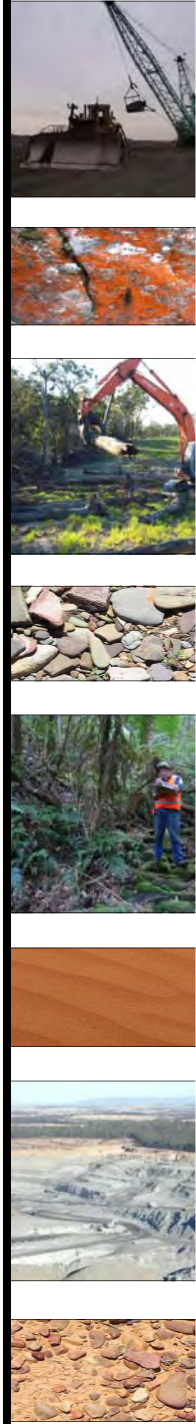

Surface Water Assessment
(GSSE 2010c)

APPENDIX M

WHITEHAVEN COAL LIMITED

Rocglen Coal Mine Extension Project

Part 3A of the *EP&A Act 1979*

Environmental Assessment:-

Surface Water Assessment

December 2010

WHM01-003

GSS ENVIRONMENTAL
Environmental, Land and Project Management Consultants

EXECUTIVE SUMMARY

An application for project approval under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) is to be made to permit the expansion of the currently approved Rocglen Coal Mine to maximise coal recovery and allow for improved mine progression. GSS Environmental (GSSE) was commissioned by Whitehaven Coal Limited (the "Proponent") to prepare this Surface Water Assessment to fulfil the requirements detailed in the Director-General's Requirements relating to the preparation of an Environmental Assessment to accompany the Part 3A application.

The key aspects addressed within the Surface Water Assessment include the identification of potential surface water impacts as a result of the Project, a description of the proposed mitigation and management measures to be implemented to address these potential impacts, licensing requirements, recommendations for ongoing surface water monitoring, and a detailed site water balance, including a discussion on water sources, water security and predicted discharges from site.

A detailed 'daily time-step' water balance model was developed for the Project. The model was calibrated using actual site data collected during 2008 to 2010, including rainfall, discharges and dam levels, which allowed for a more reliable model to be developed.

The overall results of the water balance indicate that the site has adequate water supply through the rainfall runoff captured in sediment basins and through the use of bore water when required (which is within the existing license entitlement of 120 ML/year).

The water balance model predicted that likely annual overflow discharges of 1 day/year (on average) will occur based on the assumption that controlled discharge of water is undertaken. The controlled discharge (of treated water) to draw down the water storage within all the dirty water dams on-site significantly reduces the potential for discharge of sediment laden water to occur during uncontrolled overflow events,

Available soil and water data for the Project Site suggests that total suspended solids is likely to be the key water quality parameter requiring management throughout the Project Life to ensure the water quality in downstream watercourses is not impacted. A number of surface water management and mitigation measures are recommended by this Surface Water Assessment to ensure that the potential risk of any adverse offsite surface water impacts is minimised. All the recommended measures have been designed in accordance with the best management practices contained in Managing Urban Stormwater: Soils and Construction Volume 1 (LandCom, 2004) and Volume 2(DECC, 2008), hereafter referred to as the *Blue Book*. This includes directing dirty water runoff into suitability sized sediment basins, preferential use of water from 'end-of-line' basins and the use of chemical flocculants to help increase settlement times.

The drainage lines that will be potentially affected by the Project are very minor headwater drainage lines, which are ephemeral in nature and only flow for short periods after heavy rainfall and/or site discharges. The proposed mitigation measures to maintain flow regimes in receiving waters include the diversion of clean water around the site, along with controlled discharge off-site of treated water from existing licensed discharge points (LDPs), with one LDP to be relocated. It is anticipated that there will be minimal impact on flow regimes downstream of the Project Site due to the proposed Project.

If the surface water management and mitigation measures listed throughout this Surface Water Assessment are implemented and maintained, it is anticipated that there would be minimal impact on surface water downstream of the Project Site as a result of the proposed operations.

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GLOSARY OF KEY TERMS

DIRTY WATER **Surface runoff from disturbed catchments such as the overburden emplacement areas and stockpile areas, which could contain significant concentrations of suspended sediment.**

MINE WATER **Water extracted from the open cut extraction pit.**

CLEAN WATER **Surface runoff from undisturbed catchments relatively undisturbed by extraction processing or related activities.**

1.0 INTRODUCTION

1.1 Project Overview

Rocglen Coal Mine currently employs open cut mining methods to produce up to 1.5 million tonnes (Mt) of run-of-mine (ROM) coal annually. **Figure 1** positions the Rocglen Coal Mine in its regional setting approximately 25 km north of Gunnedah and 23 km south-east of Boggabri in the Gunnedah coalfields of NSW.

Following further drilling and definition of the local geological features, as well as additional reviews of the mine plan, an application for project approval under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) is to be made to permit the expansion of the currently approved Rocglen Coal Mine to maximise coal recovery and allow for improved mine progression ("the Project"). Due to the nature of the Project, the proposed expansion is considered 'too large' to be assessed as a modification of the existing project approval and a new application for project approval is required.

GSS Environmental (GSSE) was commissioned by Whitehaven Coal Limited (the "Proponent") to prepare an Environmental Assessment to accompany the Project Application. This Surface Water Assessment forms part of the Environmental Assessment. The following is a summary of the components of the proposed mine expansion most relevant to the Surface Water Assessment:

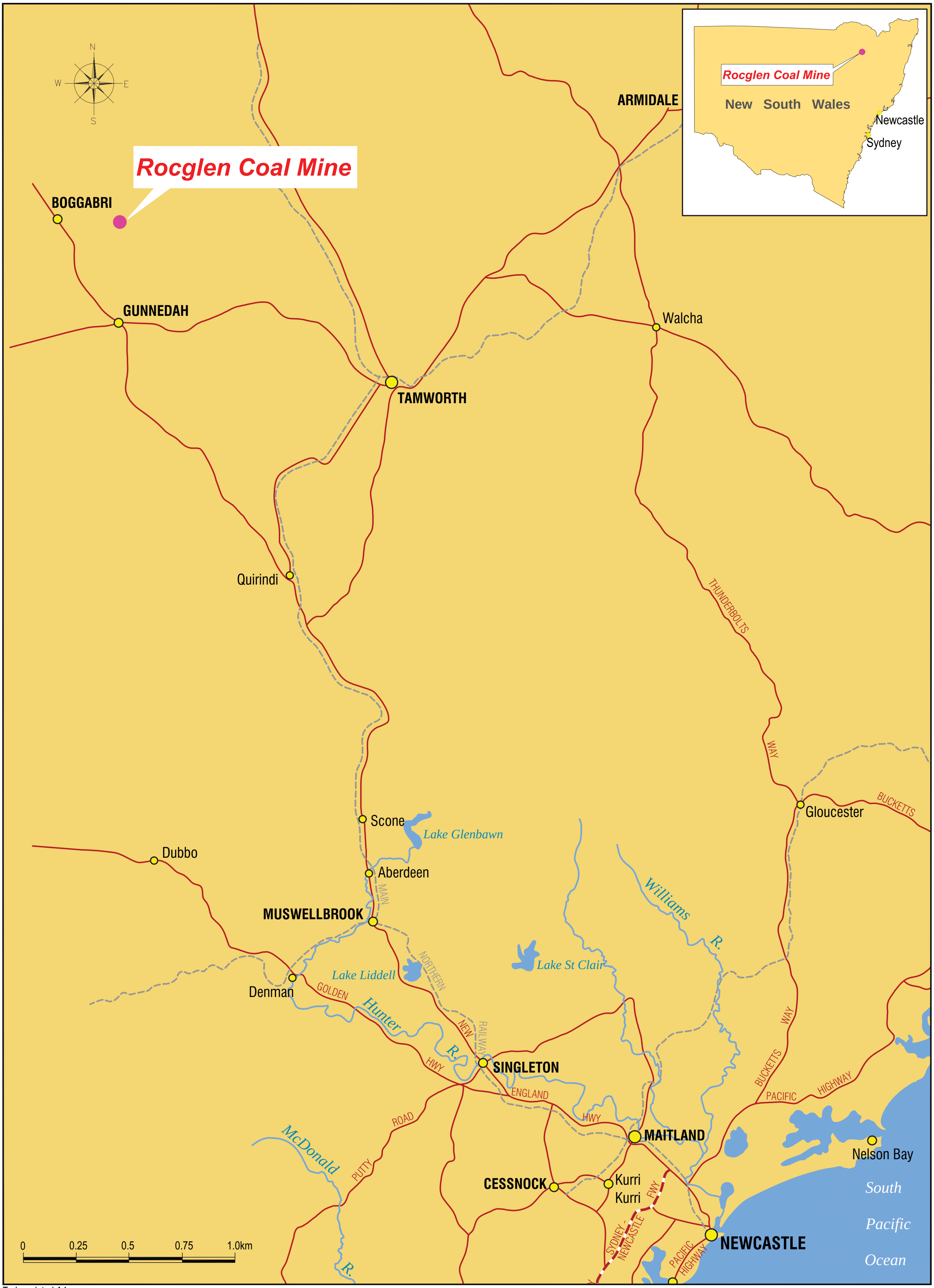
(a) **Expansion of Open Cut Pit –** expansion of the open cut pit design limit in order to access up to an additional 5 Mt of coal not previously considered in the life of mine plan. This will increase coal recovery at Rocglen by close to 30%. The footprint of the open cut pit will increase by approximately 50 hectares to a total open cut mined area of approximately 164 hectares. Coal will continue to be extracted from the expanded pit at the approved production rate of 1.5 Mtpa and using the open cut mining methods approved at Rocglen.

(b) **Extension to Life of Mine –** it is anticipated that coal extraction activities will occur for approximately 11 years following the issue of Project Approval and the subsequent issue of a new or amended mining lease. This represents an increase to the projected life of mine, for coal extraction, of up to four years.

(c) **Expansion of Northern Emplacement Area -** expansion in the footprint and height of the out-of-pit Northern Emplacement Area in order to accommodate a maximum of 12 million bank cubic meters (Mbcm), or 15 million loose cubic metres (Mlcm) accounting for swell, of overburden from the current operations and proposed pit expansion. The maximum design height of the expanded Northern Emplacement Area will be 50 metres above pre-mining landform, which is the approximate height of the adjacent ridge to the west of the Project Site at 340 metres Australian Height Datum (AHD). Early re-profiling and revegetation of the external batter slopes of the emplacement area will be undertaken to minimise visual impacts and limit erosion and downstream sedimentation.

(d) **Replacement of Soil Stockpile Areas –** the soil stockpiling areas identified as the Northern and Southern Soil Stockpile Areas will be replaced by the proposed Eastern and Western Soil Stockpile Areas to cater for the expanded open cut pit and Northern Emplacement Area. While all of the topsoil currently in the Northern Stockpile Area will be relocated, the majority of subsoil in this area will remain and will be covered with overburden due to sufficient soil material being available for rehabilitation from the expanded operation. The material to be relocated will be placed in either proposed new designated soil stockpile areas or placed directly onto areas available for rehabilitation.

(e) **Relocation of Mine Water Dam -** relocation of an 11 megalitre water storage dam, used for pit water storage, to the south-east of its current approved location.



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Rocglen Coal Mine Extension Project
Locality Plan

FIGURE 1

1.2 Methodology and Scope of this Report

This Surface Water Assessment supports the Environmental Assessment to accompany the Part 3A Project Application. The key aspects addressed within the Surface Water Assessment are as follows:

- The collation of relevant data, including meteorological (rainfall events), surface water flow regime (water quality and quantity), catchment characteristics, surface water features, and surrounding land uses. Information has been collected from a literature review of Rocglen Coal Mine and NSW government records, as well as from a site inspection undertaken on 4 February 2010 by Chad Stockham of GSSE;
- The identification of the key issues, relevant assessment criteria and constraints relating to surface water;
- The existing controls for management of surface water at Rocglen Coal Mine;
- The proposed surface water management measures to be implemented throughout the continued operations at Rocglen Coal Mine;
- The recommended safeguards and mitigation measures to be implemented to ensure that potential surface water impacts are managed and appropriate criteria are met;
- Compilation of a detailed site water balance to assist with assessment of water security and predicted discharges;
- Recommendations for ongoing surface water monitoring; and
- An assessment of the impacts of the Project on surface water flows within the Study Area and the surrounding watercourses.

This document fulfils the requirements detailed in the Director-General's Requirements (DGRs) relating to the preparation of a Surface Water Assessment, as discussed further in Section 2.0.

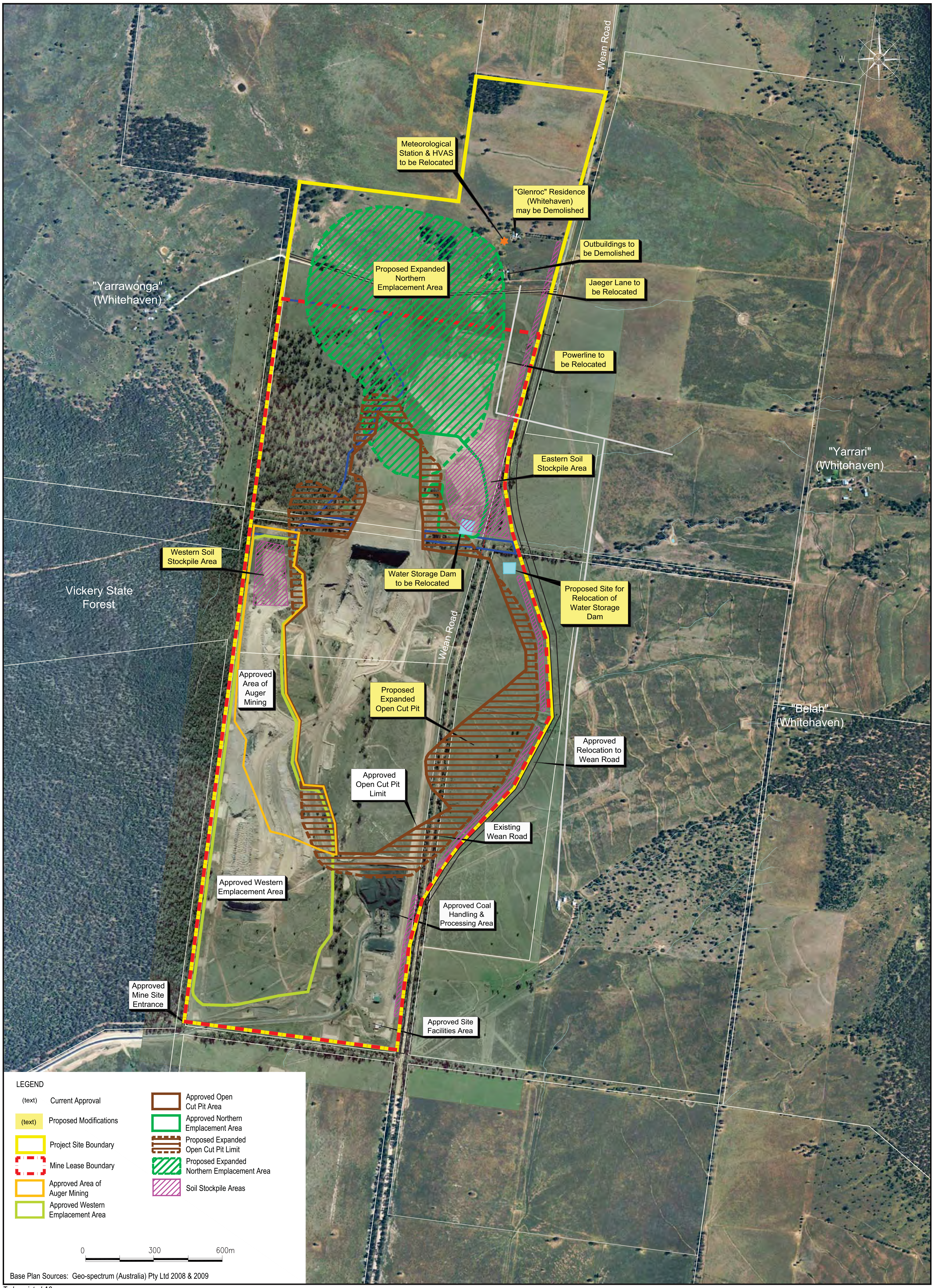
1.3 Study Area

The Study Area for the Surface Water Assessment is shown on **Figure 2** and is in line with the Project Site. Hence, the Study Area for this assessment is referred to as the Project Site in this report. Notwithstanding this, the Surface Water Assessment has also taken into consideration the catchment areas that report to the Project Site from the neighbouring land.

1.4 Objectives

The key objectives of surface water management at Rocglen, as addressed in this assessment, are as follows:

- Prevention of the flow of sediment into watercourses and the flow-on impact of sedimentation on receiving waters, being Driggle Draggle Creek and the Namoi River;
- The management of ephemeral watercourses in accordance with the expectations of the relevant government agencies (primarily the NSW Office of Water (NOW)), including the rehabilitation of the ephemeral watercourses which will be disturbed as part of the continued operations of the Rocglen Coal Mine;
- The control of surface flows on rehabilitated areas to ensure minimal soil loss and adequate soil moisture for plant growth;
- The control of discharges from the site to ensure that all discharges are within the water quality criteria set out in the existing Environmental Protection Licence (EPL);
- Prevention of the inflow of water into the active work area wherever possible;



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Rocglen Coal Mine Extension Project
Project Layout
FIGURE 2

- Minimise site water usage requirements to ensure reliance on groundwater and clean water runoff are both minimised; and
- Ensure there is sufficient water available to meet site water requirements.

1.5 Literature Review

The following project specific documentation has been reviewed by GSSE as part of the Surface Water Assessment:

- *Environmental Assessment of the Belmont Coal Project via Gunnedah*, Whitehaven Coal Mining Pty Ltd prepared by R.W. Corkery and Co. Pty Limited (October 2007);
- *Belmont Coal Project via Gunnedah – Surface Water Assessment Including Surface Water Management Plan,* NSW Department of Lands – Soil Conservation Service (September 2007);
- *Annual Environmental Management Report for the Rocglen Coal Mine*, Whitehaven Coal Mining Pty Ltd (July 2009);
- *Environmental Protection Licence 12870 – Rocglen Coal Mine,* Environmental Protection Authority – NSW (August 2009);
- *Site Water Management Plan for the Rocglen Coal Mine,* RCA Australia (2008);
- *Project Briefing Paper - Rocglen Coal Mine Project,* GSS Environmental on behalf of Whitehaven Coal Limited (December 2009);
- *Belmont Coal Project via Gunnedah – Soils and Land Capability Assessment,* Geoff Cunningham Natural Resource Consultants Pty Ltd (August 2007);
- *Rocglen Coal Mine Extension Project – Soil Survey and Land Resource Impact Assessment,* GSS Environmental (April 2010);
- Surface Water Monitoring Data, Whitehaven Coal Limited (August 2008- July 2009); and
- *Environmental Monitoring – Whitehaven Coal Operations* – Letter dated 19th March 2010 from Danny Young (Whitehaven) to Stephen O'Donoghue (DECCW)

A full list of references used for the development of this Surface Water Assessment is contained in **Section 11**.

2.0 DIRECTOR-GENERAL'S REQUIREMENTS

The Director-General's Requirements (DGRs) for the Project were provided in a letter from the Department of Planning (DoP) on 4 March 2010. **Table 1** provides a summary of the DGRs and related Environmental Assessment Requirements (EARs) provided by other government agencies relating to surface water. **Table 1** also indicates where the specific issues have been addressed within this document.

Table 1 - Summary of DGRs and EARs relevant to Surface Water Assessment

Agency	Details of Requirements	Location in document where addressed
Department of Planning (DoP) – DGRs	The Environmental Assessment of the project must include a detailed assessment of surface and groundwater impacts including:	
	• A detailed site water balance, including a description of site water demands, water disposal methods, water supply infrastructure and water storage structure	Section 7.0
	• A detailed assessment of potential impacts on:	Section 6.0
	o The quality and quantity of existing surface water and ground water resources, over both the short and long term; and	Sections 6.7 & 6.9
	o Affected licensed water users and basic landholder rights; and	
	• A detailed description of the proposed water management system and water monitoring program for the project and other measures to mitigate surface and ground water impacts.	Sections 6.3 & 9.0
NSW Office of Water (NOW) - part of the Department of Environment, Climate Change and Water (DECCW)	The *Environmental Assessment* of the project must address the following:	
	• Adequate and secure water supply for the proposal	Sections 6.11 & 7.0
	• Preparation of a site water balance including identification of site water demands, water sources, water disposal methods and water storage structures. Include methods to maximise water efficiency and hence minimise water loss on site.	Section 7.0
	• Proposed water management on the site	Section 6.3
	• Existing and proposed water licensing on the site including details of all proposed groundwater works	Section 6.9
	• An assessment of impact on adjacent licensed water users, basic landholder rights and groundwater dependant ecosystems	Section 6.9
	• An assessment of the potential impact on groundwater and surface water due to the construction of water storage facilities	Section 6.7
	• An assessment of the potential impact on groundwater and surface water due to the operation of site infrastructure which stores or produces potential contaminants.	Section 6.0
	• Development of adequate mitigating and monitoring requirements to address surface and ground water impacts	Section 6 & 9
	• Identification and assessment of any impacts on watercourses and drainage lines and the future management of these areas	Section 6.7
	The assessment should also consider the impact of the proposal on the watercourses and associated riparian vegetation within the site and provide the following:	

Agency	Details of Requirements	Location in document where addressed
	• Identify the sources of surface water • Details of stream order • Details of any proposed surface water extraction, including purpose, location of existing pumps, dams, diversions, cuttings and levees. • Detailed description of any proposed development or diversion works including all construction, clearing, draining, excavation and filling • A detailed description of the design features and measures to be incorporated into any proposed development to guard against long term actual and potential environmental disturbances, particularly in respect of maintaining the natural hydrological regime and sediment movement patterns and identification of riparian buffers • Details of the impact on water quality and remedial measures proposed to address any possible adverse effects.	Section 6.4 Section 3.6 Section 6.0 Section 6.0 Sections 6.6 & 6.7 & 6.8
	The assessment is required to provide the following information with regards to existing and proposed water management structures/dams • Date of construction (for existing structure/s) • Details of the legal status/approval for existing structure/s. • Details of any proposal to change the purpose of existing structure/s • Details if ay remedial work is required to maintain the integrity of the existing structure/s • Clarification if the structure/s is on a watercourse • Details of the purpose, location and design specifications for the structure/s • Size and storage capacity of the structure/s • Calculation of the Maximum Harvestable Right Dam Capacity (MHRDC) • Details if the structure/s is affected by floods • Details of any proposal for shared use rights, rights and entitlement of the structure/s	Section 6.0 Section 6.0
Department of Environment, Climate Change and Water (DECCW)	DECCW recommends that a water balance be prepared to model water management throughout the life cycle of the mine. A detailed water management plan will be required for control of clean water, sediment laden water from disturbed areas and potentially saline/contaminated water from mining operations and groundwater seepage into the mining void.	Section 7.0 Sections 6.0 & 8.0

<table>
<tr><th>Agency</th><th>Details of Requirements</th><th>Location in document where addressed</th></tr>
<tr><td></td><td>Any modifications to the existing discharge points will need to be identified with estimates of the frequency and volume of discharges and likely water quality for key pollutants including but not limited to:
• Total dissolved and suspended solids;
• Heavy metals;
• Grease and oil;
• nutrients;
• pH;
• Total Organic Carbon; and
• Conductivity.</td><td>Sections 6.10 & 7.4.3</td></tr>
<tr><td></td><td>The EA should consider any proposed discharge in terms of the NSW Water Quality and River flow Objectives and utilising the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000).
In addition, discharges should be guided by the Namoi Catchment Action Plan (CAP) including reference to the NSW Salinity Strategy</td><td>Section 4.0</td></tr>
<tr><td></td><td>Where beneficial reuse of mine water is proposed, an assessment of the long term sustainability of the reuse area will be required, with a specific focus on the management of salt and brine. Assessment should be undertaken against the DECC's "Environmental Guidelines: Use of Effluent by Irrigation"</td><td>Sections 6.0 & 7.0</td></tr>
<tr><td>Department of Industry and Investment – Branch of Fisheries Conservation and Aquaculture</td><td>The Environmental Assessment should specifically address impacts on the aquatic ecology and include description of:
• A topographic map of the locality at a scale of 1:25000 or less detailing the location of all component parts of the proposal, including areas of aquatic habitat and areas of aquatic habitat likely to be impacted
• Description and maps of aquatic habitat areas (creeks and wetlands) within the study area including mapping and description of aquatic and riparian vegetation
• Hydrological information of watercourses such as bed substrate, and flow duration
• The extent of aquatic habitat removal or modification which may result from the proposed development
• Discuss the potential impact of the modification or removal of habitat
• Environmental offsets or compensation for any loss of aquatic habitat
• Aspects of the management of the proposal which relate to impact minimisation</td><td>No area of significant aquatic habitat has been identified.

Watercourses are addressed in Sections 3.0 & 60.</td></tr>
<tr><td></td><td>The Environmental Assessment must also assess the following hydrological aspects of the project:
• Likely impacts on surface water hydrology including the capture of surface water or the redirection of surface water
• The impacts of altered hydrology on associated aquatic ecosystems
• Monitoring of the interaction between surface water and ground water to ensure no negative impacts on surface water quality or quantity</td><td>Sections 6.7, 6.8 & 6.3.4</td></tr>
</table>

Agency	Details of Requirements	Location in document where addressed
	• Assessment of long term impacts on surface water and associated aquatic ecological impacts • Potential amelioration of impacts.	
	The Environmental Assessment must also provide details of existing and proposed riparian buffer zones adjacent to drainage lines and existing waterways.	Sections 3.6 & 6.7

3.0 SURFACE WATER ENVIRONMENT

3.1 Rainfall / Climate

The Project Site is situated in the Namoi River Valley between the tropical and temperate climatic zones, and between the belts of the subtropical highs and the zone of mid latitude westerlies. The climate in the area of the Project Site is characterised by mild to hot summers and cool winters (R.W. Corkery and Co, 2007).

The highest temperatures occur throughout December, January and February, with the coolest temperatures occurring in July. Autumn and spring are generally mild, while winters are cool to cold with overnight lows reaching close to zero on average during winter months.

In summer, synoptic highs dominate the climate while low pressure systems pass at regular intervals bringing milder temperatures and winds from the southerly quadrant. The climate is also influenced by substantial mountain ranges to the east and south and to a lesser extent to the west (R.W. Corkery and Co, 2007).

Whilst rainfall is reasonably well distributed throughout the year; there is a slight peak in the summer months and marginally lower rainfall in autumn. On average, January is the wettest month of the year and April is the driest. The wetter months of December, January and March also have a reasonably low number of mean rain days suggesting the higher volumes of rainfall are associated with higher intensity storms falling over shorter periods of time. Such events are important when designing appropriate surface water management structures. The region is also quite susceptible to extended periods of drought.

The most relevant rainfall data used as input to the detailed water balance has been obtained from an on-site meteorological station at the Rocglen Coal Mine which has operated since April 2009 and from the BOM monitoring station at Boggabri (Retreat) (No. 55044) which has operated since 1899.

Table 2 contains the rainfall statistics for the 10th percentile (dry), 50th percentile (average) and 90th percentile (wet) rainfall years from the Boggabri (Retreat) BOM station. This data assists in the design of appropriate sediment and erosion control structures for the site.

Table 2 - Annual Rainfall Statistics (BOM station No. 55044)

10^{th} Percentile (dry year)	392.5 mm
50^{th} Percentile (median year)	578.0 mm
90^{th} Percentile (wet year)	752.0 mm

Rainfall data from the Boggabri (Retreat) BOM station shows a high correlation with data collected on-site, particularly with the site data collected since the new Rocglen Mine meteorological station was commissioned in April 2009. This is discussed further in **Section 7.3.1**.

Given the long term data available from Boggabri (Retreat) BOM station and the high correlation of this data to the Rocglen meteorological station, it was suitable for the undertaking of a detailed water balance for the site.

3.2 Landform

The Project Site is situated in the Namoi River Basin, within a small north-south tending valley between the isolated elevated areas of Vickery State Forest to the west and Kelvin State Forest to the east. The valley widens to the north and south.

Topography within the local area is irregular with elevations ranging from approximately 885 m AHD in the Kelvin State Forest and 490 m AHD in the Vickery State Forest to approximately 270 m AHD in the southern area of the valley. The eastern and western ridgelines direct runoff into the valley floor with a central crest within the Project Site separating flows to the north and south. The Project Site lies within the valley floor with gentle slopes up to approximately 2%. There are steep slopes to the east associated with the ridgeline of the Kelvin State Forest and also to the west in Vickery State Forest.

3.3 Vegetation

The Flora and Fauna Assessment (RPS, 2010) stated that ground truthing of the vegetation within the Project Site identified five vegetation communities, as follows:

- Narrow-leaved Ironbark (*E. crebra*), White Cypress (*Callitris glaucophylla*) Open Forest;
- Narrow-leaved Grey Box (*E. pilligaensis*), White Cypress (*Callitris glaucophylla*), Narrow-leaved Ironbark (*E. crebra*) Forest;
- Bimble Box *(E. populnea),* Yellow Box (*E. melliodora*) Inland Grey Box (*E. microcarpa),* Grassy Woodland, which RPS (2010) identified as an Endangered Ecological Community (EEC);
- Brigalow, which RPS (2010) also identified as an EEC; and
- Cleared Land with Scattered Trees.

The majority of the drainage lines on site are associated with the vegetation community identified as Cleared Land with Scattered Trees, or the area of existing disturbance, and have no significant riparian vegetation.

There is a small area of the Bimble Box *(E. populnea),* Yellow Box *(E. melliodora)* Inland Grey Box *(E. microcarpa)* Grassy Woodland community located on the upper reaches of Driggle Draggle Creek adjacent to the site boundary in the north-west of the Project Site. This area will not be disturbed as a result of the Project.

3.4 Surrounding Land Uses

The Project Site is located within a rural area, and with the exception of the Vickery State Forest and the Kelvin State Forest, the surrounding land is primarily utilised for traditional agricultural pursuits comprising of a combination of livestock grazing and crop cultivation. No agricultural land within the vicinity of the Project Site is considered sensitive to mining or mining-related activities.

3.5 Soils / Geology

Two soil assessments have been undertaken for the Project Site. The first was undertaken in 2007 for the assessment of the existing approved mine (Cunningham, 2007), with the second undertaken in early 2010 for this Project (GSSE, 2010). There are a total of three soil units identified across the Project Site according to the GSSE survey. The characteristics relating to surface water management of the three soil units is discussed below.

Sodic Brown Alluvial Clays (Brown Dermosol) were found to be located on the lower slopes and flats associated with the existing un-named second order drainage line and headquarters of Driggle Draggle Creek. The soils in this area have been described as having a moderate to high erodibility with moderate to high dispersibilty in the lower subsoils. The soil is generally moderately alkaline and slightly saline at depth. These soils cover the majority of the proposed open cut pit and therefore, the subsoils will be exposed.

Brown Duplex Fine Sandy Loams (Eutrophic Brown Chromosol) were found to be located on the waning mid slopes, generally along the eastern and western sides of the Project Site. The topsoils have been described as relatively stable, however the subsoils were found to be highly dispersive and strongly alkaline. The subsoils were found to be generally non-saline. This soil unit covers the proposed stockpile areas and overburden emplacements, with small sections lying within the proposed open cut pit.

The final soil unit was classified as a Self Mulching Black Earth profile (Self Mulching Back Vertosol) and was found in three isolated areas of the Project Site, generally bordering the above soil units. The soils were found to be strongly alkaline throughout the soil profile. The topsoil was found to be only slightly saline and non-sodic, however the subsoils were found to be sodic and saline at depth.

Generally across the site, the topsoils were found to be stable, non-saline and of neutral pH. However the subsoils were generally found to be moderate to highly dispersive with increasing salinity levels. The pH of the subsoil also tended to increase with depth, with highly alkaline subsoils in some areas. Hence, management of runoff from subsoils with these characteristics will need to be monitored, and specific management controls implemented where water quality monitoring shows alkaline or saline runoff.

