CENTENNIAL WESTERN COAL SERVICES PROJECT - WATER BALANCE & SURFACE WATER IMPACT ASSESSMENT

CENTENNIAL WESTERN COAL SERVICES PROJECT - WATER BALANCE & SURFACE WATER IMPACT ASSESSMENT

Prepared by:

RPS Aquaterra
Level 9, 17 York Street, Sydney NSW 2007
GPO Box 4401 Sydney NSW 2001
T: 61 2 8270 8388
F: 61 2 8270 8399
E: water@rpsgroup.com.au
W: rpsaquaterra.com.au

Our ref: S167D_R001f
Date: 26 June 2013

Prepared for:

RPS Australia East Pty Ltd on behalf of Springvale Coal Pty Ltd
Level 12
92 Pitt Street
Sydney NSW 2000

Document Status

	Issue Date	Purpose of Document
Revision A	03/05/2012	Initial Draft for Client Review
Revision B	25/09/2012	Incorporated changes to the Site Scope of Works and modelled Scenario 4
Revision C	12/12/2012	Incorporated changes derived from released DGRs and water quality Site Specific Trigger Values
Revision D	28/02/2013	Incorporated comments including water balance adjustments, new boundary limits and consistent nomenclature with EIS.
Revision E	25/03/2013	Incorporated comments and new nomenclature changes.
Revision F	26/06/2013	Update in response to Adequacy Assessment

	Name	Position	Signature	Date
Author	Alfonso Perez	Water Resource Engineer		26/06/2013
Author	Justin Bell	Senior Modeller and Surface Water Engineer		26/06/2013
Reviewer	Hugh Middlemis	Senior Principal Water Resource Engineer		25/03/2013
Reviewer	Nathan Heinrich	Senior Civil/Environmental Engineer		26/06/2013

Disclaimer

EXECUTIVE SUMMARY

Centennial Coal Company Limited (Centennial) is proposing to upgrade their current Springvale Coal Services Site and coal distribution network, referred to as the Western Coal Services Project (the Project) to support its ongoing operations in the Centennial Western Coalfield of NSW. The site is about 18km north of Lithgow. The coal distribution network connects Mount Piper Power Station in the north west, Angus Place Colliery in the north east, Springvale Colliery to the south east with Lidsdale Siding and Wallerawang Power Station located to the south east.

The current operational activities at the Springvale Coal Services Site consist of processing and stockpiling coal, bound for power generation at the Mount Piper Power Station or for transportation to the Lidsdale Siding for export and the disposal of coal Washery reject.

The Project will enable the current production of 2 Mtpa Run of Mine capacity to be increased to 7 Mtpa through the upgrade of the existing Washery and 25-year life reject disposal facilities.

This Project falls under Division 4.1 of the *NSW Environmental Planning and Assessment Act 1979.*

RPS Aquaterra have been engaged to undertake a surface water assessment and water balance study, as part of the preparation of an Environmental Impact Statement (EIS) for the proposed upgrade. This surface water assessment consists of the following main tasks for the Springvale Coal Services Site:

- A review of existing reports and assessments relevant to surface water.
- A compilation of existing surface water demand data for both the existing operation and proposed future upgrade.
- A surface water management assessment, including:
    - rainfall-runoff modeling and flood peak analysis to reflect the changes on the REAs and haul road routes,
    - soil loss and sediment transportation calculations, and
    - sediment pond size evaluation to account for the foreseen changes in the local drainage.
- A site water balance, implementing the latest configuration of the upgraded washing facility, notably the inclusion of the press belt filter, which increases the water recycling capacity, as well as the site runoff input.
- A review of the existing surface water quality data for the site and provision of an assessment in terms of the ANZECC/ARMCANZ (2000) guidelines and/or site-specific trigger values.
- An assessment of the impacts of the existing and proposed project on surface waters.
- Advice on the adequacy of any existing and proposed surface water related monitoring.
- A review of the adequacy of existing and proposed pollution control structures and assess the need for additional facilities.
- The provision of a surface water impact assessment taking into account the existing planned water management improvements for the site.
- Writing up of a comprehensive report including methodology of the study, summary of calculations, impact assessment and conclusions.

The location of the Project falls within the bounds of the Greater Metropolitan Region Unregulated River Water Sources Water Sharing Plan (WSP), which commenced on 1 July 2011. The WSP manages the protection of the environment, water extractions and licences for specific water sources and any water trading within the coverage of the plan. *The Water Management Act (WMA) 2000* regulates water resources in NSW and determines how water is used, how water works are constructed and provides rules for development near water sources. The WMA applies to all areas in which a water sharing plan has commenced.

The Washery upgrade will need to comply fully with the WSP and attention is therefore given in the document to quantifying the available water resources and understanding the quantity and quality of water being discharged from the site. Water management focuses largely on containing sediments, giving preference to the efficient use and recycling of raw water from disturbed areas rather than from undisturbed areas. The approach is also in line with the requirements of other agencies such as Part 2 of the State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011 which requires that all new proposed developments in the Sydney drinking water catchment demonstrate a neutral or beneficial effect on water quality.

The project will rely mostly on recycled water from the Washery and the use of raw water draining from disturbed surfaces, including the proposed Reject Emplacement Area (REA), as well as ground water seepage, which is saline and high in metal contents, into two dams referred to as DML and Cooks dams. The increased rate of re-circulated water from the Washery and disturbed areas will beneficially reduce discharges of worked water from the Springvale Coal Services Site as well as the risk of discharge amounts exceeding the quality criteria at the Licenced Discharge Point LDP006. Zero discharge from the operation is the future goal.

Return flows from both the proposed new Washery and existing Washery are expected to be at least 60%. The use of raw water will mostly be derived from water drained to Cooks Dam. Cooks Dam and the DML Dam are interconnected via a surface pipeline and are also via a shallow aquifer that is connected to the old mine workings. The interception and use of this water has beneficial implications in terms of reducing potential downstream water quality impacts. The use of this water also reduces the need for the Project to source alternative water supplies from the surrounding region. However, water shortages during droughts will occur and will require the provision of an external water source. Centennial is developing a regional water supply Strategy in accordance with the 1992 Springvale Mine Consent, which would utilise water generated from the underground mines. This water would be available to both Lidsdale Siding and Springvale Coal Services Site via a pipeline running along the existing overland conveyor system.

Overall the Project will provide opportunity to improve drainage with improved containment and reuse of water from worked areas and containment of sediments from worked and rehabilitated as well as natural/forested areas. This surface water study concludes that, should the Project proceeds, it is likely to be beneficial for downstream receiving waters as the amount of worked water leaving the site will be reduced and the former disturbed areas from previous open cut operations will gradually be rehabilitated. The total amount of sediment leaving the site will also be reduced as the separation of clean and worked water is made effective and the reuse of worked water increases.

ABBREVIATIONS

ARI	Annual Recurrence Interval
AWBM	Australian Water Balance Model (Boughton, 2010)
AWTS	Aerated Wastewater Treatment System
BoM	Bureau of Meteorology
CPP	Coal Processing Plant
DWBM	Dynamic Water Balance Model
DGRs	Director-General's Requirements
DP&I	Department of Planning and Infrastructure
EA	Environmental Assessment
EC	Electrical Conductivity
EP&A Act	NSW *Environmental Planning & Assessment Act 1979*
EPL	Environment Protection Licence
ha	hectares
HNCMA	Hawkesbury Nepean Catchment Management Authority
km	kilometre
LCC	Lithgow City Council
LDP	Licenced Discharge Point
LGA	Local Government Area
m	metres
mg/L	milligrams per litre
ML	Megalitres
Mtpa	Million tonnes per annum
NSW	New South Wales
NTU	Nephelometric Turbidity Units
OEH	Office of Environment and Heritage
POEO Act	*Protection of the Environment Operations Act* 1997
Project (the)	Coal Services Washery Upgrade and Coal Distribution Project
REA	Reject Emplacement Area
SCA	Sydney Catchment Authority
SEPP	State Environmental Planning Policy
SSTV	Site Specific Trigger Values
STP	Sewage Treatment Plant
SWMP	Surface Water Management Plan
t	tonnes
TPH	Total Petroleum Hydrocarbons
TSS	Total Suspended Solids
µS/cm	micro-Siemens per centimetre
WSP	Water Sharing Plan

WQOs	Water Quality Objectives

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1. INTRODUCTION

Centennial Coal Company Limited (Centennial) is proposing to upgrade their current Springvale Coal Services Site and coal distribution network, referred as to the Western Coal Services Project (the Project) (refer to Figure 1) located in the Blackmans Flat, Lidsdale and Wallerawang localities in NSW. Several operating scenarios were originally developed and then used to improve the environmental outcomes for the Project. This reiterative process led to the final defined scope of works for the Western Coal Services upgrade project, which included:

- Modifications to the reject circuit to include a belt press filter for both plants. This results in a greater water recycling capability. The process water and service water for both the existing and new Coal Processing Plants (CPPs) will be drawn from Cooks Dam at a rate of 105m^3/hr, consisting of:
  - existing CPP makeup water - 30m^3/hr,
  - new CPP makeup water - 50m^3/hr,
  - clarifier - 25m^3/hr.
- The previously proposed rejects bin has been moved 75m to the southern side of the overland conveyor.
- The project now incorporates the addition of a main single reject emplacement area covering the area of the previous REA 1 and 2. REA 4 has been dropped from the project while REA 3, which represents the existing co-disposal reject area, will be used as required as a backup to the main disposal area during maintenance or operational issues with the Belt Press Filters. Only fine reject will be deposited in the existing co-disposal area.
- Definition of two possible routes for the haul road link, route 1 running on the east close to the site limits and the route 2, which lies within the original transport corridor.

This Project falls under Division 4.1 of the *NSW Environmental Planning and Assessment Act 1979.*

RPS Aquaterra have been engaged to undertake a surface water assessment and water balance study, as part of the preparation of an Environmental Assessment (EA) for the proposed upgrade. This surface water assessment consists of the following main tasks for the Project site:

- A review of existing reports and assessments relevant to surface water.
- A compilation of existing surface water demand data for both the existing operation and proposed future upgrade.
- A surface water management assessment, including:
  - rainfall-runoff modeling and flood peak analysis to reflect the changes on the REAs and haul road routes,
  - soil loss and sediment transportation calculations,
  - sediment pond size evaluation to account for the foreseen changes in the local drainage.
- A site water balance, implementing the latest configuration of the upgrade, notably the inclusion of the press belt filter, which increases the water recycling capacity, as well as the site runoff input.
- Review of the existing surface water quality data for the site and provision of an assessment in terms of the ANZECC/ARMCANZ (2000) guidelines and/or site-specific trigger values.
- An assessment of the impacts of the existing and proposed Project on surface waters.
- Advice on the adequacy of any existing and proposed surface water related monitoring.
- A review of the adequacy of existing and proposed pollution control structures and assess the need for additional facilities.
- The provision of a surface water impact assessment taking into account the existing planned water management improvements for the site.
- Writing up of a comprehensive report including methodology of the study, summary of calculations, impact assessment and conclusions.

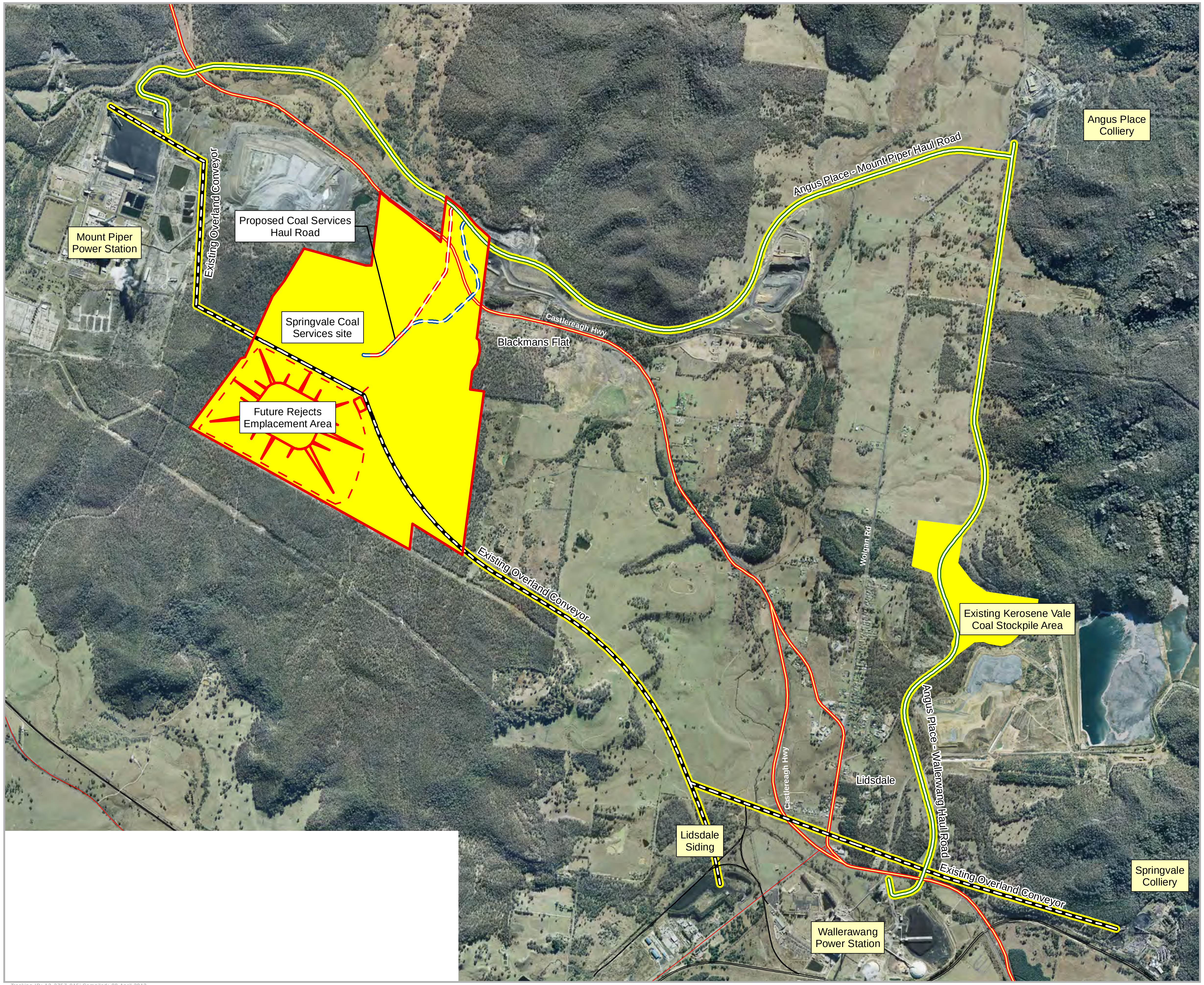
1.1 WESTERN COAL SERVICES UPGRADE PROJECT

1.1.1 Location

The proposed Springvale Coal Services Site (the Site) (refer to Figure 1 and Figure 2) is located approximately 18km north west of Lithgow, NSW. It is situated to the west of the village of Blackmans Flat. The Site is bounded in part to the north east, east, south-west and south by the Ben Bullen State Forest. The Castlereagh Highway runs along the north eastern side of the site and the Mount Piper Power Station is situated to west north west.

The coal distribution network (Figure 1) covers a broader area spanning approximately 6km^2 from the ‘gates’ of Mount Piper Power Station in the north west, Angus Place Colliery in the north east, Springvale Colliery to the south east and Lidsdale Siding and Wallerawang Power Station in the south.

The current operational activities at the Springvale Coal Services Site consists of stockpiling and handling coal bound for power generation at the Mount Piper Power Station or process of coal for export via the Lidsdale Siding. The Site also handles and emplaces coal reject produced from the Washery.



LEGEND

- Existing Overland Conveyor
- Highway
- Main Road
- Existing Haul Road
- Rail Line
- Springvale Coal Services site
- Project Application Area

Proposed Features

- Proposed Haul Road - Option 1
- Proposed Haul Road - Option 2
- Proposed Reject Emplacement Area

N

0 375 750 1,500
Metres
SCALE 1:25,000 @ A3

GDA 1994 MGA Zone 56

DATA SOURCES

RPS Aquaterra Sydney

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Please verify the accuracy of all information prior to use.

RPS Aquaterra

FIGURE 1
Coal Services Site Boundary and Distribution Network

AUTHOR	AP	REPORT NO	001d
DRAWN	TW	REVISION	1
DATE	8/04/2013	JOB NO.	S167C

Tracking ID: 12-3757-015i Compiled: 08 April 2013

LEGEND

- Highway
- Main Road
- Culvert
- Drainage Line
- Existing Overland Conveyor
- Existing Haul Road
- Lithgow City Council Landfill Site
- Springvale Coal Services site

Proposed Features

- Proposed Haul Road - Option 1
- Proposed Haul Road - Option 2
- Washery Upgrade
- Proposed Reject Emplacement Area

N

0 125 250 500
Metres
SCALE 1:8,500 @ A3

GDA 1994 MGA Zone 56

DATA SOURCES

RPS Aquaterra Sydney

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Please verify the accuracy of all information prior to use.

RPS Aquaterra

FIGURE 2

Springvale Coal Services – Proposed upgrade features

AUTHOR	AP	REPORT NO	001d
DRAWN	TW	REVISION	1
DATE	8/04/2013	JOB NO.	S167C

Tracking ID: 12-3757-014i Compiled: 08 April 2013

1.1.2 Overview

In support of its ongoing operations in the region, Centennial proposes to upgrade the existing Springvale Coal Services Site and integrate all coal transport and infrastructure under a single development consent. All current coal logistics, infrastructure and upgrades from the 'mine gates' of Springvale Coal Mine and Angus Place Colliery to Mount Piper, Wallerawang Power Stations or to Lidsdale Siding are included in this Project.

Springvale Coal Services Site receives coal from the Springvale Colliery by overland conveyor where it can be stored and processed (washed). Coal can be sent directly to Mount Piper Power Station or washed coal can be sent to Lidsdale Siding for export. The Site has existing reject emplacement areas and has a long history of open cut mining including the Lamberts Gully Open Cut Mine. This Site controls the overland conveyor system

Historically, the Springvale Coal Services Site has been used for the following activities:

- Underground extraction from Western Main and Eastern Main Collieries;
- Open cut coal extraction;
- Coal preparation and handling;
- Reject disposal;
- Coal stockpiling;
- Export coal handling; and
- Control of coal feed from the Springvale Colliery to the Mount Piper Power Station and Lidsdale Siding.

Mining operations commenced with an open cut in 1940 which extracted the Lidsdale and Lithgow Seams where the current Washery is located. Underground extraction commenced in 1942 with the western main underground entries being opposite the Washery and eastern main being where the current tailings dams are located near the main entrance to the site. The underground workings mined the Lithgow seam until the 1990's. Between 1980 and 1994, three separate open cuts were developed which extracted the remaining coal south of the Castlereagh Highway from Mount Piper Power Station to the Springvale Coal Services site entrance. The Lamberts Gully Open Cut Mine was operational from 1994 to 2010 and extracted coal from both the north and south of the overland conveyor.

The Springvale Joint Venture purchased the site in October 1994, who under a 1992 planning consent relating to the main Springvale Colliery, constructed the overland conveyor, coal stockpile facilities, reject disposal facilities and rebuilt the existing Washery.

The Washery was originally built in the early 1970s and used to produce export steaming coal which was trucked across the Castlereagh Highway to the Wallerawang Rail Siding (now part of the Pine Dale Mine site). The Washery was upgraded in 1995 following the purchase of the site from Novacoal in 1994.

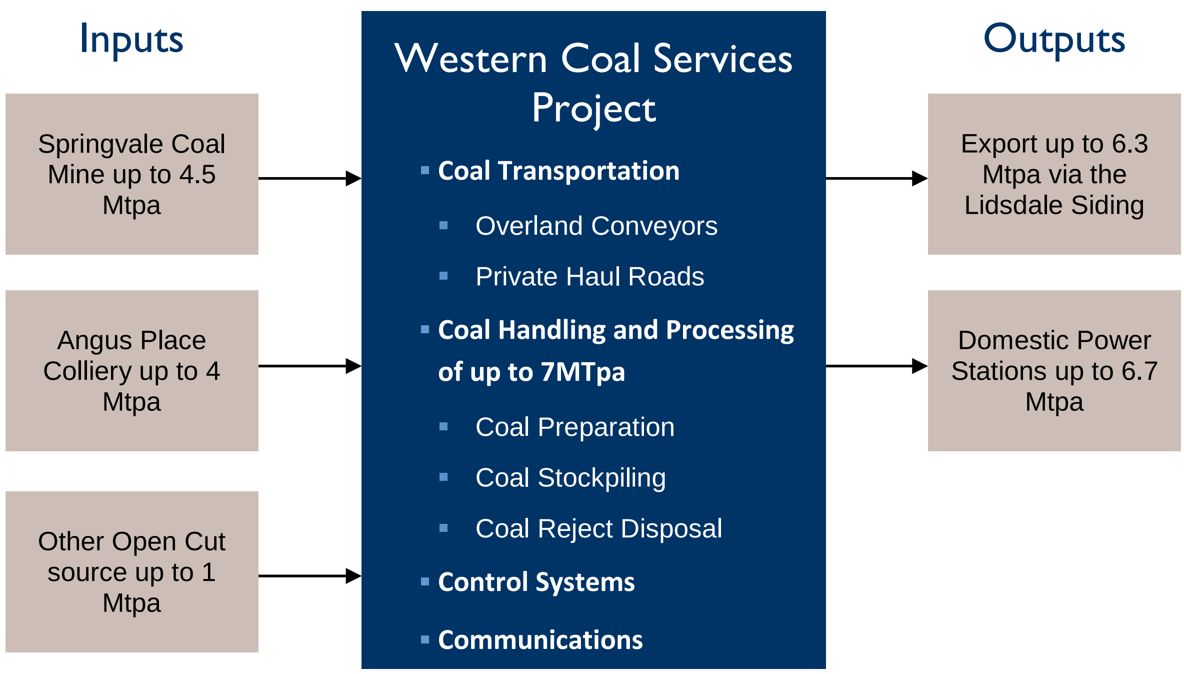
In support of its ongoing operations in the region, Centennial proposes to upgrade the existing Coal Services site and integrate all coal transport and infrastructure under a single development consent. All current coal logistics, infrastructure and upgrades from the 'mine gates' of Springvale Coal Mine, Angus Place Colliery and Lamberts Gully Open Cut, to Mount Piper, Wallerawang Power Stations or to Lidsdale Siding are included in this Project.

Key upgrade components include:

- Upgrading the existing Washery, workshops and infrastructure within the Springvale Coal Services Site by constructing a new Washery adjacent to the existing facility that will remain operational to provide a total processing capacity of up to 7 Mtpa;
- Construction of processing infrastructure such as additional conveyors and transfer points and other coal handling requirements to cater for the upgraded Washery facility within the existing disturbance footprint of the Springvale Coal Services site;

- Extending and enlarging an existing reject emplacement area to enable sufficient reject disposal capacity for a 25 year life;
- Increasing the utilisation of the return side of the existing overland conveyor system to enable up to 6.3 Mtpa of coal to be delivered to Lidsdale Siding;
- Constructing a private haul road, approximately 1.3 km in length, linking the Springvale Coal Services Site with the existing private haul road from Angus Place Colliery to Mt Piper Power Station. This private road will cross a section of the existing Pine Dale Mine operation and over the Castlereagh Highway. The preferred location of the new private haul road is identified on Figure 7;
- Improving the current water management systems on the Springvale Coal Services Site by separating clean and dirty water streams prior to either reuse or discharge off site;
- Integrating the existing approved transport and processing of coal at Springvale Coal Mine and Angus Place Colliery into the one consent;
- Integrating the remaining rehabilitation, monitoring, water management and reporting requirements associated with the Lamberts Gully Mine which occupies the Springvale Coal Services Site; and
- Continued use of all existing approved infrastructure, facilities and activities associated with the transport and processing of coal from each mine gate and the point of delivery to the Springvale Coal Services site. This infrastructure includes the existing conveyors, private haul roads, Kerosene Vale Stockpile Area, reject emplacement areas, services, access roads, car parks and buildings.

Figure 3: Overview of the Western Coal Services Project



Of particular note to water management and sediment and erosion control are the following changes to the Site as a result of the proposed development:

- A second Washery will be added to the water circuit while the existing plant will be integrated into the new water recycling circuit. This will include a new fines recovery system using press filters which will recover in the order of 60% of the retained water. The new system will be more efficient in terms of water reuse and that will not produce any additional worked water, other than for wash down purposes. Modifications to the reject circuit to include a belt press filter for both plants. This results in a greater water recycling capability. The process water and service water for both the existing and new CPPs will be drawn from Cooks Dam at a rate of 105m3/hr, consisting of:
  - existing CPP makeup water – 30 m^3/hr,
  - new CPP makeup water – 50 m^3/hr,
  - clarifier – 25 m^3/hr.
- The washed coal product will have total moisture content in the order of 8% by weight, while the fine reject material will have moisture content in the order of 32%. The fine reject will be combined with the coarse reject and conveyed to a separate bin near on the southern side of the overland conveyor. From here it will be trucked to the designated reject emplacement area (REA) (refer to Figure 2).
- The Site contains several self-contained drainage areas (open voids and areas containing paddocks which do not spill). These are shown on Figure 4 and Figure 5. The proposed reject emplacement area will alter the drainage by filling a small drainage depression. Delta Electricity has approval to emplace ash in the area to the north eastern part of old mining area which will fill the old mining voids. The emplacement area will be rehabilitated and surface drainage from this area will be directed through sediment control ponds.
- Concrete collection sumps will be incorporated into the new Washery design and water recycling system to control sediment laden water from the new plant; the clarifier overflow and the water content in tailings drained by the press belt will be directly recycled into the Washery tank. The water contained in the coal product will be partially drained and directed to the Existing Washery Dam for its posterior reuse. The overall assumed recirculation from the Washery is around 60% of the total water usage, which is 63 m^3/hr.
- The existing Washery will still operate on the site and surface runoff will continue to be drained into pollution control ponds. Particularly relevant are the existing Washery Dam and the Existing Stockpile Dam shown on Figure 4 and Figure 5 and Figure 6.
- The existing DP&I approved Lamberts Gully open cut water monitoring and management plans will be integrated into the management of the upgraded coal services site.
- Sediment laden water from the proposed private haul road will be collected and contained.
- There will be an increased extent of separation of clean and dirty water across the Site.
- Installation of additional pollution control infrastructure.
- Inclusion of one main single reject emplacement area (REA) covering a surface of approximately 75 ha at the southwest corner of the Site, with capacity for 25 Mt (to be filled at a rate of 1 Mtpa for 25 years) to an RL of 1,000 m ASL, which is between 40 and 50 m high from the current ground level elevation. It will generally have side slopes at a grade of 1:3 with 5.5 m wide benches for access and drainage every 5 m of vertical rise.
- The existing co-disposal rejects area, will be used as required as a backup to the main disposal area during maintenance or operational issues with the Belt Press Filters. Only fine reject will be deposited in the existing co-disposal area.

According to the water balance results, it is anticipated that the Springvale Coal Services Site, even after the increase in coal processing capacity, will still be a net producer of water, although it will suffer water shortages during prolonged dry periods and. Treated excess water will continue to be discharged through the licenced discharge point (LDP006). Centennial is currently investigating methods to better separate clean and dirty water systems on Site and this is likely to involve passing water from above the site, through a combination of existing and new channels and pipes from above the Site down to the current location of LDP006 near the main entrance.

This include the diversion of the flows from the catchments upstream the proposed REA in the southern side of the site. Major interception of the clean runoff from catchments 9, 12 and 13 (see Figure 5) will be implemented as proposed.

The existing haul roads and overland conveyors will be maintained as per current operations.

LEGEND

- Highway
- Main Road
- Existing Haul Road
- Existing Overland Conveyor
- Culvert
- Drainage Line
- Reservoir / Pond
- Washery Upgrade
- Local Catchment Boundary
- Void / Endoric Area
- Lithgow City Council Landfill Site
- Springvale Coal Services site
- Pond

N

0 200 400 800
Metres
SCALE 1:16,500 @ A3

GDA 1994 MGA Zone 56

DATA SOURCES

RPS Aquaterra Sydney

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Please verify the accuracy of all information prior to use.

RPS Aquaterra

FIGURE 4 -

Existing Site Layout and Surface Water Catchments

AUTHOR	AP	REPORT NO	001d
DRAWN	TW	REVISION	1
DATE	28/02/2013	JOB NO.	S167C

Tracking ID: 12-3757-020d Compiled: 28 February 2013

DATA SOURCES

RPS Aquaterra Sydney

RPS Aquaterra

FIGURE 5 - Proposed upgrade to Site Layout and Surface Water Catchments

AUTHOR	AP	REPORT NO	001d
DRAWN	TW	REVISION	1
DATE	8/04/2013	JOB NO.	S167C

Tracking ID: 12-3757-019I Compiled: 08 April 2013

LEGEND

- Water Monitoring Site
- HEC-RAS Model Cross-Section
- Highway
- Main Road
- Existing Haul Road
- Culvert
- Drainage Line
- Lithgow City Council Landfill Site
- Springvale Coal Services site

Proposed Features

- Proposed Haul Road - Option 1
- Proposed Haul Road - Option 2
- Proposed Washery Upgrade
- Proposed Reject Emplacement Area

DATA SOURCES

RPS Aquaterra Sydney
HEC-RAS Model Cross-Sections source WRM Water & Environment Pty Ltd (2005)

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Please verify the accuracy of all information prior to use.

RPS Aquaterra

FIGURE 6

Surface Water Monitoring Locations

AUTHOR	AP	REPORT NO	001d
DRAWN	TW	REVISION	1
DATE	8/04/2013	JOB NO.	S167C

MapID: 12-3757-003e - Published 08 April 2013

1.2 CONTEXT OF THE REPORT

This surface water assessment report is included within a compendium of other specialist consultant studies undertaken for the EIS. It should be read in conjunction with the overarching Environmental Assessment (RPS, 2012) and RPS Aquaterra's Groundwater Impact Assessment (2012) report for completeness.

1.3 SCOPE OF WORKS

The scope of work for this project builds on the efforts of previous studies (refer to Section 3.1.1), which assisted in the development of the current project. It addresses the proposed upgrade and the most recent planning. Previous work used to inform this study has been reviewed, as part of this study.

The surface water assessment consisted of the following main tasks for the Springvale Coal Services Site:

- A review of existing reports and assessments relevant to surface water.
- A compilation of existing surface water demand data for both the existing operation and proposed future upgrade.
- An update of the site water balance taking in to account the new Washery facility and recycling initiatives.
- A review of the existing surface water quality data for the site and provision of an assessment in terms of the ANZECC/ARMCANZ (2000) guidelines and/or site-specific trigger values.
- An assessment of the impacts of the existing and proposed project on surface waters.
- Advice on the adequacy of any existing and proposed surface water related monitoring.
- A review of the adequacy of existing and proposed pollution control structures and needs for additional facilities.
- A study of site drainage patterns and storm water facilities (existing and proposed, including separation of clean and dirty water systems).
- An assessment of peak flow rates for selected probabilities of rainfall that will be estimated for areas of concern related to spillages and pollution.
- Addressing areas of concern highlighted in the risk assessment undertaken by RPS.
- Identification of any additional areas of concern relevant to surface water, including flood impact to the site.
- A discussion of appropriate mitigation measures to minimise soil erosion and sedimentation and the management of surface water quality and quantity.

The project also involves integrate into one approval the access, processing and distribution of coal from Springvale Mine and Angus Place Colliery. This distribution system includes the existing private haul roads to both Wallerawang and Mount Piper Power Station, the existing overland conveyor system and the Kerosene Vale stockpile area located adjacent to the Angus Place Colliery to Wallerawang Power Station.

Note: The Kerosene Vale Stockpile Area is used to temporarily store coal when either Wallerawang or Mt Piper Power Stations are unable to accept coal. This site is covered by an existing Water Management Plan and has previously been assessed by GHD 2010. Stormwater run-off from disturbed areas of Kerosene Vale Stockpile Area drain to a separate dirty water system, which is directed through on-site settling ponds and dosing system prior to discharge through Licensed Discharge Point 3 (LDP 003) of Angus Place Colliery EPL. RPS is currently completing the surface water assessment for Angus Place Colliery which, includes assessing the Kerosene Vale Stockpile Area in detail. No additional activities are proposed for the Kerosene Vale Stockpile Area as part of this report.

1.4 REPORT OBJECTIVES

This specialist report has been compiled to meet the Director-General's Requirements (DGRs) of the Department of Planning and Infrastructure (DP&I). Furthermore, the conditions of Centennial's Environmental Protection Licence (EPL) are addressed. A number of policies, guidelines, plans and statutory provisions relating to surface water management have been used for reference where applicable. These are outlined in Sections 1.4.2 and 1.4.3.

1.4.1 Director-General's Requirements

The DGRs for the Project (application number SSD 5579, issued on November 2012) have identified water as a 'key assessment requirement'. The DGRs for the Project that relate to surface water are listed in Table 1.1. These are likely to be superseded by the above application.

Table 1.1: Surface water related Director-General's Requirements

Category	Requirement	Where addressed
General Requirements	The Environmental Impact Statement (EIS) for the development must meet the form and content requirements in Clauses 6 and 7 of Schedule 2 of the Environmental Planning and Assessment Regulation 2000 in addition, the EIS must include: • A detailed description of the development, including: - need for the proposed development; - likely staging of the development - including construction, operational stage/s and rehabilitation; - likely interactions between the development and any approved and proposed mining operations, including detailed assessments of any required modifications to the approvals for these operations; - likely interactions with other approved developments/projects at the site; and - plans of any proposed building works:	Section 1
	• Consideration of all relevant environmental planning instruments, including identification and justification of any inconsistencies with these instruments;	Section 1.4.3
	• A risk assessment of the potential environmental impacts of the development, identifying the key issues for further assessment;	
	• A detailed assessment of the key issues specified below, and any other significant issues identified in this risk assessment, which includes: - a description of the existing environment, using sufficient baseline data;	Section 3
	- an assessment of the potential impacts of all stages of the development, taking into consideration relevant guidelines, policies, plans and statutes;	Sections 8 and 9
	- a description of the measures that would be implemented to avoid, minimise and, if necessary, offset the potential impacts of the development, including proposals for adaptive management and/or contingency plans to manage any significant risks to the environment; and	Section 8
	- an assessment of the potential cumulative impacts of the project operating, in this regard, you are required to include a detailed assessment in the EIS of the potential cumulative impacts of the project operating in conjunction with any existing, approved and/or proposed coal mining development and power generation in the vicinity of the site, and to carry out a suitable sensitivity analysis of this assessment;	Section 9
	• A consolidated summary of all the proposed environmental management and monitoring measures, highlighting commitments included in the EIS.	Sections 8 and 9
	The EIS must be accompanied by a report from a qualified quantity surveyor providing: • a detailed calculation of the capital investment value (as defined in clause 3 of the Environmental Planning and Assessment Regulation 2000) of the proposal, including details of all the assumptions and components from which the CIV calculation is derived;	

Category	Requirement	Where addressed
	• a close estimate of the jobs that will be created by the development during the Construction and operational phases of the development; and • Certification that the information provided is accurate at the date of preparation.	
Key Issues (Soil and water)	• A detailed assessment of potential impacts on the quality and quantity of existing surface water and ground water resources in accordance with the NSW Aquifer Interference Policy, including; - impacts on affected licensed water users and basic landholder rights; - impacts on riparian, ecological, geo-morphological and hydrological values of watercourses, including groundwater dependent ecosystems and environmental flows; - a clear description of the interactions between surface and ground water resources on the site, including water within underground mine voids and pathways to water discharges from the site; and - whether the development can operate to achieve a neutral or beneficial effect on water quality in the drinking water catchment, consistent with the provisions of State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011;	Sections 8 and 9
	• A detailed site water balance, including a description of site water demands, water disposal methods (inclusive of volume and frequency of any water discharges), water supply infrastructure and water storage structures; and	Sections 6.2 and 7
	• Identification of any licensing requirements, including existing or future Environment Protection Licences (EPLs) or Pollution Reduction Programs (PRPs), and approvals under the Water Act 1912 and/or Water Management Act 2000;	Sections 1.4.3 and 5
	• Demonstration that water for the construction and operation of the development can be obtained from an appropriately authorised and reliable supply in accordance with the operating rules of any relevant Water Sharing Plan (WSP);	Section 1.4.3
	• A description of the measures proposed to ensure the development can operate in accordance with the requirements of any relevant WSP or water source embargo;	Sections 8, 9 and 10
	• A detailed description of the proposed water management system (including sewerage), water monitoring program and all other proposed measures to mitigate surface water and groundwater impacts	Section 4
References	The assessment of the key issues listed above must take into account relevant guidelines, policies, and plans as identified. While not exhaustive, the following contains a list of some of the guidelines, policies, and plans that may be relevant to the environmental assessment of this development. • National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000) • National Water Quality Management Strategy: Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC/ARMCANZ, 2000) • National Water Quality Management Strategy: Guidelines for Sewerage Systems – Effluent Management (ARMCANZ/ANZECC, 1997) • National Water Quality Management Strategy: Guidelines for Sewerage Systems – Use of Reclaimed Water (ARMCANZ/ANZECC, 1999) • Using the ANZECC Guideline and Water Quality Objectives in NSW (DEC) • State Water Management Outcomes Plan (SWMOP) (NSW Government, 2002) • Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011 • NSW Government Water Quality and River Flow Objectives (OEH). • Approved Methods for the Sampling and Analysis of Water Pollutants	Section 11

Category	Requirement	Where addressed
	in NSW (DEC) • Managing Urban Stormwater: Soils & Construction, Volume 2E, Mines and Quarries (Landcom, 2004) • Managing Urban Stormwater: Treatment Techniques (DECC/EPA, 1997) • Managing Urban Stormwater: Source Control (DECC) • Floodplain Development Manual (DIPNR, 2005) [replaced Floodplain Management Manual (2001)] • Floodplain Risk Management Guideline (DECC) • A Rehabilitation Manual for Australian Streams (LWRRDC and CRCCH) • Technical Guidelines: Bunding & Spill Management (DECC) • Environmental Guidelines: Use of Effluent by Irrigation (DECC)	

1.4.2 Additional Standards and Guidelines

In addition to the DGRs references requirements and the legislation described in the following section, the site and proposed upgrades have also been examined in relation to the documents listed in Table 1.2.

Table 1.2: Standards, plans and guidelines

Document	Where addressed/utilised
• Hawkesbury Nepean River Health Strategy (HNCMA, 2007) • Hawkesbury-Nepean Catchment Action Plan 2007 – 2016 (HNCMA, 2008) • Independent Inquiry into the Hawkesbury Nepean River System (Healthy Rivers Commission, 1998)	Section 3.5 and Section 5
• Australian Rainfall and Runoff (Engineers Australia) • Australian Water Balance Model (Broughton, 2010)	Section 7
• Managing Urban Stormwater: Soils and Construction, Volume 2E – Mines and quarries (DECC, 2008)	Section 7

1.4.3 Legislation

Environmental Planning and Assessment Act 1979 (EP&A Act)

The *Environmental Planning and Assessment Act (EP&A Act) 1979* provides the overarching statutory framework for assessing development in NSW. The EP&A Act enables the development of State Environmental Planning Policies (SEPPs).

The Coal Services Washery Upgrade and Coal Distribution Project is classified as a State Significant Development listed under Clause 5(3) of Schedule 1 of SEPP (State and Regional Development) 2011, therefore Part 4, Division 4.1 of the EP&A Act applies.

State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011

Part 2 of the *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011* requires that all new proposed development in the Sydney drinking water catchment demonstrate a neutral or beneficial effect on water quality. To achieve optimal water quality or maintain current water quality in the catchment, the *Healthy Catchments Strategy 2009-2012 (SCA, 2009)* was developed. The Strategy includes the development of annual Healthy Catchment Programs to assist in meeting water resource objectives. A description of relevant catchments and watercourses is provided in Section 4.5.3 of this report and outlines how the flow network is being revised to accommodate this requirement to enable a healthier environment.

Water Management Act 2000, Water Act 1912 and Water Licensing

The Water Management Act (WMA) 2000 regulates water resources in NSW and determines how water is used; how water works are constructed and provides rules for development near water sources. The WMA 2000 applies to all areas in which a water sharing plan has commenced.

The location of the Project falls within the bounds of the Greater Metropolitan Region Unregulated River Water Sources Water Sharing Plan (WSP), within the Wywandy Management Zone, which commenced on 1 July 2011. The WSP manages the protection of the environment, water extractions and licences for specific water sources and any water trading within the coverage of the plan. The Washery upgrade aims to make use of available site water, including recovery from the plant, seepage water which is intercepted in the DML Dam and Cooks Dam and supplemented with water contained in pollution containment ponds below the Washery The seepage water is thought to originate from old mine workings, reject emplacements and shallow aquifers. The DML Dam is located adjacent to the Cooks Dam and also leaks into Cooks Dam. Prioritising the use of this water will help reduce the amount of water discharged from the Site and move the water management system closer towards achieving zero discharge. Cooks Dam and DML dams are off-channel Storage facilities and are not located on the creeks which drain the Lamberts Gully.

The Coal Services dams and sediment/retention basins have been assessed by the NSW Office of Water as not requiring surface water licences under Part 2 of the *Water Act 1012* (letter to Centennial Coal from NSW Office of Water, 12 November 2010). This is conditional on the continued application of the Site Water Plan of the time, and to allow water to run through the Lamberts Gully and Existing Conveyor Dam unhindered (as if the dam had a "transparent wall"). In addition, the recycling of process water is in keeping with industry best practice and Centennial's EPL.

Protection of the Environment Operations Act 1997 and Environmental Protection Licence

As determined in Section 120 of the *Protection of the Environment Operations (POEO) Act 1997*, waters are not to be polluted except as expressly provided for in an Environmental Protection Licence (EPL).

Centennial have been granted an EPL for coal works and mining for coal (EPL3607), which covers the mining operation, surface facilities, overland conveyors and the Springvale Coal Services Site. EPL467 held by Angus Place Colliery covers the mining operation, surface facilities and road haulage of coal. It is proposed (as a component of the proposed upgrade) to apply for a separate EPL covering the Springvale Coal Services Site inclusive of all coal transport infrastructure and operations, thereby integrating components of both EPL3607 and 467.

EPL3607 (as per version date 19 December 2011) allows for the discharge of water from the Licenced Discharge Point number 6 (LDP006) currently located near the site entrance and Castlereagh Highway, which subsequently flows into Wangcol Creek. Discharged water is required to be monitored for quality as specified in Table 1.3. The volumetric/mass limit on LDP006 for discharge is 10,000kL/day.

Table 1.3: Licenced allowable discharge from Coal Services site (EPL3607)

Pollutant at LDP006	Units of measure	100 Percentile concentration limit
Oil and Grease	mg/L	10
pH	pH units	6.5 – 8.5
Total Suspended Solids (TSS)	mg/L	30

2. INVESTIGATION METHODOLOGY

2.1 DATA REVIEW

Water management plans, baseline studies, reports and data relevant to surface water covering the Coal Services Site and relevant nearby facilities have been reviewed. This was carried out to utilise the latest information on current water management practices, assess the cumulative impact of the Project and collate and analyse baseline water quality data. This includes the following reports:

- Douglas Partners, March 2010, *Stage 2 Hydrogeological Assessment, Licence Application for Bores and Structures*, Western Main Colliery, Castlereagh Highway, Blackmans Flat.
- GHD, August 2009, Revised Surface Water Management Plan, Lamberts Gully Coal Mine.
- GHD, December 2006, Surface Water Management Plan, Lamberts Gully Coal Mine.
- GHD, January 2010, Centennial Coal Company Limited, Lamberts Gully LDP006 – Surface Water Quality Baseline Study.
- SKM, August 2010, Mt Piper Power Station Ash Placement Project – Appendix D Hydrology and Water Quality.
- Springvale Coal, Lamberts Gully Open Cut Environmental Monitoring Plan (Draft).
- GHD, July 2011, Centennial Coal Company Limited. Springvale Coal Services LDP006 Water Quality Targets – Report No. 21/15193/123324.
- GHD, March 2012, Springvale Coal Services, *Surface Water Management Plan (Draft).*
- AURECON, July 2012, Springvale Coal Services, *Dirty Water Management Report (Draft).*
- Centennial Coal, September 2012, Springvale Coal Services Upgrade Project Briefing Paper.
- GHD, November 2012, Centennial Coal Company Limited. Coal Services Water Quality Assessment, LDP006 ANZECC Assessment – Report No. 21/21926.

2.2 SITE VISIT

Site visits to the Springvale Coal Services Site and relevant areas of the coal distribution network were conducted on 15 February and 5 March 2012, by Craig Schultz, RPS Aquaterra Senior Principal Hydrologist. These visits were conducted to identify and assess potential surface water impacts from the proposed upgrade and to confirm the information provided in previous reports.

2.3 PRELIMINARY INVESTIGATION AND FINDINGS

A preliminary findings meeting between Centennial and RPS Aquaterra on 23 February 2012 enabled the effective communication of any surface water management concerns at the Site and for the Project. As a result of this consultation a draft surface water management report was submitted in May 2012 accounting for scenarios 1, 2 and 3. Scenarios 2 and 3 included the implementation of 4 different Reject Emplacement Areas (REAs). Details and conclusions of the simulated scenarios 2 and 3 can be found in Appendix D.

The new proposed layout of the site according to the new scope of works for the Project is represented in Scenario 4 - Future Lay Out.

3. EXISTING SURFACE WATER ENVIRONMENT

3.1 REGIONAL SETTING

The Springvale Coal Services Site is located less than 1km west of the Blackmans Flat locality, in the Local Government Area of Lithgow City Council. Blackmans Flat is situated on the western slope of the Great Dividing Range in NSW.

