HANCOCK PROSPECTING PTY LTD

Alpha Coal Project Environmental Impact Statement

F3 Site Water Management System and Water Balance Technical Report

Alpha Coal Project
Site water management system and water balance technical report

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HANCOCK COAL PTY LTD

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Glossary

AEP	Annual exceedance probability
ARI	Average recurrence interval
BOM	Bureau of Meteorology
CHPP	Coal handling and preparation plant
DERM	QLD Department of Environment and Resource Management
DME	QLD Department of Minerals and Energy (former)
DSA	Design storage allowance
EIS	Environmental impact statement
EPA	QLD Environmental Protection Agency (former)
EPC	Exploration permit for coal
ESCP	Erosion and Sediment Control Plan
MIA	Mine industrial area
MDL	Mineral development licence
ML	Megalitres
MLA	Mining lease application
MRL	Mandatory reporting level
Mtpa	Million tonnes per annum
NHMRC	National Health and Medical Research Council
ROM	Run of mine
NAF	Non acid forming
PAF	Potentially acid forming
WMS	Water management system

1. Introduction

1.1 Background

Parsons Brinckerhoff Australia Pty Ltd (PB) has been commissioned by Hancock Prospecting Pty Ltd (HPPL) to prepare a site water management system concept and water balance for the Alpha Coal Project (the Project). This report will contribute to the Environmental Impact Statement (EIS) for the Project.

The Alpha Coal Project comprises the development of a new open cut coal mine in the Galilee Basin, Central Queensland and associated infrastructure, to service international export energy markets for thermal coal. The Project is approximately 360 km south of south-west of Mackay, and approximately 430 km west of Rockhampton. The nearest residential area to the Project is the township of Alpha, located approximately 60 km south of the Project area.

The Project will comprise a 42 million tonne per annum (Mtpa) of run of mine (ROM) coal mining operation, with a mine life of 30 years. The Project will consist of multiple open cut pits where overburden will be removed by draglines, shovel, excavators, and trucks. Coal will be mined and transported from the pits by truck and shovel operations. The ROM coal will be sized, conveyed and washed via a multi-modular coal handling and preparation plant (CHPP). Overburden will be stockpiled in out-of-pit and in-pit spoil dumps. Coarse rejects from the coal preparation plant will be disposed with the overburden, while fine rejects (tailings) will be managed via a tailings storage facility.

The Project is located within the Lagoon and Sandy Creek catchment, forming the south-westerly portion of the Belyando River system. The catchment is bounded by the Great Dividing Range to the west and a north-south line of low hills to the east and extends to the south of the Capricorn Highway and northward to around Wendouree. The creeks will be diverted within the Mine Lease Application (MLA) area to enable progression of mining activities. It should be noted that the upper reaches of Sandy Creek are named Greentree Creek on published topographic maps. For the purpose of this report this section of Sandy Creek will be referred to as Greentree Creek to allow ease of identification of reaches.

1.2 Scope of works

This section outlines the Site Water Management Strategy and water balance scope of works undertaken for the Project EIS. Key features include:

- development of surface water management system concepts for the Year 1, 5, 10, 20 and 30 landforms.
- diversion of runoff from undisturbed catchments around the mine site.
- partial segregation of water within the mine site based on quality.
- reuse of contaminated water around site, with contaminated water preferentially reused.
- sufficient storage capacity within site dams for sediment control.

- undertake a water balance of the mine site to estimate runoff volumes, identify potential overflows, and identify potential water deficits / surpluses for the Year 1, 5, 10, 20 and 30 landforms.

Other aspects of surface water assessment and management are dealt with in the Flooding Technical Report, Geomorphology Technical Report, and Water Quality Technical Report in the EIS.

This report does not assess the process water management system (including the tailings storage facility, decant dam and return water system). The process water management system is dealt with in the Alpha Coal Tailings Storage Facility Concept Design Report in the EIS

2. Design objectives and criteria

2.1 Water management system design objectives

The *Terms of Reference for an Environmental Impact Statement – Alpha Coal Project* sets the following key water management strategy objectives:

- Maintenance of sufficient quantity and quality of surface waters to protect existing beneficial downstream uses of those waters (including maintenance of in-stream biota).
- Maintenance or replication of the existing geomorphic condition of local watercourses.
- Minimisation of impacts on flooding levels and frequencies both upstream and downstream of the Project.

The first of these points is the most relevant to water management and water balance, with the greatest risk for potential off-site impacts on water quality being the discharge of pit water, process water, coal stockpile and potentially overburden runoff prior to rehabilitation. These water sources may contain contaminant concentrations that exceed acceptable limits for the preservation of downstream environmental values.

In line with leading industry practice, the objectives of the water management system design for the Project are to:

- Minimise the volume of pit water (surface runoff draining to pit and groundwater seepage) generated by the Project.
- Avoid the need for discharge of contaminated water under normal operating conditions through preferential onsite reuse of contaminated water stores.
- Provide sufficient onsite storage to give an acceptable level of risk of accidental off-site discharge of contaminated water during significant rainfall events (no unplanned discharge under modelled historical conditions).
- Provide sufficient onsite storage to settle coarse suspended solids from dirty water (from overburden dumps and other disturbed areas) during significant rainfall events, through the application of the relevant guideline sediment dam storage capacity.

2.2 Relevant legislation and guidelines

Various legislation and guidelines provide information about site water management. The over arching legislation is the Water Act 2000, which aims to provide for the sustainable management of water and other resources. Environmental values and water quality objectives are set out in the Environmental Protection (Water) Policy 2009.

Site water storages have been sized in accordance with the Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland (Technical Guidelines). The Technical Guidelines were prepared for the former Department of Minerals and Energy (DME) and published in 1995, but are now administered by the Department of Environment and Resource Management (DERM). DERM intends to replace the Technical Guidelines with a Manual for Dams, however, this manual has not yet been finalised and has therefore not been adopted for this Project.

The Technical Guidelines require that the design of a site water management system for any mining and processing operation should be based on the concept of risk management for the purpose of protection of the environment.

2.2.1 DME guideline uncontaminated runoff criteria

In the Technical Guidelines, design risk criteria are selected based on the appropriate hazard category for the structure under consideration. The selection of the hazard category is based on the potential outcomes of the failure to contain the waste water (i.e. the toxicity of the waste and the attributes of the receiving environment). The Technical Guidelines refer to uncontaminated or contaminated runoff. For the purposes of selecting a hazard category for this assessment, uncontaminated waste has been taken to mean Low-Toxicity waste as defined in the Technical Guidelines according to Table 2-1.

Table 2-1: Toxicity concentrations for determination of hazard category

Category	Concentration
Toxic	>100 x drinking water standard (NHMRC)
Sub-Lethal	10-100 x drinking water standard (NHMRC)
Low-Toxicity	<10 x drinking water standard (NHMRC)

Source: *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* (DME, 1995)

Non-environmentally sensitive receiving waters are defined as having *"no environmental features of significance or no environmental damage expected"* and *"no sensitive ecology within 5 km".*

Based on the aquatic and terrestrial ecology assessments prepared for the Alpha Coal Bulk Sample Project by AustralAsian Resource Consultants Pty Ltd (2009), the receiving waters in the vicinity of the Project site are considered sensitive. The Fringing Riparian Woodland ecological community was identified and is listed as "Of Concern" under the DERM Biodiversity status. The Southern Squatter Pigeon was identified and is listed as "Vulnerable" under both the *Environmental Protection and Biodiversity Conservation Act 1999* and the Nature Conservation (Wildlife) Regulation 2006. Six Marine Overfly species and fifteen Migratory bird species listed under the under the *Environmental Protection and Biodiversity Conservation Act 1999* were identified.

For uncontaminated runoff into environmentally sensitive receiving waters, the Technical Guidelines recommend that runoff should be retained in a sediment dam designed to hold the 10% AEP 24-hour storm above design maximum sediment deposit levels. The dam should be designed to by-pass when full. The contents of this dam should be drawn down within 10 days, depending on stored water quality and receiving water flows.

2.2.2 DME guideline contaminated runoff criteria

Sufficient reserve storage should be available in all dams to contain the Design Storage Allowance (DSA). The DSA is the storage required at 1 November each year that will be filled by the process inputs and the runoff from the three month critical wet period if it should occur.

The cumulative rainfall data having the required AEP for the three month wet period is assessed from meteorological monthly decile analysis data (refer to Section 3.1). The runoff calculation assumes that no catchment losses occur. Design AEP from hazard category is summarised in Table 2-2.

Table 2-2: Design AEP for DSA based on hazard category

Hazard for failure impacts	Hazard	AEP
Approaches a no discharge case and may involve the loss of cyanide tailings and the dam wall. Loss of life could be expected	High	0.001
Toxic waste discharge with riparian users downstream (within 5 km) sensitive ecology (within 5 km) or the contamination of significant ground water resources	High	0.005
Discharge of toxic waste with no downstream riparian users (within 5 km) or no significant ecology (within 5 km)	High	0.01
Discharge of sub-lethal wastes with significant riparian users (within 5 km), sensitive ecology (within 5 km) or contamination of groundwater resource	Significant	0.02
Discharge of sub-lethal wastes with no riparian users (within 5 km), no sensitive ecology (within 5 km) and no contamination of groundwater resource	Significant	0.05
Discharge of low-toxicity wastes and the minimum standard for unlicensed discharge of waste from the site	Low	0.1

Source: *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* (DME, 1995)

The Mandatory Reporting Level (MRL) is defined as the available storage volume below the spillway crest, equivalent to the lower of the AEP (design risk) 72-hour storm or the AEP wave allowance, at which DERM must be advised.

2.2.3 Code of Environmental compliance for high hazard dams containing hazardous waste

The Environmental Protection Authority (EPA) (now DERM) developed a Code of Environmental Compliance for Environmental Authorities for High Hazard Dams Containing Hazardous Waste.

The Code defines hazardous waste as *"any substance, whether liquid, solid or gaseous, derived by or resulting from, the processing of minerals that tends to destroy life or impair or endanger health"*. The Code notes that such dams are *"primarily used for storing process water, recycling treatment liquors and for tailings disposal."*

A dam is a high hazard dam if it contains hazardous waste and one or more of the following situations occur:

1. In the event of dam failure or overflow, the dam's content would have one of the more of the following actions:
   - flow to a sensitive or commercial place
   - flow to a riverine area containing permanent water
   - contaminate a water supply for human consumption
   - contaminate a water supply for stock.
2. The dam is located within a:
   - declared catchment or sub artesian area
   - watercourse and the dam's surface area exceeds 1 ha.

3. The dam has a surface area greater than 2 ha.

Under this definition, it is possible that the following dams on the Alpha Coal Project will be designated hazardous waste dams, and be regulated by DERM:

- Tailings storage facility and any associated return water dams.
- Environmental dams receiving water contaminated by mine operations.

2.3 Adopted design criteria

An initial geochemical assessment has been undertaken by SRK Consulting Australasia Pty Ltd (2010) for the Alpha Coal Bulk Sample Project, including overburden, coal washery waste and raw coal materials. The geochemical assessment found that:

- *"Test results indicate that between 81% and 94% of the overburden is non acid forming (NAF) and less than 7% may be potentially acid forming (PAF). Indications are that the PAF material has low acid forming capacity (sulphide content of less than 0.2%). The acid forming potential of the remaining 6 to 13% of overburden is uncertain.*
- *"The test results for coal washery waste samples indicated that at least some of the washery waste was PAF. Test results for the blended raw coal sample did not show that the blended coal was PAF or NAF. The blended coal was classed uncertain.*
- *"The potential for acid and metalliferous drainage from the test pit floor material is variable with some samples classed NAF and others either uncertain or PAF. No chemical elements in either the overburden or washery waste materials were found to be significantly enriched.*
- *"Neutral waters contacting the overburden would be expected to remain circum-neutral. Salinity release (probably sourced from contained pore water) would be expected to occur over the short term (as a short term flush). However, it would not be expected to occur in the longer term. Metal and metalloid concentrations of waters contacting the overburden or washery waste are not expected to increase significantly.*
- *"Dispersivity testing was conducted on fifteen samples selected from overburden and coal washery waste by chemical and physical tests.*
- *"Results of dispersivity testing indicate that the claystones, mudstones and clays are dispersive or potentially dispersive. The siltstones and sandstones are slightly dispersive (occasionally dispersive) and washery waste non-dispersive".*

Based on the above findings, the following minimum design criteria have been set for the purposes of conceptual design.

2.3.1 Sediment dams

Based on the findings of the geochemical assessment for the Alpha Coal Bulk Sample Project, it is considered unlikely that leachate/runoff from overburden dumps would be contaminated. However, as soils are dispersive, runoff is likely to have elevated suspended solids concentrations. This is based on the assumption that areas of particularly sodic or saline materials are managed in accordance with the measures described in Volume 2 Section 16 of the EIS. Sediment dams have therefore been sized in accordance with the criteria recommended in the Technical Guidelines for the discharge of uncontaminated runoff to environmentally sensitive receiving waters (refer to Section 2.2.1).

'Wet' sediment dams are proposed for the Project. Wet dams comprise a 'settling zone' for temporary treatment storage and a 'sediment zone' for storage of sediment. The 'settling zone' has been sized to store runoff from the 10% AEP 24 hour duration storm. The 'sediment zone' has been sized at a nominal 20% of the 'settling zone'. A runoff coefficient of 0.5 for disturbed areas has been adopted for sediment dam sizing purposes.

As there is still the potential for overburden runoff to have elevated salinity and/or metals, provision will be made for a manually operated valve on all sediment dam outlet pipes to prevent discharge if water quality is unsuitable. An additional 'reuse zone' will be provided in sediment dams to cater for this water.

Typical design features of proposed sediment dams are as follows:

- 'sediment zone' for sediment storage sized at 20% of 'settling zone'
- 'reuse zone' for storage of water for possible onsite reuse sized at 20% of 'settling zone'
- 'settling zone' for temporary treatment storage
- slotted riser and discharge pipe with valve arrangement to allow manual operation of pipe
- slotted riser sized to drawdown 'settling zone' over 10 days
- select clay fill embankment with 1:3 (V:H) slopes
- embankment crest 5 m wide with gravel capping and 3% cross-fall
- spillway at top water level to safely convey the 0.1% AEP peak flow
- freeboard between top-water-level and top-of-bank
- scour protection at the discharge pipe outlet
- pump and pipeline system to transfer water to the creek system (via the overflow drain and final sediment dam), where a free draining discharge pipe is not practical.

2.3.2 Environmental dams (or 'regulated dams')

Environmental dams (or 'regulated dams') are split into two categories based on the runoff source:

1. Environmental dams (receiving water from the CHPP, MIA, coal stockpile pads etc)
2. Pit dewatering dams (receiving water from the pit).

The concentrations of potential contaminants are likely to place water stored in pit dewatering and environmental dams in the sub-lethal category. From Section 2.2.2, the DSA design criteria for sub-lethal water, is the 2% AEP, based on discharge to sensitive receiving waters. Discussions will be held with DERM to confirm this design criterion.

Environmental dams have been sized to capture the 2% AEP DSA 3-month critical wet period rainfall (with a runoff coefficient of 1.0) for the purposes of conceptual design. Critical wet period rainfall depths are provided in Section 3.1.

The requirements described in Section 2.2.2 have not been specifically applied to pit dewatering dams as these are ‘turkeys nest’ dams with minimal local catchments. However, for the purposes of conceptual design, pit dewatering dams have been sized to achieve no discharge when operated as part of the overall site water management system under historical climate conditions, as determined through water balance modelling.

2.3.3 Referrable dams

A referrable dam is one that would, in the event of failure, put population at risk. This is determined by conducting a failure impact assessment. Such a dam is assigned a Category 1 or Category 2 failure impact rating, and is considered 'referrable' under the provisions of the *Water Supply (Safety and Reliability) Act 2008* and the *Water Act 2000*.

Dams that have not already been assessed as having a Category 2 failure impact rating must be assessed every 5 years if they are more than 8 m high and have:

- a storage capacity of more than 500 ML, or
- a storage capacity of more than 250 ML and a catchment area more than three times the maximum surface area of the dam at full supply level.

If there is no population at risk, a dam is not referrable and is not subject to the referrable dam provisions of the *Water Supply (Safety and Reliability) Act 2008*.

Development permits are required for all new referrable dams and for all modifications to existing referrable dams to increase the storage capacity by more than 10%.

Dams containing hazardous waste are not considered referrable dams under the *Water Act 2000* and are instead regulated under the *Environmental Protection Act 1994*. Under the definition of hazardous waste in the *Environmental Protection Act 1994*, it is possible that the site environmental dams may be deemed hazardous waste dams.

The final configuration of the site dams will be established during later design stages, and will depend on the availability of construction materials and the relative costs of excavation and embankment construction. Under the currently proposed water management system for the Project, there are numerous dams and/or flood levees that may meet the criteria for undertaking a failure impact assessment.

3. Existing environment

This section provides an overview of the existing surface water environment at the Project site, focusing on climate and rainfall-runoff characteristics. Other surface water information and assessment is provided in the Flooding Technical Report, Geomorphology Technical Report, and Water Quality Technical Report.

3.1 Climate data

Climate data used in the water balance model was based on 110 years (1900-2009) of patched-point daily data. The patched-point data was sourced from the Data Drill database, developed by DERM. Data Drill accesses grids of data interpolated (using splining and kriging techniques) from point observations by the Bureau of Meteorology (BoM). The patched-point data is considered superior to site observations for modelling purposes because it draws on a greater dataset, both spatially and in time.

Annual rainfall for the site is provided in Figure 3-1. Summary statistics for rainfall and evaporation are presented in Table 3-1.

Figure 3-1: Annual rainfall for Alpha – Data Drill (1889 to 2009)

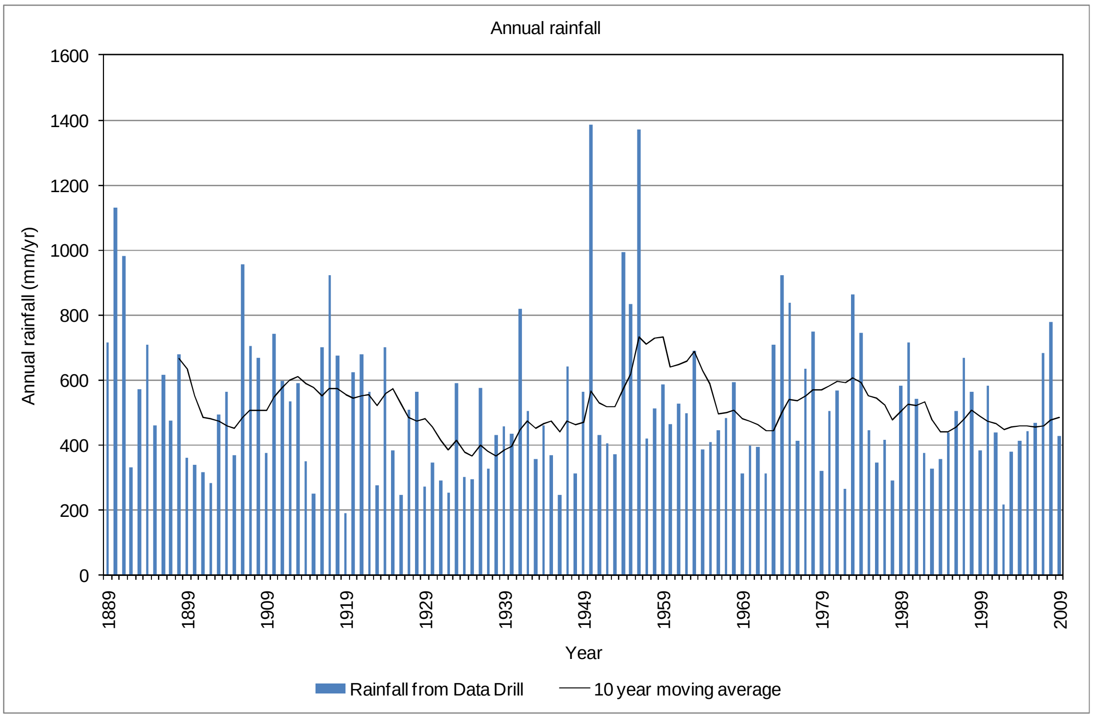


Table 3-1: Summary climate statistics Alpha (1889 to 2009)

Statistic	Annual rainfall (mm)	Annual evaporation (mm)	Annual potential evapotranspiration (mm)
10th percentile	293	2,187	1,656
50th percentile (median)	477	2,293	1,772
90th percentile	779	2,385	1,869
99th percentile	1322	2523	1944
Mean	526	2,292	1,767
Minimum	190	1,810	1,518
Maximum	1,385	2,657	1,977
Standard deviation	220	103	86

A three month wet period decile analysis was undertaken for the Project area. This was done by calculating the maximum cumulative rainfall depth for any consecutive three month period within each water year (i.e. July to June) for the 110 year period from 1900 to 2009. A Log Pearson III probability distribution was fit to the 110 year data set. The frequency curve is provided in Figure 3-2. Rainfall depths for various AEP's are provided in Table 3-2.

Figure 3-2: Three month wet period frequency curve for Alpha – Data Drill (1900 to 2009)

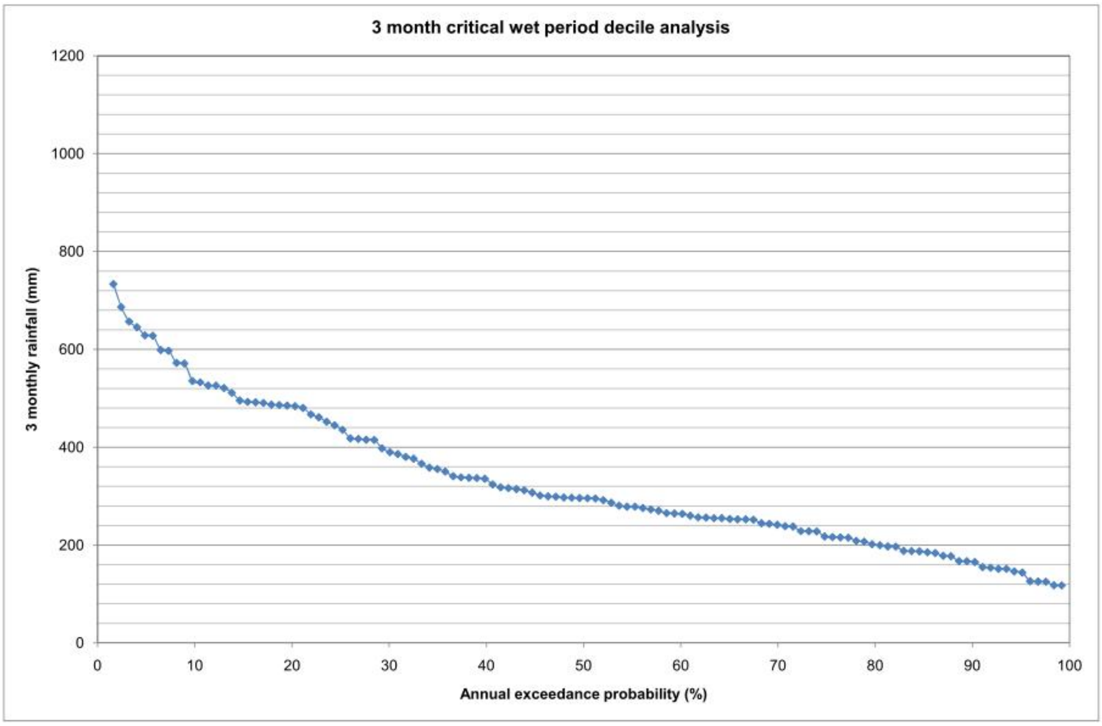


Table 3-2: Three month wet period rainfall depths for Alpha

AEP (%)	ARI (years)	Rainfall depth (mm)
10%	10	533
5%	20	627
2%	50	751
1%	100	847
0.5%	200	946
0.1%	1,000	1,187

Design intensity-frequency-duration rainfall data was also prepared for the Project area in accordance with the method outlined in Australian Rainfall and Runoff (The Institution of Engineers Australia, 2001).

3.2 Stream flow data

There are no stream gauging stations operating within the study catchment. However, five stream gauges have operated near the Project area by DERM. Details of these gauges are provided in Table 3-3.