3.6 Surface Hydrology

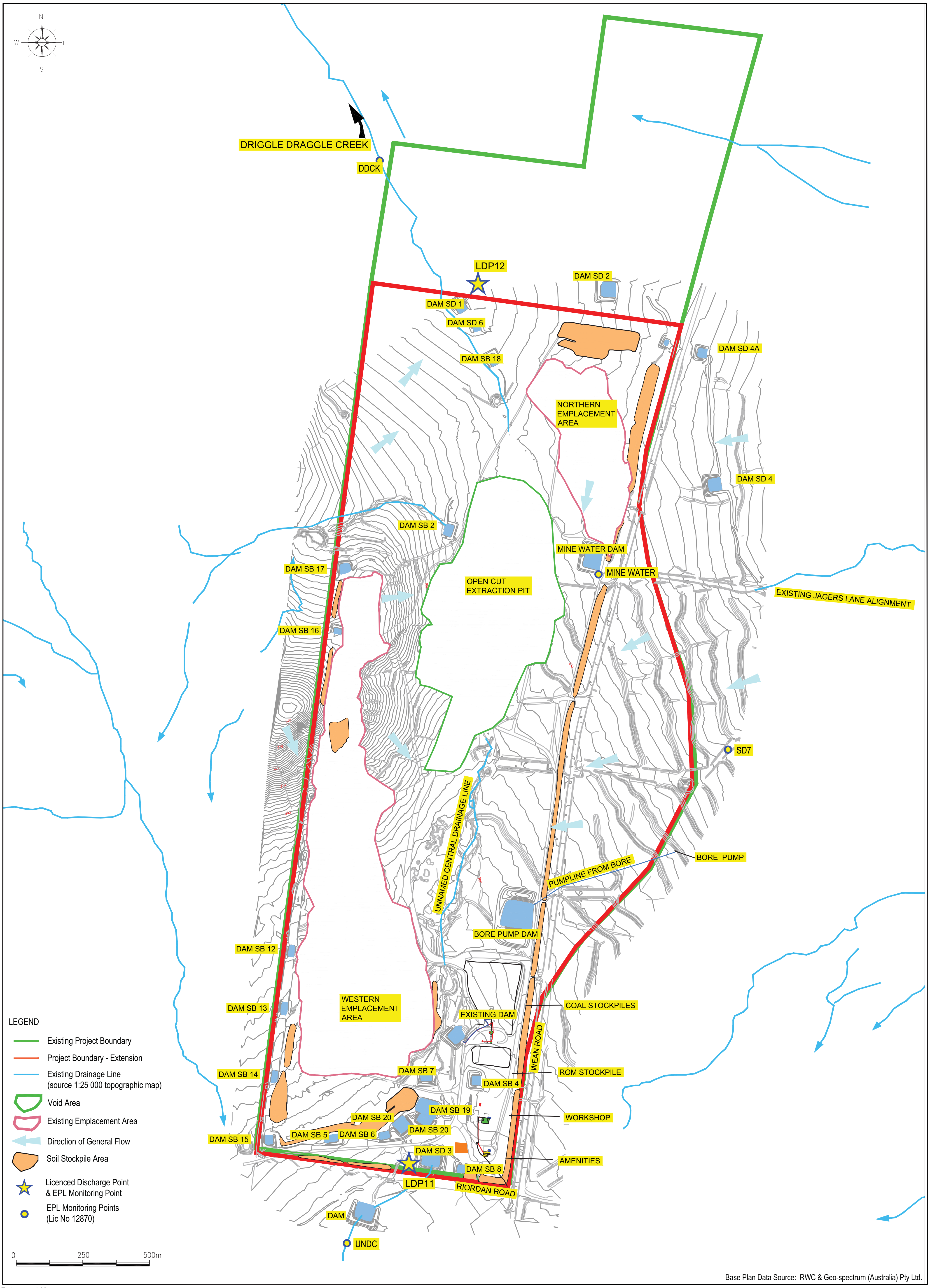
3.6.1 Regional Hydrology

The Project Site lies within the Namoi River catchment area with all areas of the site ultimately draining to the Namoi River. As runoff exits from the south of the Project Site, it reports to the Namoi River via an unnamed flow depression that flows generally in a southerly direction before turning west into the Namoi River approximately 10 km from the Project Site. To the north, runoff from the Project Site reports to Driggle Draggle Creek, which subsequently reports to Namoi River via Barbers Lagoon drainage line approximately 14 km from the Project Site.

3.6.2 Local Hydrology

The Project Site lies within a central crest of the valley floor between the hills of the Vickery State Forest and the Kelvin State Forest. The drainage lines within the area have been altered via previous agricultural activities and the present mining operations of the Rocglen Coal Mine. The existing surface hydrology environment is shown on **Figure 3**.

Prior to mining operations, there are several drainage lines that would have entered the site from the east and drained into the two ephemeral drainage lines that lie within the Project Site. These drainage lines originate from the ridgeline of the Kelvin State Forest and run down into the valley floor. Previous agricultural activities on the neighbouring land to the east of the current alignment of Wean Road, believed to be for soil conservation purposes, have heavily modified the drainage paths that enter the Project Site. The drainage lines now flow into the Project Site via a series of contour drains and dams. The runoff from the eastern catchment is split in two, with Jaeger Lane being the approximate catchment divide. The runoff from the northern section is directed around the northern end of the current mine boundary, whilst runoff from the southern section reports to the approved water management system within the mine (see **Section 5**). The runoff that currently reports to the water



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Rocglen Coal Mine Extension Project
Existing Surface Water Structures

FIGURE 3

management system from the eastern catchment ultimately leaves the site via the southern licensed discharge point (LDP) (see **Section 3.7**).

The catchment lying to the west of the Project Site within the Vickery State Forest has been temporarily diverted around the existing approved mining operations, which previously entered the central drainage line. In the north, a second order ephemeral drainage line has been diverted to the north and into the head waters of Driggle Draggle Creek as part of the existing mine approval with the commitment to re-instate after the completion of mining. To the south, a clean water diversion diverts runoff from the Vickery State Forest around the existing mine site and back into the central drainage line to the south of the mining area.

Within the existing approved mining area, there are currently two major catchments that generally drain north or south. The water is discharged through two (2) LDPs (LDP 11 in the south and LDP 12 in the north) held under the approved Environmental Protection Licence (EPL 12870) for the existing mining operation (see **Section 3.7**).

Surface hydrology in both the northern and southern catchment areas within the existing approved mining area have been heavily disturbed to allow for the effective pollution control of sediments prior to discharge off site through the LDPs. In the southern catchment area, this has resulted in the existing second order ephemeral unnamed central drainage line having had sections being modified into a series of channels and dams which form the current approved water management system for the mine. There are also some isolated parts of the drainage line that remain intact, but these have also been heavily disturbed by past agricultural activities. Where the un-named central drainage line exits the existing mining area in the south, it flows through very flat, heavily disturbed agricultural land. The drainage line has poorly defined bed and banks with no significant riparian vegetation and flows through a series of dams and overland flow paths. The creek is unlikely to provide any significant riparian habitat with no vegetation other than grasses due to previous clearing of the area. This ephemeral creek line is reflective of all water drainage lines running from the Project Site. A photo of this drainage line (looking downstream) immediately downstream of the Project Site is shown in **Plate 1**.

Plate 1 - Un-Named Central Drainage Line
(looking downstream, immediately downstream of the Project Site)

The head waters of Driggle Draggle Creek in the north (first order ephemeral drainage line), where water discharges from the existing mine site, is similar in nature. The drainage line is ephemeral but does have some shallow depressions that hold water. Water flows into the drainage line via existing contour banks and dams associated with the existing approved surface water management system. The creek is very poorly defined and has no significant riparian vegetation, with the exception of the small area of Bimble Box *(E. populnea),* Yellow Box *(E. melliodora),* Inland Grey Box *(E. microcarpa)* Grassy Woodland community as identified by RPS (2010). As stated in **Section 3.3**, this area of vegetation will not be disturbed as a result of the Project. Other than this small area, the drainage line is unlikely to provide any significant riparian habitat with no vegetation other than grasses due to previous clearing of the area. A photo of the drainage line (looking downstream) on which the existing dams are located within the Project Site is shown in **Plate 2**.

Plate 2 - Looking Down Slope at the Head Waters of Driggle Draggle Creek
(poorly defined immediately to the north of the existing mining operation)

Overall the surface hydrology within and immediately surrounding the Project Site (with the exception of the State Forest areas) have been heavily disturbed by past agricultural activities and altered within areas of the Project Site via the existing approved mining operations. No drainage lines within the Project Site were found to contain significant riparian vegetation with the majority of the drainage lines having poorly defined bed and banks.

3.7 Licensed Discharge Points

Rocglen Coal Mine currently has two DECCW LDPs covered under EPL 12870 for their existing operations. They both allow for wet weather discharges, with LDP 11 located at the outlet of Storage Dam SD3 at the southern end of the Project Site and LDP 12 located on the northern boundary of the Project Site. They both have concentration limit conditions placed on them to ensure the water discharge is of a suitable quality (see **Section 3.8**). The locations of the LDPs are shown on **Figure 3**.

3.8 Existing Surface Water Quality and Assessment Criteria

3.8.1 Regulatory Assessment Criteria

Impact assessment criteria for surface water are only relevant to water actually discharging from the Project Site. DECCW have included criteria in the EPL 12870 for the wet weather discharge points (otherwise known as the LDPs). The concentration limits set in the licence for both discharge locations are presented in **Table 3**.

Table 3 - Concentration Limits for LDP 11 and LDP 12 (EPL 12870)

Pollutant	Unit of Measure	100th percentile Concentration Limit
Oil and Grease	mg/L	10
pH	pH	6.5 – 8.5
Total Suspended Solids	mg/L	50*

** The total suspended solids concentration limits may be exceeded for water discharge provided that:*

- *The discharge occurs solely as a result of rainfall measured at the premises that exceeds 38.4 mm over any consecutive 5 day period immediately prior to the discharge occurring; and*
- *All practical measures have been implemented to dewater all sediment dams within 5 days of rainfall such that they have sufficient capacity to store run off from a 38.4 mm, 5 day rainfall event.*

Whilst there are no concentration limits for Conductivity and Total Organic Carbon, these parameters also have to be monitored at the LDPs. There are currently no volumetric limits placed on the LDPs.

While no concentration limits are specified, there are also requirements under the EPL 12870 to monitor the pollutant concentration at various sites within and surrounding the Project site, as well as yearly monitoring of numerous heavy metals in the Mine Water Dam. Further details of required monitoring for the Project is presented in **Section 9**.

3.8.2 Operational Criteria

In addition to the regulatory assessment criteria contained in the EPL, in the current Site Water Management Plan (SWMP) prepared by RCA in 2008, the Proponent has adopted numerous operational criteria for water quality discharged from the site during current operations. This criteria is outlined below in **Table 4**.

Table 4 – Operational Criteria adopted by the Proponent for Current Operations

Pollutant	Unit of Measure	50th percentile Concentration Limit	90th percentile Concentration Limit	100th percentile Concentration Limit
Total Suspended Solids	mg/L	≤20	≤35	≤50
Electrical Conductivity	us/cm	-	-	<350
Oil and Grease	mg/L	-	-	≤10
pH	pH	-	-	6.5 – 8.5

Whilst the operational criteria was developed prior to the EPL 12870 being obtained, three of the four 100th percentile concentration limits are included in the EPL.

3.8.3 Existing Surface Water Quality

The proponent currently undertakes water quality monitoring in line with the current SWMP (RCA, 2008). As stated above, there are also requirements under EPL 12870 to undertake routine monitoring in the mine water dam along with other locations during flow events. The following section summaries the results of this monitoring.

3.8.3.1 Baseline Water Quality Data (prior to mining)

Due to the ephemeral nature of the drainage lines located in the surrounds of the Project Site (including the un-named central drainage channel and Driggle Draggle Creek), limited baseline data was collected prior to the existing mining approval in 2008.

This makes the water quality results collected at the mine site, at this point in time, difficult to analyse. There was limited data collected in 2002, including six samples taken along different locations of the un-named central drainage line and one sample from Driggle Draggle Creek. This data has been sourced from the current SWMP (RCA, 2008) and is presented below in **Table 5**.

Table 5 – Baseline Local and Project Site Water Quality

Parameter	Unit	Sample Site							ANZECC Guidelines[3]
		BS[1]-1	WW[2]-1	WW-2	WW-3	WW-4	WW-5	WW-6	
Total Phosphorus	mg/L	4.7	NR	96.0	97.2	98.7	102.3	NR	0.02
Nitrogen (Nitrate)	mg/L	<0.01	NR	6	2	4	5	NR	0.7
Sulphate	mg/L	11	1	10	9	9	8	1	-
Bicarbonate	mg/L	41	48	81	96	107	73	50	-
Chloride	mg/L	56	2	6	4	5	8	3	-
Cadmium	mg/L	<0.001	NR	<0.001	<0.001	<0.001	<0.001	NR	0.00084
Lead	mg/L	<0.001	NR	0.02	0.02	<0.001	0.02	NR	0.02584
Zinc	mg/L	0.01	NR	0.02	0.02	0.01	0.02	NR	0.0312
Copper	mg/L	0.006	NR	<0.01	0.01	0.01	0.01	NR	0.00546
Manganese	mg/L	0.008	NR	0.15	0.05	0.12	0.20	NR	1.9
Iron	mg/L	29	5	13	8	7	19	20	-
Potassium	mg/L	27	5	14	9	13	5	5	-
Sodium	mg/L	43	11	12	13	14	42	19	-
Magnesium	mg/L	3	2	5	10	5	4	2	-
Calcium	mg/L	8	6	12	12	19	9	5	-
Conductivity	us/cm	360	98	151	165	185	154	98	30-350
pH	--	6.9	6.8	8.8	8.4	9.1	8.4	7.8	6.5-8.0

[1]*BS – Sample from Un-named Central Drainage Line*
[2]*WW – Sample from Driggle Draggle Creek*
[3] *Key default trigger values presented in ANZECC 2000 for slightly disturbed upland rivers in NSW (refer to Section 4.3.3). Heavy metals based on hard water (120-179 mg$CaCO_3$/L)*

The most relevant water quality guidelines for the area in the absence of more baseline data is the default trigger values presented in Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000) for slightly disturbed upland rivers in NSW. The one baseline water quality sample taken from the un-named drainage line showed that there were high amounts of total phosphorous and conductivity levels slightly above ANZECC guidelines.

The samples taken along Driggle Draggle Creek showed a high nutrient load, with high phosphorous and nitrate readings. The water was also slightly alkaline with four of the six readings above the ANZECC pH guideline of 8.0

Whilst the data is very limited, it does show slightly alkaline water quality in the region along with high nutrient levels. Unfortunately no analysis of total suspended solids (TSS) was reported.

3.8.3.2 Wet Weather Discharge Data

EPL 12870 outlines that surface water monitoring must be undertaken at nominated sampling locations during or immediately following discharge events where surface waters discharge off site. Since the site began operating under EPL 12870 in July 2008, there have been a total of ten discharges from the existing operations. All these discharges occurred between the period of 29 December 2009 and 20 August 2010 when the site received well above average rainfalls with 470.6 mm recorded at the site weather station over the three month period (the rainfall gauge was broken for a certain periods during the three months. A total of 658.4 mm was recorded at Gunnedah BOM Station during the same period). The water quality for these discharges is provided in **Table 6**.

Table 6 - Wet Weather Discharge Data

Sample Location	Date of Samples	pH	Electrical Conductivity (µS/cm)	Total Suspended Solids (mg/L)	Total Organic Carbon (TOC)	Grease & Oil (mg/L)	Preceding 5 Day Rainfall Totals (mm)
LDP 11 (SD3)	29-12-09	7.51	180	552	4	N/A	79.6
	04-01-10	7.74	325	1490	2	<5	25.2
	08-02-10	7.87	323	157	6	6	NR
	15-02-10	7.48	329	406	3	<5	51.2
	31-03-10	8.14	435	108	12	<5	46.6
	02-06-10	8.21	410	260	35	<5	27.0
	26-07-10*	8.34	458	17	5	<5	
	28-07-10	8.23	437	23	4	<5	23.2
	11-08-10	8.04	466	54	6	<5	26.0
	20-08-10	8.04	508	172	10	<5	15.4
LDP 12 (SB18)	15-01-10	7.51	356	1490	3	<5	21.6
	15-02-10	7.37	395	556	5	<5	51.2
	11-08-10	7.37	261	2320	5	<5	26.0
	20-08-10	7.37	422	2300	10	<5	15.4
UNDC (below LDP11)	29-12-09	6.87	94	236	7	N/A	79.6
	04-01-10	7.37	467	34	17	6	25.2
	15-02-10	7.15	318	186	8	<5	51.2
	03-08-10	7.43	109	45	17	<5	
	11-08-10	7.72	333	116	12	<5	
	20-08-10	7.9	390	152	25	<5	
DDCK (below LDP12)	15-01-10	6.86	338	157	6	6	21.6
	15-02-10	7.37	359	15	6	<5	51.2
	10-08-10	7.4	151	964	12	<5	
	20-08-10	7.96	344	912	20	<5	

NR – Site Weather Station broken during this period
UNDC – Un-named drainage channel
DDCK – Driggle Draggle Creek
SD – Storage Dam
SB – Sediment Basin
** - controlled discharge*

During several discharge events, the total suspended solids (TSS) concentration exceeded the 100% concentration limit of 50 mg/L at the LDPs. A number of these events may be found to be in non-compliance with the EPL due to the events not occurring when the previous 5 day rainfall amount is greater than 38.3 mm.

The first of these events occurred on the 4 January 2010, when an additional 25.2 mm of rain was received following the heavy rain received at the end of December 2009 leading to the discharge on the 29 December. Whilst the TSS concentration was above 50 mg/L at the discharge point, downstream in the un-named drainage channel (UNDC) the concentration had reduced to below 50 mg/L at 34 mg/L. The second discharge event, which occurred with less than 38.3 mm of rainfall received in the 5 days prior to a discharge, was on the 15 January 2010. This discharge was from LDP 12 in the north of the site. The TSS concentration downstream of LDP 12 in Driggle Draggle Creek was also above the 50 mg/L limit but had greatly reduced.

In letters dated 19 March 2010 and 27 September from the Proponent to the DECCW detailing the above events, it was reported that due to earthworks associated with increasing the capacity of Sediment Basin SB19 there was significant amounts of disturbance immediately upstream of LDP 11. With the large volume of rainfall received immediately following construction, it resulted in significant sediment flow into Storage Dam SD3 and insufficient time to settle out prior to additional rain causing frequent discharge. Since March, above average rainfall has exacerbated water management issues on site, with rainfall and runoff volumes exceeding the sites capacity for use of water prior to discharge. As a consequence of the above events the Proponent has taken action through the trialing of Floc Blocs and liquid flocculant in SD3 and SB18 to increase setting rates by chemical flocculation. The flocculation visibly reduced the sediment level of the dams, with surface water sampling during 2010 identifying significantly reduced TSS levels in SD3 . Whilst effective, the use of floc blocs proved a relatively slow process and as a consequence, the site has commenced use of liquid flocculants to further enhance capacity for assisting the settling of sediment.

Further recommended management strategies and best management practices (BMPs) to help reduce and manage the TSS concentrations on site in the future are described in **Section 6.5**.

3.8.3.3 Dry Weather / Operational Water Quality Monitoring Data

In addition to the wet weather discharge monitoring undertaken at the site, monitoring has been undertaken to meet the requirements of the EPL and existing SWMP. A summary of the results, including average values where applicable, is presented in **Table 7**.

Table 7 – Dry Weather / Operational Water Quality Monitoring Results.

Sample Location	Date of Samples	pH	Electrical Conductivity (µS/cm)	Total Suspended Solids (mg/L)	Total Organic Carbon (TOC)	Grease & Oil (mg/L)
Open Cut Extraction Pit Water (contained on-site)						
Mine Water Dam	24-06-09	9.3	1540	216	20	<10
	27-08-09	8.85	2260	60	3	<10
	16-12-09	9.15	4210	14	4	<10
	25-02-10	8.99	1390	106	5	<5
	12-05-10	8.9	2470	20	3	<5
	09-08-10	8.56	2330	8	2	<5
	08-11-10	9.12	2330	16	2	<5
	Mean	(8.9)	(2361)	(63)	(5)	(--)
Dirty Water (controlled discharged through LDP 11 at the south of the site as required)						
UNDC (downstream of site below LDP 11)	23-09-08	7.70	150	510	NS	<2
	17-12-08	6.60	145	21	NS	<2
	Mean	(7.15)	(147.5)	(265.5)	(--)	(<2)
SB8 (near offices)	17-12-08	7.80	295	1080	--	<2
	26-07-10	8.30	458	17	5	<5
	Mean	(8.05)	(376.5)	(548.5)	(5)	(--)
SB3	24-06-09	8.36	502	110	10	<10
	27-08-09	8.86	504	66	10	<10
	30-11-09	7.78	620	128	3	<10
	25-02-10	8.34	423	56	15	<5
	12-05-10	8.20	565	64	7	<5
	Mean	(8.31)	(522.8)	(84.8)	(9)	(--)
SD3* (at LDP 11)	24-06-09	8.56	354	1340	35	<10
	27-08-09	8.34	587	71	8	<10
	25-02-10	8.44	374	37	5	<5
	25-03-10	8.71	445	58		<5
	07-05-10	8.26	434	13		<5
	12-05-10	8.42	422	19	14	
	24-05-10	8.57	412	92	4	6
	09-08-10	7.62	458	239	12	<5
	12-10-10	8.31	575	11	5	
	02-11-10	8.25	478	33	6	<5
	08-11-10	8.42	472	107	7	<5
	25-11-10	7.40	522	52	9	
	Mean	(8.28)	(461)	(172.7)	(10.5)	(--)
SB7 (southern end)	16-12-09	9.38	600	18	8	<10
SB5 (southern end)	16-12-09	8.90	1440	50	7	<10
SB14 (southern end)	16-12-09	8.76	577	50	7	<10

** Not discharging at the time*
NS - Not sampled
UNDC – un-named drainage channel
SB – Sediment Basin
SD – Storage Dam

The water quality results shown in **Table 7**, reflects the high TSS concentrations observed during wet weather discharges. There were periods where the TSS concentrations dropped below 50 mg/L, especially during mid December 2009 and again during 2010, with particular efforts focussed on SD3 and the use of flocculants. Prior to this, there was well below average rainfall received during October and November 2009, with only 20.2 mm of rainfall recorded at the mine site's weather station over this period. This supports the soil survey findings that the subsoils on site are highly dispersive and take considerable amount of time to settle from the water column. Proposed management of these dispersive soils for the Project are discussed in **Section 6**.

The water analysis of electrical conductivity (EC) has shown a slight increase in the Mine Water Dam. This may be a result of the samples being taken over a dry period with evaporation rates exceeding runoff leading to a concentration of the salts. In addition, the mine water dam was also a receiving location for waters trucked to site from a Santos Gas trial well as a water re-use scheme approved through DECCW, NOW and I&I over the period of August to December 2009. The waters received from this scheme were generally higher in EC concentration, as well as higher pH which would have influenced the higher pH and EC readings in the December sampling run. The TSS concentrations in the Mine Water Dam also reduced over this period due to the dry conditions increasing retention times, allowing the sediment time to settle.

The remaining EC readings from water analysis within the dirty water system generally showed only a slight increase from the limited background data available. Although there is a lack of background data, according to the Namoi Catchment Action Plan, a number of major tributaries within the catchment have inherently high salinity levels including Goonoo Goonoo Creek, Mooki River, Upper Manilla River, Quirindi Creek and Werris Creek. Bomera Creek, in the Upper Coxs sub-catchment, historically has the highest salinity levels, whilst the Macdonald River at Bendemeer is the only site where readings are routinely below the ANZECC trigger value. As outlined in the existing (**Section 5**) and proposed (**Section 6**) water management systems, preferential use of this water for dust suppression to ensure it is contained within the site will limit the potential release of saline water to surrounding watercourses.

The water testing has also showed slightly higher alkaline water being held in the dirty water dams collecting runoff from the emplacement areas than in surrounding watercourses. This is due to the subsoils being more alkaline than the topsoils and when exposed to rainfall they produce higher alkaline runoff. These subsoil properties are typical for the region, with reduced leaching caused by higher evaporation rates than rainfall received. The pH levels will continue to be monitored, with possible neutralisation techniques investigated if required.

3.9 Existing Flow Regimes

While all existing drainage lines that report to or lie within the Project Site are ephemeral in nature, they have very little flow primarily due to previous soil conservation works and mining activities that have substantially diverted and dammed the drainage lines.

Due to the extensive modification, the central drainage line now consists of a series of dams. For the majority of the time there is no off-site discharge from this drainage line, however, under high rainfall conditions, discharge events have occurred, as discussed in **Section 3.8.3.2.**

3.10 Surface Water Features of Conservation Significance

Based on existing documentation and the site visit conducted in February 2010, there were no surface water features found within the Project Site to have conservation significance.

4.0 RELEVANT LEGISLATION, POLICY AND GUIDELINES

4.1 Introduction

A number of legislative requirements, government policies and guidelines relating to surface water management are applicable to the Project and have been considered in this Surface Water Assessment. The relevant policies, guidelines and legislative requirements are summarised below.

4.2 Legislation

4.2.1 Water Act 1912 and Water Management Act 2000

The *Water Act 1912* and *Water Management Act 2000* (WM Act) contain provisions for the licensing of water capture and use. If any dams are proposed as part of the water management, consideration must be given to whether the dams need to be licensed. There is currently an embargo in place for commercial licences in the area, which includes the Project Site, under gazette number 35 (17 March 2006). As a result, if the Proponent wishes to construct any new dams that will require a licence, it will be necessary to transfer an existing water access licence to the new location. There are currently no new 'clean' water dams proposed for the Project. There are new 'dirty' water dams (or pollution control dams) proposed for the purpose of erosion and sediment control, however these are exempt from the licensing requirements. It must be noted that the existing dams within the Project Site currently collecting 'clean' water are within the harvestable right of the property.

There are currently three water licences held under the existing approval for the purposes of mining and dewatering, with two of these licences having a combined total allocation of 120 ML and the other licence having a total of 700 ML. The 700 ML licence is for the potential interception of groundwater within the open cut extraction pit. For further information on these groundwater licences, please refer to the *Hydrogeological Assessment for Rocglen Coal Mine Extension Project* (Douglas Partners, 2010).

There is a Water Sharing Plan in place for the *Upper Namoi and Lower Namoi Regulated River Water Sources (2003)*. This Plan, however, only applies to those areas classed as 'water sources', with the drainage lines within and surrounding the Project Site not covered. On this basis, the rules and regulations contained within the Water Sharing Plan to not apply to the Project Site.

A controlled activity approval under the WM Act is typically not required for surface mining activities due to current surface mining lease/s being held and exemptions for Part 3A Major Projects (Section 91 of WM Act). However the general standards used by the NSW Office of Water (NOW) in implementing the WM Act still need to be adhered to. In this regard, any guidelines referred to by the NOW and the feedback provided by departmental officers should be considered. GSSE has considered the '*Guidelines for Controlled Activities – Riparian Corridors*' and '*Guidelines for Controlled Activities – In-Stream Works*' for watercourse rehabilitation and riparian zone rehabilitation.

4.2.2 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) is relevant to the Project as it contains requirements relating to the prevention of the pollution of waters. In this regard the discharge of water from the Project Site will need to be controlled to an agreed standard to reduce the potential for pollution of the receiving waters. As outlined above, the Proponent has an existing EPL under the POEO Act for the discharge of 'dirty' water from site. As an outcome of this Surface Water Assessment, there will be no additional discharge points required for the site. The northern discharge point (LDP12), however, will need to be moved further north to the edge of the Project Site, and, as such, the Proponent will be required to seek a variation to the existing EPL under the POEO Act to change the LDP location.

4.3 Policies and Guidelines

4.3.1 Namoi Catchment Action Plan

The Project Site is situated within the Namoi River Catchment and is covered by the Namoi Catchment Management Authority (CMA). In January 2007, the Namoi CMA published the *Namoi Catchment Action Plan* (CAP). The CAP identifies catchment issues and sets measurable management targets with respect to land practices and water quality. The management targets address issues identified as having the most significant impact on the four catchment resources, being the landscape, people and their communities, native plants and animals, and surface and groundwater systems. For surface and groundwater systems, the overriding catchment target is:

From 2006, there is an improvement in the condition of surface and ground water ecosystems.

There are a total of four management targets which underpin this catchment target including one with regards to surface and groundwater (MTW2). This target specifies:

From 2006, maintain or improve surface and ground water quality suitable for irrigation, raw drinking water and aquatic ecosystem protection at Gunnedah, Narrabri and Goangra. Target values are as determined by:

(a) *Australian & New Zealand Environmental Conservation Council Guidelines 2000, for Irrigation Water - Electrical conductivity range of 650 –1300µS/cm; and Aquatic Ecosystem Protection - mean values of Total Endosulphan < 0.03 µS/Litre and Atrazine < 0.7 µS/Litre.*

(b) *MDBC; River Salinity of 550 µS/cm 50% of the time and < 1000 µS/cm 80% of the time at Goangra (at time of writing the CAP).*

The CAP states that the underlying principle to achieving many of these targets is through the use of Best Management Practice's (BMP). The management controls presented in **Section 6** for the continued operations at Rocglen, are based on BMPs, including those presented in the *Blue Book.*

4.3.2 NSW Water Quality and River Flow Objectives

*NSW Water Quality and River Flow Objectives w*ere established by the NSW Government in September 1999 for the majority of NSW catchments. Eleven water quality objectives (WQOs) were developed for NSW rivers and estuaries and these provided guideline levels to assist water quality planning and management. According to the Namoi River Objectives, the streams located within and reporting to the Project Site are classified as "Uncontrolled Streams".

There are numerous WQOs for "Uncontrolled Streams" within the Namoi catchment depending upon the environmental values within the area. The most relevant of these objectives for the Project Site are - (a) aquatic ecosystems (maintaining or improving the ecological condition of waterbodies and their riparian zones over the long term) and (b) livestock water supply (protecting water quality to maximise the protection of healthy livestock).

The aquatic ecosystem objective is directly in-line with the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC 2000) default trigger values for slightly disturbed ecosystems in south-east Australia. These values are presented below in **Table 9**.

The livestock water supply objective is based on four key indicators. These indicators and their numerical trigger values are summarised below in **Table 8**.

Table 8 – Livestock Water Supply Guidelines for Uncontrolled Streams in the Namoi Catchment

Indicator	Numerical Criteria (trigger values)
Algae and Blue-Green Algae	Increased risk when Microcystins >11 500cells/mL and/or >2.3µg/L expressed as microcystin-LR toxicity equivalents
Salinity (electrical conductivity)	For no adverse effect – Poultry at 0 - 2985 µS/cm Dairy Cattle 0 - 3731 µS/cm Beef Cattle, Pigs, Horses at 0 - 5970 µS/cm Sheep 0 - 7462 µS/cm
Thermotolerant coliforms (faecal coliforms)	<100 thermotolerant coliforms per 100 mL (median value)
Chemical contaminants	See Table 4.3.2 of ANZECC Guidelines

The trigger values for livestock water supply are significantly higher than the trigger values for aquatic ecosystems (See **Section 4.3.3**). The Project is seeking to comply with the more conservative aquatic ecosystem trigger values.

4.3.3 ANZECC Guidelines

Water quality impacts will be assessed for aquatic ecosystems in accordance with the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC, 2000). The watercourses within the site are considered to be '*highly disturbed ecosystems*' as described in the ANZECC Guidelines, and the elevation of the site places the site in the '*upland river ecosystem'* category. Whilst ANZECC suggests that less conservative trigger values may be adopted for '*highly disturbed ecosystems'*, this assessment has used the default ANZECC trigger values as a benchmark. Key default trigger values presented in ANZECC 2000 for slightly disturbed upland rivers in NSW are shown below in **Table 9**.

Table 9 - Key Default Trigger Values for Slightly Disturbed Upland NSW Rivers (ANZECC 2000)

Indicator	Trigger Value
pH	6.5 – 8.0
Conductivity (µS/cm)	30 - 350
Turbidity (NTU)	2 - 25
Total Phosphorus (µg/L)	20
Total Nitrogen (µg/L)	250
Dissolved Oxygen (% saturation)	90 -100%
Aluminium (mg/L)	0.055
Cadmium (mg/L)	0.0005[1]
Copper (mg/L)	0.004[1]
Lead (mg/L)	0.014[1]
Nickel (mg/L)	0.028[1]
Zinc (mg/L)	0.020[1]

1. Range based on lower 85% saturation limit and typical water temperature range 13- 20^{o}C
2. Trigger values for the slightly disturbed lowland river aquatic ecosystems
3. Modified trigger levels, factored based on typical moderate water hardness (60-119 mg/L as $CaCO_3$)

The existing Rocglen operation currently adopts the EPL concentration limits as assessment criteria for pH and TSS as opposed to the ANZECC Guidelines. It does however adopt the ANZECC upper limit of 350 µS/cm for conductivity. There are numerous other default trigger values for various indicators presented in ANZECC, but due to there being currently insufficient water quality data available from the Project Site, these trigger values are impractical to adopt.

With on-going surface water monitoring, the Proponent will be able to hold discussions with the DECCW to possibly establish more suitable assessment criteria for other indicators.

4.3.4 Managing Urban Stormwater

In NSW, the most relevant and comprehensive guidelines for the designs of stormwater controls relating to mines is contained in *Managing Urban Stormwater: Soils and Construction Vol 2E – Mines and Quarries* (DECC, 2008) in conjunction with the references to Volume 1 (Landcom, 2004). Both of these references are referred to in this report as the *Blue Book*. The principles of surface water control, including the design of erosion and sediment control structures, have been adopted where applicable in this Surface Water Assessment.

4.3.5 NSW State Rivers and Estuaries Policy

The *NSW State Rivers and Estuaries Policy* contains state-wide objectives for the protection and enhancement of watercourses. The proposed surface water management should be consistent with the Policy objectives. The key aspect of this would be to demonstrate that there is no degradation of Driggle Draggle Creek or the Namoi River as a result of mining activities.

4.3.6 NSW Farm Dams Policy

The *NSW Farm Dams Policy* was introduced in 1999. Under this policy it is not necessary to obtain a licence or other consent from the DECCW for a farm dam provided:

- They are not collecting flow from a major stream; and
- The combined capacity does not exceed the Maximum Harvestable Rights Dams Capacity (MHRDC) for the property.

5.0 EXISTING SURFACE WATER MANAGEMENT

The existing SWMP for the Rocglen Coal Mine was prepared in compliance with Condition 2 of Schedule 3 of the Project Approval issued by the DoP in April 2008 under PA 06_0198. A copy of this existing SWMP is contained in **Appendix A**. The SWMP was prepared in 2008 by RCA Australia in collaboration with the Soil Conservation Service (SCS), which is a business unit of the NSW Department of Lands. The SWMP builds upon and refines the water management concepts outlined in the 2007 Environmental Assessment.

In summary, the principal objectives of the existing SWMP are to:

- Ensure sufficient quantities of water are available to meet the requirements of the mine operation while adhering to the company's harvestable quota;
- Ensure the segregation of "clean" and "dirty" waters through the use of a series of sediment basins and storage dams;
- Ensure the treatment of contaminated waters originating from the workshop area;
- Minimise the volume of water discharged from the mine site and where discharge is required ensure that water quality meets the water quality guidelines outlined in the EPL;
- Ensure the segregation of "pit" water from surface flows;
- Minimise erosion and sedimentation from active areas of the mine site;
- Minimise surface water and ground water impacts on surrounding landholders;
- Establish and maintain monitoring programs to oversee the effectiveness of controls, and; ensure the appropriate level of protection of water resources.

The locations of the approved water management structures explained below for the currently approved mine operation are shown on **Figure 3**, which has been developed from the SWMP (RCA, 2008) and recent site information.