The locality lends itself to undulating hills and mountain tops, some of which are forested with native woodland. Low-lying areas nearby the site have been predominantly cleared for residential, commercial, industrial or agricultural purposes. The major industries in the area include coal mining, forestry and power generation.

The land around the Site mainly consists of state forest (Ben Bullen State Forest), a rural residential area, and Mount Piper Power Station infrastructure, water storages and ash emplacement facilities.

3.2 CLIMATE

The climate of the region is classified as a cool-temperate mountain climate, with mild summers and cold winters.

The local climate is influenced by topography, altitude, and aspect. Maximum daily temperatures typically range between 12°C and 25°C. Frosts are common, particularly between May and September.

3.2.1 Rainfall

Rainfall data was collated from a number of BoM weather stations near the Site, due to inconsistent records at all stations. The average annual rainfall from the collated record has been calculated to be 774.6mm.

The distribution of the rainfall throughout the year is relatively uniform; however rainfall is slightly higher during the warmer months (October through to March). Rainfall intensity is locally affected by the orographic influence of the Great Dividing Range.

In order of preference, taking into consideration locality, altitude and quality of data, the following weather stations' rainfall data were used to create a long-term data set:

- Lidsdale (Maddox Lane), Station 63132. Data record from 01/08/1959 to present.
- Wallerawang Power Station, Station 63176. Data record from 01/12/1902 to 31/10/1973.
- Lithgow (Cooerwull), Station 63226. Data record from 01/01/1878 to present.
- Lithgow (Birdwood St), Station 63224. Data record from 01/04/1889 to 30/06/2006.
- Lithgow (Kylie Park), Station 63164. Data record from 01/09/1959 to 31/09/2009.
- Lithgow (Newnes Forest Centre), Station 63062. Data record from 01/04/1938 to 30/11/1999).

In addition to the above, it was observed during later hydrological model calibrations that situations occasionally existed when flow peaks were measured in the Wangcol Creek (NSW Office of Water flow gauge 212055) at times when no or very little rainfall occurred at any of the above rainfall stations. For days when such anomalies occurred, additional data were sought from the rain gauge at the nearby Pine Dale Coal Mine. Pine Dale records were not as extensive as at the other sites and recording periods were often intermittent. However, within the limited data available some periods of good quality data coincided better with the variability observed at the local streamflow gauging stations. Such data were included where deemed reliable.

Rainfall data from 1 January 1878 to 31 November 2011 is summarised in Table 3.1. Due to data quality and rain gauge spatial representation issues, the record length was shortened for purposes of this study. The period of record used in daily hydrological and water balance modeling for this study extended from August 1959 to February 2012.

Table 3.1: Long-term rainfall summary (mm)

Stat.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	80.5	75.3	69.4	53.7	51.4	63.3	59.5	61.3	55.2	64.6	69.0	71.4	774.6
Min	0.0	1.3	0.8	1.2	0.0	2.6	0.0	1.5	0.0	2.4	3.1	0.0	329.8
Max	213.6	294.5	411.4	202.6	183.8	258.7	319.0	363.8	255.0	228.4	207.7	255.9	1687.4

3.2.2 Evaporation

Daily pan evaporation has been recorded at Bathurst Agricultural Station, BoM station 63005, from 1966 to December 2011, and is presented in Table 3.2. The average daily pan evaporation is 3.7mm/day. This station is the closest to the project site (approximately 47km to the west), which records evaporation data. For use in estimating evaporation losses from open water surfaces of sediment ponds and dams, a Pan Factor of 0.85 was applied.

Table 3.2: Average daily pan evaporation (mm)

Stat.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	6.8	5.8	4.5	2.9	1.7	1.1	1.2	1.8	2.8	4.0	5.2	6.5	3.7

3.3 TOPOGRAPHY

The Coal Services site and surrounding Coal Distribution Network are located within the gently undulating Coxs River valley. The local topography at Springvale Coal Services Site is however relatively steep. The Site is situated on a slope with a northerly aspect and has elevations ranging from approximately 900m Australian Height Datum (AHD) at Wangcol Creek to 985m AHD at the southern site boundary as shown on Figure 7. The catchment area of the Lamberts Gully, which drains through Site to the Wangcol Creek, rises steeply to the south of the Site reaching 1060 m AHD at the catchment divide with the Pipers Flat Creek. The Wangcol and Pipers Flat Creek are both Tributaries of the Coxs River.

The dominant landforms in the region include the wooded hills and slopes of the Ben Bullen State Forest which occupies the catchment divide, surrounds the Project Site and dominates all parts of the Project Site that have not been impacted on by earlier mine workings.

LEGEND

- Highway
- Main Road
- Existing Haul Road
- Culvert
- Drainage Line
- Waterbody
- Contour - 1m Intermediate
- Contour - 10m Index
- Lithgow City Council Landfill Site
- Springvale Coal Services site

Proposed Features

- Proposed Haul Road - Option 1
- Proposed Haul Road - Option 2
- Washery Upgrade
- Proposed Reject Emplacement Area

N

0 125 250 500
Metres
SCALE 1:8,500 @ A3

GDA 1994 MGA Zone 56

DATA SOURCES
RPS Aquaterra Sydney

RPS Aquaterra

FIGURE 7
Site Features and Topography

AUTHOR	AP	REPORT NO	001d
DRAWN	TW	REVISION	1
DATE	8/04/2013	JOB NO.	S167C

Tracking ID: 12-3757-001m Compiled: 08 April 2013

3.4 VEGETATION

The Springvale Coal Services Site is highly disturbed, containing a number of mine voids, haul roads and emplacement areas. Some pockets of natural vegetation still exist, as well as rehabilitated land on old mining areas. The Site is bounded on three sides by Ben Bullen State Forest, which is naturally wooded.

Grazing and mining activities in the region have affected the riparian vegetation along the Coxs River and its various tributaries.

Further information on vegetation can be found in the Terrestrial Ecology Assessment (RPS – Newcastle, 2012) undertaken for this Project.

3.5 CATCHMENT DESCRIPTION

The Springvale Coal Services Site is situated in the Upper Coxs River Sub-catchment shown in Figure 8, which is within the Blue Mountains Western Catchment managed by the Hawkesbury Nepean Catchment Management Authority (HNCMA).

The Springvale Coal Services Site is located primarily south of Wangcol Creek, with a proposed private haul road crossing the Creek in the north east. The crossing location of Haul Road option 1 is approximately 700m to the south of that for option 2. The Angus Place to Mount Piper Power Station haul road and Angus Place to Wallerawang Power Station haul roads and conveyors, which are part of the coal distribution network, also cross the Coxs River, Pipers Flat Creek, Neubecks Creek and their associated tributaries at various locations.

A number of smaller tributaries feed into the aforementioned Creeks and River, which have headwaters in the state forest, mining leases or cleared private land.

Water that is collected within the Upper Coxs River Sub-catchment forms part of the Warragamba Water Supply System, which is inside the Sydney Metropolitan Drinking Water Catchment.

The SCA's Healthy Catchments Strategy 2010-12 presents a number of protection activities for the area to address risks to water quality. No priority risk drainage areas from the Strategy have been specifically identified at or nearby the Springvale Coal Services Site (for Wangcol Creek).

3.5.1 Reach Classification

The sections (reaches) of the Coxs River nearby and relevant to the Project are described in the Hawkesbury Nepean River Health Strategy (HNCMA, 2007). The Upper Coxs R2 (in part) and R3 Coxs River are positioned from the confluence of Wangcol Creek and the River to Lake Wallace.

3.5.2 Coxs River

Springvale Coal Services is situated to the west of the Upper Coxs River, which is a major tributary and headwater (elevations over 1,000m) that flows into Lake Burragorang for Sydney's drinking water. The confluence of Wangcol Creek and the Coxs River is approximately 800m downstream (south) of Long Swamp (a wetland of local significance). This confluence is called Blue Lake and is an old open cut mine void.

The River contains an impoundment, the Lake Wallace reservoir, approximately 5km south of the Wangcol Creek confluence. Lake Wallace provides Delta Electricity's Wallerawang Power Station water requirements and also Wallerawang town drinking water.

The Upper Coxs R2 has been assessed by the HNCMA (2007) as being in fairly good condition, and has following reach values in the portion relevant to the Project:

- Good riparian vegetation;
- High geomorphic recovery potential;
- Popular recreational fishing; and
- Significant community based environmental activity.

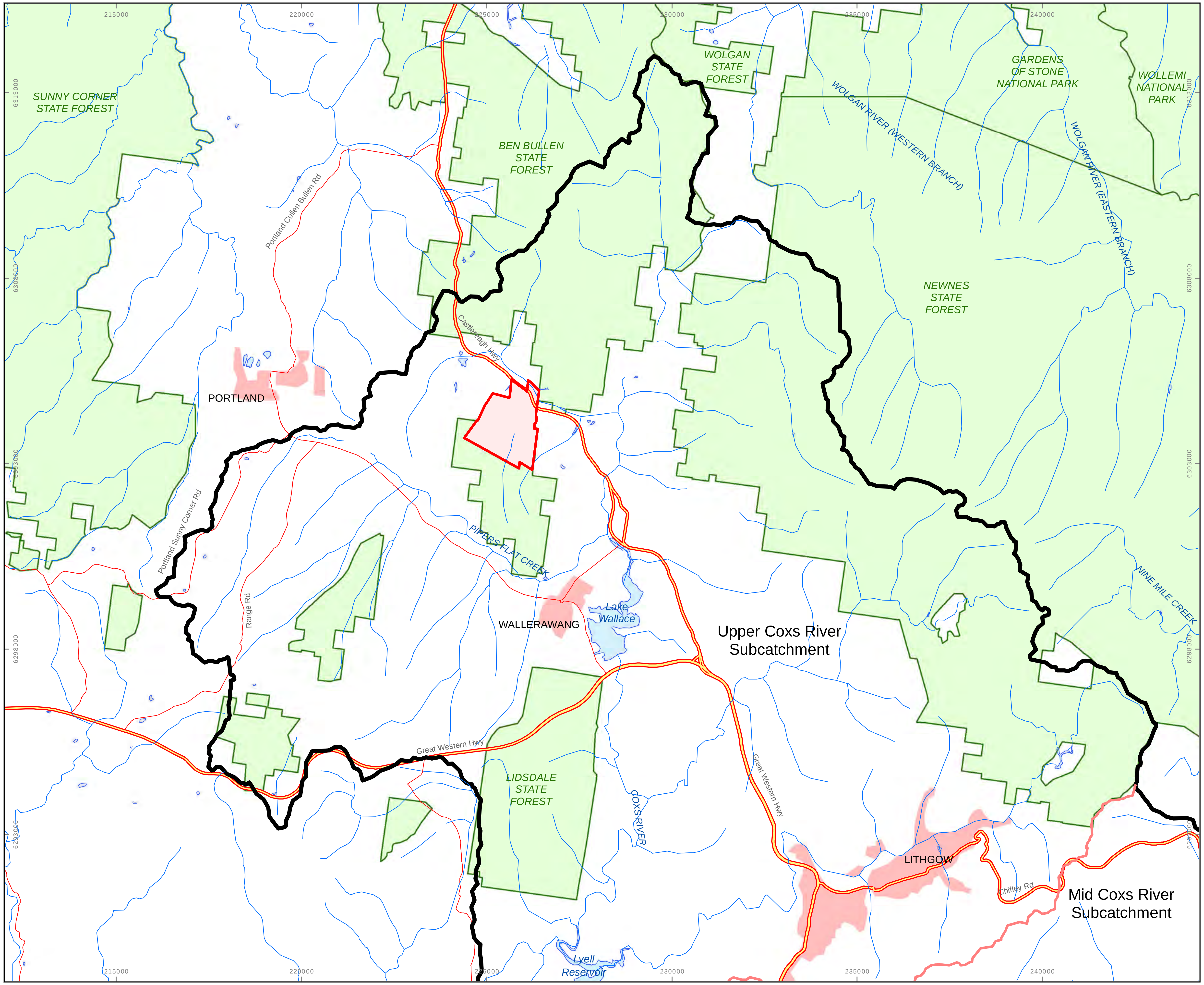
Stock access, which damages riparian areas, flow extraction, potential future mine dewatering and barriers to ecosystem functioning threaten its state. The portion relevant to this Project area has a management focus of 'assisted regeneration'.

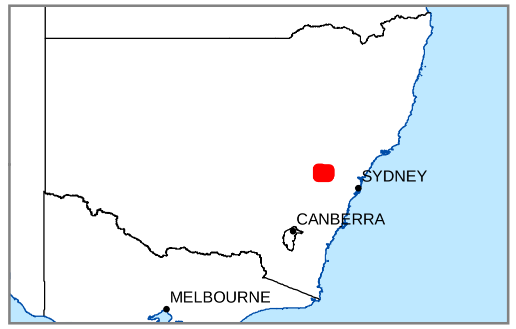
The Upper Coxs R3 has been assessed by the HNCMA (2007) as having reach values of:

- Popular recreational fishing and non-motor boating;
- High public recreation access; and
- Significant irrigation water supply.

This portion of the River is assessed as being under severe and immediate threat from riparian weed invasion and coarse sediment as a result of erosion, which creates a severe downstream impact. Under the River Health Strategy (HNCMA, 2007) the riparian land management categories for the Upper Coxs R3 has a focus on revegetation.

No wetlands have been identified as associated with these reaches (lower part of R2 and R3); however significant gorge environments are located within National Park headwaters.





LEGEND

- Catchment Boundary
- Subcatchment Boundary
- Highway
- Main Road
- Springvale Coal Services site
- Waterbody
- State Forest
- Built Up Area

N

0 1,250 2,500 5,000
Metres
SCALE 1:100,000 @ A3
GDA 1994 MGA Zone 56

DATA SOURCES
Base data RPS Aquaterra Sydney.
Subcatchments NSW Sydney Catchment Authority, SEPP March 2011.

RPS Aquaterra

FIGURE 8
Upper Coxs River Subcatchment Boundary

AUTHOR	AP	REPORT NO	001d
DRAWN	TW	REVISION	1
DATE	20/03/2012	JOB NO.	S167C

Tracking ID: 12-3757-013g Compiled: 28 February 2013

3.5.3 Wangcol Creek

Wangcol Creek is a perennial stream and joins the Coxs River, north of Lidsdale village at 'Blue Lake'. A portion of Wangcol Creek lies nearby the Castlereagh Highway and its condition in the river valley varies from partly vegetated to cleared and degraded land.

Historically, it is understood Wangcol Creek has flowed intermittently. Flows are now influenced by Pine Dale Coal Mine, Springvale Coal Services Site and Mount Piper Power Station discharges under licence conditions.

A number of smaller tributaries enter the Wangcol Creek, which have headwaters in either: cleared land, mining areas, or the Ben Bullen State Forest. The dominant land use upstream of the confluence of the Wangcol Creek and Lamberts Creek is largely forestry and other land uses occupy a relatively small portion of the catchment area.

Note: Topographic maps show that the east-west portion of this Creek is called Wangcol Creek however; many Centennial documents and their EPL label it as Neubecks Creek or Blackmans Creek (water quality results). One of its tributaries, Neubecks Creek runs from north to south and is located in Ben Bullen State Forest, north of the Castlereagh Highway. For the purposes of this report, the Creek running past the Coal Services entrance will be termed Wangcol Creek.

3.5.4 Local Catchments and Drainage

Across the majority of the Springvale Coal Services Site, natural drainage flows in a north easterly direction from Ben Bullen State Forest towards Wangcol Creek. Two major drainage lines exist, which for the purposes of this study will be termed the Huon Gully (west side of site) and Lamberts Gully (east side of site). The headwaters of these drainage lines are in undisturbed forest, however as they run through the site, some disturbance and diversion has been undertaken to reduce the contamination of these watercourses before reaching the Creek. The Huon Gully flow ends in the Huon Dam located on Mount Piper Power Station land. The Lamberts Gully is intercepted by sediment/contaminant control dams located within the Coal Services site; however this control dam permits throughput of water after sediment settling.

The local catchments that have drainage collection and/or discharge within the Springvale Coal Services Site are presented on Figure 4 for the current situation and on Figure 5 for the future Layout of the site. The area and description of each of these catchments is provided in Table 3.3.

Table 3.3: Local catchments relevant to the project area

Catchment number	Area (Ha)	Catchment Description
1	2.12	Current: Catchment 1 is 90% of undisturbed area and 10% ha of disturbed area. Catchment 1 includes Pond SH2 which is a raw water pond and a drain into SH1 located in Catchment 12 (south to Catchment 1). Catchment 1 ultimately drains to Huon Gully which is outside the limits of this study. Future: Seepage from underground mining areas will lead to water draining into Cook's dam (D1).
2	6.73	Current: 100% of catchment 2 is a rehabilitation zone. Future: Vegetation in Catchment 2 is currently in the process of being established.
3	7.42	Current: Catchment 3 is 80% bush land with the Cooks Dam taking 20% of the catchment area. Cooks dam receives waters from DML dam (D3) via seepage and spillage. Cooks Dam is the main water supply source for the Washery, by pumping water to the Washery Tank. Cooks Dam overflows to Wangcol Creek. Future: A new pipe will connect the Existing Washery Dam with Cooks Dam, increasing the inflow in the dam. The proposed Haul Road 1 passes within a corridor in the vicinity of Cooks Dam (D1) in Catchment 3. The proposed Haul Route 2 will cut through the sub-catchment but will not modify significantly the drainage, which eventually will be conducted to Cooks Dam.
4	50.59	Current: 100% of Catchment 4 is a disturbed mining area. Three water bodies exist- SLG1, SLG3 and SLG5. The three of them spill to Lamberts Gully and eventually to the Retention Dam (D2). Half of a reject emplacement area is located within the western region of Catchment 4. The other half of the emplacement is located in the adjacent Catchment 9. Future: Catchment 4 will be entirely covered by the new Reject Emplacement Area. Catchment 4 will drain eventually to the New Sediment Dam proposed for the new REA. The existing SLG1, SLG3 and SL5 will cascade flow towards the New Sediment Dam.

Catchment number	Area (Ha)	Catchment Description
5	8.82	Current: Catchment 5 is 100% disturbed and is predominately occupied by the Washery. It includes the Existing Stockpile Dam, which collects local drainage re-circulating flows to the Washery. The Existing Stockpile Dam overflows to Lamberts Gully and eventually to the Retention Dam (D2) Future: The new Washery will be placed in catchment 5. The Existing Stockpile Dam will be connected to the water recycling system currently via a pipeline to the Washery water supply tank but may also be connected to Cooks Dam in future.
6	14.92	Current: Catchment 6 is 100% undisturbed area. Sediment Pond SLG6 is located within this catchment. SLG6 receives flows from the Existing Washery Dam and overflows to the Existing Retention Dam. Three existing culverts are located along the smaller water bodies as water from the Stockpile Sediment Dam and the Washery Sediment Dam drain into this Catchment. Future: The nominated Haul Road route (both options) runs along the northern portion of Catchment 6. The Pond SLG6 will be disconnected from its upstream connection, collecting only clean runoff from catchment 6. A new pipeline from the Existing Washery Dam will be implemented, directing worked waters to Cooks Dam, which will be re-circulated to the Washery.
7	8.83	Current: Catchment 7 is 88% disturbed land and 12% undisturbed land, with the Washery Sediment Dam located within its western portion. . The Washery Sediment Dam drains into SLG 6. Approximately15% of Catchment 7 is occupied by a proposed reject emplacement area (located in the South western region of the Catchment). Future: The proposed Haul Road (both options) ends in Catchment 7's northern portion. A new pipeline from the Existing Washery Dam will be implemented, directing worked waters to Cooks Dam, which will be re-circulated to the Washery.
8	23.21	Current: All catchment 8 is disturbed area. Two contained drainage zones are located within the disturbed area and are 2.16 and 1.82 ha in size accounting for 17% of the total catchment area. Approximately 80% of Catchment 8 is a reject emplacement area. Catchment 8 drains to Huon Gully. Future: Catchment 8 will be entirely covered by the new Reject Emplacement Area, the old mine open cuts and voids will be sealed. Catchment 8 will drain eventually to the New Sediment Dam proposed for the new REA via a dirty water drain.
9	19.11	Current: Catchment 9 is 100% undisturbed area. Currently catchment 9 drains into catchment 4. Future: Catchment 9 will be limited to the clean water upstream which will be diverted around the new REA to flow towards ponds SLG2 and SLG4, which flow to the Main Conveyor Dam and eventually into Lamberts Gully. The dirty water from the new REA will entre Catchment 4 and will be directed into the new REA Pond..
10	41.14	Current: This catchment is 100% undisturbed area. The Main Sediment Dam is located within this Catchment. The Main Sediment Dam collects waters from SLG2 and SLG4, draining to Lamberts Gully and eventually to the Retention Dam (D2). The southern tip of this catchment is not located within the study area boundaries. Future: this catchment is likely to be separated from the dirty water areas and allowed to drain directly off site via the main drain adjacent to the site. The Main Sediment Dam will eventually be separated from the dirty water system and form part of the clean water system
11	55.7	Current: Catchment 11 is 90% disturbed land and 10% undisturbed. A drainage void, 6.2 ha in size, is located on the southern tip of Catchment 11. Catchment 11 drains into the Huon Dam (D4). The Huon Dam is not part of the project area and is associated with Mt Piper Power Station (located west of the dam). The north western part of this catchment extends outside of the project area. Future: This area will form part of the future Ash Emplacement operated by Delta Electricity.
12	104.87	Current: This catchment is 100% undisturbed area. Pond SH1 is located at the northern tip of Catchment 12 (adjacent to SH2) and drains south along the Huon Gully. An existing culvert is located at the southern tip of SH1 along the drainage line towards Huon Gully. The entire catchment is not part of the project area and all rain and drainage in this catchment can be classified as raw water. Future: This area will drain into the future ash emplacement area operated by Delta Electricity. Water may be diverted into the Lamberts Gully catchment.
13	178.67	Current: Catchment 13 is 100% undisturbed area and is the largest of the catchments. SLG2 and SLG4 are located within the northern tip of catchment 13. This catchment extends beyond the property lines of the project area and has raw water draining through this catchment into ponds SLG2 and SLG4, eventually draining to the Existing Conveyor Dam.

Catchment number	Area (Ha)	Catchment Description
		Future: Drainage from this catchment will be better separated from disturbed areas as it flows through the site. The sediment ponds in this area will be surrounded by more vegetation and this will then reduce the levels of sediment (transported in raw water) draining into these ponds. Flows from catchment 13 will be re-routed around the new REA to implement the separation of raw and dirty water in the site.
14	10.79	Current: This catchment is 100% disturbed area (existing co-disposal area) with approximately 60% of this catchment being self-contained tailings ponds. Catchment 14 drains directly to the Retention Dam (D2) Future: The area will continue to be used as required as a backup to the proposed tailings dewatering system It is expected that the existing Co Disposal REA will be partially rehabilitated and only two of the existing ponds used as a back up to the belt filter presses.
15	19.69	Current: Catchment 15 is 100% undisturbed area. The northern boundary of Catchment 15 runs along the Castlereagh Highway. The whole catchment drains away from the site through 3 existing culverts under the Castlereagh Highway. The eastern half of this catchment is not located within the project area boundaries. Future: No changes are expected in the future in catchment 15 and it will continue to form part of the clean water drainage system of Lamberts Gully.
16	12.31	Current: Catchment 16 is 100% undisturbed area and extends around Catchment 14. It drains directly to Lamberts Gully and eventually into the Retention Dam (D2). Future: The separation of clean water from this catchment forms part of the ongoing water management improvements at the Springvale Coal Services Site.
17	1.81	Current: Catchment 17 is 100% undisturbed area and it is located between Catchment 5 and Catchment 16. The Existing Conveyor Dam drains through Catchment 7 and into Existing Stockpile Dam (located in Catchment 5) Future: This clean area It will drain separately from disturbed areas prior to discharging offsite.
18	3.31	Current: Catchment 18 is 100% rehabilitation zone. It drains to catchments 2 and 10. Future: Vegetation in this catchment is in the process of being established and the small water body located in this catchment will drain raw water into a small water body located in Catchment 10 and eventually to the Existing Conveyor Dam which in turn will form part of the future clean water diversion system.
19	46.55	Current: Catchment is 70% undisturbed area and 30% disturbed land with the DML Dam (D3) located in its north eastern region. In addition, a contained drainage zone approximately 7.2 ha in area is located on the western side of Catchment 19. The whole catchment drains to DML Dam, which filtrates and spills to Cooks Dam (DM1). There is a water body located to the eastern side of the drainage void which connects and spill to the DML Dam. Seepage from underground mining areas permits worked water to drain towards the DML dam. The northern half of this catchment is not located within the study area and is subject to ash filling and Lithgow Council's Waste Disposal facility. Future: The Haul Road Route 2 will pass between DML Dam and Cooks Dam, presumably improving soil compaction and reducing seepage between both dams.

3.6 GROUNDWATER-SURFACE WATER INTERACTION

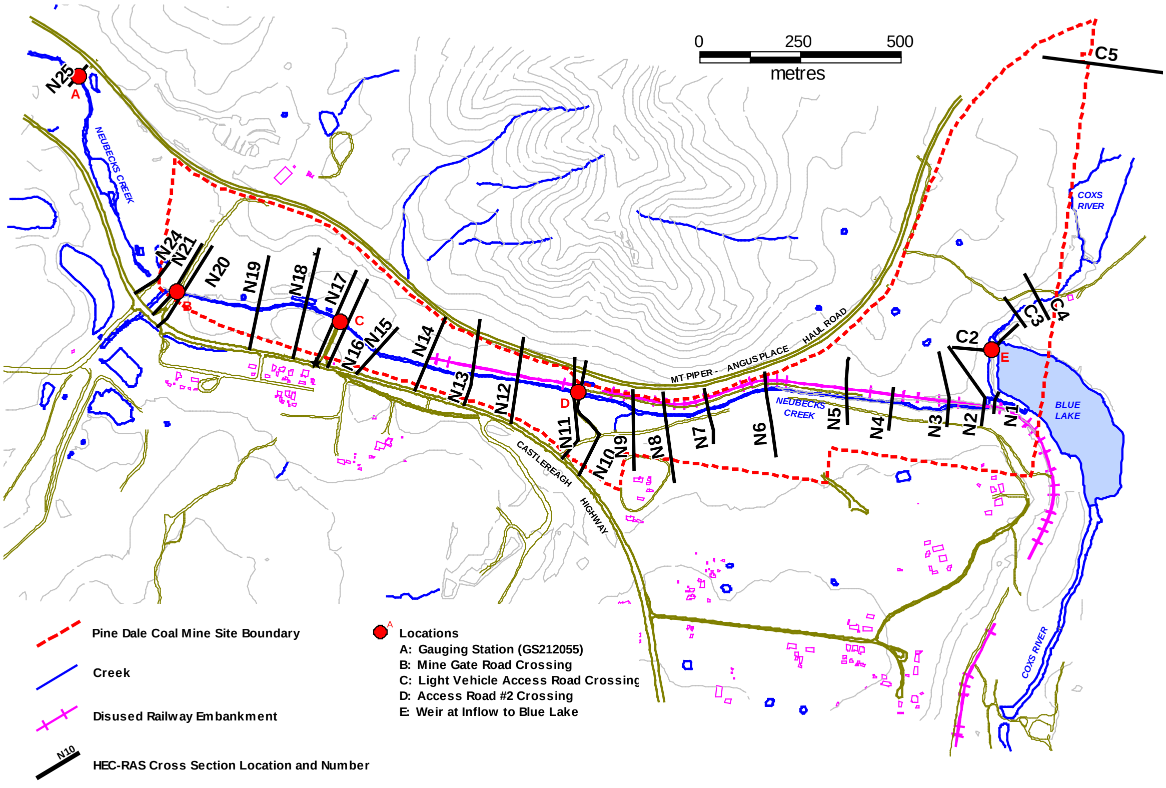
Further detail on groundwater within the Project and surrounding area can be found in the Western Coal Services Groundwater Impact Assessment (RPS Aquaterra, February, 2013) carried out for this Project. The most significant aspect of the local groundwater system is that water seeping out of the old mine workings and open cut overburden is intercepted by the Cooks and the DML dams. The quality of this water (refer to Appendix A) is such that it is preferable to retain and use this water on site. The ground water modelling predicts a net filtration from the ground water to the DML and Cooks Dams of around 120m^3/day (60m^3/d for each dam). However the latest studies and rainfall-runoff vs. water balance model calibration suggest that the filtration to the mentioned dams may be higher, in the order of 200 to 240 m^3/d (100 to 120 m^3/d for each dam). It is suspected some rain water recharge from the old mine open-cuts and voids 1 and 2 may have an impact on the water filtration to the dams, and hence in the water balance of the site. Rainfall in these drainage voids can rapidly filtrate directly to the DML and Cooks dams before reaching the general ground water levels. Refer to Figure 4 and Figure 5 for the location of the identified drainage voids.

Furthermore the earth wall separating the DML and Cooks Dam was design as a permeable wall and it is believed to leak water from DML to Cooks Dam at an approximate rate of 0.4ML/d, according to the conclusions of the water balance model calibration (Section 6.1.2).

3.7 FLOODING

A flood study of Wangcol Creek and the Coxs River was undertaken for Pine Dale Coal Mine by WRM Water and Environment in 2005. Modeling conducted for this study outlines design flood levels for 20, 100 and 500 year Annual Recurrence Interval (ARI) events at multiple points along Wangcol Creek. In particular, the flood levels at N25, N24 and N21 (Figure 9) are of particular relevance, as they are located adjacent to the Springvale Coal Services Site. A summary of flood elevations at selected points are quantified and presented in Table 3.4. The majority of the Site appears to be located above the floodplain of Wangcol Creek when assessed against a topographical contour map (Figure 7), with the exception of areas near the entrance gate.

Figure 9: Existing Site Layout and Location of HEC-RAS Model Cross-Sections Cox River



Source: Neubecks Creek and Coxs River Flood Study, WRM Water & Environment Pty Ltd, 2005

Table 3.4: 20, 100 and 500 year ARI design flood levels (WRM, 2005)

HEC-RAS Model Cross-Section #	Minimum Channel Elevation (mAHD)	Design Flood Level		
		20 year ARI	100 year ARI	500 year ARI
N25	903.0	904.9	905.2	905.6
N24	899.1	902.0	902.2	902.5
N21	898.6	901.8	902.0	902.2

4. SITE WATER MANAGEMENT

4.1 EXISTING SURFACE WATER MANAGEMENT SYSTEM

A Surface Water Management Plan (SWMP) for the Springvale Coal Services Site was developed by GHD in accordance with project approval conditions (PA06_0017) in May 2006. This was subsequently modified (again by GHD) under approval (PA06_0017 MOD1) in September 2008.

Further to that, and in order to account for the changes to site operations including the management responsibilities of Huon Dam, the ash emplacement area and the Lithgow Council Waste facility a new draft SWMP (under Springvale Coal Services) was produced by GHD and approved in August 2009. This work is ongoing and will result in progressive upgrading of the water management system operating at the Springvale Coal Services Site. In particular, the work will further separate clean water from the upper portion of the Lamberts Gully catchment from disturbed areas. Ultimately, the intention is to allow this water to pass through the Site and discharge as clean water into Wangcol Creek via the current LDP006 location. The following sections describe the current water management system.

4.1.1 Surface Water Capture and Containment

A number of existing dams and sediment basins across the northeast and southeast perimeter of the Site provide containment of predominantly surface run-off. The arrangement of the basins permits the settling of suspended sediment prior to discharge at LDP006 under EPL3607. Surface water predominantly entering these containment basins is either run-off from undisturbed catchment areas off site or from the partly rehabilitated open cut areas. Water running off from contaminated hardstand areas is directed to primary sediment control basins, which is then either recycled or further treated within the existing water management system.

The main surface water capture and containment dams are summarised in Table 4.1. The various dams and ponds have been numbered for use in this study, the sediment and pollution control pond numbers are preceded by an “S” and if located in the catchment draining the Lamberts Gully (LG) they are preceded by the letters “SLG”. Major water storage dams are simply preceded by the letter “D” in keeping with numbering systems of earlier studies.

Although this study concentrates on the main processing site and the proposed infrastructure upgrades, the Project also includes a number of other existing physical components (see Figure 1) such as the Kerosene Vale coal storage area and the various existing private haul roads and conveyors. The haul roads were originally constructed with appropriate drainage provisions including piped culverts, protected batters and drainage diversion channels. Kerosene Vale has an established drainage system and a licensed discharge point associated with Angus Place Colliery. No works are proposed on the existing infrastructure or Kerosene Vale and were not subject to separate investigation as part of this study

Table 4.1: Main Surface Water Capture and Containment Summary

Name	Water Balance ID*	Function	Measured Surface Area (m^2)	Inflow	Estimated Storage Volume (ML)	Outflow
Clean runoff Ponds in upper section of Lamberts Gully	SLG1 SLG3 SLG5	Water Retention	7,942	Receives surface runoff from upstream disturbed catchments and from REA.	9.40	Water is transferred downstream towards the Retention Dam and then current LDP006. In the future water will be directed to the New Sediment Dam.
Worked runoff Ponds in upper section of Lamberts Gully	SLG2 SLG4	Water Retention	14,700	Receives surface runoff from undisturbed catchments.	15.07	Water is transferred downstream to the Retention Dam and then the current LDP006.
New Sediment Dam	New Sediment Dam	Water retention		Receives surface runoff from the new proposed REA.	6.00	Water is transferred to the Existing Washery Sediment Dam for its use in the Washery.
Existing Conveyor Dam	Existing Conveyor Dam	Water Retention	18,973	Receives surface runoff from upstream catchment.	25.30	Water is transferred downstream to the Retention Dam and then current LDP006.
Existing Stockpile Dam	Existing Stockpile Dam	Retention and usage on site	1,690	Surface run-off from coal stockpile area.	4.49	Water is transferred from the Stockpile Sediment Pond to the Washery Make up tank.
Existing Washery Dam	Existing Washery Dam	Retention and usage on site	3,870	Local surface run-off, overflow from the Washery Clarifier and inflow from the New Sediment Dam.	3.79	It feeds the Washery make-up Tank. The construction of pipe (DN225) will direct all discharge to Cooks Dam.
Sediment No.6 Pond	SLG6	Water Retention	1,783	Surface run-off from small catchment below the existing Washery Dam.	3.57	The construction of pipe (DN225) will render this dam redundant. Water will either evaporate or overflow into current LDP006 drain.
Washery Make-up Tank	Water Storage Tank	Storage for Washery	-	Water received from Stockpile Sediment Dam and Cooks Dam.	0.6	Water pumped to Washery. over flow is discharged through a pipe to the Existing Washery Dam.
Cooks Dam	Cooks Dam	Water Retention	11,905	Surface water runoff from upstream catchment areas, infiltration from ground water and seepage from DML dam. Pipe line from Washery Dam.	23.81	Water is pumped from the Cooks Dam to the washery tank. Water is pumped to DML Dam Cooks dam overflows to Wangcol Creek.
DML Dam	DML Dam	Water Retention	38,089	Receives surface runoff from upstream and infiltration from ground water.	118.84	Evaporation and seepage in to Cooks Dam. In addition water can bepumped to Cooks Dam when required.
Existing Retention Dam	Existing Retention Dam	Water retention and storage before discharging at LDP006	4,813	Surface water runoff from upstream catchment areas. Water is pumped from the Main Sediment Dam in to the Retention Dam.	4.49	Water can be pumped from the Retention Dam to the Washery. Water overflows from this dam to the current discharge point (LDP006).

Storage volumes have been calculated by measuring upper water mark contour and estimating the depth based on the lower contour and steepness of the surroundings for each pond.

Storages are regularly inspected and also managed through dredging (when required) to maximise full retention, settling and sedimentation volumes. Operations in these catchments are managed and maintained locally through erosion and sediment control measures including sediment basins, diversion drains and bunding as per the *Managing Urban Stormwater: Soils and Construction Guidelines (Landcom, 2004).*

4.1.2 Water Supply

Water existing on site can be categorised into two main types as listed in Table 4.2. Water for processes is sourced from various dams around the site as detailed above.

Table 4.2: Site Water Sources

Raw (primary)	Treated and Recycled
• Rain interception • Runoff from undisturbed areas entering the lease area or in pit rainfall inflows • Runoff from rehabilitated areas • Municipal water supply (potable)	• Site stormwater from disturbed and partly rehabilitated areas which enters the main pollution / sediment control ponds • Dewatering pumps at the base of the open cut area (currently not in use) • Water generated from the washery reject disposal system • Water intercepted in DML and Cooks dam from runoff from the old open cut areas and seepage from the old underground workings and open cut overburden.

4.1.3 Site Water Demands and Use

Water is used for coal washing, dust suppression on haul roads and the coal stockpile and wash-down.

Municipal water is provided for domestic water use is used in workshops, washrooms and offices.

For the treatment of domestic waste water, the site has two biocycle Aerated Wastewater Treatment Systems (AWTSs), one adjacent to the control room and one adjacent to the main office. The control room has a single WC (water closet) and hand basin. The main unit is attached to the bathhouse and change rooms and consists of two WC, one trough, eight showers and three hand basins, clean and dirty sided change rooms. This unit was designed to cater for the Lamberts Gully Open Cut mining as well as the Coal Services personnel (~40 personnel (FTE) during the Open Cut mining operation. Treated effluent is irrigated on adjacent landscaped areas. The current load for operations of the Coal Services site consists of 15 personnel.

Prolonged drought conditions and/or dry windy conditions can cause an increase in water requirements for dust suppression and a decrease in harvestable amounts of stormwater draining from disturbed areas.

4.2 EXISTING MONITORING PROGRAM

The current site monitoring program is maintained to ensure erosion and sediment control measures are working effectively, monitor potential contaminants and to comply with EPL3607 requirements.

The monitoring undertaken involves routine water quality sampling at 11 locations and visual inspections of settlement ponds, sumps, culverts and storm water drainage channels. Two relatively new monitoring points (Wangcol Creek NSW Office of Water Gauging Station 212055 and Wangcol Creek Far Downstream) were added to the monitoring program in September 2011. These sites enable the analysis of receiving water quality as well as the quality of water in Wangcol Creek after sufficient mixing should have occurred downstream of the site’s discharge point. Additional sampling may be required during, and/or subsequent to, high rainfall events. The parameters and frequency of monitoring at each location are detailed in Table 4.3.

Table 4.3: Surface Water Monitoring Program

Site Code	Purpose	Frequency	Parameters
LDP006	Water quality monitoring requirement for EPL3607.	Monthly (during discharge)	pH, EC, Total Suspended Solids (TSS), Oil and Grease (TOG) Total Dissolved Solids (TDS), Hardness, CO_3, OH, HCO_3, Alkalinity, SO_4, Cl, Ca, Mg, Na, K, NO_3, P, Al, B, Cd, Fe, Mn, Ni(filt), Ni(tot), Se, Zn(tot) & Zn (filt)
	National Pollutant Inventory (NPI) reporting	Quarterly (Feb, May, Aug and Nov).	NPI Parameters – 40 priority substances
Wangcol Ck Upstream Wangcol Ck Downstream Wangcol Ck NOW Station 212055 Wangcol Ck Far Downstream	Water quality of Wangcol Creek	Weekly	pH, EC, TSS, TOG TDS, Hardness, CO_3, OH, HCO_3, Alkalinity, SO_4, Cl, Ca, Mg, Na, K, NO_3, P, Al, B, Cd, Fe, Mn, Ni(filt), Ni(tot), Se, Zn(tot) & Zn (filt)
Cooks Dam	Water quality	Weekly	pH, EC, TSS, TOG TDS, Hardness, CO_3, OH, HCO_3, Alkalinity, SO_4, Cl, Ca, Mg, Na, K, NO_3, P, Al, B, Cd, Fe, Mn, Ni(filt), Ni(tot), Se, Zn(tot) & Zn (filt)
Existing Retention Dam Existing Conveyor Dam Existing Stockpile Dam Existing Washery Dam SLG6	Water quality	Weekly	pH, EC, TSS, TOG

All sampling and analysis is understood to be compliant with relevant Australian Standards (including AS/NZS 5667.1:1998 and APHA, 1998 (1060)) and/or NATA registered methods, and Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DEC). All samples are submitted to a NATA accredited laboratory. In addition to the parameters listed in the table above, for each sample taken the following are also recorded:

- Date;
- Time;
- Sampler's name;
- Field sampling records (including whether LDP006 discharge point is flowing or not, weather conditions);
- Instrument calibration records;
- Chain of Custody Records; and
- Analytical requests.

Monitoring results for water quality and usage are maintained in an up-to-date database, from the outset of monitoring, to enable simple collation and presentation to government agencies as required.

4.3 POTENTIAL CHANGES TO SURFACE WATER MANAGEMENT

The principal objective of the proposed upgrades at the Springvale Coal Services Site surface water management scheme will aim to have an overall neutral or beneficial effect on receiving waters when assessed against the existing cumulative impacts to the system. This objective is proposed to be achieved by minimising discharges from the dirty water cycle and keeping clean and dirty water separate across the Site as far as reasonable and feasible. Clean water from undisturbed areas upstream will be progressively separated by controlled drainage and water diversions and then passed through the site via a passive conduit to Wangcol Creek. The result of this will be that the controlled discharges from the disturbed water system will be reduced as a cumulative result of increased usage in the Washery process and an overall decrease in surface water flow (as a result of emplacement development, progressive void infilling and rehabilitation across the disturbed areas of the site). The water diversions from disturbed areas will be designed to minimise concentrations or unstable overland flow.

4.3.1 Stormwater Management

The overall management of stormwater has been investigated for this Project while specific controls are proposed to contain water from the new REA. The Washery upgrade including new conveyors and stockpiling arrangements are all located within the existing pollution control system and no modifications are necessary. The overall site water management is progressively being upgraded in accordance with the requirements of previous approvals and Pollution Reduction Programs attached to the EPL.

The Project will involve the construction of a new REA which will cover and extend the existing REA known as the A Pit REA. The new REA, shown on Figure 2, covers an existing area previously disturbed by the Lamberts Gully open cut coal mine. The new REA will be constructed with benches every 5 m of vertical lift with an overall slope of 3:1 (H:V). The surface of the emplacement will be drained via channels located on each bench with the benches graded at 5% inward to a surface drain. These drains would lead to a collection point at approximately 100 m intervals to a protected channel which allows water to flow down to the next bench. The grade of each bench channel would be approximately 1 to 3% allowing safe passage of a 1 in 100 ARI design storm event.

A New Sediment Dam will be constructed to collect the runoff from the proposed REA. The New Sediment Dam will have a capacity of approximately 15 ML and it will include a low outflow pipe and a spillway, both of which would discharge into the Existing Washery Dam. Water contained in the Existing Washery Sediment Dam can either be recycled into the Washery process water circuit or transferred to Cooks Dam for later reuse or discharged at LPD006 if acceptable water quality. Ponds SLG1, SLG3 and SLG5 will collect part the runoff in the western side of the proposed REA, eventually flowing to the New Sediment Dam. The position of these ponds and the New Sediment Dam is shown on Figure 5.

4.3.2 Water Use and Production

The proposed upgrade will utilise, where possible, the same water supply system as the existing Washery. However, some upgrades have been identified, which will involve strategies to increase water supplies and water security as well as the use of water contained in pollution control ponds and recycled from the reject circuit. (Refer to Surface Water Management Plan, GHD 2012). Water from the existing Washery Dam has been directed to Cooks Dam, although it can still be diverted to SLG6 and eventually the Existing Retention Dam if acceptable water quality (see Figure 6). Cooks Dam will become the main Washery water supply source and the Retention Dam will become the final sediment settling pond, most of the time receiving only clean storm waters from undisturbed areas, acceptable treated water and last resort for emergency water supplies. This will help to maximise the extent of usage and re-usage of recycled water.

With the implementation of the new Washery the water demand will increase. The proposed design of the upgrade produces additional return flows of water. A press belt for the drainage of the reject material has been proposed to maximise the recovery of worked water at the Washery. The press belt can drain around 70% of the water content in the reject material, recirculating it to the Washery tank. The coal product can also be drained on site to reduce its water content before transport off site. These measures require the rearrangement of the Washery drainage systems, pipes, pumps and additional concrete sumps to direct worked water into the existing worked water management system.

Water supplies and water requirements are discussed in more detail with quantitative information in the water balance study for the Project (refer to Section 8).

4.3.3 Water Monitoring

The water quality monitoring for the Site is considered to be adequate based on the existing Water Management Plan. The relevant monitoring points are presented in Figure 6 and discussed in Section 5. For developing a quantitative, risk based understanding of surface water requirements, water supply security, water discharges, sediment generation and storage changes in ponds, some additional monitoring may be necessary to enable surface water model calibrations and the water balance modeling conducted for the project (see Section 8) to be refined so that they can be an ongoing means of predicting the effects of water management interventions to minimise water related risks.

Seepage outflows of water from the old open cut overburden and remaining old underground works are a significant source of raw water draining into the DML and Cooks Dams. Water that is not used becomes a potential source of poor quality water that can discharge through the existing LDP006 and into Wangcol Creek. The amount varies in response to rainfall recharge to shallow groundwater and possible ingress of water from open voids and overburden. The catchment of the DML and Cooks Dam is subject to future ash emplacement from Mount Piper Power Station and a Waste Disposal Facility to be operated by Lithgow City Council. Both activities will likely reduce the volume of water entering the DML and Cooks Dam. This should be understood and trends monitored as the ash emplacement and waste disposal area grow in size. The amount of seepage can be inferred from a mass balance at each dam provided that storage changes and all other inputs and outputs are measured. Similar arguments can apply to improving the mass balance of all components of the entire Springvale Coal Services Site. Therefore, for long term improvements of the water supply estimates and impacts of potential future changes in drainage and changes to the water supply circuit it is recommended that:

- Records to be kept of water levels of both DML and Cooks Dam;
- The spillway from Cooks Dam may be converted to the new licenced discharge point with automatic flow metering in consultation with the EPA. Should this occur, the existing LDP006 will be converted to a monitoring point;
- Water moved between the main dams should be measured using flow meters;
- Continue monitoring at the weather station located at Pinedale Coal Mine directly opposite the site for use in future studies;
- Wind velocity and rainfall should be measured on site and used as a trigger to activate or stop dust suppression at the stockpiles. The water supply to the sprinklers should be measured; and
- The storage capacity of all sediment ponds and water supply dams should be surveyed.