Table 3-3: Stream flow gauging station

Location	Gauge number	Period of record
Operational gauges		
Belyando River at Gregory Development Road	120301B	From 1976
Native Companion Creek at Violet Grove	120305A	From 1967
Mistake Creek at Twin Hills	120309A	From 1976
Discontinued gauges		
Belyando River at Mt Douglas	120301A	1949 – 1975
Mistake Creek at Charlton	120306A	1968 – 1993

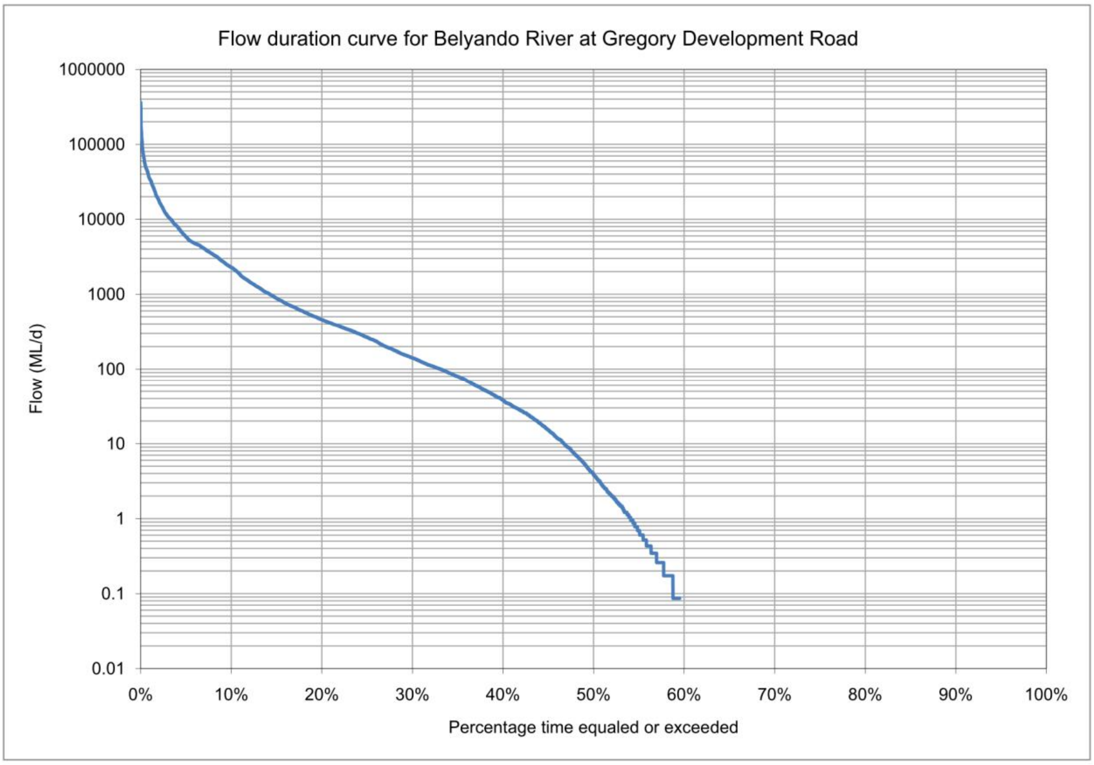
Source: DERM database

The Belyando River at Gregory Development Road streamflow record has been used for calibration of the rainfall-runoff models used in the water balance analysis. This station was selected as it is located downstream of the site on the Belyando River, and the study catchment makes up part of the Belyando River catchment at that location.

The mean annual flow in the Belyando River at Gregory Development Road was 603,784 ML/yr for the period 1976 to 2009. The median flow was 369,146 ML/yr. The minimum and maximum recorded flows are 48,611 ML/yr and 3,286,773 ML/yr respectively.

A daily flow duration curve for the Belyando River at Gregory Development Road is provided in Figure 3-3 for the period 1976 to 2009. The contributing catchment area is 35,411 km^2. The curve shows that whilst the highest recorded mean daily flow was 362,187 ML/day (which occurred in January 2008), for 50% of the time flows were less than 3.9 ML/day, and for 40% of the time, there was no flow.

Figure 3-3: Flow duration curve for Belyando River (GS 120301B)



3.3 Catchment description

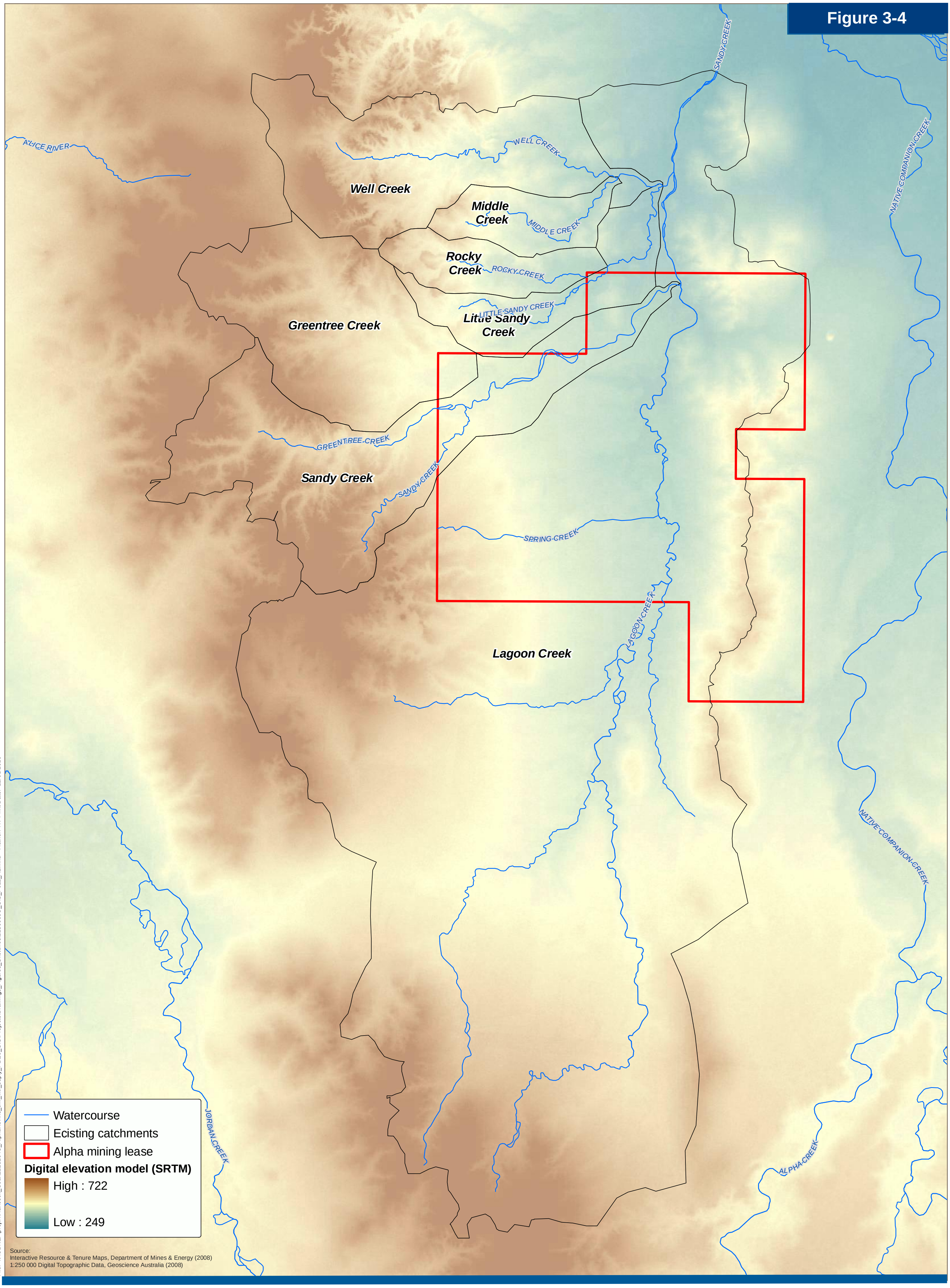
The study area comprises the catchment of Lagoon Creek from its headwaters to Sandy Creek at the confluence with Middle Creek. The study area comprises a number of creeks, including Lagoon, Spring, Sandy, Little Sandy (also known as Sandy), Greentree (also known as Sandy), Rocky, Well, and Middle Creeks. These creeks are all tributaries of the Belyando River system and its alluvial floodplain. Flooding is associated with flows in Lagoon Creek and in the minor creeks draining the MLA area to Lagoon Creek. The region is characterised by predominantly large rural properties with cattle grazing and cropping being the most common land use.

A summary of the existing catchment areas included in the model is provided in Figure 3-4 and in Table 3-4.

Table 3-4: Existing subcatchment breakdown

Catchment	Area (ha)
Greentree Creek	19,731
Lagoon Creek	186,081
Little Sandy Creek	8,225
Rocky Creek	5,369
Well Creek	20,926
Sandy Creek	27,167
Middle Creek	5,087
Total	**272,585**

Figure 3-4



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Existing Catchment Plan

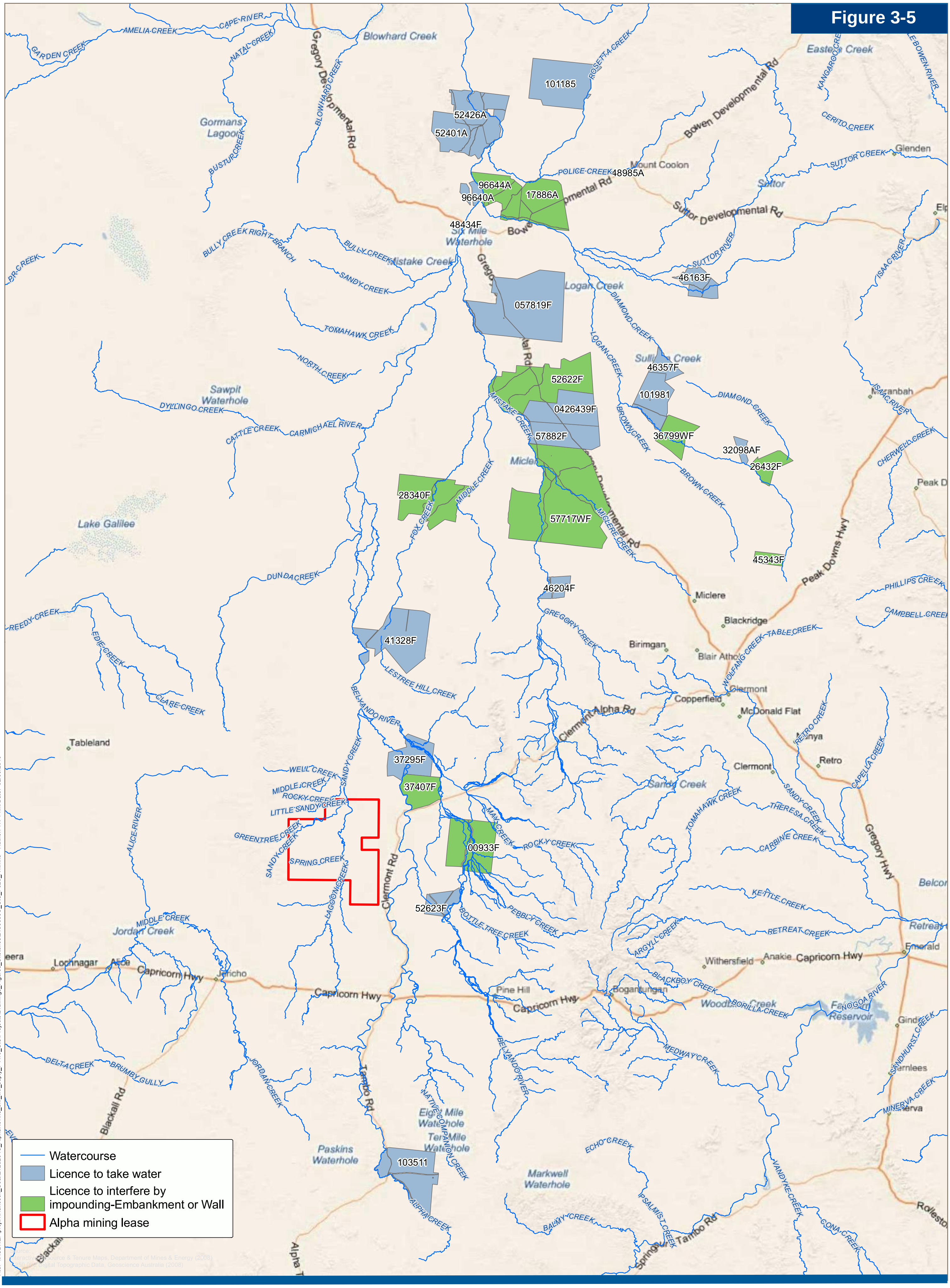
3.4 Surface water license holders

A search of the State of Queensland Water Entitlements System has been undertaken to identify surface water license holders in the Burdekin region. The results of the search are shown in Figure 3-5, and further details are provided in Appendix A.

The search indicated that there are no surface water license holders on Lagoon Creek downstream of the Project. The closest license holder downstream of the Project is located on the Belyando River near Gregory Development Road, which is approximately 175km downstream of the MLA boundary. This is a license to take water for domestic supply (Licence Number 48434F).

Other license holders are located in closer proximity to the Project, but are not on downstream watercourses and have therefore not been considered further in this report.

Figure 3-5



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Licence permit holders

3.5 Surface runoff

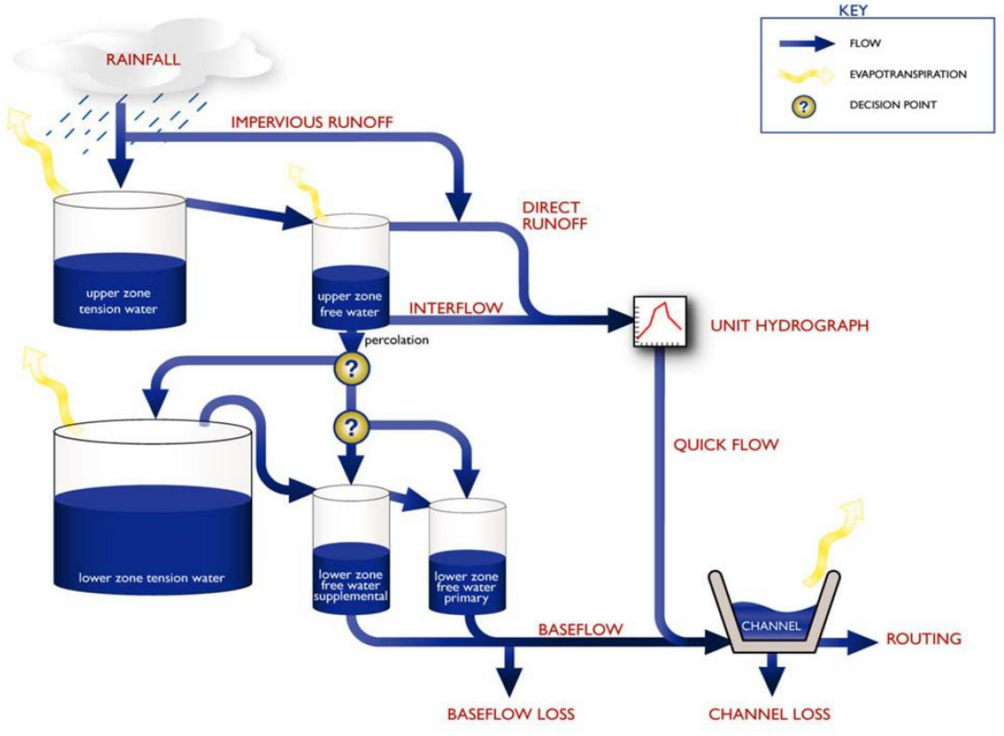
The volume of surface water runoff has been estimated using two rainfall-runoff models that have been incorporated into the water balance model – the Sacramento model, and the Australian Water Balance Model (AWBM).

3.5.1 Sacramento model

The Sacramento model was used to generate a daily time series of runoff from undisturbed and rehabilitated catchments.

The Sacramento model was developed by Burnash, Ferral and McGuire in 1973. It is an explicit soil-moisture accounting-type model developed by the United States National Weather Service and the California Department of Water Resources, and was originally used for flood forecasting applications. The Sacramento model consists of a number of storages connected by catchment processes. The model components and the relationships between them are shown in Figure 3-6.

Figure 3-6: Schematic layout of Sacramento model (Source: CRC for Catchment Hydrology, 2004)



Rainfall on the catchment is considered as falling on one of two types of surface, permeable areas or impervious areas which are linked to the channel system. Runoff is produced from impervious areas in any rainfall event. The permeable area, by contrast, produces runoff only when the rainfall is sufficiently heavy. In this portion, initial soil moisture storage, the upper zone tension storage, must be filled before water is available to enter other storages. This represents the depth of precipitation required to meet interception requirements and is water bound closely to soil particles. When this tension storage is filled, water is accumulated in the upper zone free water storage, from where it is free to drain to deeper storages or to move laterally to appear in the stream channel as interflow.

The vertically draining water, or percolation, can enter one of three lower zone storages, the lower zone tension storage (the depth of water held closely by the soil particles) or one of the two lower zone free water storages, primary and supplemental (that are available for drainage as base flow or subsurface outflow). The two free water storages fill simultaneously but drain independently at different rates to produce the variable base-flow recession.

Evaporation occurs from surface water areas at the potential rate, but in other areas, varies with both evapo-transpiration demand and the volume and distribution of tension water storage.

The surface runoff and interflow are routed to the catchment outlet by a non-dimensional unit hydrograph. In catchments where significant nonlinearities may be present, such as extensive floodplains that may alter the mean travel times, a layered Muskingum routing technique, effectively introducing a number of linear storage-discharge relationships, can be used.

To implement the model in a given catchment, a set of 18 parameters must be defined. These parameters define the generalised model for a particular catchment. The parameters are usually derived for a gauged catchment by a process of calibration where the recorded streamflows are compared with calculated streamflows. The parameters are adjusted to produce the best match between the means and standard deviations of the daily streamflows, to match the difference in peak flow discharge.

Sacramento parameters adopted for the undisturbed catchments of the Project area are provided in Table 3-5. These parameters were determined from calibrating the predicted flows for the baseline ‘undisturbed’ catchment to the Belyando River at Gregory Development Road (station 120301B) streamflow record.

Table 3-5: Adopted Sacramento model parameters for baseline catchment

Parameter	Description	Adopted value
ADIMP	The additional fraction of pervious area, which develops impervious characteristics under soil saturation, conditions.	0.15
LZFPM	Lower Zone Free Water Primary Maximum, the maximum capacity from which primary base flow can be drawn.	350
LZFSM	Lower Zone Free Water Supplemental Maximum, the maximum volume from which supplemental baseflow can be drawn.	5
LZPK	The ratio of water in LZFPM, which drains as baseflow each day.	0.02
LZSK	The ratio of water in LZFSM which drains as baseflow each day.	0.35
LZTWM	Lower Zone Tension Water Maximum, the maximum capacity of lower zone tension water. Water from this store can only be removed through evapotranspiration.	200
PCTIM	The impervious fraction of the basin, and contributes to direct runoff.	0.025
PFREE	The minimum proportion of percolation from the upper zone to the lower zone directly available for recharging the lower zone free water stores.	0.0
REXP	An exponent determining the rate of change of the percolation rate with changing lower zone water storage.	3.3
RSERV	Fraction of lower zone free water not available for transpiration purposes.	0.3

Parameter	Description	Adopted value
SARVA	A decimal fraction representing that portion of the basin normally covered by streams, lakes and vegetation that can deplete streamflow by evapotranspiration.	0.001
SIDE	The decimal fraction of observed base flow, which leaves the basin, as groundwater flow.	0.5
SSOUT	The volume of the flow which can be conveyed by porous material in the bed of stream.	0.002
UZFWM	Upper Zone Free Water Maximum, this storage is the source of water for interflow and the driving force for transferring water to deeper depths.	150
UZK	The ratio of water in UZFWM, which drains as interflow each day.	0.4
UZTWM	Upper Zone Tension Water Maximum. The maximum volume of water held by the upper zone between field capacity and the wilting point which can be lost by direct evaporation and evapotranspiration from soil surface. This storage is filled before any water in the upper zone is transferred to other storages.	220
ZPERC	Proportional increase in percolation from saturated.	15

A comparison of predicted and gauged runoff depths is provided in Figure 3-7 for the period 1977 to 2009 (recorded data).

Figure 3-7: Comparison of predicted and gauged runoff depth for Belyando River at Gregory Development Road

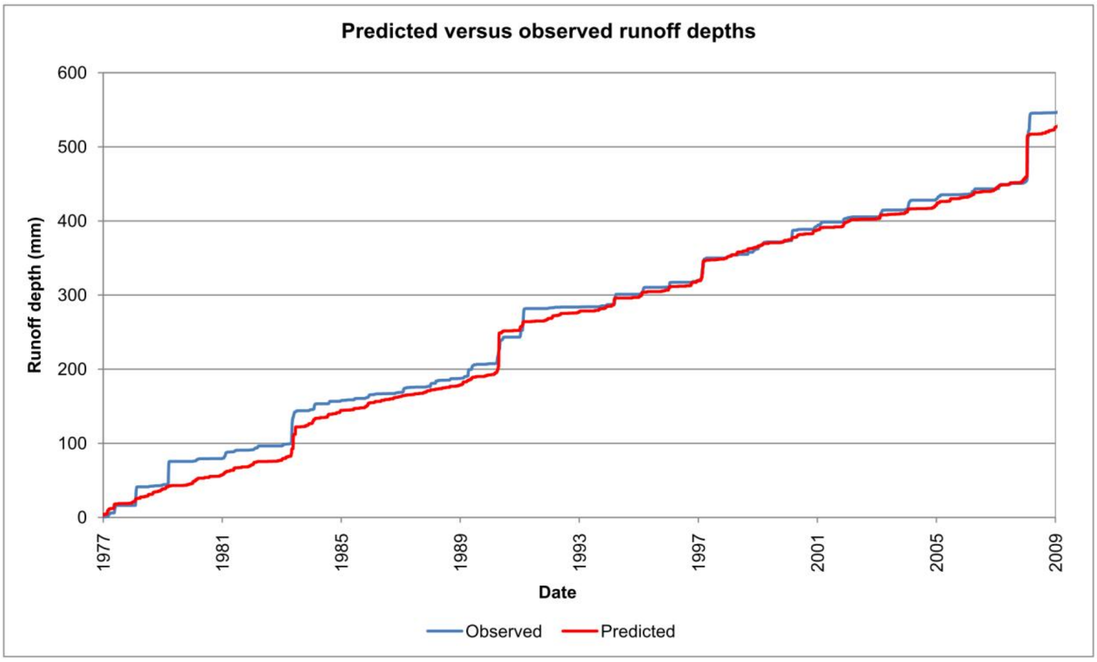


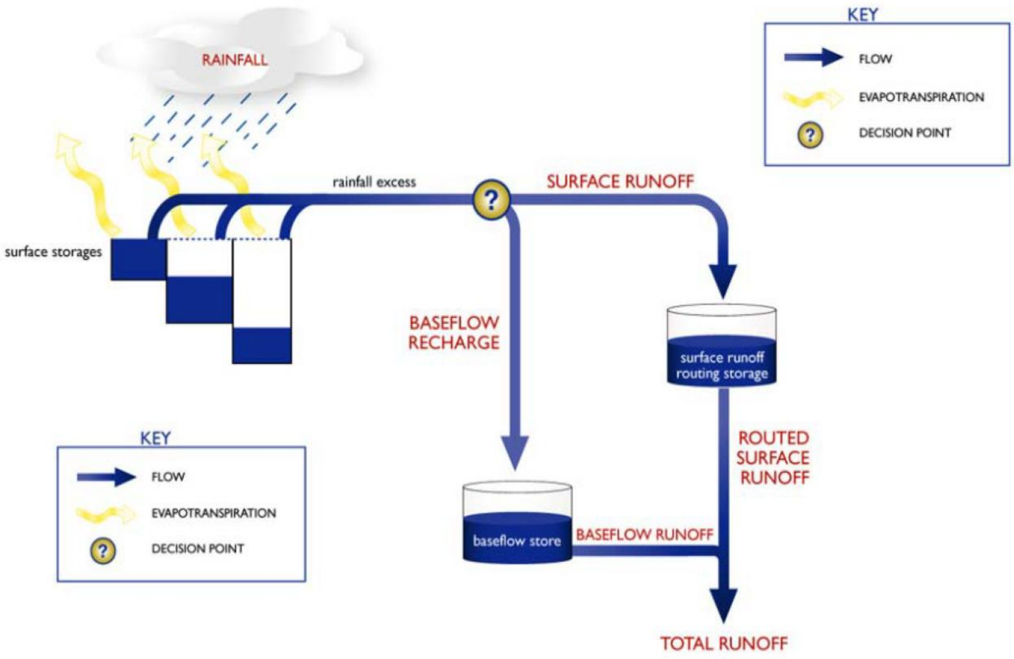
Figure 3-7 shows that annual runoff depths predicted by the Sacramento model are generally lower than the gauged runoff depths, but compare reasonably well. The mean annual runoff depth predicted by the Sacramento model was 16.3 mm/yr (3.3% of mean annual rainfall) for the period 1977 to 2009. The mean annual runoff depth at the gauging station was 17.1 mm/yr (3.4% of mean annual rainfall) for the period 1977 to 2009.

3.5.2 Australian Water Balance Model

The Australian Water Balance Method (AWBM) (Boughton, 1993) was used to derive catchment runoff time series from disturbed catchments for use in the water balance.

AWBM is a partial area saturation overland flow model. The use of partial areas divides the catchment into regions that produce runoff (contributing areas) during a rainfall-runoff event and those that do not. These contributing areas vary within a catchment according to antecedent catchment conditions, allowing for the spatial variability of surface storage in a catchment. The use of the partial area saturation overland flow approach is simple, and provides a good representation of the physical processes occurring in most Australian catchments (Boughton, 1993). This is because daily infiltration capacity is rarely exceeded, and the major source of runoff is from saturated areas. A schematic layout of AWBM is provided in Figure 3-8.

Figure 3-8: Schematic layout of AWBM runoff model (Source: CRC for Catchment Hydrology, 2004)



AWBM parameters for disturbed catchment types were derived by adjusting the surface storage capacity to achieve the assumed catchment yield. The catchment yield was estimated based on typical yields observed from other mine sites around Australia and on mine sites in Central Queensland. A summary of the adopted parameters from each catchment type is provided in Table 3-6.

Table 3-6: Adopted AWBM parameters

Parameter	Description	Landuse Industrial	Open pit	Active spoil	Rehabilitated spoil
BFI	Baseflow index	0	0	0.103	Sacramento model used
K	Baseflow recession constant	1	1	1	
A1	Partial area	0.134	0.2	0.136	
A2	Partial area	0.433	0.2	0.27	
A3	Partial area	0.433	0.6	0.594	
C1	Surface storage capacity	2.3	5	50	
C2	Surface storage capacity	22.9	70	100	
C3	Surface storage capacity	45.7	90	500	

The quantities of runoff resulting from the various types of landuses in the water balance model over 110 years of water balance simulation are summarised in Table 3-7.