Current water management is partially segregated into clean and dirty water systems and is achieved through the use of purpose built controls. These controls were constructed in accordance with design criteria outlined in the SCS's Design Manual (SCS, 1990). An outline of the design specifications is provided in the SWMP (RCA, 2008).

Clean water management comprises diversion of clean water away from disturbed areas through diversion banks and waterways, and includes retention in clean water storage dams.

Dirty water management comprises capture and treatment of runoff water from disturbed areas across the site. The majority of surface water drains to the south end of the site via catch banks where it is captured and treated within a series of interconnected sediment basins prior to reuse on the site or discharged through LDP 11. A small part of the site (primarily the northern soil stockpile area) drains to the north where it is directed to a sediment basin prior to discharge through LDP 12.

Sediment basins located on the site, excluding the Mine Water Dam, have a combined total storage capacity of 36 ML. Captured water is re-used on-site for dust suppression, including around the crushing and screening operations.

As outlined in **Section 3.8,** there have been a total of 10 wet weather discharge events at the site since operations commenced in 2008.

In addition to the general description above, the current water management system also includes:

- Sediment Basin (SB4) to specifically contain and treat flows from the ROM pad area;
- Sediment Basin (SB8) to specifically contain and treat flows from the facilities/amenities area;
- Mine Water Dam for water to be pumped to and from the open cut extraction pit;
- Bore Pump Dam for water to be pumped to and from a groundwater bore; and
- Various clean water storage dams (with Maximum Harvestable Right Dam Capacity).

The existing water management system has adequately managed water for the mining operations with the exception of elevated TSS in surface water during discharge events (see **Section 3.8**). The proposed expansion of operations requires extension and modification to the water management items and will include the refinement of the sediment controls to address elevated TSS occurring during wet weather discharge.

The following changes are proposed as part of the Project:

- Additional water management controls to deal with water from increased disturbance footprint in the northern area of the site;
- Additional water management controls to address TSS issues during wet weather discharge;
- Relocation of the Mine Water Dam; and
- More effective diversion of clean water from off-site catchments to the east.

These are discussed in further detailed in **Section 6**.

6.0 SURFACE WATER IMPACTS AND PROPOSED MANAGEMENT MEASURES

6.1 Introduction

The following section outlines the anticipated surface water impacts, and the proposed surface water management measures to be implemented for the Project. The proposed Rocglen Extension Project would occur progressively as the mine resources are depleted. As a result, associated changes in water management will be implemented to ensure the effective control of potentially polluted water, as well as ensuring the water demands of the Project are met at various stages of the mine life. Water management measures are described for three key scenarios in the operational (mining) phase, as well as a brief overview of drainage controls to be implemented on the final landform of the mine site in **Section 6.3**.

6.2 Objectives

The principle objective of surface water management at the mine site is to segregate clean and dirty water flows and to minimise surface flows across disturbed areas. The key water management strategies proposed to be adopted across the Project Site are summarised as follows:

1. Dirty water generated from disturbed areas, such as the soil stockpile areas and overburden emplacement areas, as a result of rainfall/runoff would be captured and diverted using contour banks and drop structures in a manner that minimises the potential for concentrated overland flow and subsequent erosion. This water would be channelled through a series of sediment basins to reduce sediment loads prior to discharge.
2. Water generated within the open cut pit, primarily as a result of rainfall/runoff and possible groundwater seepage, would be managed within the open cut via in-pit sumps. This water would be directed to and contained within these in-pit sumps until it is necessary to pump the water to the Mine Water Dam (proposed to be relocated as part of the Project), which will be specifically constructed (‘turkeys nest’) to receive mine water from these sumps.
3. Clean water diversions should be constructed wherever possible upstream of disturbance areas, such as the open cut pit and overburden emplacement areas, to minimise the amount of dirty water to be contained and treated within the dirty water management system. The primary function of these clean water diversions will be to redirect clean water flowing onto the Project Site from adjacent lands (including agricultural land and the Vickery State Forest) and into existing drainage lines.
4. Progressive rehabilitation of all formed surfaces, such as shaped overburden emplacement areas, long-term soil stockpiles and drainage lines, should occur to help reduce the amount of TSS (and possible high pH and salinity) in runoff from disturbed areas. This would also reduce the dependence on the sediment controls and help improve water quality.
5. Re-use of as much water as possible collected in the open cut extraction pit and/or dirty water dams for dust suppression purposes. There should also be the preferential use of water on-site to minimise the chance of pollution to downstream waterways.
6. Sediment control structures should be maintained to ensure the design capacities are maintained for optimum settling rates. This would be most critical for those ‘end-of-line’ sediment basins which discharge from the Project Site.
7. Effective revegetation, maintenance and monitoring program for the site.

6.3 Proposed Water Management System

A number of mitigation measures are recommended for implementation at Rocglen to ensure the effective management of surface water on-site and minimise the risk of any off-site impacts on surface water resources. An overview of the proposed water management system, which incorporates these measures at four key stages of the life of the mine, is provided below. The following sections also describe how these measures will specifically be applied to the various areas of the Project Site throughout the life of the mine.

The proposed water management for Years 1, 5 and 10 of the proposed Rocglen Extension Project are illustrated on **Figure 4**, with the final landform shown on **Figure 5**.

6.3.1 Scenario 1 - Year 1 of Expanded Operation

The short term surface water management system for the site focuses on water management measures to be implemented for Year 1 of the expanded operation (see **Figure 4**). The system is divided into three management areas depending upon the characteristics of the runoff, with these being for clean water management, dirty water management and mine water management. All three systems should largely operate independently. The proposed management system has been integrated into the existing system, with additional measures implemented to target the existing suspended solids pollution problem at the site.

The proposed configuration of the mitigation measures for the surface water system in Year 1, including diversion banks, sediment dams and drop structures, is presented in **Figure 4.**

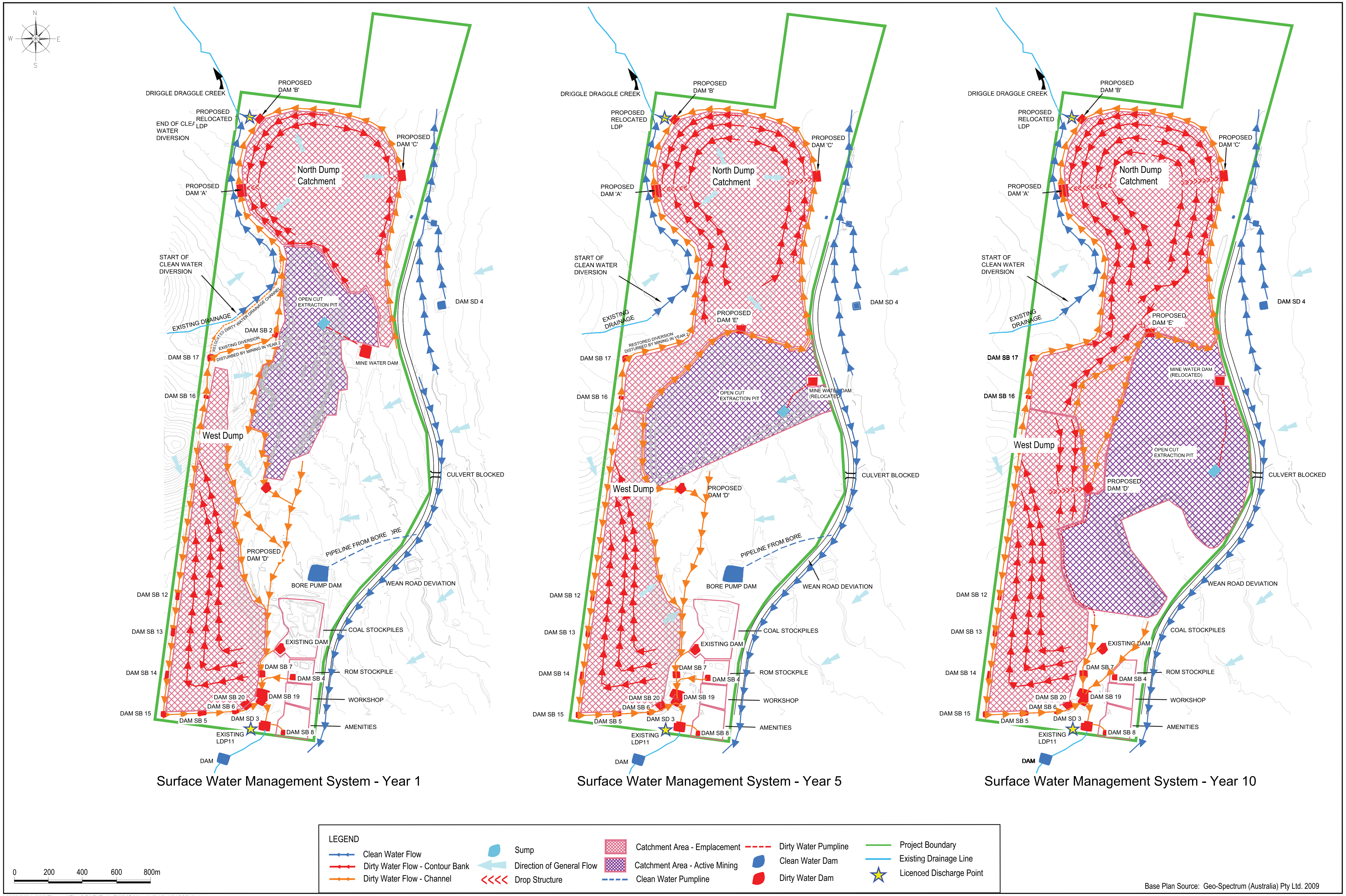
Clean Water Management

Clean water mitigation measures proposed for Year 1 involves the construction of additional clean water diversion banks in key strategic locations. Runoff that currently flows onto the site from the east (agricultural lands) will be diverted by two separate clean water diversion banks located on the east boundary of the mine site. The larger of these diversion banks will redirect flows to the south while the smaller diversion bank will redirect flows to Driggle Draggle Creek to the north. To ensure that the maximum amount of overland flow is intercepted it is proposed to provide a nominal overlap between these diversion banks at a location representing the boundary between the two representative catchments (approximately Jaeger lane). These diversion banks are proposed to be built on the eastern side of the Wean Road diversion.

Clean water flows entering the Project Site from the west, to the north of Sediment Basin SB17, will be redirected to the north around the proposed disturbance areas via a permanent clean water diversion into Driggle Draggle Creek (see **Section 6.7** below for more detail).

Where clean water diversions are implemented, the diversion banks should be constructed generally in accordance with *Blue Book Standard Drawing SD 5.6*. A summary of the general minimum design specifications is as follows;

- Gradient of the diversion banks should be approximately 1%;
- Height of the bank should have at least 400 mm freeboard;
- Channel width should be at least 3 m;
- A level spreader (or sill) should be constructed at the bank discharge point to reduce the risk of erosion at this point, as per *SD 5-6*; and
- Within ten days of construction, pasture should be sown to prevent erosion of the bank and drain.



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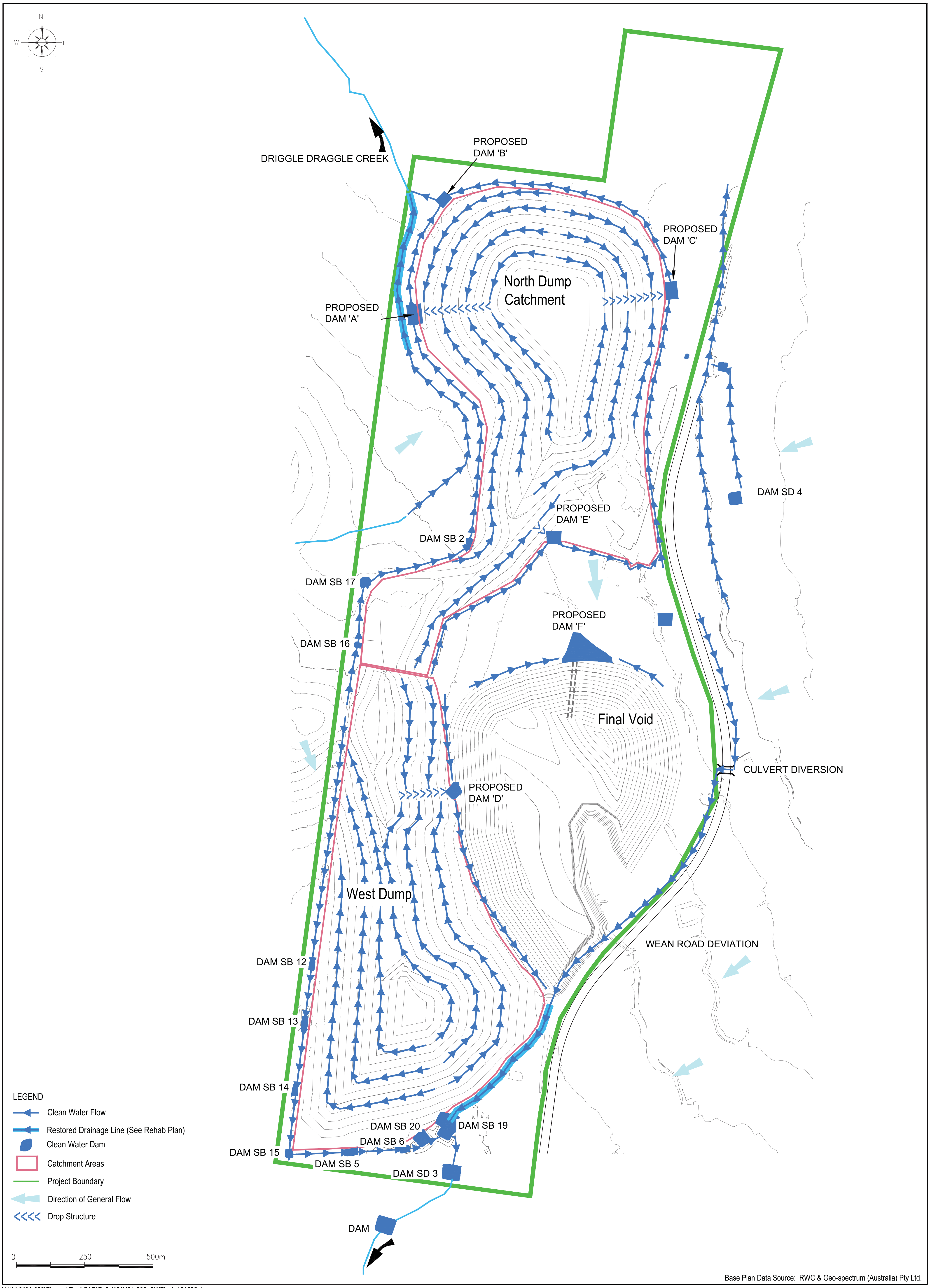
Rocglen Coal Mine Extension Project
Surface Water Management System - Years 1, 5 and 10
FIGURE 4



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Rocglen Coal Mine Extension Project
Proposed Surface Water Management Plan - Final Landform
FIGURE 5

The clean water diversion channels should be designed to convey the 20 year Annual Recurrence Interval (ARI) storm event, as recommended by the Volume 2E of the *Blue Book* for temporary drainage controls, where the duration of disturbance is greater than 3 years.

The diversion banks should be inspected monthly, or following a significant rain event to ensure that they are capable of carrying the surface water flow of the catchment at non-erosive velocities or concentrations.

Dirty Water Management

The proposed dirty water management system largely incorporates the existing dirty water system in the south with a newly developed system in the north. The system is based around a series of sediment basins to allow for the settlement of sediment in the runoff from disturbed areas. The dirty water system is a closed system and water that is collected in the basins will be re-used for dust suppression as required. Excess water in the system can be discharged off the site via the existing LDP in the south and the proposed new location of the LDP in the north when the water is an acceptable quality (see **Section 6.10**).

There are a total of seven proposed dirty water catchment areas contained within the Project Site. Each catchment contains at least one appropriately sized sediment basin to treat the sediment-laden runoff. Six of these catchments are located to the south of the central crest and naturally drain towards the south. These are known as the West Dump, Coal Stockpiles, ROM Stockpile, Workshop, Amenities and General Southern dirty water catchments.

The existing system located around the western and southern sides of the Western Emplacement Area will be used to contain and treat runoff from the catchment referred to as West Dump. A dirty water channel located along the western edge of the Project Site will receive the majority of dirty water flows from the West Dump. This channel will skirt the western and southern perimeters of the Project Site flowing through Sediment Basins SB12, SB13, SB14, SB15, SB5, SB6 and SB20 before flowing to SB19. Once the Western Emplacement Area is shaped, the runoff from the western side will be conveyed to the dirty water channel via a series of proposed contour banks and a rock drop structure. Runoff from the eastern (unshaped) side will be directed into a proposed dirty water drain. This area of the West Dump will be an active overburden emplacement area and the channel will need to be progressively reconstructed to the west as the emplacement encroaches upon it. A new sediment basin will be constructed (proposed Dam ‘D’) on the eastern side of the dump to treat water before it flows down into the existing basins along the unnamed central drainage line. The General Southern dirty water catchment also reports to the same system.

Runoff from the dirty water catchments referred to as Coal Stockpile, ROM Stockpile and Amenities will be directed into the ‘existing dam’, Sediment Basin SB4 and Sediment Basin SB8, respectively. The water then reports into the un-named central drainage line. Runoff from the workshop area is directed into an oil/water separator before reporting to Sediment Basin SB19.

Sediment Basin SB19 is located on the un-named central drainage line in the southern area of the site receiving all flows from the West Dump, General Southern, Coal Stockpile and ROM Stockpile catchments. From here, all flows are directed to SD3 which also receives flows from the Amenities and Workshop catchments. This SD3 was originally a clean water storage dam; however it will now form part of the dirty water system for this Project. LDP 11, under EPL 12870, is located on the outlet of SD3 and will allow for the controlled discharge of treated dirty water from the Project Site.

The dirty water management in the north of the Project Site has been developed to incorporate the expanded disturbance area associated with the proposed Northern Emplacement Area. The construction of a number of sediment basins will be required to ensure dirty water generated throughout the area is contained and treated.

Several existing dams (SD1, SD2, SD6 and SB18) will also be removed due to the expanded footprint of the emplacement area, with SB2 also needing to be removed in Year 2 of the expanded operation to make way for the expanded open pit.

A dirty water channel will be constructed around the proposed footprint of the Northern Emplacement Area to collect runoff. On the western side of the emplacement area, a dirty water channel starting at the northern end of the Western Emplacement Area will flow northwards between the permanent clean water diversion and the proposed open cut pit expansion footprint. A section of this dirty water channel will need to be temporarily relocated prior to Year 2 of the expanded operation to make way for the extended open cut pit. Once the pit is backfilled, the channel will be restored to its original position around to the toe of the emplacement area. From here, the channel will continue northwards around the Northern Emplacement Area where it will ultimately report to a proposed sediment dam (Proposed Dam ‘B’). The western arm of this channel will include Sediment Basins SB16, SB17 and Proposed Dam ‘A’ at strategic locations along the length of the channel and, as mentioned above, will flow parallel to the clean water diversion bank. The runoff from the western side of the Northern Emplacement Area will report to this channel. Where the emplacement has been shaped, contour drains will convey runoff from the emplacement to a rock drop structure that will report to Proposed Dam ‘A’. A similar system will be used on the eastern side of the emplacement, with the rock drop structure reporting to a proposed sediment dam (Proposed Dam ‘C’), and the eastern arm of the dirty water channel flowing northwards around the toe of the emplacement and into Proposed Dam ‘B’.

The eastern and western arms of the dirty water channel, which skirt the east and west perimeters of the Northern Emplacement Area, converge at the Proposed Dam ‘B’. This will allow for the final treatment of water before it can be discharged through the proposed new location for the LDP into Driggle Draggle Creek.

The Soil Survey and Land Resource Impact Assessment (GSSE, 2010) (**Section 4.1**) contains control measures for management of soil stockpiles which are applicable to all years of operation.

Mine Water Management

Runoff from within the open cut pit will be directed into in-pit sumps where it will be contained and pumped to the Mine Water Dam as required. The Mine Water Dam is a ‘turkeys nest’ dam with no catchment and will be kept at a level so that is does not overflow.

6.3.2 Scenario 2 – Year 5 of Expanded Operation

Due to the expansion of the open cut pit and Northern Emplacement Area, minor changes to the dirty water management system and mine water management system will need to be made sometime between Year 1 and Year 5 of the expanded operation. The proposed water management is shown on **Figure 4**.

Dirty Water Management

With the expansion of the Northern Emplacement Area southwards over the backfilled pit, the eastern arm of the dirty water channel around the emplacement will be extended around the toe. A new sediment dam will be constructed (Proposed Dam ‘E’) along this drainage line to treat sediment-laden runoff from the expanded overburden emplacement area. Additional contour banks and associated extension of the rock lined drop structures will occur on the Northern Emplacement as more area is shaped.

In the south, the water management system will remained unchanged to that of Year 1 with no major change to the disturbance footprints in the area.

Mine Water Management

The current location of the Mine Water Dam is predicted to be mined through by the middle of Year 2 of the expanded operation. Before this date, a new Mine Water Dam will be constructed further to the east between the eastern extent of the open cut pit and the Wean Road re-alignment. As above, the Mine Water Dam will be constructed as a ‘turkeys nest’ dam with no catchment and will be kept at a level so that is does not overflow. In-pit sumps will continue to be used to collect runoff from within the pit and pump to the new Mine Water Dam as required.

6.3.3 Scenario 3 – Year 10 of Expanded Operation

Further expansion of the Northern and Western Emplacement Areas will occur between Year 5 and Year 10 of the expanded operation. The open cut pit also moves further south and is backfilled in the north as it progresses. The clean water management system and the mine water management system will remain unchanged; however there will be numerous changes to the dirty water management system over this period. The proposed water management is shown on **Figure 4**.

Dirty Water Management

With the expansion of the Northern Emplacement Area additional contour banks and associated extension of the rock lined drop structures will be constructed. This also includes the construction of a rock lined drop structure into Proposed Dam ‘E’.

With the expansion of the Western Emplacement Area footprint towards the east, contour banks and an associated rock lined drop structure will be constructed to convey water to Dam ‘D’, which will be enlarged to accommodate the additional emplacement area and to assist with pumping of water around the pit.

The pit will have moved south by this stage and it is likely that flows from Dam ‘D’ will not be able to be diverted in overland flow around the pit. The enlarged Dam ‘D’ will allow increased capture of runoff and for this water to be pumped around the pit into the drainage line that reports to Dam SB19.. The bore pump dam will also be removed due to the open cut pit expansion. This dam will be relocated if the additional water source is still required.

6.3.4 Scenario 4 – Final Landform

This scenario represents the site in a fully rehabilitated state as shown in **Figure 5**. The runoff from the Northern and Western Emplacement Areas will be managed by contour banks and rock drop structures conveying water off the relatively steep rehabilitated surfaces to the gentle surrounding slopes. The un-named central drainage line will be re-instated to its original line where possible (final void will lie over a section of the original alignment), with some of the catchment to the east of Wean Road allowed to once again flow back into this drainage line once fully rehabilitated and stable.

The dams will remain in place for post-mining landuse (such as farming practices) subject to consultation with the relevant government agencies about the licensing conditions at the time. Dam ‘D’ will be retained primarily to provide a stable outlet from the drop structure and to direct water into the contour drain that flows south. If required, the dams will be removed so that water use rights are complied with. An additional dam (Dam ‘F’) will be constructed to the north of the final void to assist with the prevention of surface water runoff into the void. Dam ‘F’ will be sufficiently large (in the order of 15 ML) to capture large storm events (e.g. 10 year ARI) and allow this water to be evaporated and used for stock water purposes to minimise discharge into the final void. A low flow pipe will be installed (below the primary spillway, however above the dam base) to safely convey dam overflows to the base of the final void. Extreme rainfall events will result in flows over the spillway and into the final void.

The channel located along the western edge of the Project Site (that receives flows from the West Dump) should be assessed for signs of erosion within the channel to ensure the long-term stability of the channel. Where any erosion is occurring (or is likely to occur) the bed and banks of the channel should be stabilised through methods consistent with the *Blue Book*. It is anticipated that this would include rock lining (where required) in accordance with the *Blue Book*, including the placement of appropriately sized rocks above a filter layer of suitable geotextile.

6.4 Water Sources

The majority of water required on the site will be utilised for dust suppression activities, including in the crushing and screening process. A nominal amount of potable water and water for ablutions is required on-site and will continue to be trucked in from an external source.

Water sources for operational activities will be used in the following order of preference:

- Mine Water (via Mine Water Dam);
- Dirty water from the sediment basins, preferentially sourced from the basins with higher EC readings;
- Licensed bores (via Bore Pump Dam);
- Clean water within MHRDC (via storage dams); and
- Water occasionally trucked in from off-site as required.

6.5 TSS Mitigation Measures

As presented in **Section 3.8,** the existing water quality in relation to TSS at the site needs to be improved. The subsoils are highly dispersive in some locations with moderate to high erodibility (Cunningham, 2007). In addition to standard sediment control measures such as sediment basins, progressive rehabilitation and minimising the disturbance footprint, it is recommended that further mitigation measures be employed to reduce the risk of uncontrolled discharge.

The first measure is to ensure that sediment basins SD3 and proposed Dam ‘B’ (all dirty water within the Project Site reports to one of these dams before exiting the site) be drawn down and emptied at all times. This will allow for maximum storage of runoff when the next rainfall event occurs and minimise the chances of a discharge off-site. It is Whitehaven’s preference to promptly use any water that reports to either of these dams for dust suppression or pumped into other sediment basins around the site. However this will be influenced to a large degree by the volume of pit water stored in the Mine Water Dam, which will be utilised prior to utilising the water within SD3 and proposed Dam B.

Chemical flocculation to help increase the settling times of the sediment in the water column will also be employed as required. Tests using Floc Blocs have already indicated that TSS concentrations can be reduced via chemical flocculation. It is predicted that on some occasions, controlled discharge of water from the discharge dams may be undertaken following flocculation and sampling confirming discharge criteria can be met. There are various other methods and techniques available to remove solids from sediment-laden water and the most appropriate will be determined for use on a case by case basis in conjunction with specialists and relevant government agencies.

Flocculants that may be used include alum, gypsum or synthetic flocculants such as polyacrylamide. All have particular environmental constraints, but all are well recognised as useful chemicals for the task of clarifying water prior to discharge to a natural waterway. Due to the low frequency of application and practical needs for operating on a mine site, the task of flocculating water prior to discharge will likely be conducted by an external contractor or by site environmental personnel. It is recommended that an appropriate mass of flocculant be dissolved in an agitated vessel, transported to site and released into the dam.

The final concentration of flocculant should be determined by measuring suspended solid levels and ensuring an adequate dosage is delivered. The prescribed dosage should take into account relevant toxicity levels and other environmental considerations. Water can typically be released to the environment one to two days after flocculation.

6.6 Sediment Basin Design

As part of this assessment, an analysis of the sediment basin capacities was undertaken for existing dams, along with the required volumes calculated for proposed sediment basins. Calculations and analysis were undertaken following the guidelines and procedures presented in *Volume 1 and 2E (Mines and Quarries)* of the *Blue Book* for the minimum criteria for Type D/F sediment dams.

The existing dams around the south of the Project Site, which will be incorporated into the proposed surface water management system, were analysed against these guidelines. It was found that there was enough capacity in the existing system to meet these guidelines for future operations associated with the Project for the southern area. Where additional capacity will be required, the proposed sediment basins will be established to achieve sufficient capacity. Most of these are located around the Northern Emplacement Area to treat sediment-laden runoff originating from this emplacement area.

The general parameters that remained constant for the analysis of existing dams and designs of proposed dams are presented below.

- **Design Storm of 5 Days, 90th Percentile** - based on the minimum design criteria presented in Table 6.1 of *Volume 2E (Mines and Quarries)* of the *Blue Book* and the existing EPL, which recommends adopting a 90th percentile design storm event when designing a Type D/F basin where the duration of disturbance will be greater than 3 years. For the Gunnedah region, the 5 day, 90th percentile rainfall depth is 38.4 mm.
- **Volumetric Runoff Coefficient of 0.64** – this reflects the *Blue Book* soil hydrologic group D which has a very high runoff potential. Group D soils are fine-textured (clay) and are surface sealed. The coefficient is also in line with the default runoff characteristic presented in *Volume 2E (Mines and Quarries)*, which recommends using soil hydraulic group D in the absence of site-specific data.
- **Soil Classification of Type D (dispersive)** – based on the soil survey study undertaken for the site (Cunningham, 2007), the soils have been classified as dispersive.
- **Soil Erodibility Factor (K factor) of 0.05** - based on the conservative default criteria presented in the *Blue Book*. It should be noted that the soil survey study undertaken for the site (Cunningham, 2007) suggested a value of 0.035.
- **Rainfall Erosivity Factor of 1500 –** based on Project Site's location on the rainfall erosivity maps presented in Appendix B of Volume 1 of the *Blue Book*.

Conservative ground cover management factors (C-factor) were adopted for the calculation of the anticipated sediment storage zones for the basins (based on anticipated percentage ground cover). Where the basins receive runoff from within the disturbed areas of the site it was assumed that ground cover varied from 0% to 50% depending on the year of mining and the areas subject to on-going emplacement and the progressive revegetation of previously disturbed areas.

An inspection of the proposed and existing sediment basins should be undertaken as part of the routine site environmental inspection program or following significant rainfall. Various information, such as the general condition of the dam, evidence of overflow, condition of downstream catchments, water colour, evidence of eroding surfaces and approximate retained capacity, should be recorded.

6.7 Drainage Lines

6.7.1 Impacts

The following drainage lines will be impacted on by the Project:

- The head waters of Driggle Draggle Creek (first order);
- Upper section of the central drainage line (second order); and
- An approximate 125 m section of the central drainage line immediately below the existing approved open cut limit.

Approximately 1 km of the head waters of Driggle Draggle Creek will be impacted on by the proposed expanded Northern Emplacement Area. The drainage line is currently heavily disturbed through past clearing practices associated with agricultural production combined with the construction of clean water and dirty water storage dams along the drainage line.

The upper section of the central unnamed drainage line where it exits Vickery State Forest will be impacted upon by the expansion of the open cut pit. The drainage line is currently diverted north and into Driggle Draggle Creek via a temporary diversion and dams.

An additional 125 m of the disturbed section of the central drainage line lies within the expanded extent of the open cut pit. The section of drainage line that will be removed is already heavily disturbed via the existing approved mining operations.

6.7.2 Mitigation Measures

It is proposed that the upper section of the central drainage line be permanently diverted into Driggle Draggle Creek prior to disturbance. This will allow for the passage of clean water northwards around the open cut pit and the Northern Emplacement Area expansions. The permanent diversion would join the existing alignment of Driggle Draggle Creek immediately downstream of the proposed disturbance areas and proposed Dam B, which comprises the proposed new location for the LDP. It will replace the existing approved temporary diversion and will also form the relocated alignment of the head waters of Driggle Draggle Creek that will be impacted upon by the Northern Emplacement Area expansion.

It is also proposed that the majority of the central drainage line, that lies outside the emplacement areas, be reinstated as close as possible to its original path (refer to **Figure 5**).

All the affected drainage lines are in either the upper reaches of the catchment or have been previously heavily disturbed by mining or agricultural practices and are not considered to be of conservation significance. Despite this, it is proposed, where practical, that sections of drainage lines that are or will be impacted upon by the mining operation be rehabilitated post-mining. The rehabilitation program would seek to achieve a long-term enhancement of the ecological value of the drainage lines through the restoration of natural hydraulic conditions and appropriate revegetation of a riparian corridor.

The updated Site Water Management Plan (SWMP) for the Rocglen Coal Mine will need to include further details on the drainage line rehabilitation works. It is recommended that full details on the drainage line rehabilitation works be incorporated into a detailed site closure (and rehabilitation) strategy to be prepared 5 years prior to mine closure. Works within the restored drainage lines should be generally undertaken in accordance with Section 5.3.3 of the *Blue Book* (Volume 1) and the *'Guidelines for Controlled Activities – In-Stream Works'* (DWE, 2008) for watercourse rehabilitation and riparian zone rehabilitation.

Keys design elements of channel establishment works include:

- Implement effective temporary erosion controls to provide for the short-term stabilisation of the channel;
- Design and construct the stream channel so that it would be stable for the long-term and minimises the potential for the migration of any erosion upstream or downstream;
- The sections of the central drainage line to be rehabilitated, should be re-instated as a compound channel with a main channel conveying the small to medium flows, and a floodplain used to convey the high overbank flows;
- The main channel forming part of the re-instated central drainage line should be generally trapezoidal in shape with 3:1 (H:V) bank batters;
- The floodplain forming part of the re-instated central drainage line should utilise the post-mining land surface to form a wide floodplain channel bed with a low slope such that erosive forces in the floodplain are reduced;
- Natural meanders should be used instead of straight lines to reflect natural stream characteristics;
- Where there are high erosive forces (such as high flow velocity or steep grades) the channel bed should be rock lined where required and constructed in accordance with the *Blue Book*, including the placement of appropriately sized rocks above a filter layer of suitable geotextile.; and
- Soil should be packed in between rocks to allow sedges and grasses to be established within the channel to provide for long-term channel stability.

Where drainage lines on site are still largely intact and are not being actively eroded, channel establishment earthworks are not recommended. In these cases it is recommended that revegetation of a riparian corridor be undertaken, as described below.

Following earthworks and channel establishment, a riparian corridor should be established with a minimum width of 10 m, measured horizontally and at right angles to the flow from the top of both banks on the streams. Key design elements of the riparian corridor establishment include:

- Implement effective temporary erosion controls to provide for the short-term stabilisation of the riparian corridor;
- Restore naturally occurring soil to the riparian corridor (i.e. as stripped from area pre-disturbance);
- Restore a vegetated riparian corridor along the stream channel (10 m from top of bank);
- Establish a diverse range of locally occurring vegetation species;
- Establish a full range of vegetation types, including trees, shrubs and grass covers;
- No exotics species are to be introduced; and
- Maintain the rehabilitated riparian corridor for two years after initial rehabilitation.