4.3.4 Private Haul Road

As part of the upgrade a new haul road link between the Springvale Centennial Coal Services Site to the existing private haul road between Angus Place Colliery to Mount Piper Power Station haul road is proposed. Two options have been identified and are presented in Figure 1 and Figure 7. Both proposed link roads cross the existing Pine Dale Lease ML1569.

The design and route selection of haul roads needs to be undertaken with careful consideration of surface hydrology and drainage.

During the route selection and design stages the following items are typically considered:

- The minimisation of surface water catchment and drainage line crossings;
- The orientation of the route, such that drainage line crossings are perpendicular as far as reasonable and feasible; and
- Effective drainage to control surface runoff and minimise erosion.

Where drainage line crossings are required, they will be designed to minimise disturbance to the bed and bank, minimise obstructions to flow and ensure the long term stability of the structure. The perpendicular orientation of the road to drainage lines is usually an effective method of achieving this by minimising bridge span.

The control of erosion on unsealed/haul roads and the design of drains will be addressed as part of the updates of the Surface Water Management Plan (SWMP) and any new roads will be designed in accordance with; *Managing Urban Stormwater: Soils and Construction, Volume 2C: Unsealed Roads (DECC, 2008)*.

An understanding of the surface drainage requirements can be achieved through calculation of the design peak flow discharge, which will be influenced by the nature of the road, the sensitivity of receiving water and the environment and the potential consequences of drainage structure failure.

Haul Road Option 1

Option 1 is a new haul road located adjacent to the existing access road. It deviates to the east and continues down gradient to pass along the south eastern wall of the Cooks Dam before crossing the Castlereagh Highway and the Wangcol Creek.

Option 1 is the longer of the two proposed routes and is the closest to the Blackmans Flat Township, so will require longer embankments to be rehabilitated and stabilised. However, since the route is adjacent to an existing road, the impacts on the environment would most likely be less than Option 2. Either Option 1 or Option 2 will be designed such that the existing flood risk is not increased due to the proposed development.

Haul Road Option 2

Option 2 is the most direct of the proposed routes and deviates to the north heading up gradient across an area of vegetation before descending and passing along the earth embankment that lies between the DML Dam and the Cooks Dam.

The higher elevation of Option 2 will make this route less prone to flooding. As per Option 1, it will also include rehabilitation of the river crossing to minimise potential erosion and sedimentation impacts and the design of Option 2 will be such that the existing flood risk will not be increased due to the proposed development.

It is noted that there is little difference, from a surface water management perspective, between Haul Road Option 1 or Option 2.

5. EXISTING SURFACE WATER QUALITY

5.1 ANZECC GUIDELINES AND USE IN NSW

Water quality results from Springvale Coal Services Site's monitoring program from Wangcol Creek, site dams and sediment ponds have been compared to the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000).* The guidelines form a part of the National Water Quality Management Strategy and provide a comprehensive approach to the preparation and implementation of water quality management objectives and actions. The Guidelines also provide generic benchmark values that can be used to assess the quality of waters and Centennial is in the process of developing site specific water quality triggers based on ANZECC guidelines.

When applying the guidelines to the Project, the booklet *'Using the ANZECC/ARMCANZ Guidelines and Water Quality Objectives in NSW'* (DEC, 2006) was utilised as an overarching framework.

There are also heavy industrial uses of water within the catchment, the primary one being Delta Electricity's Mount Piper and Wallerawang Power Stations. The immediate receiving waters of Wangcol Creek is derived from the Mount Piper Power Station and flows into the Coxs River upstream of Lake Wallace which represents the main water supply dam for the Wallerawang Power Station. Downstream of Lake Wallace is Lake Lyall which is also an important water supply structure for the power stations.

5.1.1 Environmental Values, Human Uses and Water Quality Objectives

The community's environmental values for water in NSW were investigated during the *Healthy Rivers Commission Inquiry* (Healthy Rivers Commission, 1998), which set 'Water Quality Objectives' (WQOs) for catchments. They are used when assessing and managing impacts to waterways. Specific WQOs have only been adopted for nutrients in the Hawkesbury Nepean catchment area as they are considered significant to the Sydney Drinking Water Catchment (NSW Government, 2001).

Other environmental values of the water sources in the surrounding area are for recreational uses, primary industry, irrigation, stock watering and aquatic ecosystems. The protection of aquatic ecosystems and the use of indicators relating to this value from the ANZECC/ARMCANZ (2000) guidelines are used in this assessment as they are considered to be the most sensitive. The watercourses have other specific values as stated in the *'Upper Coxs River Sub-catchment Plan'* (HNCMA, 2007), which are summarised in Section 4.5 that can also be protected with these ANZECC/ARMCANZ indicators.

5.1.2 Protection Levels

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ 2000) form part of Australia's National Water Quality Management Strategy. The primary objective of the guideline is to provide an authoritative guide for setting water quality objectives required to sustain current or likely future, environmental values for natural and semi-natural water resources in Australia and New Zealand. *Trigger values are fundamental to using the ANZECC guidelines. The trigger values for different indicators of water quality may be given as a threshold value or a range of desirable values. Trigger values are conservative assessment levels, not pass/fail' compliance criteria. Local conditions vary naturally between waterways and it may be necessary to tailor trigger values to local conditions or local guideline levels. As part of the current assessment process, Springvale Coal Services is undertaking aquatic ecology and ecotoxicological work within Wangcol Creek in order to determine the potential biological effects within the receiving waters.*

Some Site Specific Trigger Values (SSTV) have been calculated by GHD 2012, however this is an ongoing process which has yet to be finalised. As such, the data provided in the following sections is of a preliminary nature and subject to ongoing review and assessment

In this study, the water quality has been assessed using the 80th percentile of Wangcol Creek upstream data, ANZECC & ARMCANZ 2000 default trigger values and the EPL3607 concentration limits. For cadmium, nickel and zinc, the SSTV has been calculated with respect to the 20th percentile hardness from the Neubecks Creek Far Downstream monitoring station to provide a conservative Hardness Modified Trigger Value (HMTV).

Boron was not included within the SSTV. Although not hardness dependent, the 90% level of protection from the ANZECC/ARMCANZ (2000) guidelines has been used as an intermediate target for assessing water quality improvement; therefore the 90% level of protection trigger value was also used for Boron.

The aquatic ecology data and analysis is provided separately within the EIS

5.1.3 Waterway Issues and Level of Risk

Key issues that are relevant to ambient water quality surrounding the Springvale Coal Services Site area, and also relate to the development include pH, salinity, total suspended solids, some dissolved metals and Dissolved Oxygen. The crossing of the proposed haul road over Wangcol Creek is a potential hazard for dust and fine solids entering the waterway if the appropriate measures fail to be implemented.

5.1.4 Indicators

Physical and chemical stressor indicators for ‘slightly to moderately disturbed’ ecosystems were utilised for this assessment as these are based upon and include the key issues relating to the current site’s activities and proposed development. The trigger values for these indicators are detailed in the section below.

5.2 ANZECC (2000) TRIGGER LEVELS

Trigger levels are “the concentrations (or loads) for each water quality parameter, below which there exists a low risk that adverse biological (or ecological) effects will occur. They are the levels that trigger some action; either continued monitoring in the case of low risk situations or further ecosystem-specific investigations in the case of high risk situations” (ANZECC/ARMCANZ, 2000). The Guidelines state that “they are not intended to be an instrument to assess ‘compliance’ and should not be used in this capacity” (ANZECC/ARMCANZ, pg. 7.4-4, 2000).

Local conditions at most sites tend to vary and insights into the characteristics of the water quality are best understood through local monitoring and interpretation of data. At least two years of data (24 data points) and other considerations are required to develop site-specific trigger values (SSTV). For some parameters, site specific trigger levels have been developed (GHD 2012) and are displayed in Table 5.1.

In conjunction with Aquatic Ecological Studies, these values have been applied as the SSTV’s for this study. ANZECC/ARMCANZ (2000) default trigger values have not been developed for all analytes that are tested from samples collected due to insufficient data. Furthermore, due to the paucity of some data sets the GHD (2011) report recommends that following the capture of 24 data points from the Wangcol Creek (Neubecks) NOW station (212055) for all parameters, an independent study should be conducted to assess its suitability as a sampling ‘reference point’ (to represent baseline water quality) or contribute to an understanding of a more general ‘reference condition’. This sampling location has been selected to provide data to be used as an appropriate background site for Neubecks Creek.

The ANZECC/ARMCANZ (2000) guidelines are designed to be applied to ambient water only. Although they have been used for comparison purposes in the following section, it must be noted that local conditions need to be taken into consideration, and therefore the Guidelines cannot have a blanket approach.

Water storages used for the containment of pollution and water recycling onsite will generally have parameter levels of physical and chemical stressors, and some toxicants closer to or exceeding trigger levels compared with natural watercourses/bodies.

Table 5.1: ANZECC (2000) and Site Specific Trigger Values (SSTV) for Water Chemistry

Parameter	Units	GHD (2011) Derived SSTV	GHD (2012) Derived SSTV	S.E. Australia Freshwater Ecosystems (ANZECC/ARMCANZ, 2000)
Physical and Chemical Stressors				
pH	pH Units	6.5 – 8.5[1]	6.5 – 9.0	
Total Nitrogen	mg/L		0.4	0.25[#]
Total Phosphorus	mg/L		0.02	0.02[#]
Sulphate	mg/L		1000	1000
TSS	mg/L		30	253
Salinity				
Electrical Conductivity (EC)	µS/cm	1162[1]	445	
Turbidity	NTU			2-25[#]
Toxicants				
Metals and Metalloids				
Aluminum	mg/L	0.08*	0.118[2]	
Boron	mg/L			0.68[+]
Cadmium (modification)1	mg/L	0.003[2]	0.001[2]	
Iron	mg/L		0.3[2]	0.3
Manganese	mg/L	2.07[1]	1.9[2]	
Nickel (modification)1	mg/L	0.074*[3]	0.0836[2]	
Zinc (modification)1	mg/L	0.054*[3]	0.1096[2]	
Non-metallic Inorganics				
Nitrate	mg/L			0.7[#]

Notes

1 Taken from GHD (2011) assessment of SSTV Water Quality Targets.

2.Taken from GHD (2012) Water Quality Assessment

3 These metals required a modification to the trigger value in relation to the hardness of the water as per Table 3.4.3 in ANZECC/ARMCANZ (2000) using 90% trigger values. The value for Total Hardness as CaCO3 (283 mg/L (GHD 2011)) has been taken from the 80th percentile of seven samples collected at the Wangcol Creek NOW Station, which is upstream of LDP006.

+ Taken from trigger values for toxicants for freshwater – which is consistent with GHD (2011), 90% protection of species, slightly to moderately disturbed ecosystems (ANZECC/ARMCANZ, 2000, Table 3.4.1).

* Insufficient data to derive SSTV (Al & Ni), therefore default 90% trigger value for physical and chemical stressors for south-east Australia for slightly disturbed freshwater aquatic ecosystems taken from ANZECC/ARMCANZ, 2000, Table 3.4.1 (GHD 2011). This level has also been used where the SSTV value is higher than the 80th percentile at Wangcol Creek upstream (Zn).

Taken from the default trigger values for total nitrogen, total phosphorus, turbidity and suspended particulate matter (SPM) for south-east Australia for slightly disturbed freshwater aquatic ecosystems – Upland rivers (ANZECC/ARMCANZ, 2000, Table 3.3.3).

5.3 PRE-PROJECT BASELINE SURFACE WATER QUALITY

A summary of the baseline data and an analysis to provide value ranges and a mean are presented in Appendix A with concentrations exceeding trigger values expressed in bold. Water quality trend graphs for pH, EC and Total Suspended Solids (TSS) are displayed in Figure 10, Figure 11 and Figure 12. The water quality piper for the analysis of the anions and cations present in the water can be seen in Figure 13. A summary discussion of the results for a number of key parameters is provided in the following sub-sections.

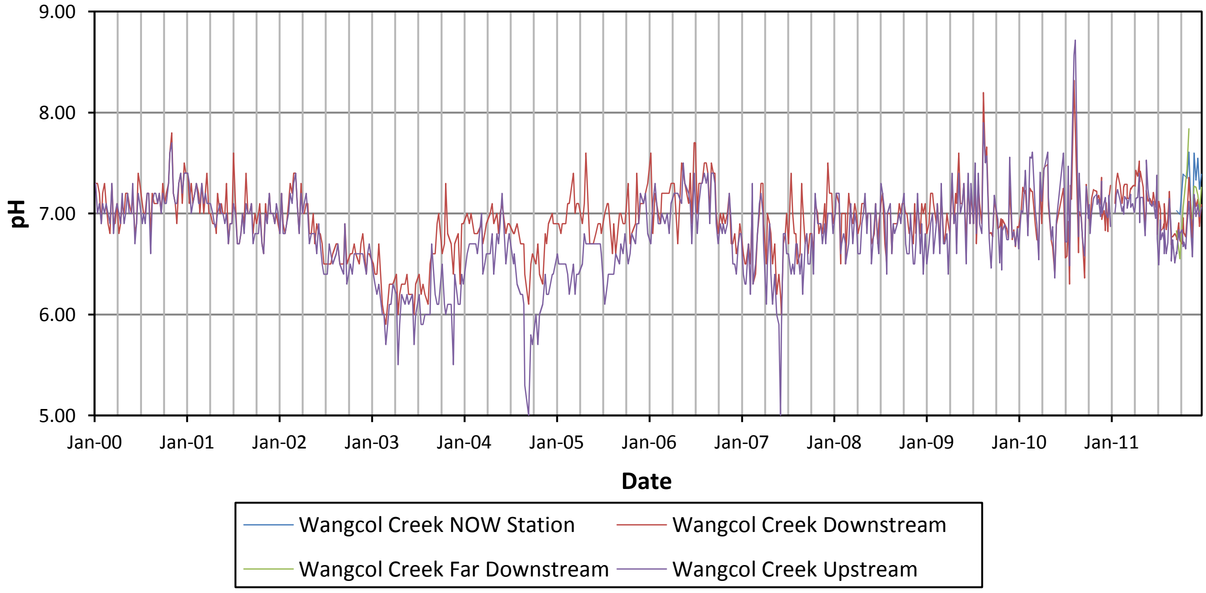
Comparison of the median values with the ANZECC/ARMCANZ (2000) trigger values showed that exceedances occurred at 10 of the 13 monitoring sites, most notably Cooks Dam with 5 exceedances, and LDP006 with 4 exceedances.

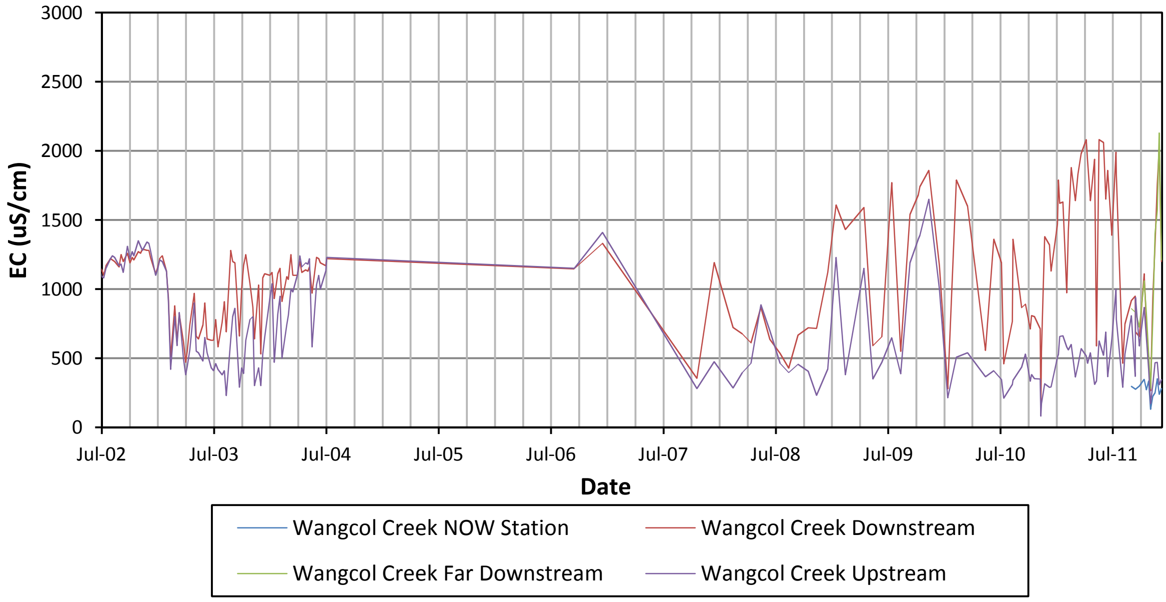
EC values were most frequently in exceedance of the trigger values with pH, Boron, Nickel and Zinc also showing regular exceedances.

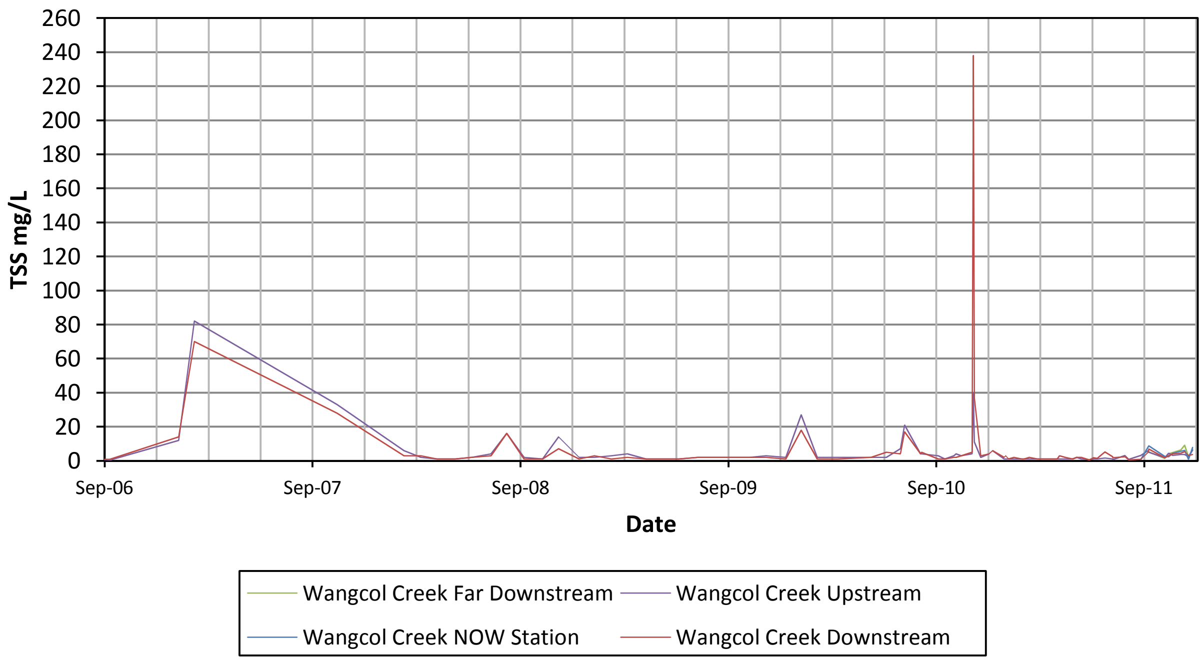
The Existing Conveyor Dam, the upstream Sediment Pond 2 and Wangcol Creek Upstream were the only sites to have no exceedances. However, for Sediment Pond 2, there have only been 11 samples taken at this site since October 2010, which is a relatively low sample rate compared with some of the other sites. The good quality of the water at Main Sediment Pond, Sediment Pond 2 and Wangcol Creek Upstream sites can be attributed to a relatively undisturbed, or, in the case of the Existing Conveyor Dam and Sediment Pond 2, a partly rehabilitated larger catchment, to enable dilution and cleaner raw water runoff.

The duration of monitoring and number of samples varies from site to site and for the determinants analysed, which should be taken into consideration when comparing the water quality between different sites. For example, LDP006, Wangcol Creek Upstream and Wangcol Creek Downstream have significantly more data than the other sites as monitoring commenced in 2000, whilst for most sites monitoring commenced in 2010.

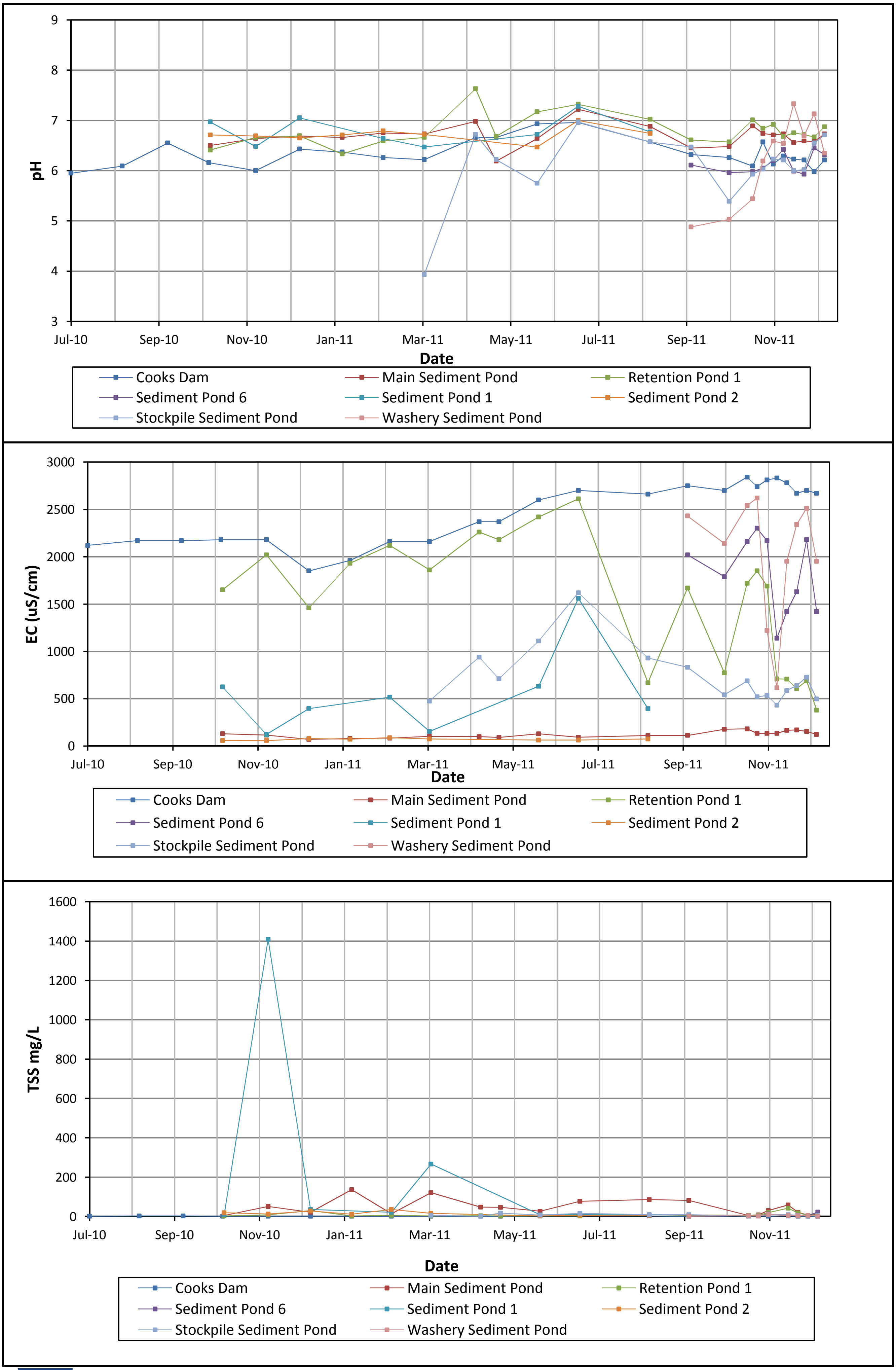
Note: In Appendix A, when quantities of a substance fall below the Limit of Reporting (LOR) a '<' symbol is applied to the number by the laboratory. When analysing results to produce a mean and range, the '<' symbol was removed, as a 'less than a number' has no value and cannot be evaluated. Hence in these instances range and mean values are potentially over estimated.





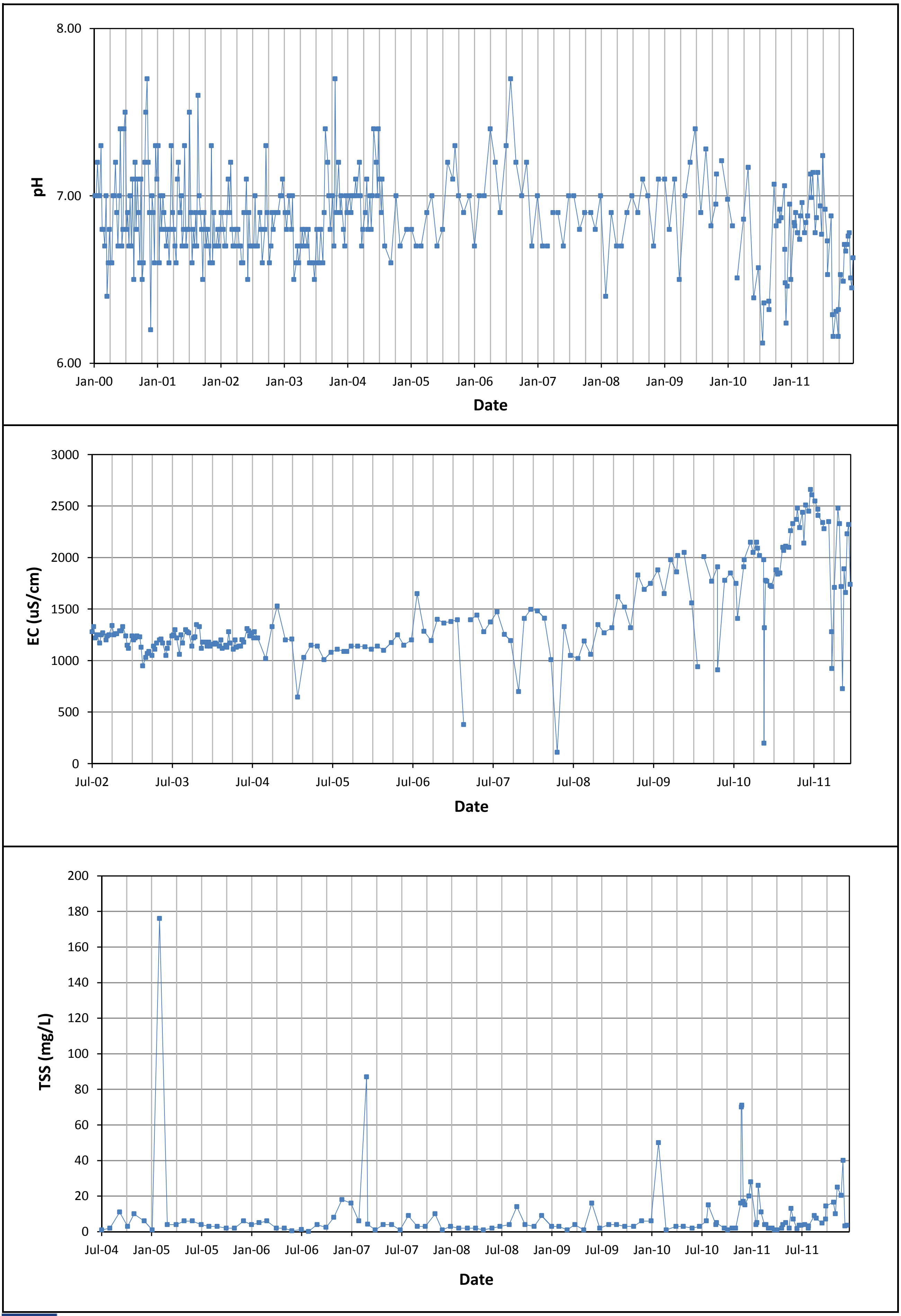


WANGCOL CREEK WATER QUALITY TRENDS **FIGURE 10**

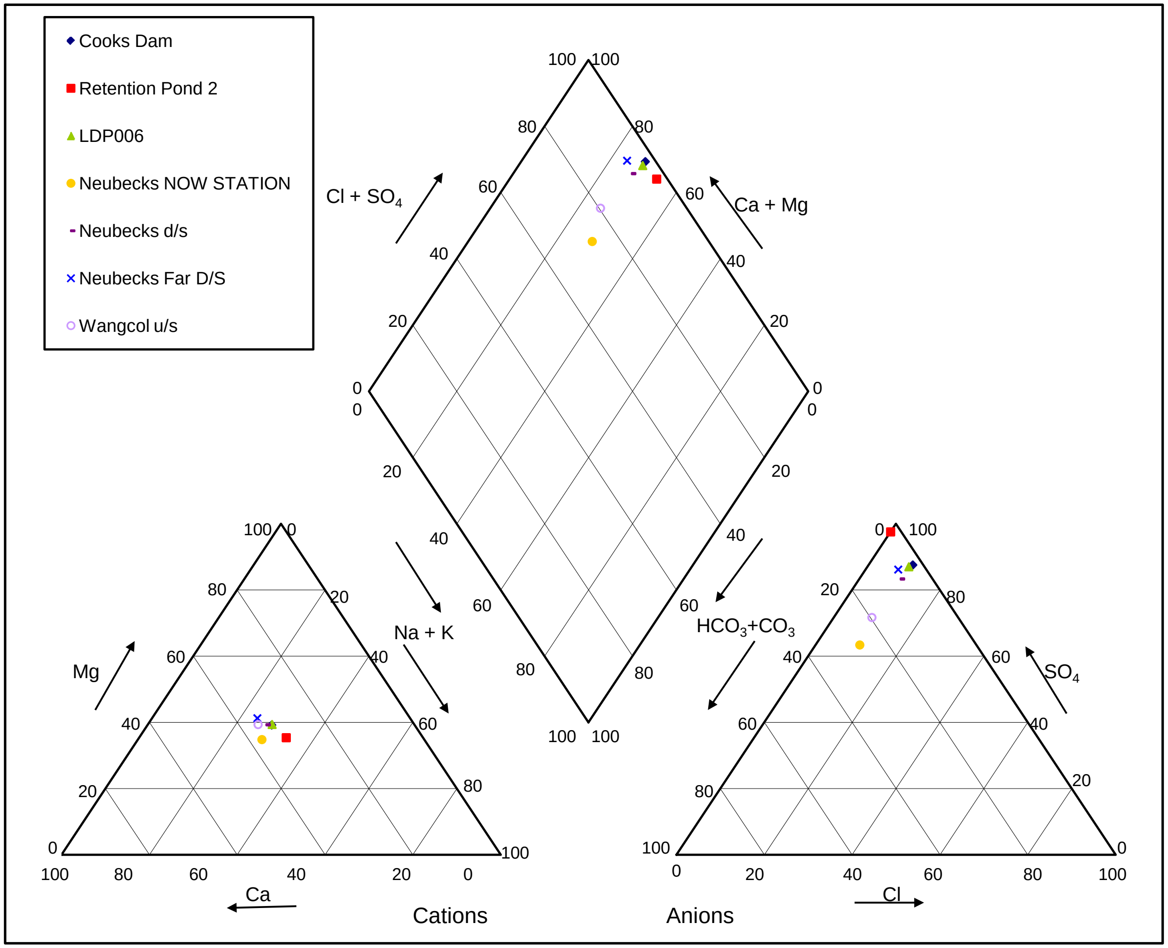


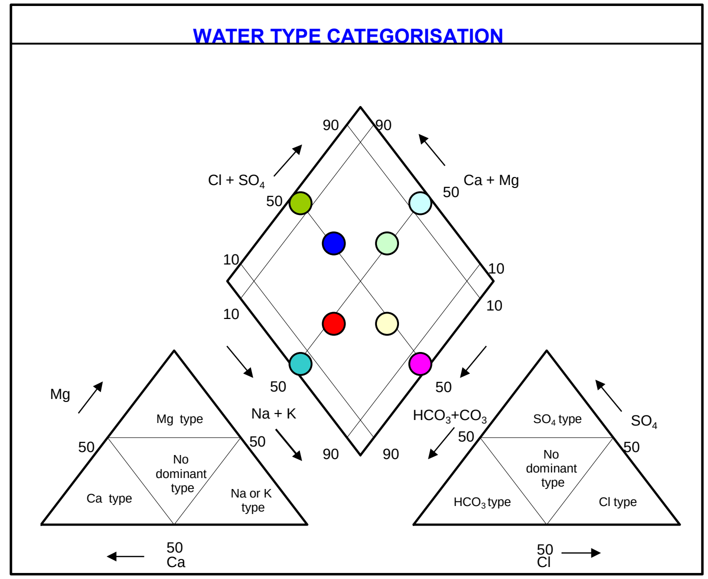
RPS Aquaterra

SEDIMENT PONDS AND DAMS WATER QUALITY TRENDS **FIGURE 11**



8.00
7.00
6.00
pH
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Date
3000
2500
2000
1500
1000
500
0
EC (uS/cm)
Jul-02
Jul-03
Jul-04
Jul-05
Jul-06
Jul-07
Jul-08
Jul-09
Jul-10
Jul-11
Date
200
180
160
140
120
100
80
60
40
20
0
TSS (mg/L)
Jul-04
Jan-05
Jul-05
Jan-06
Jul-06
Jan-07
Jul-07
Jan-08
Jul-08
Jan-09
Jul-09
Jan-10
Jul-10
Jan-11
Jul-11
Date





WATER TYPE SUB-FIELDS

Ca + Mg, Na + K type	Ca + Mg type
HCO_3, Cl + SO_4 type	HCO_3 + CO_3 type
Na + K, Ca + Mg type	Na + K type
Cl + SO_4, HCO_3 type	Cl + SO_4 type

RPS Aquaterra

Piper Diagram

Figure 13

Date: 08/03/12

Project: Coal Services
Project No: S167D

Description: Piper Diagram: Water Quality
Client: Centennial Coal

HydroCHEM 2.0

5.3.1 Salinity

The maximum value salinity, measured in terms of electrical conductivity (EC), has exceeded the SSTV of 1162µS/cm at 10 sites. Of the remaining 3 sites; the Existing Conveyor Dam, Wangcol Creek NOW Station (Neubecks) and Sediment Pond 2, none have shown no exceedances of EC since measurements commenced in October 2010.

Significant median value exceedances where found at 5 sites; Cooks Dam, LDP006, Retention Pond 1, Retention Pond 2, Existing Stockpile Dam and Existing Washery Sediment Dam (The median EC for LDP006 only marginally exceeded at 1270 µS/cm).

Median values range from 50 to 2700µS/cm with the largest median value of 2630µS/cm and sustained high values at Cooks Dam as shown in Figure 11. EC levels at LDP006 have progressively been increasing over time as presented in Figure 12 and appear to be impacting the EC of Wangcol Creek. There is a study currently underway to examining the relative contribution of flows into Cooks Dam from various sources in order to manage water quality outcome requirements at LDP006. In addition, the current revision of the EPL includes the requirement to undertake a study of the salinity of treated mine water.

5.3.2 pH

Median pH values are shown to be below the acidic trigger value of 6.5 at 4 of the monitoring sites; the Cooks Dam, SLG6, Existing Washery Dam and Stockpile Sediment Dam.

This may be indicative of these ponds receiving low pH water that drains from the site or suggest that the standing water has a tendency for reduced pH. Furthermore, pH values have been tending to be more acidic in recent years at LDP006, as shown in Figure 12.

There have been no exceedances of the alkaline value of 8 with the exception of Wangcol Creek Upstream, which has had two consecutive measurements taken in August 2010 with pH Unit values of 8.57 and 8.72.

5.3.3 Total Suspended Solids

Results for TSS can provide an indicator of local land management practices that may increase sediment loads in watercourses. The assumed trigger value for this site is 30mg/L as this is the 100% concentration limit set on the site's EPL for LDP006.

TSS concentrations showed infrequent exceedances, the majority of which occurred in the Existing Conveyor Dam and the upstream Sediment Pond 1, which would be expected considering their purpose. However, the other sediment ponds showed no exceedances of TSS.

The highest value of TSS occurred in Sediment Pond 1 with one reading of 1410mg/L occurring on 29 November 2010, which may have been related to a reading of 238mg/L at Wangcol Creek downstream on 1 December 2010 (Figure 10). These readings are exceptionally high compared to all other sites and times. The highest values, overall, of TSS were 100 to 200mg/L. These were recorded, however, soon after the rehabilitation of emplacement areas and in conjunction with a known high rainfall event, which caused flooding in the region and therefore is attributed to runoff from an actively disturbed area which has since been stabilised.

5.3.4 Turbidity

The ANZECC/ARMCANZ (2000) default upper value for turbidity (25NTU) has been used as an appropriate trigger as Wangcol Creek is located in a region of highly disturbed land. LDP006 has had frequent exceedances of the trigger value with upper values ranging from 30 to 200NTU. Turbidity measurements across the site at other locations have all been below the trigger value with the exception of one sample from Wangcol Creek NOW and Sediment Pond 6, which were on the same date and most likely associated with a rainfall event.

5.3.5 Dissolved Metals

Comparison of the analysis results for dissolved metals against the SSTV and hardness modified trigger values (HMTV) estimated by GHD (2012) and some ANZECC/ARMCANZ (2000) guideline values for 90% level of protection show the following:

- Aluminium concentrations showed occasional exceedances at some monitoring sites but no median values exceeded the trigger value of 0.118 mg/L. Most aluminium exceedances were found at Wangcol Creek Upstream, Downstream and Far Downstream with no exceedances at LDP006 and Cooks Dam. Exceedance values were typically up to 0.3mg/L.
- Boron analysis was not undertaken at 6 of the 13 sites and very infrequently at some of the remaining 7. The median Boron values exceeded the guideline trigger value of 0.68mg/L at 3 sites being Cooks Dam, LDP006 and Retention Pond 1. Six sites exceeded the trigger value for Boron, with most of the samples exceeding the guideline value at Cooks Dam and LDP006. The highest Boron values have occurred in Cooks Dam with values ranging from 1.46 to 1.74mg/L between November 2011, when sampling began, and December 2011. The fifth and final measurement at Cooks Dam in December 2011 was considerably less than previous ones at 0.07mg/L. LDP006 showed exceedances in 11 samples since 2005.
- Median Cadmium results were below the SSTV at four of the five sites where it has been measured. Marginal exceedance of the SSTV was found at LDP006 with a maximum concentration of 1.6×10^{-3} mg/L, compared with the SSTV of 1.0×10^{-3} mg/L.
- Nickel (filtered) concentrations have been shown to be in exceedance of the hardness modified default trigger value at all 7 sites where it has been measured. With the exception of Wangcol Creek NOW Station, Upstream and Downstream sites, all median values exceed the trigger value with the greatest median values of 0.348mg/L and 0.267mg/L found at Cooks Dam and LDP006 respectively, which are typically an order of magnitude higher than median concentrations at other sites. Cooks Dam and LDP006 have also been shown to have the most frequent exceedances with almost all samples showing excess levels since sampling began in July 2010.
- Zinc (filtered) concentrations show that the median values exceed the hardness modified SSTV in 3 of the 7 sites where this has been measured. The exceptions are all Wangcol Creek monitoring sites, which show some recent exceedances. The highest values are found in Cooks Dam and LDP006, where median values are 0.358mg/L and 0.304mg/L respectively.
- Manganese (filtered) has been measured at 5 sites and of these, median recordings have exceeded the SSTV of 1.9mg/L at Cooks Dam (4.08mg/L) and LDP006 (2.67mg/L). Of recent times, the Wangcol Creek NOW Station, which has been sampled since September 2011, has had a Manganese range of 0.2 to 16mg/L, with an average of 3.09mg/L.

5.3.6 Nutrients

Median nitrate levels were all below the default ANZECC/ARMCANZ (2000) guideline value at all sites monitored.

The WQOs (trigger values) for nutrients in the 'mixed use rural areas and sandstone plateau' category as presented in Table 2 of the *'Statement of Joint Intent'* for the catchment (NSW Government, pg. 22, 2001). The indicator value for WQOs are 0.035mg/L for Total Phosphorus and that for Total Nitrogen is 0.7mg/L. These trigger levels are higher than the ANZECC/ARMCANZ (2000) guideline levels for upland rivers.

Total Phosphorus median results at all sites monitored are below the WQO level, with the highest result occurring in the Cooks Dam at 0.12mg/L in August 2010. All results for Total Nitrogen at all monitored sites were below the WQO level.

5.3.7 Total Anions and Total Cations

A piper diagram (Figure 13) was developed to assess the composition of the water at 7 locations. The piper diagram is a graphical representation of the relative concentration of the major cations (Na, Mg, Ca and K) and anions (HCO_3, Cl, SO_4 and CO_3) and allows characterisation and comparison between various water types.

The cation plot shows that all samples are of 'no dominant type' however calcium and magnesium are the most dominant cations, with proportions typically around 30 to 40% in all samples. Anions are strongly dominated by SO_4 with proportions of 80 to 90% in most samples.

The calcium and magnesium sulphate type water is most likely attributable to the gypsum (CaSO4) formation, which was induced by the presence of the limestone weirs that were designed to increase the pH of the discharge by reacting with sulphuric acid. This is further corroborated by the decreased dominance of SO_4 in the samples taken from both Wangcol Creek NOW Station and upstream sites as these are upstream of the discharge point. The Limestone weirs have since been removed.

5.3.8 Oil and Grease

All samples were below the EPL3607, LDP006 limit of 10mg/L. There is one single sample taken from LDP006 in October 2010 that measured 12mg/L, but it is suspected that there was a typographical error during the data collection and the actual reading should have been 12 µg/L. Limited analysis for heavier Total Petroleum Hydrocarbons (TPH) fractions within C15-C28, C29-C36 yielded values of 50 to 100mg/L in LDP006, Wangcol Creek Downstream and Wangcol Creek Upstream.

6. HYDROLOGICAL MODELING METHODOLOGY

6.1 HYDROLOGICAL ANALYSES

The main hydrological analyses undertaken as part of this assessment has included:

- Daily rainfall runoff modeling.
- Peak flow rate estimates of runoff for various annual recurrence intervals (ARIs) at important positions, such as culverts built below railway lines.
- Estimates of annual rates of sediment generation for each catchment area.
- Estimates of required sediment settling pond sizes and comparisons to the sizes of the existing pollution control ponds on the property.
- The application of a custom built, spreadsheet-based model of the dynamic, daily mass balance of water across the project site to test the sufficiency of water supply system and likely extent of discharges from the site.

The Springvale Coal Services Site, due to its steep gradient is not flood prone but the local drainage systems aim to minimise erosion and sediment production. A number of required analyses contained in the *Floodplain Risk Management Guideline (DECC, 2007)* have also been undertaken for this assessment.

6.1.1 Developing Model Parameters

The latest version of the Australian Water Balance Model (AWBM Version 2010, in Boughton, 2010) was used to calculate the runoff from rainfall at the Springvale Coal Services Site area. The AWBM is a catchment water balance model that can relate runoff to rainfall with daily data, and calculates losses from rainfall for flood hydrograph modeling. The model uses 3 surface stores to simulate partial areas of runoff. The water balance of each surface store is calculated independently of the other. The model calculates the moisture balance (rainfall-evapotranspiration) of each partial area at daily time steps. At each time step, rainfall is added to each of the 3 surface stores and evapotranspiration is subtracted from each store.

When runoff occurs from any surface store, part of the runoff becomes recharge of the base flow store (water content in soil not reaching ground water storages but becoming base flow runoff). The remainder of the runoff is surface runoff. The base flow store is depleted at a rate depending on the moisture of the soil.

The AWBM was selected for use in this study as it has a proven track record for use in runoff simulations and is well suited for applications in Australian catchments (Boughton, 2010). The AWBM is based on saturated overland flow generation of runoff. It was developed from a theoretical analysis of the behaviour of elementary units of surface storage in catchment areas. Model outputs distinguish between baseflow and surface runoff.

Calibration of the AWBM (discussed below) provided parameters that could be used for application in rainfall runoff modeling of the catchments listed in Table 3.3 and presented on Figure 4.

Appropriate parameters were also derived for use in the application of other hydrological tools such as the Rational Method for peak flow estimates and the Revised Universal Soil Loss Equation (RUSLE) Method (See section 7.1.3 and 7.1.4 respectively) for estimating sediment production which are explained in Appendix A of *Managing Urban Stormwater: Soils and Construction, Volume 1, 4th Edition (Landcom, 2004).*

Climate data for evaporation and rainfall, as well as rainfall intensity duration frequency information were obtained from the Bureau of Meteorology (BoM) website.

The runoff output of the AWBM model is used as the input for the Springvale Coal Services Site Upgrade Dynamic Water Balance Model (DWBM) built for this Project. The dynamic water balance model evaluates the balance of each water storage element (ponds, dams and Washery tank) accounting for water inputs (local runoff from AWBM model, water transfers, spillage and seepage from upstream storage elements and ground water filtration) and outputs (storage surface evaporation, water transfers, spillage and seepage to downstream storage elements and site water demand) for each daily timestep.

The balance model provides daily results on discharges to LDP006, failures to meet the Washery water demand, and all intermediate water mass movements between water storage elements.