Table 3-7: Annual runoff depths from various landuse types

Landuse	Annual runoff depth (mm/yr) Mean	10th percentile	50th percentile	90th percentile
Undisturbed	18.4	6.7	11.2	41.9
Rehabilitated spoil	18.4	6.7	11.2	41.9
Industrial	141.7	26.7	103.6	307.1
Open pit	89.3	16.5	56.5	222.2
Unrehabilitated active spoil	19.4	0.0	6.7	65.9

3.5.3 Sensitivity analysis

A high runoff scenario has been developed in order to check the soundness of the proposed water management system with higher than expected runoff inflows.

While previous experience suggests the adopted runoff characteristics are reasonable, there is little data available to support the adopted parameters. Research on spoil runoff characteristics has indicated high variability from site to site, and from pit to pit. The presence of preferential flow paths from the surface to pits and surface sealing of spoil material can result in relatively large volumes of runoff making its way to the pit floor. Consequently, a sensitivity analysis is normally required to better understand the potential variance from the modelled behaviour.

The high runoff scenario assumed that:

- Undisturbed and rehabilitated catchments are unchanged.
- 90th percentile runoff from open pits was a factor of 1.4 higher than the base case.
- 90th percentile runoff from active spoil was a factor of 2.5 higher than the base case.

This is likely to be a pessimistically high runoff scenario. If the system performs adequately, under these parameters it is likely to be sound over a wide range of conditions. The adopted runoff parameters are provided in Table 3-8. The quantities of runoff resulting from the various types of landuses in the model over 110 years of water balance simulation are summarised in Table 3-9.

Table 3-8: Sensitivity analysis - AWBM parameters for high runoff scenario

Landuse	BFI	K_{base}	A1	A2	A3	C1 (mm)	C2 (mm)	C3 (mm)
Open pit	0	1	0.2	0.4	0.4	5	15	50
Unrehabilitated active spoil	0	1	0.2	0.4	0.4	25	50	250

Table 3-9: Sensitivity analysis - annual runoff depths for high runoff scenario

	Annual runoff depth (mm/yr)			
Landuse	Mean	10^{th} percentile	50^{th} percentile	90^{th} percentile
Undisturbed	18.4	6.7	11.2	41.9
Rehabilitated spoil	18.4	6.7	11.2	41.9
Industrial	141.7	26.7	103.6	307.1
Open pit	157.7	34.2	127.0	316.4
Unrehabilitated active spoil	63.7	3.8	42.8	163.2

It is anticipated that further sensitivity analyses (in relation to new groundwater and geochemistry data) will be required during detailed design.

4. Proposed water management system

4.1 Water segregation

Where practical, it is proposed to segregate water within the mine site according to its quality to minimise the stored volumes of water with high concentrations of contaminants. This would allow containment of water requiring treatment (e.g. settling suspended sediment) and water suitable for direct discharge (e.g. undisturbed catchments) to be diverted.

Five water classifications have been nominated for the mine site, as described below:

- **Process water management system** – managing process water that has been used in the coal processing plant (CPP). This includes the tailings storage facility, decant dam and return water system.
- **Clean water system** – separating clean runoff from undisturbed areas from the contaminated and dirty water management systems, and diverting it to the creek system. This type of water has low turbidity and low salinity.
- **Contaminated water management system** – managing runoff from the open pit and other areas that could contribute contaminants, such as the MIA, CHPP, coal stockpiles and dump stations.
- **Dirty water management system** – treating runoff from overburden dumps and other disturbed areas that could contain sediment.
- **Groundwater management system** – groundwater will be extracted from the aquifer using a borefield to minimise seepage into the pit. Bore water is expected to be of reasonably high quality and will be kept separate from dirty and contaminated water.

Contaminated, dirty and clean water management systems are discussed in the following sections. This report does not assess the groundwater or process water management systems (in particular, the risk of overflows from the tailings storage facility and decant dam has not been assessed). The groundwater management system is discussed in the Groundwater Technical Report in Volume 5, Appendix G. The tailings storage facility and decant dam are discussed in the Alpha Coal Tailings Storage Facility Concept Design Report in Volume 5, Appendix J.

4.2 Clean water system

Clean water runoff from undisturbed catchments will be diverted around the mine site to minimise the site water inventory and maintain pre-development discharges into Lagoon Creek. Flood waters from Lagoon Creek will also be diverted around the mine site.

The clean water system comprises:

- Diversion of Lagoon Creek and Sandy Creek around the mine site. Levees will be provided along the edge of the pit area and creek diversions to help control flow and prevent waters entering the pit area. The design criteria for pit flood immunity is the 3000 year ARI storm event (equivalent to 1% chance of failure over the 30 year life of the mine). The design of creek diversions is described in the Flooding Technical Report.

- Clean water catch drains to divert minor catchments around the mine site, where practical. Catch drains have been considered when delineating catchments, but have not been designed as part of the water management system. The size of catch drains will be considered further during detailed design.
- Highwall dams and levees upslope of the pit to reduce peak flow rates and velocities from undisturbed catchments. Highwall dams have not been included in the water management system and should be considered during detailed design where possible.
- Raw water dam to store water imported to the site.
- A pump and pipeline system from the raw water dam to deliver stored water to either:
  - CPP (for processing of ROM coal into product coal)
  - MIA (for vehicle wash and workshop)
  - ROM dump and transfer stations (for dust suppression via sprayers)
  - water treatment plant (for potable applications).

Clean water runoff from the rehabilitated spoil dump will be released back into Lagoon Creek at the completion of mining. Water from rehabilitated areas will be released once rehabilitation success criteria are met.

4.3 Contaminated water management system

While water will be carefully managed to minimise the volume discharging to the open mine pits, some water will make its way into the pits either via direct rainfall, runoff from and seepage through overburden dumps, or undisturbed catchments upslope of pits that cannot be practically diverted around or captured in highwall dams. Highwall dams have not been included in the water management system, as they would have limited impact on reducing runoff volumes into the pit. However, they may provide an opportunity to reduce peak flow rates and velocities into the pit during detailed design where practical.

The contaminated water management system comprises:

- Small sumps in the pit floor to collect and contain local surface water runoff from the pit floor, high wall, low wall and end walls.
- Pit dewatering pumps and associated dewatering pipelines to transfer pit water to the nearest pit dewatering dam, if necessary via a small staging dam.
- A drainage system to convey runoff from disturbed areas to the nearest environmental dam.
- Environmental and pit dewatering dams to store and contain contaminated water from the above sources. Care has been taken in the location of storages and the layout of the drainage system to minimise the areas draining to these dams, so as to minimise the storage requirements and reduce the risk of uncontrolled spilling during rainfall events.
- A return water pump and pipeline system from each environmental and pit dewatering dam to deliver stored water to either:

- a nearby truck fill station (for haul road dust suppression)
- the CPP
- the tailings decant dam.

- A borefield to minimise groundwater seepage into the pit and provide water for use in the mine processes.

Water captured in the contaminated water management system will be used as a priority to meet demands in order to minimise the volume of stored water and therefore the risk of off-site discharge. Imported water will only be used to meet demands when there is a water deficit or high quality water is required.

During extended wet periods, surplus contaminated water will be stored in-pit once the pit dewatering dams have reached their capacity.

4.4 Dirty water management system

Dirty water runoff from disturbed areas will be captured in sediment dams to encourage suspended solids to settle. Captured water would be released to Lagoon Creek only when water quality discharge criteria have been met. Runoff from large storm events will overflow from sediment dams.

Sediment dams will allow time for coarse sediments to settle and, if necessary, allow a suitable flocculent to be added to remove fine or dispersive sediment to meet allowable turbidity discharge limits. As runoff from overburden dumps could potentially have elevated salinity and/or metals, provision will be made for a manually operated valve on all outlet pipes to prevent discharge if water quality is unsuitable. Additional capacity has also been provided in the ‘reuse zone’ of sediment dams to cater for this water.

Sediment dams would be provided to intercept runoff from the overburden dump. The eastern portion of the overburden dump drains east, and sediment dams have been provided to intercept dirty runoff before it reaches Lagoon Creek. The eastern sediment dams (SD1 to SD10) overflow to a drain running along the western side of the main haul road. The overflow drain discharges to a final sediment dam (SD-21), which discharges to Lagoon Creek. The western portion of the overburden dump drains to the pits, and sediment dams have been provided to intercept dirty runoff before it reaches the pit. Water captured in the western sediment dams (SD11 to SD20) will be pumped back to the eastern sediment dams. However, the western sediment dams will overflow to the pit during large storm events.

The dirty water management system comprises:

- A drainage system to convey runoff from the overburden dump to the nearest sediment dam.
- Sediment dams to capture water from the overburden dump.
- A pump and pipeline system to transfer captured water from the western sediment dams (SD11 to SD20) to the eastern sediment dams (SD1 to SD10).
- A pump and pipeline system to transfer captured water from the eastern sediment dams (SD1 to SD10) to the overflow drain, where free-draining outlets are not practical.

- An overflow drain running in a south-north direction along the western side of the main haul road. This drain will capture any low-flow releases or overflows from the eastern sediment dams (SD1 to SD10).
- A final sediment dam (SD-21) located at the discharge point of the south-north overflow drain. This dam would discharge to Lagoon Creek, and will be the only release point from the dirty water management system to the creek. The release point is located at approximately 449826.841E and 7443561.347N.
- A stream flow gauging station to determine and record stream flows on Lagoon Creek upstream of the release point from the final sediment dam (SD21).

The discharge of water from the final sediment dam (SD21) to Lagoon Creek must only take place during periods of natural flow events. Discharge from SD21 should not exceed 20% of the flow in Lagoon Creek, as measured at the gauging station. Water quality criteria for discharges to Lagoon Creek are provided in the Water Quality Technical Report in the EIS.

Sediment dams are to be maintained in a drawn-down state as much as practical, so that sufficient capacity is available in the 'settling zone' to capture water from subsequent storm events. The following strategy will be used to operate the eastern and final sediment dams:

- Leave sediment dam outlets in an open position (i.e. drawn down).
- Monitor dams regularly using visual inspection and in situ measurement (including turbidity, pH and electrical conductivity).
- Close dam outlets where the visual inspection or in situ measurement indicates elevated contaminant concentrations compared to discharge criteria, or there is an emergency spill event.
- Take corrective action, such as repair infrastructure, extended retention time, flocculation, review upstream erosion and sediment controls, or evacuation (for a spill event).
- Reopen outlet upon completion of corrective action and suitable inspection.
- Continue monitoring in accordance with conditions, unless a corrective action event occurs, in which case samples will also be taken before discharge.
- Remove sediment regularly to maintain the capacity of the 'sediment zone'.

In the event that water stored in sediment dams does not meet discharge criteria, this water could be reused onsite to minimise the risk of an overflow to the creek system. However, this would only occur on a temporary basis whilst corrective action is being sought, and would not be undertaken as part of normal operating conditions, unless the 'reuse overburden runoff scenario' is adopted. Details of the reuse overburden runoff scenario are provided in Sections 5.7.2 and 6.4.1.

4.5 Staging of the water management system

The components of the water management system would evolve as the Project expands, to be compatible with the mine landform and schedule. This development of the mine water management system over the mine's 30-year life is illustrated through snapshots at five stages of the mine landform:

- Year 1
- Year 5
- Year 10
- Year 20
- Year 30.

These landforms were adopted as representative of the Project during the life of the operation. Conceptual water management system plans are provided in Figure 4-1 to Figure 4-5 for the Year 1, 5, 10, 20 and 30 landforms. The plans show the mine progression, areas of disturbance, areas of rehabilitation, and the required water management structures for each landform. A schematic diagram showing the general connectivity between water sources, demands and storages is provided in Figure 4-6.

Excluding the process water management system, a total of 33 water management dams are required to manage water supply and runoff from the site over the life of the Project. Dam staging is summarised in Table 4-1.

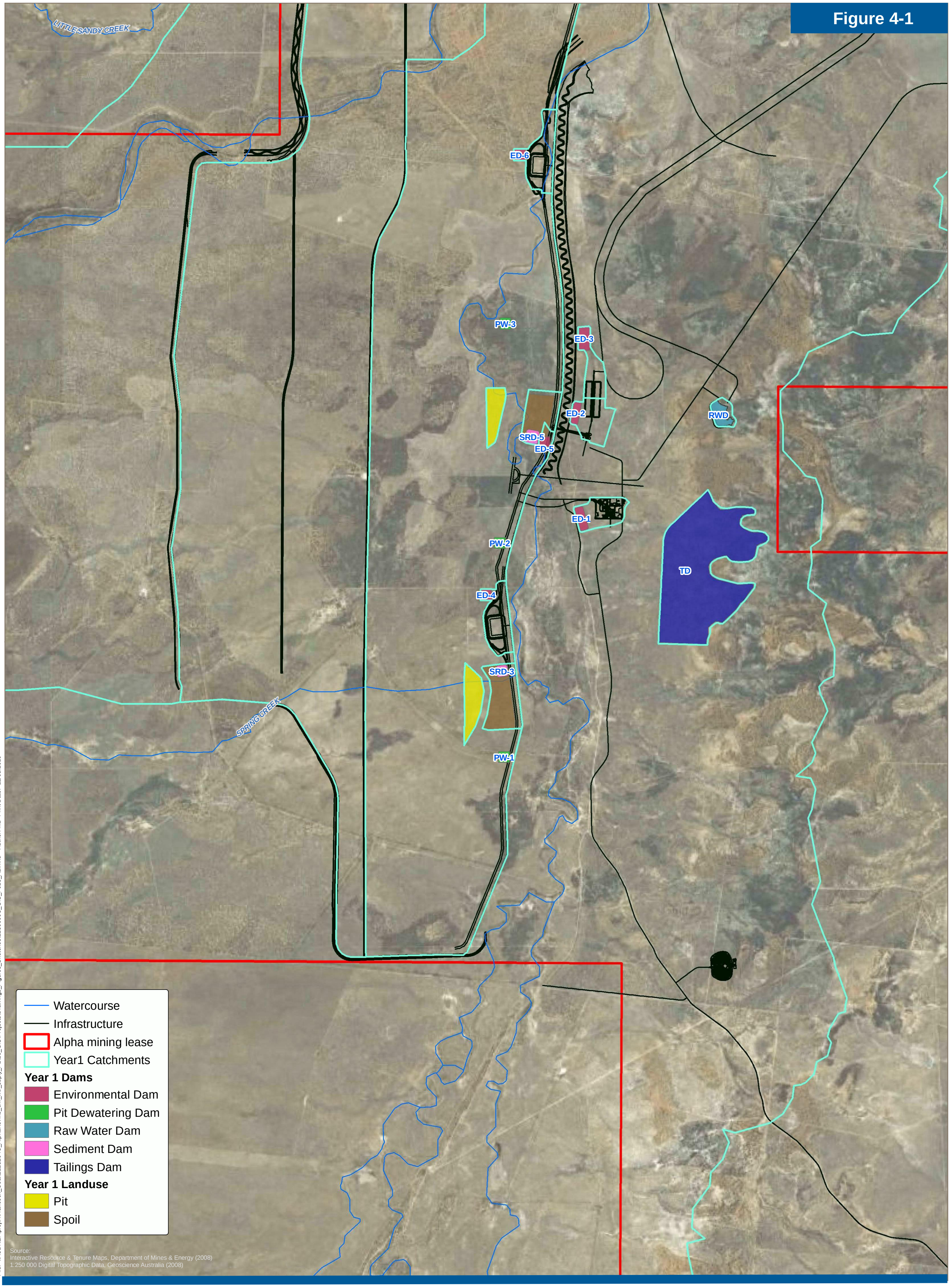
Table 4-1: Total number of dams over life of the Project

Year	Environmental dams		Sediment dams	Bore water collection dams ^	Raw water dams	Total
	CHPP, MIA, ROM dump	Pit dewatering				
Year 1	6	4	3	1	1	15
Year 5	6	4	11	1	1	23
Year 10	6	4	21	1	1	33
Year 20	6	4	21	1	1	33
Year 30	6	4	21	1	1	33

Note: ^ Only the central bore water collection dam has been included. Minor bore water collection dams have been excluded. The tailings storage facility and decant dam have been excluded.

It has been assumed that dams will be constructed to their maximum capacity when they are first commissioned. In practice, there may be opportunities for staging storage capacities without compromising the system's security when catchment areas increase as the mine develops.

Figure 4-1



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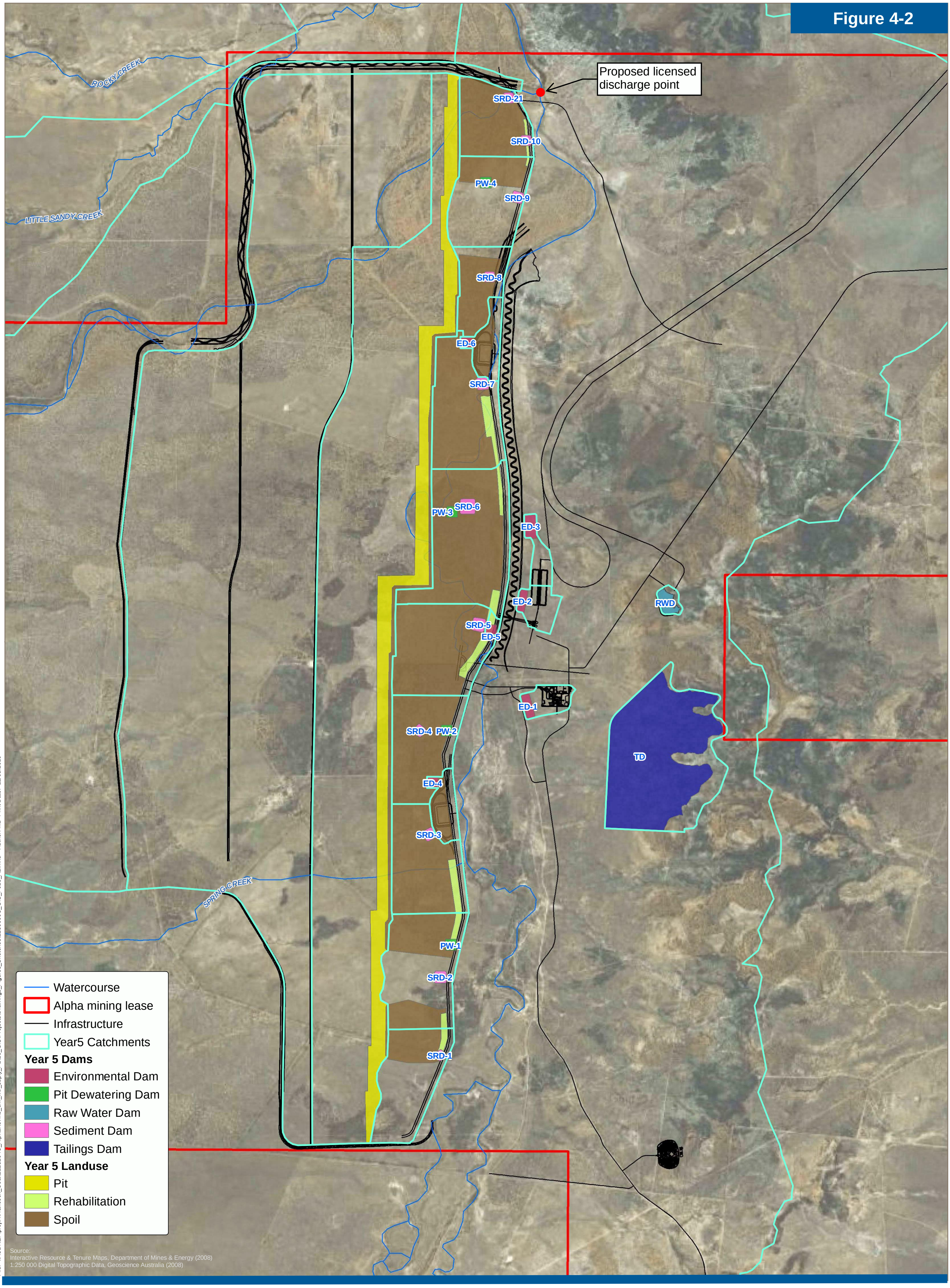
PARSONS BRINCKERHOFF

0 1 2 3 4 5
Kilometres

ALPHA COAL PROJECT

Water Management System Concept - Year 1

Figure 4-2



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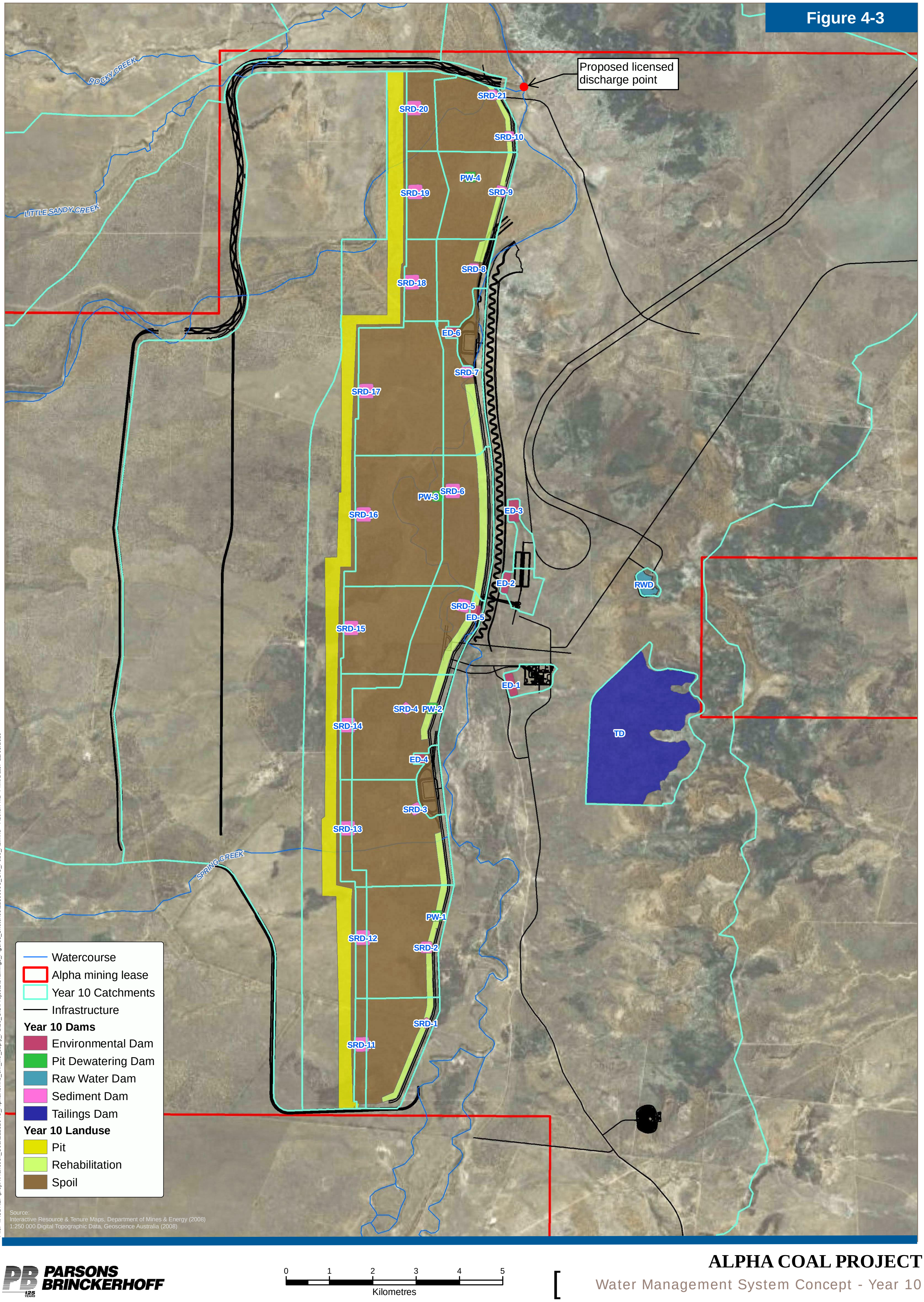
ALPHA COAL PROJECT

Water Management System Concept - Year 5

Figure 4-3



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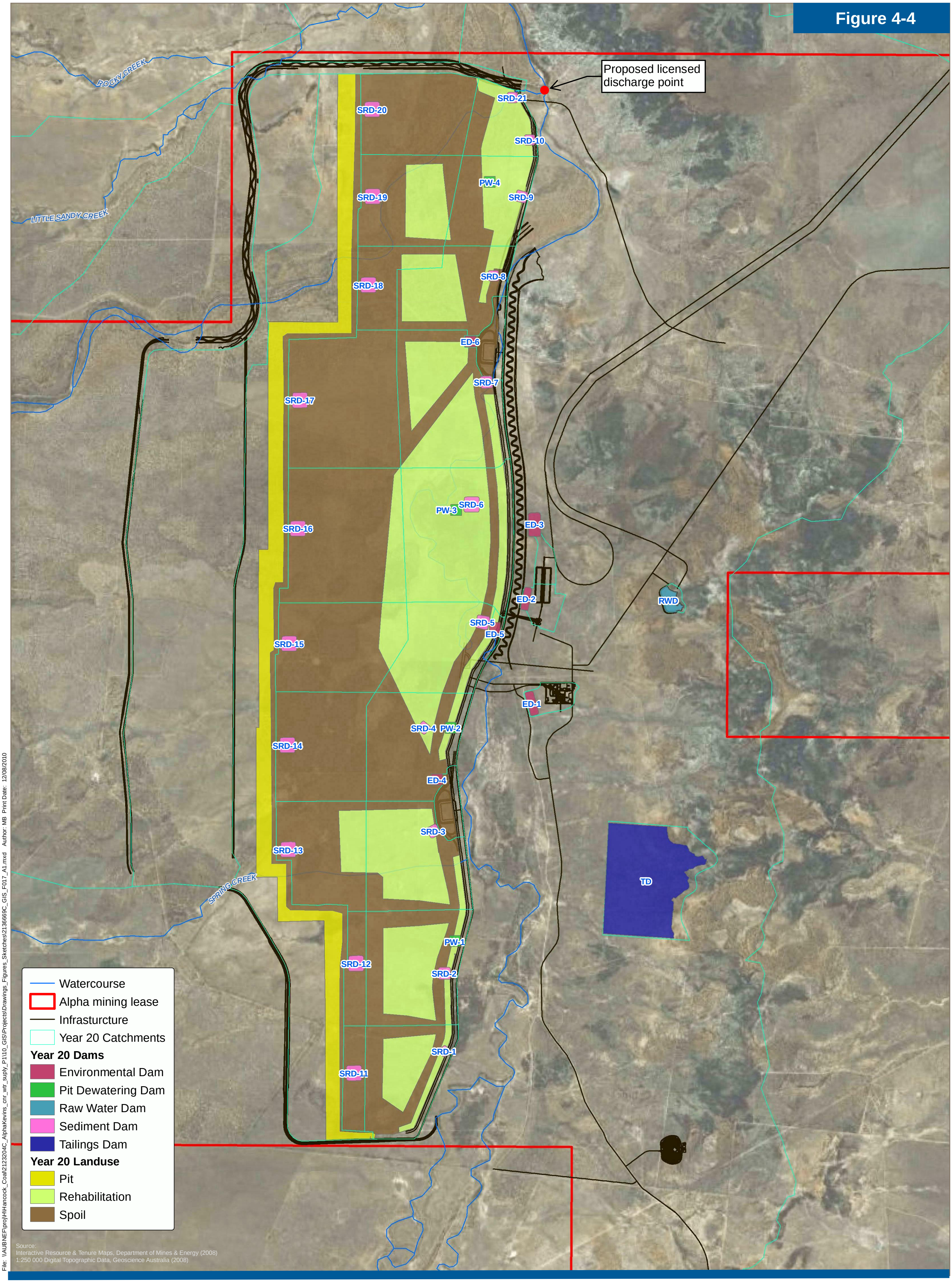
ALPHA COAL PROJECT