6.8 Flow Regimes

As described above in **Section 6.3,** all clean water flowing onto the Project Site is proposed to be diverted around the disturbance areas and into existing drainage lines. The clean water runoff from the eastern catchment will be diverted either north into Driggle Draggle Creek or south into the central unnamed drainage line. This will result in a large area of clean catchment being diverted around the site and into the natural drainage system rather than being held in the site water management system.

The clean water runoff from the west of the Project Site originating in the Vickery Sate Forest will also be either diverted north or south into the same drainage lines.

As a result of the diversions, only runoff that lands within the proposed water management system of the Project Site will be contained for pollution control. This equates to an area of approximately 380 ha at the full extent of the mining operation. This should help maintain ephemeral flows and sediment movement patterns in the watercourses downstream of the Project Site. It must also be noted that through the provisions of the EPL, water of suitable quality contained within the water management system can also be discharged when required through the LDPs.

6.9 Summary of Proposed and Existing Dams

A summary of the existing and proposed dam status for those structures contained within the Project Site during both the operational phase and the final landform are presented in **Table 10**. All dam locations (excluding those to be removed) are shown on **Figures 3** and **4**.

Table 10 - Existing and Proposed Dam Status

Dam ID	Construction Date	Existing Purpose (including legal status)	Proposed Changes	Capacity (ML)
Clean Water Dams				
SD1	2008	Clean water storage (within MHRDC)	Removal (due to North Dump)	N/A
SD2	2008	Clean water storage (within MHRDC)	Removal (due to North Dump)	N/A
SD4[1]	2008	Clean water storage (within MHRDC)	Nil	4.8
SD4A[1]	2008	Clean water storage (within MHRDC)	Nil	1.8
SD6	2008	Clean water storage (within MHRDC)	Removal (due to North Dump)	N/A
Dam[1]	2008	Clean water storage (within MHRDC)	Nil	9.8
CB13	Farm dam built prior to mine approval	Clean water storage (within MHRDC)	Nil	Not Known (<1)
			Combined Clean Water Storage Capacity	**16.4**
Dirty Water Dams				
SD3[2]	2008	Clean water storage (within MHRDC)	Conversion to dirty water dam (sediment basin) for final treatment before discharge through LDP 11 (excluded from HR)	8.4
SB2	2008	General sediment basin (excluded from HR)	Scheduled removal in Year 2 (due to open cut pit)	1.7
SB4	2008	ROM Stockpile sediment basin (excluded from HR)	Nil	1.8
SB5	2008	Soil Stockpile sediment basin (excluded from HR)	Nil	1.7
SB6	2008	Soil Stockpile sediment basin (excluded from HR)	Nil	1.2
SB7	2008	West Dump sediment basin (excluded from HR)	Nil	3.7
SB8	2008	Amenities sediment basin (excluded from HR)	Nil	1.1
SB12	2008	West Dump sediment basin (excluded from HR)	Nil	1.2
SB13	2008	West Dump sediment basin (excluded from HR)	Nil	1.3
SB14	2008	Soil Stockpile sediment basin (excluded from HR)	Nil	1.2
SB15	2008	Soil Stockpile sediment basin (excluded from HR)	Nil	1.6
SB16	2008	West Dump sediment basin (excluded from HR)	Nil	0.6

Dam ID	Construction Date	Existing Purpose (including legal status)	Proposed Changes	Capacity (ML)
SB17	2008	West Dump sediment basin (excluded from HR)	Nil	1.7
SB18	2008	Primary sediment basin for northern stockpile area (excluded from HR)	Removal (due to North Dump)	N/A
SB19	2008 (modified 2009)	Final sediment basin (excluded from HR)	Becomes second last basin (due to SD3 converted to a sediment basin)	17.3
SB20	2009	Soil Stockpile sediment basin (excluded from HR)	Nil	6.7
Existing Dam	Farm dam built prior to mine approval	Coal Stockpile sediment dam (excluded from HR)	Nil	Not Known
Proposed Dam 'A'	Year 1	Sediment basin for North Dump (excluded from HR)	N/A	15
Proposed Dam 'C'	Year 1	Sediment Basin for North Dump (excluded from HR)	N/A	15
Proposed Dam 'B'	Year 1	Final sediment basin for North Dump prior to discharge through LDP (excluded from HR)	N/A	2
Proposed Dam 'D'	Year 1	Additional sediment basin for West Dump (excluded from HR)	Enlarged to 6.3 ML before Year 10 to account for West Dump	2 (6.3)
Proposed Dam 'E'	Year 5	Sediment Basin for North Dump expansion south (excluded from HR)	N/A	2
			Combined Dirty Water Storage Capacity (excluding coal stockpile dam)	**85.2 (89.5)**
Other Water Storage Dams				
Mine Water Dam	2008	Storage of pit water (excluded from HR)	Scheduled location change around Year 2 (due to pit expansion)	13.3
Bore Pump Dam	2009	Storage of bore pump water (excluded from HR)	Scheduled removal in Year 10 (due to pit expansion)	33.4
Proposed Dam 'F'	Final Landform (after Year 10)	Water Storage (to prevent runoff into Final Void)	N/A	TBD
			Combined Storage	**46.7**

[1] Located outside the Project Site
[2] Converted to a dirty water dam (sediment basin)
TBD – to be determined subject to approval
MHRDC - maximum harvestable right dam capacity
HR – harvestable right

None of the dams are affected by flood flows as those that do lie on watercourses are located within the upper end of the catchment. The clean water storage dams combined capacity of around 17 ML is well within the MHRDC of approximately 32 ML for the Project Site (see below).

6.10 Licensing Requirements

6.10.1 Maximum Harvestable Right Dam Capacity

The maximum dam capacity of the Project Site is determined by the following calculation:

MHRDC = Project Site Area (ha) x Multiplier Value (0.07)

The MHRDC has been calculated to be approximately 32 ML based on the Project Site Area of 460ha.

All existing clean water storage dams that will be used for water supply are within the MHRDC of 32 ML. Hence no licences are required for these existing dams.

6.10.2 Dirty Water Dams

All the existing and proposed dirty water dams (sediment basins) are exempt from harvestable right calculations under the *NSW Farm Dams Policy 1999*. The purpose of the dams is to prevent the contamination of downstream waterways from pollutants such as TSS. The Mine Water Dam is also exempt for the same environmental purposes.

The Bore Water Dam will be used as a ‘turkeys nest’ dam to contain water pumped from the licensed groundwater bores. It will not capture water from the natural catchment and is therefore exempt from licensing under the *NSW Farm Dams Policy 1999*.

6.10.3 Licensed Discharge Points

The current LDP 11 will continue to be used at the southern end of the Project Site. However, due to the expansion of the Northern Emplacement Area, the current LDP 12 will be superseded and require relocation. It is proposed that a new LDP be positioned at the outlet of the proposed Dam ‘B’ located at the northern boundary of the Project Site, which would enable discharge into Driggle Draggle Creek. This will replace LDP 12. Discussions with the DECCW will need to take place to determine the requirements for this new LDP location.

6.10.4 Groundwater Licences

There are currently three water licences held under the existing approval for the purposes of mining and dewatering, with 2 of these bore licences having a combined allocation of 120 ML and the other having an allocation of 700 ML. The 700 ML licence is for the potential interception of groundwater within the mine pit. For further information on these groundwater licences please refer to the *Hydrogeological Assessment for Rocglen Coal Mine Extension Project* (Douglas Partners, 2010).

6.11 Contaminated Water and Sewage Disposal

There are no changes associated with the Project that will alter the existing water management systems associated with contaminated water or sewage disposal. Potentially contaminated water from the workshop and wash bay area will continue to be diverted to an oil separating unit for treatment and separation. The clarified water then reports to existing sediment basins, with the remaining contaminated water disposed of off-site.

Sewage will continue to be disposed of by one or a combination of the following two methods:

- A bio-cycle (or equivalent) system with effluent irrigation onto undisturbed areas of the ‘Belmont’ or ‘Roseberry’ properties.
- Storage and pump-out systems, with pump outs and disposal undertaken by a licensed waste disposal contractor to an approved sewage treatment plant.

6.12 Potable Water Supply

Potable water will continue to be harvested from the roofs of the site buildings with additional water sourced and transported by water tanker from the Gunnedah and/or Boggabri town water supplies when required. It is expected that between 60 to 100 kL of potable water would be required each year.

7.0 SITE WATER BALANCE

7.1 Introduction

This section examines the site water requirements and available water storage against water availability to present a water balance for the Project Site. Site water balance calculations were undertaken for the scenarios referred to as Years 1, 5 and 10 of the expended operation. The results based on dry, median and wet rainfall conditions are presented below.

GSSE used Microsoft Excel to develop a detailed daily time step water balance taking into account the available daily rainfall records for over 100 years of actual historical data.

The detailed site data available (dam storages, water usage, rainfall and discharges) during the 2008, 2009 and early 2010 has enabled the water balance model to be calibrated to closely match the recorded site conditions during this period. Given the high quality of site data and good model calibration, GSSE is confident that the results of the model are an accurate reflection of the probable water balance to be experienced. It is considered that the site water balance for the three scenarios (Years 1, 5 and 10) provides an appropriate representation of the range of conditions likely to be experienced across the site throughout the Project Life.

The site water balance applies to the whole Project Site, with the exception of the water for the amenities (potable and ablutions), as this is trucked to site and is maintained as a separate system from the overall site water management.

7.2 Assumptions and Model Calibration

The data sources for the model inputs and outputs are described in the sections below.

The catchment areas were estimated by GSSE using the progressive Life of Mine landform drawings provided by Whitehaven, delineating between different catchment areas based on varying runoff characteristics. More detail on the catchment area estimation is provided in **Section 7.3.1**.

Whitehaven supplied detailed water usage, storage, and site meteorological data for the Annual Environmental Monitoring Report (AEMR) reporting period of 1 August 2008 to 31 July 2009. For this period the following records and observations were used for calibration:

- Clean water storage from 0 to 10.117 ML;
- Dirty water storage from 0 to 10.063 ML;
- Pit water storage from 0 to 3.372 ML;
- 5 ML of bore water (from licensed bores) used for dust suppression (mine site and processing facility);
- 48 ML of surface water (from sediment basins) used for dust suppression (mine site and processing facility);
- Negligible groundwater seepage into the mine pit; and
- Observations of full dams in December 2008 following high rainfall.

Records of site discharges occurring between December 2009 to February 2010 were used to calibrate the model, which GSSE considers representative of site water management.

For the establishment of the water balance model, GSSE assumed generic runoff coefficients using appropriate references (including the *Blue Book* and Australian Rainfall and Runoff) and previous experience. The model was then calibrated primarily via adjusting the runoff coefficients in order to achieve runoff volumes that provide water balance results mimicking recorded and observed conditions. These calibrated runoff coefficients were used for the modelling of the predicted water balance scenarios.

The model assumes that bore water is pumped into the Bore Pump Dam (and subsequently used on-site) when storage levels within the Mine Water Dam and dirty water dams fall below 15 ML (which roughly equates to the volume of the Mine Water Dam).

For the model results presented in **Section 7.6** it has been assumed that controlled discharges are not undertaken, which presents the worst case scenario where there is negligible day to day on-site water management undertaken. This would mean that dams are not drawn down following rainfall and that discharge from the dams only occurs when extreme rainfall events occur resulting in dam overflows. Discharge during extreme rainfall events is consistent with the current EPL which allows wet weather discharge from site.

In practice, it is anticipated that the approvals (and in particular the EPL) will allow controlled discharges from site, and subsequently the model was re-run under assumptions that controlled discharges do occur. The results of this investigation are presented in **Section 7.7**.

7.3 Water Sources (Model Inputs)

7.3.1 Rainfall Runoff

Rainfall

Long term historical rainfall data was primarily used from the Boggabri BOM Station (No. 55044), which was found to have high correlation with the short term site meteorological data.

A new meteorological station for the Rocglen Mine was commissioned in April 2009. **Figure 6** shows a comparison of the data collected on-site (from the new station) with the data collected from the nearby Boggabri BOM Station. **Figure 6** shows that the Boggabri data has a high correlation with the data collected on-site for the period of April 2009 to December 2009 and is therefore suitable for use in the water balance model.

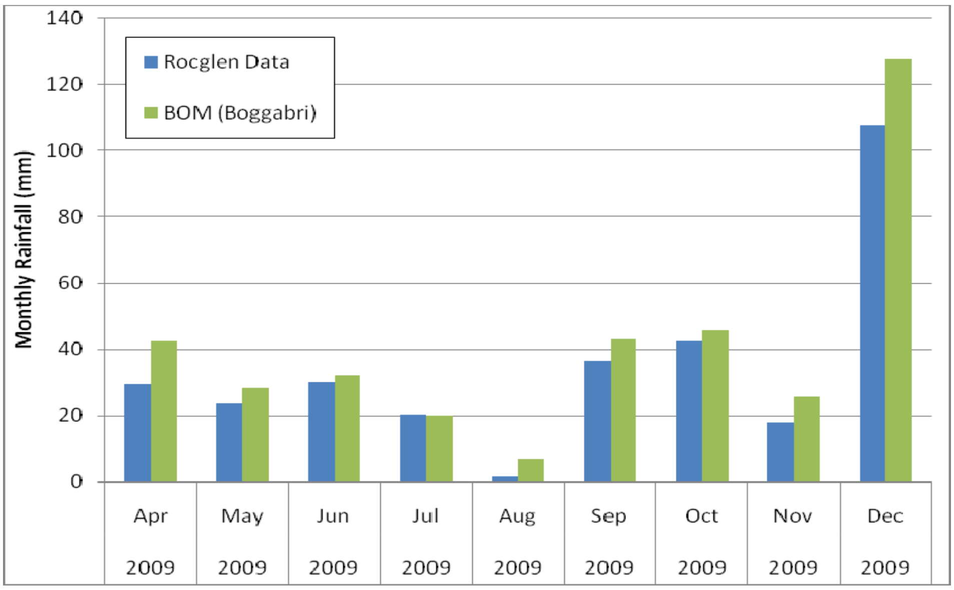

Figure 6 – Rainfall Data Comparison

109 years (1900 to 2008) of rainfall data was utilised from the Boggabri BOM Station. Where gaps were identified in the Boggabri data (i.e. November 1911, July to November 1929, and October to November 1988) data from the Gunnedah Pool BOM Station (Station No. 55023) was utilised.

The statistical dry, median and wet years from the Boggabri Station are:

- Dry year (10th percentile) – 392 mm;
- Median year (50th percentile) – 578 mm; and
- Wet year (90th percentile) – 752 mm.

The model was run for the full 109 years of data available (for each scenario of Years 1, 5 and 10 of the expanded operation). The results of this continuous model were reviewed and analysed to show probable water balance results. In order to predict results for a probable dry year (10th percentile), median year (50th percentile) and wet year (90th percentile) a summary of the annual water balance results was produced from which trend-lines were approximated and used to estimate dry/median/wet year results.

In addition to this, the data for a selected dry year (10th percentile), median year (50th percentile) and wet year (90th percentile) was selected and presented in graphs to show possible variation in inputs/outputs throughout a 12 month period. Where possible, years were selected with preceding years of fairly average rainfall. The years selected as being representative of dry, median and wet years are:

- 1979 (dry year) – 392 mm;
- 1989 (median year) – 575.7 mm; and
- 1942 (wet year) – 752.2 mm.

Catchment Areas

GSSE delineated between different catchment areas based on varying runoff characteristics. The following catchments were defined and areas estimated:

- Clean area (undisturbed);
- Partially disturbed areas, which are those largely undisturbed by mining but with a small amount of disturbance such as roads or other minor infrastructure located within them (e.g. 10% disturbed);
- Predominantly disturbed areas, which are those containing a mixture of clean and disturbed areas (e.g. >%50 disturbed);
- Loose spoil emplacement, which has high infiltration;
- Shaped spoil emplacement, which has lower infiltration than loose spoil; and
- Mine extraction pit and hardstand, which has high runoff.

It should be noted that the large off-site clean water catchment to the east is proposed to be entirely diverted around the Project Site, and therefore, the potential clean water available from this catchment has not been included within the water balance model. In practice, Rocglen may choose to supplement their water supply on-site from the existing clean water dams (SD4 and SD4A) that intercept this clean water. If this occurs Rocglen will need to ensure that they do not exceed their MHRDC as discussed in **Section 6.10.1**.

Rainfall runoff will be captured in the dirty water dams (sediment basins) on-site, which only collect runoff from catchment areas within the Project Site.

Runoff Coefficients

Runoff coefficients for each of the different catchment areas were selected through the calibration process described in **Section 7.2**. Rainfall runoff was calculated by estimating an 'initial loss' (in mm) followed by a loss consisting of a constant fraction of the remaining rainfall for that day (as described with *Australian Rainfall and Runoff Book* 2).

7.3.2 Groundwater (From Bores)

There are currently two bore licences held under the existing approval for the purpose of mining, which have a combined total allocation of 120 ML. Water is pumped from the bores to the Bore Pump Dam.

During the 2008-2009 AEMR period a bore water use of 5 ML was reported. The water balance model assumes that a maximum of 120 ML is available from bores, and the bore water is pumped into the Bore Pump Dam when total water storage levels on-site fall below 15 ML, which is approximately two month's supply of water required to meet dust suppression needs.

7.3.3 Groundwater (from Mine Pit)

In theory, the mine pit could intercept groundwater which would enter the site water management system, however, in practice there has been negligible inflow into the existing pit which the Hydrogeological Assessment (Douglas Partners, 2010) have attributed to low permeability of the strata and the general exceedance of evaporation over rainfall. For the operational water balance it has been assumed that evaporation from the pit floor and walls will account for the negligible amount inflow that may occur.

7.3.4 Other

Water has been trucked to site in the past to supplement the water supply during extended dry periods. Whilst this has not been included within the water balance model, in practice this is an option available to Rocglen.

7.4 Water Losses and Usage (Model Outputs)

7.4.1 Evaporation

Long term historical evaporation data was used from the Gunnedah Resource Centre BOM Station (No. 55024). Average monthly evaporation rates have been used within the water balance model, so that the daily evaporation rate varies throughout the year depending on the month. The volume of the evaporation also varies based on the estimated surface area of the water storages (which is relative to the volume of water storages) on each day.

Evaporation from the upper soil layers has not been specifically included within the water balance model, however, the calibration of the model has accounted for this evaporation within the selected runoff coefficients.

7.4.2 Water Usage

The predicted water usage is based around the recorded usage by AEMR year combined with Whitehaven's estimates of future demand. Water usage consists of the dust suppression for the site and during the crushing process.

It is assumed within the water balance model that general site dust suppression is 0.25 ML/day on those days where rainfall is less than 5 mm. Dust suppression associated with the crushing facility is assumed to be 0.015 ML/day.

This water is sourced from on-site water storages (sediment basins and the Mine Water Dam); unless storages are very low in which case the water is sourced from the available groundwater bores.

7.4.3 Site Discharges

The water balance has assumed that discharges occur when the storage exceeds the storage capacity, which occurs during a rainfall event. This is consistent with the current EPL which allows wet weather discharge from site.

The EPL permits wet weather discharge from Dam SD3 (at the southern boundary of the site) and a location at the northern boundary of the current mine lease which is proposed to be moved further north to cater for the expanded operation.

In practice, Rocglen may choose to discharge (after effective water treatment) during dry periods to de-water strategic sediment dams, however this has not been assumed to occur within the water balance model for the results presented in **Section 7.6**. The analysis presented in **Section 7.7** demonstrates the effect controlled discharges will have on site water management.

7.5 Storages

The water balance model assumes that all dirty water dams (sediment basins) are available for water storage during a rainfall event. These dams and their available storage are shown in **Table 11**.

Table 11 - Water Storages (assumed within water balance model)

Dam ID	Year 1 Storage Capacity (ML)	Year 5 Storage Capacity (ML)	Year 10 Storage Capacity (ML)
SB2	1.7	0	0
SB4	1.8	1.8	1.8
SB5	1.7	1.7	1.7
SB6	1.2	1.2	1.2
SB7	3.7	3.7	3.7
SB8	1.1	1.1	1.1
SB12	1.2	1.2	1.2
SB13	1.3	1.3	1.3
SB14	1.2	1.2	1.2
SB15	1.6	1.6	1.6
SB16	0.6	0.6	0.6
SB17	1.7	1.7	1.7
SB19	17.3	17.3	17.3
SB20	6.7	6.7	6.7
SD3	8.4	8.4	8.4
Mine Water Dam	13.3	13.3	13.3
Proposed Dam ‘A’	15	15	15
Proposed Dam ‘B’	2	2	2
Proposed Dam ‘C’	15	15	15
Proposed Dam ‘D’	2	2	6.3
TOTAL	**98.5**	**96.8**	**101.1**

In practice there is likely to be more dam storage available than is listed above, but the above has been adopted to ensure the model is conservative. Clean water dams, which are also off-site (i.e. SD4, SD4A and dam to south of Project Site) and Bore Pump Dam, which is on-site, have not been assumed to be available for storage of rainfall runoff within the water balance model. In practice, the mine pit would also serve as a water storage area during heavy rainfall events.

It is assumed that where suitable water collected in the sediment basins is transferred to other basins on-site to ensure maximum water storage capacity is maintained and that discharge does not occur unless all basins in the sediment basin chain are full. All dams are shown in **Figure 4**.

7.6 Water Balance Results

The water balance results for the selected mining scenarios (i.e. Years 1, 5 and 10) are shown in the following sections.

7.6.1 Scenario 1 - Year 1 of Expanded Operation

Figure 7 shows the annual total data results from the water balance for all the relevant inputs and outputs of the water balance model for the Year 1 Scenario.

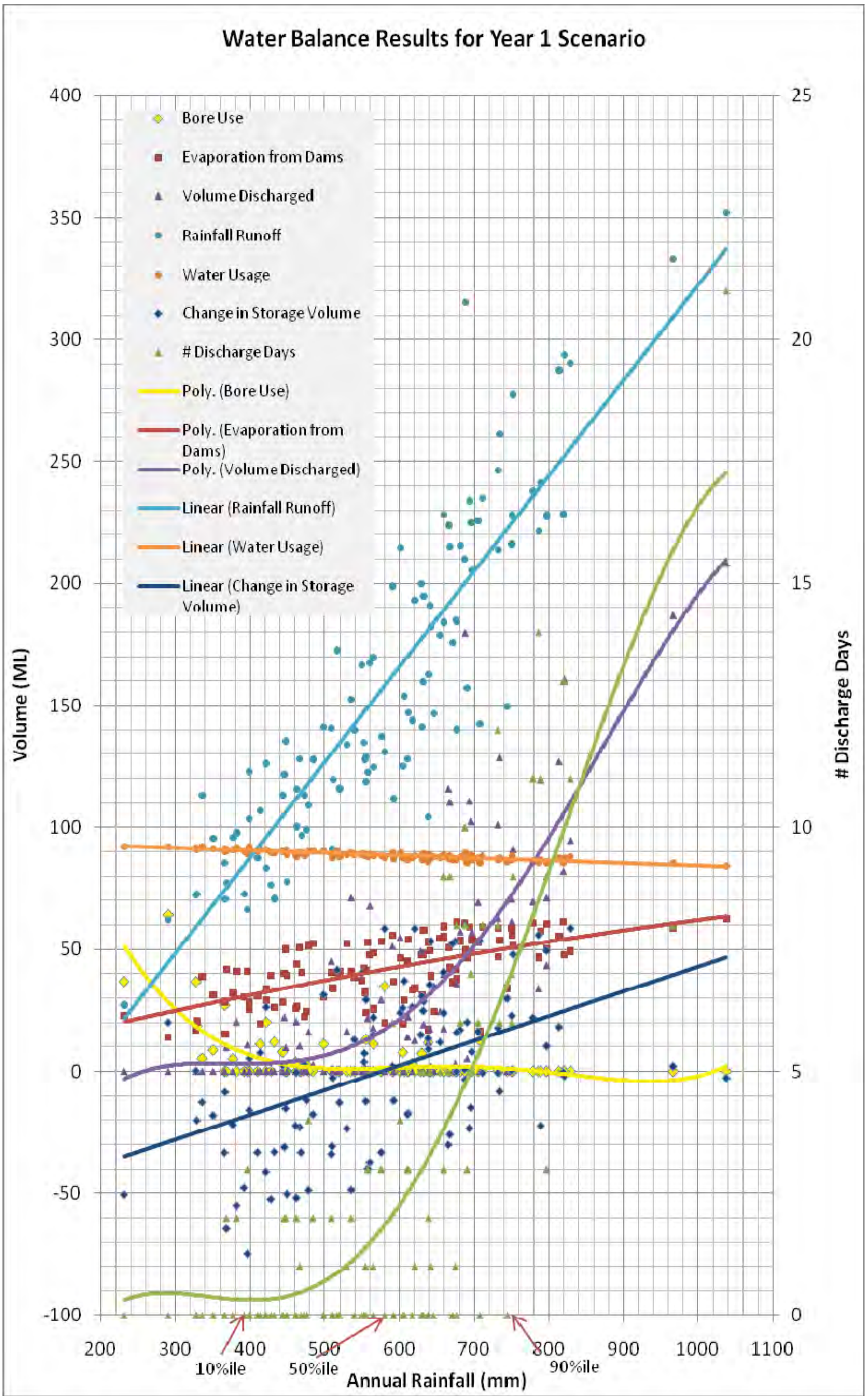

Figure 7 – Water Balance Results Year 1 Scenario

Figure 7 demonstrates that there is wide scatter of data results for some of the inputs/outputs. One example of this is the bore use, which does not show a consistent relationship to rainfall. The amount of bore water used is largely dependent on the water storage at the start of the year and the distribution of rainfall throughout the year. Trend lines have been produced which provide a better tool for interpreting the results, and predicting water balance results for dry, median and wet years.

Using the trend lines shown in **Figure 7** as a guide, the predicted water balance totals for dry, median and wet years has been estimated and is shown in **Table 12**.

Table 12 - Water Balance Results for Year 1 Scenario (Annual Summaries)

	Description	Dry (ML/year)	Median (ML/year)	Wet (ML/year)
Water Source (Inputs)	Rainfall Runoff	85	160	230
	Bore Use	10 (*)	0 (*)	0
Water Losses and Usage (Outputs)	Evaporation (from dams)	30	45	55
	Water Usage (dust suppression including crushing)	90	90	85
	Discharged (wet weather)	0	20	70
Balance (Input-Output)	Change in water storage on site (**)	-25	+5	+20

Note (*) A wide scatter in the bore usage occurred, with 65 ML used in one very dry year, and 35 ML in one relatively median year
Note (**) Change in water storage is calculated from other data, rather than being read from the trend line

Water Supply

The results of the water balance model demonstrate that:

- Rainfall runoff captured in sediment basins on-site will provide for the majority of water demand.
- It is likely that bore water will be required to supplement water supply in dry years up to 65 ML/year.
- Typically bore water is not required to supplement water supply in median years, however, in some years a bore supply up to 35 ML/year may be required.
- It is unlikely that bore water would be required in wet years.
- Additional sources of water supply are not required for the dry, median or wet year scenarios.

Discharges from Site

The overall average of all rainfall years for the Year 1 Scenario shows that on average:

- There will be **3.1 days of discharge per year**, of which:
  - 2.3 days occurred when the dam design criteria (i.e. rain of 38.4 mm in 5 days) was exceeded; and
  - 0.8 days occurred when the dam design criteria (i.e. rain of 38.4 mm in 5 days) was not exceeded.

This is consistent with the *Blue Book*, which states that for dams designed to the 90th percentile criteria, there is likely to be from 2 to 4 overflow events per year.

The events where discharge occurred, but the design criteria was not exceeded, were all as a result of a combination of the following factors:

- A high rainfall period had proceeded the day of discharge so that dams were at full capacity before the event occurred; and
- The substantial rainfall event (but still under 38.4 mm) in a short period of 1 to 2 days.

As expected in dry years the likelihood of discharge decreases, and in wet years the likelihood increases. Interpretation of the results suggests the following likely discharges (and range of discharges) for the dry, median and wet years (shown in **Table 13**).

Table 13 - Predicted Discharges from Site for Year 1 Scenario

<table>
<tr><th></th><th>Description</th><th>Dry</th><th>Median</th><th>Wet</th></tr>
<tr><td rowspan="3">Number of Discharge Days per Year</td><td>Where rain was more than 38.4mm in 5 days</td><td>0 Days
(from 0 to 3 days)</td><td>2 Days
(from 0 to 6 days)</td><td>6 Days
(from 0 to 10 days)</td></tr>
<tr><td>Where rain was less than 38.4mm in 5 days</td><td>0 Days
(from 0 to 1 days)</td><td>0 Days
(from 0 to days)</td><td>1 Days
(from 0 to 4 days)</td></tr>
<tr><td>Total Number of Days Per Year</td><td>0 Days
(from 0 to 3 days)</td><td>2 Days
(from 0 to 6 days)</td><td>7 Days
(from 0 to 12 days)</td></tr>
<tr><td colspan="2">Total Volume Discharged (per year)</td><td>0 ML
(from 0 to 20 ML)</td><td>20 ML
(from 0 to 60 ML)</td><td>70 ML
(from 0 to 120 ML)</td></tr>
</table>

Selected Representative Years

Figures 8, 9 and **10** show a summary of the water balance results for the specific historical rainfall years of:

- 1979 - 293 mm of rainfall and is therefore consider representative of what may occur in a dry year;
- 1989 - 575.7 mm of rainfall and is therefore consider representative of what may occur in a median year; and
- 1942 - 752.2 mm of rainfall and is therefore consider representative of what may occur in a wet year.

It is important to note that the results for these specific historical years do not match the statistical averages for the dry, median and wet years shown in **Table 12**. This is due to the scatter in results owing to many factors (such as initial dam storage and rainfall distribution) and showing they are not simply a direct relationship to how much rain fell in a year.

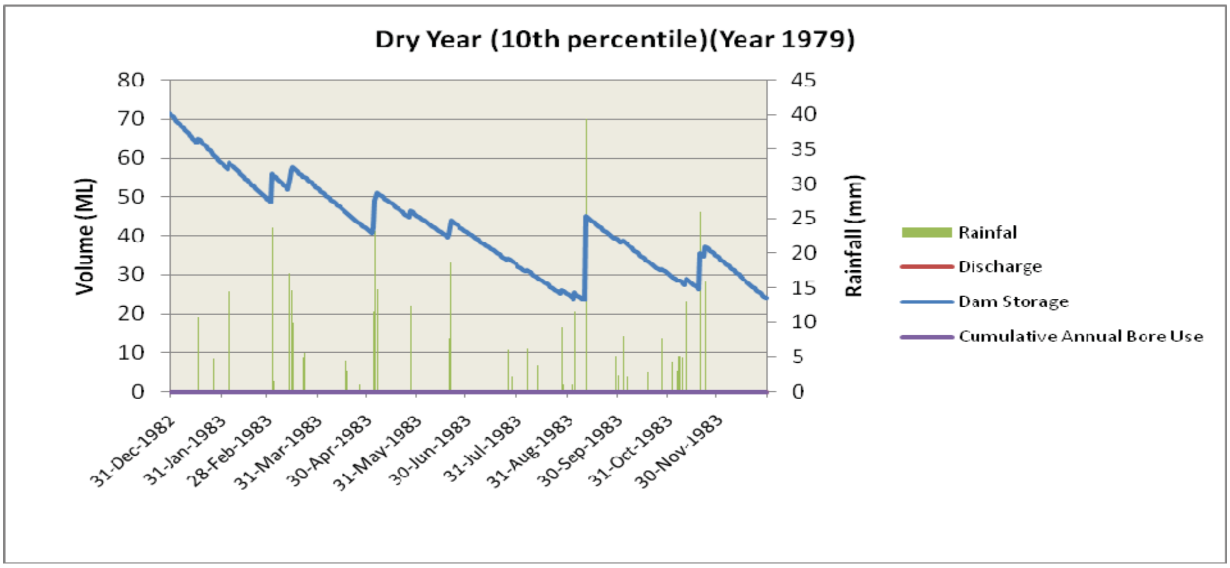

Figure 8 – Water Balance Results Year 1 Scenario - Historical 'Dry' Rainfall Year 1979

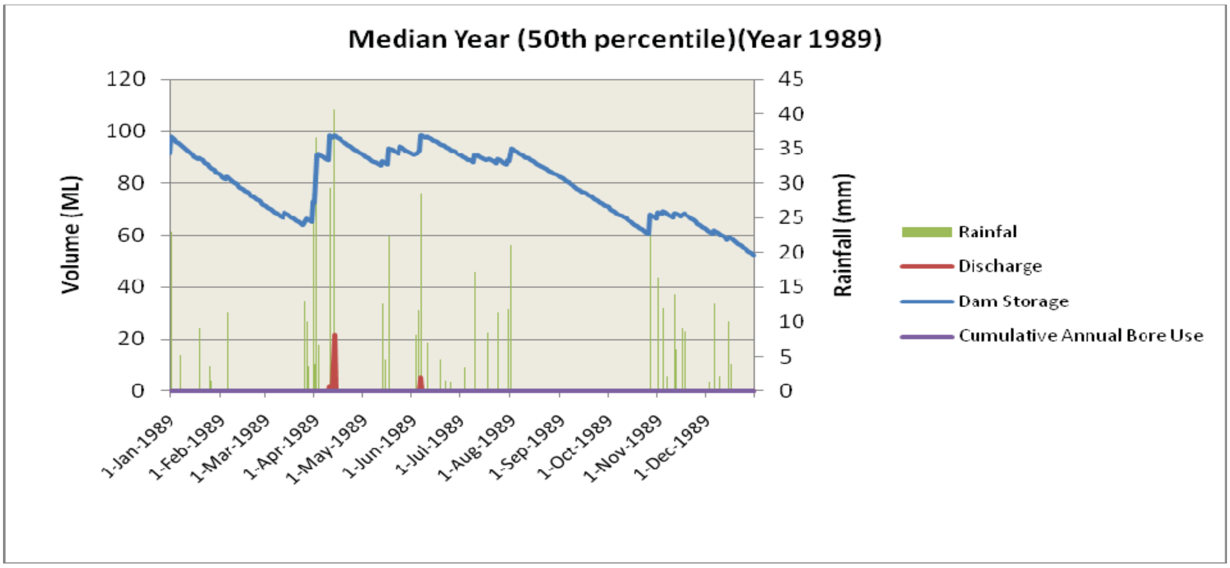

Figure 9 – Water Balance Results Year 1 Scenario - Historical 'Median' Rainfall Year 1989

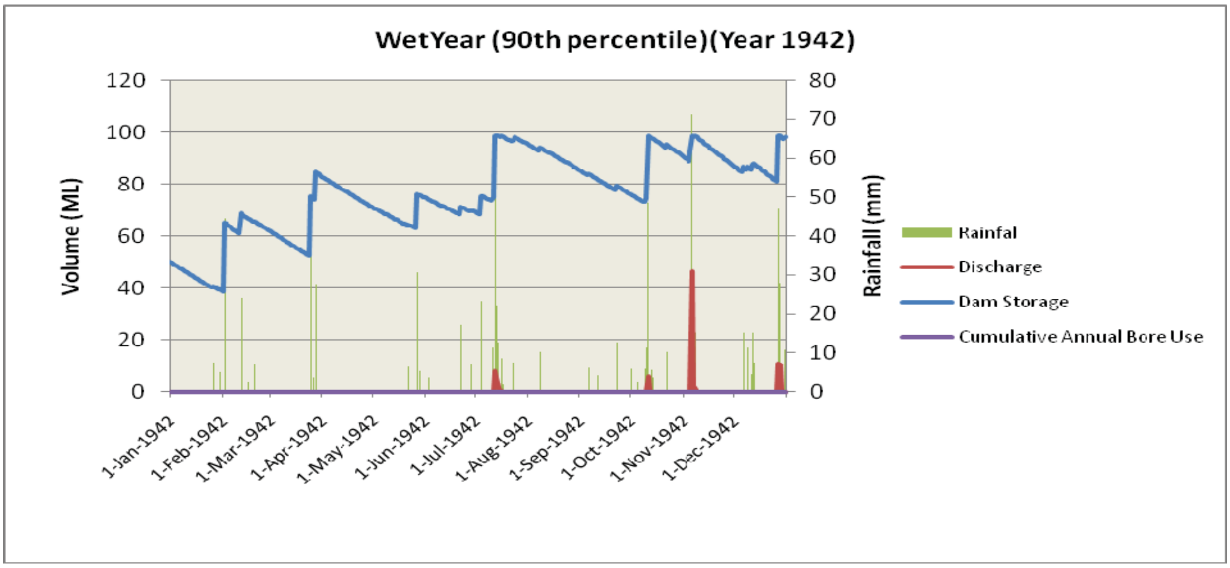

Figure 10 – Water Balance Results Year 1 Scenario - Historical 'Wet' Rainfall Year 1942

7.6.2 Scenario 2 - Year 5 of Expanded Operation

Figure 11 shows the annual total data results from the water balance for all the relevant inputs and outputs of the water balance model for the Year 5 Scenario.