6.1.2 Hydrological Model Calibration

For hydrological modelling purposes the Springvale Coal Services Site can broadly be described as consisting of three main hydrological response zones based on significant differences in land use and surface conditions:

- Locally Representative Response Zone referred to as the “Undisturbed Zone”. This zone currently consists of a combination of natural and planted forest and is therefore also referred to as the “Forested zone”. It has not been impacted on by historical mining or the Coal Service Project and for the purposes of this report is referred to as “Undisturbed”. The runoff from this zone is referred to as “Clean”;
- Disturbed Surface Response Zone or “Disturbed Zone”. Surface areas in this zone have previously been worked by coal mining or are currently being worked and then rehabilitated by the Springvale Coal Services. The drainage system is being managed using a variety of drains, bunds, drop structures, pipes, sediment dams and erosion control measures. Water leaving this zone is referred to as “worked water”; and
- Zero Runoff or drainage voids. This zone represents the surface areas from which no runoff can occur. They consist either of open cut voids caused by historical mining or as open pollution containment ponds located in the Co-disposal area.

The accuracy of the model output depends on factors such as the availability of sufficient reliable rainfall and runoff for use in calibrating the model. Important to this study is the need to distinguish between the hydrological responses of the above zones. Distinction between the runoff response from areas that have and have not been disturbed by mining is not possible using only the flow gauge (LDP006) which is located on the Lamberts Gully. However, there exists another flow gauge located on Wangcol Creek, upstream of LDP006, that can be assumed representative of the hydrological response of “Undisturbed Zones” and has been used to calibrate the catchments which have not been disturbed by mining activity.

The calibration therefore relied the assumption that the hydrological response reflected at a local flow gauging station on the Wangcol Creek is representative of the hydrological response of the hillsides surrounding the Springvale Coal Services Property and the areas of the property that have not been disturbed by mining activities. The characteristics of these catchments are very similar being covered with natural and commercial forests, steep slopes, incised valleys and underlain by similar soils and geology. By calibrating the Wangcol Creek catchment and applying its parameters to the forested areas (undisturbed by mining) of the Lamberts Gully catchment, it was possible to then use the flow gauge at LDP006 to calibrate the rainfall runoff response from the remaining surface areas of the catchment which have been disturbed by historical mining activities and currently by the Springvale Coal Services Projects. The calibration of the AWBM runoff model parameters for the disturbed areas needed to done by first linking the AWBM to the Coal Services Dynamic Water Balance Model (DWBM) so that the additional effects of the various sediment control dams, water supply dams and the on-site water use could be accounted for in the model calibration. The linkage was also needed for subsequent applications of the DWBM to test scenarios of future upgrades to the Springvale Coal Services. Simulations were performed at a daily level.

The various sub-catchments included in the AWBM simulation for the Springvale Coal Services Site are shown on Figure 4 for the current situation and Figure 5 for the future layout and they are listed in Table 3.3. Each sub-catchment is further subdivided into hydrological response zones (i.e. undisturbed, disturbed and void). The catchment areas and relative portions of hydrological response zones are described above in Table 3.3. The runoff response for each zone was modelled separately. Relative portions of clean and dirty water are in some instances mixed once they enter the drainage system and this extent of mixing affects the quantity and quality of water that that reaches the LDP006 at present.

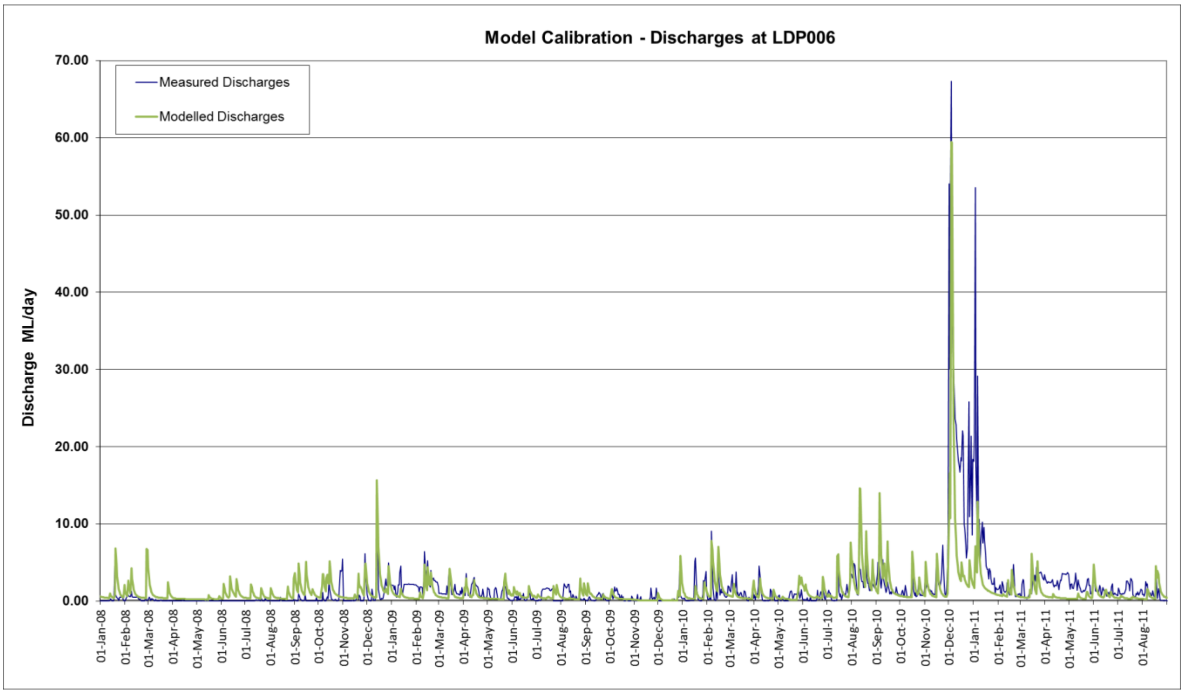
For each catchment the surface topography, existing and planned drainage facilities, and water storage facilities were examined and the positions and dimensions of relevant water related infrastructure such as culverts and storage ponds were obtained. Appropriate catchment boundaries related to the Springvale Coal Services Site were defined and the associated catchment characteristics such as areas, slopes, surface conditions, land use, soils and vegetation were described at a level of detail necessary for use in rainfall runoff hydrological modeling. The information was also needed for other applications such as flood peak estimates and sediment studies.

The model calibration was undertaken within the constraints of the available data. The main constraints being as follows:

- The Lamberts Gully is located in a valley surrounding by high lying ridges and it is highly likely that spatial variations in rainfall are affected by topography of project site and the surrounding hills. This also applies to the Wangcol Catchment. The representativeness of the rainfall data used was further compromised by the need to compile the data set using gauges from much further away (e.g. from Lidsdale).
- The transfer of water to the reservoirs which feed water to the Washery has not been measured and a fixed rate of transfer has been assumed in the model. The actual pumping is intermittent and the associated effects on spillages from the Retention and Cooks Dam are therefore unknown. This could affect the variability of flow at LDP006 and hence the accuracy of the model calibration; however given that the upgrade will involve more consistent Washery feed, this assumption is considered accurate. See Section 7.2.1 for the model assumptions.
- The storage capacity of the various dams and sediment dam has been estimated from Lidar data and information used in previous reports by GHD (2012 and 2009). Uncertainties in storage volumes affects the mass balance of each dam and hence the timing and amounts of spillage from the numerous dams on the Property, affecting the calibration of flows at LDP006.
- The design of the flow gauging station at LDP006 is adequate for measuring most daily discharges and low flows but it was not well suited for measuring peak flow rates during flood events. Later upgrades of the flow meter station in 2011 have been performed to allow higher flows to be measured.

Despite the above limitations it was possible to calibrate the AWBM model at a level of detail adequate for use in predictive purposes with the DWBM discussed further below. The above limitations were considered in recommending additional monitoring as part of the proposed Springvale Coal Services Upgrade so that the model calibrations can be further refined as the project progresses. The final calibration was made using the set of log reliable data from January 2009 to August 2011. In this period the correlation factor between measured flows at LDP006 and modelled discharges at the same point is of 70%.

Figure 14: Model calibration – Compared observed and modelled discharged flows at LDP006



6.1.3 Flood Peak Estimates

Estimates of flood peaks were conducted using the Rational Method based on Landcom, 2004 guidelines. The information was provided for selected dam sites aiming at the 2 year 6 hour rainfall event needed to determine sediment storage requirements. For flood peak estimates at dam site spillways the rainfall producing flood peaks were determined for a range of probabilities of annual occurrences of rainfall intensities over the concentration times needed for runoff amounts needed to reach peak flow rates. The rainfall intensities are presented in Table 6.1 and the peak flow rates for the respective ARI's are presented in Table 6.2.

6.1.4 Soil Loss

The catchment conditions have been examined and the annual sediment production amounts for each catchment located within or draining across the Project area. The soil loss was quantified using the Revised Universal Soil Loss Equation (RUSLE) Method for estimating sediment production.

The method uses the rainfall intensity of the 2 year, 6 hour storm (= 7.78 mm/hr) to calculate the Rainfall Erosivity Factor. The rest of the parameters used in the method are explained in Appendix A of *Managing Urban Stormwater: Soils and Construction, Volume 1*, 4th Edition (Landcom, 2004).

Firstly the soil loss was calculated in the project site with no rehabilitated areas, corresponding with the existing situation. The results are summarised in the Table 6.3.

Table 6.1: Rainfall Intensity Duration Frequency (IDF) data for design purposes (mm/hr)

Water Storage Site	**SLG1**	**SLG2**	**SLG3**	**SLG4**	**SLG5**	**Existing Stockpile Dam**	**Existing Washery Dam**	**SLG7**	**SLG6**	**New Sediment Dam**	**Existing Conveyor Dam**	**Cooks Dam**	**Retention Dam**	**DML Dam**
Contributing Catchment	25% CH4	CH13+CH9	25% CH4	CH2	25% CH4	62% CH5	CH7	38% CH5	CH6	25% CH4 +CH8	CH10+CH18	CH3	CH16	CH19
Total catchment area (ha)	12.65	197.78	12.65	6.73	12.65	5.47	8.83	3.35	14.92	35.86	44.45	7.42	19.92	39.35
Design Rainfall for Individual Storage Ponds and Dams (mm/hr)														
Time of concentration (min)	**21**	**59**	**21**	**16**	**21**	**15**	**18**	**13**	**22**	**31**	**34**	**17**	**25**	**32**
1 yr,tc	33.8	19.1	33.8	39.0	33.8	40.7	36.7	44.0	32.9	27.5	26.7	38.2	31.2	27.2
5 yr,tc	43.6	24.4	43.6	50.5	43.6	52.6	47.5	57.0	42.5	35.5	34.4	49.4	40.3	35.0
10 yr,tc	55.7	30.6	55.7	64.9	55.7	67.7	60.9	73.6	54.2	44.9	43.6	63.5	51.3	44.4
20 yr,tc	63.0	34.2	63.0	73.7	63.0	76.9	69.0	83.8	61.3	50.6	49.1	72.0	57.9	49.9
50 yr,tc	72.9	39.2	72.9	85.4	72.9	89.2	79.9	97.1	70.9	58.4	56.6	83.5	67.0	57.6
100 yr,tc	86.4	46.0	86.4	101.7	86.4	106.5	94.9	116.3	83.9	68.8	66.7	99.4	79.2	67.9

tc: time of concentration

Table 6.2: Characteristic flow conditions and flood peaks for selected ARIs (ML/d)

Water Storage Site	SLG1	SLG2	SLG3	SLG4	SLG5	Existing Stockpile Dam	Existing Washery Dam	SLG7	SLG6	New Sediment Dam	Existing Conveyor Dam	Cooks Dam	Retention Dam	DML Dam
Contributing Catchment	25% CH4	CH13+CH9	25% CH4	CH2	25% CH4	62% CH5	CH7	38% CH5	CH6	25% CH4 +CH8	CH10+CH18	CH3	CH16	CH19
Contributing area (ha)	12.65	197.78	12.65	6.73	12.65	5.47	8.83	3.35	14.92	35.86	44.45	7.42	19.92	39.35
Peak Flows for Individual Storage Ponds and Dams (m^3/s)														
1:1 yr	0.49	4.36	0.49	0.30	0.49	0.26	0.38	0.17	0.57	1.14	1.37	0.33	0.72	1.24
1:5 yr	1.01	8.79	1.01	0.62	1.01	0.52	0.76	0.35	1.16	2.32	2.79	0.67	1.46	2.51
1:10 yr	1.57	13.44	1.57	0.97	1.57	0.82	1.20	0.55	1.80	3.58	4.31	1.05	2.27	3.88
1:20 yr	2.14	18.22	2.14	1.33	2.14	1.13	1.64	0.76	2.46	4.88	5.87	1.44	3.11	5.29
1:50 yr	3.12	26.22	3.12	1.94	3.12	1.65	2.38	1.10	3.58	7.08	8.51	2.09	4.51	7.67
1:100 yr	4.32	36.04	4.32	2.71	4.32	2.31	3.32	1.54	4.96	9.77	11.73	2.92	6.25	10.58
Peak Flows for Individual Storage Ponds and Dams (ML/d)														
1:1 yr	42.71	376.92	42.71	26.25	42.71	22.22	32.41	14.73	49.07	98.66	118.80	28.35	62.19	106.96
1:5 yr	86.97	759.08	86.97	53.55	86.97	45.34	66.05	30.07	99.89	200.32	241.07	57.81	126.51	217.11
1:10 yr	135.44	1161.56	135.44	83.95	135.44	71.20	103.26	47.38	155.43	309.73	372.49	90.54	196.50	335.60
1:20 yr	185.26	1573.97	185.26	115.27	185.26	97.86	141.56	65.24	212.48	421.79	507.08	124.26	268.34	456.95
1:50 yr	269.40	2265.52	269.40	167.80	269.40	142.50	206.00	95.04	308.89	611.66	735.00	180.87	389.83	662.52
1:100 yr	373.67	3114.08	373.67	234.17	373.67	199.18	286.73	133.23	428.16	843.71	1013.61	252.19	539.61	913.77

Table 6.3: Results of Soil Loss Calculations – With No Rehabilitated Areas

Catchment No	Area (ha)	Average Slope	% Undisturbed Area	% Disturbed Area	% Rehabilitated Area	Annual Soil Loss (t/year)
CH 1*	2.12	15.7%	90%	10%	0%	53.50
CH 2	6.73	3.6%	0%	100%	0%	127.32
CH 3	7.42	11.8%	100%	0%	0%	59.29
CH 4	50.59	6.7%	0%	100%	0%	2164.53
CH 5a	5.47	4.0%	0%	100%	0%	482.94
CH 5b	3.35	6.1%	100%	0%	0%	14.01
CH 6	14.92	6.5%	100%	0%	0%	62.39
CH 7	8.83	7.5%	13%	88%	0%	335.19
CH 8	23.21	7.0%	0%	100%	0%	993.06
CH 9	19.11	13.9%	100%	0%	0%	201.12
CH 10	41.14	2.6%	100%	0%	0%	47.98
CH 11a*	11.32	19.9%	100%	0%	0%	206.79
CH 11b*	11.32	14.2%	30%	70%	0%	1108.15
CH 11c*	33.05	6.8%	0%	100%	0%	1414.16
CH12*	104.87	10.9%	100%	0%	0%	838.22
CH 13a	29.45	14.5%	100%	0%	0%	386.18
CH 13b	15.78	1.1%	100%	0%	0%	8.53
CH 13c	10.52	11.4%	100%	0%	0%	84.07
CH 13d	26.30	1.1%	100%	0%	0%	14.21
CH 13e	10.52	2.8%	100%	0%	0%	12.27
CH 13f	12.62	2.5%	100%	0%	0%	14.72
CH 13g	73.49	7.0%	100%	0%	0%	307.29
CH14	10.79	3.0%	60%	40%	0%	93.62
CH 15**	19.69	3.5%	100%	0%	0%	36.40
CH16	12.31	3.6%	100%	0%	0%	22.76
CH17	1.81	60.6%	100%	0%	0%	59.72
CH18	3.31	90.9%	0%	100%	0%	1117.55
CH19a	23.28	10.0%	60%	40%	0%	636.93
CH19b	23.28	3.8%	70%	30%	0%	162.22
TOTAL to LAMBERTS GULLY	**423.21 ha**					**7,408 t/yr**
TOTAL to HUON GULLY	**162.69 ha**					**3,621 t/yr**
CH 15	**19.69 ha**					**36 t/yr**

- * Catchments 1, 11 and 12 (marked in blue) drain to Huon Gully, whereas the rest of the catchments within the project site drain to Lamberts Gully and eventually to LDP006.
- ** Catchment 15 (marked in brown) drain to Wangcol Creek independently of LPD06

This is the total soil loss expected for all the catchments draining to the Springvale Coal Services site, which include large undisturbed areas outside the project limits, especially catchments 9, 12, 13 and fractions of catchments 10, 11 and 15.

The largest soil losses are expected in catchments with high proportion of undisturbed areas, like catchments 4, 7, 8, 11 and 19.

The degree of rehabilitation within the project area will have a very positive impact in minimising the soil loss. If catchments 2, 4, 8 and 18 were rehabilitated completely as proposed in the upgraded site layout (14% of rehabilitated areas) the soil loss will be reduced by approximately 2,000 t/yr (almost 20% of the total soil loss), as per the results in Table 6.4.

Table 6.4: Results of Soil Loss Calculations – With Rehabilitated Areas

Catchment No	Area (ha)	Average Slope	% Undisturbed Area	% Disturbed Area	% Rehabilitated Area	Annual Soil Loss (t/year)
CH 1*	2.12	15.7%	90%	10%	0%	53.50
CH 2	6.73	3.6%	0%	0%	100%	67.91
CH 3	7.42	11.8%	100%	0%	0%	59.29
CH 4	50.59	6.7%	0%	0%	100%	1154.42
CH 5a	5.47	4.0%	0%	100%	0%	482.94
CH 5b	3.35	6.1%	100%	0%	0%	14.01
CH 6	14.92	6.5%	100%	0%	0%	62.39
CH 7	8.83	7.5%	13%	88%	0%	335.19
CH 8	23.21	7.0%	0%	0%	100%	529.63
CH 9	19.11	13.9%	100%	0%	0%	201.12
CH 10	41.14	2.6%	100%	0%	0%	47.98
CH 11a*	11.32	19.9%	100%	0%	0%	206.79
CH 11b*	11.32	14.2%	30%	70%	0%	1108.15
CH 11c*	33.05	6.8%	0%	100%	0%	1414.16
CH12*	104.87	10.9%	100%	0%	0%	838.22
CH 13a	29.45	14.5%	100%	0%	0%	386.18
CH 13b	15.78	1.1%	100%	0%	0%	8.53
CH 13c	10.52	11.4%	100%	0%	0%	84.07
CH 13d	26.30	1.1%	100%	0%	0%	14.21
CH 13e	10.52	2.8%	100%	0%	0%	12.27
CH 13f	12.62	2.5%	100%	0%	0%	14.72
CH 13g	73.49	7.0%	100%	0%	0%	307.29
CH14	10.79	3.0%	60%	40%	0%	93.62
CH 15**	19.69	3.5%	100%	0%	0%	36.40
CH16	12.31	3.6%	100%	0%	0%	22.76
CH17	1.81	60.6%	100%	0%	0%	59.72
CH18	3.31	90.9%	0%	0%	100%	596.03
CH19a	23.28	10.0%	60%	40%	0%	636.93
CH19b	23.28	3.8%	70%	30%	0%	162.22
TOTAL to LAMBERTS GULLY	**423.21 ha**					**5,353 t/yr**
TOTAL to HUON GULLY	**162.69 ha**					**3,621 t/yr**
CH 15	**19.69 ha**					**36 t/yr**

- * Catchments 1, 11 and 12 (marked in blue) drain to Huon Gully, whereas the rest of the catchments within the project site drain to Lamberts Gully and eventually to LDP006.
- ** Catchment 15 (marked in brown) drain to Wangcol Creek independently of LPD06

6.1.5 Sediment Dam Size Evaluation

The requirements for minimum storage dimensions for sediment control ponds were estimated for the future site layout and Washery upgrade. These were compared for compliance purposes against the existing storages of the control ponds located on the site. The calculations were carried out using the standard procedures given in Appendix A of *Managing Urban Stormwater: Soils and Construction, Volume 1* (Landcom, 2004) and additional criteria given *Managing Urban Stormwater: Soils and Construction, Volume 2E – Mines and Quarries* (DECC, 2008).

The water storage ponds have been grouped representing independent catchments:

- Storage Group 1: SLG1, SLG3, SLG5 and the New Sediment Dam.
- Storage Group 2: SLG2, SLG4, Existing Conveyor Dam and Existing Retention Dam.
- Storage Group 3: Existing Stockpile Dam and SLG7.
- Storage Group 4: Existing Washery Dam, DML Dam and Cooks Dam.

Storage groups 1, 3 and 4 collect worked water with high fine suspended particle content. The minimum required storage capacities of these ponds have been calculated as to provide capacity to contain all runoff expected from up to the 95-percentile rainfall event. The total storage capacity required is the sum of the sediment settling volume plus the sediment storage volume. In the standard calculation the sediment storage volume is 50% of the sediment settling volume.

The design parameters used were:

- Design rainfall duration: 5 days
- Design rainfall event percentile: 95 percentile
- 5 day, 95 percentile rainfall depth: 42 mm

Storage group 2 collects clean runoff from upstream catchments before discharge at LDP006. The minimum storage requirements are less severe in this case. The settling volume is calculated to provide capacity to allow the design particle (i.e. 0.02 mm in equivalent diameter) to settle in the peak flow expected from the design storm (i.e. 0.25-year ARI). Peak flow/discharge for the 0.25-year, is calculated as ½ of the peak flow for the 1yr return period peak flow as shown in Table 6.2. The volume of the basin's settling zone can be determined as the product of the basin's settling surface area and a standard settling depth (i.e. 0.6 m) to allow for particles to settle. In the standard calculation, the sediment storage volume is equal to the sediment settling volume.

Results are presented in Table 6.5

Table 6.5: Comparison between existing dam sizes and required dam sizes needed to achieve adequate sediment settling.

Site	Catchment Area	Existing Storage Capacity		Required Storage Capacity				Meets requirements?
		Individual	Combined	Settling	Storage	Total Individual	Total Combined	
	(ha)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	
SLG1	12.65	3,580	**24,410 m^3**	2,072	1,036	3,108	**18,135 m^3**	Yes. Although storage pond SLG3 seems not to meet the individual required volume, if the new Sediment Dam is designed with 15,000 m^3 of storage, the overall volume requirement for the storage group will be met.
SLG3	12.65	1,780		2,072	1,036	3,108		
SLG5	12.65	4,050		2,072	1,036	3,108		
NEW SEDIMENT DAM	35.86	15,000*		5,874	2,937	8,811		
SLG2	197.78	7,150	**44,870 m^3**	5,882	5,882	11,764	**18,136 m^3**	Yes. Although SLG2 seems not to meet the individual required volume, the overall requirement for the storage group will be met.
SLG4	6.73	7,930		410	410	819		
CONVEYOR DAM	44.45	25,300		1,854	1,854	3,708		
RETENTION DAM	19.92	4,490		923	923	1,845		
STOCKPILE DAM	5.47	1,990	**4,490 m^3**	896	448	1,344	**2,167 m^3**	Yes.
SLG7	3.35	2,500		549	274	823		
EXISTING WASHERY DAM	8.83	3,790	**146,440` m^3**	3,272	1,636	4,907	**16,399 m^3**	Yes. Although the Existing Washery Dam seems not to meet the individual required volume, the overall requirement for the storage group will be met.
DML DAM	39.35	118,840		6,446	3,223	9,668		
COOKS DAM	7.42	23,810		1,215	608	1,823		

6.2 SPRINGVALE COAL SERVICES DYNAMIC WATER BALANCE MODEL (DWBM)

6.2.1 Model Assumptions

The main assumptions associated with water requirements and operating rules as applied in the model are detailed in the various scenarios tested further below.

There are five main sources of water available at the Springvale Coal Services Site:

- Natural "Clean" water runoff from areas not disturbed by mining operations (this water is not harvested on the project site for the future scenarios).
- Worked "Dirty" water, which is mostly runoff from surfaces disturbed by historical mining activities and activities associated with the Springvale Coal Services site and nominal amounts of return flows from the existing Washery. This includes the drainage of the new proposed REA at the south west extreme of the site for the future layout scenario. This drainage will be collected in a New Sediment Dam with a proposed storage capacity of 15 ML. This new dam will transfer flows to the Existing Washery Dam, which will supply the Washery Tank, when possible, at a maximum rate of approximately half of the basic Washery demand (1.02 ML/d in Scenario 4).
- Water filtration from the old open cut area which is intercepted in the DML and Cooks dams at a rate of 0.1 ML/d for each dam. There also exist seepage between DML dam and Cooks dam, which has been assumed to be 0.4 ML/d. These infiltration and seepage figures have an impact in the water balance since the water contained in Cooks dam in used to supply the Washery, as discussed in Section 8.2.
- Worked water is pumped from the existing Stockpile Dam to the Washery tank for its used. The existing Stockpile Dam collects local runoff and a portion of the water content in the coal after being washed. The recirculation pump rate at the existing Stockpile Dam, has been assumed at a maximum rate of approximately half of the basic demand of the Washery (1.02 ML/d in Scenario 4) in lack of more accurate information on the performance of this particular pump.
- Potable water purchased from the Lithgow City Council. This water is only used for potable purposes.

There are five main water uses on the Springvale Coal Services Site:

- Potable water use at offices, workshops and washrooms at an assumed rate of 0.003 ML/d.
- Dust suppression;
  - for stockpiles using sprinklers (when wind speeds exceed 5m/s and provided that the rainfall is less than 1 mm in a particular day), at an assumed rate of 0.068 ML/d
  - dust suppression using trucks on haul roads (this applies on all operating days except days with more than 1 mm of rainfall and provided there is no visible evidence of dust on haul roads) at a rate of 0.136 ML/d
- Water use at the old Washery; at a rate of 0.72ML/d.
- Water use at the proposed new Washery, at a rate of 1.2 ML/d.
- Water user at the clarifier, at a rate of 0.6 ML/d.

6.2.2 Water Balance Inputs and Outputs

The Springvale Coal Services Dynamic Water Balance Water (DWBM) is a spread sheet based daily simulation model that includes 52 years of rainfall data so that the impacts of climate and associated highly variable hydrological responses can be interpreted relative to the impacts on water security and discharge of water from the project site. The results of the model are presented as excerpts of information shown on the worksheets contained in the model.

The sheets contain the following information:

- Daily runoff generation by AWBM for clean catchment areas and dirty catchment areas. The information used includes inputs such as:
  - daily rainfall data;
  - daily evaporation data;
  - catchment areas with land use details; and
  - calibrated model parameters.
- Simulation of all inputs and outputs to dams and ponds on the project site. Separate simulations are performed for dams which are part of clean water drainage channels and dams on channels which intercept dirty water. Some dirty water channels also currently intercept runoff from undisturbed areas, which will likely be reduced in future. In the model, it is assumed that in the future the separation between clean and worked water will be almost complete, re-circulating most of the worked water so the discharges at LDP006 will have a larger clean water component.
- The input information includes:
  - stage area capacity relationships of ponds;
  - rainfall at pond surfaces (adjusted daily as surface areas change in response to changing water levels in dams);
  - evaporation at pond surfaces (adjusted daily as surface areas change in response to changing water levels in dams);
  - inflow from spillages from upstream dams (where relevant);
  - inflows of water from incremental catchment areas (runoff from undisturbed and disturbed areas as appropriate);
  - runoff from surrounding catchments; and
  - water intercepted in dams (particularly DML and Cooks Dams) which arises from groundwater seepage from the old open cut.
- The outputs include:
  - daily mass balance of storage changes in the dams due to all inputs and outputs;
  - spillages;
  - water use abstractions where relevant;
  - losses due seepage; and
  - losses due to evaporation from pond surfaces (adjusted daily as surface areas change in response to changing water levels in dams).
- Statistics are provided of daily averages, maximum and minimum values as well as percentiles representing the probability of occurrence of daily inputs and out puts to the mass balance.
- Separate flow network diagrams with mass balance information are presented for:
  - clean water drainage system and associated sediment control dams;
  - worked water drainage system inclusive of dams, site discharges and transfers to the water supply reservoir; and
  - water use system.
- Summary tables present separate annual water balance results for:
  - clean water drainage system;
  - dirty water drainage system;
  - water supply dams;
  - water use system; and
  - water discharged from the site.

7. WATER BALANCE RESULTS FOR PROPOSED UPGRADE

The water balance results focus firstly on presenting a Base Case Scenario (Scenario 1) which reflects the current situation in terms of existing drainage, sediment ponds and water supply systems. This is followed by a second set of scenarios (Scenarios 2a, 2b and 2c) to test methods to interconnect and operate water storage facilities so as to secure sufficient water for the Project and the third scenario (Scenario 3) explores the possibility of being able to discharge clean water without using it and without it coming into contact with worked water. Scenario 4 represents the last modifications to the future layout and modifications proposed to the site. In this report are presented the Scenario 1 – Base Case and the Scenario 4 – Future Layout. In order to avoid confusion, Scenarios 2 and 3 are presented in Appendix D; although not relevant for the conclusions of this study they do however demonstrate the complex nature of the site.

For purposes of comparison, the scenarios all use the same 52 year daily rainfall record to reflect the effects of natural variability of climate on the runoff response and water balance. Runoff from various sources is routed differently in the various scenarios. The main input and water transfer differences associated with these scenarios are summarised in Table 7.1. The scenarios are discussed separately thereafter.

Table 7.1: Summary of main inputs controlling water use and water transfers in the Coal Services Water Balance Model (ML/day)

Daily water resources, use and return flows	**Scenario One\Base Case (ML/day)**	**Scenario Four \ Future Lay Out (ML/day)**
Offices and Workshops water demand	0.003	0.003
Dust Suppression on Roads (only if rainfall<1mm/d)	0.136	0.136
Dust Suppression on Stockpiles (If rainfall<1mm/d & wind velocity >5m/s)	0.068	0.068
Water used at Washery 1	0.680	0.720
Water used at Washery 2	0.000	1.200
Clarifier Overflow	0.000	0.600
TOTAL Water Demand	**0.887**	**2.727**
Water in the coal draining to stay on site	0.151	0.428
Water in Tailings to be re-circulated in Washery (press belt)	0.000	0.489
Water re-circulated from Clarifier Overflow	0.000	**0.600**
TOTAL Water Re-usage	**0.151**	**1.517**
Water in coal lost via evaporation or to leave the site on conveyor	0.279	0.794
Water in tailings lost via evaporation	0.250	0.209
Water lost in dust suppression, offices, workshop, etc.	**0.207**	**0.207**
TOTAL Water Lost	**0.736**	**1.210**
Groundwater seepage to DML Dam	0.100	0.100
Groundwater seepage to Cooks Dam	0.100	0.100
Leakage from DML Dam to Cooks Dam	0.400	0.400
Pump between DML Dam and Cooks Dam	0.000	0.000
Pipeline from Existing Washery Dam to Cooks Dam	0.000	Variable 0.700 to 17.000
Transfer from Retention Dam to Cooks Dam	0.000	0.000

Description and results of Scenarios 1 and 4 can be found in Sections 8.1 and 8.2 of this report. Scenarios 2 and 3 can be found in Appendix D at the end of this report.

7.1 SCENARIO 1 - BASE CASE

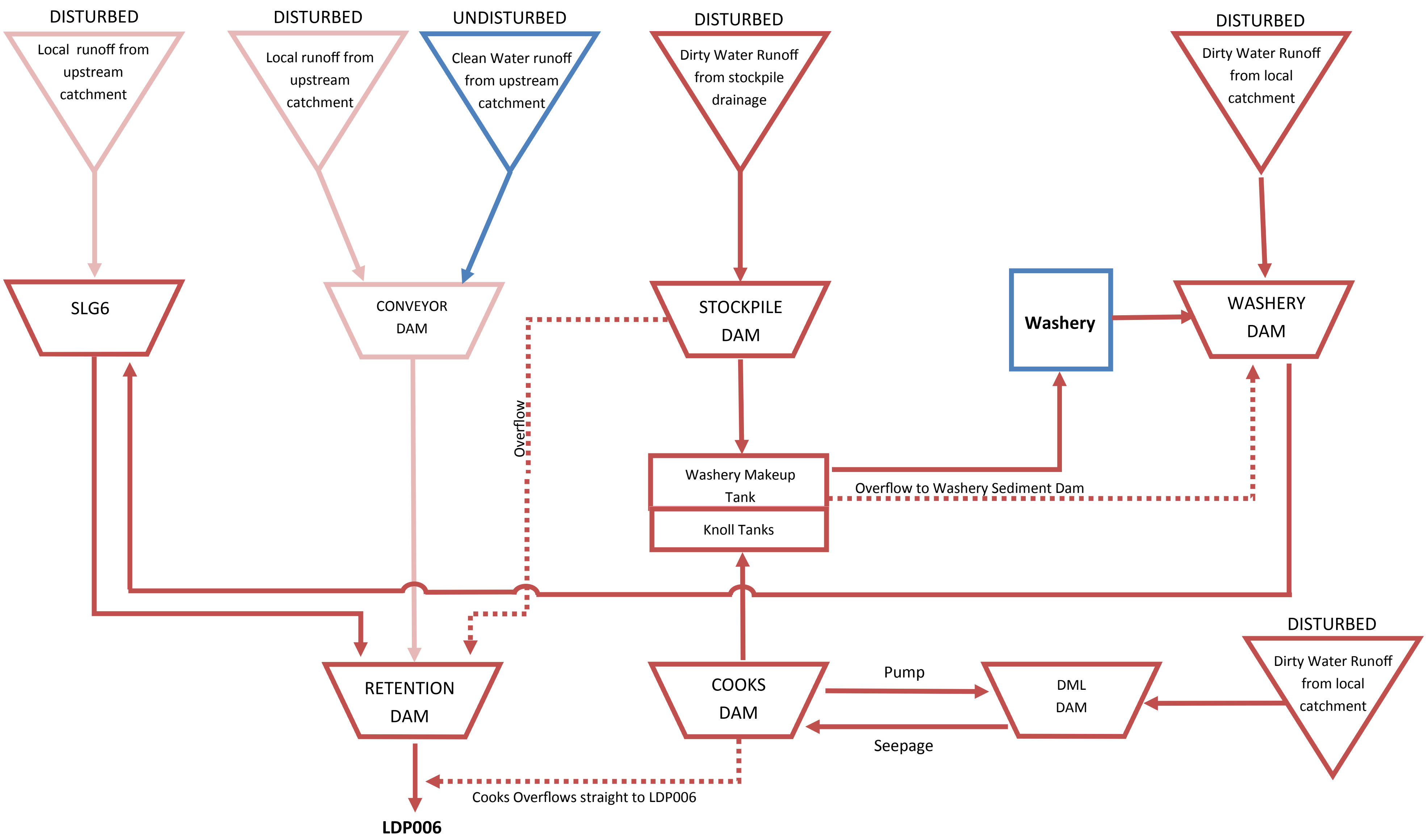
The base case scenario focuses on the current (March 2012) drainage and water supply systems as a basis for understanding the impacts and benefits of the proposed Springvale Coal Services Upgrade. The current water use situation only has one Washery in operation. Water from disturbed and undisturbed areas that drain into the Lamberts Gully all eventually drain into the Retention Dam where it is mixed before being spilt back into Lamberts Gully. Water spilt from Cooks Dam joins this spillage just upstream of the licenced discharge point at LDP006. The effect of this mixing of clean and worked water has previously increased the sediment loading on the Retention Dam, and also unnecessarily increased the total volume of water that reaches LDP006. The discharge historically included all the water from forested areas located upstream of the Project Area.

The base case scenario is a representation of the normal operation of the site in recent years for calibration of the rainfall-runoff and water balance models purposes. It excludes the current program of progressively separating the clean and dirty water circuits but demonstrates the problems recently faced by the site in meeting the volume discharge criteria of 10 ML per day on LDP006. The model excludes the recently implemented water link between the Existing Washery Dam and Cooks Dam, but includes the continuous pumping from Cooks dam to DML dam at maximum rate of 7.2 ML/d to maintain water storage on site and minimise the discharged from Cooks Dam to LDP006, which has been operating several years.

For details on the calibration of the model see section 6.1.2.

A summary of the results of the base case scenario is provided in Table 7.2, while details of the model is presented in Appendix B, namely the water balance output tables of results for annual quantities of water and flow diagrams with the associated quantities of average daily inputs and outputs.

FLOW DIAGRAM — SCENARIO 1: BASE CASE



RPS Aquaterra

Table 7.2: Scenario 1 - Base Case: Summary statistics of water balance of water supplies in relation to water requirements and discharge amounts at LDP006 in relation to the licenced discharge amounts.

	Washery	Dust Suppression on Stockpiles	Dust Suppression on Roads	Spillage to LDP006 from COOKS DAM	Spillage to LDP006 from RETENTION DAM	Total Discharge at LDP006
	ML/Day	ML/Day	ML/Day	ML/Day	ML/Day	ML/Day
Water Requirement / Allowance	**0.680**	**0.069**	**0.136**	**N/A**	**N/A**	**10**
Daily Average	0.625	0.042	0.083	0.030	1.434	1.479
Daily Maximum	0.680	0.068	0.136	19.034	217.710	220.888
Daily Minimum	0.258	0.000	0.000	0.000	0.000	0.000
5 Percentile	0.274	0.000	0.000	0.000	0.027	0.027
10 Percentile	0.330	0.000	0.000	0.000	0.051	0.052
20 Percentile	0.680	0.000	0.000	0.000	0.109	0.110
30 Percentile	0.680	0.000	0.000	0.000	0.181	0.183
40 Percentile	0.680	0.068	0.136	0.000	0.271	0.274
50 Percentile	0.680	0.068	0.136	0.000	0.402	0.404
70 Percentile	0.680	0.068	0.136	0.000	0.955	0.962
90 Percentile	0.680	0.068	0.136	0.000	3.209	3.252
95 Percentile	0.680	0.068	0.136	0.000	5.539	5.685
98 Percentile	0.680	0.068	0.136	0.000	10.327	10.959

As can be seen from Table 7.2, the site is exposed to significant discharge exceedences during high rainfall events. These result mostly from flood waters arising from the large undisturbed forested areas upstream of the site and draining to the Retention Dam. The simulated results also indicate that discharges at LDP006 are common and mostly below 10 ML per day: more than 98% of the time the water discharge is within the allowed limits.

The results also show that the current system cannot sustain the supply to the existing Washery if reliance is placed on water from Cooks Dam only. According to the model results shortages occur between 10% and 20% of the days. These simulated water shortages concur with historical experience during droughts when additional water supply supplements were needed from the nearby Huon Dam which is managed by the neighbouring power station.

The base scenario provided a starting point for comparative purposes in evaluating further scenarios compiled to test options for managing and transferring water from other dams into Cooks Dam in order to obtain a secure water source for the Western Coal Services Upgrade Project.

7.2 SCENARIO 4 – FUTURE LAYOUT: INCLUSION OF WESTERN COAL SERVICES UPGRADE

Scenario 4 is a series of new runs approaching a different configuration of the site.

The main changes introduced here are the inclusion of a press belt in the Washery, which allows a high percentage of the water contained in the tailings after the wash to drain and be recycled. In this scenario the operation of the Washery has been modelled to operate as follows:

- Washery 1 uses 30 m^3/hr and Washery 2 uses 50m^3/hr.
- 63% of the washing water goes to the washed coal, of which 35% is drained and enter the Existing Stockpile Dam and 65% is lost in evaporation and moisture in coal exported off-site.
- The other 37% of the washing water goes to the Tailings, of which 70% is re-circulated to the Washery tank directly (press belt) and 30% is lost in evaporation and moisture on tailings.
- Clarifier overflow is 25 m^3/hr, which is discharged to the Existing Washery Dam.

As a result, the total overall water recycled directly (clarifier and press belt) or indirectly (coal stock pile drainage) at the Washery is of approximately 1.50ML/day, which represents 60% of the total water used in the Washery.

The second main change introduced in this Scenario 4 is the proposed REA which in this simulation is one unique area in the south-west corner of the site, covering an area of approximately 75 ha. The new REA drainage will be collected by dirty water drains which will direct the flows to a New Sediment Dam situated adjacent to the Washery. The New Sediment Dam has been modelled with a total storage capacity of 15 ML, i.e. a water surface area of 100m x 50m and depth variable between 3 m and 4 m, depending on the internal embankment slope. To accommodate the new drainage arrangement at and around the new unique proposed REA the contributing subcatchments in the area were modified. In particular the catchments 4, 7, 8 and 9 were modified as per Figure 5. It is important to notice that sub catchment 8 currently (Scenario 1) drains to Huon Gully, exiting the site with no interaction with the Washery. Subcatchment 8 however, at present, coincides with the A Pit REA (formerly the Lambert Gully Open Pit) and being an active working area is highly disturbed. Currently catchment 8 is endoreic, with no surface drainage. In the new Scenario 4, the drainage of the subcatchment 8 will be intercepted and diverted to be used at the Washery, improving the water availability on the site as well as water quality in Huon Gully. A diversion bund will be constructed upstream of the new proposed REA such that run-on into subcatchment 8 is prevented. Huon Gully does not currently discharge to Wangcol Creek, rather, it is captured by Huon Dam on Mt Piper Power Station land (the dam being formed by an old open cut dating back to the early 1970s). It is understood that this dam does not discharge due to the size of the void. Following remediation of the new REA, subcatchment 8 will be rehabilitated.

Clean runoff from upstream catchments will be re-routed towards the ponds SLG2 and SLG4 which will drain eventually to the Main Sediment Dam preventing drainage from disturbed and undisturbed areas to mix.

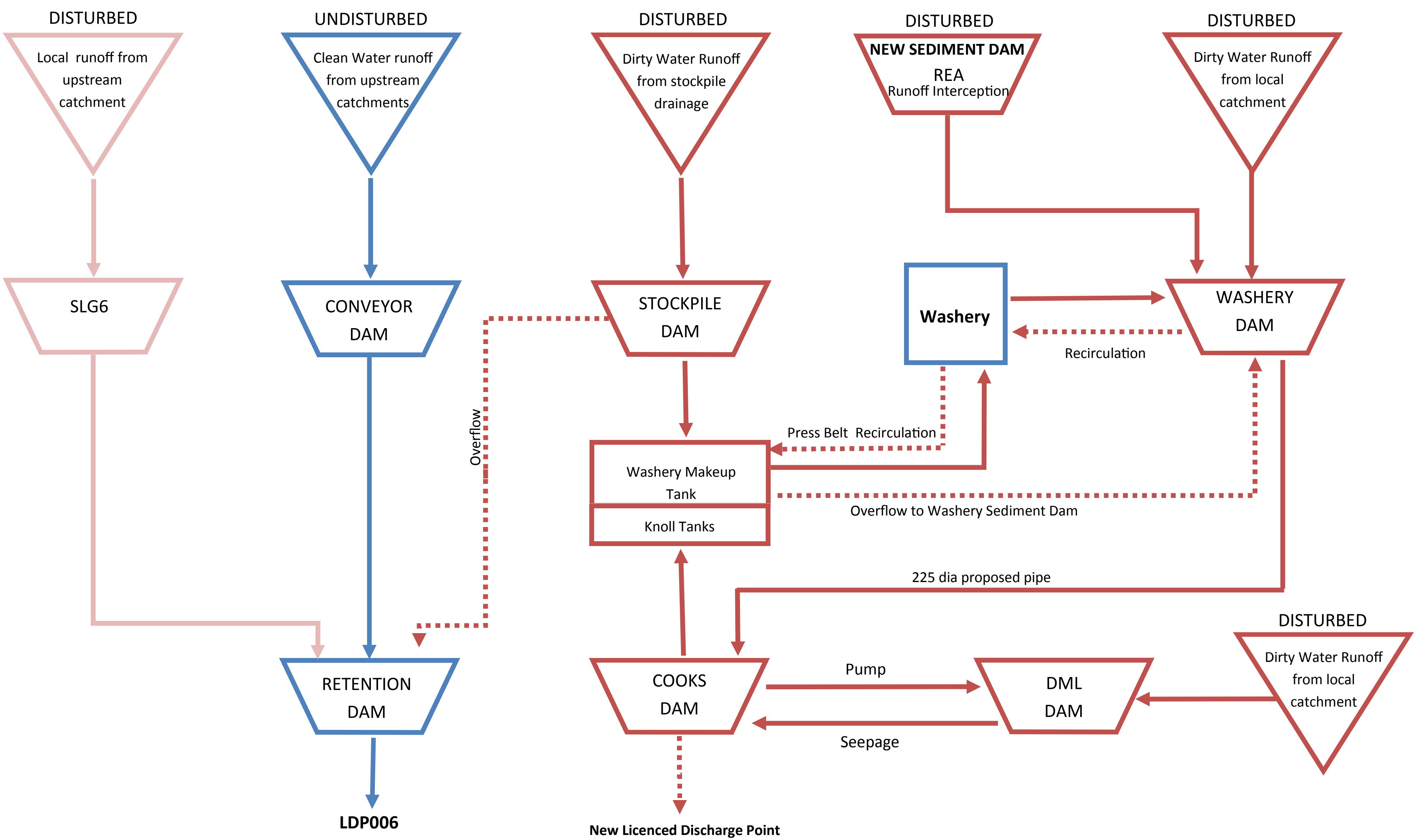
Recent recommendations by GHD, 2009 and 2012, have included some strategies to alter the drainage systems and ensure that the water supply system relies more on the use of water from worked water areas. Scenario 4 also implement the improvements as per recommendations stated in the Surface Water Management Plan, by GHD 2012, i.e. the new overflow pipeline to connect the Existing Washery Dam with Cooks Dam, instead of overflowing to SLG6 and eventually to the Retention Dam. This measure reduces the dirty water discharges to LDP006 and improves the water availability to be used at the Washery.

Scenario 4 maintains the continuous pumping from Cooks Dam to DML Dam at maximum rate of 7.2 ML/d but does not include any additional transfer of water between dams and ponds. The proposed flow transfers in Scenarios 2b, 2c and 3 have not been implemented here. For details on superseded Scenarios 2 to 3 see Appendix D.