Water Management System Concept - Year 10



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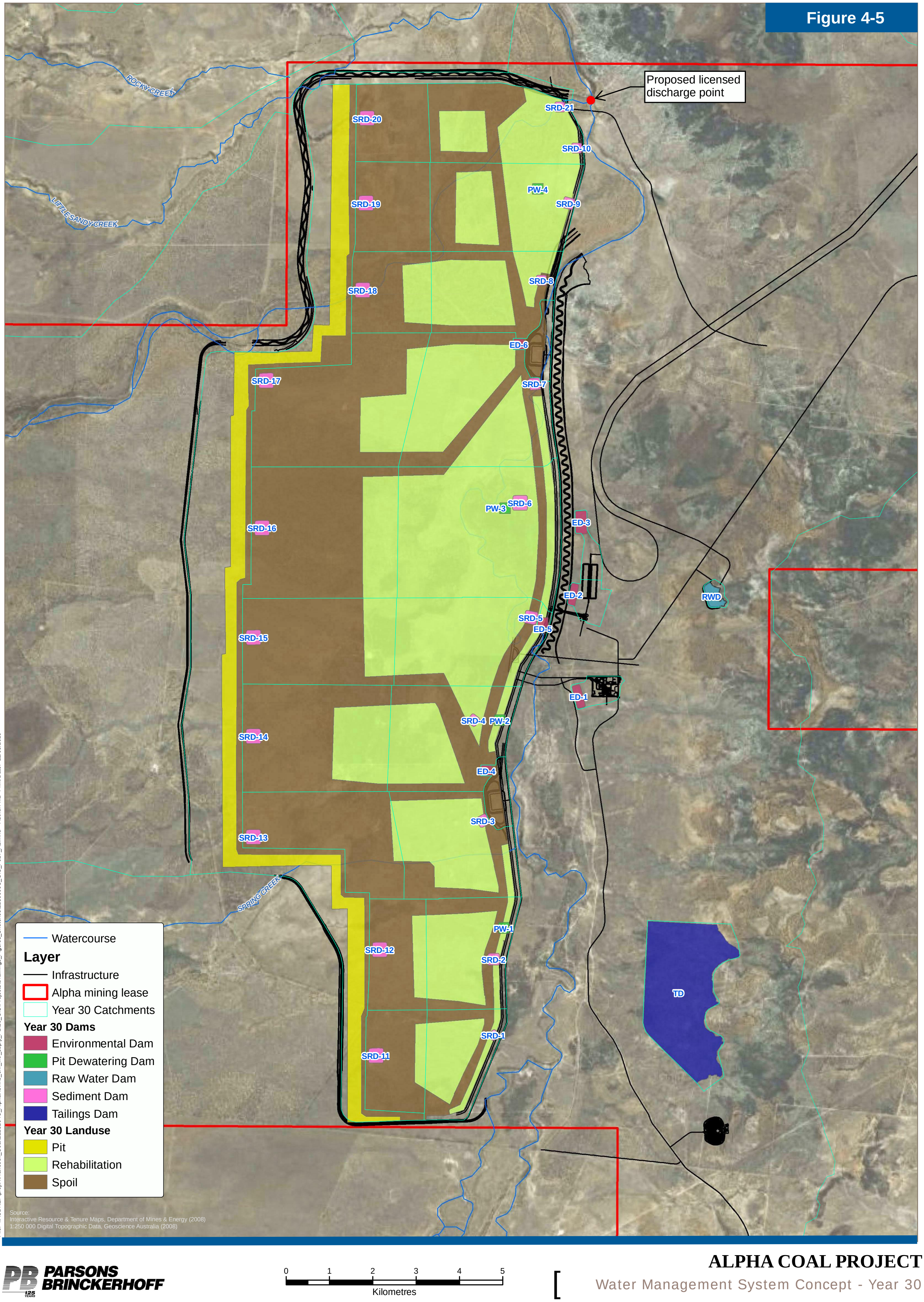
ALPHA COAL PROJECT

Water Management System Concept - Year 20



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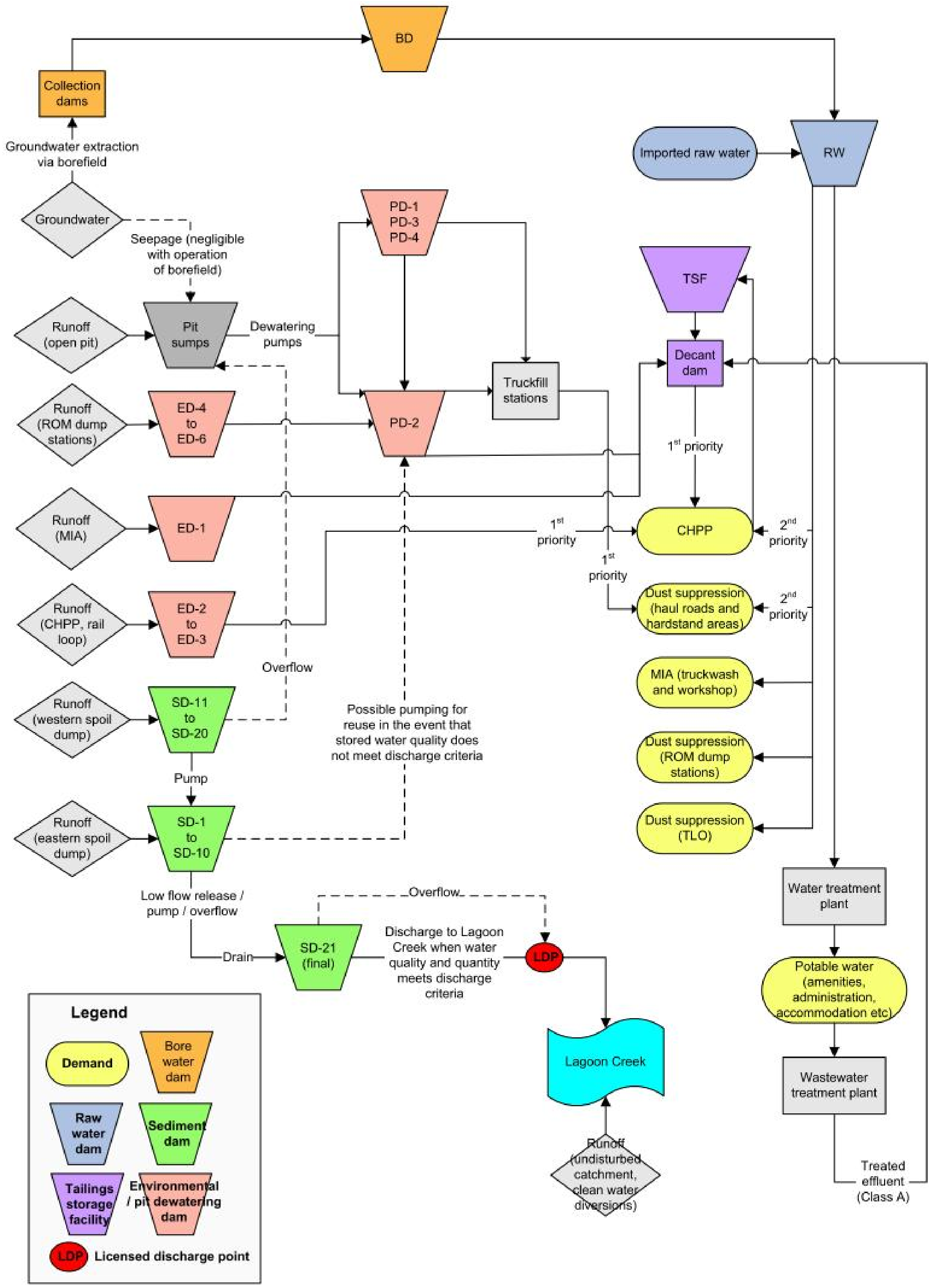
ALPHA COAL PROJECT

Water Management System Concept - Year 30

Figure 4-6: Schematic of overall water management system concept



4.6 Erosion and sediment controls during construction

An Erosion and Sediment Control Plan (ESCP) should be prepared and implemented during the construction of mine infrastructure. The plan should be in accordance with appropriate statutory requirements, including conditions of the Environmental Authority. Controls should be established to a standard consistent with the *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland* (DME, 1995).

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.

5. Site water balance modelling

5.1 Modelling approach

A water balance has been undertaken for the Project's water management system in order to assess the performance of the system, and to estimate annual runoff volumes and identify likely water deficit and surplus. The water balance has also been used to identify possible overflows from sediment dams, environmental dams and pit dewatering dams.

5.1.1 GoldSim model

A water balance model of the Project was developed in GoldSim, a widely used platform for mine site water balance studies. The model was developed for the Year 1, 5, 10, 20 and 30 landforms and was routed for 110 years of climate data based on a daily time step.

The network diagram presented in Figure 4-6 shows the conceptual layout and interconnectivity of storages for the mine site.

5.2 Model assumptions

The water balance model has been developed and refined to a level of detail suitable for concept design and cost estimation of water management infrastructure. Some assumptions and simplifications were incorporated into the model that may limit its applicability for other applications:

- Pump rating curves have not been discretely modelled, and therefore the model does not represent delays that could occur when transporting water around the site.
- Runoff parameters have been selected using experience on other similar projects with limited quantitative data to assess the runoff characteristics of disturbed mine site catchments.
- Tailings disposal system, and the runoff water which would be contained and reused within the tailings return water system, are not included in the water balance model. This report does not assess the risk of overflows from the tailings storage facility or decant dam.
- While the model assesses the performance of the system under historical extremes that may reasonably be expected to reoccur in the future, it does not specifically quantitatively incorporate the impact of future climate change on runoff.
- Borefield extraction rates should be considered provisional only. Groundwater modelling and borefield optimisation will be performed during detailed design and could potentially result in different extraction rates than those presented in Section 5.4.2.
- Evaporation is set to zero on days of rainfall. Whilst this is a conservative approach for assessing dam overflows, it is not a conservative approach for assessing water supply deficits and may underestimate the requirement for water from external sources.

This report presents a conceptual water management system that will be refined and optimised as detailed design proceeds, and the runoff quantity and quality characteristics of the overburden are better understood.

5.3 Model data

5.3.1 Catchments

Catchment boundaries for the water management system were delineated using the conceptual mine plans, and by making reasonable assumptions about the likely destination of runoff.

Catchment boundaries are shown on the conceptual water management system plans provided in Figure 4-1 to Figure 4-5 for the Year 1, 5, 10, 20 and 30 landforms. A summary of catchment areas is provided in Table 5-1. A more detailed breakdown of catchment areas is provided in Appendix B.

Table 5-1: Summary of catchment areas

Structure	Catchment area (ha)				
	Year 1	**Year 5**	**Year 10**	**Year 20**	**Year 30**
Water management system					
ED-1	66	66	66	66	66
ED-2	40	40	40	40	40
ED-3	65	65	65	65	65
ED-4	63	63	63	63	63
ED-5	2	2	2	2	2
ED-6	83	83	83	83	83
SD-1	-	317	325	423	372
SD-2	-	411	454	552	498
SD-3	103	339	483	506	613
SD-4	-	317	436	480	642
SD-5	-	409	249	412	660
SD-6	77	555	368	749	1,139
SD-7	-	382	228	663	906
SD-8	-	175	205	397	518
SD-9	-	320	297	335	674
SD-10	-	247	280	219	600
SD-11	-	-	68	117	324
SD-12	-	-	66	117	340
SD-13	-	-	74	441	607
SD-14	-	-	102	500	836
SD-15	-	-	341	544	701
SD-16	-	-	607	788	1,029
SD-17	-	-	589	731	972
SD-18	-	-	138	218	343
SD-19	-	-	171	429	357
SD-20	-	-	130	450	303
Pit (PW1, PW2, PW3, PW4)	94	4,106	2,227	2,791	2,857
RW	27	27	27	27	27
Sub total	*619*	*7,924*	*8,182*	*12,206*	*15,636*

Structure	Catchment area (ha)				
	Year 1	Year 5	Year 10	Year 20	Year 30
Tailings storage facility and decant dam					
TSF	516	756	756	510	581
Sub total	*516*	*756*	*756*	*510*	*581*
Undisturbed catchment					
Creek system	271,450	263,906	263,647	259,870	256,369
Sub total	*271,450*	*263,906*	*263,647*	*259,870*	*256,369*
Total	**272,586**	**272,586**	**272,586**	**272,586**	**272,586**

Note: Non-water management system bypasses site storages.

Table 5-1 shows that the pit catchment is largest in Year 5 of the Project (of the snapshot landforms modelled). This is because the western natural catchment, between the first progressive diversion drain and the pit boundary, drains into the pit. To reduce this catchment area, additional progressive diversion drains would be required. This will be investigated during detailed design.

The area draining to the water management system increases steadily over the life of the Project, as the pits and spoil dump expands. The change in landuse breakdown within the water management system catchment is summarised in Table 5-2.

Table 5-2: Change in landuse for the surface water management catchment

Landuse	Area (ha)				
	Year 1	Year 5	Year 10	Year 20	Year 30
Undisturbed	47	4,153	1,544	1,905	1,779
Rehabilitated spoil	0	114	297	3,222	5,618
Industrial / hardstand	318	318	318	318	318
Open pit	92	696	789	909	980
Unrehabilitated spoil	135	2,616	5,207	5,823	6,913
Raw water dam	27	27	27	27	27
Total	**619**	**7,924**	**8,182**	**12,206**	**15,636**

Note: Table only includes areas that drain to the surface water management system storages.

The contributing catchment inflow was modelled for each storage in the water balance model by summing the products of unit runoff depth time-series (derived using the rainfall-runoff models) and the corresponding partial catchment areas.

5.3.2 Dam sizes

Sediment dam capacities adopted in the water balance model are summarised in Table 5-3. Capacities are based on the criteria for discharge of uncontaminated runoff to sensitive receiving waters (refer to Section 2.2), with an allowance for sediment and reuse water storage.

Table 5-3: Sediment dam capacities

Structure	Maximum catchment area (ha)	Capacity (ML)			
		Settling zone	Sediment zone	Reuse zone	Total
SD-1	423	268	54	54	376
SD-2	552	350	70	70	490
SD-3	613	389	78	78	544
SD-4	642	407	81	81	570
SD-5	660	418	84	84	586
SD-6	1,139	722	144	144	1,011
SD-7	906	575	115	115	804
SD-8	518	329	66	66	460
SD-9	674	427	85	85	598
SD-10	600	380	76	76	532
SD-11	324	205	41	41	288
SD-12	340	216	43	43	302
SD-13	607	385	77	77	539
SD-14	836	530	106	106	742
SD-15	701	444	89	89	622
SD-16	1,029	653	131	131	914
SD-17	972	616	123	123	862
SD-18	343	218	44	44	305
SD-19	429	272	54	54	380
SD-20	450	285	57	57	400

A nominal capacity of 100ML has been adopted for the final sediment dam SD-21.

It may be possible to reduce the size of individual dams by providing the required storage volume in multiple dams. This will be investigated during detailed design.

Environmental dam capacities adopted in the water balance model are summarised in Table 5-4. Environmental dam capacities were sized for the 2% AEP 3-month critical wet period rainfall (criteria for discharge of sub-lethal wastes with significant riparian users, sensitive ecology or contamination of groundwater resource - refer to Section 2.2). For comparison purposes, estimated runoff volumes for various design storm events are also provided in Table 5-4.

Table 5-4: Environmental / pit dewatering dam capacities

Dam	Maximum catchment area (ha)	Capacity (ML)			
		Adopted volume	10% AEP 24-hour (R = 127mm)	2% AEP 72-hour (R = 256mm)	2% AEP 3-month (R = 751mm)
ED-1	66	492	83	168	492
ED-2	40	302	51	103	302
ED-3	65	487	82	166	487
ED-4	63	471	80	161	471
ED-5	2	18	3	6	18
ED-6	83	620	105	212	620
PW-1	-	750	-	-	-
PW-2	-	1,250	-	-	-
PW-3	-	750	-	-	-
PW-4	-	750	-	-	-

Note: Excludes sediment storage

Pit dewatering dams (PW-1, PW-2, PW-3 and PW-4) will have a 'turkeys nest' configuration, and have minimal catchment area receiving mainly pumped inflows from the pit sumps. Pit dewatering dams have therefore been sized based on the results of historical water balance modelling, to achieve no discharge and to provide a reasonable level of pit dewatering when operated as part of the overall water management system over the 110-year simulation. Pit dewatering dam capacities adopted in the water balance model are summarised in Table 5-4.

No limit has been applied in the water balance model on the volume of in-pit sump storage.

Stage-storage relationships for dams were included in the water balance model and were estimated based on an assumed depth of 5.5 m and side slopes of 1:3 (V:H). This assumption will be refined at the detailed design stage, once the final configuration of site dams is established.

5.3.3 Pump rates

The following pump rates were adopted in the water balance model:

- pit sump to pit dewatering dam – 25.9 ML/day each (300 L/s)
- environmental dam / pit dewatering dam to PW2 – 25.9 ML/day each (300 L/s)
- western sediment dams to eastern sediment dams – 25.9 ML/day each (300 L/s)
- low flow outlets of eastern sediment dams – sized to empty 'settling zone' over 10 days (various sizes).

For water balance modelling purposes, it has been assumed that bore water will be pumped to the raw water dam at a rate equal to the daily extraction rate from the aquifer.

5.3.4 Operating rules

Operating rules would be subject to ongoing development and refinement. The following operating rules have been assumed for water balance modelling:

- Pumping from pit sumps to PW1, PW3 and PW4 stops if the dam capacity exceeds 75%. Pumping from pit sumps to PW2 stops if the dam capacity exceeds 50% (trigger level set lower for PW2 to ensure adequate capacity is available to receive pumped inflows from environmental dams). During extended wet periods, water will be stored in the mine pits once pit dewatering dams have reached their capacity.

- Pumping from ED4, ED5, ED6, PW1, PW3 and PW4 to PW2 occurs when the capacity of these dams exceeds 25.9ML (maximum daily pump rate). Pumping stops if the volume of PW2 exceeds 75%.

- Pumping from the western sediment dams to the eastern sediment dams occurs when the water level reaches the 'settling zone'. Pumping can continue if the eastern sediment dams are overflowing to SD-21.

- The 'sediment zone' of both environmental and sediment dams is 100% full throughout the simulation.

- Sediment dam overflows are included in the model. The western sediment dams overflow to the pit. The eastern sediment dams all overflow to the final sediment dam, which overflows to Lagoon Creek.

- Water captured above the 'settling zone' in sediment dams is released to the creek, along with overflows. Sediment dam low flow outlets are assumed to be open throughout the duration of the simulation. Onsite reuse of water captured in sediment dams has not been included in the water balance model.

- Demands for the truck fill stations are sourced from pit dewatering dams (PW1, PW2, PW3 and PW4). The truck fill station demand has been divided evenly between these four dams. If adequate water is not available from a pit dewatering dam, the raw water dam is used to satisfy the demand.

- The CHPP demand is sourced from the following dams (in order of priority):

  1. Environmental dams located east of the main haul road (ED1, ED2 and ED3). Water is sourced from the dam with the highest stage. In reality, ED3 will pump to the tailings decant dam, and the CHPP would source water directly from the decant dam rather than PW2.

  2. The main pit dewatering dam (PW2). In reality, PW2 will pump to the tailings decant dam, and the CHPP would source water directly from the tailings decent dam rather than PW2.

  3. Raw water dam.

  It has been assumed that water pumped from PW2 to the tailings decant dam will be transferred onto the CHPP immediately (i.e. within the daily time step of the water balance model). Water will only be pumped from PW2 to the decant dam when it is required in the CHPP. For this reason, the decant dam has not been modelled.

- The MIA, sprayer and potable water demands are always sourced from the raw water dam (as high quality water is required).

- The pit sumps have been lumped in the water balance model.

- The pump rates provided in Section 5.3.3 have been adopted in the water balance model. It has been assumed these rates would not be limited by pump/pipeline capacity.
- An average daily dust suppression demand has been applied in the water balance model irrespective of rainfall.
- When the raw water dam falls below 50%, imported water is pumped into the dam. No limit has been applied in the model on the volume of imported water available to the site.

The current model includes only the above basic operating rules (suitable for concept design), however, it is recommended that these are refined once new groundwater and geochemistry data becomes available. This would allow water quality to be modelled, improve the reliability of water quality prediction, and maintain storages with spare capacity to contain storm events (for turbidity control). Operating rules should be developed to manage competing interests, including water retention to use around the site, water retention for dilution, and maintaining spare capacity to contain storm events.

5.4 Water inputs

Water inputs for the Project comprise:

- surface water runoff
- groundwater (either extracted from the dewatering borefield or from seepage into the mining void)
- imported water.

5.4.1 Surface water runoff

Outputs results from the rainfall-runoff models were used as input to the water balance model. Rainfall-runoff models are described in Section 3.3.

5.4.2 Groundwater

Groundwater will be extracted using a borefield in order to minimise seepage into the mine pits. Extracted groundwater would be discharged to several bore water collection dams, which would transfer water to a larger central collection dam, and then onto the raw water dam for onsite reuse.

Preliminary borefield extraction rates were estimated, and are further discussed in the Groundwater Technical Report in Volume 5, Appendix G. Estimates for the 'low to average aquifer transmissivity case' are provided in Table 5-5.

Table 5-5: Estimated borefield extraction rates

Year	Extraction rate (ML/yr)
Year 1	1,577
Year 5	1,261
Year 10	946
Year 20	631
Year 30	631

It has been assumed that seepage into the pit would be negligible with the operation of the borefield.

Borefield extraction rates will be refined following further groundwater investigations. The effect of experiencing larger than expected extraction rates would be an increase to the borefield system capacity and a decrease in imported water required to meet demands during a water deficit.

5.4.3 Imported water

Raw water will be imported to the mine site to meet demands during a water deficit, and also to provide a high quality water source (e.g. potable applications, workshop, vehicle wash, sprayers). Imported water will be stored in the raw water dam.

Various water supply options have been identified by HPPL, with the following water supply options, listed in order of preference:

1. Gorge Weir below Burdekin Falls Dam
2. Burdekin Falls Dam
3. Connors River Dam
4. Bowen Basin coal seam gas water
5. Surat Basin coal seam gas water.

The above options will be investigated further by HPPL and do not form part of the scope of this technical report. If untreated coal seam gas water is to be supplied, appropriate controls would be required.

5.5 Water demands

Mine water demands for the Project comprise:

- CHPP make-up water
- Haul road and hardstand watering (dust suppression)
- Workshop and vehicle wash (MIA)
- Potable water
- Miscellaneous uses, such as construction water.

5.5.1 Coal handling and preparation plant

CHPP make-up water requirements, net of tailings return water, are provided in Table 5-6. Coal processing rates are also provided.

Table 5-6: CHPP make-up water demand estimates

Year	ROM coal processed (Mt/yr)	CHPP make-up water (ML/yr)
Year 1	26.5	4,981
Year 5	43.2	8,111
Year 10	43.2	8,111
Year 20	43.2	8,111
Year 30	43.2	8,111

Make-up water for the CHPP will be sourced from contaminated water as a priority. It is understood that contaminated water will be of a suitable quality for this purpose.

The tailings management system has been excluded from the water balance model, as the CHPP make-up demand is net of tailings return water.

5.5.2 Haul road and hardstand watering

Mine water will be used for dust suppression on haul roads, hardstand areas and the ROM dump and transfer station sprayers. A summary of the dust suppression demands is provided in Table 5-7.

Table 5-7: Dust suppression demand estimates

Year	Haul road and hardstand (ML/yr)	ROM dump and transfer station sprayers (ML/yr)	Total dust suppression demand (ML/yr)
Year 1	1,747	205	1,952
Year 5	1,996	205	2,201
Year 10	2,307	205	2,512
Year 20	2,929	205	3,134
Year 30	3,552	205	3,757

Water for dust suppression of haul road and hardstand areas will be sourced from pit dewatering dams as a priority (via truck fill stations). It is understood that contaminated water will be of suitable quality for this purpose.