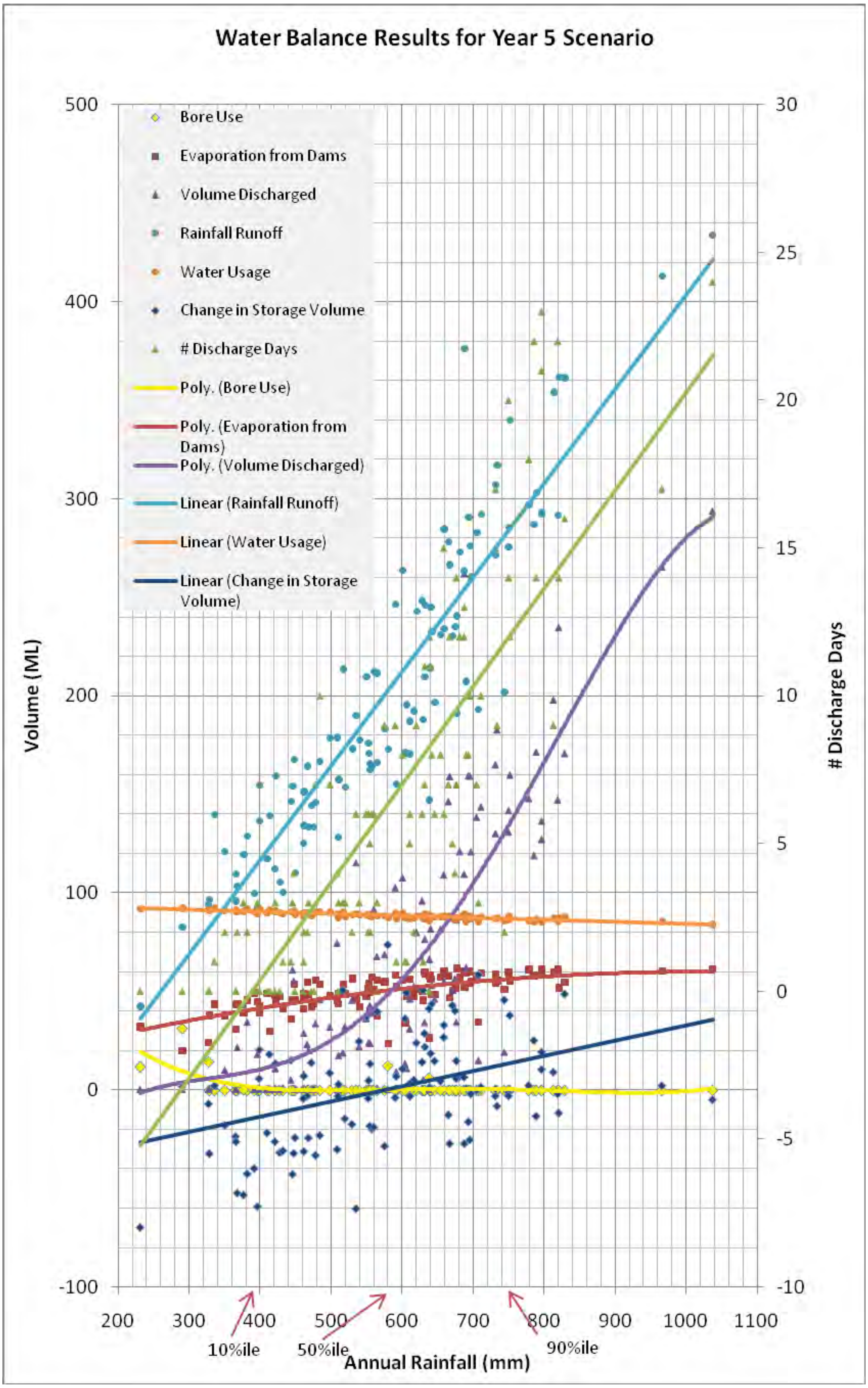

Figure 11 – Water Balance Results Year 5 Scenario

Figure 11 demonstrates that there is wide scatter of data results for some of the inputs/outputs. Trend lines have been produced which provide a better tool for interpreting the results, and predicting water balance results for dry, median and wet years.

Using the trend lines shown in **Figure 11** as a guide, the predicted water balance totals for dry, median and wet years has been estimated and is shown in **Table 14**.

Table 14 - Water Balance Results for Year 5 Scenario (Annual Summaries)

	Description	Dry (ML/year)	Median (ML/year)	Wet (ML/year)
Water Source (Inputs)	Rainfall Runoff	110	200	290
	Bore Use	0 (*)	0 (*)	0
Water Losses and Usage (Outputs)	Evaporation (from dams)	40	50	60
	Water Usage (dust suppression including crushing)	90	90	85
	Discharged (wet weather)	10	50	115
Balance (Input-Output)	Change in water storage on site (**)	-30	+10	+30

Note (*) A wide scatter in the bore usage occurred, with 35 ML used in one very dry year, and 15 ML in one relatively median year
Note (**) Change in water storage is calculated from other data, rather than being read from the trend line

The primary change in the water balance results for Year 5 (compared to Year 1) is the increase in rainfall runoff, which is a result of the increase in mine pit area and shaped emplacement areas which have higher runoff coefficients than loose emplacement areas.

Water Supply

The results of the water balance model demonstrate that:

- Rainfall runoff captured in sediment basins on-site will provide for the majority of water demand.
- It is unlikely that bore water will be required in most dry, median or wet years; however, in some years a bore supply up to 35 ML/year may be required.
- Additional sources of water supply are not required for the dry, median or wet year scenarios.

Discharges from Site

The overall average of all rainfall years for the Year 5 Scenario shows that on average:

- There will be **6.4 days of discharge per year**, of which:
  - 4.0 days occurred when the dam design criteria (i.e. rain of 38.4 mm in 5 days) was exceeded; and
  - 2.4 days occurred when the dam design criteria (i.e. rain of 38.4 mm in 5 days) was not exceeded.

The total number of discharges is slightly higher than predicted in the *Blue Book*, which states that for dams designed to the 90th percentile criteria, there is likely to be from 2 to 4 overflow events per year. The events where discharge occurred, but the design criteria was not exceeded, were all as result of a combination of the following factors:

- A high rainfall period had proceeded the day of discharge so that dams were at full capacity before the event occurred; and
- The substantial rainfall event (but still under 38.4 mm) in a short period of 1 to 2 days.

As expected in dry years the likelihood of discharge decreases, and in wet years the likelihood increases. Interpretation of the results suggests the following likely discharges (and range of discharges) for the dry, median and wet years (shown in **Table 15**).

Table 15 - Predicted Discharges from Site Year 5 Scenario

	Description	Dry	Median	Wet
Number of Discharge Days per Year	Where rain was more than 38.4mm in 5 days	1 Days (from 0 to 2 days)	4 Days (from 0 to 5 days)	10 Days (from 2 to 14 days)
	Where rain was less than 38.4mm in 5 days	0 Days (from 0 to 2 days)	2 Days (from 0 to 5 days)	4 Days (from 1 to 10 days)
	Total Number of Days Per Year	**1 Days** (from 0 to 3 days)	**6 Days** (from 0 to 9 days)	**14 Days** (from 2 to 22 days)
Total Volume Discharged (per year)		**10 ML** (from 0 to 40 ML)	**50 ML** (from 0 to 105 ML)	**125 ML** (from 15 to 180 ML)

Selected Representative Years

Figures 12, 13 and **14** show a summary of the water balance results for the specific historical rainfall years of 1979 (dry), 1989 (median) and 1942 (wet), as described above.

It is important to note that the results for these specific historical years do not match the statistical averages for the dry, median and wet years shown in **Table 14**. This is due to the scatter in results owing to many factors (such as initial dam storage and rainfall distribution) and showing they are not simply a direct relationship to how much rain fell in a year.

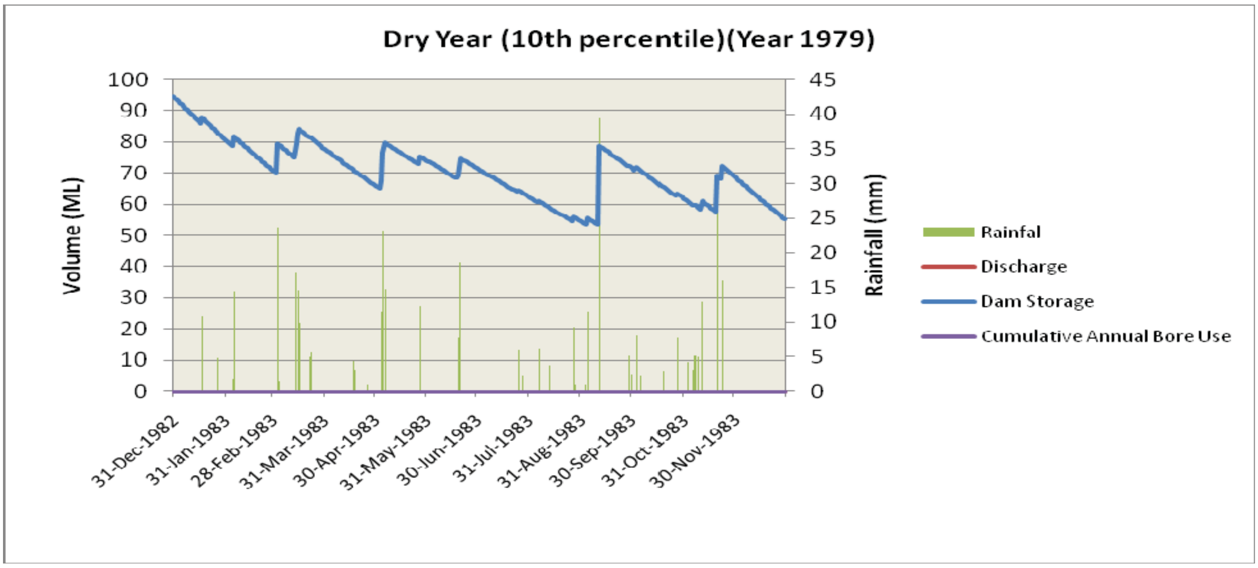

Figure 12 – Water Balance Results Year 5 Scenario - Historical 'Dry' Rainfall Year 1979

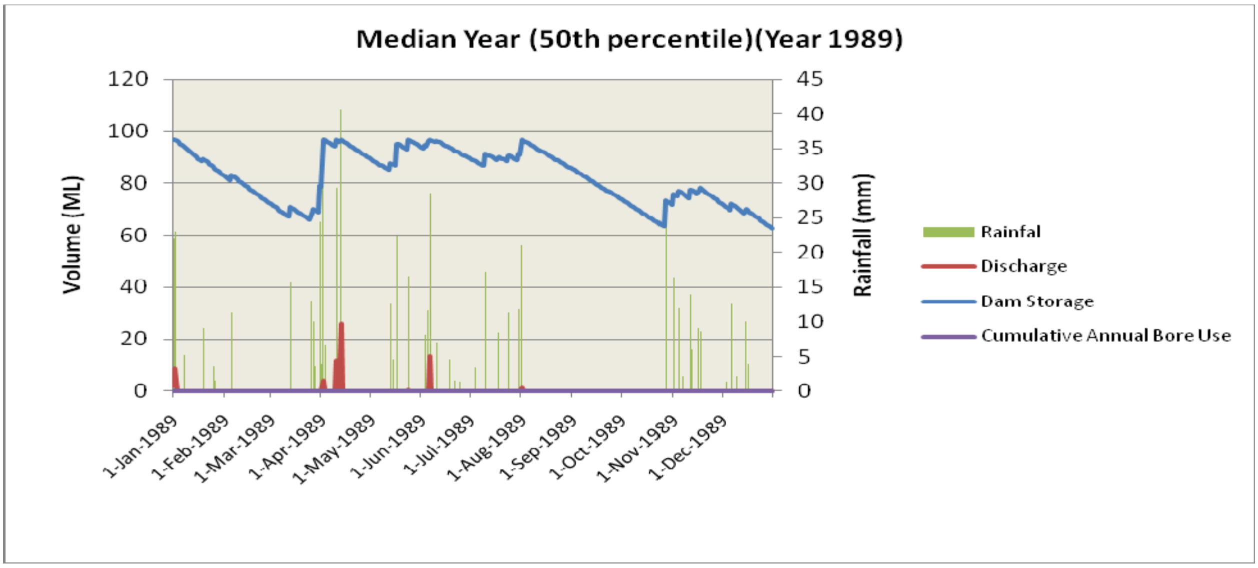

Figure 13 – Water Balance Results Year 5 Scenario - Historical 'Median' Rainfall Year 1989

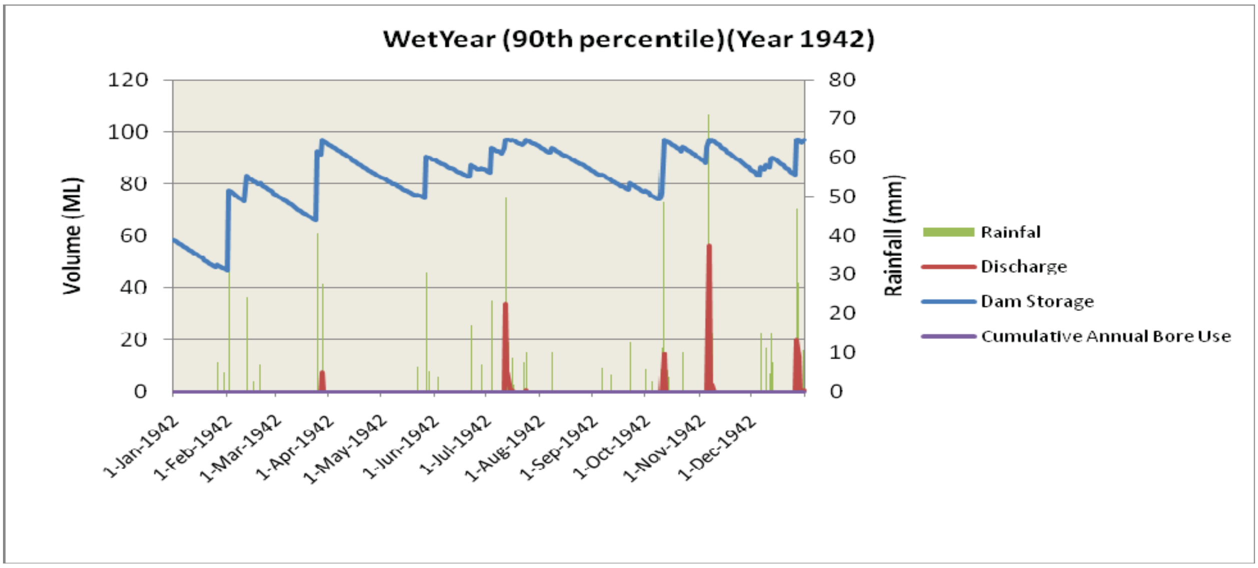

Figure 14 – Water Balance Results Year 5 Scenario - Historical 'Wet' Rainfall Year 1942

7.6.3 Scenario 3 - Year 10 of Expanded Operation

Figure 15 shows the annual total data results from the water balance for all the relevant inputs and outputs of the water balance model for the Year 10 Scenario.

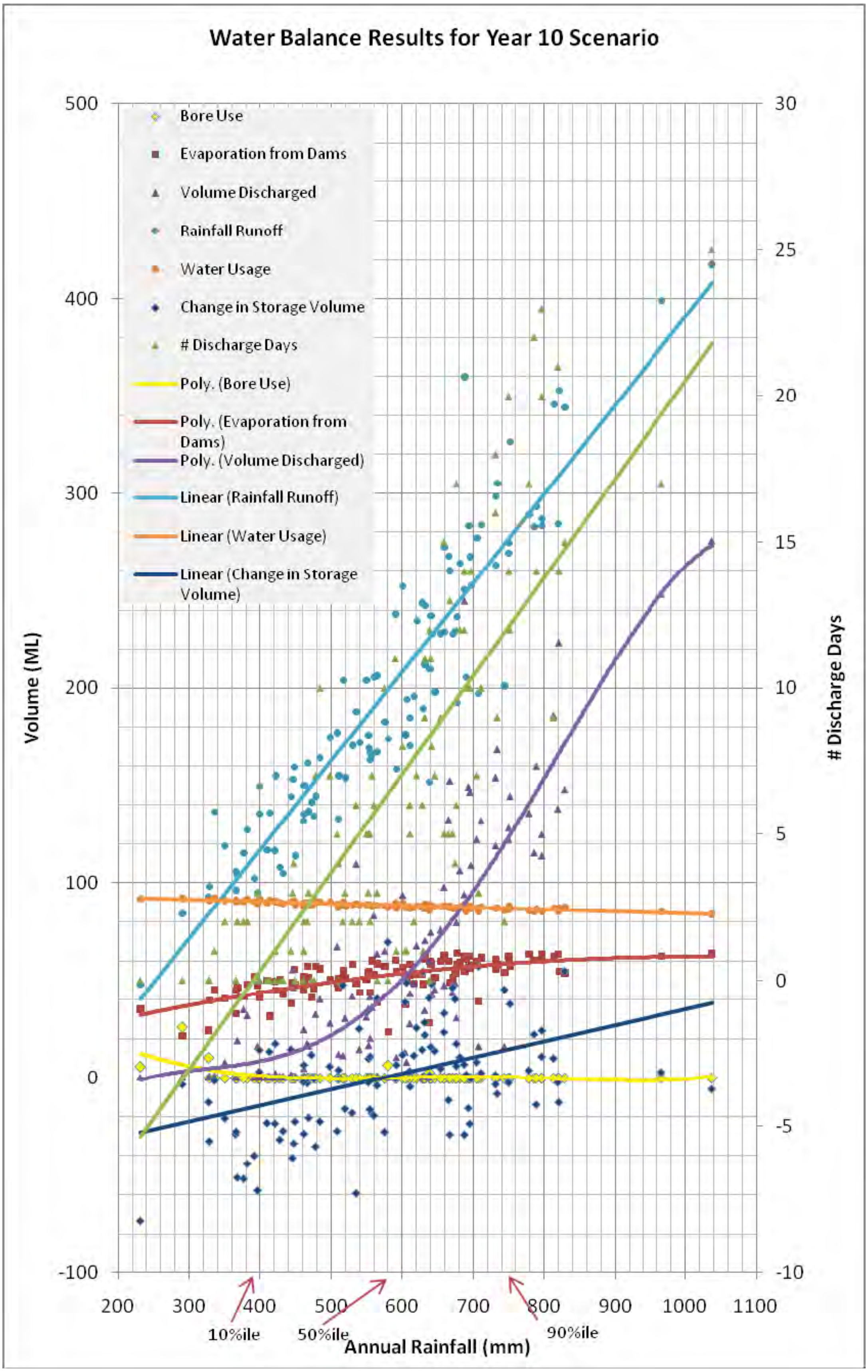

Figure 15 – Water Balance Results Year 10 Scenario

Figure 15 demonstrates that there is wide scatter of data results for some of the inputs/outputs. Trend lines have been produced which provide a better tool for interpreting the results, and predicting water balance results for dry, median and wet years.

Using the trend lines shown in **Figure 15** as a guide, the predicted water balance totals for dry, median and wet years has been estimated and is shown in **Table 16**.

Table 16 - Water Balance Results for Year 10 Scenario (Annual Summaries)

	Description	Dry (ML/year)	Median (ML/year)	Wet (ML/year)
Water Source (Inputs)	Rainfall Runoff	110	200	280
	Bore Use	0 (*)	0 (*)	0
Water Losses and Usage (Outputs)	Evaporation (from dams)	45	55	60
	Water Usage (dust suppression including crushing)	90	90	85
	Discharged (wet weather)	10	45	120
Balance (Input-Output)	Change in water storage on site (**)	-35	+10	+15

Note (*) A wide scatter in the bore usage occurred, with 25 ML used in one very dry year, and 10 ML in one relatively median year
Note (**) Change in water storage is calculated from other data, rather than being read from the trend line

The results from Year 10 are similar to the result for the Year 5. The primary change in the water balance results for Year 10 (compared to Year 1) is the increase in rainfall runoff, which is a result of the increase in open cut extraction area and shaped/rehabilitated emplacement areas which have higher runoff coefficients than loose emplacement areas.

Water Supply

The results of the water balance model demonstrate that:

- Rainfall runoff captured in sediment basins on-site will provide for the majority of water demand.
- It is unlikely that bore water will be required in most dry, median or wet years; however, in some years a bore supply up to 25 ML/year may be required.
- Additional sources of water supply are not required for the dry, median or wet year scenarios.

Discharges from Site

The overall average of all rainfall years for the Year 10 Scenario shows that on average:

- There will be **6.4 days of discharge per year**, of which
  - 3.9 days occurred when the dam design criteria (i.e. rain of 38.4 mm in 5 days) was exceeded; and
  - 2.5 days occurred when the dam design criteria (i.e. rain of 38.4 mm in 5 days) was not exceeded.

The total number of discharges is slightly higher than predicted in the *Blue Book*, which states that for dams designed to the 90th percentile criteria, there is likely to be from 2 to 4 overflow events per year. The events where discharge occurred, but the design criteria was not exceeded, were all as a result of a combination of the following factors:

- A high rainfall period had preceded the day of discharge so that dams were at full capacity before the event occurred; and
- The substantial rainfall event (but still under 38.4 mm) in a short period of 1 to 2 days.

As expected in dry years the likelihood of discharge decreases, and in wet years the likelihood increases. Interpretation of the results suggests the following likely discharges (and range of discharges) for the dry, median and wet years (shown in **Table 17**).

Table 17 - Predicted Discharges from Site for Year 10 Scenario

	Description	Dry	Median	Wet
Number of Discharge Days per Year	Where rain was more than 38.4mm in 5 days	1 Days (from 0 to 2 days)	3 Days (from 0 to 5 days)	9 Days (from 2 to 14 days)
	Where rain was less than 38.4mm in 5 days	0 Days (from 0 to 2 days)	2 Days (from 0 to 7 days)	5 Days (from 0 to 10 days)
	Total Number of Days Per Year	**1 Days** (from 0 to 3 days)	**5 Days** (from 0 to 12 days)	**14 Days** (from 2 to 22 days)
Total Volume Discharged (per year)		**10 ML** (from 0 to 35 ML)	**45 ML** (from 0 to 90 ML)	**120 ML** (from 15 to 160 ML)

Selected Representative Years

Figures 16, 17 and **18** show a summary of the water balance results for the specific historical rainfall years of 1979 (dry), 1989 (median) and 1942 (wet), as described above

It is important to note that the results for these specific historical years do not match the statistical averages for the dry, median and wet years shown in **Table 16**. This is due to the scatter in results owing to many factors (such as initial dam storage and rainfall distribution) and showing they are not simply a direct relationship to how much rain fell in a year.

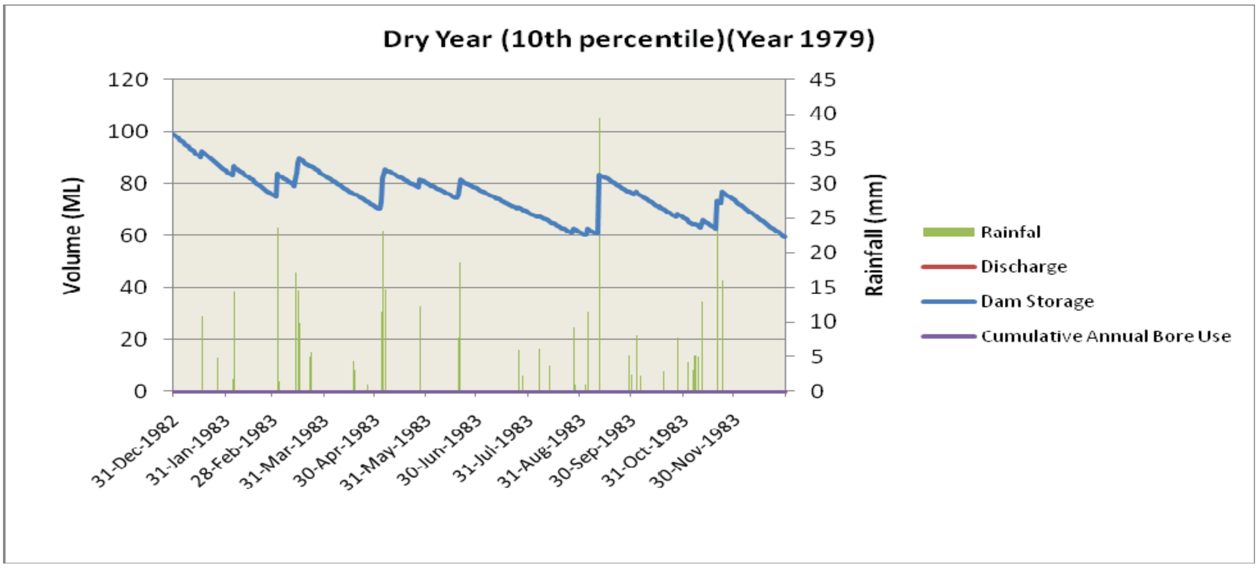

Figure 16 – Water Balance Results Year 10 Scenario - Historical 'Dry' Rainfall Year 1979

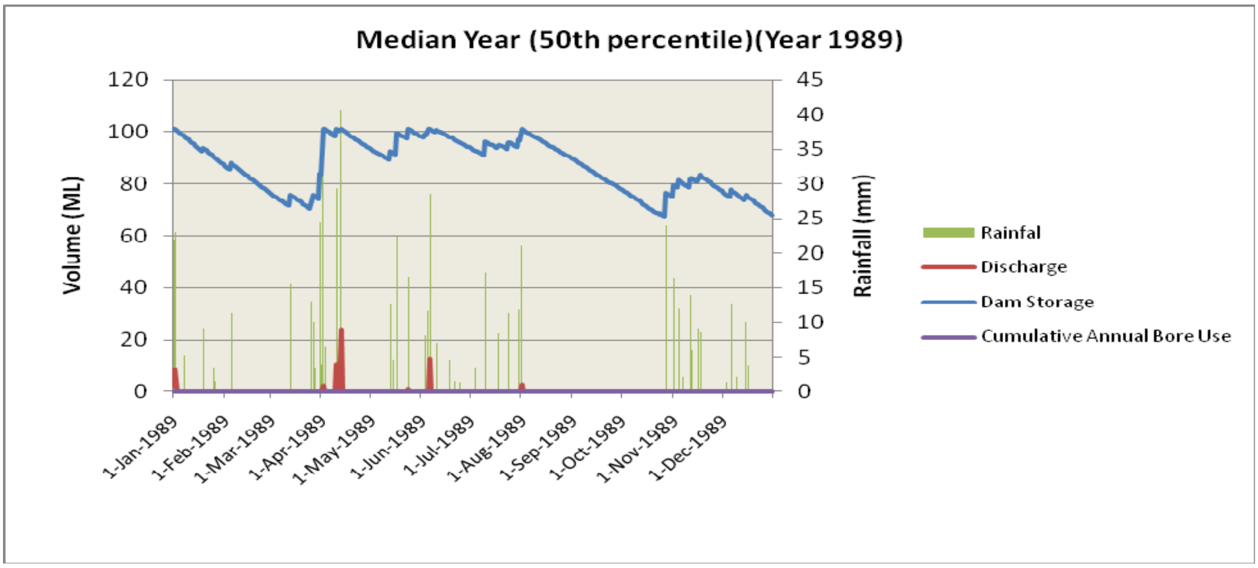

Figure 17 – Water Balance Results Year 10 Scenario - Historical 'Median' Rainfall Year 1989

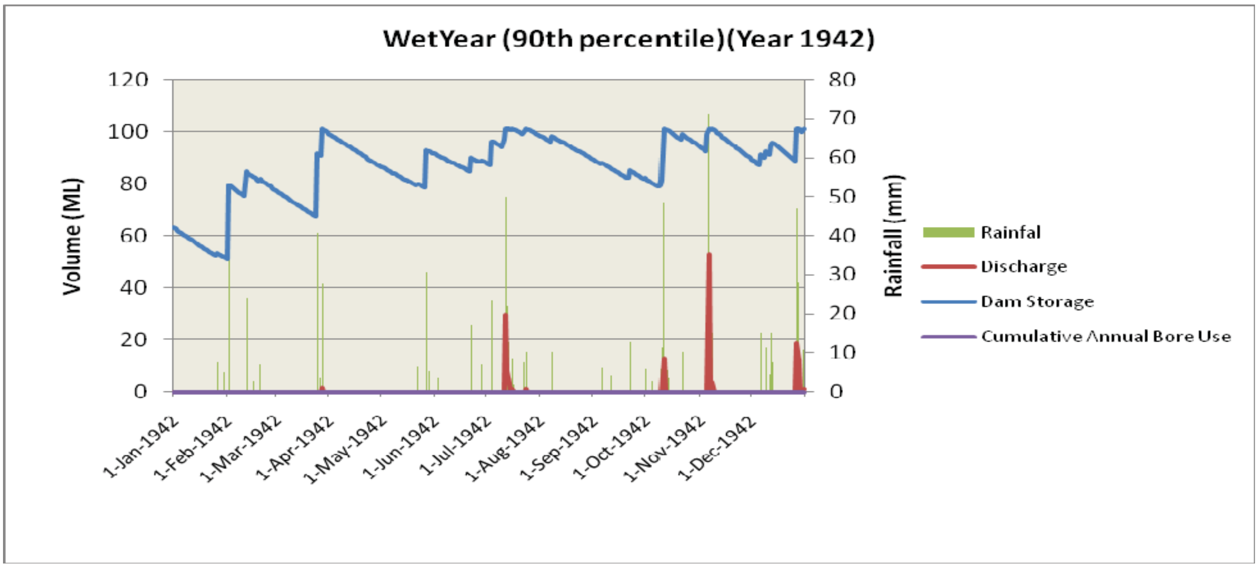

Figure 18 – Water Balance Results Year 10 Scenario - Historical 'Wet' Rainfall Year 1942

7.7 Controlled Discharge of Treated Water

The results presented in the above sections are based on the assumption that there is negligible day to day on-site water management undertaken, and that the site does not flocculate and undertake controlled discharge of treated water off-site.

In practice, it is anticipated that the approvals (and in particular the EPL) will allow controlled discharges from site, and subsequently the model was re-run under assumptions that controlled discharges do occur. To investigate the impact on the water management from controlled discharges from site, the model has been re-run with the following assumptions:

- 5 days after rainfall (allowing time for settlement and flocculation) controlled discharge would occur from site;
- Controlled discharge would occur at a rate of 2 ML/day (1 ML/day from each LDP); and
- Controlled discharge would occur until dams are drawn down to a level such that there is only 15 ML of water retained within the Mine Water Dam and dirty water dams (which roughly equates to the volume of the Mine Water Dam). This essentially means that all the dirty water dams would be fully drawn down.

The key changes in the water balance results under these assumptions were a significant reduction in the predicted number of overflow discharges from site and an increase to the predicted bore use.

For the Scenario 1 (Year 1 of Expanded Operation) the key results of assuming controlled discharges are:

- The average number of overflow discharges reduced from 3.1 days/year to 0.6 days/year (along with a comparable reduction to the volume of overflow discharges); and
- The average bore use increased from 4 ML/year to 50 ML/year (and a maximum of 83 ML/year).