The water balance results for Scenario 4 can be found in Appendix C, which presents the water balance output tables of results for annual quantities of water. Also presented in Appendix C are the flow diagrams which depict the main components of the drainage system and their linkages to water supply systems together with the associated quantities of average daily inputs and outputs of water.

A summary of the results of water supply and discharges are shown in Table 7.3 , which presents the raw water supply at the Washery and discharge to LDP006.

FLOW DIAGRAM — SCENARIO 4: FUTURE LAYOUT



RPS Aquaterra

Table 7.3: Scenario 4 – Future Layout: Summary statistics of water balance of water supplies in relation to water requirements and discharge amounts at LDP006 in relation to the licenced discharge amounts (ML/day)

	Washery ML/Day	Dust Suppression on Stockpiles ML/Day	Dust Suppression on Roads ML/Day	Flow Transfer from NEW DAM to the Washery	Pipeline to COOKS DAM from EXISTING WASHERY DAM	Spillage to LDP006 from COOKS DAM	Spillage to LDP006 from RETENTION DAM	Total Discharge at LDP006
	ML/Day	**ML/Day**	**ML/Day**	**ML/Day**	**ML/Day**	**ML/Day**	**ML/Day**	**ML/Day**
Water Requirement / Allowance	**2.52 ML/d**	**0.069**	**0.136**	**N/A**	**N/A**	**N/A**	**N/A**	**10**
Daily Average	2.308	0.052	0.104	0.595	0.632	0.378	0.937	1.329
Daily Maximum	2.520	0.068	0.136	0.960	46.502	45.427	180.513	208.180
Daily Minimum	0.594	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5 Percentile	1.208	0.000	0.000	0.002	0.000	0.000	0.027	0.027
10 Percentile	1.357	0.000	0.000	0.013	0.000	0.000	0.042	0.043
20 Percentile	2.317	0.000	0.000	0.067	0.000	0.000	0.074	0.075
30 Percentile	2.520	0.068	0.136	0.160	0.000	0.000	0.112	0.115
40 Percentile	2.520	0.068	0.136	0.355	0.000	0.000	0.160	0.174
50 Percentile	2.520	0.068	0.136	0.960	0.585	0.000	0.229	0.278
70 Percentile	2.520	0.068	0.136	0.960	0.645	0.040	0.524	0.717
90 Percentile	2.520	0.068	0.136	0.960	1.337	0.792	1.915	2.796
95 Percentile	2.520	0.068	0.136	0.960	2.379	2.001	3.538	5.247
98 Percentile	2.520	0.068	0.136	0.960	4.071	4.327	7.090	10.639

7.3 CONCLUSIONS OF THE WATER BALANCE MODELING SCENARIOS

Scenario 1 or current base situation, was used to calibrate the model and to establish a starting point for comparison. The results from Scenario 1 show that the Springvale Coal Services Site does not meet with the water needs of the Washery for at least 10% of the time. Scenario 1 also shows that the average discharge at LDP006 is relatively low, around 1.5 ML/d (and is less than the the allowed limit of 10ML/d) and, although there have been events in which the discharge have exceeded the allowed limit; it has been only 2% of the days that this has occurred. Discharges at LDP006 are made mainly from spillages from the Retention Dam, with spillages from Cooks Dam being practically nil. In the current situation the Retention Dam holds a mixture of clean and worked water.

Scenario 4 is a simulation of the future layout of the Springvale Coal Services Site, including the new Washery, new press belt, new REA and new pipeline link between the Existing Washery Dam and Cooks Dam. In this future scenario the total water demand for the site is 2.7 ML/d (2.5 ML/d for the Washery and 0.2 ML/d for dust suppression). The water will be supplied from different sources:

- 25% of the supply is pumped from Cooks Dam, 60% of which is worked water transferred from the Existing Washery Dam via the implemented pipe link, which is re-circulated to the system.
- 40% of the supply comes from the Existing Washery Dam, of which 40% is re-circulated water from the clarifier overflow and 60% is transferred from the New Sediment Dam, which collects the runoff from the proposed REA.
- 17% of the water supply is re-circulated worked water from the press belt.
- 18% of the water is re-circulated worked water from the coal existing Stockpile Dam.

In total the recirculated worked water adds up to 50% of the total water demand of the site.

Table 7.4: Summary of water usage balance - Future scenario

	Average Daily Flow (ML/d)	Annual Flow (ML/y)
Total Site Water Demand (Washery + dust suspension)	2.7	985.5
WATER INPUTS		
Water supply from disturbed areas Runoff	1.037	378.5
Water supply from undisturbed areas Runoff	0.191	69.7
Water supply from ground water Seepage	0.2	73.0
Water supply from imported sources	0.316	115.3
TOTAL WATER INPUTS	**1.744**	**636.5**
WATER OUTPUTS		
Discharges to LPD006	0.378	138.0
Losses (evaporation + infiltration + coal moisture)	1.412	515.4
TOTAL WATER OUTPUTS	**1.790**	**653.4**
WATER RECYCLED		
Water Recycled on site	1.364	497.9
TOTAL WATER RECYCLED	**1.364**	**497.9**

Table 7.5: Summary of diverted flows around the site - Future scenario

	Daily Flow (ML/d)	Annual Flow (ML/y)
Diverted flows from disturbed areas Runoff	0.074	27.01
Diverted flows from undisturbed areas Runoff	0.826	301.49
TOTAL DIVERTED FLOWS	**0.900**	**328.50**

The New Sediment Dam plays an important role in the water supply of the Springvale Coal Services Site and it is important that it hold enough storage capacity to supply the plant during prolonged dry periods. The proposed minimum storage volume for this Dam is 15 ML (15,000 m^3).

The simulated scenario does not meet with the water demand for at least 20% of the days. This is a higher amount than the water shortages in the current situation. Expected water shortages in the Washery will be between 20% and 30% of the days in the future, which is an increase compared to the current situation. The availability of water in the future relies on the worked water recirculation, the effective drainage and water storage of the New Sediment Dam at the proposed REA location.

Discharges at LDP006 have been slightly reduced to a daily average of 1.33 ML/d and only 2% of the time the discharges are over the limit of 10ML/d. Besides the almost total separation of clean and worked water means that approximately 70% of the discharge is clean water from the Retention Dam and only the other 30% will be spillage from Cooks Dam.

The results presented in this report are subject to certain limitations of the model and the accuracy of the different assumptions (see Section 7.1.2 for calibration details and Section 7.2.1 for model assumptions). In particular the features on which the model relies are:

- Accuracy of the water cycle at the Washery and percentages of water that can be re-circulated in the system.
- Storage volumes of the different ponds and dams. The volumes used in the DWBM are inferred from the aerial photography and digital topography available, with some uncertainties of the depth and extent of the contours under the water level. It is advisable to confirm the inferred volumes with bathymetric survey of existing dams.
- Ground water and surface water interaction is an uncertainty that has been managed using reasonable assumptions and engineering judgment. The value of the net infiltration from ground water to DML and Cooks Dams used in the model is 100 m^3/day for each dam, slightly higher than the net filtration predicted from the ground water model. The reasons for this increase are founded in the knowledge that rainfall entering old mine open cuts and voids can travel underground relatively quickly downstream, reaching the surface dams before recharging the ground water storages. A reduction of 50% in the filtration from ground water to DML and Cooks Dams will mean a reduction of the water availability at the Washery of 3.5%, whereas reducing the seepage between DML and Cooks Dams of 50% will mean a reduction of water availability at the Washery of 1.5%.

The improvement in the confidence of these input data will improve the calibration of the model and the confidence in the results.

8. IMPACT ASSESSMENT AND MITIGATION MEASURES

8.1 ASPECT AND IMPACTS DEFINITION

Surface water related aspects are elements of the Project that can interact with the environment. These are direct aspects where Centennial has influence and control over their activities. The impact to surface water is the actual interaction with or impact on the environment.

8.2 POTENTIAL IMPACTS ON THE SURFACE WATER SYSTEM AND MITIGATION MEASURES

Aspects and impacts identified for the Project are detailed in Table 8.1. These are divided into various phases of construction, standard operations and rehabilitation.

Overall, and after mitigation measures have been implemented, the Project's impact on water quality will be reduced from current levels. A time of transition and 'settling in' during and after construction and changes to some primary uses of settling ponds and drainage lines will occur. No increased land scouring is expected or additional sedimentation impact to offsite watercourses is anticipated. The upgrade of the washery will ensure that all water from the coal handling, associated stockpile areas and reject emplacement areas is channelled correctly to sediment settling/pollution control ponds before being either recycled and/or sufficiently treated.

The current workload of the site will increase from 15 to 18 personnel. Most personnel work in the office and do not make use of the showers, so an average usage of 60 litres per person per day is expected. The current usage on site will then increase from 900 litres per day to 1,080 litres per day (20% increase). As indicated in Section 4.1.2, there is sufficient capacity within the existing sewerage system for the projected increase in workforce during standard operations and therefore wastewater aspects of the Western Coal Services Project will not have an impact on the surrounding environment.

For construction, there will be a separate demountable bathhouse and crib room, including toilets and showers for an average of 50 workers. This temporary facility is planned to be a pump-out only system and disposed of off-site. Water usage is expected to be 125 per person per day, totalling 6,250 l per day. The construction phase is expected to last 18 months

The following is a summary of the aspects and impacts identified during the three phases of the Project.

8.2.1 Construction

The key potential impacts on surface waters identified during the construction phase include disruptions to Springvale Coal Services Site drainage through infrastructure positioning and sedimentation due to increased erosion. Altered drainage patterns may arise due to the excavation and movement of soil, dam construction/merging and haul road construction. However, this can be mitigated through comprehensive site water management and erosion and sediment control plans that ensure the adequate drainage to minimise local flood risk and sedimentation is monitored and cleared as necessary. An element of such planning is to propose and consider options for site selection of infrastructure and route selection for haul roads such that erosion, flood risk and water quality impacts are mitigated as far as is practicable.

As stated above the waste water usage during construction will have no impact on surface water features.

8.2.2 Standard Operations

The key aspects that have the potential to cause impacts during the operational phase include:

- Storage, use and discharge of treated water have the potential to mobilise contaminants during transit and have elevated levels of EC and TDS due to evaporation during storage.
- Sustained rainfall may lead to a decrease in settling pond residence times and hence an increase in suspended sediments levels of the discharged water.
- Coal stockpiles, spoil piles and coal fines on the ground can lead to pollution of surface

water runoff. Dust suppression and effective drainage can adequately mitigate against these potential impacts.

8.2.3 Rehabilitation

During the rehabilitation phase the removal of infrastructure has the potential to impact drainage patterns. Final site drainage at the Springvale Coal Services Site will be contoured to ensure effective drainage and the land re-vegetated or modified as appropriate. Compliance with the water quality monitoring program and established water management plan should ensure that site contamination is not an issue during the operational and rehabilitation phases.

Table 8.1: Surface water aspects, impacts and mitigation

Surface water related aspect	Potential or actual impacts (pre-control)	Mitigation Measures
Construction Phase		
Excavation and movement of soil, and alterations to site drainage	• Sedimentation of onsite containment ponds, culverts, drainage structures and water resources in the immediate vicinity. • Potential decrease in water quality. • Localised changes to shallow drainage patterns as a result of a net reduction in soil cover. This is likely to increase runoff as the shallow soil profile has a reduced capacity to retain water.	• A detailed site water management plan and erosion and sediment control plan will be prepared prior to construction and operational activities. • These plans will be compliant with all applicable development consent conditions, EIS commitments and Environmental Protection Licence requirements. • Contaminated water is contained within the site boundary through stormwater catch drains and channeled towards the containment ponds. • Erosion and sediment controls will also be implemented as per Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom, 2004) and volume 2E, Mines and Quarries (DECC, 2008).
Additional dam construction / merging of existing dams	• Sedimentation behind dam. • Potential decrease in water quality due to standing water and construction materials / processes. • Disruption to flow regime causing erosion.	• The proposed structure will be designed to minimise erosion and disruption to the current flow regime. Regular inspection of erosion and sediment control measures and inflow / outflow points, particularly following storm events will be carried out.
Dredging culverts	• Mobilisation of contaminants in sediments. • Increasing TSS and turbidity of discharged water during dredging	• Effective containment of sediment during dredging. Diverting water flow around the works site to temporary storage or temporarily stopping flow until works are complete. • Consideration to the location of disposal should be made. The REA would be considered a suitable repository for this material. • Depending on the condition of the dredged material sampling and quality determination should be undertaken routinely and prior to disposal
Haul road construction	• Increased localised flood risk due to impact on surface water flow regime. • Damage to bank and increased sedimentation and/or erosion caused by drainage line crossings. • Decrease in quality of waters receiving haul road drainage. • Flooding of haul road due to inadequate drainage or interception of perched water table. • Increased erosion and disruption to vegetation caused by windblown dust.	• An Erosion and Sedimentation Control Plan (ESCP) or a Site Water Management Plan (SWMP), which includes control provisions for this construction-related activity should be compiled. • The orientation of drainage line crossings should be perpendicular to minimise damage to bed and bank. • The design of the crossings should also minimise sedimentation and erosion • Haul roads should be sited as high as possible to reduce the potential for flooding and potential failure. • Utilise water for dust suppression if winds exceed 5km/hr and rainfall during the previous 24 hours is less than 1mm. • The proposal of two options for the haul road and route selection to ensure potential or actual impacts are minimized.
Emplacement slope	• Erosion due to increased runoff velocity down slope.	• Design slope gradient and shape such that flow velocity does not lead to excessive

Surface water related aspect	Potential or actual impacts (pre-control)	Mitigation Measures
profile	• Accumulation of runoff from disturbed areas. • In Route 2, possible structural damage to the earth wall separating DML Dam and Cooks Dam	erosion. • Ensure adequate preferential drainage occurs (via channels) if benching is used. • Anticipate the effect of removing vegetation and implement drainage and settlement ponds as required • In Route 2, perform adequate geotechnical and earth wall stability studies, as well as appropriate earth works to secure earth wall stability between DML and Cooks dams.
Most aspects, impacts and controls as per those in Standard Operations will apply to the Construction Phase		
Standard Operations		
Storage and use of runoff from disturbed areas	• Water draining from the coal Washery and stockpile areas is currently controlled by the two dams. The size of these dams has been assessed as part of the water balance, in addition to estimates of the number and size of required sediment control ponds.	• This will be determined following the outcome of the water balance and the number and pond size requirements. Water should be re-circulated back through the system from these ponds. • The use of galvanised equipment (e.g. spray nozzles) where appropriate should be considered in order to maximised and prolong system performance. • Rigorous maintenance checks should be conducted routinely in order to assess the suitability and efficiency of the management system and also the suitability of the routine monitoring program.
Discharge of treated water from site	• The combination (mixing) and discharge of worked clean and treated water from site.	• One of the main objectives of the upgrade to the SWMP is the separation of clean and dirty water systems. • Site water is proposed to be managed via a series of containment / settlement ponds and returned to the Washery. • Clean water runoff is proposed to be separated from undisturbed areas and a new discharge point attached to Cooks Dam. This dam will become the main water supply dam for the operation. • Surplus treated water will then discharge through a separate licence point. • Discharges of treated water will still occur from the new licence point on Cooks Dam during high rainfall events. The point would require monitoring to determine compliance with licence limits and if required, further treatment may be necessary.
Excessive sedimentation	• The generation of excessive sedimentation in site streams (particularly Lamberts Gully) exceeding EPL. • Subsequent changes to water quality, increase deposition of sediment downstream in Wangcol Creek, including clogging of culverts under the Castlereagh Highway. • Creation of swampy areas below the discharge point in the vicinity of the Highway. • Alterations to drainage channel dimensions and creek	• Rehabilitation of all exposed surfaces that drain towards drainage channels and sediment ponds should be undertaken • The provision of additional pollution control storage capacity to cater for the new REA as well as reducing discharge of smaller ponds into the main Lamberts Gully drainage line. In turn these will become clean catchment areas. • The separation of natural drainage from disturbed areas will allow for more effective containment of sediment on site. • Use of flocculants to reduce suspended solids in dams within the drainage line as

Surface water related aspect	**Potential or actual impacts (pre-control)**	**Mitigation Measures**
	geomorphology.	necessary until these dams are effectively separated from the clean water system or otherwise contain clean water from completed rehabilitation areas.
Loss of storage capacity in sediment control dams.	• Excess sediment filling dams and potentially leaving site. • Leakage through dam wall.	• Survey / measure sediment accumulation. • De-silt settlement dams as required. • Remove and deposition dredged material to a nominated emplacement site.
Dust Suppression	• Impact on vegetation and quality of discharged water through the gradual degradation of recycled water quality.	• Monitor quality of recycled water and dilute with clean water as required.
Coal stockpiles and reject emplacement	• Seepage of poor quality water entering ground and surface waters. • The increased surface elevation of spoil piles leading to increased erosion.	• Ensure effective containment of seepage and runoff. • Emplace spoil when wet to minimise erosion by wind. • Continued monitoring and management in order to assess the integrity and suitability of containment structures.
Waste coal fines	• Contamination of surface runoff.	• All areas should be cleared of coaly material maintained in a 'clean' state to enable efficient management of controlled runoff. • As a secondary control, a low bund and drain inside the boundary fence could be constructed as part of the upgraded management system. • During periods of sustained wind and low rainfall areas containing fines should be wetted and managed accordingly.
Blocked drainage channels	• Sediment may back up under proposed haul road crossings.	• The haul road crossing at Wangcol Creek will require sufficient culvert sizing. • The entire drainage channel should remain clear. Upstream catchments must be managed to minimise sediment losses and reduce the risk of downstream sediment deposition at key localities such as road crossings. • Dredge drainage channels and sediment deposition areas as required, particularly following high rainfall events. • During dredging activities all channels and temporary containment areas should be suitably contained.
Vegetation removal	• Increased soil erosion may occur if a significant amount of vegetation is removed from catchment areas adjacent to the Coal Services site. • Species loss may lead to an overall degradation of the environment.	• Anticipate impact of vegetation removal and landscape areas so that slope gradient and shape does not lead to uncontrollable runoff velocities causing excessive erosion. • Maintain adequate fire breaks in forested area. • Re-vegetate where possible.

Surface water related aspect	Potential or actual impacts (pre-control)	Mitigation Measures
Flooding	• Flooding of Castlereagh Highway as a result of blocked culverts / inadequate drainage capacity under the highway. • During and following prolonged rainfall events pumping from Cooks Dam to the DML containment takes place in order to minimise spillage and reduces risk of overtopping of the Dam. This pumping saves water, reduces spillage to LDP006 and reduces risk of overtopping the dam and flooding the highway downstream. The potential for a 'backwater' effect from clogging of culverts could cause partial flooding near the main entrance.	• Clear drainage lines / culverts under the highway and towards Wangcol Creek. The size of the cleared drain needs to be adequate to handle the quantities of stormwater discharged at the culverts below the bridge. • Landscape slopes from the highway to Wangcol Creek. • Keep the main drainage channel and culverts clear of sediment.
Leakage from storage dams	• Leakage from existing dams (DML and Cooks) could cause poor quality water to leave site without being channeled through LP006.	• Check dam walls for leakages and implement appropriate repairs / maintenance measures. • Undertake routine monitoring and assess data obtained from the site monitoring borefield.
Storage and use of chemicals/ fuel at the Springvale Coal Services Site	• Accidental spills and leaks entering the site surface water reuse system. • Potential discharge to Wangcol Creek.	• Spill kits are available at key locations e.g. machine maintenance areas. • The management of chemicals, fuel and potential spills are undertaken in accordance with Technical Guidelines: Bunding & Spill Management (DECC). • Routine monitoring of water quality. • In the case of an environmental incident, a Pollution Incident Response Management Plan is in place for the site.
Rehabilitation		
Removal of infrastructure from the Springvale Coal Services Site	• Changed drainage patterns flowing into Wangcol Creek after closure.	• A post-closure rehabilitation plan will be developed for the site in accordance with the agreed land use. • Final site drainage will be properly contoured to mitigate any impact from ponding, bunds and drains

9. CUMULATIVE IMPACTS

A review of existing and approved projects in the area that could potentially generate a cumulative impact on surface has been undertaken as part of this assessment. A summary of the significant projects, their potential impact, mitigation measures and residual consequences is provided in Table 9.1.

Given the numerous industrial operations in the vicinity of the Springvale Coal Services Site, the cumulative environmental impacts need to be taken into consideration when assessing the potential for catchment scale disturbances. Due to the location of the Project, there is the potential for subsequent effects to downstream users. Therefore, a catchment scale assessment is required to ensure minimal environmental disturbances and to estimate potential impacts.

In combination with planned mine extension projects at Angus Place and Springvale Collieries, the cumulative impacts of the three mining upgrades need to be accurately assessed for potential environmental degradation, so appropriate mitigation measures can applied. Approved projects that have also been considered include the Western Rail Coal un-loader and the Mt Piper Power Station extension.

Water quality of Wangcol Creek has the potential to be affected by releases of water from the proposed Delta ash placement site. Water infiltration to and leachate from the ash emplacement will be managed accordingly with the exposed area of ash limited to reduce the potential for infiltration

Impacts to flooding as a result of surrounding industries are proposed to be managed by diverting clean water runoff from external catchment, (undisturbed land in the Ben Bullen State Forest) away from the disturbed areas. The design of these diversion drains would be so that 100 year ARI flood event could be conveyed from the external catchments into these areas. The concentration of flood flows, increased water levels upstream, redirected water across the floodplains and increased flood velocities were all considered potential consequences of cumulative activity in the area.

Increases in environmental flows from surrounding industries may impact on flows further up the catchment. Impacts on environmental flows as a result of surrounding industries are proposed to be managed by diverting clean water runoff from external catchments (undisturbed land in the Ben Bullen State Forest and progressively remediated subcatchments) around disturbed areas. The design of these diversion drains would be so that 100 year ARI flood event could be conveyed.

Table 9.1: Cumulative effects summary

Project Description	Potential Environmental Effect	Mitigation Measure
Lake Wallace (LCC, May 2011a and DE, 2008) An impoundment of the Coxs River located within the Sydney Drinking Water Catchment.	• Variations in water quantity and changes to environmental flows in the Coxs River.	• Water is released to accommodate environmental flows during normal operations and as part of the Drought Management Plan. The frequency of controlled discharges will be managed (following sustained periods of high rainfall) in order to prevent the back-up of floodwater in the Upper Coxs River Catchment.
Wallerawang Power Station (Dixone,E, April 2008) Water that is used in the power stations cooling system is primarily drawn from Lake Wallace and during dry periods from Lake Lyall.	• Increases in environmental flows. • Erosion and sediment control.	• Management strategy to reduce salt / pollutant loading. • An ongoing routine water quality monitoring program (Cardno Ecology Lab, 2010). • Installation of erosion and sediment control measures to treat runoff from capped areas until vegetative cover is established. • The collection pond provides primary treatment of water through sediment removal. • The need for water uptake from the Coxs River by Wallerawang Power Station has been reduced as a result of a mine water transfer system which provides benefits to the Coxs River catchment.
Mount Piper Power Station Ash Dam Emplacement (SKM, 2010) Proposed ash placement sites at Lamberts North and Lamberts South.	• Surface water hydrology and water availability has the potential to be altered in the Upper Coxs River / Wangcol Creek in the form of a reduction in runoff volume as a result of reduced catchment area and the need for additional external water sources to supply the demand. • Water quality in Wangcol Creek may be affected by releases of water from the proposed ash placement site.	• The installation of diversion drains. • Excess runoff would be captured and retained for site rehabilitation and dust suppression. • Diversion drains would be employed for the purpose of managing clean water runoff from external undisturbed catchments around disturbed areas. The design of these diversion drains would be so that 100 year ARI flood event could be conveyed. • Western Coal Services new REA lies on the same land as the proposed Lamberts South Ash Emplacement. Using this site for Ash or coal reject does not result in different impacts.
Mt Piper Power Station Extension (SKM, 2009) An application for a new Base Load Power Station was approved in January 2010. The existing power station is situated in the upper catchment of the western arm of Wangcol Creek.	• A holding pond which contains an underflow weir drains water from the site to Wangcol Creek. • Licenced discharge to receiving waters.	• The need for water uptake from the Coxs River by Wallerawang Power Station has been reduced as a result of a mine water transfer system. • An independent water treatment system would be implemented as part of the extension. • Brine used in the treatment process is stored in holding ponds, and is concurrently used to condition fly ash.

Project Description	Potential Environmental Effect	Mitigation Measure
		• Mine water exchange would ensure no additional drawing from the surrounding waterways. Water quality of the surrounding catchments was projected to be assured by the ongoing policy of 'zero discharge'.
Mt Piper Power Station Ash Placement Project (SKM, 2010) New ash placement area within the Huon Gully.	• Ash placement landform. • Localised diversions whilst under construction.	• Separation of clean and dirty catchments. • Progression rehabiliation.
Angus Place Colliery (Aurecon, 2010) An EA for a proposed modification of the existing PA for new longwall panels (LW910, LW900W and LW1001 to LW1019), increasing annual coal production from 3.5 Mtpa to 4Mtpa.	• Changes to flow regimes and surface flow contributions to the hanging swamp environments identified around the area. • The cracking of dry creek beds causes instability or loss of flows. • Increased underground water interception will mean increasing discharged flows to Cox's River	• Improvements to the existing water management plan will be identified as part of the modification process. Any potential minor changes to surface flow will be assessed as part of these modifications. • Surface monitoring lines should be installed at relevant locations to provide accurate measurements of subsidence, and discharge monitoring
Blackmans Flat Waste Management Facility (Geolyse, 2006) The DA for this facility was approved in 2006. The proposed site (preparation of an existing mine void) for the landfill is up gradient of the coal services site straddling the northern boundary of the coal services site.	• Leachate and stormwater containment and management. • Overflow prevention. • Waste water and effluent management with discharges into the DML Dam.	• The installation of an on-site wastewater and effluent management system integrated with the proposed design. • The management of leachate would involve capture, containment and if necessary offsite disposal at a licenced treatment facility. • The prevention of overflow was planned by the design and management of the storage system, which included containment of a 25 year ARI 24 hour storm event • The DML Dam was projected to be the main discharge point for surface waters, with a clear intention on diversion away from the landfill areas. Monitoring of the DML Dam will be required in order that its suitability to receive surface water discharge is maintained.

Project Description	Potential Environmental Effect	Mitigation Measure
Springvale Mine (Centennial Coal, 2010) Development of longwalls LW416 to LW432 and LW501 to LW503 at Springvale Mine. Increasing the coal annual production from 3.4 Mtpa to 4.5Mtpa.	• Longwalls 415, to 432 lie beneath areas of Endangered Ecological Community (EEC) known as 'Temperate Highland Peat Swamps on Sandstone' THPSS known as Sunnyside Swamp. • The proposed longwall mining will result in some surface subsidence. Monitoring of surface water flows during existing longwall advancement detected no impact to the swamp environment. • Increased underground water interception will mean increasing discharged flows to Cox's River	• The Springvale Delta Water Scheme was established between Centennial Springvale and Delta Electricity to improve the management of water at the Springvale Colliery and to reduce the extraction of water by Delta Electricity from the Cox's River supplies. The scheme operates under two scenarios, normal and abnormal. Under normal circumstances all water is transferred to Wallerawang Power Station. Under abnormal/emergency circumstances water is discharged through LDP009 and LDP010. • Monitoring of surface water flows during existing longwall advancement detected no impact to the swamp environment.
Mobile Resource Recovery Mill (Advitech, 2011) DA for the trial of a mobile resource recovery mill (MRRM) at Blackmans Flat. Proposed to conduct a six month trial to produce up to 29,000t of road base.	• Small amounts of waste water from the production of road base would contain fly ash and coal Washery reject fines.	• The proposed trial has no waterways adjoining it. • The storage of water on the proposed site was proposed to occur in a 4,000L tank adjacent to the mill. • All diesel held on site was proposed to be stored in a diesel drum on a plastic spill pallet to minimise the potential of spills. • Any waste water produced from the trial would not contain any toxic or hazardous materials and would be deposited on the ground.
Western Rail Coal Unloader (SKM, 2007) Approved in June 2009 for the construction and operation of a rail balloon loop and coal unloading facility. The rail loop is located in the floodplains of Pipers Flat Creek, crossing the creek twice. Once on the northern side and once on the eastern side of the loop.	• Construction of the rail loop has the potential to act as an obstruction to flood flows of the Pipers Flat Creek with the potential for these flows to back up behind embankments. • The construction of embankment structures will concentrate flood flows, leading to increases in water levels upstream. This may result in the redirection of water across the floodplains and increase overall flood velocities.	• Creek channel augmentation. • Creek flow regulation. • Channel diversion and management.
Pine Dale Coal Mine (Aquaterra, 2010) Part 3A application for an open cut mining extension (Yarraboldy Extension), approved in February 2011. **Pine Dale Coal Mine – Stage 2 Extension** (Aquaterra, 2012)	• Alterations to existing surface water flows. • Periodic clean water discharges.	• Surface water inflow is managed as follows; • Clean water is diverted around the mining areas; • Surface water inflow is directed to the in-pit sump; • Water is retained within the sump for as long a period as possible to allow settlement of suspended particles.

Project Description	Potential Environmental Effect	Mitigation Measure
Part 4 application for extension of open cut mining area, currently awaiting public exhibition of EIS.		

10. MONITORING, MANAGEMENT AND LICENSING

10.1 On-Going Monitoring

Routine monitoring is currently undertaken at 11 locations (water quality) as well as visual inspection of sediment ponds, culverts and stormwater drainage channels. The water quality locations include several stations in Wangcol Creek. Table 10.1 presents the parameters and frequency of monitoring at these locations and the current monitoring regime is proposed to continue.

Table 10.1: Surface Water Monitoring Program

Site Code	Purpose	Frequency	Parameters
LDP006	Water quality monitoring requirement for EPL3607.	Monthly (during discharge)	pH, EC, Total Suspended Solids (TSS), Oil and Grease (TOG) Total Dissolved Solids (TDS), Hardness, CO_3, OH, HCO_3, Alkalinity, SO_4, Cl, Ca, Mg, Na, K, NO_3, P, Al, B, Cd, Fe, Mn, Ni(filt), Ni(tot), Se, Zn(tot) & Zn (filt)
	National Pollutant Inventory (NPI) reporting	Quarterly (Feb, May, Aug and Nov).	NPI Parameters – 40 priority substances
Wangcol Ck Upstream Wangcol Ck Downstream Wangcol Ck NOW Station 212055 Wangcol Ck Far Downstream	Water quality of Wangcol Creek	Weekly	pH, EC, TSS, TOG TDS, Hardness, CO_3, OH, HCO_3, Alkalinity, SO_4, Cl, Ca, Mg, Na, K, NO_3, P, Al, B, Cd, Fe, Mn, Ni(filt), Ni(tot), Se, Zn(tot) & Zn (filt)
Cooks Dam	Water quality	Weekly	pH, EC, TSS, TOG TDS, Hardness, CO_3, OH, HCO_3, Alkalinity, SO_4, Cl, Ca, Mg, Na, K, NO_3, P, Al, B, Cd, Fe, Mn, Ni(filt), Ni(tot), Se, Zn(tot) & Zn (filt)
Existing Retention Dam Existing Conveyor Dam Existing Stockpile Dam Existing Washery Dam SLG6	Water quality	Weekly	pH, EC, TSS, TOG

As outlined in Section 4.2, sampling will be undertaken in accordance with appropriate quality control procedures.

10.2 Management

As presented in Section 4.1, the Coal Services Site is currently governed by a SWMP that was prepared in response to the previous project approval conditions. This SWMP has been updated on several occasions (2008, 2009 and 2012). It is anticipated that the SWMP will again be updated following approval of the proposed Project.

Construction Environmental Management Plans (CEMPs) will be implemented for the proposed Haul Road Options and works on existing infrastructure and designs will be consistent with best-practice Erosion and Sediment Control management protocols.

10.3 Licensing

Section 7.3 presents the predicted water balance under the proposed conditions. Harvestable Rights Dams limitations do not apply to this Site since all dams are used for capture, containment and recirculation of drainage and/or effluent that is required by regulation (EPL) to prevent contamination of a water source.

11. CONCLUSIONS

The proposed Western Coal Services Upgrade Project has resulted in an opportunity and purpose to address strategies to further improve drainage systems and manage water quality across an older mining area. The Springvale Coal Services Site comprises of a complex drainage system where runoff crosses over undisturbed areas, forested areas underlain by dispersive soils, rehabilitated mining areas and disturbed mining areas as well as drains and channels that pass through several sediment containment and erosion control structures before discharging through a licenced discharge point (LDP006) and then into the Wangcol Creek.

The Project will include the installation a new Washery with a press belt, a unique new Reject Emplacement Area and the practical separation of the clean and worked water on the site.

In general terms the future scenario improves the water management given a New Sediment Dam of at least 15 ML of storage capacity will be implemented to collect the proposed REA local drainage and the worked water recirculation reaches approximately 60% of the total water demand.

Cooks Dam and the DML Dam are interconnected primary via a pipeline which enables pumping water between dams. Both dams are also fed via ground water filtration connected to old mine works and voids. Furthermore the earth wall separating the DML and Cooks Dam was design as a permeable wall and it is believed to leak water from DML to Cooks Dam at an approximate rate of 0.4ML/d, according to the conclusions of the water balance model calibration (section 6.1.2). The interception and use of this water has beneficial implications in terms of reducing potential downstream water quality impacts. The use of this water also reduces the need for the Project to source alternative water supplies from the surrounding regions. However, water shortages during droughts will occur. Expected water shortages in the Washery will be between 20% and 30% of the days in the future, which is an increase compared to the current situation. This is due to the increase of the overall water demand, although the improvements on the worked water recirculation, the effective drainage and water storage of the new REA will help to compensate partially the increase of the water demand. A separate supply of water can be obtained from the Springvale Colliery as the expanded underground mine is expected to have an excess of intercepted ground water in the future and it is part of Centennial's water management strategy in the region..

The Project will rely mostly on the use of water contained within the pollution control system and recycling initiatives, including the new proposed REA, as well as ground water interception in DML and Cooks Dams. The design of the new REA is provided in detail in the EIS and consists of a drainage blanket to be placed beneath the new emplacement to minimise build-up of water pressures within the emplacement landform. Accordingly, infiltration through the new REA will be intercepted by this drainage layer and transferred to the New Sediment Dam.

The increased rate of re-circulated water from the Washery and worked areas will beneficially reduce discharges of worked water from the Springvale Coal Services Site as well as the risk of discharge amounts exceeding the quality criteria. Discharges to Wangcol Creek have been slightly reduced to a daily average of 1.33 ML/d and exceedances (of the 10ML/d limit) are potentially only expected 2% of the time. The almost total separation of clean and worked water will mean, however, that approximately 70% of the discharge is clean water from the Retention Dam and only the other 30% will be spillage from Cooks Dam. If a new Licenced Discharge Point was located separately at the discharge from Cooks Dam, then the discharges at LDP006 will be under the current volumetric limit on EPL3607 virtually 98.5% of the time.

Zero effluent discharge is not possible, but the licenced discharge limits are more achievable, although they will be exceeded during flood events.

The sediment control will also comply with the design limits for the different catchments. It is predicted that the total water storage capacity implemented at the Springvale Coal Services Site will be enough to settle and contain the expected sediment production, limiting the sediment discharges to minimal and admissible. The degree of rehabilitation in the future will help in reducing the total amount of soil loss, expecting a reduction of approximately 2,000 t/year when the proposed rehabilitated areas are completed.

The results presented in this report are subject to certain limitations of the model and the accuracy of the different assumptions (see Section 7.1.2 for calibration details and Section 7.2.1 for model assumptions).

In particular the features on which the model relies are:

- Accuracy of the water cycle at the Washery and percentages of water that can be re-circulated in the system.
- Storage volumes of the different ponds and dams. The volumes used in the DWBM are inferred from the aerial photography and digital topography available, with some uncertainties of the depth and extend of the contours under the water level. It is advisable to collate the inferred volumes with measured data.
- Ground water and surface water interaction is an uncertainty that has been managed using reasonable assumptions and engineering judgment. The value of the net infiltration from ground water to DML and Cooks Dams used in the model is 100 m^3/day for each dam; slightly higher than the net filtration predicted from the ground water model. The reasons for this increase are founded in the knowledge that rainfall on old mine open cuts and voids can travel underground relatively quickly downstream, reaching the surface dams before recharging the ground water storages. However, the impact of the groundwater infiltration in the site water availability is limited.

Overall the development will provide an opportunity to obtain an enhanced properly drained and rehabilitated landscape, with improved containment and reuse of water from worked areas and improved settlement of sediments from worked, rehabilitated and natural/forested areas. Should the project proceeds, it is likely to result in beneficial outcomes for downstream receiving water bodies, since the amount of worked water leaving the site will be reduced. The total amount of sediments leaving the Site will also be reduced as the separation of clean and worked water is made effective and the reuse of worked water increases. As the rehabilitation of the disturbed areas continues to take place in the future, the Site will see a reduction in the soil loss and expected sediment production.

12. REFERENCES

Advitech Pty Ltd, 2011, *Mobile Resource Recovery Mill – Statement of Environmental Effects Weston Matrix,* Advitech Pty Ltd, Mayfield.

ANZECC/ARMCANZ, 2000, *National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality*.

Aquaterra Consulting Pty Ltd, June 2010, *Pine Dale Coal Mine Yarraboldy Extension Ground Water Assessment Part 1,* Specialist consultant studies compendium.

Aurecon Australia Pty Ltd., 2010, *Assessment of Hydrogeological Impacts Angus Place Project Modification Centennial Angus Place* – Appendix 7.4 of RPS Impact Assessment Report 208362.

Aurecon Australia Pty Ltd., 2012, *Springvale Coal Services Washery and Rejects Emplacement Area Dirty Water Management Report.*

Australian Bureau of Statistics (Commonwealth of Australia), 2007, *2006 Census of Population and Housing, Basic Community Profile – Blackmans Flat*.

Boughton, W., 2010, Rainfall-Runoff Modeling with the AWBM [Australian Water Balance Model], Crows Nest.

Cardno Ecology Lab, 2010, 'Potential Impacts of Discharges from Wallerawang Power Station on the Upper Coxs River'.

Centennial Coal, November 2010, *Longwall mining of Longwalls 415, 416 and 417 at the existing Springvale Colliery Part 1, Springvale, NSW,* Centennial Coal.

Centennial Coal, November 2010, *Longwall mining of Longwalls 415, 416 and 417 at the existing Springvale Colliery Final EPBC Referral Springvale Part 2, Springvale, NSW,* Centennial Coal.

Centennial Coal, November 2010, *Longwall mining of Longwalls 415, 416 and 417 at the existing Springvale Colliery Final EPBC Referral Springvale Executive Summary Part 3, Springvale, NSW,* Centennial Coal.

Centennial Coal, September 2012, *Springvale Coal Services Upgrade Project Briefing Paper*.

Delta Electricity (DE), *2008, Delta Electricity Western Water Management Licence Annual Compliance Report 2007-08*.

Department of Environment and Climate Change NSW (DECC), 2008. *Managing Urban Stormwater: Soils and Construction – Unsealed Roads*. Volume 2C.

Department of Environment and Climate Change NSW (DECC), 2008. *Managing Urban Stormwater: Soils and Construction – Mines and Quarries*. Volume 2E.

Dixone,E, April 2008, *Kerosene Vale Stage 2 Ash Repository Area Environmental Assessment,* Parsons Brinckerhoff, Sydney.

Douglas Partners, March 2010, *Stage 2 Hydrogeological Assessment, Licence Application for Bores and Structures, Western Main Colliery, Castlereagh Highway, Blackmans Flat*.

Engineers Australia, September 2007, Australian Rainfall & Runoff – A guide to flood estimation. Vol 2, electronic version. Crows Nest.

Geolyse, August 2006, *Development Assessment Report (205158_REO_001) Blackmans Flat Waste Management Facility*, City of Lithgow Council.

Gutteridge Haskins & Davey (GHD), December 2006, *Surface Water Management Plan, Lamberts Gully Coal Mine*. Sydney.

Gutteridge Haskins & Davey (GHD), August 2009, *Revised Surface Water Management Plan, Lamberts Gully Coal Mine*. Sydney.

Gutteridge Haskins & Davey (GHD), January 2010, *Centennial Coal Company Limited, Lamberts Gully LDP006 – Surface Water Quality Baseline Study*. Sydney.

Gutteridge Haskins & Davey (GHD) 2011, *Springvale Coal Services LDP006 Water Quality Targets*

Gutteridge Haskins & Davey (GHD) 2012, *Coal Services Water Quality Assessment, LDP006 ANZECC Assessment*

Gutteridge Haskins & Davey (GHD) 2012, *Surface Water Management Plan Springvale Coal Services*

Hawkesbury Nepean Catchment Management Authority (HNCMA), 2007, *Hawkesbury Nepean River Health Strategy*.

Healthy Rivers Commission, 1998, *Independent Inquiry into the Hawkesbury Nepean River System*.

Landcom, 2004, *Managing Urban Stormwater: Soils and Construction*. Volume 1, Edition 4.

Lithgow City Council (LCC), 17 May 2011a, 'Fish River Water Supply'. Internet page.

NSW Government, 12 March 2001, *Statement of Joint Intent for the Hawkesbury Nepean River System*.

NSW Office of Water, 12 November 2010, correspondence from Richard Nevill to Centennial Coal (Mr Barry McMahon, Wallerawang NSW) 'Lamberts Gully – Site Water Management'.

NSW Sydney Catchment Authority (SCA), 2009, *Healthy Catchments Strategy 2009-2012*. NSW Government.

NSW Sydney Catchment Authority (SCA), March 2011, State Environmental Planning Policy – Catchment Area Map. NSW Government.

NSW Department of Primary Industries, Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011, NSW Government.

RPS Aquaterra, March 2012, *Coal Services Washery Upgrade and Distribution Network Groundwater Impact Assessment*. Chatswood.

RPS, March 2012, *Terrestrial Ecology Assessment - Coal Services Washery Upgrade and Distribution Network.* Newcastle.

Sinclair Knight Merz (SKM), April 2007, *Western Rail Coal Unloader Environmental Assessment: Chapter 5 – 'Assessment of Key Environmental Issues'*. St Leonards.

Sinclair Knight Merz (SKM), August 2010, *Mt Piper Power Station Ash Placement Project: Appendix D – 'Hydrology and Water Quality'*. St Leonards.

Sinclair Knight Merz (SKM), September 2009, *Mt Piper Power Station Extension* Environmental Assessment. St Leonards.

Springvale Coal, *Lamberts Gully Open Cut Environmental Monitoring Plan (Draft)*.

WRM Water and Environment Pty Ltd (WRM), November 2005, *Neubecks Creek and Coxs River Flood Study – Pine Dale Coal Mine Proposal*. Paddington.

