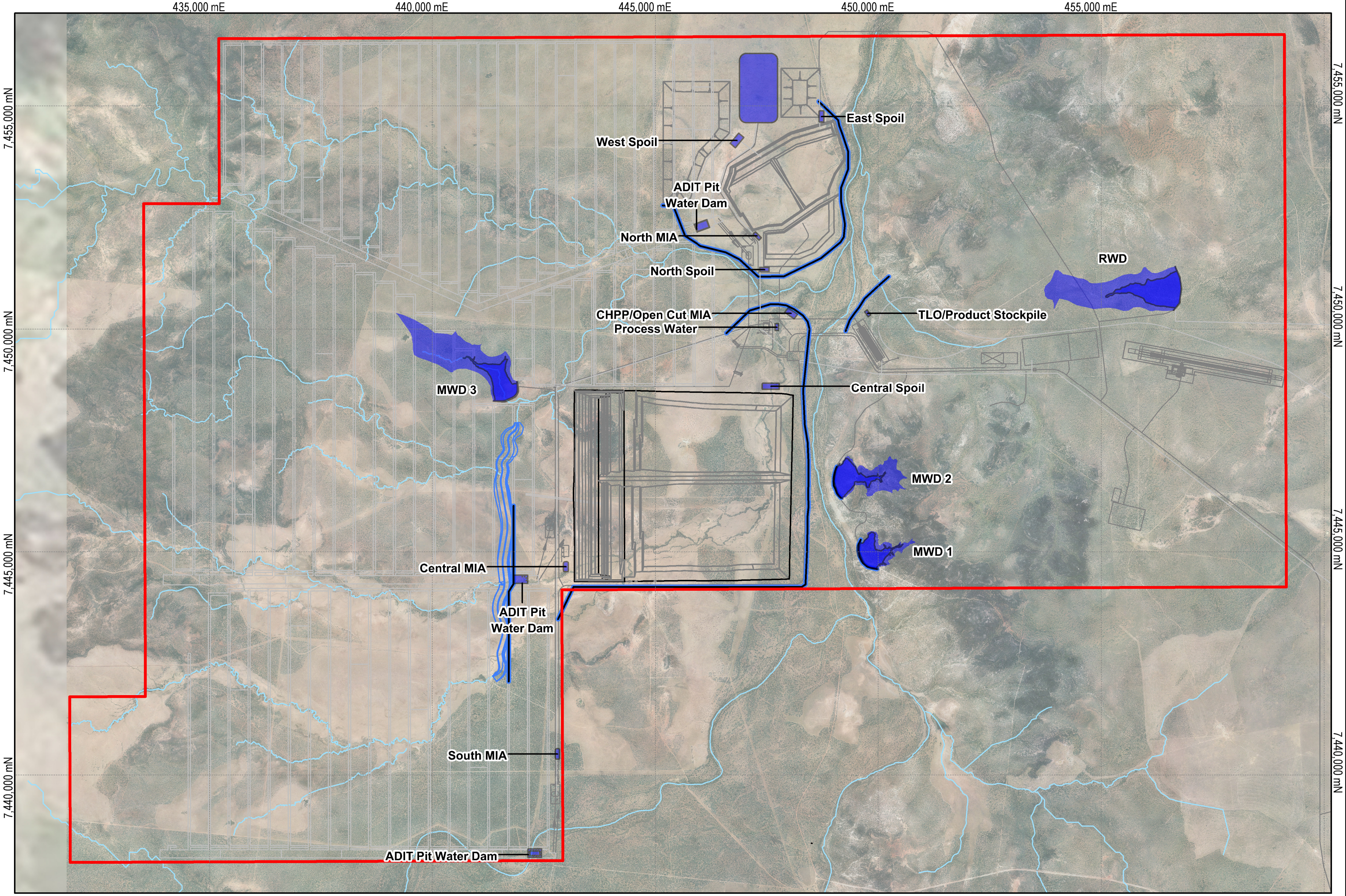
- Open cut pit sumps to collect local runoff from the pit floor, ramps, high, low and end walls;
- Open cut pit dewatering pumps and pipelines to transfer water from the central pit sump to either MWD 1 or 3 and from the northern pit sump to MWD 2;
- Underground mine water collection system;
- Advance underground mine dewatering borefield;
- Underground mine pumps and pipelines to transfer water from each collection system and borefield to the associated adit pit dams and then on to MWD 3;
- Appropriate runoff interception and conveyance systems to capture runoff originating from the potentially contaminating mine process areas (MIAs, CHPP, TLO, product stockpile);
- A pump and pipeline system to transfer water from each process area dam to the nearest mine water dam;
- Appropriate runoff interception and conveyance systems to capture runoff originating from the active spoil and overburden emplacement areas;
- A pump and pipeline system to transfer water from each spoil dam to nearest mine water dam; and
- A return water pump and pipeline system from each mine water dam to deliver stored water to either:
  - A water fill station (for haul road dust suppression - MWD 2 and 3 only);
  - The Process Water Dam (to supply the CHPP); or
  - Another mine water dam for the purpose of managing inventory levels during prolonged wet or dry periods.

4.3.1 Relinquishment of Spoil Areas from the Mine WMS

Runoff from the rehabilitated spoil and overburden will be monitored using an appropriate water quality monitoring program. Once it can be demonstrated, on the basis of water quality monitoring results that the runoff is suitable for discharge to the receiving environment each area will be removed in turn from the mine WMS and the runoff allowed to bypass the mine WMS.

4.4 Layout and Staging of the Water Management System

During the projected 30 year life of mine (LOM) the nature of the mine water management system will adapt to reflect changes in site operations as well as the extent and nature of the disturbed and rehabilitated areas. Mine years 5, 10 and 30 have been chosen to be most representative of these predicted changes and Figure 4-2 to Figure 4-4 show conceptual layouts for the mine WMS including the extent of mine progression and the areas of disturbed and rehabilitated catchments. The requisite water management storages that will be required to ensure that the stated design objectives (refer section 2.1) are met are shown on Figure 4-1. Figure 4-5 to Figure 4-8 also show general schematics for the water management system. The figures show that the out-of-pit tailings storage facility (TSF) will only be used for the first five years of mine operation and that tailings placement will continue in the North open cut pit for the rest of the mine life.



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Mining Lease Application (MLA70425) Boundary
Existing Watercourse
Diverted Watercourse
Diversion Levee

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CONCEPT MINE WMS - STORAGE LOCATIONS

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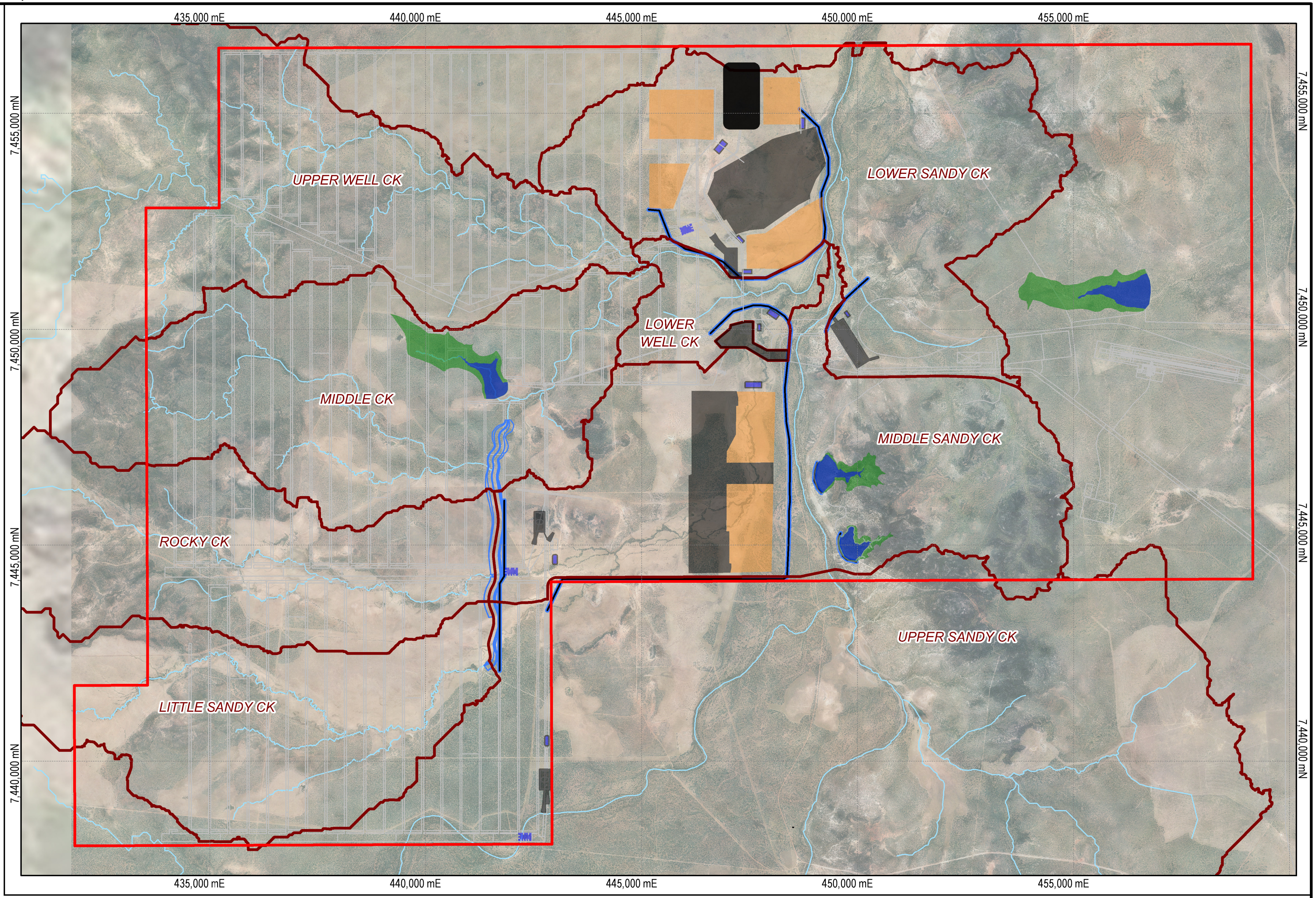

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Hardstand		Water		Mining Lease Application (MLA70425) Boundary		Diverted Watercourse	
Spoil		Natural Surface		Existing Watercourse		Diversion Levee	
Tailings Storage		Rehabilitated Surface		Catchment Boundary			

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CONCEPTUAL LAYOUT OF THE MINE WMS - YEAR 5

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SITE WATER MANAGEMENT SYSTEM AND WATER BALANCE

Figure: 4-2

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SITE WATER MANAGEMENT SYSTEM AND WATER BALANCE

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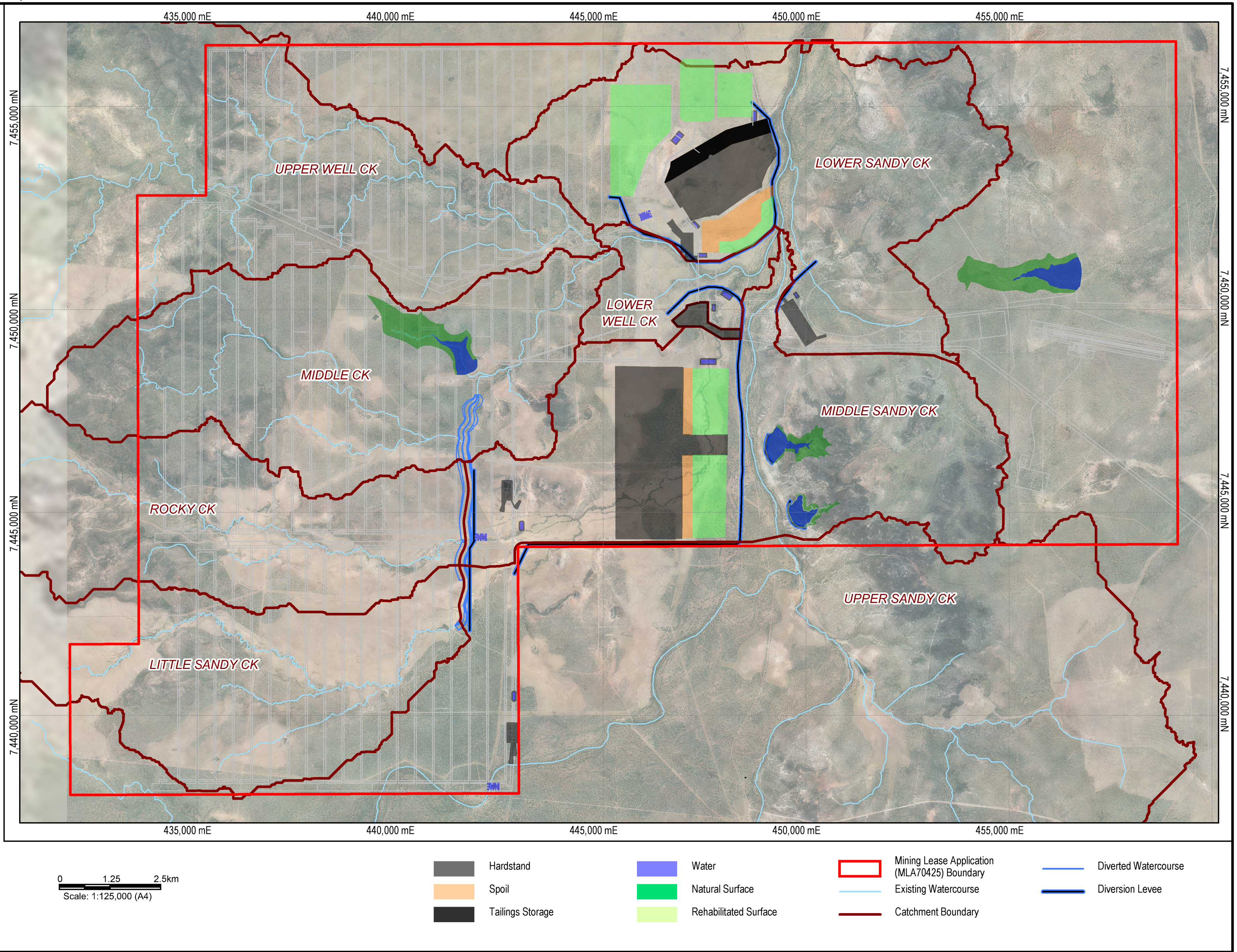
CONCEPTUAL LAYOUT OF THE MINE WMS - YEAR 10



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SITE WATER MANAGEMENT SYSTEM AND WATER BALANCE

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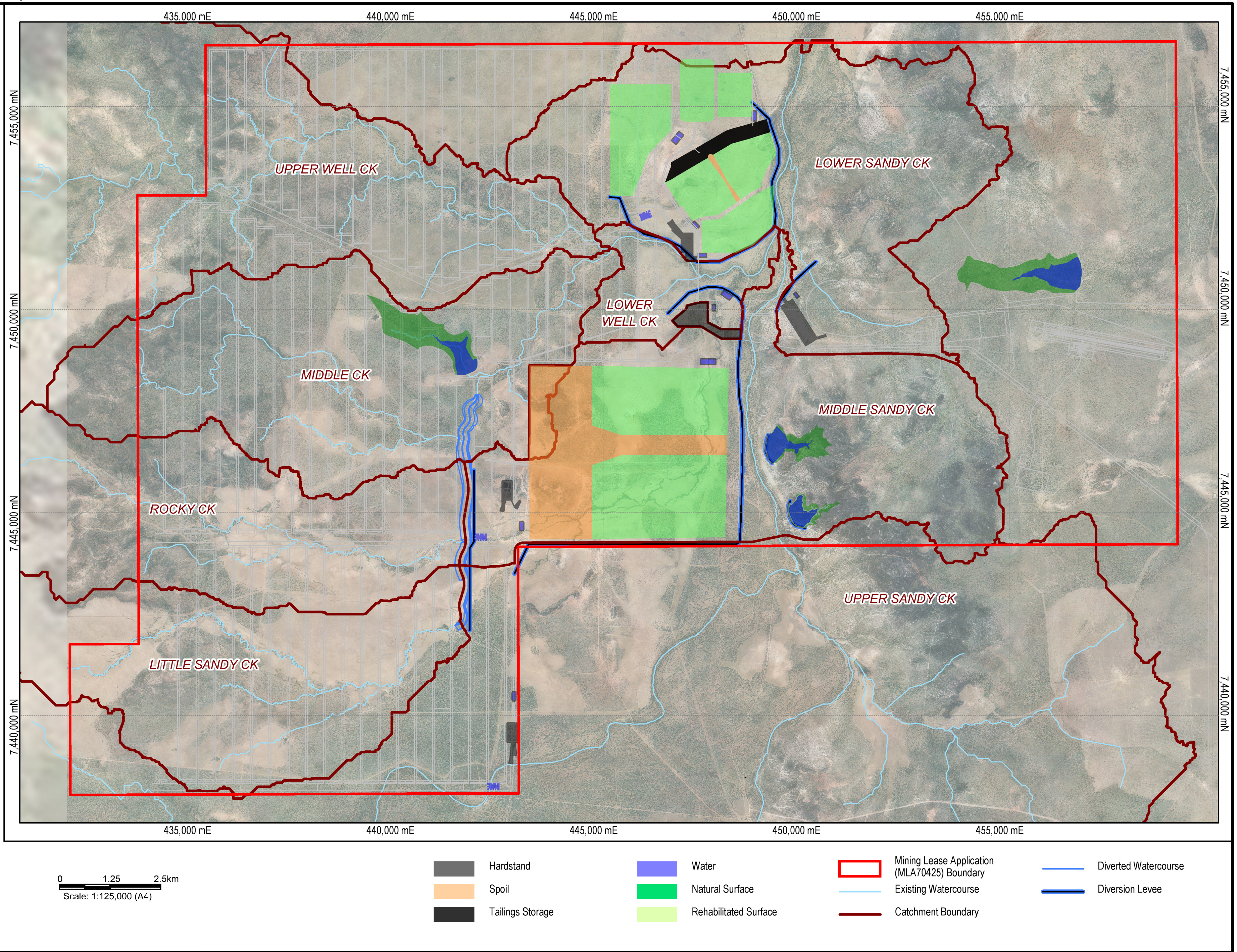
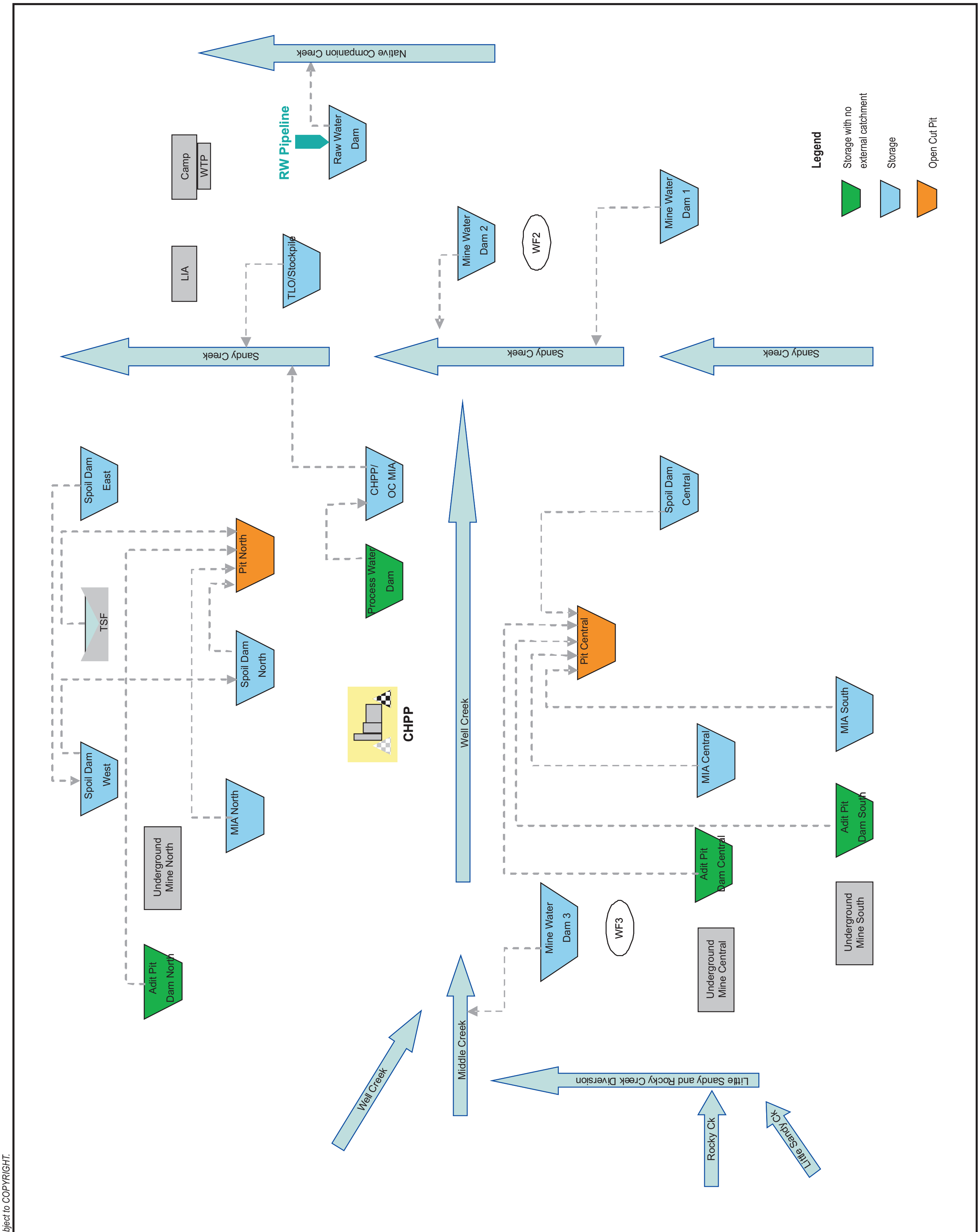
CONCEPTUAL LAYOUT OF THE MINE WMS - YEAR 30