For the Scenario 2 (Year 5 of Expanded Operation) the key results of assuming controlled discharges are:

- The average number of overflow discharges reduced from 6.4 days/year to 1.0 days/year (along with a comparable reduction to the volume of overflow discharges); and
- The average bore use increased from a negligible volume to 43 ML/year (and a maximum of 77 ML/year).

For the Scenario 3 (Year 10 of Expanded Operation) the key results of assuming controlled discharges are:

- The average number of overflow discharges reduced from 6.4 days/year to 0.9 days/year (along with a comparable reduction to the volume of overflow discharges); and
- The average bore use increased from a negligible volume to 43 ML/year (and a maximum of 78 ML/year).

The impact of introducing controlled discharge to the water management is shown in **Figure 19** which presents a summary of the water balance results for the historical rainfall year 1989 (median) for the Scenario 2 (Year 5 of Expanded Operation).

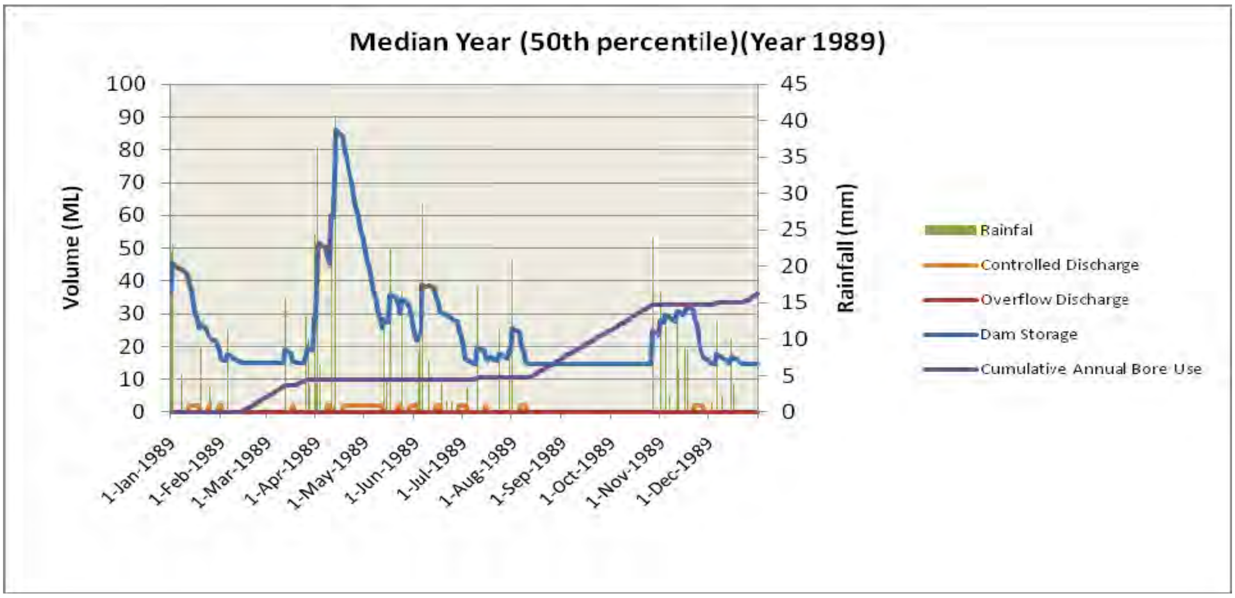

Figure 19 – Water Balance Results Year 5 Scenario - Historical 'Median' Rainfall Year 1989 (assuming controlled discharge undertaken)

By comparing **Figure 19** to **Figure 13** it can be seen that, at the same stage of mine operation under the same rainfall conditions, the inclusion of controlled discharge results in:

- Numerous controlled discharge events following rainfall;
- A reduction in overflow discharge events to zero;
- A reduction in the typical amount of water stored on-site; and
- An increase in bore use from negligible to about 17 ML.

7.8 Conclusions

The detailed site data available during the 2008, 2009 and early 2010 has enabled the water balance model to be calibrated effectively. GSSE is confident that the results of the model are a reasonably accurate reflection of the probable water balance to be experienced.

The overall results of the water balance indicate that the site has adequate water supply primarily through the rainfall runoff captured in sediment basins, which can be supplemented through the use of bore water when required.

The model indicates that use of bore water is highly dependent on the water management practices adopted. Assuming controlled discharge is undertaken to draw down the dirty water dams, the typical bore water usage will be 40 to 50 ML/year and will be within the license entitlement of 120 ML/year for all years.

The model indicates that the number of overflow discharges is also highly dependent on the water management practices adopted. Assuming controlled discharge is undertaken, likely annual overflow discharges of 1 day (on average) per year are expected, which will occur under extreme rainfall events (greater than the license threshold of 38.4mm in 5 days).

In practice the mine pit would provide substantial additional on-site storage (temporarily), which would reduce the potential for overflow discharge to occur.

7.9 Recommendations

It is recommended that:

- The proposed dams are built to at least the specified sizes, and made larger where practical to provide additional storage in order to further reduce the chance of uncontrolled overflow discharge. Increasing the total storage will provide opportunity to retain and treat water prior to controlled discharge (see below);
- Water be promptly transferred amongst sediment basins to ensure the maximum available on-site storage capacity of rainfall events is maintained; and
- That controlled discharge of treated (e.g. settled and/or flocculated) water be undertaken to draw down the water storage within all the dirty water dams on-site, which would provide the capacity to contain the majority rainfall events and reduce uncontrolled overflow discharge.

Primarily it is the controlled discharge (of treated water) that will have the most significant impact on reducing the potential for discharge of sediment laden water. Whilst the overall discharge volumes will not change significantly, discharge in a controlled manner allows adequate settlement of sediment to be achieved prior to discharge.

8.0 SITE WATER MANAGEMENT PLAN

A Site Water Management Plan (SWMP) will be prepared following project approval in accordance with regulatory requirements and conditions of consent. The SWMP will be developed in accordance with the *Blue Book* (Volume 1 and Volume 2E), and will address the impacts and mitigation measures discussed in **Section 6** of this Surface Water Assessment.

It is recommended that the SWMP incorporate the following:

- On-site soil and water management principles and objectives, including the following:
  - Containment of dirty water runoff from open cut areas by directing this water into in-pit sumps.
  - Pumping excess dirty water from the in-pit sumps into the Mine Water Dam.
  - Directing sediment-laden runoff from disturbance areas and rehabilitated areas into designated sediment control dams.
  - Installing temporary erosion and sediment control devices as required (i.e. sediment fences, sand bag weirs) to minimise the discharge of sediment laden water from newly disturbed areas.
  - Diverting clean water runoff unaffected by the operations away from disturbed areas and off-site, where possible.
  - Maintaining sediment control structures to ensure that the designed capacities are maintained for optimum settling of sediments.
  - Implementing an effective revegetation and maintenance program for the site.
  - Draw down of dirty water dams in accordance with Blue Book.
- Identification of sources of sedimentation and erosion.
- Soil Best Management Practices (BMPs) to be implemented on-site, including:
  - mine planning considerations (such as minimising disturbance);
  - topsoil/subsoil handling and stockpiling procedures; and
  - topsoil/subsoil respreading procedures.
- Water BMPs to be implemented on-site, including;
  - clean water diversions;
  - dirty water capture and treatment;
  - additional sediment protection measures to be employed during the life of the Project; and
  - maintenance of sediment control structures.
- Drainage line rehabilitation.
- Water monitoring procedures.
- Documentation and reporting procedures.

9.0 SURFACE WATER MONITORING PROGRAM

9.1 Introduction

The original Surface Water Monitoring Program was prepared by RCA Australia in conjunction with the NSW Soil Conservation Service in 2008. The document was prepared in accordance with the project approval issued by the Department of Planning (PA 06_0198) and included:

- provision of baseline data on surface water flows and quality in adjoining creeks and waterbodies that could be affected by the project;
- surface water impact assessment criteria;
- a program to monitor the impact of the project on surface water flows and quality; and
- procedures for reporting the results of this monitoring.

The extension to mining operations currently being considered will necessitate changes to the existing surface water management structures and will include the implementation of additional controls where required. Many aspects of the original Monitoring Program are still relevant to the expanded mine operation; however a few alterations are required to account for changes to the water management system.

Whilst the continuation of water quality monitoring is recommended for the site, the establishment of volumetric flow monitoring at the Driggle Draggle Creek monitoring point and the southern drainage channel monitoring point is not warranted. These drainage lines are ephemeral and do not flow regularly enough to warrant the establishment and maintenance of flow gauging stations within those drainage lines.

9.2 Baseline Data

The baseline water quality data available for the site is presented in **Section 3.8.3**. The amount of baseline data available for the receiving waters is fairly limited due to the ephemeral nature of drainage lines in the general area and the limited extent of existing monitoring results.

9.3 Surface Water Impact Assessment Criteria

The impact assessment criteria for surface water are only relevant to water actually discharged from the mine site. The existing EPL (No, 12870) for Rocglen Mine contains concentration limits for water discharged through LDP 11 and LDP 12. These are presented above in **Table 3.** It is recommended that these criteria be retained as the on-going water quality criteria for the Project.

9.4 Monitoring Locations

9.4.1 Regulatory Compliance

It is currently proposed that the same monitoring be undertaken at the Project Site for pollutant discharges that is currently contained in the EPL with a changed location of LDP 12.

Table 18 identifies the monitoring point locations, the type of monitoring point, the pollutants to be measured, the frequency and sampling method. The location of these monitoring points is shown on **Figure 4**.

Table 18 - Proposed Surface Water Monitoring Locations for Regulatory Compliance

Identification	Type of Monitoring Point	Pollutants	Frequency	Sampling Method
LDP 11	Wet Weather Discharge	Conductivity (µS/cm) Oil and Grease (mg/L) Total Organic Carbon (mg/L) Total Suspended Solids (mg/L) pH	*Special Frequency 1 (all)*	In situ Grab sample Grab sample Grab sample In situ
LDP 12	Wet Weather Discharge		*Special Frequency 1 (all)*	
Driggle Draggle Creek to the north of the Project Site	Baseline Data and Wet Weather Discharge (downstream of site)		*Special Frequency 2 (all)*	
Un-named drainage channel to the south of the Project Site	Baseline Data and Wet Weather Discharge (downstream of site)		*Special Frequency 2 (all)*	
Dam SD7 (eastern side of Project Site)	Baseline Data (upstream of site)		*Special Frequency 2 (all)*	
Mine Water Dam	Water Quality	Aluminium Arsenic Bicarbonate Chloride Conductivity Iron Manganese Oil and Grease Sodium Total Organic Carbon Total Suspended Solids pH	Yearly Yearly Yearly Yearly Quarterly Yearly Yearly Quarterly Yearly Quarterly Quarterly Quarterly	Grab sample Grab sample Grab sample Grab sample In situ Grab sample Grab sample Grab sample Grab sample Grab sample Grab sample In situ

Special Frequency 1 – means the collection of samples as soon as practicable after each discharge commences and in any case not more than 12 hours after each discharge commences.

Special Frequency 2 – means the collection of samples quarterly (in the event of flow during the quarter) at a time when there is flow and as soon as practicable after each wet weather discharge from LDP 11 and LDP 12 commences and in any case not more than 12 hours after each discharge commences.

9.4.2 Additional Operational Monitoring

In addition the monitoring required under the modified EPL for the Project, surface water monitoring is proposed for internal dams within the Project Site. This additional monitoring will allow the performance of the surface water management system to be assessed for various areas around the Project Site, with additional controls targeting these potential problem areas to be implemented. It will also allow for the monitoring of salt and alkalinity in dams collecting water from subsoils.

9.5 Reporting of Monitoring Data

It is recommended that Whitehaven collate surface water analysis data and maintain an up to date record of analysis both in hard copy (laboratory reports) and electronic (results) format. These results should be interpreted as they are received in order to ensure appropriate operational guidance on maintaining water quality within desired parameters.

The results of water quality analysis will need to be reported in the AEMR, and should be made available to the Community Consultative Committee (CCC) members on a regular basis as part of the Environmental Monitoring Reporting process, as well as to the Gunnedah Shire Council.

In the event that an exceedance in surface water quality criteria is identified, the exceedance will need to be reported to the relevant agencies in accordance with the requirements of the EPL.

10.0 CONCLUSION

The drainage lines that will be affected by the proposed Rocglen Coal Mine Extension Project are very minor headwater drainage lines that are ephemeral in nature and only flow for short periods after heavy rainfall and/or site discharges. There was no volumetric flow data for these streams and little baseline water quality information to help quantify the potential impacts. The proposed mitigation measures to maintain flow regimes include diverting water flowing onto the Project Site from upstream catchments via clean water diversions, along with treated dirty water being allowed to discharge from LDPs. Based on this information alone, it is anticipated that there will be minimal impact on flow regimes downstream of the Project Site due to the proposal.

Available soil and water data for the Project Site suggests that TSS is likely to be the key water quality parameter requiring management throughout the life of the Project to ensure the water quality in downstream watercourses is not impacted. A number of surface water management and mitigation measures are recommended by this Surface Water Assessment to ensure that the potential risk of any adverse off-site surface water impacts is minimised. This includes directing dirty water runoff into suitability sized sediment basins, preferential use of water from 'end-of-line' basins and the use of chemical flocculants to help increase settlement times.

Salinity and alkalinity will also be closely monitored in the runoff from overburden dumps to ensure that there are no adverse effects on downstream waterways. Preferential use of saline and/or alkaline water for on-site purposes will occur to reduce the risks of discharge.

The water balance developed for the Project indicated that the site would be relatively balanced, with sufficient water available for reuse in dry periods and some wet weather discharges following large rainfall events. The calibration of the model using actual site data collected during 2008 to 2010 allowed for a more reliable model to be developed.

The overall results of the water balance indicate that the site has adequate water supply through the rainfall runoff captured in sediment basins and through the use of bore water when required (which is within the existing license entitlement of 120 ML/year).

The water balance model predicted that likely annual overflow discharges of 1 day/year (on average) will occur based on the assumption that controlled discharge of water is undertaken. The controlled discharge (of treated water) to draw down the water storage within all the dirty water dams on-site significantly reduces the potential for discharge of sediment laden water to occur during uncontrolled overflow events,

If the surface water management and mitigation measures identified and discussed within this Surface Water Assessment are implemented and maintained, it is anticipated that there would be minimal impact on surface water downstream of the Project Site as a result of the proposed Rocglen Coal Mine Extension Project.

11.0 REFERENCES

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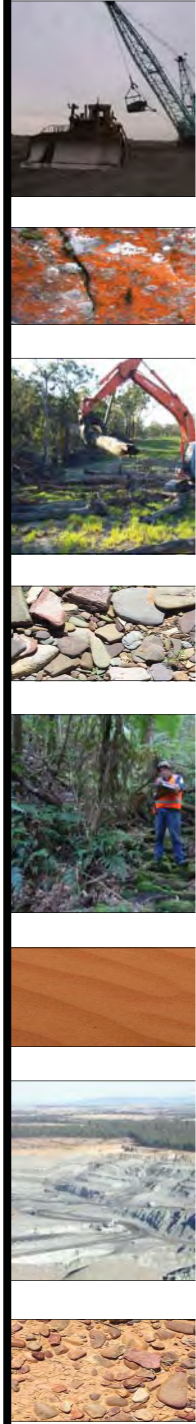
Existing Site Water Management Plan



APPENDIX A

Whitehaven Coal Mining Pty Ltd

ABN: 65 086 426 253

Site Water Management Plan

for the

Rocglen Coal Mine

Prepared by:

RCA

in conjunction with

SOIL CONSERVATION SERVICE (A Business unit of the NSW Department of Lands)

Whitehaven Coal Mining Pty Ltd
ABN: 65 086 426 253

Site Water Management Plan

for the

Rocglen Coal Mine

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FORWARD

Whitehaven Coal Mining Pty Ltd (Rocglen Coal Project) is required under its project approval issued on 15th April 2008 (PA 06_0198, See **Appendix 1**) to prepare a Water Management Plan (WMP) to guide the management of water resources through the construction and operational life of the Rocglen Coal Mine. The WMP incorporates a predicted site water balance, and erosion and sediment control plan, a surface water monitoring program, a groundwater monitoring program, and a surface and groundwater response plan.

GLOSSARY OF ACRONYMS

AEMR – Annual Environmental Management Report

PA – Project Approval

DECC – Department of Environment and Climate Change

DWE – Department of Water and Energy

DoP – Department of Planning

DPI (MR) – Department of Primary Industries (Mineral Resources)

EA – Environmental Assessment

ESCP – Erosion and Sediment Control Plan

GTA's – General Terms of Approval

GWMP – Groundwater Monitoring Program

SWMonP – Surface Water Monitoring Program

WMP – Water Management Plan

WCM – Whitehaven Coal Mining Pty Ltd

CONTENTS

APPENDICES

TABLES

1.0 INTRODUCTION

This Water Management Plan (WMP) for the Rocglen Coal Mine ("the mine"), formerly known as the Belmont Coal Project, has been prepared in compliance with Condition 2 of Schedule 3 of the project approval issued by the Department of Planning (PA 06_0198). The WMP will not only satisfy the requirement of the consent, but will also address monitoring requirements as specified within the Environment Protection Licence as issued by the DECC. Throughout the WMP, reference to Condition 2 relates to that consent condition PA 06_0198.

The Rocglen Coal Mine is to be managed by Whitehaven Coal Mining Pty Ltd (WCM). The WMP incorporates:

- A description of water management of the mine site including objectives and the design and location of the surface water management structures **(Section 2)**;
- The predicted site water balance **(Section 3)**;
- An erosion and sediment control plan **(Section 4)**;
- A surface water monitoring program **(Section 5)**;
- A groundwater monitoring program **(Section 6)**; and
- A surface and groundwater response plan **(Section 7)**.

The WMP has been prepared by RCA Australia (RCA) as the suitably qualified experts in relation to groundwater assessment, and the Soil Conservation Service, a business unit of the NSW Department of Lands, as the suitably qualified experts for the surface water component of the plan. The WMP builds upon and refines the water management concepts in the 2007 Environmental Assessment (EA) for the mine, and has been prepared for the life of the mine. In the event that refinements to mine design result in altered water management requirements, or operational experience and/or monitoring leads to changes to the method of managing or monitoring water, the WMP will be updated. Any updated WMP will be submitted to the Director-General for endorsement.

To assist in keeping the WMP as concise as possible, the document has been prepared with reference to six figures of the mining lease ("the mine site"). **Figure 1** presents the general locality of the mine site. **Figure 2** presents the location and function of surface water management structures. **Figure 3** presents the representative catchments from which annual surface water yields for the mine site have been based. **Figure 4** presents the generalised design of erosion and sediment control features to be employed on the mine site. **Figure 5a and 5b** presents the location of surface water and groundwater monitoring points for the mine site and surrounds. **Figure 6** presents the conceptual final landform and surface water management features.

For management purposes, the water within the mine site has been divided into four classes.

1. **"Clean" water** – surface runoff from catchments undisturbed or relatively undisturbed by mining or related activities and rehabilitated catchments. Clean water flows are shown on **Figure 2**. All surface water emanating from the final landform will be clean, with the final landform surface water management

presented on **Figure 6**.

2. **"Dirty" water** – surface runoff from disturbed catchments such as the active mine area and overburden emplacement, ROM and product coal stockpiles, soil and subsoil stockpiles and rehabilitated area (until stabilised), all of which could contain sediments. Dirty water used to supply the water requirements of the mine site is captured within 2 catchments on the mine site, referred to as the "disturbed area" and "open cut" catchments. It should be noted that a proportion of the water in these catchments will not flow over disturbed areas or within the cut, rather, the catchment itself contains either areas of disturbance or the open cut void.

3. **"Contaminated" water** – surface runoff which could potentially contain hydrocarbons.

4. **"Pit" water** – water from the void which will be retained in sumps within the void or pumped to segregated storages specifically for storage of pit water.

2.0 SITE WATER MANAGEMENT

2.1 Objectives

The principal objectives of site water management are as follows.

(i) To ensure sufficient quantities of water can be obtained through the capture of “dirty” water, harvesting of “clean” water, and extraction/harvesting groundwater to meet the requirements of dust suppression on the mine site.

(ii) To ensure the segregation of “dirty” water from “clean” water, with “dirty” water directed to and detained in sediment basins which, on discharge, flow to storage dams. “Clean” water, comprising clarified water originating from the sediment basins and run-on water collected in accordance with the Company’s harvestable right, will be directed to and/or collected in storage dams.

(iii) To ensure the treatment and separation of “contaminated” water from the workshop and wash bay area by diversion to an oil separating unit, with clarified water reporting to sediment basins.

(iv) To ensure segregation of “pit” water from surface flows by collection in isolated pit de-watering dams.

(v) To maximise the use of “dirty” and “pit” water for dust suppression purposes and minimise the necessity to harvest “clean” run-on water.

(vi) To minimise the volume of water discharged from the mine site, but, should the discharge of water prove necessary, ensure sufficient settlement time is provided prior to discharge such that suspended sediment within the water meets the water quality criteria as specified in the DECC Environment Protection Licence.

(vii) To minimise erosion and sedimentation from all active and rehabilitated areas of the mine site.

(viii) To monitor the effectiveness of surface water controls and ensure all relevant surface and groundwater quality criteria are met.

(ix) To monitor the impact on groundwater level, quality and availability.

(x) To minimise any impacts on the availability of surface water or groundwater to surrounding residents and landholders.

(xi) To establish a method of assessing the level of impact on groundwater supply attributable to the mine.

2.2 Surface Water Management Structures

2.2.1 Introduction

Operational water requirements will be preferentially sourced from “dirty” water run-off collected on site, together with any surface water and groundwater which accumulates in the open cut and pumped to designated pit de-watering dams. Any shortfall will be supplemented by harvested “clean” water. **Figure 2** presents the surface water management structures and their function for the life of the mine. **Figure 4** provides the general construction detail for erosion and sediment control.

A general description of the design of these surface water management structures along with more specific detail on the dimensions of each is presented in sub-sections 2.2.2 and 2.2.3.

2.2.2 Clean Water Management

Diversion, collection and storage of “clean” water will be achieved using a series of diversion banks (prefix DB), waterways (WW) and storage dams (SD) which will be constructed prior to surface disturbance activities within the adjacent upslope catchments.

The design period for all diversion bank and storage dam structures has been at a minimum of a 1 in 10 year average recurrence interval (ARI). The design for all structures has been based on the Soil Conservation Service Design Manual, SCS (1990).

<u>Diversion Banks</u>

Each diversion bank will exhibit the features identified below, with the dimensions for each diversion bank based on the upslope catchment area and slope.

- Trapezoidal channel.
- Bank batters between 1:3 to 1:6 (V:H).
- Channel batters are to be 1:6 (V:H).
- Channel grade 1:400 (5cm/20m) if channel is bare.
- Channel grade 1:200 (10cm/20m) if channel is to be kept well grassed.
- Level sill outlet to each channel.
- Stable grass cover to be maintained below sill outlets.
- Sill width to be constructed with minimum 1.5 x channel base width.

Table 2.1
Diversion Bank Specifications

Structure ID	Catchment Area (ha)	Channel Bottom Width (m)	Channel Grade (%)	Bank Height (m)	Sill Width (m)	Slope Below Sill (%)	Construction Timing 1
DB1	15	3	0.2	0.8	6	2	1
DB2	5	2	0.2	0.8	6	2	1
DB3	25	3	0.2	0.8	6	2	1
1 Construction timing refers to year in which each structure is to be constructed							
Source: Soil Conservation Service							

Table 2.1 presents the specifications of the diversion banks as illustrated on **Figure 2.**

All diversion bank structures have been designed to cater for water velocity of 1.2m/s, an acceptable rate considering these structures will be maintained and well grassed. Where conditions are unfavourable to establishment of sufficient groundcover over these structures, additional actions of rock or mesh lining will be considered for appropriate erosion control. All structures will be inspected following significant storm events to ensure the structures have been able to sustain those flow velocities.

<u>Waterways</u>

Waterways will provide a drainage path for water flowing from the east and west of the project site. Waterway 1 is located on the western boundary of the project site and will direct surface flows from Vickery State Forest to the north and south to ensure clean water flows do not interact with disturbed areas. Waterway 2 is located on the south-eastern side of the project site and will direct flows south via a series of sediment basins and storage dams prior to being able to discharge off the project site. WW2 provides for capture of surface water flows originating from off site. Storage dams are located immediately upstream of the access point to the project area to assist in water capture and limit velocity of flow.

The waterway will be sown immediately following construction to establish a cover crop to further reduce potential for erosion and sedimentation. The seasonal conditions will have a direct influence on the effective operation of the waterways, and in the event that groundcover establishment has been ineffective, alternate options such as rock armouring will be introduced to ensure effective erosion and sediment control. Specifications for the waterways are presented in **Table 2.2**.

Table 2.2
Waterway Specifications

Structure ID	Waterway Width (m)	Bank Height (m)
WW1	12	0.7
WW2	Initially 25 and widen the 35 once it links with central drainage depression	0.8-1.0
Source: Modified after Soil Conservation Service (2007)		

Storage Dams

Storage Dams to be constructed on the project site (in addition to existing dams to be retained) will provide for clean water storage. The storage dam locations are illustrated on **Figure 2**, with specifications identified in **Table 2.3** below.

Table 2.3
Storage Dam Specifications

Structure ID		Catchment Area (ha)	Volume (m3)	Depth (m)	Dimensions length * width (m*m)	Outlet Width (m)	Sill Width (m)
Driggle Draggle Creek Catchment							
GBD-1	Gully Block Dam to capture water from Vickery SF catchment prior to diversion to Driggle Draggle Creek Catchment	60	1000	3	28*26	4	8
SD-1	On the northern boundary of the Project Site.	124	1400	3	30*30	6	9
SD-2	Outside northern boundary of project site	144	7000	3	50*50	15	35
SD-6	On the northern boundary of the Project Site, spilling to SD1	124	1000	3	28*26	4	8
Southern Catchment							
SD-3	On southern boundary of Project Site	888	5000	3	50*50	20	40
SD-4	Upstream of relocated Wean Road at crossing of Jaegar Lane	177(1)	2000	3	30*30	4	8
SD-7	On eastern side of relocated Wean road south of Jaegar Lane	773	5000	3	50*50	20	40
SD-8	At southern end of project site collecting water from CB11 and spilling to SD3	25	5000	3	50*50	15	35

Note 1: Majority of runoff diverted away from the dam to the south via existing contour banks. Effective catchment estimated at <30ha.
Source: Modified after Soil Conservation Service (2007).

Figure 2 identifies the storage dams to be installed, each of which will exhibit the following features.

- Excavation and dam bank batters to be at least 1:3 (V:H).
- Crest width to be a minimum of 3m wide.

- Freeboard to be a minimum of 1m above top water level up to a wall height of 3m. Above 3m there will be an increase in freeboard of 0.1m for every 1m increase in wall height.
- Inlet and outlet channel batters are to be 1:6 (V:H).
- Outlet channel grade 1:400 (5cm/20m) if channel is bare.
- Outlet channel grade 1:200 (10cm/20m) if channel is to be kept well grassed.
- Level sill outlet to each outlet channel.
- Stable grass cover to be maintained below sill outlets.
- Sill width to be constructed with minimum 1.5 * channel base width.

2.2.3 Dirty Water Management

Figure 2 also presents the proposed dirty water management controls. Catch banks (prefix CB) will be constructed to divert potentially sediment-laden waters into sediment basins (prefix SB) constructed downstream of these areas of disturbance. The size and storage capacity of the sediment basins have been determined based on the settlement time requirements of the most common soil type (Soil Type D – Landcom, 2004) present on the mine site (based on GCNRC, 2007). This soil type has a predominantly moderate to high dispersibility which requires a designated settling zone volume and sediment storage zone volume. This design allows water that is potentially laden with suspended solids or sediments to settle out prior to any discharge from the storage.

The storage size has also been based on a 90% 5 day storm event. Application of this measure results in an overall sediment basin capacity on site of 35.129ML. Table 2.5 identifies the storage capacity of individual sediment basins, with a combined overall capacity of 36ML, excluding the void. This demonstrates sufficient capacity in the sediment basin system as required under the 90% 5 day storm event parameters recommended in the Blue Book Landcom guidelines.

The assumptions used in determining the required sediment basin capacity are as follows:-

The percentile Vs Rainfall Depth for the Gunnedah Station 055023 as presented in Appendix L of the Blue Book determined a rainfall depth of 39mm. The volumetric runoff coefficient defined as the portion of rainfall that runs off as stormwater was set at 0.5. Calculation of settling zone volume, storage zone volume and total basin volume for the dirty water catchments is as presented below:

Site	Cv	$R_{xday,\ y\%}$	Total Catchment Area	Settling Zone Volume (m3)	Sediment Storage Volume (m3)	Total Basin Volume (m3)
Western Emplacement	0.5	39	74	14430	3749	18179
Northern Emplacement	0.5	39	9	1755	456	2211
Void	0.5	39	60	11700	3039	14739

Catch Banks

The general features for each of the catch banks presented on **Figure 2** will be the same as for the diversion banks, ie. designed for a minimum of a 1 in 10 year ARI, based on SCS (1990). **Table 2.4** provides the specifications and construction timing for each catch bank.

Table 2.4
Catch Bank Specifications

Structure ID	Catchment Area (ha)	Channel Bottom Width (m)	Channel Grade (%)	Bank Height (m)	Sill Width (m)	Slope Below Sill (%)
Northern Emplacement						
CB1	4	3	0.3	0.7	6	2.0
CB2	4	3	0.3	0.7	6	2.0
Western Emplacement						
CB3	25	3	0.2	0.7	6	2.0
CB4	30	4	0.2	0.7	8	2.0
CB6	4	3	0.3	0.7	6	2.0
CB9	4	3	0.3	0.7	6	2.0
CB10	10	3	0.3	0.7	6	2.0
CB11	4	3	0.3	0.6	6	2.0
CB12	5	3	0.3	0.7	6	2.0
Coal Handling Area						
CB5	4	3	0.3	0.7	6	2.0
Site Facilities Area						
CB7	4	3	0.3	0.7	6	2.0
Northern Soil Stockpile Area						
CB8	10	3	0.2	0.7	6	2.0
Source: Soil Conservation Service						

All catch banks have been designed to cater for water velocity of 1.2m/s, an acceptable rate considering these banks will be well grassed. Where conditions are unfavourable to establishment of sufficient groundcover over these structures, additional actions of rock or mesh lining will be considered for appropriate erosion control. All structures will be inspected following significant storm events to ensure the structures have been able to sustain those flow velocities.

Catch banks will be constructed on the following basis:

- The channel of the bank is to be trapezoidal.
- Bank batters between 1:3 to 1:6 (V:H).
- Channel batters are to be 1:6 (V:H).
- Channel grade 1:400 (5cm/20m) if channel is bare.
- Channel grade 1:200 (10cm/20m) if channel is well grassed.
- Level sill outlet to each channel.
- Stable grass cover to be maintained below sill outlets.
- Sill width approximately 1.5* channel base width.

Sediment Basins

The sediment basins are presented in **Figure 2** and will store and settle out potentially sediment laden waters as directed by the constructed catch banks.

Sediment basin construction requirements will include the following:

- Excavation and dam bank batters to be at least 1:3 (V:H).
- Crest width to be a minimum of 3m wide.
- Freeboard to be a minimum 1m above top water level up to a wall height of 3m. Above that there would need to be an allowance made of 0.1m/m increase in wall height.
- Inlet and outlet channel batters are to be 1:6 (V:H).
- Outlet channel grade 1:400 (5cm/20m) if channel is bare.
- Outlet channel grade 1:200 (10cm/20m) if channel well grassed.
- Level sill outlet to each channel.
- Stable grass cover to be maintained below sill outlets; and
- Sill width of approximately 1.5* channel base width.
- Marker point in each basin identifying 25% sediment storage level to assist in determining clean out timing.

Sediment basin design specifications are presented in **Table 2.5** below. The design specifications are based on sizing relative to catchment area as defined in the Northern and Western Emplacement, Coal Handling and Site Facilities Area, and Northern and Southern Stockpile Areas. It should be noted that some storages will receive waters from more than one catchment, thereby increasing their required storage volume. This is relevant to basins SB7 and SB19, which receive waters off the western emplacement as well as from the eastern catchment via WW2.

It should be noted that Sediment Basins 4 and 8, located adjacent to the coal handling and site facilities area will serve a dual purpose of retention of sediment laden waters, as well as potentially contaminated surface flows from the coal stockpile area and surface facilities area. The potential for contaminated flows to these storages is considered to be minimal as drainage will be diverted away from these areas, with waters from the workshop area reporting to an oil separator to ensure hydrocarbon contaminated water is captured for off site disposal.

Sediment Basin 20 located in the southern soil stockpile area and will be positioned to capture any sediment flows from the soil stockpile area to minimise potential for sediment laden waters to flow through WW2. Any discharge of water from this storage will result in discharge to clean receiving waters, and as such, is a nominated discharge point which would require sampling at each discharge event.

As indicated on Figure 2, dirty water from the western emplacement runs north and south. For the southern flows, sediment basins 9-15 are strategically located to direct flows from the western edge of the emplacement, with SB3 capturing southern flows on the eastern edge of the emplacement. Sediment basins 5, 6 and 7 are located on the southern edge of the emplacement. The southern flows from the western emplacement are ultimately directed to sediment basin 19 which acts as the final discharge point to receiving waters.

Northerly flows from the western emplacement are directed via sediment basins 16 and 17 on the western edge and sediment basin 2 on the eastern edge. Sediment basin 2 acts as the final discharge point to receiving waters.

The northern emplacement directs surface water flows on the south-western side via a catch bank to sediment basin 1. Should sediment basin 1 discharge, water flows are directed on the eastern side of the emplacement where it is captured via catch bank 8 and into sediment basin 18. Sediment basin 18 acts as the final discharge point to receiving waters.

Surface water flows from the coal handling area are directed to sediment basin 4. Discharge from sediment basin 4 would result in flows into WW2 prior to filtration through SB7 and SB19. As a consequence sediment basin 4 is a final discharge point to receiving waters in WW2.