Water for dust suppression of the ROM dump and transfer stations will be sourced from the raw water dam, as contaminated water is not suitable for use in the sprayers.

The water balance analysis assumed that dust suppression water will be applied evenly throughout the year (irrespective of rainfall depth).

5.5.3 Workshop and vehicle wash

Water will be required in the MIA for use in the vehicle wash and workshop. A summary of the MIA demands is provided in Table 5-8.

Table 5-8: MIA demand estimates

Year	MIA demand (ML/yr)
Year 1	240
Year 5	391
Year 10	391
Year 20	391
Year 30	391

Water for the MIA will be sourced from the raw water dam, as contaminated water is not suitable for this use.

5.5.4 Potable water

Potable water is required in the administration building, amenities and accommodation village. A summary of the potable water demands is provided in Table 5-9.

Table 5-9: Potable water demand estimates

Year	Potable water demand (ML/yr)
Year 1	210
Year 5	167
Year 10	140
Year 20	144
Year 30	154

Imported water to the site will be used for potable applications (refer to Section 5.4.3). Imported water and bore water will be stored in the raw water dam, and would be treated in an onsite potable water treatment plant prior to use for potable applications. Wastewater will be treated onsite in a packaged wastewater treatment plant. Treated effluent (Class A) will be discharged to the tailings decant dam.

Potable water has been included in the water balance, however, treated effluent has not been included as volumes are not expected to be significant when compared to other inputs to the system.

5.5.5 Demand summary

A summary of the water demands is provided in Table 5-10. The demand increases over the life of the Project, with the peak occurring in Year 30.

Table 5-10: Water demand summary

Year	CHPP make-up water (ML/yr)	Dust suppression (ML/yr)	MIA demand (ML/yr)	Potable water demand (ML/yr)	Total site demand (ML/yr)
Year 1	4,981	1,952	240	210	7,383
Year 5	8,111	2,201	391	167	10,870
Year 10	8,111	2,512	391	140	11,154
Year 20	8,111	3,134	391	144	11,780
Year 30	8,111	3,757	391	154	12,413

5.6 Other losses

5.6.1 Evaporation

Evaporation estimates were based on Data Drill sourced evaporation data. A ‘pan factor’ correction was applied to account for the difference between measured ‘pan evaporation’ and evaporation that occurs from an open water body. Pan evaporation is measured in a small dish that takes extra heat in through the sides of the pan and tends to overestimate lake evaporation. Evaporation rates from large water bodies are also diminished by the accumulation of humidity above the water surface (amongst other factors). A pan factor of 0.83 was adopted for this assessment based on consideration of the spread of values presented in the Technical Guidelines (1995).

DERM requires that evaporation is arbitrarily set to 0 mm on days of rainfall, and has been applied to the model. This is considered an extremely conservative approach for assessing dam overflows, however, this requirement has been applied on other recent projects at the request of DERM and is therefore assumed to apply to the Alpha Coal Project.

Evaporative surface area has been determined based on the stage-storage relationships presented in Section 5.3.2.

5.6.2 Seepage from dams

Some water will be lost from dams as a result of seepage through the foundation. Site dams should have low seepage losses and, depending on the subsoils, an engineered liner may be required. Water balance modelling has assumed seepage losses to be negligible.

5.7 Results

Model results are summarised in Table 5-11, Table 5-12 and Table 5-13. The tables provide results for 10th percentile (dry), 50th percentile (median) and 90th percentile (wet) rainfall years based on 110 years of water balance simulation. Calender years 1931, 1944 and 2008 have been adopted as representative dry, median and wet rainfall years respectively. The apparent imbalance in the results tables is a result of carry over storage being available to satisfy demands between the various calendar years of the model simulation.

Results in Table 5-11, Table 5-12 and Table 5-13 are for the base case. For the base case, it is assumed that overburden runoff will be uncontaminated (with elevated suspended solids only). Water stored in the final sediment dam will be discharged to Lagoon Creek when water quality discharge criteria has been met.

Table 5-11: Annual site water balance - 10th percentile dry year

		Baseline	Year 1	Year 5	Year 10	Year 20	Year 30
Catchment area							
WMS	Ha	-	619	7,924	8,182	12,206	15,636
TSF	Ha	-	516	756	756	510	581
Undisturbed catchment	Ha	272,585	271,450	263,906	263,647	259,870	256,369
Total catchment	***Ha***	**272,585**	**272,586**	**272,586**	**272,586**	**272,586**	**272,586**
Proportion of catchment in WMS and TSF		0%	0.4%	3.2%	3.3%	4.7%	5.9%
WMS Runoff							
Natural	ML/yr	-	3	270	101	124	116
Open pit	ML/yr	-	10	79	89	103	111
Industrial	ML/yr	-	48	48	48	48	48
Spoil	ML/yr	-	0	0	0	0	0
Rehabilitated	ML/yr	-	0	7	19	210	353
Total WMS runoff	***ML/yr***	**-**	**62**	**405**	**258**	**485**	**628**
Undisturbed catchment	ML/yr	17,739	17,666	17,175	17,158	16,912	16,684
Inflows to WMS							
Borefield	ML/yr	-	1,577	1,261	946	631	631
Imported water	ML/yr	-	6,022	9,479	10,412	11,111	11,772
Outflows from WMS							
Dam evaporation (net of rain)	ML/yr	-	297	432	389	456	512
Demand	ML/yr	-	7,383	10,870	11,154	11,780	12,413
Sediment dam release (offsite)	ML/yr	-	12	38	41	177	292

Notes: Excludes tailings management system

Table 5-12: Annual site water balance - 50th percentile median year

		Baseline	Year 1	Year 5	Year 10	Year 20	Year 30
Catchment area							
WMS	Ha	-	619	7,924	8,182	12,206	15,636
TSF	Ha	-	516	756	756	510	581
Undisturbed catchment	Ha	272,585	271,450	263,906	263,647	259,870	256,369
Total catchment	***Ha***	**272,585**	**272,586**	**272,586**	**272,586**	**272,586**	**272,586**
Proportion of catchment in WMS and TSF		0%	0.4%	3.2%	3.3%	4.7%	5.9%
WMS Runoff							
Natural	ML/yr	-	5	442	164	203	190
Open pit	ML/yr	-	44	330	374	431	464
Industrial	ML/yr	-	317	317	317	317	317
Spoil	ML/yr	-	8	151	301	337	400
Rehabilitated	ML/yr	-	0	12	32	343	578
Total WMS runoff	***ML/yr***	***-***	***373***	***1,252***	***1,188***	***1,630***	***1,948***
Undisturbed catchment	ML/yr	29,029	28,908	28,105	28,078	27,675	27,303
Inflows to WMS							
Borefield	ML/yr	-	1,577	1,261	946	631	631
Imported water	ML/yr	-	5,633	8,819	9,557	10,451	11,033
Outflows from WMS							
Dam evaporation (net of rain)	ML/yr	-	85	115	0	37	111
Demand	ML/yr	-	7,383	10,870	11,154	11,780	12,413
Sediment dam release (offsite)	ML/yr	-	53	352	588	850	1,081

Notes: Excludes tailings management system

Table 5-13: Annual site water balance - 90th percentile wet year

		Baseline	Year 1	Year 5	Year 10	Year 20	Year 30
Catchment area							
WMS	Ha	-	619	7,924	8,182	12,206	15,636
TSF	Ha	-	516	756	756	510	581
Undisturbed catchment	Ha	272,585	271,450	263,906	263,647	259,870	256,369
Total catchment	***Ha***	**272,585**	**272,586**	**272,586**	**272,586**	**272,586**	**272,586**
Proportion of catchment in WMS and TSF		0%	0.4%	3.2%	3.3%	4.7%	5.9%
WMS Runoff							
Natural	ML/yr	-	32	2,796	1,040	1,282	1,198
Open pit	ML/yr	-	222	1,680	1,904	2,194	2,365
Industrial	ML/yr	-	1,079	1,079	1,079	1,079	1,079
Spoil	ML/yr	-	90	1,750	3,482	3,894	4,623
Rehabilitated	ML/yr	-	0	76	200	2,169	3,652
Total WMS runoff	***ML/yr***	**-**	**1,423**	**7,381**	**7,705**	**10,619**	**12,917**
Undisturbed catchment	ML/yr	183,481	182,718	177,640	177,466	174,923	172,566
Inflows to WMS							
Borefield	ML/yr	-	1,577	1,261	946	631	631
Imported water	ML/yr	-	4,274	4,429	6,255	6,333	6,915
Outflows from WMS							
Dam evaporation (net of rain)	ML/yr	-	0	54	0	0	0
Demand	ML/yr	-	7,383	10,870	11,154	11,780	12,413
Sediment dam release (offsite)	ML/yr	-	221	2,636	4,311	6,582	8,664

Notes: Excludes tailings management system

5.7.1 Sensitivity analysis – high runoff scenario

The results of the site water balance for the high runoff scenario are summarised in Table 5-14 for the Year 30 landform, when the water management system catchment is largest. The table provides results for a 90th percentile (wet) rainfall year based on 110 years of water balance simulation. Parameters used in the high runoff scenario are discussed in Section 3.5.3.

Table 5-14: Annual site water balance for Year 30 landform - high runoff scenario - 90th percentile wet year

		Base case	High runoff scenario
		Year 30	**Year 30**
WMS Runoff			
Natural	ML/yr	1,198	1,198
Open pit	ML/yr	2,365	3,528
Industrial	ML/yr	1,079	1,079
Spoil	ML/yr	4,623	10,319
Rehabilitated	ML/yr	3,652	3,652
Total WMS runoff	***ML/yr***	**12,917**	**19,777**
Undisturbed catchment	ML/yr	172,566	172,566
Inflows to WMS			
Borefield	ML/yr	631	631
Imported water	ML/yr	6,915	4,002
Outflows from WMS			
Dam evaporation (net of rain)	ML/yr	0	0
Demand	ML/yr	12,413	12,413
Sediment dam release (offsite)	ML/yr	8,664	12,941

Notes: Excludes tailings management system

Table 5-14 shows that the release of water from sediment dams to the creek system increases to 35.4 ML/d (12,941 ML/yr) for a wet year for the Year 30 landform under the high runoff scenario. The demand for imported water decreases to 11.0 ML/d (4,002 ML/yr) for a wet year for the Year 30 landform under the high runoff scenario. The pit dewatering and environmental dams perform satisfactorily and do not overflow over the 110 year water balance simulation. However, the volume of water stored in-pit during extended wet periods would increase and may interrupt mining activities.

The volume of water stored in site dams will be monitored during the Project. This data, along with data from the meteorological monitoring station, will provide information on likely runoff rates from the site. In the event that runoff rates are higher than anticipated, out-of-pit storages would need to be upsized to allow for increased pit dewatering.

5.7.2 Sensitivity analysis – reuse overburden runoff scenario

As described in Section 2.3.1, it is likely that runoff from the overburden dump would be considered uncontaminated, with elevated suspended solids concentrations only. However, in the event that overburden runoff has elevated salinity and/or heavy metals, water captured in sediment dams would be reused onsite to minimise discharge to the creek system.

A second operational scenario has been developed to assess the impact of reusing water captured in sediment dams onsite. In this scenario, sediment dam outlets are assumed to be closed throughout the water balance model simulation and captured water is pumped to PW-2 for onsite reuse. All other operational rules remain unchanged. The capacities of environmental dams and pit dewatering dams remain unchanged, and the additional water would be accommodated by reducing the rate of pit dewatering.

The results of the site water balance for the reuse of overburden runoff scenario are summarised in Table 5-15, Table 5-16 and Table 5-17. The tables provide results for 10th percentile (dry), 50th percentile (median) and 90th percentile (wet) rainfall years based on 110 years of water balance simulation. Note that the rainfall-runoff parameters adopted in this scenario are the same as those adopted for the base case.

Table 5-15: Annual site water balance - reuse overburden runoff scenario - 10th percentile dry year

		Baseline	Year 1	Year 5	Year 10	Year 20	Year 30
Catchment area							
WMS	Ha	-	619	7,924	8,182	12,206	15,636
TSF	Ha	-	516	756	756	510	581
Undisturbed catchment	Ha	272,585	271,450	263,906	263,647	259,870	256,369
Total catchment	***Ha***	**272,585**	**272,586**	**272,586**	**272,586**	**272,586**	**272,586**
Proportion of catchment in WMS and TSF		0%	0.4%	3.2%	3.3%	4.7%	5.9%
WMS Runoff							
Natural	ML/yr	-	3	270	101	124	116
Open pit	ML/yr	-	10	79	89	103	111
Industrial	ML/yr	-	48	48	48	48	48
Spoil	ML/yr	-	0	0	0	0	0
Rehabilitated	ML/yr	-	0	7	19	210	353
Total WMS runoff	***ML/yr***	**-**	**62**	**405**	**258**	**485**	**628**
Undisturbed catchment	ML/yr	17,739	17,666	17,175	17,158	16,912	16,684
Inflows to WMS							
Borefield	ML/yr	-	1,577	1,261	946	631	631
Imported water	ML/yr	-	6,022	9,479	10,412	11,150	11,694
Outflows from WMS							
Dam evaporation (net of rain)	ML/yr	-	308	470	431	626	764
Demand	ML/yr	-	7,383	10,870	11,154	11,780	12,413
Sediment dam release (offsite)	ML/yr	-	0	0	0	0	0

Notes: Excludes tailings management system

Table 5-16: Annual site water balance - reuse overburden runoff scenario - 50th percentile median year

		Baseline	Year 1	Year 5	Year 10	Year 20	Year 30
Catchment area							
WMS	Ha	-	619	7,924	8,182	12,206	15,636
TSF	Ha	-	516	756	756	510	581
Undisturbed catchment	Ha	272,585	271,450	263,906	263,647	259,870	256,369
Total catchment	***Ha***	**272,585**	**272,586**	**272,586**	**272,586**	**272,586**	**272,586**
Proportion of catchment in WMS and TSF		0%	0.4%	3.2%	3.3%	4.7%	5.9%
WMS Runoff							
Natural	ML/yr	-	5	442	164	203	190
Open pit	ML/yr	-	44	330	374	431	464
Industrial	ML/yr	-	317	317	317	317	317
Spoil	ML/yr	-	8	151	301	337	400
Rehabilitated	ML/yr	-	0	12	32	343	578
Total WMS runoff	***ML/yr***	**-**	***373***	***1,252***	***1,188***	***1,630***	***1,948***
Undisturbed catchment	ML/yr	29,029	28,908	28,105	28,078	27,675	27,303
Inflows to WMS							
Borefield	ML/yr	-	1,577	1,261	946	631	631
Imported water	ML/yr	-	5,633	8,664	9,207	10,062	10,490
Outflows from WMS							
Dam evaporation (net of rain)	ML/yr	-	110	228	0	325	450
Demand	ML/yr	-	7,383	10,870	11,154	11,780	12,413
Sediment dam release (offsite)	ML/yr	-	0	0	0	0	0

Notes: Excludes tailings management system

Table 5-17: Annual site water balance - reuse overburden runoff scenario - 90th percentile wet year

		Baseline	Year 1	Year 5	Year 10	Year 20	Year 30
Catchment area							
WMS	Ha	-	619	7,924	8,182	12,206	15,636
TSF	Ha	-	516	756	756	510	581
Undisturbed catchment	Ha	272,585	271,450	263,906	263,647	259,870	256,369
Total catchment	***Ha***	**272,585**	**272,586**	**272,586**	**272,586**	**272,586**	**272,586**
Proportion of catchment in WMS and TSF		0%	0.4%	3.2%	3.3%	4.7%	5.9%
WMS Runoff							
Natural	ML/yr	-	32	2,796	1,040	1,282	1,198
Open pit	ML/yr	-	222	1,680	1,904	2,194	2,365
Industrial	ML/yr	-	1,079	1,079	1,079	1,079	1,079
Spoil	ML/yr	-	90	1,750	3,482	3,894	4,623
Rehabilitated	ML/yr	-	0	76	200	2,169	3,652
Total WMS runoff	***ML/yr***	**-**	**1,423**	**7,381**	**7,705**	**10,619**	**12,917**
Undisturbed catchment	ML/yr	183,481	182,718	177,640	177,466	174,923	172,566
Inflows to WMS							
Borefield	ML/yr	-	1,577	1,261	946	631	631
Imported water	ML/yr	-	4,079	2,525	2,875	1,321	1,321
Outflows from WMS							
Dam evaporation (net of rain)	ML/yr	-	0	812	0	0	0
Demand	ML/yr	-	7,383	10,870	11,154	11,780	12,413
Sediment dam release (offsite)	ML/yr	-	0	0	0	0	0

Notes: Excludes tailings management system

From Table 5-17 it can be seen that for a wet year, there is no overflow from sediment dams for the scenario when overburden runoff is reused onsite and sediment dam outlet pipes remain closed. The 'reuse zone' and 'settling zone' of sediment dams are adequate to store this additional water. The site remains in an annual water deficit, and the additional water is reused onsite within a reasonably short period time.

The water balance predicted that overflows from sediment dams to the creek system would occur for extremely wet years (i.e. > 90th percentile rainfall years). However, it is expected that Lagoon Creek would experience high flows during these periods, and that any overflows from the final sediment dam would be well diluted. Water quality impacts to Lagoon Creek are therefore expected to be insignificant. The water balance did not predict any overflows from pit dewatering or environmental dams over the 110 year water balance simulation.

Comparison with the base case indicates that imported water requirements are lower when overburden runoff is reused onsite, as expected. The reduction is much more significant for a wet year than a dry year, as there is limited overburden runoff that could be reused onsite during a dry year. The onsite reuse of overburden runoff is therefore not expected to impact the design of the raw water supply system, which must provide security of supply during prolonged dry periods.

6. Potential impacts and mitigation measures

6.1 Site water demand

The water balance results indicate there will be a water deficit throughout the life of the Project, and that imported water will be required to make-up the deficit. External water supply options for the Project are outlined in Section 5.4.3.

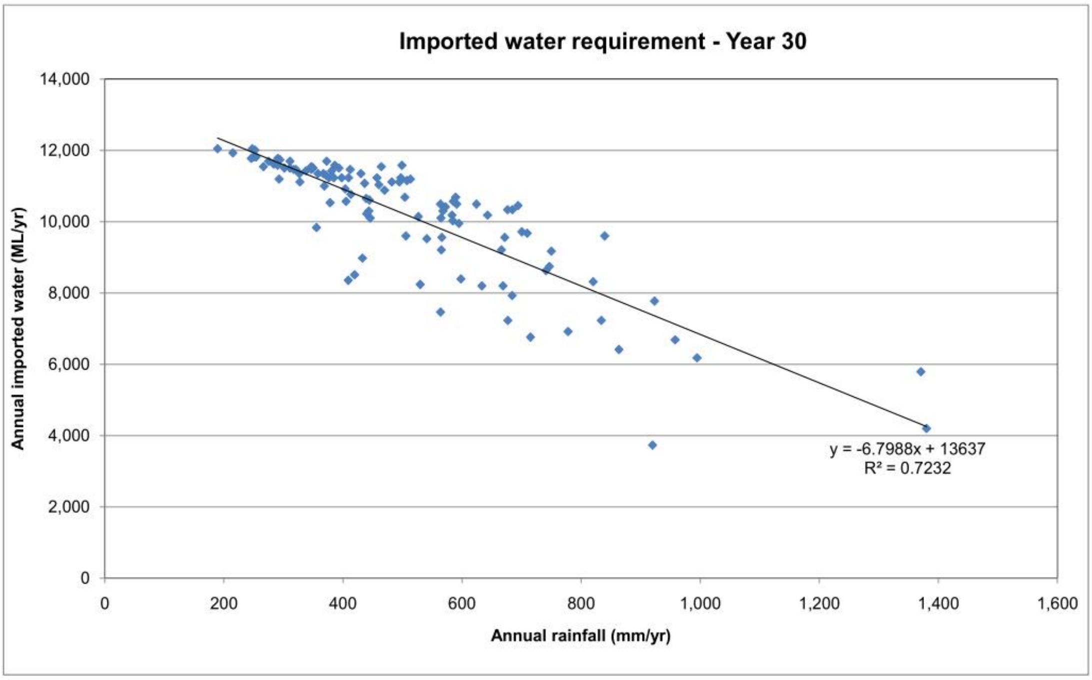
The requirement for imported water during a representative 10th percentile (dry) year is summarised in Table 6-1.

Table 6-1: Imported water requirement for a dry year

Year	Imported water (ML/yr)
Year 1	6,022
Year 5	9,479
Year 10	10,412
Year 20	11,111
Year 30	11,772

The requirement for imported water is greatest in Year 30, when demands are highest. A plot of annual imported water requirement versus annual rainfall depth is provided in Figure 6-1 for Year 30. Plots for Years 1, 5, 10 and 20 are given in Appendix C.

Figure 6-1: Annual imported water requirement over the 110 year water balance simulation for Year 30



The plot in Figure 6-1 shows that the maximum annual requirement for imported water was 12,044 ML/yr for the Year 30 landform, over the 110 year water balance simulation using historical rainfall and evaporation data. This occurred under prolonged dry conditions, when a year with approximately 252 mm/yr rainfall was preceded by a year with approximately 290mm/yr rainfall. The data scatter on the plot may be attributed to the inter-relationship of the annual volume of available water to the distribution of rainfall throughout the year, total rainfall, soil wetness/ dryness and carry over storage.

Note that a moderate volume of imported water is required for demands that need high quality water such as potable applications, workshop, vehicle wash, sprayers, irrespective of the mine water balance. Whilst treated bore water is of suitable quality for these applications, it is not of sufficient quantity to meet demands during the later years of the Project when borefield extraction rates are lowest and demands highest.

6.2 Wet weather impacts on mining

Small water volumes will be able to be stored in in-pit sumps without interruption to mining activities. However, during extended wet periods, with standard capacity dewatering systems, relatively large volumes of water will accumulate in-pit and may interrupt mining activities.

The maximum in-pit storage volumes (combined pit sumps) over the 110 year water balance simulation are provided in Table 6-2.

Table 6-2: Maximum in-pit storage volumes

Year	Maximum volume (ML/yr)
Year 1	203
Year 5	4,307
Year 10	2,367
Year 20	3,316
Year 30	3,588

The frequency of in-pit flooding over the 110 year water balance simulation for Year 5 of the Project, when the pit catchment is greatest, is illustrated by the plots provided in Figure 6-2 and Figure 6-3.

Figure 6-2: Frequency of in-pit flooding over the 110 year water balance simulation for Year 5

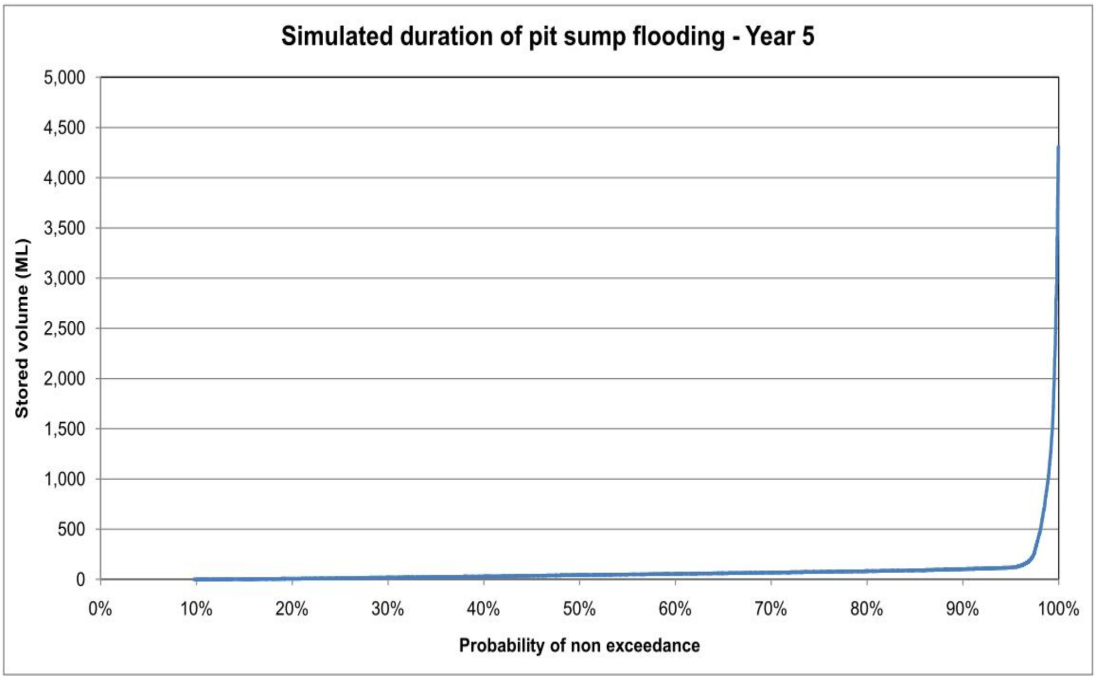
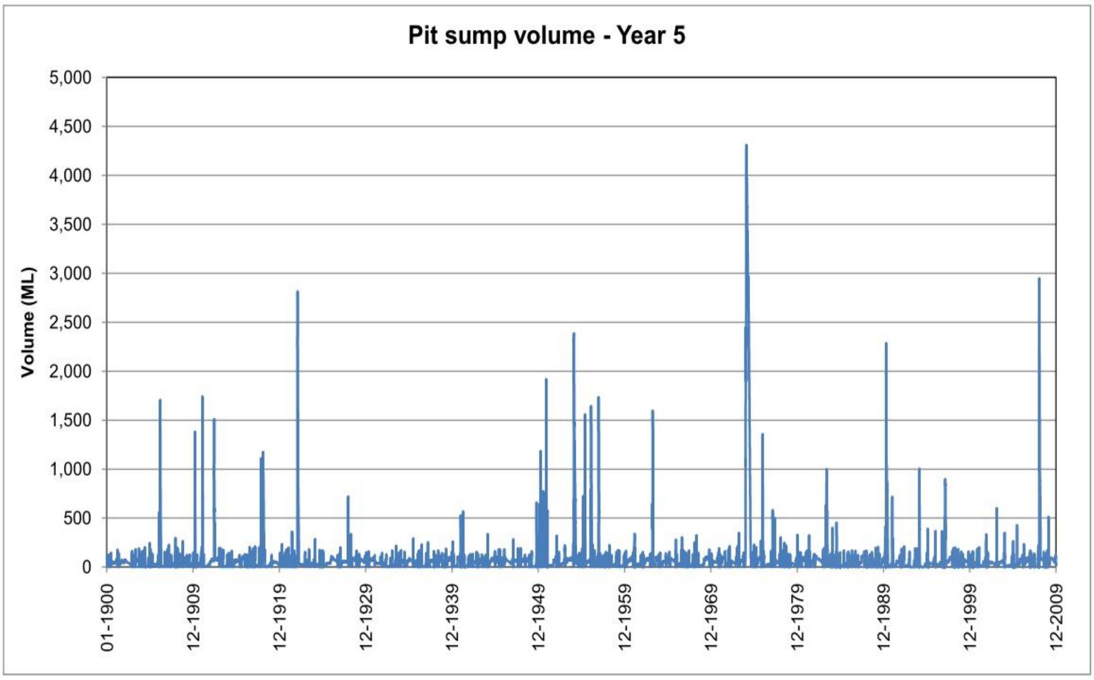


Figure 6-3: In-pit flooding over the 110 year water balance simulation for Year 5



The pit dewatering dam sizes have been chosen to provide a reasonable level of pit availability over the 110 year water balance simulation. The plots in Figure 6-2 and Figure 6-3 show that the pit dewatering system will generally be able to maintain dry pits, but during extended wet periods, mining may be interrupted by in-pit flooding. Large volumes of water are only stored in-pit infrequently and negligible water (less than 102ML) is stored in-pit for 90% of the time.