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CONCEPT WMS SCHEMATIC - STORAGE OVERFLOW PATHS

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SITE WATER MANAGEMENT SYSTEM & WATER BALANCE Figure: **4-5**

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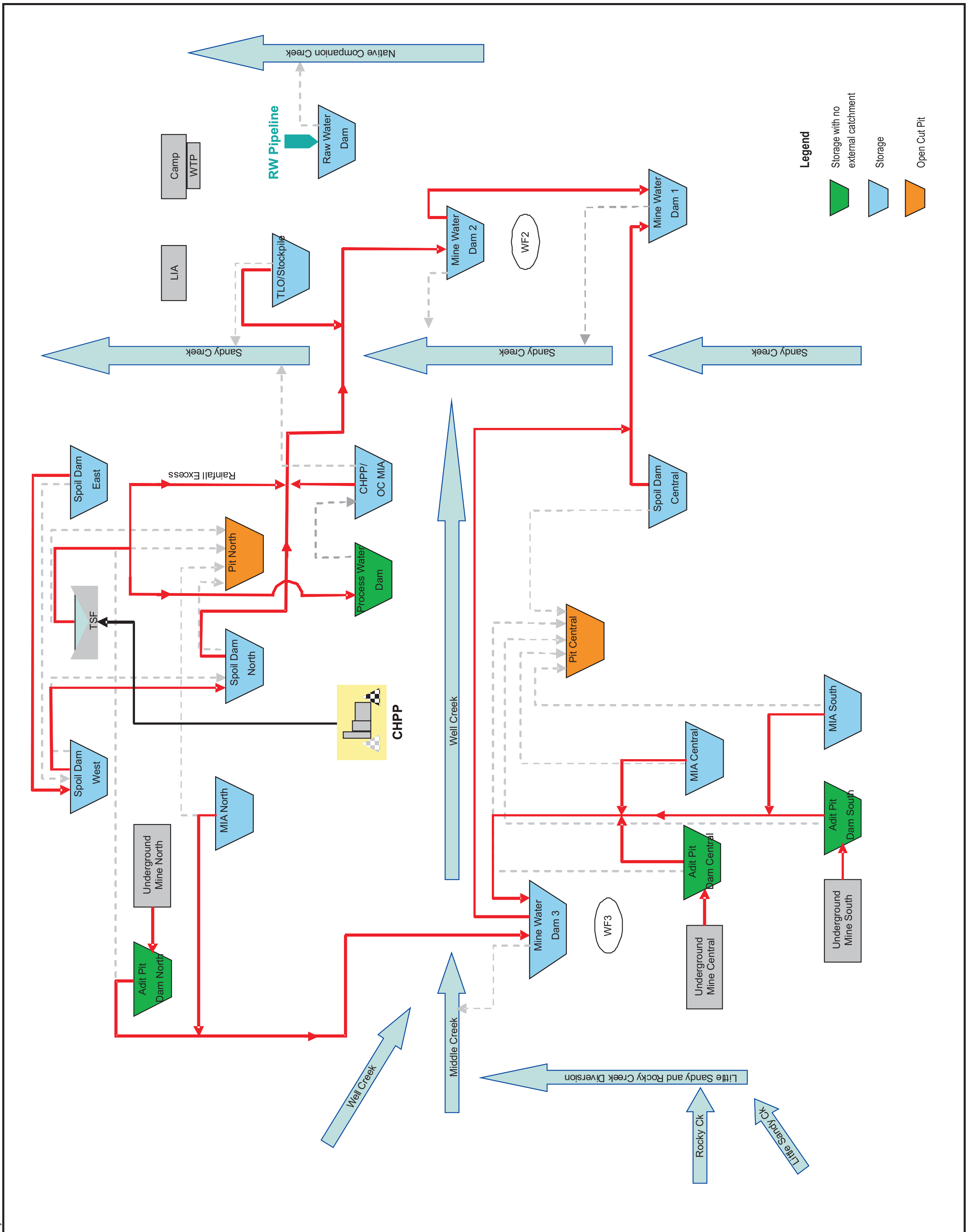

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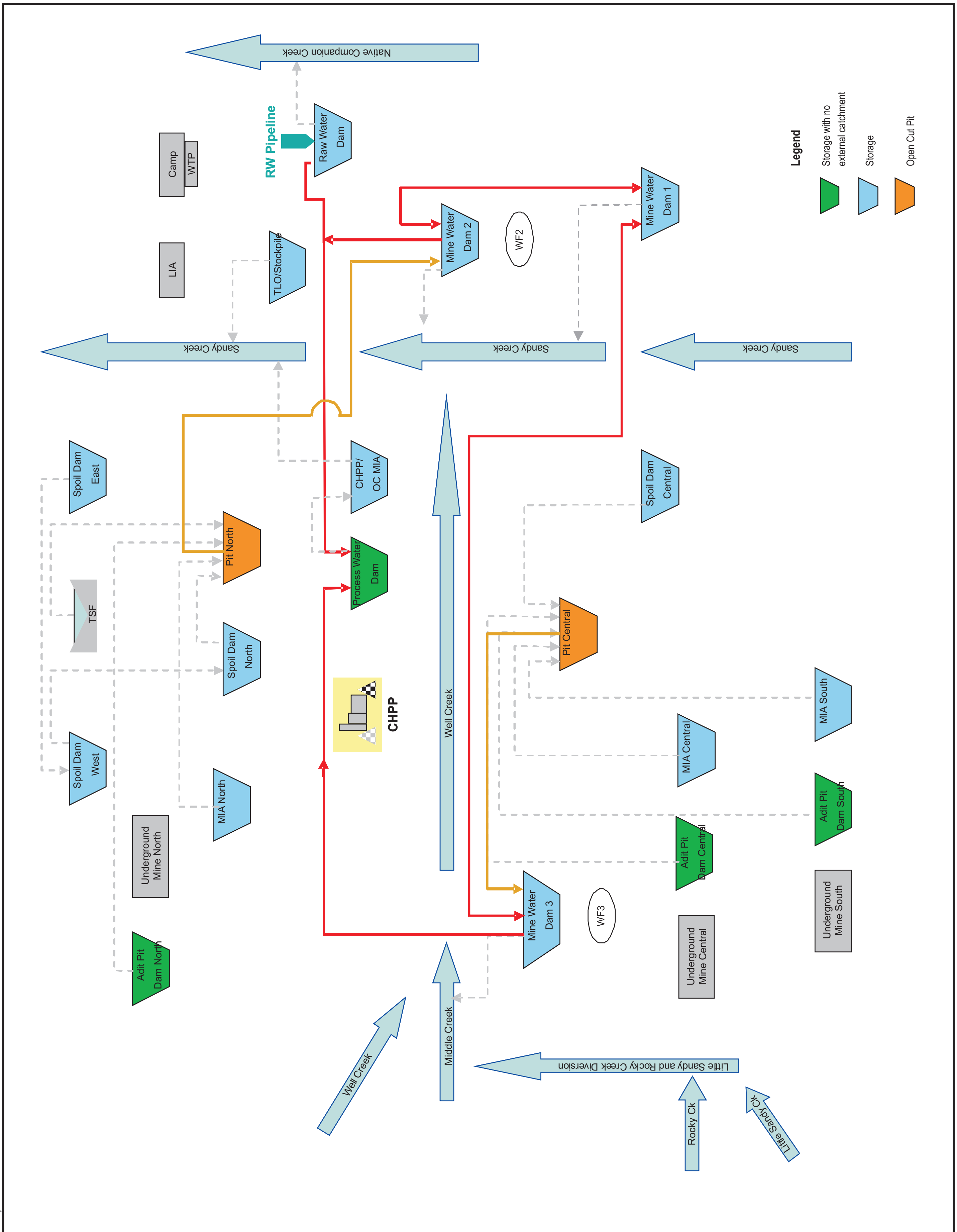
CONCEPT WMS SCHEMATIC -
WATER RECOVERY FLOW PATHS

URS

SITE WATER MANAGEMENT SYSTEM & WATER BALANCE

Figure: **4-6**

File No: **42626660-g-2091.cdr** Drawn: **RG** Approved: **CP** Date: **15-04-2011** Rev. **A** A4



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CONCEPT WMS SCHEMATIC - WATER REDISTRIBUTION AND PIT DEWATERING FLOW PATHS

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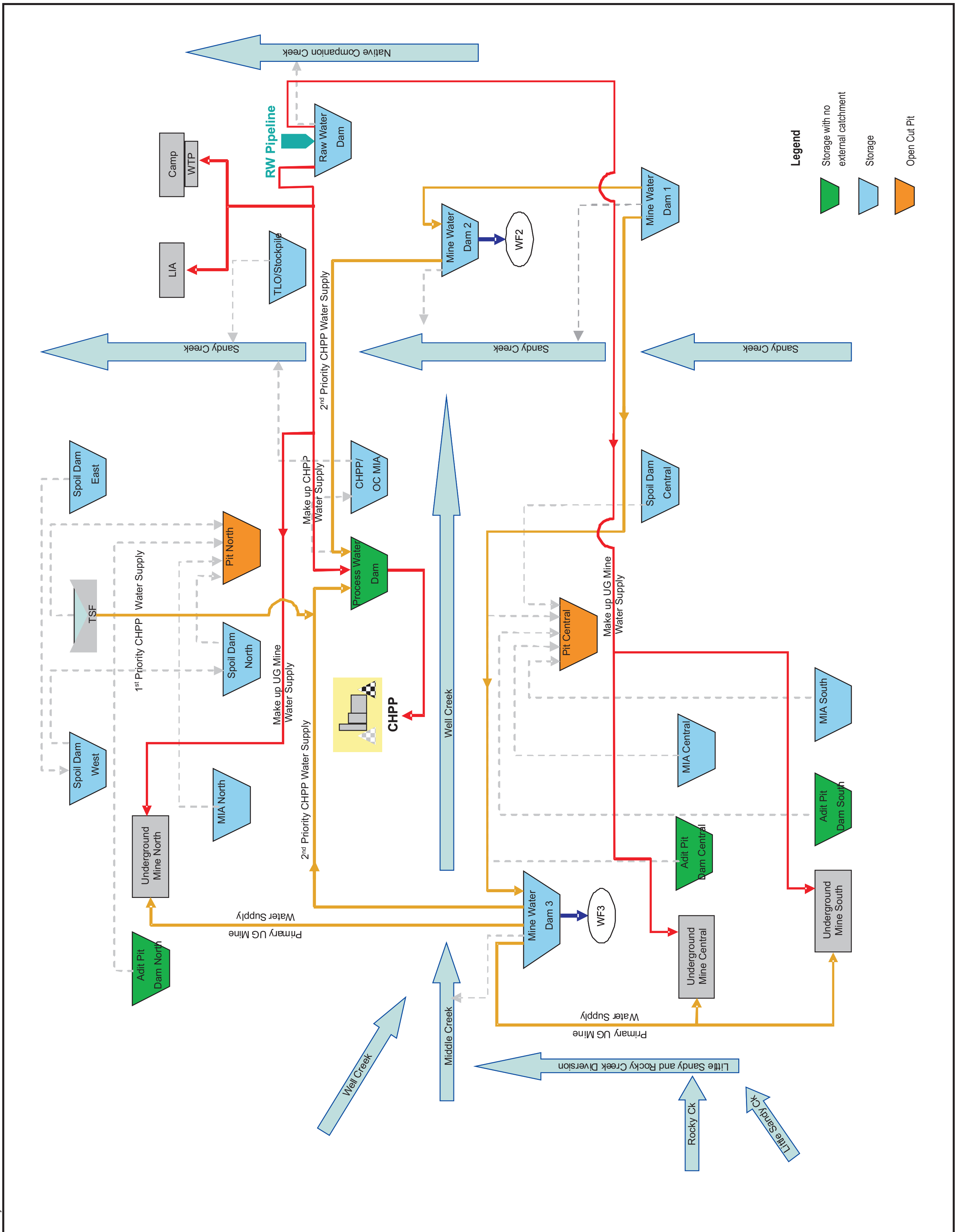
SITE WATER MANAGEMENT SYSTEM & WATER BALANCE

Figure: **4-7**

File No: **42626660-g-2092.cdr** | Drawn: **RG** | Approved: **CP** | Date: **15-04-2011** | Rev. **A** | A4



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CONCEPT WMS SCHEMATIC -
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SITE WATER MANAGEMENT SYSTEM & WATER BALANCE

Figure: **4-8**

File No: **42626660-g-2093.cdr** Drawn: **RG** Approved: **CP** Date: **15-04-2011** Rev. **A** A4

4.5 Erosion and Sediment Controls During Construction

An Erosion and Sediment Control Plan (ESCP) will be prepared and implemented during the construction of the mine infrastructure and will be in accordance with appropriate statutory requirements, including conditions of the Environmental Authority. Controls should be established to a standard consistent with the DME (1995) guidelines as well as any other applicable guidelines such as the IEA S*oil Erosion and Sediment Control Guidelines* (1996) as well as any relevant local Regional Council conditions.

The ESCP should include:

- Identification of soil and water management issues, including existing site conditions, soil and climatic data, erosion prone areas, location of the nearest and other relevant environmentally sensitive areas.
- Clear understanding and application of proposed control measures including the following actions - minimise disturbance, provide temporary and permanent drainage measures as early possible, identification of suitable erosion and sediment controls for the site, implement effective revegetation.
- Drawings to accompany the ESCP identifying the development and staging of works of temporary erosion and sediment control measures, including measures to cope with heavy rainfall events to aid in limiting unforseen construction delays due to wet weather.
- Compliance with the recognised approval processes.
- Maintain and supervise implementation of the ESCP, and undertake scheduled inspections of the implementation of the ESCP.
- Undertake monitoring of the effectiveness of the ESCP including diary notes/logbook entries of control techniques used on-site, and water quality sampling both upstream and downstream of disturbed areas.

Recommended erosion and sediment controls include:

- Where possible, avoid disturbance to natural watercourses and riparian areas, and reinstate any disturbed areas.
- Reduce or limit overland flow runoff volume and velocity by minimising catchment size, increasing flowpath length, and providing for water infiltration into soils.
- During the construction phase, early planning and construction of temporary drainage systems will minimise erosion and avoid delays in initial earthworks.
- Diversion of upslope water to reduce on-site erosion by limiting catchment size, thereby reducing total volume of contaminated runoff requiring treatment and reduced downtime following prolonged rain events.
- Install permanent drainage structures as early as possible, including stabilised drainage outlets.

Site Water Balance Model

5.1 Modelling Approach

A water balance based on historical rainfall records has been undertaken on the proposed mine WMS using GoldSim software which is extensively used in a wide range of environmental modelling applications including mine site water management. The water balance was able to assess the performance of the proposed mine WMS by estimating likely runoff volumes, site water demands and identifying possible water deficits or surpluses as well possible overflows from the water storages.

The water balance model (WBM) was developed for each of the year 5, year 10 and year 30 year mine plans with 110 years of input climate data from the Bureau of Meteorology SILO Data Drill. Model simulations were based on a daily time step. An additional worst case scenario (maximum catchment area reporting to the mine WMS) was also assessed to represent the year 30 mine plan but with the assumption that none of the proposed rehabilitated areas were sufficiently established for runoff to be diverted around the mine WMS.

Concept layout plans and schematics for the modelled mine WMS are shown in Figure 4-1 to Figure 4-8.