Surface water flows from the site facilities area are directed to sediment basin 8. Discharge from sediment basin 8 would result in flows into Storage Dam 3 prior to release off site. As a consequence sediment basin 8 is a final discharge point to receiving waters SD3.

Table 2.5
Sediment Basin Specifications

Structure ID	Catchment Area (ha)	Volume (m3)	Depth (m)	Dimensions length * width (m * m)	Outlet Width (m)	Sill Width (m)
Northern Emplacement						
SB1	9	2500	3	35*35	3	6
Western Emplacement						
SB2	4	2000	3	35*35	3	6
SB3	25	2000	3	35*35	3	6
SB5	2.5	2000	3	35*35	3	6
SB6	3	2000	3	35*35	4	8
SB7	3.5	3000	3	40*40	4	8
SB9	7	1000	3	27*27	3	6
SB10	2.5	1000	3	27*27	3	6
SB11	2.5	1000	3	27*27	3	6
SB12	2.5	1000	3	27*27	3	6
SB13	2.5	1000	3	27*27	3	6
SB14	2.5	1000	3	27*27	3	6
SB15	5.5	2000	3	35*35	3	6
SB16	3	1000	3	27*27	3	6
SB17	4	2000	3	35*35	3	6
SB19	3	5000	3	50*50	15	35
Coal Handling Area						
SB4	4	1000	3	27*27	3	6
Site Facilities Area						
SB8	4	1000	3	27*27	3	6
Northern Soil Stockpile Area						
SB18	20	2000	3	35*35	3	6
Southern Soil Stockpile Area						

SB20	4	2500	3	35*35	3	6
Source: Modified after Soil Conservation Service(2007)						

Sediment Basins will be managed to ensure retention of sufficient capacity to reduce the potential for discharge off site. The management practices to be employed to ensure this is achieved are as follows:-

- Preferential sourcing of dirty water for dust suppression purposes. Preference will be given to sourcing water from the discharge points. Each discharge dam will have a water level gauge for monitoring water levels and enable preferential use to reduce potential for discharge.
- Each sediment basin will have a marker indicating 25% sediment storage capacity level, to enable clean out of basins upon reaching that storage mark.
- Regular water quality analysis to assess effectiveness of sediment system. Where sediment levels are determined to be at higher volumes that discharge limits, consideration will given to ameliorative measures including use of flocculants, and increase in sizing or additional sediment basin construction.

On construction of the surface water management structures, survey will be carried out to ensure capacities as stated are achieved. A final construction plan will be issued to the DoP, DECC, DPI and DWE to confirm sizing of structures on site. The effectiveness of the surface water management system will be monitored on a regular basis, particularly as the open cut advances, and additional areas are stripped of soil. Where additional sediment controls are required, they will be implemented in accordance with an amended Water Management Plan.

2.2.4 Pit Water Management

Capacity for pit water storage will need to be retained during the operation of the mine and will be managed either as sumps within the open cut and/or surface storages isolated and contained to ensure it does not mix with surface water flows. A capacity of 11,000m3 will need to be retained for pit water purposes in these storages or sumps based on water balance calculations as conducted in the EA for the project. This capacity was based on the assumption of negligible groundwater inflows as predicted in the groundwater assessment. Any construction of out of pit dams for the storage of pit water would be based on a design to minimise potential for seepage from the dams. Design will be based on lining the dams with material of hydraulic conductivity $<1*10^{-9}$ and where possible, location of the dam within a backfilled section of the open cut void such that in the event that overflow occurs, the water would drain back in to the open cut void. The potential locations for pit water surface dams are identified on **Figure 2**. Actual final location of such structures will be based on operational requirements at the time to ensure proximity to active void. Any construction of a surface pit water storage dam will include the provision for access to enable direct pumping of pit water to water carts for use in dust suppression. Water levels in the pit water dam will be monitored on a daily basis with capacity to pump back to the void in the event that discharge is considered likely

3.0 SITE WATER BALANCE

3.1 Introduction

The primary objective in managing the quantity of water captured/discharged on the mine site is to ensure sufficient water is captured to meet the construction and operational requirements of the proposal. The capture of dirty water will be maximised such that clean water captured and used by the mine remains within the maximum harvestable right for the mine site. Section 3.2 presents the annual site water requirements and, based on the surface water management structures of the mine site, Section 3.3 identifies the surface water available for capture (including a calculation of maximum harvestable right for the mine site and additional land owned by WCM). Section 3.4 balances the mine site requirements against water availability over the life of the mine.

3.2 Site Water Requirements

Water requirements on the mine site will vary over the life of the operation. Water use will initially revolve around dust suppression during the construction phase of the development. This will expand to operational requirements once production commences.

Annual water requirements of the mine are expected as follows:-

Activity	Predicted Use (ML)
Project Site – exposed surfaces and internal roads	50-55
Hardstand Areas and Stockpiles	20-25
Crushing and Screening Operations	3-4
Transport Route Construction	25
TOTAL	**90-109**

Ablutions and potable water will be trucked in from off site and are not included in these calculations. Climatic factors will also play a significant role in water requirements for dust suppression and will be assessed on a year to year basis. Operational water needs will be preferentially sourced from the on-site sediment basins and surface and groundwater flows into the open cut. Any shortfall will be supplemented by storage dams on site as well as through surface water harvesting from adjacent properties owned by WCM.

3.3 Water Availability

3.3.1 Maximum Dam Capacity

Of the “clean” water that could be captured on the mine site each year, WCM has a right to collect and use only a proportion of this, ie. the maximum harvestable right[2]. The maximum harvestable right for the mine site was determined in the following manner.

Maximum Harvestable Right = Catchment Area (ha) X Multiplier Value[3]
Dam Capacity
= 25.6ML = 366 X 0.07

2 "dirty" water used for environmental purposes, eg. Dust suppression is not considered as part of the maximum harvestable right for the mine site.
3 The calculation is based on the Department of Natural Resources document Rural Production and Water Sharing Landholders Information Package (1999).

It should be noted, however, that WCM's landholdings in the vicinity and including the mine site exceed more than 3000ha allowing for an additional maximum dam capacity of more than 184ML/Yr available (3000ha – 366ha = 2634 X 0.07 = 184ML).

3.3.2 Annual Water Availability

Table 3.1 provides the total "clean" and "dirty" water from associated catchments both within the project site and from adjacent catchment areas. The catchment yields are presented for low (10^{th} percentile), average (50^{th} percentile) and high (90^{th} percentile) rainfall years.

Table 3.1
Annual Catchment Yields

Catchment	Area (ha)	Yield (10^{th} Percentile 373.6mm) (ML/year)	Yield (50^{th} Percentile 619.9mm) (ML/year)	Yield (90^{th} Percentile 843.4mm) (ML/Yr)	Associated Water Storage (ML)
"Dirty" water from northern emplacement	9	3.36	5.58	7.59	4.5
"Dirty" water from western emplacement and ROM coal stockpiles	74	27.65	45.87	62.41	31.5
Open Cut Area	60	22.42	37.19	50.60	11
Total Dirty Water		**53.42**	**88.65**	**120.61**	**47**
"Clean" water within the project site southern catchments	888	331.76	550.47	748.94	17
"Clean" water within the project site northern catchment	50	18.68	31.00	42.17	2.4
"Clean" water external to the project site but within the project site catchments	634	236.86	393.02	534.72	51.4

and on proponent owned properties					
Total Clean Water		**587.30**	**974.48**	**1325.82**	**70.8**
Total Clean and Dirty Water		**640.72**	**1063.13**	**1446.43**	**117.8**
Source: Modified after Soil Conservation Service (2007).					

The above table provides the total available water predicted for within the project site as well as associated clean water flows generated off-site and associated storage capacities. This demonstrates the capacity for WCMPL to utilise clean water from off the project site, on WCMPL owned lands, to make up any shortfall in dirty water captured on site for required dust suppression purposes.

3.3.3 Site Water Balance

A site water balance for the actual project site, identifying site water requirements (averaged at 100ML/yr) is presented in **Table 3.2** below. Site water use is based on sourcing water requirements from the dirty water system. As demonstrated in the Table there will be a shortfall in dirty water for both dry and average rainfall years, with an excess in dirty water in a wet year. The shortfall in dirty water will be supplemented by on site clean water storage. The "clean water" component also comprises clean water runoff generated from the eastern catchment. Off-site water storages SD4, SD7 and SD2 will capture some of this water, with excess water directed via WW2 through the south-east corner of the project site as per the natural drainage path through to the southern drainage channel. The water balance assumes a negligible inflow of groundwater into the void, with all surface runoff and groundwater inflow to the void comprised within the dirty water component presented below.

Table 3.2
Project Site Water Balance

	10% Yield (ML/Year)	**50% Yield (ML/Year)**	**90% Yield (ML/Year)**	**Project Site Water Storage (ML)**
"Dirty Water"	53.42	88.65	120.61	47
Site Water Requirements	100	100	100	
"Dirty Water" Balance	- 46.58	-11.35	+20.61	
"Clean Water"	350.44	581.47	841.11	19.4
"Clean Water" Balance	+303.86	+570.12	+841.11	

It is noted that the estimated available water exceeds the storage capacities both on site and those off the project site**.** However, as the majority of water will be continually taken from the on site dirty water storages, with supplementary amounts from on site clean water storage, either for operational purposes or through evaporation, dirty water discharge from the site is expected to occur infrequently. In the event that discharge does occur, a sample will be obtained from the discharge source to verify water quality is within required parameters. The water management system has been designed to reduce potential for discharge of sediment laden waters through sediment basin capacities as well as the in-line placement thereby ensuring a settling process as water travels through the sediment basin system.

In addition to the above commitments, water for dust suppression purposes on site will be preferentially sourced from the nominated discharge storages to assist in reducing potential for discharge. Monitoring of these points on a regular basis will determine relative water quality to enable adequate planning for ameliorative measures if required.

Should discharges become more prevalent than predicted, the following procedures will be considered:

- Alternative management practices of disturbed areas to increase infiltration rates by increased establishment of vegetative cover to improve water take up and reduce runoff rates.
- Construction of additional sediment basins or enlargement of existing sediment basins.
- Flocculation of sediment basins to acceptable discharge level of water quality to expedite the draining of basins.

WCMPL will endeavour to minimise water use on site to ensure surface water flows that existed pre-mining are not significantly affected and does not reduce water availability to downstream users. WCMPL commitment to maximising water use from the dirty water system and only obtaining supplementary water requirements from clean water storages will aid in this process. On site water requirements will be monitored each year, and opportunities investigated for any opportunities for improved water efficiency, particularly in terms of dust suppression.

3.4 Water Balance Review

A more accurate water balance will be developed as the mine progresses and as data is gathered.

For operational purposes, an excel spreadsheet will be developed for the mine site which allows for a monthly calculation of water availability in the Storage Dams and Sediment Basins. The mine site water balance will be updated each year to reflect the recorded use and storage of water as well as any changes to the progression of mining on the mine site.

Rather than update the WMP each year, a summary of site water use and storage will be supplied in each AEMR for the mine along with the updated site water balance for the remaining life of the mine.

3.5 Groundwater – Surface Water Interaction

While the site water balance does not include groundwater which may seep into the mine void and accumulate in in-pit sumps or designated “pit water” dams, it is acknowledged that should there be extended periods of rainfall and therefore reduced evaporation or greater than expected seepage, in-pit management of the accumulated groundwater will be difficult and therefore pumped to the designated pit water dams which will be isolated from surface water flows.

Water levels within the designated “pit water” dams will be managed by pumping direct to water carts for use in dust suppression across the site, or in the unlikely event that pit water volumes exceed requirements, pit water will be retained within the sumps in the void of the pit to ensure discharge of pit water does not occur.

4.0 EROSION AND SEDIMENT CONTROL PLAN

4.1 Introduction

In accordance with Condition 3(4), this **Erosion and Sediment Control Plan (ESCP)** is consistent with the requirements of the Department of Housing’s Managing Urban Stormwater: Soils and Construction Manual (Landcom, 2004). All erosion and sediment control structures will be constructed or erected in accordance with the recommendations identified in the relevant standard drawing and construction notes of Landcom (2004). **Figure 4** presents the generalised design of each of the erosion and sediment control structures identified in **Figure 2** (as drainage control and water management structures).

The **ESCP** has been structured as follows:

(i) Section 4.2 – identifies activities for the construction and operational phases of the mine that could cause soil erosion and/or generate sediment.

(ii) Section 4.3 – describes the location, function, and capacity of erosion and sediment control structures.

(iii) Section 4.4 – describes measures to be employed to minimise soil erosion and the potential for the migration of sediments to downstream waters, and measures to monitor and maintain structures over time.

4.2 Sources of Erosion and Sedimentation

4.2.1 Construction

During construction, erosion and sedimentation could potentially result directly or indirectly from:

(i) surface water runoff over exposed surfaces, eg. Cleared areas, stockpiles etc,; and
(ii) surface water runoff from roads under construction.

Elevated winds may also result in erosion of finer material during clearing and soil stripping activities, and from exposed surfaces and stockpiles.

4.2.2 Operations

During operations, erosion and sedimentation could potentially result directly or indirectly from:

(i) surface water runoff from areas disturbed in advance of, and during mining;
(ii) surface water runoff from topsoil, subsoil and overburden stockpiles and emplacements prior to rehabilitation;
(iii) surface water runoff from the coal processing area;
(iv) surface water runoff from rehabilitated areas prior to full stabilisation;
(v) discharges of water at erosive velocities; and
(vi) runoff from roads at erosive velocities.

Elevated winds may also result in erosion from exposed surfaces.

4.3 Erosion and Sediment Control Structures

The structures presented on **Figure 2** and described in **Tables 2.1** to **2.5**, will be the primary erosion and sediment control structures as these will direct and control the velocity of surface water and prevent uncontrolled flows and discharges of water. As the final landform is created, additional erosion controls in the form of contour banks and rock or grass-lined flumes, will be progressively constructed (see **Figure 6**). The contour banks on the sloped surfaces of the final landform will direct surface water flows to a number of flumes which will control the flow of water off the constructed final landform and therefore assist in reducing erosion and maintaining the long term stability of the landform. It is the preference of WCM to construct the flumes with a grass substrate. However, if rock flumes are deemed more appropriate, these will be constructed with >80% of rock with a diameter of at least 200mm and to the following design.

- Channel width >1m.
- Bank height >500mm
- Channel parabolic in shape
- Excavated batters of 1:4 (V:H) or shallower.

Figure 4 presents the design features of each of the referenced structures which have been based on the recommendations of Landcom (2004).

Silt-stop fencing will be installed as required, especially during the construction phase, to assist in reducing the suspended sediment level in surface water flows from road construction and other areas of activity. **Figure 4** also presents the design features to be adhered to when installing the silt-stop fencing.

4.4 Erosion and Sediment Control Management

WCM will remain vigilant is managing erosion and sedimentation on the mine site and, by only discharging water which satisfies the criteria identified by DECC in the Environment Protection Licence, will minimise the potential for migration of sediments to downstream waters. Although the structures presented on **Figure 4** have been designed to enable the movement of surface water on the mine site at non-erosive velocities, the following additional procedures and management practices will be implemented to further reduce the risk of erosion and sedimentation.

(i) Any structure required to control erosion and sedimentation will be constructed or installed prior to the commencement of activities in that area.

(ii) Areas on the mine site without some form of vegetation cover will be minimised. A non-persistent cover crop will be sown on any exposed surfaces not required for operational purposes or stockpiles retained in excess of three months.

(iii) The erosion and sediment control structures will be inspected monthly, or after a rainfall event of >25mm/24hr, to assess their success in preventing erosion, identify signs of potential erosion and determine the retained capacity, especially within the sediment basins.

(iv) The erosion and sediment control structures will be cleaned of accumulated sediment material (or extended or replaced) as soon as 20% capacity is lost due to the accumulation of material such that the specified capacities are maintained.

(v) Access to areas of the mine site affected by localised flooding will be restricted until such time as the ground is no longer waterlogged. This will reduce the potential for vehicular traffic to further disturb the soil surface which in turn may result in greater erosion potential over these areas.

(vi) As part of a surface water monitoring program, water flowing from the nominated discharge points will be sampled for suspended sediments.

(vii) In the event the suspended sediment concentration in any discharged water exceeds 50mg/L:
- DECD will be advised and salient preceding weather information will be provided;
- The upstream structures will be inspected and cleaned of consolidated sediment as required;
- The sediment basin(s) will be enlarged to provide for greater settlement time for the sediment laden water; and/or
- An additional storage dam will be constructed downstream with this becoming the new site discharge point and monitoring location. DECC will be advised to enable amendment to the Environment Protection Licence; and/or
- A flocculant will be added to the water contained within the sediment basin or storage dam to increase the efficiency of sediment settlement.

(viii) Water captured in the open cut void will be allowed time to settle within the sumps before being pumped to one or more of the designated “pit water” dams identified in **Figure 2** if required. Salinity levels of water accumulating in the mine void will be monitored on a quarterly basis to assess water quality (see Section 5).

(ix) All surface water flows from the flumes will flow to sediment basins.

(x) If, following heavy rain, erosion is identified on the rehabilitated landform or in operational areas, it will be remediated quickly using one or a combination of the following:

- Filling the erosion channels
- Cross-ripping (along the contour) to assist infiltration
- Installation of additional controls, eg banks sown with a non-persistent cover crop.

(xi) Areas previously identified as exhibiting and treated to prevent further erosion will be monitored on a minimum monthly basis or following a rainfall event of >25mm/24hr.

5.0 SURFACE WATER MONITORING PROGRAM

5.1 Introduction

This **Surface Water Monitoring Program (SWMonP)** has been prepared in compliance with Condition 3(5) and includes:

(a) provision of baseline data on surface water flows and quality in adjoining creeks and waterbodies that could be affected by the project;

(b) surface water impact assessment criteria;

(c) a program to monitor the impact of the project on surface water flows and quality; and

(d) procedures for reporting the results of this monitoring.

5.2 Baseline surface water quality

Due to the intermittent nature of the unnamed drainage channel and Driggle Draggle Creek adjacent to the project site, limited data has been collected for the provision of baseline water quality information. **Table 5.1** below provides water quality data from a sample obtained from the central drainage channel within the Rocglen site in 2002 (BS-1), together with samples from Driggle Draggle Creek (WW1-6) taken prior to the Canyon development. The results indicate a similarity in water quality in Driggle Draggle Creek and the drainage line within the Rocglen project which is not unexpected given the similarity in catchments, land use and geology.

Table 5.1
Local and Project Site Water Quality

Parameter	Unit	Sample Site						
		BS-1	WW-1	WW-2	WW-3	WW-4	WW-5	WW-6
Total P	mg/L	4.7	NR	96.0	97.2	98.7	102.3	NR
Nitrogen (Nitrate)	mg/L	<0.01	NR	6	2	4	5	NR
Sulphate	mg/L	11	1	10	9	9	8	1
Bicarbonate	mg/L	41	48	81	96	107	73	50
Chloride	mg/L	56	2	6	4	5	8	3
Cadmium	mg/L	<0.001	NR	<0.001	<0.001	<0.001	<0.001	NR
Lead	mg/L	<0.001	NR	0.02	0.02	<0.001	0.02	NR
Zinc	mg/L	0.01	NR	0.02	0.02	0.01	0.02	NR
Copper	mg/L	0.006	NR	<0.01	0.01	0.01	0.01	NR
Manganese	mg/L	0.008	NR	0.15	0.05	0.12	0.20	NR
Iron	mg/L	29	5	13	8	7	19	20
Potassium	mg/L	27	5	14	9	13	5	5
Sodium	mg/L	43	11	12	13	14	42	19
Magnesium	mg/L	3	2	5	10	5	4	2
Calcium	mg/L	8	6	12	12	19	9	5
Conductivity	us/cm	360	98	151	165	185	154	98
pH		6.9	6.8	8.8	8.4	9.1	8.4	7.8

Source: Whitehaven Coal Mining Pty Ltd (2002)

The above water quality results provide only a snapshot of local water quality and will need to be further developed to provide for more relevant data. As conditions allow, based on water flows within the intermittent streams, sampling will be undertaken over the next 12 months prior to mining commencing to provide for additional detail which will enable long-term comparison with water quality results obtained once mining commences. Sampling will continue at points along Driggle Draggle Creek to the north and the unnamed drainage depression to the south over the life of the mine, and during discharge events for ongoing water quality monitoring.

It is also acknowledged that there is limited information currently available in terms of catchment flows, and the impact of the mine on reduced or increased catchment flows and its impact on water quality. In order to improve current knowledge of existing catchment flows, and the impact of the mine on future catchment flows, WCMPL, will, in conjunction with DWE, establish flow monitoring devices at the Driggle Draggle Creek monitoring point and southern drainage channel monitoring point to enable data collection and analysis. Data obtained will also be provided to DWE for their records and analysis as required.

5.3 Surface Water Impact Assessment Criteria

Impact assessment criteria for surface water are only relevant to water actually discharged from the mine site.

Recorded values for pH, Total Suspended Solids (TSS), electrical conductivity and oil and grease from water discharged from the mine site will be compared against the criteria presented in **Table 5.2**. This criteria is as prescribed in the Statement of Commitments submitted by WCM. In addition, any criteria as prescribed by the DECC in the Environment Protection Licence will be included as a component of the impact assessment criteria.

Table 5.2
Assessment Criteria

Parameter	Unit of Measure	50% concentration limit	90% concentration limit	100% Concentration limit
Total Suspended Solids	mg/L	≤20	≤35	≤50
Electrical Conductivity	us/cm	-	-	<350
Grease and Oil	mg/L	-	-	≤10
pH		-	-	6.5-8.5

The recorded values will be measured and plotted to identify any trends over time. DECC will be notified in the event of increasing levels of any parameter.

5.4 Surface Water Monitoring Locations

The location of all surface water monitoring points are presented on **Figure 5a and 5b** and are based on the Statement of Commitments produced by WCM or as amended upon the issue of an Environment Protection Licence by the DECC.

Table 5.3 identifies the monitoring point locations, the type of monitoring point along with a brief description (where relevant) of the location. These monitoring points may be updated on the receipt of the Environment Protection Licence from DECC to reflect their requirements.

Table 5.3
Monitoring Locations

Location	Type of Monitoring Point	Description of Location
SB2, SB4, SB8, SB18, SB19, SB20	Wet Weather Discharge	Discharge points from dirty water system to the environment
DDCK (Driggle Draggle Creek) UNDC (Unnamed drainage channel)	Baseline data and wet weather discharge	Driggle Draggle Creek north of project site and the unnamed drainage channel south of the project site
MV-1	Water Quality	Sumps within the void and/or surface storages for pit water.
SD1, SD3, SD4, SD7, SB2, SB4, SB8, SB18, SB19, SB20	Erosion and Sediment Control and Water Quality	Selected Storage Dams and Sediment Basins within the Mining Lease
SD=Storage Dam, MV=Mine Void, SB=Sediment Basin.		

5.5 Monitoring Parameters and Frequency

Tables 5.4 to **5.7** present the parameters to be monitored, the frequency of monitoring and the sampling method for each parameter.

Table 5.4
Wet Weather Discharge Points

Parameter	Unit of measure	Frequency	Sampling Method
Total Suspended Solids	mg/L	As soon as practicable after overflow commences and not more than 12 hours after the commencement of overflow	Representative sample
Grease & Oil	mg/L		Representative sample
pH			Representative sample
Electrical Conductivity	us/cm		Representative sample
Total Organic Carbon			Representative Sample

Table 5.5
Driggle Draggle Creek and Unnamed Drainage Channel

Parameter	Unit of measure	Frequency	Sampling Method
Total Suspended Solids	mg/L	Quarterly for baseline data when creeks are flowing & during discharge events as soon as practicable after discharge commences and not more than 12 hours after the commencement of overflow	Representative sample
Grease and Oil	mg/L		Representative sample
pH	pH		Representative sample
Electrical Conductivity	us/cm		Representative sample
Total Organic Carbon			Representative sample

Table 5.6
Storage Dams and Mine Void

Parameter	Unit of measure	Frequency	Sampling Method
Erosion	-	Quarterly or following rainfall of >25mm/24hr	Visual Inspection
Sedimentation	-		Visual Inspection

Table 5.7
Storage Dams and Mine Void

Parameter	Unit of measure	Frequency	Sampling Method
Total Suspended Solids	mg/L	Quarterly	Representative sample
Grease and Oil	mg/L		Representative sample
pH	mg/L		Representative sample
Electrical Conductivity	mg/L		Representative sample
Representative Metals	mg/L	Annual	Representative sample
Representative Ions	mg/L		Representative sample

5.6 Reporting of Monitoring Results

WCM will collate surface water analysis data and maintain an up to date record of analysis results both in hard copy (laboratory reports) and electronic (results) format. These results will be interpreted by WCM as they are received in order to ensure appropriate operational guidance on maintaining water quality within desired parameters.

The results of water quality analysis will be reported in the Annual Environmental Management Report (AEMR) and will be made available to the Community Consultative Committee members on a regular basis as part of the Environmental Monitoring Reporting process, as well as to Gunnedah Shire Council.

In the event that an exceedance in surface water quality criteria is identified, the exceedance will be reported to the relevant agencies in accordance with Condition 5(3) and 5(4).

6.0 GROUNDWATER MONITORING PROGRAM

6.1 Introduction

In compliance with Condition 3(6), this Groundwater Monitoring Program (GWMP) has been prepared to include:

- (a) further development of the regional and local groundwater model;
- (b) detailed baseline data to benchmark the natural variation in groundwater levels, yield and quality (including at any privately owned bores in the vicinity of the site);
- (c) groundwater impact assessment criteria;
- (d) a program to monitor the impact of the project on groundwater levels, yield and quality; and
- (e) procedures for reporting the results of this monitoring.

The GWMP also comprises Groundwater Contingency measures, as per the requirement of condition 3(2c).

6.2 Groundwater Model

A hydrogeological model for the project site was developed by RCA as part of the initial environmental assessment for the development. The model identified groundwater flows within the strata as flowing from east to west following the regional topographic fall from the Kelvin Range in the east to the Namoi River in the west. The depth of groundwater within the project site is relatively constant at 35 metres.

The modelling undertaken for the project was based on the best available information, however it is recognised that the monitoring program being undertaken by WCMPL will provide the opportunity to utilise the data obtained for assessment against the initial model. This will also enable updates to be made to the groundwater model as is required in the project approval.

6.2.1 Groundwater Seepage Volume

Water accumulating in the open cut mine workings will comprise a combination of accumulated rainfall, surface water run-off (from within the "open cut" catchment and dust suppression activities etc.) and groundwater seepage.

Based on model simulations, the average inflow of groundwater to the open cut is predicted to average 1,643m3/day during years 1 to 3, increasing to an average of 2,235m3/day during years 4 to 5 and decreasing during years 6 and 7 to 1,813m3/day. These predictions are expected to be an overestimate of actual inflows as they were based on the assumption that the bulk of material for each stage is removed instantaneously rather than by progressive excavation. Even comparing these levels of inflow against likely evaporation rates, it is considered likely that there may be a small surplus of water accumulating in the open cut, which would be captured by the use of sumps and used for dust suppression purposes across the site. In the event that inflows are greater than that predicted, surface storages will be constructed to enable pumping from the void to the designated "pit water" dams which will be isolated from surface water flows.

Validation of predicted inflows to the pit sumps will be made by use of a meter on pumps to ascertain the amount of water pumped either direct to water carts or to surface "pit water" storages. Whilst this will include surface flows within the pit itself, it will provide a reasonable estimate of the extent of groundwater inflow.

WCMPL understands that groundwater seepage into the pit which is utilised for on-site dust suppression may require licensing under the expected water management principles being developed for the Murray-Darling Basin. WCMPL will await the advice of the DWE on this requirement and undertake any actions as required. It is also noted that part of the mine site extends into the area covered by the Water Sharing Plan for the Upper and Lower Namoi Groundwater sources 2003, and any licensing details will need to be determined in association with the water sharing plan.

6.2.2 Groundwater Drawdown

The drawdown in the regional water table predicted by the groundwater model at the completion of the project is expected at 11m at the project site boundary, and down to 2m or less within 5km of the limit of open cut mining. In considering those properties that are project related, it is considered that the only non-project related bores that may be affected by the mining operation are located on the "Surrey" and "Carlton" properties.

Despite the limited potential for significant impact on groundwater levels on adjacent properties, WCM will undertake a monitoring program over the life of the mine to provide validation of drawdown prediction, and undertake mitigation measures in the event that monitoring confirms that mining activity is impacting on groundwater depth and yield on adjacent properties. In addition, where monitoring indicates a significant difference to predictions in the initial groundwater model, WCM will engage a suitably qualified consultant to reassess the groundwater impacts and provide for further development and refinement of the groundwater model.

6.3 Groundwater Monitoring

6.3.1 Monitoring Locations

The GWMP applies to a total of eleven registered bores where groundwater levels, saturated thickness and quality will be measured. In addition to these sites, five piezometers will also be installed and fitted with data loggers. MP1, MP2 and MP3 are located between the open cut and the nearest non project related bores. MW4 is located further to the south to provide additional information from the zone between the mine and the alluvial system, and would provide the capacity for triangulation of these points to indicate general water table depths. MW5 is located to the west of the project site to provide monitoring data on the western edge of the project. This piezometer will be located either within Vickery State Forest or on the adjacent "Yarrawonga" property. The locations are presented on **Figure 5**.

- GW050395, GW050166, GW011015 and GW011066 on the "Glenroc" property.
- GW045621 on the "Yarrawonga" property.
- GW044068 and GW044069 on the "Yarrari" property.
- GW022319 on the "Roseberry" property.
- GW133369 on the "Brolga" property.
- GW052956 on the "Surrey" property.
- GW020545 on the "Carlton" property.
- MP-1 on the "Glenroc" property.
- MP-2 on the "Belmont" property.
- MP-3 on the "Stratford" property.
- MP-4 on the "Roseberry" property.
- MP-5 within Vickery State Forest.

All bores used for groundwater monitoring will be licensed by the DWE.

6.3.2 Monitoring Parameters, Frequency and Procedures

Baseline monitoring of water chemistry, SWL, available drawdown and yield is to be conducted at all registered bores identified above prior to the commencement of mining. This will provide a basis for comparison with future monitoring events to be undertaken once mining commences. Baseline monitoring of water chemistry will include those parameters listed in **Table 6.1**. Groundwater levels will assessed to the nearest 0.01m and all monitoring locations surveyed to AHD so relative levels can be determined.

Subsequent measurement of groundwater levels will be undertaken at quarterly intervals, with data loggers from MP1-MP5 downloaded at quarterly intervals. Assessment of electrical conductivity and pH at the identified sites will be undertaken quarterly, with yield and other chemical parameters assessed on a six monthly basis. **Table 6.1** presents the parameters to be measured, frequency of monitoring and sampling method. Monitoring will continue for a period of up to 5 years after mining has ceased, however this will be assessed in accordance with monitoring results of the life of the mine and extent of impact as confirmed by those results.

Table 6.1
Groundwater Monitoring

Parameter	Unit of Measure	Frequency	Sampling Method
SWL	m AHD	Quarterly	Bore Dipping
Conductivity	us/cm		Representative Sample
pH	pH		Representative Sample
Lead	mg/L	6 monthly	Representative Sample
Alkalinity	mg/L		Representative Sample
Chloride	mg/L		Representative Sample
Sulphate	mg/L		Representative Sample
Sodium	mg/L		Representative Sample
Potassium	mg/L		Representative Sample
Nitrite	mg/L		Representative Sample
Nitrate	mg/L		Representative Sample
Manganese	mg/L		Representative Sample
Magnesium	mg/L		Representative Sample
Iron	mg/L		Representative Sample
Arsenic	mg/L		Representative Sample
Aluminium	mg/L		Representative Sample
Note: Frequency of monitoring and the pollutant/s to be monitored may be varied by the DECC once the variability of the groundwater quality is established.			

Bores will be purged prior to sampling until pH and salinity measurements have become stable. This usually involves sampling using a low flow pump, or removal of at least three bore volumes of groundwater, or purging until dry. Samples will be collected and placed in appropriately preserved containers and kept cool. Samples will be transported under chain of custody documentation and arrive at the NATA accredited laboratory within appropriate holding times. WCMPL will ensure that the methodologies in place for groundwater sampling procedures and utilised by the contracted sampler are in accordance with standard procedures consistent with those utilised by DWE and in accordance with:-

> Jiwan, J.S & Gates, G., (1992), *A Practical Guide For Groundwater Sampling (1st Ed.),* DWR Technical Services Division Report TS92.080.

In addition to those parameters presented in **Table 6.1,** additional parameters may be monitored annually to assess any trends in groundwater chemistry over time. These include the following.

- Total Petroleum Hydrocarbons – these contaminants (typically oils and diesel) will be used during mining.
- Heavy Metals – some heavy metals may be associated with waste oils. These may include arsenic, cadmium, chromium, nickel, lead (already included in **Table 6.1**), copper, manganese and zinc.
- Major cations and anions – to assess overall changes in groundwater chemistry.

6.3.3 Assessment and Reporting

Monitoring results obtained as a result of the groundwater monitoring program will be collated and assessed by WCM personnel. Monitoring results will be made available to the members of the Community Consultative Committee on a regular basis through the committee meetings. Monitoring results will also be made available to Gunnedah Shire Council and will be presented in the Annual Environmental Management Report.

The monitoring results will provide the capacity for WCM to assess any impacts of the mining operation on background levels. In the event that monitoring confirms a significant shift in water quality parameters, or water depth and yield of adjacent bore sites, then WCM would liaise with DWE with regard to restorative measures at these sites, and in accordance with the Groundwater Contingency Plan.

7.0 SURFACE AND GROUNDWATER RESPONSE PLAN

A response plan for surface and groundwater monitoring is required in the event that assessment criteria is exceeded, and to respond to any unforeseen impact of the project. The plan sets out the procedure which will be followed in order to ensure a timely and co-ordinated response.