During extended wet periods, the rate of pit dewatering exceeds the rate at which water is reused onsite and dewatering ceases because pit dewatering dams are full. During these periods, water storage will be provided in inactive areas of the pits when mining is focused on active pit areas. This would allow dewatering of rainfall runoff from active pit areas to continue during wet periods, and would minimise interruptions to mining. Appropriate locations for in-pit storage will be identified during detailed design.

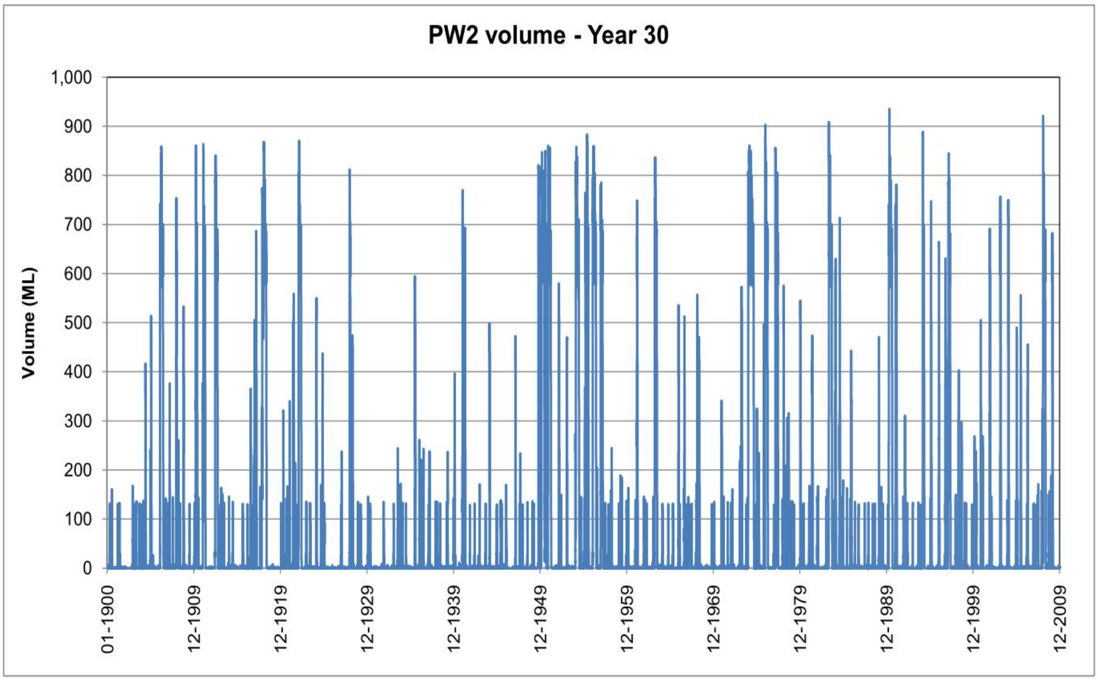
6.3 Dam performance

Environmental and pit dewatering dams have been sized to achieve no discharge when operated as part of the overall water management system under historical climate conditions, as determined through water balance modelling.

Pumping to pit dewatering dams from the pit will cease when a maximum operating level is achieved (refer to Section 5.3.4 for assumed operating rules). This will maintain adequate freeboard in these dams, so that small runoff events from the local catchment will not cause the dams to overflow following extended periods of pit dewatering.

The performance of the main pit dewatering dam, PW2, is shown in Figure 6-4 for the Year 30 landform. PW2 receives dewatering from the pit sumps, as well as pumped from environmental dams (ED4 to ED6) and pit dewatering dams (PW1, PW3 and PW4). PW2 has a capacity of 1,250 ML. The performance of other environmental dams is illustrated by the plots given in Appendix C.

Figure 6-4: Volume stored in PW2 over the 110 year water balance simulation for Year 30



The water balance results showed that none of the proposed environmental or pit dewatering dams overflow during the 110 year model simulation. As such, there is not expected to be any uncontrolled discharge of contaminated water from the sites water management system. Contaminated runoff will be reused onsite in the mining process. As discussed in Section 6.2, storage will be provided in-pit during extended wet periods, until pit dewatering dams have capacity to receive dewatering.

Although environmental dams are not expected to overflow, spillways should be provided for these dams in the event that there is an emergency. Spillways from environmental dams east of the haul road (ED1 to ED3) will discharge to Lagoon Creek. Spillways from the pit dewatering dams (PW1 to PW4) and environmental dams west of the haul road (ED4 to ED6) would discharge to the overflow drain. The overflow drain discharges to SD21, and then Lagoon Creek.

As stated previously the operational rules incorporated into the model are limited, and further refinement should be undertaken once water quality objectives have been finalised, and geochemistry and groundwater data is updated. Refinements to operational rules are likely to affect the frequency of storage volumes, but should have less effect on the overflow discharges.

6.4 Impacts on downstream flow

The water management system has been designed to maintain flows in the creek system, as much as practical. However, the evaporation and use of water captured in the site water management system results in a reduction in the volume of runoff to the creek system.

Predicted median annual flows in Lagoon Creek at the study catchment outlet are provided in Table 6-3, based on the 110-year water balance simulation. The study catchment outlet is located approximately 3.5 km downstream of the MLA boundary.

Table 6-3: Median annual flow in Lagoon Creek at study catchment outlet

		Baseline	Year 1	Year 5	Year 10	Year 20	Year 30
Undisturbed catchment runoff	ML/yr	29,029	28,908	28,105	28,078	27,675	27,303
Release from WMS	ML/yr	-	53	352	588	850	1,081
Total runoff to creek	ML/yr	***29,029***	***28,961***	***28,457***	***28,666***	***28,525***	***28,384***
Change	*ML/yr*	-	-68	-572	-363	-504	-645
% Change	*%*	-	-0.2%	-2.0%	-1.3%	-1.7%	-2.2%

Table 6-3 shows that the median runoff volume to the creek system decreases over the life of the project, as the area draining to the water management system increases. A decrease in baseline median annual runoff volumes of approximately -645 ML/yr are predicted by Year 30 as a result of the Project. This is equivalent to a reduction of -2.2% in baseline median flows in Lagoon Creek at the study catchment outlet, but a reduction of -0.2% in the Belyando River at Gregory Development Road. The baseline median flow at the Belyando River at Gregory Development Road gauging station is 369,146 ML/yr (refer to section 3.2).

As discussed in Section 3.4, a search of the State of Queensland Water Entitlements System indicated that there are no licensed surface water users on Lagoon Creek downstream of the Project. The closest license holder downstream of the Project is located on the Belyando River near Gregory Development Road. This is approximately 175km downstream of the MLA boundary, and is unlikely to be significantly impacted by the predicted -0.2% reduction in median flows as a result of the Project.

Once mining ceases and disturbed areas are rehabilitated, some decrease in flow downstream of the site is expected to remain as the final void catchment will continue to retain some runoff. The final rehabilitated landform will be shaped to minimise the area draining to the final void as much as practical.

6.4.1 Sensitivity analysis – reuse overburden runoff scenario

Predicted median annual flows in Lagoon Creek are provided in Table 6-4 for the reuse overburden runoff scenario, based on the 110-year water balance simulation. For this scenario the outlet pipes from sediment dams remain closed throughout the simulation, and stored water is reused onsite rather than discharged to Lagoon Creek.

Table 6-4: Median annual flow in Lagoon Creek at study catchment outlet – sensitivity analysis – reuse overburden runoff scenario

		Baseline	Year 1	Year 5	Year 10	Year 20	Year 30
Undisturbed catchment runoff	ML/yr	29,029	28,908	28,105	28,078	27,675	27,303
Release from WMS	ML/yr	-	0	0	0	0	0
Total runoff to creek	ML/yr	***29,029***	***28,908***	***28,105***	***28,078***	***27,675***	***27,303***
Change	*ML/yr*	-	-121	-924	-951	-1,354	-1,726
% Change	*%*	-	-0.4%	-3.2%	-3.3%	-4.7%	-6.0%

Table 6-4 shows more significant reductions in median flows in Lagoon Creek for the reuse overburden runoff scenario. A decrease in baseline median annual runoff volumes of approximately -1,726 ML/yr are predicted by Year 30. This is equivalent to a reduction of -6.0% in baseline median flows in Lagoon Creek at the study catchment outlet, but a reduction of -0.5% in the Belyando River at Gregory Development Road. A -0.5% reduction is still unlikely to significantly impact the closest downstream surface water licence holder, located on the Belyando River near Gregory Development Road.

7. Conclusions

The Alpha Coal Project Site Water Management System presented in this report has been developed to provide some operational flexibility and has been designed to segregate clean, dirty and contaminated water types.

Clean water from undisturbed catchments will be diverted around the mine site to Greentree and Lagoon Creeks as much as practical. This will assist to maintain flows in the creek system.

Dirty water runoff from disturbed areas, such as overburden dumps, will be directed to sediment dams to encourage settling. This water potentially contains elevated levels of suspended solids. Captured water will be discharged to Lagoon Creek when water quality discharge criteria has been met, which will assist to maintain flows in the creek system. Water will be discharged at a single licensed discharge point located at the outlet of the final sediment dam (at approximately 449826.841E and 7443561.347N). Discharge would only take place during periods of natural flow, and would not exceed 20% of the flow in Lagoon Creek. In the event that overburden runoff contains elevated salinity and/or heavy metals, water stored in sediment dams would be reused onsite and not released to Lagoon Creek.

Contaminated runoff captured in-pit will be pumped to pit dewatering dams. Contaminated runoff from the CHPP, MIA and coal stockpile pads will be pumped to environmental dams. This water potentially contains high levels of suspended solids, elevated salinity levels, and other contaminants. Contaminated water will not be discharged to Lagoon Creek, and will instead be used to meet site demands as a priority. To minimise groundwater seepage into the pit, it is proposed to extract groundwater using a borefield.

The water balance has been analysed for the proposed water management system to predict annual runoff volumes and to identify likely water deficits and surpluses. GoldSim software was used to develop a water balance model that simulated expected operations at various mine stages (snapshot Years 1, 5, 10, 20 and 30) using historical daily rainfall and evaporation data.

The reuse and evaporation of water captured in the site water management system results in a reduction in the volume of runoff to the creek system. Runoff volumes will decrease over the life of the Project as the area draining to the water management system increases. The water balance predicted a decrease in baseline median annual runoff volumes to Lagoon Creek of approximately -645 ML/yr by Year 30. This is equivalent to a reduction of -2.2% in baseline median flows in Lagoon Creek at the study catchment outlet, but a reduction of -0.2% in the Belyando River at Gregory Development Road. The predicted -0.2% reduction is unlikely to significantly impact the closest downstream surface water licence holder, located on the Belyando River near Gregory Development Road.

The water balance predicted a water deficit throughout the life of the mine. Imported water will be required to make-up the deficit. The requirement for imported water peaks in Year 30, with a requirement of 11,772 ML/yr for a 10^{th} percentile (dry) year.

8. Limitations

The current water balance model includes only basic operating rules, suitable for conceptual design. Operating rules should be upgraded when further water quality, groundwater and geochemistry data becomes available. Operating rules should be developed to manage competing interests including water retention for use around site, water retention for dilution and maintaining spare capacity for containment of storm events.

The proposed water management system should be refined and optimised as detailed design proceeds, and water quality, groundwater and geochemistry characteristics are confirmed from ongoing monitoring programs.

9. References

AustralAsian Resource Consultants Pty Ltd, 2009, *Alpha Coal Bulk Sample Project - Creek Ecology and Morphology Report*.

AustralAsian Resource Consultants Pty Ltd, 2009, *Alpha Coal Bulk Sample Project - Flora and Fauna Assessment*.

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

CRC for Catchment Hydrology, 2004, *Rainfall Runoff Library User Guide*.

Department of Minerals and Energy, 1995, *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland*.

JBT Consulting Pty Ltd, 2010, *Alpha Coal Project – Review of Mine Dewatering Requirements.*

Queensland Government, 2009, *Burdekin Basin Resource Operations Plan*.

SRK Consulting (Australasia) Pty Ltd, 2010, *Geochemical Characterisation of Alpha Project Test Pit*.

The Institution of Engineers Australia, 2001, *Australian Rainfall and Runoff*.

Appendix A

Licensed water users

Table A-1: Surface water license holders in the Burdekin region

Licence number	Licence type	Purpose	Allocation volume (ML)	Allocation area (ha)	Location parcel	Attached parcel	Watercourse
52426A	Licence to take water	Waterharvesting			22/SP218335	22/SP218335	Suttor River
57220A	Licence to take water	Waterharvesting					Suttor River
57382A	Licence to take water	Waterharvesting					Suttor River
96640A	Licence to take water	Irrigation, Waterharvesting		650	3/SP112964	3/SP112964	Suttor River
46163F	Licence to take water	Irrigation, Waterharvesting		40	4/DC93	4/DC93	Suttor River
52401A	Licence to take water	Irrigation, Stock Intensive, Waterharvesting		317	5078/PH955	5078/PH955	Suttor River
96644A	Licence to interfere by impounding-Embankment or Wall	Impound Water			1/SP116044, 3/SP112964	1/SP116044, 3/SP112964	Suttor River
45019A	Licence to take water	Irrigation		50	3/SP112964	3/SP112964	Suttor River
55019A	Licence to interfere by diversion-Other	Divert the Course of Flow					Suttor River
57383A	Licence to take water	Waterharvesting					Suttor River
185466	Licence to interfere by diversion-Channel	Divert the Course of Flow					Suttor Creek
176585	Licence to interfere by diversion-Channel	Divert the Course of Flow					Suttor Creek
405184	Licence to take water	Mining	14		136/SM804305		Sellheim River
405603	Licence to take water	Mining	14				Sellheim River
34908A	Licence to interfere by impounding-Embankment or Wall	Impound Water			136/SM804305	136/SM804305	Ut Sellheim River
14922A	Licence to take water	Irrigation		30	10/GF50	1/MPH13796, 10/GF50	Cape River
26147A	Licence to take water	Irrigation		10	14/GF179	14/GF179	Cape River
54174A	Licence to take water	Irrigation	162		12/GF50	12/GF50	Cape River
54217A	Licence to take water	Irrigation	250		3/GF65	3/GF65	Cape River

Table A-1: Surface water license holders in the Burdekin region

Licence number	Licence type	Purpose	Allocation volume (ML)	Allocation area (ha)	Location parcel	Attached parcel	Watercourse
54447A	Licence to take water	Rural	360		2/RP902027	2/RP902027	Cape River
96629A	Licence to take water	Irrigation, Waterharvesting		15	3/GF65	3/GF65	Cape River
52490A	Licence to take water	Mining	25				Cape River
70867A	Licence to take water	Irrigation	90		13/CP908303	13/CP908303	Cape River
54907A	Licence to take water	Domestic Supply	1.5		402/GF200	402/GF200	Homestead Creek
60648A	Licence to take water	Irrigation	48		4/GF63	4/GF63	Homestead Creek
60758A	Licence to take water	Irrigation	18		1/MPH527	1/MPH527	Betts Creek
60899A	Licence to take water	Irrigation	4		11418/MPH34817	11418/MPH34817	Betts Creek
85693A	Licence to take water	Irrigation	2		2/MPH13598	2/MPH13598	Betts Creek
85699A	Licence to take water	Irrigation	4.5		3/CP903940	3/CP903940	Betts Creek
39675A	Licence to take water	Irrigation	50		1/MPH21404	1/MPH21120, 1/MPH21352, 1/MPH21404, 1/MPH33845, 2/MPH21783, 2/MPH33845, 3/MPH21120	Betts Creek
404311	Licence to take water	Any	59		19/GF102		Betts Creek
48994A	Licence to take water	Irrigation		16	1/GF26	1/GF26	Betts Creek
54111A	Licence to take water	Domestic Supply, Irrigation	10		7/RP889531	7/RP889531	Betts Creek
85692A	Licence to take water	Irrigation	2		1/MPH13598	1/MPH13598	Betts Creek
35350A	Licence to interfere by impounding-Excavation	Impound Water			5078/PH955	5078/PH955	Ut Grahame Creek
101185	Licence to take water	Waterharvesting			1/SM837228		Rosetta Creek
101186	Licence to take water	Waterharvesting			1/SM837228		Rosetta Creek
48985A	Licence to take water	Domestic Supply, Mining	150		4/AP7703		Police Creek
96794A	Licence to take water	Domestic Supply	0.9		52/M7213	1/MPH34382	Police Creek

Table A-1: Surface water license holders in the Burdekin region

Licence number	Licence type	Purpose	Allocation volume (ML)	Allocation area (ha)	Location parcel	Attached parcel	Watercourse
181582	Licence to take water	Domestic Supply	0.9		A/AP19948	23/M7212, 24/M7212, 25/M7212, 26/M7212, 27/M7212	Police Creek
49034A	Licence to take water	Domestic Supply, Stock	50		4/AP7703	4/AP7703, 6/SM99	Police Creek
49035A	Licence to interfere by impounding-Embankment or Wall	Impound Water			4/AP7703	4/AP7703	Police Creek
49045A	Licence to take water	Domestic Supply	1.5		307/MPH20088	4/SM81	Police Creek
49047A	Licence to take water	Domestic Supply	3		71/MPH13513	7/SM71	Police Creek
55005A	Licence to take water	Irrigation		80	3/SP112964	3/SP112964	Belyando River Anabranch
55006A	Licence to interfere by impounding-Embankment or Wall	Impound Water			3/SP112964	3/SP112964	Belyando River Anabranch
96640A	Licence to take water	Irrigation, Waterharvesting		650	3/SP112964	3/SP112964	Belyando River Anabranch
00933F	Licence to interfere by impounding-Embankment or Wall	Impound Water			3308/PH485	3308/PH485	Belyando River
52623F	Licence to take water	Waterharvesting			48/BE62	48/BE62	Belyando River
48434F	Licence to take water	Domestic Supply			1/PER207046	3/AY29	Belyando River
37295F	Licence to take water	Stock			1/BF51	1/BF51	Ut Belyando River
057819F	Licence to take water	Waterharvesting			4/SP116046	4/SP116046	Mistake Creek
57717WF	Licence to interfere by impounding-Embankment or Wall	Impound Water			10/BL58	10/BL58	Mistake Creek
57882F	Licence to take water	Waterharvesting			2/CP882192	2/CP882192	Mistake Creek
0426439F	Licence to take water	Waterharvesting			5070/PH1056	5070/PH1056	Mistake Creek
41235F	Licence to take water	Waterharvesting			2/CP882192	2/CP882192	Mistake Creek

Table A-1: Surface water license holders in the Burdekin region

Licence number	Licence type	Purpose	Allocation volume (ML)	Allocation area (ha)	Location parcel	Attached parcel	Watercourse
46204F	Licence to take water	Irrigation, Waterharvesting		200	2/RU78	2/RU78	Mistake Creek
57746WF	Licence to interfere by impounding-Embankment or Wall	Impound Water			2/RU78	2/RU78	Mistake Creek
57883F	Licence to take water	Waterharvesting			2/CP882192	2/CP882192	Mistake Creek
57884F	Licence to take water	Waterharvesting			2/CP882192	2/CP882192	Mistake Creek
41234F	Licence to take water	Irrigation		150	2/CP882192	2/CP882192	Mistake Creek
57718WF	Licence to interfere by impounding-Embankment or Wall	Impound Water			10/BL58	10/BL58	Mistake Creek
57847F	Licence to take water	Waterharvesting			4/SP116046	4/SP116046	Mistake Creek
52670F	Licence to interfere by diversion-Channel	Divert the Course of Flow			2/CP882192	2/CP882192	Mistake Creek
0426441F	Licence to take water	Irrigation		300	5070/PH1056	5070/PH1056	Pelican Lagoon
52622F	Licence to interfere by impounding-Embankment or Wall	Impound Water			656/SP138788	656/SP138788	Pelican Lagoon
174169	Licence to interfere by impounding-Embankment or Wall	Impound Water			5070/PH1056	5070/PH1056	Pelican Lagoon
41328F	Licence to take water	Stock			7/DR34	3500/PH748	Fox Creek
28340F	Licence to interfere by impounding-Embankment or Wall	Impound Water			2/SP104491	2/SP104491	Fox Creek
37407F	Licence to interfere by impounding-Embankment or Wall	Impound Water			1/BF27	1/BF27	Belyando River (Anabranch)
103511	Licence to take water	Waterharvesting			7/DM40	7/DM40	Alpha Creek
37488F	Licence to interfere by impounding-Embankment or Wall	Impound Water			1/BF51	1/BF51	Belyando River (Longreach Channel)
101981	Licence to take water	Waterharvesting			1/SP210553	1/SP210553	Logan Creek

Table A-1: Surface water license holders in the Burdekin region

Licence number	Licence type	Purpose	Allocation volume (ML)	Allocation area (ha)	Location parcel	Attached parcel	Watercourse
104710	Licence to take water	Stock	15		1/BL54	5/BL41	Logan Creek
101980	Licence to interfere by impounding-Embankment or Wall	Impound Water			1/SP210553		Logan Creek
32098AF	Licence to take water	Waterharvesting			3/RP617023	3/RP617023	Logan Creek
36799WF	Licence to interfere by impounding-Embankment or Wall	Impound Water			2/DC174	2/DC174	Logan Creek
45343F	Licence to interfere by impounding-Embankment or Wall	Impound Water			3/SP167241	3/SP167241	West Logan Creek
45342F	Licence to take water	Irrigation		200	3/SP167241	3/SP167241	West Logan Creek
46357F	Licence to take water	Waterharvesting			6/SP125740	6/SP125740	Diamond Creek
57803F	Licence to interfere by impounding-Embankment or Wall	Impound Water			6/SP125740	6/SP125740	Diamond Creek
26432F	Licence to interfere by impounding-Excavation	Impound Water			1/RP613564	1/RP613564	Ut Diamond Creek
104711	Licence to take water	Irrigation		8	4/DC93	4/DC93	Eaglefield Creek
52668F	Licence to interfere by impounding-Embankment or Wall	Impound Water			4/DC93	4/DC93	Eaglefield Creek
17886A	Licence to interfere by impounding-Embankment or Wall	Impound Water			2/SM77	2/SM77	Ut Suttor River

Appendix B

Catchment areas

Table B1: Year 1 Catchment landuse breakdown

	Area (ha)					
Catchment	**Natural**	**Spoil**	**Pit**	**Rehab**	**Industrial**	**Total**
ED1					65.6	**65.6**
ED2					40.2	**40.2**
ED3					64.8	**64.8**
ED4					62.7	**62.7**
ED5					2.3	**2.3**
ED6					82.6	**82.6**
SD1						**0.0**
SD2						**0.0**
SD3	25.3	77.7				**102.9**
SD4						**0.0**
SD5						**0.0**
SD6	19.9	57.0				**76.8**
SD7						**0.0**
SD8						**0.0**
SD9						**0.0**
SD10						**0.0**
SD11						**0.0**
SD12						**0.0**
SD13						**0.0**
SD14						**0.0**
SD15						**0.0**
SD16						**0.0**
SD17						**0.0**
SD18						**0.0**
SD19						**0.0**
SD20						**0.0**
Pit	2.2		92.0			**94.2**
TSF	516.0					**516.0**
RW	26.9					**26.9**
Creek	271,450.0					**271,450.0**

Table B2: Year 5 Catchment landuse breakdown

	Area (ha)					
Catchment	Natural	Spoil	Pit	Rehab	Industrial	Total
ED1					65.6	**65.6**
ED2					40.2	**40.2**
ED3					64.8	**64.8**
ED4					62.7	**62.7**
ED5					2.3	**2.3**
ED6					82.6	**82.6**
SD1	224.2	84.4		8.8		**317.4**
SD2	201.3	195.6		14.6		**411.4**
SD3	26.0	293.3		19.7		**339.0**
SD4	37.5	279.8				**317.2**
SD5	26.8	362.1		20.4		**409.3**
SD6	51.9	484.5		18.6		**554.9**
SD7	31.4	325.1		25.6		**382.0**
SD8	44.8	130.0				**174.8**
SD9	226.4	92.5		1.1		**320.0**
SD10	15.7	226.0		4.8		**246.5**
SD11						**0.0**
SD12						**0.0**
SD13						**0.0**
SD14						**0.0**
SD15						**0.0**
SD16						**0.0**
SD17						**0.0**
SD18						**0.0**
SD19						**0.0**
SD20						**0.0**
Pit	3267.1	143.0	696.3			**4106.3**
TSF	756.0					**756.0**
RW	26.9					**26.9**
Creek	263,906.0					**263,906.0**