5.2 Modelling Assumptions

The WBM has been developed to a level of sophistication appropriate for supporting the preparation and validation of the concept mine WMS. Some simplifications and assumptions have been made as follows:

- All pump transfers are carried out ‘instantaneously’ within each time step based on the pumps given capacity and water availability. No account has been made of the time taken to physically move water around the system;
- Pump rates, transfers and operational rules have not been optimised and will be further refined as the Project moves towards detailed design;
- The performance of the WMS has been assessed based on historical climatic extremes however the impacts of potential changes to severe climatic events as a result of climate change have not been incorporated into the model;
- Underground mine dewatering rates are based on early provisional estimates which are likely to change as more detailed groundwater modelling is carried out;
- Evaporation rates are applied to storage water surfaces irrespective of rainfall;
- Haul road dust suppression demand is reduced to zero on days when rainfall is in excess of evaporation;
- All storages are assumed to be at half capacity at the start of each simulation; and
- The storage capacity of any one dam has been optimised to the extent that the chance of an uncontrolled discharge to the receiving environment is less than 1:100 AEP.

5.3 Rainfall Runoff Model

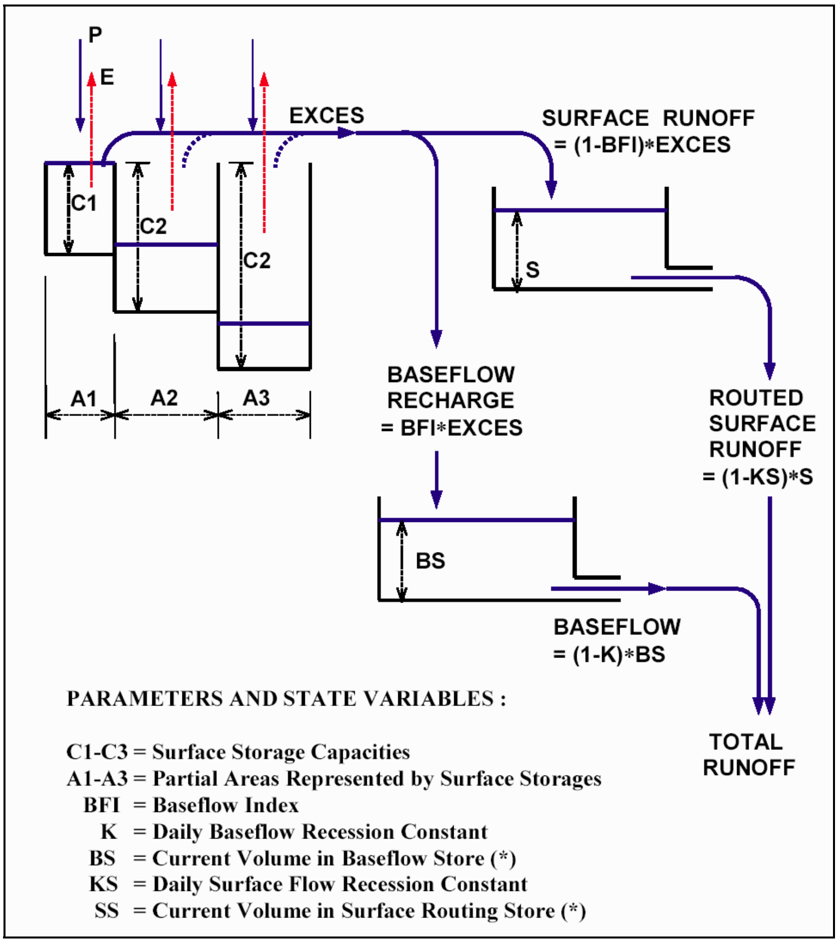
In order to estimate the predicted volumes of surface runoff that may be input into the mine WMS rainfall and evaporation climate data are routed through a rainfall-runoff (R-R) model. This is considered to be a superior method to simply using fixed runoff coefficients and the Australian Water

Balance Model (AWBM) (Boughton, 1993) was selected for this purpose due to its simplicity, widespread usage in many similar applications and ease of parameterisation and calibration.

5.3.1 Model Description

The AWBM is a daily rainfall-runoff model that calculates runoff as saturation excess from three surface stores of different capacities. This allows for partial area runoff at different times from different parts of the catchment during a storm. There are three surface storage capacities C1, C2 and C3 that occupy partial areas of the catchment A1, A2 and A3 respectively. The average surface storage capacity is the sum of the three products of capacity and partial area, i.e. C1.A1 + C2.A2 + C3.A3. The average surface storage capacity is the single parameter determining the amount of runoff. In the daily water balance calculations, the daily rainfall is added to each of the three surface stores, and potential evapotranspiration is subtracted while water remains in the store. When the amount of water in any store exceeds the capacity of that store, the excess becomes runoff and the amount in store is reset to the capacity.

The runoff generated as excess from the surface stores is divided into surface runoff and baseflow recharge by the baseflow index (BFI). The discharge from baseflow storage each day is governed by the baseflow recession constant (K_b) and calculated as (1.0 – K_b) times the amount in baseflow store (BS). The two baseflow recharge and discharge parameters affect the timing of runoff but not the volume of runoff. The discharge from the surface runoff routing storage (S) each day is governed by the surface flow recession constant (K_s) and calculated as (1.0 – K_s) times the amount in the surface runoff store.



Source: Podger, 2004

Figure 5-1 Structure of the AWBM Rainfall-Runoff Model

5.3.2 Model Calibration

Calibration of the AWBM was carried out using the Rainfall Runoff Library (RRL), a software package developed by CRC for Catchment Hydrology which can generate daily catchment runoff from daily rainfall and evapotranspiration data. The package contains several commonly used R-R models and calibration tools to allow the model to be calibrated against recorded flow gauge data. Calibration was carried out using data from the Native Companion Creek at Violet Grove (120305A) gauge. Input rainfall data was produced by generating a catchment weighted average based on actual rainfall data from two recording stations within the stream gauge catchment area with records concurrent with the stream gauge data. Missing records were infilled from SILO Data Drills generated for the same location as the rainfall recording station. Table 5-1 summarises the details of the rainfall stations used.

Table 5-1 Rainfall Recording Stations used to Calibrate AWBM

Rainfall Station	Station Number	Start of records	End of records	Number of Missing Records Infilled	Percentage of Catchment Weighted Average
Durrandella	35165	January 1958	n/a	37	27.6%
Alpha Post Office	35000	January 1887	n/a	284	74.4%

Three objective functions were used to calibrate the model; Nash-Sutcliffe coefficient of efficiency (NSE), flow duration curve and percentage difference in runoff. Due to the presence of an unusually large rainfall and discharge event on 19/04/90 calibration was carried out for three separate periods; before the 1990 event only, after the 1990 event only and for the entire length of available data. In all calibrations a model warm-up period of one year was chosen. Assessment of the calibration results indicated that the best optimisation of the objective functions was achieved by calibrating over the entire set of available data. Table 5-2 shows the calibration results for NSE and differences in modelled and observed runoff and flows. A monthly NSE of 0.880 and a 4.6% overall difference of flows as well as the comparison of flow duration curves and monthly flows in Figure 5-2 and Figure 5-3 show a good level of model fit. Final adopted AWBM parameters for natural, undisturbed catchment surfaces are shown in Table 5-4.

Table 5-2 AWBM Calibration Results for Native Companion Creek at Violet Grove

NSE		Difference in Runoff		Total Runoff (mm)		Mean Runoff (mm/yr)		Runoff Percentage	
Daily	Monthly	Percent	Absolute	Observed	Model	Observed	Model	Observed	Model
0.462	0.880	4.6%	22.8mm	522.6	499.8	12.07	12.62	2.06%	2.15%

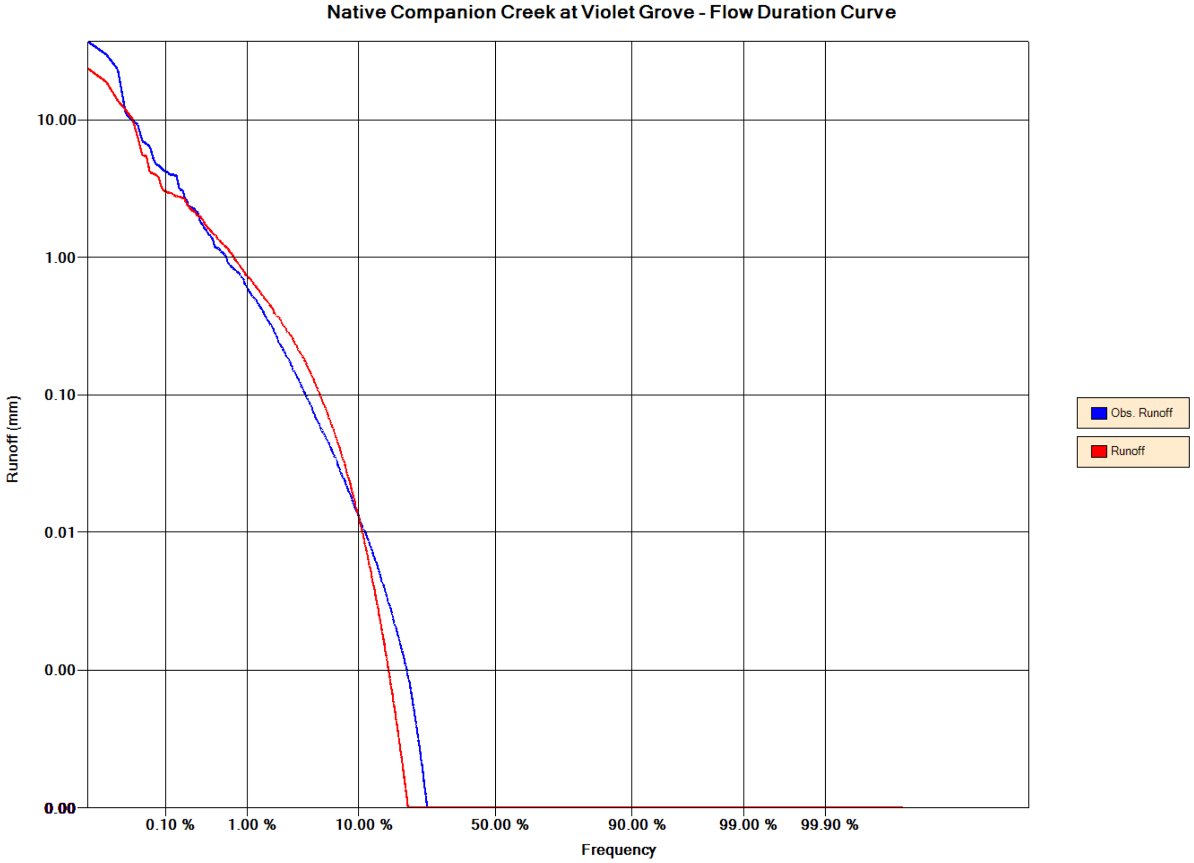


Figure 5-2 Comparison of Modelled and Observed Flow Duration Curves for Native Companion Creek at Violet Grove

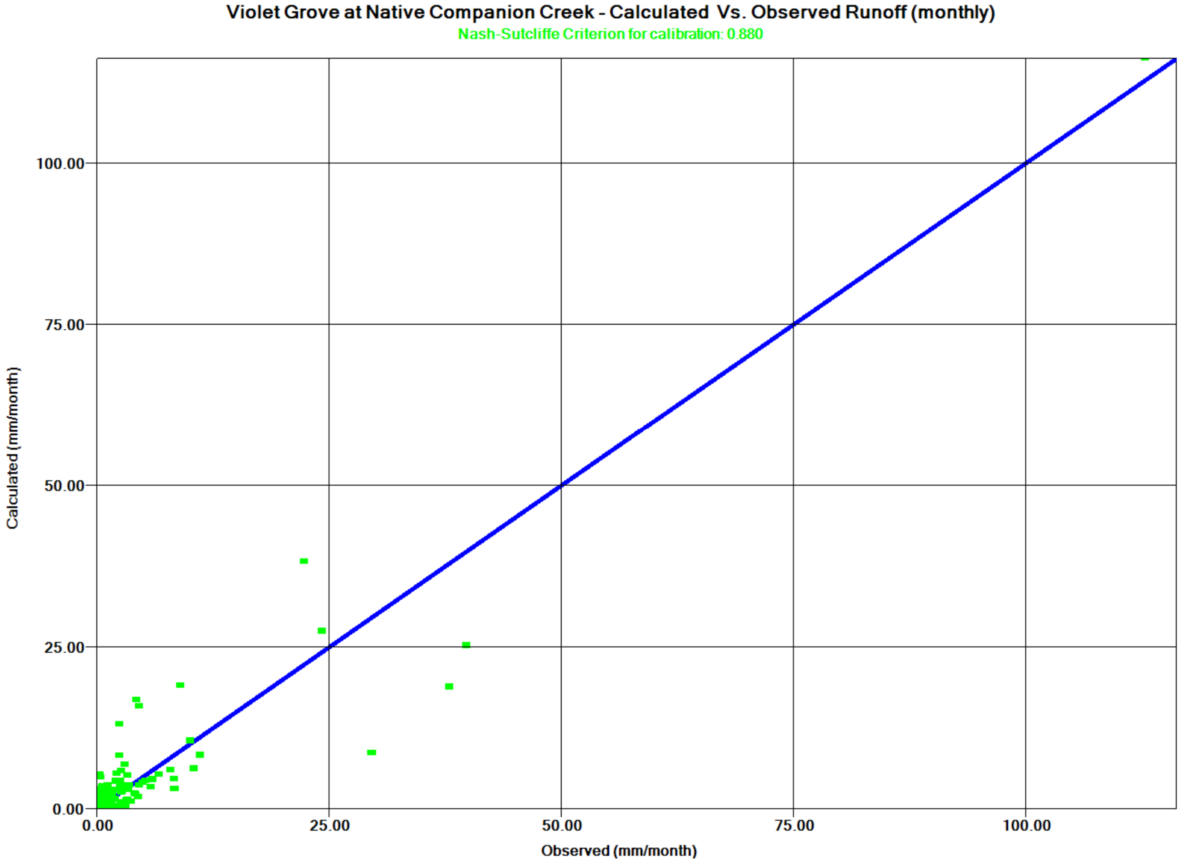


Figure 5-3 Comparison of Monthly Observed and Modelled Runoff for Native Companion Creek at Violet Grove

Land areas designated as revegetated were assumed to have the same AWBM parameters as natural areas. This assumption does not impact the model performance in any way as runoff generated from these areas is designed to bypass the mine WMS. Due to the lack of calibration data available runoff parameters for spoil and hardstand areas values have been estimated to take into account the inferred physical differences between spoil and hardstand areas and natural (relatively undisturbed) catchments. These differences may be summarised as:

- Spoil catchments have less interception storage due to absence of, or reduced cover of vegetation;
- Spoil catchments can have higher storage and infiltration in some areas due to presence of loose dumped spoil and characteristics of drag line spoil;
- Spoil catchments can include areas of relatively higher compaction due to truck traffic and consolidation over time;
- Spoil catchments are in some areas poorly drained and are continually changing at the surface due to the ongoing operations of mining and dumping; and
- Hardstand areas are relatively heavily compacted and most areas are intended to be well drained for safe mining operations. However, the hardstand areas are often relatively flat and include many minor small surface depressions, which produce some losses as water is retained on the surface and evaporates away after rainfall events.

The final AWBM parameters for spoil and hardstand were achieved by adjusting the catchment storage depths (C1-C3) to produce higher runoff rates, reducing the surface flow recession constant and in the case of hardstand parameters, reducing the base flow index to zero to reflect the expectation that there would be no significant baseflow from hardstand areas.

5.3.3 Model Land Types and Adopted Parameters

Four separate landuse types have been incorporated into the Project WBM to represent differences in land use, potential for contamination and runoff depth. Land types are described in Table 5-3 and the final AWBM parameters adopted for the WBM are shown in Table 5-4.

Table 5-3 Kevin's Corner WBM Land Types

Land Type	Description	Runoff Management
Natural	All undisturbed areas both upstream of, and within the MLA	Wherever possible to be diverted around the mine WMS.
Revegetated	All previously disturbed areas that have been successfully rehabilitated.	Wherever possible to be diverted around the mine WMS.
Hardstand	All potential sources of contaminated runoff such as open cut pits, MIAs, ROM pads etc.	To be contained onsite and managed within the mine WMS.
Spoil	All active spoil and overburden areas.	To be contained onsite and managed within the mine WMS.

Table 5-4 Adopted AWBM Parameters

Parameter	Description	Landuse			
		Natural	Revegetated	Spoil	Hardstand
A1	Partial area	0.047	0.047	0.047	0.047
A2	Partial area	0.172	0.172	0.172	0.172
C1	Surface storage capacity	39.5	39.5	8	5
C2	Surface storage capacity	180.0	180.0	40	25
C3	Surface storage capacity	368.6	368.6	85	50
BFI	Base Flow Index	0.363	0.363	0.363	0
K_b	Base flow recession constant	0.699	0.699	0.699	n/a
K_s	Surface flow recession constant	0.756	0.756	0.1	0.1

5.4 Model Data

5.4.1 Mine WMS Storages

The mine WMS consists of 17 dams with various functions. Optimisation of the mine water balance for each stage plan has identified the minimum storage volume required for each dam to ensure the objectives stated in section 2.1 are met. The function and proposed capacity for each dam is given in Table 5-5. Concept locations for each dam are shown in Figure 4-1.

Table 5-5 Concept Mine WMS Storages

Storage Type	Function	Storage Name	Preliminary Proposed Minimum Capacity (ML)
Mine Water Dams	The main dams for storage of all contaminated mine water.	MWD 1	2500
		MWD 2	1800
		MWD 3	2500
Raw Water Dam	Storage of pipeline raw water.	Raw Water Dam	1020
Process Area Dams	Containment of runoff from all potentially contaminating mine process areas. Water is then pumped to one of the mine water dams.	Southern MIA	15
		Central MIA	15
		Northern MIA	35
		CHPP/Open Cut MIA	100
		TLO/Product Stockpile	65
Spoil Dams	Containment of runoff from all spoil and overburden emplacement areas. Water is then pumped to one of the mine water dams.	Central Spoil	370
		East Spoil	80
		West Spoil	280
		North Spoil	500
Adit Pit Dams	'Turkeys nest' (i.e. no catchment area) dams that will receive all dewater from the underground mines before transfer to the mine water dams.	Adit Pit Dam South	80
		Adit Pit Dam Central	80
		Adit Pit Dam North	80
Process Water Dam	Balance pond for supply of water to the CHPP. Also 'turkeys nest' configuration.	Process Water Dam	150

5.4.2 Catchment Areas – Mine Water Management System

Catchment boundaries for the WMS have been delineated using conceptual mine plans for each of the 5, 10 and 30 year landforms and Figure 4-2 to Figure 4-4 show the extent of each model land use type. The catchment areas reporting to each storage are shown in Table 5-6 with a more detailed breakdown of catchment areas with land uses given in Appendix A. Table 5-7 summarises the changes in land use types for each of the year 5, 10 and 30 year mine plans.