APPENDIX A:
SURFACE WATER QUALITY
SUMMARY & ANALYSIS

Colliery Site Reference	Sample Set Summary	pH	TSS	TDS	Ec (uS/cm)	Oil & Grease	Manganese Filt (mg/L)	Iron (filt) (mg/L)	Zinc (Tot) (mg/L)	Turbidity (NTU)	Aluminium	Arsenic	Barium	Boron	Boron Filt (mg/L)	Cadmium	Cadmium Filt (mg/L)	Calcium	Chromium (III) (mg/L)	Chromium (VI)	Chloride	Cobalt	Copper	Cyanide	Iron Total	Ferrous Iron (mg/L)	Lead	Magnesium	Manganese Total	MBAS	Mercury
Cooks Dam	Min	5.95	0.4	804	1850	5	1.94	0.05	0.301	2	0.01			0.07	1.21	0.0004	0.0001	28			68							16			
	Median	6.26	2.0	2114	2630	5	4.08	0.25	0.335	5	0.01			1.72	1.45	0.00055	0.0004	186			102							136			
	Mean	6.34	1.9	2002	2464.2	5	11.3	0.307	0.335	6	0.014			1.342	1.48	0.0007	0.0004	179			109							131			
	Max	6.96	3.0	2486	2840	5	149	0.79	0.369	11	0.06			1.74	1.78	0.0014	0.0005	219			166							157			
	Sample Count	24	22	21	24	18	21	20	2	3	21	0	0	5	16	8	11	21	0	0	20	0	0	0	0	0	0	21	0	0	0
LDP006	Min	6.12	0.1	210	110	0.00	0.34	0.01	0.01	1.00	0.01		0.01	0.32	0.79	0.0001	0.0001	101	0.01	0.01	10	0.01	0.00	0.00	0.01	0.07	0.001	70	0.65	0.10	0.00
	Median	6.87	4.0	1473	1270	5.00	2.67	0.22	0.11	13.50	0.01		0.02	0.97	1.26	0.0004	0.0003	172	0.01	0.01	76	0.05	0.00	0.00	0.26	0.07	0.001	127	2.72	0.10	0.00
	Mean	6.87	9.4	1512	1441	3.80	4.24	0.53	0.14	29.44	0.02		0.02	0.97	1.25	0.0004	0.0005	160	0.01	0.01	80	0.06	0.00	0.00	0.26	0.07	0.001	117	3.48	0.11	0.00
	Max	7.70	176.0	2182	2660	12.00	130.00	5.64	0.47	215.00	0.05		0.02	1.50	1.67	0.0016	0.0018	203	0.01	0.01	116	0.17	0.01	0.00	0.50	0.07	0.002	147	10.00	0.20	0.00
	Sample Count	342	125	58	212	117	114	113	88	36	22	9	9	12	18	18	10	21	4	9	29	9	9	7	2	1	9	21	9	8	9
Main Sediment Pond	Min	6.19	4.6		70	5				20																					
	Median	6.69	29.6		123	5				21.5																					
	Mean	6.68	44.8		124	5				21.5																					
	Max	7.22	136.0		183	5				23																					
	Sample Count	21	19	0	21	18	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wangcol Creek NOW Station (Neubecks)	Min	6.71	0.6	150	130.0	5.00	0.20	0.05	0.02	7.00	0.01			0.07	0.05		0.0001	15			6							9			
	Median	7.34	4.4	258	278.5	5.00	0.45	0.19	0.02	16.00	0.02			0.09	0.06		0.0001	28			11							16			
	Mean	7.28	4.4	265	275.1	5.00	3.09	0.20	0.02	16.67	0.05			0.34	0.06		0.0002	49			26							32			
	Max	7.61	8.8	440	353.0	5.00	16.00	0.33	0.02	27.00	0.20			0.84	0.06		0.0004	126			67							84			
	Sample Count	12	9	8	12	8	7	7	1	3	7	0	0	5	2	0	6	7	0	0	6	0	0	0	0	0	0	7	0	0	0
Wangcol Creek Downstream (Neubecks)	Min	5.90	0.4	420	118.0	0.00	0.09	0.04	0.01	2.00	0.01	0.03		0.12	0.19	0.0001	0.0001	35			21							23			
	Median	6.96	2.0	1031	1120.0	5.00	1.55	0.22	0.04	6.50	0.01	0.03		0.37	0.55	0.0002	0.0002	87			41							62			
	Mean	6.95	7.5	1079	1093.7	4.59	2.57	0.23	0.07	5.75	0.03	0.03		0.37	0.71	0.0003	0.0002	92			49							67			
	Max	8.32	238.0	1778	2080.0	9.00	55.00	0.81	0.23	8.00	0.14	0.03		0.62	1.17	0.0005	0.0003	162			82							119			
	Sample Count	597	82	24	167	77	68	67	41	4	22	1	0	5	17	9	11	22	0	0	21	0	0	0	0	0	0	22	0	0	0
Wangcol Creek Far Downstream (Neubecks)	Min	6.55	0.8	554	280.0	5	0.265	0.05	0.071	4	0.02			0.07	0.21		0.0002	20			7							10			
	Median	7.18	4.6	1028	859.0	5	1.75	0.07	0.071	6	0.04			0.34	0.29		0.0002	75			28							54			
	Mean	7.15	4.5	1068	1061.1	5	10.24	0.17	0.071	6.3	0.129			0.372	0.29		0.0002	68			25							48			
	Max	7.84	9.2	1932	2130.0	5	63	0.4	0.071	9	0.52			0.77	0.36		0.0002	106			46							72			
	Sample Count	11	8	7	11	8	7	7	1	3	7	0	0	5	2	0	6	7	0	0	6	0	0	0	0	0	0	7	0	0	0
Wangcol Creek Upstream (Neubecks)	Min	5.00	0.4	38	82.00	0.00	0.08	0.08	0.00	5.00	0.01	0.02		0.08	0.09	0.0001		21			9							14			
	Median	6.87	2.0	350	580.00	5.00	0.50	0.22	0.01	15.00	0.02	0.02		0.26	0.12	0.0001		37			16							25			
	Mean	6.82	5.2	433	704.27	4.63	1.90	0.27	0.02	13.80	0.07	0.02		0.36	0.14	0.0001		46			18							32			
	Max	8.72	82.0	1320	1650.00	8.00	49.00	1.92	0.10	23.00	0.34	0.02		1.07	0.27	0.0003		161			32							110			
	Sample Count	598	82	25	167	77	68	67	43	5	22	1	0	5	17	9	11	22	0	0	21	0	0	0	0	0	0	22	0	0	0
Retention Pond 1	Min	6.33	3.0		380	5				8	0.01			1.42			0.0004	206										142			
	Median	6.69	5.6		1690	5				14	0.01			1.42			0.0004	206										142			
	Mean	6.80	9.9		1522.7	5				14	0.01			1.42			0.0004	206										142			
	Max	7.63	42.4		2610	5				20	0.01			1.42			0.0004	206										142			
	Sample Count	21	19	0	20	18	0	0	0	2	1	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0
Sediment Pond 6	Min	5.93	2.2		1140	5				23																					
	Median	6.08	4.4		1905	5				33																					
	Mean	6.14	7.3		1823	5				33																					
	Max	6.45	22.8		2300	5				43																					
	Sample Count	10	8	0	10	7	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sediment Pond 1	Min	6.47	7.6		123	5																									
	Median	6.75	15.0		456.5	5																									
	Mean	6.80	220.8		550.6	5																									
	Max	7.28	1410.0		1560	5																									
	Sample Count	8	8	0	8	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sediment Pond 2	Min	6.47	3.0		58	5																									
	Median	6.71	13.0		73	5																									
	Mean	6.72	15.4		70.7	5																									
	Max	7.00	36.0		89	5																									
	Sample Count	9	9	0	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stockpile Sediment Pond	Min	3.93	2.0		432	5				9																					
	Median	6.22	6.4		663.5	5				10																					
	Mean	6.11	7.3		736.6	5				10																					
	Max	6.97	17.0		1620	5				11																					
	Sample Count	16	14	0	16	13	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Washery Sediment Pond	Min	4.88	1.6		617.0	5.00				2.00																					
	Median	6.45	3.4		2240.0	5.00				8.50																					
	Mean	6.22	4.2		2031.7	5.00				8.50																					
	Max	7.33	10.8		2620.0	5.00				15.00																					
	Sample Count	10	8	0	10	7	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Colliery Site Reference	Colliery Site Reference	Sample Set Summary	Nickel (Total)	Nickel Filt (mg/L)	Potassium	Selenium	Silver	Sodium	Total Sulphur (Sulphate)	Zinc Filt (mg/L)	Nitrogen (Ammonia) (mg/L)	Nitrite as N (mg/L)	Nitrate as N (mg/L)	Nitrate + Nitrite (mg/L)	Total Nitrogen as N (mg/L)	Total Kjeldhal Nitrogen as N	Total Phosphorous	Total Phenols (mg/L)	Carbonate Alkalinity (mg/L)	Bicarbonate Alkalinity (mg/L)	Hydroxide Alkalinity (mg/L)	Total Alkalinity (mg/L)	Total Hardness	Total Fluoride	Chlorine (free)	Chlorine (tot)	C10-C14 Fraction ug/L	C15-C28 Fraction ug/L	C29-C36 Fraction ug/L	C10-C36 Fraction (sum) ug/L
Cooks Dam	Cooks Dam	Min	0.382	0.006	4	0.01		18	86	0.011		0.01	0.01	0.01	0.06	0.1	0.01		1	4	1	4	136		0.1	0.1				
		Median	0.4555	0.348	26	0.01		170	1200	0.358		0.01	0.03	0.045	0.1	0.15	0.01		1	40	1	42	1010		0.1	0.1				
		Mean	0.4579	0.3494	24.8	0.01		176.9	1142.6	0.363		0.018	0.041	0.053	0.12	0.15	0.02		1	40.9	1	39.1	990		0.1	0.1				
		Max	0.531	0.502	32	0.01		256	1450	0.523		0.1	0.16	0.16	0.3	0.2	0.12		1	82	1	59	1180		0.1	0.1				
		Sample Count	8	21	21	21	0	21	21	21	0	21	21	16	7	2	21	0	21	21	21	16	21	0	1	1	0	0	0	0
LDP006	LDP006	Min	0.028	0.160	18.00	0.01	0.001	99.00	26.00	0.170	0.01	0.01	0.01	0.01	0.06	0.20	0.01	0.05	1.00	5.00	1.00	5.00	542	0.06	0.01	0.08	50.00	100.00	50.00	50.00
		Median	0.302	0.267	21.00	0.01	0.001	160.00	952.50	0.304	0.04	0.01	0.03	0.05	0.20	0.30	0.01	0.05	1.00	48.00	1.00	49.00	972	0.09	0.10	0.14	50.00	100.00	50.00	50.00
		Mean	0.290	0.286	21.62	0.01	0.002	159.38	950.50	0.302	0.06	0.02	0.05	0.08	0.26	0.32	0.05	0.05	1.00	40.71	1.00	43.94	886.4	0.09	0.10	0.15	50.00	100.00	50.00	50.00
		Max	0.468	0.433	28.00	0.10	0.010	201.00	1290.00	0.494	0.15	0.11	0.15	0.32	0.60	0.50	0.45	0.05	1.00	58.00	1.00	58.00	1110	0.10	0.24	0.27	50.00	100.00	50.00	50.00
		Sample Count	22	23	21	28	8	21	28	22	8	21	21	25	15	5	29	8	21	21	21	17	21	9	5	5	2	2	2	2
Main Sediment Pond	Main Sediment Pond	Min																												
		Median																												
		Mean																												
		Max																												
		Sample Count	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wangcol Creek NOW Station (Neubecks)	Wangcol Creek NOW Station (Neubecks)	Min	0.005	0.005	4.00	0.01		12.00	42.00	0.009		0.01	0.01	0.01	0.05	0.10	0.01		1.00	29.00	1.00	35.00	74.00							
		Median	0.006	0.007	6.00	0.01		21.00	94.00	0.028		0.01	0.01	0.04	0.10	0.25	0.01		1.00	48.00	1.00	41.50	136.00							
		Mean	0.047	0.051	8.57	0.01		52.29	265.14	0.067		0.02	0.02	0.04	0.15	0.25	0.01		1.00	50.43	1.00	41.50	251.86							
		Max	0.162	0.192	18.00	0.01		146.00	751.00	0.200		0.07	0.04	0.07	0.40	0.40	0.02		1.00	73.00	1.00	48.00	660.00							
		Sample Count	7	7	7	7	0	7	7	7	0	7	7	2	7	2	7	0	7	7	7	2	7	0	0	0	0	0	0	0
Wangcol Creek Downstream (Neubecks)	Wangcol Creek Downstream (Neubecks)	Min	0.025	0.011	5.00	0.01		24.00	146.00	0.01		0.01	0.01	0.01	0.04	0.10	0.01		1.00	1.00	1.00	1.00	182.00		0.10	0.10	50.00	100.00	50.00	50.00
		Median	0.058	0.078	12.50	0.01		72.50	494.00	0.11		0.01	0.02	0.02	0.10	0.20	0.01		1.00	53.00	1.00	51.00	471.00		0.10	0.10	50.00	100.00	50.00	50.00
		Mean	0.075	0.119	13.41	0.01		84.86	551.32	0.12		0.01	0.04	0.04	0.13	0.20	0.02		1.00	52.32	1.00	51.12	509.05		0.10	0.10	50.00	100.00	50.00	50.00
		Max	0.198	0.285	22.00	0.01		154.00	1000.00	0.26		0.03	0.13	0.13	0.40	0.30	0.08		1.00	92.00	1.00	92.00	894.00		0.10	0.10	50.00	100.00	50.00	50.00
		Sample Count	8	22	22	22	0	22	22	22	0	22	22	17	7	2	22	0	22	22	22	17	22	0	1	1	1	1	1	1
Wangcol Creek Far Downstream (Neubecks)	Wangcol Creek Far Downstream (Neubecks)	Min	0.006	0.008	4	0.01		14	48	0.027		0.01	0.01	0.04	0.03	0.2	0.01		1	23	1	23	91							
		Median	0.044	0.044	9	0.01		54	433	0.071		0.01	0.01	0.05	0.1	0.2	0.01		1	39	1	24	410							
		Mean	0.0417	0.0629	9.4	0.01		59.3	389.4	0.090		0.02	0.03	0.05	0.12	0.2	0.014		1	38.14	1	24	371.14							
		Max	0.075	0.171	16	0.01		127	688	0.179		0.06	0.08	0.06	0.2	0.2	0.03		1	60	1	25	561							
		Sample Count	7	7	7	7	0	7	7	7	0	7	7	2	7	2	7	0	7	7	7	2	7	0	0	0	0	0	0	0
Wangcol Creek Upstream (Neubecks)	Wangcol Creek Upstream (Neubecks)	Min	0.008	0.009	4.00	0.01		14.00	80.00	0.010		0.01	0.01	0.01	0.02	0.40	0.01		1.00	28.00	1.00	28.00	110.00		0.10	0.10	50.00	100.00	50.00	50.00
		Median	0.015	0.013	6.00	0.01		26.00	179.50	0.030		0.01	0.01	0.02	0.10	1.35	0.01		1.00	60.50	1.00	62.00	189.50		0.10	0.10	50.00	100.00	50.00	50.00
		Mean	0.018	0.027	6.91	0.01		35.05	220.73	0.041		0.11	0.02	0.16	0.17	1.35	0.02		1.00	63.41	1.00	67.47	249.14		0.10	0.10	50.00	100.00	50.00	50.00
		Max	0.039	0.259	24.00	0.01		193.00	980.00	0.282		1.88	0.06	1.88	0.40	2.30	0.08		1.00	124.00	1.00	124.00	855.00		0.10	0.10	50.00	100.00	50.00	50.00
		Sample Count	8	22	22	22	0	22	22	22	0	22	22	17	7	2	22	0	22	22	22	17	22	0	1	1	1	1	1	1
Retention Pond 1	Retention Pond 1	Min		0.333	29	0.01		237	1400	0.332		0.01	0.06				0.01		1	43	1		1100							
		Median		0.333	29	0.01		237	1400	0.332		0.01	0.06				0.01		1	43	1		1100							
		Mean		0.333	29	0.01		237	1400	0.332		0.01	0.06				0.01		1	43	1		1100							
		Max		0.333	29	0.01		237	1400	0.332		0.01	0.06				0.01		1	43	1		1100							
		Sample Count	0	1	1	1	0	1	1	1	0	1	1	0	0	0	1	0	1	1	1	0	1	0	0	0	0	0	0	0
Sediment Pond 6	Sediment Pond 6	Min																												
		Median																												
		Mean																												
		Max																												
		Sample Count	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sediment Pond 1	Sediment Pond 1	Min																												
		Median																												
		Mean																												
		Max																												
		Sample Count	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sediment Pond 2	Sediment Pond 2	Min																												
		Median																												
		Mean																												
		Max																												
		Sample Count	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stockpile Sediment Pond	Stockpile Sediment Pond	Min																												
		Median																												
		Mean																												
		Max																												
		Sample Count	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Washery Sediment Pond	Washery Sediment Pond	Min																												
		Median																												
		Mean																												
		Max																												
		Sample Count	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX B:
SCENARIO 1 - BASE CASE
SUMMARY TABLES AND FLOW CHARTS

Appendix B: Scenario One Base Case: Summary tables and flowcharts

Scenario One: Summary of Annual Water Balance for worked water on mine site

Worked water on mine site								
Annual Average (ML/year)								**ML/Day**
		Inputs				**Outputs**		**Storage**
Pond / dam	Description	Upstream Spill	Clean runoff	Worked runoff	Rainfall onto pond	Evaporation	Spill	Daily Average
S-LG1	Spills into S-LG3	0.00	0.90	22.63	0.19	0.28	23.43	7.14
S-LG3	Spills into S-LG5	23.43	0.90	22.63	0.13	0.19	46.87	4.03
S-LG5	Spills into STOCKPILE DAM	46.87	1.79	45.26	0.48	0.74	93.65	29.13
STOCKPILE DAM	Spills into RETENTION DAM	93.65	3.59	21.83	0.19	0.28	65.82	2.47
WASHERY DAM	Spills into RETENTION DAM	0.00	51.57	95.31	0.30	0.46	146.70	4.63
	Total	**163.94**	**58.75**	**207.66**	**1.28**	**1.95**	**376.46**	**47.39**
		Total Inputs	**431.63**			**Total Outputs**	**378.41**	

Scenario One: Summary of Annual Water Balance for Water supply storage facilities

Water supply storage facilities											
Annual Average (ML/Year)											**ML/Day**
		Inputs					**Outputs**				**Storage**
Pond / dam	Description	Upstream Spill	Clean runoff	Disturbed runoff	Rainfall onto pond	Groundwater Seepage and leaks from upstream dams	Water to supply tanks	Evaporation	Spill	Leakage	Daily Average
DML DAM	Spills into COOKS DAM	0.00	33.52	65.02	0.56	36.50	0.00	0.86	111.27	120.72	13.57
COOKS DAM	Spills into LDP006	111.27	8.22	0.00	0.24	157.22	272.90	0.36	10.79	0.02	23.00
	Total	**111.27**	**41.74**	**65.02**	**0.79**	**193.72**	**272.90**	**1.21**	**122.05**	**120.74**	**36.57**
		Total Inputs	**412.55**			**Total Outputs**	**516.90**				

Scenario One: Summary of Annual Water Balance for Water Supply and On Site water use

Water Supply and on Site Water Use											
Annual Average (ML/Year)											**ML/Day**
		Inputs				**Outputs**					**Storage**
Pond/ dam	Description	Domestic water pipeline	Rainfall onto pond	Water Supply from Cooks Dam	Washery	Dust Spray	Dust Tankers	Evaporation	Domestic Water Use	Spill	Daily Average
WATER SUPPLY RESERVOIR	Supply on site raw water	0.00	0.00	272.90	215.93	19.11	37.85	0.00	0.00	0.00	0.60
Municipal Water for Offices, workshops and showers	On site water use	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
	Total	**0.02**	**0.00**	**272.90**	**215.93**	**19.11**	**37.85**	**0.00**	**0.02**	**0.00**	**0.60**
		Total Inputs	**272.92**			**Total Outputs**	**272.92**				

Scenario One: Summary of Annual Water Balance for Water from surrounding catchments and undisturbed site areas

Water from surrounding catchments and undisturbed site areas								
Annual Average (ML/Year)								**ML/Day**
		Inputs				**Outputs**		**Storage**
Pond/ dam	Description	Upstream Spill	Clean runoff	Disturbed runoff	Rainfall onto pond	Evaporation	Spill	Daily Average
S-LG2 + S-LG4	Spill into CONVEYOR DAM	0.00	199.05	26.86	1.38	2.11	225.16	44.02
CONVEYOR DAM	Spill into RETENTION DAM	225.16	45.58	13.21	0.66	1.01	283.58	14.86
	Total	**225.16**	**244.63**	**40.07**	**2.03**	**3.12**	**508.74**	**58.88**
		Total Inputs	**511.89**		**Total Outputs**	**511.85**		

Scenario One: Summary of Annual Water Balance for Retention Dam and LDP006

Annual Average Discharge (ML/Year)								ML/Day
		Inputs				**Outputs**		**Storage**
Pond/ dam	Description	Upstream Spill	Clean runoff	Disturbed runoff	Rainfall onto pond	Evaporation	Spill	Daily Average
RETENTION DAM	Spill into LDP006	496.09	27.60	0.00	0.30	0.45	523.51	4.60
LDP006	Spill Coal Services Site and drains to Wangcol creek	534.30	5.54	0.00	0.00	0.00	539.84	0.00
	Total	**1030.39**	**33.13**	**0.00**	**0.30**	**0.45**	**1063.35**	**4.60**
		Total Inputs	**1063.82**		**Total Outputs**	**1063.80**		

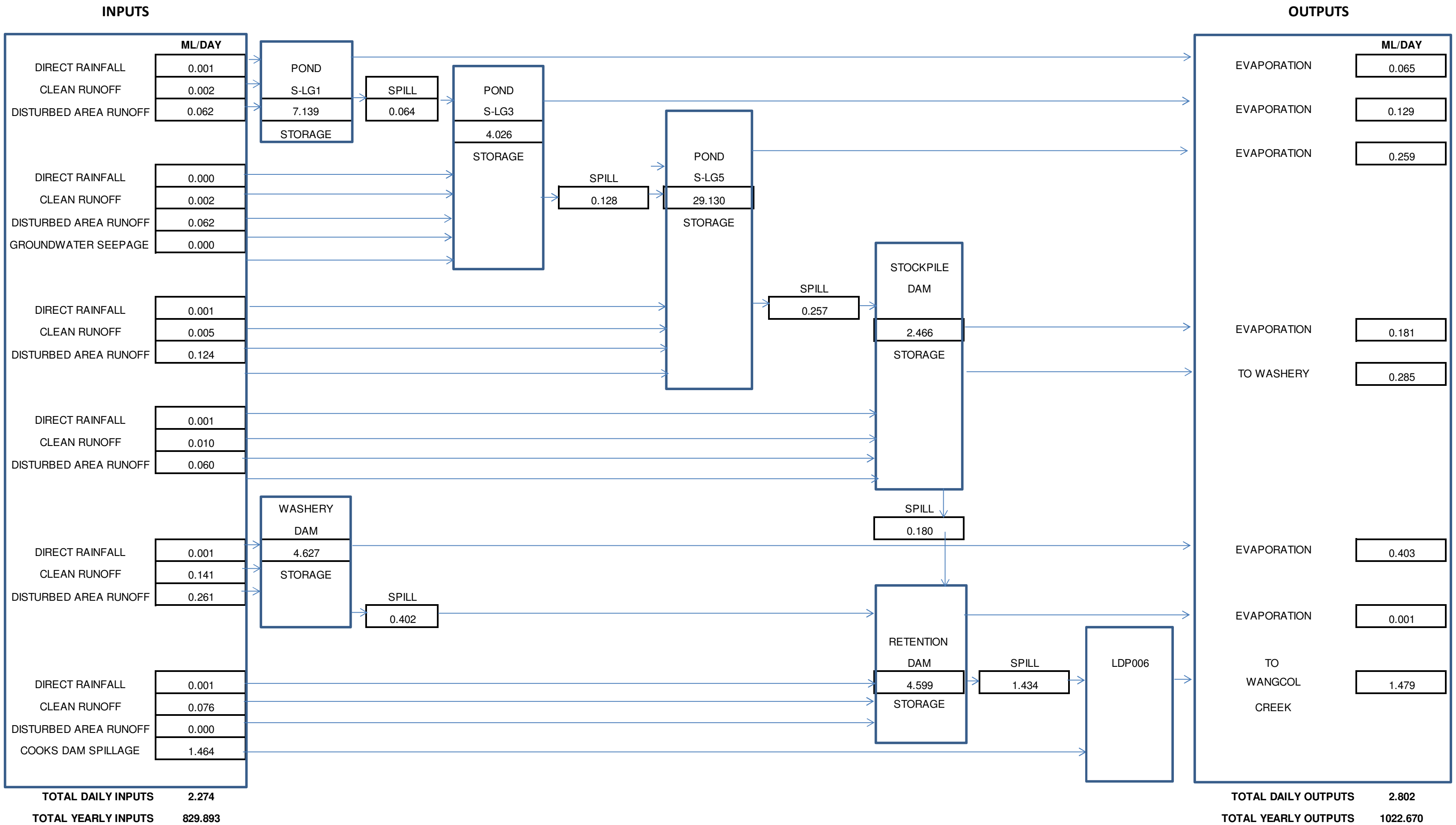
Scenario One: Daily Result for Licensed discharge point 6 spillage into Wangcol Creek

	LDP006
	OUTPUTS
Discharge to Wangcol Creek	(ML/D) Scenario 1
Average	1.48
Dry (10th Percentile)	0.05
Wet (90th Percentile)	3.25

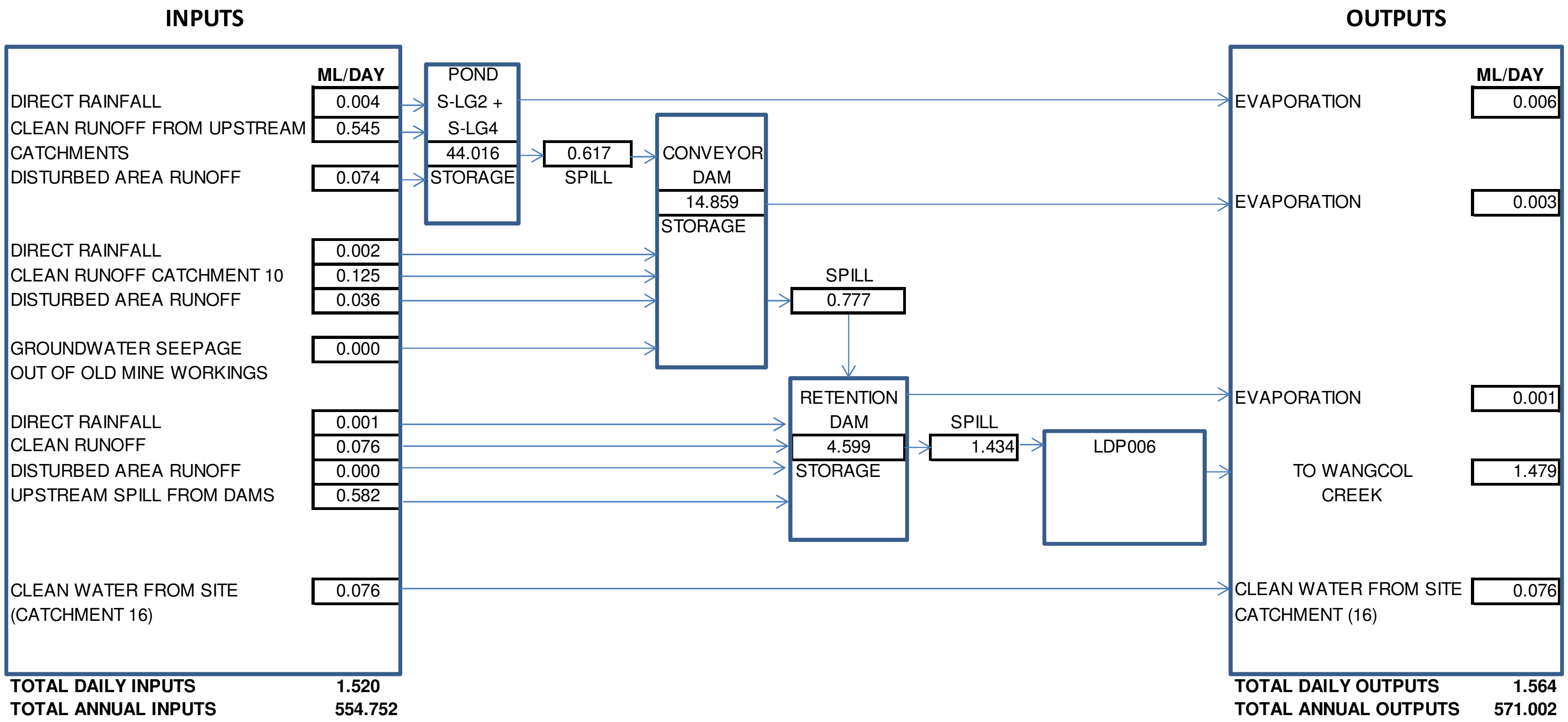
Scenario One: **Daily worked and undisturbed area runoff for ponds and dam in incremental catchment area**

	Undisturbed Area Runoff (ML/day)			Worked Area Runoff (ML/day)		
Pond/ Dam	Daily Average	10% Percentile	90% Percentile	Daily Average	10% Percentile	90% Percentile
S-LG1	0.0025	0.0001	0.0049	0.0620	0.0010	0.1550
S-LG3	0.0025	0.0001	0.0049	0.0620	0.0010	0.1550
S-LG5	0.0049	0.0002	0.0098	0.1240	0.0020	0.3100
STOCKPILE DAM	0.0098	0.0004	0.0197	0.0598	0.0010	0.1495
WASHERY DAM	0.1413	0.0059	0.2828	0.2611	0.0042	0.6528
DML DAM	0.0918	0.0038	0.1839	0.1782	0.0028	0.4454
COOKS DAM	0.0225	0.0009	0.0451	0.0000	0.0000	0.0000
S-LG2 + S-LG4	0.5453	0.0226	1.0918	0.0736	0.0012	0.1840
CONVEYOR DAM	0.1249	0.0052	0.2500	0.0362	0.0006	0.0905
RETENTION DAM	0.0756	0.0031	0.1514	0.0000	0.0000	0.0000
LDP006	0.0152	0.0006	0.0304	0.0000	0.0000	0.0000

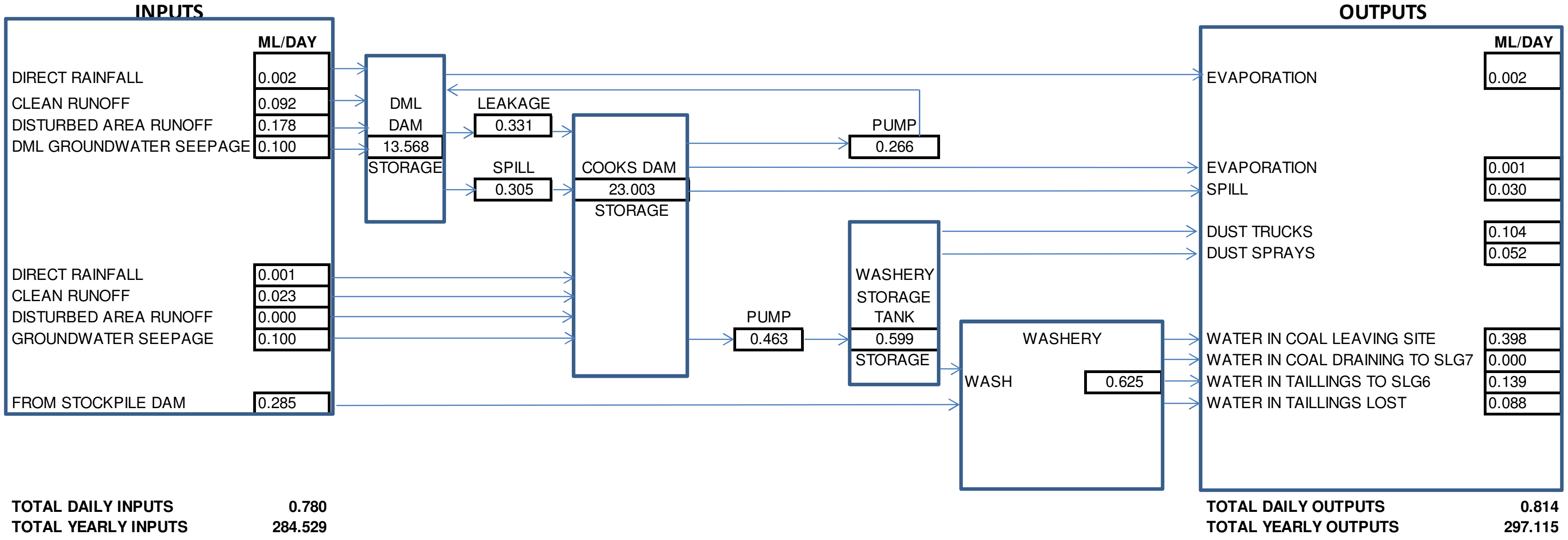
WATER BALANCE FOR WORKED WATER



WATER BALANCE FOR CLEAN WATER DISCHARGE



WATER BALANCE FOR RAW WATER SUPPLY



APPENDIX C:
SCENARIO 4 – FUTURE LAYOUT SUMMARY TABLES AND FLOW CHARTS

Appendix C: Scenario Four Future Layout: Summary tables and flowcharts

Scenario Four: Summary of Annual Water Balance for worked water on mine site

Worked water on mine site									
Annual Average (ML/year)									ML/Day
		Inputs				Outputs			Storage
Pond / dam	Description	Upstream Spill	Clean runoff	Worked runoff	Rainfall onto pond	Evaporation	Piped to Cooks dam	Spill	Daily Average
S-LG1	Spills into S-LG3		0.00	50.48	0.02	0.03		50.47	3.58
S-LG3	Spills into S-LG5	50.47	0.00	50.48	0.01	0.02		100.92	1.78
S-LG5	Spills into New Sediment Dam	100.92	0.00	50.48	0.03	0.03		151.38	4.05
NEW SEDINENT DAM	Spills into WASHERY DAM	151.38	0.00	143.11	0.02	0.03		77.18	5.72
WASHERY DAM	Spills into Cooks Dam	77.18	22.39	30.84	0.01	0.02	230.61	230.61	2.75
STOCKPILE DAM	Spills into S-LG6		0.00	21.83	0.02	0.03		160.62	1.99
S-LG7	Spills into RETENTION DAM	160.62	2.44	4.57	0.00	0.01		0.46	0.47
	Total	**540.57**	**24.84**	**351.78**	**0.12**	**0.17**	**230.61**	**771.64**	**20.34**
		Total Inputs		**917.31**		**Total Outputs**		**1002.42**	

Scenario Four: Summary of Annual Water Balance for Water supply storage facilities

Water supply storage facilities											
Annual Average (ML/Year)											**ML/Day**
		Inputs					**Outputs**				**Storage**
Pond / dam	Description	Upstream Spill	Clean runoff	Disturbed runoff	Rainfall onto pond	Groundwater Seepage and leaks from upstream dams	Water to supply tanks	Evaporation	Spill	Leakage	Daily Average
DML DAM	Spills into COOKS DAM	0.00	36.10	27.00	0.27	36.50	0.00	0.42	893.40	141.49	92.14
PIPELINE	Pipe line from S-LG7 to COOKS DAM	230.61									
PIPELINE	Pipe line from RETENTION DAM to COOKS DAM	0.00									
COOKS DAM	Spills into LDP006	893.40	8.22	0.00	0.06	177.99	224.17	0.10	935.06	0.00	15.48
	Total	**1124.02**	**44.32**	**27.00**	**0.34**	**214.49**	**224.17**	**0.52**	**1828.46**	**141.49**	**107.63**
		Total Inputs	**1410.16**			**Total Outputs**	**2194.64**				

Scenario Four: Summary of Annual Water Balance for Water Supply and On Site water use

Water Supply and on Site Water Use											
Annual Average (ML/Year)											ML/Day
		Inputs				Outputs					Storage
Pond/ dam	Description	Domestic water pipeline	Rainfall onto pond	Water Supply from Cooks Dam	Washery	Dust Spray	Dust Tankers	Evaporation	Domestic Water Use	Spill	Daily Average
WATER SUPPLY RESERVOIR	Supply on site raw water	0.00	0.00	224.17	167.21	19.11	37.85	0.00	0.00	0.00	0.60
Municipal Water for Offices, workshops and showers	On site water use	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
	Total	**0.02**	**0.00**	**224.17**	**167.21**	**19.11**	**37.85**	**0.00**	**0.02**	**0.00**	**0.60**
		Total Inputs	**224.20**			**Total Outputs**	**224.19**				

Scenario Four: Summary of Annual Water Balance for Water from surrounding catchments and undisturbed site areas

Water from surrounding catchments and undisturbed site areas								
Annual Average (ML/Year)								ML/Day
		Inputs				Outputs		Storage
Pond/ dam	Description	Upstream Spill	Clean runoff	Disturbed runoff	Rainfall onto pond	Evaporation	Spill	Daily Average
S-LG2 + S-LG4	Spill into CONVEYOR DAM	0.00	219.10	26.86	0.10	0.15	245.89	15.07
CONVEYOR DAM	Spill into RETENTION DAM	245.89	45.58	13.21	0.14	0.22	304.58	25.30
	Total	**245.89**	**264.68**	**40.07**	**0.24**	**0.37**	**550.47**	**40.37**
		Total Inputs	**550.88**		**Total Outputs**	**550.84**		

Scenario Four: Summary of Annual Water Balance for Retention Dam and LDP006

Annual Average Discharge (ML/Year)								ML/Day
		Inputs				**Outputs**		**Storage**
Pond/ dam	Description	Upstream Spill	Clean runoff	Disturbed runoff	Rainfall onto pond	Evaporation	Spill	Daily Average
RETENTION DAM	Spill into LDP006	391.24	20.42	0.00	0.04	0.05	341.88	4.49
LDP006	Spill Coal Services Site and drains to Wangcol creek	1276.93	5.54	0.00	0.00	0.00	485.26	0.00
	Total	**1668.17**	**25.96**	**0.00**	**0.04**	**0.05**	**827.14**	**4.49**
		Total Inputs	**1694.17**		**Total Outputs**	**827.19**		

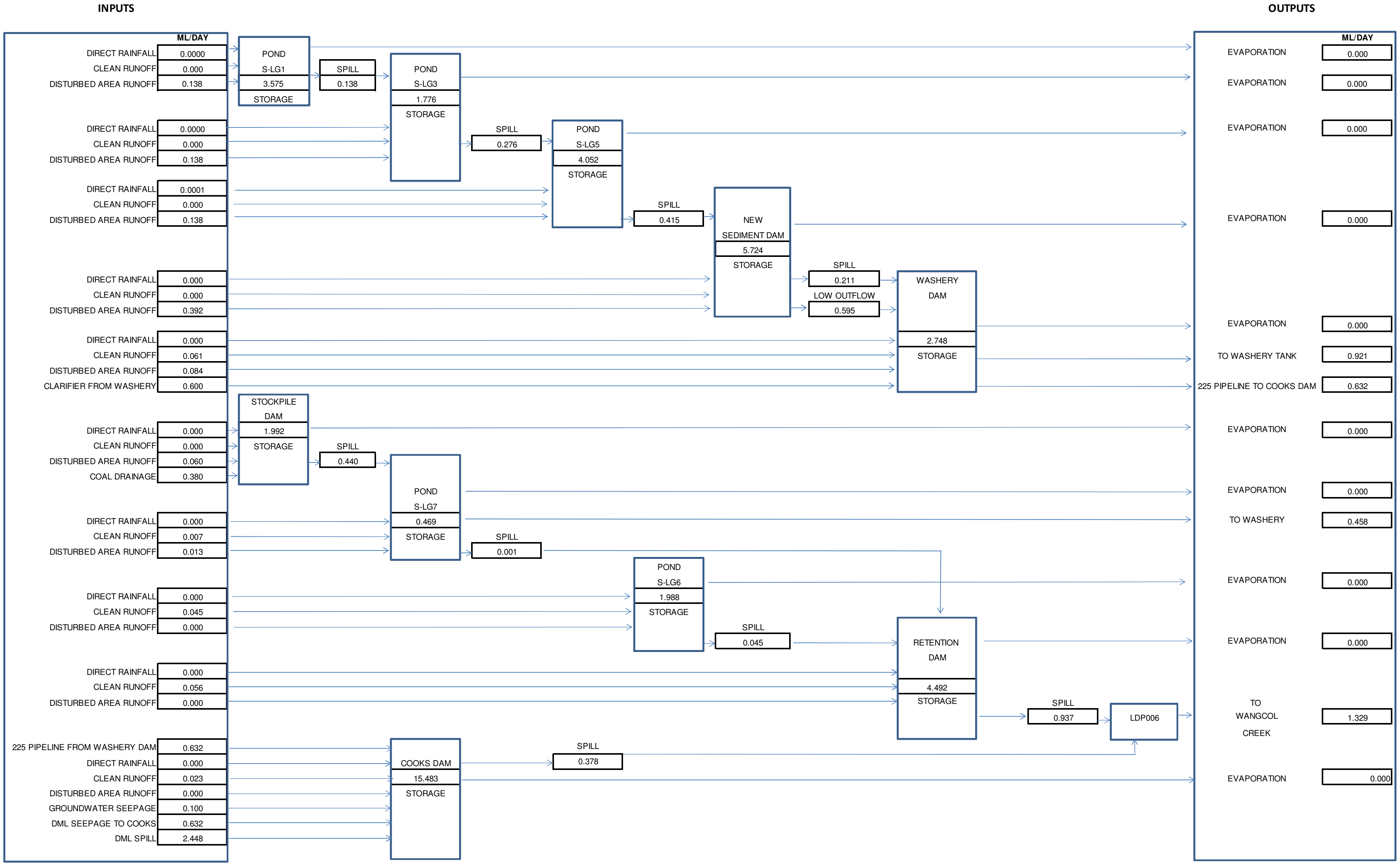
Scenario Four: Daily Result for Licensed discharge point 6 spillage into Wangcol Creek

	LDP006
	OUTPUTS
Discharge to Wangcol Creek	(ML/D)
Average	1.33
Dry (10th Percentile)	0.04
Wet (90th Percentile)	2.80

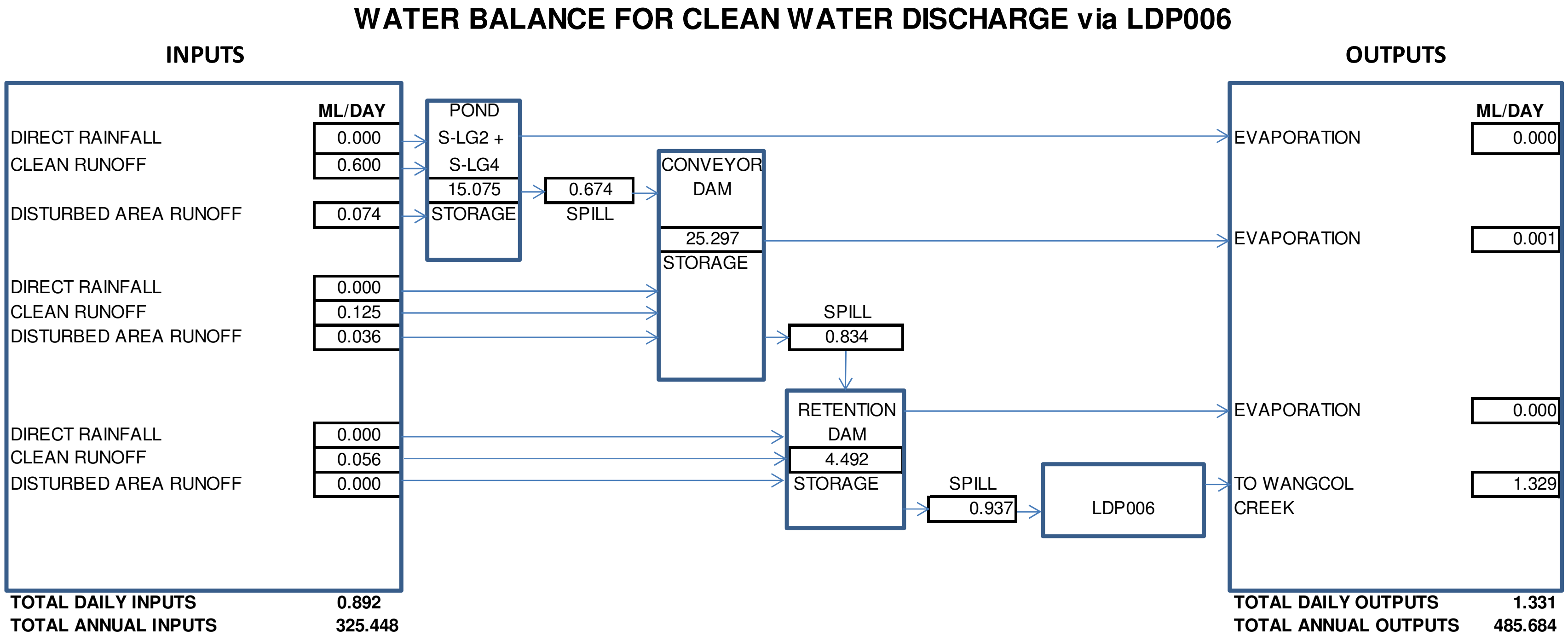
Scenario Four: Daily worked and undisturbed area runoff for ponds and dam in incremental catchment area

	Undisturbed Area Runoff (ML/day)			**Worked Area Runoff (ML/day)**		
Pond/ Dam	Daily Average	10% Percentile	90% Percentile	Daily Average	10% Percentile	90% Percentile
S-LG1	0.000	0.000	0.000	0.138	0.002	0.346
S-LG3	0.000	0.000	0.000	0.138	0.002	0.346
S-LG5	0.000	0.000	0.000	0.392	0.006	0.980
NEW SEDIMENT DAM	0.000	0.000	0.000	0.392	0.006	0.980
STOCKPILE DAM	0.000	0.000	0.000	0.060	0.001	0.150
S-LG7	0.007	0.000	0.013	0.013	0.000	0.031
WASHERY DAM	0.061	0.003	0.123	0.084	0.001	0.211
DML DAM	0.099	0.004	0.198	0.074	0.001	0.185
COOKS DAM	0.023	0.001	0.045	0.000	0.000	0.000
S-LG2 + S-LG4	0.600	0.025	1.202	0.074	0.001	0.184
CONVEYOR DAM	0.125	0.005	0.250	0.036	0.001	0.090
RETENTION DAM	0.056	0.002	0.112	0.000	0.000	0.000
LDP006	0.015	0.001	0.030	0.000	0.000	0.000

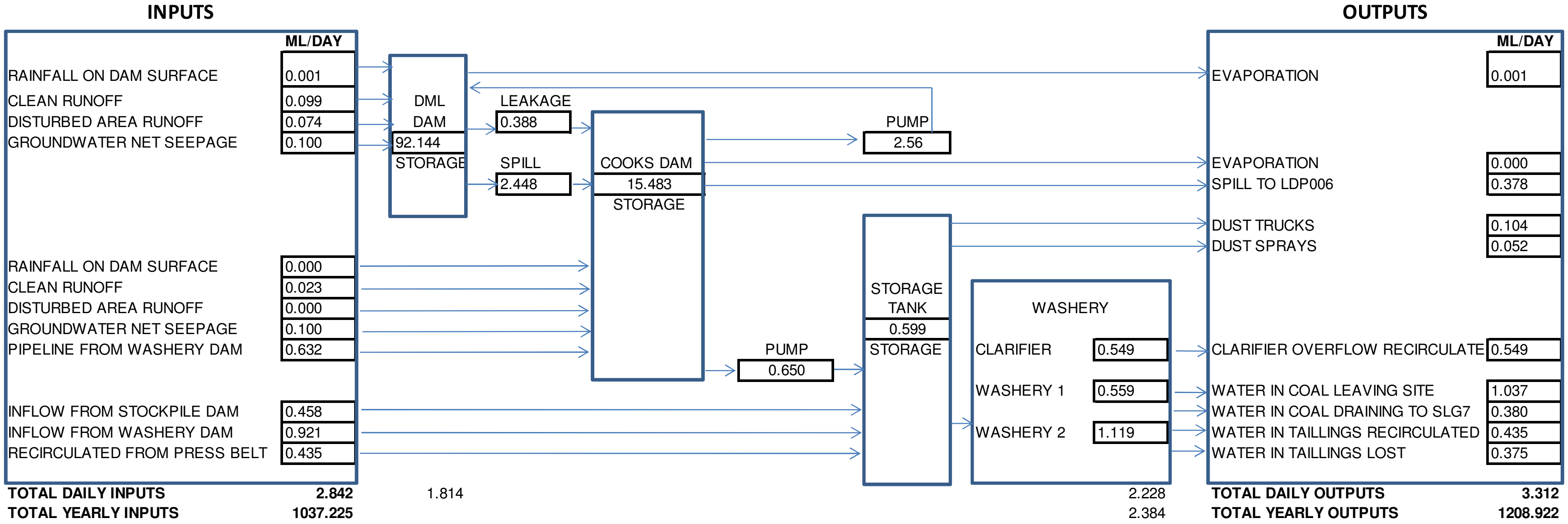
WATER BALANCE FOR WORKED WATER



TOTAL DAILY INPUTS	2.114	TOTAL DAILY OUTPUTS	3.341
TOTAL YEARLY INPUTS	771.560	TOTAL YEARLY OUTPUTS	1219.529


WATER BALANCE FOR CLEAN WATER DISCHARGE via LDP006
INPUTS
OUTPUTS
ML/DAY
DIRECT RAINFALL
0.000
CLEAN RUNOFF
0.600
DISTURBED AREA RUNOFF
0.074
POND
S-LG2 +
S-LG4
15.075
STORAGE
0.674
SPILL
CONVEYOR
DAM
25.297
STORAGE
DIRECT RAINFALL
0.000
CLEAN RUNOFF
0.125
DISTURBED AREA RUNOFF
0.036
SPILL
0.834
RETENTION
DAM
4.492
STORAGE
DIRECT RAINFALL
0.000
CLEAN RUNOFF
0.056
DISTURBED AREA RUNOFF
0.000
SPILL
0.937
LDP006
ML/DAY
EVAPORATION
0.000
EVAPORATION
0.001
EVAPORATION
0.000
TO WANGCOL
CREEK
1.329
TOTAL DAILY INPUTS
0.892
TOTAL ANNUAL INPUTS
325.448
TOTAL DAILY OUTPUTS
1.331
TOTAL ANNUAL OUTPUTS
485.684

WATER BALANCE FOR RAW WATER SUPPLY



APPENDIX D: PREVIOUS WATER BALANCE SCENARIOS 2 AND 3 DESCRIPTION, SUMMARY TABLES AND FLOW CHARTS

Summary of main inputs controlling water use and water transfers in the Springvale Coal Services Water Balance Model

Daily water resources, use and return flows	**Scenario One Base Case**	**Scenario Two A**	**Scenario Two B**	**Scenario Two C**	**Scenario Three**
	(ML/day)	**(ML/day)**	**(ML/day)**	**(ML/day)**	**(ML/day)**
Offices and Workshops water demand	0.003	0.003	0.003	0.003	0.003
Dust Suppression on Roads (only if rainfall<1mm/d)	0.136	0.136	0.136	0.136	0.136
Dust Suppression on Stockpiles (only if rainfall<1mm/d and wind velocity >5m/s)	0.068	0.068	0.068	0.068	0.068
TOTAL Washery Demand	**0.680**	**1.691**	**1.691**	**1.691**	**1.691**
Water used at Washery 1	0.680	0.677	0.677	0.677	0.677
Water used at Washery 2	0.000	1.014	1.014	1.014	1.014
Clarifier Overflow	0.000	0.000	0.000	0.000	0.000
Water in the coal after washing (63.7% of wash water)	0.430	1.076	1.076	1.076	1.076
Water in the coal draining to stay on site	0.150	0.000	0.000	0.000	0.000
Water in coal lost via evaporation or to leave the site on conveyor	0.280	1.076	1.076	1.076	1.076
Water in Tailing after washing (36.3% of wash water)	0.250	0.615	0.615	0.615	0.615
Water in Tailings to be re-circulated in Washery (stockpile drainage or press belt)	0.126	0.000	0.000	0.000	0.000
Water in tailings lost via evaporation	0.250	0.615	0.615	0.615	0.615
TOTAL Water Re-usage	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Groundwater seepage to DML Dam	0.240	0.240	0.240	0.240	0.240
Groundwater seepage to Cooks Dam	0.240	0.240	0.240	0.240	0.240
Leakage from DML to Cooks Dam	0.400	0.400	0.400	0.400	0.400
Pump between DML and Cooks Dam	0.000	0.000	5.000	5.000	5.000
Pipeline from S-LG7 to Cooks	0.000	0.864	0.864	0.864	0.864
Transfer from Retention Dam to Cooks Dam	0.000	0.000	0.000	1.300	1.300

1. Scenario 2: Inclusion of the Coal Services Upgrade with changes to the water requirements and minor changes to the water supply system to improve water security.