Table B3: Year 10 Catchment landuse breakdown

	Area (ha)					
Catchment	**Natural**	**Spoil**	**Pit**	**Rehab**	**Industrial**	**Total**
ED1					65.6	**65.6**
ED2					40.2	**40.2**
ED3					64.8	**64.8**
ED4					62.7	**62.7**
ED5					2.3	**2.3**
ED6					82.6	**82.6**
SD1	51.6	237.9		35.8		**325.3**
SD2	39.7	377.6		36.4		**453.7**
SD3	26.0	439.1		18.2		**483.2**
SD4	37.5	372.5		25.7		**435.7**
SD5	26.8	192.4		29.5		**248.6**
SD6	51.9	255.0		61.4		**368.3**
SD7	31.4	162.7		33.8		**227.9**
SD8	20.1	173.5		11.1		**204.7**
SD9	23.5	249.2		24.3		**297.0**
SD10	14.9	245.0		20.3		**280.3**
SD11		68.1				**68.1**
SD12		66.0				**66.0**
SD13		74.0				**74.0**
SD14		101.7				**101.7**
SD15		340.6				**340.6**
SD16		606.9				**606.9**
SD17		588.9				**588.9**
SD18		137.5				**137.5**
SD19		170.8				**170.8**
SD20		130.3				**130.3**
Pit	1221.1	217.2	789.1			**2227.3**
TSF	756.0					**756.0**
RW	26.9					**26.9**
Creek	263,647.0					**263,647.0**

Table B4: Year 20 Catchment landuse breakdown

	Area (ha)					
Catchment	**Natural**	**Spoil**	**Pit**	**Rehab**	**Industrial**	**Total**
ED1					65.6	**65.6**
ED2					40.2	**40.2**
ED3					64.8	**64.8**
ED4					62.7	**62.7**
ED5					2.3	**2.3**
ED6					82.6	**82.6**
SD1	51.6	197.3		174.1		**423.1**
SD2	39.7	230.3		282.0		**552.0**
SD3	26.0	141.9		338.2		**506.0**
SD4	37.5	353.4		89.1		**479.9**
SD5	26.8	66.6		318.1		**411.6**
SD6	51.9	52.6		644.1		**748.6**
SD7	31.4	217.0		414.7		**663.0**
SD8	20.1	171.3		205.6		**397.1**
SD9	23.5	133.4		177.8		**334.7**
SD10	15.6	56.3		147.5		**219.4**
SD11		116.6				**116.6**
SD12		117.1				**117.1**
SD13		358.7		82		**440.7**
SD14		499.9				**499.9**
SD15		469.4		75		**544.4**
SD16		690.7		97		**787.7**
SD17		730.7				**730.7**
SD18		187.8		30.1		**217.9**
SD19		281.5		147		**428.5**
SD20		450.2				**450.2**
Pit	1581.2	300.4	909.4			**2791.1**
TSF	510.0					**510.0**
RW	26.9					**26.9**
Creek	259,870.0					**259,870.0**

Table B5: Year 30 Catchment landuse breakdown

Catchment	Area (ha)					
	Natural	Spoil	Pit	Rehab	Industrial	Total
ED1					65.6	**65.6**
ED2					40.2	**40.2**
ED3					64.8	**64.8**
ED4					62.7	**62.7**
ED5					2.3	**2.3**
ED6					82.6	**82.6**
SD1	51.6	105.9		214.8		**372.3**
SD2	39.7	142.2		316.0		**497.8**
SD3	26.0	174.8		412.0		**612.7**
SD4	37.5	247.7		356.8		**642.0**
SD5	26.8	84.3		548.9		**660.0**
SD6	51.9	80.0		1006.8		**1138.7**
SD7	31.4	220.9		654.0		**906.2**
SD8	20.1	151.6		346.8		**518.4**
SD9	23.5	205.7		444.5		**673.7**
SD10	15.8	232.7		351.1		**599.6**
SD11		286.0		38.0		**324.0**
SD12		277.4		62.5		**339.9**
SD13		591.0		16.0		**607.0**
SD14		612.7		223.1		**835.8**
SD15		571.7		129.3		**701.0**
SD16		799.7		229.5		**1029.2**
SD17		791.1		180.4		**971.5**
SD18		255.8		87.6		**343.4**
SD19		356.8				**356.8**
SD20		303.5				**303.5**
Pit	1455.2	421.3	980.0			**2856.5**
TSF	581.0					**581.0**
RW	26.9					**26.9**
Creek	256,369.0					**256,369.0**

Appendix C

Additional water balance plots (base case)

Figure C-1: Imported water requirement based on 110 year water balance simulation – Year 1

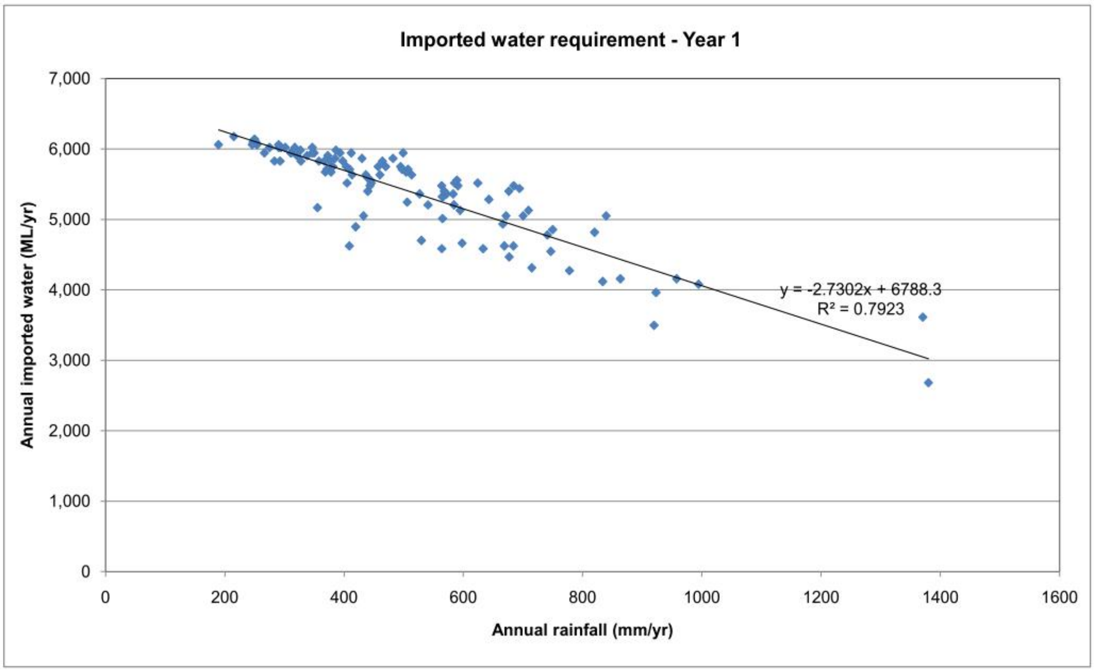


Figure C-2: Imported water requirement based on 110 year water balance simulation – Year 5

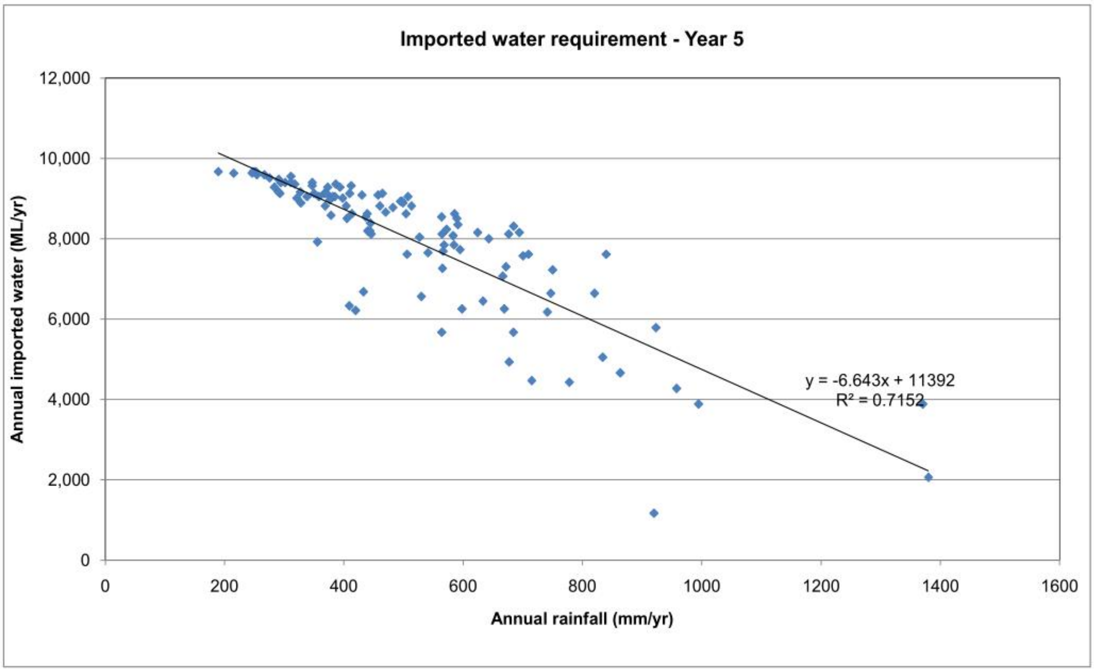


Figure C-3: Imported water requirement based on 110 year water balance simulation – Year 10

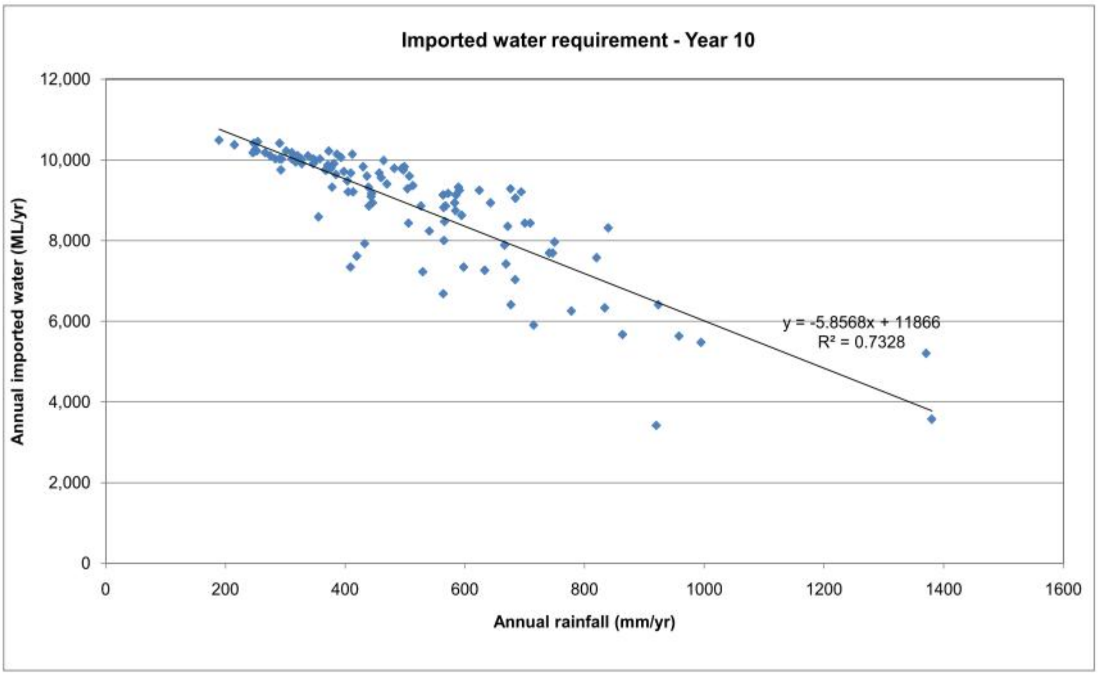


Figure C-4: Imported water requirement based on 110 year water balance simulation – Year 20

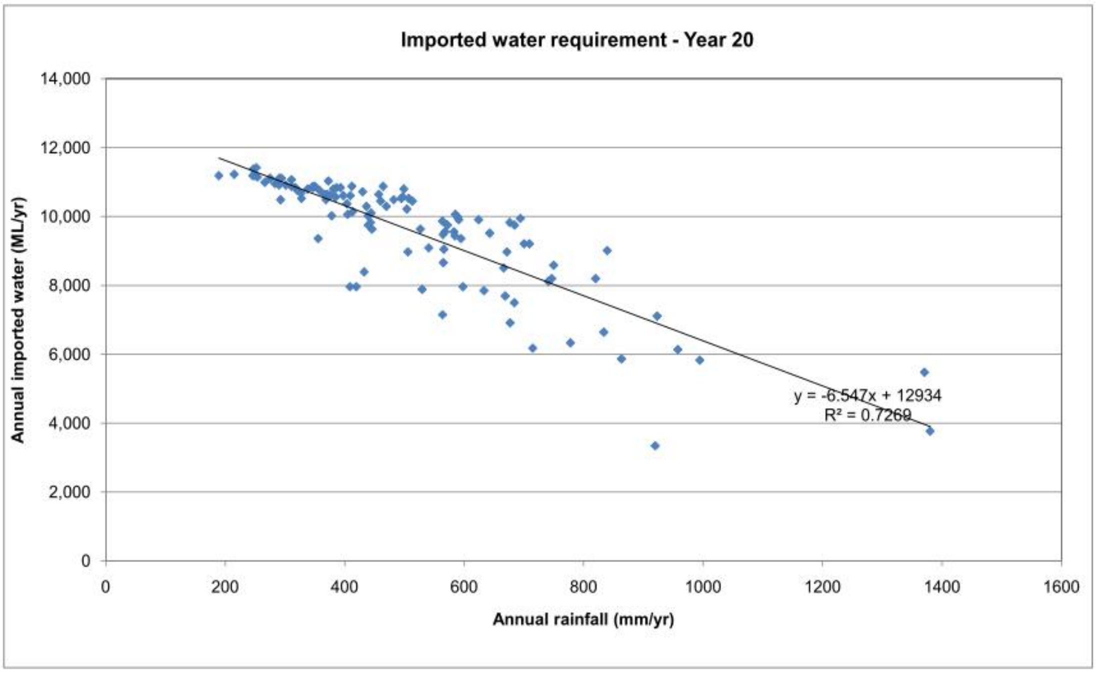


Figure C-5: Imported water requirement based on 110 year water balance simulation – Year 30

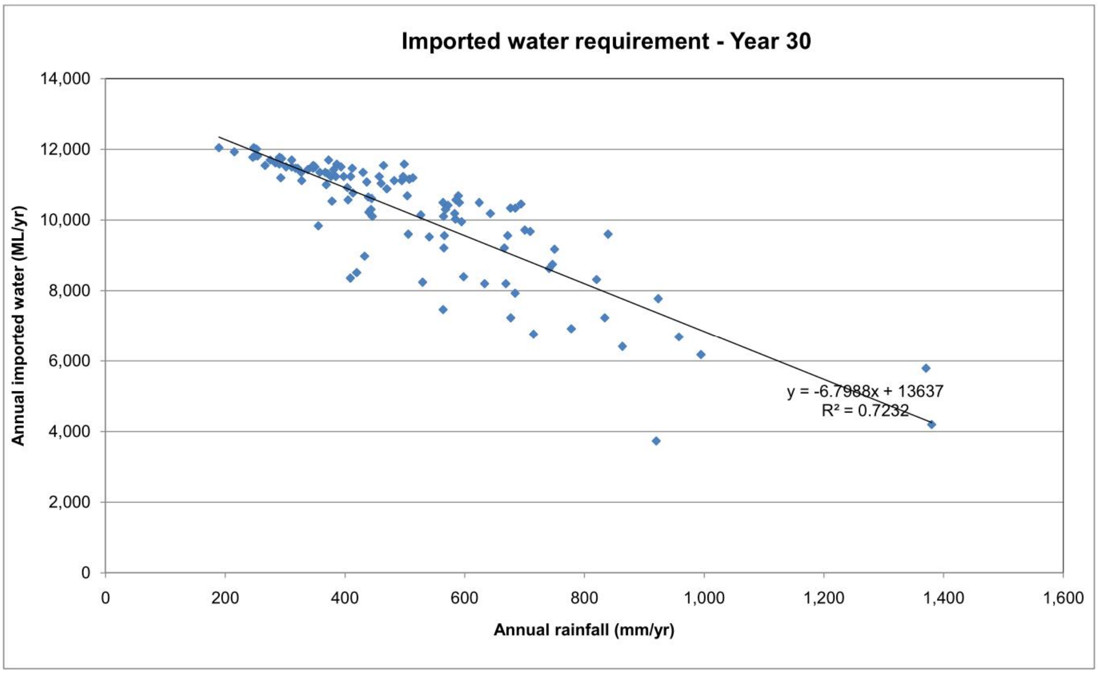


Figure C-6: Frequency of pit flooding based on 110 year water balance simulation – Year 1

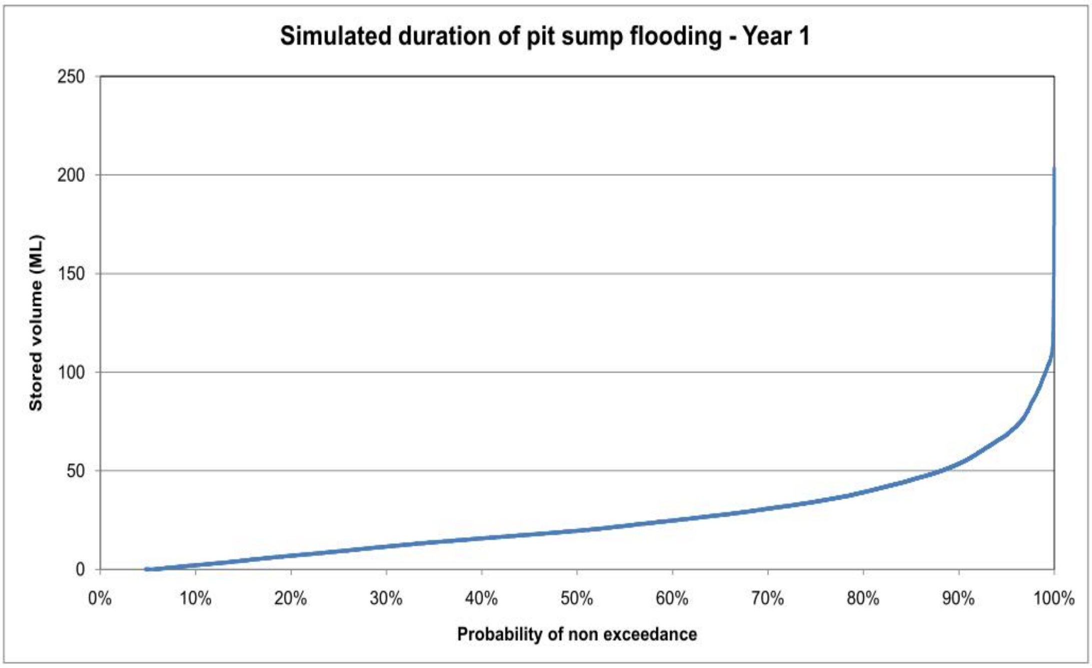


Figure C-7: Frequency of pit flooding based on 110 year water balance simulation – Year 5

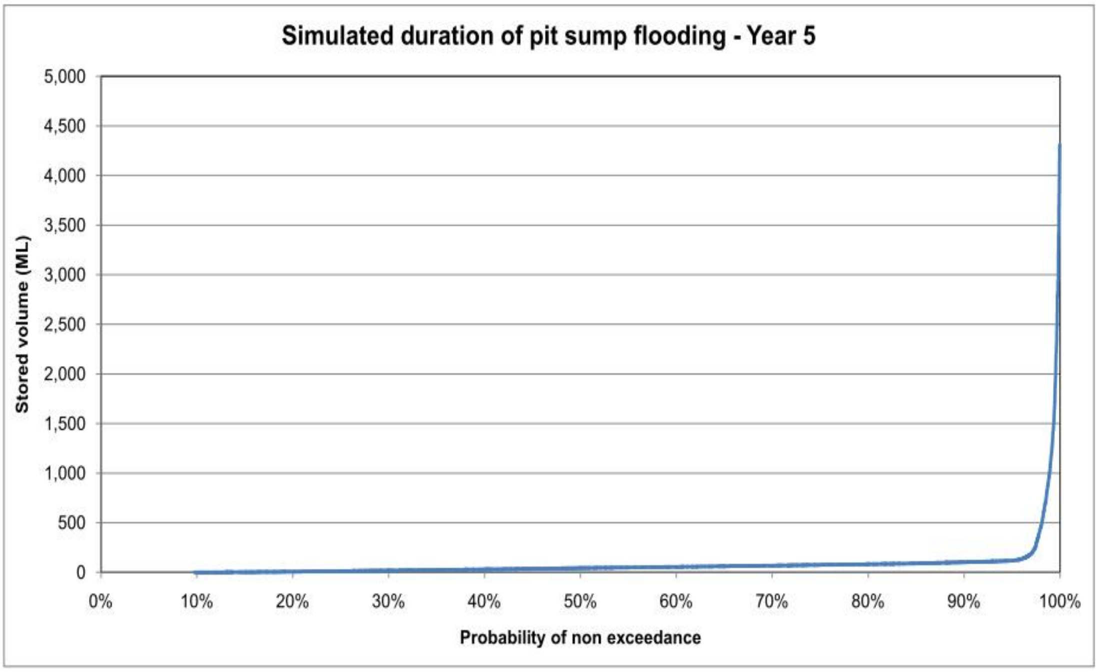


Figure C-8: Frequency of pit flooding based on 110 year water balance simulation – Year 10

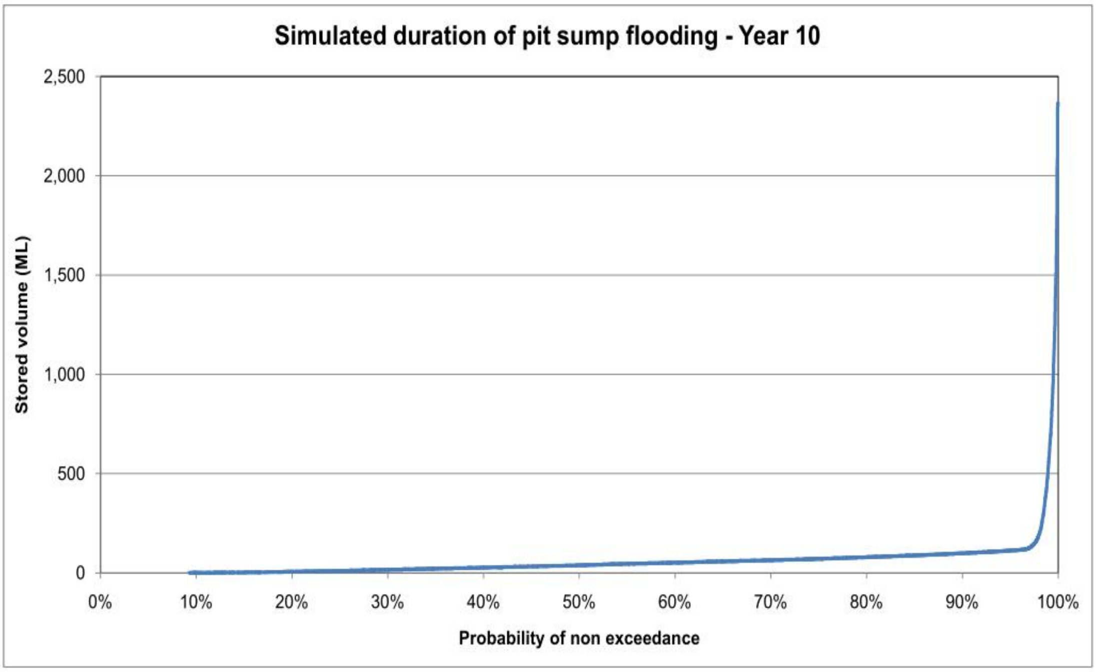


Figure C-9: Frequency of pit flooding based on 110 year water balance simulation – Year 20

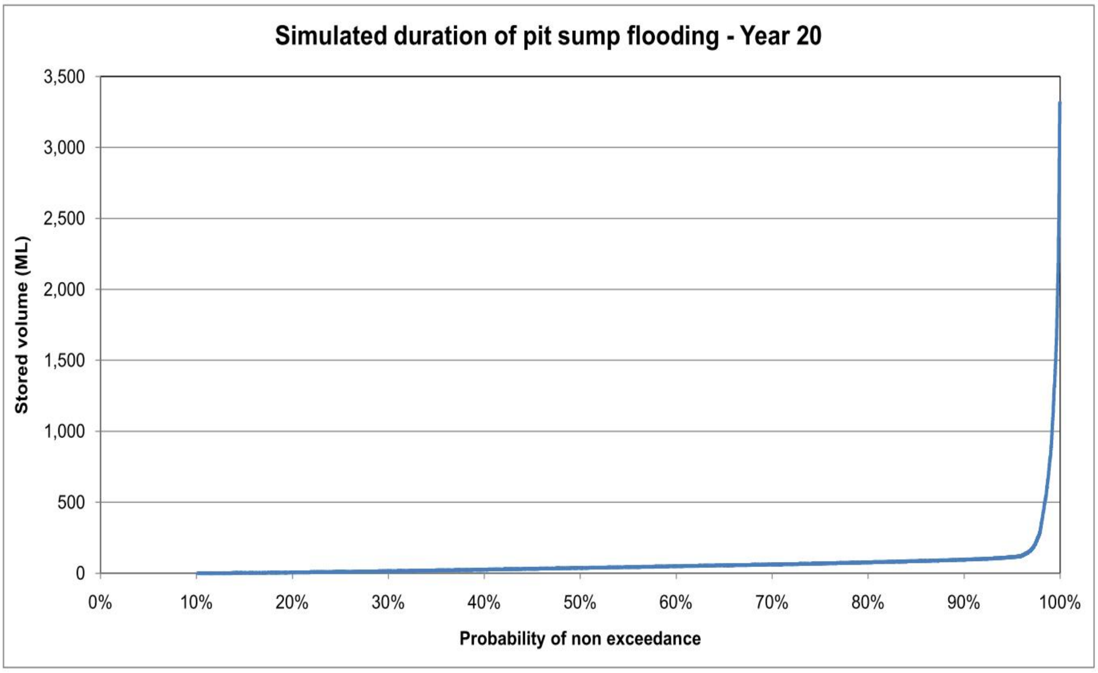


Figure C-10: Frequency of pit flooding based on 110 year water balance simulation – Year 30