Table 5-6 Summary of Storage catchment Areas

Storage or Pit	Catchment Area (ha)		
	Year 5	Year 10	Year 30
MWD 1	69.2	69.2	69.2
MWD 2	103.1	103.1	103.1
MWD 3	220.1	220.1	220.1
Raw Water Dam	213.3	213.3	213.3
Southern MIA	16.9	16.9	16.9
Central MIA	14.8	14.8	14.8
Northern MIA	24.7	24.7	24.7
CHPP/Open cut MIA	58.5	58.5	58.5
TLO/Product stockpile	40.3	40.3	40.3
Central spoil	364.0	93.4	-
East spoil	94.7	-	-
West spoil	249.2	-	-
North spoil	179.2	121.6	
Central Open Cut Pit	444.2	747.8	841.5
North Open Cut Pit	411.0	315.0	-
TSF	169.0	-	-
North In-Pit TSF	-	96.0	96.0

Table 5-7 Landuse Changes for the Mine WMS

Landuse	Catchment Area (ha)		
	Year 5	Year 10	Year 30
Natural	605.6	605.6	605.6
Rehabilitated	0	783.8	2129.0
Spoil	887.1	215.0	0
Hardstand	1010.5	1218.1	996.8
Total WMS	2503	2039	1602
Total WMS Inc. Rehab	2503	2823	3731

5.4.3 Catchment Areas – Creeks

Wherever practical all runoff from undisturbed and rehabilitated areas within the Project site will be diverted around the mine WMS. Changes to the catchment areas of some creeks will occur both as a result of the planned diversion of Rocky and Little Sandy Creeks and as a result of mine progression. Changes to catchment areas as result of the diversion channel are discussed in detail in Appendix M2.2, Kevin's Corner Hydraulics Technical Report. Figure 5-4 shows the creek catchments (developed case with diversion) used for the WBM and Table 5-8 details their areas and any changes resulting from mine progression. Note that only natural and rehabilitated landuse types are shown as the runoff from all other landuse types is contained within the mine WMS.

Table 5-8 Changes to Creek Catchments

Catchment	Year 5 (km^2)		Year 10 (km^2)		Year 30 (km^2)	
	Natural	Rehab	Natural	Rehab	Natural	Rehab
Little Sandy Creek[1]	42.29	n/a	42.29	n/a	42.29	n/a
Rocky Creek[1]	46.62	n/a	46.62	n/a	46.62	n/a
Middle Creek	50.91	n/a	51.91	n/a	50.91	n/a
Upper Well Creek	249.85	n/a	249.85	n/a	249.85	n/a
Lower Well Creek	8.59	n/a	8.59	n/a	8.59	n/a
Upper sandy Creek	2220.66	n/a	2220.66	n/a	2220.66	n/a
Middle Sandy Creek	47.92	n/a	44.46	3.13	35.37	12.21
Lower Sandy Creek	46.39	n/a	46.65	4.71	46.78	8.95

1 Indicates catchment area due to diversion channel

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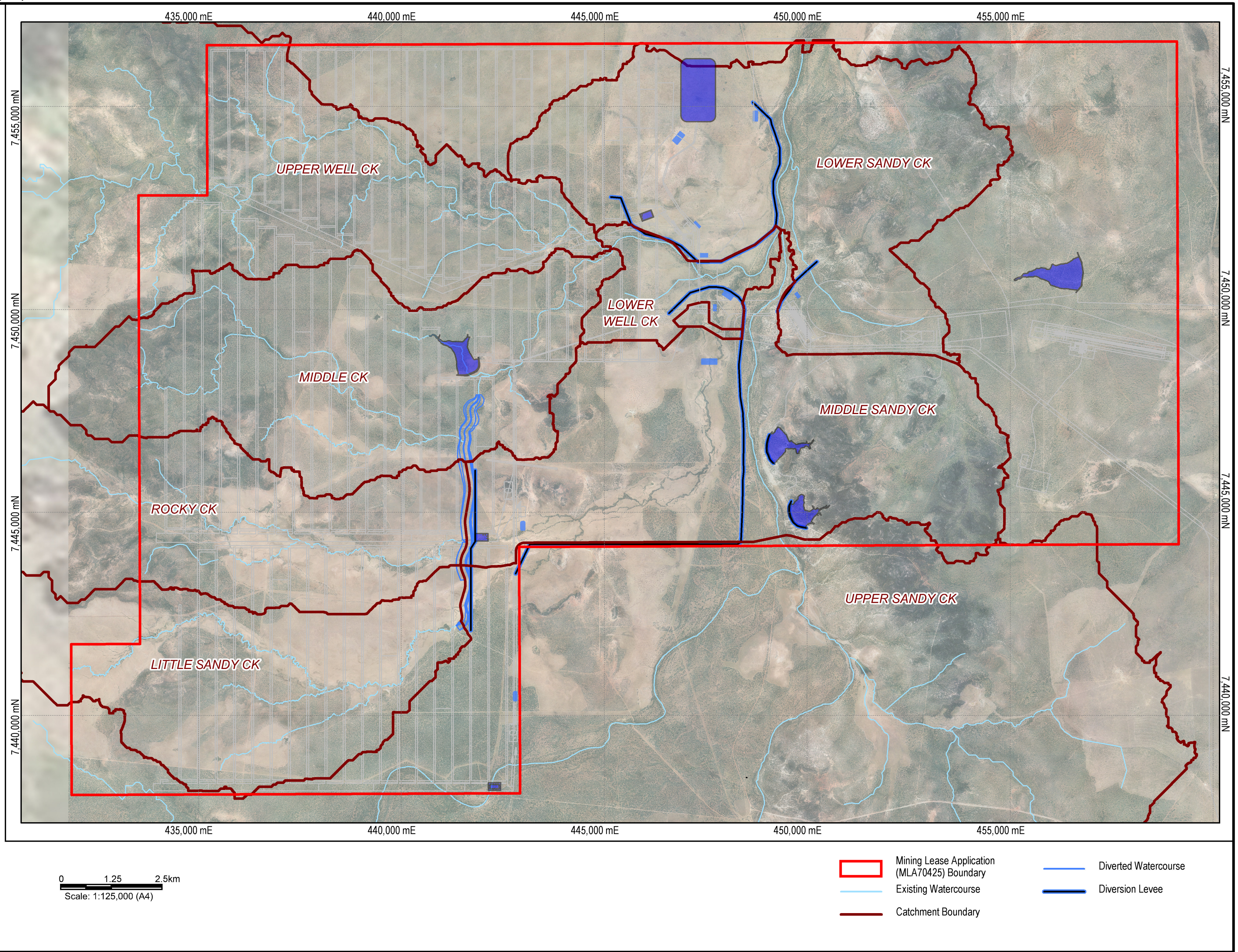

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WATER BALANCE MODEL - CREEK CATCHMENTS

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SITE WATER MANAGEMENT SYSTEM AND WATER BALANCE

Figure: 5-4

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Approved: CP

Date: 15-04-2011

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5.4.4 Pump Rates

All pump rates have been set at 200Ls^{-1} with the following exceptions:

- Pit dewatering rates have been set at 300 Ls^{-1};
- Transfers of water between the mine water dams have been set at 300 Ls^{-1}; and
- Transfers from the mine water dams and TSF to the process water dam have been set at 300 Ls^{-s}.

5.4.5 Operating Rules

Basic operating rules suitable for concept level design have been incorporated into the WBM as given below. It is expected that they will be subject to ongoing development and modification as more detailed information becomes known regarding aspects such as dewatering requirements for the underground mines and groundwater seepage into the open cut pits.

- Pumping to any of the three mine water dams ceases once they exceed their full supply level (FSL). This prevents overflows from these dams being triggered by pumped inflows from other dams and allows capacity to contain inflows from the reporting catchment as well as direct rainfall;
- Pump rules allow MWD 1 to balance inflows and outflows to MWD 2 and 3 in the following ways:
    - Excess water is transferred from MWD 2 and 3 to MWD 1 ensuring the capacity of MWD 2 and 3 to contain further inflows is maintained;
    - Water is pumped back from MWD 3 to MWD 2 and 3 allowing operational water demands taken from MWD 2 and MWD 3 to continue to be met.
- The CHPP water demand is sourced with the following priority:
    - From the TSF decant,
    - From either MWD 2 or MWD 3,
    - From the Raw Water Dam.
- The underground mine water demand is sourced with the following priority:
    - From MWD 3;
    - The Raw Water Dam.
- Water demand for potable/sanitation uses and washdown has been sourced from the raw water dam;
- Water fill points for haul road dust suppression are sourced from MWD 2 and MWD 3.

5.5 Water Demands

Various water demands exist for the Project and consist of:

- CHPP make-up water;
- Haul road and hardstand dust suppression;
- Underground mine operations;
- Vehicle wash down and workshop; and
- Potable/sanitation.

5.5.1 Process Water System

Tailings decant water return provides a significant water input into the process water system which is also augmented by direct rainfall onto the TSF. Losses also occur as Evaporative losses also occur from both the tailings beach as well as the ponded water. In order to capture these factors the WMB also included a simple model of the CHPP process water system and TSF based on current production estimates; assumptions relating to ROM feed, product coal and tailings properties may change as more information becomes known. Out-of-pit tailings storage will cease after year five of the mine life and the TSF will be capped and revegetated. Tailings placement will continue in the North open cut pit for the remaining life of mine. Table 5-9 details the assumptions used to model the CHPP, TSF and decant return stream.

Table 5-9 Assumed CHPP and Tailings Properties

Factor	Assumed Value
Tailings dry tonnage[1 2]	2.8 Mtpa
Tailings slurry solids content (w/w)[1]	30%
Tailings dry density[1]	1.61 tm^{-3}
Tailings settled dry density[1]	0.8 tm^{-3}
CHPP production water losses[1]	27%
TSF gross decant water[3]	73% (i.e. 27% entrained water)
Tailings beach angle[4]	1%
Maximum tailings area (year 5)	169 ha
Maximum tailings area (years 10 and 30)	96 ha

1 Hancock 2010 2 Varies 3 Not including direct rainfall/evaporation 4 LPSDP 2007

5.5.2 CHPP Water Demand and Tailings Storage Facility Water Return

It is expected that contaminated water will be suitable for use in the CHPP and water will be sourced from tailings decant as a priority and then from MWD 2 and MWD 3. Raw water make up will only be used once all sources of mine water are unavailable. CHPP water demands are shown in Table 5-10.

Table 5-10 CHPP Make-Up Water Demand

Year	ROM Coal Processed ($Mtyr^{-1}$)	CHPP Make up Water Demand ($MLyr^{-1}$)
5	27.4	5,454
10	35.6	6,677
30	26.1	4,974

5.5.3 Haul Road and Hardstand Dust Suppression

Input WBM water demand for haul road dust suppression is shown in Table 5-11. The actual dust suppression demand will be slightly lower as demand is reduced to zero when rainfall exceeds evaporation. It is assumed contaminated mine water sourced from truck fill points located at MWD 2 and MWD 3 will be suitable.

Table 5-11 Dust Suppression Water Demand Estimates

Year	Haul Road and Hardstand ($MLyr^{-1}$)
5	1011
10	1011
30	1011

5.5.4 Underground Mine Operations

Water will be required to sustain underground mining operations. Table 5-12 details the predicted demand. It is assumed that mine water will be of a suitable quality for this purpose. Water is sourced from MWD 3 will be of a suitable quality for this purpose.

Table 5-12 Underground Mine Operations Water Demand Estimates

Year	Underground Mine Water ($MLyr^{-1}$)
5	570
10	644
30	528

5.5.5 MIA Demands

Water is required for washdown of plant and equipment at each MIA. Table 5-13 shows the total demand for washdown. Contaminated mine water will be unsuitable for this purpose therefore the MIA water demand sourced directly from the Raw Water Dam.

Table 5-13 MIA Raw Water Demand Estimates

Year	MIA Raw Water Demand ($MLyr^{-1}$)
5	3.6
10	3.6
30	3.6

5.5.6 Potable Water

Treated raw water will be required to meet the various potable and sanitation water demands. Demand will be sourced from the raw water dam prior to treatment by the onsite WTP. Table 5-14 summarises the raw water potable demand.

Table 5-14 Raw Water Potable Demand Estimates

Year	Potable Raw Water Demand (MLyr^{-1})
5	142
10	111
30	108

5.6 Water Inputs

Water inputs for the Project come from several sources as described below:

5.6.1 Surface Runoff

Climate data (rainfall and evaporation) are routed through the rainfall-runoff model within the WBM to generate daily runoff flows. The rainfall-runoff model is described in section 5.3.

5.6.2 Underground Mine Dewatering

Current dewatering estimates for the underground mines are given in Table 5-15. At the current stage of planning a high degree of uncertainty exists in relation to both the establishment program of groundwater bores as well as the expected production rates required for depressurisation of the D-seam. To that extent the estimated dewatering rates shown in Table 5-15 may only be considered preliminary and represent a rolling ten year average of current predictions.

Table 5-15 Underground Mine Dewatering Rates

Year	Underground Mine Dewater Rate (ML yr^{-1})
5	5708
10	4793
30	3627

5.6.3 Raw Water Pipeline

At this stage it is proposed that additional raw water make up will be sourced, via a pipeline from the Sunwater-operated Connors River Dam. This will be stored in the raw water dam and will be used to meet high quality demands (potable/sanitation, vehicle wash down, workshops etc) as well as providing supply for other mining operations during periods when the mine is in water deficit.

5.7 Other Losses

5.7.1 Evaporation and Seepage

Daily evaporation rates were sourced from the SILO data drill and applied both through the rainfall-runoff model as well as to the surface of all water storages. No adjustments were made to the data before input into the water balance. Seepage from dams was not considered in the model.

Results

6.1 System Capacity to Limit Uncontrolled Discharges

The mine WMS, assessed using 110 years of water balance simulation was able to sufficiently contain all predicted inflows and to meet the design criteria stated in section 2.3. Table 6-1 shows the number of overflow events (uncontrolled discharges) predicted by the water balance simulation for all dams with overflows to the receiving environment.

Exceedance probability (Figure 6-1 and Appendix B.1) and storage plots for each of the mine water dams (Figure 6-2 to Figure 6-4 and Appendix B.2) show that the mine WMS will experience the greatest stress (in terms of water inputs) during year 5 when groundwater inflows from the underground mines and runoff from spoil and overburden emplacement areas are at their greatest. By providing sufficient system capacity to reduce the probability of an uncontrolled discharge to less than 1:100 AEP for year 5 mine plan the system will have adequate capacity for all other assessed scenarios including the year 30 worst case scenario.

Table 6-1 Mine WMS - Uncontrolled Discharge Events

Storage	Year 5		Year 10		Year 30		Year 30 – No Rehab	
	Uncontrolled Discharges	Volume (ML)	Uncontrolled Discharges	Volume (ML)	Uncontrolled Discharges	Volume (ML)	Uncontrolled Discharges	Volume (ML)
MWD 1	0	-	0	-	0	-	0	-
MWD 2	0	-	0	-	0	-	0	-
MWD 3	1	2.7	0	-	0	-	0	-
CHPP/MIA Open Cut	0	-	0	-	0	-	0	-
TLO/Product Stockpile	0	-	0	-	0	-	0	-