7.1 Procedure

- Exceedance in surface water quality or groundwater quality and/or level is identified;
- Record the timing, location, environmental conditions and any other contributing factors to any exceedance;
- Advice issued to relevant agencies within 24 hours;
- Sampling point and areas upstream inspected to ascertain cause of exceedance;
- Operational practices reviewed to determine if any current operational practice contributed to the exceedance;
- Implementation on ameliorative measures on site to minimise the potential for future exceedance, which may include clean out, redesign or alteration to structures and/or operational practice;
- Written advice to relevant agencies identifying actions undertaken to reduce further risk of exceedance;
- Where specific cause of exceedance cannot be identified, external advice may be sought;
- Ongoing future monitoring to ensure ameliorative measures have been successful with assessment criteria being met;
- Where ameliorative measures cannot be achieved evaluate compensation options.

The assessment criteria for surface water has been identified in Section 5.3. The assessment criteria for groundwater is described below.

Investigations into the reliance of groundwater bores in the locality has provided a contingency level on which actions would be required by WCM to address groundwater quantity and quality.

In terms of groundwater quantity, where it is identified that standing water levels within bores on non-project related properties reduce by more than 10% from the baseline pre-mining levels, and it is assessed as being as a result of mining, WCM will deepen the existing bore or establish a new bore in the impacted area to achieve a yield that is at least equal to that which existed pre-mining. In assessing the cause of reduction in groundwater level, consideration will be given to monitoring results obtained over time, yield measurements determined pre-mining, current pumping regimes on each site, and seasonal conditions. An independent qualified hydrogeologist will be engaged to provide the determination as to the cause of the reduction in Standing Water Levels and report findings to the relevant agencies.

Where it is identified that deepening or re-drilling a bore would not be sufficient to provide a replacement source of comparable quality, WCM will investigate the possibility of constructing additional surface water containment structures, or providing direct transfer of comparable quality water from other sources. This action would be undertaken in consultation with the affected property owner.

In terms of groundwater quality, it will be assessed in accordance with the baseline water quality measures first and then NEPM agricultural irrigation guideline levels, with the ANZECC guideline levels to be used where no NEPM guidelines have been published. This will generally reflect the fact that the existing water quality does not meet aesthetic drinking water guideline levels. Impacts on water quality parameters of pH, TDS, other anions and heavy metals (not considered by NEPM criteria) will be based on comparisons with baseline monitoring data.

If groundwater quality criteria as described above is exceeded, the data will be analysed and the impacted bore resampled. If an exceedance is still observed, additional bores would be installed around the affected bore to assess the extent of impact. This will confirm the risk of impact to adjoining groundwater users. Any such assessment of this impact would be based on sound advice from an appropriately qualified hydrogeological consultant.

7.2 Unforeseen Impacts

The potential for unforseen impacts as a result of the development are considered low, however, in order to ensure against material harm to the environment an unforeseen impact procedure will be followed as per **Table 7.1** below:

Table 7.1
Unforeseen Impact Procedure

Stage	Procedure
1	Review the unforseen impact, including consideration of: • Any relevant monitoring data; and • Current mine activities and land management practices in the relevant catchment.
2	Commission an investigation by an appropriate specialist into the unforseen impact, if considered appropriate by the Environmental Specialist.
3	Develop appropriate ameliorative measures based on the results of the above investigations, in consultation with the relevant authorities.
4	Implement additional monitoring where relevant to measure the effectiveness of the improvement measures.

7.3 Review

The adequacy and relevance of the response plan will be assessed on a daily basis through operational practice. In the event where operational procedures demonstrate inefficiencies or gaps in the response procedures, amendment to the plan will be made in consultation with relevant agencies.

8.0 REFERENCES

ANZECC, 2000. Fresh and Marine Water Quality Guideline, Australian Water Association, Artarmon, NSW.

Landcom, 2004. Managing Urban Stormwater: Soils and Construction Manual, Sydney.

RCA Australia, 2007. Groundwater Impact Assessment of the proposed Belmont Coal Project, Prepared on behalf of Whitehaven Coal Mining Pty Ltd – Part 1 of the Specialist Consultant Studies Compendium.

R.W Corkery & Co Pty. Limited, 2007. Environmental Assessment for the proposed Belmont Coal Project, Orange, NSW.

Soil Conservation Service, 2007. Surface Water Assessment for the Proposed Belmont Coal Project. Prepared on behalf of Whitehaven Coal Mining Pty Ltd – Part 6 of the Specialist Consultant Studies Compendium.

APPENDIX 1

RELEVANT PROJECT APPROVAL CONDITIONS

(PA 06_0198)

(No. of pages excluding this page = 2)

Schedule 3
Specific Environmental Conditions

SOIL AND WATER

Note: These conditions should be read in conjunction with sections 4, 5, 10, 13 and 17 of the Statement of Commitments.

Discharge

1. Except as may be expressly provided for by an EPL, the Proponent shall not discharge any surface waters from the site.

WATER MANAGEMENT PLAN

2. The Proponent shall prepare and implement a Water Management Plan for the project to the satisfaction of the Director-General. This plan must:
   - (a) be prepared in consultation with DWE and DECC by suitably qualified expert/s whose appointment/s have been approved by the Director-General;
   - (b) be submitted to the Director General prior to the commencement of construction activities (not including construction of the Kamilaroi Highway and Hoad Lane intersections or sections 1 and 2 of the road transport route); and
   - (c) include a:
     - Site Water Balance;
     - Erosion and Sediment Control Plan;
     - Surface Water Monitoring Plan;
     - Groundwater Monitoring Program; and
     - Surface and Groundwater Response Plan, setting out the procedures for:
       - investigating, and if necessary mitigating, any exceedances of the surface or groundwater assessment criteria (see below); and
       - responding to any unforeseen impacts of the project.

SITE WATER BALANCE

3. The Site Water Balance must:
   - (a) include details of:
     - sources and security of water supply;
     - water use on site;
     - water management on site;
     - any off-site water transfers;
   - (b) describe measures to minimise water use by the project; and
   - (c) be reviewed and recalculated each year in the light of the most recent water monitoring data.

EROSION AND SEDIMENT CONTROL

4. The Erosion and Sediment Control Plan must:
   - (a) be consistent with the requirements of *Managing Urban Stormwater: Soils and Construction* manual (Landcom 2004, or its latest version);
   - (b) identify activities that could cause soil erosion and generate sediment;
   - (c) describe measures to minimise soil erosion and the potential for transport of sediment to downstream waters;
   - (d) describe the location, function, and capacity of erosion and sediment control structures; and
   - (e) describe what measures would be implemented to monitor and maintain the structures over time.

SURFACE WATER MONITORING PROGRAM

5. The Surface Water Monitoring Plan must include:
   - (a) detailed baseline data on surface water flows and quality in creeks and other waterbodies that could be affected by the project;
   - (b) surface water impact assessment criteria;
   - (c) a program to monitor the impact of the project on surface water flows and quality; and
   - (d) procedures for reporting the results of this monitoring.

GROUNDWATER MONITORING PROGRAM

6. The Groundwater Monitoring Program must include:
   (a) further development of the regional and local groundwater model;
   (b) detailed baseline data to benchmark the natural variation in groundwater levels, yield and quality (including at any privately owned bores in the vicinity of the site);
   (c) groundwater impact assessment criteria;
   (d) a program to monitor the impact of the project on groundwater levels, yield and quality; and
   (e) procedures for reporting the results of this monitoring.

APPENDIX 2
FIGURES 1-6

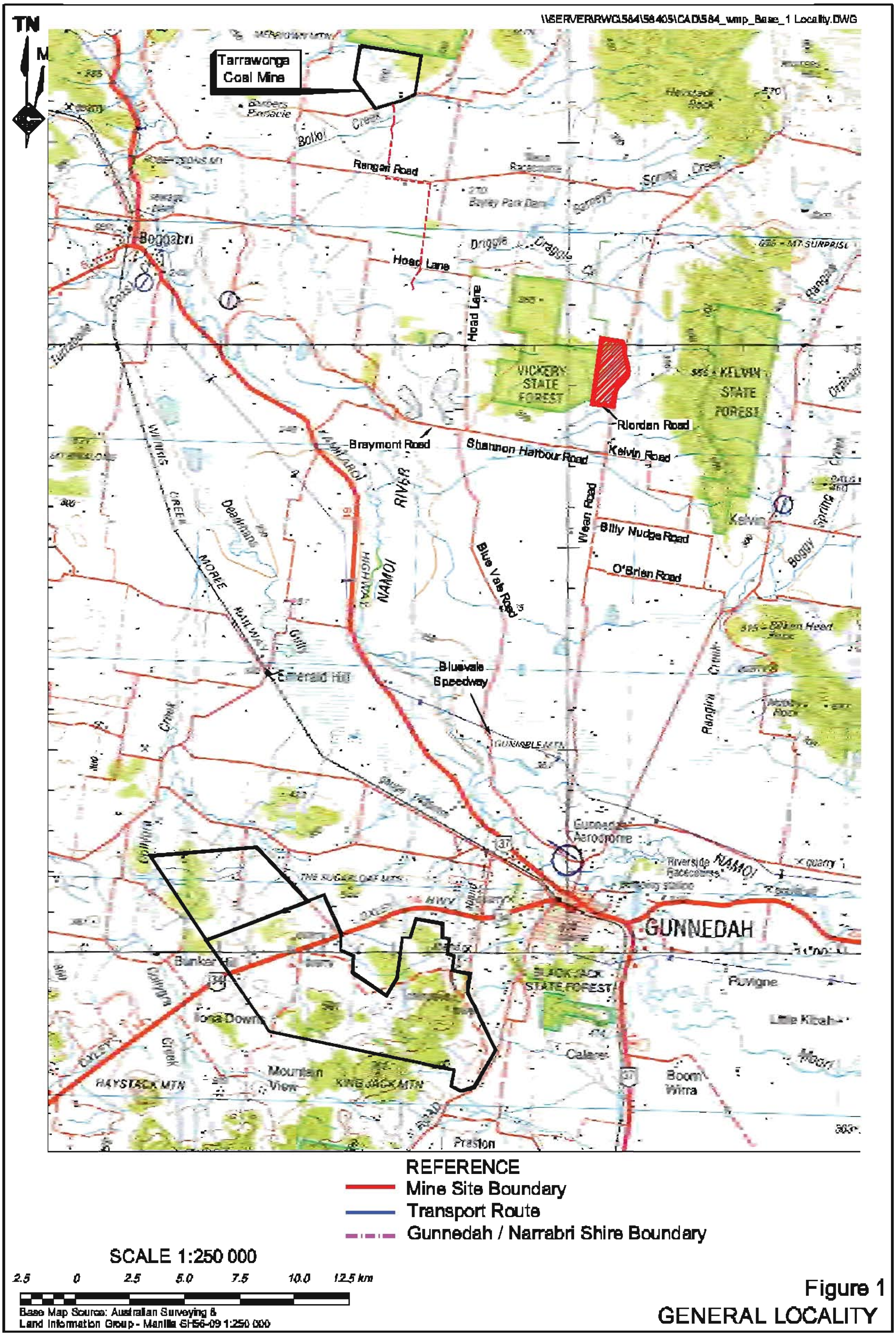


Figure 1
GENERAL LOCALITY

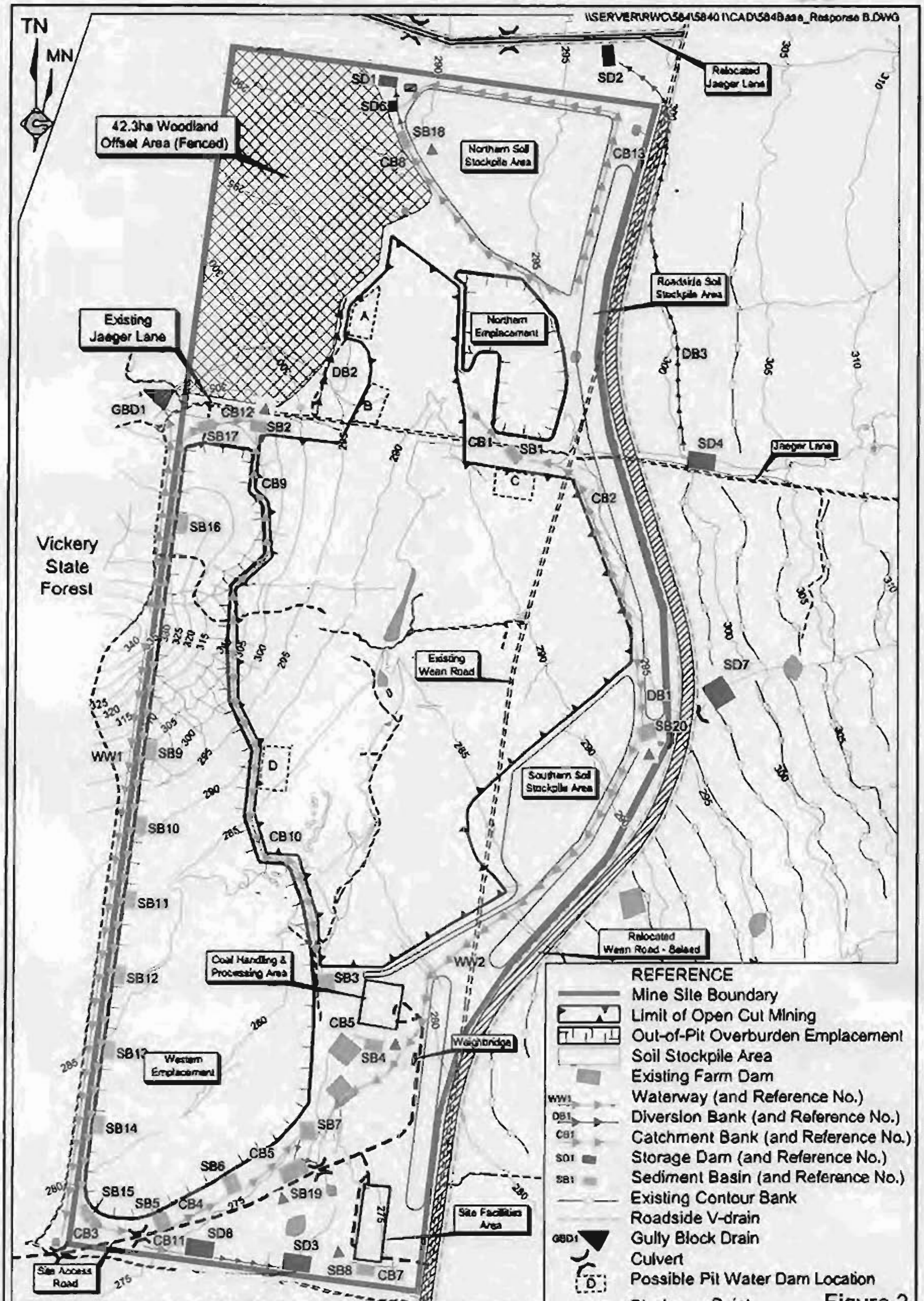


Figure 2
SURFACE WATER MANAGEMENT STRUCTURES

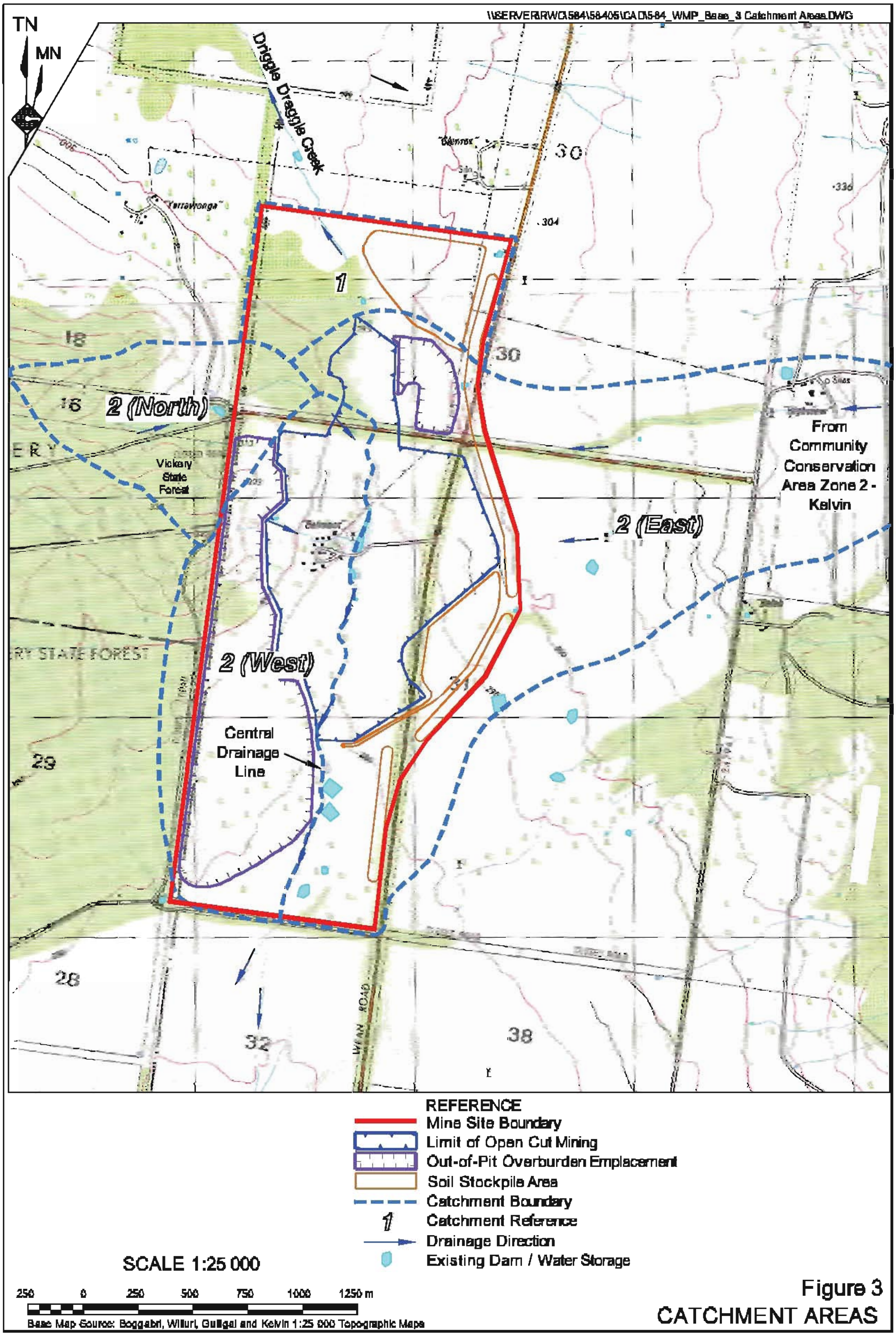


Figure 3
CATCHMENT AREAS

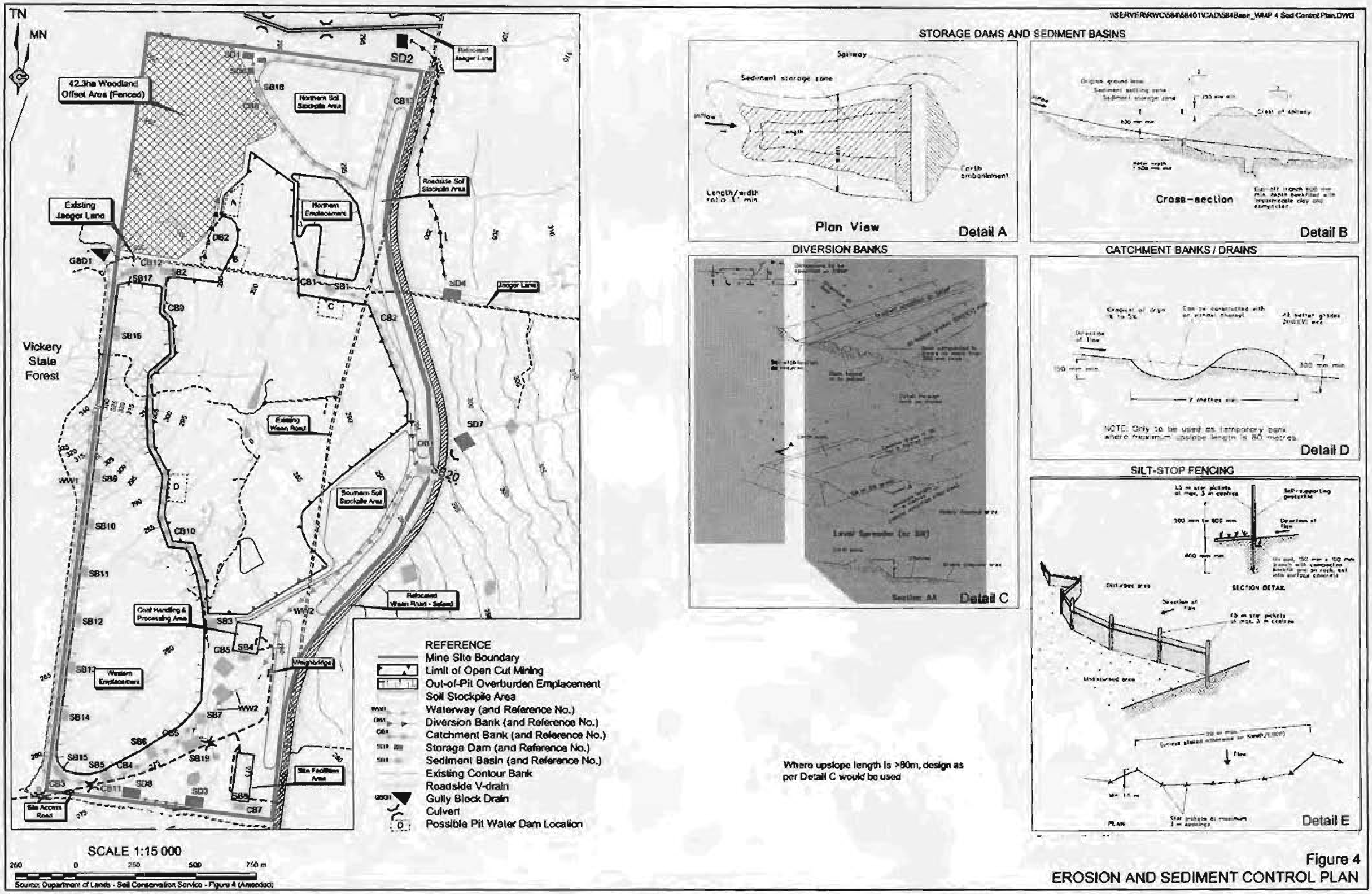


Figure 4
EROSION AND SEDIMENT CONTROL PLAN

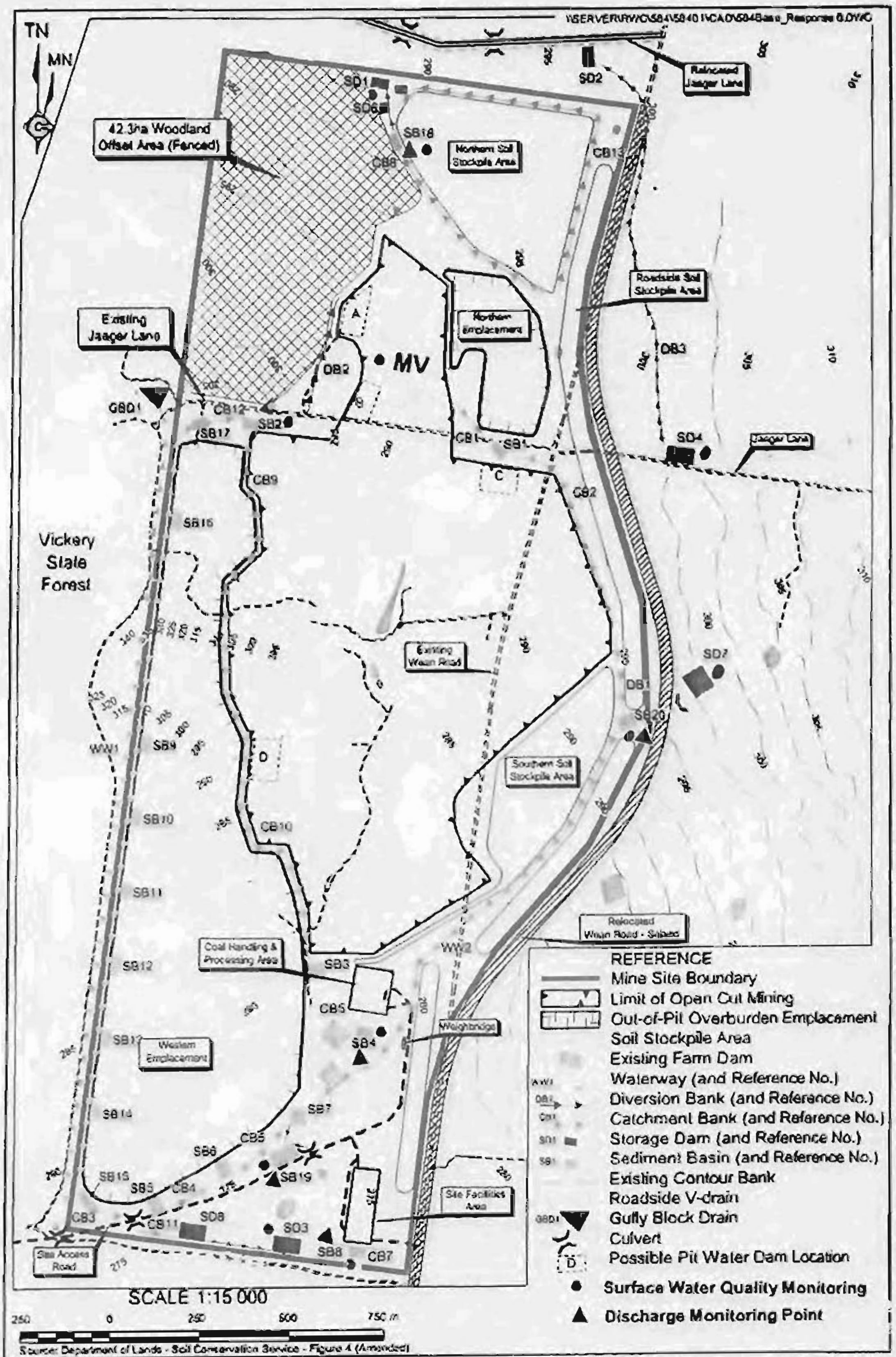
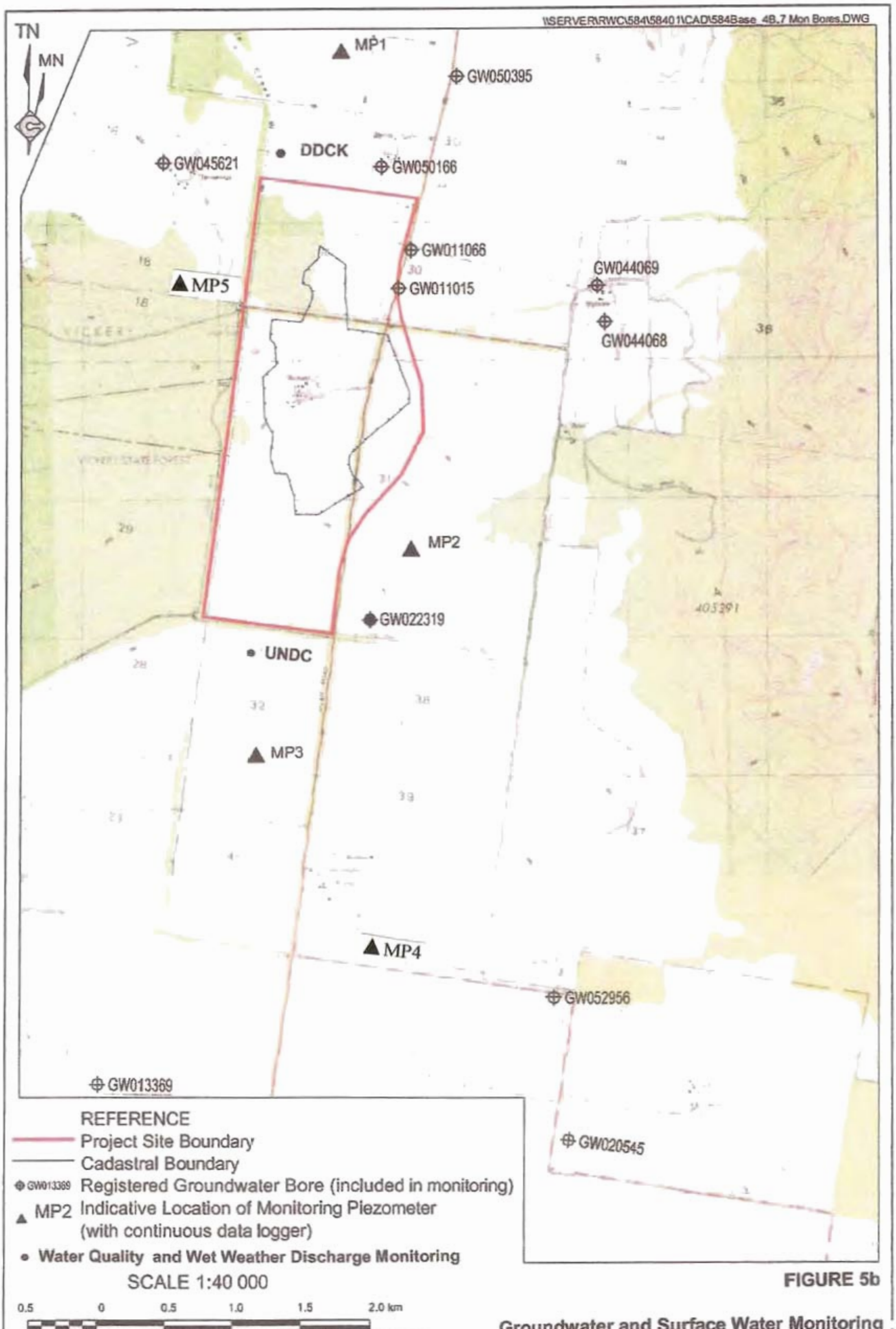


FIGURE 5a

SURFACE WATER MONITORING LOCATIONS



Base Map Source: Boggabri, Willuri, Gulligal & Kelvin 1:25 000 Topographic Maps

FIGURE 5b

Groundwater and Surface Water Monitoring

Note: A Colour Version of this figure is available on the project CD

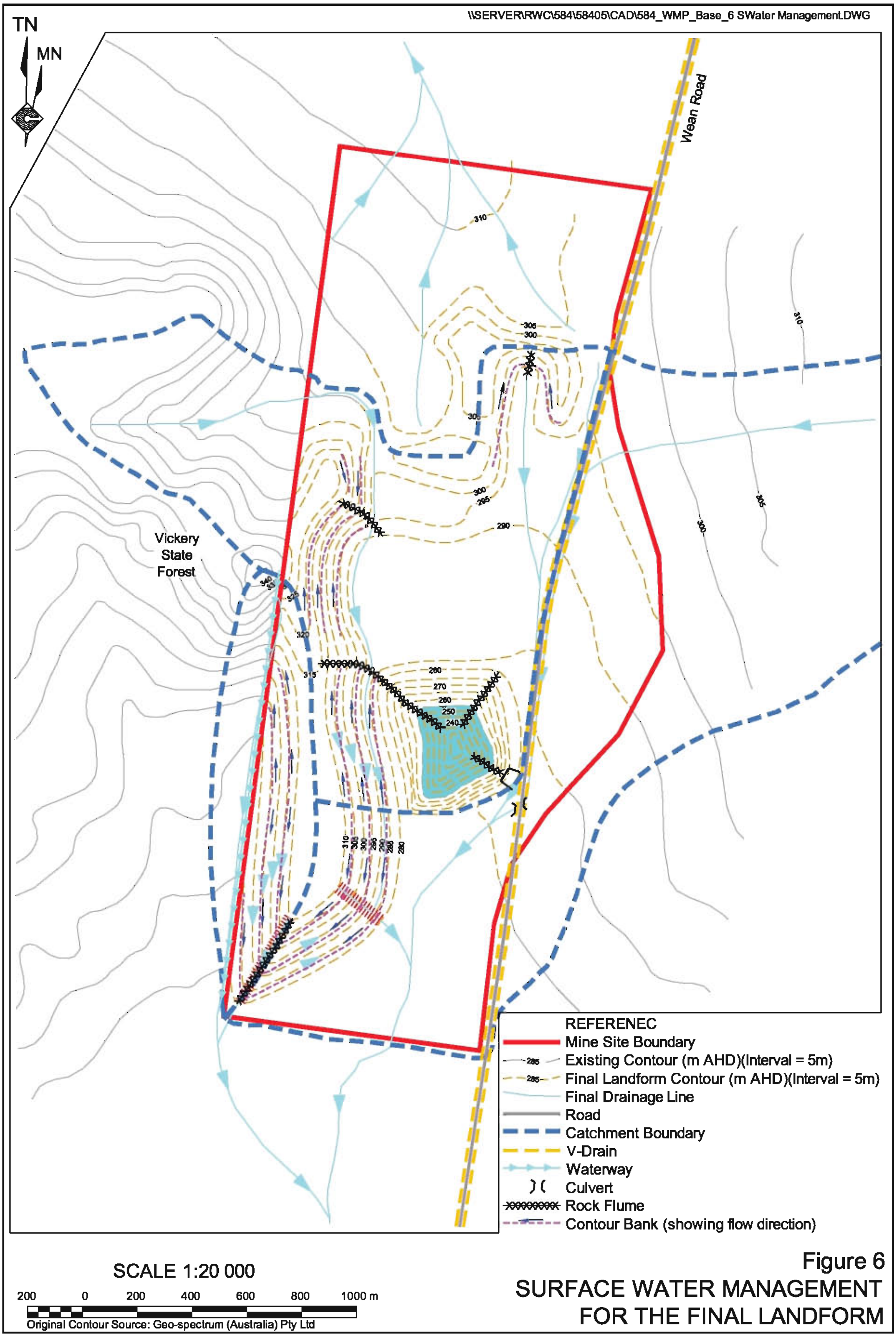


Figure 6
SURFACE WATER MANAGEMENT FOR THE FINAL LANDFORM