For this set of scenarios the coal services upgrade is included by presenting incremental improvements to the water supply system so that the benefit of each method to improve the supply can be quantified. Three incremental strategies were tested (Scenario 2a, 2b and 2c) the results for these scenarios are presented in Appendix C difference between water requirements for this Scenario and the Base Case (Scenario 1) are tabulated above in Table 8.1 and specific differences are presented below:

- An increased water requirement at the proposed washery (increase from 41m^3/hour for the existing washery to 102m^3/hour to accommodate the 61m3/hour water use at the new washery). The washeries are expected to operate for about 6050 hours per annum. The annual average water requirement will be about 617ML/annum.

- The water requirements used for dust suppression and for domestic purposes in the base scenarios as well as the future upgrade were the same with the values being set to representing future conditions

The water supply scenarios are tested below:

1.1. Scenario 2a

Scenario 2a was added because the results of the base case scenario demonstrated that the water supply to the existing washery could not be met and therefore it would be necessary to implement additional water supply strategies. The changes added to the base case scenario included:

- A new pipeline to drain worked water from Sediment Pond SLG7 back to Cooks Dam in line with the recommendations presented in the Water Management Plan, GHD 2012. This dam is fed by stormwater draining the worked area and coal stockpiles on the western side of the Washery as well as worked water from emplacement areas to the south. This pipeline will route some of the water to Cooks Dam that previously drained into Lamberts Gully. It will therefore will reduce the amount of worked water discharged at LDP006 and increase the available water supply from Cooks Dam.
- A new reject emplacement area will be built below pond SLG7 severing the connectivity between it and existing sediment Pond SLG9.

The changes were included in the CSWBM and the results are presented in Appendix C: 2a. The key statistics for the current water supply security and the discharges at LDP006 are presented in Table 8.3.

Table 8.3 clearly indicates that raw water shortages still occur (percentiles of water supply to the washery indicate that the full water requirement is not sustained) and therefore additional water is required.

Scenario 2a: Summary statistics of water balance of water supplies in relation to water requirements and discharge amounts at LDP006 in relation to the licenced discharge amounts.

	Pipeline to Cooks Dam From S-LG7	**Pipeline to Cooks Dam from DML Dam**		**Washery ML/Day**	**Dust Suppression on Stockpiles ML/Day**	**Dust Suppression on Roads ML/Day**	**LDP006**	
			Water Requirement	1.691	0.068	0.136	Allowed Discharge	10ML/Day
			Water Supply				Actual Discharge	ML/Day
Daily Average	0.290	0.396	Daily Average	1.027	0.010	0.020	Daily Average	1.312
Daily Maximum	0.864	0.400	Daily Maximum	1.691	0.068	0.136	Daily Maximum	220.194
Daily Minimum	0.000	0.000	Daily Minimum	0.430	0.000	0.000	Daily Minimum	0.000
5 Percentile	0.006	0.400	5 Percentile	0.645	0.000	0.000	5 Percentile	0.024
10 Percentile	0.014	0.400	10 Percentile	0.654	0.000	0.000	10 Percentile	0.048
50 Percentile	0.161	0.400	50 Percentile	0.817	0.000	0.000	50 Percentile	0.398
70 Percentile	0.321	0.400	70 Percentile	1.210	0.000	0.000	70 Percentile	0.841
90 Percentile	0.864	0.400	90 Percentile	1.691	0.068	0.136	90 Percentile	2.701

Scenario 2a: Summary of Annual Water Balance for worked water on mine site

Worked water on mine site									
Annual Average (ML/year)									**ML/Day**
		Inputs				**Outputs**			**Storage**
Pond / dam	Description	Upstream Spill	Clean runoff	Worked runoff	Rainfall onto pond	Evaporation	Piped to Cooks dam	Spill	Daily Average
S-LG1	Spills into S-LG3		0.90	22.63	0.19	0.28		23.43	7.14
S-LG3	Spills into NEW DAM	23.43	0.90	22.63	0.13	0.19		46.87	4.03
NEW DAM	Spills into S-LG6+S-LG8	46.87	1.79	45.26	0.45	0.68		93.67	25.91
S-LG6 + S-LG8	Spills into RETENTION DAM	93.67	3.59	21.83	0.26	0.40		118.93	3.87
S-LG7 + S-LG9	Spills into RETENTION DAM		34.91	95.31	0.12	0.17		24.42	1.09
PIPELINE	Pipe line from S-LG7 to COOKS DAM						105.75		
	Total	**163.96**	**42.09**	**207.66**	**1.14**	**1.73**	**105.75**	**307.31**	**42.04**
		Total Inputs		**414.84**		**Total Outputs**		**414.79**	

Scenario 2a: Summary of Annual Water Balance for Water supply storage facilities

Water supply storage facilities											
Annual Average (ML/Year)											**ML/Day**
		Inputs					**Outputs**				**Storage**
Pond / dam	Description	Upstream dam Spills or Transfers	Clean runoff	Disturbed runoff	Rainfall onto pond	Groundwater Seepage and leaks from upstream dams	Water to supply tanks	Evaporation	Spill	Leakage	Daily Average
DML DAM	Spills into COOKS DAM	0.00	33.52	65.02	1.02	87.60	0.00	1.55	39.60	146.01	28.83
PIPELINE	Pipe line from S-LG7 to COOKS DAM	105.75									
PIPELINE	Pipe line from Retention Dam to COOKS DAM	0.00									
COOKS DAM	Spills into LDP006	39.60	8.22	0.00	0.06	233.61	386.07	0.08	2.26	0.00	4.36
	Total	**145.35**	**41.74**	**65.02**	**1.07**	**321.21**	**386.07**	**1.63**	**41.85**	**146.01**	**33.19**
		Total Inputs	**574.40**			**Total Outputs**	**575.57**				

Scenario 2a: Summary of Annual Water Balance for Water Supply and On Site water use

Water Supply and on Site Water Use											
Annual Average (ML/Year)											**ML/Day**
		Inputs				**Outputs**					**Storage**
Pond/ dam	Description	domestic water pipeline	Rainfall onto pond	Water Supply from Cooks Dam	Washery	Dust Spray	Dust Tankers	Evaporation	Domestic Water Use	Spill	Daily Average
WATER SUPPLY RESERVOIR	supply on site raw water	0.00	0.00	386.07	375.05	3.70	7.32	0.00	0.00	0.00	0.60
Municipal Water for Offices, workshops and showers	On site water use	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
	Total	0.02	0.00	386.07	375.05	3.70	7.32	0.00	0.02	0.00	0.60
		Total Inputs	386.09			Total Outputs	386.09				

Scenario 2a: Summary of Annual Water Balance for Water from surrounding catchments and undisturbed site areas

Water from surrounding catchments and undisturbed site areas								
Annual Average (ML/Year)								ML/Day
		Inputs				**Outputs**		**Storage**
Pond/ dam	Description	Upstream Spill	Clean runoff	Disturbed runoff	Rainfall onto pond	Evaporation	Spill	Daily Average
S-LG2 + S-LG4	Spill into MAIN SEDIMENT DAM	0.00	199.05	26.86	1.38	2.11	225.16	44.02
MAIN SEDIMENT DAM	Spill into Retention Dam	225.16	45.58	13.21	0.66	1.01	283.58	14.86
	Total	225.16	244.63	40.07	2.03	3.12	508.74	58.88
		Total Inputs	511.89		Total Outputs	511.85		

Scenario 2a: Summary of Annual Water Balance for Retention Dam and LDP006

Annual Average Discharge (ML/Year)								**ML/Day**
		Inputs				**Outputs**		**Storage**
Pond/ dam	Description	Upstream Spill	Clean runoff	Disturbed runoff	Rainfall onto pond	Evaporation	Spill	Daily Average
RETENTION DAM	Spill into LDP006	143.34	44.26	0.00	0.30	0.45	471.00	4.60
LDP006	Spill Coal Services Site and drains to Wangcol creek	756.84	5.54	0.00	0.00	0.00	478.80	0.00
	Total	**900.18**	**49.80**	**0.00**	**0.30**	**0.45**	**949.80**	**4.60**
		Total Inputs	**950.27**		**Total Outputs**	**950.25**		

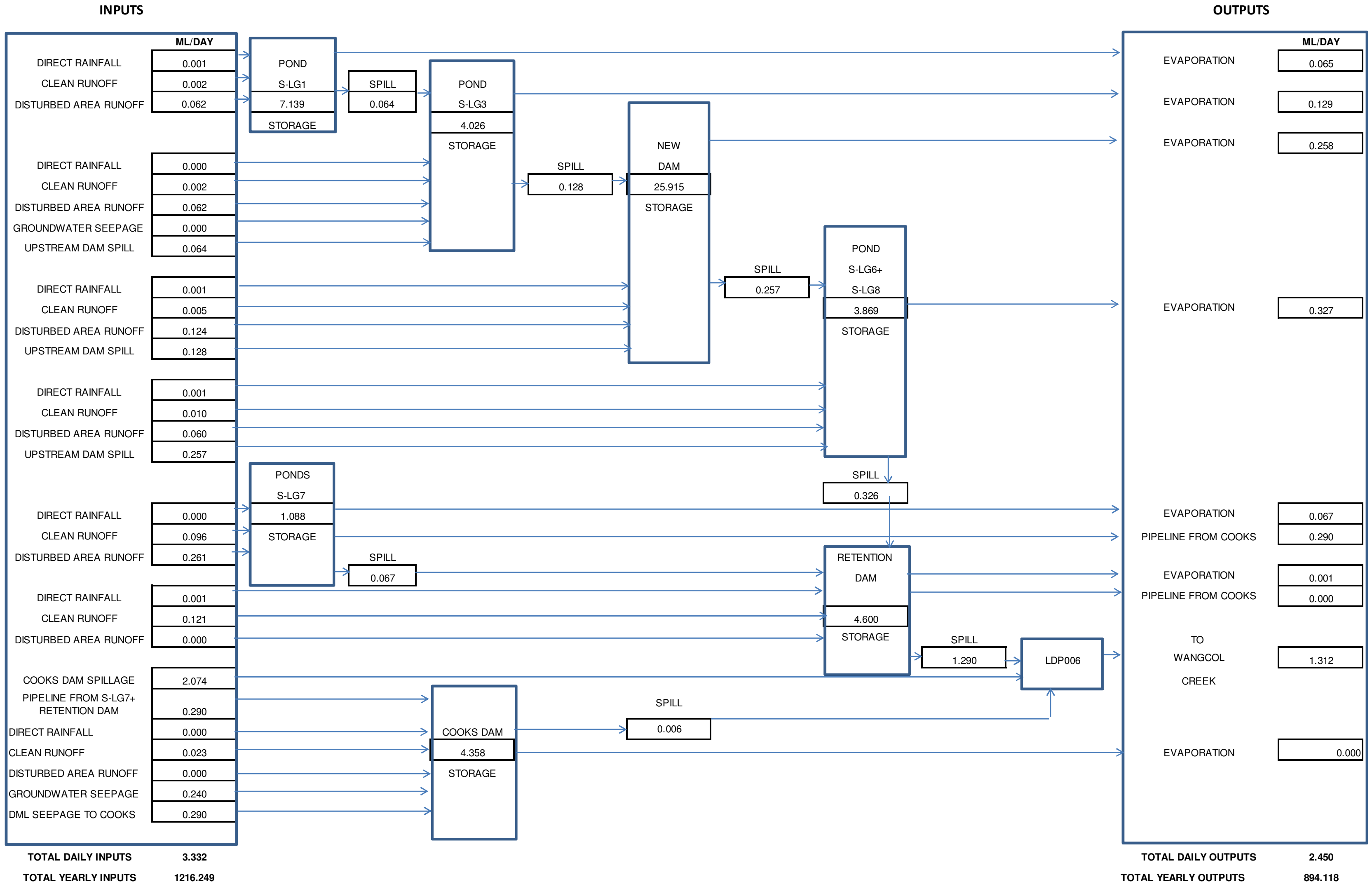
Scenario 2a: Daily Result for Licensed discharge point 6 spillage into Wangcol Creek

	LDP006
	OUTPUTS
Discharge to Wangcol Creek	(ML/D) Scenario 1
Average	1.31
Dry (10th Percentile)	0.05
Wet (90th Percentile)	2.70

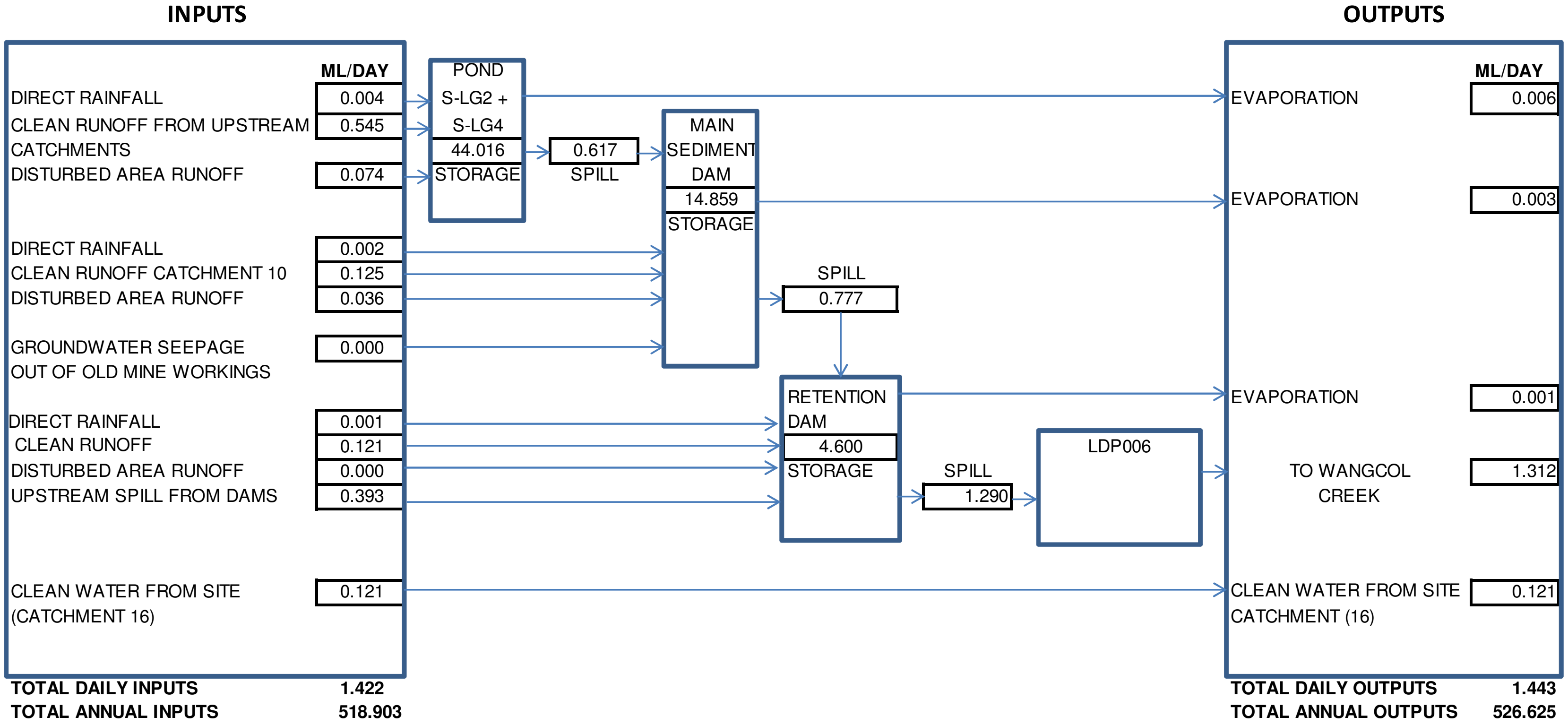
Scenario 2a: Daily worked and undisturbed area runoff for ponds and dam in incremental catchment area

	Undisturbed Area Runoff (ML/day)			Worked Area Runoff (ML/day)		
Pond/ Dam	Daily Average	10% Percentile	90% Percentile	Daily Average	10% Percentile	90% Percentile
S-LG1	0.0025	0.0001	0.0049	0.0620	0.0010	0.1550
S-LG3	0.0025	0.0001	0.0049	0.0620	0.0010	0.1550
NEW DAM	0.0049	0.0002	0.0098	0.1240	0.0020	0.3100
S-LG6 + S-LG8	0.0098	0.0004	0.0197	0.0598	0.0010	0.1495
S-LG7+ S-LG9	0.0956	0.0040	0.1915	0.2611	0.0042	0.6528
DML DAM	0.0918	0.0038	0.1839	0.1782	0.0028	0.4454
COOKS DAM	0.0225	0.0009	0.0451	0.0000	0.0000	0.0000
S-LG2 + S-LG4	0.5453	0.0226	1.0918	0.0736	0.0012	0.1840
MAIN SEDIMENT DAM	0.1249	0.0052	0.2500	0.0362	0.0006	0.0905
RETENTION DAM	0.1213	0.0050	0.2427	0.0000	0.0000	0.0000
LDP006	0.0152	0.0006	0.0304	0.0000	0.0000	0.0000

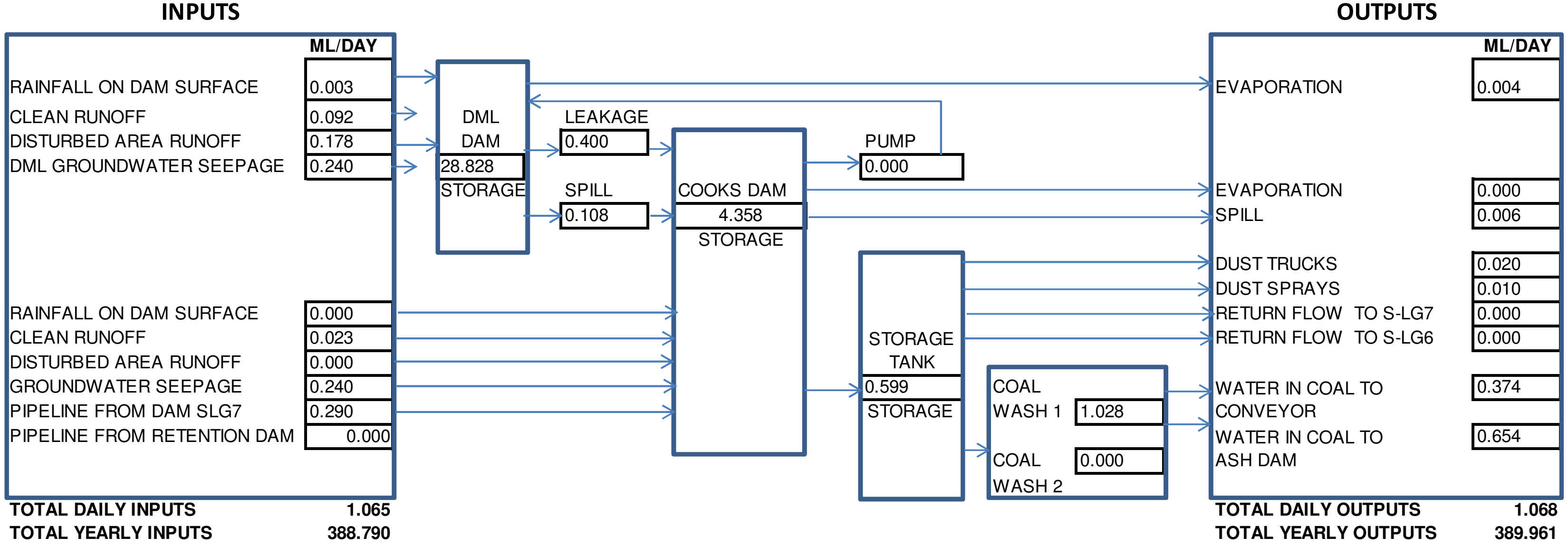
WATER BALANCE FOR WORKED WATER



WATER BALANCE FOR CLEAN WATER DISCHARGE via LDP006



WATER BALANCE FOR RAW WATER SUPPLY



1.2. Scenario 2b

The DML Dam is located adjacent to Cooks Dam and has a larger storage. It leaks into Cooks Dam. In the water balance modelling the rate of leakage is set at a fixed, assumed rate of 0.24 ML/day. The actual amount may differ. Increasing the amount in the model resulted in unnecessary wasteful spillages from Cooks Dam and reducing the amount resulted in increased water shortfalls during dry periods. The strategy implemented in modelling was to include the concept of an operating rule to simulate a pumped exchange between the two dams so as to maximise the benefit of the combined storage of the two dams in order to optimise water security and minimise the discharge of worked water. The operating rule involved keeping the storage level in Cooks Dam above 50% and below 95% of its full supply capacity, by pumping water into or out of the DML Dam. This was subject to the constraints of the amount of water in the DML Dam and pumping rate used to exchange water between the dams. The exchange is not possible if the DML Dam is spilling or empty.

The results are summarised in Table 8.4 and presented in more detail in Appendix C: 2b. The results demonstrated an increase in water security but the full requirement for raw water is still not satisfied for Coal Services Upgrade.

Scenario 2b: Summary statistics of water balance of water supplies in relation to water requirements and discharge amounts at LDP006 in relation to the licenced discharge amounts.

	Pipeline to Cooks Dam From S-LG7	Pipeline to Cooks Dam from DML Dam		Washery ML/Day	Dust Suppression on Stockpiles ML/Day	Dust Suppression on Roads ML/Day	LDP006	
			Water Requirement	**1.691**	**0.068**	**0.136**	**Allowed Discharge**	**10ML/Day**
			Water Supply				Actual Discharge	ML/Day
Daily Average	0.290	0.501	Daily Average	1.020	0.015	0.030	Daily Average	1.307
Daily Maximum	0.864	5.000	Daily Maximum	1.691	0.068	0.136	Daily Maximum	220.194
Daily Minimum	0.000	0.240	Daily Minimum	0.481	0.000	0.000	Daily Minimum	0.000
5 Percentile	0.006	0.245	5 Percentile	0.492	0.000	0.000	5 Percentile	0.024
10 Percentile	0.014	0.251	10 Percentile	0.508	0.000	0.000	10 Percentile	0.048
50 Percentile	0.161	0.359	50 Percentile	0.789	0.000	0.000	50 Percentile	0.398
70 Percentile	0.321	0.439	70 Percentile	1.691	0.000	0.000	70 Percentile	0.841
90 Percentile	0.864	0.803	90 Percentile	1.691	0.068	0.136	90 Percentile	2.698

Scenario 2b: Summary of Annual Water Balance for worked water on mine site

Worked water on mine site									
Annual Average (ML/year)									**ML/Day**
		Inputs				**Outputs**			**Storage**
Pond / dam	Description	Upstream Spill	Clean runoff	Worked runoff	Rainfall onto pond	Evaporation	Piped to Cooks dam	Spill	Daily Average
S-LG1	Spills into S-LG3		0.90	22.63	0.19	0.28		23.43	7.14
S-LG3	Spills into NEW DAM	23.43	0.90	22.63	0.13	0.19		46.87	4.03
NEW DAM	Spills into S-LG6+S-LG8	46.87	1.79	45.26	0.45	0.68		93.67	25.91
S-LG6 + S-LG8	Spills into RETENTION DAM	93.67	3.59	21.83	0.26	0.40		118.93	3.87
S-LG7 + S-LG9	Spills into RETENTION DAM		34.91	95.31	0.12	0.18		20.76	1.19
PIPELINE	Pipe line from S-LG7 to COOKS DAM						109.44		
	Total	**163.96**	**42.09**	**207.66**	**1.14**	**1.74**	**109.44**	**303.65**	**42.14**
		Total Inputs		**414.85**		**Total Outputs**		**414.83**	

Scenario 2b: Summary of Annual Water Balance for Water supply storage facilities

Water supply storage facilities											
Annual Average (ML/Year)											**ML/Day**
		Inputs					**Outputs**				**Storage**
Pond / dam	Description	Upstream dam Spills or Transfers	Clean runoff	Disturbed runoff	Rainfall onto pond	Groundwater Seepage and leaks from upstream dams	Water to supply tanks	Evaporation	Spill	Leakage	Daily Average
DML DAM	Spills into COOKS DAM	0.00	33.52	65.02	0.12	87.60	0.00	0.17	3.86	182.96	2.02
PIPELINE	Pipe line from S-LG7 to COOKS DAM	105.75									
PIPELINE	Pipe line from Retention Dam to COOKS DAM	0.00									
COOKS DAM	Spills into LDP006	3.86	8.22	0.00	0.07	270.56	388.88	0.09	0.64	0.00	4.89
	Total	**109.61**	**41.74**	**65.02**	**0.19**	**358.16**	**388.88**	**0.26**	**4.50**	**182.96**	**6.91**
		Total Inputs	**574.72**			**Total Outputs**	**576.59**				

Scenario 2b: Summary of Annual Water Balance for Water Supply and On Site water use

Water Supply and on Site Water Use											
Annual Average (ML/Year)											ML/Day
		Inputs				**Outputs**					**Storage**
Pond/ dam	Description	Domestic water pipeline	Rainfall onto pond	Water Supply from Cooks Dam	Washery	Dust Spray	Dust Tankers	Evaporation	Domestic Water Use	Spill	Daily Average
WATER SUPPLY RESERVOIR	supply on site raw water	0.00	0.00	388.88	372.21	5.59	11.08	0.00	0.00	0.00	0.60
Municipal Water for Offices, workshops and showers	On site water use	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
	Total	**0.02**	**0.00**	**388.88**	**372.21**	**5.59**	**11.08**	**0.00**	**0.02**	**0.00**	**0.60**
		Total Inputs	**388.90**			**Total Outputs**	**388.90**				

Scenario 2b: Summary of Annual Water Balance for Water from surrounding catchments and undisturbed site areas

Water from surrounding catchments and undisturbed site areas								
Annual Average (ML/Year)								ML/Day
		Inputs				**Outputs**		**Storage**
Pond/ dam	Description	Upstream Spill	Clean runoff	Disturbed runoff	Rainfall onto pond	Evaporation	Spill	Daily Average
S-LG2 + S-LG4	Spill into MAIN SEDIMENT DAM	0.00	199.05	26.86	1.38	2.11	225.16	44.02
MAIN SEDIMENT DAM	Spill into Retention Dam	225.16	45.58	13.21	0.66	1.01	283.58	14.86
	Total	225.16	244.63	40.07	2.03	3.12	508.74	58.88
		Total Inputs	511.89		Total Outputs	511.85		

Scenario 2b: Summary of Annual Water Balance for Retention Dam and LDP006

Annual Average Discharge (ML/Year)								**ML/Day**
		Inputs				**Outputs**		**Storage**
Pond/ dam	Description	Upstream Spill	Clean runoff	Disturbed runoff	Rainfall onto pond	Evaporation	Spill	Daily Average
RETENTION DAM	Spill into LDP006	143.34	44.26	0.00	0.30	0.45	471.00	4.60
LDP006	Spill Coal Services Site and drains to Wangcol creek	755.22	5.54	0.00	0.00	0.00	477.18	0.00
	Total	898.56	49.80	0.00	0.30	0.45	948.18	4.60
		Total Inputs	**948.66**		**Total Outputs**	**948.64**		

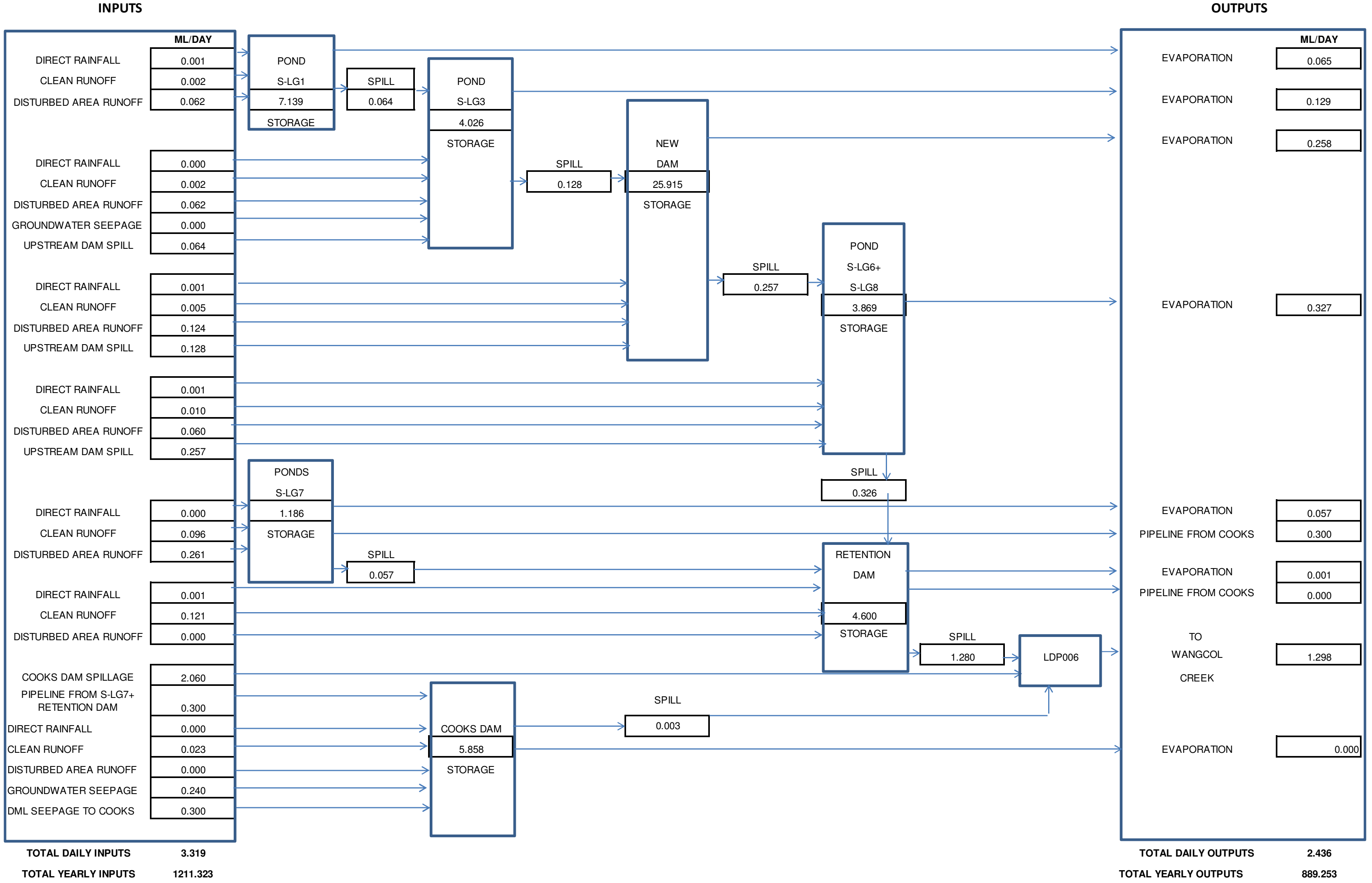
Scenario 2b: Daily Result for Licensed discharge point 6 spillage into Wangcol Creek

	LDP006
	OUTPUTS
Discharge to Wangcol Creek	(ML/D) Scenario 1
Average	1.31
Dry (10th Percentile)	0.05
Wet (90th Percentile)	2.70

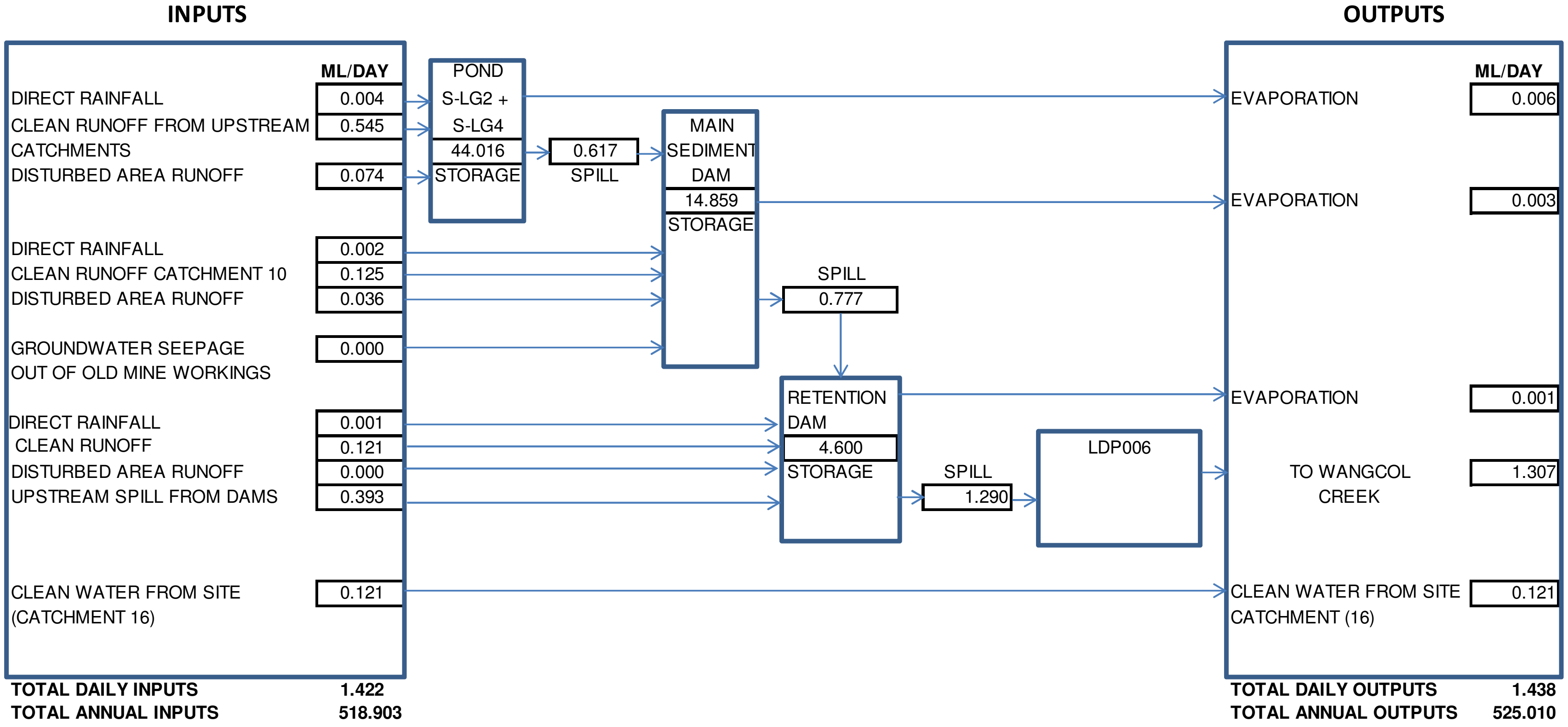
Scenario 2b: Daily worked and undisturbed area runoff for ponds and dam in incremental catchment area

	Undisturbed Area Runoff (ML/day)			**Worked Area Runoff (ML/day)**		
Pond/ Dam	Daily Average	10% Percentile	90% Percentile	Daily Average	10% Percentile	90% Percentile
S-LG1	0.0025	0.0001	0.0049	0.0620	0.0010	0.1550
S-LG3	0.0025	0.0001	0.0049	0.0620	0.0010	0.1550
NEW DAM	0.0049	0.0002	0.0098	0.1240	0.0020	0.3100
S-LG6 + S-LG8	0.0098	0.0004	0.0197	0.0598	0.0010	0.1495
S-LG7+ S-LG9	0.0956	0.0040	0.1915	0.2611	0.0042	0.6528
DML DAM	0.0918	0.0038	0.1839	0.1782	0.0028	0.4454
COOKS DAM	0.0225	0.0009	0.0451	0.0000	0.0000	0.0000
S-LG2 + S-LG4	0.5453	0.0226	1.0918	0.0736	0.0012	0.1840
MAIN SEDIMENT DAM	0.1249	0.0052	0.2500	0.0362	0.0006	0.0905
RETENTION DAM	0.1213	0.0050	0.2427	0.0000	0.0000	0.0000
LDP006	0.0152	0.0006	0.0304	0.0000	0.0000	0.0000

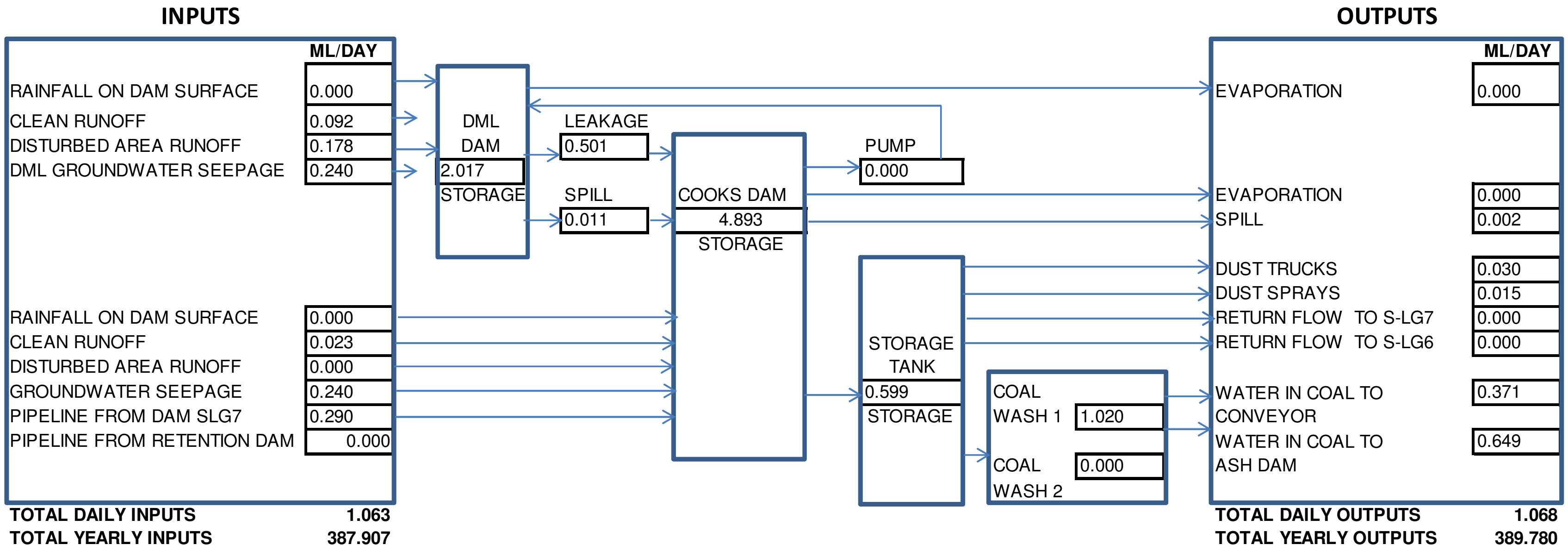
WATER BALANCE FOR WORKED WATER



WATER BALANCE FOR CLEAN WATER DISCHARGE via LDP006



WATER BALANCE FOR RAW WATER SUPPLY



1.3. Scenario 2c

Scenarios 2a and 2b make no use of any water draining from Lamberts Gully into the Retention Dam. Scenario 2c explores the possibility of using some of the water in the Retention Dam to make up the supply shortfall after implementing Scenarios 2a and 2b.

Water was only transferred from the Retention to Cooks Dam if the water level in Cooks Dam was less the 50%. The pumping rate was optimised at 1.3ML/day which is less than the 5ML/day rate of exchange with the DML Dam and resulting in more reliance on the DML Dam. The results indicate that that supplement of water from the Retention Dam enable the raw water needs of the Coal Services Upgrade to be satisfied.

Scenario 2c: Summary statistics of water balance of water supplies in relation to water requirements and discharge amounts at LDP006 in relation to the licenced discharge amounts.