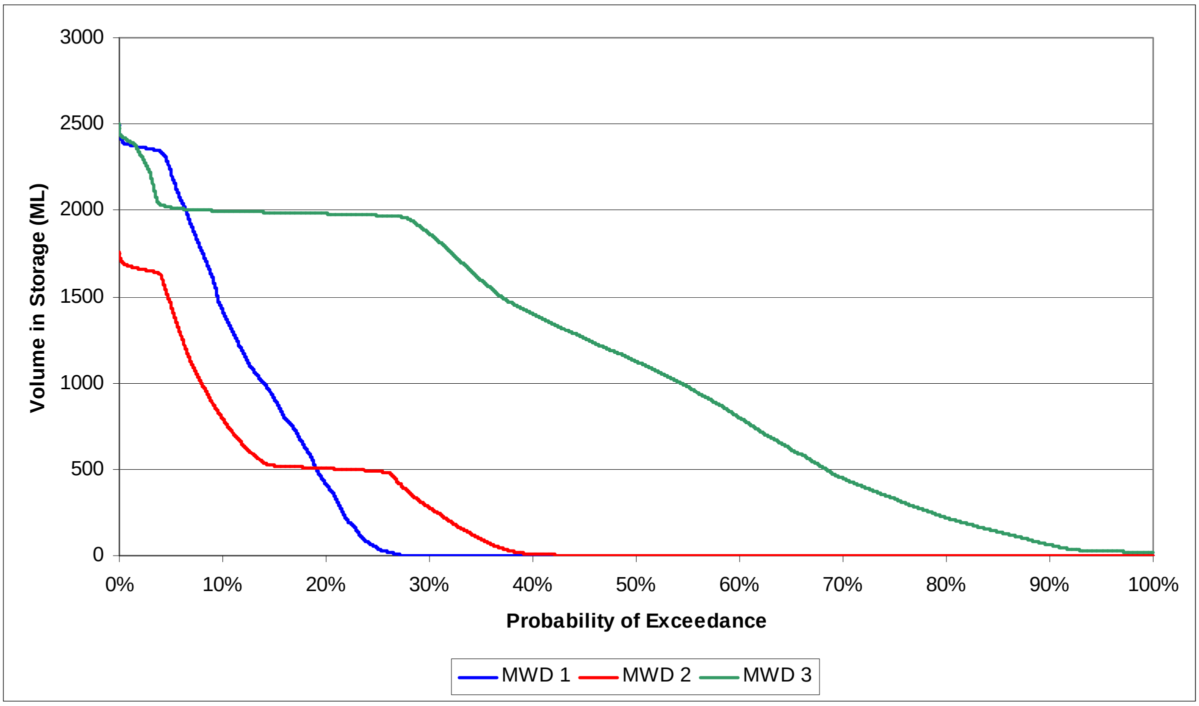

Figure 6-1 Mine Water Dams Exceedance Probability Plot - Year 5

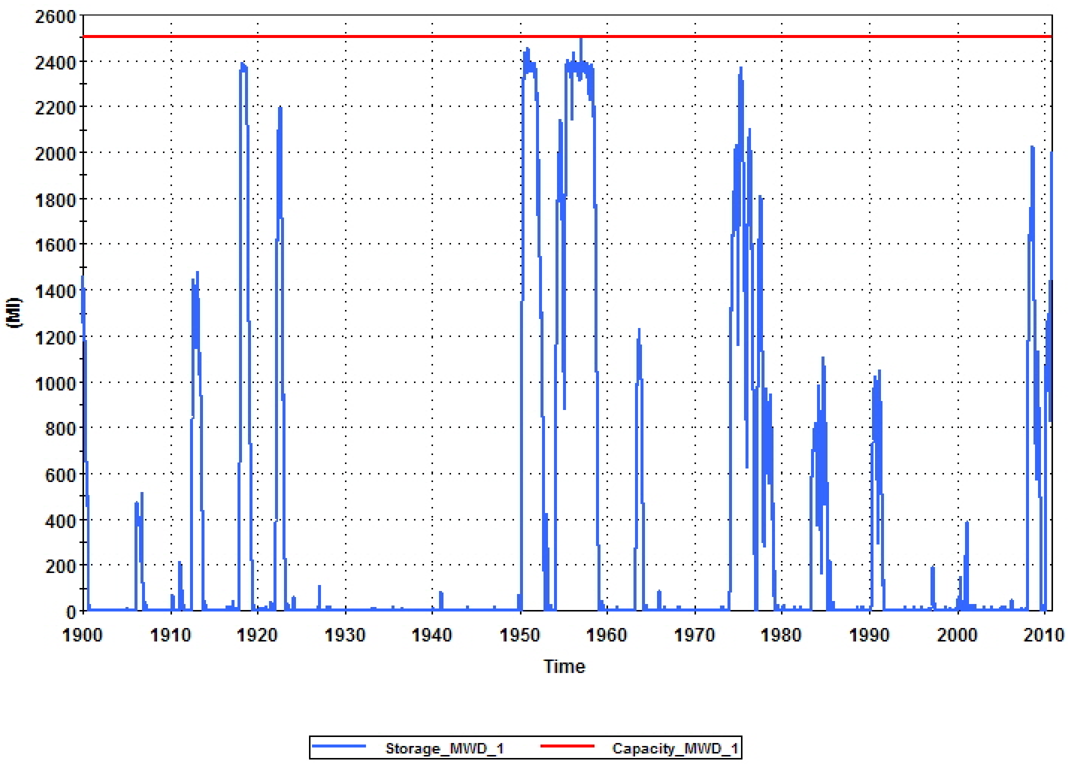

Figure 6-2 Year 5 Storage Plot - MWD 1

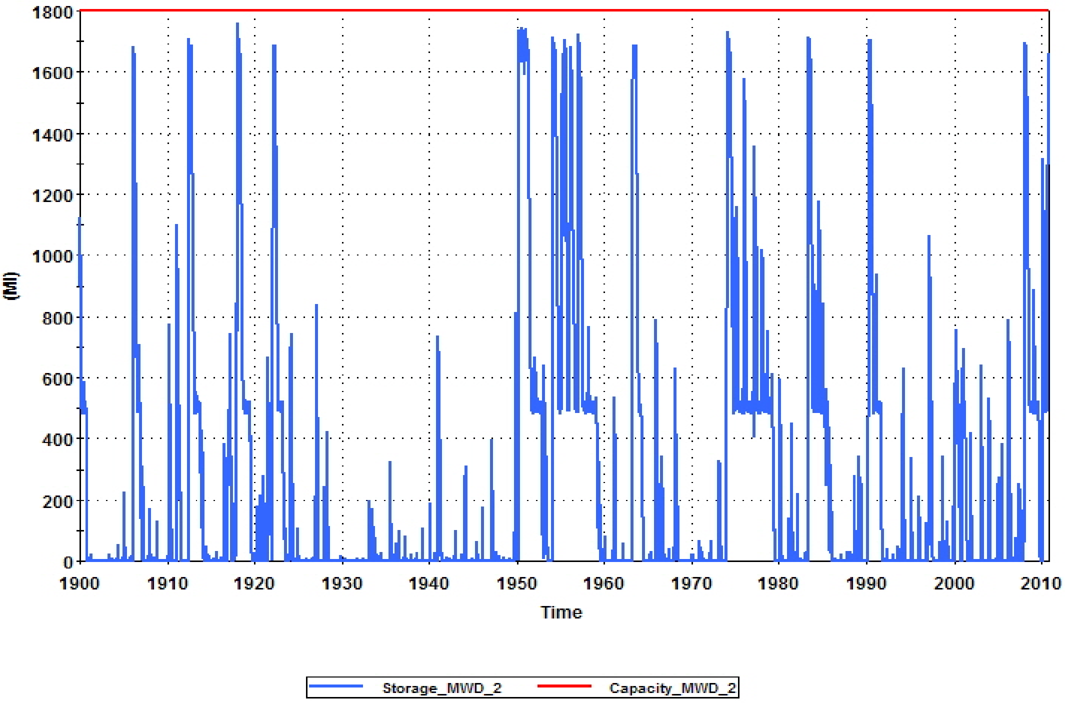

Figure 6-3 Year 5 Storage Plot - MWD 2

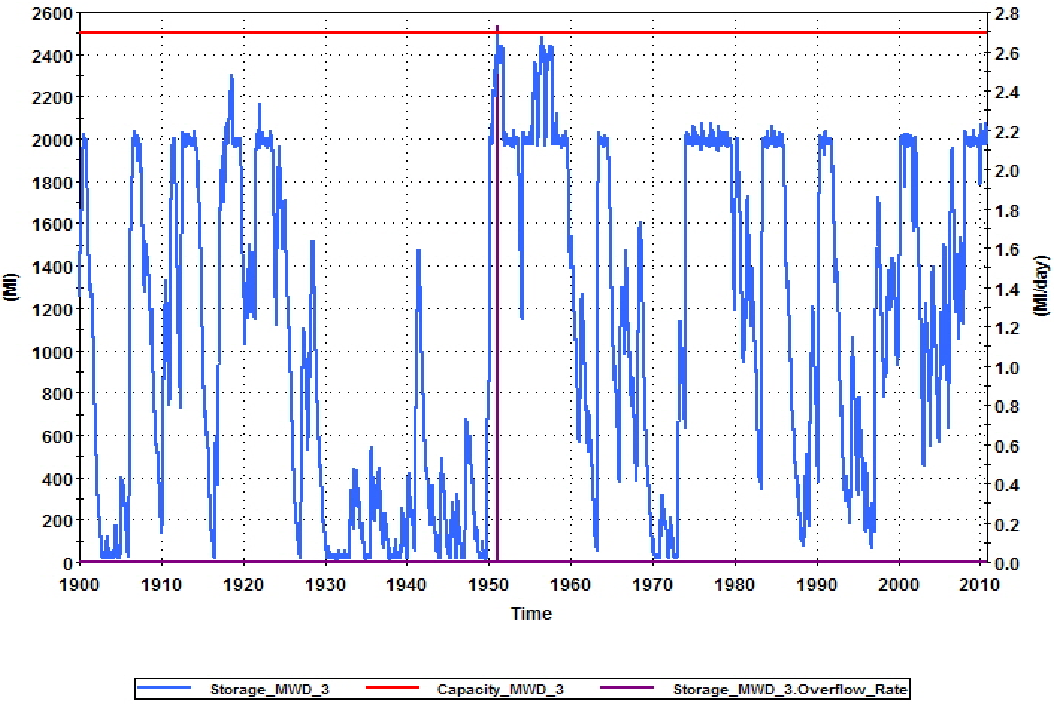

Figure 6-4 Year 5 Storage Plot – MWD 3

6.2 Raw Water Usage

The water balance results for raw water demand (Table 6-2) indicate the Project will have an overall water deficit and therefore require imported raw. Significant variation in make up raw water demand is caused both by rainfall variability and differences in groundwater input from underground mine as well as site water demands. It should be noted that regardless of the amount of mine water available there will always be a demand for pipeline raw water from those demands from which contaminated water is unsuitable.

Table 6-2 Modelled Raw Water Make-Up

Raw Water Demand (ML/yr)	Year 5	Year 10	Year 30	Year 30 – No Rehab
10th Percentile	850	1337	953	840
50th percentile	1091	2779	2243	1856
90th percentile	1260	3529	2965	2873
Mean	1077	2616	2150	1867

6.3 Open Cut Pit Availability

The level of open cut pit inundation is related to the amount of system storage capacity as pit dewatering ceases once the mine water dams reach their operating capacity. Additional storage and/or changes to system operating rules may be required to further optimise the amount of water in the open cut pits. Figure 6-5 to Figure 6-7 show exceedance probability and storage plots for the open cut pits for the year 5 scenario. Additional plots are shown in Appendix B.3 and Appendix B.4.

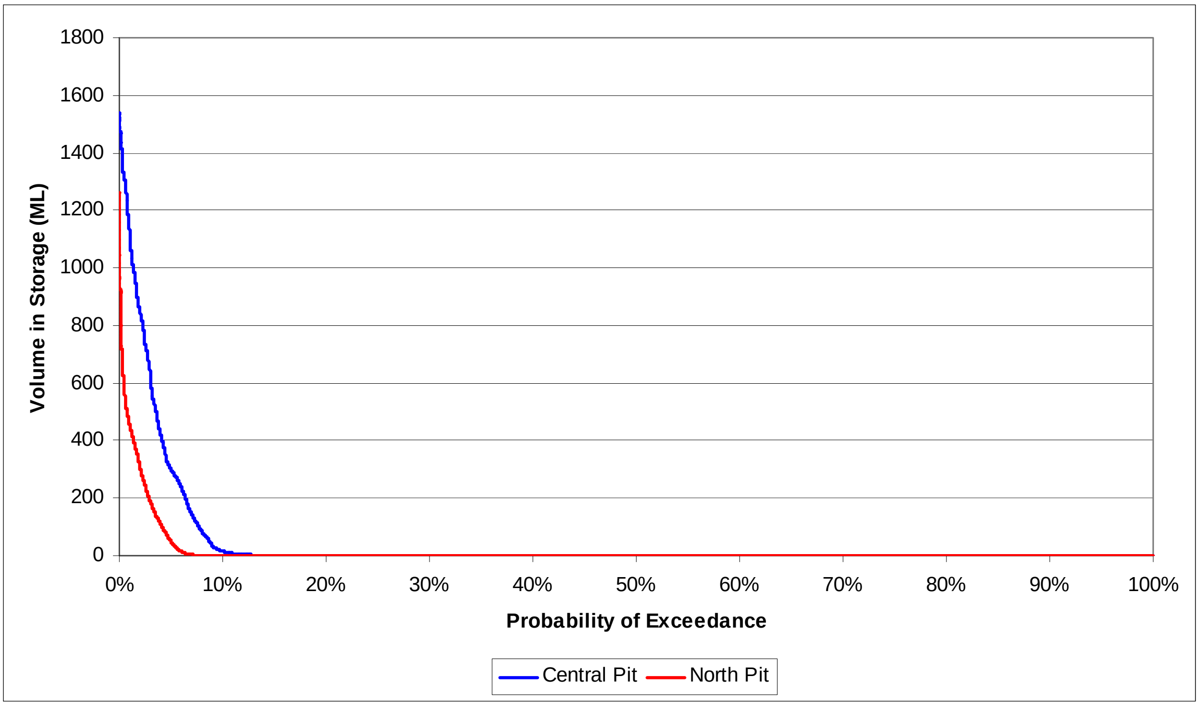

Figure 6-5 Open Cut Pits Exceedance Probability Plot - Year 5

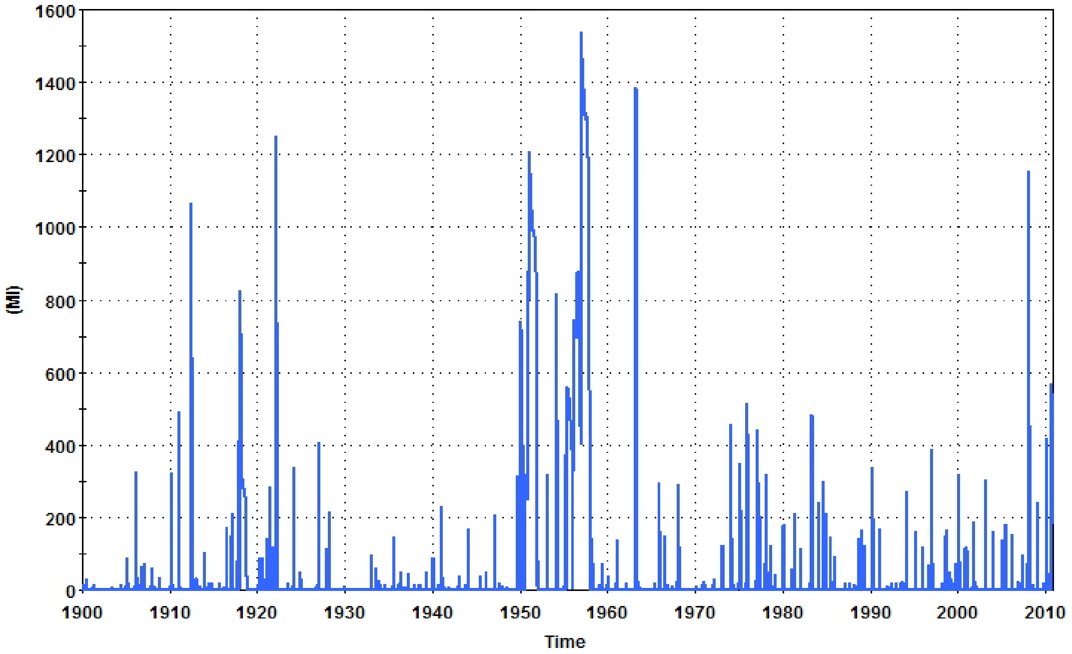

Figure 6-6 Year 5 Pit Sump Volume – Central Pit

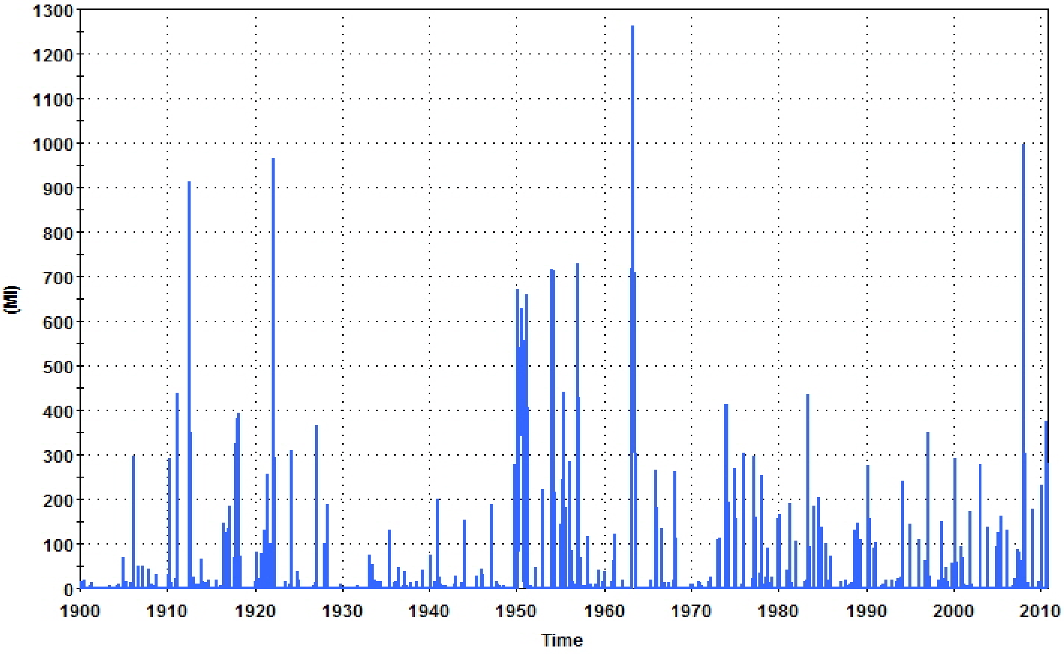

Figure 6-7 Year 5 Pit Sump Volume – North Pit

6.4 Impacts on Downstream Flow

As the mine WMS seeks to capture and contain all runoff originating from potentially contaminating catchments there will inevitably be a small reduction in the catchment reporting to the downstream watercourse (Sandy Creek). From Table 5-7 it can be seen that year 5 represents the greatest catchment area contained within the mine WMS at 25 km^2 (22 km^2 without the Raw Water Dam which is located in the catchment of Native Companion Creek), however, in year 30 if it is assumed that runoff from all the rehabilitated areas is not suitable for release then the potential catchment area reporting to the mine WMS increases to 37.3 km^2 (35.2 km^2 without the Raw Water dam). This would represent a worst case scenario in terms of reductions to the catchment reporting to Sandy Creek downstream of the Project site.

Table 6-3 shows that under the worst case scenario the reduction in flows as a result of the mine WMS would be less than 1.5%. This small reduction will not materially impact on the downstream environmental values identified in the Surface Water Quality Technical Report (Appendix M4). The progressive rehabilitation, within the constraints of the mine plan, of all disturbed areas and spoil and overburden emplacement areas will ensure that as runoff from these areas is demonstrated, thropugh appropriate water quality monitoring, to be suitable for release the minor impact on downstream flows may be reduced.

Table 6-3 Impact of Mine WMS on Downstream Flows in Sandy Creek

Description	Existing Conditions	Year 5 Mine WMS Catchment (Excluding Raw Water Dam)	Year 30 Mine WMS Catchment with containment of Runoff from all Rehabilitated areas (Excluding Raw Water Dam)
Sandy Creek catchment (km^2)	2737	2714	2706
Impact on catchment area	n/a	-0.84%	-1.29%
Mean annual runoff Volume (ML/yr) (6.5mm mean annual runoff x catchment area)	17,745	17,642	17,562
Impact on mean annual flow	n/a	-0.84%	-1.29%
Reduction in mean annual flow (ML)	n/a	149	229

Conclusions

The Kevin's Corner concept mine WMS presented in this report has been developed according to current best practice management of mine water. Wherever possible, water will be segregated according to its predicted quality allowing clean runoff from undisturbed catchments to passively bypass the WMS. Runoff from all potentially contaminating catchments including all active spoil and overburden emplacement areas will be captured and contained within the mine WMS and preferentially used to satisfy mine consumptive demands without the requirement for controlled releases.

A water balance assessment of the proposed mine WMS using GoldSim software has validated that sufficient system storage capacity is available to ensure that the probability of overflow from the WMS is less that 1:100 AEP when modelled using historical climatic conditions. It has also been demonstrated that sufficient system capacity is available to ensure that the controlled release of water from the WMS will not be necessary under the modelled conditions. Additional analysis also indicates that in a worst case scenario when runoff from all rehabilitated areas is unsuitable for release and the catchment of the mine WMS is at its greatest there is sufficient capacity is available to contain all inflows.