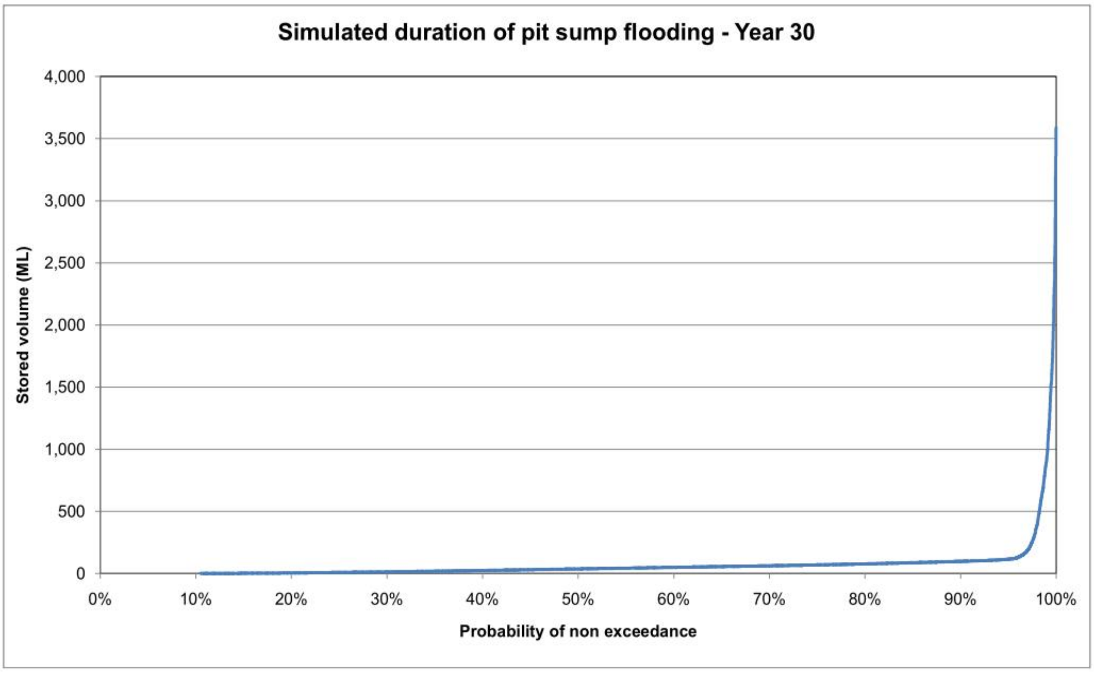


Figure C-11: Volume stored in ED1 over 110 year water balance simulation – Year 30

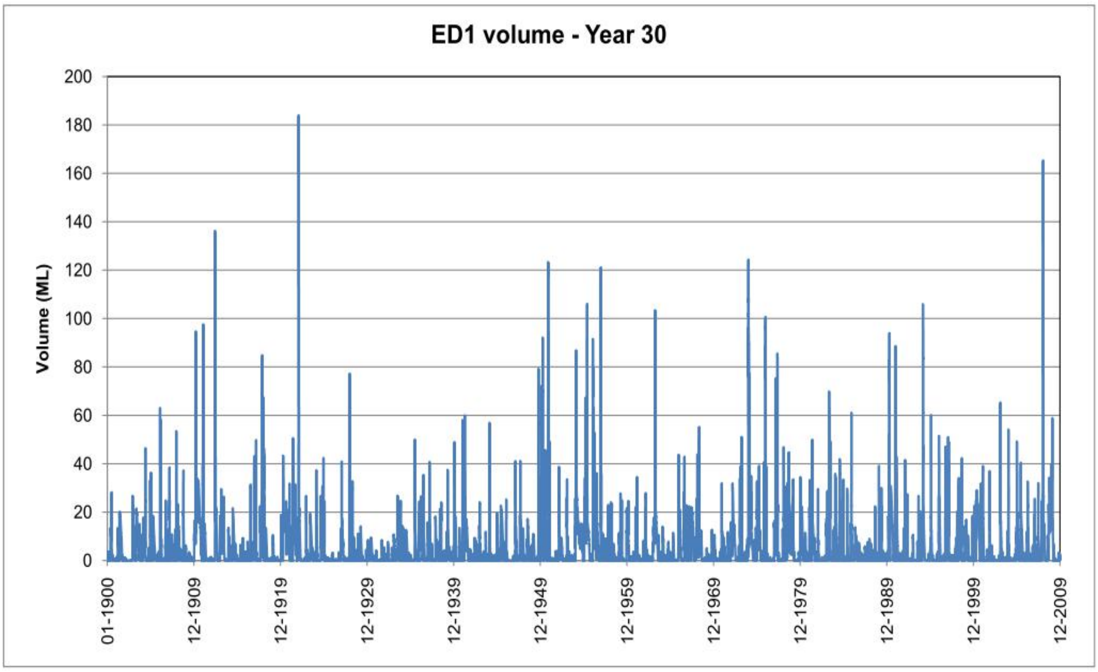


Figure C-12: Volume stored in ED2 over 110 year water balance simulation – Year 30

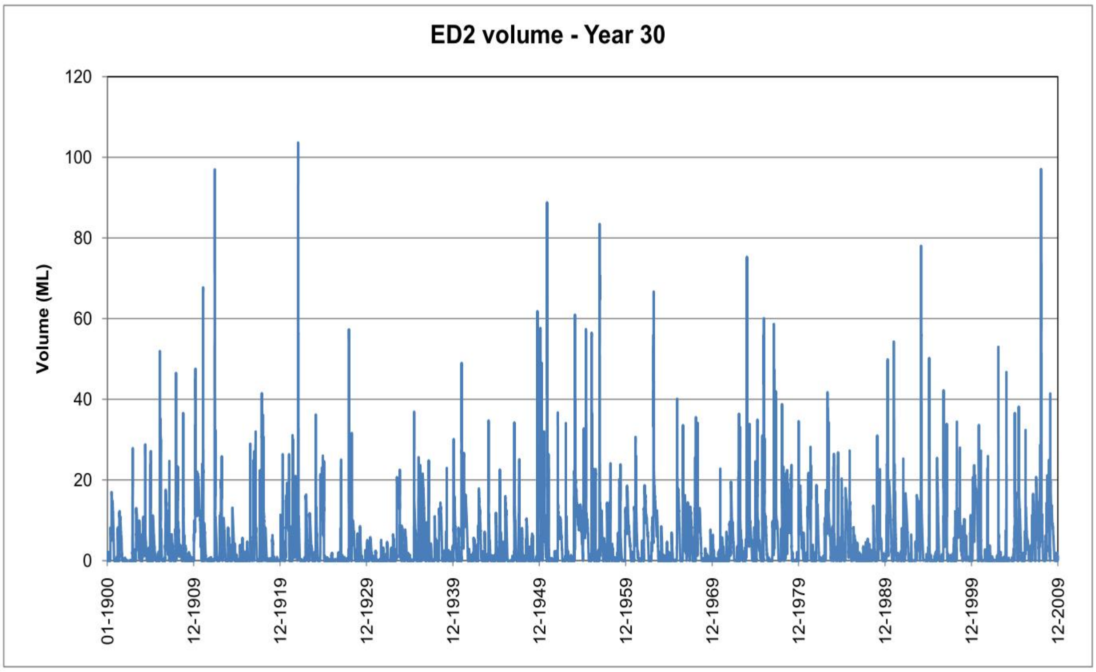


Figure C-13: Volume stored in ED3 over 110 year water balance simulation – Year 30

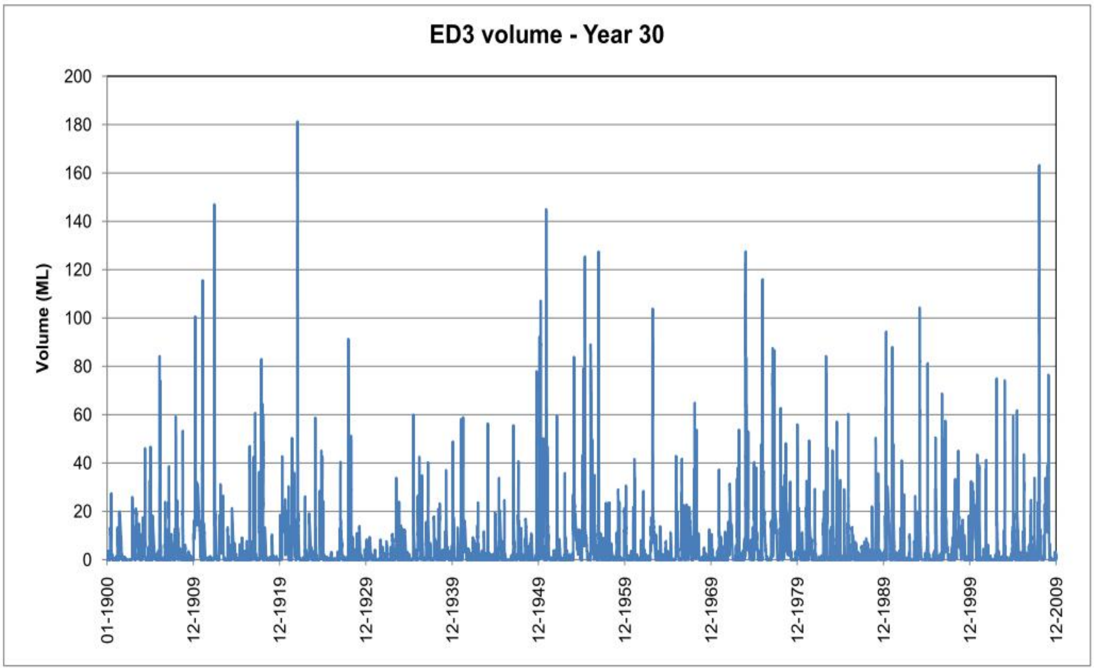


Figure C-14: Volume stored in ED4 over 110 year water balance simulation – Year 30

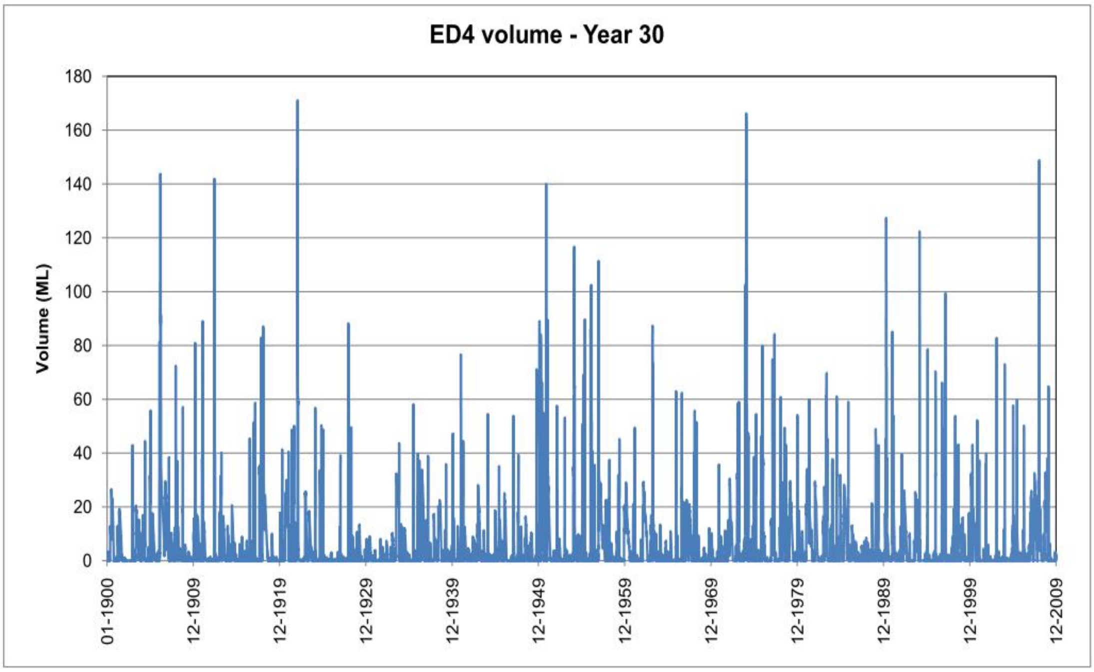


Figure C-15: Volume stored in ED5 over 110 year water balance simulation – Year 30

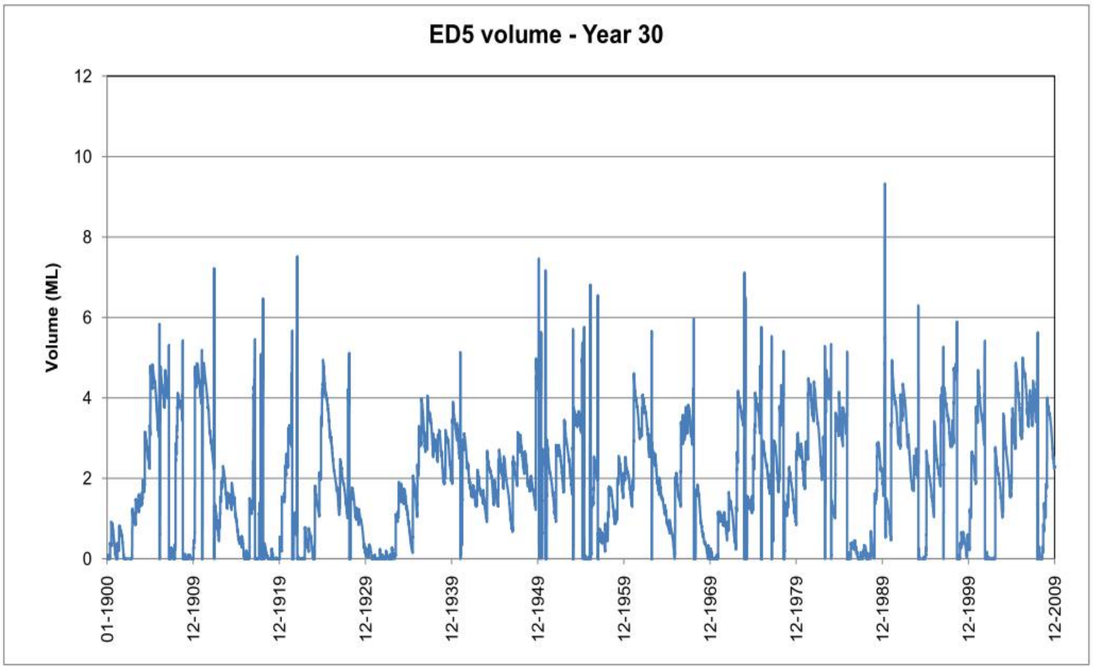


Figure C-16: Volume stored in ED6 over 110 year water balance simulation – Year 30

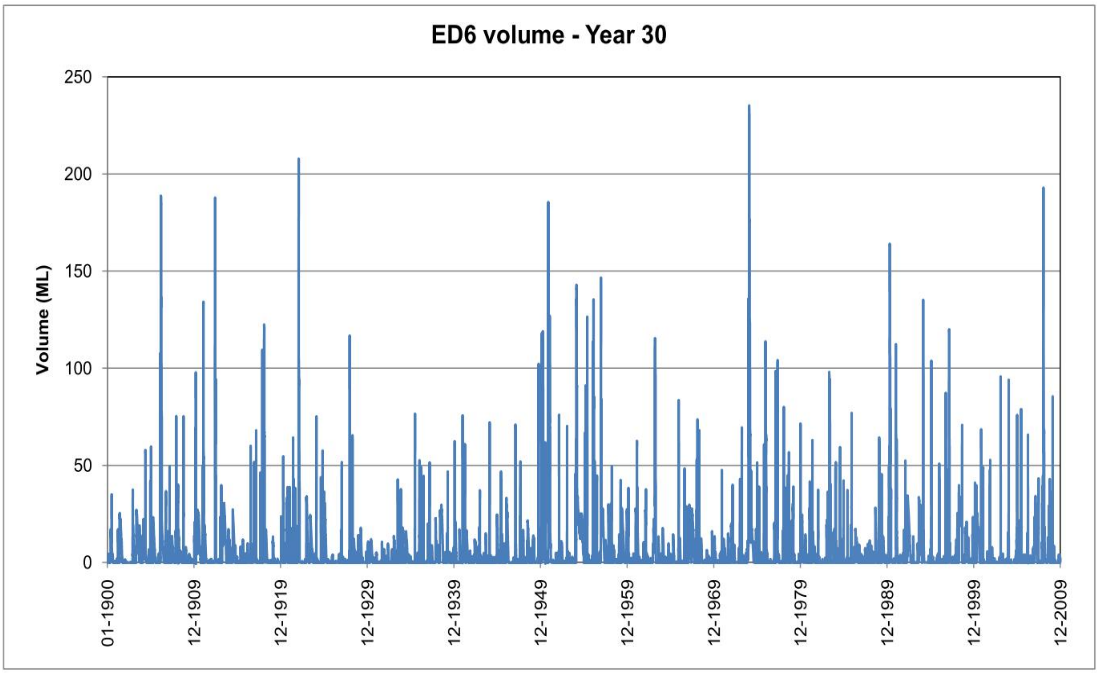


Figure C-17: Volume stored in PW1 over 110 year water balance simulation – Year 30

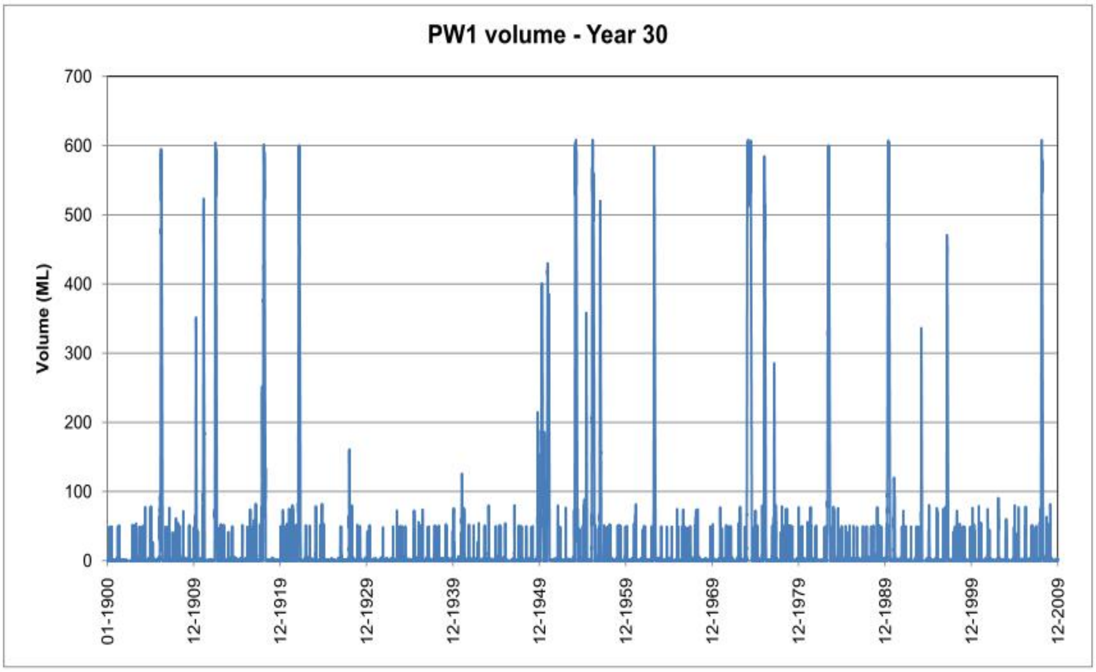


Figure C-18: Volume stored in PW2 over 110 year water balance simulation – Year 30

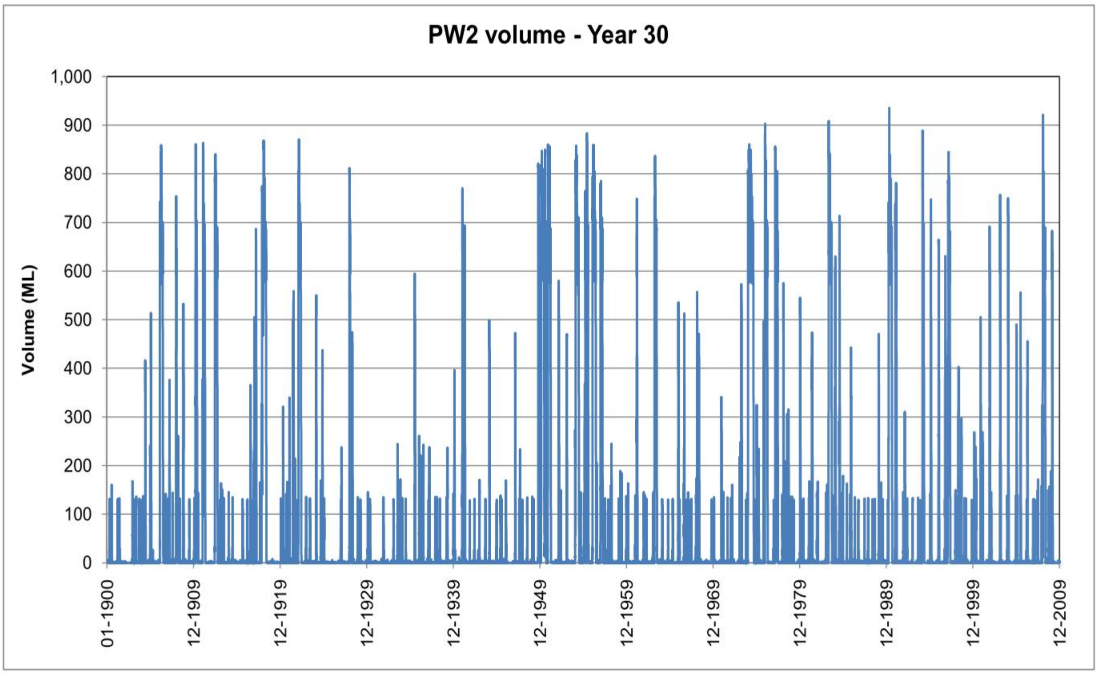


Figure C-19: Volume stored in PW3 over 110 year water balance simulation – Year 30

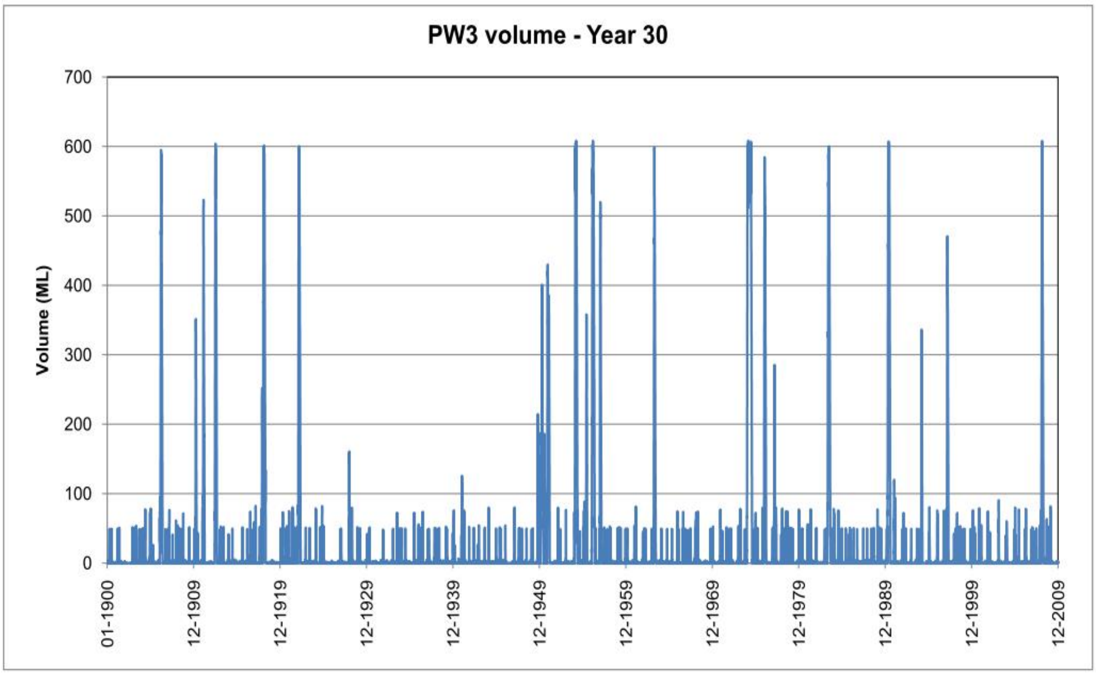


Figure C-20: Volume stored in PW4 over 110 year water balance simulation – Year 30