	Pipeline to Cooks Dam From S-LG7	Pipeline to Cooks Dam from Retention Dam	Pipeline to Cooks Dam from DML Dam		Washery ML/Day	Dust Suppression on Stockpiles ML/Day	Dust Suppression on Roads ML/Day	LDP006	
				Water Requirement	1.691	0.068	0.136	Allowed Discharge	10ML/Day
				Water Supply				Actual Discharge	ML/Day
Daily Average	0.290	0.790	0.480	Daily Average	1.691	0.052	0.104	Daily Average	1.314
Daily Maximum	0.864	1.300	5.000	Daily Maximum	1.691	0.068	0.136	Daily Maximum	220.194
Daily Minimum	0.000	0.000	0.240	Daily Minimum	1.691	0.000	0.000	Daily Minimum	0.000
5 Percentile	0.006	0.000	0.245	5 Percentile	1.691	0.000	0.000	5 Percentile	0.024
10 Percentile	0.014	0.000	0.251	10 Percentile	1.691	0.000	0.000	10 Percentile	0.048
50 Percentile	0.161	1.300	0.367	50 Percentile	1.691	0.068	0.136	50 Percentile	0.398
70 Percentile	0.321	1.300	0.400	70 Percentile	1.691	0.068	0.136	70 Percentile	0.841
90 Percentile	0.864	1.300	0.400	90 Percentile	1.691	0.068	0.136	90 Percentile	2.698

Scenario 2c: Summary of Annual Water Balance for worked water on mine site

Worked water on mine site									
Annual Average (ML/year)									ML/Day
		Inputs				**Outputs**			**Storage**
Pond / dam	Description	Upstream Spill	Clean runoff	Worked runoff	Rainfall onto pond	Evaporation	Piped to Cooks dam	Spill	Daily Average
S-LG1	Spills into S-LG3		0.90	22.63	0.19	0.28		23.43	7.14
S-LG3	Spills into NEW DAM	23.43	0.90	22.63	0.13	0.19		46.87	4.03
NEW DAM	Spills into S-LG6+S-LG8	46.87	1.79	45.26	0.45	0.68		93.67	25.91
S-LG6 + S-LG8	Spills into RETENTION DAM	93.67	3.59	21.83	0.26	0.40		118.93	3.87
S-LG7 + S-LG9	Spills into RETENTION DAM		34.91	95.31	0.12	0.17		24.42	1.09
PIPELINE	Pipe line from S-LG7 to COOKS DAM						105.75		
	Total	**163.96**	**42.09**	**207.66**	**1.14**	**1.73**	**105.75**	**307.31**	**42.04**
		Total Inputs		**414.84**		**Total Outputs**		**414.79**	

Scenario 2c: Summary of Annual Water Balance for Water supply storage facilities

Water supply storage facilities											
Annual Average (ML/Year)											ML/Day
		Inputs					**Outputs**				**Storage**
Pond / dam	Description	Upstream dam Spills or Transfers	Clean runoff	Disturbed runoff	Rainfall onto pond	Groundwater Seepage and leaks from upstream dams	Water to supply tanks	Evaporation	Spill	Leakage	Daily Average
DML DAM	Spills into COOKS DAM	0.00	33.52	65.02	0.24	87.60	0.00	0.33	11.44	175.22	4.85
PIPELINE	Pipe line from S-LG7 to COOKS DAM	105.75									
PIPELINE	Pipe line from Retention Dam to COOKS DAM	288.48									
COOKS DAM	Spills into LDP006	11.44	8.22	0.00	0.37	262.82	674.06	0.56	3.03	0.00	35.55
	Total	**405.68**	**41.74**	**65.02**	**0.61**	**350.42**	**674.06**	**0.89**	**14.47**	**175.22**	**40.41**
		Total Inputs	**863.47**			**Total Outputs**	**864.64**				

Scenario 2c: Summary of Annual Water Balance for Water Supply and On Site water use

Water Supply and on Site Water Use											
Annual Average (ML/Year)											ML/Day
		Inputs				**Outputs**					**Storage**
Pond/ dam	Description	domestic water pipeline	Rainfall onto pond	Water Supply from Cooks Dam	Washery	Dust Spray	Dust Tankers	Evaporation	Domestic Water Use	Spill	Daily Average
WATER SUPPLY RESERVOIR	supply on site raw water	0.00	0.00	674.06	617.10	19.11	37.85	0.00	0.00	0.00	0.60
Municipal Water for Offices, workshops and showers	On site water use	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
	Total	0.02	0.00	674.06	617.10	19.11	37.85	0.00	0.02	0.00	0.60
		Total Inputs	674.08			Total Outputs	674.08				

Scenario 2c: Summary of Annual Water Balance for Water from surrounding catchments and undisturbed site areas

Water from surrounding catchments and undisturbed site areas								
Annual Average (ML/Year)								ML/Day
		Inputs				**Outputs**		**Storage**
Pond/ dam	Description	Upstream Spill	Clean runoff	Disturbed runoff	Rainfall onto pond	Evaporation	Spill	Daily Average
S-LG2 + S-LG4	Spill into MAIN SEDIMENT DAM	0.00	199.05	26.86	1.38	2.11	225.16	44.02
MAIN SEDIMENT DAM	Spill into Retention Dam	225.16	45.58	13.21	0.66	1.01	283.58	14.86
	Total	225.16	244.63	40.07	2.03	3.12	508.74	58.88
		Total Inputs	511.89		Total Outputs	511.85		

Scenario 2c: Summary of Annual Water Balance for Retention Dam and LDP006

Annual Average Discharge (ML/Year)								**ML/Day**
		Inputs				**Outputs**		**Storage**
Pond/ dam	Description	Upstream Spill	Clean runoff	Disturbed runoff	Rainfall onto pond	Evaporation	Spill	Daily Average
RETENTION DAM	Spill into LDP006	143.34	44.26	0.00	0.30	0.45	471.00	4.60
LDP006	Spill Coal Services Site and drains to Wangcol creek	757.61	5.54	0.00	0.00	0.00	479.57	0.00
	Total	900.95	49.80	0.00	0.30	0.45	950.57	4.60
		Total Inputs	**951.04**		**Total Outputs**	**951.02**		

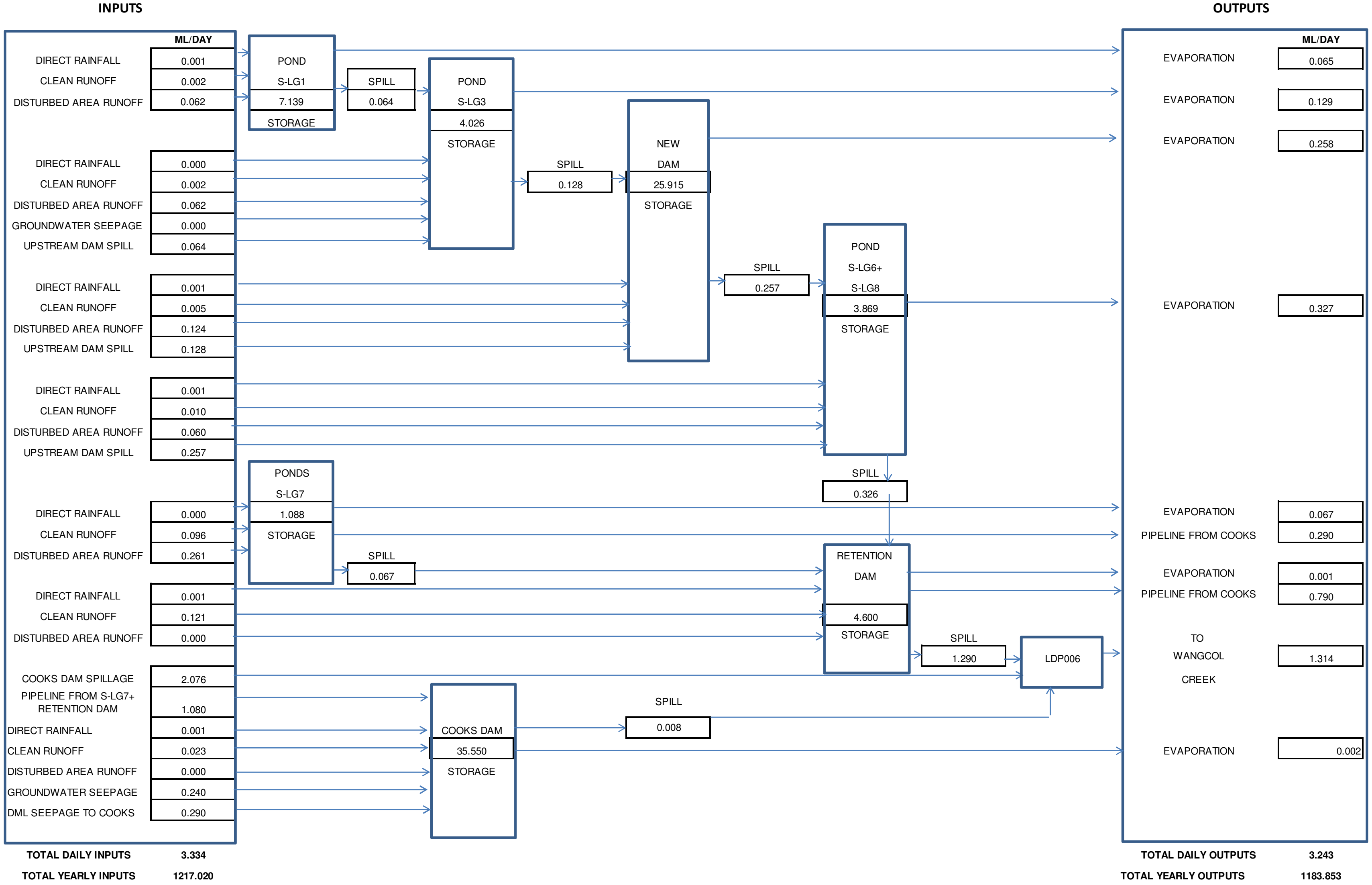
Scenario 2c: Daily Result for Licensed discharge point 6 spillage into Wangcol Creek

	LDP006
	OUTPUTS
Discharge to Wangcol Creek	(ML/D) Scenario 1
Average	1.31
Dry (10th Percentile)	0.05
Wet (90th Percentile)	2.70

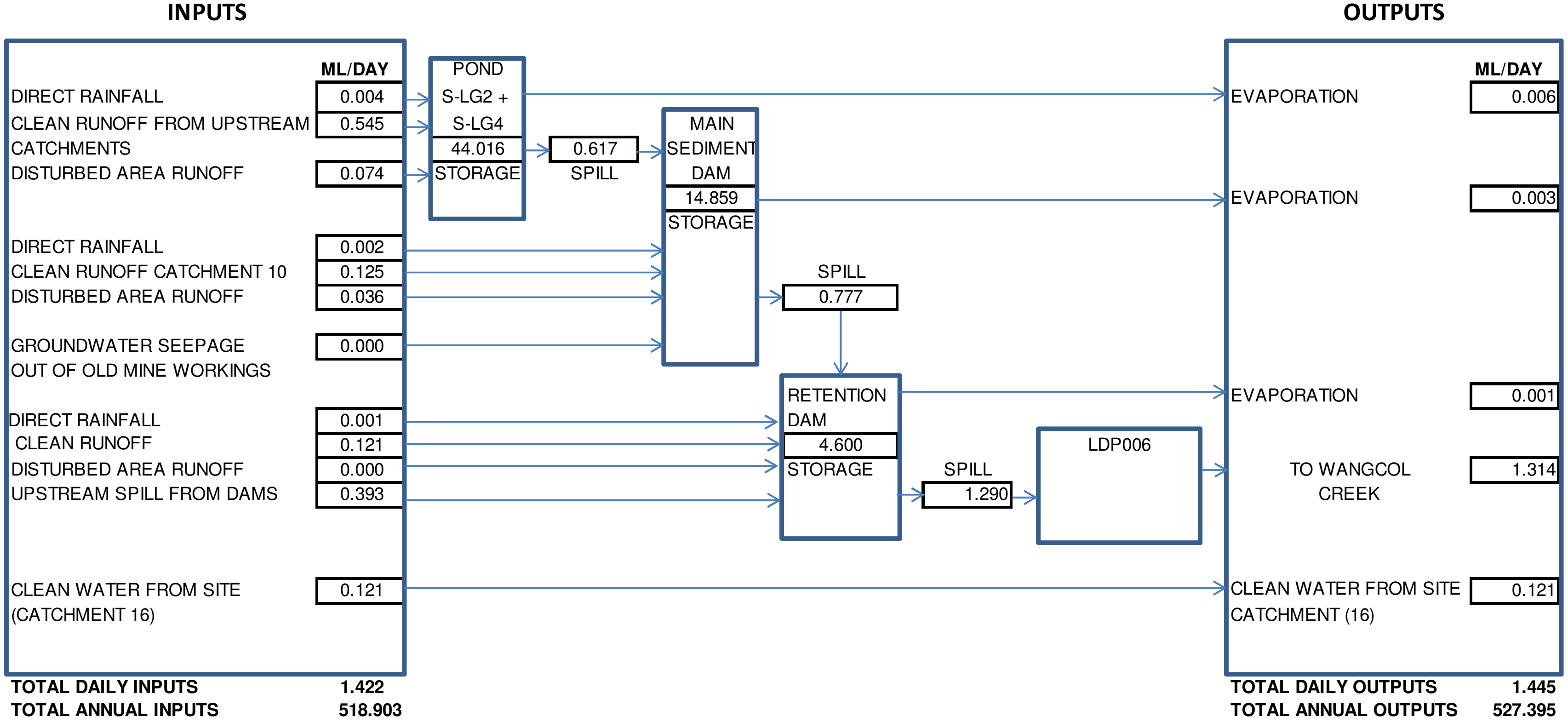
Scenario 2c: Daily worked and undisturbed area runoff for ponds and dam in incremental catchment area

	Undisturbed Area Runoff (ML/day)			Worked Area Runoff (ML/day)		
Pond/ Dam	Daily Average	10% Percentile	90% Percentile	Daily Average	10% Percentile	90% Percentile
S-LG1	0.0025	0.0001	0.0049	0.0620	0.0010	0.1550
S-LG3	0.0025	0.0001	0.0049	0.0620	0.0010	0.1550
NEW DAM	0.0049	0.0002	0.0098	0.1240	0.0020	0.3100
S-LG6 + S-LG8	0.0098	0.0004	0.0197	0.0598	0.0010	0.1495
S-LG7+ S-LG9	0.0956	0.0040	0.1915	0.2611	0.0042	0.6528
DML DAM	0.0918	0.0038	0.1839	0.1782	0.0028	0.4454
COOKS DAM	0.0225	0.0009	0.0451	0.0000	0.0000	0.0000
S-LG2 + S-LG4	0.5453	0.0226	1.0918	0.0736	0.0012	0.1840
MAIN SEDIMENT DAM	0.1249	0.0052	0.2500	0.0362	0.0006	0.0905
RETENTION DAM	0.1213	0.0050	0.2427	0.0000	0.0000	0.0000
LDP006	0.0152	0.0006	0.0304	0.0000	0.0000	0.0000

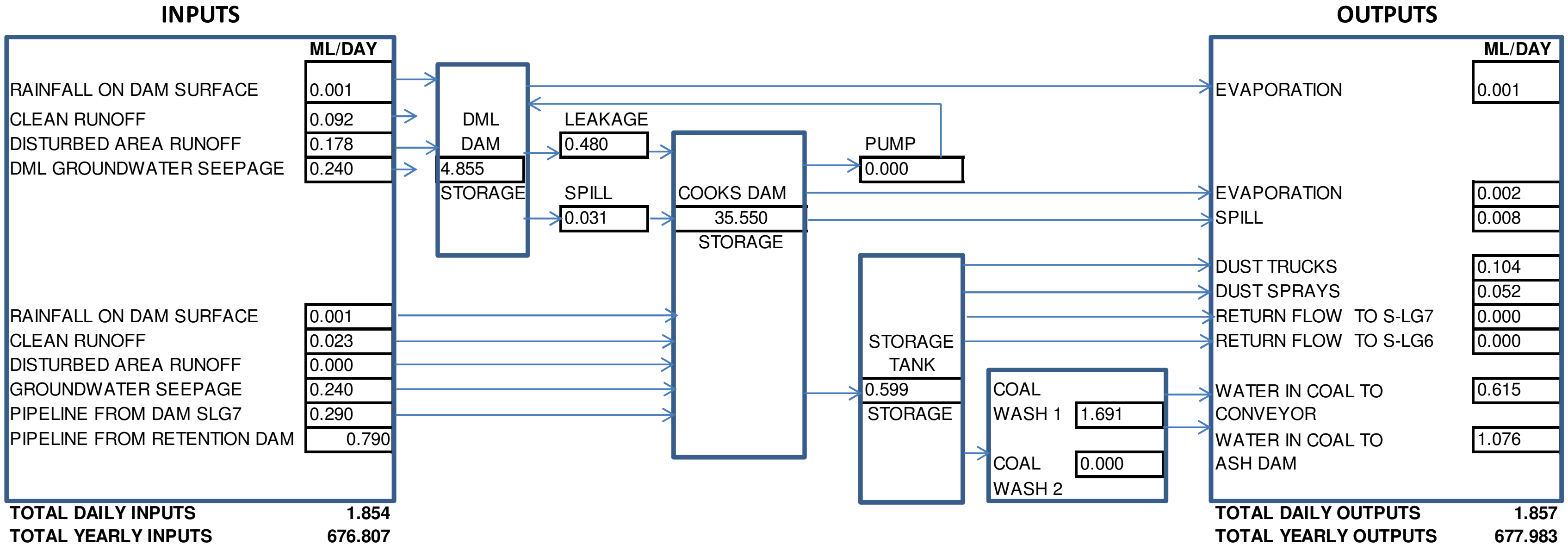
WATER BALANCE FOR WORKED WATER



WATER BALANCE FOR CLEAN WATER DISCHARGE via LDP006



WATER BALANCE FOR RAW WATER SUPPLY



2. Scenario 3: Inclusion of Coal Services Upgrade and strategies to reduce the amount of water discharged at LDP006.

The Base Case Scenario 1 for the existing water supply scheme and the set of Scenarios (2a,2b and 2c) all include substantial amounts of water from forested areas upstream of the project, being mixed with worked water at the Retention Dam before being discharged at LDP006. The prioritised use of water from Cooks Dam does not prevent this mixing even though it ensures that a larger portion of worked water is used as the main source of raw water. The licensed discharge amount should not exceed 10,000kL/day (10 ML/day). During wet periods it is not always possible to satisfy this requirement. The current strategy includes the use of sediment containment ponds to also serve to attenuate the flow from the upstream areas. It is possible to distinguish between drainage from worked areas and forested areas that have not been affected by historical mining activities or the coal services. The attenuation of water from the afforested areas occurs at sediment containment ponds SLG2, SLG4 and the Main Sediment Dam which just below pond SLG4. Dispersive soils are common in the region and increase sediment loads from the forested catchments and rehabilitated emplacement areas. Flocculation facilities have recently (March, 2012) been installed at the Main Sediment Dam to reduce sediment loadings at the Retention Dam which is also where the water is mixed with worked water before being spilt to LDP006. Considerable reductions in the risk of exceeding the licensed discharge allocations can be achieved if this water, the bulk of which does not originate from the Project Site, can be drained directly to the Wangcol Creek without entering the Retention Dam and bypassing LDP006. The drainage into the Retention Dam would be less if this water did not enter the dam. Uncertainty exists as to whether the inflow of worked water to the Retention Dam, without the additional inflow from the forested areas, would be sufficient to make up the shortfall in the transfer of raw water to Cooks Dam as tested in the above Scenario 2c. The focus of Scenario 3 is therefore to establish if this is possible.

From a practical point of view, it should be possible to modify the drainage in the vicinity of the Retention Dam so that water from the forested areas can by-pass the Retention Dam as well as LDP006. Also, the Lamberts Gully already contains two separate drainage channels between the Sediment Dam and the Retention Dam. These drainage channels cross over each using a system of pipes so that some of the (previously sediment laden) outflow from the Main Sediment Dam can be routed via a smaller sediment settling pond SLG8 before it reaches the Retention Dam. The use of SLG8 is unnecessary with the introduction of a flocculation system at the Main Sediment Dam and the pond will rather be used as a part of the sediment control facilities for the proposed new Reject Emplacement Number 4. The drainage system can therefore be reinstated to an earlier configuration of two parallel open channels.

The Western Channel can be used for draining the worked water originating from SLG6, which intercepts drainage from stockpiles below the washery, and in future this channel can also intercept the outflow from sediment pond SLG 8 which will contain worked water from Emplacement 4. This worked water needs to be routed into the Retention Dam for final sediment settling.

The Eastern Channel can be used exclusively for taking water originating from the forested areas (after sediment settling) and draining it straight out of the Lamberts Gully to the Wangol Creek, bypassing the Retention Dam and LDP006. To minimise risk of worked water reaching the Eastern Channel, the Western Channel will drain water which leaves the rehabilitated area on the eastern side of proposed emplacements number 4 (shown on Figure 2) which would all need to be routed to New Sediment Control Dam in the vicinity the current position of Pond SLG 5 shown on Figure 4. Outflows from this “New Dam” would need to be directed to the western channel possibly via pond SLG6 and must not overflow in the Sediment Dam or the Eastern Channel. Also, outflows from sediment pond SLG1 must drain into pond SLG3 and then into the “New Dam”.

The Scenario demonstrates that water shortfalls will occur during drought years. The outflow at LDP006 is however substantially reduced. We therefore suggests a system whereby a water from the afforested areas is allowed to enter the Retention Dam during drought periods in a controlled fashion but allowed to bypass the Retention Dam during periods of high rainfall when the dams are full.

Scenario 3: Summary statistics of water balance of water supplies in relation to water requirements and discharge amounts at LDP006 in relation to the licenced discharge amounts.

	Pipeline to Cooks Dam From S-LG7	**Pipeline to Cooks Dam from Retention Dam**	**Pipeline to Cooks Dam from DML Dam**		**Washery ML/Day**	**Dust Suppression on Stockpiles ML/Day**	**Dust Suppression on Roads ML/Day**	**LDP006**	
				Water Requirement	**1.691**	**0.068**	**0.136**	**Allowed Discharge**	**10 ML/Day**
				Water Supply				Actual Discharge	ML/Day
Daily Average	0.285	0.271	0.468	Daily Average	1.236	0.027	0.054	Daily Average	0.239
Daily Maximum	0.864	1.300	5.000	Daily Maximum	1.691	0.068	0.136	Daily Maximum	65.826
Daily Minimum	0.000	0.000	0.240	Daily Minimum	0.481	0.000	0.000	Daily Minimum	0.000
5 Percentile	0.000	0.000	0.245	5 Percentile	0.494	0.000	0.000	5 Percentile	0.000
10 Percentile	0.000	0.000	0.252	10 Percentile	0.521	0.000	0.000	10 Percentile	0.001
50 Percentile	0.099	0.108	0.400	50 Percentile	1.691	0.000	0.000	50 Percentile	0.003
70 Percentile	0.391	0.245	0.403	70 Percentile	1.691	0.068	0.136	70 Percentile	0.009
90 Percentile	0.864	1.072	0.725	90 Percentile	1.691	0.068	0.136	90 Percentile	0.435

Scenario 3: Summary of Annual Water Balance for worked water on mine site

Worked water on mine site									
Annual Average (ML/year)									ML/Day
		Inputs				**Outputs**			**Storage**
Pond / dam	Description	Upstream Spill	Clean runoff	Worked runoff	Rainfall onto pond	Evaporation	Piped from Cooks Dam	Spill	Daily Average
S-LG1	Spills into S-LG3	0.00	0.90	22.63	0.19	0.28		23.43	7.14
S-LG3	Spills into NEW DAM	23.43	0.90	22.63	0.13	0.19		46.87	4.03
NEW DAM	Spills into S-LG6+S-LG8	46.87	1.79	45.26	0.45	0.68		93.67	25.91
S-LG6 + S-LG8	Spills into RETENTION DAM	93.67	3.59	21.83	0.26	0.40		118.93	3.87
S-LG7	Spills into RETENTION DAM	0.00	34.91	95.31	0.12	0.17		26.28	1.09
PIPELINE	From S-LG7 to COOKS DAM	0.00	0.00	0.00	0.00	0.00	103.90	0.00	0.00
	Total	**163.96**	**42.09**	**207.66**	**1.14**	**1.73**	**103.90**	**309.17**	**42.04**
		Total Inputs	**414.84**			**Total Outputs**	**414.79**		

Scenario 3: Summary of Annual Water Balance for Water supply storage facilities

Water supply storage facilities											
Annual Average (ML/Year)											ML/Day
		Inputs					**Outputs**				**Storage**
Pond / dam	Description	Upstream Spills or Transfers	Clean runoff	Disturbed runoff	Rainfall onto pond	Groundwater Seepage and leaks from upstream dams	Water to supply tanks	Evaporation	Spill	Leakage	Daily Average
DML DAM	Spills into COOKS DAM	0.00	33.52	65.02	0.33	87.60	0.00	0.45	16.00	170.73	7.49
COOKS DAM	Spills into LDP006	16.00	8.22	0.00	0.15	258.33	480.90	0.22	4.84	0.02	12.69
PIPELINE	Transfer from S-LG7	103.90									
PIPELINE	Transfer from Retention	98.78									
	Total	**218.68**	**41.74**	**65.02**	**0.48**	**345.93**	**480.90**	**0.67**	**20.84**	**170.75**	**20.19**
		Total Inputs	**671.85**			**Total Outputs**	**673.17**				

Scenario 3: Summary of Annual Water Balance for Water Supply and On Site water use

Water Supply and on Site Water Use											
Annual Average (ML/Year)											**ML/Day**
		Inputs				**Outputs**					**Storage**
Pond/ dam	Description	domestic water pipeline	Rainfall onto pond	Water Supply from Cooks Dam	Washery	Dust Spray	Dust Tankers	Evaporation	Domestic Water Use	Spill	Daily Average
WATER SUPPLY RESERVOIR	supply on site raw water	0.00	0.00	480.90	451.18	9.97	19.75	0.00	0.00	0.00	0.60
Municipal Water for Offices, workshops and showers	On site water use	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
	Total	0.02	0.00	480.90	451.18	9.97	19.75	0.00	0.02	0.00	0.60
		Total Inputs	480.92			Total Outputs	480.92				

Scenario 3: Summary of Annual Water Balance for Water from surrounding catchments and undisturbed site areas

Water from surrounding catchments and undisturbed site areas								
Annual Average (ML/Year)								**ML/Day**
		Inputs				**Outputs**		**Storage**
Pond/ dam	Description	Upstream Spill	Clean runoff	Disturbed runoff	Rainfall onto pond	Evaporation	Spill	Daily Average
S-LG2 + S-LG4	Spill into MAIN SEDIMENT DAM	0.00	199.05	26.86	1.38	2.11	225.16	44.02
MAIN SEDIMENT DAM	Spill into Wangcol Creek	225.16	59.21	13.21	0.66	1.01	297.21	14.86
	Total	225.16	258.26	40.07	2.03	3.12	522.37	58.88
		Total Inputs	525.53		Total Outputs	525.49		

Scenario 3: Summary of Annual Water Balance for Retention Dam and LDP006

Annual Average Discharge (ML/Year)									ML/Day
		Inputs				Outputs			Storage
Pond/ dam	Description	Upstream Spill	Clean runoff	Disturbed runoff	Rainfall onto pond	Piped from Cooks Dam	Evaporation	Spill	Daily Average
RETENTION DAM	Spill into LDP006	145.20	30.62	0.00	0.10		0.13	77.01	1.02
LDP006	Spill Coal Services Site and drains to Wangcol creek	81.85	5.54	0.00	0.00		0.00	87.39	0.00
Pipeline	Piped from Cooks Dam					98.78			
	Total	227.06	36.16	0.00	0.10	98.78	0.13	164.40	1.02
		Total Inputs	**263.31**		**Total Outputs**	**263.31**			

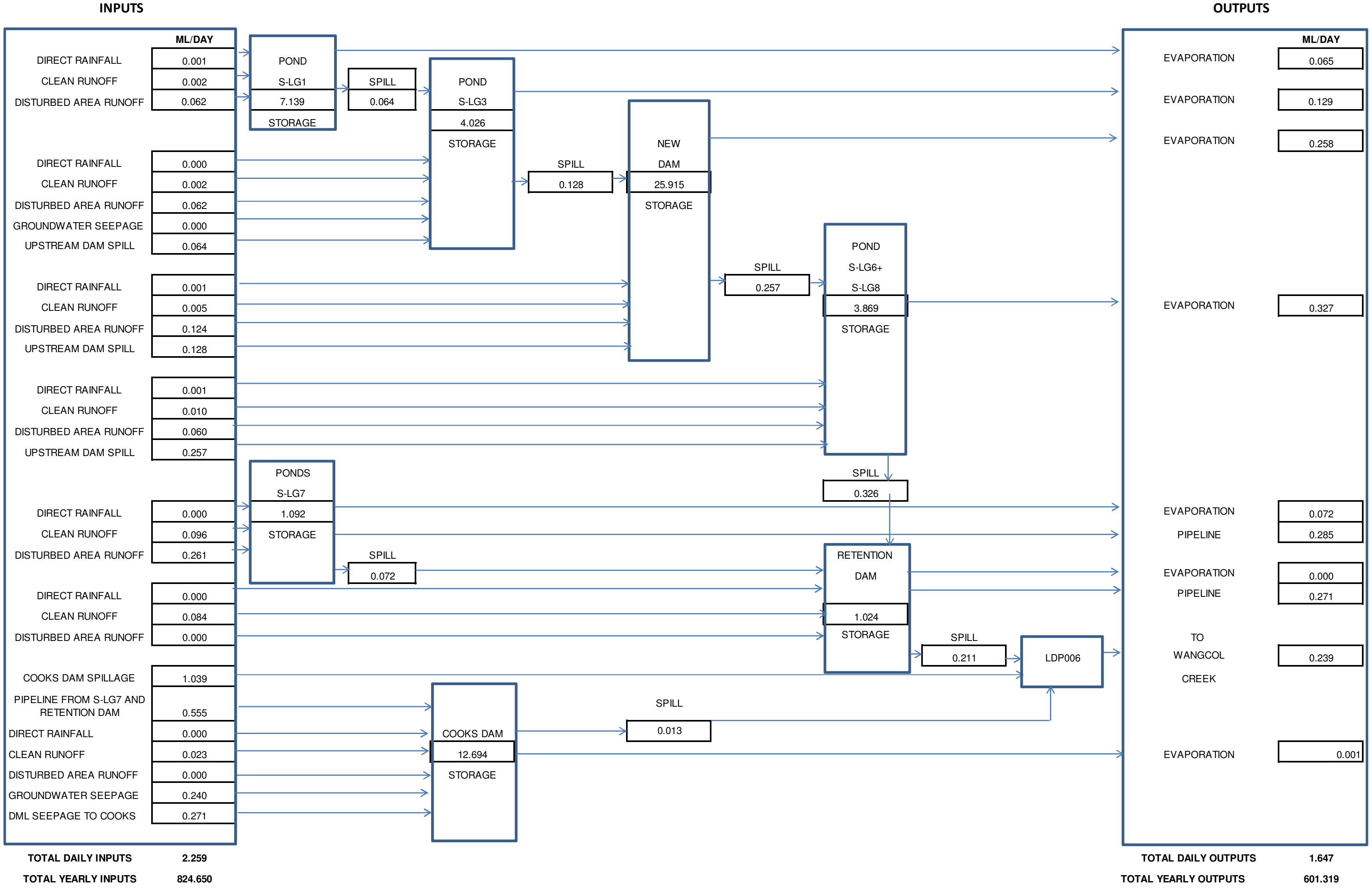
Scenario 3: Daily Result for Licensed discharge point 6 spillage into Wangcol Creek

	LDP006
	OUTPUTS
Discharge to Wangcol Creek	(ML/D) Scenario 1
Average	0.24
Dry (10th Percentile)	0.00
Wet (90th Percentile)	0.44

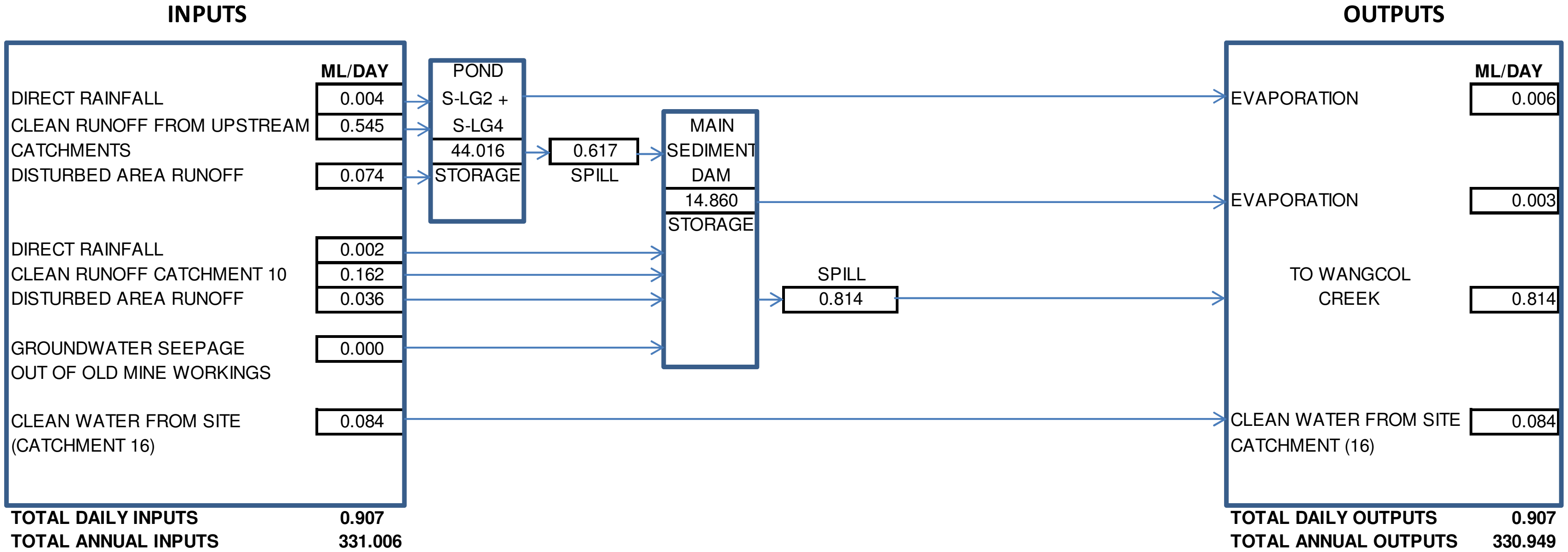
Scenario 3: Daily worked and undisturbed area runoff for ponds and dam in incremental catchment area

	Undisturbed Area Runoff (ML/day)			Worked Area Runoff (ML/day)		
Pond/ Dam	**Daily Average**	**10% Percentile**	**90% Percentile**	**Daily Average**	**10% Percentile**	**90% Percentile**
S-LG1	0.0025	0.0001	0.0049	0.0620	0.0010	0.1550
S-LG3	0.0025	0.0001	0.0049	0.0620	0.0010	0.1550
NEW DAM	0.0049	0.0002	0.0098	0.1240	0.0020	0.3100
S-LG6 + S-LG8	0.0098	0.0004	0.0197	0.0598	0.0010	0.1495
S-LG7+ S-LG9	0.0956	0.0040	0.1915	0.2611	0.0042	0.6528
DML DAM	0.0918	0.0038	0.1839	0.1782	0.0028	0.4454
COOKS DAM	0.0225	0.0009	0.0451	0.0000	0.0000	0.0000
S-LG2 + S-LG4	0.5453	0.0226	1.0918	0.0736	0.0012	0.1840
MAIN SEDIMENT DAM	0.1622	0.0067	0.3248	0.0362	0.0006	0.0905
RETENTION DAM	0.0839	0.0035	0.1679	0.0000	0.0000	0.0000
LDP006	0.0152	0.0006	0.0304	0.0000	0.0000	0.0000

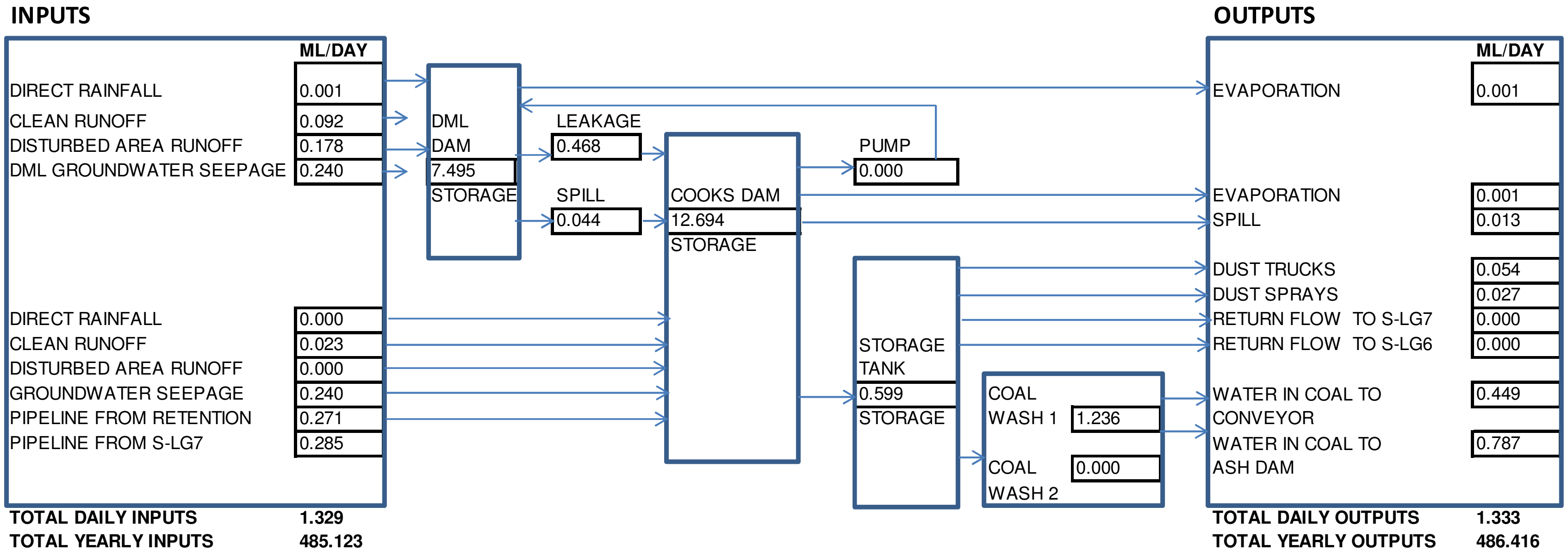
WATER BALANCE FOR WORKED WATER



WATER BALANCE FOR CLEAN WATER DISCHARGE via LDP006



WATER BALANCE FOR RAW WATER SUPPLY



Model Input Table for Various Scenarios

Daily water resources, use and return flows	**Scenario One**	**Scenario Two A**	**Scenario Two B**	**Scenario Two C**	**Scenario Three**
	(ML/day)	**(ML/day)**	**(ML/day)**	**(ML/day)**	**(ML/day)**
Cooks Dam storage for activating top up water transfers (portion FSL)	0.000	0.000	0.500	0.500	0.500
Return Flow Pump	0.000	0.000	0.000	0.000	0.000
Seepage (bore water)	0.000	0.000	0.000	0.000	0.000
Offices and Workshops	0.003	0.003	0.003	0.003	0.003
Truck Spray Dust Suppression on Roads	0.136	0.136	0.136	0.136	0.136
Washery	0.680	1.691	1.691	1.691	1.691
Percentage water used at Washery 1	100.000	40.000	40.000	40.000	40.000
Percentage water used at Washery 2	0.000	60.000	60.000	60.000	60.000
Re-use Washing Water	0.000	0.000	0.000	0.000	0.000
Dust Suppression on Stockpiles (dry windy day)	0.068	0.068	0.068	0.068	0.068
Dust Suppression on Stockpiles (wind < 5m/s)	0.000	0.000	0.000	0.000	0.000
Dust Suppression (wet rainy day)	0.000	0.000	0.000	0.000	0.000
groundwater seepage to DML Dam	0.240	0.240	0.240	0.240	0.240
groundwater seepage to Cooks Dam	0.240	0.240	0.240	0.240	0.240
leakage from DML to Cooks Dam	0.400	0.400	0.400	0.400	0.400
Pump from DML to Cooks	0.000	0.000	5.000	5.000	5.000
Percent water used at Washery returned to reject stock pile from Washery	36.364	36.364	36.364	36.364	36.364
Percent water used at Washery leaving site in coal on conveyor belt	63.636	63.636	63.636	63.636	63.636
Pipeline from S-LG7 to Cooks	0.000	0.864	0.864	0.864	0.864
Pipeline from Retention Dam to Cooks Dam	0.000	0.000	0.000	1.300	1.300

Scenario one

	Washery ML/Day	Dust Suppression on Stockpiles ML/Day	Dust Suppression on Roads ML/Day	LDP006	
Water Requirement	0.680	0.068	0.136	Allowed Discharge	10ML/Day
Water Supply				Actual Discharge	ML/Day
Daily Average	0.641	0.038	0.076	Daily Average	1.617
Daily Maximum	0.680	0.068	0.136	Daily Maximum	221.088
Daily Minimum	0.481	0.000	0.000	Daily Minimum	0.000
5 Percentile	0.487	0.000	0.000	5 Percentile	0.030
10 Percentile	0.500	0.000	0.000	10 Percentile	0.062
50 Percentile	0.680	0.068	0.136	50 Percentile	0.566
70 Percentile	0.680	0.068	0.136	70 Percentile	1.160
90 Percentile	0.680	0.068	0.136	90 Percentile	3.531

Scenario Two A

	Pipeline to Cooks Dam From S-LG7	Pipeline to Cooks Dam from DML Dam		Washery ML/Day	Dust Suppression on Stockpiles ML/Day	Dust Suppression on Roads ML/Day	LDP006	
			Water Requirement	1.691	0.068	0.136	Allowed Discharge	10ML/Day
			Water Supply				Actual Discharge	ML/Day
Daily Average	0.290	0.396	Daily Average	1.027	0.010	0.020	Daily Average	1.312
Daily Maximum	0.864	0.400	Daily Maximum	1.691	0.068	0.136	Daily Maximum	220.194
Daily Minimum	0.000	0.000	Daily Minimum	0.430	0.000	0.000	Daily Minimum	0.000
5 Percentile	0.006	0.400	5 Percentile	0.645	0.000	0.000	5 Percentile	0.024
10 Percentile	0.014	0.400	10 Percentile	0.654	0.000	0.000	10 Percentile	0.048
50 Percentile	0.161	0.400	50 Percentile	0.817	0.000	0.000	50 Percentile	0.398
70 Percentile	0.321	0.400	70 Percentile	1.210	0.000	0.000	70 Percentile	0.841
90 Percentile	0.864	0.400	90 Percentile	1.691	0.068	0.136	90 Percentile	2.701

Scenario Two B

	Pipeline to Cooks Dam From S-LG7	Pipeline to Cooks Dam from DML Dam		Washery ML/Day	Dust Suppression on Stockpiles ML/Day	Dust Suppression on Roads ML/Day	LDP006	
			Water Requirement	1.691	0.068	0.136	Allowed Discharge	10ML/Day
			Water Supply				Actual Discharge	ML/Day
Daily Average	0.290	0.501	Daily Average	1.020	0.015	0.030	Daily Average	1.307
Daily Maximum	0.864	5.000	Daily Maximum	1.691	0.068	0.136	Daily Maximum	220.194
Daily Minimum	0.000	0.240	Daily Minimum	0.481	0.000	0.000	Daily Minimum	0.000
5 Percentile	0.006	0.245	5 Percentile	0.492	0.000	0.000	5 Percentile	0.024
10 Percentile	0.014	0.251	10 Percentile	0.508	0.000	0.000	10 Percentile	0.048
50 Percentile	0.161	0.359	50 Percentile	0.789	0.000	0.000	50 Percentile	0.398
70 Percentile	0.321	0.439	70 Percentile	1.691	0.000	0.000	70 Percentile	0.841
90 Percentile	0.864	0.803	90 Percentile	1.691	0.068	0.136	90 Percentile	2.698

Scenario Two C

	Pipeline to Cooks Dam From S-LG7	Pipeline to Cooks Dam from Retention Dam	Pipeline to Cooks Dam from DML Dam		Washery ML/Day	Dust Suppression on Stockpiles ML/Day	Dust Suppression on Roads ML/Day	LDP006	
				Water Requirement	1.691	0.068	0.136	Allowed Discharge	10ML/Day
				Water Supply				Actual Discharge	ML/Day
Daily Average	0.290	0.790	0.480	Daily Average	1.691	0.052	0.104	Daily Average	1.314
Daily Maximum	0.864	1.300	5.000	Daily Maximum	1.691	0.068	0.136	Daily Maximum	220.194
Daily Minimum	0.000	0.000	0.240	Daily Minimum	1.691	0.000	0.000	Daily Minimum	0.000
5 Percentile	0.006	0.000	0.245	5 Percentile	1.691	0.000	0.000	5 Percentile	0.024

	Pipeline to Cooks Dam From S-LG7	Pipeline to Cooks Dam from Retention Dam	Pipeline to Cooks Dam from DML Dam		Washery ML/Day	Dust Suppression on Stockpiles ML/Day	Dust Suppression on Roads ML/Day	LDP006	
10 Percentile	0.014	0.000	0.251	10 Percentile	1.691	0.000	0.000	10 Percentile	0.048
50 Percentile	0.161	1.300	0.367	50 Percentile	1.691	0.068	0.136	50 Percentile	0.398
70 Percentile	0.321	1.300	0.400	70 Percentile	1.691	0.068	0.136	70 Percentile	0.841
90 Percentile	0.864	1.300	0.400	90 Percentile	1.691	0.068	0.136	90 Percentile	2.698

Scenario Three

	Pipeline to Cooks Dam From S-LG7	Pipeline to Cooks Dam from Retention Dam	Pipeline to Cooks Dam from DML Dam		Washery ML/Day	Dust Suppression on Stockpiles ML/Day	Dust Suppression on Roads ML/Day	LDP006	
				Water Requirement	**1.691**	**0.068**	**0.136**	**Allowed Discharge**	**10 ML/Day**
				Water Supply				Actual Discharge	ML/Day
Daily Average	0.285	0.271	0.468	Daily Average	1.236	0.027	0.054	Daily Average	0.239
Daily Maximum	0.864	1.300	5.000	Daily Maximum	1.691	0.068	0.136	Daily Maximum	65.826
Daily Minimum	0.000	0.000	0.240	Daily Minimum	0.481	0.000	0.000	Daily Minimum	0.000
5 Percentile	0.000	0.000	0.245	5 Percentile	0.494	0.000	0.000	5 Percentile	0.000
10 Percentile	0.000	0.000	0.252	10 Percentile	0.521	0.000	0.000	10 Percentile	0.001
50 Percentile	0.099	0.108	0.400	50 Percentile	1.691	0.000	0.000	50 Percentile	0.003
70 Percentile	0.391	0.245	0.403	70 Percentile	1.691	0.068	0.136	70 Percentile	0.009
90 Percentile	0.864	1.072	0.725	90 Percentile	1.691	0.068	0.136	90 Percentile	0.435