The amount of required system storage has been shown to be very sensitive to water inflows from dewatering of the underground mines and changes in the predicted groundwater inflow volumes may require substantial changes to the proposed volumes of the three large mine water dam. Additionally, the estimates for raw water demand show considerable variation throughout the life of the mine and are also heavily influenced by groundwater inflows. As groundwater inflows remain constant irrespective of rainfall they are able to satisfy a significant proportion of the total site water demand during periods of prolonged low rainfall. As more data on groundwater volumes becomes available a more accurate assessment of the required raw water make up will be made.

As the proposed mine WMS seeks to capture and contain runoff from all contaminating sources there will be an inevitable loss of some catchment area to the downstream watercourse. However it has been shown that these losses, under a worst case scenario will only result in a 1.29% reduction in baseline downstream flows. This small reduction may be considered negligible and would have no detrimental impact on the downstream environmental values.

References

Boughton, W. C, 1993, A Hydrograph-Based Model for Estimating the Water Yield of Ungauged Catchments

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Queensland Government, 2010, Terms of reference for an Environmental Impact Statement – Kevin's Corner Project, Coordinator-General, Qld Government.

Limitations

URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Hancock Galilee Pty Ltd and only those third parties who have been authorised in writing by URS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated 23rd July 2010.

The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared between November 2010 and April 15th 2011 and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

Appendix A Catchment Data

Table A-1 Year 5 - Detailed Catchment Data

Storage/Pit	Year 5 Catchment Area (ha)			
	Natural	Spoil	Hardstand	Rehabilitated
MWD 1	69.2			
MWD 2	103.1			
MWD 3	220.1			
Raw Water	213.3			
Southern MIA			16.9	
Central MIA			14.8	
Northern MIA			24.7	
CHPP/Open cut MIA			58.5	
TLO/Product stockpile			40.3	
Central spoil		364.0		
East spoil		94.7		
West spoil		249.2		
North spoil		179.2		
Central Pit			444.2	
Northern Pit			411.0	

Table A-2 Year 10 - Detailed Catchment Data

Storage/Pit	Year 10 Catchment Area (ha)			
	Natural	Spoil	Hardstand	Rehabilitated
MWD 1	69.2			
MWD 2	103.1			
MWD 3	220.1			
Raw Water	213.3			
Southern MIA			16.9	
Central MIA			14.8	
Northern MIA			24.7	
CHPP/Open cut MIA			58.5	
TLO/Product stockpile			40.3	
Central spoil		93.4		
East spoil				
West spoil				
North spoil		121.6		
Central Pit			747.8	
Northern Pit			315.0	

Table A-3 Year 30 - Detailed Catchment Data

Storage/Pit	Year 30 Catchment Area (ha)			
	Natural	Spoil	Hardstand	Rehabilitated
MWD 1	69.2			
MWD 2	103.1			
MWD 3	220.1			
Raw Water	213.3			
Southern MIA			16.9	
Central MIA			14.8	
Northern MIA			24.7	
CHPP/Open cut MIA			58.5	
TLO/Product stockpile			40.3	
Central spoil				
East spoil				
West spoil				
North spoil				
Central Pit			841.5	
Northern Pit				

Table A-4 Year 30 (Worst Case Rehab Failure) - Detailed Catchment Data

Storage/Pit	Year 30 (Worst Case Rehab Failure) Catchment Area (ha)			
	Natural	Spoil	Hardstand	Rehabilitated
MWD 1	69.2			
MWD 2	103.1			
MWD 3	220.1			
Raw Water	213.3			
Southern MIA			16.9	
Central MIA			14.8	
Northern MIA			24.7	
CHPP/Open cut MIA			58.5	
TLO/Product stockpile			40.3	
Central spoil		1221.3		
East spoil		94.7		
West spoil		318.8		
North spoil		179.2		
Central Pit			841.5	
Northern Pit		315		

Appendix B Water Balance Results

B.1 Additional Exceedance Probability Plots – Mine Water Dams

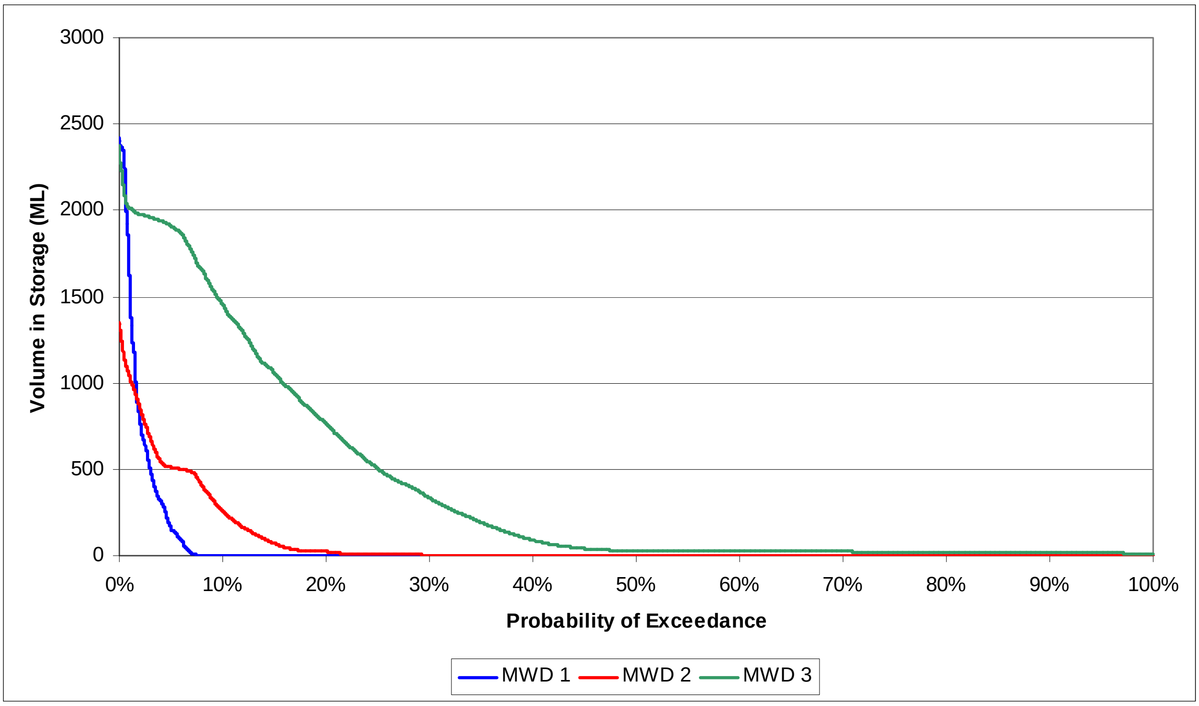

Figure B-1 Mine Water Dams Exceedance Probability Plot - Year 10

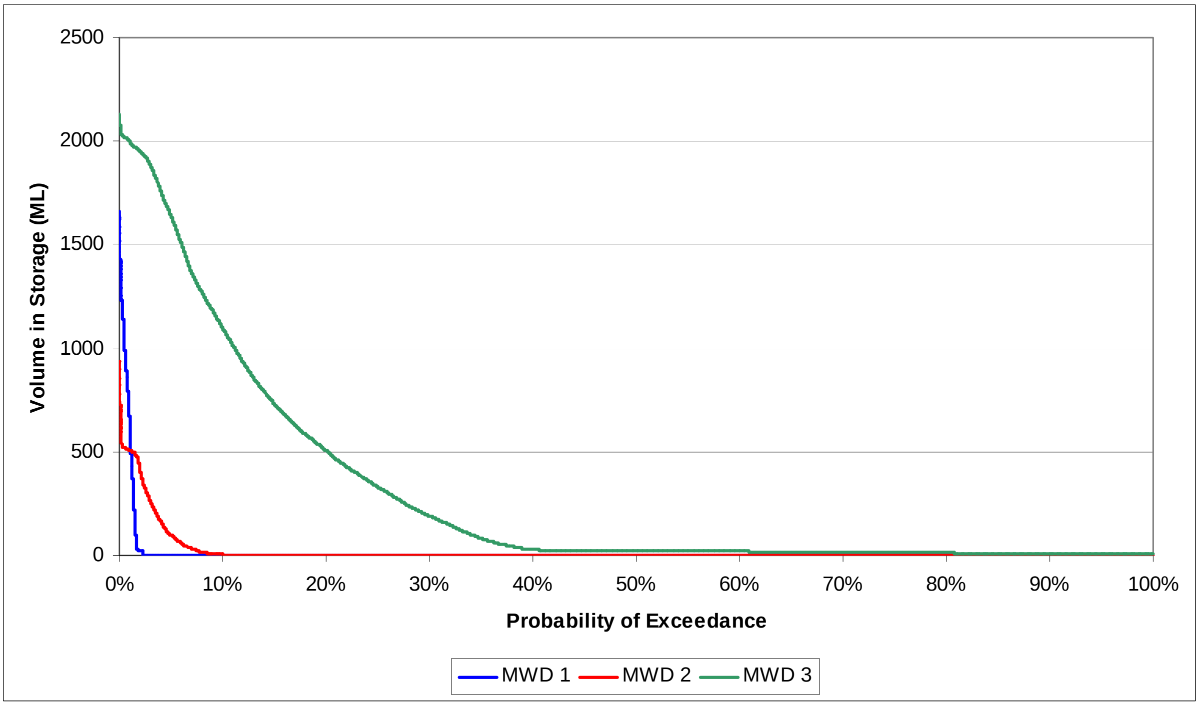

Figure B-2 Mine Water Dams Exceedance Probability Plot - Year 30

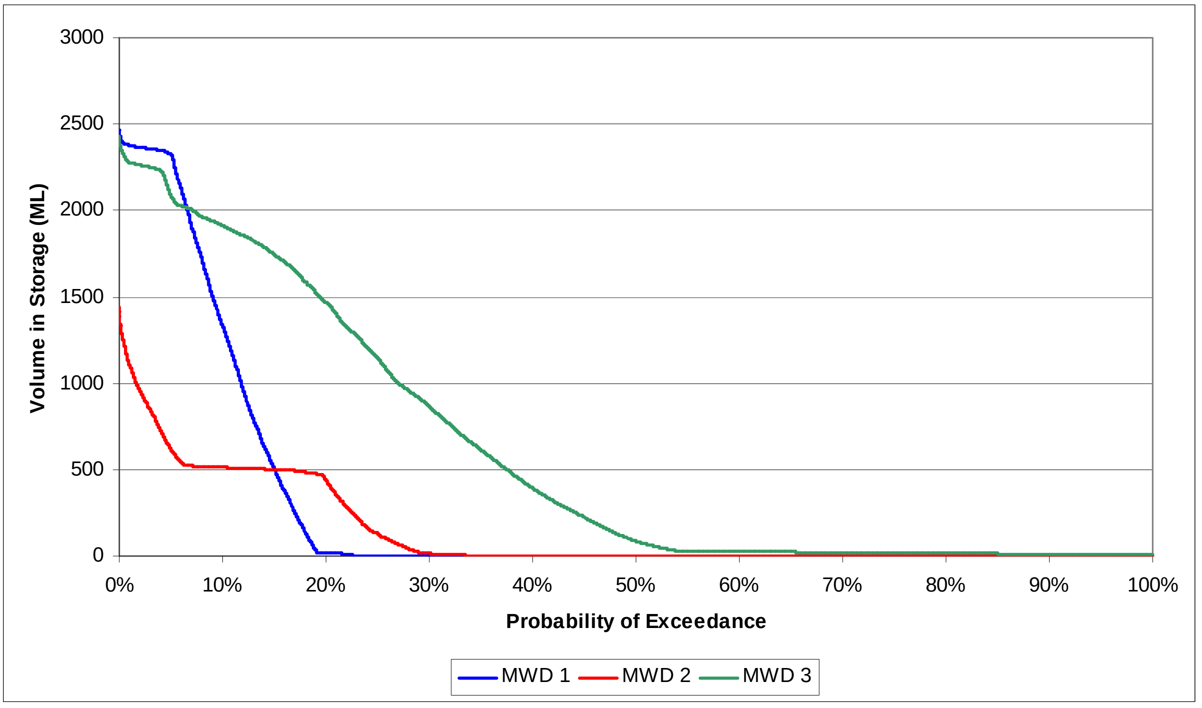

Figure B-3 Mine Water Dams Exceedence Probability Plot - Year 30 (Worst Case Rehab Failure)

B.2 Additional Storage Plots – Dams

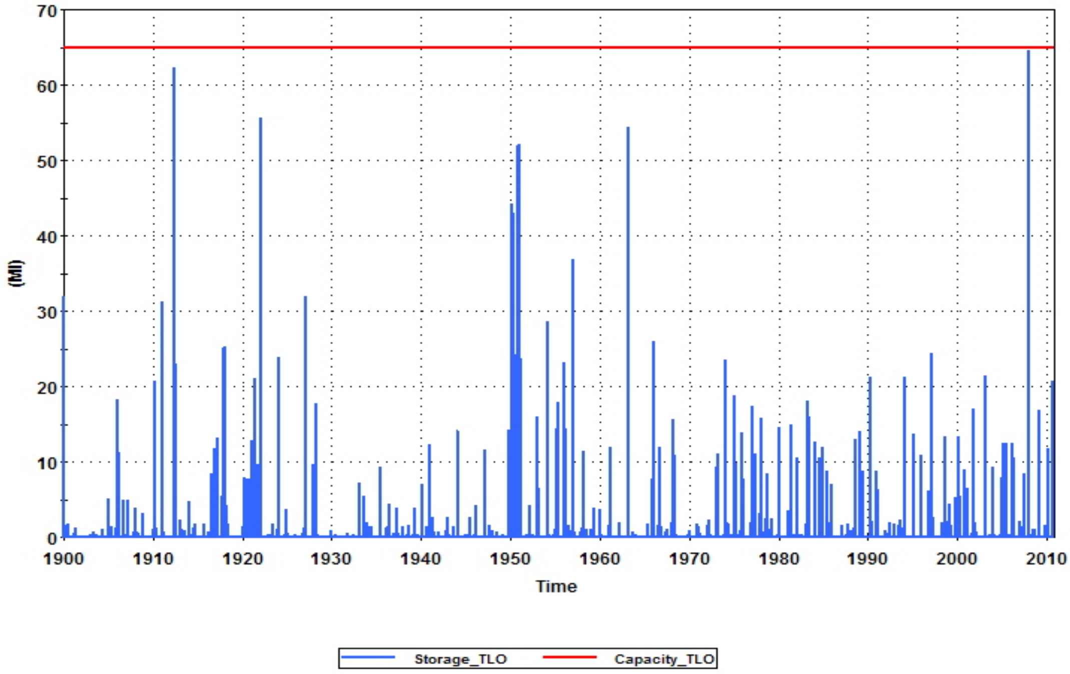

Figure B-4 Year 5 Storage Plot - TLO Product Stockpile Dam

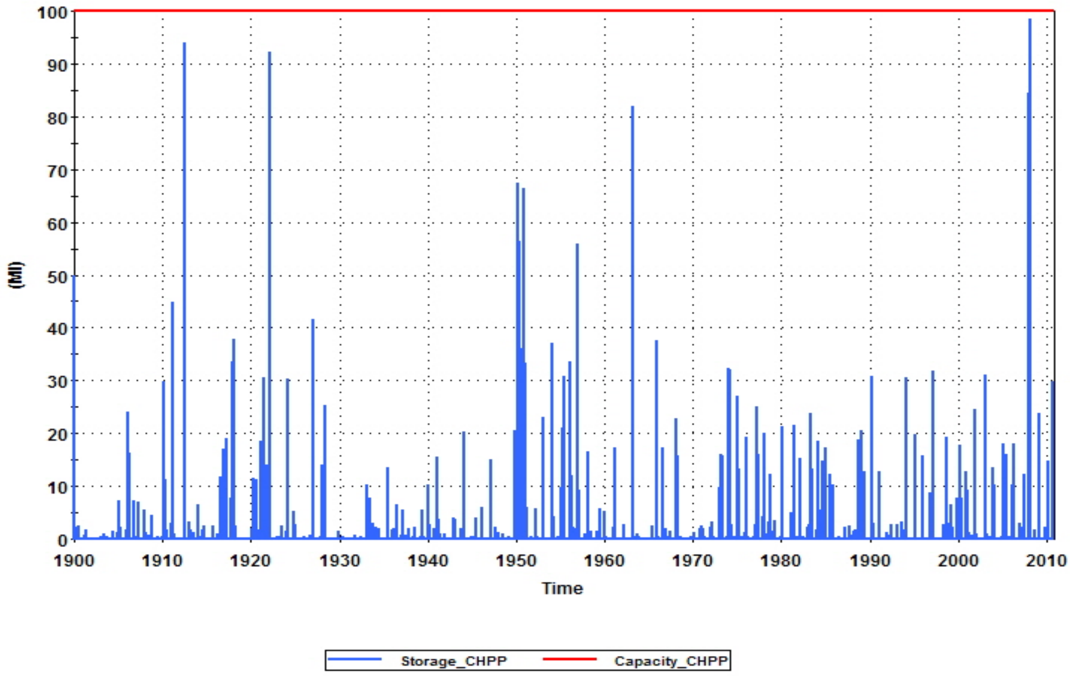

Figure B-5 Year 5 Storage Plot - CHPP/Open Cut MIA Dam

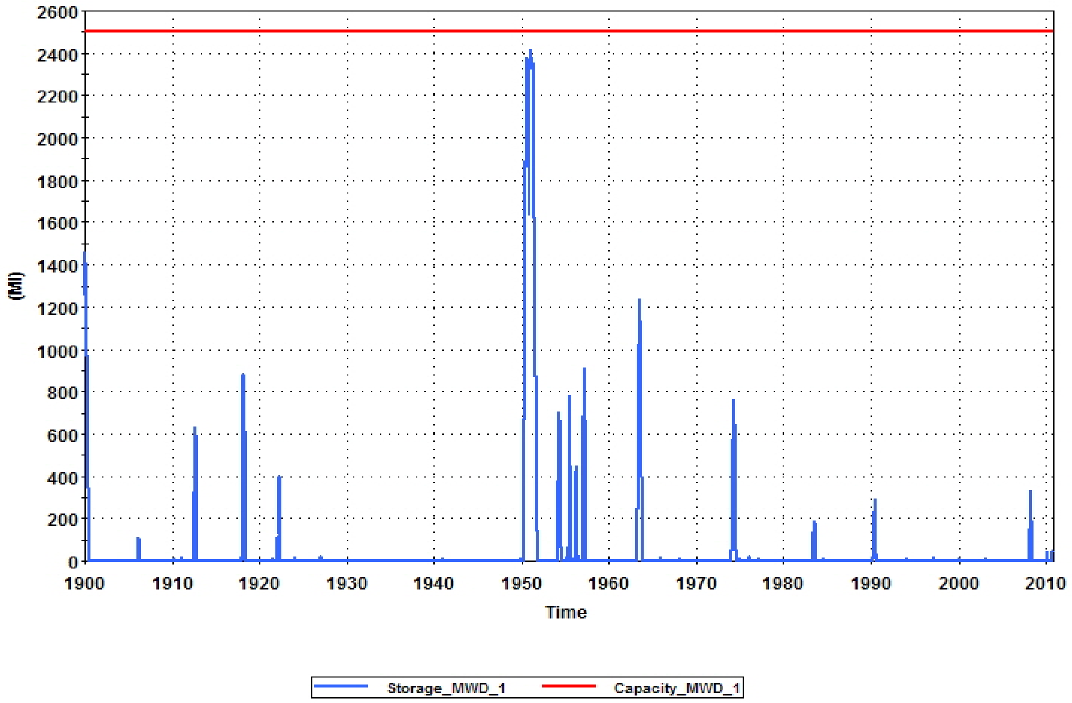

Figure B-6 Year 10 Storage Plot - MWD 1

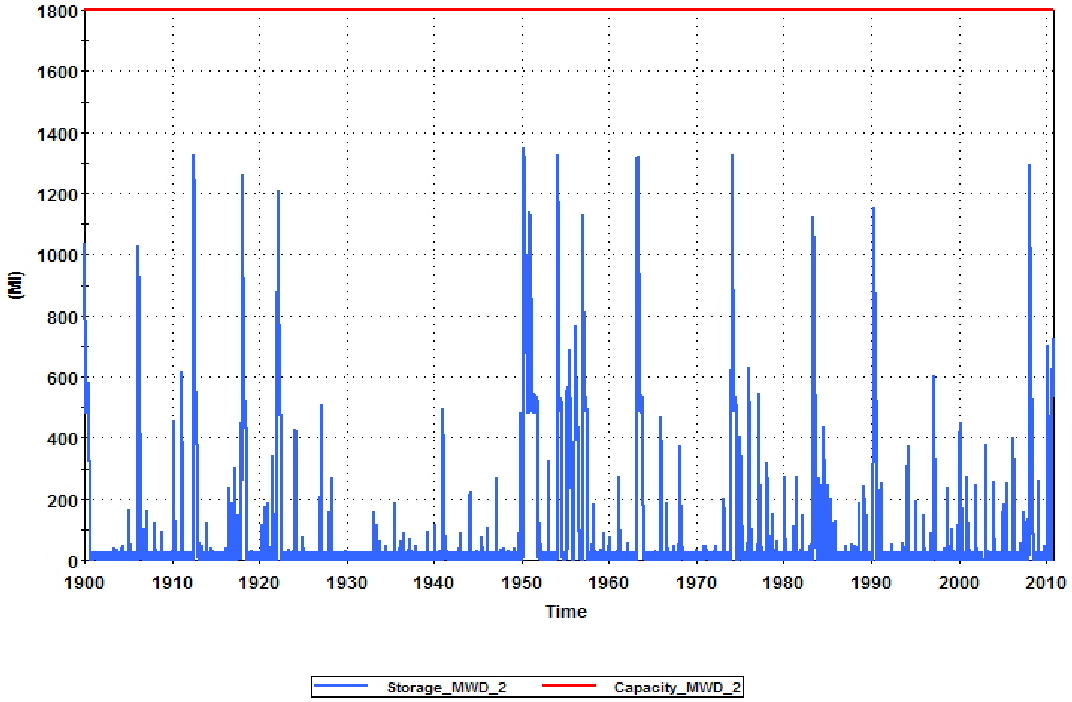

Figure B-7 Year 10 Storage Plot - MWD 2

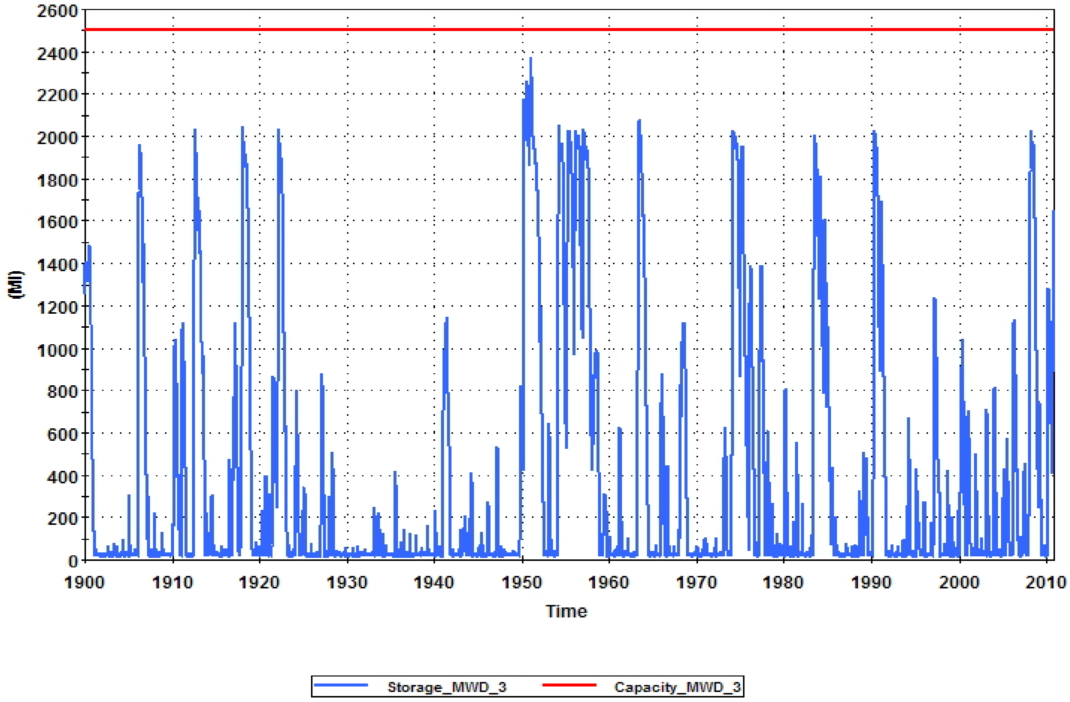

Figure B-8 Year 10 Storage Plot - MWD 3

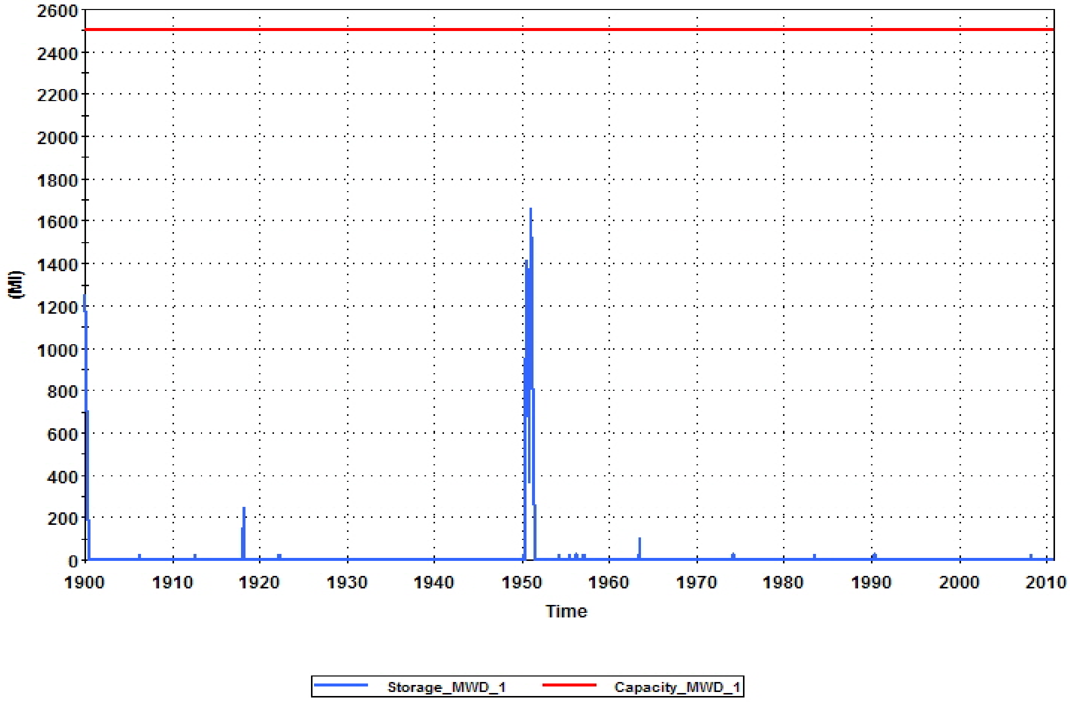

Figure B-9 Year 30 Storage Plot - MWD 1

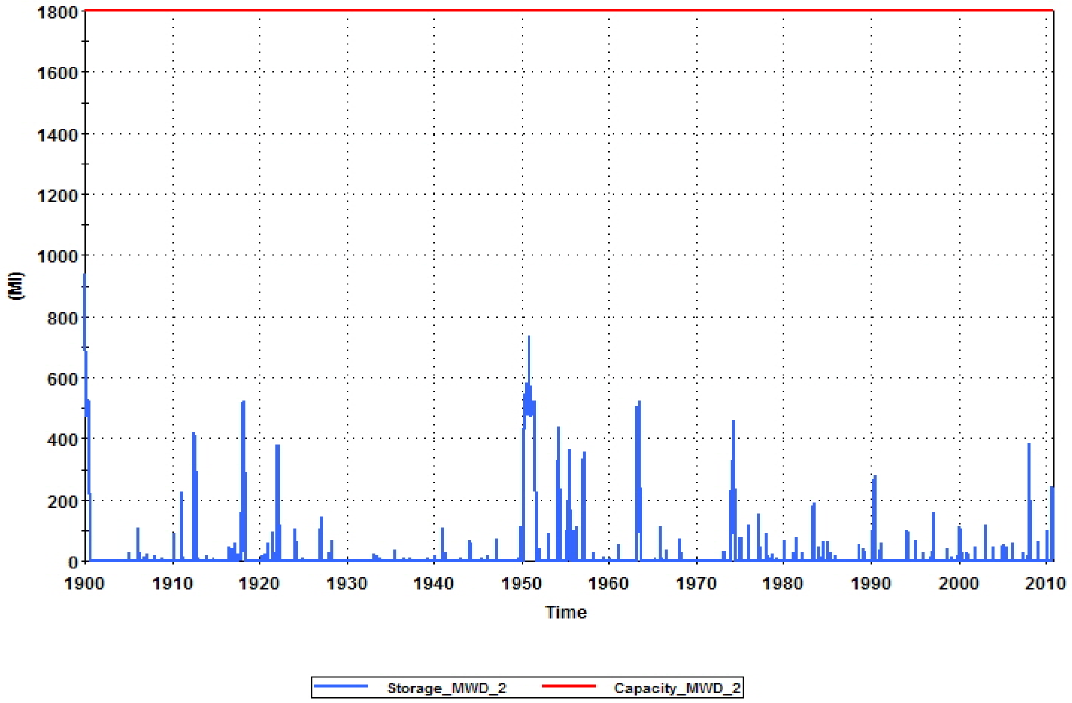

Figure B-10 Year 30 Storage Plot - MWD 2

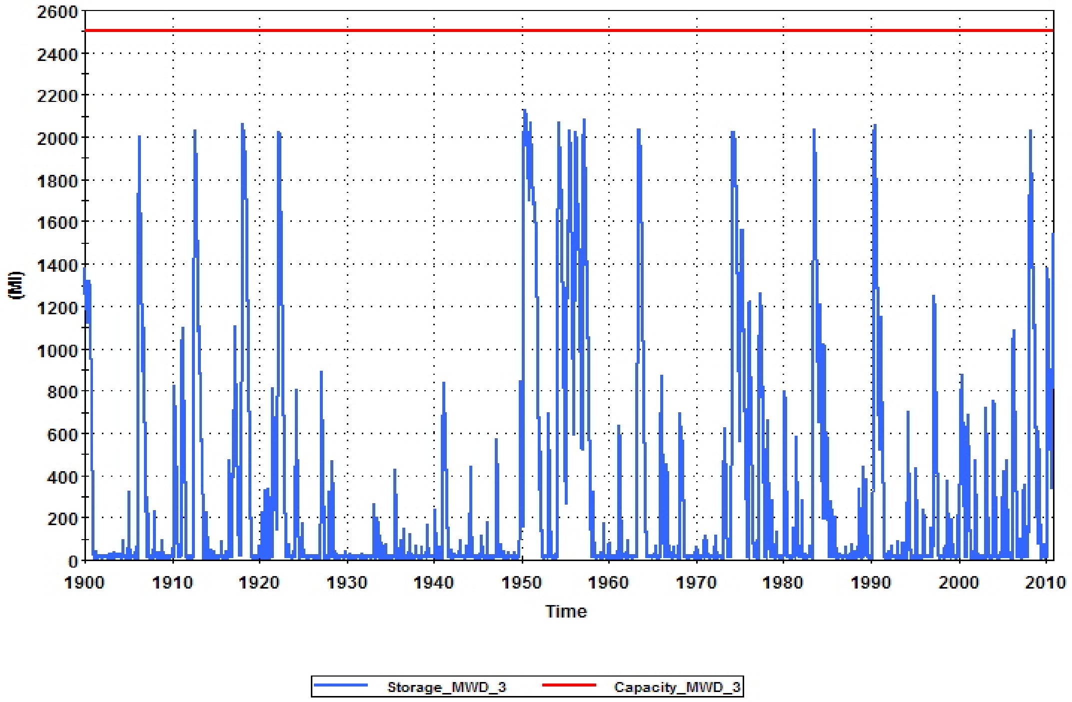

Figure B-11 Year 30 Storage Plot - MWD 3

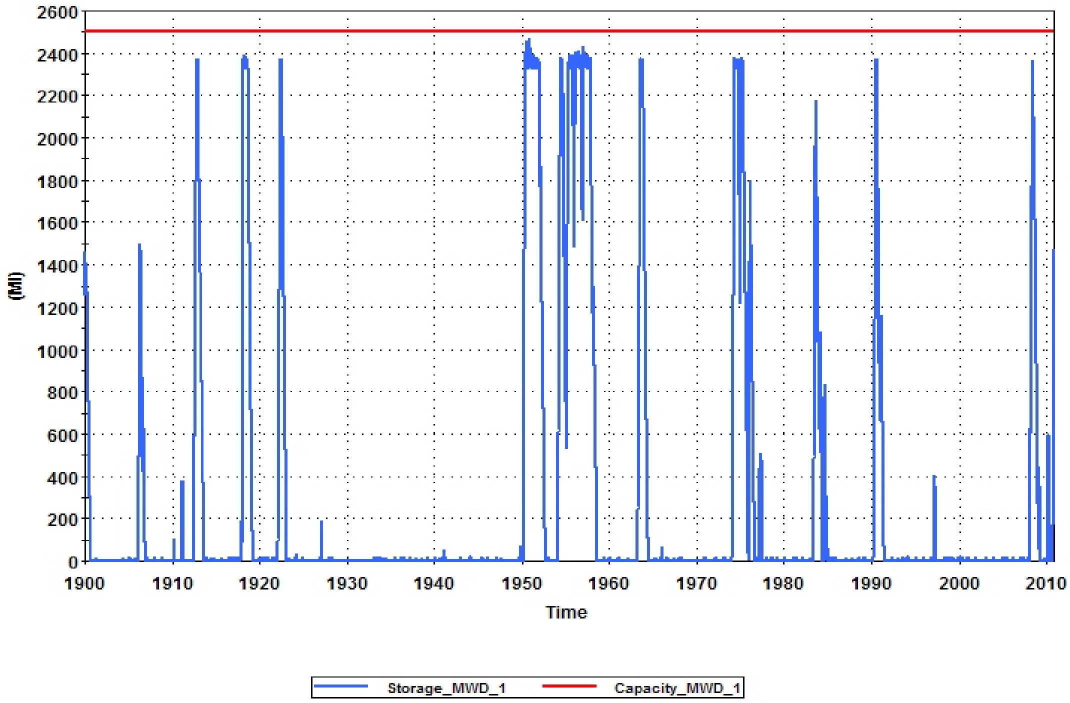

Figure B-12 Year 30 (Worst Case Rehab Failure) Storage Plot - MWD 1

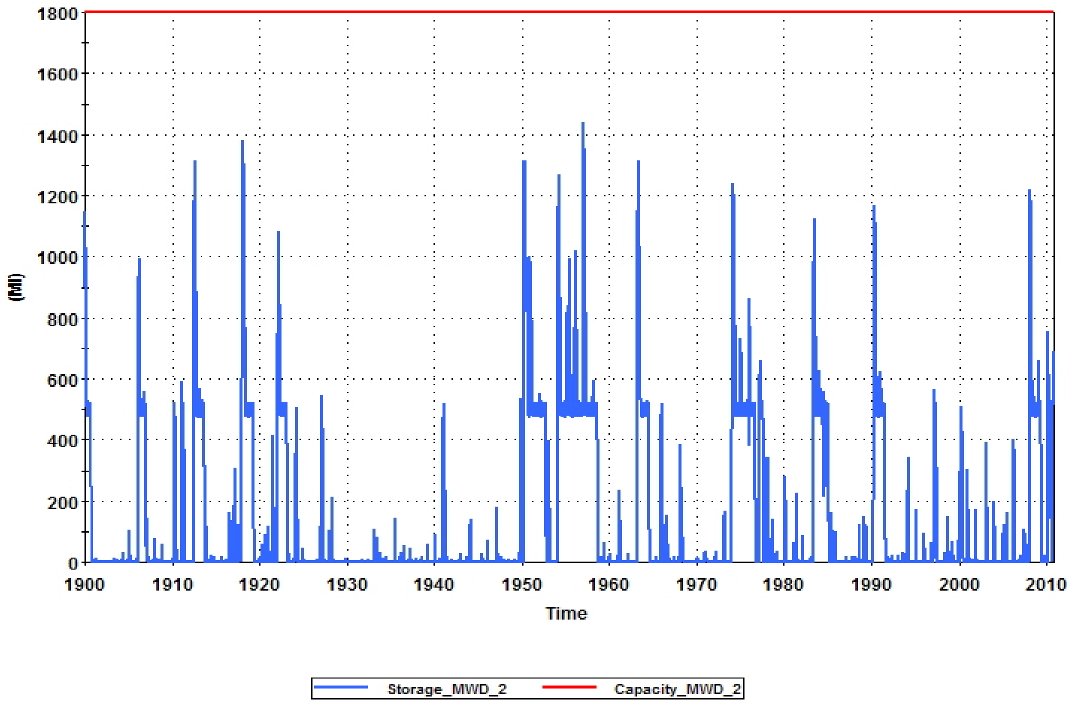

Figure B-13 Year 30 (Wost Case Rehab Failure) Storage Plot – MWD 2

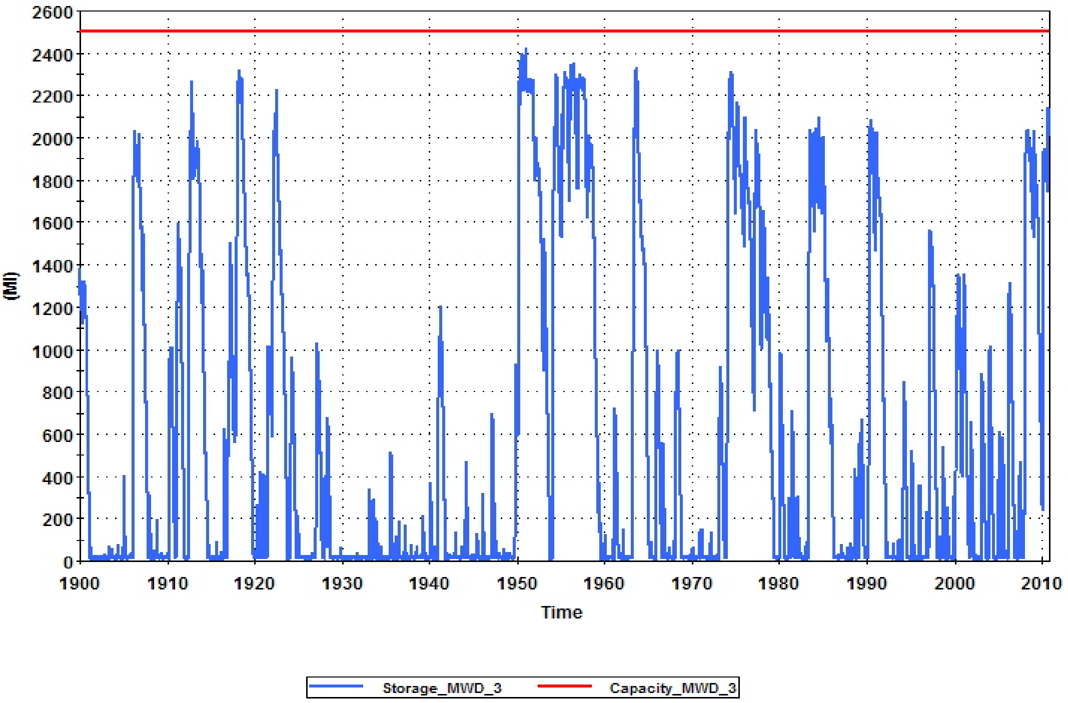

Figure B-14 Year 30 (Worst Case Rehab Failure) Storage Plot – MWD 3

B.3 Additional Exceedance Probability Plots – Open Cut Pits

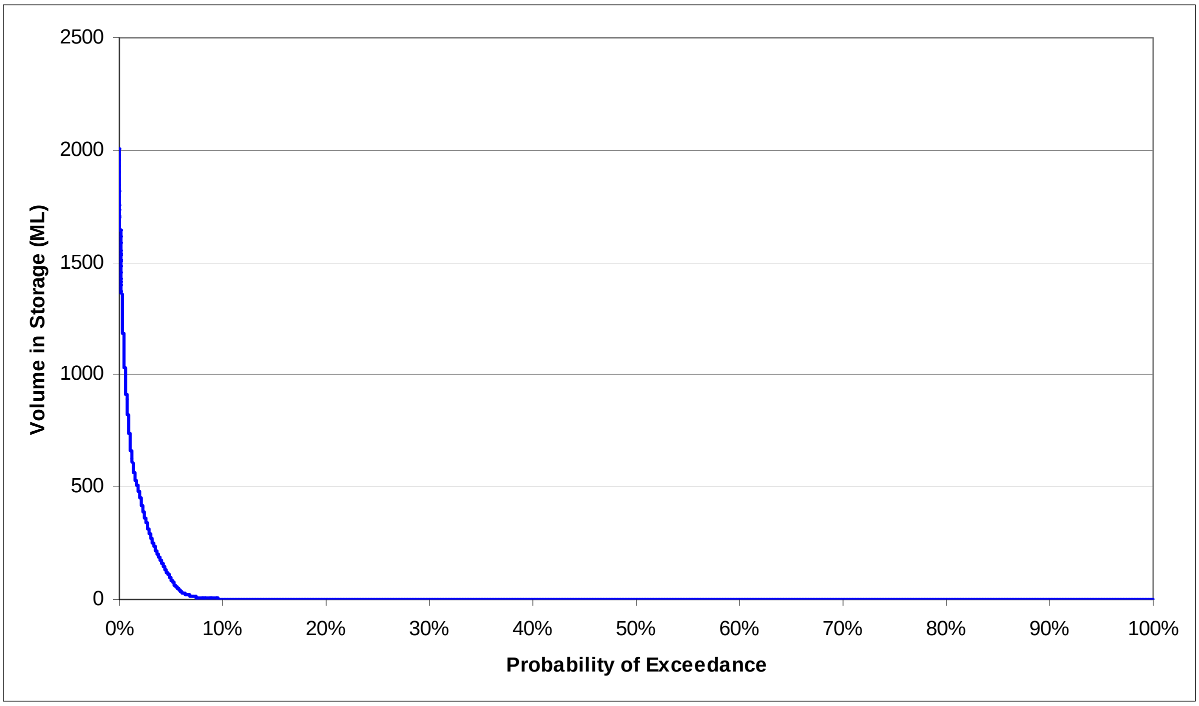

Figure B-15 Central Open Cut Pit Exceedance Probability Plot - Year 10

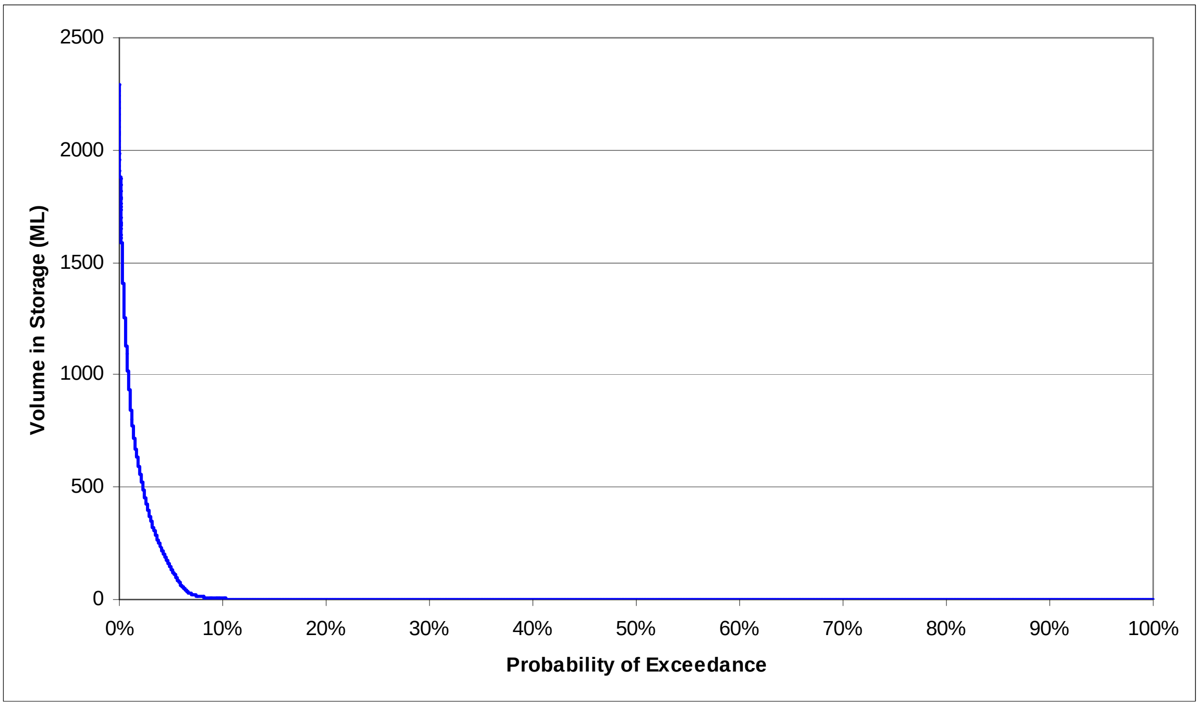

Figure B-16 Central Open Cut Pit Exceedence Probability Plot - Year 30

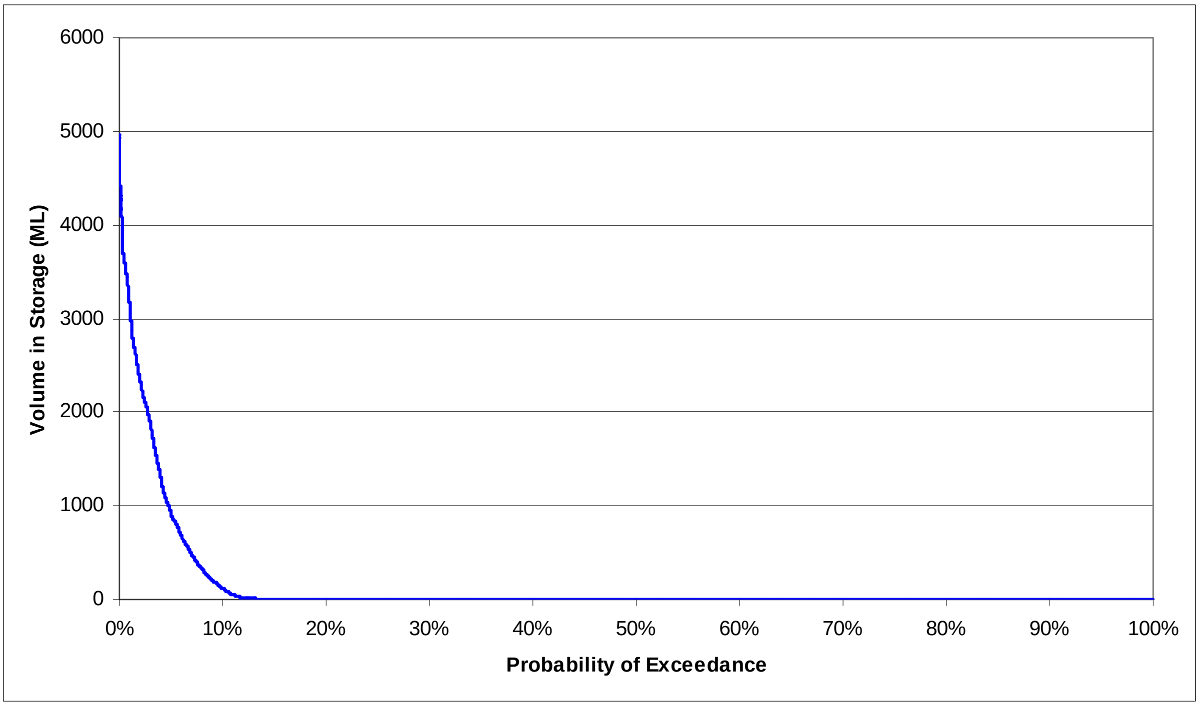

Figure B-17 Central Open Cut Pit Exceedence Probability Plot - Year 30 (Worst Case Rehab Failure)

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B.4 Additional Storage Plots – Open Cut Pits

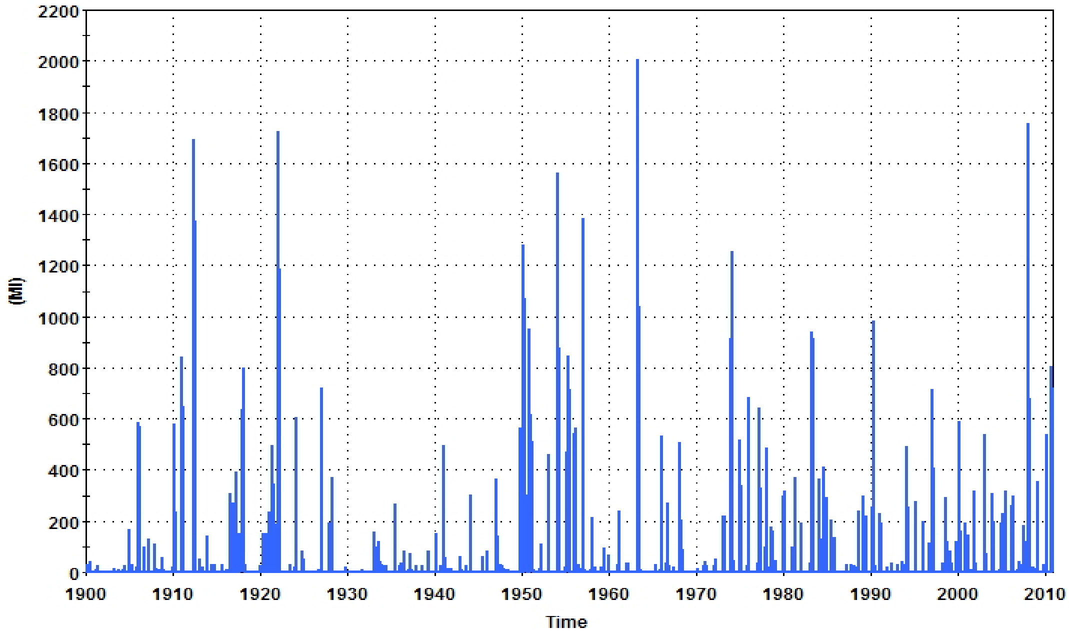

Figure B-18 Year 10 Storage Plot - Central Pit Sump

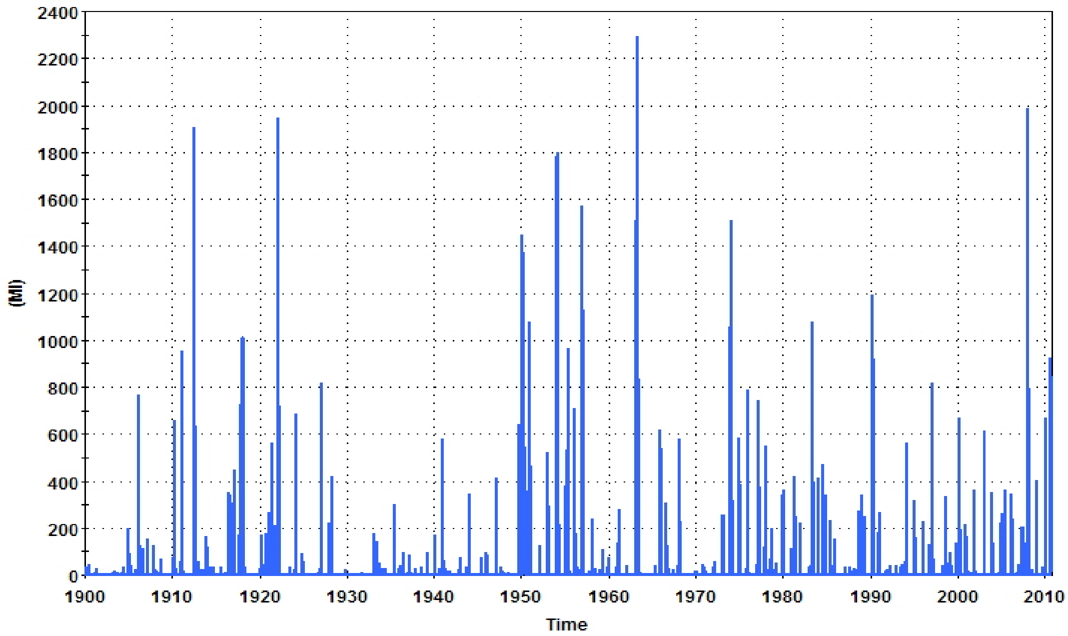

Figure B-19 Year 30 Storage Plot - Central Pit Sump

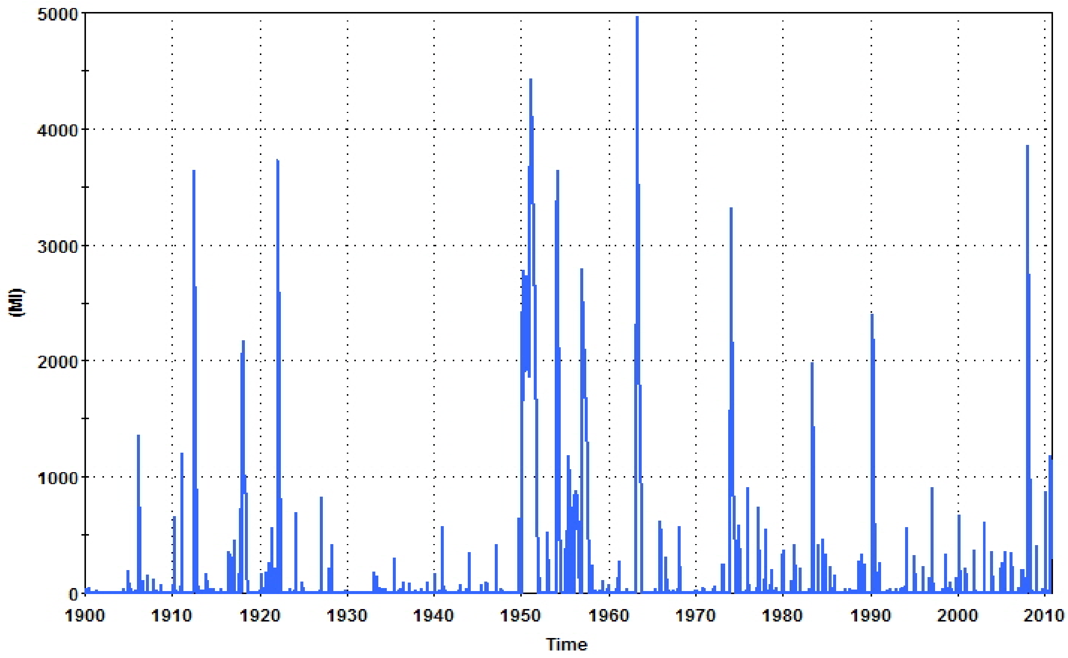

Figure B-20 Year 30 (Worst Case Rehab Failure) Storage Plot - Central Pit Sump

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